



Saugus Iron Works National Historic Site

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 Saugus Iron Works National Historic Site (hereafter, the Site) 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 Site, 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 Site today, climate suitability in summer under the high-emissions pathway is projected to improve for 19, remain stable for 16 (e.g., Figure 2), and worsen for 12 species. Suitable climate ceases to occur for 14 species in summer, potentially resulting in extirpation of those species from the Site. Climate is projected to become suitable in summer for 24 species not found at the Site today, potentially resulting in local colonization. Climate suitability in winter under the high-emissions pathway is projected to improve for 28, remain stable for 14, and worsen for 8 species. Suitable climate ceases to occur for 5 species in winter, potentially resulting in extirpation from the Site. Climate is projected to become suitable in winter for 32 species not found at the Site 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 Site based on both NPS Inventory & Monitoring Program data and eBird observation data (2016), plus those species for which climate at the Site 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.

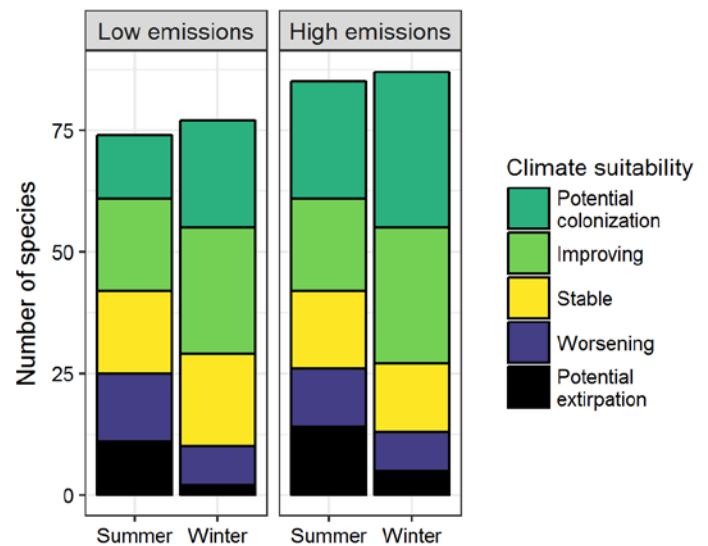


Figure 1. Projected changes in climate suitability for birds at the Site, by emissions pathway and season.

Results (continued)

Potential Turnover Index

Potential bird species turnover for the Site between the present and 2050 is 0.26 in summer (42nd percentile across all national parks) and 0.21 in winter (28th percentile) under the high-emissions pathway. Potential species turnover declines to 0.16 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 Site is or may become home to 12 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, Saugus Iron Works National Historic Site 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

Site may serve as an important refuge for 9 of these climate-sensitive species, 3 might be extirpated from the Site in at least one season by 2050.



Figure 2. Climate at the Site 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).

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 9 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 Site based on both NPS Inventory & Monitoring Program data and eBird observation data, plus those species for which climate at the Site 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
American Wigeon	-	Potential colonization
American Black Duck	x	Worsening*
Mallard	Potential extirpation [^]	Stable
Northern Shoveler	-	Potential colonization
Green-winged Teal	-	Potential colonization
Bufflehead	-	Improving
Hooded Merganser	-	Improving [^]
Common Merganser	-	Potential extirpation
Ruddy Duck	-	Potential colonization
Ruffed Grouse	-	Potential extirpation
Pied-billed Grebe	-	Potential colonization

Common Name	Summer Trend	Winter Trend
Double-crested Cormorant	x	Potential colonization
American White Pelican	-	Potential colonization
American Bittern	-	Potential colonization [^]
Great Blue Heron	Improving	Improving
Great Egret	Improving	-
Little Blue Heron	Potential colonization	-
Cattle Egret	Potential colonization	-
Green Heron	Improving	-
Black-crowned Night-Heron	x	Potential colonization
Yellow-crowned Night-Heron	Potential colonization	-
Black Vulture	Potential colonization	Potential colonization
Turkey Vulture	x	Improving*

Common Name	Summer Trend	Winter Trend
Mississippi Kite	Potential colonization	-
Northern Harrier	-	Improving
Sharp-shinned Hawk	x	Improving
Cooper's Hawk	x	Stable
Bald Eagle	-	Improving
Red-shouldered Hawk	Potential colonization	-
Red-tailed Hawk	Improving	Stable
Rough-legged Hawk	-	Stable
Killdeer	Improving	Potential colonization
Lesser Yellowlegs	Stable^	-
Dunlin	-	Potential colonization^
American Woodcock	-	Potential colonization
Bonaparte's Gull	-	Potential colonization
Laughing Gull	Potential colonization^	-
Ring-billed Gull	Potential extirpation^	Improving
Herring Gull	Stable	Stable^
Great Black-backed Gull	x	Stable
Forster's Tern	-	Potential colonization
Rock Pigeon	Worsening	Worsening
Mourning Dove	Stable	Improving
Yellow-billed Cuckoo	Improving*	-
Barn Owl	-	Potential colonization
Chuck-will's-widow	Potential colonization	-
Chimney Swift	Stable	-
Belted Kingfisher	Stable	Improving
Red-bellied Woodpecker	Improving	Improving
Downy Woodpecker	Stable	Improving
Hairy Woodpecker	Stable	Stable

Common Name	Summer Trend	Winter Trend
Northern Flicker	Stable	-
American Kestrel	x	Improving
Merlin	-	Improving^
Peregrine Falcon	-	Improving
Eastern Wood-Pewee	Improving	-
Eastern Phoebe	Improving	Potential colonization
Great Crested Flycatcher	Improving	-
Eastern Kingbird	Stable	-
Loggerhead Shrike	-	Potential colonization
White-eyed Vireo	Potential colonization	-
Bell's Vireo	Potential colonization	-
Warbling Vireo	Stable	-
Red-eyed Vireo	Potential extirpation	-
Blue Jay	Stable	Worsening
American Crow	Worsening	Stable
Fish Crow	Potential colonization	-
Horned Lark	Potential colonization	Stable
Purple Martin	Potential colonization	-
Tree Swallow	Potential extirpation	-
Barn Swallow	Stable	-
Cliff Swallow	Potential colonization	-
Carolina Chickadee	Potential colonization	Potential colonization
Black-capped Chickadee	Potential extirpation	Potential extirpation
Tufted Titmouse	Improving	Stable
Red-breasted Nuthatch	Potential extirpation	Potential extirpation
White-breasted Nuthatch	Worsening	Worsening

Common Name	Summer Trend	Winter Trend
Brown-headed Nuthatch	-	Potential colonization
Brown Creeper	-	Stable
House Wren	Potential extirpation	-
Sedge Wren	-	Potential colonization
Carolina Wren	-	Improving
Golden-crowned Kinglet	-	Improving
Ruby-crowned Kinglet	-	Potential colonization
Hermit Thrush	Potential extirpation	Improving
Wood Thrush	Worsening	-
American Robin	Worsening	Improving
Gray Catbird	Potential extirpation	-
Brown Thrasher	Improving	Potential colonization
Northern Mockingbird	Improving	Improving
European Starling	Stable	Stable
American Pipit	-	Potential colonization
Cedar Waxwing	Worsening	-
Smith's Longspur	-	Potential colonization
Snow Bunting	-	Potential extirpation
Ovenbird	Stable	-
Prothonotary Warbler	Potential colonization	-
Kentucky Warbler	Potential colonization	-
Northern Parula	Potential colonization	-
Yellow Warbler	Potential extirpation	-
Palm Warbler	-	Potential colonization [^]
Pine Warbler	Potential extirpation [^]	Potential colonization

Common Name	Summer Trend	Winter Trend
Yellow-rumped Warbler	-	Improving
Yellow-throated Warbler	Potential colonization	-
Yellow-breasted Chat	Potential colonization	-
Eastern Towhee	Improving	-
American Tree Sparrow	-	Worsening*
Chipping Sparrow	Worsening	Potential colonization
Field Sparrow	Improving	-
Savannah Sparrow	Potential extirpation	Potential colonization
LeConte's Sparrow	-	Potential colonization
Seaside Sparrow	Potential colonization [^]	-
Fox Sparrow	-	Improving
Song Sparrow	Worsening	Improving
Lincoln's Sparrow	-	Potential colonization
White-throated Sparrow	-	Improving
Dark-eyed Junco	-	Improving
Summer Tanager	Potential colonization	-
Scarlet Tanager	Worsening	-
Northern Cardinal	Improving	Stable
Rose-breasted Grosbeak	Potential extirpation	-
Blue Grosbeak	Potential colonization	-
Indigo Bunting	Improving	-
Dickcissel	Potential colonization	-
Bobolink	Potential extirpation	-
Red-winged Blackbird	Stable	Improving
Eastern Meadowlark	Improving	-
Rusty Blackbird	-	Improving
Brewer's Blackbird	-	Potential colonization

Common Name	Summer Trend	Winter Trend
Common Grackle	Worsening	Improving
Brown-headed Cowbird	Stable	-
Orchard Oriole	Improving*	-
Baltimore Oriole	Worsening*	-

Common Name	Summer Trend	Winter Trend
House Finch	-	Worsening
American Goldfinch	Worsening	Stable
House Sparrow	x	Worsening