Responses of plant and butterfly communities in mesic meadows to long-term aridification in the western United States

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Session Topic: **Wildland Fire, Drought, and Climate Change Adaptation**

Background/Questions

As the climate warms and the hydrologic cycle changes, the western U.S. is becoming more arid, and the process and effects of aridification are intensifying. As distinct from drought, aridification refers to gradual, long-term drying of the climate. Aridification most commonly has been referenced in the context of terrestrial water balance, such as decreases in soil moisture and streamflow, and research on the effects of aridification has tended to emphasize physical rather than biological processes. Here we describe a new research initiative to quantify changes in the plant and butterfly communities in mesic montane meadows in the Greater Yellowstone Ecosystem (GYE) and Great Basin Desert (GBD) in response to 30 years of changes in water availability. Mesic meadows are of interest because they support high levels of biodiversity, but are highly vulnerable to climate-driven aridification. Our research team has historic data on plant and butterfly distributions and abundances across a suite of montane meadows in both regions. Although the regions are physically disjunct, the Rocky Mountains are the primary source of the flora and fauna in the GBD, and there is considerable overlap in species composition. The primary mesic ecosystems in the GYE are groundwater-fed meadows, whereas those in the Great Basin are woody riparian areas and meadows fed by both surface water and groundwater.

We will test the hypotheses that over the past three decades:

1) Interannual variability in the GYE and GBD as measured by total snow cover, snow water equivalent, snowmelt date, and total water year and winter precipitation increased.
2) The area of mesic meadows in both regions decreased while the area of woody riparian vegetation in the Great Basin increased, yet the abundance of nectar-producing plants in both regions decreased.
3) The abundances of butterfly species associated with mesic meadows and those that regularly feed on nectar decreased, whereas the abundances of butterflies associated with woody riparian vegetation and that rarely feed on nectar were stable or increased.

Methods

We will use the Parameter-elevation Regressions on Independent Slopes Model (PRISM) as our source of climate data. We will use the "SnowCloudMetrics" code in Google Earth Engine to derive annual (2001–present) snow disappearance date and spring-to-summer snow

persistence from remote sensing and gridded snow products. We will use National Agricultural Inventory Program data to characterize size and configuration of mesic meadows and riparian cover during historical and recent time periods. We will resurvey plant and butterfly distributions and abundances in each montane meadow. The composite data will allow us to assess how changes in snowpack, precipitation and water availability, and area of the meadows may be affecting plant and butterfly species distribution and abundance.

Conclusions

Synthesis of different types of evidence is not yet widespread in ecology. However, the use of composite indicators to identify the onset and severity of drought has become common and accepted. This will be one of the first studies to assess effects of aridification on invertebrate and plant species in the western U.S.