



Southern Colorado Plateau

INVENTORY & MONITORING NETWORK

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Title: Changes to vegetation structure and tree species composition drive bird species turnover following disturbance in southwestern United States mixed-conifer forest

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Vital Signs Monitoring Overview: Landbirds are a widespread and diverse group typically at or near the top of the food chain with relatively well understood ecology and population biology. They select habitat based on a combination of biotic and abiotic elements and serve as good indicators of ecosystem health and environmental change.

Key Findings

- Both bird and tree community composition shifted significantly at BAND following the high-severity Las Conchas Fire. Local bird densities increased for 18% of species and decreased for 32% of others after the fire, indicating community turnover occurred.
- Despite a large range of canopy cover (approx. 5-95%) included in the models, over 60% of species did not show supported associations with this variable. However, a subset of species was sensitive to loss of both canopy and subcanopy cover.
- One third of species showed negative associations with increasing sapling density, perhaps indicating a preference for mature trees.
- About 35% of the bird community, including early and late successional species, had lower breeding densities with increasing tree basal area, indicating a need for disturbance and potential negative effects of forest infill.
- Subsets of species were positively associated with increased local tree species richness, subalpine spruce and aspen tree compositions, and increasing ponderosa pine dominance, showcasing the importance of plant species composition for birds.

Summary: [Climate change](#) has the potential to rapidly alter the structure and tree species composition of Southwestern mixed-conifer (MC) forests, particularly at the southern edge of this ecosystem's occurrence. On the one hand, extended severe drought has led to elevated mortality of mesic-adapted spruce and subalpine fir tree species and large-diameter trees. On the other, historic fire suppression has led to the infilling of MC forest with white and Douglas firs, which, when combined with higher temperatures, has led to elevated instances of high-severity wildfire. These disturbances can lead to reduced canopy cover and loss of conifers, as well as the homogenization of post-fire tree species. MC forest provides habitat for over 50 species of breeding birds, many of which have experienced steep (~20%) population declines in the Southwest during the last decade. Degradation of habitat through wildfire and tree die-offs may be an important mechanism of population declines, though habitat associations of MC birds in the Southwest are poorly understood.

In this study, the [Southern Colorado Plateau Network](#) (SCPN), in collaboration with partners at [The Institute for Bird Populations](#), analyzed local habitat associations for 34 species of MC birds. The study included monitoring data of both breeding-season bird densities and twelve microhabitat variables collected at [Bandelier National Monument](#) (BAND) and [Grand Canyon National Park](#) (GRCA). The habitat-specific data included eight years of data that spanned an eleven-year period (2008-2018). Study sites encompassed a gradient of warm-dry MC forest dominated by white fir, Douglas fir, and ponderosa pine to cold-wet forests with Engelmann spruce, subalpine fir, and quaking aspen. Prescribed fire at GRCA during 2012 overlapped 26% of monitoring sites and monitoring sites at BAND burned during the high-severity [Las Conchas Fire](#) in 2011, providing a natural experiment of wildfire effects on birds.



American
Three-toed
Woodpecker
(J. Stringfield/
NPS)

Both bird and tree species compositions shifted significantly after the Las Conchas Fire at BAND, though smaller shifts in the bird community at GRCA also occurred following prescribed fires. Forests at BAND lost large numbers of fire-sensitive white and Douglas fir and post-fire communities included transitions to ponderosa pine, aspen, and Gambel oak dominated stands. A subset of species, especially Mountain Chickadee, Red-breasted Nuthatch, Ruby-crowned Kinglet, Brown Creeper, Western Flycatcher, Hermit Thrush, Red-naped and Williamson's Sapsuckers, and Orange-crowned and Yellow-rumped Warblers were most disturbance sensitive, with average population declines of ~75% and local extirpations of some species after the fire. Conversely, many fire-adapted specialists increased dramatically at BAND monitoring sites after the fire, including Clark's Nutcracker, Olive-sided Flycatcher, and American Three-toed Woodpecker.

The mechanisms explaining bird species turnover were tied to both structure and plant species composition. The loss of canopy cover (especially below a threshold of 75%), subcanopy foliage cover, foliage height diversity (the number of vertical foliage layers), and mature trees explained the loss of disturbance-sensitive species in the post-fire landscape. However, reduced local tree species richness, loss of subalpine tree species, and increasing ponderosa pine dominance were also important in explaining local densities. Overall, the loss of canopy cover and forest structural complexity, and the homogenization and impoverishment of the tree community are likely major drivers of changing habitat suitability for landbirds in disturbed MC forest.

However, some disturbance is important, even for birds of late-successional habitat in MC forest. Over a third of species, including both disturbance-avoidant and early-successional species, showed increased local densities with declining tree basal area, which may correspond to either higher stem densities of trees or larger diameter mature trees. MC forest birds may prefer more open forest canopies, and benefit from thinning where infill by Douglas and white fir have increased tree densities. Forms of disturbance such as prescribed fire are also likely beneficial for many species, including some that are extirpated after high-severity wildfire. Applying disturbance patchily on the landscape to create a mosaic of forest structures and successional stages is most likely to support the full diversity of MC bird species.

Management Implications

- A subset of mixed-conifer bird species is only present following high-severity wildfire, while other species were nearly extirpated by the same fire. A mosaic of disturbed and undisturbed habitat on the landscape is therefore essential to maintain habitat for the full mixed-conifer bird community.
- The loss of canopy cover below a threshold value of 75%, as well as declining subcanopy cover, mature tree density, and foliage height diversity are key drivers of the local extirpation of disturbance-sensitive species. Maintaining areas of higher canopy and subcanopy cover when thinning will allow more of these species to persist in treated landscapes.
- A third of species are averse to high tree basal area and likely benefit from light disturbance such as prescribed fire and thinning of infilled forests with dense white fir and Douglas fir understories.
- Tree species homogenization and loss of mesic-adapted spruces, subalpine fir, and aspen are mechanisms of local species loss following high-severity wildfire. Fostering a higher diversity of trees, especially subalpine species, in disturbed landscapes will help maintain a higher diversity of bird species.

Mixed-conifer habitat on slope at Angels Window on the North Rim of Grand Canyon National Park (Michael Quinn/NPS)

