

A Review of Climate Change Effects on Terrestrial Rangeland Birds

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Introduction: We evaluated existing literature on predicted and known climate change effects on terrestrial rangeland birds. We asked the following questions: 1) How does climate change affect birds? 2) How will birds respond to climate change? 3) Are species already responding? 4) How will habitats be impacted?

Materials & Methods: We reviewed published literature ranging from climate change models to long-term studies of bird population trends, movement patterns, and nesting success. Population and nesting data from our own bird studies in the American Southwest were also re-analyzed to detect any changes in productivity of aridland riparian birds in response to changes in temperature and precipitation during a period of long-term drought.

Results & Discussion: Rangeland birds respond to climate change both directly and indirectly. Direct effects include dehydration and heat stress from increased temperature and reduced availability of water.

Indirect effects of climate change are multi-fold. Birds are migrating earlier in the spring. A study of 63 years of data for 96 species of bird migrants in Canada showed that 27 species have altered their arrival dates significantly, with most arriving earlier, in conjunction with warming spring temperatures. Birds also are delaying fall departure. In a study of 13 North American passerines, 6 species were found to delay departure dates in relation to warming. Some birds in Europe are even failing to migrate at all.

Earlier egg-laying has been reported. One large-scale study showed that birds are laying eggs at an average rate of 6.6 days earlier per decade. North American Tree Swallows (*Tachycineta bicolor*) are nesting up to 9 days earlier than 30 years ago, corresponding to an increase in average spring temperatures (Dunn and Winkler 1999). Temperature cues can lead not only to earlier lay dates but also to mismatch of laying dates with food availability and fewer surviving young (Both et al. 2006).

Bird populations are expected to shift poleward, or to higher elevations, to stay coupled to shifting environments as climate changes. Ontario Breeding Bird Atlas data show “southern” bird species are more numerous, having expanded their range north compared to 20 years ago. An Audubon study of 35 warbler species found that ranges of 7 species shifted north in the past 24 years whereas none shifted south. We found that breeding distributions of the endangered Southwestern Willow Flycatcher (*Empidonax traillii extimus*) contract closer to water sources in dryer years (Mann-Whitney U Test: 76054.5, $P = 0.028$). Elevational distributions of some bird species are also changing, as habitats shift upward.

Global warming can change entire ecological communities. Food and nesting materials may no longer be available upon arrival of migratory species. Birds may face new prey, parasites, competitors, and predators to which they are not adapted. Species residing in protected sites may shift into non-protected sites, exposing them to new threats.

Drought and long-term climate change can lead to reproductive failure. Bolger et al. (2005) reported reduced numbers of nestlings in southern California in drought years compared to normal years. We discovered that nesting success of Willow Flycatcher declined in dryer years ($X^2=14.1$, $P<0.001$). More nests of Black-Chinned Hummingbirds (*Archilochus alexandri*) failed as breeding season temperatures increased ($\Delta AIC = 0.0$, $W_i > 0.90$). Population crashes of some bird species are linked to increased intensity and frequency of El Niño storms associated with climate change.

Conclusions: Potential effects on bird habitats include loss and shifts in distributions of habitats, and changes related to responses by invasive species, changes in fire frequency. Other indirect effects include potential changes in the incidence of diseases and parasites, changes in budding, nesting and migration phenologies, changes in availability of food resources, disruption of food webs, and decoupling of environmental cues and bird population responses.

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