



## Craters of the Moon National Monument

### 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 Craters of the Moon National Monument (hereafter, the Monument) 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 Monument, 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 Monument today, climate suitability in summer under the high-emissions pathway is projected to improve for 16, remain stable for 41, and worsen for 15 species. Suitable climate ceases to occur for 17 species in summer, potentially resulting in extirpation of those species from the Monument (e.g., Figure 2). Climate is projected to become suitable in summer for 11 species not found at the Monument today, potentially resulting in local colonization. Climate suitability in winter under the high-emissions pathway is projected to improve for 22, remain stable for 4, and worsen for 6 species. Suitable climate does not cease to occur for any species in winter. Climate is projected to become suitable in winter for 32 species not found at the Monument 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 Monument based on both NPS Inventory & Monitoring Program data and eBird observation data (2016), plus those species for which climate at the Monument 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.

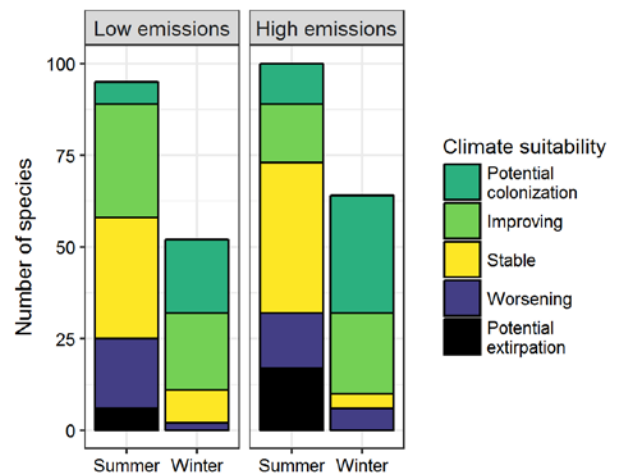


Figure 1. Projected changes in climate suitability for birds at the Monument, by emissions pathway and season.

## Results (continued)

### Potential Turnover Index

**Potential bird species turnover for the Monument between the present and 2050 is 0.22 in summer (36<sup>th</sup> percentile across all national parks) and 0.21 in winter (29<sup>th</sup> percentile) under the high-emissions pathway. Potential species turnover declines to 0.11 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 Monument 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). While the Monument may serve as an important refuge for

### Management Implications

Parks differ in potential colonization and extirpation rates, and therefore different climate change adaptation strategies may apply. **Under the high-emissions pathway, Craters of the Moon National Monument 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

17 of these climate-sensitive species, one, the Red Crossbill (*Loxia curvirostra*), might be extirpated from the Monument in summer by 2050.



**Figure 2. Although currently found at the Monument, suitable climate for the Red-winged Blackbird (*Agelaius phoeniceus*) may cease to occur here in summer by 2050, potentially resulting in local seasonal extirpation.** 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 17 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 Monument based on both NPS Inventory & Monitoring Program data and eBird observation data, plus those species for which climate at the Monument 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                       | Improving                           |
| Gadwall               | Worsening <sup>^</sup>  | -                                   |
| Mallard               | Worsening* <sup>^</sup> | Improving                           |
| Blue-winged Teal      | Potential extirpation   | -                                   |
| Cinnamon Teal         | x                       | Potential colonization              |
| Northern Shoveler     | -                       | Potential colonization              |
| Canvasback            | -                       | Potential colonization              |
| Redhead               | Worsening <sup>^</sup>  | -                                   |
| Ring-necked Duck      | -                       | Improving                           |
| Greater Scaup         | -                       | Potential colonization <sup>^</sup> |
| Hooded Merganser      | -                       | Potential colonization <sup>^</sup> |
| Ruddy Duck            | Potential extirpation   | Potential colonization              |
| Chukar                | Improving*              | -                                   |

| Common Name               | Summer Trend           | Winter Trend                        |
|---------------------------|------------------------|-------------------------------------|
| Wild Turkey               | -                      | Potential colonization              |
| Pied-billed Grebe         | x                      | Improving                           |
| Western Grebe             | -                      | Potential colonization              |
| Clark's Grebe             | -                      | Potential colonization              |
| American Bittern          | -                      | Potential colonization <sup>^</sup> |
| Great Blue Heron          | Stable                 | -                                   |
| Great Egret               | -                      | Potential colonization              |
| Black-crowned Night-Heron | -                      | Potential colonization              |
| Northern Harrier          | Stable <sup>^</sup>    | Improving                           |
| Cooper's Hawk             | -                      | Potential colonization              |
| Swainson's Hawk           | Worsening <sup>^</sup> | -                                   |
| Red-tailed Hawk           | Stable                 | Improving                           |
| Ferruginous Hawk          | Worsening <sup>^</sup> | -                                   |

| Common Name             | Summer Trend           | Winter Trend           |
|-------------------------|------------------------|------------------------|
| Rough-legged Hawk       | -                      | Worsening              |
| American Coot           | x                      | Improving              |
| Killdeer                | Stable                 | Improving              |
| Greater Yellowlegs      | -                      | Potential colonization |
| Long-billed Curlew      | Improving*^            | -                      |
| Wilson's Snipe          | Potential extirpation  | -                      |
| Wilson's Phalarope      | Worsening^             | -                      |
| Ring-billed Gull        | Worsening*^            | Potential colonization |
| Iceland Gull (Thayer's) | -                      | Potential colonization |
| Rock Pigeon             | Improving              | Stable                 |
| Eurasian Collared-Dove  | x                      | Improving              |
| Mourning Dove           | Improving              | Improving              |
| Lesser Nighthawk        | Potential colonization | -                      |
| Common Nighthawk        | Stable                 | -                      |
| Rufous Hummingbird      | Potential extirpation  | -                      |
| Red-naped Sapsucker     | -                      | Potential colonization |
| Hairy Woodpecker        | Stable                 | -                      |
| Northern Flicker        | Worsening              | Improving              |
| Gilded Flicker          | Potential colonization | -                      |
| American Kestrel        | x                      | Improving              |
| Olive-sided Flycatcher  | Potential extirpation  | -                      |
| Western Wood-Pewee      | Worsening*^            | -                      |
| Willow Flycatcher       | Stable                 | -                      |
| Gray Flycatcher         | Improving              | -                      |
| Dusky Flycatcher        | Stable                 | -                      |
| Cordilleran Flycatcher  | Stable                 | -                      |
| Say's Phoebe            | Improving              | Potential colonization |
| Ash-throated Flycatcher | Improving*             | -                      |

| Common Name  | Summer Trend           | Winter Trend           |
|--|------------------------|------------------------|
| Cassin's Kingbird                                    | Potential colonization | -                      |
| Western Kingbird                                     | Improving              | -                      |
| Eastern Kingbird                                     | Stable                 | -                      |
| Loggerhead Shrike                                    | Stable                 | Potential colonization |
| Warbling Vireo                                       | Stable                 | -                      |
| Pinyon Jay   | Improving*             | -                      |
| California/Woodhouse's Scrub-Jay (Western Scrub-Jay) | -                      | Potential colonization |
| Black-billed Magpie                                  | Stable^                | Worsening*             |
| Clark's Nutcracker                                   | Stable^                | Worsening*             |
| American Crow  | Stable                 | -                      |
| Common Raven   | Stable                 | Stable                 |
| Horned Lark  | Stable                 | Improving              |
| Northern Rough-winged Swallow                        | Stable                 | -                      |
| Tree Swallow   | Potential extirpation  | -                      |
| Violet-green Swallow                                 | Stable                 | -                      |
| Barn Swallow   | Improving*             | -                      |
| Cliff Swallow  | Stable                 | -                      |
| Black-capped Chickadee                               | Stable                 | Worsening*             |
| Mountain Chickadee                                   | Stable                 | Worsening*             |
| Juniper Titmouse                                     | Improving              | -                      |
| Bushtit  | -                      | Potential colonization |
| Red-breasted Nuthatch                                | Potential extirpation  | -                      |
| Pygmy Nuthatch                                       | Potential colonization | -                      |
| Rock Wren  | Stable                 | Potential colonization |
| House Wren   | Stable                 | -                      |
| Bewick's Wren  | Potential colonization | Potential colonization |
| Blue-gray Gnatcatcher                                | Improving*             | -                      |

| <b>Common Name</b>          | <b>Summer Trend</b>    | <b>Winter Trend</b>    |
|-----------------------------|------------------------|------------------------|
| Ruby-crowned Kinglet        | -                      | Potential colonization |
| Western Bluebird            | Potential colonization | -                      |
| Mountain Bluebird           | Stable                 | -                      |
| Swainson's Thrush           | Potential extirpation  | -                      |
| American Robin              | Potential extirpation  | Improving              |
| Sage Thrasher               | Worsening*             | -                      |
| European Starling           | Stable                 | Improving              |
| American Pipit              | -                      | Potential colonization |
| Cedar Waxwing               | Stable                 | -                      |
| Chestnut-collared Longspur  | -                      | Potential colonization |
| Common Yellowthroat         | Stable                 | -                      |
| Yellow Warbler              | Potential extirpation  | -                      |
| Yellow-rumped Warbler       | Potential extirpation  | Potential colonization |
| Grace's Warbler             | Potential colonization | -                      |
| Black-throated Gray Warbler | Improving              | -                      |
| Wilson's Warbler            | Potential extirpation  | -                      |
| Green-tailed Towhee         | Stable^                | -                      |
| Spotted Towhee              | Stable                 | -                      |
| Abert's Towhee              | -                      | Potential colonization |
| Rufous-winged Sparrow       | Potential colonization | -                      |
| Cassin's Sparrow            | Potential colonization | -                      |
| American Tree Sparrow       | -                      | Stable                 |
| Chipping Sparrow            | Stable                 | -                      |
| Brewer's Sparrow            | Worsening*             | -                      |

| <b>Common Name</b>                      | <b>Summer Trend</b>    | <b>Winter Trend</b>    |
|---|------------------------|------------------------|
| Vesper Sparrow                          | Worsening*             | -                      |
| Lark Sparrow                            | Improving*             | Improving              |
| Black-throated Sparrow                  | Improving              | -                      |
| Sagebrush/Bell's Sparrow (Sage Sparrow) | Stable^                | -                      |
| Savannah Sparrow                        | Potential extirpation  | -                      |
| Grasshopper Sparrow                     | Stable                 | -                      |
| Song Sparrow                            | Stable                 | Improving              |
| White-crowned Sparrow                   | -                      | Improving              |
| Dark-eyed Junco                         | x                      | Improving              |
| Western Tanager                         | Stable                 | -                      |
| Black-headed Grosbeak                   | Stable                 | -                      |
| Lazuli Bunting                          | Stable                 | -                      |
| Red-winged Blackbird                    | Potential extirpation  | Improving              |
| Western Meadowlark                      | Worsening              | -                      |
| Yellow-headed Blackbird                 | Stable                 | -                      |
| Brewer's Blackbird                      | Worsening*             | Improving              |
| Common Grackle                          | Stable                 | -                      |
| Great-tailed Grackle                    | Potential colonization | Potential colonization |
| Brown-headed Cowbird                    | Potential extirpation  | Potential colonization |
| Bullock's Oriole                        | Stable                 | -                      |
| House Finch                             | Improving*             | Potential colonization |
| Cassin's Finch                          | Worsening              | Stable                 |
| Red Crossbill                           | Potential extirpation^ | -                      |
| Pine Siskin                             | Potential extirpation  | Worsening*             |
| Lesser Goldfinch                        | Potential colonization | Potential colonization |
| American Goldfinch                      | Stable                 | -                      |
| House Sparrow                           | x                      | Improving              |