# Forecasting Bromus Tectorum and Fire Threat: Site Soil Type Versus Population Traits

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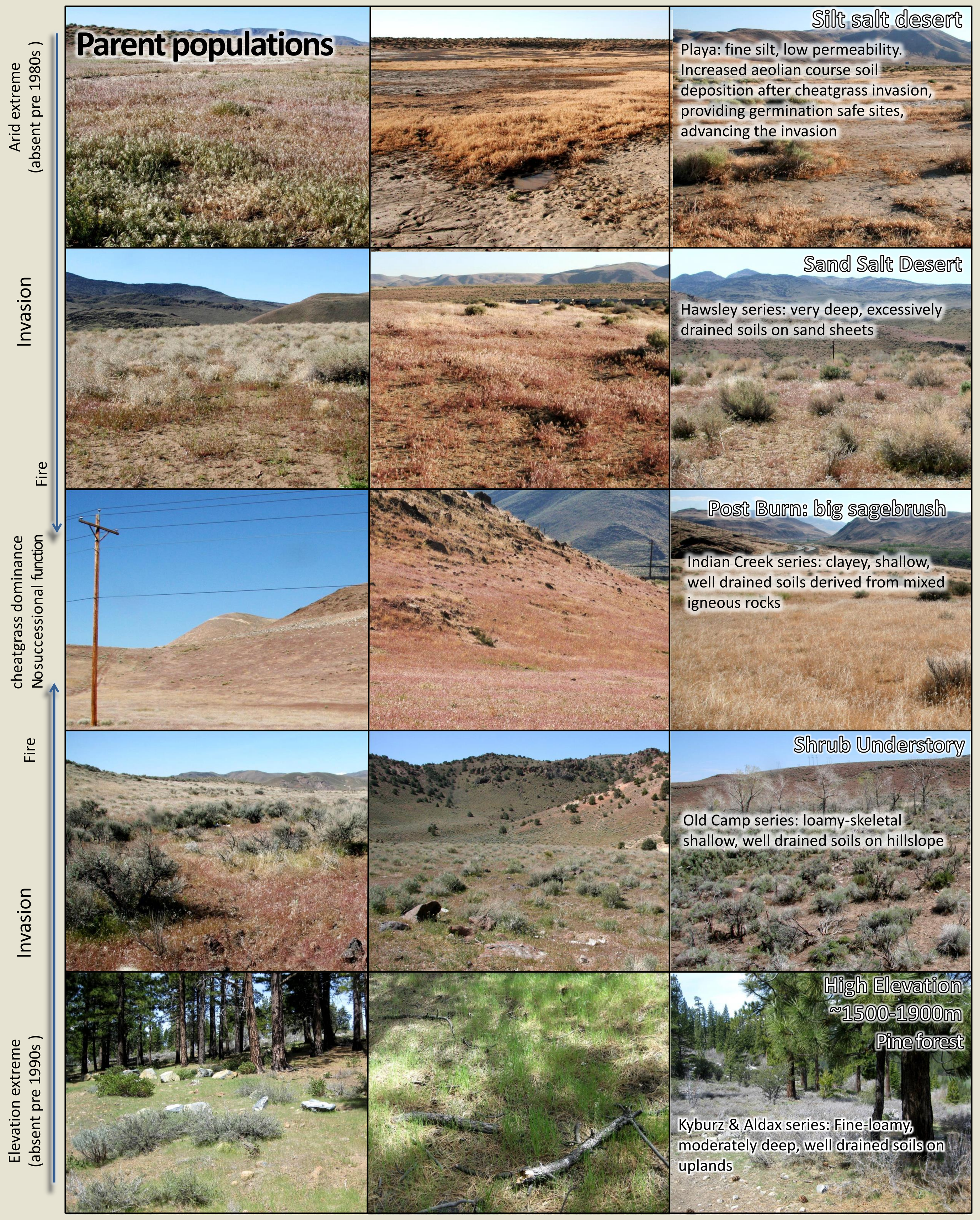
Cheatgrass (*Bromus tectorum*) management is a formidable task that requires prioritization of efforts. Invading virtually all arid/semiarid habitat types in northwestern Nevada, cheatgrass populations can radically vary by annual weather conditions. We conducted multiple observational experiments to determine to what degree climate vs. soil-habitat vs. heritable traits affect phenology, biomass and seed banks.




## Methods

In a greenhouse reciprocal garden we tested two treatment variables 1) seed source population (n=5) and 2) soil type (n=5). We measured four response variables:
1) Biomass 2) Seed to biomass ratio 3) Days to flowering and 4) Total life duration.

Seed was collected from parent populations and then grown for 2 generations in a greenhouse under equal conditions before experiment to avoid any maternal environment effects. Pots were watered equally (100ml/ 3days)

## Biomass

Our results found that biomass differed by soil type and seed source . High elevation populations had the largest biomass irrespective of soil medium. Among the lower elevation populations only the salt desert populations ranked the greatest in its own soil*, possibly indicating adaptation to the harsh salt desert habitat. Understory soils were the most productive + .

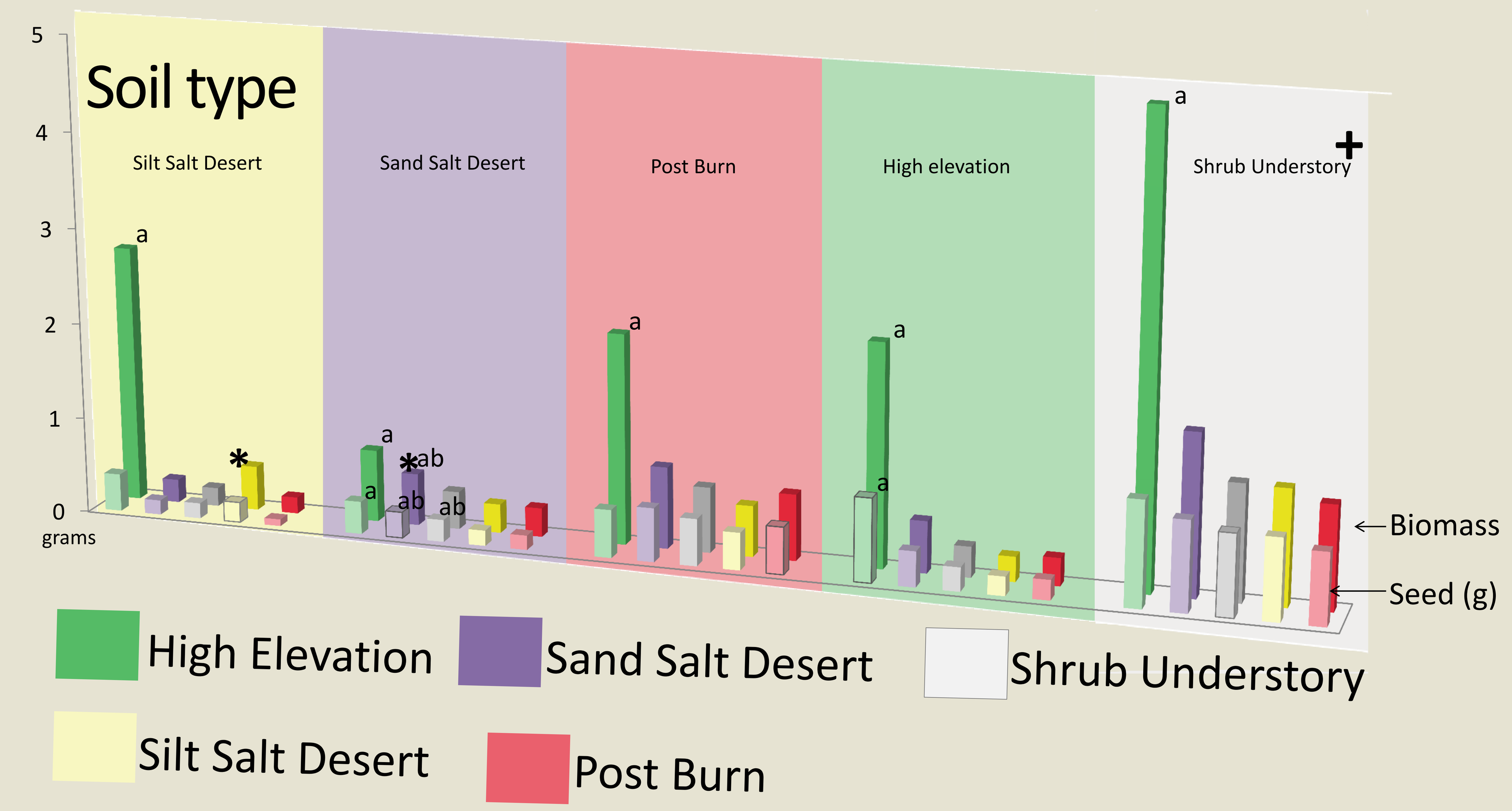



**Figure 1**. Total and seed biomass per plant. Seed source on the X-axis and grouped by soil type.
- a, ab represent significant differences (p<0.05) from group

## Flowering

Days to flowering differed by seed source. Soil type had little effect on flower timing (sphere size). High elevation seed source exhibited delayed flowering and a long life span. Total life span differed more by soil type than seed source. Salt desert soils lead to shorter life spans *.

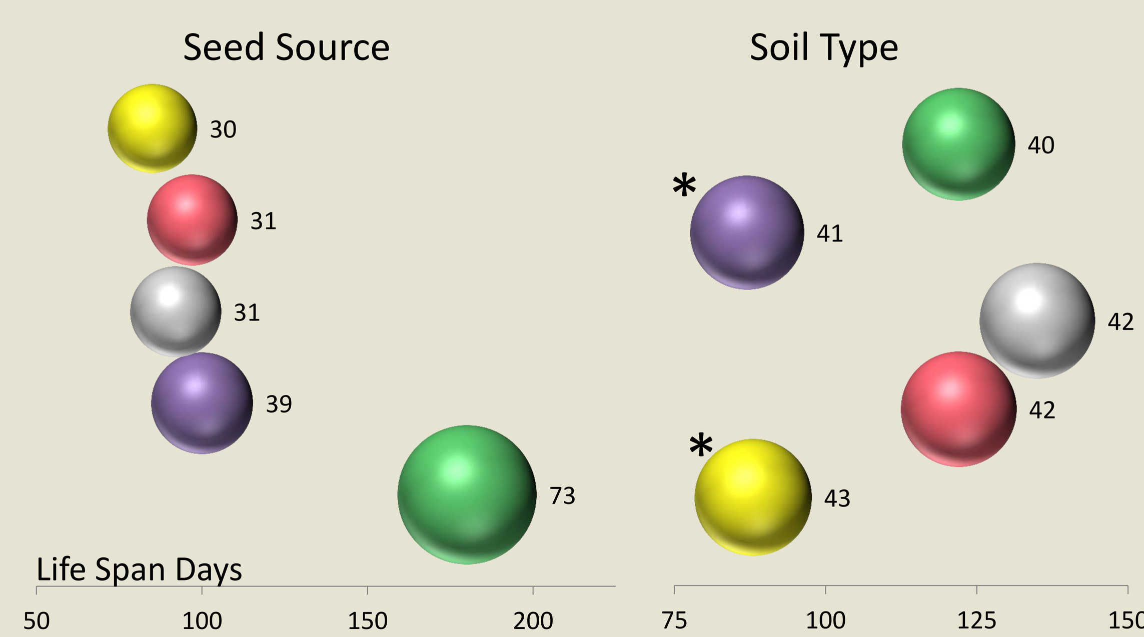



**Figure 5**. Life span on X-Axis. Data label (Sphere size) is days to flowering.

## Seed Production

| Table 1. Reproductive percent of total biomass. | | |
|---|---|---|
| | Soil type | Seed Source |
| **High Elevation** | 66 a | 29 b |
| **Post Burn** | 63 ab | 63 a |
| **Shrub Understory** | 59 ab | 67 a |
| **Sand Salt Desert** | 50 bc | 61 a |
| **Silt Salt Desert** | 38 c | 61 a |

Seed to total biomass ratios responded to soil type and seed source **(Table 1)**. Plants exhibited lower resource allocation to seed production when grown in silt salt desert soils. Cheatgrass seed from higher elevations displayed the lowest percent of seed to total biomass.

## Field common garden

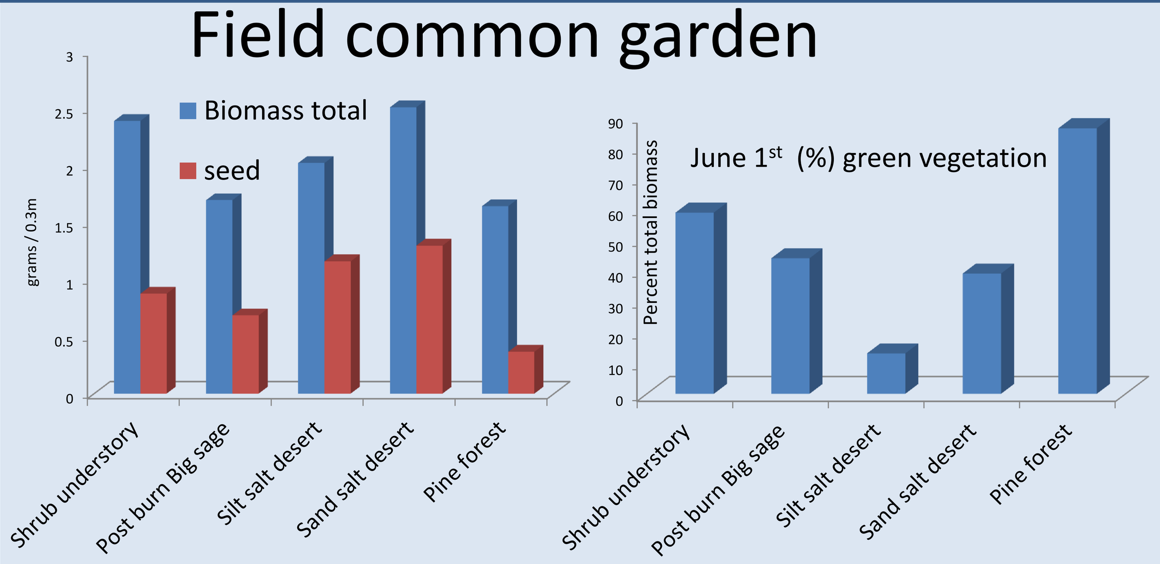
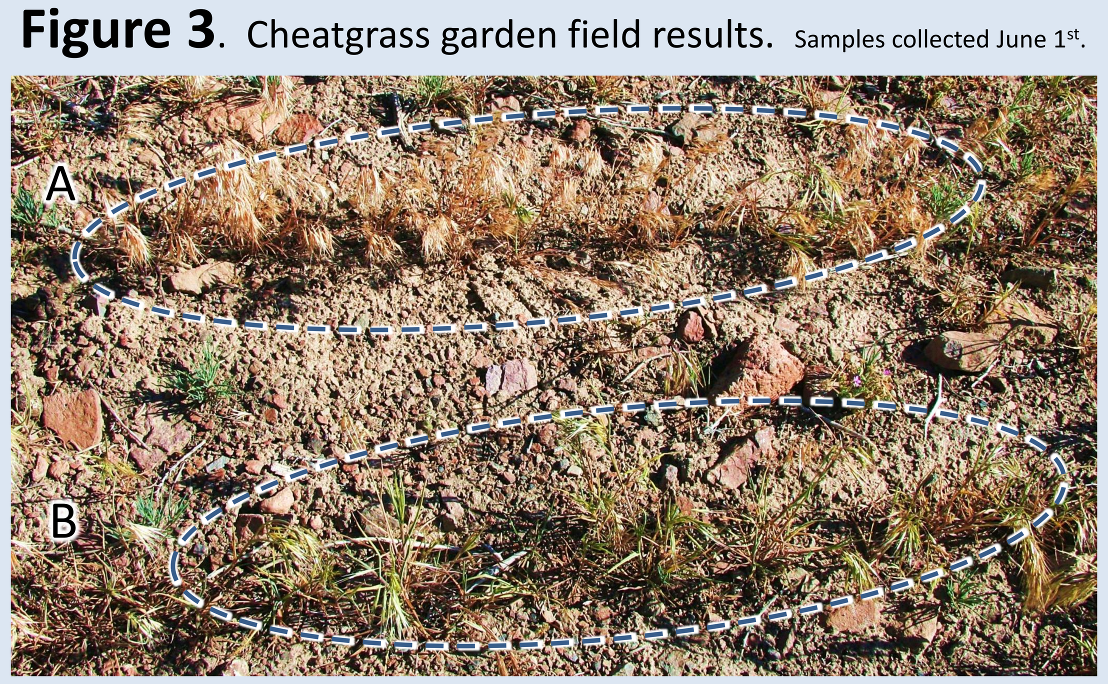



**Figure 3**. Cheatgrass garden field results. Samples collected June 1st.




Drill row of seed population. (A) Silt salt desert – senesced (B) Pine forest- still green. Photo June 1st

## Seed Banks

(measured by bioassay technique)

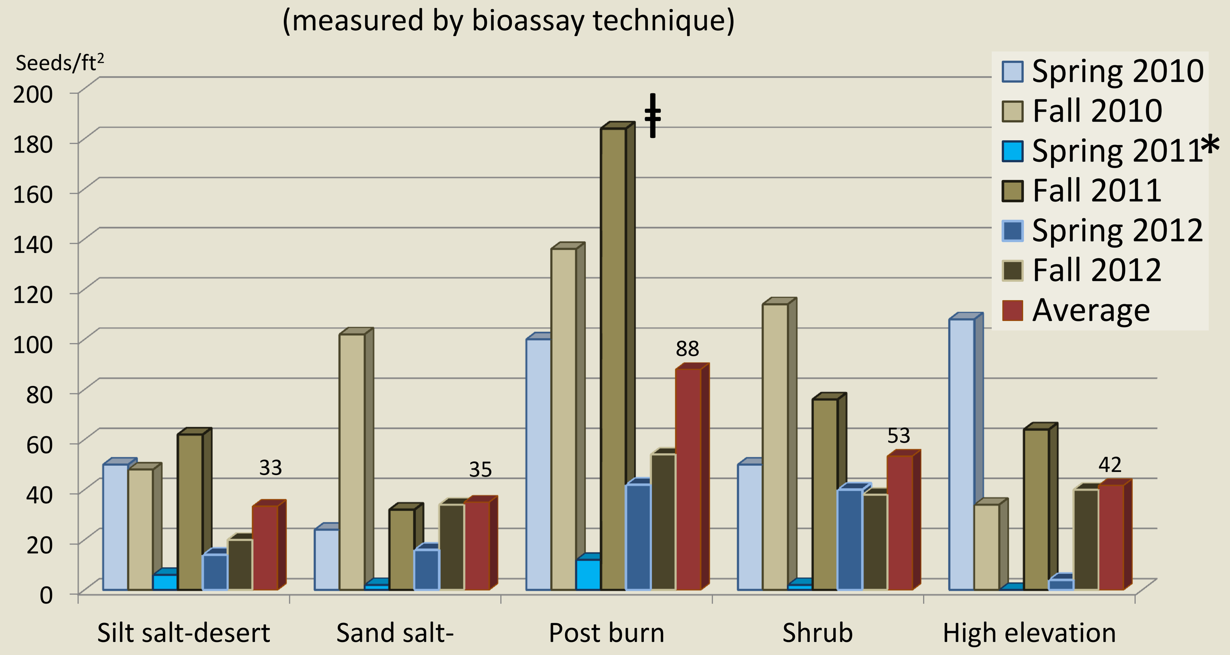
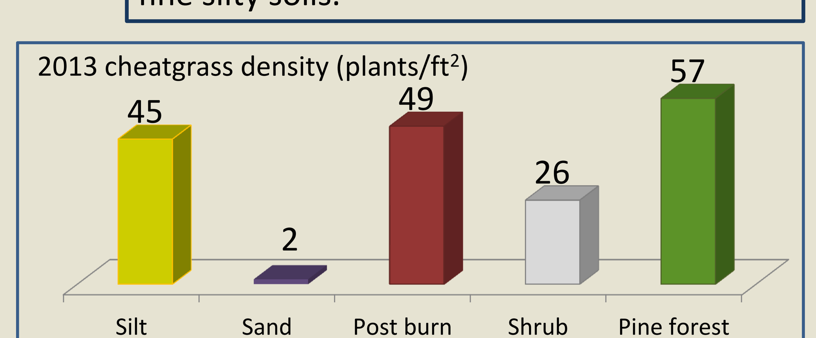



**Figure 2**. Seed bank (seeds/~.09m² [1ft²]) measured the first week of May and August. Annual variation can be explained by favorable germination conditions. For example 2011 had an abundant germination year beginning with a warm wet October 2010. The high degree of germination led to a small spring 2011 seed bank *. Concurrently with a large dense population (2011), high seed production led to a large Fall ǂ seed bank.

## Summer Germination and Secondary flowering


**Figure 4.** (A) Summer germination (June 17th 2009) Silt Salt Desert site, (B) single plant 2nd crop of seed production.

Secondary flowering and summer germination most commonly occurred on fine silty soils.




## Discussion

Experimental and field observation research found that big sagebrush and post fire habitat is at the greatest risk for fire. Big sage understory soils were the most productive (**Figure 1**) creating more fuels and increased fire risk while post burn sites had the largest seed banks (**Figure 2**). Experimentally, silt salt desert soil decreased seed production (**Table 1**). However, in the field, salt desert plants produced more seed compared to other populations (**Figure 3**). Summer germination and secondary flowering may also compensate for initial reduced seed production (**Figure 4**). Sand salt desert maintained the smallest seed banks and had very low establishment during drought years (2012-2013) indicating a possible lower fire risk. Pine forest populations exhibited heritable traits (delayed flowering **Figure 5** and increased biomass **Figure 1**). However a larger biomass was not observed in arid common gardens (**Figure 3**) indicating a resource availability limitation. The longer green vegetative period of forest populations and lower seed production (**Figure 3**) compared to salt desert populations, which flowered and senesced ~ a month earlier in common gardens, indicates a lower fire risk for high elevation cheatgrass populations.