Big sagebrush ecosystem response to climate & disturbance

Big sagebrush ecosystems are a major component of landscapes in the western U.S. and provide vital habitat to a wide array of wildlife species. However, big sagebrush ecosystems have been dramatically impacted by disturbances in the past several decades. This collaborative research between USGS and the University of Wyoming focuses on understanding how climatic and soil conditions influence big sagebrush ecosystems and forecasting how sagebrush ecosystems may change in the future.

PAST FINDINGS  (SUPPORTED BY US FWS, USGS ECOSYSTEMS MISSION AREA, NORTH CENTRAL CSC)

Big sagebrush depends on winter precipitation: Despite its extremely wide geographic distribution, our work identified that sagebrush exists only in places where soil moisture is reliably recharged during the cool season when evapotranspiration is lower than precipitation. (See Schlapefer et al 2012 Ecohydrology)

Soil water dynamics drive potential big sagebrush migration: Our ecohydrological niche-modeling work linked process-based soil water assessment tools with species distribution models to identify where big sagebrush distribution may shift upslope and northward in coming decades. (See Schlapefer et al 2012 Ecography.)

Interactions between climate and vegetation can have unexpected impacts on patterns of moisture availability. Our work characterized how disturbances that alter the vegetation in big sagebrush ecosystems can influence the water yield of these widespread ecosystems and modify the water available to regenerating plants. (See Bradford et al 2014 Ecosystems, 2014 Journal of Ecology).

Climate change will modify seasonal patterns of water availability in big sagebrush ecosystems. Our research quantified the impacts of altered climate on future ecohydrology across big sagebrush ecosystems. Results suggest that most sites will be wetter in the spring, but drier during the summer, and changes were especially large for mid- to high-elevation sites in the northern half of our study area. Drier summer conditions in high elevation, SB-Montane sites may result in increased habitat suitability for big sagebrush and greater sage-grouse habitat, while those same conditions will likely reduce habitat suitability for the dry ecosystem types. (See Palmquist et al 2016 and In Review.)
CURRENT PROJECTS

Forecasting big sagebrush plant community composition and vegetation structure: This work integrates detailed projections of soil moisture availability into plant community models to assess multi-decadal impacts of changing climate and disturbance regimes in core sage grouse habitats.

Assessing the future of big sagebrush regeneration: Building on past findings, this project is describing potential future distribution of big sagebrush as well as potentially important invasive plant species, and quantifying how climate change may impact natural big sagebrush regeneration.

Projecting the impact of climate change on soil moisture and temperature: Recent work (Chambers et al, 2014 RMRS-GTR-326) has identified links between sagebrush ecosystem resistance/resilience and soil temperature and moisture conditions. This project is quantifying how changing climate will alter the distribution of temperature and moisture regimes.

Characterizing environmental controls over big sagebrush mortality: Widespread plant mortality events associated with recent drought have highlighted the potential vulnerability of water-limited ecosystems to the warmer and seasonally dryer climate predicted under most future climate change scenarios. Recent work has indicated that woody plant mortality is closely linked to dynamics and availability of soil moisture, and that climate change is likely to elevate the risk of mortality for woody plants, especially in much of the western U.S. This project is investigating a recent big sagebrush mortality event in Wyoming to identify controls and forecast the implications for the sustainability of sagebrush ecosystems.

POTENTIAL FUTURE DIRECTIONS

Validating models with experiments - spatial variability in big sagebrush ecosystem response: Relatively little is known about how sagebrush genetic variation will interact with climate, soils, and disturbance to determine future changes in big sagebrush plant communities. This project would implement a distributed network of manipulative field experiments to quantify local adaptation, variation in demographic rates and growth-climate relationships across a species' distribution, and the optimal way to mix spatial and temporal patterns with process-level understanding to strengthen ecological forecasts.

RECENT SAGEBRUSH ECOSYSTEM PUBLICATIONS


Rottler, C. M., Burke, I. C., Palmquist, K. A., Bradford, J. B., and Lauenroth, W. K. (In Review.) Reclamation after oil and gas development does not speed up succession or plant community recovery in big sagebrush ecosystems in Wyoming.


