

Four of five pinyon-juniper tree species declining in their ranges in the West

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University of Nevada, Reno doctoral student Elise Pletcher measures a single-leaf pinyon sapling as part of ongoing research to track the trends on pinyon-juniper woodlands. Credit: Robert Shriver; University of Nevada, Reno.

Pinyon-juniper woodlands host unique wildlife and wildlife habitat, as well as areas for hiking and outdoor recreation. They are also part of a

web of healthy ecosystems that, together, help to balance water availability, storage and runoff; and prevent erosion. A new study published in *Global Ecology and Biogeography* and led by University of Nevada, Reno researcher Robert Shriver sheds new light on what is happening in pinyon-juniper woodlands across the West. The research is unique, in that it looks at both tree mortality, as well as recruitment, or new seedlings and saplings, to calculate a "net effect." And, the news isn't necessarily good, particularly in warmer, drier locations.

"We found that four of the five species were declining," said Shriver, an assistant professor in the University's College of Agriculture, Biotechnology & Natural Resources. "And, in the driest, warmest locations, up to about 50% of populations are declining. It's pretty severe in those locations, which are usually at [lower elevations](#) that tend to be hotter and get less water than woodlands at higher elevations."

Shriver said that when looking at all locations studied, which included over 6,000 plots and more than 59,000 tagged trees, up to 10-20% of populations were declining. Of the five species, including two pinyon pines and three junipers, *Pinus edulis*, more commonly referred to as two-needle pinyon or simply pinyon, showed the greatest declines, with about 24% of its populations in decline. The other pinyon species and two of the juniper species showed more moderate declines overall, but still quite severe declines in the hotter, drier areas. These species include *Pinus monophylla* (single-leaf pinyon), *Juniperus monosperma* (one-seed juniper) and *Juniperus scopulorum* (Rocky Mountain juniper). *Juniperus osteosperma* (Utah juniper) was the only species that did not show a decline.

"Utah juniper was the exception to everything," Shriver, who conducts research as part of the College's Department of Natural Resources & Environmental Science and Experiment Station, said. "What we found pretty much matches up with what we know about that species'

resiliency. It's the most abundant in the Great Basin, and is typically less vulnerable to hotter, drier climate conditions, so it could mean that there might be compositional shifts occurring in the future, where some areas that are mixed species might become more juniper-dominated."

Gathering the data and building the models

In part, Shriver used data from the Forest Inventory and Analysis, a nationwide survey of forested lands in the U.S., conducted by the U.S. Forest Service.

"They tag the trees and return to the same plots for comparison at least every 10 years, but they have a systematic scheme to determine where," he explained. "They are making sure they are getting a broad sample of both federal and private land. The result is a representative sample of what all forests look like across the U.S., even covering some very remote locations. It's staggered, with 10% of plots surveyed in a given year."

Shriver said the plots that were included in this pinyon-juniper research were first sampled between 2000 and 2007, and were surveyed the second time between 2010 and 2017. It is data obtained within those 10-year spans that he used for the research. He pointed out, however, that the Forest Service survey doesn't capture as complete data on recruitment, or seedlings, since they don't tag anything under 1 inch in diameter. Trees of this size are counted, but not tagged.

"Recruitment is the really hard part," he said. "Tree mortality is easy to see, but recruitment is harder to observe, so it's been harder to account for. Having a stable population is dependent on both mortality and recruitment. So, we developed a new statistical approach that allowed us to understand and factor in recruitment. Using these modeling approaches, we were able to quantify what the recruitment rate is in

these different areas, and then combine that data with the mortality data to get a more clear, accurate picture of what is really going on in terms of change in species' populations under different climate conditions and woodland densities in different regions."

The research excluded plots where fire mortality or intentional tree harvesting occurred, allowing the researchers to more directly observe changes occurring due to climatic conditions across each species' range.

Impacts of the findings

Shriver says the declines in populations they calculated could be significant for a number of reasons.

"In regard to wildlife, probably the most significant effect is on the pinyon jay, which has been in decline for the last couple of decades, and is really dependent on the seed that is produced by pinyon pine," he said. "The areas where the pinyon jay tends to choose are on that border of the sagebrush and the pinyon. It likes those habitats that are probably the most vulnerable. But, beyond the pinyon jay, certainly a number of species could be affected—mule deer, and other birds and wildlife."

In addition, Shriver said pinyons and pine nut harvesting are culturally important, to Native Americans and others, and pinyon-juniper woodlands provide recreational value for hikers and outdoor enthusiasts. Importantly, he adds, there's the functions that pinyon-juniper woodlands play in our watersheds. Pinyon-juniper woodlands play an important role in water and soil retention in some locations.

What does the future hold?

"We are likely to see pretty big changes in where we find forests in the

Great Basin and the Southwest over the next few decades," Shriver said. "A lot of places where we saw forests, we may not see them, especially in lower elevations, because they tend to be the hottest and driest."

Shriver said there has been a lot of expansion in these woodlands since the mid-1800s, and that some declines may not be a bad thing everywhere. For example, in some areas the pinyon-juniper woodlands have encroached on shrubland ecosystems that provide important ecosystem services and unique wildlife habitat. And, the trees, especially when packed in too densely and without enough moisture, also increase the intensity of wildfires.

"Our results also suggest that for some locations, management actions could slow down or reverse the woodland declines," Shriver said. "As it gets warmer and drier, the density of trees a landscape is able to support lessens, so reductions in tree density might expand the envelope of where the trees can be, reducing the chance of large [tree mortality](#) events."

While woodland decline could create an opportunity for expansion of native shrublands such as sagebrush, Shriver cautioned that other, less beneficial vegetation could also take hold.

"Just because the pinyon and juniper die off, doesn't mean something desirable would establish in their place," he said. "You might get cheatgrass or other undesirable vegetation."

Shriver said the purpose of the research and models it created is to help anticipate the vulnerability of woodlands and forecast coming range shifts, so that we might be able to sway the outcomes to be more positive ones.

"If we know where this is likely to happen, we can do the best we can to influence what might happen next," he said. "We might be able to direct

these into ecosystems that might support native plants and animals in the Great Basin and the Southwest, and fit into our watersheds in a beneficial way."

More information: Robert K. Shriver et al, Dry forest decline is driven by both declining recruitment and increasing mortality in response to warm, dry conditions, *Global Ecology and Biogeography* (2022). [DOI: 10.1111/geb.13582](https://doi.org/10.1111/geb.13582)

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