



Southern Colorado Plateau

INVENTORY & MONITORING NETWORK

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Title: Breeding birds of high-elevation mixed-conifer forests have declined in national parks of the southwestern U.S. while lower-elevation species have increased, with responses to drought varying by habitat

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Lazuli
Bunting/
Kaaren
Perry
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Parks Included in this Brief: [Bandelier National Monument](#), [Canyon de Chelly National Monument](#), [Grand Canyon National Park](#), [Mesa Verde National Park](#), [Petrified Forest National Park](#), [Wupatki National Monument](#)

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Habitat and molt strategy shape responses of breeding bird densities to climate variation across an elevational gradient in Southwestern national parks

[Climate change](#) is predicted to play a major role in driving changes to bird populations in the arid Southwestern United States, yet the specific climate variables influencing population density, as well as the differences in climate effects across the elevational habitat gradient, remain poorly studied. Long-term population monitoring provides a key tool for understanding the year-to-year variation in breeding bird populations, and to decipher how future climate may benefit or hurt species. In a recent study, [The Institute for Bird Populations](#) (IBP), in collaboration with NPS's [Southern Colorado Plateau Inventory and Monitoring Network](#) (SCPN), used one such dataset, collected over twelve years (2007-2018) in six parks across Colorado, New Mexico, and Arizona, to determine breeding-season population trends in relation to climate variables from the previous year (Figure 1).

[Jones et al \(2024\)](#) analyzed the densities of 50 bird species in Bandelier National Monument (NM), Canyon de Chelly NM, Grand Canyon National Park (NP), Mesa Verde NP, Petrified Forest NP, and Wupatki NM, in relation to spring and summer drought and the timing of North American monsoon rainfall, an important regional pulse of precipitation between July and September. To better understand how climate effects vary by habitat, they used bird population monitoring data from four habitats, including grassland-shrublands, pinyon-juniper woodlands, riparian woodlands, and mixed-conifer forest, that represent a ~1,500 m elevational gradient.

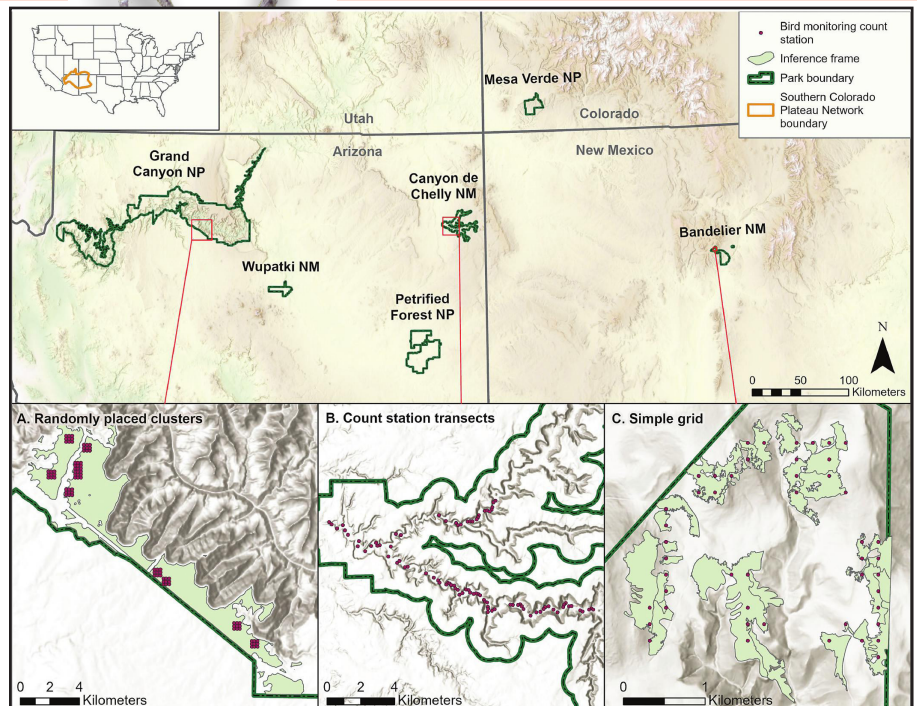


Figure 1. Locations and spatial sampling designs in six Southern Colorado Plateau Network national parks. Monitored parks are bounded in dark green and labeled. Filled polygons in panels (A) and (C) represent the sampling frame (i.e., area of inference for the habitat type selected for monitoring) in three parks and represent the variation in sampling designs across parks. See Methods for sampling frame in Canyon de Chelly NM. Points represent individual count stations, which were arrayed as randomly placed clusters (A), linear transects (B), or simple grids (C) in each park.

A key objective of the research was to understand how populations were faring within protected areas, and trends largely varied by elevational habitat category (Figure 2). After controlling for climate effects, specialist birds of [montane mixed-conifer forest](#), both residents and migrants, showed declines in breeding density from 2007 to 2018, which may reflect negative effects of wildfire and drought-related tree die-off on habitat suitability. By contrast, many species of lower-elevation [grassland-shrublands](#) and [pinyon-juniper woodlands](#) increased on the study plots. There were no clear trends for species of [riparian woodlands](#), though the sample size of species was small.

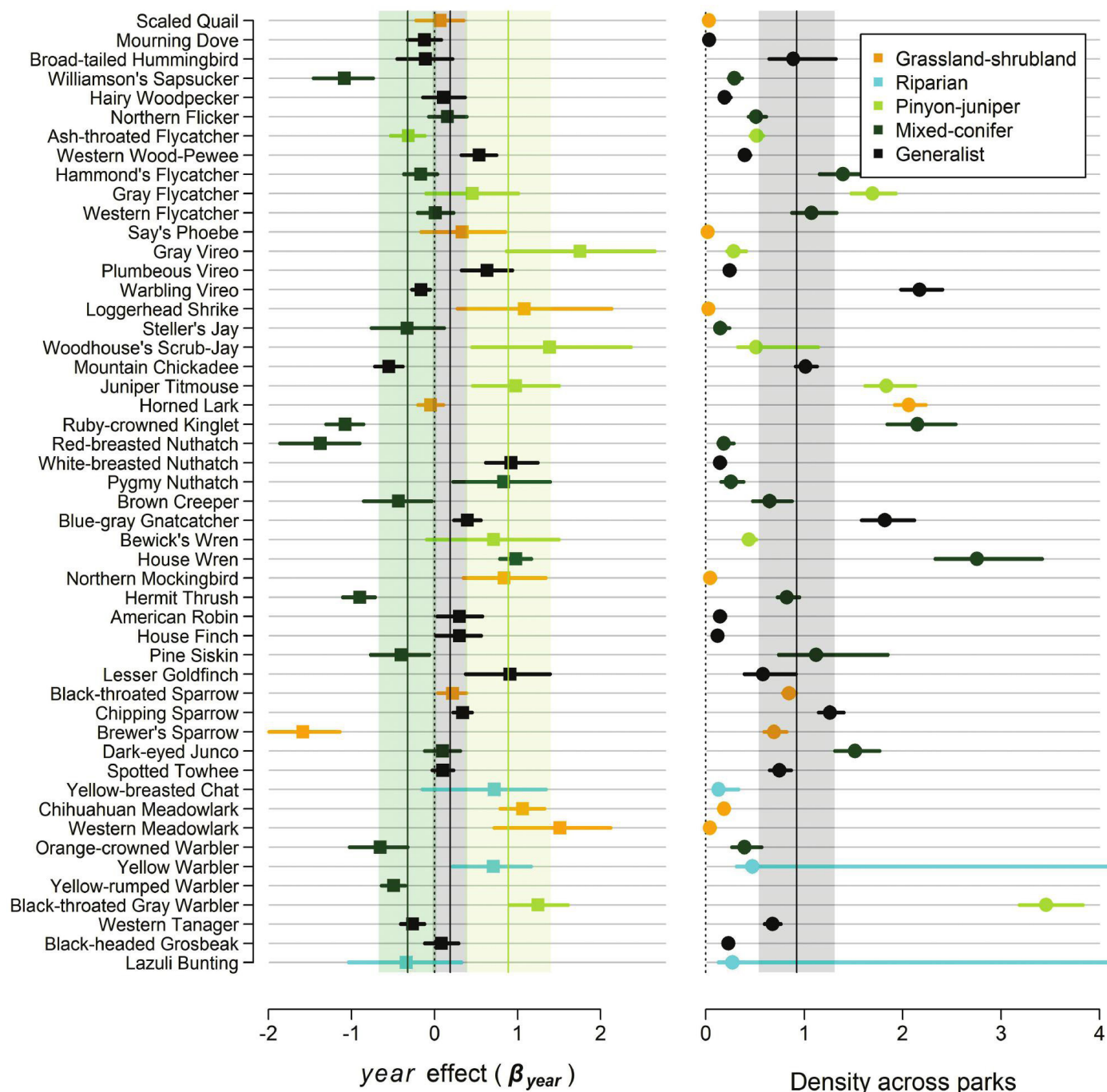
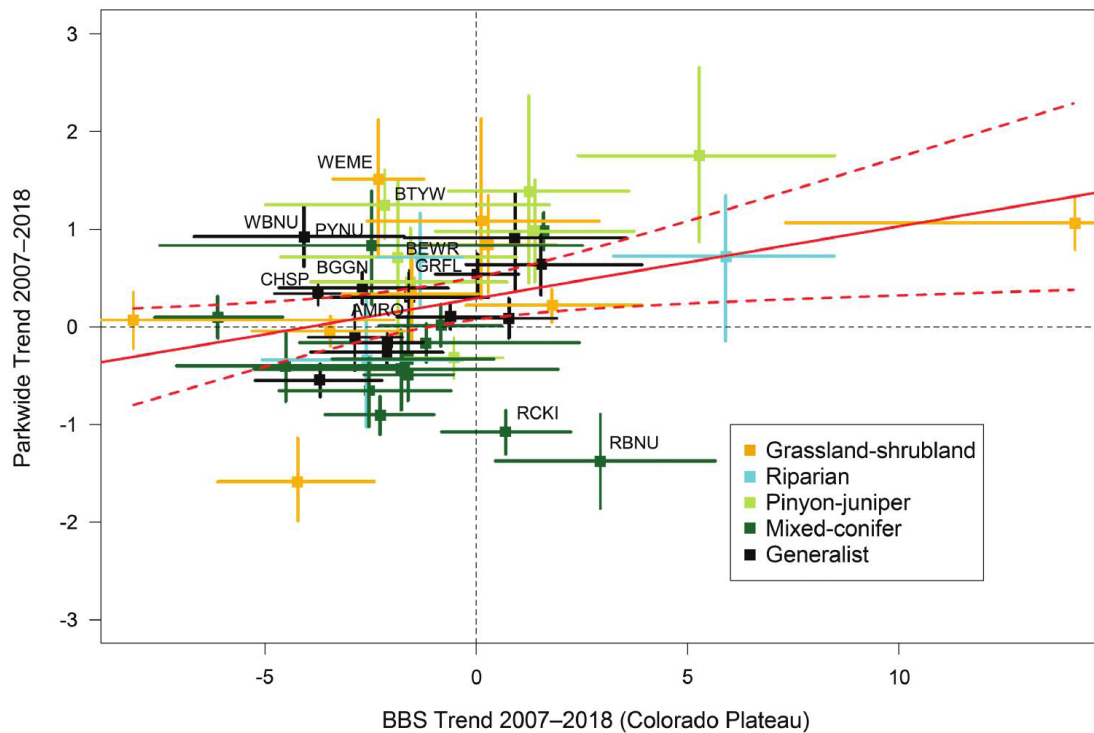


Figure 2. Across-park year effects (population trend estimates) and densities (birds ha⁻¹) for 50 Southwestern bird species. The year effect refers to the effect of increasing year over the timeseries on breeding densities after controlling for park and climate effects. The median value and 95% Bayesian credible interval are plotted for each species; species are listed in taxonomic order. Vertical lines and shading represent the mean and standard error for (1) all species (black line and gray shading), (2) pinyon-juniper species (light green line and shading), and (3) mixed-conifer species (dark green line and shading). The plotted habitat groupings showed large average effect sizes of year.

Overall, population trends across parks were significantly correlated with Colorado Plateau (i.e., Bird Conservation Region S16) Breeding Bird Survey trends over the same time period, suggesting similar population trends on protected and unprotected lands, likely because the key drivers were climatic. However, species favoring open woodlands and shrublands increased locally despite regional declines, while spruce-fir associated mixed-conifer species (found at higher elevations) declined in the parks despite regional increases (Figure 3).



Black-headed
Grosbeak/
Dave Menke
USFWS

Figure 3. Local (parkwide) bird population trends reflect regional (Colorado Plateau) trends. Plotted points represent median (for parkwide trends) and mean (for regional trends) trend estimates, while vertical and horizontal lines represent the 95% Bayesian Credible Intervals (BCIs). Regional trends correspond to trends for the Colorado Plateau/Southern Rockies Bird Conservation Region (S16) of the continent-wide Breeding Bird Survey (BBS), derived from Sauer et al. (2020). Trend line and confidence intervals are from a linear model of local trends as a function of regional trends. Labeled species indicate those declining locally but increasing regionally (lower right quadrant) and vice versa (upper left quadrant). Species codes are: AMRO = American Robin, BEWR = Bewick's Wren, BGGN = Blue-gray Gnatcatcher, BTYW = Black-throated Gray Warbler, CHSP = Chipping Sparrow, GRFL = Gray Flycatcher, PYNH = Pygmy Nuthatch, RCKI = Ruby-crowned Kinglet, RBNU = Red-breasted Nuthatch, WBNU = White-breasted Nuthatch, WEME = Western Meadowlark.



Riparian habitat at Canyon de Chelly
National Monument/Romaine Guy CC BY-
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Pinyon-juniper habitat at Mesa Verde
National Park/Jacob W Frank-NPS



Mixed-conifer habitat at North Rim of Grand
Canyon National Park/NPS



Grassland-shrubland habitat at Wupatki
National Monument/NPS

The study also sought to understand how breeding-season densities were affected by drought. Low precipitation paired with above-average temperatures are predicted to be an increasing climatic fixture in the Southwest, which is currently in the midst of a 20-year megadrought. The paper found that drought effects (quantified as the Climatic Moisture Deficit) varied considerably by habitat, with increasingly positive effects for birds breeding in habitats that occur at higher elevations (Figure 4A). Mixed-conifer forest species benefited from drought, likely due to earlier snowmelt and breeding phenology, while middle-elevation pinyon-juniper species were unaffected and grassland-shrubland species at the lowest elevations were negatively affected, perhaps due to reduced nest survival.

Another climate variable that may be important for bird populations in the region is the timing of the North American monsoon, which varies from year to year, largely in response to the El Niño Southern Oscillation. Many climate models suggest that monsoon rains will be increasingly delayed, with reduced rainfall in June and July and increased rainfall in September and October. Later rainfall was predicted to result in fewer resources for breeding birds and their young, with negative consequences for population density. Study results, however, showed that responses to monsoon timing largely varied by habitat, with birds breeding in open grassland-shrubland responding negatively to earlier monsoon rains, and species of higher elevation habitats responding positively. In addition to habitat, results indicated that molt strategy (when and where a bird replaces its feathers in the fall) also played a role in explaining sensitivity to monsoon timing. Species that perform a stopover molt in northwestern Mexico (“molt migrants”) responded positively to earlier monsoon rains, while species that molt predominantly on the Southwestern breeding grounds showed non-significant or negative effects (Figure 4B).



Broad-tailed Hummingbird/
Dylan Hanor-NPS

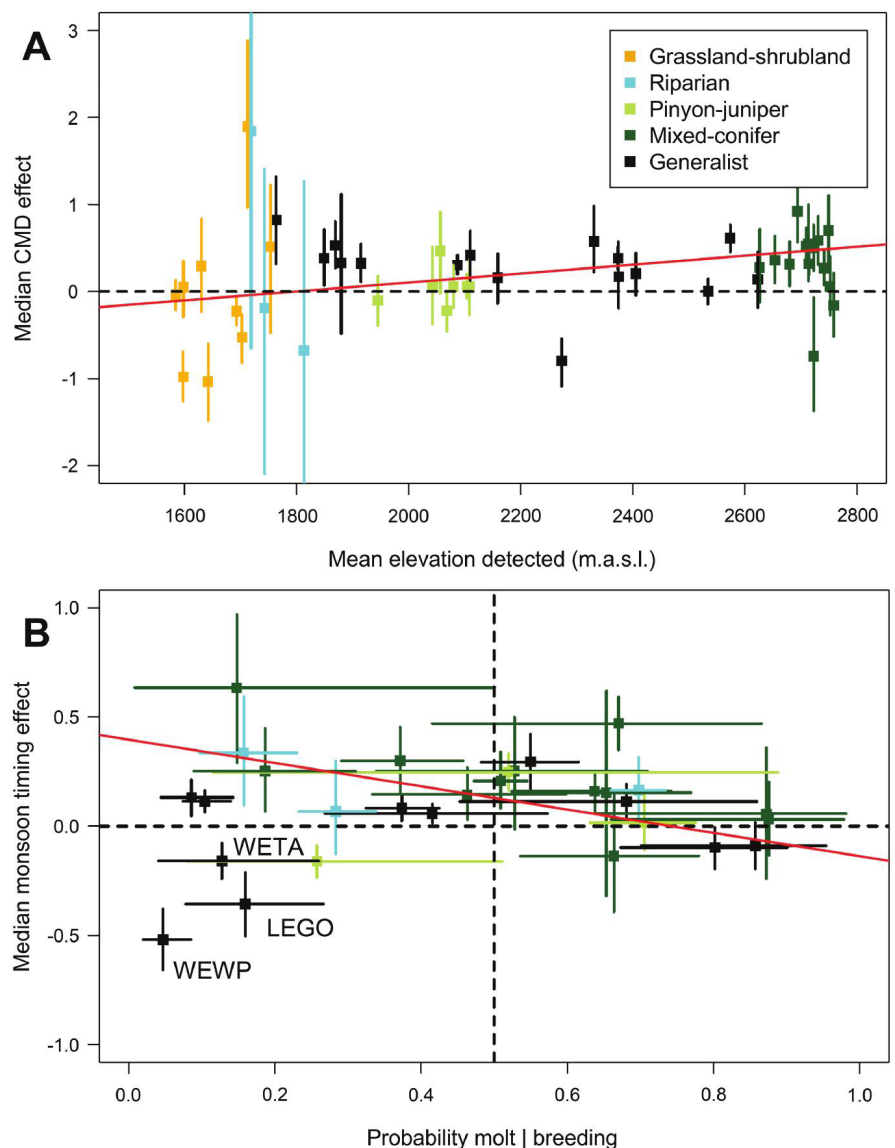


Figure 4. Breeding elevation and molt migration propensity influence the relationship between climatic variables and breeding densities. **(A)** Spring and summer drought (CMD) had an increasingly positive effect with average elevation of detection (a proxy for breeding elevation). High-elevation mixed-conifer forest birds responded positively to drought in the previous year, while pinyon-juniper species showed no response and grassland-shrubland species were negatively affected. **(B)** Earlier monsoon rains (higher monsoon timing values) are associated with increased densities of molt migrants in the following year, while species molting on the breeding or overwintering grounds tended to be unaffected or negatively affected. The measure of molt migration propensity (probability of molt | breeding) is from Pyle et al. (2018); only species included in that analysis ($n = 29$) are plotted. Notable exceptions to this trend are labeled. Trend lines are derived from phylogenetic linear models run using the phylolm package with a Brownian motion evolution model. Species codes are: LEGO = Lesser Goldfinch, WETA = Western Tanager, WEWP = Western Wood-pewee.

Many migratory species that have evolved the stopover molt strategy molt faster than those that molt on the breeding or nonbreeding grounds, and time their arrival in the monsoon region with peak green-up from the monsoon rains. Earlier monsoon rainfall on the molting grounds is therefore more likely to lead to a successfully timed molt and more birds returning to breed the following spring. By contrast, the delayed arrival of monsoon rains projected by some climate models could result in a “phenological mismatch” between the arrival of molt migrants in the monsoon region and the peak pulse of food resources needed to molt successfully. Molt migration and the conservation of habitat on the molting grounds are rarely discussed in conservation plans, but our results suggest this period of the yearly cycle may play an outsized role in population dynamics.



Grasslands greening up after monsoons at Petrified Forest National Park/Halie Larsen-NPS



Mixed-conifer habitat at Bandelier National Monument/NPS

A key finding of the work is that climate is already affecting the population dynamics of birds within Southwestern national parks, though responses to both drought and the timing of the monsoon are highly variable across habitats. Habitat-specific studies of climate effects on birds are likely to be most informative for managers, as neither drought nor rainfall timing showed universal effects on breeding densities. Alarming, the work also suggests that mixed-conifer forest species at the southern, “warm edge” limits of their breeding ranges are declining, and a better understanding of how drought and wildfire affect habitat suitability for these species is urgently needed. Predictive modelling of climate effects on wildlife populations is increasingly necessary to inform management, particularly as the Southwestern climate continues to diverge from its historical baseline.

Learn more about individual breeding bird population trends based on habitat, and discover important management implications of this work below:

[Grasslands-shrublands at Petrified Forest National Park and Wupatki National Monument](#)

[Mixed-conifer at Bandelier National Monumnet and Grand Canyon National Park \(North Rim\)](#)

[Pinyon-Juniper at Grand Canyon National Park \(South Rim\) and Mesa Verde National Park](#)

[Riparian at Canyon de Chelly National Monument](#)



Monsoon storm over Grand Canyon National Park/NPS