Predicting changes in California's diverse environments: Introducing the ORIDE climate change experiment

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INTRODUCTION

- Climate change models predict that the duration and intensity of drought in the Western United States, including the Great Basin sagebrush ecosystem, will increase in future climate regimes (*1*).
- As water is the primary driver of community structure and ecosystem processes in grasslands and shrublands worldwide (*2*), these climate change predictions indicate that grass- and shrub- dominated ecosystems may be particularly sensitive to changes in climate (*3*; *4*).
- Little climate change research has occurred in the Great Basin sagebrush ecosystem. To date, we still do not understand how sagebrush and the associated plant communities will respond to predicted changes in climate.
- Our goal is to investigate the impacts of intense, long-term drought on the western Great Basin sagebrush ecosystem. To accomplish this, we implemented a drought experiment (Fig. 1) in native sagebrush vegetation. This experiment is part of a large network of concurrent drought experiments using the same methods, called the International Drought Experiment (IDE) network.

Figure 1. Two control plots in the foreground and two drought plots in the background at the AA site of the ORIDE experiment.

RESEARCH OBJECTIVES

Over the next four years, we will track changes in

- species composition
- forage and root production
- sagebrush seedling recruitment
- drought stress of both *Artemisia cana* and *A. arbuscula*

These data will help inform future species conservation and grazing management decisions for the Bureau of Land Management.

METHODS

Our experiment is located in Southeastern Oregon, east of Gerber Reservoir on land managed by the Bureau of Land Management (Fig. 2).

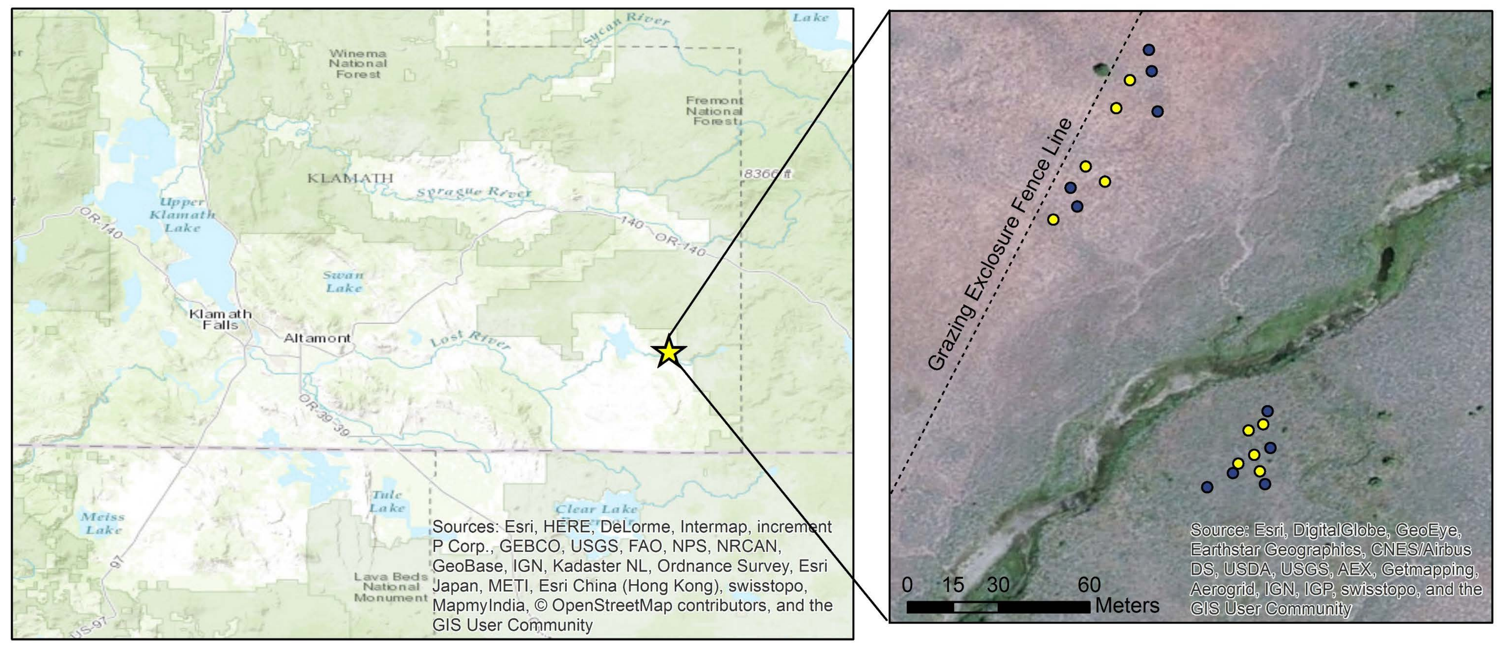

Figure 2. The ORIDE experiment is located on the border of California and Oregon inside a grazing exclosure, on either side of an intermittent stream. Blue dots represent control plots. Yellow dots represent drought treatment plots.

Experimental Design:

- 10 paired plots, five treatment and five control, at two study sites. One study site dominated by *Artemisia arbuscula* (AA site) and the other by *A. cana* (AC site).
- Five 3.0 m x 3.0 m rainfall shelters per site exclude ~41% of incoming rainfall. Each sampling plot is 4m^2.

Abiotic Data:

- Continuous soil moisture (Decagon Devices) – integrated over 5-10 cm in AA plots and 15-20 cm in AC plots. Soil temperature at 5 cm in four plots.
- Soil chemical and physical properties.

Figure 3. Students clip biomass to estimate forage production.

Plant Community and Ecosystem Sampling:

- Species composition, diversity, and richness.
- Above- and Below- ground net primary production (forage production and root production; Fig. 3).
- Sagebrush seedling survival & recruitment.

Sagebrush Physiological Measurements:

- Predawn (between 03:00 and 05:00) and midday (between 14:00 and 16:00) xylem pressure potential measurements on *A. cana*.
- Sampling occurred on 16 individuals, (drought n=8, control n=8) in late July and late August 2016.
- We performed paired t-tests to compare treatment effects at predawn and midday at both sampling dates.

Figure 4. Using a Scholander-type pressure chamber to measure xylem pressure potential.

FIRST YEAR RESULTS

Plant Community Composition

AA site

- Species richness ranged from 12 - 19 species 4.0 m^{-2}; mean species richness was 16.3 species 4.0 m^{-2} (0.9 SE).
- The most abundant grasses were *Festuca idahoensis* and *Elymus elymoides*, while common forbs included *Navarretia intertexta*, *Blepharipappus scaber*, *Lomatium* sp., and *Gilia* sp. Common shrubs included *Artemisa arbuscula* and *Eriogonum sphaerocephalum*. Interestingly, the CAM photosynthetic species, *Sedum stenopetalum,* was also common.

AC site

- Species richness ranged from 12 – 18 species 4.0 m^{-2}, and mean species richness was 14.2 species 4.0 m^{-2} (0.6 SE).
- The most abundant grasses were *Festuca idahoensis, Elymus elymoides*, and *Bromus japonicus*, while common forbs included *Epilobium brachycarpum, Collomia grandiflora, and Achillea millefolium*. *Artemisia cana* was the most abundant shrub, although a few of the plots also contained *A. arbuscula.*

Aboveground Net Primary Production

- As expected, mean ANPP was greater at the AC site (145.6 g m^{-2}; 15.9 SE) than the AA site (66.6 g m^{-2}; 10.0 SE). There were no treatment differences.

Xylem pressure potentials

- *Artemisia cana* demonstrated greater drought stress in August compared with July, as expected. Plants in both July and August recovered overnight (Table 1).
- There were no significant differences between drought and control plants both midday and predawn, in both July and August ($p > 0.5$).

Table 1. Midday and predawn xylem pressure potentials in MPa. Standard deviation in parentheses.

Date	Trt	Ψ_{midday}	$\Psi_{predawn}$
Late July	Drought	-2.3 (0.3)	-1.1 (0.3)
	Control	-2.5 (0.2)	-1.3 (0.2)
Late August	Drought	-3.0 (0.4)	-1.9 (0.5)
	Control	-3.3 (0.4)	-1.8 (0.5)

UPCOMING RESEARCH

- Continued collection of plant community, ecosystem, and sagebrush physiological measurements for three more years.
- Sagebrush seedling germination and establishment study in collaboration with other Great Basin sagebrush IDE sites (Summer 2017).
- Effect of drought on annual leaf litter decomposition rates.
- Cross-site analysis with other Great Basin sagebrush IDE sites in western Wyoming and Utah (collaboration with Drs. Lynn Moore, Karen Beard, and Andrew Kulmatski).

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