

# Defining Oil and Gas Pad Reclamation Success on Wyoming's BLM Lands

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# What is Reclamation/Restoration Success?

- “The intent of ecological restoration is to return an ecosystem to its developmental trajectory and to ensure that it has the capacity to continue its development thereafter” – Crewell, 2009
- “Reestablishment of a productive, functional, and sustainable ecosystem suitable for post-mining land use” – Stahl, et al., 2009
- “The process of improving disturbed land to achieve land capability equivalent to the pre-disturbed condition” – Univ. of Alberta, 2004
- “Restoration attempts to return an ecosystem to its historic trajectory” – SER Primer, 2004

# How is success really defined?

- In a practical (and economic) sense, the regulatory agencies with oversight of a particular piece of land define reclamation success
- Issues we have come across in the process of working with our oil and gas database:
  - Discrepancies between and amongst regulatory agencies
    - Reclamation requirements vary
    - Reclamation monitoring protocol and reporting standards vary
  - Reference site problems
    - Moving targets
    - Vary greatly in small areas
  - Lack of trend (trajectory) analysis incorporated into success criteria

# Reclamation Requirements 2013



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# 2013 Reclamation Requirements

Field Office	Percent Cover	Erosion Control/Soil Stability	Noxious Weeds	Grass Richness	Forb Richness	Forb Density	Shrub Richness	Shrub Density	Plant Vigor
JIO(Pinedale)	X	X	X	X	X	X	X	X	X
PAPO (Pinedale)	X	X	X	X	X	X	X	X	X
Kemmerer	X	X	X						
Rawlins	X	X	X						
Buffalo	n/a	n/a	n/a	n/a	N/a	n/a	n/a	n/a	n/a
Casper	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Cody & Worland	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Rock Springs	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Lander	X	X	X			X		X	
WDEQ	X	X							

# WDEQ SWPPP Criteria for Reclamation

Criteria	WDEQ Release Criteria
Re-vegetation	<p>Finalized stabilization will be evaluated on all disturbed sites and must have at least 70% of background perennial ground cover to meet stabilization criteria. Locations are required to have vegetative cover to the access roads around the well sites, unless permanently installed anchor points have been built on the site.</p> <p>Where permanent anchor points are installed, the vegetation cover will be measured outside the anchor points for the purpose of complying with the SWPPP requirement. Additional areas may have to be re-vegetated to comply with other agency specifications and should follow the most stringent of the requirements. Reestablished vegetation does not have to be the same composition as the background or native vegetation, but will be evaluated using a common technique for each. Trained personnel will collect the information and documentation for evaluated areas.</p>

# Reclamation Criteria in Moxa

**Table 1. Reclamation goals identified by the Moxa Arch Area ROD (1998) were used to assess reclamation on BP Moxa assets.**

<b>Criteria</b>	<b>Reclamation Goals</b>	<b>Final Abandonment Standards</b>
Qualitative Site Conditions / Soil Surface Stability	Interim reclamation area re-contoured, protected from erosion, vegetation consists of native plant community.	Erosion features equal to or less than surrounding areas and water infiltrates naturally into the soil without any visible signs of soil erosion (gulying, headcutting, slumping, deep rilling).
Vegetation Cover	On-site canopy cover (shrubs, forbs, grasses) must be 50% of vegetation occurring off-site in three years, and 80% or greater of vegetation cover occurring off-site in five years.	Basal cover of desirable perennial species is at least 80% of basal cover of the adjacent undisturbed area.
Weed Composition	Site has less than 10% weed cover.	Site is free of State or County listed noxious weeds and have less than 10% weed cover.
Species Diversity and Species Composition	Disturbed acres re-vegetated with self-sustaining, vigorous, diverse, native (or approved) plant community.	Disturbed acres re-vegetated with self-sustaining, vigorous, diverse, native (or approved) plant community. Density of 'positive' vegetation enough to sufficiently control erosion and unwanted species invasion.
Plant Resilience		Evident by well developed root systems and flowers. Shrubs established having a designated "young" age class.

Table 1. JIO reclamation success criteria

Criteria	Roll-Over	Final
Erosion	Site must be stable as defined in BLM Tech Note 346. The % of bare ground must be equal to or less than reference site.	Site must be stable as defined in BLM Tech Note 346. Ground cover must be equal to or greater than reference site vegetation and litter decomposing into soil.
Native Forbs	Average density/frequency must be a minimum of 75% of the reference site. Diversity of forbs on a reclaimed site must be equal to or greater than reference site.	Average density/frequency and total diversity of forbs must be equal to or greater than reference area.
Native Shrubs	Average density/frequency must be at least 50% of reference site. Rabbitbrush not more than 10% of shrub composition. At least 15% density/frequency of shrub component must be dominant species on reference site. Diversity equal to or greater than reference site.	Average density/frequency must be at least 50% reference site. Rabbitbrush not composing more than 10%. At least 25% density/frequency must be dominant species from reference site. Diversity must be equal to or greater than reference site.
Native Grasses	Site must have a minimum of 3 native perennial grass species, 2 of which must be bunch grass species.	Sites must produce equal or greater pounds of production per acre as reference site. Minimum of 3 native perennial species must be included with at least 2 bunch grass species.
Non-Native Weeds	Sites must be free from all noxious weeds listed on the Wyoming or Federal noxious weed list, in addition to highly competitive invasive species (cheatgrass and other weedy brome).	Sites must be free from all noxious weeds listed on the Wyoming or Federal noxious weed list, in addition to highly competitive invasive species (cheatgrass and other weedy brome).
Plant Vigor	Plants must be resilient as displayed by well developed root system, flowers, and seed heads.	Plants must be resilient as displayed by well developed root system, flowers, and seed heads. Shrubs must be well established and in "young" age class at a minimum.

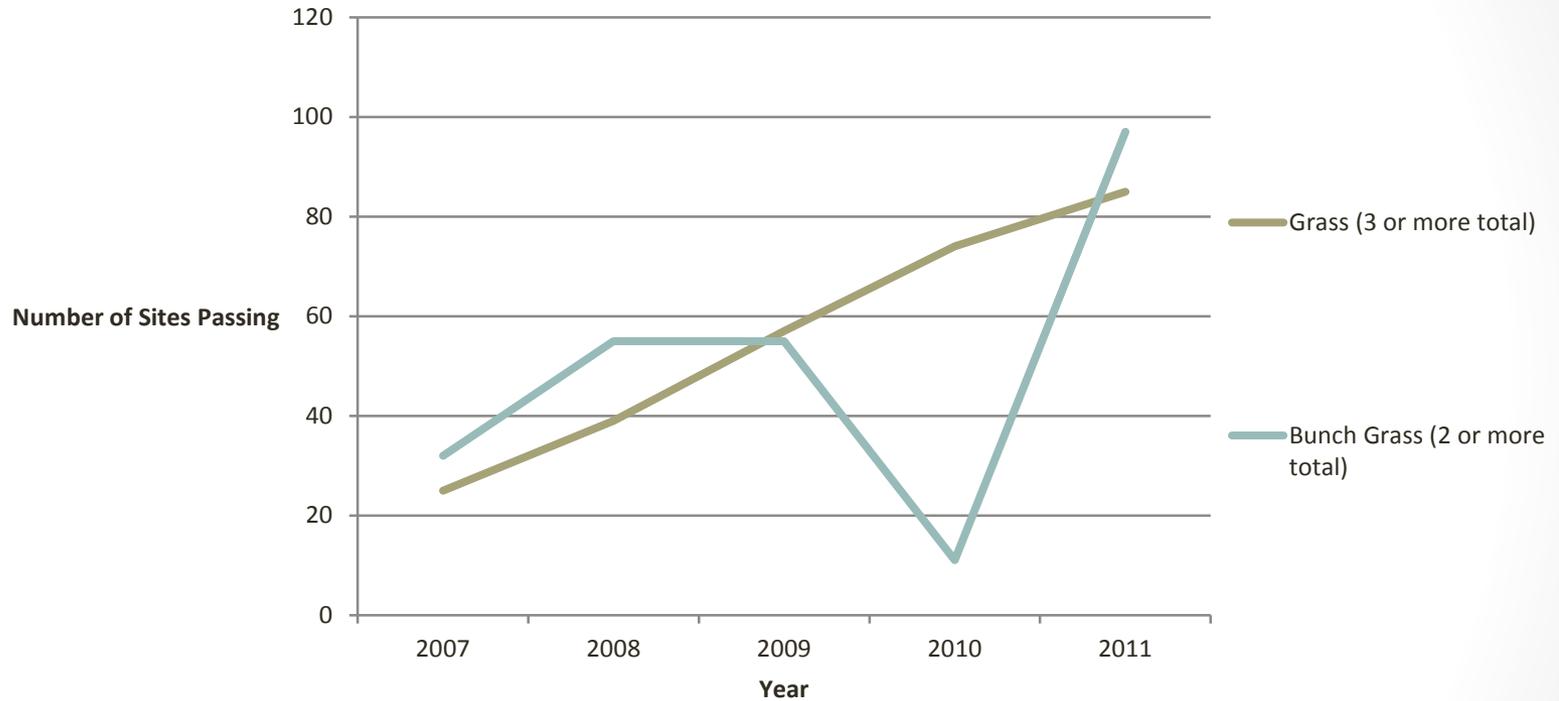
# Kemmerer BLM vs. JIO

- Jonah 2011:
  - 51 Sites pass WDEQ SWPPP Criteria (43.9%)
  - 0 Sites pass every JIO Interim Criteria (0%)
- Moxa 2011:
  - 338 Sites pass WDEQ SWPPP Criteria (54.6%)
  - 312 Sites pass Moxa ROD Interim Reclamation Criteria (50.4%)
- Cross-Query Results 2011:
  - 91 Jonah Sites pass Moxa ROD Interim Criteria (78.4%)
  - 0 Moxa Sites pass every JIO Interim Criteria

# Problems with inconsistent monitoring

- Inconsistent timing
  - Difficult to identify trends
  - Difficult to actually know the story
  - Makes binary criteria questionable by creating moving targets in reference areas
- Inconsistent methodology
  - Occurs in fields and across fields
  - Difficult to compare data
  - Difficult to understand what the data is telling us
  - Occurs between years
  - Requires additional training of monitoring employees

# Sites Passing Grass and Bunch Grass Requirements in Jonah



## Mean Collection Dates:

2007 – July 14

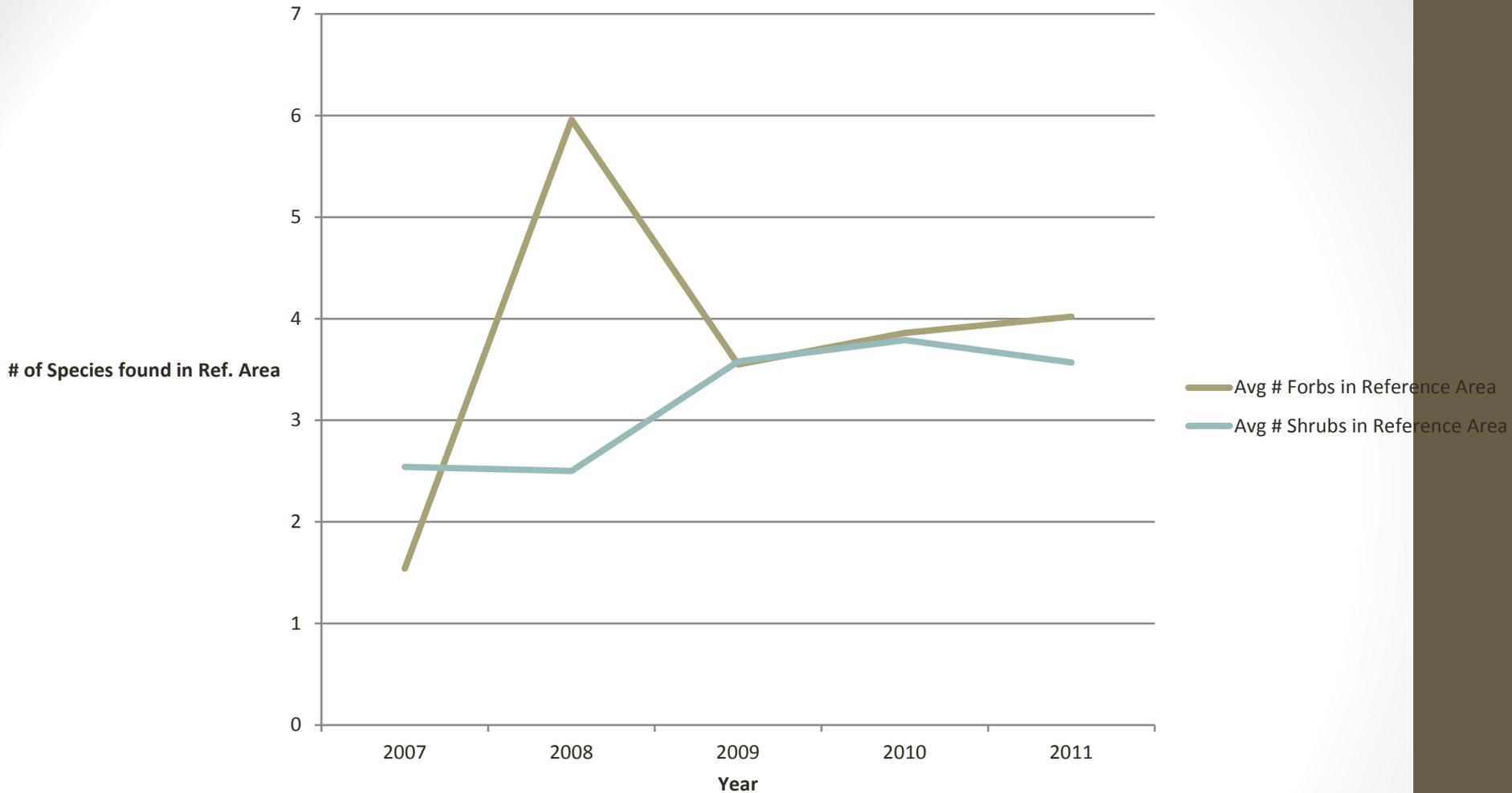
2008 -- June 14

2009 – July 16

2010 – June 4

2011 – July 7

## Forb and Shrub Diversity on Reference Sites By Year



-Changes may be due to several factors:

Monitoring timing

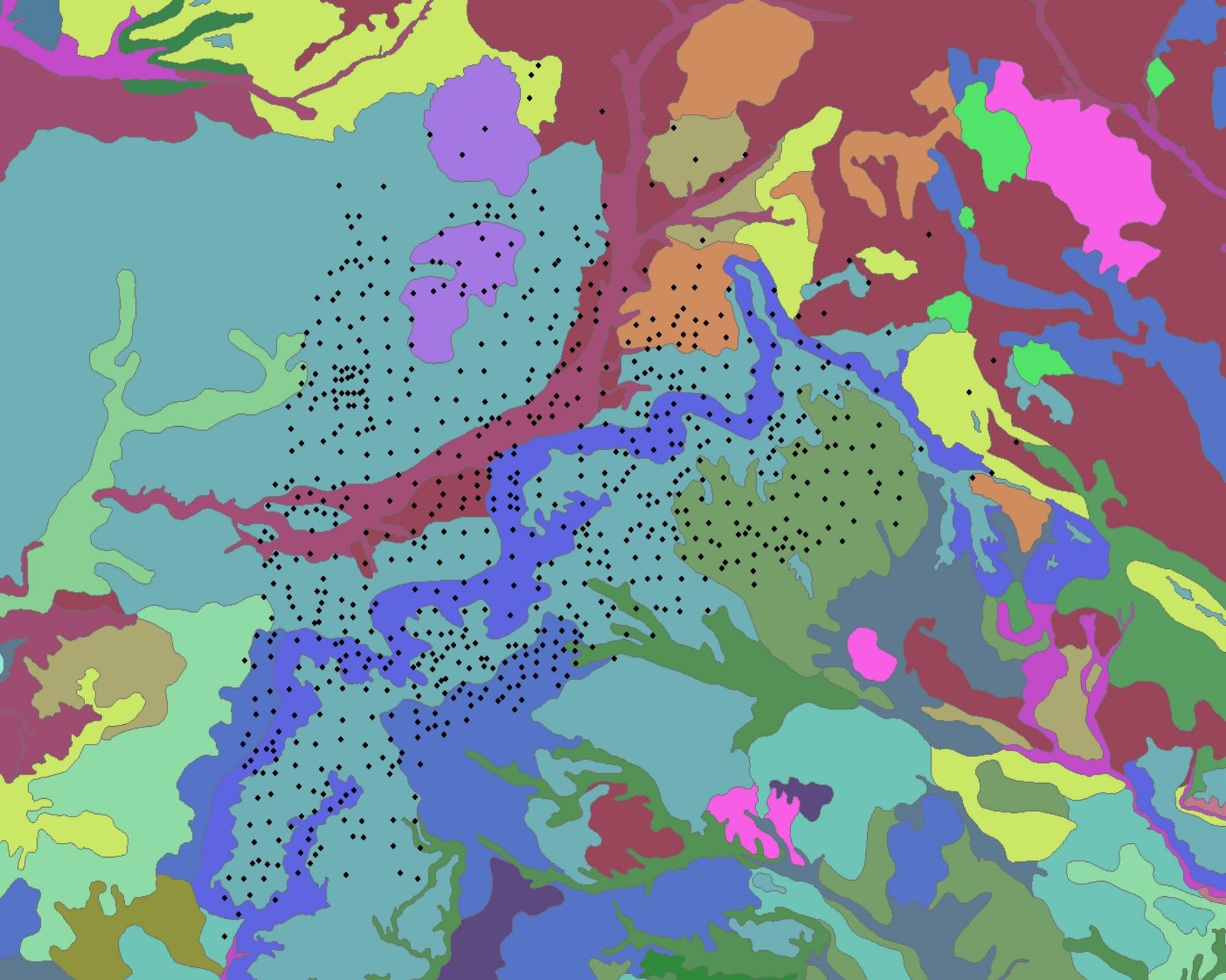
Available Moisture

Grazing/off-site disturbance

# Reference Sites Con't.

- Using NRCS Soil Map we found in one map unit in one year:
  - Forbs
    - Diversity ranged from 1-7 forbs on reference sites
    - Average was 2.57 forbs per site
    - Standard Deviation was 1.65
  - Percent Bareground Cover
    - Ranged from 11% - 48%
    - Average was 30.56%
    - Standard Deviation was 9.72
  - Large variations across other vegetation measurement categories
- Binary criteria may be questionable when using one reference site

Map Unit Symbol	API	No forbs present undisturbed	No forbs present disturbed
5203	49-035-21391	1	2
5203	49-035-21425	1	0
5203	49-035-21509	7	2
5203	49-035-21548	1	0
5203	49-035-21556	4	0
5203	49-035-21557	2	0
5203	49-035-21558	5	2
5203	49-035-21585	4	1
5203	49-035-21643	3	0
5203	49-035-21667	3	0
5203	49-035-21751	3	0
5203	49-035-21764	2	0
5203	49-035-21844	7	2
5203	49-035-21856	1	0
5203	49-035-21867	3	1
5203	49-035-21899	5	4
5203	49-035-21907	6	2
5203	49-035-21918	2	3
5203	49-035-21923	3	2
5203	49-035-21942	3	0
5203	49-035-21991	4	3
5203	49-035-22066	7	5
5203	49-035-22232	2	0
5203	49-035-22233	2	0
5203	49-035-22234	1	2



# Reference Sites in map unit 5203

- Veg cover changes throughout a growing season – data below was obtained from JIDMS, I used all operators monitoring data on reference sites only (as I don't know what companies other than BP used for seed mixes, etc. on their reclaimed areas).
- 2009 – Sites monitored between May 28 – June 5 averaged 4.2 forbs, sites monitored in mid-July averaged 2.7 forbs
- 2010 – Sites monitored late May averaged 3.98 forbs, sites in late-July/early-Aug averaged 6.92 forbs
- 2011 – sites monitored early June averaged 10.6 forbs, sites monitored late July averaged 3.4 forbs



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# Some preliminary results

- May 22
  - Bareground = 49.7%
  - Percent forbs = 3.7%
- May 27
  - Bareground = 47.1%
  - Percent forbs = 8.3%
- May 31
  - Bareground = 40.5%
  - Percent forbs = 9.5%

# Inconsistent Methodology

Operator	Location	Collection Date	Collection Method	Disturbed Avg. Density/Freq. Forbs
Operator X	SHB 35-9	06/22/2011	Frequency	10
Operator X	SHB 53-17	06/22/2011	Frequency	70
Operator X	SHB 57-17	06/22/2011	Frequency	10
Operator X	SHB 69-17	06/22/2011	Frequency	20
Operator X	SHB 73-17	06/22/2011	Frequency	20
Operator X	COR 15-31	06/21/2011	Frequency	40
Operator X	COR 22-31	06/21/2011	Frequency	30
Operator X	COR 27-31	06/21/2011	Frequency	20
Operator X	COR 37-31V	06/21/2011	Frequency	30
Operator X	COR 44-31	06/21/2011	Frequency	0
Operator X	COR 61-30	06/21/2011	Frequency	10
Operator X	COR 64-31	06/21/2011	Frequency	20
Operator X	COR 65-31	06/21/2011	Frequency	40
Operator X	COR 68-31V	06/21/2011	Frequency	0
Operator X	COR 77-30	06/21/2011	Frequency	80
Operator X	JF 1-5X	06/17/2011	Frequency	10
Operator Y	CABRITO 15-20	07/10/2011	Line-Point Interce	0.40000006
Operator Y	CABRITO 9-29	07/10/2011	Line-Point Interce	0.100000001
Operator Y	STUD HORSE BUTTE 16-20	07/10/2011	Line-Point Interce	0
Operator Y	CABRITO 10-25 PAD	07/09/2011	Line-Point Interce	0.100000001
Operator Y	CABRITO 15-13	07/09/2011	Line-Point Interce	0
Operator Y	CABRITO 3-25 PAD	07/09/2011	Line-Point Interce	0
Operator Y	CABRITO 15-25 PAD	07/08/2011	Line-Point Interce	1.200000048
Operator Y	CABRITO 4-30	07/08/2011	Line-Point Interce	0.5
Operator Y	CABRITO 5-30 PAD	07/08/2011	Line-Point Interce	0.300000012
Operator Y	CORONA 1-11 PAD	07/08/2011	Line-Point Interce	0
Operator Y	CORONA 11-30 PAD	07/08/2011	Line-Point Interce	0

# Methodology over the years

Pad	Treatment	Year	PercentBG	Method
Cab5-29	A	2006	48	Ocular
Cab5-29	A	2007	74	Ocular
Cab5-29	A	2008	26.5	Modified daubenmire
Cor11-30	A	2006	57	Ocular
Cor11-30	A	2007	.	
Cor11-30	A	2008	50.5	Modified daubenmire
Cor11-31	A	2006	55	Ocular
Cor11-31	A	2007	74.5	Ocular
Cor11-31	A	2008	41.5	Modified daubenmire
Cor14-30	A	2006	57	Ocular
Cor14-30	A	2007	86	Ocular
Cor14-30	A	2008	58.75	Modified daubenmire
Shb15-15	A	2006	54	Ocular
Shb15-15	A	2007	84	Ocular
Shb15-15	A	2008	31.25	Modified daubenmire
Shb15-17	A	2006	54	Ocular
Shb15-17	A	2007	.	
Shb15-17	A	2008	44.25	Modified daubenmire
Cab13-13	B	2006	65	Ocular
Cab13-13	B	2007	89	Ocular
Cab13-13	B	2008	21.5	Modified daubenmire

# Other monitoring issues

How to accurately represent a site?

How to choose where to place transect(s)?

- These images are from the same site in Wamsutter, the image on the left is taken ~60m from a snow fence (100% bareground), the image on the right is taken ~5m from a snow fence (>75% cover).



# Solutions

- Monitoring
  - Consistent Timing – Currently working with degree day models
  - Consistent Methods -- Currently working with statisticians at UW in effort to try to create a method that is simple, time-efficient, statistically valid, repeatable, and can provide an accurate description of the entire reclaimed area
- Use more than one reference site per well pad
  - Median criteria across soil map units?
  - Trends over time on a given well-pad?
- Unify our definition of Reclamation Success and Reclamation Success Criteria
  - If not identical, at least on the same page across and amongst agencies will make life easier on all

# Questions?

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