METER
ENVIRONMENT

PREDICTING THE STABILITY OF RANGELAND PRODUCTIVITY TO CLIMATE CHANGE

Dr. Lauren Hallett, researcher at the University of California, Berkeley, recently conducted a study testing the importance of compensatory dynamics on forage stability in an experimental field setting where she manipulated rainfall availability and species interactions. She wanted to understand how climate variability affected patterns of species tradeoff in grasslands over time and how those tradeoffs affected the stability of things like forage production across changing rainfall conditions.

SPECIES TRADEOFF

A key mechanism that can lead to stability in forage production is compensatory dynamics, in which the responses of different species to climate fluctuations result in tradeoffs between functional groups over time. These tradeoffs could help mitigate the negative effects of climate variability on overall forage production. Dr. Hallett comments, "In California grasslands, there's a pattern that is part of rangeland dogma, that in dry years you have more forbs, and in wet years you have more grasses. I wondered if you could manage the system so that both forbs and grasses are present in the seed bank, able to respond to climate. This would perhaps buffer community properties, like soil cover for erosion control and forage production in terms of biomass, from the effects of climate variability."

MANIPULATING SPECIES COMPOSITION

Dr. Hallett capitalized on the pre-existing grazing manipulation that her lab had done over the previous four years. The grazing she replicated for this study was experimentally controlled, making it easier to ensure consistency. She built rainout shelters where she collected the water and applied it to dry versus wet plots. She also manipulated species composition, allowing only grasses, only forbs, or a mix of the two. These treatments allowed her to study changes in cover and biomass.

Hallett used METER soil moisture probes and METER data loggers to characterize the treatment effects of this experiment and to parameterize models that predict rangeland response to climate change. She says, “I wanted to verify that my rainfall treatments were getting a really strong soil moisture dynamic, and I found the shelters and the irrigation worked really well.” Along with above-ground vegetation, she collected soil cores and looked at nutrient differences in conjunction with soil moisture. Since her field site is located within the Sierra Foothills Research and Extension Center, Dr. Hallett was able to rely on precipitation data that was already measured on-site.

ZL6 data logger

RESULTS

Dr. Hallett found that in areas experiencing moderate grazing, there was a strong species tradeoff between grasses and forbs. She comments, “I had a seedbank that had both functional groups represented, and those tradeoffs did a lot to stabilize cover over time.”

When Dr. Hallett replicated the experiment in an area that had a history of low grazing, she found that the proportion of forbs wasn’t as high in the seedbank. As a consequence, there was a major loss of cover in the dry plots. She explains, “When the grass died, there weren’t many forbs to replace it, and you ended up with a lot of bare ground. The areas that were lightly grazed had more litter, so initially, the soil moisture was okay, but as the season progressed into a dry condition and the litter

decomposed, there wasn't enough new vegetation to stabilize the soil." As a result, Dr. Hallett thinks in low-grazed areas it's important to have an intermediate level of litter. She says, "You need enough litter to increase soil moisture, but not so much that it would suppress germination of the forbs because as the season progresses and gets really dry, if you don't have forbs in the system, you lose a lot of ground cover."

SURPRISES LEAD TO A NEW STUDY

Dr. Hallett was surprised that within her three treatments there seemed to be differences in when the functional groups were drying down the soil. This inspired new questions, leading her to use her dissertation data to generate a larger grant through the USDA. Her new study will perform extensive rainfall manipulations to measure the effects of early-season versus late-season dryout, and vary species within those parameters. She says, "One of the reasons you have grass years versus forb years is the timing of rainfall. For instance, if you have a really dry fall, you tend to have more forbs because their seedlings are more drought resistant. Conversely, if you have a wet fall, you tend to see more grasses because you have continual germination throughout the season. So, the timing of rainfall matters in terms of what species are in the system. We are going to look at the coupling between the species that gets selected for the fall versus what would be able to grow well in the spring, and we will be studying how that affects a whole range of things such as ground cover, above-ground production for forage, below-ground investment of different functional groups, and how these things might relate to nutrient cycling and carbon storage."

You can read more about Dr. Hallett's rangeland research and her current projects here.

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