David Little Livestock
Range Management Endowment
AT THE UNIVERSITY OF IDAHO

2019 Project Progress Report: Seed Bank Response to Wildfire Frequency in Sagebrush Steppe Plant Communities

PERSONNEL:
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PRELIMINARY RESULTS for 2019:

BACKGROUND:

Fire was a widespread disturbance mechanism in much of the sagebrush ecosystem prior to settlement (McAdoo et al. 2013). However, the size and frequency of fire has increased, and today's mega-fires (>100,000 acres) place large landscapes at risk of annual grass invasion that ultimately alter historic fire regimes. With the rapid invasion of annual grasses following disturbance, plant communities that were once sagebrush and native perennial bunchgrasses are transitioning to annual grass monocultures, feeding the cheatgrass (*Bromus tectorum*)-fire cycle that burns as frequent as every 5-10 years (Pellant 1996).

A consequence of increased wildfire in sagebrush steppe ecosystems may be a depletion of native plant species in the soil seed bank (the seed bank represents seeds left in the soil from current and previous years' seed crops). This depletion is a problem because it reduces a site's ability to restore itself after a fire disturbance. Additionally, if the seed bank is depleted of native seed, weedy species with high dispersal capabilities and high growth rates are more likely to become disproportionately established (Tausch 1999). In order to break the annual grass-fire cycle an understanding of the soil seed bank based on wildfire frequency is critical. For example, by understanding soil seed banks based on wildfire frequency, natural resource managers can better prioritize restoration treatments (i.e., seedings) post-disturbance to areas that likely will not recover without human input.

Elmore County Idaho is a well-known hot spot for numerous natural (lightning) and human-caused annual fires that are in excess of 300 acres. During 2016, 55,176 acres of BLM owned land and 11,052 acres of private owned land in Idaho were burned due to fire (2017 BLM). From 2000-2016, Elmore County experienced a total of 257 separate fires (personal communication – Lonnie Huter BLM) with native sagebrush steppe plant communities rapidly transitioning to cheatgrass monocultures. Hence, Elmore County provides a unique location to identify relationships between wildfire frequency and the composition of the seed bank. Results from this research will improve land manager's ability to strategically restore sagebrush steppe plant communities improving wildlife habitat and livestock forage.

HYPOTHESIS or OBJECTIVES:

The objectives of this study are to evaluate soil seed banks in sagebrush steppe rangelands that have various wildfire histories (i.e., time since wildfire and frequency of wildfires) to determine a plant community's: 1) resilience to fire, and 2) resistance to invasive annual grasses. Our specific hypotheses include: **H_1:** postfire recovery success will be correlated with wildfire history (time since wildfire and frequency of wildfires); **H_2**: repeated wildfires reduce fire-adapted native plant species and increase annual grass invasion.

PROCEDURES:

Study sites were located in Elmore County and represent a range of time since wildfire (0-20 years), and frequency of wildfires (1-5) based on historic wildfire perimeters (imagery acquisition from Inside Idaho; http://inside.uidaho.edu/). Geographic Information Systems (GIS) data was used to determine study site locations. A total of 15 study sites were initially located across an elevation gradient to capture both Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) and mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*) plant communities. The seed bank was sampled on October 2018 after seed dissemination and before field germination.

Within each study site, a center point was randomly determined for seed bank collection. At the center point, 3, 50-m transects were placed in a spoke design. On each 50-m transect, 25 soil cores were collected at 2-m intervals. Samples from each transect will be consolidated for a total of 3 samples per study site. Both mineral soil and litter was collected and included in each sample. Soil cores consisted of a 3-inch diameter PVC coupling that was pounded approximately 5 cm into the soil using a plywood slat and rubber mallet (soil sample is 98 cm^3 per core). The depth of 5 cm was chosen based on research that found the majority of seeds lie above that depth (Russi et al. 1992; Traba et al. 2004). Soil cores were placed in plastic Ziploc bags and stored in coolers during transportation to the University of Idaho College of Natural Resources' large refrigerated storage in Moscow, Idaho.

To estimate the viable seed bank, germination was used as a proxy. The seed bank samples were placed in cold-wet conditions to break dormancy (refrigerator at 1°C for ~60-days). Samples were spread over sterile sand (25 X 60 cm flats) and manually watered to initiate germination (watering continued as needed). As soon as seedlings could be identified (species-level identification), it was counted and removed from the flat to reduce the possibility of germination suppression due to competition. Once germination ceased (approximately 4 months), samples were placed under warm-dry conditions for 14-days. Samples were then mixed and watered to reinitiate the second germination phase which lasted another 2 months. Under ideal conditions, this phase would have lasted 2 additional months for a total of 4 months, however, the greenhouse bay where samples were growing became contaminated with a potato fungus and all seeds were killed. Due to the greenhouse contamination and loss of seeds, results in a total germination period of 6 months will be analyzed. Plant density by species and richness will be determined for each study site.

All statistical analysis will be conducted using Statistical Analysis Software (SAS 2006) during the spring of 2020. Effects of time since wildfire and frequency of wildfires on soil seed bank will be analyzed using a mixed model analysis of variance. Time since wildfire and frequency of wildfires will be considered a fixed effect and seed bank will be the random effect. Seed density correlated to time since wildfire and frequency of wildfires will also be analyzed using linear regression.

ACCOMPLISHMENTS or RESULTS:

- Study sites were located (including time since wildfire and frequency of wildfires) on lands managed by the Idaho Department of Lands across Elmore County, Idaho.
- Seed bank samples were collected on 24 and 25 October 2018 on 9 study sites (27 composite samples; Table 1).
- Seed bank samples are currently being stored in a refrigerator at the University of Idaho, Moscow.
- Samples were planted early January by Hulet and Price (Hulet's graduate student) in the Sixth Street Greenhouse on U of I's campus. Price collected seedling data through June 2019.
- All data has been collected and organized for each study site.
- Data analysis and manuscript preparation is in process.

PUBLICATIONS or OUTPUTS:

The results from this research will show proof of concept to utilize wildfire history (i.e., time since wildfire and frequency of wildfire) to: 1) prioritize restoration treatments (i.e., probability of natural recovery following wildfire), 2) assess the impact of annual grass fire regimes on soil seed banks, 3) evaluate sagebrush steppe ecosystems resilience to wildfire, and 4) evaluate sagebrush steppe ecosystems resistance to annual grass invasion. Anticipated publications/outputs include:

- A research note will be submitted Spring 2020
- Extension publication/information sheet created Spring 2020

Table 1. Table of study sites, location (latitude/longitude), number of wildfires that have impacted the study site, and time (years) since the last wildfire for each study site.

Study Sites	Latitude	Longitude	Number of Wildfires	Time since Wildfire (years)
S1	43.072042	-115.985519	3	12
S2	43.080738	-115.982425	2	32
S3	43.123461	-115.923134	3	7
S4	43.116222	-115.934813	2	7
S5	43.33933	-115.861925	3	4
S6	43.334791	-115.860225	2	4
S11	43.248506	-115.6355	1	35
S12	43.248091	-115.628729	1	5
S13	43.252697	-115.632065	2	5