Oft-overlooked grasslands build biodiversity, resilience over centuries

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Grasslands' biodiversity and resilience to disturbances such as fire, heat and drought is the result of a slow process over hundreds of years, like that of old growth forests, finds new CU Boulder-led research.

Publishing in the journal *Science* on Aug. 5, 2022, as part of a special issue on grasslands, the study contradicts years of assumptions that grasslands' ecological development is quick and their recovery is rapid, posing new challenges to their successful restoration.

"Old growth grasslands have a unique suite of characteristics that develop over a really long time. Recovering grasslands do not have the same species or the same characteristics as they did prior to soil tilling or tree planting, and they take centuries to redevelop," said Katharine Suding, senior author of the paper and Distinguished Professor in the Department of Ecology and Evolutionary Biology and Institute of Arctic and Alpine Research (INSTAAR) at CU Boulder. "It's an important reminder that we need to conserve the ancient grasslands that are still intact."

An expert in the field of North American grasslands, Suding partnered with other experts from around the world to evaluate the current state of global grassland science, conservation and restoration—from arid, prairie and coastal grasslands, to those in the tropics and savannahs.

Grasslands, which account for nearly 40% of land-based ecosystems, provide habitat for a wide diversity of animals and plants, and contribute to the livelihoods of over 1 billion people worldwide. They also provide significant carbon sequestration and biodiversity benefits, and can be more resilient than forests in the face of a quickly changing climate.

Yet over the past couple of centuries, ancient grasslands around the world have largely been converted into farmland, used to grow trees or been developed as cities expand.

The researchers found that while the destruction of these pristine grasslands can occur very quickly, complete recovery of grassland biodiversity and essential ecosystem functions occurs slowly or not at all.

The findings further emphasize the importance of conserving the world's remaining untouched grasslands.

"If you plant trees in an older grassland or till it for agriculture, you will probably never get many of the unique diversity and belowground characteristics back. It is irreversible," said Suding.

Restoration takes time

Grasslands store the bulk of their material underground, in roots that can reach as far as 20 feet deep. This unseen physical presence is how they can store a lot of carbon—about a third of all carbon stored on land—and remain resilient to fire and other ecological disturbances. It's also why grasslands are often underappreciated in comparison to forests. If it's out of sight, it's out of mind.

Grassland restoration, however, can take a page out of forests' playbook.

"'Old growth' is not only a term for forests, but one that applies to grasslands as well," said co-author Elise Buisson, who co-authored that finding in a 2015 publication.

Old growth grasslands are unique in their underground structures and biodiversity compared to newer, younger grasslands. And while these old growth ecosystems may never be fully replicated in modern-day landscapes, they provide a model for restoration efforts, said Suding.

Even a decade ago, grassland restoration focused on distributing species' seed onto a landscape, adding grazing or fire, and stepping aside. The new analysis finds that it takes more than a hands-off approach to be successful. Instead of tossing all the ingredients into a crockpot and turning it on high, grasslands may need more of a step-by-step recipe approach to restoration.

"We should think of restoration as more of guiding a trajectory. Some species don't come in right at the start, and the disturbance that maintains the grassland needs time to grow and be tweaked as these species get established and the soil develops," said Suding. "These processes take time."

For example, some plants do well reproducing from seed in, say, the upper Midwest but not in Colorado due to the drier climate. Many tropical grasses don't spread by seed at all, instead by rhizomes and tubers underground, and are much more difficult to reestablish.

Implications for policy

The report comes a year after the start of the United Nations Decade on Ecosystem Restoration, which aims to restore degraded ecosystems around the world to increase biodiversity, help achieve the Sustainable Development Goals and the Paris Climate Agreement. At the same time, planting trees has become a popular "natural solution" around the world to remove large quantities of carbon from the atmosphere.

Yet while the UN initiative explicitly states, "Planting trees on natural grassland may destroy more than it creates," as countries make ambitious goals and commitments to ecosystem restoration this decade, Suding worries that for many, this only means planting trees.

"We would lose a huge element of the biodiversity on Earth if we planted trees in old growth grasslands," said Suding. "I think we need to be a little bit more careful about what's best for the globe, in terms of where to restore what."

As climate change threatens the American West through drought, heat and wildfire, grasslands are also a resilient choice to use less water, reduce soil erosion and keep carbon in the ground over time. It's the

older, veteran grasslands that are most beneficial in this regard.

"They're very resilient to a lot of these threats that we're increasingly experiencing. Grasslands are resilient and can deliver well in terms of our priorities of carbon storage, water infiltration and soil health," said Suding.

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More information: Elise Buisson et al, Ancient grasslands guide ambitious goals in grassland restoration, *Science* (2022). DOI: 10.1126/science.abo4605

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