



Traits, Tradeoffs, and Pivot Points

How Climate, Plant, and Soil Properties Affect Vegetation Growth on the Northern Colorado Plateau



Grassland, Capitol Reef National Park.

As the northern Colorado Plateau heads into a hotter, drier future, there will be ecological winners and losers.

Figuring out how different vegetation communities will fare is tricky. A recent study aimed to identify which vegetation communities might come out ahead, which might lag behind, and what might make the difference.

Like cars with different body types and horsepower, plant species have different adaptations and growth rates. For example, a sports car can out-perform a pickup on the highway, but a pickup truck can out-perform a sports car on a bumpy dirt road. Both travel easily on the highway, but each has traits best-suited to different environments, and those traits come with tradeoffs. Similarly, all plants do better when conditions are good for growth, but fast-growing species (“responders”) tend to crowd out slower-growing competitors. When growth conditions are poor, drought-resistant species (“resisters”) do better, while responders may perish. Over time, these adaptations to local climate sort plant species into vegetation communities able to persist under prevailing conditions.

But what if those prevailing conditions change? As gardeners and farmers know, certain traits make certain species

well-suited to their environments. Scientists from the Northern Colorado Plateau Network (NCPN) and U.S. Geological Survey used satellite imagery to broaden the view, analyzing how entire communities of native plants performed under varying conditions over time. They used data for wet and dry periods at 520 sites in seven national parks over a 15-year period.

The study revealed that traits and tradeoffs also occur at the landscape scale. Vegetation communities in wetter regions, such as pinyon-juniper and sagebrush steppe, proved more *responsive* to moisture, but more susceptible to drought. Communities in drier regions, such as blackbrush and desert grasslands (see above), were more *resistant* to drought but less able to grow quickly under favorable conditions.

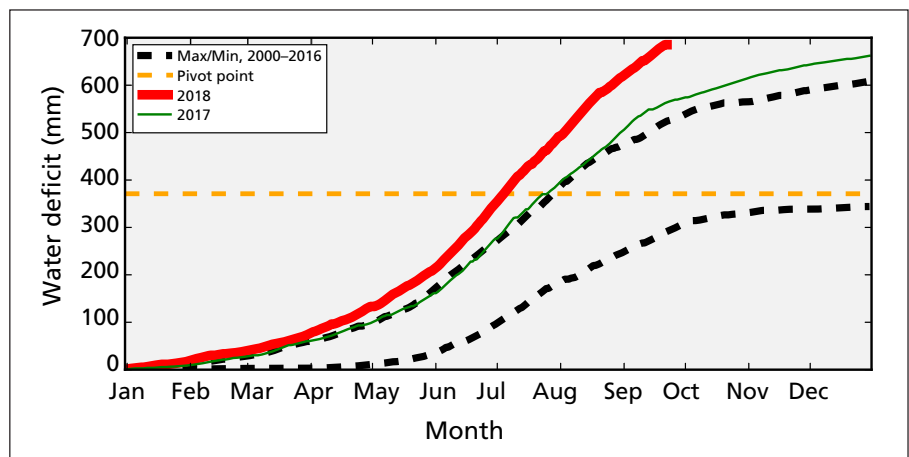
To help park managers know which communities might be most drought-resistant, the study’s authors identified “pivot points” for each community. The pivot point is the amount of water where vegetation production teeters between below and above average condition. The authors also determined growth rates for different plant communities in droughty (bumpy) or moist (smooth) years. Combined, this information suggests how different vegetation communities may fare in a warmer, drier climate.

Here's an example of how climate data can be used to estimate vegetation condition. In September 2018, Capitol Reef National Park was experiencing its worst drought since 2000. In the figure at right, the horizontal orange line is the drought-stress pivot point for the Hartnet area. The red line is the 2018 water deficit (an estimate of drought stress). When the red line rises above the orange line, then vegetation production is likely to be below average, favoring communities with greater resistance.

However, the September figures showed an “extremely bumpy dirt road” kind of year, in which *all* communities in this area were likely suffering. If the road plants are on is bad enough or long enough, it will become impassable, even for drought-adapted species that could otherwise coast through a less-severe dry spell. Ultimately, the plant community may change to a new group of species from drier environments—including weeds, which often arrive first.

Having a look “under the hood” revealed that soil properties can help “turbocharge” a location, making it more productive. In dry, sandy areas, a little clay helps hold water. In moister, clayey areas, a little sand helps water infiltrate to deeper depths where it can be stored for later use. These properties give a boost to some vegetation types in dry years.

In the southwestern U.S., climate, plant, and soil properties interact to affect water availability for vegetation growth. Now that scientists have untangled some of these interactions, managers have new insight to current conditions and what the future may hold—and can start planning for it. Anticipating how vegetation may change with climate is akin to knowing the road ahead, and figuring out which vehicle will be right for the conditions.



“Water deficit” is the the amount of water vegetation would use if water were available. When the pivot point for water deficit at a given location is exceeded, plant communities perform below average. This figure shows the amount by which the pivot point for water deficit has been exceeded in each of the past two years at Capitol Reef National Park.

Graphic by climateanalyzer.org

Why Does this Information Matter?

In combination with continued monitoring, the knowledge gained from this study can help park managers answer several key questions:

- How bad or good is the weather relative to other years since 2000?
- How sensitive are different vegetation communities to drought?
- Where and when might we first expect to see climate impacts to vegetation?
- Will the current vegetation community at this location be viable in the future?
- Are wildlife corridors located in climate-sensitive vegetation communities?
- Which places, and which mix of species, might be best for restoration and conservation efforts?

To learn more, see D. P. Thoma, S. M. Munson, and D. L. Witwicki, *Landscape pivot points and responses to water balance in national parks of the southwest US*. Journal of Applied Ecology, July 2018.

Blackbrush community, Canyonlands National Park.

