Researchers study elevated CO2 and climate warming in mixed grasslands

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Jane Zelikova (left), a UW research scientist in the Department of Botany, works with David Augustine, a USDA collaborator, at the High Plains Grassland Research Station located northwest of Cheyenne. Credit: Julie Kray Photo

Twenty-five small plots in a mixed-grass prairie northwest of Cheyenne may very well provide the clues that Wyoming ranchers and land managers need to make grassland ecosystems more resistant to wide fluctuations in rainfall and temperatures that are forthcoming with future climate change.

Jane Zelikova, a research scientist in the University of Wyoming's Department of Botany, collaborated on an eight-year research project that revealed plots that had elevated carbon dioxide levels were most likely to be resistant to future climate change. The research took place at the High Plains Grassland Research Station on 2,873 acres of USDA property, situated five miles northwest of Cheyenne.

"The most resistant grassland was that under elevated CO2 (conditions)," Zelikova says. "These grasslands changed from being dominated by two very common species now (western wheatgrass, an intermediate grass, and blue grama, a short grass) toward other gramonoids and forbs that aren't as dominant now."

Zelikova was lead writer on a paper, titled "Long-Term Exposure to Elevated CO2 Enhances Plant Community Stability by Suppressing Dominant Plant Species in a Mixed-Grass Prairie," that was published in the Oct. 13 issue of the *Proceedings of the National Academy of Sciences* (*PNAS*). The journal is one of the world's most prestigious multidisciplinary scientific serials, with coverage spanning the biological, physical and social sciences.

David G. Williams, a UW professor and department head of botany, and Elise Pendall, a UW associate professor of botany, contributed to the paper.

"We didn't expect our simulated global change conditions would lead to more stable plant communities with year-to-year changes in precipitation," Williams says. "This will help us refine models used to predict how our grasslands will behave and function 100 years from now."

Out in the field

Climate drives the distribution of vegetation across the globe, and some vegetation types are more vulnerable to climate change, while others are more resistant. Evaluating responses in climate change is essential to predict ecosystem function under future climate scenarios.

In a mixed-grass prairie, Zelikova and other UW researchers used a multi-factor field experiment to show that the effects of CO_2 and warming on plant community structure and productivity depend on inter-annual variation of precipitation.

Research took place in mixed grassland, which is a combination of short grasses and intermediate statured grasses. During the experiments, five circular plots were warmed; five had elevated atmospheric levels of CO_2; five had both elevated CO_2 and warming; five were watered only; and five served as a control group, Zelikova says.

The plots that were warmed had an overhead ring that contained infrared lamps about 1.5 meters above each plot. Other plots contained ground-based black rings, which pumped CO_2 into designated areas. Each plot measured 3.4 meters in diameter.

The research revealed that the production and composition in grassland communities—exposed to elevated CO_2 levels only—showed the most resistance to fluctuation in temperatures and precipitation, Zelikova says. Because there are dry and wet years in Wyoming, the general productivity of mixed grasslands varies. When it is a dry year, there is less grassland growth. In a wet year, there is more.

"Elevated CO_2 stabilizes the fluctuations. The highs are less high and the lows are less low," Zelikova says. "This is good news for people trying to plan and manage grasslands."

"Elevated CO_2 caused the dominant grasses to decline in relative abundance and allowed the non-dominant plants to increase in abundance," Williams adds. "This created a more even distribution of plant species. This led to greater stability in elevated CO_2 grass plots."

The plots, left to the natural elements, showed the least resistance to climate change, Zelikova says.

"The control plots didn't have as much resistance to the changes that would be happening in wet and dry years," she says. "In addition, CO_2 can overcome some of the negative effects of warming."

Research also revealed that:

- Plots that were only irrigated proved somewhat stable in terms of grassland productivity, but there was no shift in the amount of dominant and sub-dominant plant species.
- Plots that were only warmed had little effect on production stability. However, subdominant plants—that are not currently very abundant—responded largely to warming.
- Plots that were warmed and received elevated levels of CO_2 had similar production stability to plots that received only elevated levels of CO_2. However, during dry years, elevated CO_2 levels were more important to mixed grassland growth than warming. During wet years, warming was more important than elevated levels of CO_2.
- During the eight years of research, there were three years classified as "wet," two dry years and three that were considered average.

"The key about a stability and resistance plan is to take the long view," Zelikova says. "Stability in composition and production (of mixed grasslands) across wet and dry years will be important in the future, when climate will be more variable."

Receiving recognition

This marks the first time Zelikova's research has been published in

PNAS.

"This is definitely a big deal. Hopefully, it will be a high-profile paper and people will read it," Zelikova says. "The goal is to raise the profile of the work that I and my collaborators are doing."

And to make the research relevant for real-world use.

For example, Zelikova says this will help ranchers plan their livestock grazing and help land managers manage resources management in wet years versus dry years.

"It isn't just interesting to us studying from an ecology viewpoint, but also for people who manage grasslands in general," she says.

More information: "Long-term exposure to elevated CO2 enhances plant community stability by suppressing dominant plant species in a mixed-grass prairie." *PNAS* 2014 ; published ahead of print October 13, 2014, [DOI: 10.1073/pnas.1414659111](https://doi.org/10.1073/pnas.1414659111)

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