Reclaiming Greater-Sage Grouse Habitat Within a Gas Field: A Ten-Year Perspective

2nd Annual Sage Grouse Reclamation Workshop

Casper, WY – March 24, 2015

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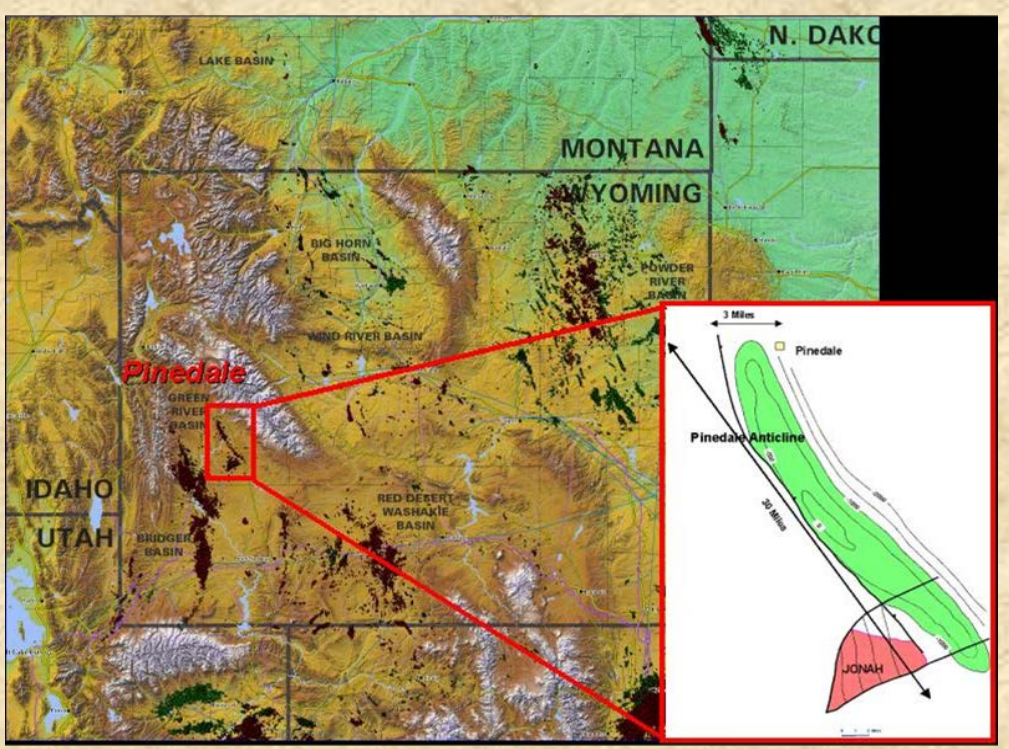
PINEDALE ANTICLINE BACKGROUND



- Green River Basin of SW Wyoming
- Elevation 7,200’ to 7,400’
- Average precipitation ~ 9 inches/year
- 90% of acreage is Federal BLM
- Upper Green River Basin has one of the largest Greater Sage Grouse populations in the US

- Sagebrush dominated rangeland, critical habitat for sage grouse and ungulate populations
- Disturbed areas in the natural gas fields are being restored using native plant species that are beneficial in critical sage grouse and large ungulate habitat.
- This has not always been the case.

THEN AND NOW

- Past Reclamation Activities
  - Focus on site stabilization
  - Grass dominated seed mixes
  - No emphasis on native plant species habitat
- Today's Focus
  - Restoration of natural sagebrush habitat
  - Native plant species
  - Ensuring critical habitat exists for Greater Sage Grouse and obligate species
  - Site stabilization

Reclaiming Greater-Sage Grouse Habitat Within a Gas Field: A Ten-Year Perspective

Rainbow 11-31 (2011)

Drill Seeded 2004

SEED MIXES (PLS lbs/ac)

				PRE-2004	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
					SHM	SH05	SH06	SH07	SH08PL	SH09F	SH10F	SH11F	SH12HAB	SH13HAB
				17.0	*5.18*	*5.18*	*7.18*	*9.40*	*9.25*	*9.30*	*9.45*	*9.45*	*9.70*	*10.12*
Prairie Sagewort	*Artemisia frigida*	ARFR4	Shrubs		0.05	0.05	0.05	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Wyoming Big Sagebrush	*Artemisia tridentata ssp. wyomingensis*	ARTRW8	Shrubs		0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.55	0.5
Four-wing Saltbush	*Atriplex canescens*	ATCA2	Shrubs	1.0	0.5	0.5	0.5	0.5						
Shadscale Saltbush	*Atriplex confertifolia*	ATCO	Shrubs										0.5	0.5
Gardner's Saltbush	*Atriplex gardneri*	ATGA	Shrubs						1.0	1.0	1.0	1.0	1.0	1.0
Winterfat	*Krascheninnikova lanata*	KRLA2	Shrubs	2.0	1.0	1.0	1.0	1.0	1.5	1.5	1.5	1.5	0.45	0.5
Antelope Bitterbrush	*Purshia tridentata*	PUTR2	Shrubs	1.0										
Common Yarrow	*Achillea millefolium*	ACMI2	Forbs						0.1			0.1		
Western Yarrow	*Achillea millefolium var. occidentalis*	ACMIO	Forbs		0.05	0.05	0.05	0.10		0.10	0.10		0.10	0.10
Rocky Mountain Beeplant	*Cleome serrulata*	CLSE	Forbs										0.5	0.5
Tapertip Hawksbeard	*Crepis acuminata*	CRAC2	Forbs											0.25
Sulphur-flower Buckwheat	*Eriogonum umbellatum*	ERUM	Forbs						0.25	0.25	0.25	0.25	0.25	
Northern Sweetvetch	*Hedysarum boreale*	HEBOM	Forbs								0.15	0.15	0.15	0.15
Great Basin Lupine	*Lupinus ×alpestris*	LUAL5	Forbs										0.3	0.15
Silvery Lupine	*Lupinus argenteus*	LUAR3	Forbs		1.0	1.0								
Mountain Lupine	*Lupinus pusillus*	LUPU	Forbs				1.0							
Silky Lupine	*Lupinus sericesus*	LUSES2	Forbs					0.5					0.2	
Pale Evening Primrose	*Oenothera pallida*	OEPAP	Forbs											0.02
Firecracker Penstemon	*Penstemon eatonii*	PEEA	Forbs					0.15	0.15	0.15	0.15	0.15	0.15	0.15
Littleflower Penstemon	*Penstemon procerus*	PEPR2	Forbs		0.05		0.03		0.05	0.05	0.05	0.05	0.05	0.05
Rydberg's Penstemon	*Penstemon rydbergii*	PERY	Forbs			0.05								
Subglaber Penstemon	*Penstemon subglaber*	PESU2	Forbs				0.02							
Gooseberryleaf Globemallow	*Sphaeraicea grossularifolia*	SPGR2	Forbs										0.15	0.11
Scarlet Globemallow	*Sphaeralcea coccinea*	SPCO	Forbs	1.0	0.03	0.03	0.03	0.05	0.10	0.15	0.15			0.04
Munro's Globemallow	*Sphaeraicea munroana*	SPMU2	Forbs									0.15		
Indian Ricegrass	*Achnatherum hymenoides*	ACHY	Grasses	4.0	1.0	1.0	1.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Thickspike Wheatgrass Rosanna	*Elymus lanceolatus*	ELLA3	Grasses	4.0				1.0	1.0	1.0	1.0	1.0	1.3	1.5
Slender Wheatgrass	*Elymus trachycaulus*	ELTR7	Grasses				2.0	2.0	1.0	1.0	1.0	1.0	1.0	1.0
Western Wheatgrass Critana	*Pascopyrum smithii*	PASM	Grasses	4.0										
Sandberg Bluegrass	*Poa secunda*	POSE	Grasses		1.0	1.0	1.0	1.5	1.5	1.5	1.5	1.5	1.0	1.0
Bluebunch Wheatgrass	*Pseudoroegneria spicata*	PSSP6	Grasses											0.5
			Shrub ct:	3	4	4	4	4	4	4	4	4	5	5
			Forb ct:	1	4	4	5	4	5	5	6	6	9	10
			Grass ct:	3	2	2	3	4	4	4	4	4	4	5
			Shrub PLS:	4.00	2.05	2.05	2.05	2.10	3.10	3.10	3.10	3.10	2.60	2.60
			Forb PLS:	1.00	1.13	1.13	1.13	0.80	0.65	0.70	0.85	0.85	1.85	1.52
			Grass PLS:	12.00	2.00	2.00	4.00	6.50	5.50	5.50	5.50	5.50	5.25	6.00

SEED MIXES (PLS lbs/ac)

				PRE-2004	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
					SHM	SH05	SH06	SH07	SH08PL	SH09F	SH10F	SH11F	SH12HAB	SH13HAB
				17.0	*5.18*	*5.18*	*7.18*	*9.40*	*9.25*	*9.30*	*9.45*	*9.45*	*9.70*	*10.12*
Prairie Sagewort	*Artemisia frigida*	ARFR4	Shrubs		0.05	0.05	0.05	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Wyoming Big Sagebrush	*Artemisia tridentata ssp. wyomingensis*	ARTRW8			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.55	0.5
Four-wing Saltbush	*Atriplex canescens*	ATCA2		1.0	0.5	0.5	0.5	0.5						
Shadscale Saltbush	*Atriplex confertifolia*	ATCO											0.5	0.5
Gardner's Saltbush	*Atriplex gardneri*	ATGA							1.0	1.0	1.0	1.0	1.0	1.0
Winterfat	*Krascheninnikova lanata*	KRLA2		2.0	1.0	1.0	1.0	1.0	1.5	1.5	1.5	1.5	0.45	0.5
Antelope Bitterbrush	*Purshia tridentata*	PUTR2		1.0										
Common Yarrow	*Achillea millefolium*	ACMI2	Forbs						0.1			0.1		
Western Yarrow	*Achillea millefolium var. occidentalis*	ACMIO			0.05	0.05	0.05	0.10		0.10	0.10		0.10	0.10
Rocky Mountain Beeplant	*Cleome serrulata*	CLSE											0.5	0.5
Tapertip Hawksbeard	*Crepis acuminata*	CRAC2												0.25
Sulphur-flower Buckwheat	*Eriogonum umbellatum*	ERUM							0.25	0.25	0.25	0.25	0.25	
Northern Sweetvetch	*Hedysarum boreale*	HEBOM									0.15	0.15	0.15	0.15
Great Basin Lupine	*Lupinus ×alpestris*	LUAL5											0.3	0.15
Silvery Lupine	*Lupinus argenteus*	LUAR3			1.0	1.0								
Mountain Lupine	*Lupinus pusillus*	LUPU					1.0							
Silky Lupine	*Lupinus sericesus*	LUSES2						0.5					0.2	
Pale Evening Primrose	*Oenothera pallida*	OEPAP												0.02
Firecracker Penstemon	*Penstemon eatonii*	PEEA						0.15	0.15	0.15	0.15	0.15	0.15	0.15
Littleflower Penstemon	*Penstemon procerus*	PEPR2			0.05		0.03		0.05	0.05	0.05	0.05	0.05	0.05
Rydberg's Penstemon	*Penstemon rydbergii*	PERY				0.05								
Subglaber Penstemon	*Penstemon subglaber*	PESU2					0.02							
Gooseberryleaf Globemallow	*Sphaeraicea grossularifolia*	SPGR2											0.15	0.11
Scarlet Globemallow	*Sphaeralcea coccinea*	SPCO		1.0	0.03	0.03	0.03	0.05	0.10	0.15	0.15			0.04
Munro's Globemallow	*Sphaeraicea munroana*	SPMU2										0.15		
Indian Ricegrass	*Achnatherum hymenoides*	ACHY	Grasses	4.0	1.0	1.0	1.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Thickspike Wheatgrass Rosanna	*Elymus lanceolatus*	ELLA3		4.0				1.0	1.0	1.0	1.0	1.0	1.3	1.5
Slender Wheatgrass	*Elymus trachycaulus*	ELTR7					2.0	2.0	1.0	1.0	1.0	1.0	1.0	1.0
Western Wheatgrass Critana	*Pascopyrum smithii*	PASM		4.0										
Sandberg Bluegrass	*Poa secunda*	POSE			1.0	1.0	1.0	1.5	1.5	1.5	1.5	1.5	1.0	1.0
Bluebunch Wheatgrass	*Pseudoroegneria spicata*	PSSP6												0.5
			Shrub ct:	3	4	4	4	4	4	4	4	4	5	5
			Forb ct:	1	4	4	5	4	5	5	6	6	9	10
			Grass ct:	3	2	2	3	4	4	4	4	4	4	5
			Shrub PLS:	4.00	2.05	2.05	2.05	2.10	3.10	3.10	3.10	3.10	2.60	2.60
			Forb PLS:	1.00	1.13	1.13	1.13	0.80	0.65	0.70	0.85	0.85	1.85	1.52
			Grass PLS:	12.00	2.00	2.00	4.00	6.50	5.50	5.50	5.50	5.50	5.25	6.00

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			Forb ct:	1	4	4	5	4	5	5	6	6	9	10
			Grass ct:	3	2	2	3	4	4	4	4	4	4	5
			Shrub PLS:	4.00	2.05	2.05	2.05	2.10	3.10	3.10	3.10	3.10	2.60	2.60
			Forb PLS:	1.00	1.13	1.13	1.13	0.80	0.65	0.70	0.85	0.85	1.85	1.52
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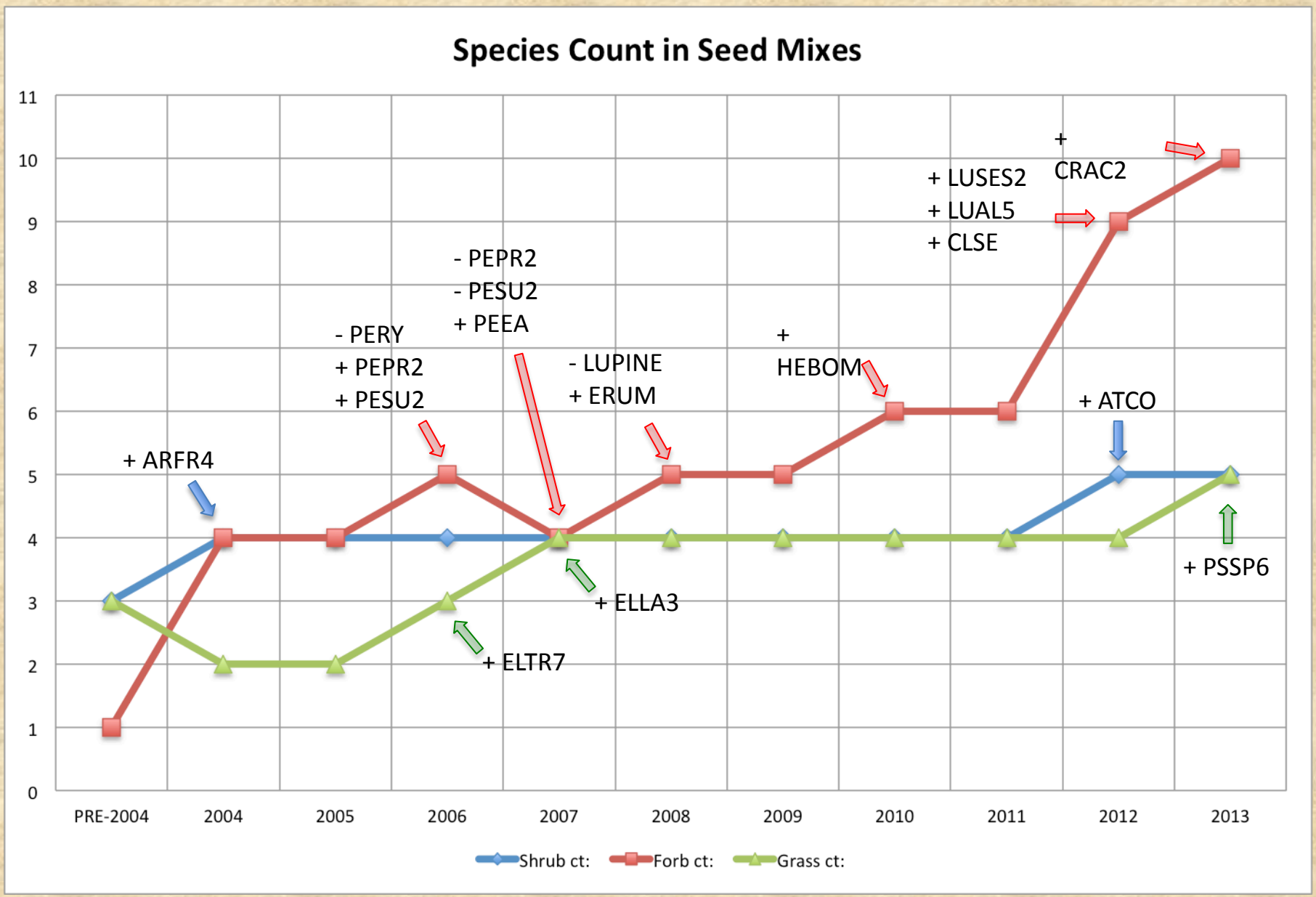

Species Count in Seed Mixes
11
10
9
8
7
6
5
4
3
2
1
0
PRE-2004
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
+ ARFR4
- PERY
+ PEPR2
+ PESU2
- PEPR2
- PESU2
+ PEEA
- LUPINE
+ ERUM
+ HEBOM
+ LUSES2
+ LUAL5
+ CLSE
+ CRAC2
+ ATCO
+ PSSP6
+ ELLA3
+ ELTR7
Shrub ct:
Forb ct:
Grass ct:

Observations

- FACTORS CONTRIBUTING TO SUCCESS

Antelope 2-9 (2011)

Hydro-seeded 2004

Observations

- FACTORS CONTRIBUTING TO SUCCESS
  - PRECIPITATION

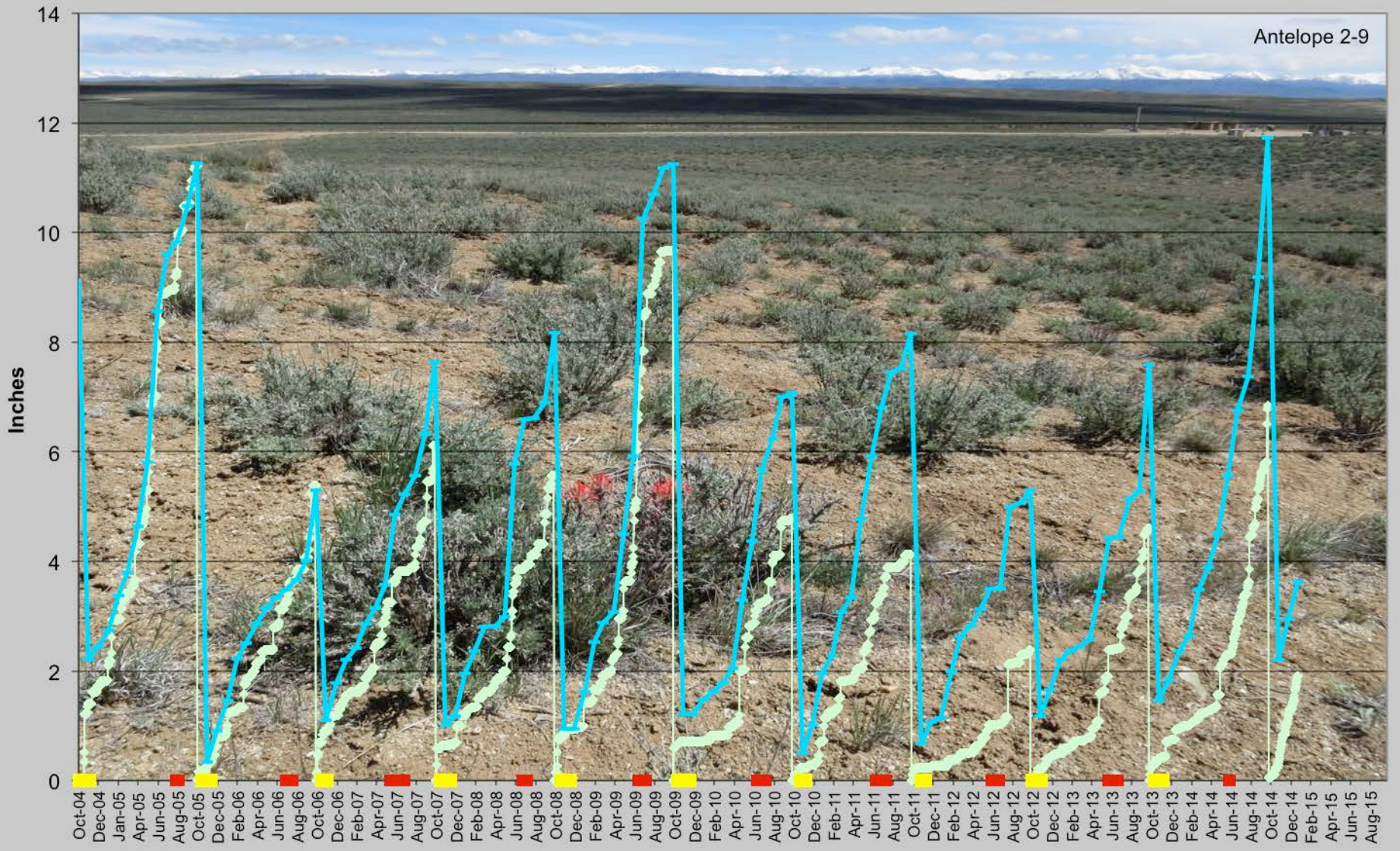
Antelope 2-9 (2011)

Hydro-seeded 2004

Cumulative Inches of Precipitation

Annually - Oct 1 through Sept 30

Big Piney and Boulder Rearing Stations, WY




7/25/05
NF 13-32
A
2005


New Fork
13-32 A
PP
7/12/06
2006


New Fork
13-32 A
photoplot
7-09-07
2007


PP
New Fork
13-32 A
7/9/08
2008


PROJECT
SWEPI
DATE
7/13/09
SITE
New Fork 13-32
NAME
RSC
PLOT
PP NF 13-32 A
DIRECTION
2009


PP New Fork
13-32
7/1/10
2010


PP New Fork
13-32
7/7/11
2011


PP
New Fork 13-32
A
6/18/12
2012


PP New Fork
13-32 A
6/18/13
2013

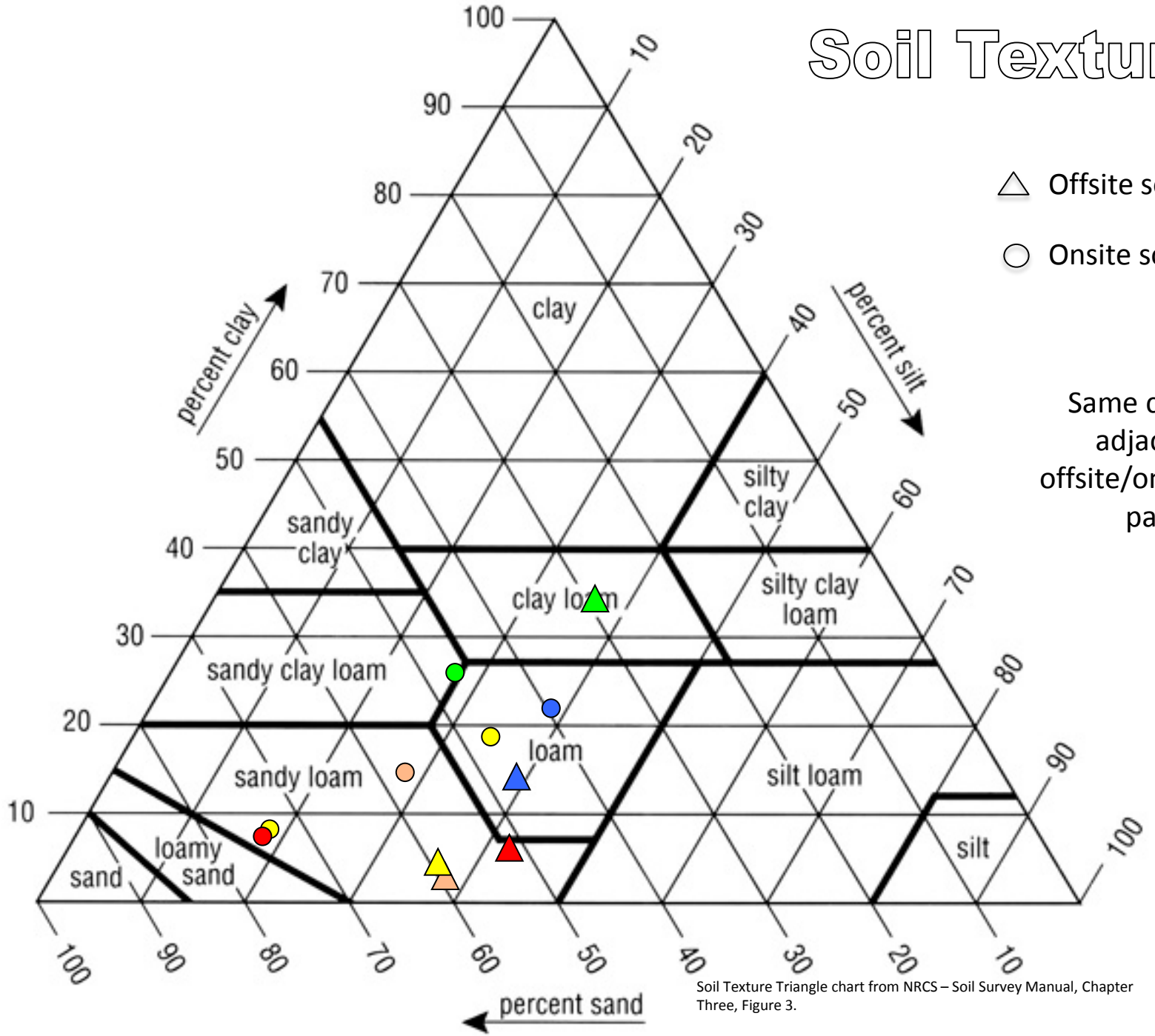
Observations

- FACTORS CONTRIBUTING TO SUCCESS
  - PRECIPITATION
  - SOILS AND SOIL BED PREPARATION

Boulder 1-32 (2014)

Drill/hydro-seeded 2010

Soil Texture



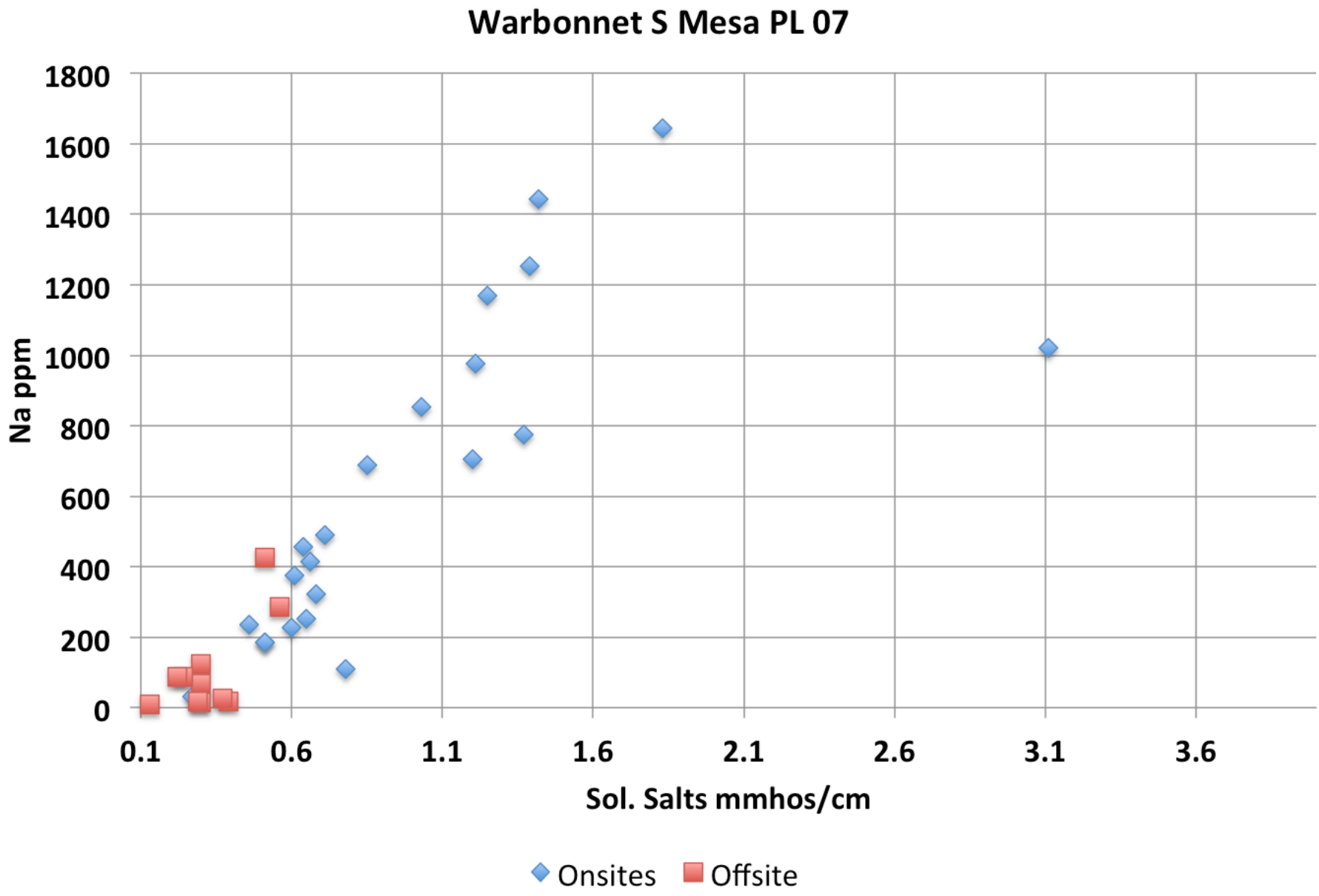
△ Offsite soil sample

○ Onsite soil sample

Same color = adjacent offsite/onsite soil pair

Soil Texture Triangle chart from NRCS – Soil Survey Manual, Chapter Three, Figure 3.

Observations



Observations

S Mesa-Warbonnet LGS (2014)

Drill-seeded 2007

Observations

– SOILS AND SOIL BED PREPARATION

- SEEDING INTO SUBSOIL WITH NO TOPSOIL

Boulder 1-32 (2014)

Drill/hydro-seeded 2010

Observations

Boulder 1-32 (2014)

Drill/hydro-seeded 2010

Observations

FACTORS CONTRIBUTING TO SUCCESS

PRECIPITATION

SOILS AND SOIL BED PREPARATION

Rainbow 11-31 2004

Drill Seeded 2004

Observations

Rainbow 11-31 2011

Drill Seeded 2004

Observations

- FACTORS CONTRIBUTING TO SUCCESS
  - PRECIPITATION
  - SOILS AND SOIL BED PREPARATION
  - SEEDING METHODS

Riverside 2-14 (2014)

Drill-seeded 2004


ROUGH RIDER


CATERPILLAR


FINN


Great Plains
3R606NT


FINN

Observations


Truax Brillion Packer wheels

Warbonnet 7-5


Seeded 2007

N Mesa 4-7


Seeded 2007

Warbonnet 7-5


Seeded 2009

Riverside 13-4

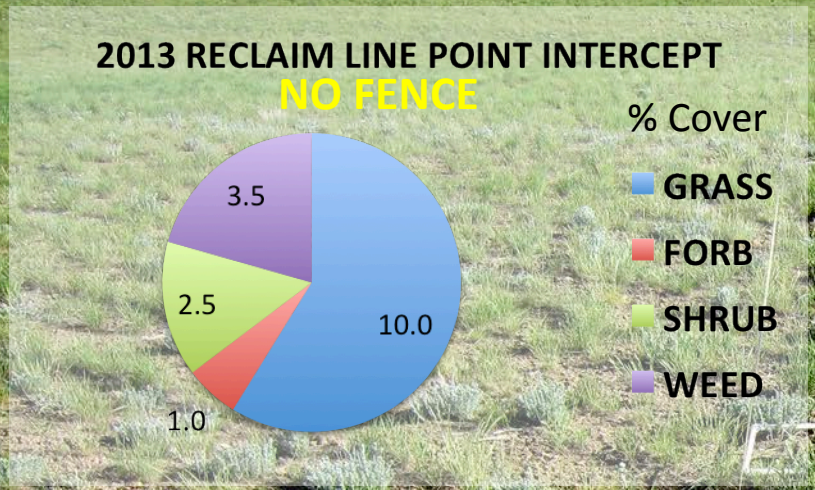

Seeded 2007

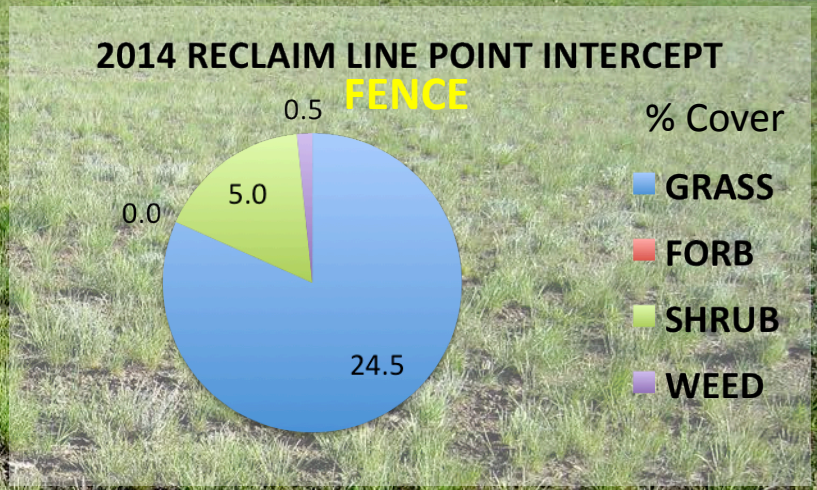
Antelope 14-4

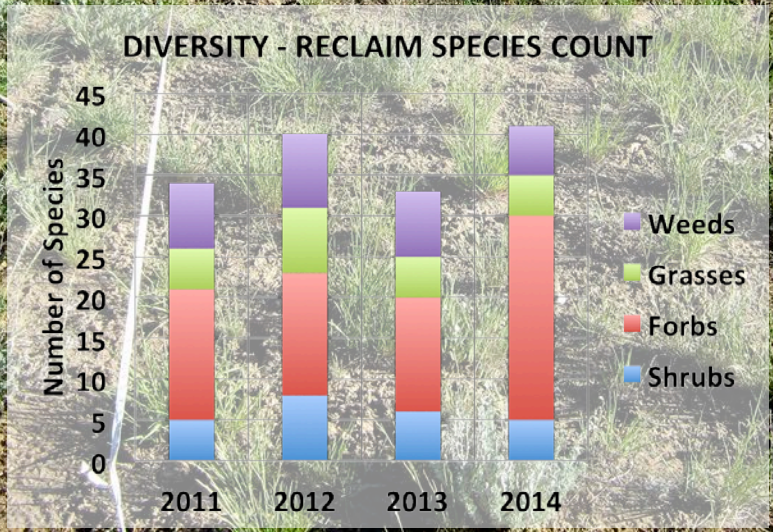
Observations

- FACTORS CONTRIBUTING TO SUCCESS
  - PRECIPITATION
  - SOILS AND SOIL BED PREPARATION
  - SEEDING METHODS
  - FENCING

Observations







Stewart Point 16-6 (2014)

Drill-seeded 2010

Observations

- FACTORS CONTRIBUTING TO SUCCESS
  - PRECIPITATION
  - SOILS AND SOIL BED PREPARATION
  - SEEDING METHODS
  - FENCING
  - NOT STRESSING OVER MOST WEEDS

Rainbow 13-31 (2014)

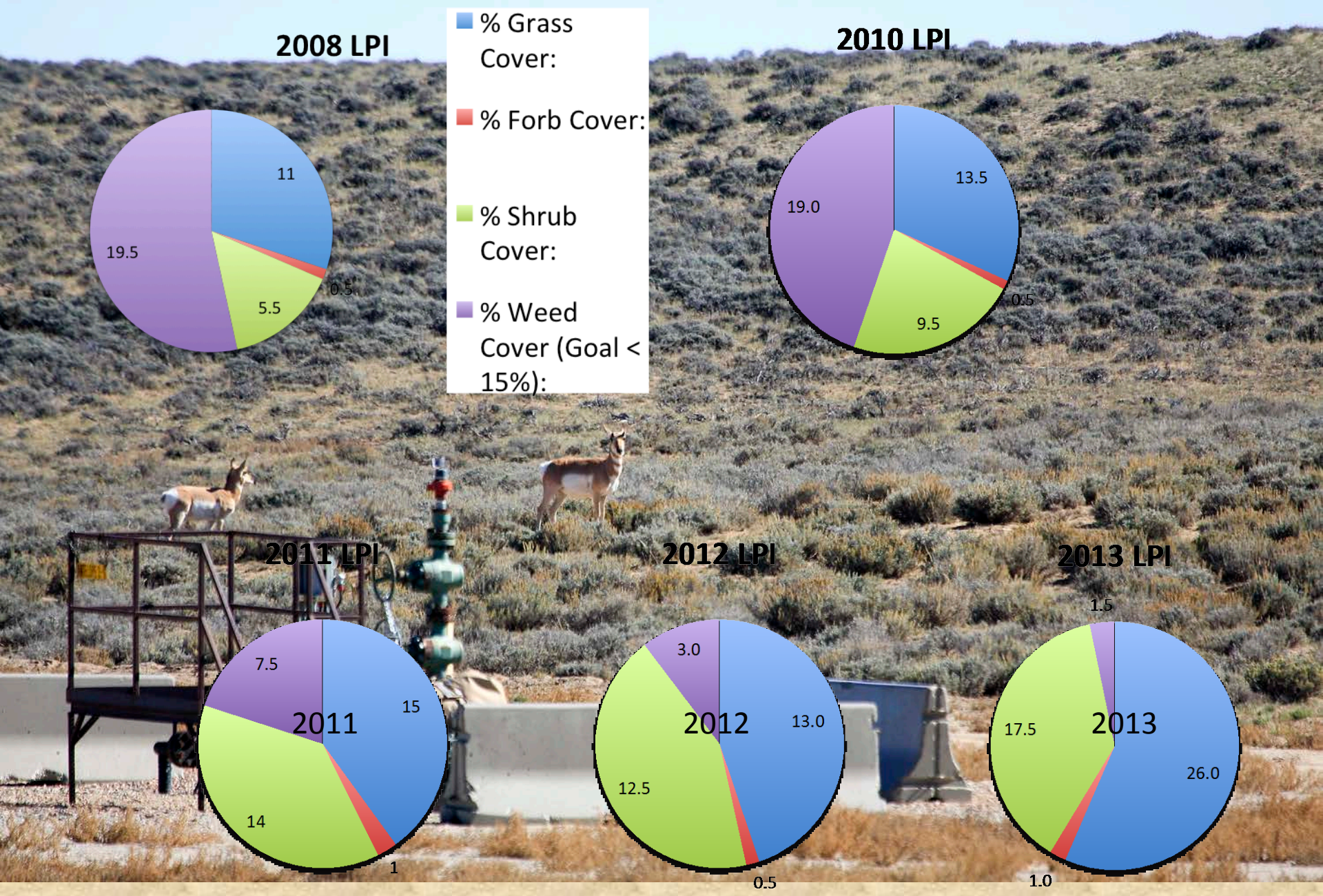
Drill-seeded 2006

Antelope 2-9 (2005)

Hydro-seeded 2004

Antelope 2-9 (2011)

Hydro-seeded 2004



Antelope 2-9

Hydro-seeded 2004

Observations

- FACTORS CONTRIBUTING TO SUCCESS
  - PRECIPITATION
  - SOILS AND SOIL BED PREPARATION
  - SEEDING METHODS
  - FENCING
  - NOT STRESSING OVER MOST WEEDS
  - PATIENCE

Antelope 14-4 (2007)

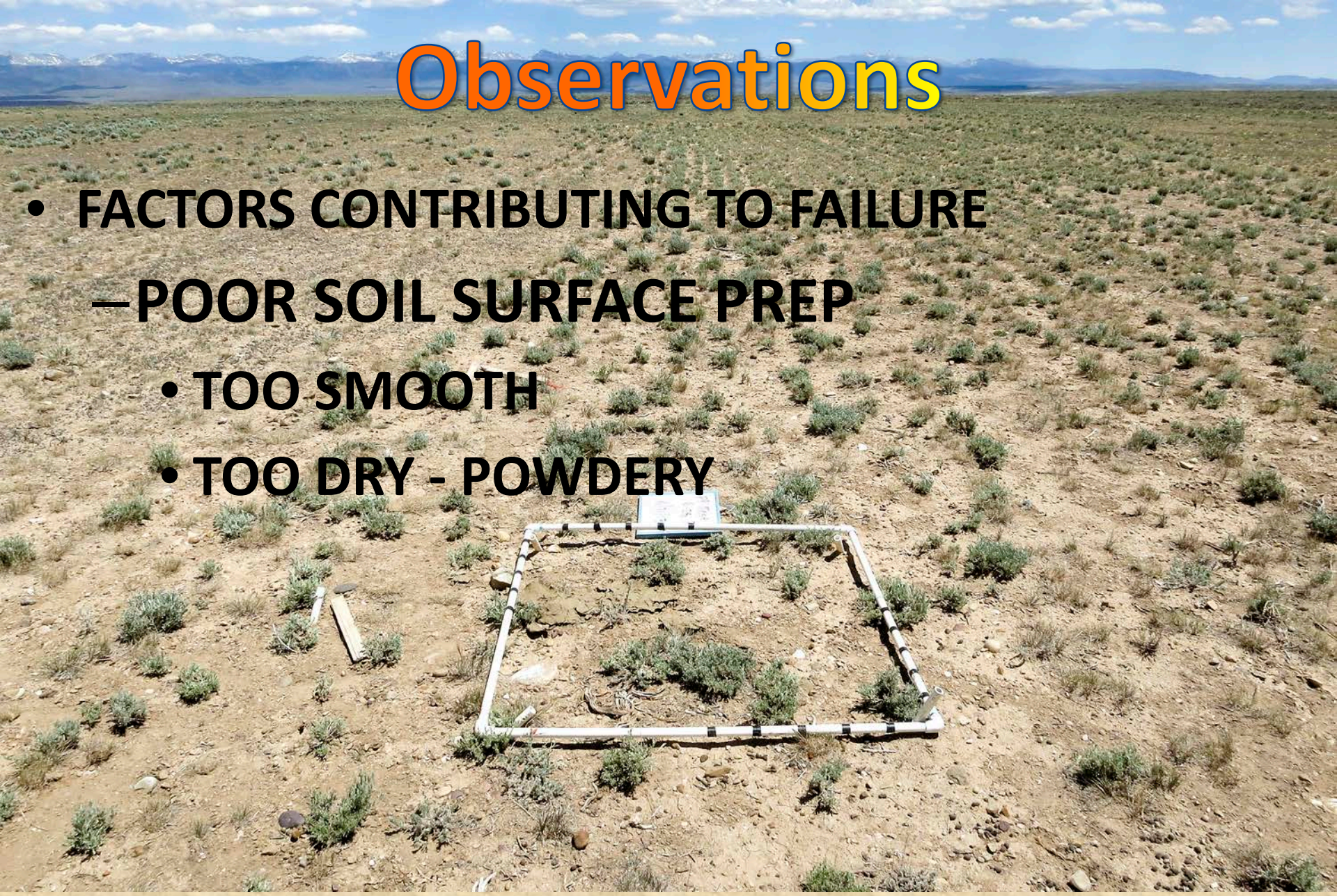
Drill-seeded 2004

SEEDED SITES ONLY

SEED MIX SPECIES USED THROUGH 2012			Number of Reclaims Species Seeded Into	No Shows	% of Reclaims where Species Observed	Number of Reclaim Sites where Species in Seed Mix first observed - by Growing Season.									
					%	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
Four-wing Saltbush	ATCA2	Shrubs	26	0	100	15	6	4		1					
Wyoming Big Sagebrush	ARTRW8		51	1	98	40	7	3							
Winterfat	KRLA2		50	1	98	38	9	1		1					
Gardner's Saltbush	ATGA		34	3	91	22	6	3							
Shadscale Saltbush	ATCO		10	1	90	9									
Prairie Sagewort	ARFR4		50	6	88	18	17	3	1			4		1	
Antelope Bitterbrush	PUTR2		7	7	0										
Rocky Mountain Beeplant	CLSE	Forbs	10	0	100	10									
Yarrow	ACMI2/ACMIO		51	1	98	25	14	7	3	1					
Firecracker Penstemon	PEEA		37	2	95	22	10	2	1						
Sulphur-flower Buckwheat	ERUM		33	6	82	18	6	2	1						
Silky Lupine	LUSES2		14	4	71	7			1	2					
Northern Sweetvetch	HEBOM		24	7	71	16		1							
Scarlet Globemallow	SPCO		38	12	68	3	7	5	6	5					
Rydberg's Penstemon	PERY		9	3	67			2	3		1				
Silvery Lupine	LUAR3		21	8	62	8	2				1	2			
Littleflower Penstemon	PEPR2		45	22	51	8	9	4	1			1			
Mountain Lupine	LUPU		6	3	50	2		1							
Gooseberryleaf Globemallow	SPGR2		10	5	50	4	1								
Munro's Globemallow	SPMU2		4	2	50		2								
Subglaber Penstemon	PESU2		5	4	20				1						
Great Basin Lupine	LUAL5		9	8	11	1									
Indian Ricegrass	ACHY	Grasses	51	0	100	46	5								
Thickspike Wheatgrass Rosanna	ELLA3		45	0	100	29	12	2		1			1		
Western Wheatgrass Critana	PASM		7	0	100	5	2								
Sandberg Bluegrass	POSE		51	1	98	31	16	3							
Slender Wheatgrass	ELTR7		44	1	98	34	6	2		1					

Observations

- FACTORS CONTRIBUTING TO FAILURE
  - –POOR SOIL SURFACE PREP
    - TOO SMOOTH
    - TOO DRY - POWDERY



Mesa 6-28

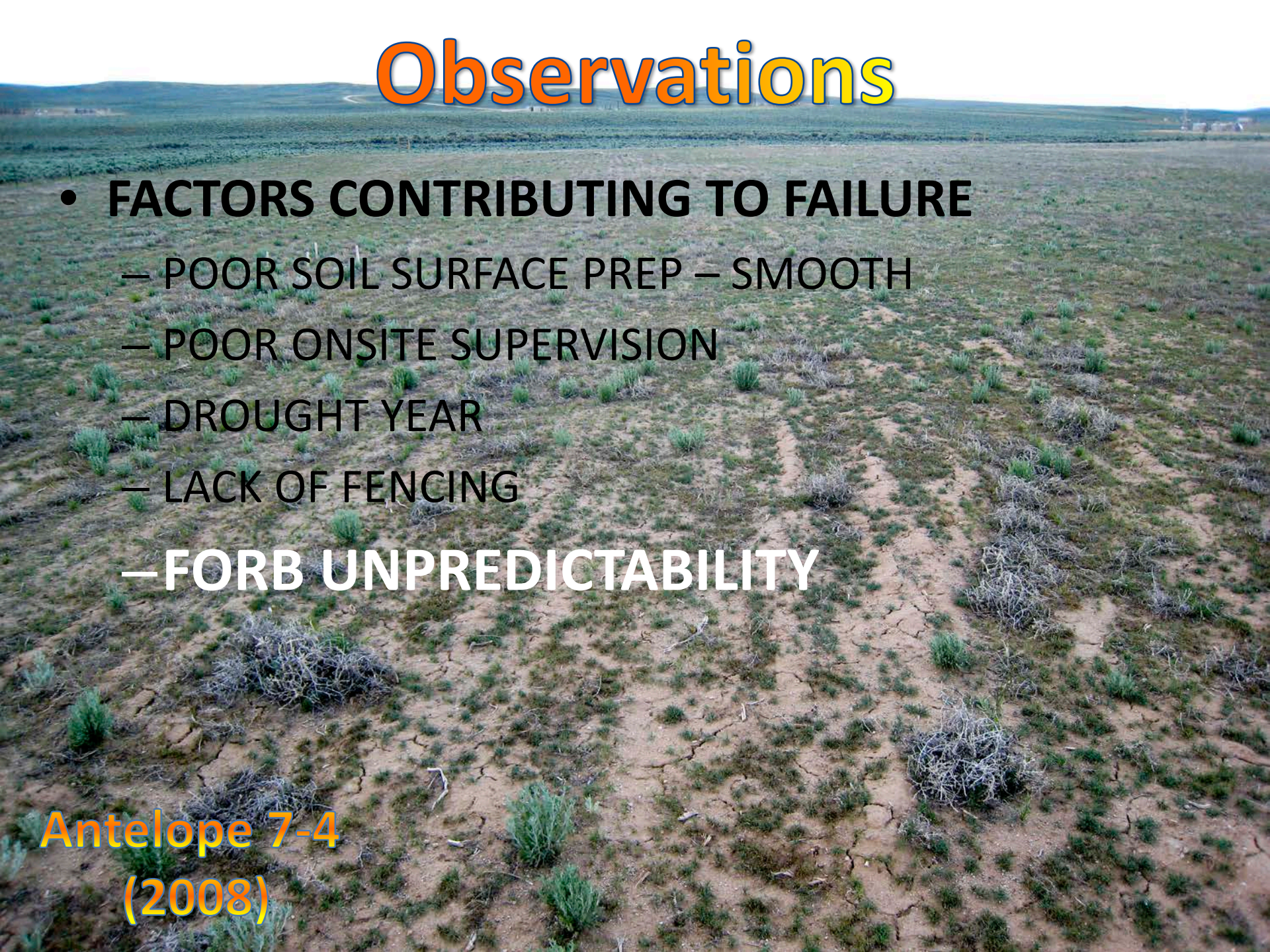
Observations

- **FACTORS CONTRIBUTING TO FAILURE**
  - POOR SOIL SURFACE PREP – TOO SMOOTH
  - **POOR ONSITE SUPERVISION**

Observations

Observations

- **FACTORS CONTRIBUTING TO FAILURE**
  - POOR SOIL SURFACE PREP – SMOOTH
  - POOR ONSITE SUPERVISION
  - DROUGHT YEAR
  - LACK OF FENCING
  - **FORB UNPREDICTABILITY**



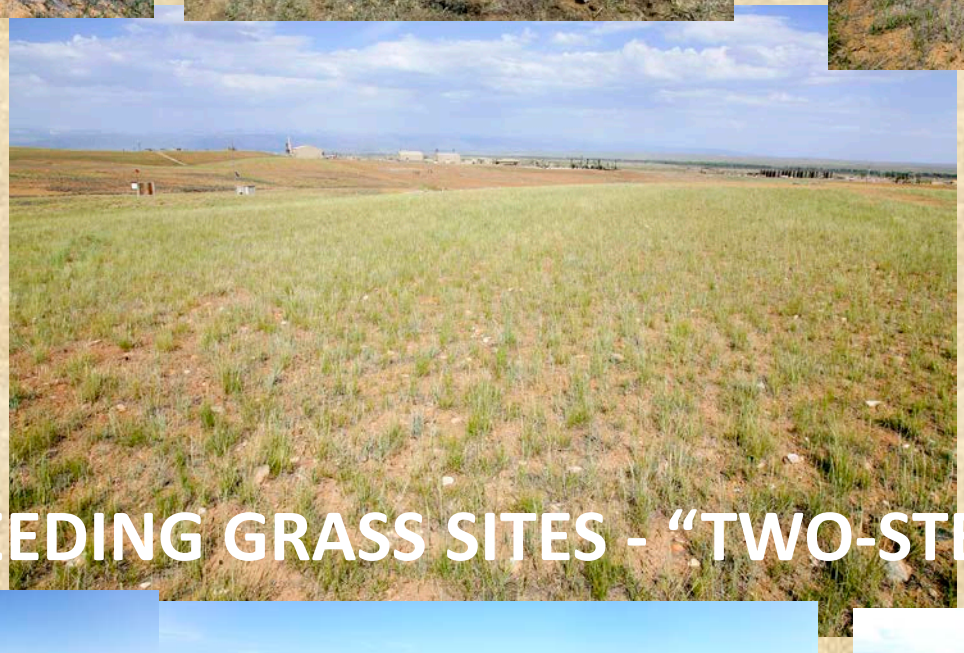
Antelope 7-4 (2008)

Observations

- **FACTORS CONTRIBUTING TO FAILURE**
  - POOR SOIL SURFACE PREP – SMOOTH
  - POOR ONSITE SUPERVISION
  - DROUGHT YEAR
  - LACK OF FENCING
  - FORB UNPREDICTABILITY
  - **OVERSEEDING GRASS SITES - "TWO-STEP METHOD"**

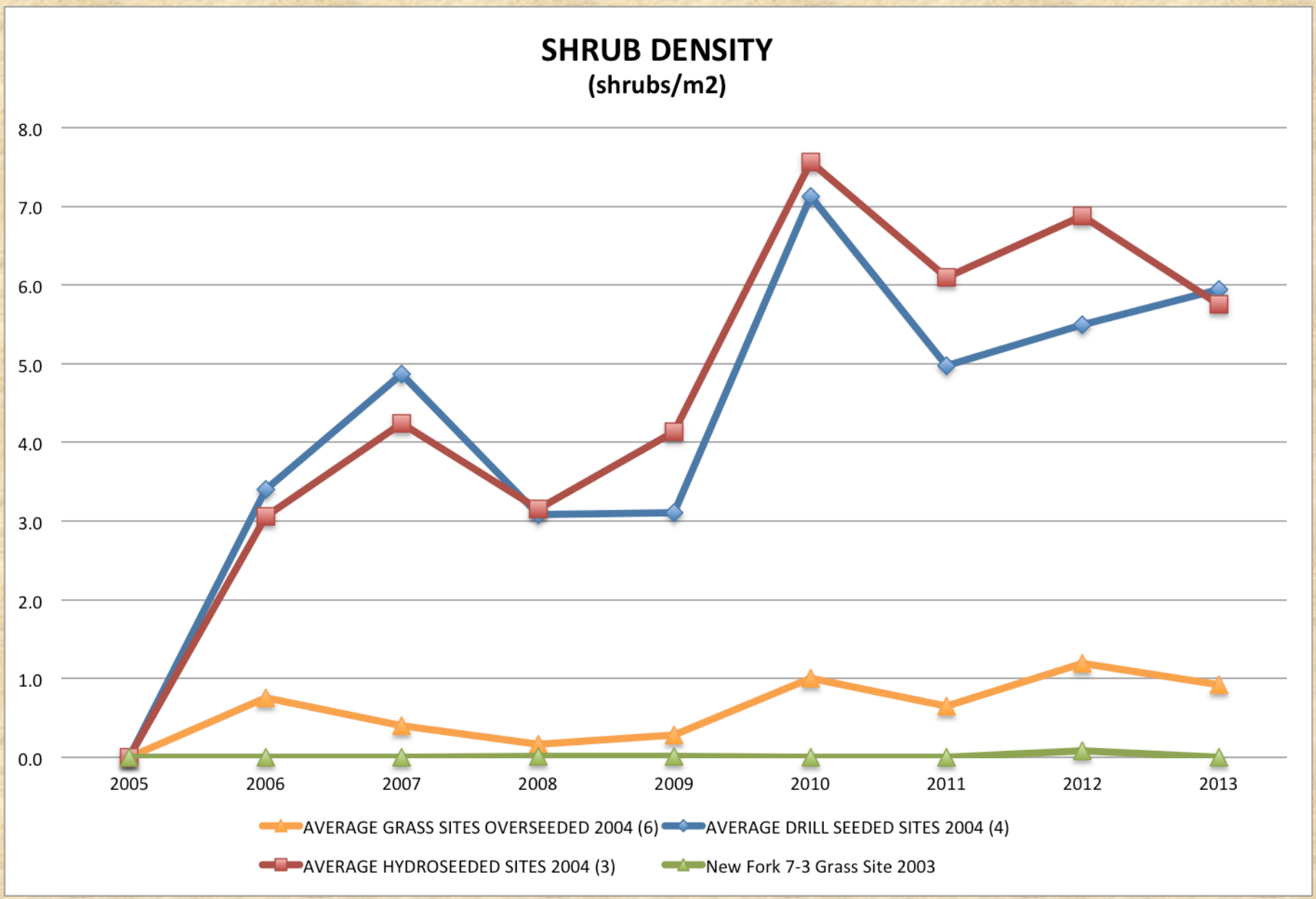
Antelope 7-4 (2008)

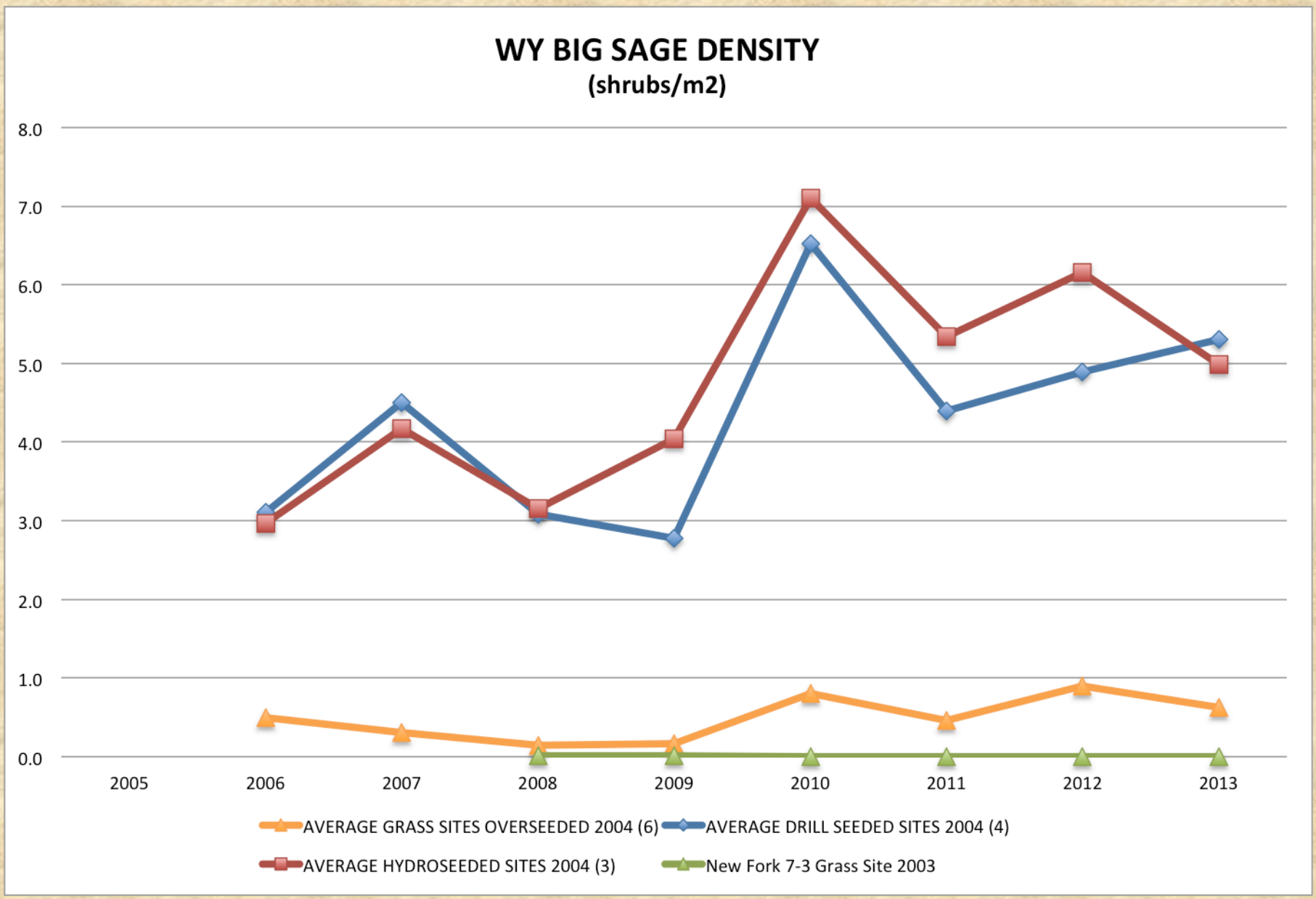


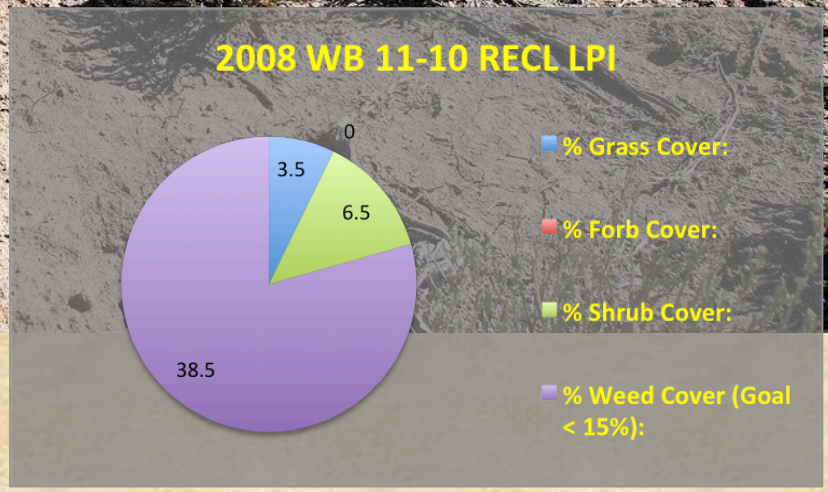
OVERSEEDING GRASS SITES - “TWO-STEP METHOD”




SHRUB DENSITY
(shrubs/m2)
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
2005
2006
2007
2008
2009
2010
2011
2012
2013
AVERAGE GRASS SITES OVERSEEDED 2004 (6)
AVERAGE DRILL SEEDED SITES 2004 (4)
AVERAGE HYDROSEEDED SITES 2004 (3)
New Fork 7-3 Grass Site 2003

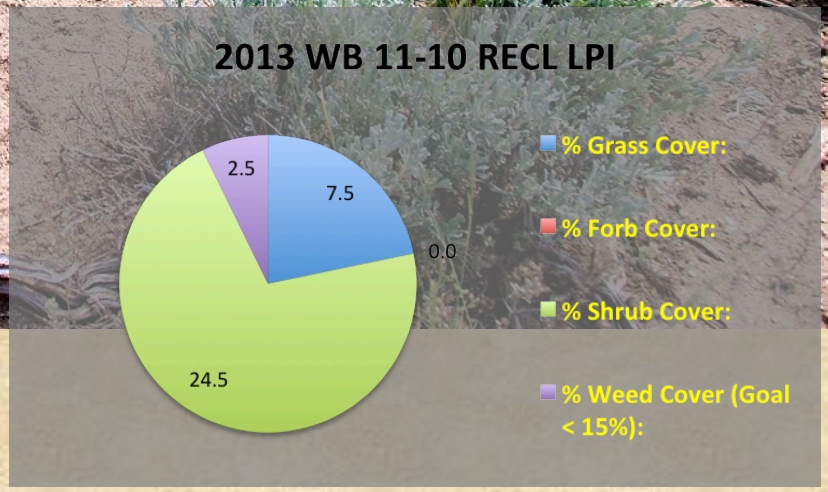

WY BIG SAGE DENSITY
(shrubs/m2)
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
2005
2006
2007
2008
2009
2010
2011
2012
2013
AVERAGE GRASS SITES OVERSEEDED 2004 (6)
AVERAGE DRILL SEEDED SITES 2004 (4)
AVERAGE HYDROSEEDED SITES 2004 (3)
New Fork 7-3 Grass Site 2003

Observations



Warbonnet 11-10 (2008)

Observations



Warbonnet 11-10 (2014)

Observations

- **FACTORS CONTRIBUTING TO FAILURE**
  - POOR SOIL SURFACE PREP – SMOOTH
  - POOR ONSITE SUPERVISION
  - DROUGHT YEAR
  - LACK OF FENCING
  - LACK OF AVAILABLE FORBS
  - OVERSEEDING GRASS SITES - "TWO-STEP METHOD"

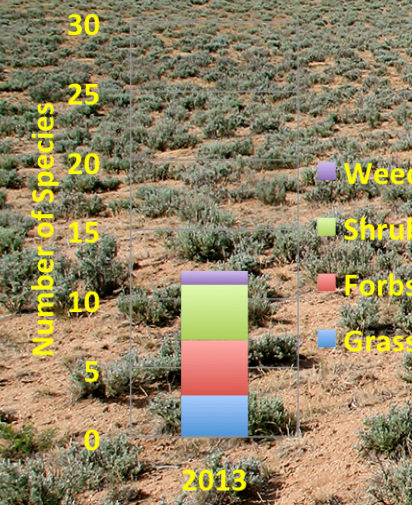
Antelope 7-4 (2008)

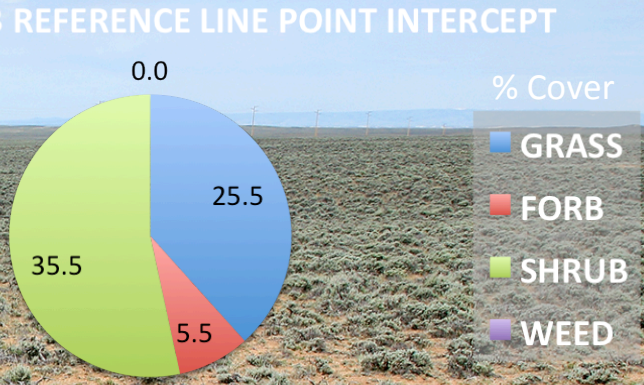
REMEMBER PATIENCE?

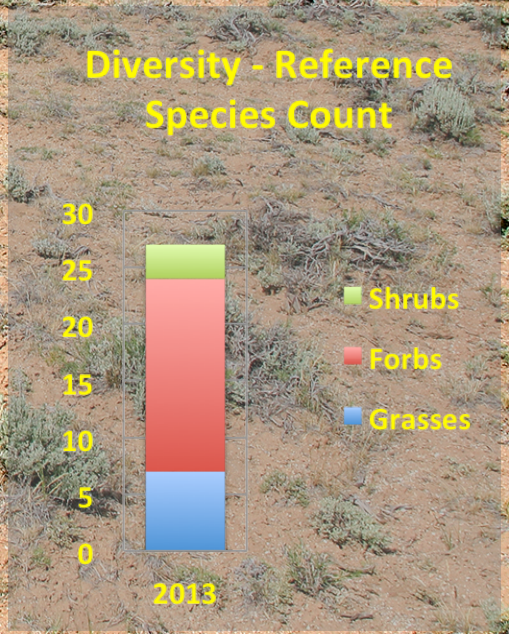
Hydro/drill-seeded 2005/06

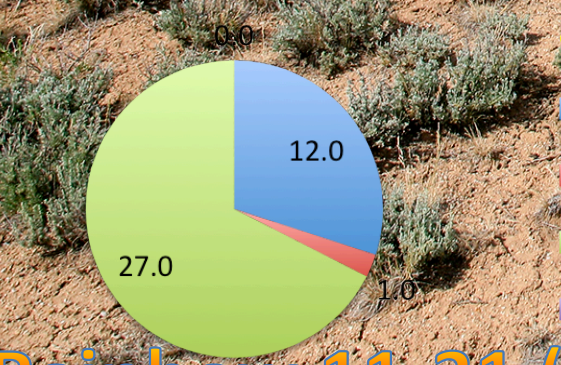

Antelope 7-4
(2014)
Hydro/drill-seeded 2005/06

How Do They Compare:







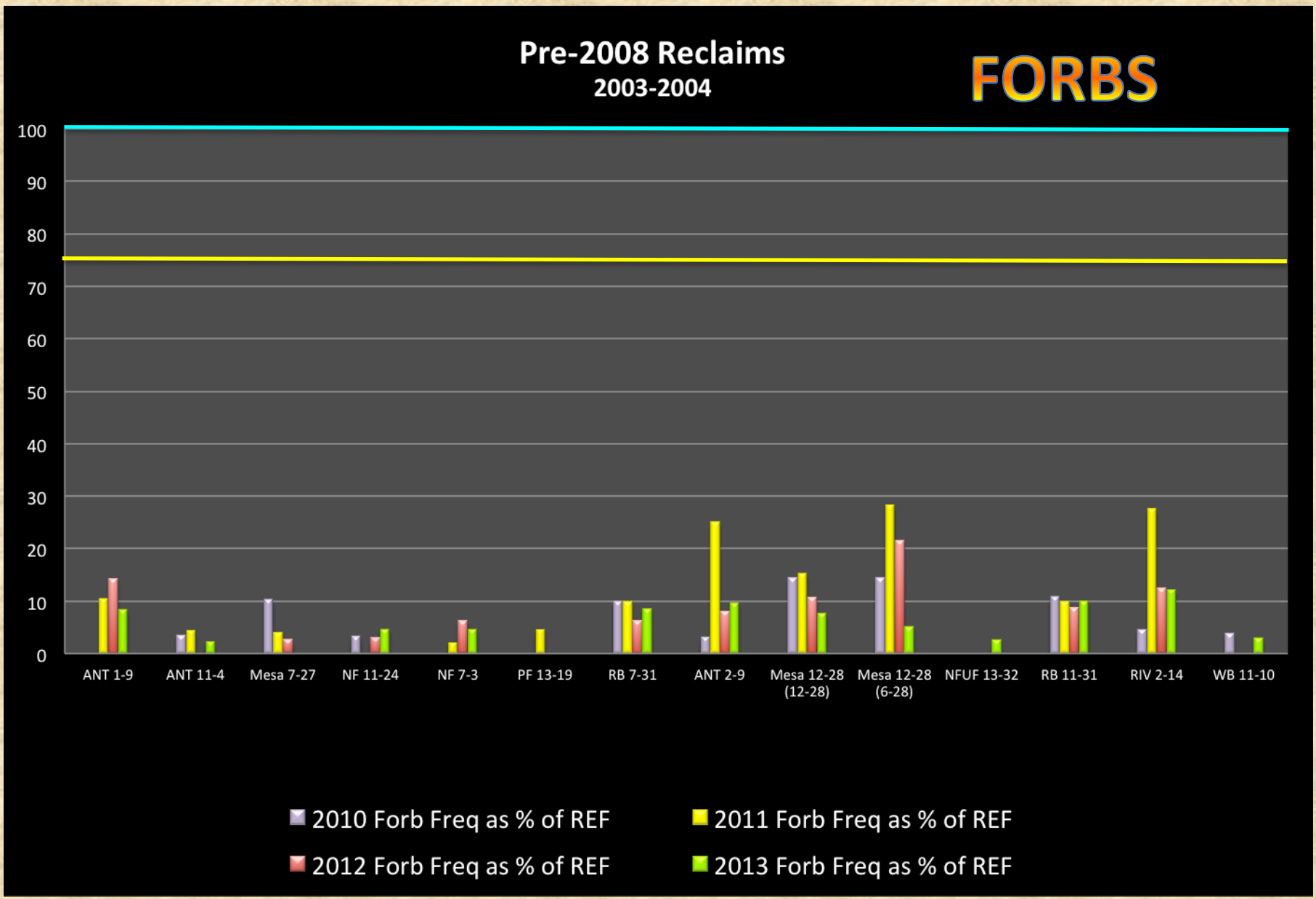


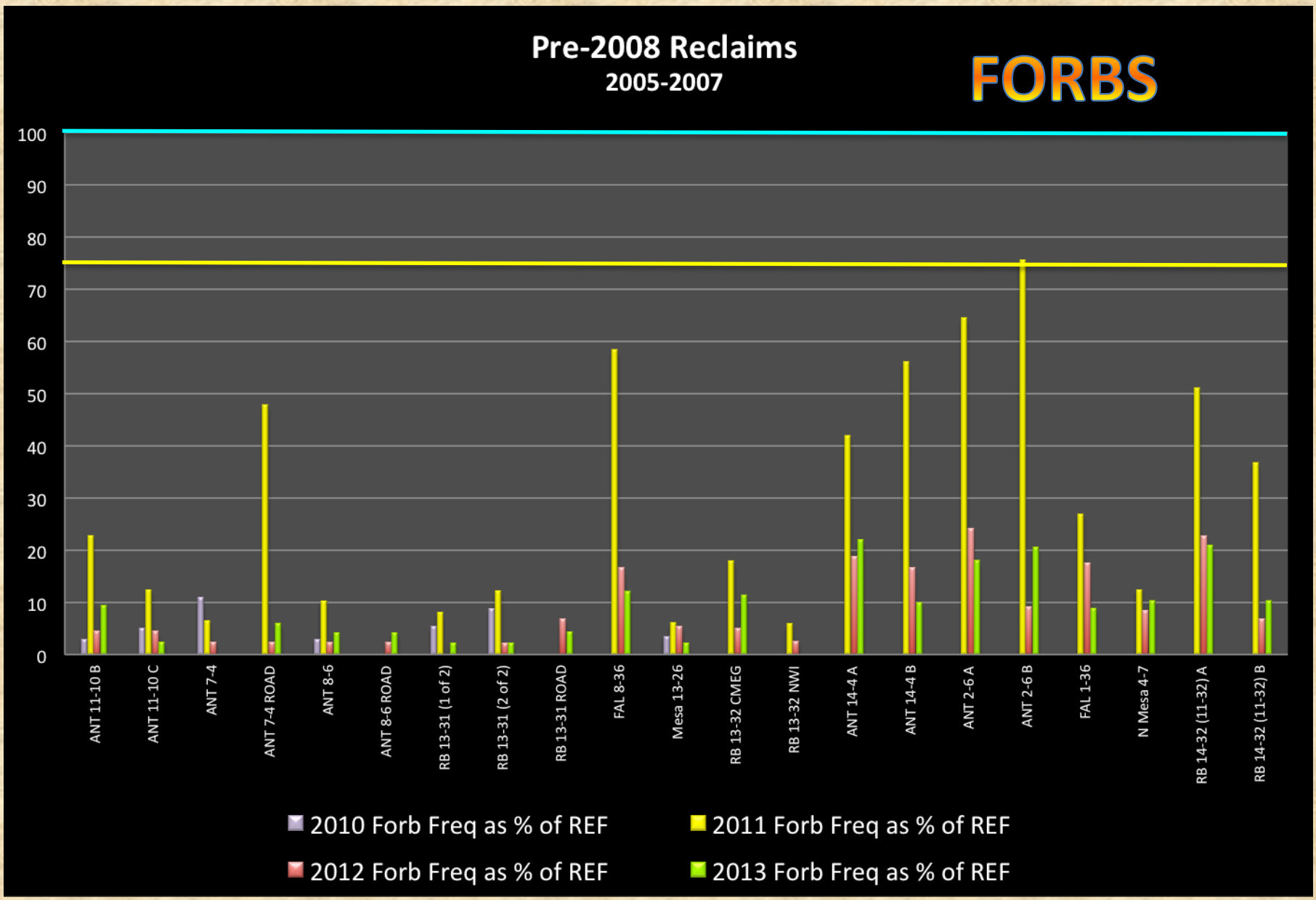
Rainbow 11-31 (2014)

Drill-seeded 2004

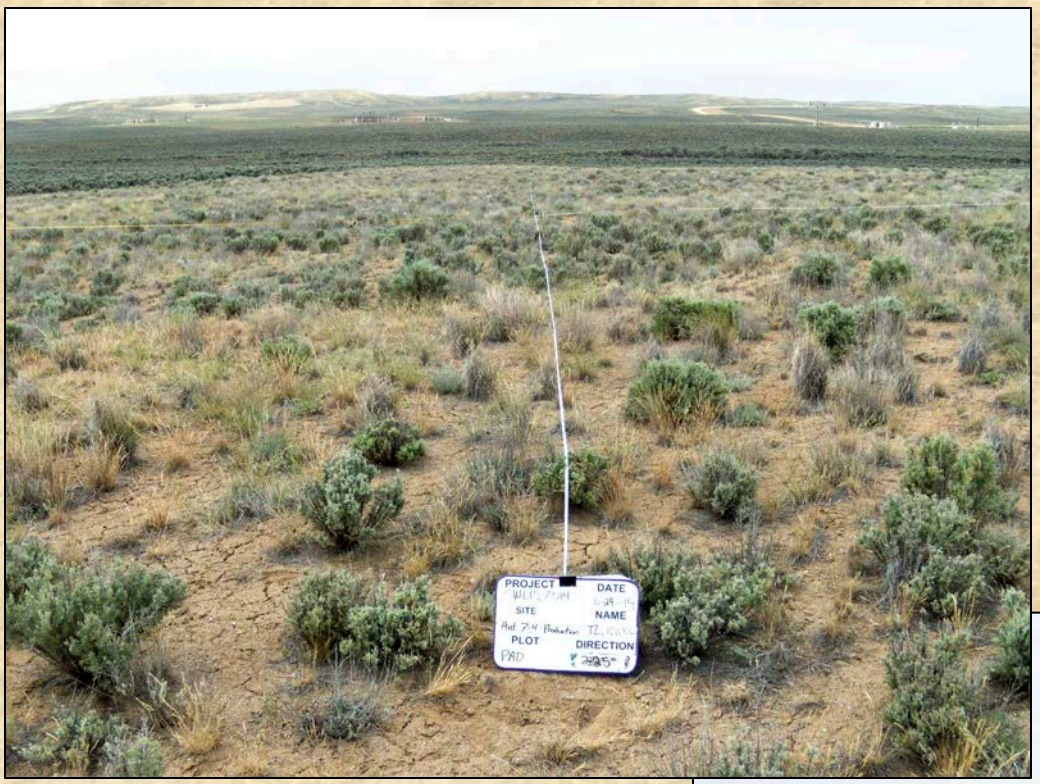
Pre-2008 Reclaims
2003-2004

FORBS




Pre-2008 Reclaims
2005-2007
FORBS
100
90
80
70
60
50
40
30
20
10
0
ANT 11-10 B
ANT 11-10 C
ANT 7-4
ANT 7-4 ROAD
ANT 8-6
ANT 8-6 ROAD
RB 13-31 (1 of 2)
RB 13-31 (2 of 2)
RB 13-31 ROAD
FAL 8-36
Mesa 13-26
RB 13-32 CMEG
RB 13-32 NWI
ANT 14-4 A
ANT 14-4 B
ANT 2-6 A
ANT 2-6 B
FAL 1-36
N Mesa 4-7
RB 14-32 (11-32) A
RB 14-32 (11-32) B
2010 Forb Freq as % of REF
2011 Forb Freq as % of REF
2012 Forb Freq as % of REF
2013 Forb Freq as % of REF
5 Year ROD requirement: 75% of REF
8 Year ROD requirement: 100% of REF

Antelope 7-4 Reclaim



Antelope 7-4 Reference

Sandy ESD Average Annual Site Production 550 lbs/acre

Antelope 7-4 Reclaim

Common name	Current Production (lbs/acre)	Current Composition (% Dry Wt)	ESD Reference Plant Community Composition (% by weight)	Composition Similarity (% allowed)
Indian ricegrass	185.3	25.8%	**30.0%**	25.8%
Sandberg bluegrass	113.9	15.9%	**5.1%**	5.1%
Slender wheatgrass	22.5	3.1%	**25.1%**	3.1%
Squirreltail	21.0	2.9%	**15.1%**	2.9%
Western wheatgrass	5.5	0.8%	**5.1%**	0.8%
Crested wheatgrass	0.0	0.0%	**0.0%**	0.0%
Indian paintbrush	11.6	1.6%	**5.1%**	1.6%
Firecracker penstemon	0.0	0.0%	**5.1%**	0.0%
Scarlet globemallow	0.0	0.0%	**5.1%**	0.0%
Stemless mock goldenweed	0.0	0.0%	**5.1%**	0.0%
Common yarrow	0.0	0.0%	**5.1%**	0.0%
Fleabane	0.0	0.0%	**5.1%**	0.0%
Woollypod milkvetch	0.0	0.0%	**5.1%**	0.0%
Wyoming big sagebrush	219.4	30.6%	**10.0%**	10.0%
Prairie sagewort	121.2	16.9%	**10.0%**	10.0%
Fourwing saltbush	12.5	1.7%	**10.0%**	1.7%
Winterfat	4.0	0.6%	**5.1%**	0.6%
Rubber rabbitbrush	0.0	0.0%	**5.1%**	0.0%

Total Current Production	716.9
Total Grass Production	348.15
Total Forb Production	11.65
Total Shrub Production	357.10

61.7% Composition SI

Method from Habich, E.F. 2001, *Ecological Site Inventory,* BLM Technical Reference 1734-7, National Applied Resource Sciences Center, Denver, CO.

Sandy ESD Average Annual Site Production 550 lbs/acre

Antelope 7-4 Reference

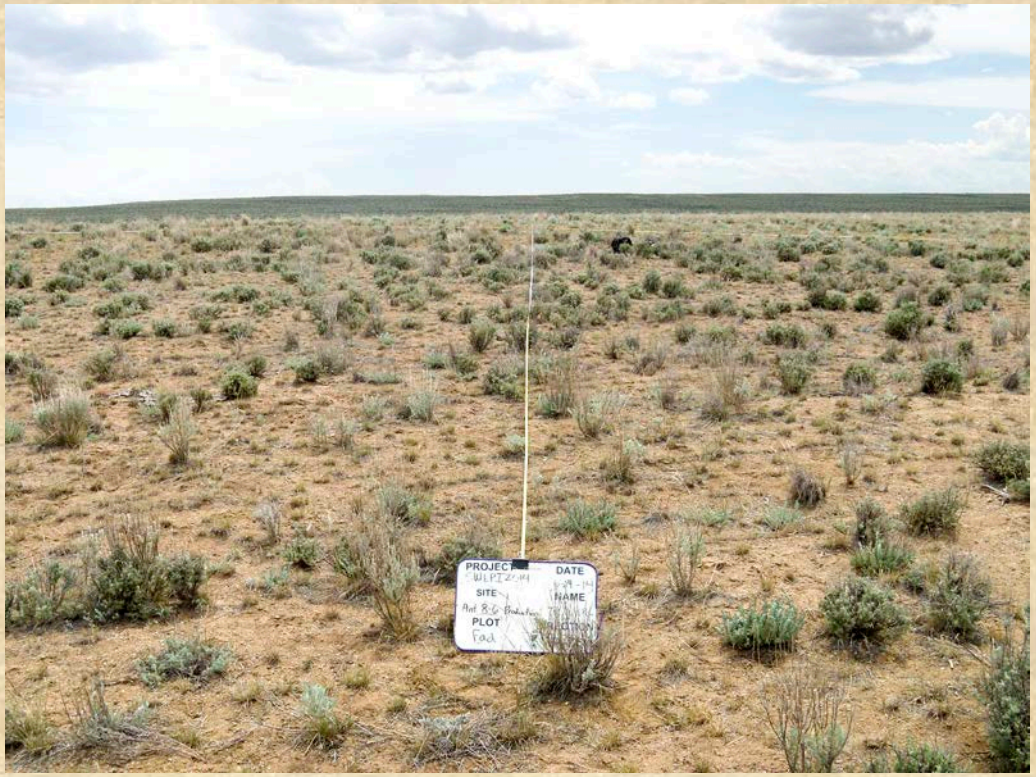
Common name	Current Production (lbs/acre)	Current Composition (% Dry Wt)	ESD Reference Plant Community Composition (% by weight)	Composition Similarity (% allowed)
Western wheatgrass	52.7	13.2%	**5.1%**	5.1%
Indian ricegrass	6.0	1.5%	**30.0%**	1.5%
Sandberg bluegrass	5.9	1.5%	**5.1%**	1.5%
Squirreltail	4.4	1.1%	**15.1%**	1.1%
Needle and thread	0.0	0.0%	**0.0%**	0.0%
Hood's phlox	16.5	4.1%	**5.1%**	4.1%
Woollypod milkvetch	5.2	1.3%	**5.1%**	1.3%
Cushion buckwheat	4.1	1.0%	**5.1%**	1.0%
Hooker's sandwort	1.3	0.3%	**5.1%**	0.3%
Matted Buckwheat	0.0	0.0%	**0.0%**	0.0%
Fleabane	0.0	0.0%	**5.1%**	0.0%
Scarlet globemallow	0.0	0.0%	**5.1%**	0.0%
Flaxleaf plainsmustard	0.0	0.0%	**5.1%**	0.0%
Stemless mock goldenweed	0.0	0.0%	**5.1%**	0.0%
Granite prickly phlox	0.0	0.0%	**5.1%**	0.0%
Wyoming big sagebrush	291.0	73.1%	**10.0%**	10.0%
Green rabbitbrush	11.0	2.8%	**10.0%**	2.8%
Gardner's saltbush	0.0	0.0%	**5.1%**	0.0%
Plains pricklypear	0.0	0.0%	**0.0%**	0.0%

Total Current Production	398.0
Total Grass Production	69.01
Total Forb Production	27.02
Total Shrub Production	302.01

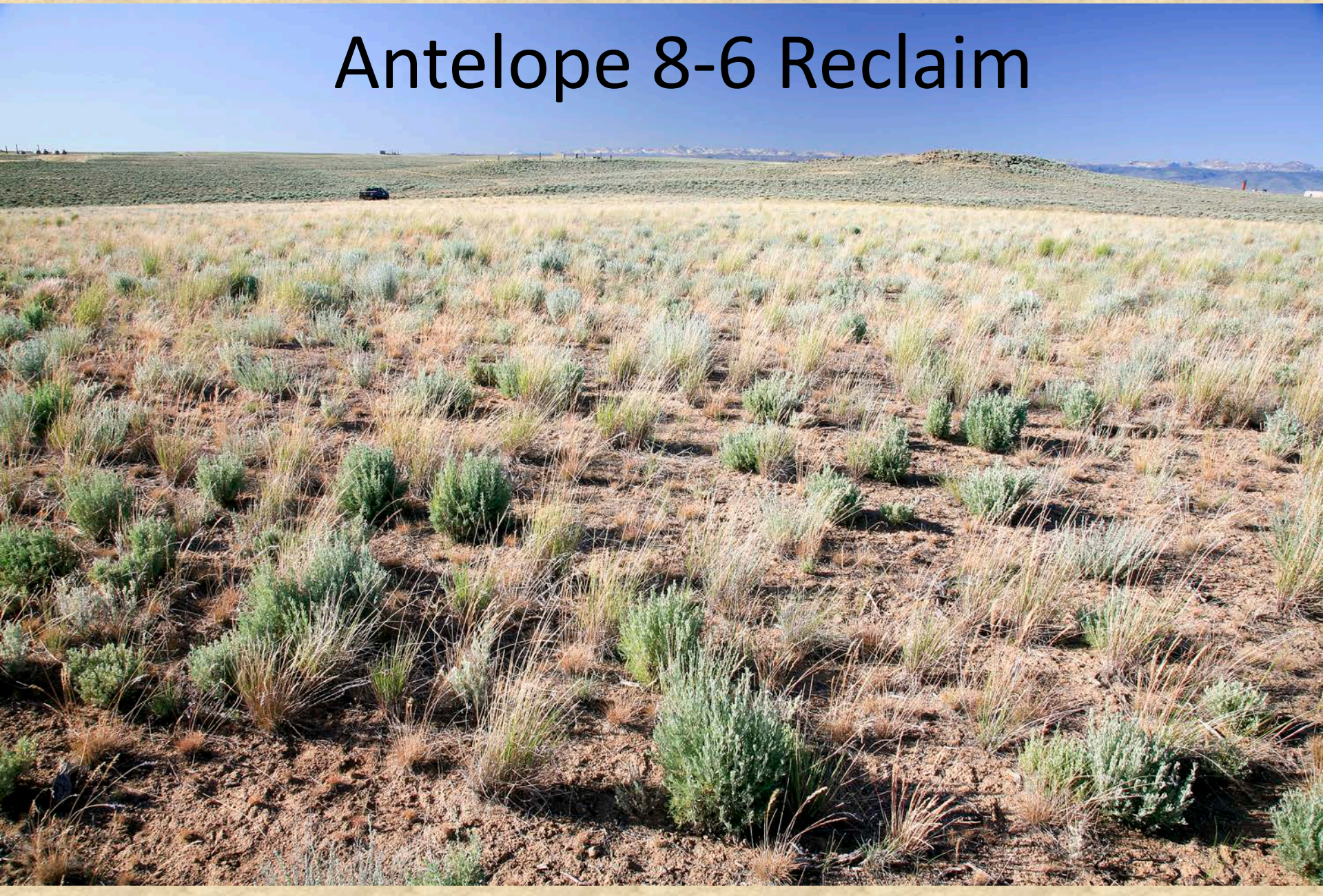
28.7% Composition SI

Method from Habich, E.F. 2001, *Ecological Site Inventory,* BLM Technical Reference 1734-7, National Applied Resource Sciences Center, Denver, CO.

Antelope 8-6 Reclaim

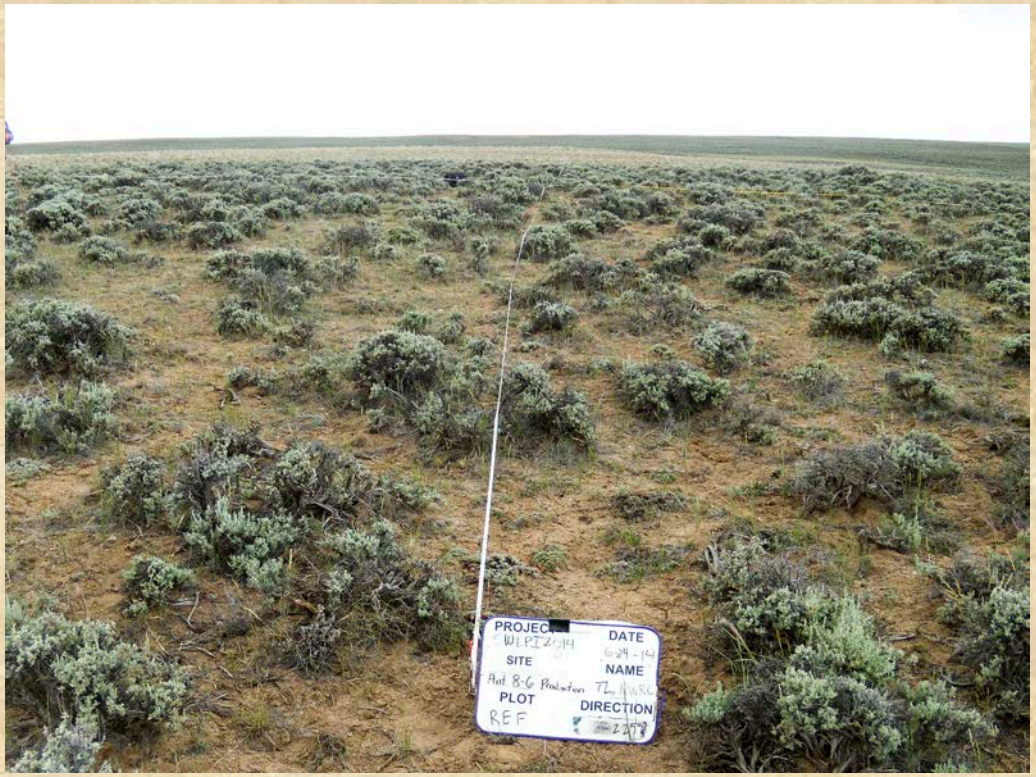


Antelope 8-6 Reclaim



Antelope 8-6 (2011)

Antelope 8-6 Reference



Loamy ESD Average Annual Site Production	500 lbs/acre

Antelope 8-6 Reclaim

Common name	Current Production (lbs/acre)	Current Composition (% Dry Wt)	ESD Reference Plant Community Composition (% by weight)	Composition Similarity (% allowed)
Sandberg bluegrass	327.33	31%	**5.0%**	5.0%
Indian ricegrass	197.65	19%	**20.0%**	18.6%
Western wheatgrass	110.00	10%	**5.0%**	5.0%
Slender wheatgrass	56.25	5%	**10.0%**	5.3%
Squirreltail	42.00	4%	**10.0%**	4.0%
Woollypod milkvetch	19.76	2%	**5.0%**	1.9%
Scarlet globemallow	0.00	0%	**5.0%**	0.0%
Common yarrow	0.00	0%	**5.0%**	0.0%
Fleabane	0.00	0%	**5.0%**	0.0%
Hood's phlox	0.00	0%	**5.0%**	0.0%
Indian paintbrush	0.00	0%	**5.0%**	0.0%
Wyoming big sagebrush	239.19	23%	**15.0%**	15.0%
Prairie sagewort	51.48	5%	**5.0%**	4.9%
Winterfat	12.91	1%	**5.0%**	1.2%
Fourwing saltbush	4.34	0%	**5.0%**	0.4%
Desert madwort				

Total Current Production	1060.9
Total Grass Production	733.22
Total Forb Production	19.76
Total Shrub Production	307.92

61.2% Composition SI

Loamy ESD Average Annual Site Production 500 lbs/acre

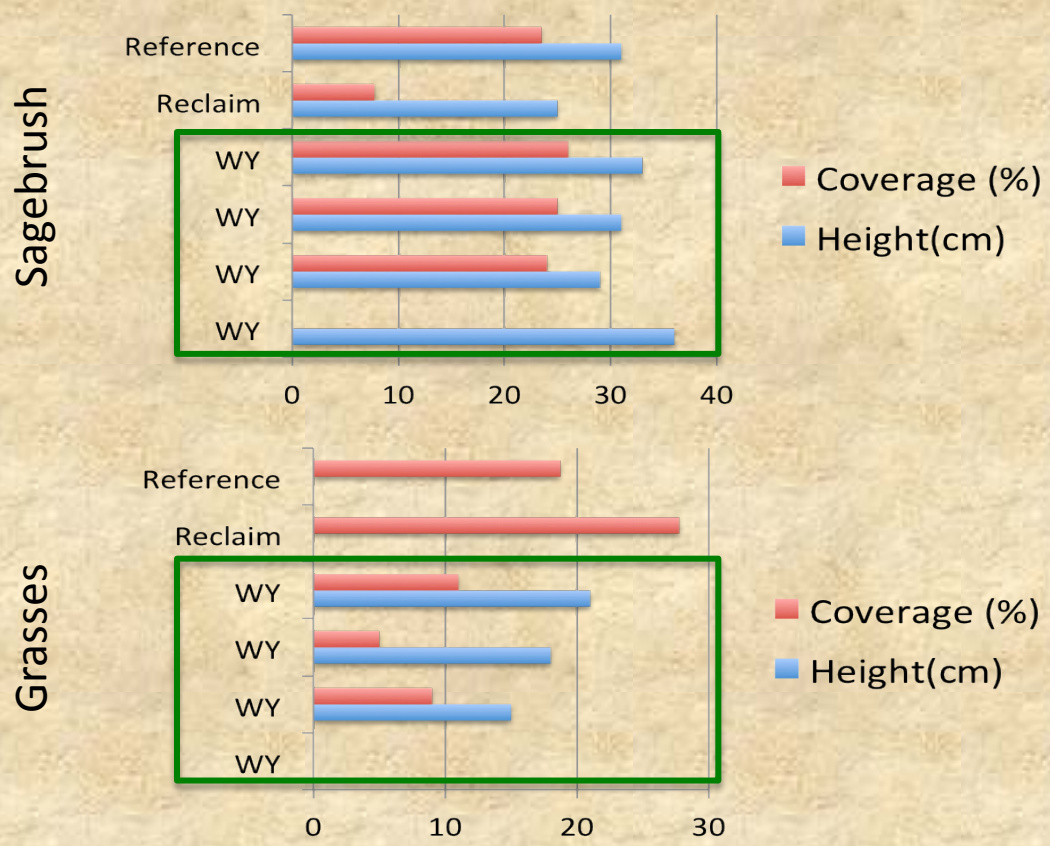
Antelope 8-6 Reference

Common name	Current Production (lbs/acre)	Current Composition (% Dry Wt)	ESD Reference Plant Community Composition (% by weight)	Composition Similarity (% allowed)
Western wheatgrass	38.3	9.4%	5.0%	5.0%
Squirreltail	13.2	3.3%	10.0%	3.3%
Sandberg bluegrass	5.9	1.5%	5.0%	1.5%
Needle and thread	5.4	1.3%	20.0%	1.3%
Indian ricegrass	5.3	1.3%	20.0%	1.3%
Hood's phlox	30.0	7.4%	5.0%	5.0%
Stemless mock goldenweed	21.9	5.4%	5.0%	5.0%
Granite prickly phlox	18.6	4.6%	2.0%	2.0%
Fleabane	2.5	0.6%	5.0%	0.6%
Hooker's sandwort	1.9	0.5%	2.0%	0.5%
Bigseed biscutroot	1.1	0.3%	5.0%	0.3%
Cushion buckwheat	0.9	0.2%	5.0%	0.2%
Holboell's rockcress	0.0	0.0%	5.0%	0.0%
Tapertip hawksbeard	0.0	0.0%	5.0%	0.0%
Rosy pussytoes	0.0	0.0%	5.0%	0.0%
Wyoming big sagebrush	250.9	61.8%	15.0%	15.0%
Plains pricklypear	6.3	1.6%	0.0%	0.0%
Green rabbitbrush	3.7	0.9%	5.0%	0.9%
Winterfat	0.0	0.0%	5.0%	0.0%

Total Current Production	406.0
Total Grass Production	68.14
Total Forb Production	76.99
Total Shrub Production	260.89

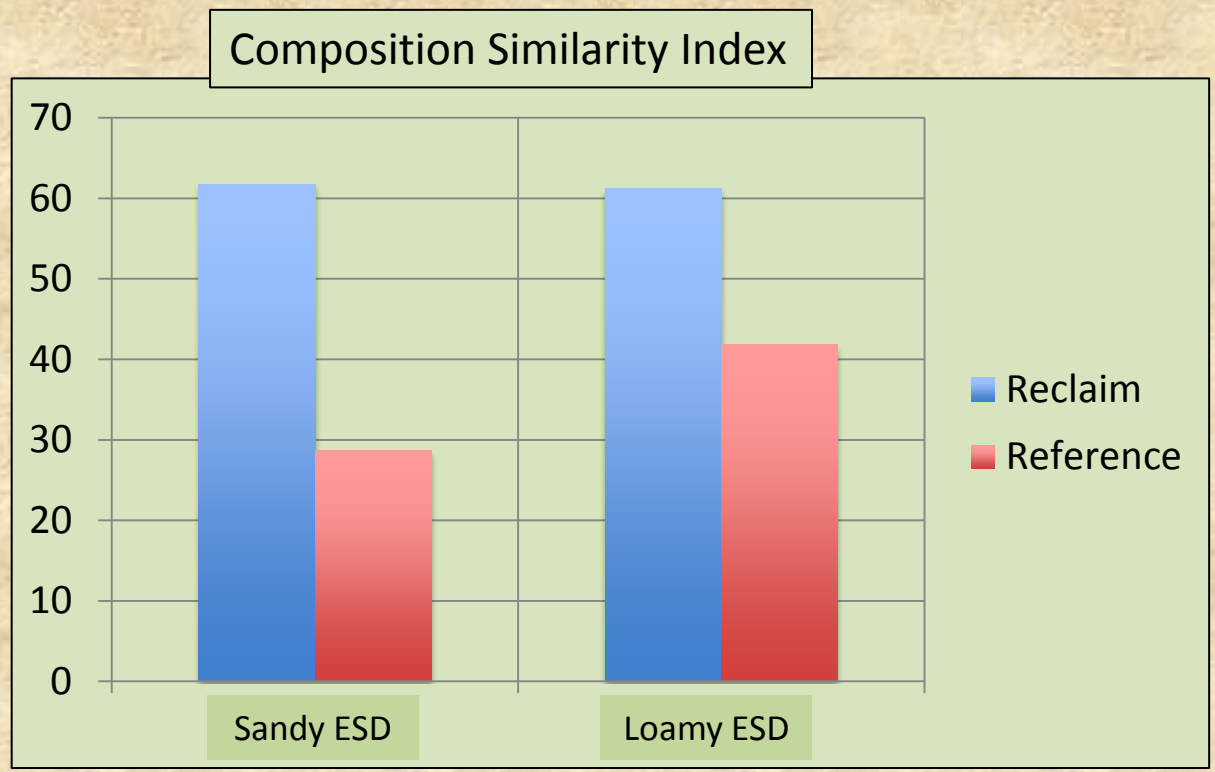
41.8% Composition SI

Connelly Sage Grouse Nest Site Guideline Comparison[1]

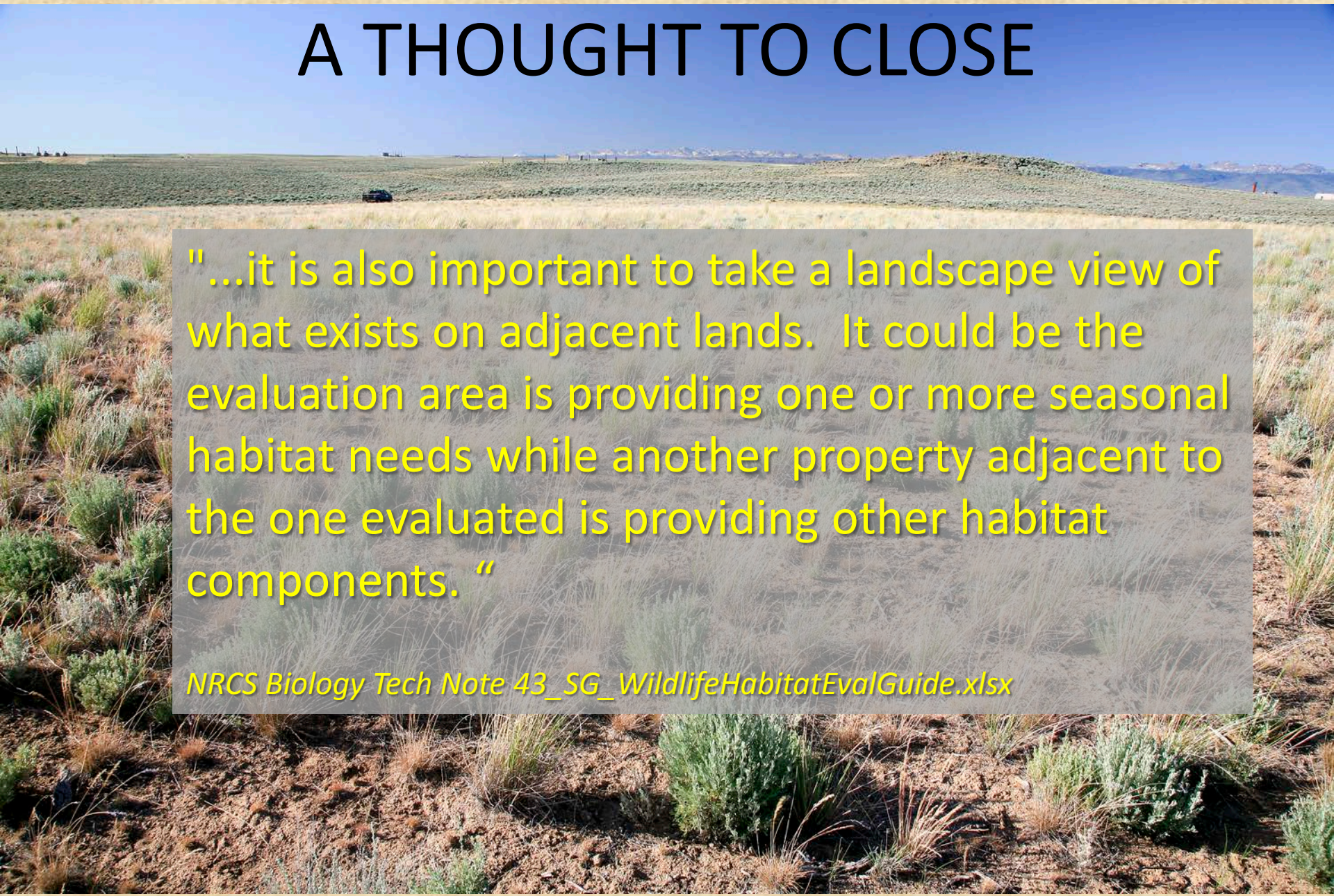


[1] Adapted from *Guidelines to manage sage grouse populations and their habitats*, Connelly, John W. et. al., 2000, in: Wildlife Society Bulletin 2000, 28(4), 967-985.

A THOUGHT TO CLOSE



A THOUGHT TO CLOSE



"...it is also important to take a landscape view of what exists on adjacent lands. It could be the evaluation area is providing one or more seasonal habitat needs while another property adjacent to the one evaluated is providing other habitat components. "

NRCS Biology Tech Note 43_SG_WildlifeHabitatEvalGuide.xlsx

Our thanks to:

- Shell Exploration & Production Company
- 2nd Annual Sage Grouse Reclamation Workshop
- C-M Environmental Group, Inc.
- Blue Wing Consulting, LLC
- North Wind Resource Consulting

S Mesa-Warbonnet LGS (2009)

Drill-seeded 2007