“On the Horizon”

The Next Steppe Conference

Thursday, November 6, 4:15 p.m. -5:15 p.m.

Moderator:

John Cissel, Joint Fire Science Program

Presenters:

Dr. Susan Meyer, USFS

Dr. April Hulet, Agricultural Research Services

Dr. Matt Reeves, USFS

Cheatgrass Die-off as a Restoration Opportunity

Susan E. Meyer, Research Ecologist

USFS Rocky Mountain Research Station,
Shrub Sciences Laboratory, Provo, Utah

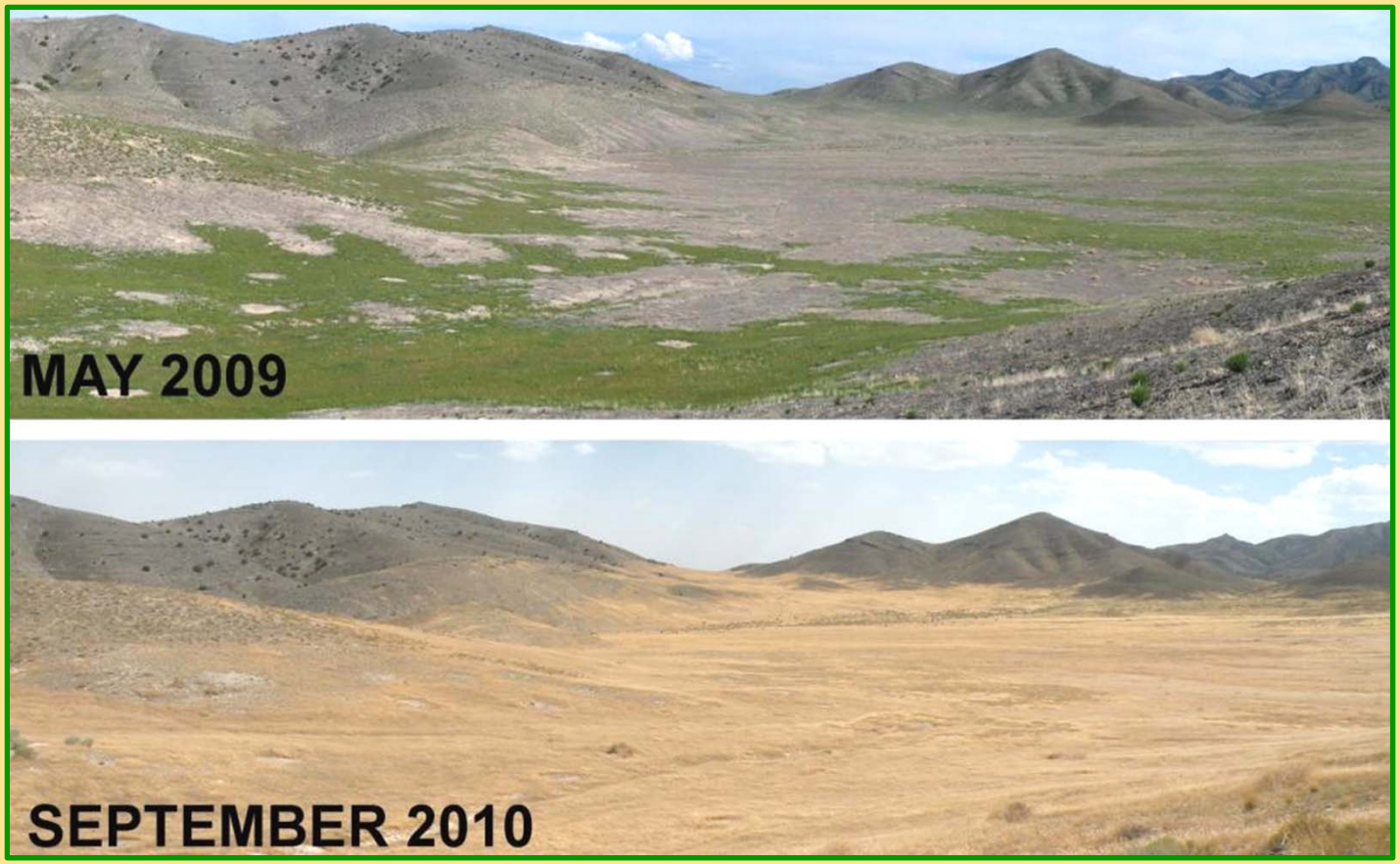
What Is a Cheatgrass Die-off?

Cheatgrass die-off is caused by emergence failure of this annual grass in an area previously occupied by a dense cheatgrass monoculture.

Die-offs vary in size from a few hundred square feet to many hundreds of acres.

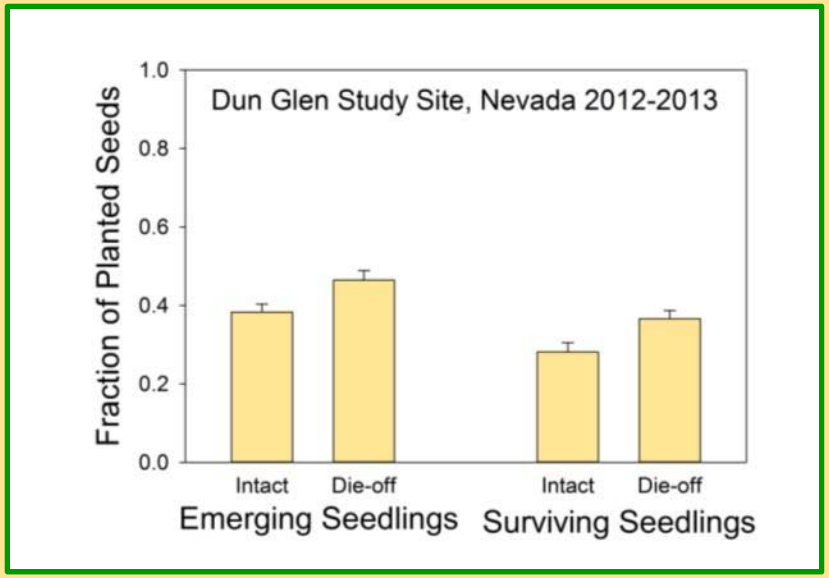
Large die-offs are areas of management concern because of forage loss and potential for erosion.

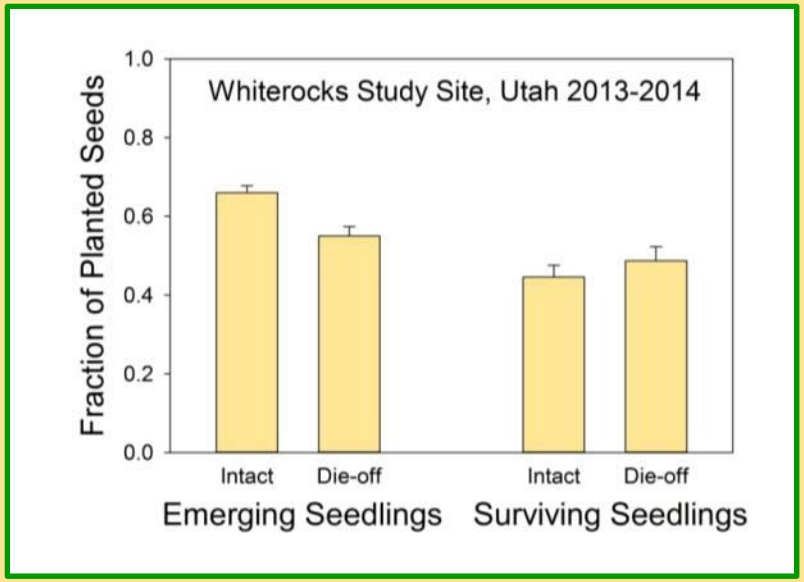
Die-offs Are Usually Transient



Lost Dog Study Site, Skull Valley, Utah

Can Cheatgrass Establish into Die-offs? Yes.

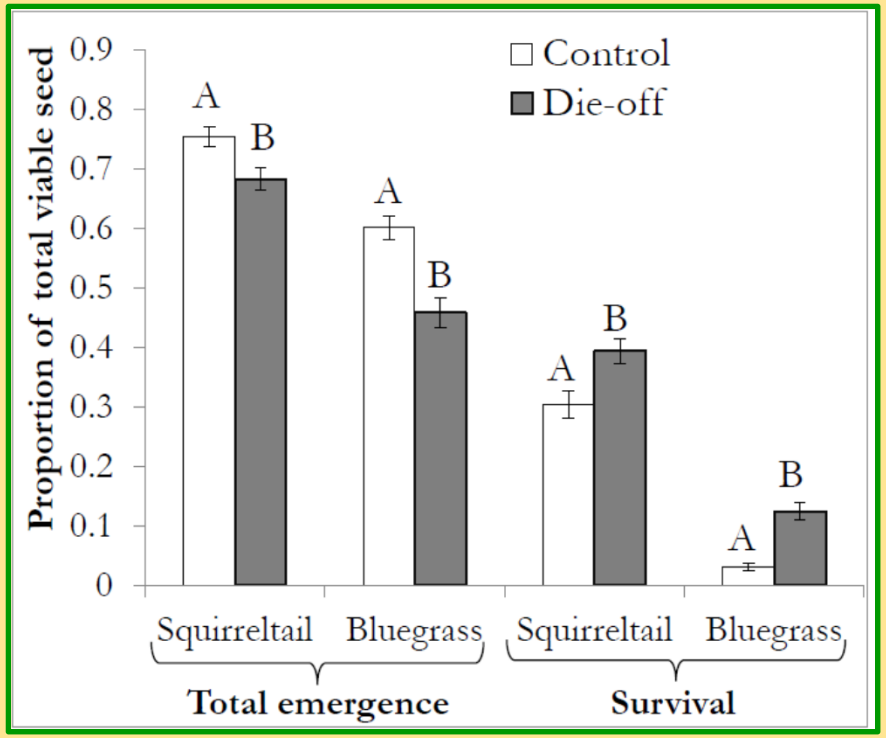


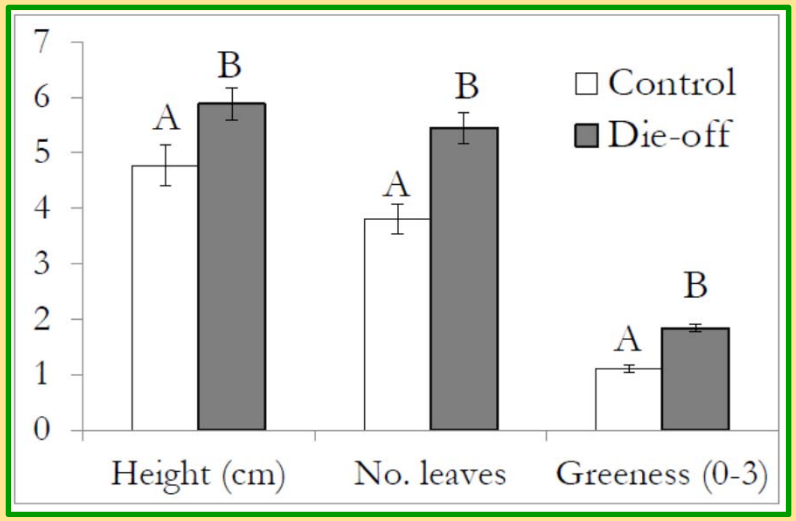


Cheatgrass emergence and survival from planted seeds were similar in die-off areas and adjacent intact stands.

From Joshua Nicholson, MS thesis, Brigham Young University, 2014

Can Native Plants Establish into Die-offs? Yes!





Seedling emergence was somewhat lower in the die-off at Dun Glen, but survival and growth were significantly increased.

From Owen Baughman, MS thesis, University Nevada Reno, 2014

What Causes Die-offs?

Although there are many hypotheses regarding the causes of cheatgrass die-offs, our research over the past four years has produced strong evidence for the following hypothesis:

Cheatgrass stand failure is caused by a complex interaction among multiple soilborne fungal pathogens.

Black Fingers of Death
Pyrenophora semeniperda

This fungal pathogen attacks seeds in the seed bank

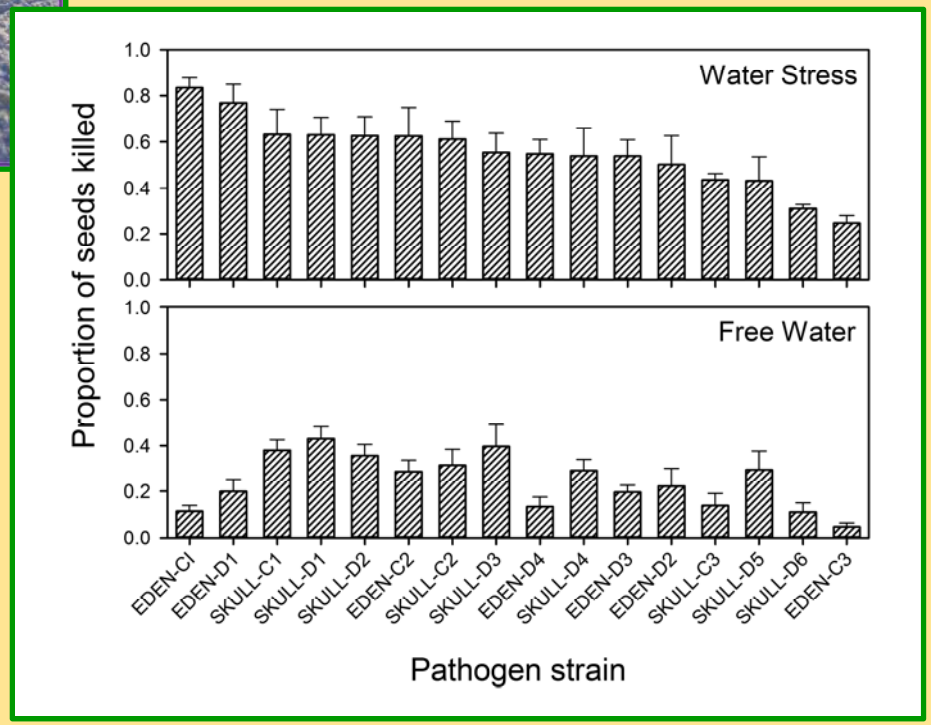
Its primary prey is dormant seeds in the persistent seed bank

It has limited ability to kill germinating seeds and probably plays no direct role in stand failure (die-off)

Stand recovery following die-off is strongly influenced by this pathogen, which can sometimes kill >99% of the seeds in the persistent seed bank.

Fusarium Seed Rot

Fusarium seed rot is caused by one or more undescribed species in the Tricinctum group of the fungal genus *Fusarium.* This disease is believed to be the primary cause of most cheatgrass stand failure.



Bleach Blonde Syndrome

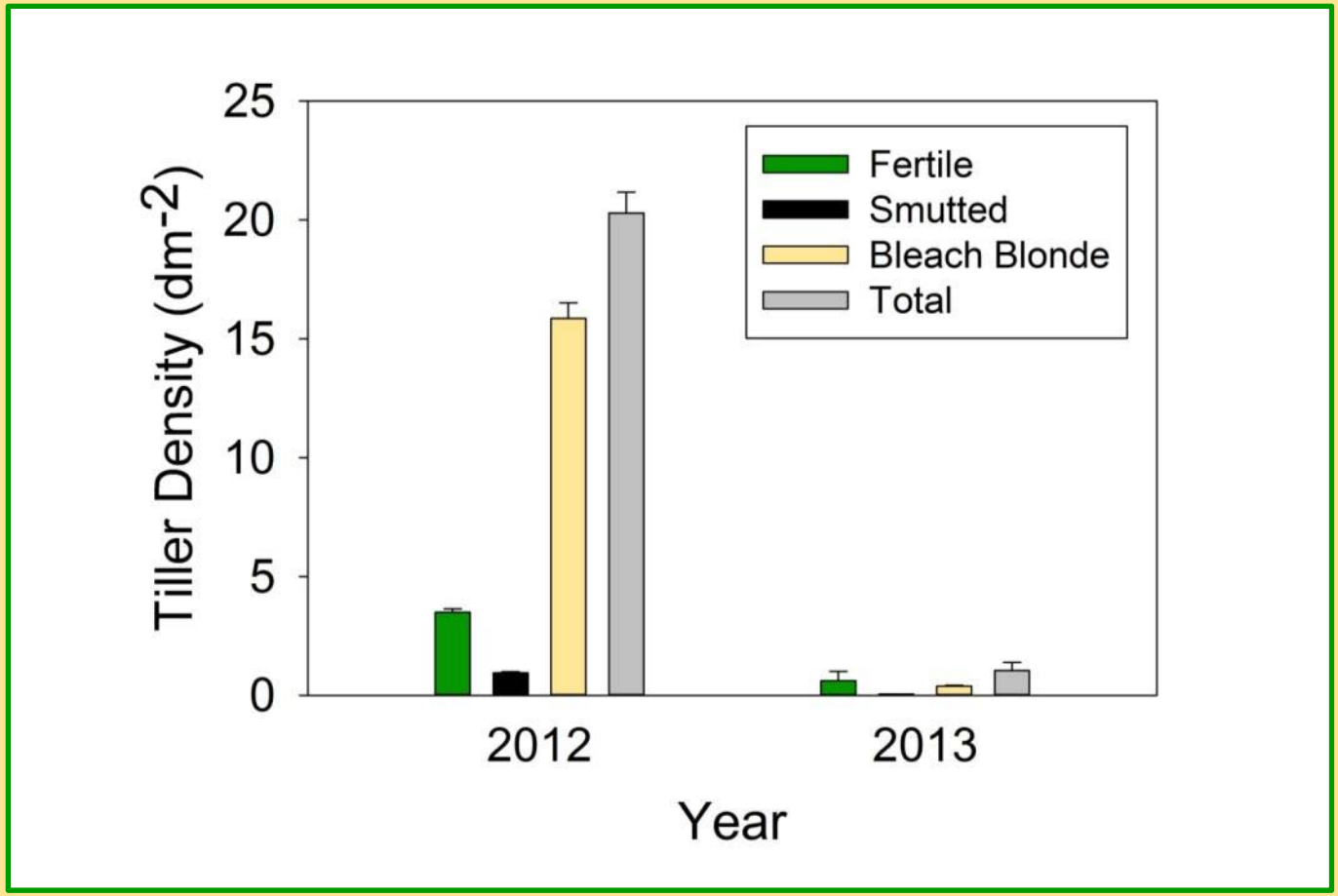
Bleach blonde syndrome is a newly discovered disease caused by an undescribed taxon in the fungal family Rutstroemiaceae. It appears to set the stage for stand failure.

The Legacy of a Bleach Blonde Epidemic

Bleach blonde epidemic
Year One

Stand failure
Year Two

The Legacy of a Bleach Blonde Epidemic



Soil Fungistasis and Die-off Cycles

- The bleach blonde pathogen is activated by a specific stimulus from the host roots at high host density.
- The Fusarium seed rot pathogen is always present, but it is suppressed by the soil microbial community at low labile carbon (aka carbohydrate) levels, that is, through the process of fungistasis.
- A pulse of labile carbon can 'wake up' the Fusarium and cause a die-off.
- A possible source of this pulse of labile carbon is carbohydrate-rich bleach blonde litter.
- Post-die-off, the labile carbon is again tied up by the microbial community, and disease levels drop dramatically the following year.

Testing the Soil Fungistasis Hypothesis

Die-off near the Great Salt Lake - 2014

Can Adding Labile Carbon Cause a Die-off?

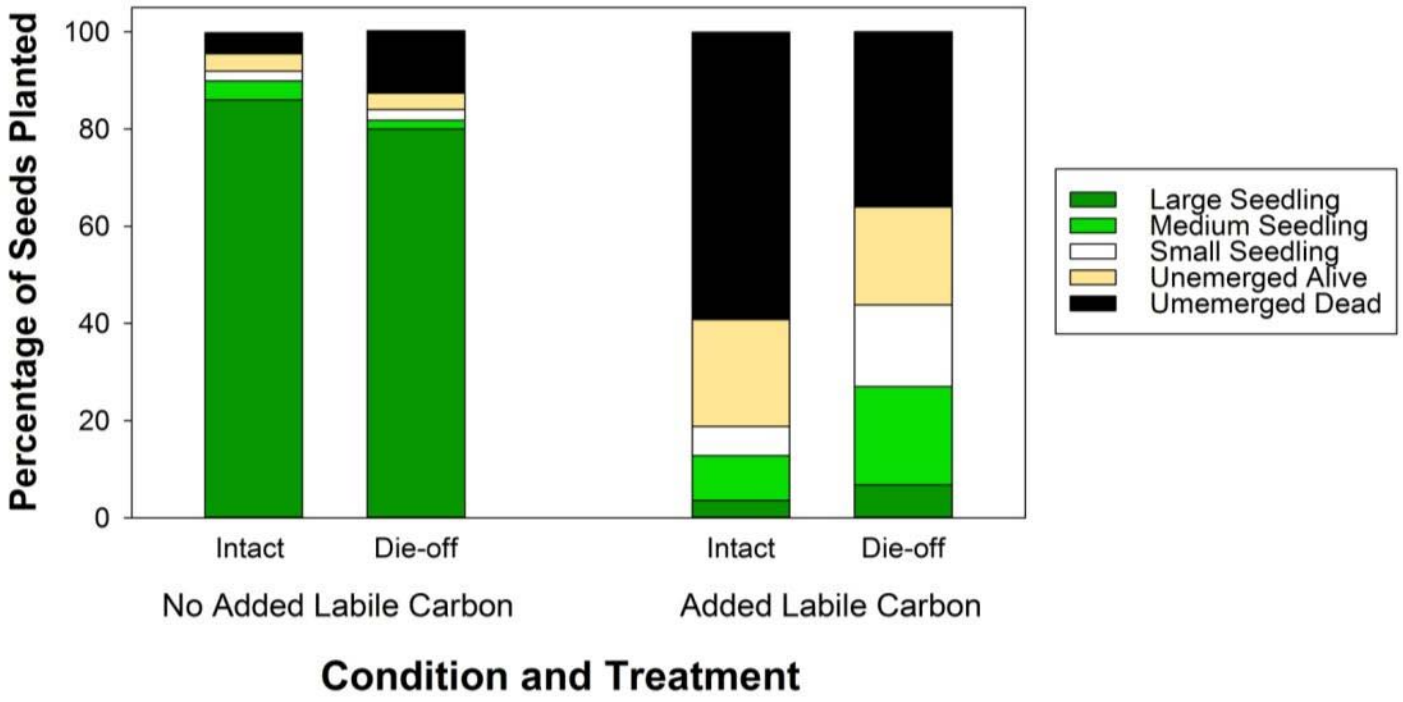
- Collected 40 ring microcosms, 20 each from recent die-off and intact cheatgrass areas in Paradise Valley near Winnemucca, Nevada in August 2014
- Each ring was planted with 50 non-dormant pink-dyed cheatgrass seeds
- Half of the rings received a labile carbon addition and half did not
- All rings were watered to field capacity and incubated under lights at room temperature for 7 days
- Emerged seedlings were classified as large (ca.>3 cm long), medium (1-3 cm long), or small (<1 cm long)
- Unemerged seeds were excavated and placed in petri dishes for 3 days.
- Seeds were scored either as unemerged alive (germinated) or unemerged dead.
- Data were analyzed using two-way ANOVA for a randomized design.

Die-off in a Dish?
Just Add Sugar

No added labile carbon

Added labile carbon

Adding Labile Carbon to Ring Microcosms



A Possible Tool for Restoration

If we can predict or manipulate disease in the field to decrease cheatgrass competition in the context of restoration seeding, this could make it possible to restore large areas now dominated by near-monocultures of this plant, which are commonly considered impossible to seed successfully.

This would uncouple the restoration seeding process from the post-fire rehabilitation process, which is primarily undertaken for a different purpose (soil stabilization).

In turn, this would permit a longer-term planning window and a more restoration-focused approach, resulting in a higher probability of seeding success.

Some Unanswered Questions

- What combination of environmental and biotic factors causes the complex spatial patterns of die-off observed on the landscape?
- Are there any other pathogens involved?
- Can die-off probability be evaluated by determining pathogen inoculum loads in the soil using molecular genetic techniques?
- Can die-offs be created by adding labile carbon, and to what extent does this depend on the *in situ* pathogen load?

Acknowledgments

Funding for this project and related cheatgrass disease research over the last seven years was provided by grants from these organizations.

Joint Fire Science Program
Research Supporting Sound Decisions

BLM
Integrated Cheatgrass Die-off Project

USDA
United States Department of Agriculture
National Institute of Food and Agriculture

Co-principal Investigators:

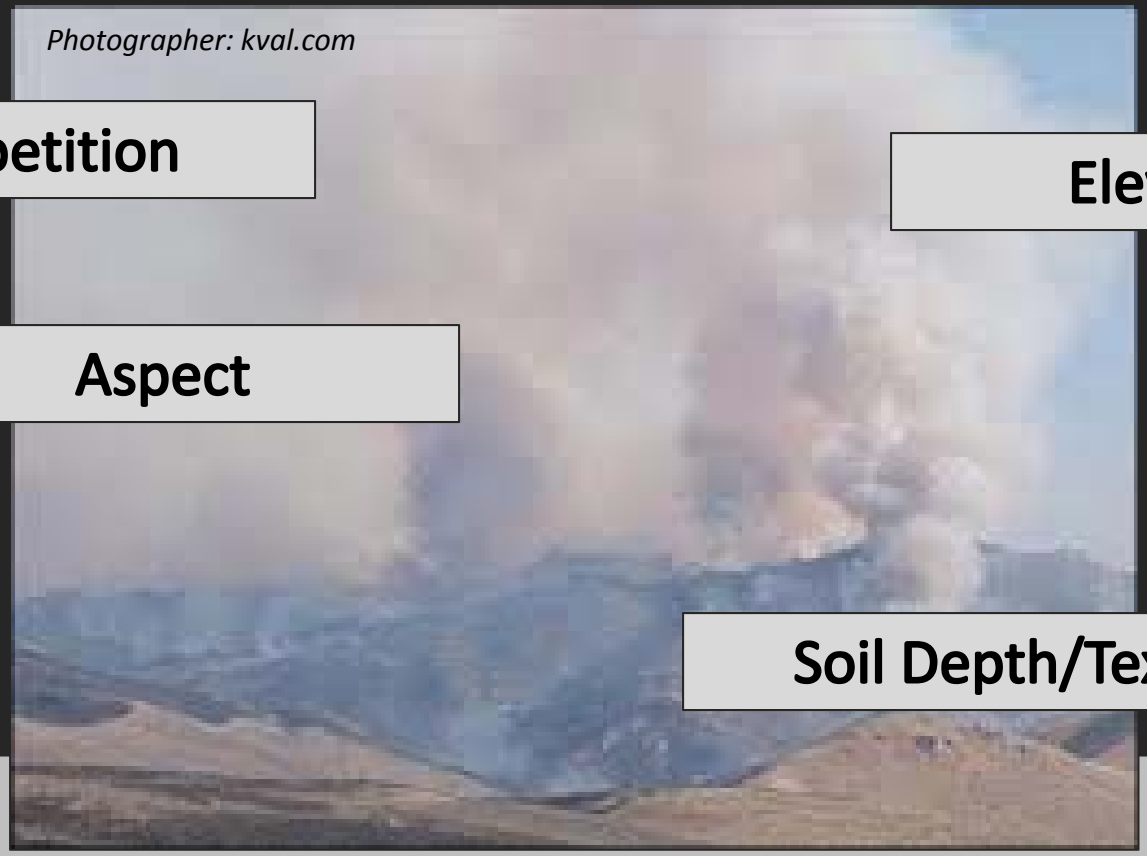
Julie Beckstead, Gonzaga University
Beth Leger, U Nevada Reno
Peter Weisberg, U Nevada Reno
Phil Allen, Brigham Young University
Brad Geary, Brigham Young University
Zach Aanderud, Brigham Young University
Craig Coleman, Brigham Young University

Special thanks to my colleague and graduate student JanaLynn Franke, whose personal research has formed the basis for much of our progress in understanding the mechanisms of cheatgrass die-off.

The Use of Seed Enhancement Technologies to Improve Sagebrush Establishment Across an Elevation Gradient

April Hulet, Kirk Davies, and Matt Madsen
USDA-Agricultural Research Service | Burns, Oregon

Fire Severity



Photographer: kval.com

Competition

Elevation

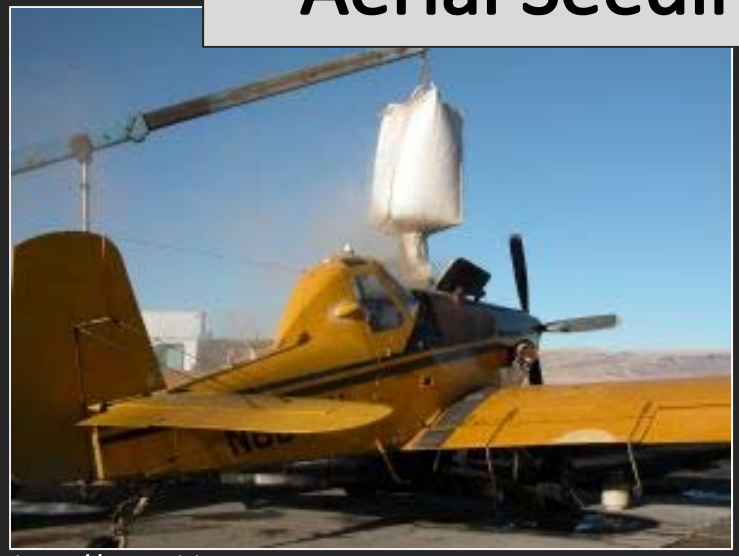
Aspect

Soil Depth/Texture

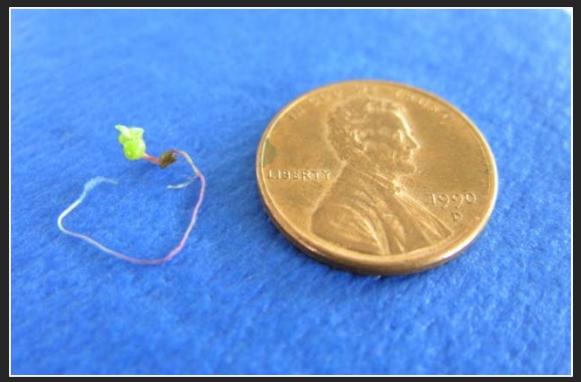
Sagebrush Restoration Methods

Rangeland Drills

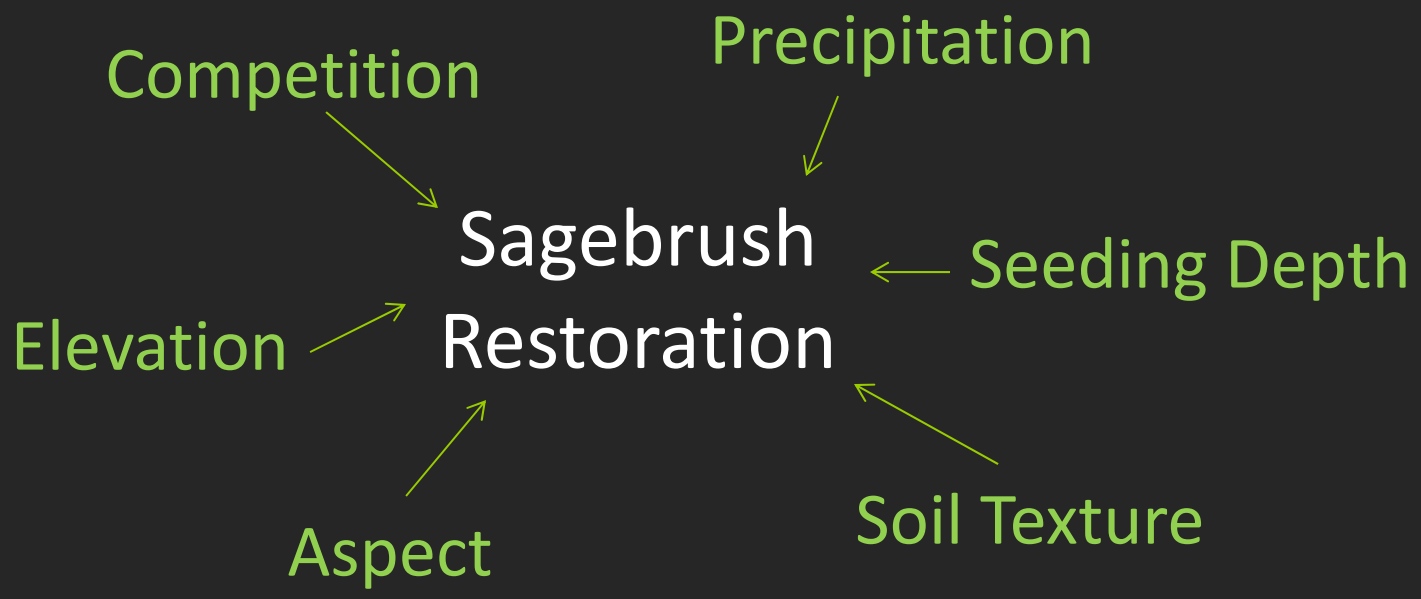
Aerial Seeding



http://www.blm.gov



Limited by Biotic and Abiotic constraints



Seed Enhancement Technologies

Seed Enhancement Technologies: Dr. Matt Madsen

Seed Pillows

Seed Pellets

Extruded Seed Pillows

Ingredients

Dough extrusion

Dusting

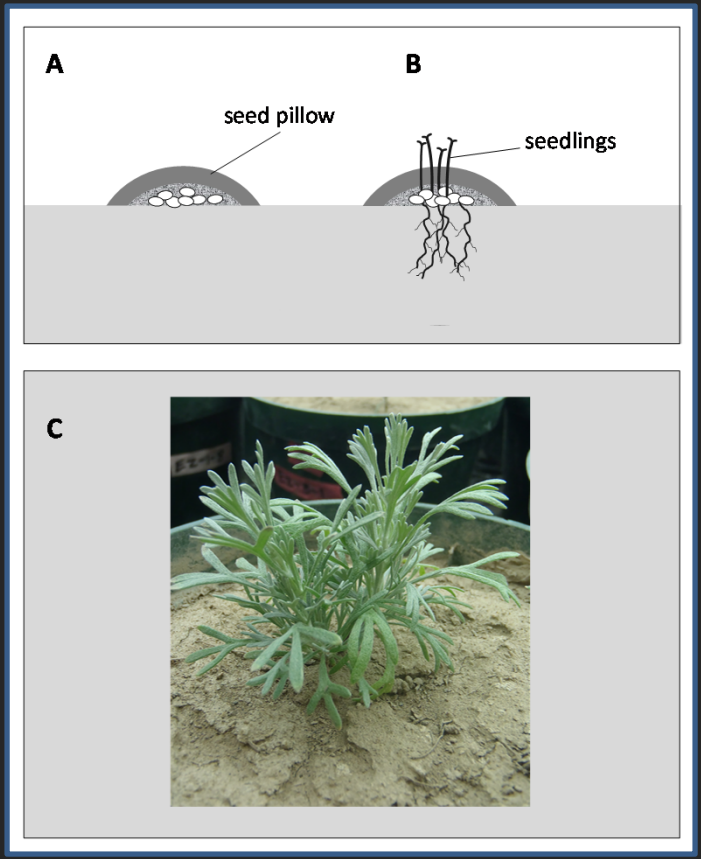
Rip cut

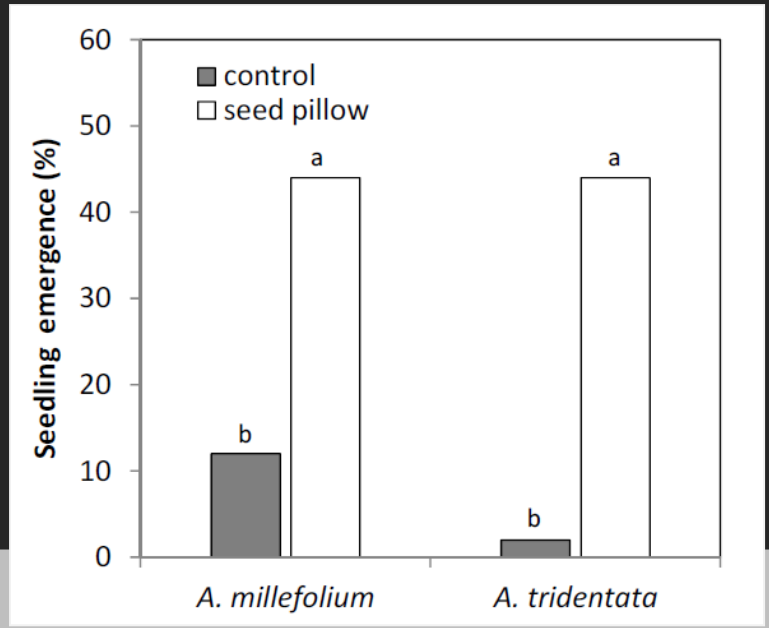
Cross cut

Dried seed pillows

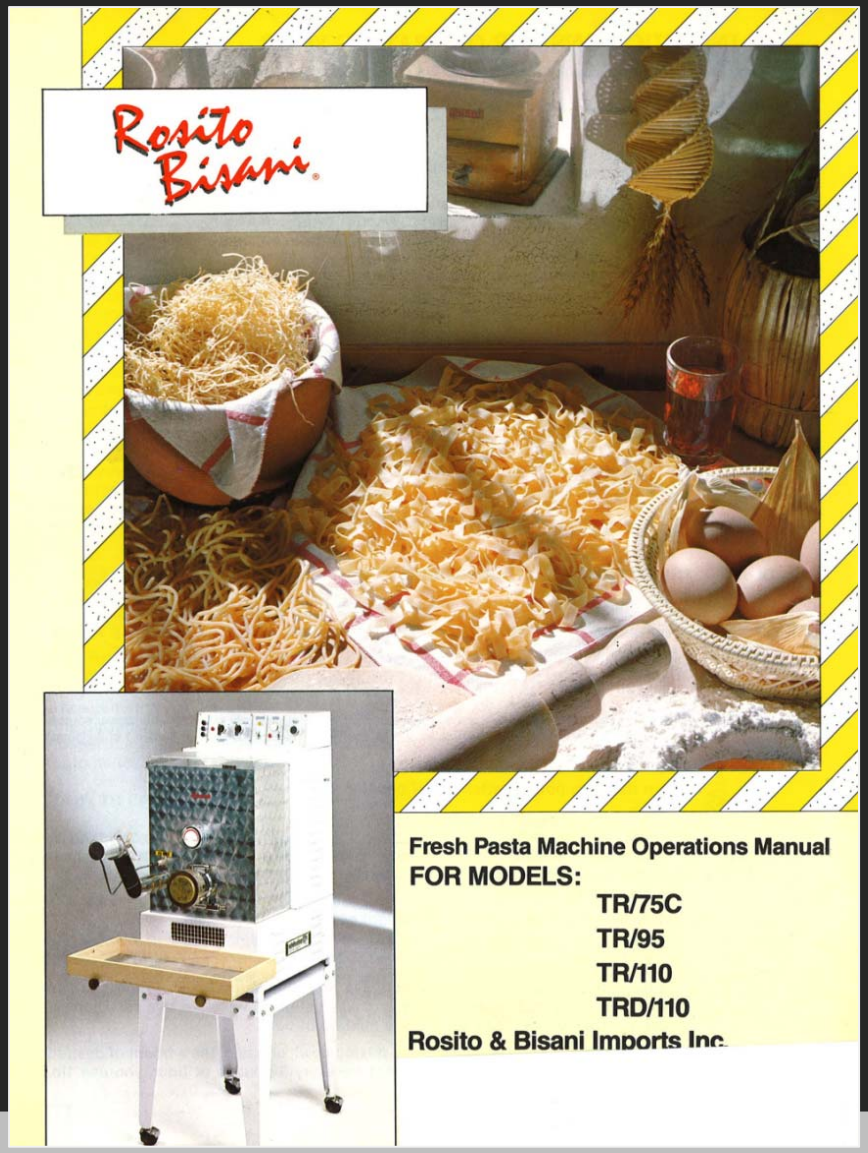
Madsen and Svejcar. U.S. Provisional Patent Application, 2012

Extruded Seed Pillows

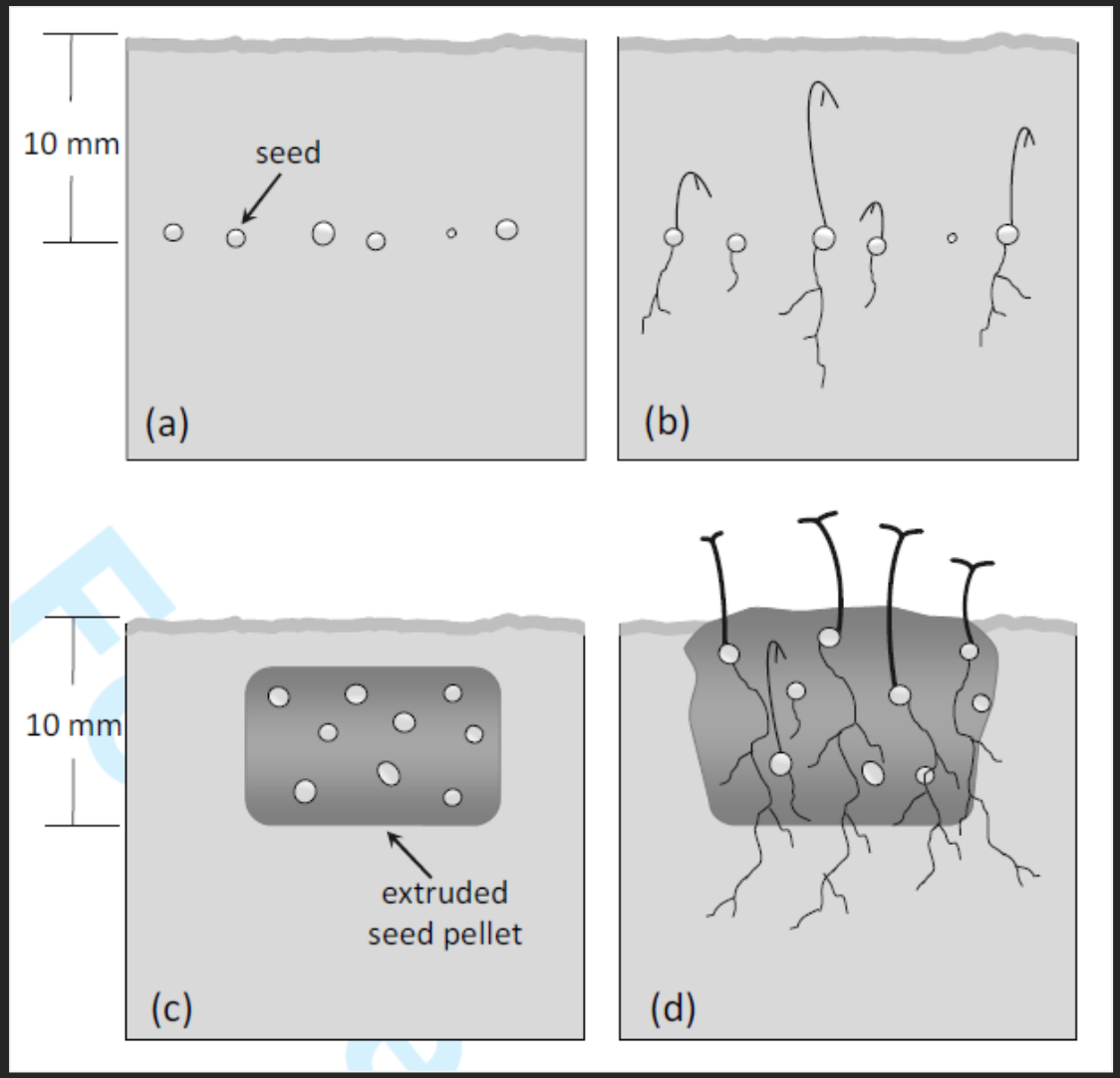




Extruded Seed Pellets



Extruded Seed Pellets



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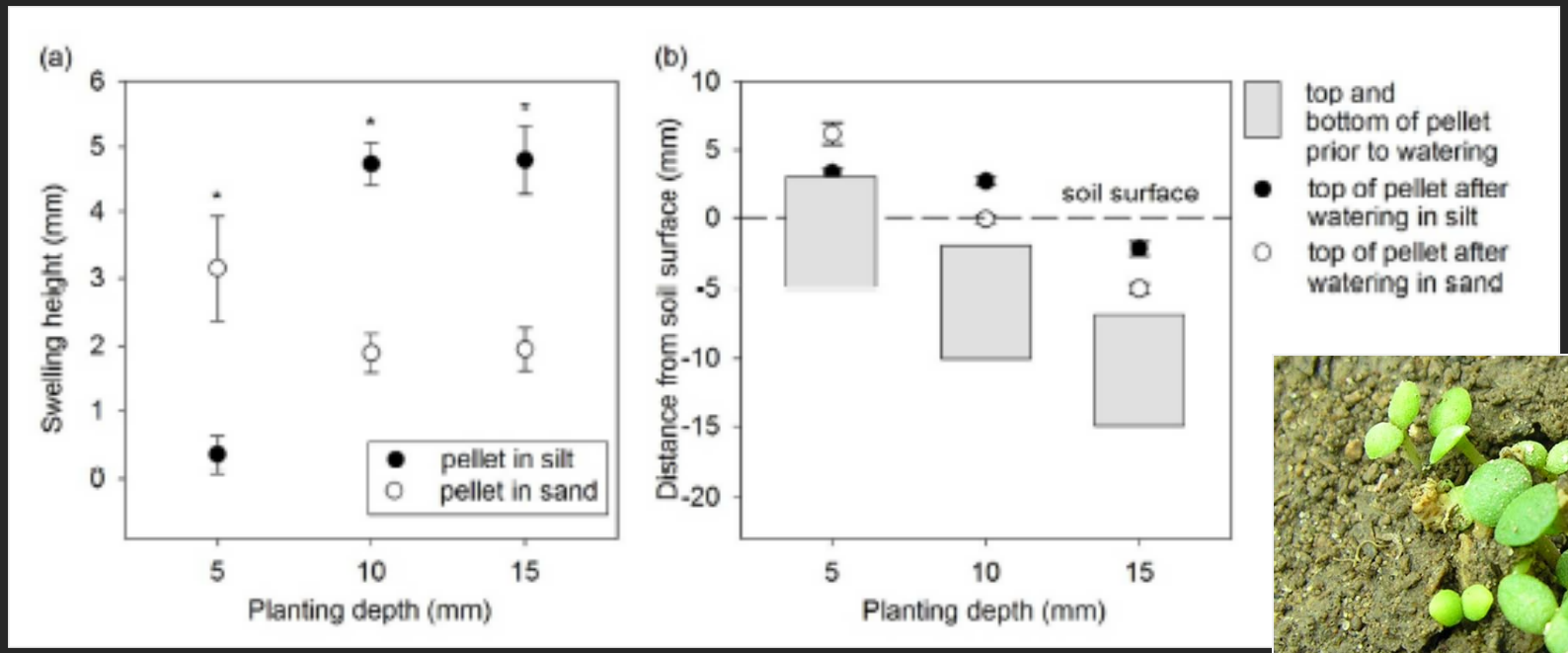
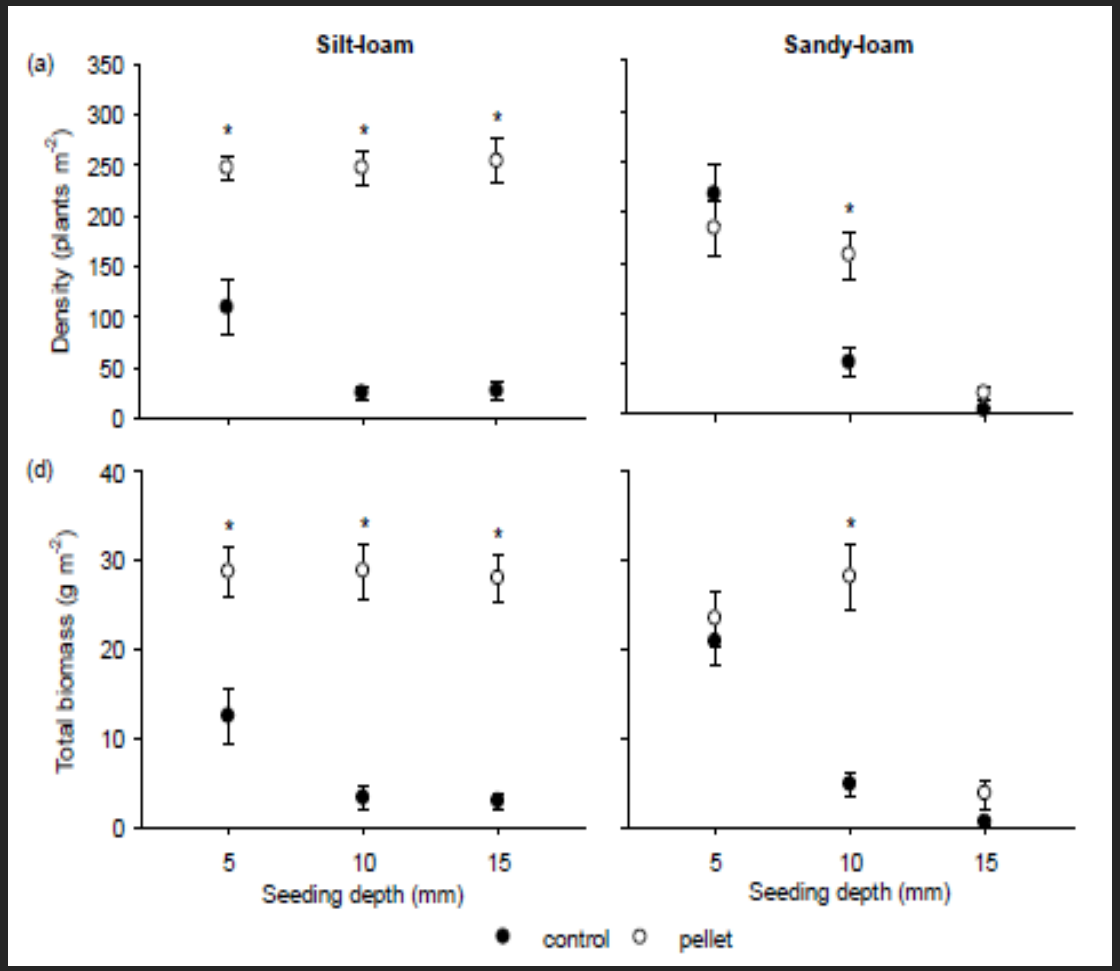


Extruded Seed Pellets



Restoring Sage-grouse Habitat after Fire:

Success of Different **Restoration Methods** across an **Elevation Gradient**

Photographer: Kent Ellett

DAN AGUAYO/THE OREGONIAN

Restoring Sage-grouse Habitat after Fire:

Success of Different **Restoration Methods** across an **Elevation Gradient**

Broadcast Seeding

Broadcast Seeding and Packing

Restoring Sage-grouse Habitat after Fire:

Success of Different **Restoration Methods** across an **Elevation Gradient**

Broadcast Seeding

Broadcast Seeding and Packing

Seed Pillows

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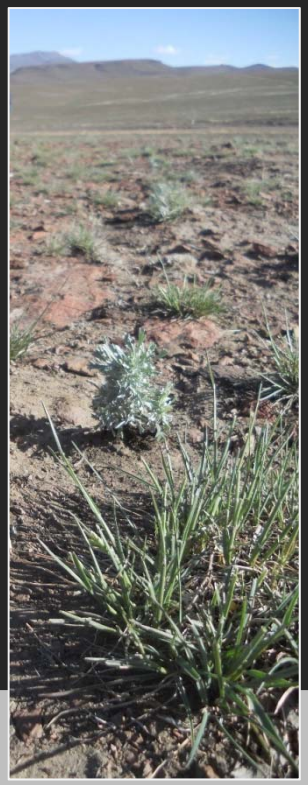
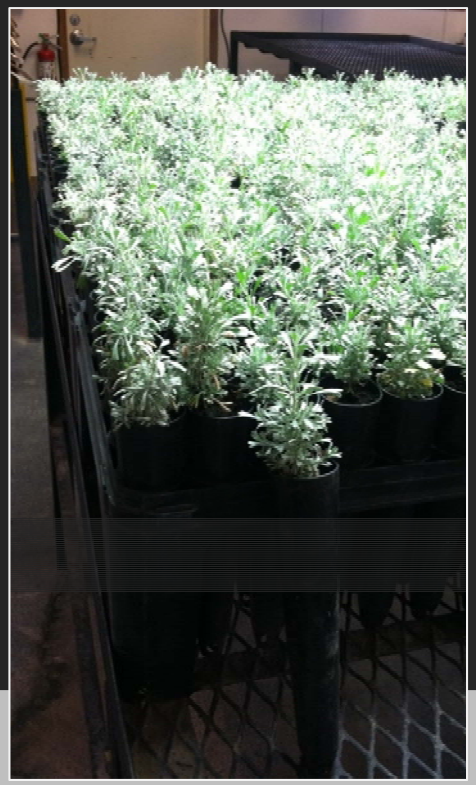




Broadcast Seeding

Broadcast Seeding and Packing

Seed Pillows

Sagebrush Seedlings

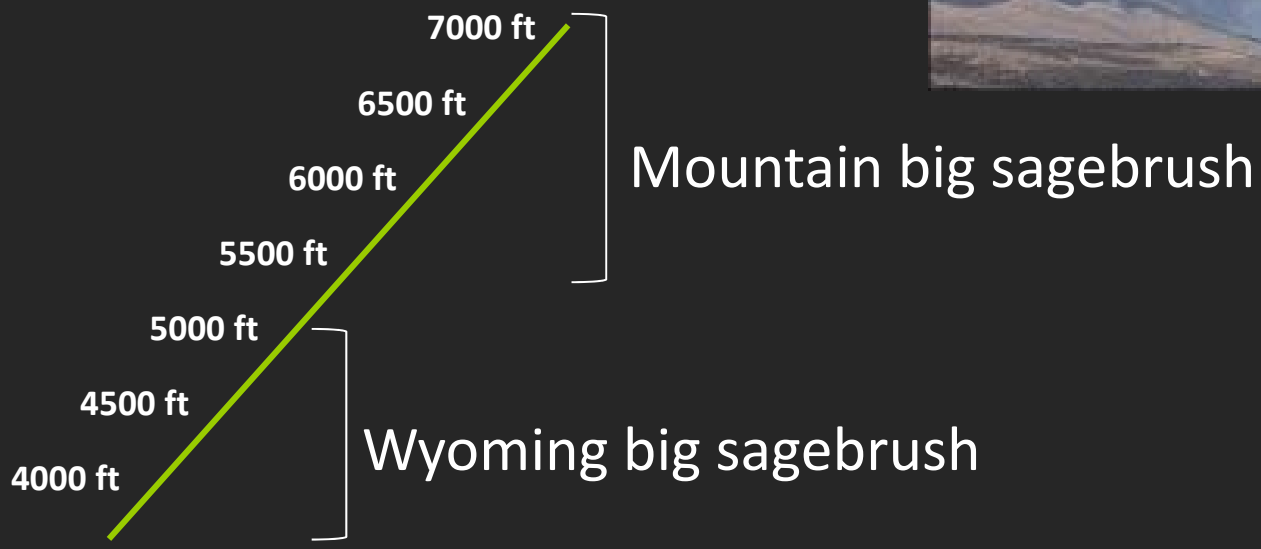
Restoring Sage-grouse Habitat after Fire:

Success of Different **Restoration Methods** across an **Elevation Gradient**

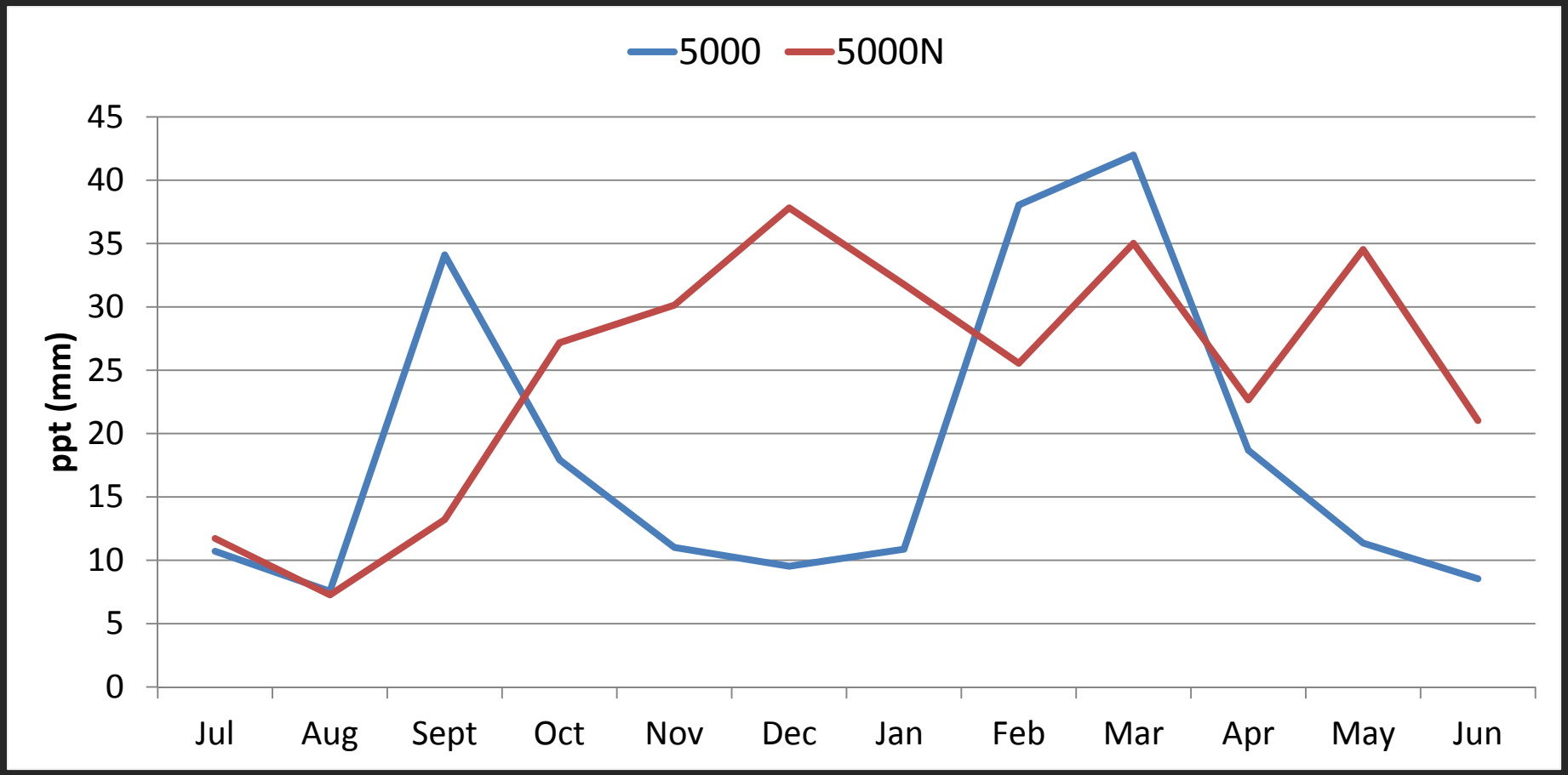
- Broadcast Seeding
- Broadcast Seeding and Packing
- Seed Pillows
- Sagebrush Seedlings
- Natural Recovery

Restoring Sage-grouse Habitat after Fire:

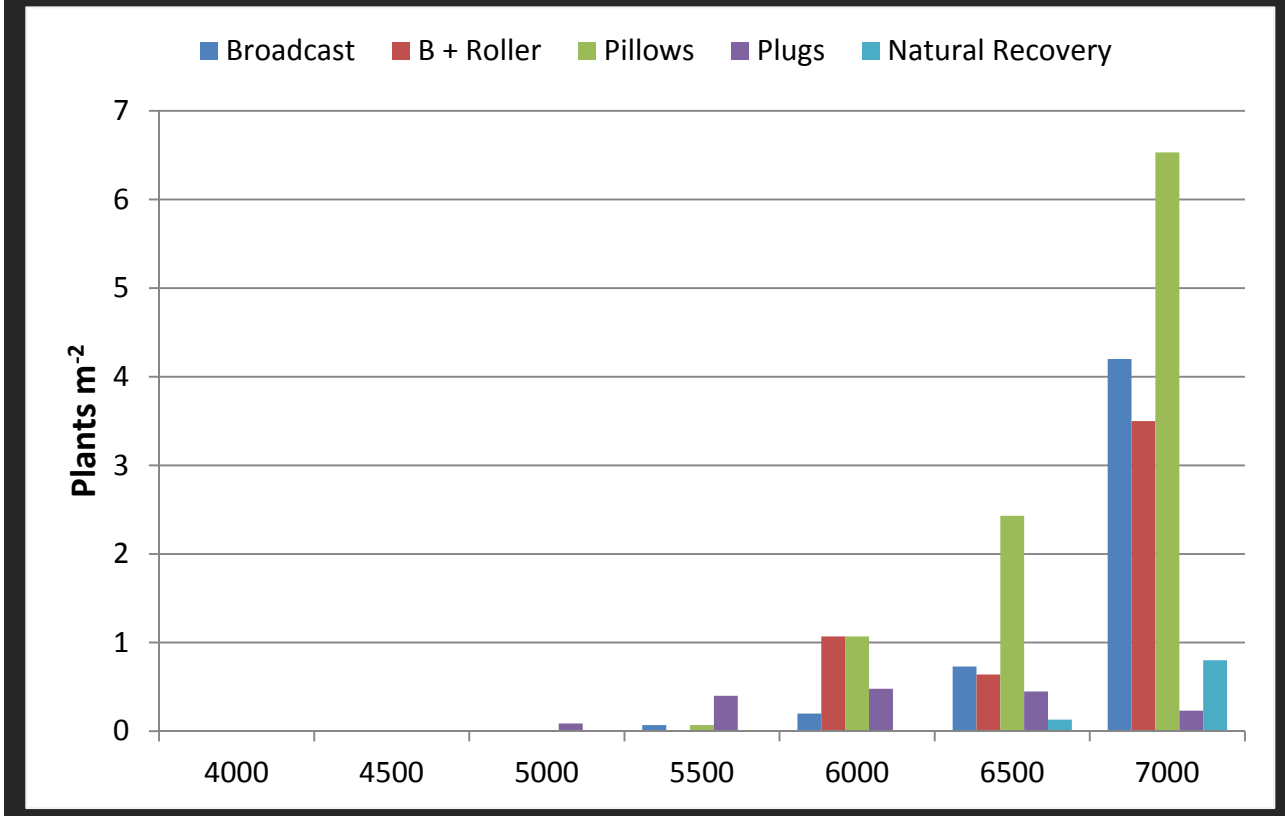
Success of Different
Restoration Methods
across an
Elevation Gradient

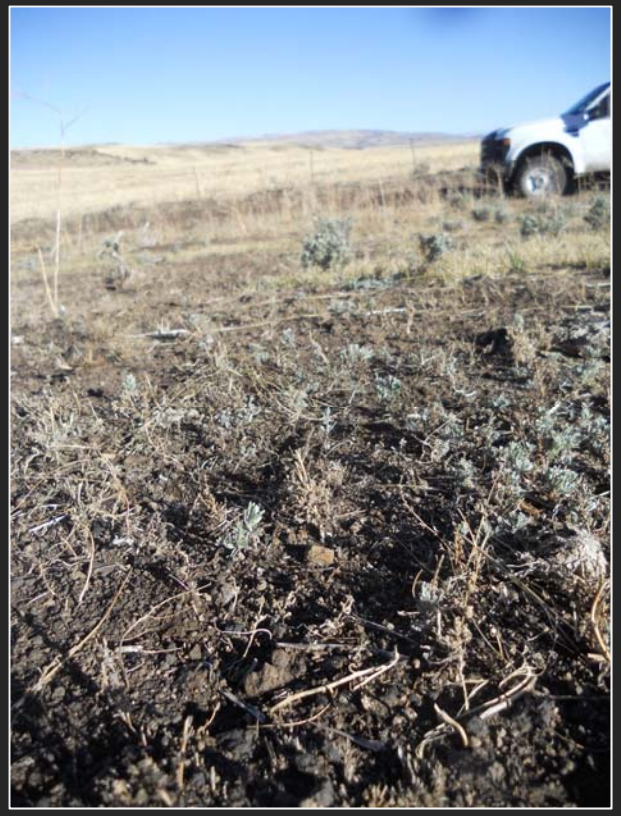


Restoring Sage-grouse Habitat after Fire: PRISM data



Restoring Sage-grouse Habitat after Fire: Preliminary Results





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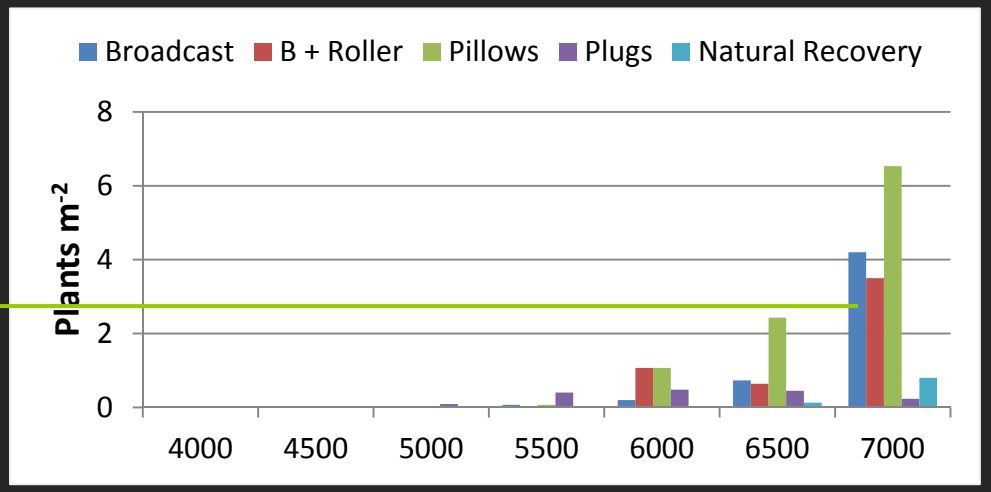
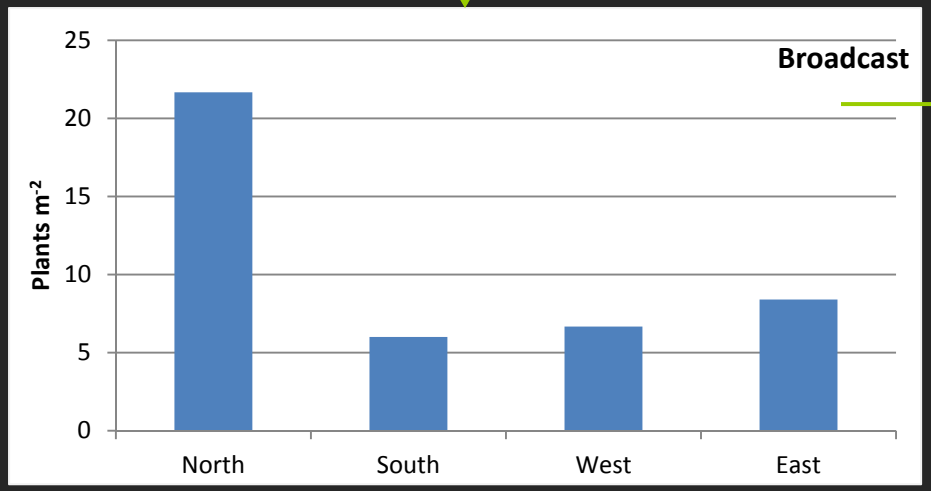
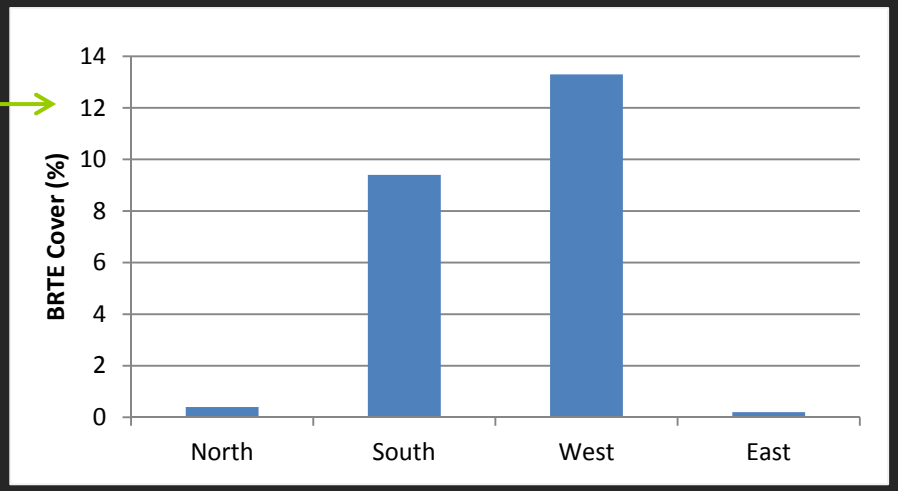
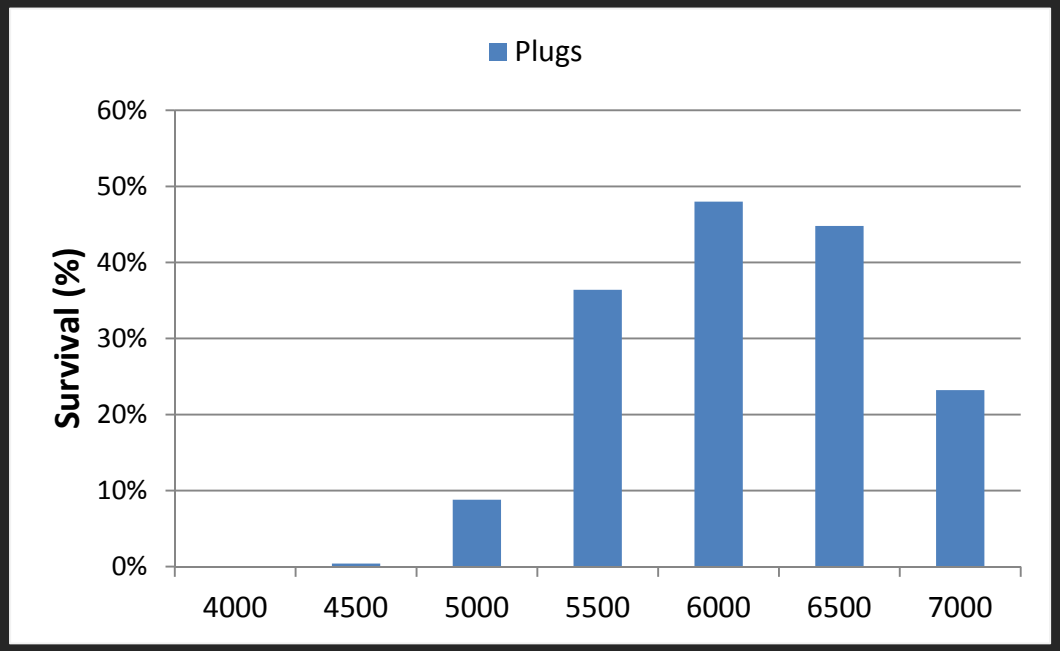






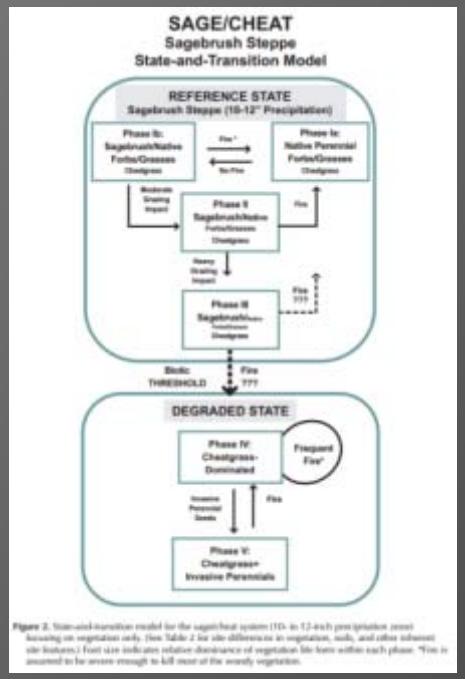
Restoring Sage-grouse Habitat after Fire: Preliminary Results

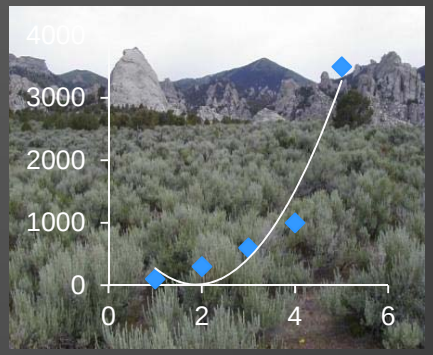


Restoring Sage-grouse Habitat after Fire

Questions

Simulation Modeling and Emerging Technologies for Understanding and Prioritizing Management Actions





The Next Steppe: Sage-grouse and rangeland wildfire in the Great Basin
Boise,
November 6, 2014

Dr. Matt Reeves (USFS, RMRS, Research Ecologist)
Leonardo Frid (Apex RMS)

Simulation Modeling

Not going to discuss model theory

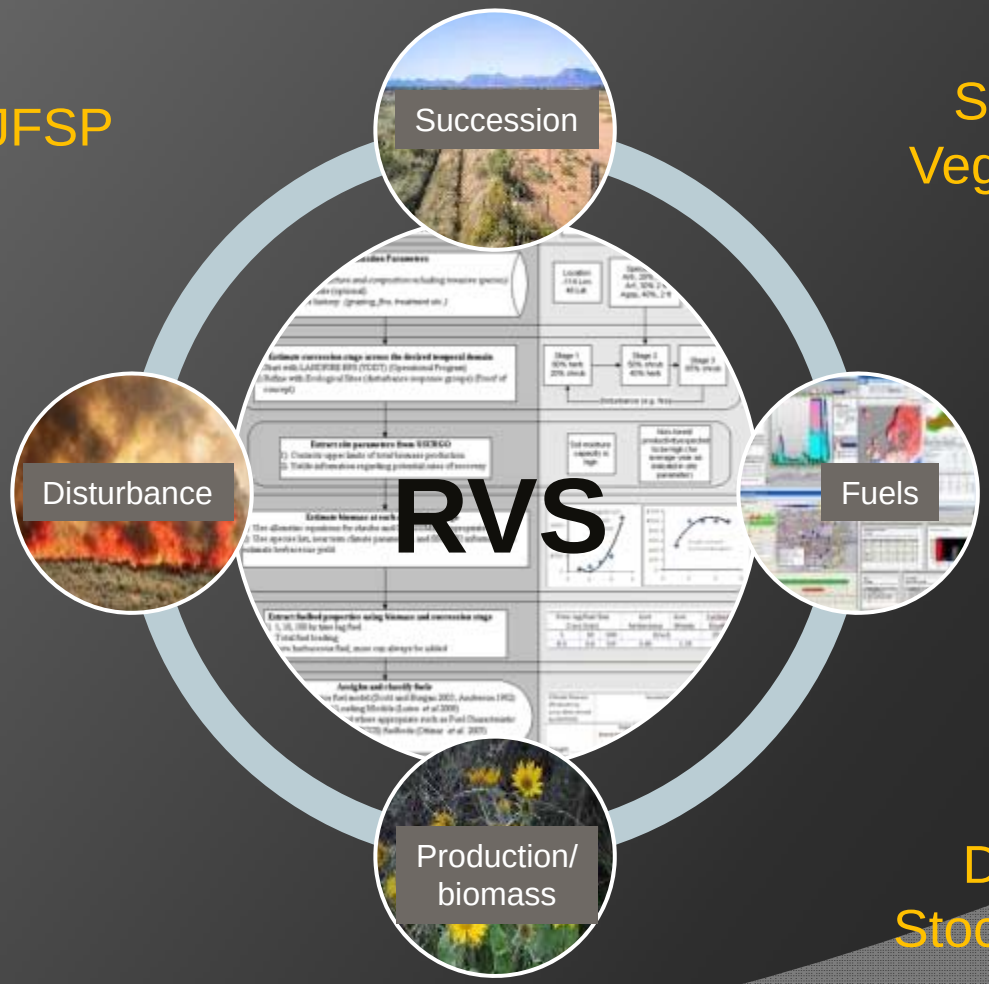
Explain our efforts to develop a quantitative model platform for rangelands:

- *Potential uses*
- *Limitations*
- *Development stage*
- *Policy, fire operations and science implications*

Simulation Modeling:
Rangeland Vegetation Simulator (RVS)

Began in 2012; JFSP

Similar to Forest Vegetation Simulator



4 modules

Deterministic and Stochastic components

Simulation Modeling:
Rangeland Vegetation Simulator (RVS)

Input	Output		
X, Y	**Fuels**	**Production**	**Succession**
Composition	1, 10, 100 hr	Herbaceous biomass	State / stage
Structure	Fuel Loading Model	Shrub biomass	Structure / assemblages
Rainfall	Surface Fire Behavior Fuel Model (FBFM)	Annual production	
Design criteria (herbivory, herbicide, fire)	XML for FCCS	Stem density	

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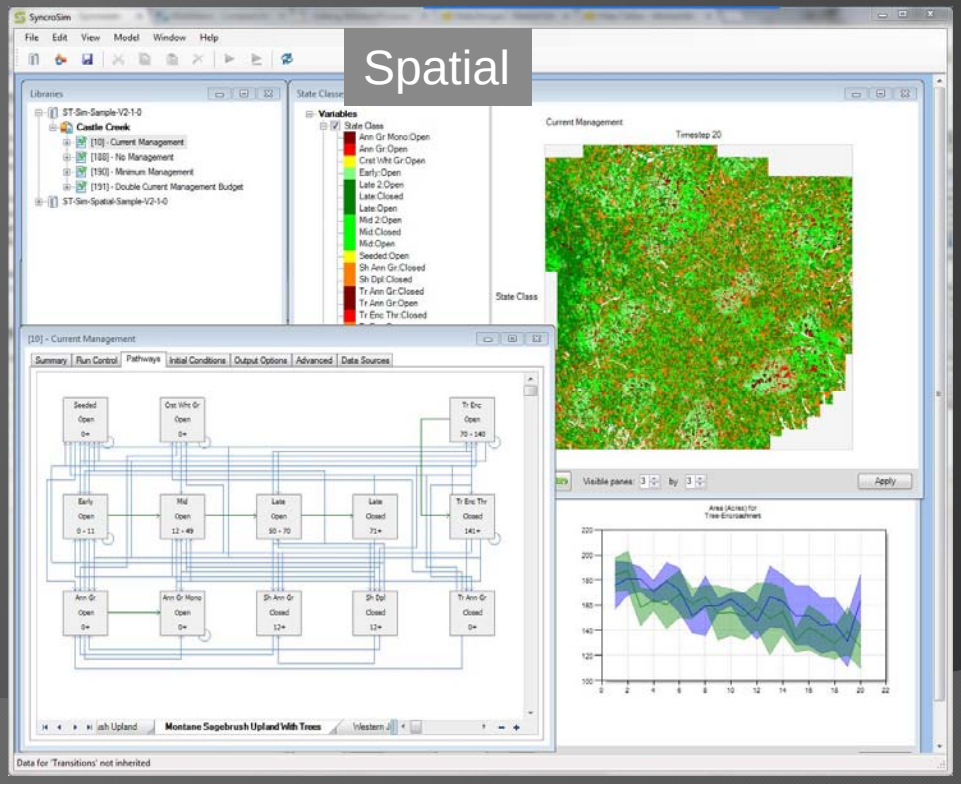

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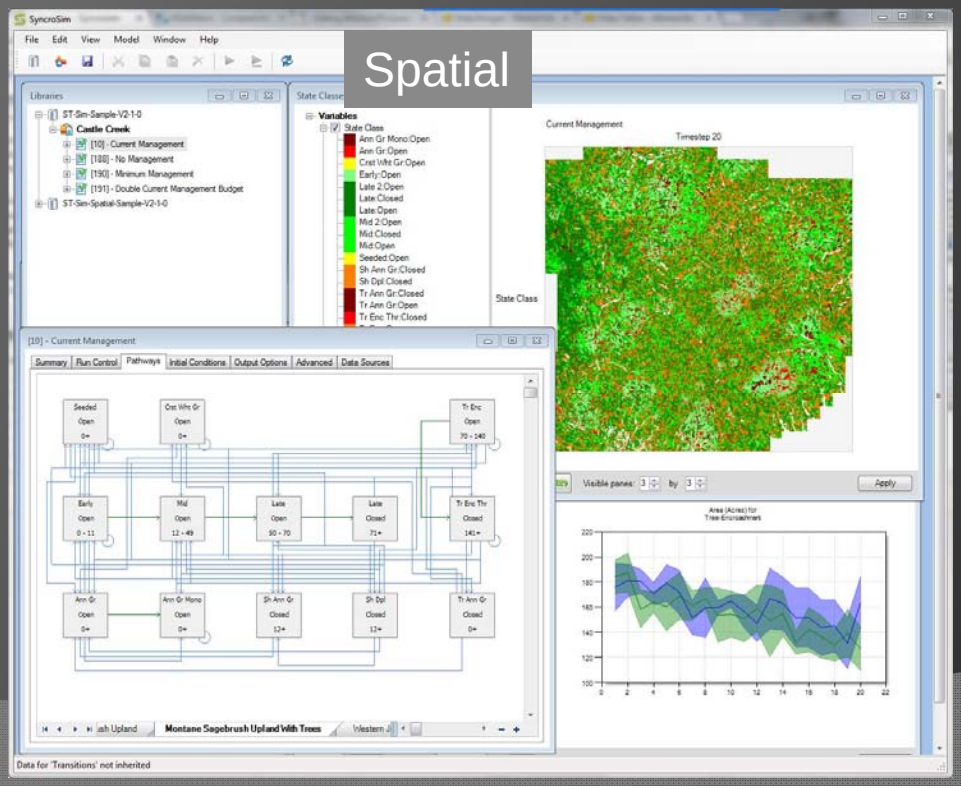

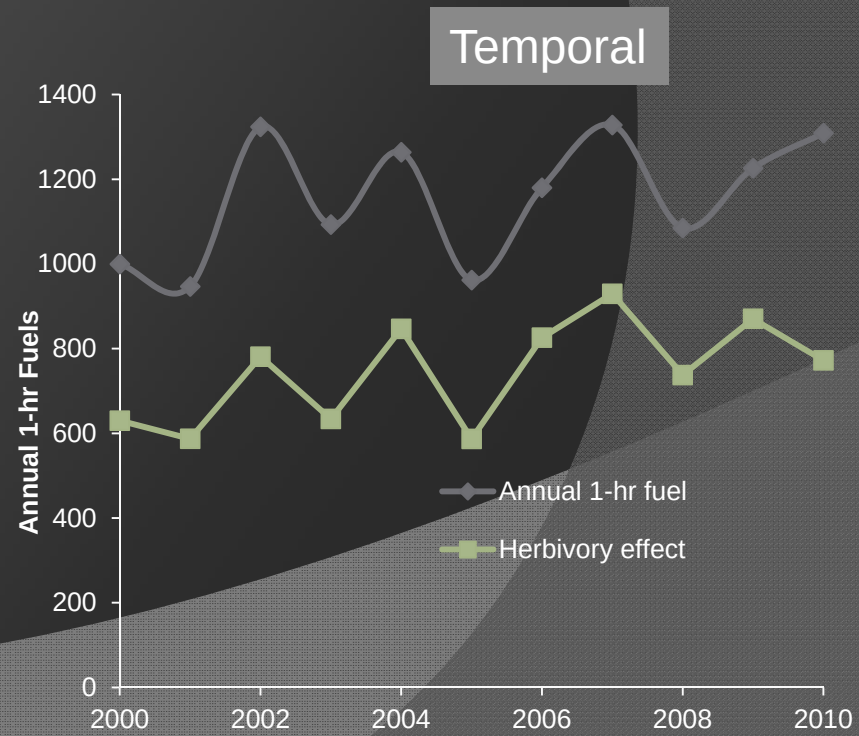

Simulation Modeling:
Rangeland Vegetation Simulator (RVS)

Relative Ranking of Threats to Sage-Grouse in Idaho
(Idaho Sage-grouse Advisory Committee 2006)

1) Wildfire
2) Infrastructure
3) Annual Grassland
4) Livestock Impacts
5) Human Disturbance
6) West Nile Virus
7) Prescribed Fire
8) Seeded Perennial Grassland
9) Climate Change
10) Conifer Encroachment
11) Isolated Populations
12) Predation
13) Urban/Exurban Development
14) Sagebrush Control
15) Insecticides
16) Agricultural Expansion
17) Sport Hunting
18) Mines/Landfills/Gravel Pits
19) Falconry

Simulation Modeling:
Rangeland Vegetation Simulator (RVS)

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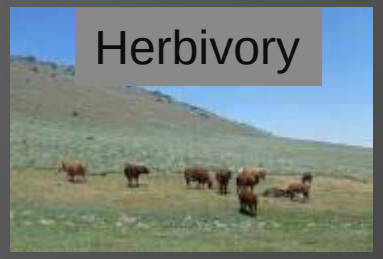
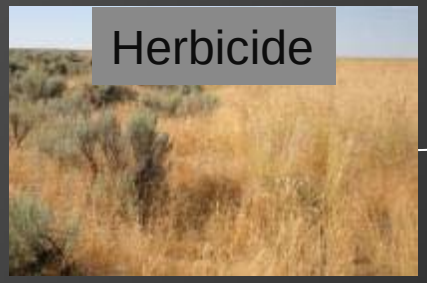
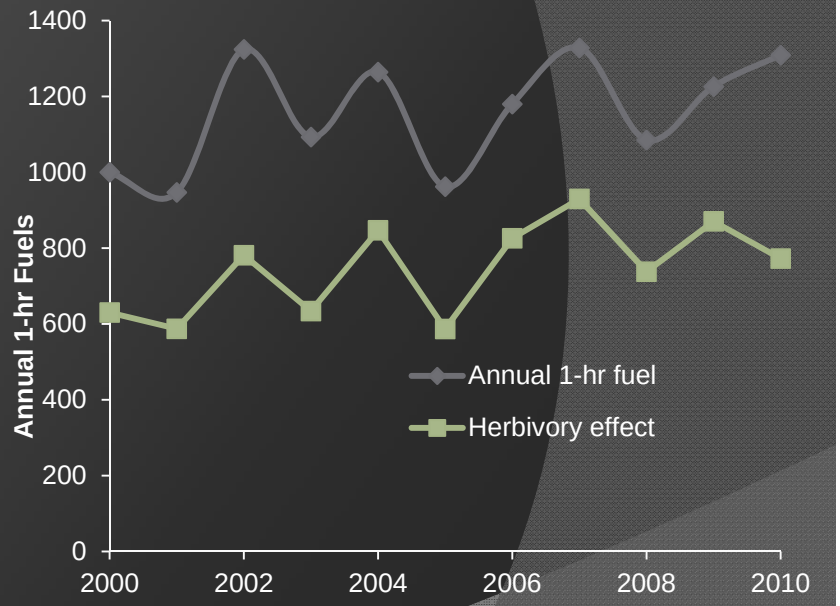


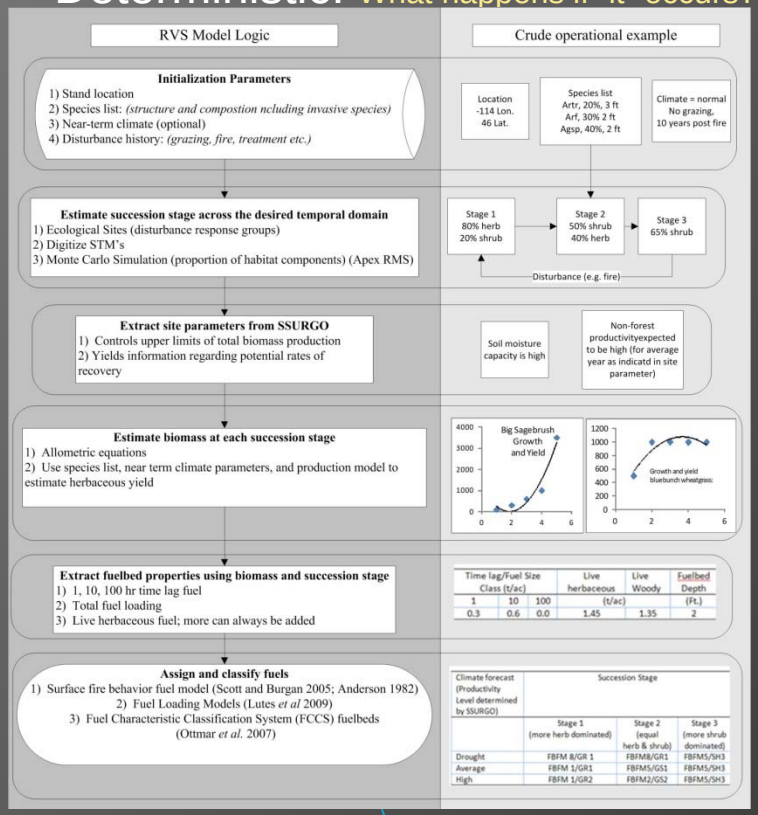


Greatest emphasis is on Inter-annual evaluation of fuelbeds in response to disturbance



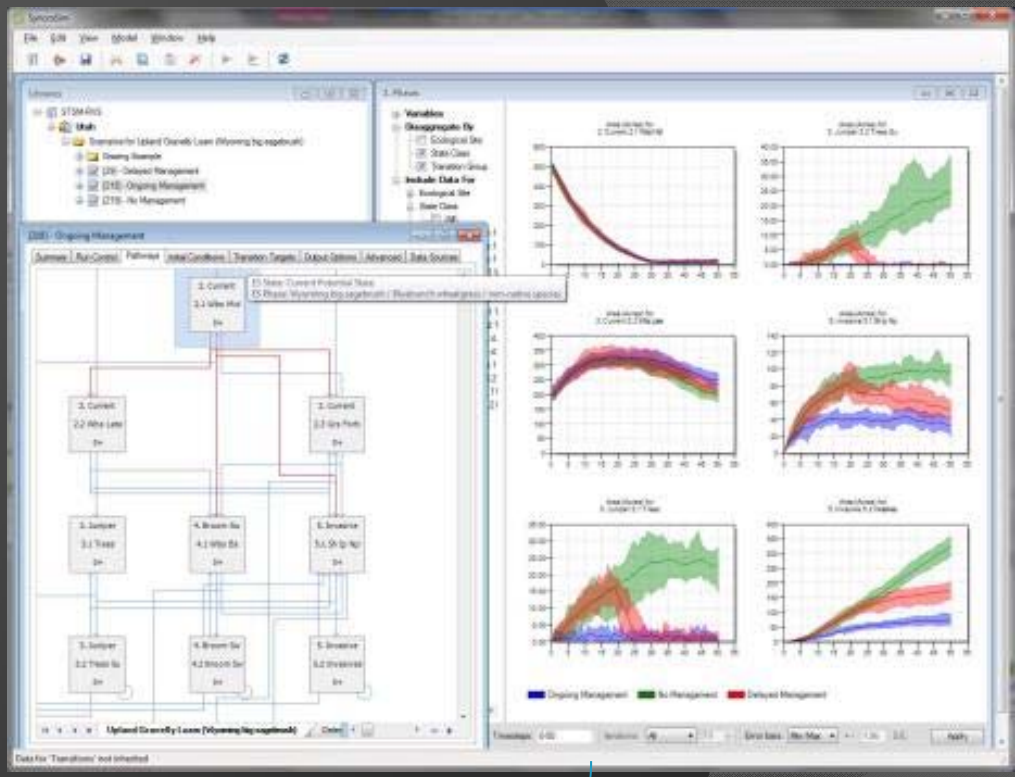
Simulation Modeling:
Rangeland Vegetation Simulator (RVS)

Deterministic: What happens if "it" occurs?



+

Stochastic: Will it occur? When where?



Research Direction:

Merge deterministic and stochastic modeling via State-Transition Simulation

Simulation Modeling:
Rangeland Vegetation Simulator **(RVS)**

Many State-Transition modelling efforts now taking shape, especially in GB

Differing resolution; Differing knowledge base; Disparate goals

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RVS Design

Reliability

Transparency

Consistency

Simulation Modeling:
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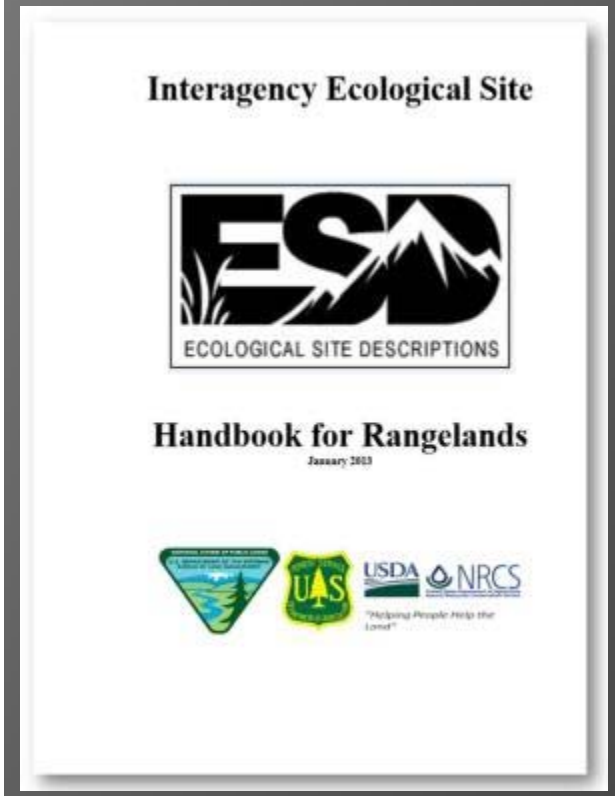
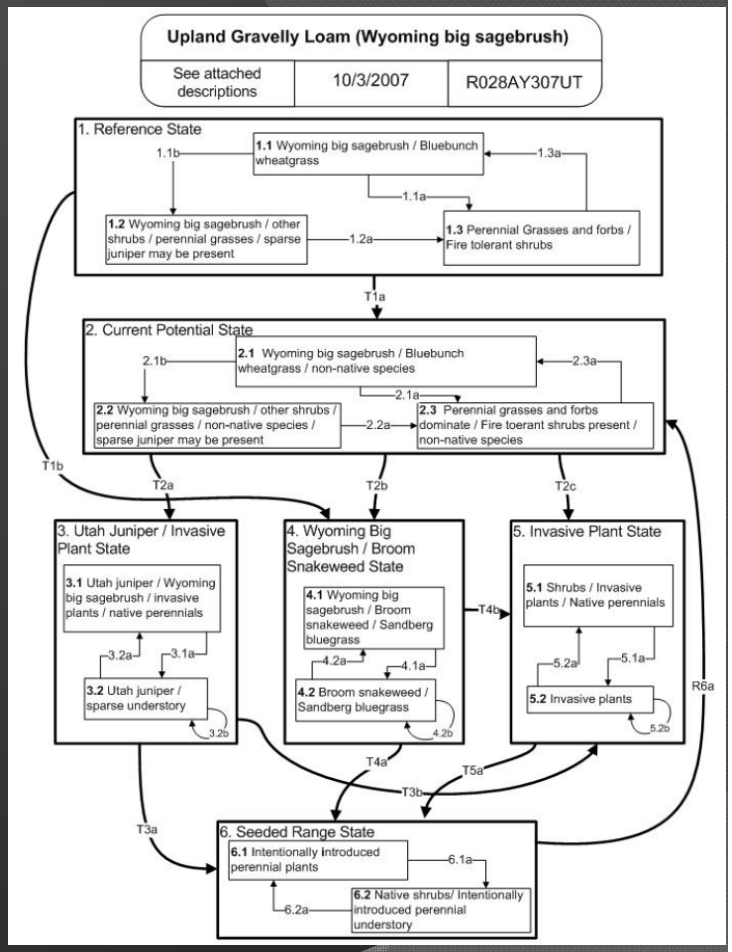


Interagency framework

Managers getting used to them

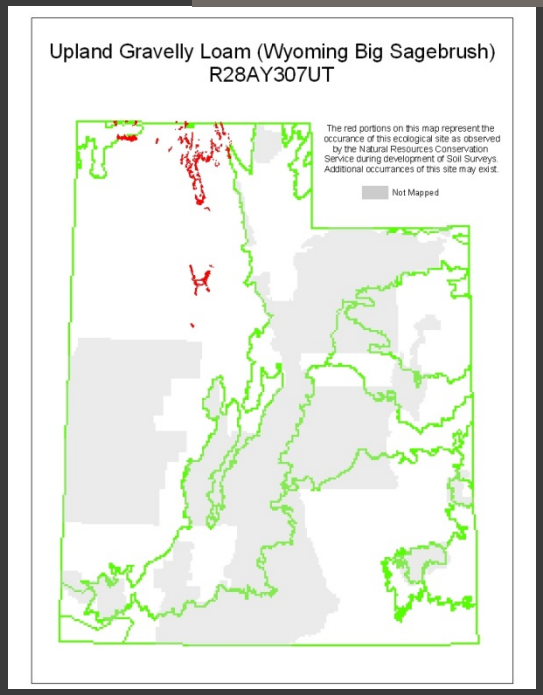
Consistent process for information

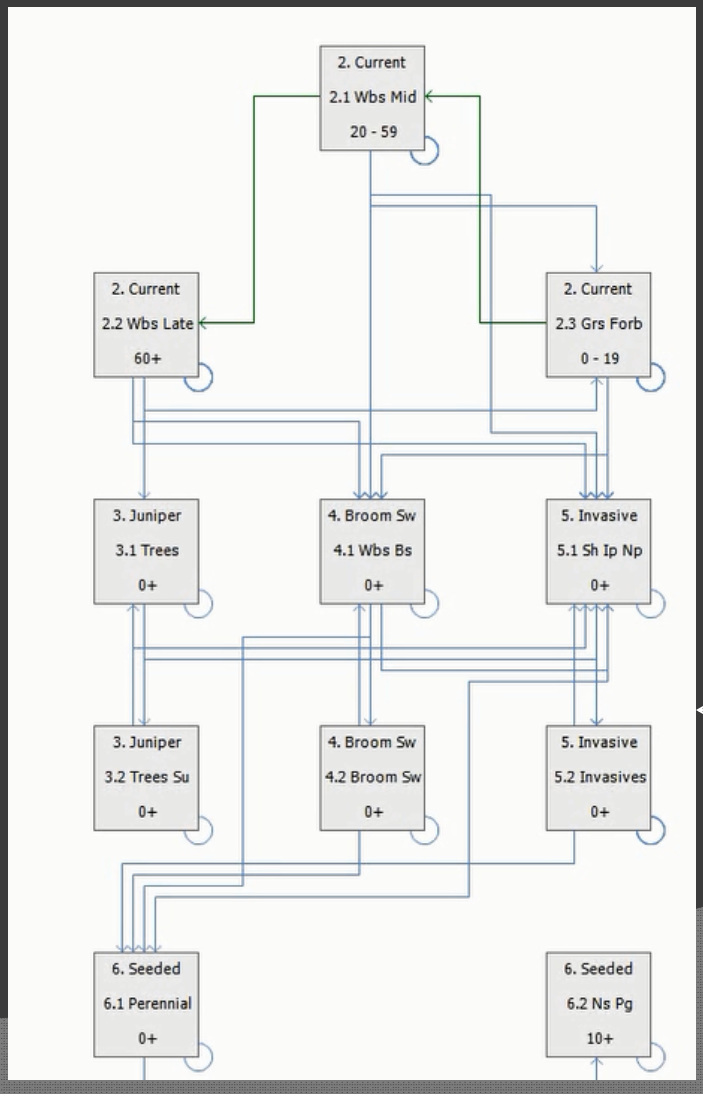
Calibration possible with BLM data: AIM

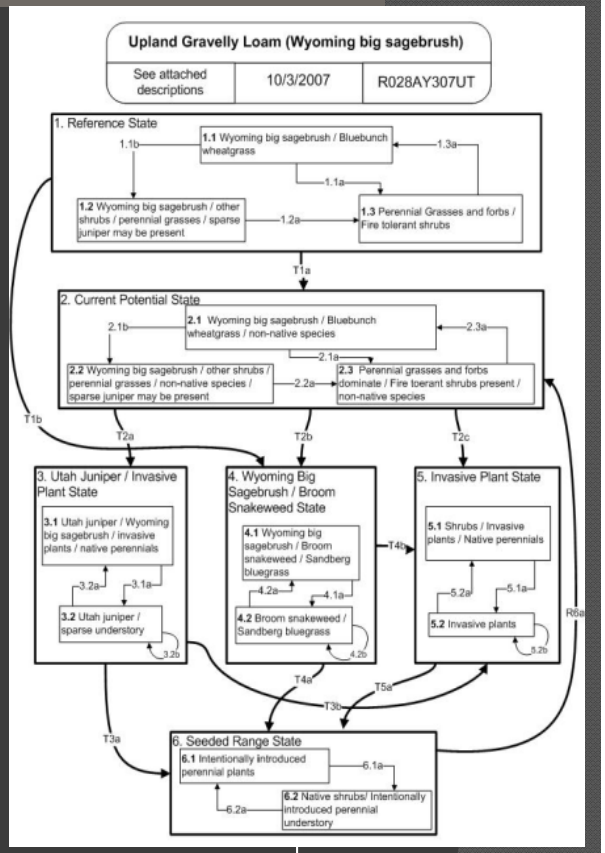


On annual time-step populate states with productivity, fuels, biomass, ecology

RVS: *Case Study*







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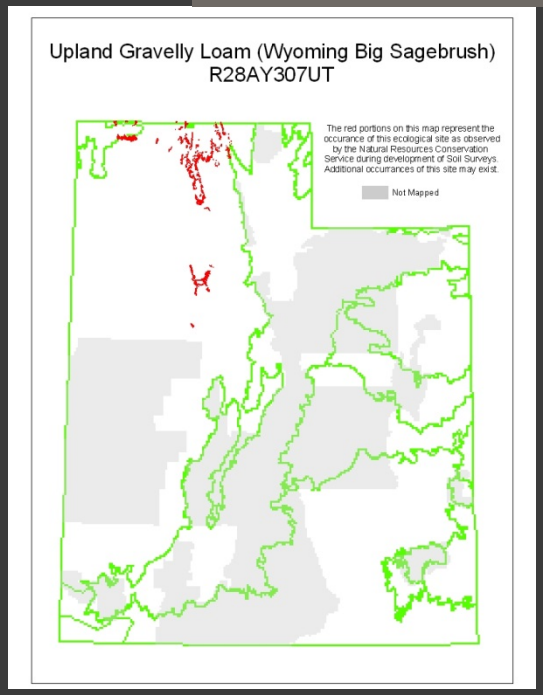
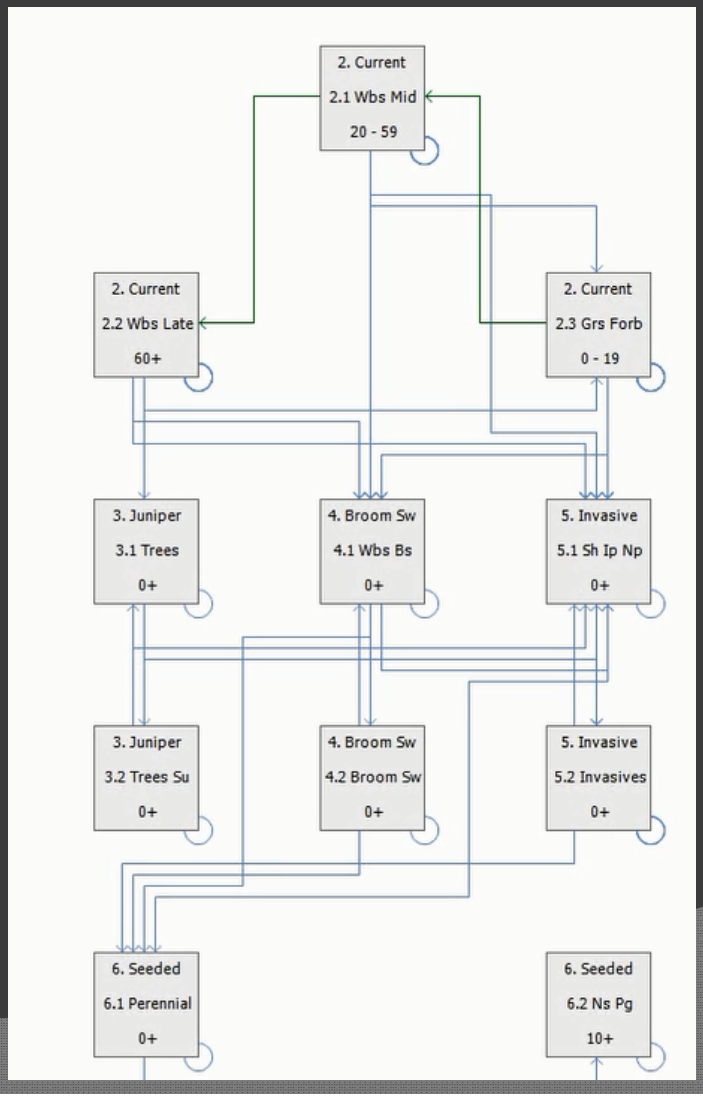
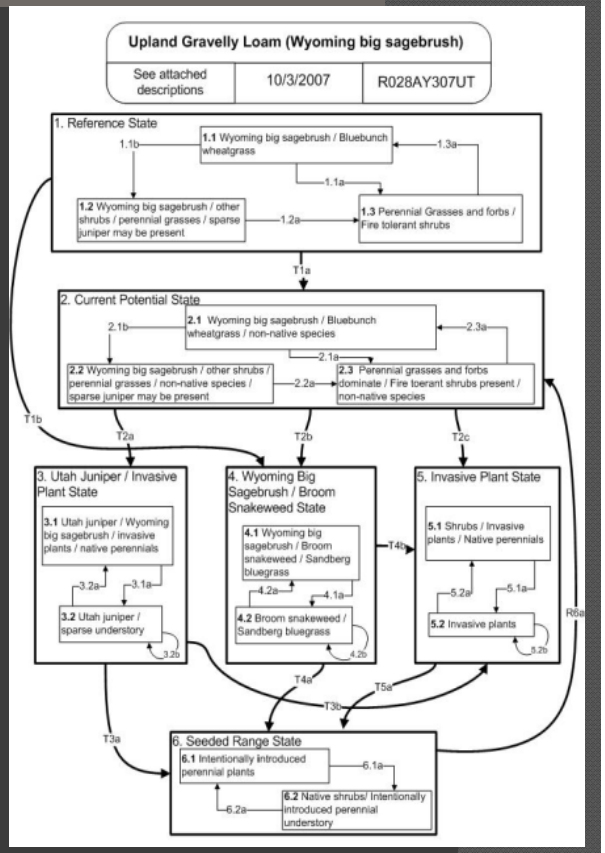
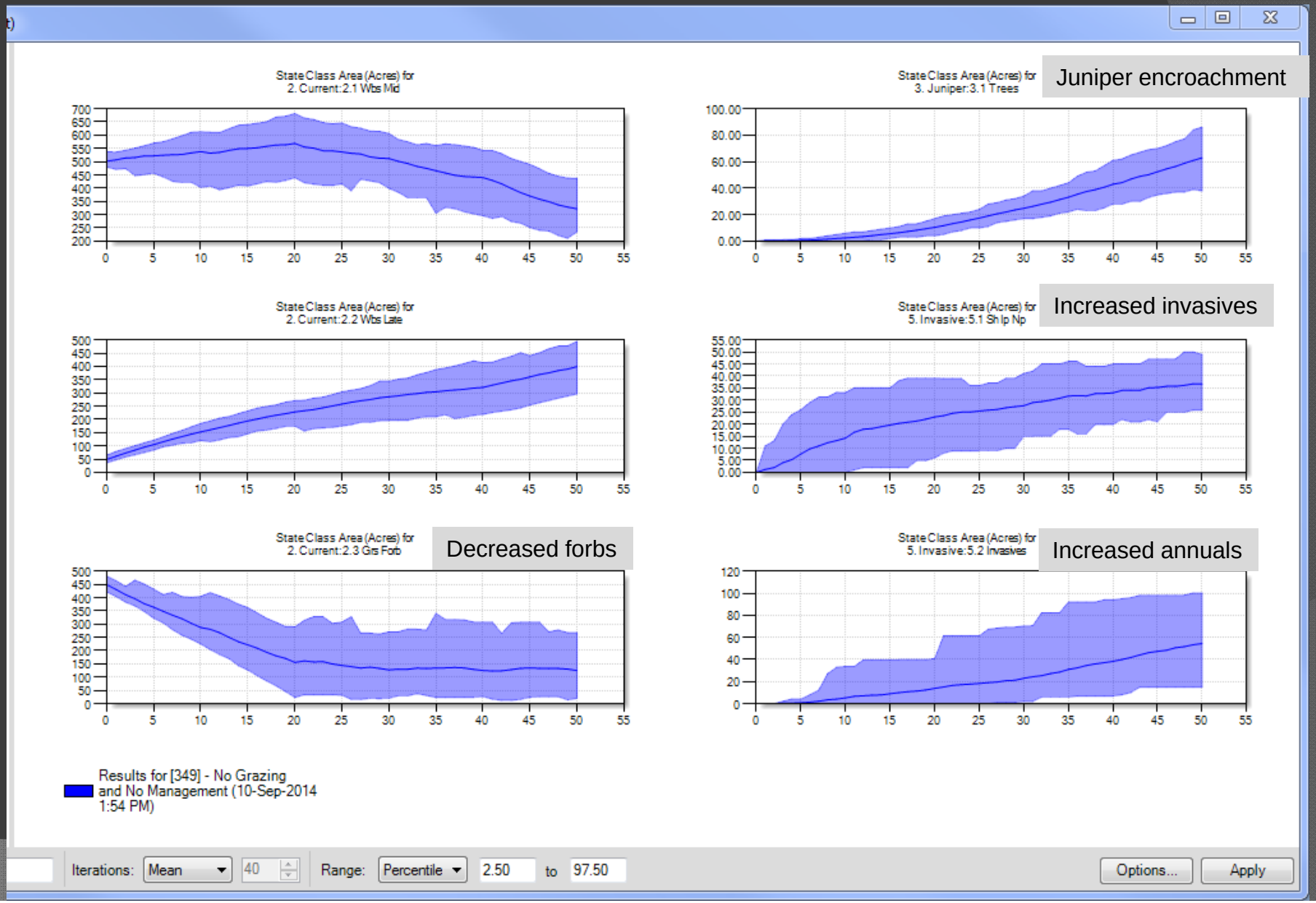






RVS: *Case Study* *(No management)*



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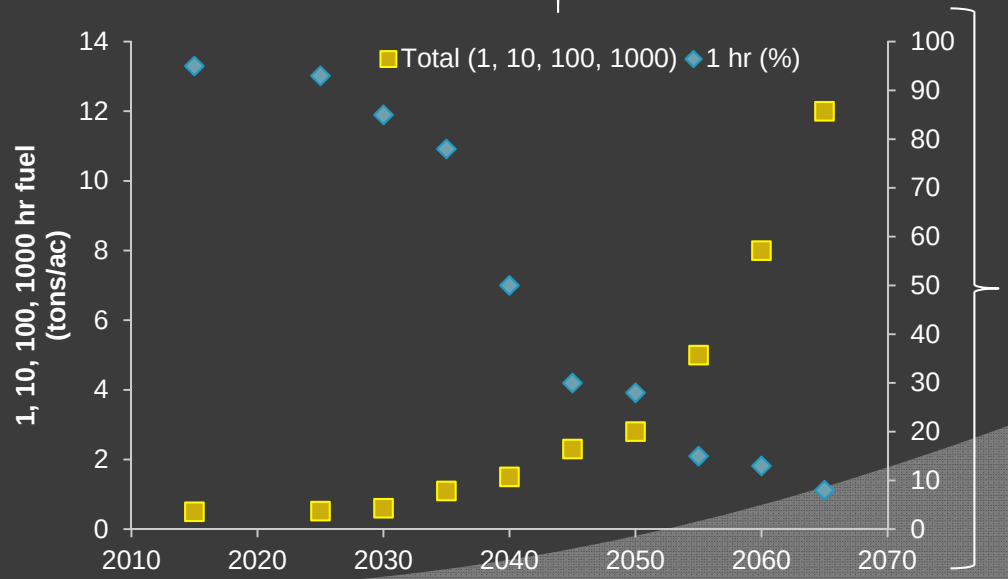
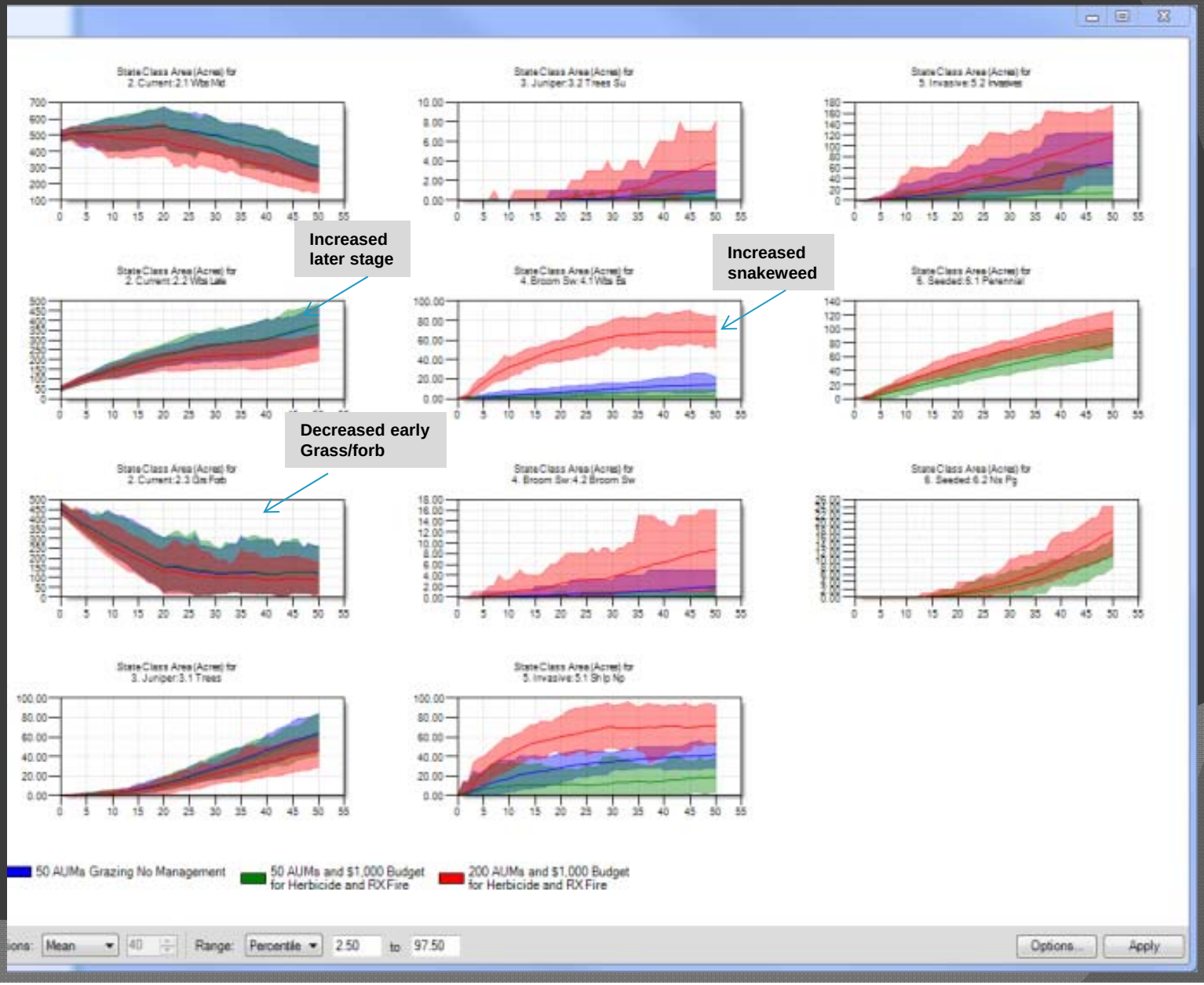


Unique to RVS

RVS: *Case Study* *(management)*



RVS: *Potential Uses*

1) Justification of stocking rates. Litigation (R3 USFS example)

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Mogollon chaparral

Annual production?

Fuel loading?

Stocking rates justified?

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1) Justification of stocking rates. Litigation (R3 USFS example)
2) Prioritizing treatments in space and time
3) Estimating effectiveness of planned treatments
4) Quantifying fuels from inventory data
5) Interagency planning (Reliability, Transparency, Consistency)

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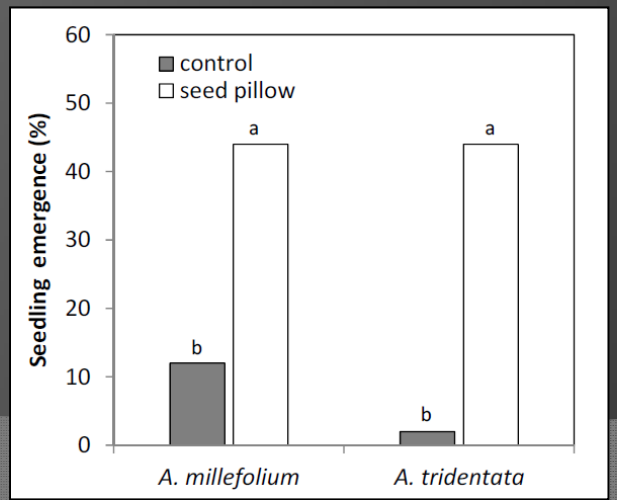
Example Questions

a) What is the probability of seeding success across the landscape? Based on this, where and when should we treat? How will seed pillow change this?



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Example Questions

a) What is the probability of seeding success across the landscape? Based on this, where and when should we treat?

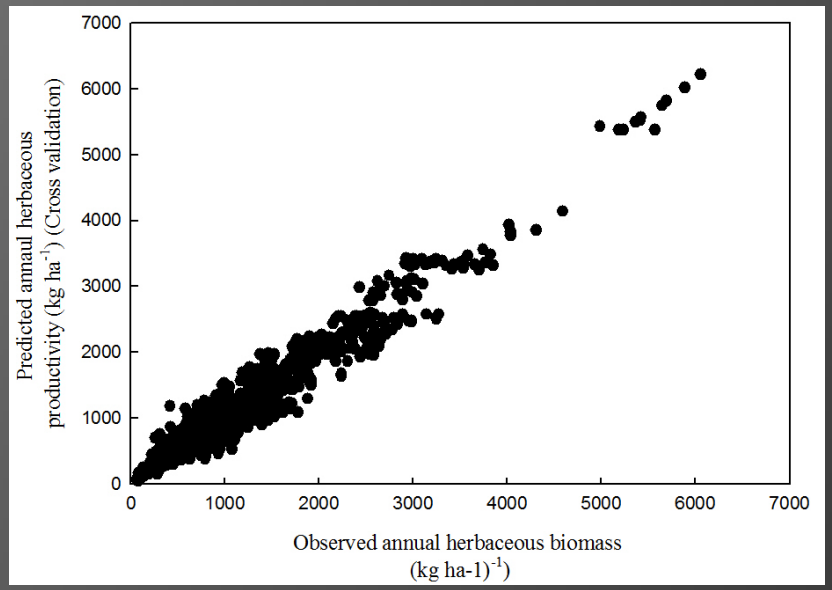
b) Is it better to invest $100,000 up front to increase forb richness or $10,000 for 10 years?

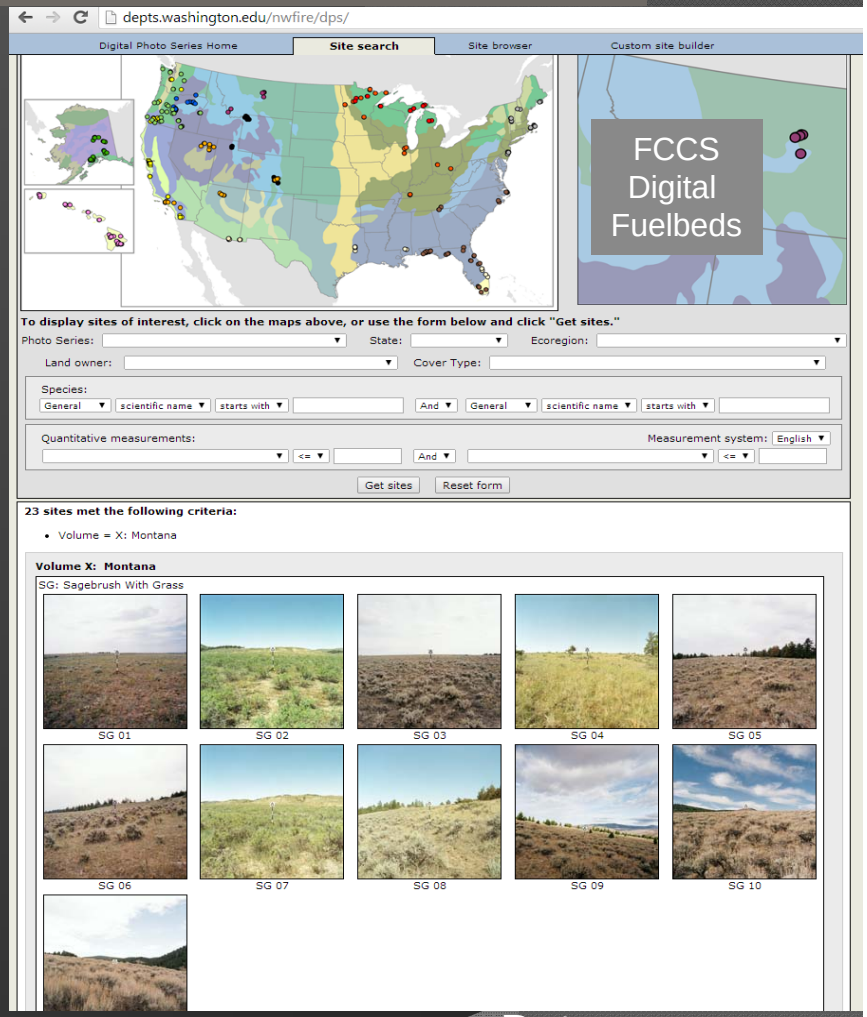
RVS: *Limitations*

1) Many species have incomplete information
2) Lack of plot inventory
3) Ecological Sites are prototypical
4) Little or no calibration of ecological dynamics
5) Merging with Forest Vegetation Simulator

RVS: *Development Stage*

Calibration/Validation stage





Funding available

Beta Release

RVS

RVS: *Policy, Fire Ops., Science*

Policy	Fire Mgt
Consistent framework for justifying Management	Comprehensive fuels data set
Prioritize budgets (where, when how)	Identify “tipping” points
Support policies for increasing quality of sage grouse habitat	Optimize burn plans (achieve multiple objectives)
Enable evaluation of wild horse & burro impacts	Positive feedback between BLM inventory and implications for fire and fuel management
	More precise estimates of fire severity and behavior

Concluding Remarks

- Simulation modelling mature enough to enable appropriate decisions
- RVS is consistent, transparent, reliable
- Provides feedback between BLM monitoring and fire management (TerraDat)
- Novel framework for bridging management and science gap
- Bureau decisions often litigated; seek support of simulation; rich rangeland information