A Closer Look at When Grasses Need a Drink

Soils, Precipitation, and Desert Grasses

The results of a recent study may help land managers to prioritize grassland conservation and restoration efforts. Park managers can't do much about climate. But with the right information, they can make choices based on how different grassland communities behave in different soil types.

The Setting

On the northern Colorado Plateau, native perennial grasses are a key component of many ecosystems. At higher elevations, cool-season grasses live throughout the summer. At lower elevations, grasslands contain both cool- and warm-season grasses. Here, cool-season grasses are more productive early in the growing season, when temperatures are lower. Later in the summer, they go dormant. Warm-season grasses at lower elevations use water more efficiently and thrive later on, in the hot summer sun.

This seasonality led park managers to wonder if predicted future climate trends might cause the balance of cool-season and warm-season grasses to shift in favor of one or the other.

Temperatures already exceed the historic range of variability in many southwestern parks, and at least one study of plants on the Colorado Plateau has shown an overall decline of cool-season perennial grasses.

At a Glance

On the northern Colorado Plateau, cool-season grasses that grow in the spring may be better protected from drought than previous studies have indicated.

In this study, cool-season grasses showed more resilience to drought and unusual wetness than warm-season grasses.

Warm-season grasses at steep, rocky sites that couldn't store much water in their soils were most affected by drought.

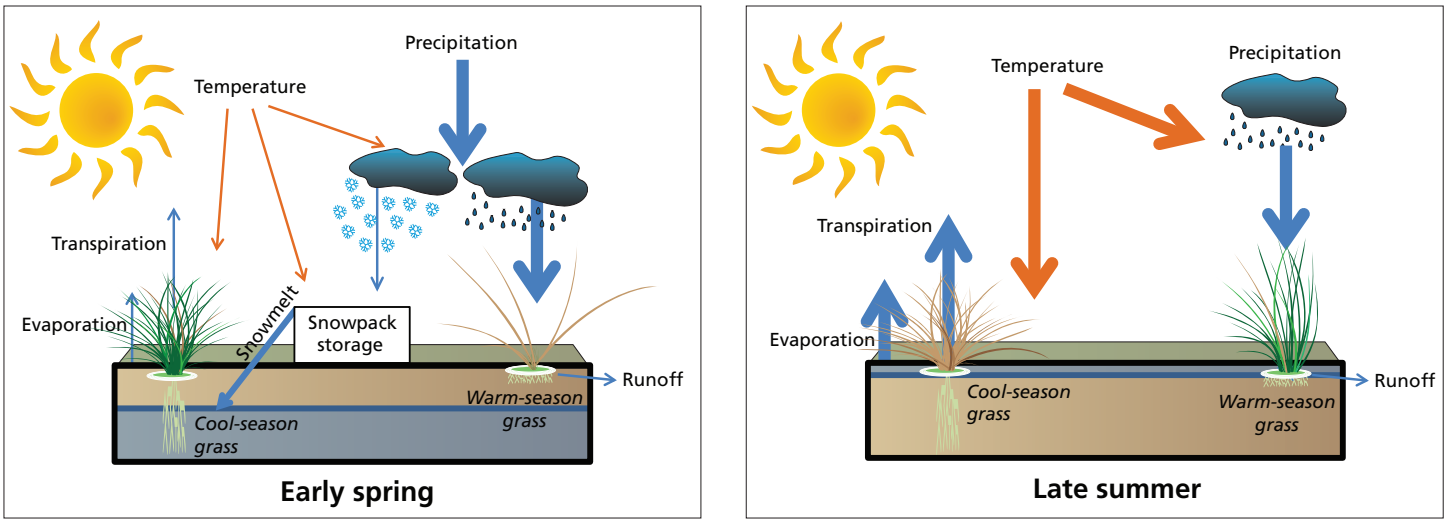
For warm-season grasses, getting a drink in August can be especially helpful.

Managers can use this information to prioritize conservation and restoration efforts.

What We Did

To explore a possible shift, our ecologists looked at changes in grass cover (the area covered by plants in a series of sample plots) over time at sites in five Northern Colorado Plateau Network parks. Cool-season grasses dominated sites at Curecanti National Recreation Area and Dinosaur National Monument. Arches, Canyonlands, and Capitol Reef national parks were co-dominated by cool-season and warm-season grasses.

We related the plant-cover data to climate factors, such as temperature, precipitation, and measures of water that are important to plants: soil moisture, drought, and evapotranspiration—the amount of water leaving the soil, either directly (evaporation) or through plants (transpiration). They also looked at the timing of climate patterns and plant growth. In semiarid regions, it is especially important that plants get water at the times when they need it, yet warm temperatures earlier in the spring mean that soils can dry up more quickly. Drought-resistant species can take longer than a month to respond to water shortage or surplus, so it was important to look at variable time periods.



When cool-season grasses start growing in early spring (left), the soil contains water stored from winter rains and snowmelt. Evaporation (water loss into the air) and transpiration (water loss through plant use) are low throughout the winter. Higher summer temperatures cause evaporation to increase, drying the soil. At the same time, plants use more water. In late summer (right), the stored water has been used up, and warm-season grasses thrive in the hot summer sun. Monsoon rains periodically wet the surface. Warm-season plants quickly soak up the water, before it evaporates.

What We Learned

The results were surprising. The study period (2009–2014) included times of both drought and unusual wetness. Cool-season grasses were expected to decline under drought, but didn't at most sites. In both wet and dry years, the cover of springtime cool-season grasses (like those at Arches, Canyonlands, and Capitol Reef) fluctuated less than the warm-season grasses that grew alongside them. They also fluctuated less than cool-season grasses that grew in slightly higher, cooler areas at Curecanti NRA and Dinosaur NM. This suggests that early spring cool-season grasses can be well-protected from drought.

Over the winter, the soil acts like a tank that fills up as precipitation falls and plants are not actively using it (see figure). During this study, there always seemed to be some moisture left in the tank when cool-season grasses started growing in the early spring. This was not necessarily the case later in the season, when other grasses started growing.

Looking at climate factors over different time periods affected the responses we saw. Cool-season grasses tended to be affected by multiple months of winter and spring climate more than that of any single month. In a soil type that was particularly good at storing water, warm-season grasses dramatically increased their cover after an unusually wet monsoon rain season. Single-month patterns were also important: precipitation in August was strongly correlated with warm-season grass growth. It seems that for warm-season grasses, getting a drink in August—after a couple of hot, dry summer months—can be especially helpful. The only significant decline seen under drought in this study was in warm-season grasses at a site whose rocky soils had low ability to store water.

What Can We Do With This Information?

This study found that warm-season grasses at steep, rocky sites that couldn't store much water in their soils were most affected by drought. In response, land managers might choose to:

- Protect sensitive areas of steep, rocky sites from grazing or trampling in drought years.
- Reduce stressors in sensitive areas by prioritizing treatments to remove exotic plants and/or prevent erosion and fire.
- Consider soil properties during restoration efforts. For example, focus restoration of warm-season grasses on sites that hold more water.
- Use a variety of species for restoration, including some that are more likely to succeed in a warmer climate.
- Use restoration strategies more likely to succeed in unpredictable cycles of wet and dry years.

Information in this brief was summarized from Witwicki, D. L., S. M. Munson, and D. P. Thoma. 2016. Effects of climate and water balance across grasslands of varying C3 and C4 grass cover. Ecosphere 7(11):e01577. 10.1002/ecs2.1577