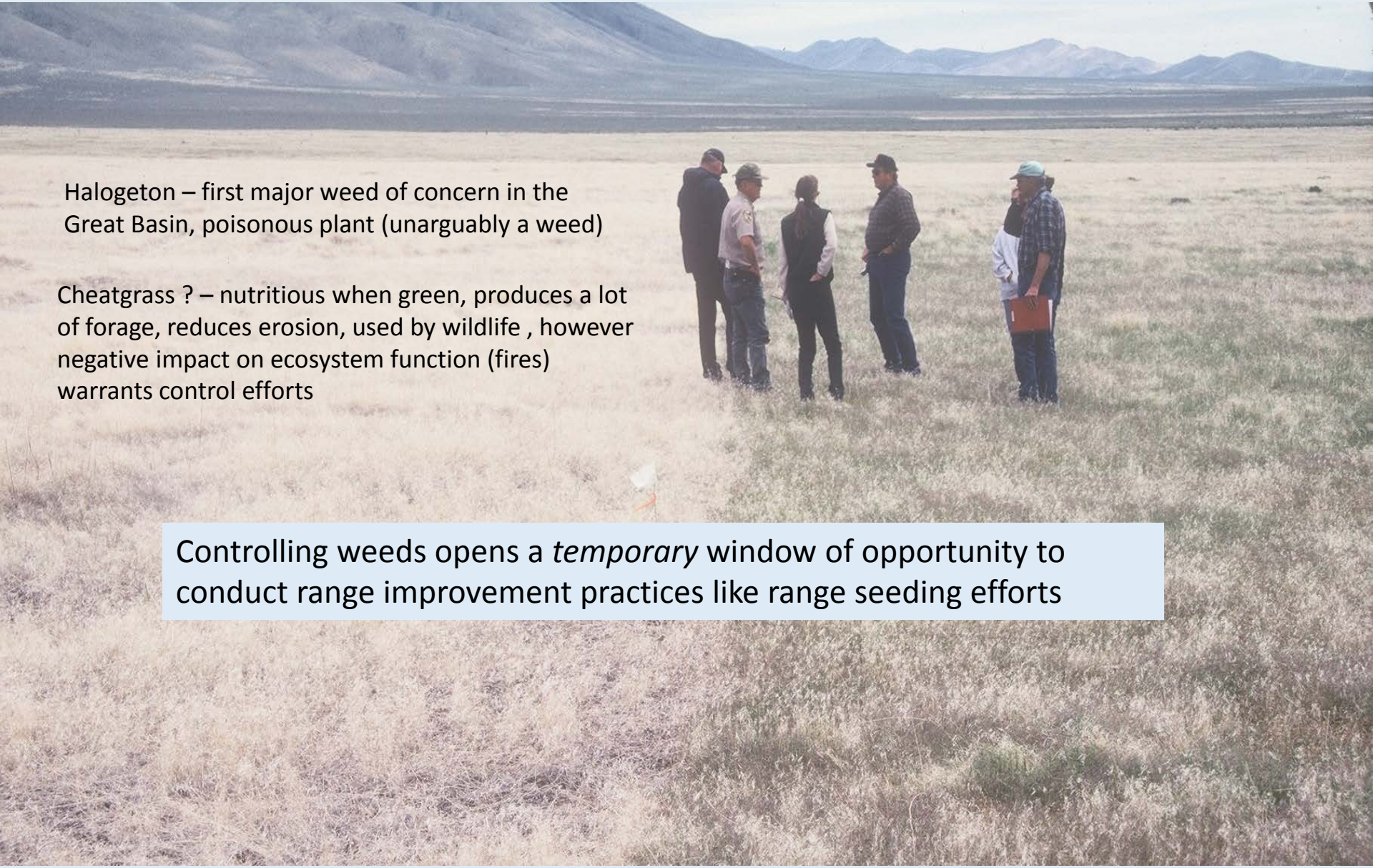
# The Role of Weed Control in Rangeland Rehabilitation

Dan Harmon and Charlie Clements

USDA-ARS Great Basin Rangelands Research Unit
Reno, Nevada

# What is a weed?



Halogeton – first major weed of concern in the Great Basin, poisonous plant (unarguably a weed)

Cheatgrass ? – nutritious when green, produces a lot of forage, reduces erosion, used by wildlife , however negative impact on ecosystem function (fires) warrants control efforts

Controlling weeds opens a *temporary* window of opportunity to conduct range improvement practices like range seeding efforts

# What is a weed?

A Weed - a plant that is not valued where it is growing and is usually of vigorous growth; especially : one that tends to overgrow or choke out more desirable plants

# Rangeland Weeds

Native plants may be considered undesirable and require control to improve plant communities.
Example : sagebrush meadow invasion or Juniper shrub land invasion

*Mechanical weed control most common method of weed control on rangelands today*

# Chemical Weed Control

Discovery of phenoxyacetic herbicides in Britain and the United States during 1940 to 1944 marked the beginning of the herbicide phase of the ‘‘Chemical Era of Agriculture.

The Nature Conservancy

**Weed Control Methods Handbook:**
**Tools & Techniques for**
**Use in Natural Areas**

Manual & Mechanical

Grazing

Prescribed Fire

Biological Control

Herbicides

The most effective weed control on arid cheatgrass invaded Rangelands

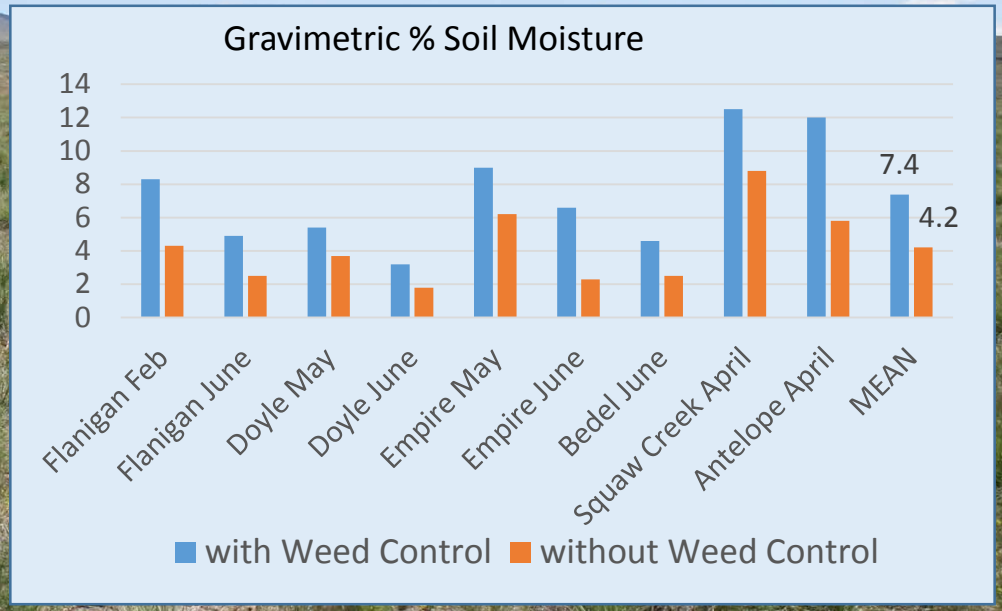
# The Role of Weed Control in Rangeland Rehabilitation

*Why do we remove weeds?*

Resources are not infinite they are limited

If cheatgrass competition is not decreased *prior* to seeding you loose ~ half your soil moisture. Example: seeding into a 12” precipitation zone without decreasing cheatgrass competition is *really* like seeding into a 6” precipitation zone and usually leads to failure.

**43% of soil moisture lost to weed competition** (mean)



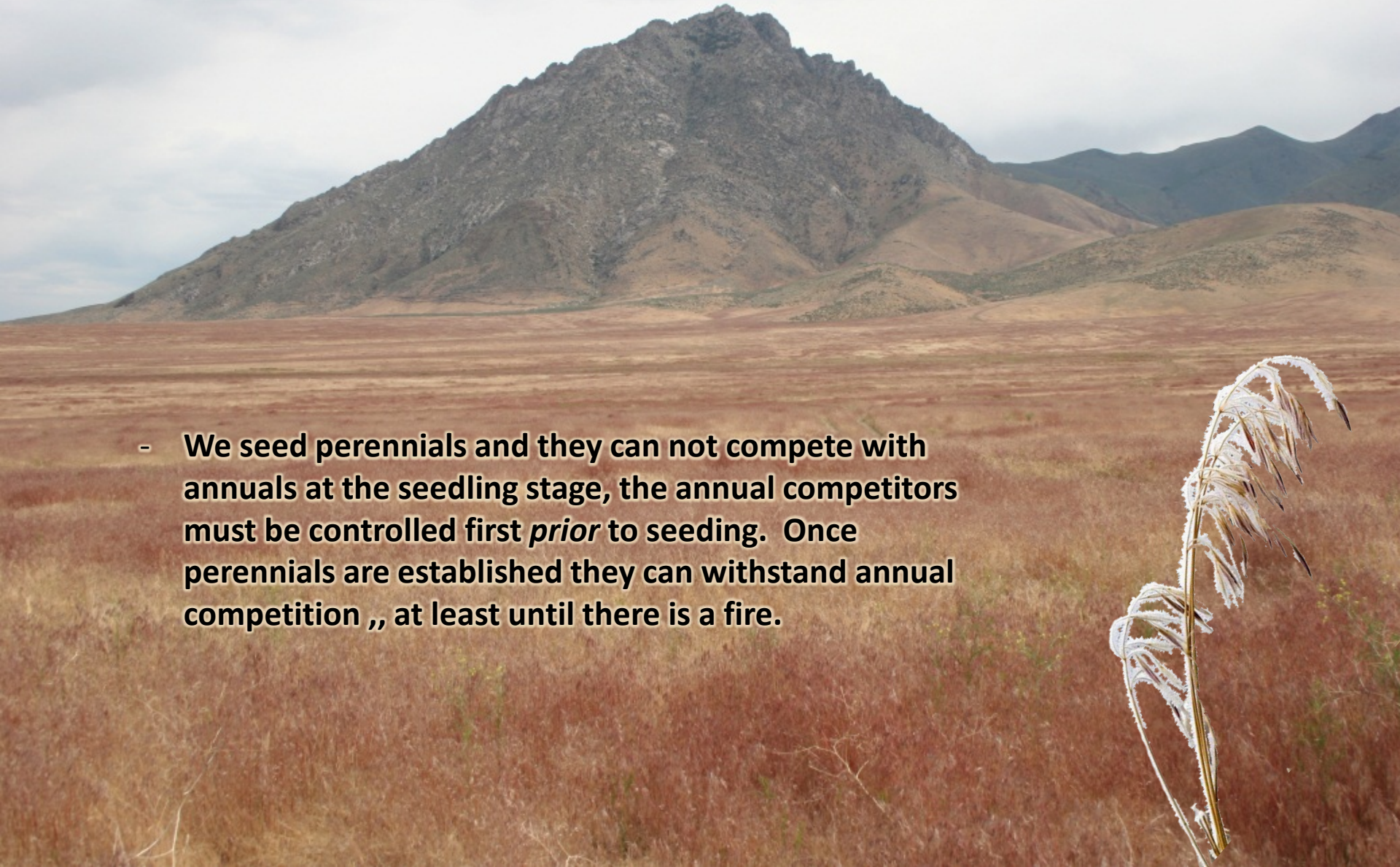
*Why do we remove weeds?*

Competition - an interaction between organisms or species in which both competitors are harmed

Competitive exclusion principle- species less suited to compete for resources should either adapt or die out, *is this the fate of Great Basin Native plants if we do not intervene?*

# Weed Control
## *Decreasing Competition*

**At the ***seedling stage*** cheatgrass is the #1 competitor for resources in the Great Basin**



- **We seed perennials and they can not compete with annuals at the seedling stage, the annual competitors must be controlled first *prior* to seeding. Once perennials are established they can withstand annual competition ,, at least until there is a fire.**

# Cheatgrass
# The Closed Community

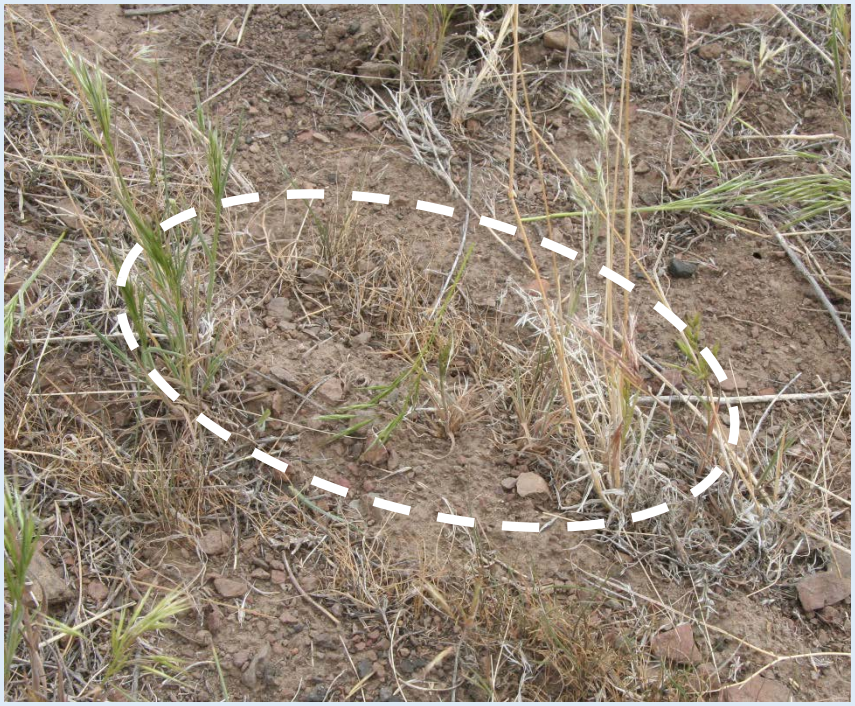
*"Successful seeding in closed communities of cheatgrass is an exception rather than the rule." (Robertson, J. H. and C. K. Pearce. 1945).*

*"As little as 43 cheatgrass plants per meter $^2$ can outcompete perennial grass seedlings"* Eckert at al. 1970

*"Lack of available soil moisture…was the major deterrent to perennial seedling success".* Evans et al. 1970

# Weed Control and Cheatgrass Competition

Competition eliminates the recruitment of new “desirable” range plants
forage grasses, critical wildlife shrubs, native grasses and forbs

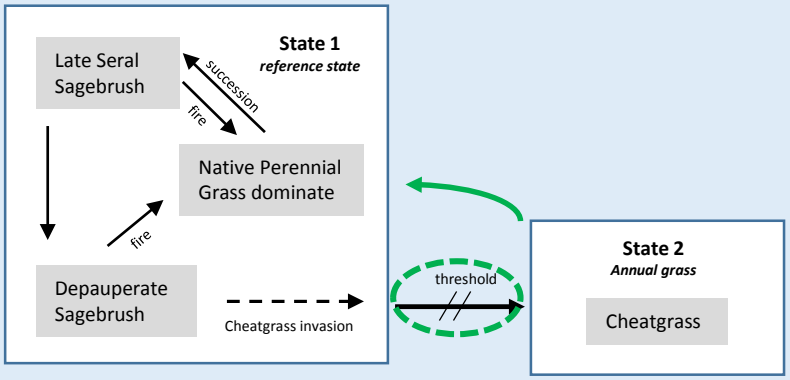


With weed competition
Seedling death usually occurs by June

Without weed competition
Seedling grow large enough with deeper roots to survive dry summer months

# cheatgrass control eliminates *thresholds* and allows transitions between states

## State and Transition Models




State : Annual Grass State

This state's ecological processes are driven by the dominance of cheatgrass, where native and invasive plant species may also be present. Cheatgrass dramatically affects the soil/plant/water relationships of a site. Research has shown that plant species differ substantially in their effects on soil water content and temperature, and on their effects on the frequency and intensity of disturbance. After cheatgrass has invaded a site, the fundamental nutrient cycling processes, root pores, mycorrhizal associations, microbial species, and soil organic material change (Chapin et al. 1997; Belnap and Phillips, 2001). These alterations may eventually create ecologically impoverished sites that are very difficult to restore to functionally diverse perennial herbaceous and woody communities. The competitiveness of cheatgrass and its ability to quickly establish after a disturbance make this state extremely resistance to change and resilient after a disturbance.

Annual Grass State: Community phases maintained, in a self-sustaining manner, by frequent fire.

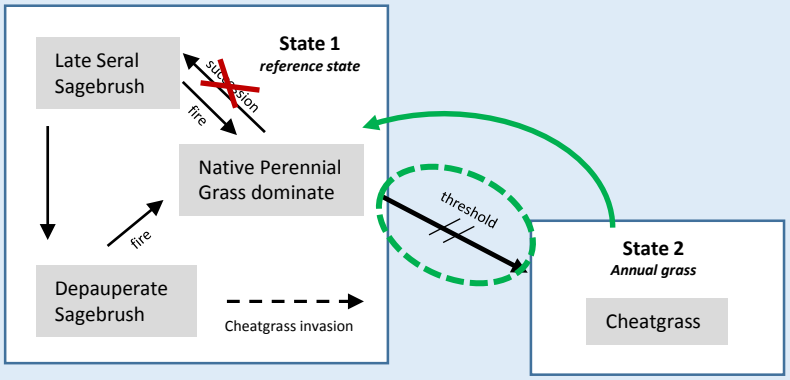
Indicators: A site where ecological processes are driven by cheatgrass.

Feedbacks: A self sustaining disturbance regime of frequent fire.

decreases soil moisture and limits the establishment of perennials

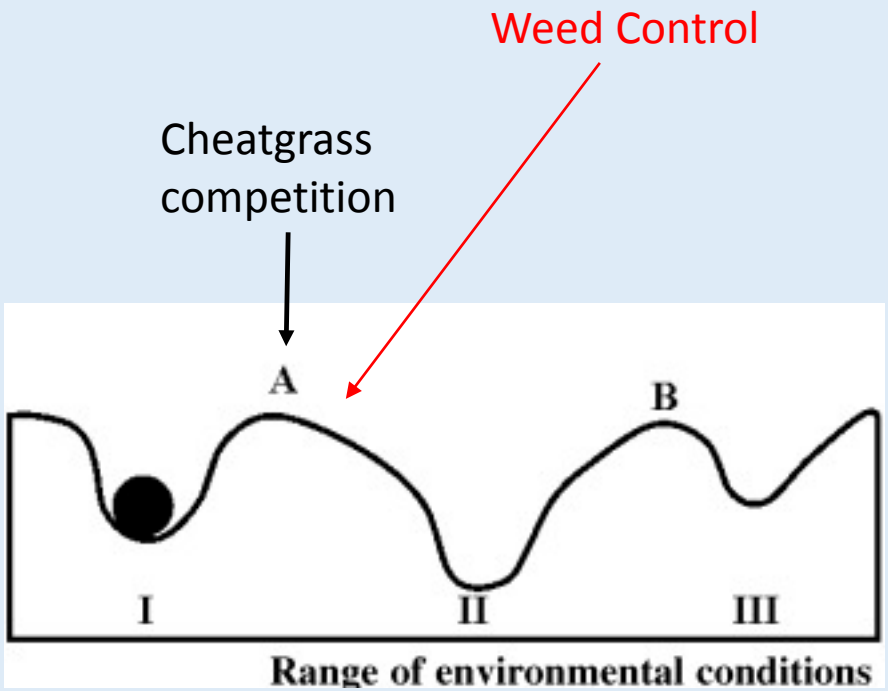
# cheatgrass control eliminates *thresholds* and allows transitions between states

## State and Transition Models

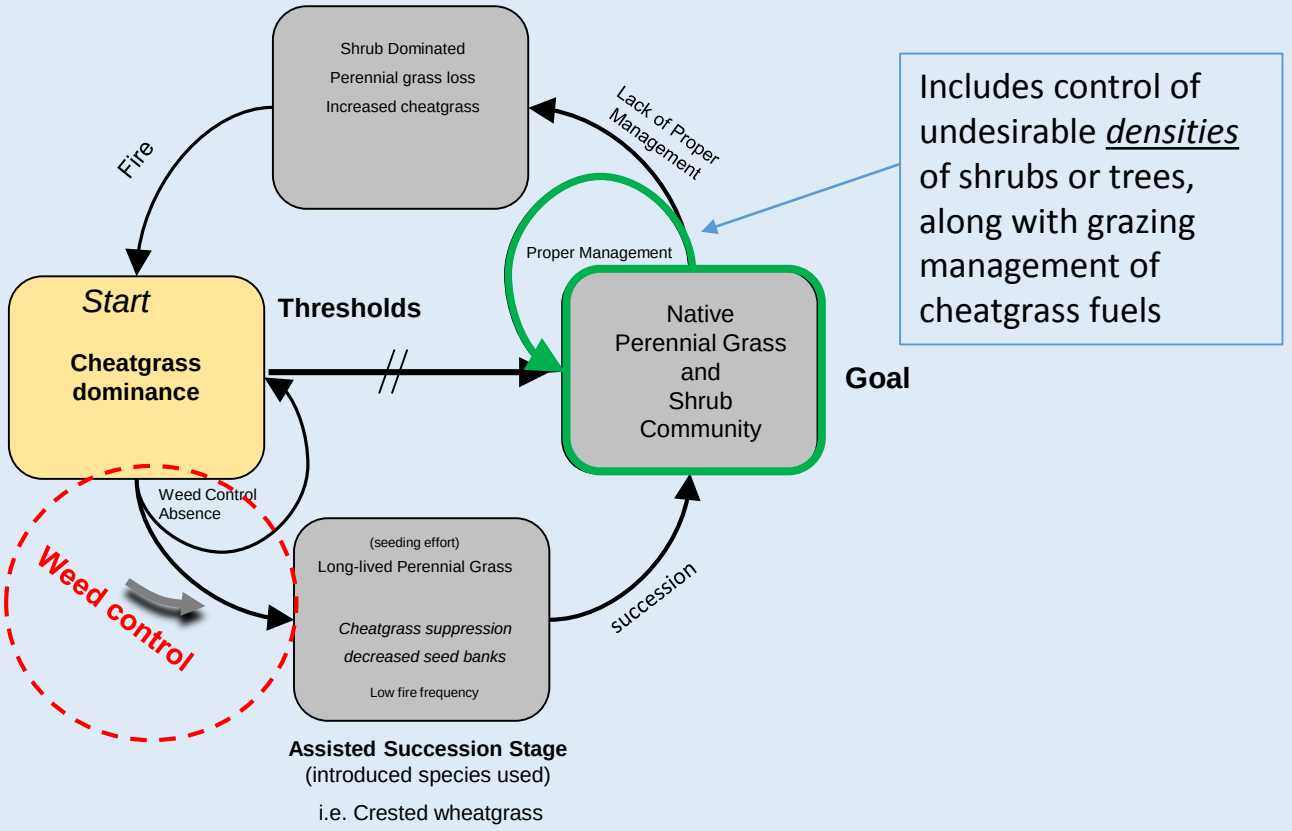



Not all perennials are resistant to cheatgrass invasion equally, some perennials may transition directly from the perennial grass phase to the annual phase. Perennials that do not establish dense enough or persist long enough are not resistant or resilient. Photo: Big Squirreltail (*Elymus multisetus*) 5 years after seeding.

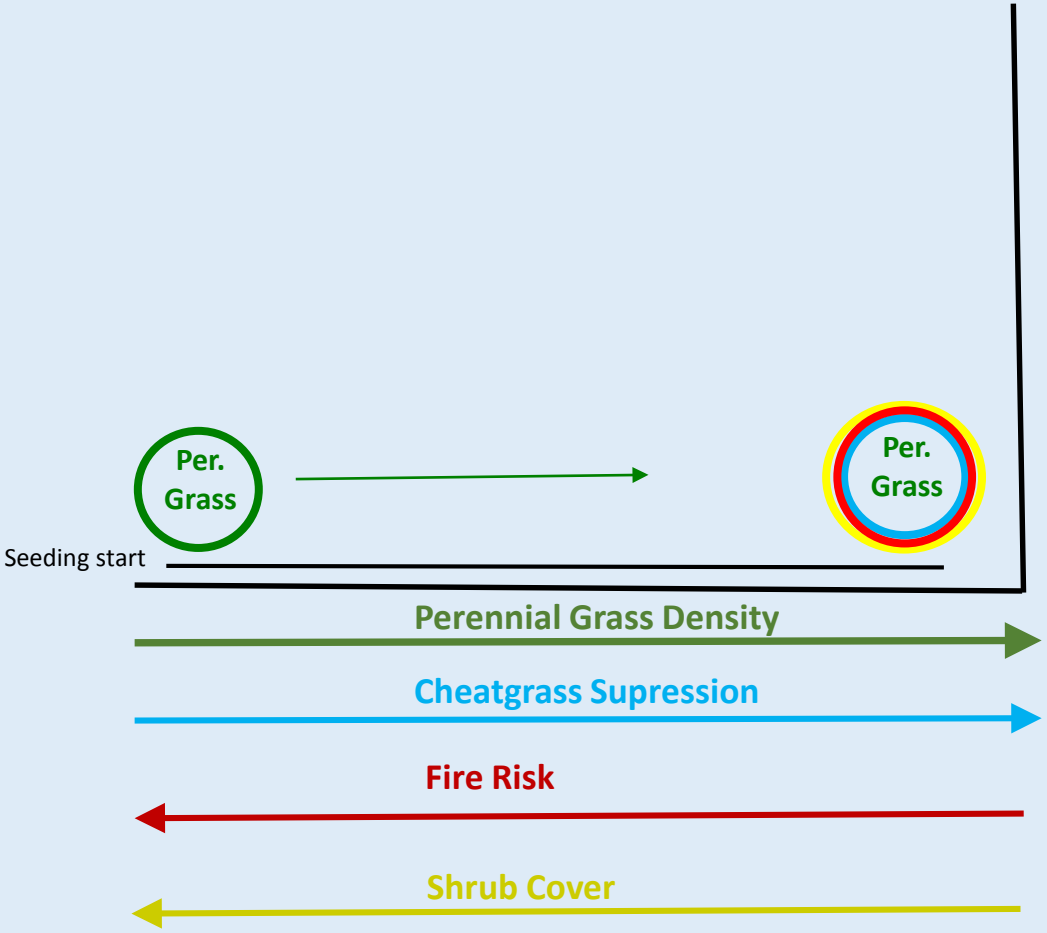
# cheatgrass control and stable state transitions

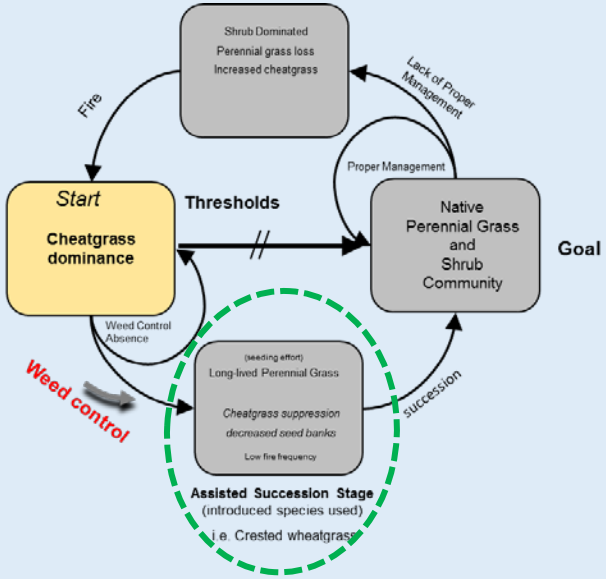


# Rangeland Rehabilitation and Management Cycle

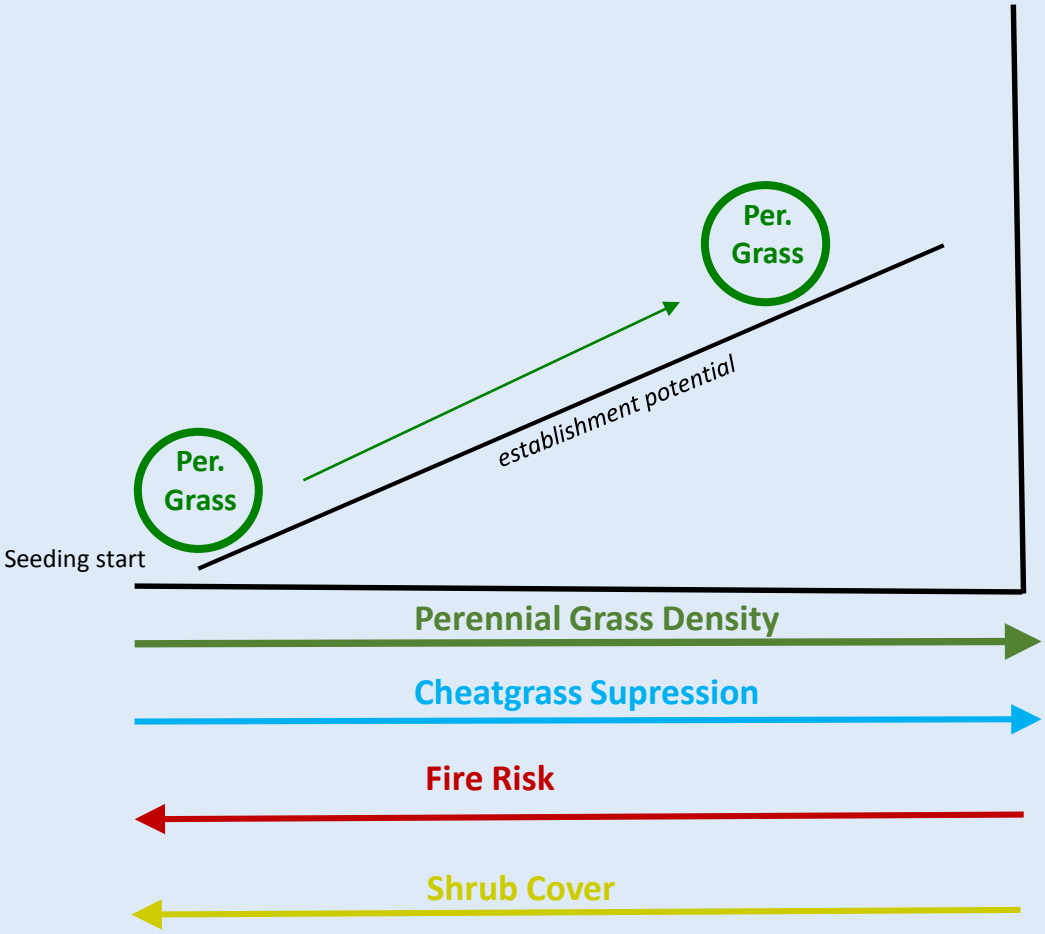


Successful seeding of long-lived perennial grasses leads to high cheatgrass suppression and decreased fire risk and assisted succession

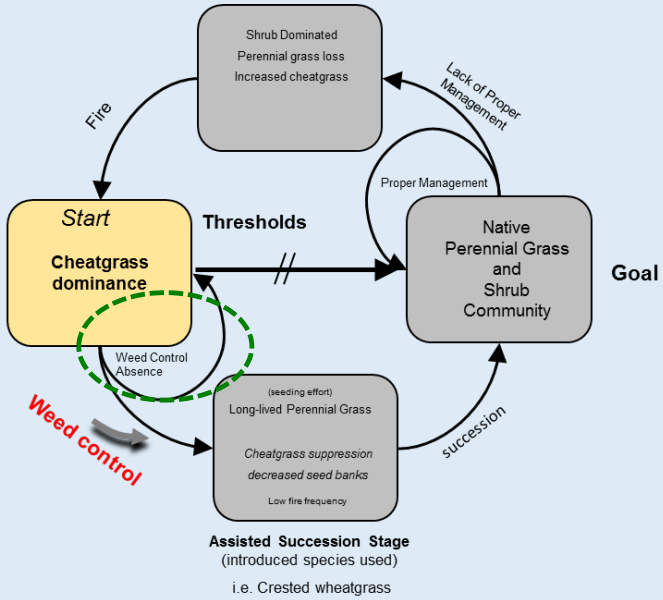


With out decreasing cheatgrass competition prior to seeding, establishing a high density of perennial grass is an *uphill battle* and usually fails.

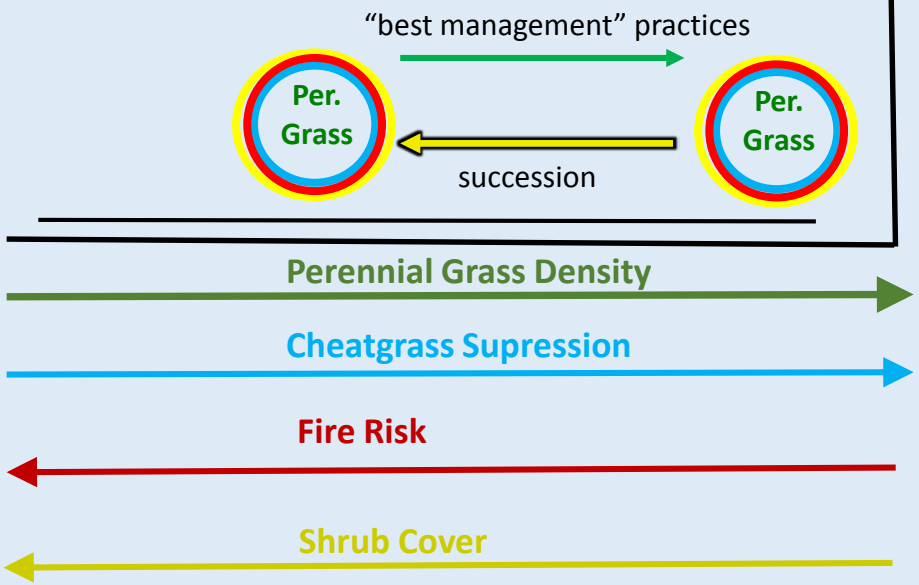



Rangeland Rehabilitation & Management Cycle

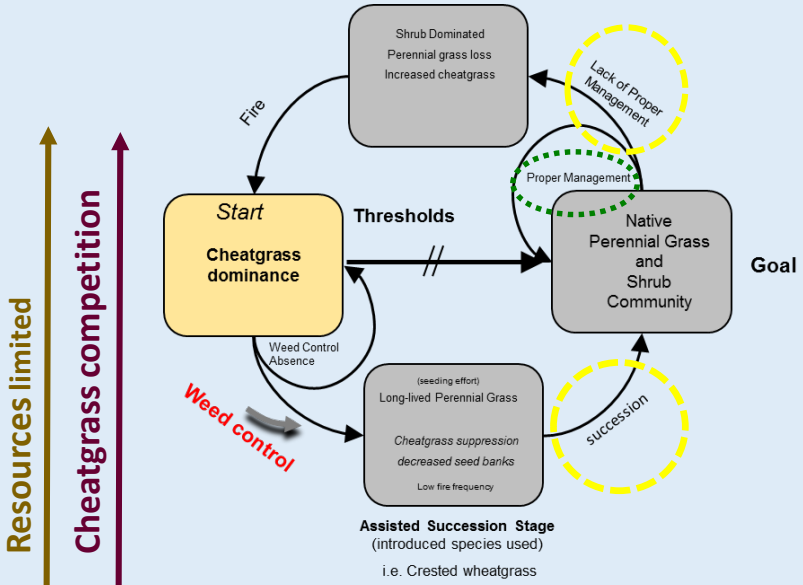



Shrubs are not resistant to cheatgrass invasion. The understory of a shrub is a favorable micro-environment for cheatgrass. As succession increases shrub cover of a perennial grass community "best management" must control for that so that shrubs do not increase so much so, that perennial grass densities are lost.

*a productive sustainable balance of perennial grass, shrubs and forbs must <u>always</u> be actively managed for*




Rangeland Rehabilitation & Management Cycle



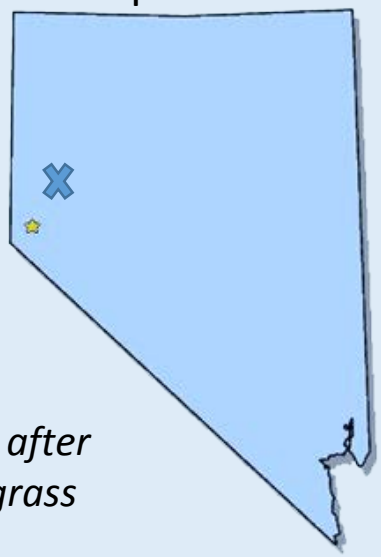

# On the Ground Examples of Weed Control and Rangeland Rehabilitation

## Discing Control

Wildfire Aug 2006

*Control may even be required after a fire, cool fast moving cheatgrass fires do not kill surface seed*

Empire NV



Empire, Nevada
2006 - 5.7”
2007 – 9.7”
2011 – 13”
2012 – 4.4”

*Soil series*
Shawave-Deadyon-Slipback association
Droughty loam 8-10”
MLRA 26

Discing cheatgrass control

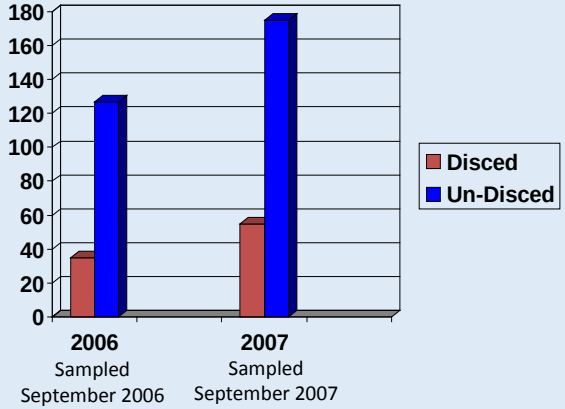
Spring application – kills plants, prevents *new* seed production
- Buries seed below germination/emergence potential

Disc treatments

Sept 2006 - seeded Oct 2006

May 2007 – seeded Oct 2007

Cheatgrass seed bank densities /ft$^2$

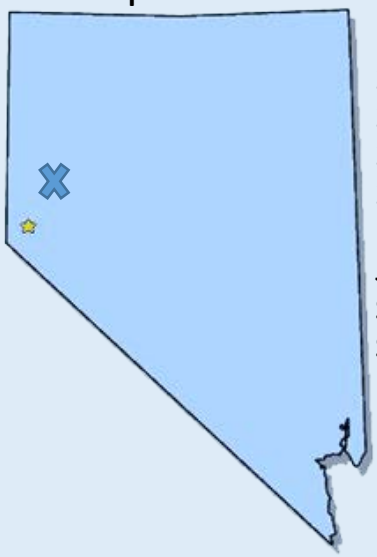



bioassay

# On the Ground Examples of Weed Control and Rangeland Rehabilitation

## Discing Control

### Empire NV



Empire, Nevada
2006 - 5.7”
2007 – 9.7”
2011 – 13”
2012 – 4.4”

*Soil series*
Shawave-Deadyon-Slipback association
Droughty loam 8-10”
MLRA 26

Wildfire Aug 2006

Drill Seeded Rangeland Drill

Seeded Oct 2006 & Oct 2007

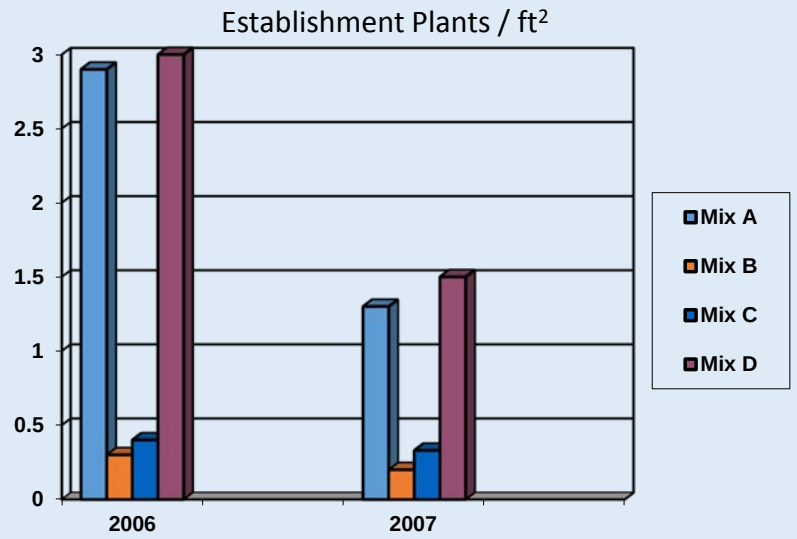
- 60 Total Plots (32’ x 200’)
- 30 Plots For Each 2006 and 2007 Seedings
- Half of the Plots Disced, Including Controls

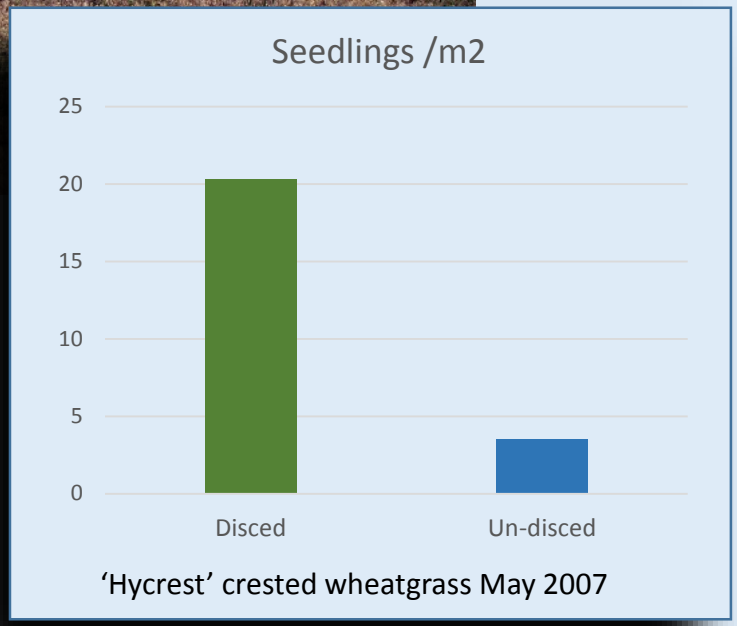
Seeded Species
A = ‘Hycrest’ Crested Wheatgrass (7 lbs/ac)
B = Sherman Big Bluegrass (2 lbs/ac)
C = Bottlebrush Squirreltail (4 lbs/ac)
D = Mix
- ‘Hycrest’ Crested Wheatgrass (4 lbs/ac)
- Sherman Big Bluegrass (1 lb/ac)
- Bottlebrush Squirreltail (2 lbs/ac)
- Indian Ricegrass (1 lb/ac)
- Wyoming Big Sagebrush (.25 lb/ac)
- ‘Immigrant’ Forage Kochia (.50 lb/ac)
- ‘Ladak’ Alfalfa (.25 lb/ac)

# On the Ground Examples of Weed Control and Rangeland Rehabilitation

## Discing Control

'Hycrest' crested wheatgrass seeded after disc treatment




'Hycrest' crested wheatgrass May 2007

Seeded Species
A = 'Hycrest' Crested Wheatgrass (7 lbs/ac)
B = Sherman Big Bluegrass (2 lbs/ac)
C = Bottlebrush Squirreltail (4 lbs/ac)
D = Mix
- 'Hycrest' Crested Wheatgrass (4 lbs/ac)
- Sherman Big Bluegrass (1 lb/ac)
- Bottlebrush Squirreltail (2 lbs/ac)
- Indian Ricegrass (1 lb/ac)
- Wyoming Big Sagebrush (.25 lb/ac)
- 'Immigrant' Forage Kochia (.50 lb/ac)
- 'Ladak' Alfalfa (.25 lb/ac)

# On the Ground Examples of Weed Control and Rangeland Rehabilitation

## Discing Control

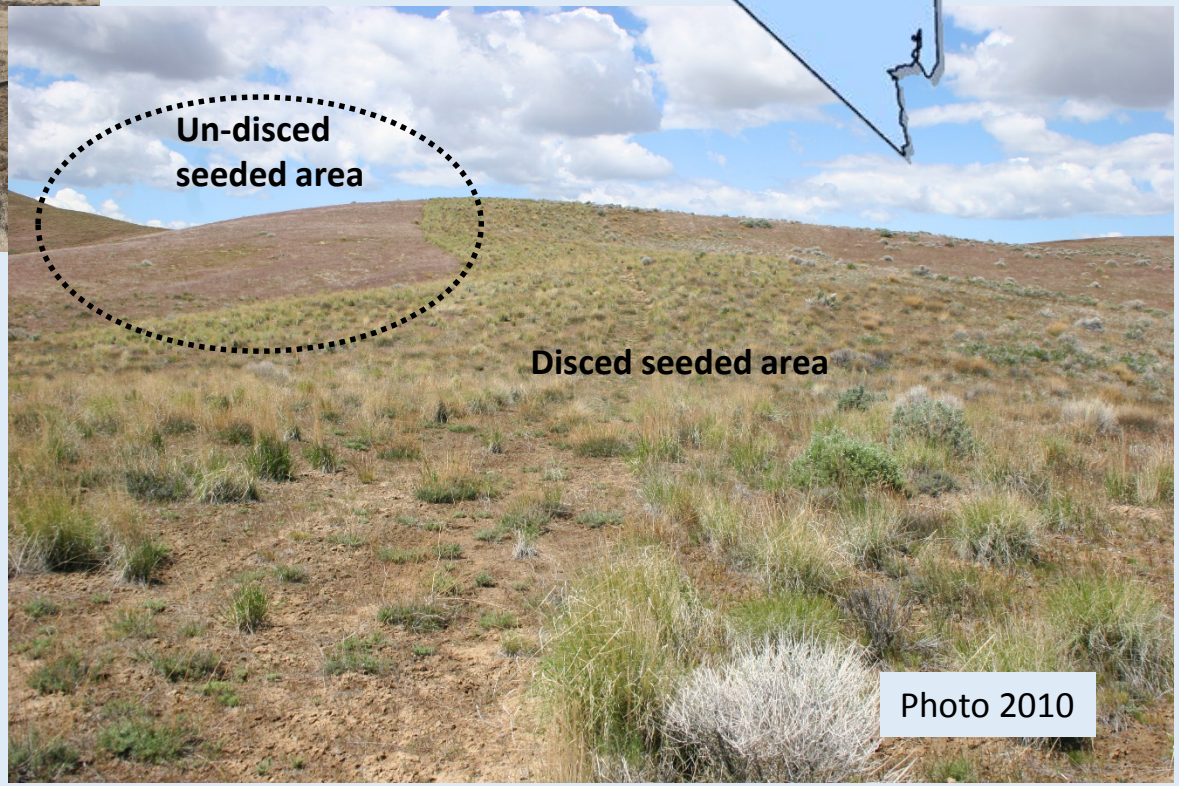
Dunphy NV

Dunphy, Nevada
1997 – 14.01”
1998 – 6.64”
1999 – 11.34

*Soil Series*
Orovada fine sandy loam
Loamy 8-10
MLRA 25

Disced 1996 Spring

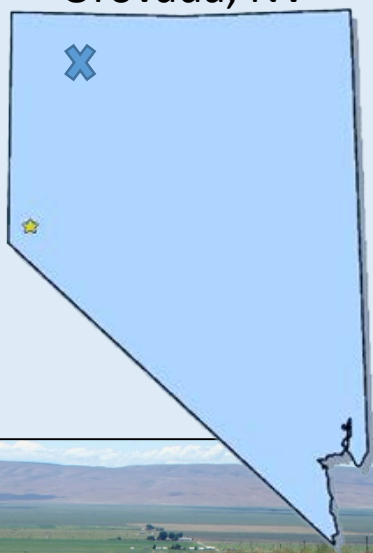
Seeded Fall 1996
Bluebunch wheatgrass
Crested wheatgrass
Sagebrush
Forage Kochia



# On the Ground Examples of Weed Control and Rangeland Rehabilitation

## Discing Control

Orovada, NV

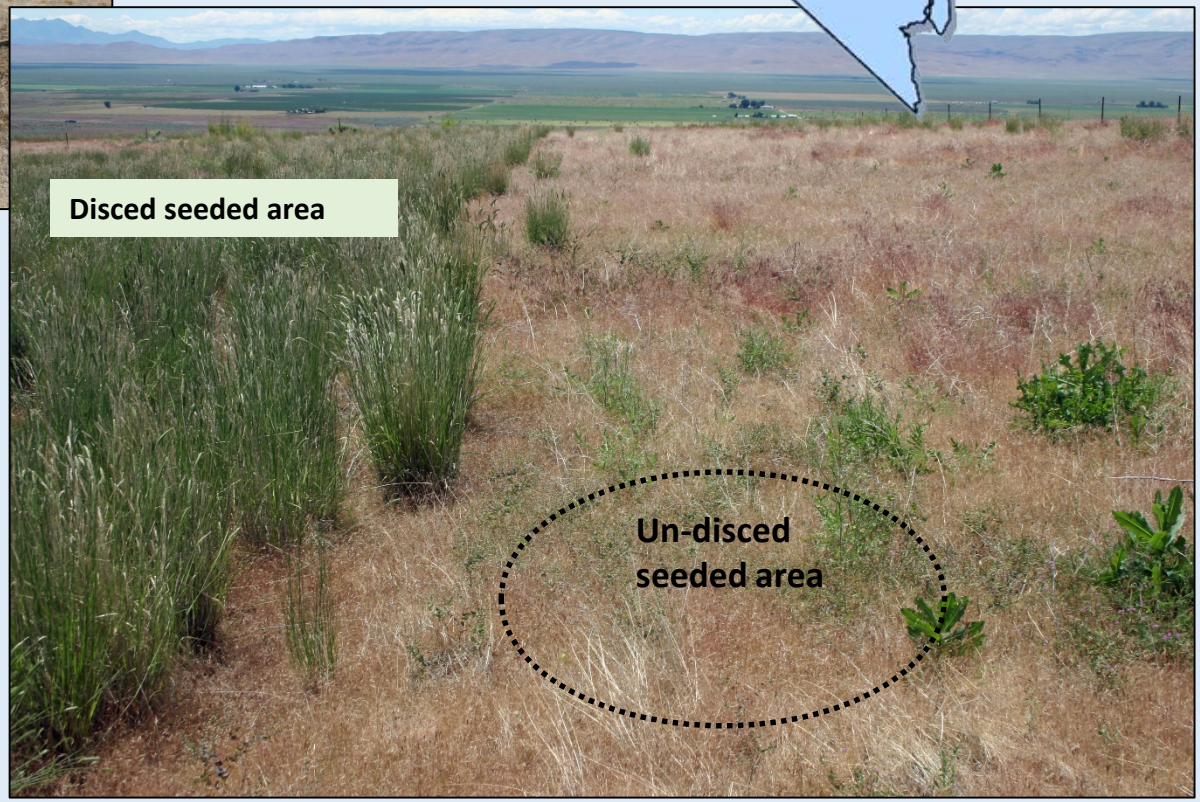


Orovada, Nevada
2001 – 5.63”
2002 – 8.49”
2003 – 8.42”
2004 – 8.89”

*Soil Series*
Snapp-McConnel-Adelaide association
DROUGHTY LOAM 8-10
MLRA 23/24

Discing 2000 Spring

Drill seeded Fall 2000
Seeded species
‘Hycrest’ crested wheatgrass
Sherman big bluegrass



# On the Ground Examples of Weed Control and Rangeland Rehabilitation

## Discing Control


*Proximity to agricultural fields limited herbicide control use and required disc control*

King River NV

Kings River, Nevada
2012 -4.72”
2013 – 6.73”
2014 – 4.62”
2015 – 9.39”
2016 – 8.96”

*Soil series*
Orovada fine sandy loam
DROUGHTY LOAM 8-10
MLRA 23/24

Disc Fall 2010

Disc Spring 2011

Cheatgrass cover Spring 2011

Cheatgrass cover Spring 2012

*Spring disc is best*

# On the Ground Examples of Weed Control and Rangeland Rehabilitation

## Horse Creek Ranch

**Timeline of Activities**

September 2010 - Disced 40 acres

October 2010 - Small plot Plant Material test seeding , No-till drill 10 acres
- Rehabilitation single mix seeding, Rangeland drill 20 acres
- Forage kochia seed storage test- Broadcast and No-till drill 20 acres

April 2011 - Disced 40 acres
- Cheatgrass Roundup® control 10 acre exclosure

October 2011 - Rehabilitation single mix seeding, Rangeland drill 40 acres*
- Logan, Utah ARS Plant Material seeding ~1 acre

May 2012 - Broadleaf herbicide 2-4D control 40 acres*
- Broadleaf herbicide 2-4D control 10 acre exclosure

October 2012 - Re-seeding rehabilitation single mix seeding No-till drill 40 acres*
- No-till drill single mix seeding 10 acre exclosure

October 2013 - Rehabilitation single mix seeding No-till drill – Greenstrips*

* represents the same 40 acres initially seeded in 2011

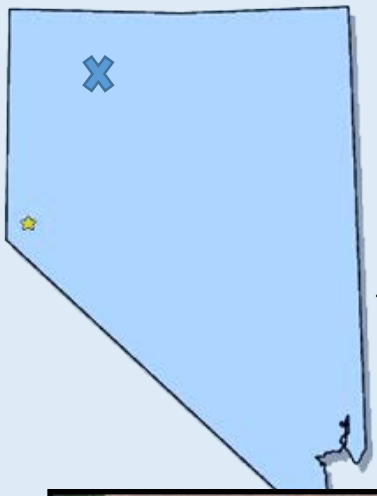
September 2014 – Fall grazing of cheatgrass, with prior and follow-up monitoring

October 2014 - Plant material seeding test (8 species) and Native vs. Introduced mixes test

October 2015 – Drill seeded 20 acres (Siberian wheatgrass), Introduced vs. native seed mix test

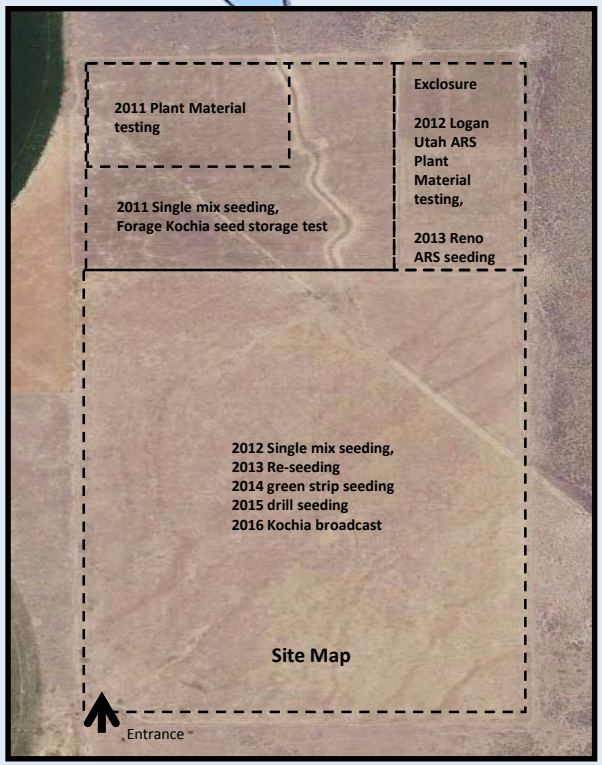
Dec 2016 – Broadcast 'snowstorm forage kochia 40 acres

## King River NV



Kings River, Nevada
2012 -4.72"
2013 – 6.73"
2014 – 4.62"
2015 – 9.39"
2016 – 8.96"

*Soil series*
Orovada fine sandy loam
DROUGHTY LOAM 8-10
MLRA 23/24



# On the Ground Examples of Weed Control and Rangeland Rehabilitation

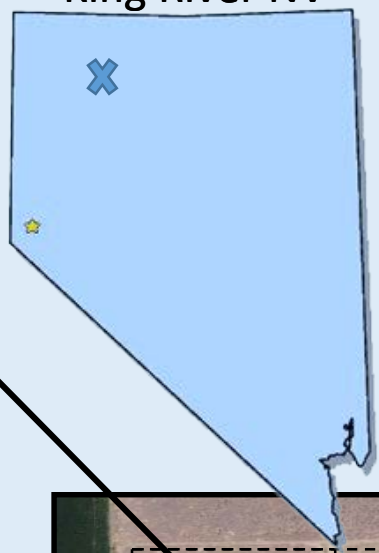

## Plant material Tests

| Shrub Species | Status | Rate (acre)/ Cost (lb) | Established |
|---|---|---|---|
| Shadscale *Atriplex confertifolia* | Native | 4 lbs 10$ | No |
| Four-wing Saltbush *Atriplex canescens* | Native | 4 lbs 15$ | No |
| Gardners saltbush *Atriplex garderni* | Native | 4 lbs 10$ | No |
| 'Immigrant' Forage Kochia *Kochia prostrata ssp. virescens* | Introduced | 2 lbs 20$ | Yes |
| 'Snowstorm' Forage Kochia *Kochia prostrata ssp. grisea* | Introduced | 2 lbs NA | Yes |

| Forb Species | Growth | Rate (acre)/ Cost (lb) | Established |
|---|---|---|---|
| Lewis Flax *Linum lewisii* | perennial | 1 lbs 15$ | No |
| Western Yarrow *Achillea millefolium* | perennial | 0.5 lbs 60$ | No |
| Baily's Buckwheat *Eriogonum bailyii* | Annual | 0.5 lbs NA | No |
| White stem stickleaf *Mentzelia albicaulis* | Annual | 0.5 lbs NA | No |
| Desert pincusion *Chenactis stevoides* | Annual | 0.5 lbs NA | No |
| Silver scale saltbush *Atriplex argentia* | Annual | 0.5 lbs NA | No |

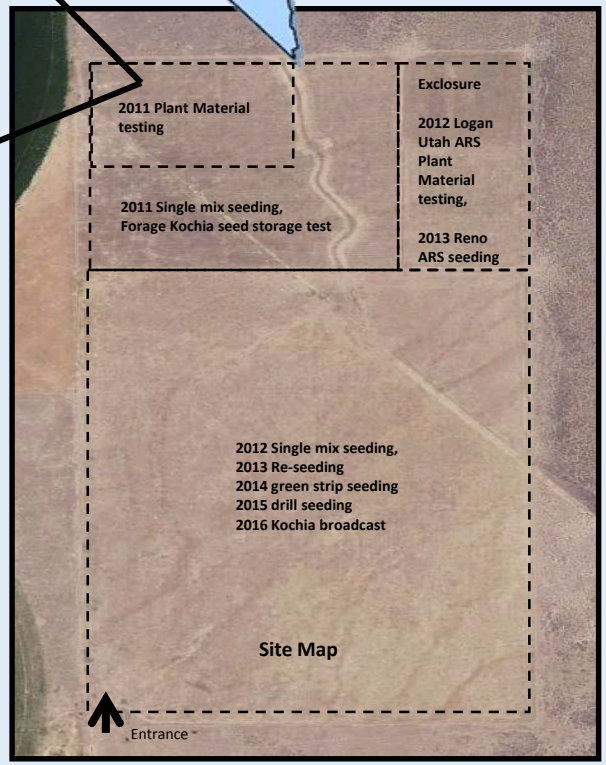
| Grass Species | Status | Rate(acre) / Cost (lb) | Established |
|---|---|---|---|
| Sherman Big Bluegrass *Poa ampla* | Native | 2 lbs 7$ | No |
| Thickspike Wheatgrass *Elymus lanceolatus* | Native | 7 lbs 10$ | No |
| 'Secar' Bluebunch Wheatgrass *Elymus wawawaiensis* | Native | 7 lbs 10$ | No |
| Bottlebrush Squirreltail *Elymus elymoides* | Native | 7 lbs 20$ | Yes < 10 plants |
| 'Whitmar' Wheatgrass *Pseudoroegneria spicata* | Native | 7 lbs 15$ | No |
| Creeping wildrye *Leymus triticoides* | Native | 10 lbs 20$ | No |
| Needle and Thread *Stipa comata* | Native | 7 lbs 60$ | No |
| Desert Needle grass *Stipa speciosa* | Native | 7lbs 45$ | No |
| 'Hycrest' Crested Wheatgrass *Agropyron critsatum* | Introduced | 7lbs 4$ | Yes |
| 'Nordan' Crested Wheatgrass *Agropyron desertorum* | Introduced | 7 lbs 4$ | Yes |
| 'Ephraim' Crested Wheatgrass *Agropyron cristatum* | Introduced | 7lbs 5$ | Yes |
| Siberian Wheatgrass *Agropyron fragile* | Introduced | 7lbs 5$ | Yes |
| Bozoisky I & II Russian Wildrye *Psathyrostachys junceus* | Introduced | 7lbs 7$ | No |
| 'Amur' Intermediate wheatgrass *Thinopyrum intermedium* | Introduced | 9 lbs 7$ | Yes 1 plant |
| Tall wheatgrass *Thinopyrum ponticum* | Introduced | 9 lbs 4$ | Yes < 5 plants |

## King River NV



Kings River, Nevada
2012 -4.72"
2013 – 6.73"
2014 – 4.62"
2015 – 9.39"
2016 – 8.96"

*Soil series*
Orovada fine sandy loam
DROUGHTY LOAM 8-10
MLRA 23/24



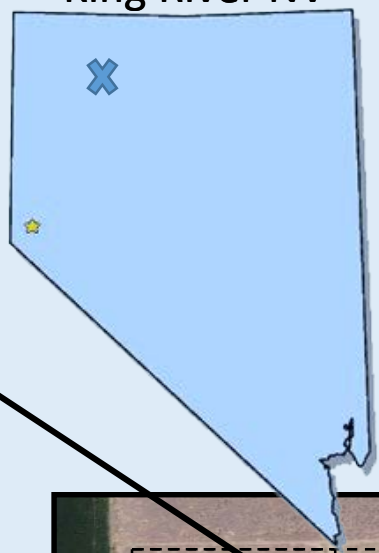
# On the Ground Examples of Weed Control and Rangeland Rehabilitation

## Plant material Tests
## Transplants
## Logan UT USDA-ARS

King's River PMT Logan ARS Plots 5/1/2014 (plants/$m^2$)

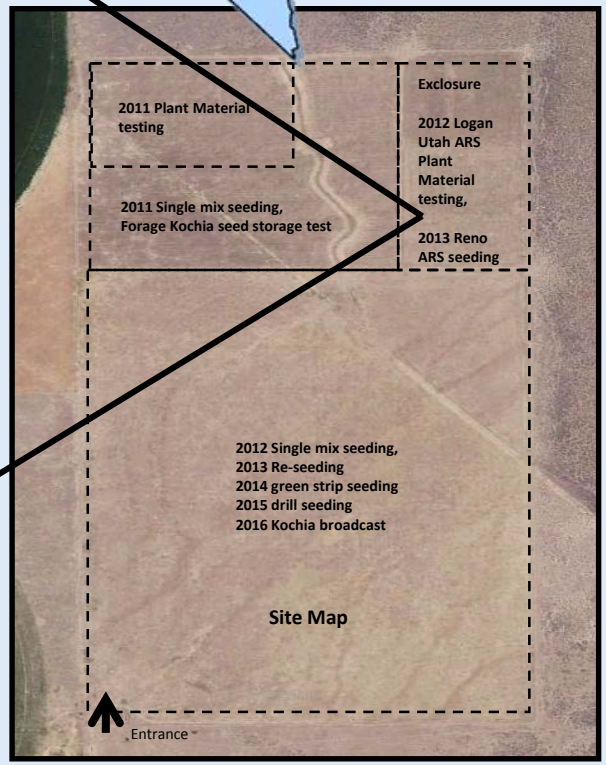
| Species | Rep I | Rep II | Rep III | Rep IV | Average |
|---|---|---|---|---|---|
| **'Hycrest II'** **crested wheatgrass** *Agropyron cristatum* | 1.7 | 1 | 1.7 | 3 | **1.9** |
| **'Vavilov II'** **siberian wheatgrass** *Agropyron fragile* | 3.7 | 1 | 4 | 5 | **3.4** |
| **'Bozoisky II'** **russian wildrye** *Psathyrostachys juncea* | 0 | 0 | 0.3 | 0.3 | **0.2** |
| **Saltgrass** *Distichlis spicata* | 0 | 0 | 0 | 0 | **0** |
| **'Alkar'** **tall wheatgrass** *Thinopyrum ponticum* | 0 | 0 | 0 | 0 | **0** |
| **Valvilov II &** **' Immigrant' Kochia** *Kochia prostrata ssp. virescens* | 4.3<br>0.02 | 2<br>0.02 | 5<br>0.1 | 4.3<br>0.02 | **3.9**<br>**0.04** |
| **Vavilov II & 'Snowstorm'Kochia** *Kochia prostrata ssp. grisea* | 3<br>0.17 | 3.7<br>0.14 | 8.7<br>0.17 | 5.3<br>0.06 | **5.2**<br>**0.14** |
| **Valvolov II &** **'KZ6X' kochia** *Kochia prostrata ssp. grisea* | 4<br>0.07 | 2.3<br>0.06 | 4<br>0.13 | 5.3<br>0.08 | **3.9**<br>**0.09** |
| **'Oahe'** **Intermediate wheatgrass** *Thinopyrum intermedium* | 0 | 0 | 0 | 0 | **0** |
| **'Trailhead'** **Basin wild rye** *Lemus cenereus* | 0 | 0 | 0 | 0 | **0** |
| **'Shashone'** **beardless wildrye** *Leymus multicaulis* | 0 | 0 | 0 | 0 | **0** |
| **Alkali sacatoon** *Sporobolus airoides* | 0 | 0 | 0 | 0 | **0** |
| **'Recovery'** **western wheatgrass** *Pascopyrum smithii* | 0 | 0 | 0.3 | 0 | **0.08** |

## King River NV



Kings River, Nevada
2012 -4.72"
2013 – 6.73"
2014 – 4.62"
2015 – 9.39"
2016 – 8.96"

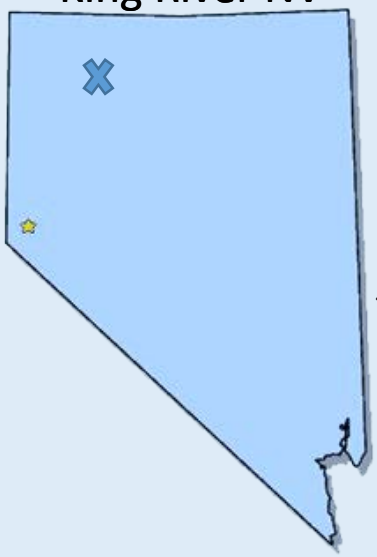
*Soil series*
Orovada fine sandy loam
DROUGHTY LOAM 8-10
MLRA 23/24



On the Ground Examples of Weed Control and Rangeland Rehabilitation

# Discing Control

## King River NV



Kings River, Nevada
2012 -4.72”
2013 – 6.73”
2014 – 4.62”
2015 – 9.39”
2016 – 8.96”

*Soil series*
Orovada fine sandy loam
DROUGHTY LOAM 8-10
MLRA 23/24

*With good cheatgrass control prior to seeding, species like Siberian wheatgrass and forage kochia established well and now the perennial grass suppresses cheatgrass (resistance) and the kochia decreases fire risk (high leaf moisture content) as well as both plants providing a great forage resource*

# Herbicide Control

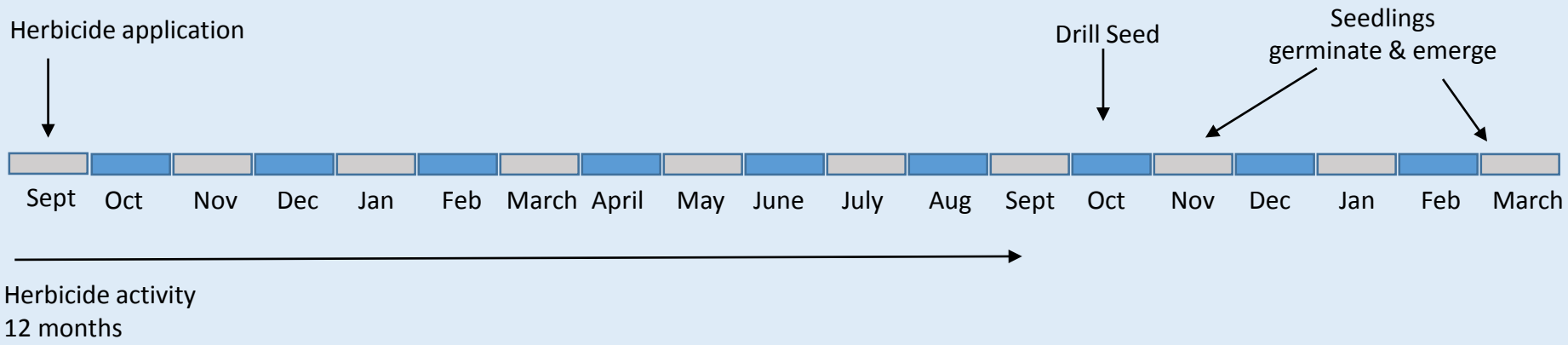
Soil Active Herbicides – will kill *all* newly germinated seedlings for one growing season, if applied correctly they *will not effect* already established perennial plants.

**Plateau** (imazapic 23.6%) - $175/gallon - rate 6oz/acre = **$8.20/acre product**
**Landmark XP** (Sulfometuron 50%, Chlorsulfuron 25%) - $800/4lbs – rate 1.75oz/acre = **$21.86/acre product**


# Herbicide Control

## Herbicide application timeline

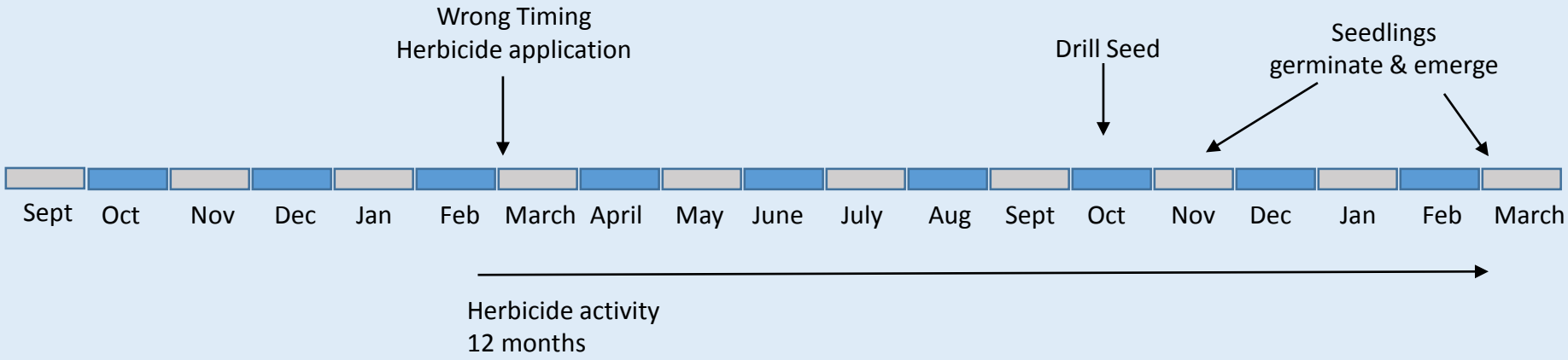
Apply in the early fall, before cheatgrass germination and while perennials are dormant to avoid leaf contact and possible damage



# Herbicide Control

## Herbicide application timeline

Spring applications risk killing seeded species, also cheatgrass has likely already germinated and the herbicide will be less effective (apply pre-emergent) and existing perennials will be actively growing (lots of green leaf) and may be damaged by the herbicide application leaf contact.



# Herbicide Control

*Far too often I see critical review of control methods such as herbicides as failures. For example a study that only uses herbicides and does not seed after should not be surprised by the short term effects and deem herbicides a failure. That is a poor understanding of the role of herbicides in rangeland rehabilitation.*

Herbicides only open a short window of opportunity (1-2 year) to conduct improvement practices like seeding. If you do not change the plant community (increase perennial density) cheatgrass will re-invade just like it did the first time.

It is best to measure plant community change by plant density and NOT cover percent's. Cover percent increases only represent a response to increased resources (precipitation, less competition) and *do not* represent a change in plant community function.

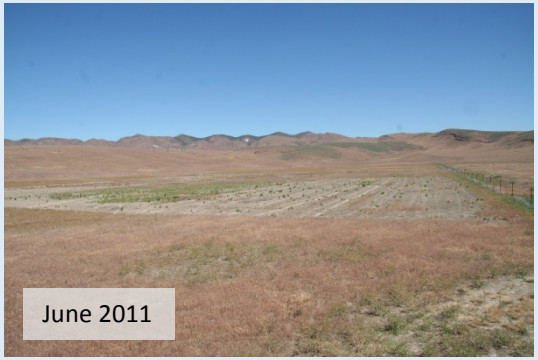
Measure perennial grass densities NOT cover percent.

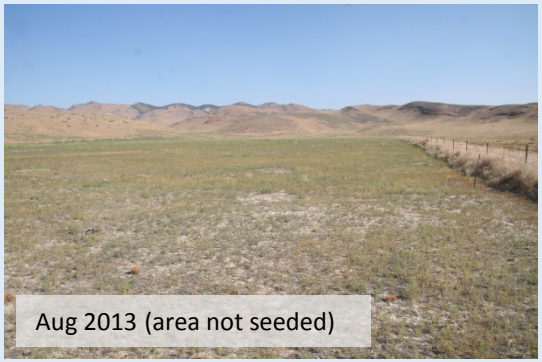
# Measuring perennial grass densities

The increase of cover of the residual native perennial grasses (release) (Photo) after herbicide cheatgrass control *does not* lead to increased resistance and is a poor measure. Cheatgrass will re-invade this just like it did the first time , because these perennial grasses are not dense enough to be resistant to invasion, only changes in density lead to functional changes like increased cheatgrass suppression. That is why density measures are always best !

# On the Ground Examples of Weed Control and Rangeland Rehabilitation

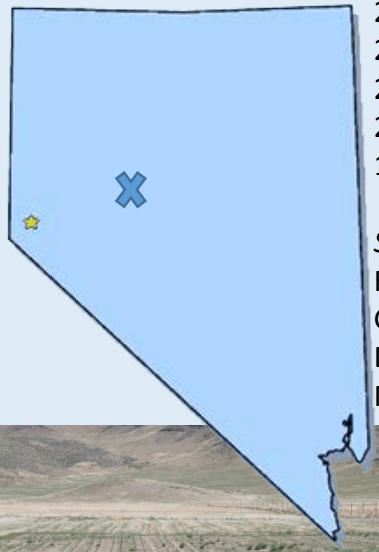
## Herbicide Control Timeline

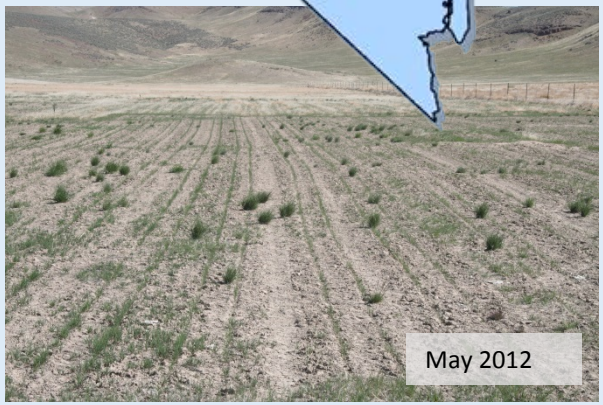

Sept 2011
seeding

Antelope NV



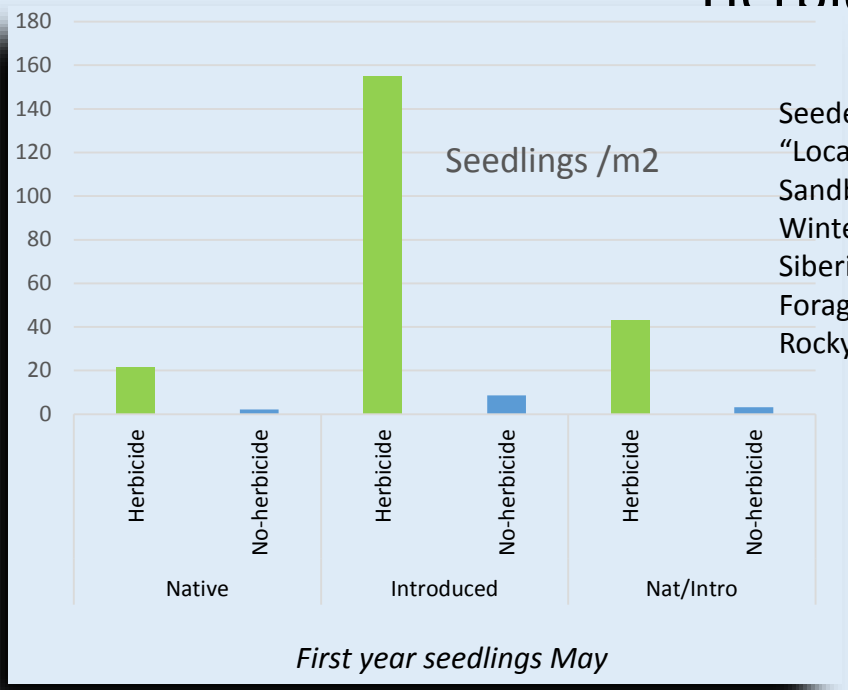
Antelope, Nevada
2012 – 2.1”
2013 – 1.86”
2014 – 4.62”
2015 – 9.39”
16 – 8.96”

*Soil series*
Hessing-Wholan-Dun
Glen association
DROUGHTY LOAM 8-10
MLRA 27




# On the Ground Examples of Weed Control and Rangeland Rehabilitation

## Herbicide Control



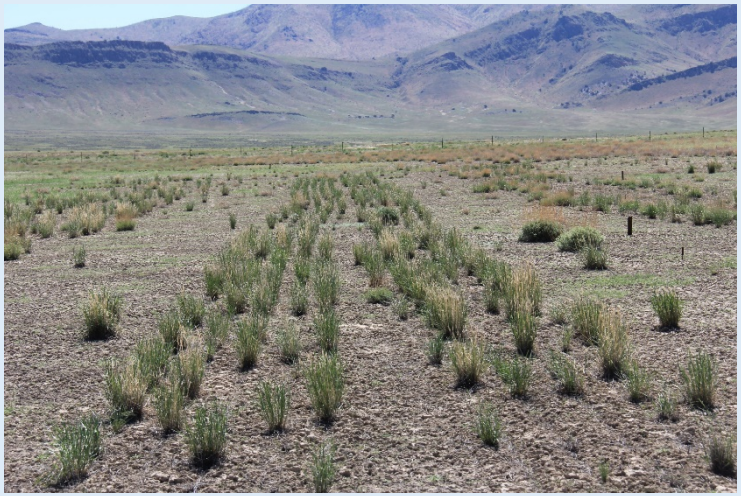

*First year seedlings May*

Seeded species
"Local" collection Squirreltail
Sandburg bluegrass
Winterfat
Siberian wheatgrass
Forage Kochia
Rocky Mnt Bee Plant

### Antelope NV

Antelope, Nevada
2012 – 2.1"
2013 – 1.86"
2014 – 4.62"
2015 – 9.39"
16 – 8.96"

*Soil series*
Hessing-Wholan-Dun
Glen association
DROUGHTY LOAM 8-10
MLRA 27



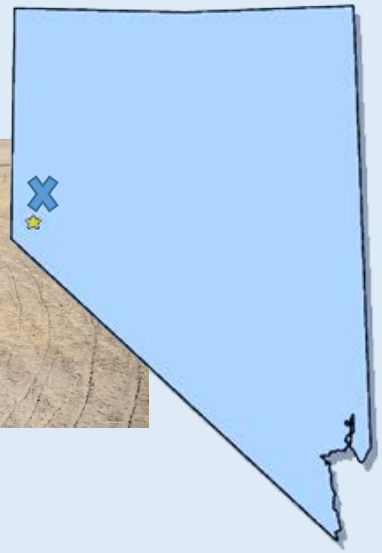
# On the Ground Examples of Weed Control and Rangeland Rehabilitation

## Herbicide Control Timeline

spray

Cheatgrass rosettes “die”

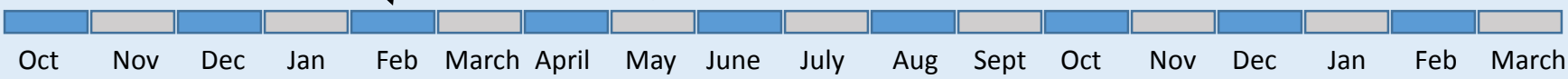
Bedel, NV



Bedel, Nevada
2013 – 4.54”
2014 – 5.56”
2015 – 10.65”
2016 – 12.88”

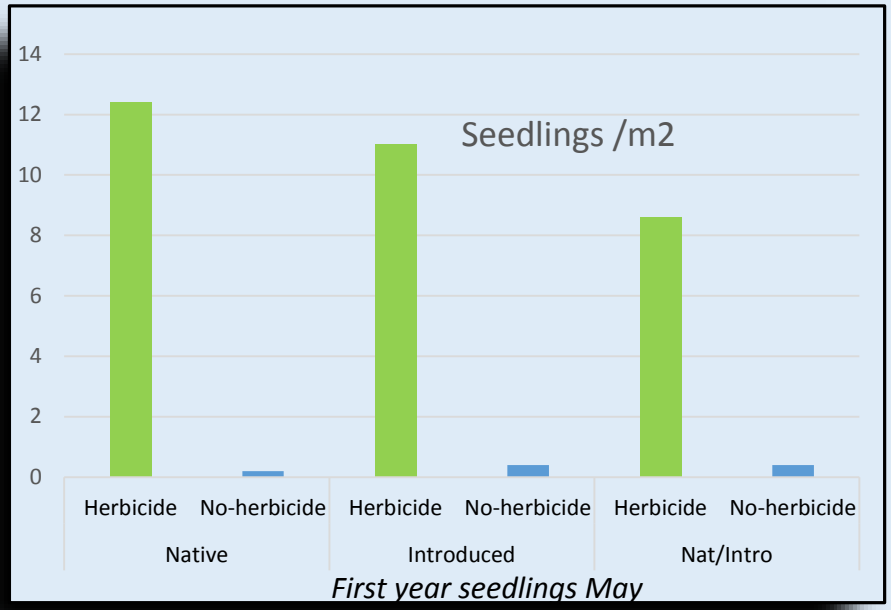
*Soil series*
Wedertz sandy loam
LOAMY 8-10
MLRA 26

Seedling emerge



# On the Ground Examples of Weed Control and Rangeland Rehabilitation

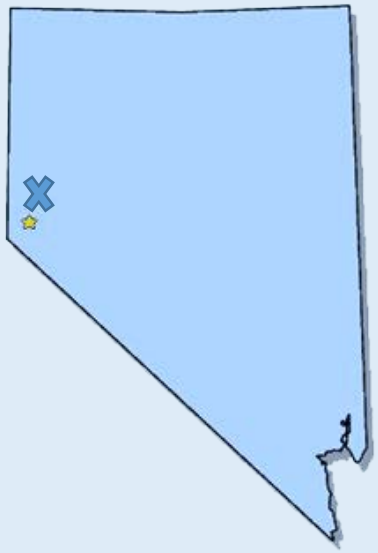
## Herbicide Control




*First year seedlings May*

Seeded species
'Anatone' bluebunch
Sherman big bluegrass
Sandburg bluegrass
Wyoming sagebrush
'Hycrest'
Forage Kochia
Rocky Mnt Bee Plant

Bedel, NV



Bedel, Nevada
2013 – 4.54"
2014 – 5.56"
2015 – 10.65"
2016 – 12.88"

*Soil series*
Wedertz sandy loam
LOAMY 8-10
MLRA 26

*‘‘Who weeding slacketh, good husbandry lacketh.”*

Thomas Tusser, (Five hundred points of good husbandry 1557)

# Questions...


THANK YOU!
USDA
USDA Agricultural Research Service
NEVADA SECTION
Society For Range Management