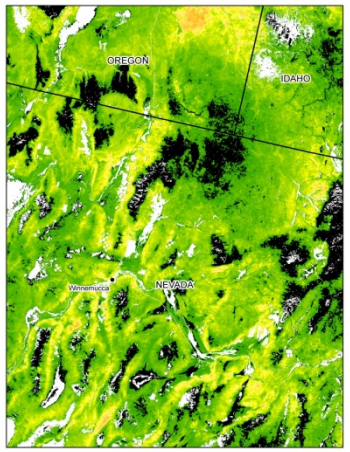


Cheatgrass Die-off Project

Don Major, BLM Project Lead

GBRI/BLM Idaho

GREAT BASIN Restoration Initiative

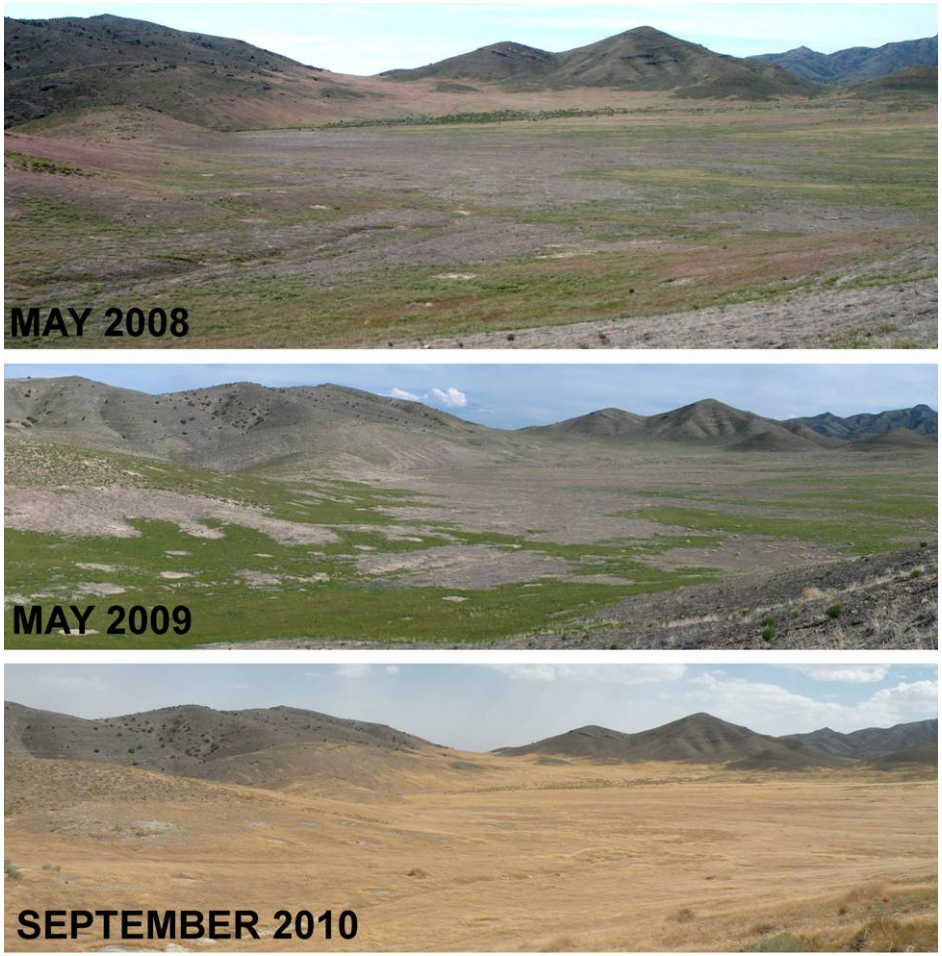
What is Cheatgrass Die-off?

- **Cheatgrass is an annual plant, it establishes a stand from seed every year.**
- **What we call 'dieoff' could more accurately be called establishment or stand failure.**
- **Stand failure results when seedlings fail to emerge or are killed post-emergence but prior to seed production.**
- **Such processes have been intensively studied in annual cereal crops, and these studies provide a model for our approach to establishing dieoff causal factors.**

GREAT BASIN Restoration Initiative

GREAT BASIN
Restoration Initiative

Lost Dog Study Site, central Skull Valley UT



Cheatgrass once again dominated this big sagebrush site 2 years after the dieoff.

GREAT BASIN Restoration Initiative

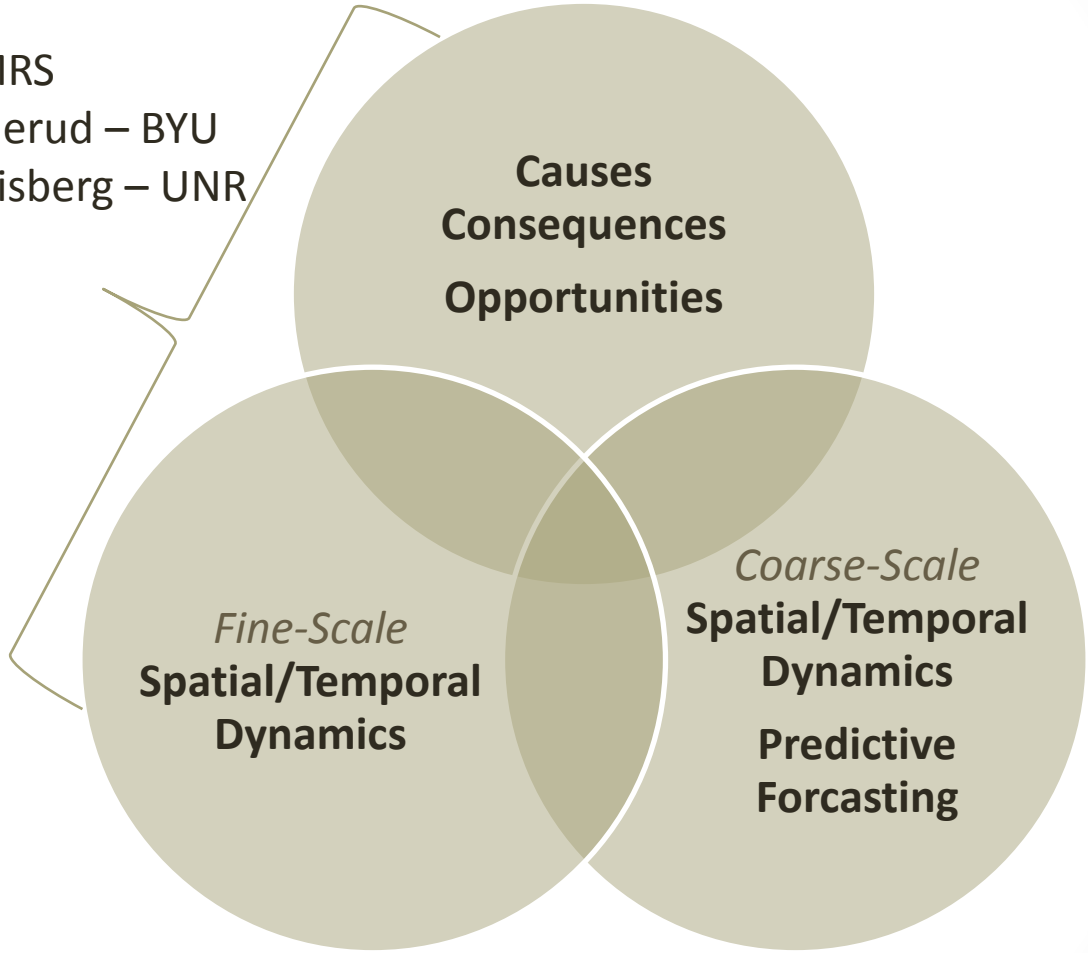
Project Objectives

- What are the causes of cheatgrass die-off?
- What are the spatio-temporal dynamics of cheatgrass die-off areas?
- What is the extent of die-off?
- Can we monitor the trend of die-off areas (retraction, expansion, or areas of new occurrences) and predict short and long-term changes in the phenomena under current and future climate scenarios?

GREAT BASIN
Restoration Initiative

Integrated Science Project

Susan Meyer, USFS RMRS
Brad Geary, Zach Aanderud – BYU
Beth Ledger, Peter Weisberg – UNR
Julie Beckstead - GU



Bruce Wiley, USGS EROS
Stephen Boyte, SGT Inc.
Colin Homer, USGS EROS

GREAT BASIN Restoration Initiative

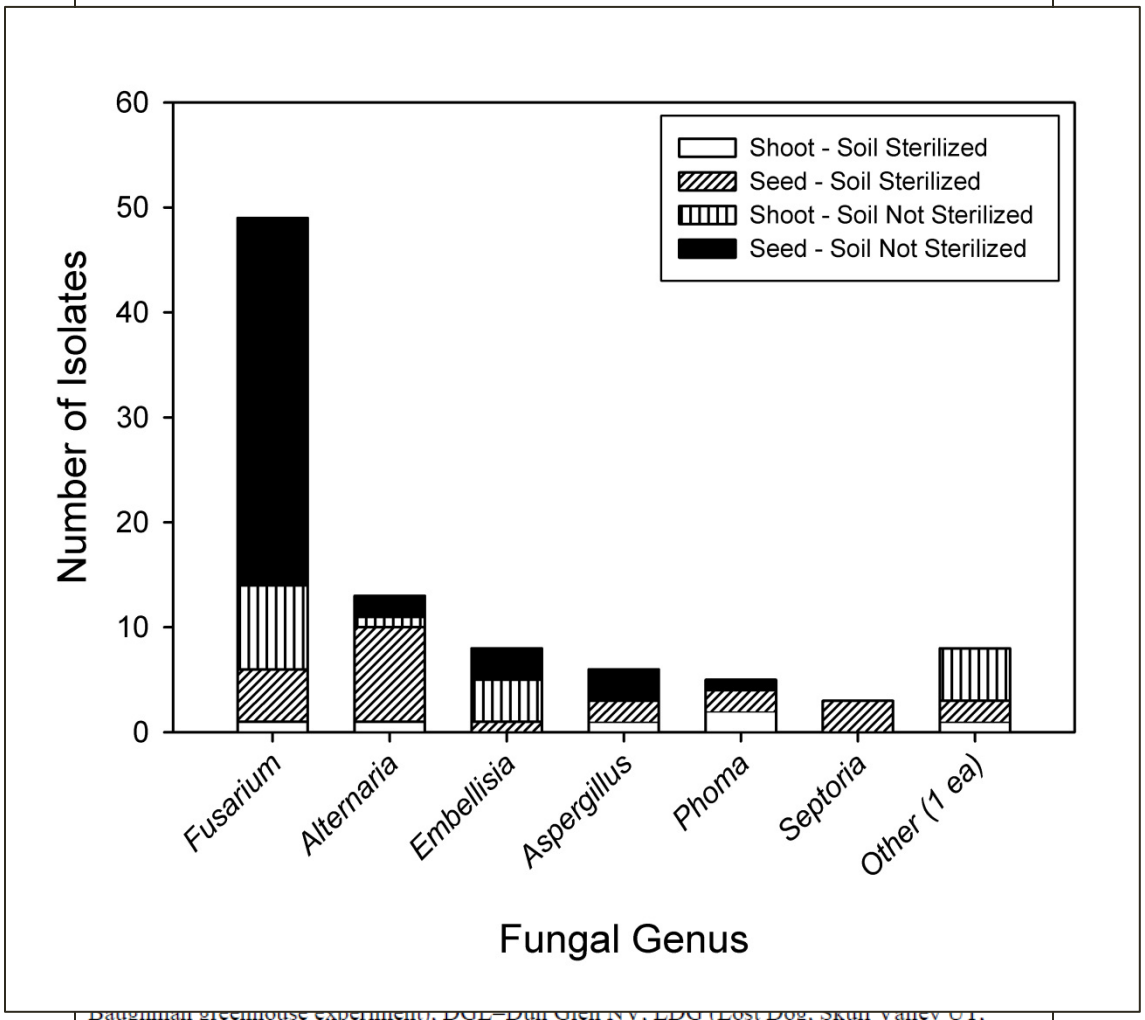
Causes/Consequences/Opportunities
Research Questions

- **Determine the causes of cheatgrass dieoffs**
- **Establish the factors that determine the rate and successional trajectory of dieoff recovery**
- **Determine whether dieoffs represent restoration opportunities**

GREAT BASIN
Restoration Initiative

Identify Potential Causes

Table 1. Fungal genera isolated to date from seeds/seedlings in soils from five die-off sites. Genera are ranked by total number of isolates obtained.



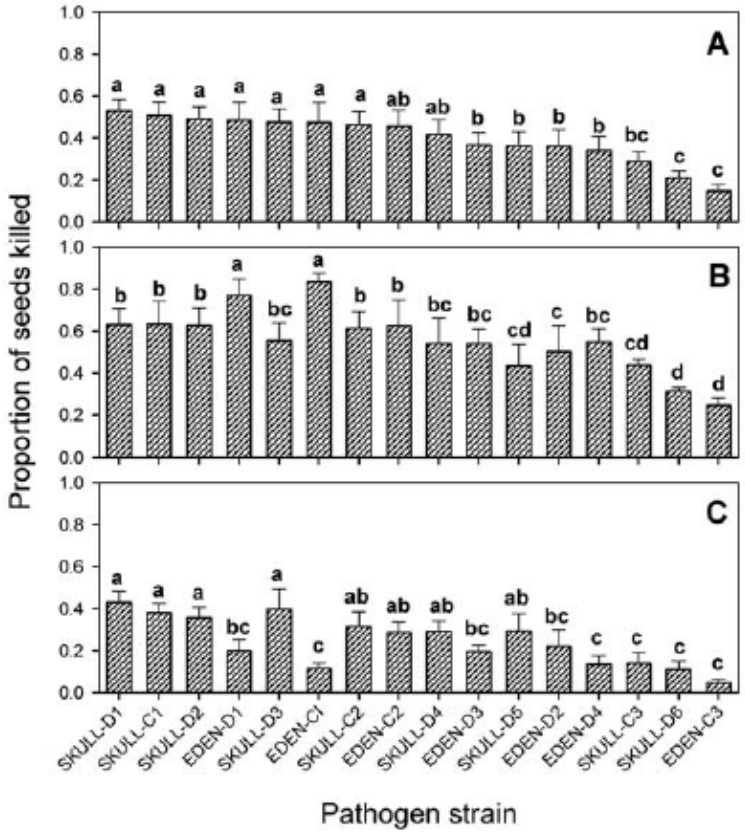
Baughman greenhouse experiment), DGL=Dull Glen NV, LDG (Lost Dog, Skull Valley UT, non-sterile soil isolates from Baughman greenhouse experiment), WRK=Whiterocks Exclosure, Skull Valley UT.

GREAT BASIN Restoration Initiative

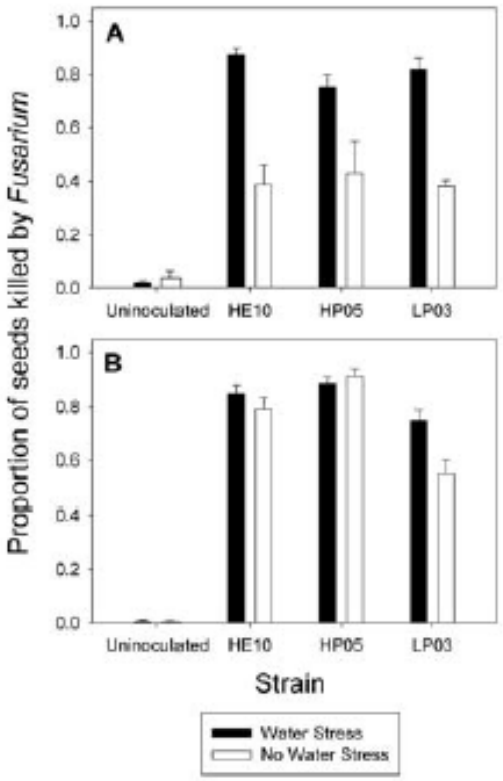
Fusarium

Dormant Seed Pathogenicity Test – Fusarium

Cheatgrass Seed

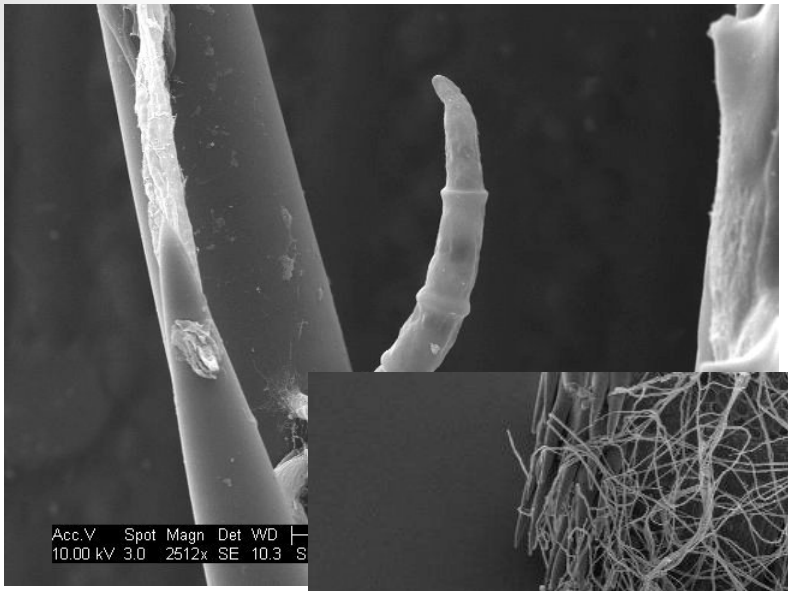


Native Seed



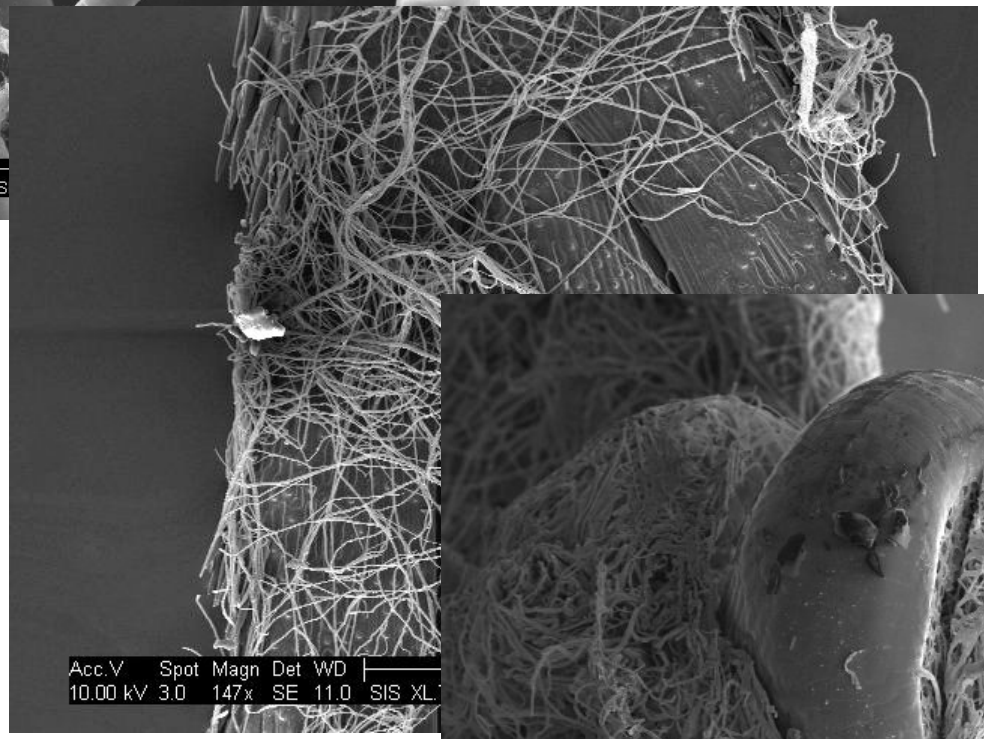
Squirreltail

Bluebunch wheatgrass


Acc.V Spot Magn Det WD
10.00 kV 3.0 2512x SE 10.3


ATTACK
OF THE KILLER
TOMATOES!

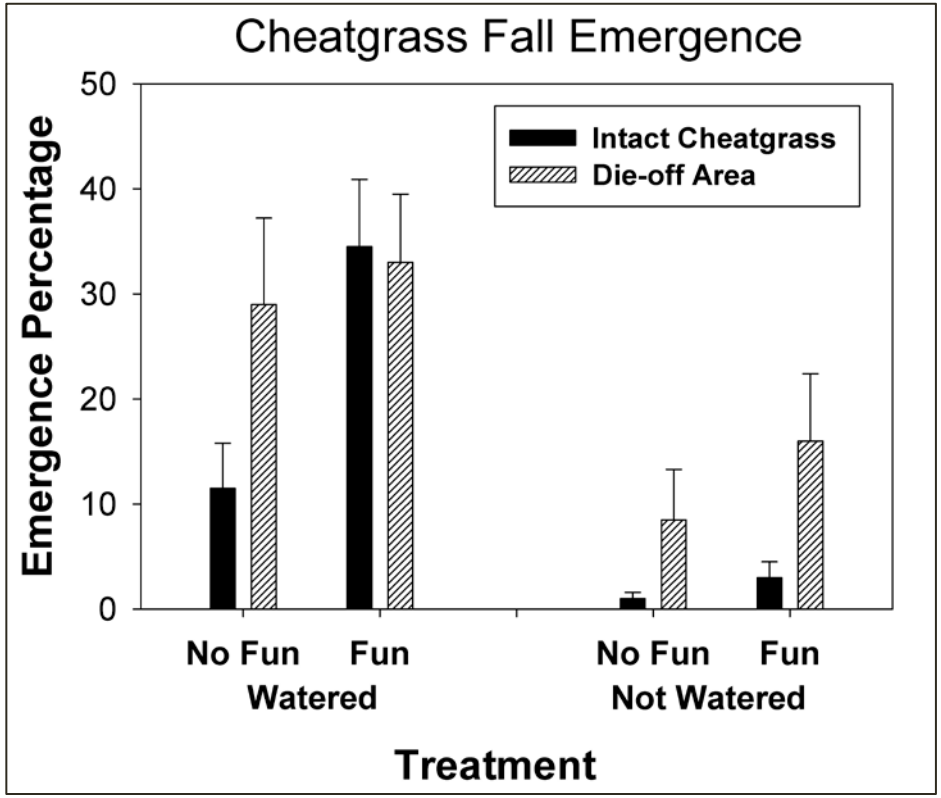
Fusarium


Acc.V Spot Magn Det WD
10.00 kV 3.0 147x SE 11.0 SIS XL


Acc.V Spot Magn Det WD 100 µm
10.00 kV 3.0 164x SE 9.9 SIS XL.TIF

Dun Glen Precision Field Seeding Experiments

10 Blocks, 240 plots
Trtmts:
DO vs Control
Irr. vs No Irr.
Litter vs Litter Rem
Innoc (Captan) vs Fusarium



SEED Pre-Germ	SEED Germ	Post-Winter	GROW SEASON - End

Dun Glen Precision Field Seeding Experiments

12 Treatments x 4 spp x 10 B = 480 plots

Trtmts:

Control

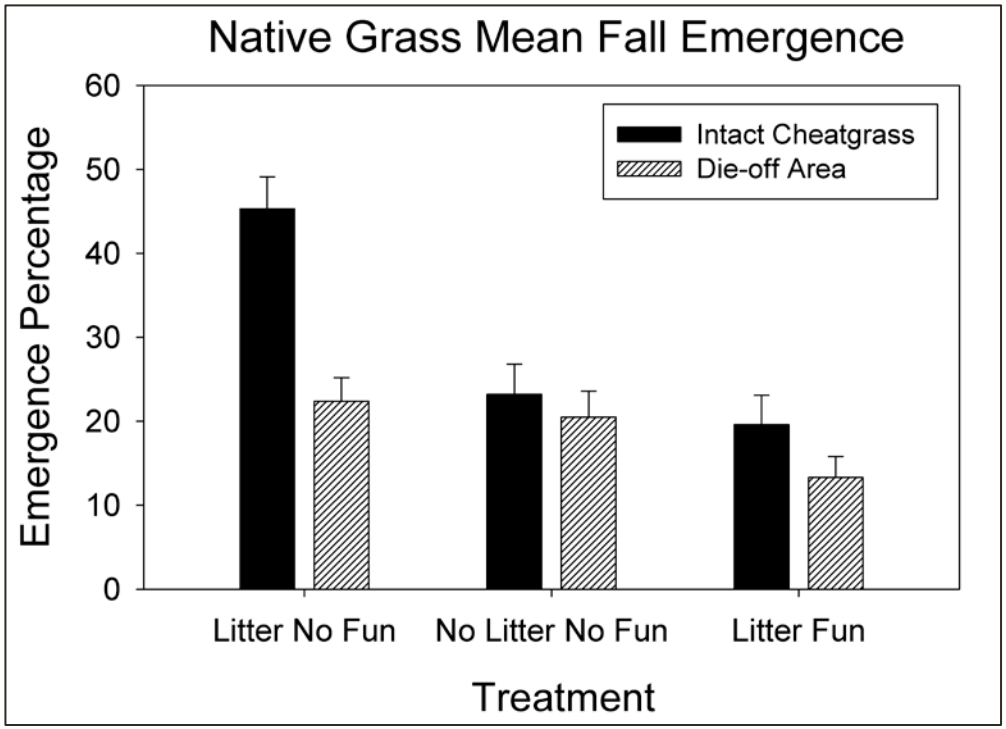
Water only

Fungicide

Fungicide + water

Litter removal

Litter removal plus water



Watered Plots only

SEED Pre-Germ	SEED Germ	Post-Winter	GROW SEASON - End

A new player…or partner in crime!

In Cheatgrass…
-mainfests late in flowering
-seeds fail to fill and entire plant turns "bleach blonde"

Bleach Blonde Syndrome

Close relative of *Roetstromia floccosum* aka "Dollar Spot" cool season turf disease

GREAT BASIN Restoration Initiative

Causes and Consequences: Preliminary Results -

- *Fusarium* is the most likely seed pathogen implicated in die-offs, because it has been recovered from killed cheatgrass seeds at high frequency at all five die-off survey sites, that is, at much higher frequency than any other fungal organism.
- Strains of *Fusarium* isolated from killed cheatgrass seeds have been demonstrated to be pathogenic on nondormant cheatgrass seeds in laboratory pathogenicity trials carried out at high inoculum loads and at warm temperature, with increased pathogenicity under water stress. How this pathogen functions under field conditions is under investigation.
- Several *Fusarium* strains isolated from die-offs have also been shown to be pathogenic on native grass seeds (bluebunch wheatgrass, squirreltail, Sandberg bluegrass) under conditions similar to those described above for cheatgrass, indicating that *Fusarium* is a generalist pathogen that can attack seeds of multiple grass species.
- Another grass pathogen, *Roetstromia floccosum* (aka *Sclerotinea homeocarpa* or dollar spot) has been found to have major impacts on cheatgrass in some die-off areas. It does not cause die-off directly, but seed set is prevented in diseased plants, which lodge early in the season and form dense, matted litter. This reduction in seed rain and increase in litter load could be part of the predisposing conditions leading up to a die-off.

GREAT BASIN Restoration Initiative

Preliminary Results:

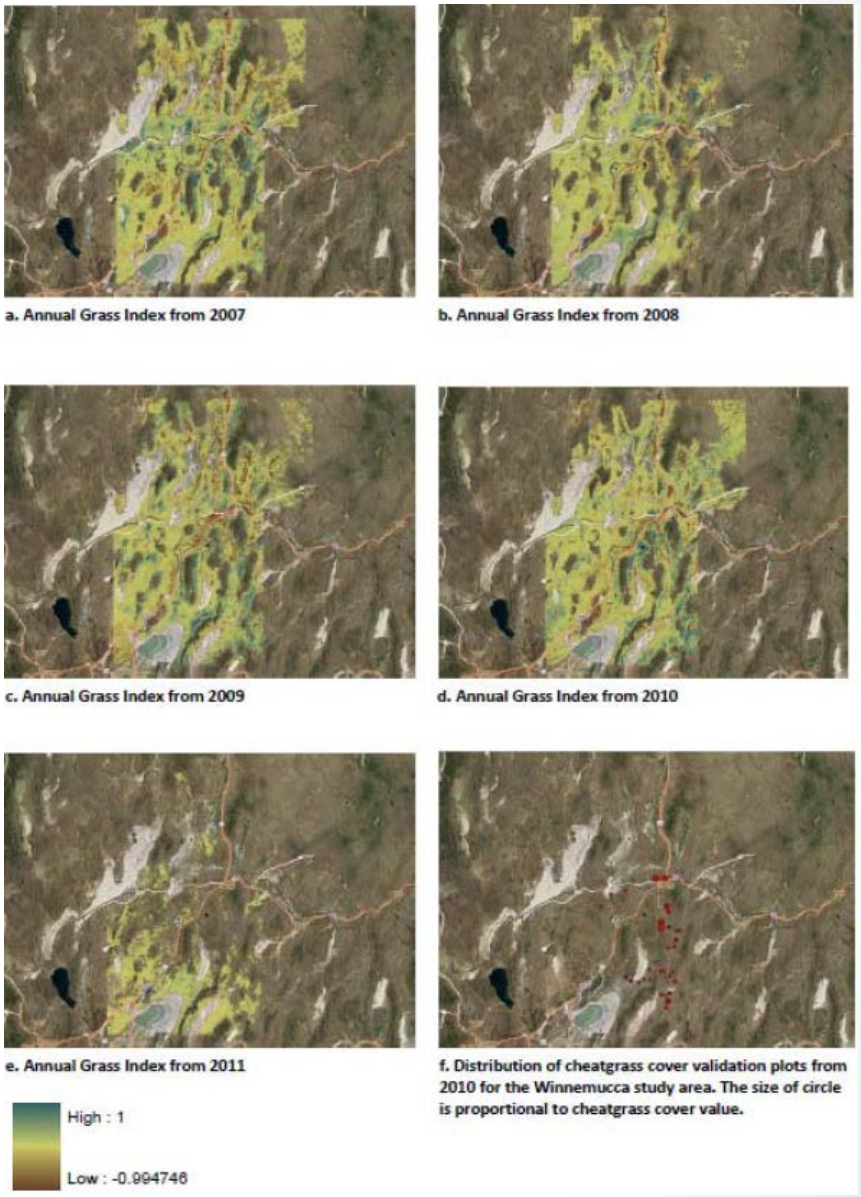
- Preliminary emergence data from Dun Glen die-off site indicate that the soil feedback dynamic established in a die-off soil has differential effects on cheatgrass vs. native grass seeds.
- Cheatgrass (litter rem. plots only), emergence higher in die-off than in intact cheatgrass areas. Fungicide treatment of the seeds improved emergence threefold in intact cheatgrass, but had no effect in the die-off area, where emergence was high regardless of fungicide application. *This suggests that the intact cheatgrass areas are incipient cheatgrass die-off areas, whereas the die-offs may already be on a trajectory toward cheatgrass reestablishment.*
- Native grasses (watered plots only), emergence was 2x as high in intact cheatgrass areas than in die-off areas, as long as litter layer left intact. With litter layer removed, intact cheatgrass and die-off areas had similarly low emergence. *Suggests that litter in intact plots had a positive effect on native grass emergence, probably by improving moisture relations(mulching).* In the die-offs, this positive effect was essentially cancelled out by some negative effect associated with the litter. P/A litter had no net effect on native grass emergence. Fungicide had a null effect, except in the litter present intact cheatgrass treatment (Neg). Thus shed little light on the reason for reduced emergence in the die-off treatment.

Fine-scale Mapping CGDO with Landsat TM Imagery Winnemucca Area, NV

Annual Grass Index (AGI)

$$AGI = \frac{\max(NDVI_{SPRING}) - \max(NDVI_{SUMMER})}{\max(NDVI_{SPRING}) + \max(NDVI_{SUMMER})}$$

Time Period: 1999 – 2011
Evaluate AGI inter-annual differences to characterize:
New invasion (+2 SD) or
Die-offs (-2 SD).



a. Annual Grass Index from 2007

b. Annual Grass Index from 2008

c. Annual Grass Index from 2009

d. Annual Grass Index from 2010

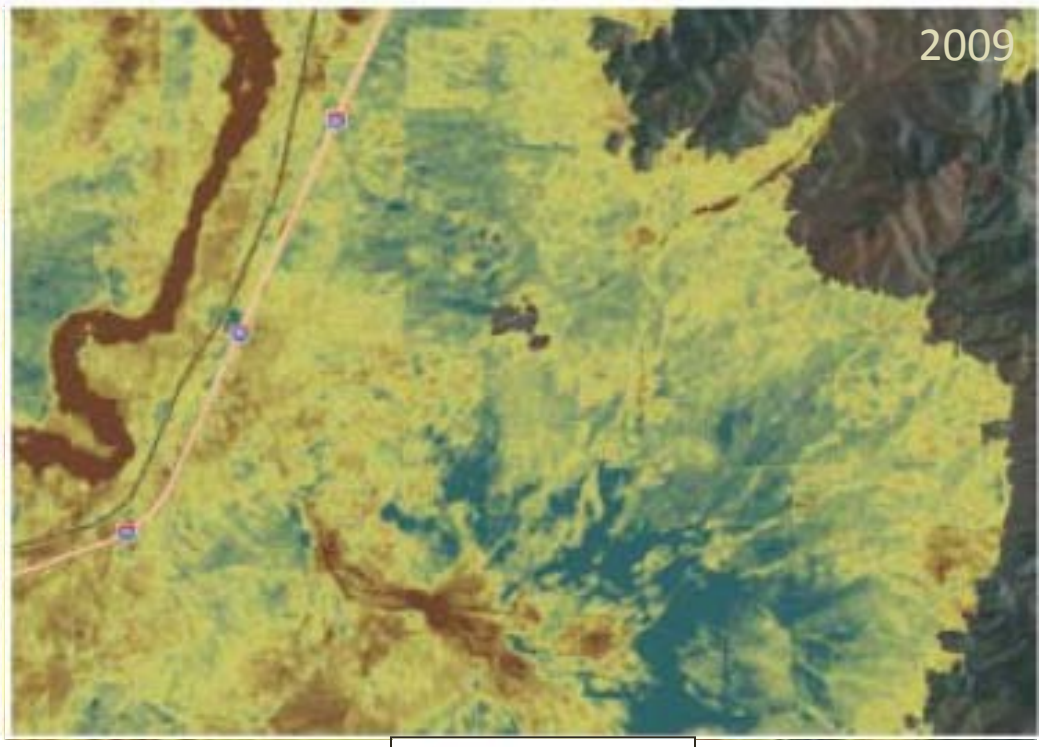
e. Annual Grass Index from 2011

f. Distribution of cheatgrass cover validation plots from 2010 for the Winnemucca study area. The size of circle is proportional to cheatgrass cover value.

Fine-scale Cheatgrass Mapping

Evaluate AGI interannual changes and identify anomalies

Red = Die-off Green = New Invasions

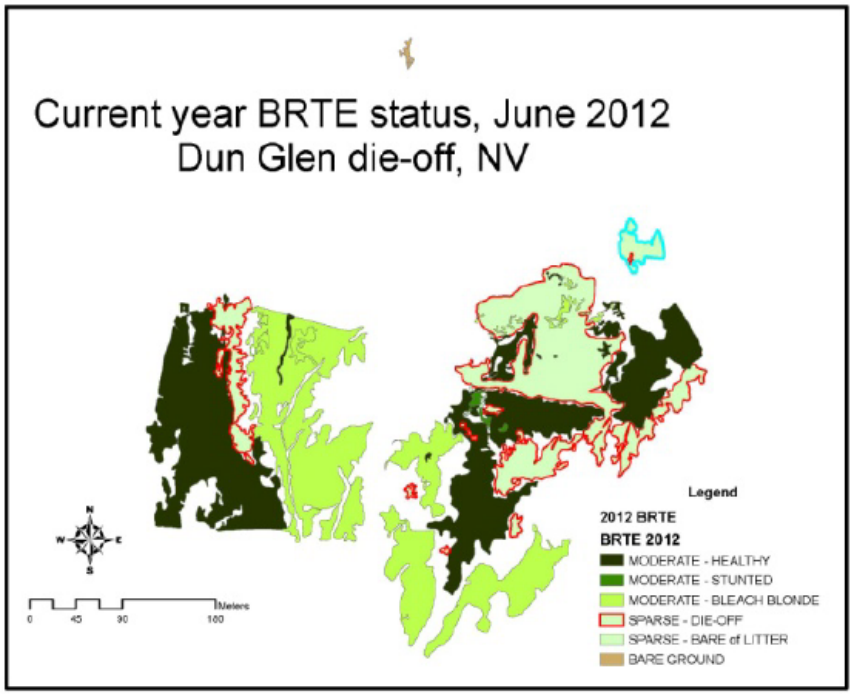


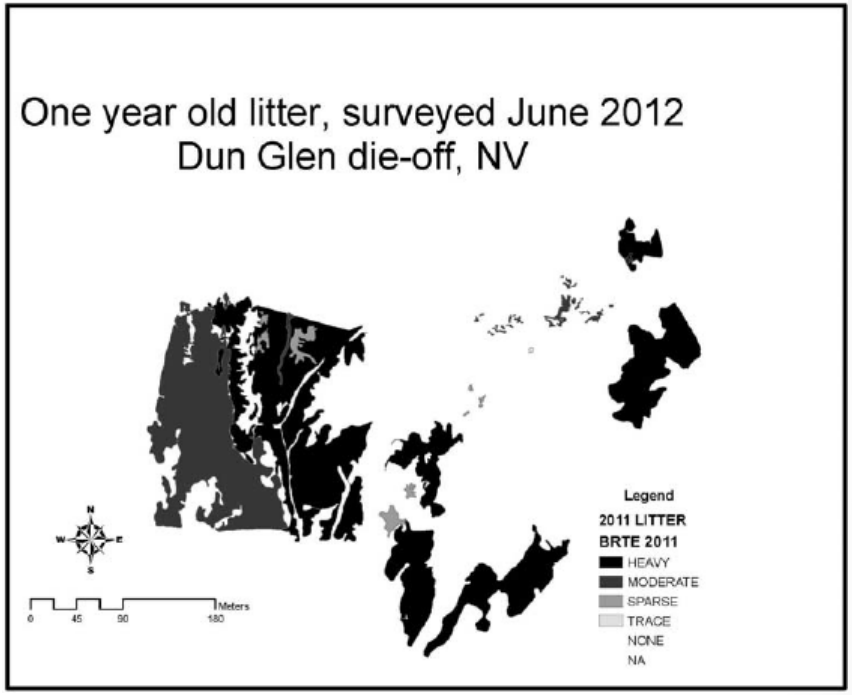
2007 – 2009 Annual Grass Index

Dun Glen Site, NV

Fine-scale Cheatgrass Successional Study

In Progress

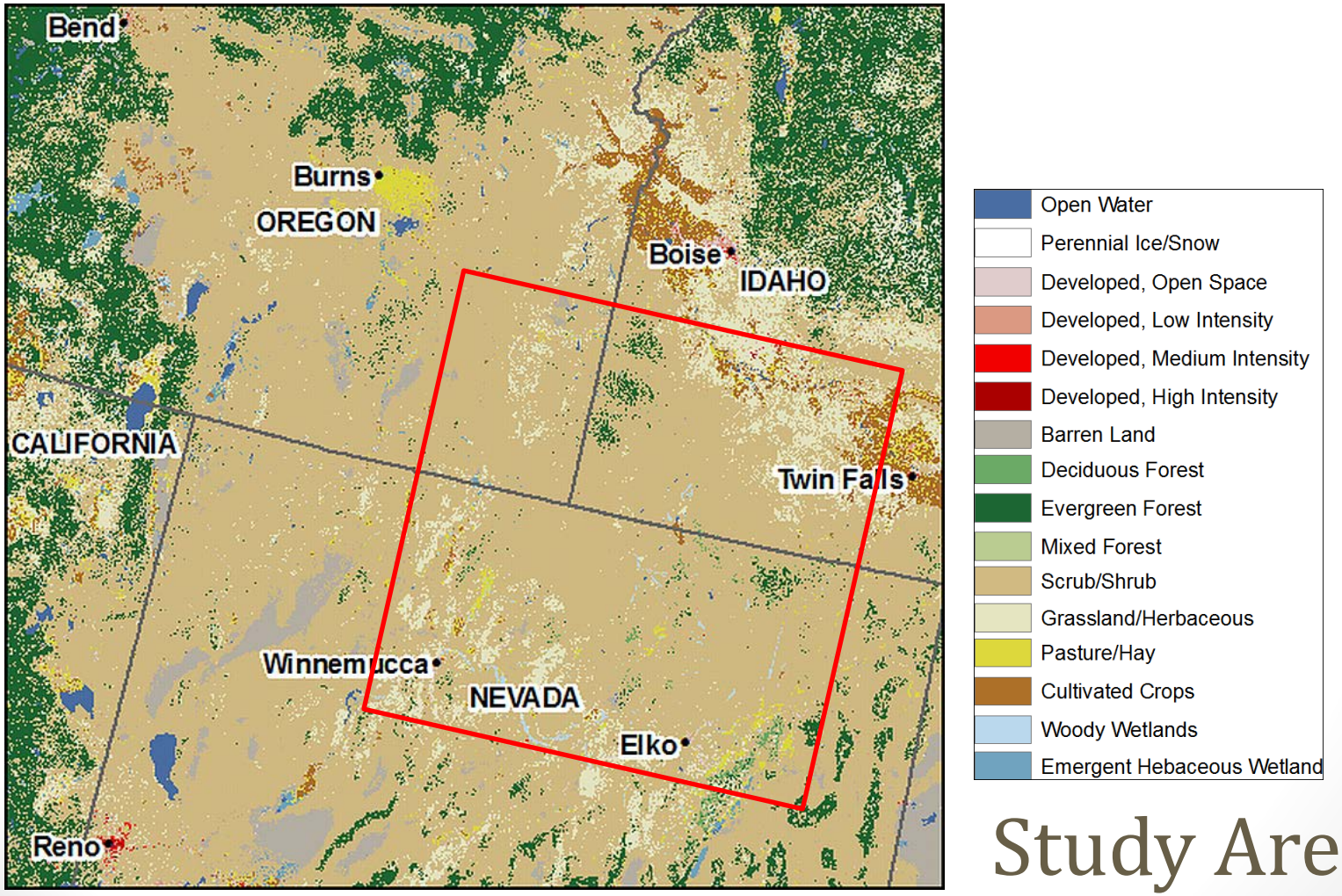




Examining the multi-year pattern and role of litter in a complex mosaic of die-off and intact cheatgrass stands

Cheatgrass and dieoff mapping in Northern NV / Northern Great Basin

USGS – Earth Resources Observation and Science (EROS) Center



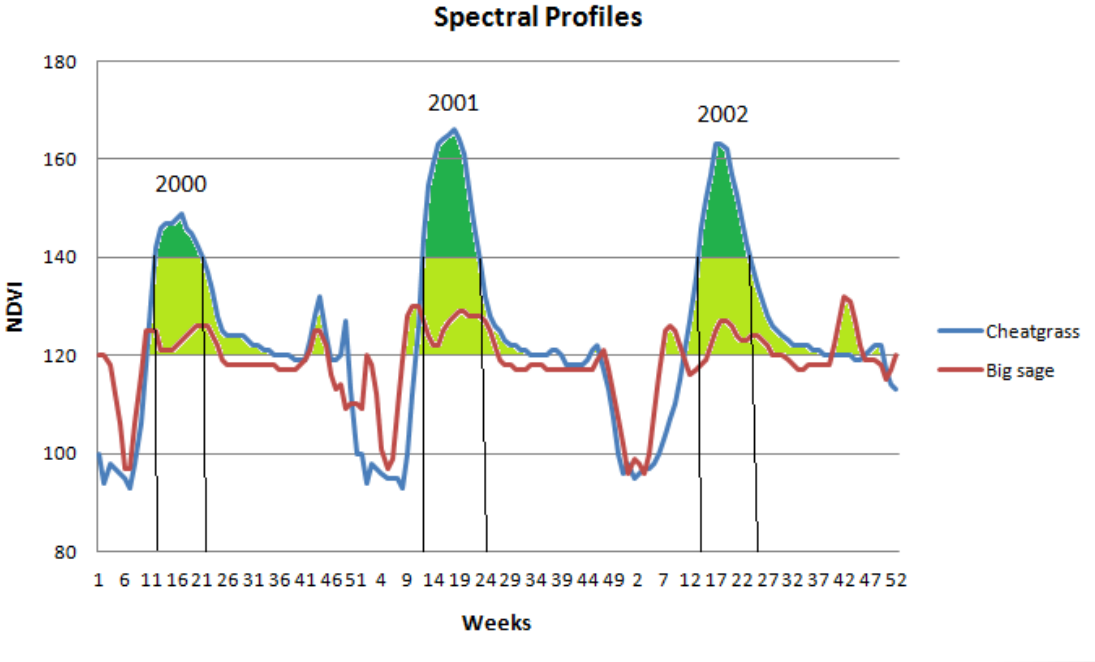
Study Area

Methods—The Premise

Early spring phenology of cheatgrass produces an NDVI profile distinguishable from other vegetation types.

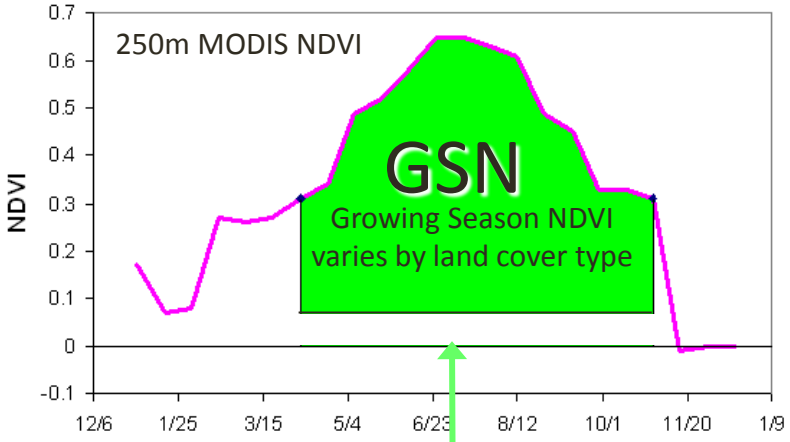
Remote sensing data: Normalized Difference Vegetation Index (NDVI) measures the amount of green biomass

We used expedited
Spectroradiometer (
to monitor seasonal
biomass.



Two pixels (one cheatgrass and one big sagebrush) in close proximity show distinctly different profiles during early spring.

Rangeland dynamics: space and time



SPACE

Long-term Mean GSN
Elevation
Land Cover
Compound Terrain Index
Slope
Aspect
SSURGO range production
+ other

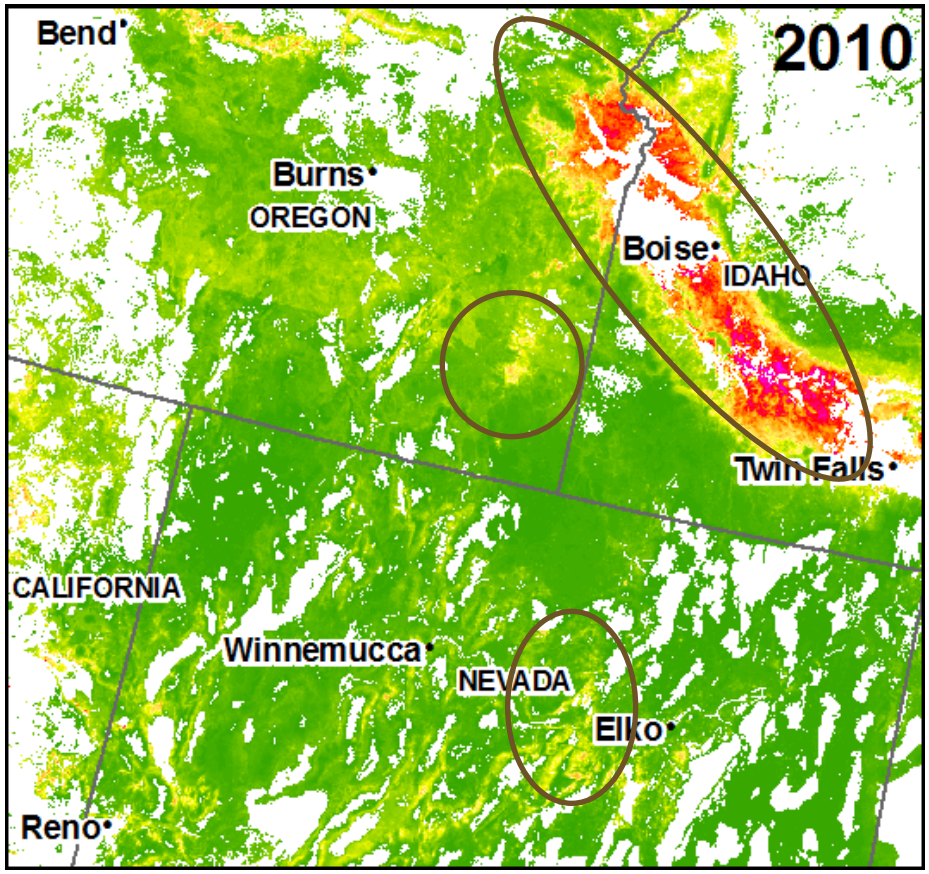
TIME

Winter Precipitation
Spring Precipitation
Early Summer Precipitation
Late Summer Precipitation
Fall Precipitation
Winter Max Temperature
Spring Max Temperature
+ other

Modeled GSN = f(site potential, weather)

Comprehensive regression tree models are developed for each land cover class

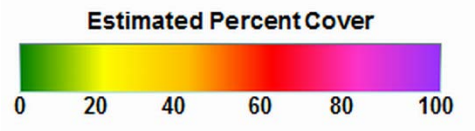
Time Series of Percent Cover Results (2000 – 2010)



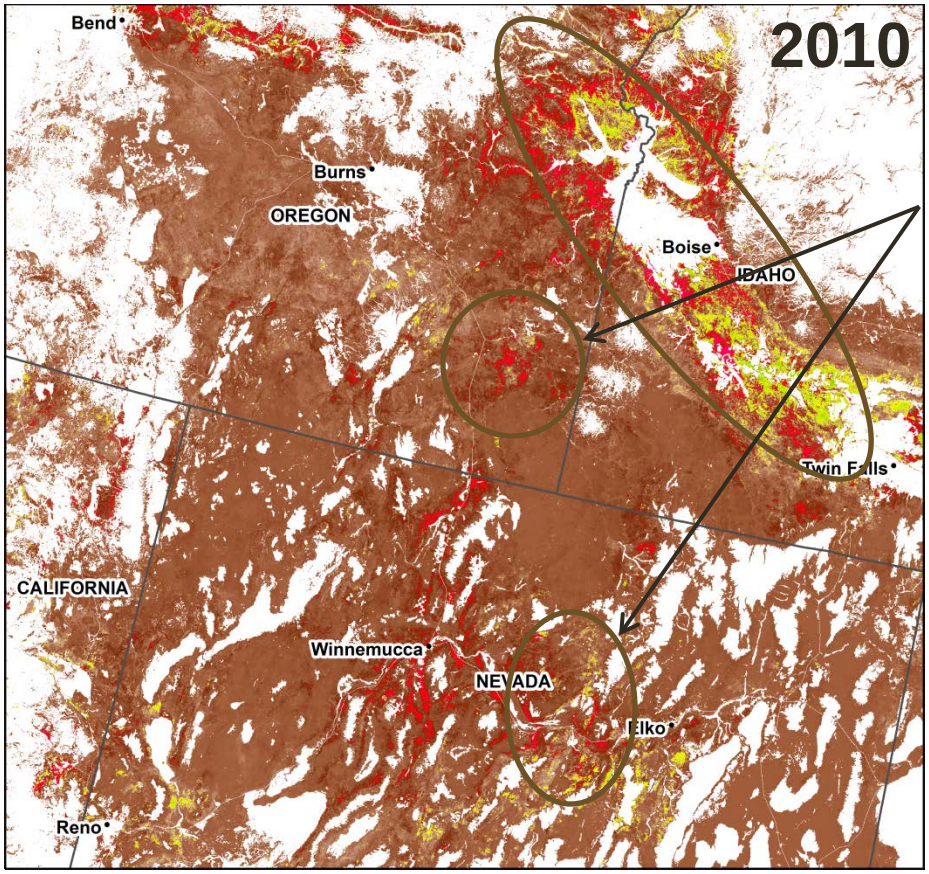
Areas of high spatial & temporal variability in percent cover characterize the maps.

Model Accuracy:
Training Data (35,988 cases)
Average error = 4.4% cover
Relative error = 0.33
R^2 = 0.85

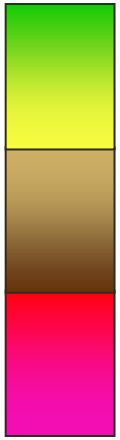
Test Data (4012 cases)
Average error = 4.6% cover
Relative error = 0.34
R^2 = 0.83



Time Series of Dieoff Results (2000 - 2010)



Areas of high spatial & temporal variability in cheatgrass performance characterize the maps. Underperformance indicates areas of probable dieoff.

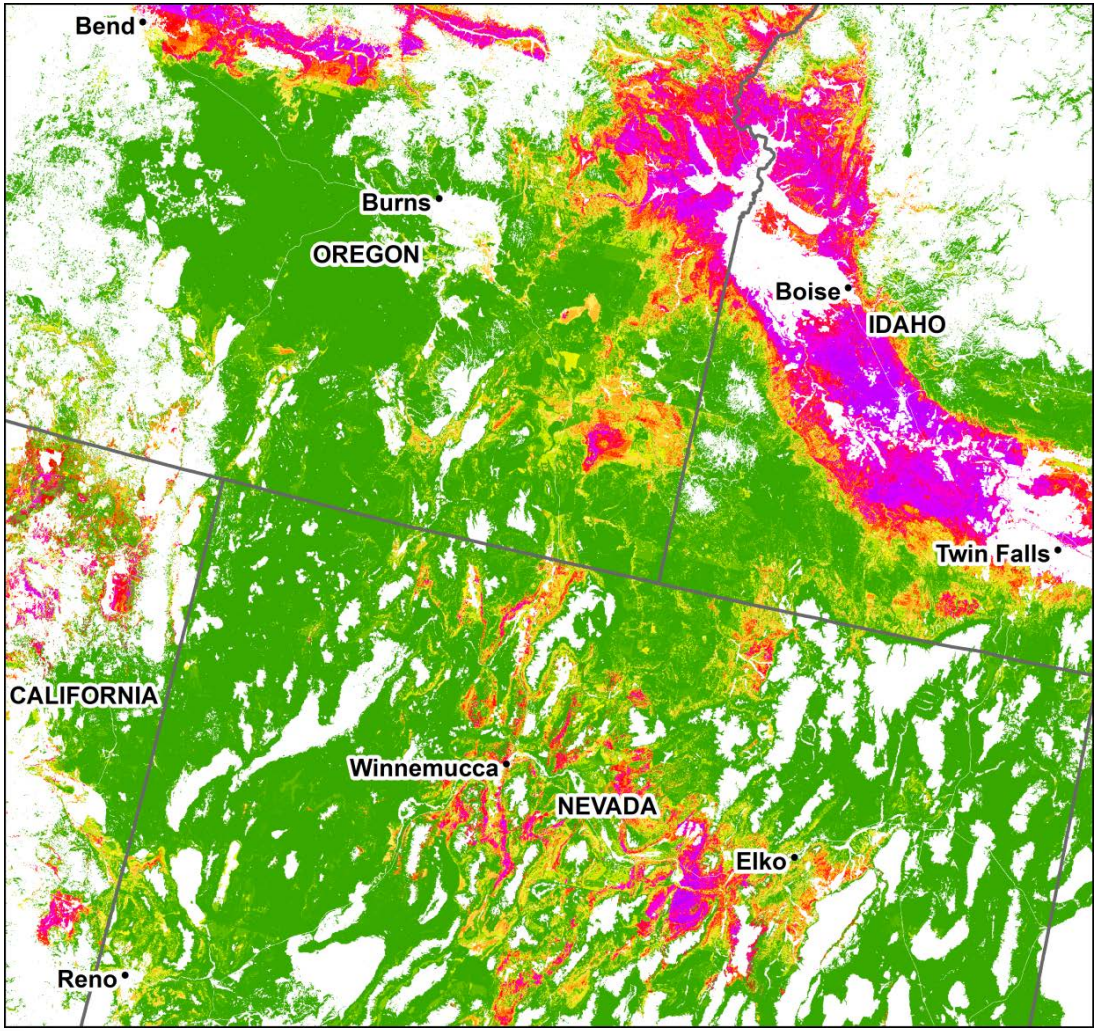


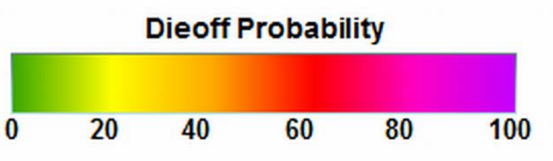
Overperformance

Normal

Underperformance

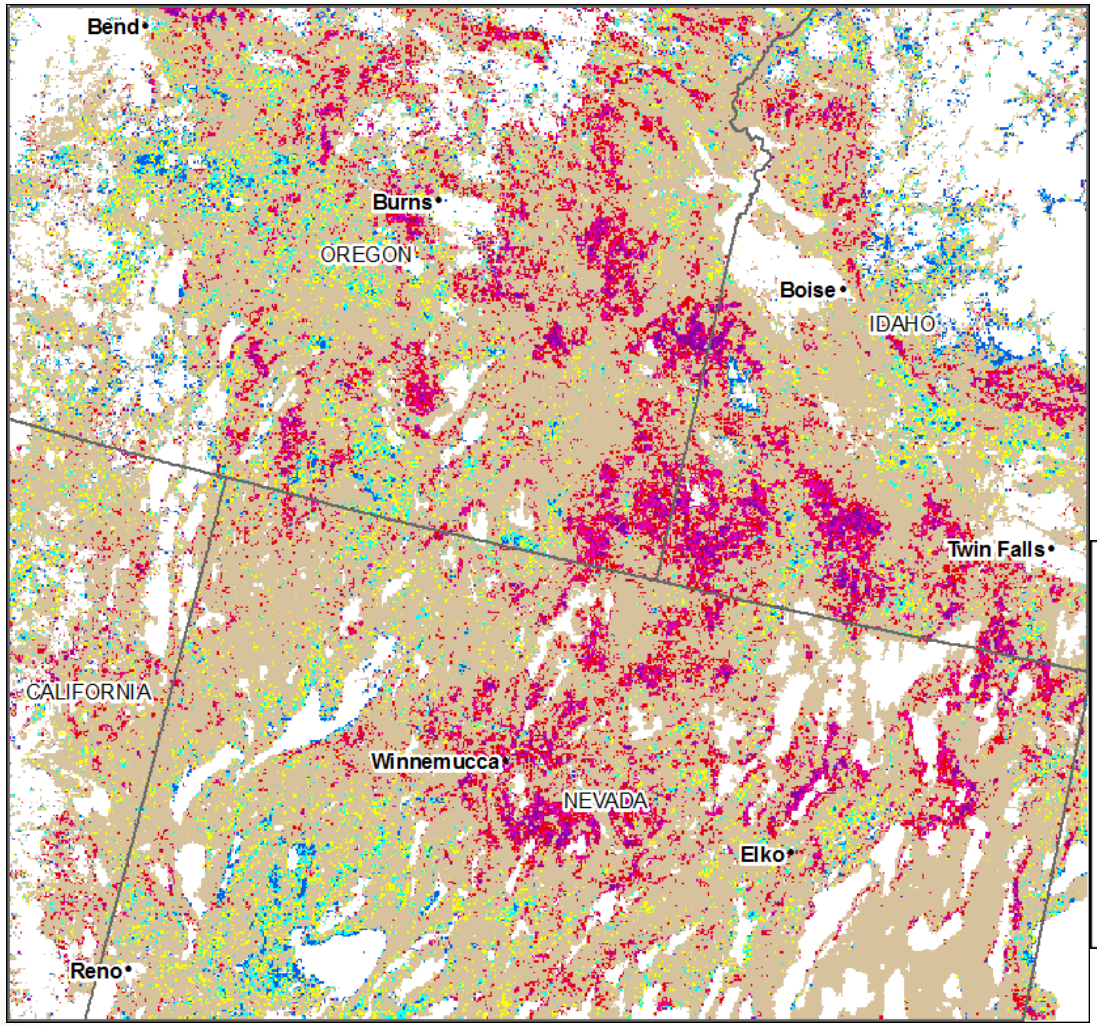
Present Day Dieoff Probability





Dieoff time-series, topographic, soils, latitude proxy, land cover, and climate data integrated into a decision-tree model to create the probability map.

Cheatgrass Anomaly (Dieoff) Trends

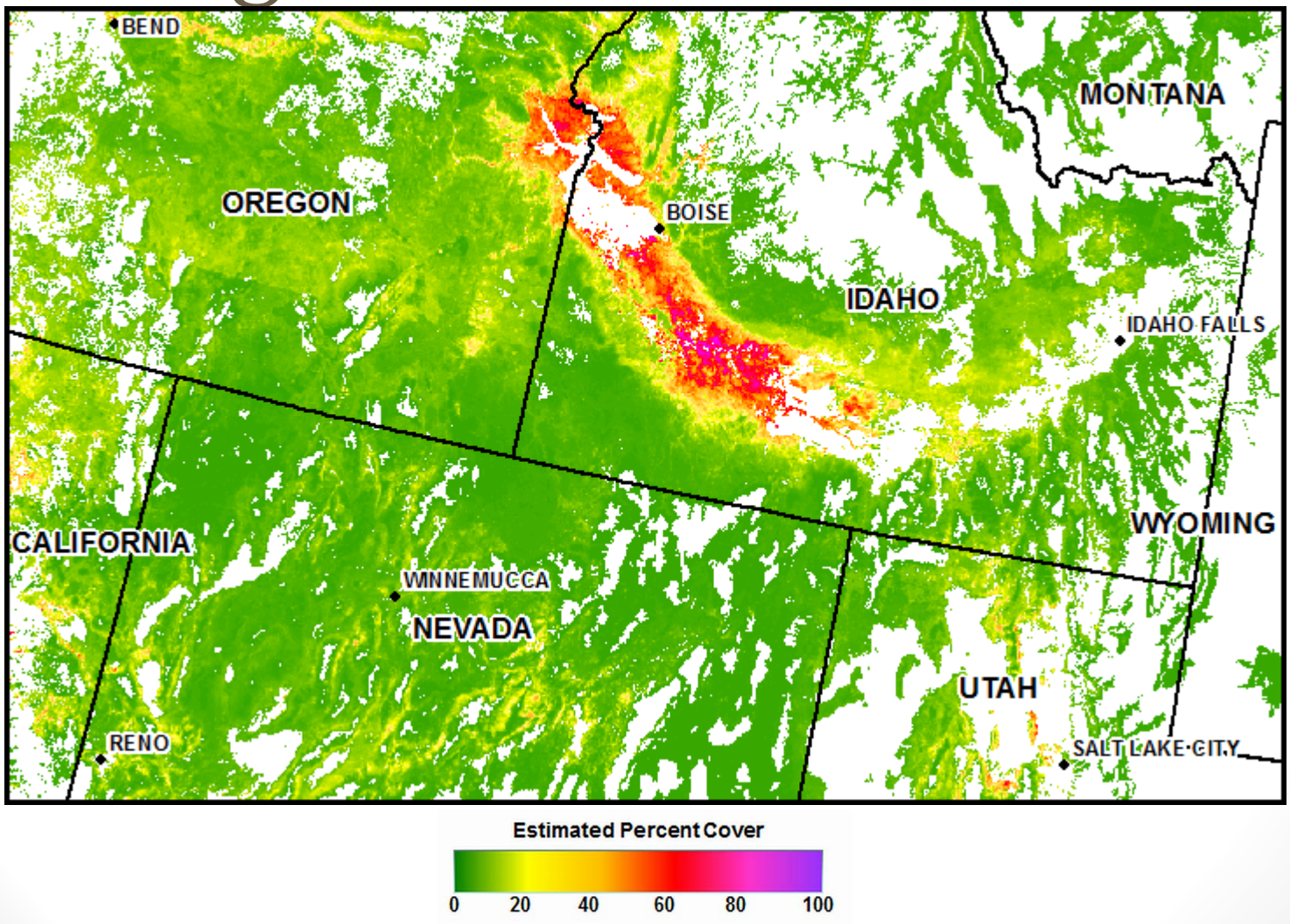


Negative trends indicate declining cheatgrass performance during the study period and could indicate a shift to dieoff or more severe dieoff.

Significant Trend

- Positive trend at 95% CI
- Positive trend at 90% CI
- Positive trend at 80% CI
- No Significant trend
- Negative trend at 80% CI
- Negative trend at 90% CI
- Negative trend at 95% CI

2010 Northern Great Basin Cheatgrass Percent Cover



2010 Northern Great Basin Cheatgrass Die-off