

Even Sonoran Desert plants aren't immune to climate change

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UC Riverside researchers sampling plants in part of the Sonoran Desert. Credit: UCR/Tesa Madsen-Hepp

In North America's hottest, driest desert, climate change is causing the decline of plants once thought nearly immortal and replacing them with

shorter shrubs that can take advantage of sporadic rainfall and warmer temperatures.

Many studies have documented how a hotter, drier world is causing a redistribution of plants in temperate mountain regions. A new UC Riverside study documents the unexpected ways plants in part of the Sonoran Desert are doing the same.

"The plants are shifting, but in weird ways," said Tesa Madsen-Hepp, first author of the study and UCR evolution and ecology doctoral candidate. "We thought most of them would move to higher elevations with cooler temperatures. But while some lower-elevation trees are declining and shifting upwards, we're also seeing some other species moving down, toward hotter parts of the desert."

Furthermore, the researchers believe the trends they observed are likely to continue despite the extreme precipitation events of the past few months. "It's really the warming temperatures causing the most stress for these species, and a year of rain won't mitigate the long-term drought trajectory," Madsen-Hepp said.

Published in the journal *Functional Ecology*, the research not only [documents](#) how some types of plants are shifting downward in elevation but examines those plants' physical characteristics to explain why the shift is happening.

To make their observations, the research team visited the Boyd Deep Canyon Desert Research Center, just south of Palm Desert, in 2019. The research area spans an 8,000-foot desert-to-mountaintop range across which they traveled from top to bottom sampling plants. This same area had been previously examined by ecologists in both 1977 and 2008, providing a basis for comparison with the more recent findings.

"Species we typically think of as pretty stress tolerant, like California juniper and pinyon pine, are declining, or shifting upwards. And even though they're shifting up, they don't appear to be thriving in their new locations," Madsen-Hepp said. "Moving into their former low-elevation spots are plant species with shallower root systems, like brittlebush, burrow bush, and ocotillo."



Sonoran Desert plants are shifting in response to more heat and more sporadic rainfall. Credit: Tesa Madsen-Hepp/UCR

In addition to root systems that don't rely as much on deep soil water, which is increasingly scarce, these shorter plants are also able to grow faster and invest fewer resources in their leaves.

"These are weedier species. They have "cheaper" leaves in terms of the carbon cost to produce them, and they are drought deciduous," said Marko Spasojevic, senior author and assistant professor in UCR's Department of Evolution, Ecology, and Organismal Biology.

"In other words, they can drop the leaves when conditions get too stressful and wait for the drought to be over."

Plants that keep their leaves year-round tend to invest in thicker leaves with higher carbon content. They are at a disadvantage compared to plants more easily able to shed. When plants drop leaves, the atmosphere can no longer pull water out of them, which eases demand on the roots to provide the lost water.

"The live-slow-die-old strategy that used to work for plants in this environment just isn't working as well anymore. The increased climate stress in an already extreme environment is pushing them to their physiological thresholds," Madsen-Hepp said. "Once these plants reach their limit, there is no fixing it. There's just not much we can do to bring them back," she said.

The team also found that in contrast to more temperate ecosystems, the lower desert elevations are warming faster than the [higher elevations](#). The shrubs and bushes taking over are not necessarily coming from the highest points in the [desert](#). They're also lower-elevation plants that have generally expanded their range.

At about 29 meters per decade, the upward range shifts are on par with the higher end of global rates for plant movement in response to climate warming. On average, plants in temperate regions have shown range shift rates between 5 and 30 meters a decade.

"We often think of the tundra as the bellwether for [climate change](#).

Arctic and alpine ecosystems are very sensitive. We're seeing here that this ecosystem is just as sensitive if not more so," Spasojevic said. "And we already know the answer to easing the stress on it. It's very simple. Cut fossil fuel emissions."

More information: Tesa R. Madsen-Hepp et al, Plant functional traits predict heterogeneous distributional shifts in response to climate change, *Functional Ecology* (2023). [DOI: 10.1111/1365-2435.14308](https://doi.org/10.1111/1365-2435.14308)

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