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Research Brief for Resource Managers

Release:	Contact:	Phone:	Email:
August 2019	Scott Abella	702-774-1445	scott.abella@unlv.edu

Mojave and Sonoran Desert Fire Science Consortium, School of Life Sciences, University of Nevada, Las Vegas, 89154-4004

Long-Term Change in Mojave Desert Vegetation during 37 Years of Climatic and Land-Use Dynamics

Abella, S.R., R.J. Guida, C.L. Roberts, C.M. Norman, and J.S. Holland. 2019. Persistence and turnover in desert plant communities during a 37-year period of land use and climate change. Ecological Monographs. https://doi.org/10.1002/ecm.1390

Deserts are already at climatic extremes and as such, have been hypothesized to be biomes among the most sensitive to global change. However, there are contrasting views of change in desert plant communities. Some authors have viewed desert vegetation as relatively unchanging, while others have viewed desert vegetation as having rapid turnover in species composition similar to many temperate ecosystems. Managing and conserving desert landscapes could benefit from further information on long-term change in desert communities to resolve uncertainties such as whether a decline in species simply represents a transient cycle or a more permanent trend.

A recent study in press with Ecological Monographs collected and analyzed a long-term data set of fluctuations in perennial plant communities in the eastern Mojave Desert. Over 100 transects were established in 1979 in Lake Mead National Recreation Area and adjoining Bureau of Land Management holdings (Fig 1). The transects spanned a broad elevation gradient from 183 m near the Colorado River to 1,719 m at the summit of Spirit Mountain. The 1979 transects were re-measured in 2008 and 2016 to examine shifts in species distributions through time and along the elevation gradient.

Management Implications

- Comparing the 1970s to 2007-2016, precipitation in the study area declined 16% and average daily minimum temperature rose 1.2°C.
- During this time, distributions of 59% of plant species shifted up in elevation, while 41% of species moved downward, an unusually high percentage.
- Despite the drying, the current conditions of fewer freezes and lack of grazing by non-native animals have apparently favored increases in desert perennial plant cover and species diversity.

During the 37-year period, most measures of the native perennial plant community changed temporally. For example, species richness (number of species per 600-m^2 transect)

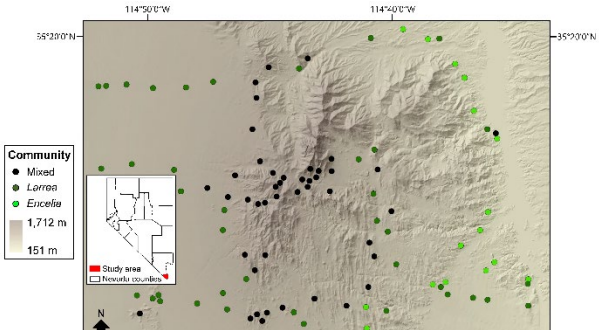

***Fig 1**. Location of the long-term study area in the Newberry Mountains of southern Nevada and distribution of transects measured in 1979, 2008, and 2016.*

increased 23% between 1979 and 2016. Concurrently, perennial plant cover doubled. There was no increase in non-native perennial plants. Although the most widespread non-native plants in the Mojave Desert are annuals, which were not measured in this study, lack of new invasions by perennials was notable given increasing reports of expanding non-native perennials elsewhere.

In assessing change along elevational gradients and species distributions, high-elevation communities did not display greater change than low-elevation communities. This finding was surprising given results elsewhere that change is occurring faster and disproportionately at the highest elevations. Environmental refugia, such as drainages with supplemental moisture or north-facing slopes, were unrelated to species shifts. The average upward shift in elevation among species was 6 m/decade. This is within the range reported for temperate biomes. However, the 41% of species moving downslope on this desert landscape was unusually high.

Approximately half of the species on a transect were stable, inhabiting a given transect each measurement year within the 37-year period. The other half of species widely fluctuated, colonizing or disappearing entirely from a transect. These desert communities may follow a core-transient species model where a site's species are either persistent (core species) or transient in approximately equal proportions.

The overall increases in perennial plant abundance and species richness occurred seemingly paradoxically during a 37-year period when average precipitation declined 16% (from 17 cm to 14 cm/year) and minimum temperatures warmed 1.2°C. It is possible that despite the drying, the less frequent occurrence of freezes – to which desert plants are susceptible – favored many perennial species. Additionally, grazing by domestic livestock and feral burros was phased out after the 1979 vegetation measurements by the 1990s.

The unique data set offered several insights for managing desert vegetation and for conservation strategies during global change generally. For example, assisted migration, a controversial strategy of moving species to favorable climates, may not be feasible regardless on this local landscape because high- and mid-elevation species already inhabited the highest elevations as well as moist refugia. As a result, moving low-elevation species upward would involve moving primarily creosote bush (*Larrea tridentata*) vegetation up in elevation. This widespread community already inhabits much greater area than the rare woodlands inhabiting the highest elevations of the study area. Instead, limiting other stressors seems like a viable strategy for facilitating adaptation to a changing climate on this landscape. Non-native plants, including annuals based on earlier research, have remained at low abundance and fire has not been prevalent compared to many areas of the Mojave Desert where shrublands have been damaged by unnatural fires. Although cause and effect cannot be established, cessation of grazing by non-native animals correlated with large increases in native perennial plants. Continuing to manage the landscape for native species while more fully exploring the potential conservation needs of high-elevation woodland species could contribute to continuing the legacy of conserving high-quality native desert communities on this mountain landscape.

Fig 2. Repeat photos of desert communities of the Newberry Mountains, southern Nevada, in 1979 (top) and 2008 (bottom). Photos by J. Holland and C. Roberts.