USDA Forest Service
U.S. DEPARTMENT OF AGRICULTURE

Rocky Mountain Research Station

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JULY 2021

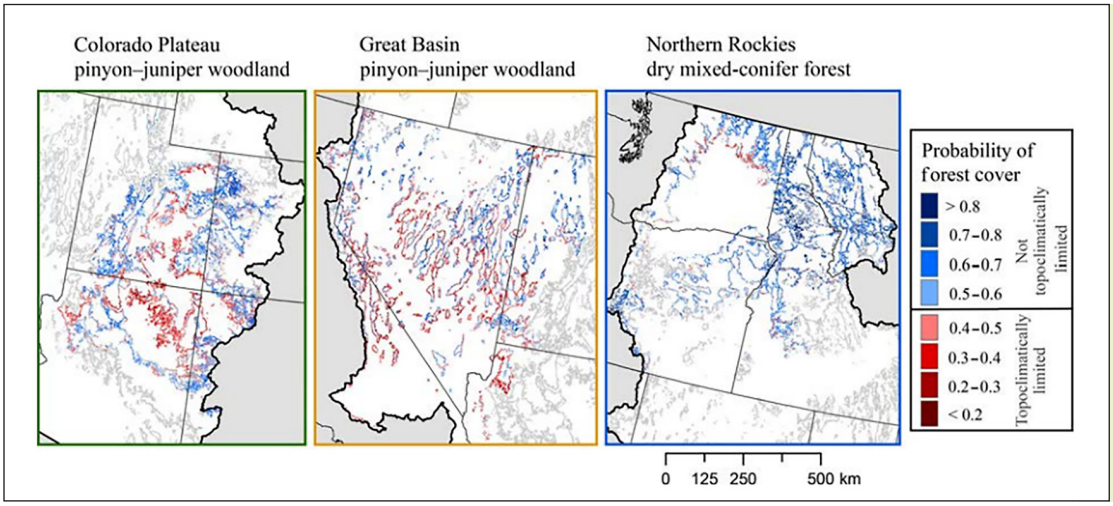
Climbing With Climate Change: Increasing Aridity Is Forcing Some Treelines to Retreat Uphill

Lower treelines in the Intermountain West are often defined by the boundary beyond which conditions are too dry for trees. Scientists are observing tree mortality in response to global climate changes and associated increased aridity in some places. Land managers are keenly interested in these changing ecological dynamics and how forests will shift in response to climate change.

Recent Rocky Mountain Research Station (RMRS) research shows that some lower treelines in the Intermountain West will be sensitive to the changing climate. RMRS Research Ecologist Ali Urza and colleagues used existing vegetation classifications to map lower treelines in a 650,000 mi^2 region in the U.S. Intermountain West. They used these maps to model the topographic and climatic drivers of lower treeline position for each major forest type and identify treelines limited by climate change. And, they learned: it depends!

The team also used spatial data of soil properties, recent fire, and land use to identify lower treelines that have already been pushed uphill by events other than climate, such as physical barriers, land use, and fire. Peter Weisberg from the University of Nevada, Reno and coauthor of this study says, "Treelines are zones of dynamic tension where the tree growth form reaches its ecophysiological limits—or as this paper shows, is often limited for other reasons. Understanding what controls the position of treeline is mission-critical for understanding shifts in future forest distribution."

The researchers found that the lower treeline of pinyon–juniper woodlands is largely limited by topography and climate and is likely to be sensitive to increasing temperatures and associated droughts, moving uphill as the conditions become drier. These results suggest that much of the lower treeline in the Intermountain West is currently climate limited and will be sensitive to ongoing climate changes. In



Maps of predicted topoclimatic limits to lower treeline in Colorado Plateau pinyon–juniper woodland, Great Basin pinyon–juniper woodland, and Northern Rockies dry mixed conifer forest. These maps are available in the recent publication: Evidence of Widespread Topoclimatic Limitation for Lower Treelines of the Intermountain West, United States.

contrast, dry mixed-conifer lower treelines in the northern portion of the study area rarely reached their modeled topoclimatic limit, suggesting that nonclimatic processes, including fire and land use, constrain the lower treeline above its limits in this forest type. Maps of these predicted limits to lower treeline are now available to managers at broad scales to identify portions of the landscape at risk of climate-driven woodland contraction and to prioritize vegetation treatments.

Urza says, "In the western U.S., a lot of management happens at the lower treeline, where we have recently seen both tree expansion into adjacent ecosystems and drought-induced dieback. Understanding the controls on the position of lower treeline can help managers anticipate forest shifts in response to climate change and plan vegetation treatments."

Scientists conducting plant community and tree demographic measurements in a pinyon–juniper lower treeline in the Toiyabe Mountains, Nevada. Courtesy photo by Peter Weisberg, University of Nevada, Reno.

KEY MANAGEMENT CONSIDERATIONS

- Three forest types account for 65.2 percent of lower treeline in the Intermountain West: Colorado Plateau pinyon–juniper woodlands, Great Basin pinyon–juniper woodlands, and Northern Rocky Mountain dry mixed–conifer forests.
- In pinyon–juniper woodlands of the Colorado Plateau and the Great Basin, 46 percent of the lower treeline was found to be topoclimatically-limited, suggesting that increasing temperature and associated droughts may result in widespread treeline shifts to higher elevations or more mesic locations.
- In dry mixed-conifer lower treelines in the northern portion of the study area, only 10 percent of lower treelines were found to be limited by climate, indicating that lower treelines in this region are largely constrained above their climate potential and will therefore be less responsive to climate change.
- Maps of predicted topoclimatic limits to lower treeline can be used by managers at broad scales to identify portions of the landscape at risk of climate-driven woodland contraction and to prioritize vegetation treatments.

FURTHER READING

Urza, Alexandra K.; Weisberg, Peter J.; Dilts, Thomas. 2020. Evidence of widespread topoclimatic limitation for lower treelines of the Intermountain West, United States. Ecological Applications. doi: 10.1002/eap.2158.

Bisbing, Sarah M.; Urza, Alexandra K.; Buma, Brian J.; Cooper, David J.; Matocq, Marjorie; Angert, Amy L. 2020. Can long-lived species keep pace with climate change? Evidence of local persistence potential in a widespread conifer. Diversity and Distributions. doi: 10.1111/ddi.13191.

Flake, S.W.; Weisberg, P.J. 2019. Fine-scale stand structure mediates drought-induced tree mortality in pinyon–juniper woodlands. Ecological Applications. 29(2), p.e01831.

PROJECT LEAD

Ali Urza is a research ecologist with the Maintaining Resilient Dryland Ecosystems Science Program of the Rocky Mountain Research Station. Her research has focused on the ecology of arid and semi-arid ecosystems of the western United States. Connect with her at: https://www.fs.usda.gov/rmrs/people/aurza.

The Rocky Mountain Research Station is one of seven units within USDA Forest Service Research & Development. RMRS maintains 14 field laboratories throughout a 12-state geography encompassing parts of the Great Basin, Southwest, Rocky Mountains, and the Great Plains. While anchored in the geography of the West, our research is global in scale. RMRS also administers and conducts research on 14 experimental forests, ranges and watersheds and maintains long-term research databases for these areas. Our science improves lives and landscapes. More information about Forest Service research in the Rocky Mountain Region can be found here: https://www.fs.usda.gov/rmrs/.