

# Long-term Comparison of Vegetation Reference Area on Reclaimed Coal Mines in Northeastern Wyoming

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# General Questions to Consider

- Do reclaimed areas generally mirror their selected reference area over time?
- If not, what are the associated challenges that may apply?
  - Changes in sampling pool based on methodology (changing reference area locations)
  - Age of the reclaimed area that is compared
  - Grazing differences on either the reclaimed or the reference area
  - Seeding methodology changes over time
  - Precipitation variance
  - Changes in the reference area communities themselves
- What is the cheatgrass presence over time in the native community?

# Background

- Consistency Issues - Within a given mine, comparative differences between years may vary on the use of:
  - established reference/control area during initial phase of operation
  - newly established reference/control area due to loss of a previously established area from mining operations
  - if a mine has switched to an extended reference area.
- Not all coal mines in Northeastern Wyoming used the same mapping of community types and initial sampling methodology.
- This presentation will address general issues as applied to the historical information from one mine.
- NOTE: Qualitative comparison only.

# Reference Areas in Wyoming<sup>1</sup>

- In this context, Reference Area (REFA) is a general term meaning a land unit established to evaluate revegetation success. REFA is representative of a vegetation community or communities that will be affected by mining activities, in terms of
  - physiography, - soils
  - vegetation, - land use history.
- The REFA and its corresponding postmine vegetation communities must be approved by WDEQ-LQD and shall be defined in the approved Reclamation Plan.
- Type of reference areas or methods that can be used for comparative analysis during bond release are:
  - Limited Reference Area
  - Control Area
  - Comparison Area
  - Extended Reference Area
  - Technical Revegetation Success Standard

<sup>1</sup>Wyoming Dept. of Environmental Quality – Land Quality Dept.  
Current Rules and Regulations for Coal: Chapters 1 & 2

# Limited Reference Area

- Established during baseline sampling to represent one vegetation community to be reestablished.
- The representative nature of the “limited reference area” is determined by quantitative comparisons of vegetation cover, total ground cover, and production between the “limited reference area” and proposed affected areas at the 90 percent confidence level.
- Revegetation success determined by direct statistical comparison.
- Reference area should be “at least 5 acres”.



# Control Area

- Established during baseline sampling to represent one vegetation community to be reestablished.
- Quantitative comparisons of vegetation cover, total ground cover, and production between the proposed “control area” and the vegetation community to be affected are used to demonstrate the representative nature of the “control area”.
- Control areas should be “at least two acres”.
- Revegetation success can be climatically adjusted, dependent on the WDEQ-LQD Administrator.

# Comparison Area

- Established after vegetation community has been affected.
- A qualitative determination is used to evaluate if the proposed “comparison area” adequately represents the affected vegetation community.
- May be used when other types of reference areas are not available and/or will not be representative.
- When evaluating Chapter 4 revegetation success performance standards, data from the “comparison areas” are directly compared by statistical procedures to data from the reclaimed area.





# Extended Reference Area

- Includes a major portion of one or more pre-mine vegetation community within the permit area.
- Should be established during baseline sampling.
- Sampling includes areas proposed to be affected and areas that will be unaffected.
- Postmine, the unaffected areas within a given vegetation type, constitute the reference area for revegetation success evaluation for that community.
- Extended reference areas are directly compared by statistical procedures to data from the reclaimed area.
- Areas should be “as large as possible”.



# Technical Revegetation Success Standard

- Derived from a minimum five years of baseline data.
- Representative over a range of climatic conditions.
- May be extended to a mine permit amendment area, if data is applicable.



# History of Example Area

- Reference areas have changed over time due to mining progression:
  - started with control areas 1981
  - moved to an extended reference area 1991
  - moved to limited reference areas 2008

# Methodology: Point-Line Intercept

## 1981-present

- Sampling methodology stayed constant over time.
- 50-meter transect .
- Percent cover measurements were taken from point-intercepts at 1-meter intervals along a 50-meter transect using some type of pointer.
- Each point-intercept represented 2% towards cover measurements.
- Percent cover measurements recorded aerial “first-hit” and basal cover point-intercepts by live foliar vegetation species, litter, rock, or bare ground. Litter included all organic material that was from the previous year’s growth (did not include standing dead vegetation from current year’s growth).
- Aerial hits were used to determine the summarized % vegetative cover and % ground cover.

# Description of Major Vegetation Communities in Example Area

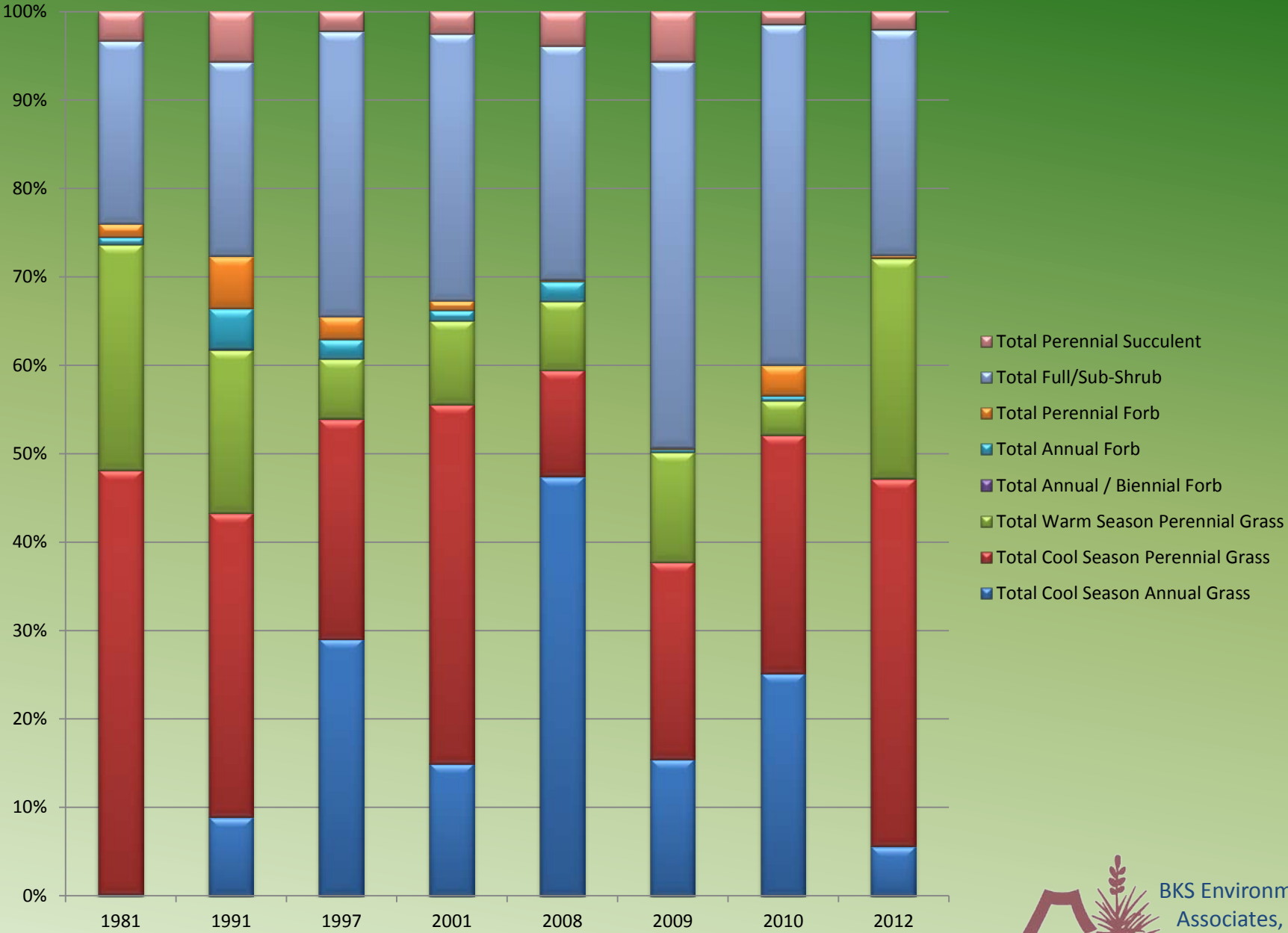
- Big Sagebrush (BSS)
  - Characterized by rolling upland terrain with generally dense shrub cover. Supports a dominance of big sagebrush (*Artemisia tridentata*), western wheatgrass (*Elymus smithii*), threadleaf sedge (*Carex filifolia*), Sandberg bluegrass (*Poa secunda*), blue grama (*Bouteloua gracilis*), needle-and-thread (*Hesperostipa comata*), prairie junegrass (*Koeleria macrantha*), and plains pricklypear cactus (*Opuntia polyacantha*).
- Upland Grassland (UG)
  - Characterized by rolling upland terrain with a limited shrub cover. Support a dominance of western wheatgrass, Sandberg bluegrass, blue grama, and plains pricklypear cactus.



# Big Sagebrush Community



# Relative Vegetation Cover by Lifeform



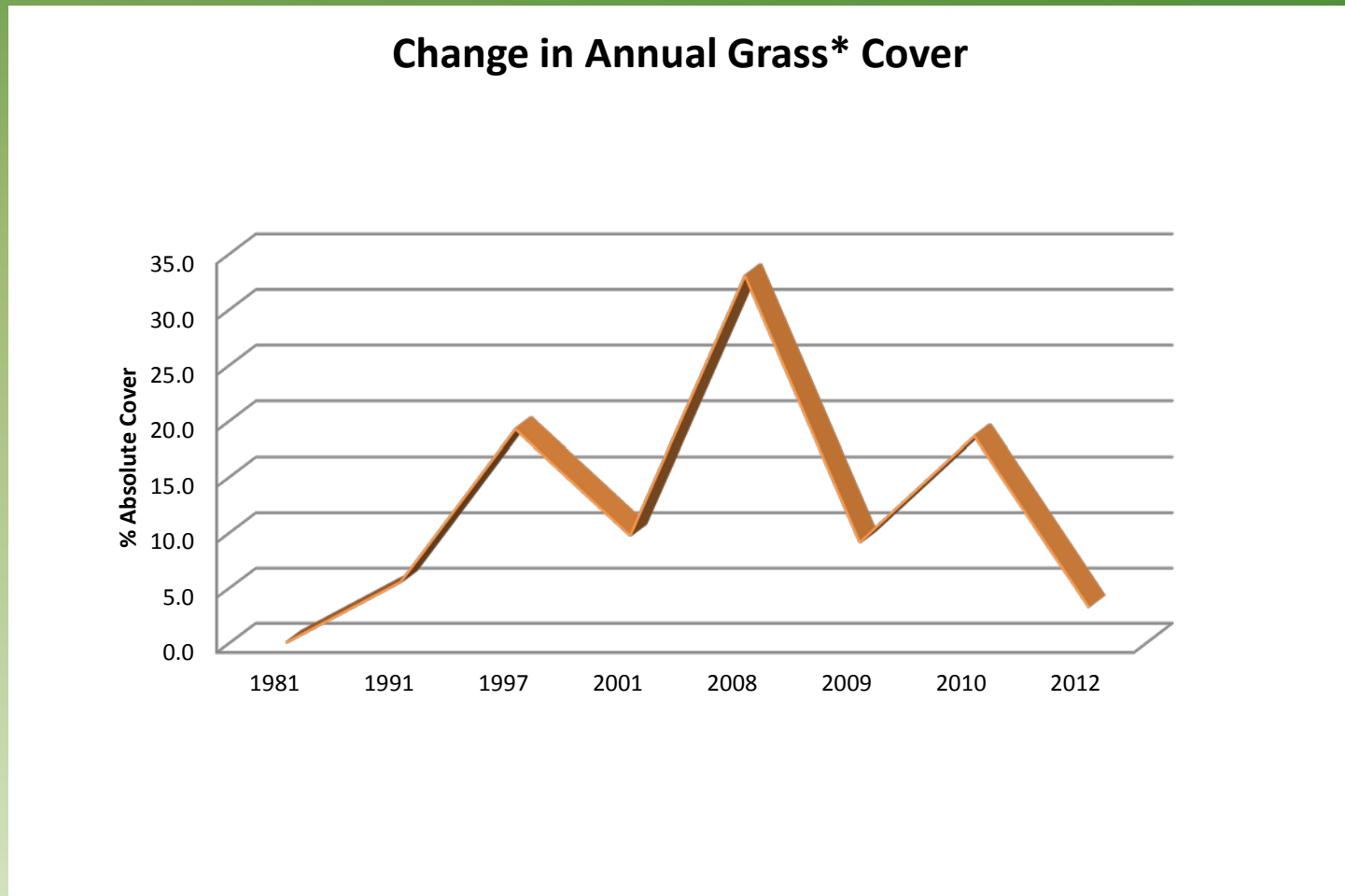


# Changes in Big Sagebrush Community over Time

- % of annual grasses cover generally increased over time but varied by year; 2012 tough even for cheatgrass
- % of annual forb and perennial forb cover averaged 1.5% and 1.9% relative vegetation cover, respectively; also variable by year
- % of cool season perennial grass cover stayed relatively consistent over time, except 2008) and averaged 31.3% relative cover
- % warm season perennial grass cover generally fluctuated over time

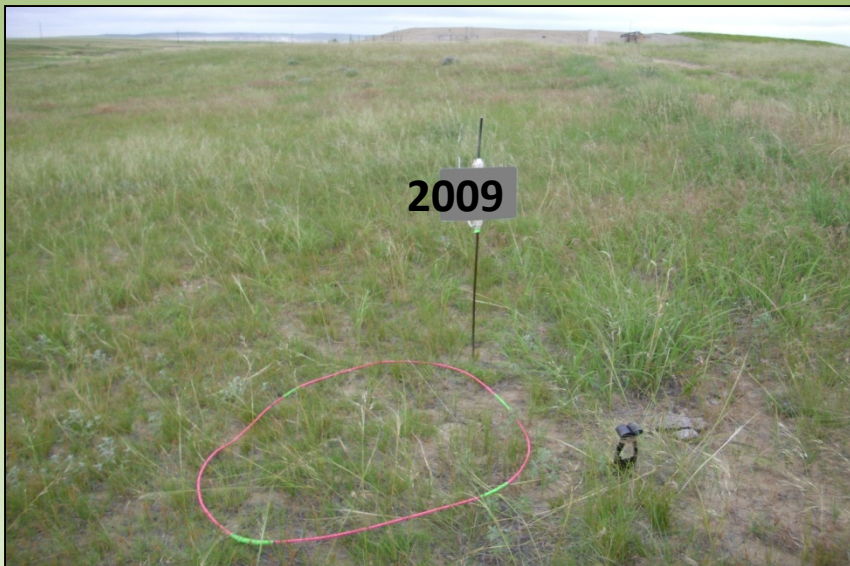
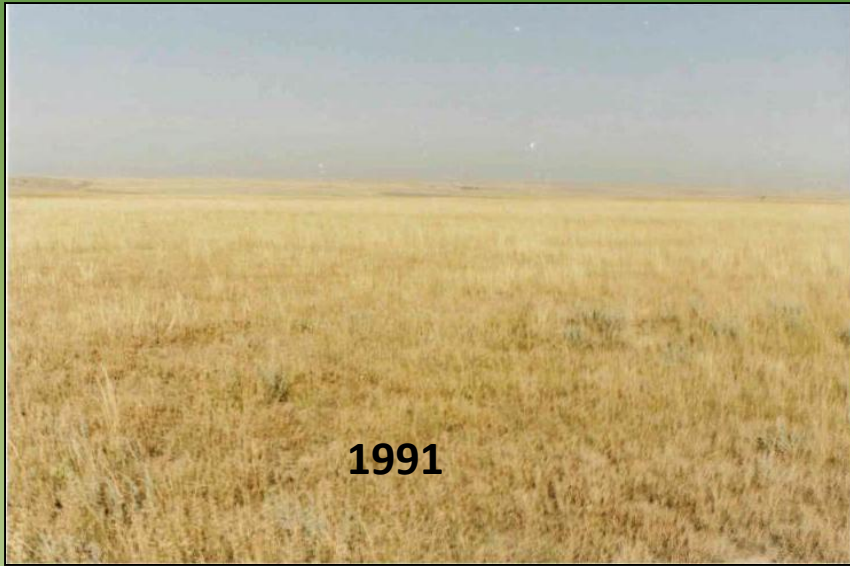


# Changes in Annual Grass Cover within the Big Sagebrush Community

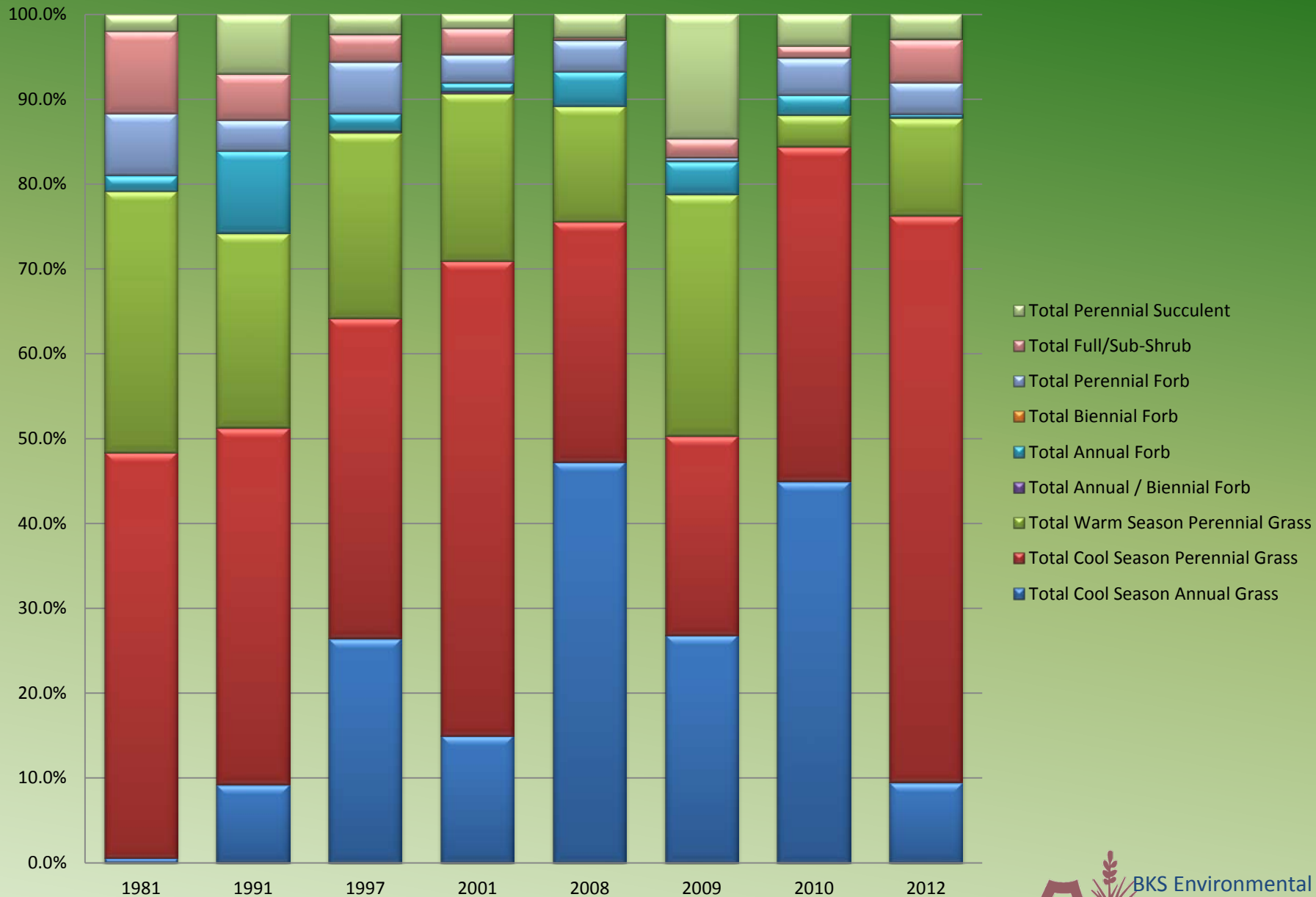


\*The dominant annual grass was *Bromus tectorum* (cheatgrass)

# Upland Grassland Community



# Relative Vegetation Cover by Lifeform

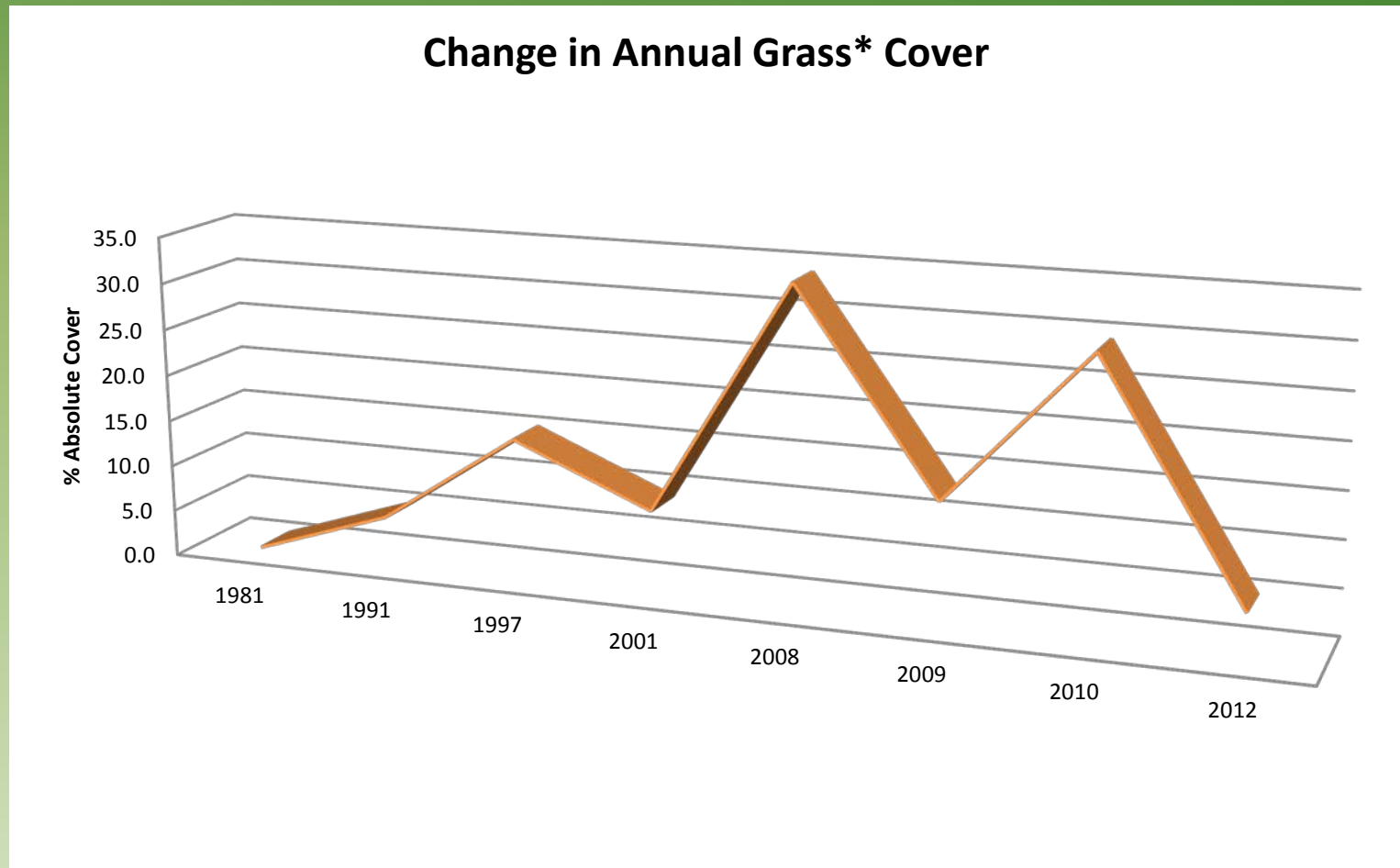


# Changes in Upland Grassland Community Over Time

- % of annual grass cover generally increased over time but varied by year; same effect in 2012 as Big Sagebrush REFA
- % of annual and perennial forb cover variable
- % of cool season perennial grass cover generally exceeded perennial warm season grass with the exception of 2009
- % of full and sub-shrub cover variable



# Changes in Annual Grass Cover within the Upland Grassland Community



\*The dominant annual grass was *Bromus tectorum* (cheatgrass)

# Summary of Cheatgrass Activity

- Little or no cheatgrass was present in 1981
- Overall peak in 2008 but had two smaller “peaks” in 1997 and 2010
- Less than 5% in 2012
- BSS averaged about 12% and UG averaged about 18% between 1997 and 2010

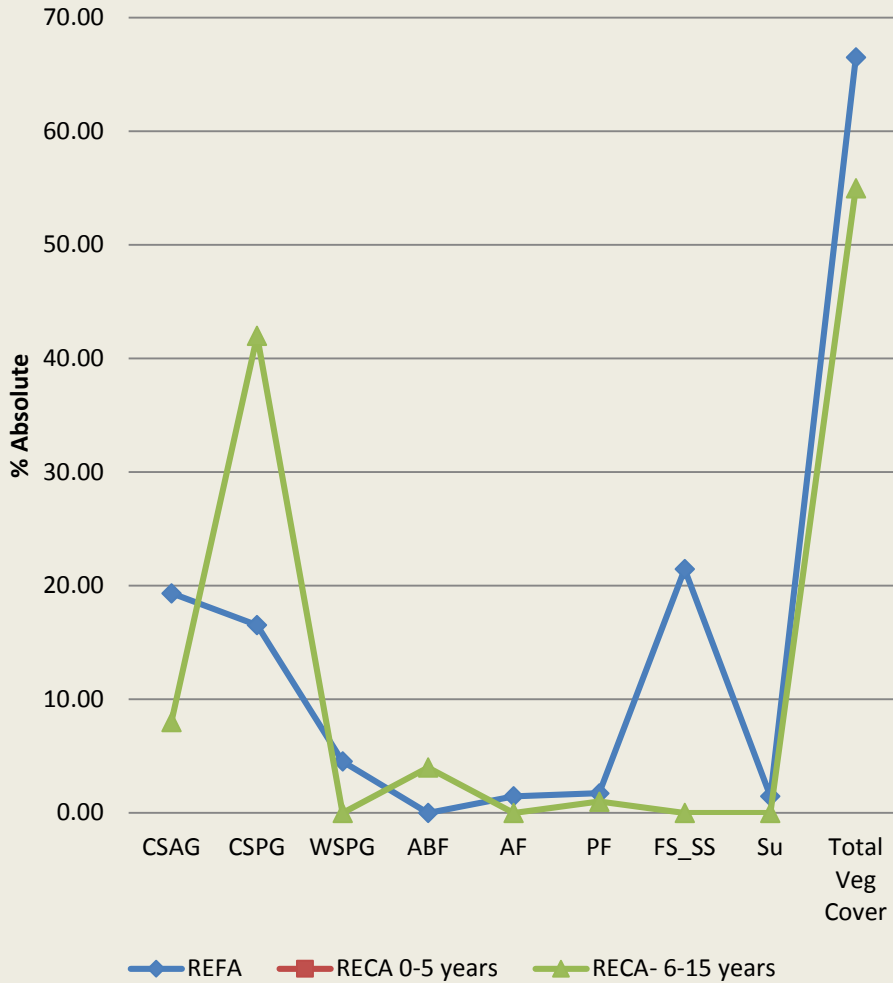
# Comparing BSS and UG REFA's to Reclaimed Sites

- RECA data was available from 1997 to 2012
- RECA seed mixes used for comparison were:
  - BSS: 3 different seed mixes that varied slightly
  - UG: 2 different seed mixes that varied slightly
  - Composite mean of all RECA seed mixes within a given REFA, i.e., did not try to break out different mixes
- Grazing occurred on REFA in 2008 prior to sampling but not in 2009, 2010, and 2012
- Age of RECA was split into 0-5 years, 6-15 years, and 16+ years dependent on the REFA year



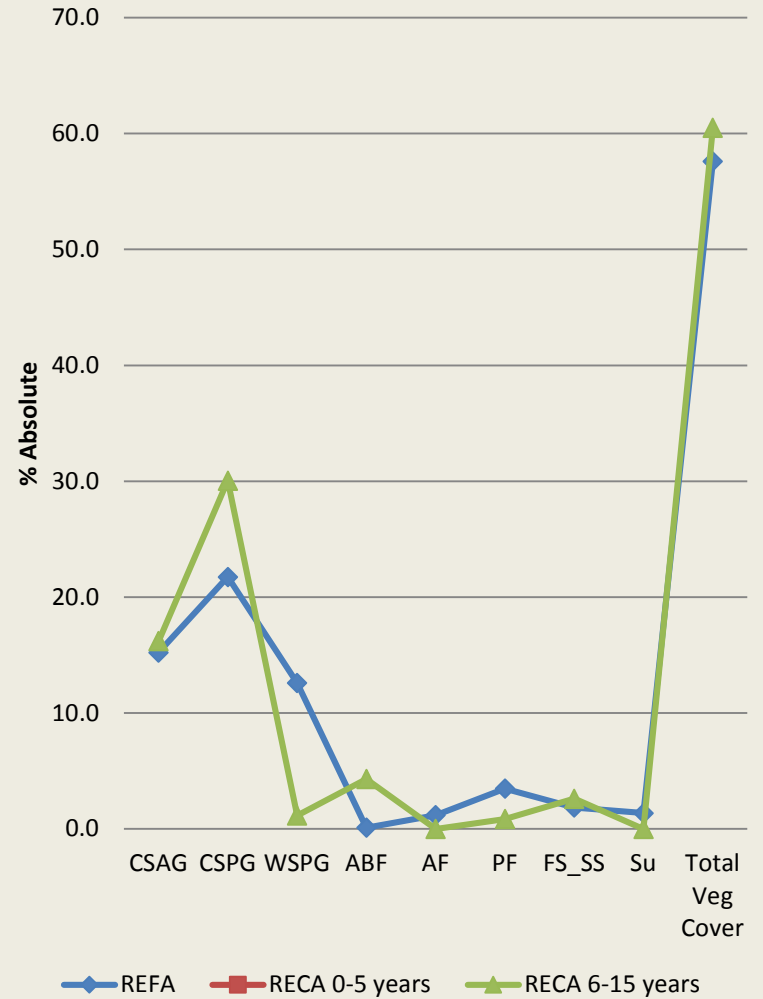
## BSS

### % Absolute Vegetation Cover RECA vs. REFA for 1997



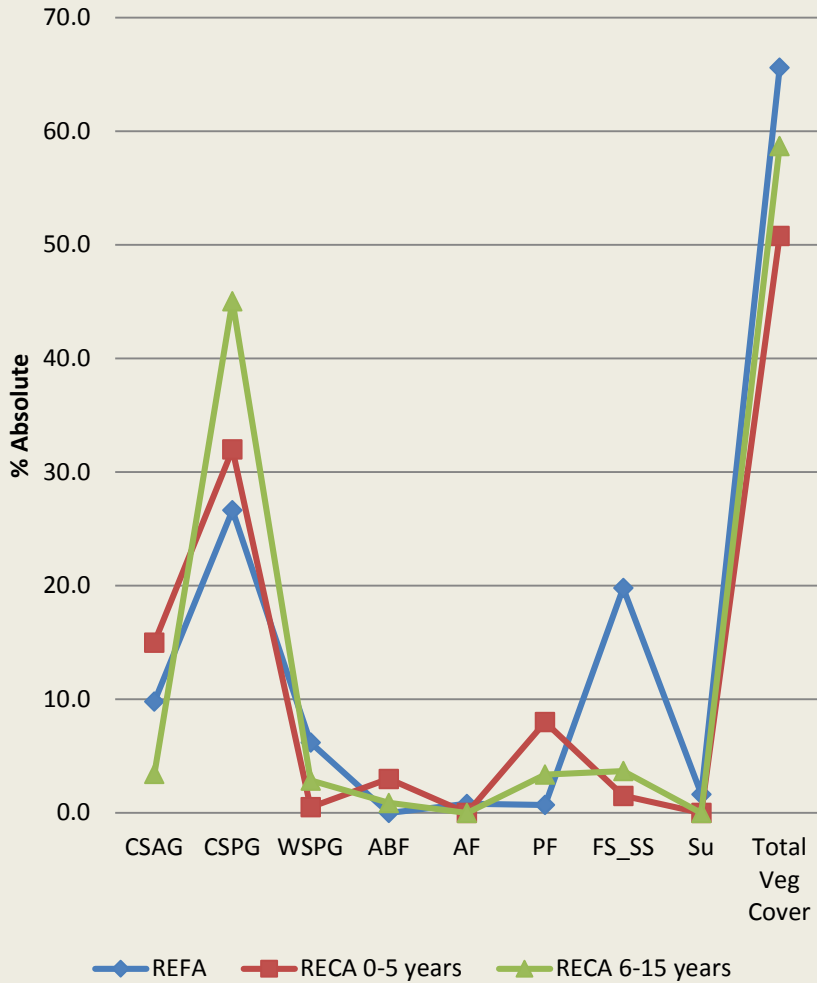
## UG

### % Absolute Vegetation Cover RECA vs. REFA for 1997



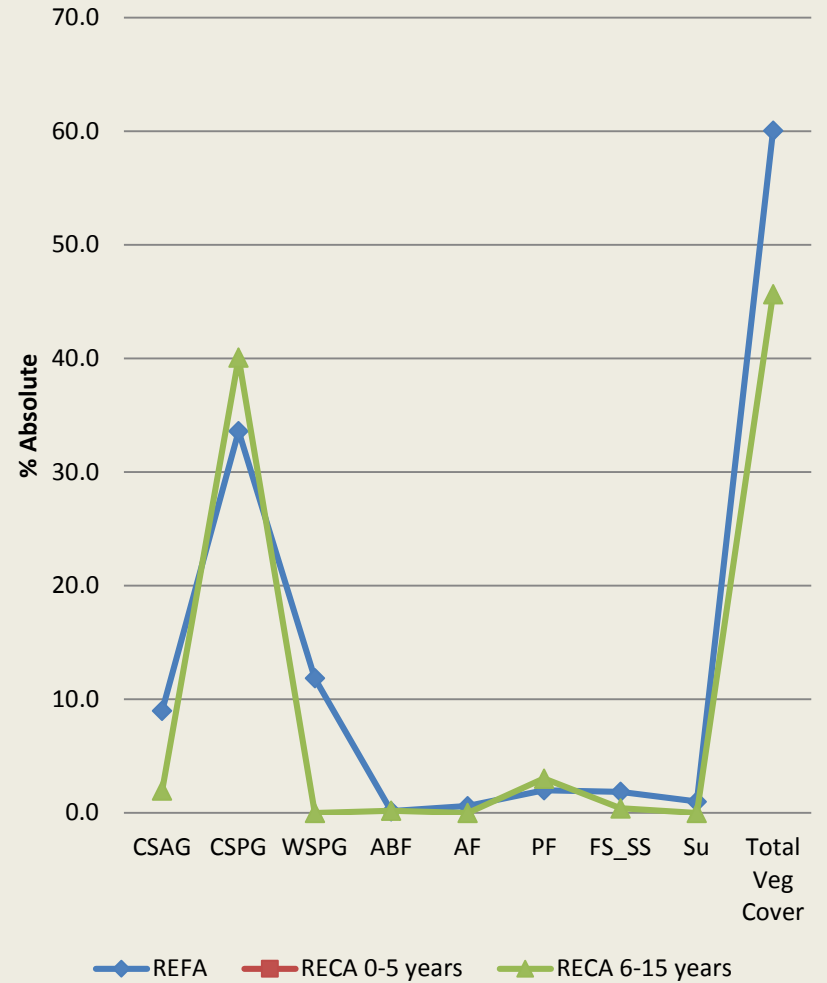
## BSS

### % Absolute Vegetation Cover RECA vs. REFA for 2001

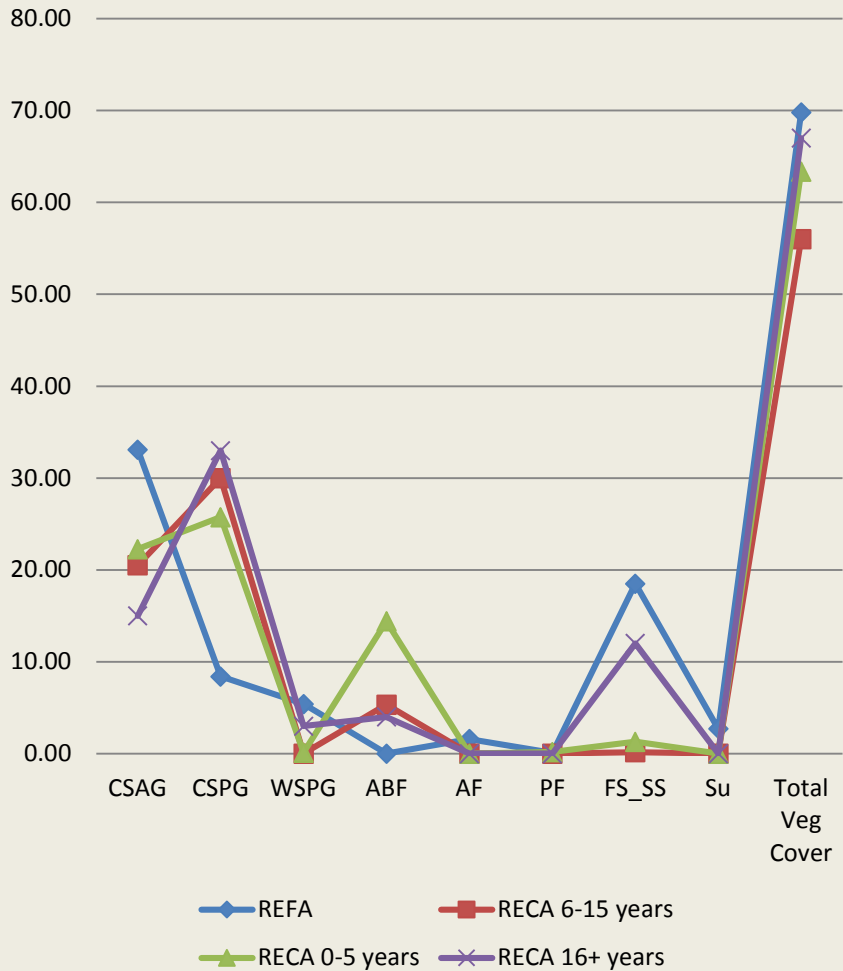


## UG

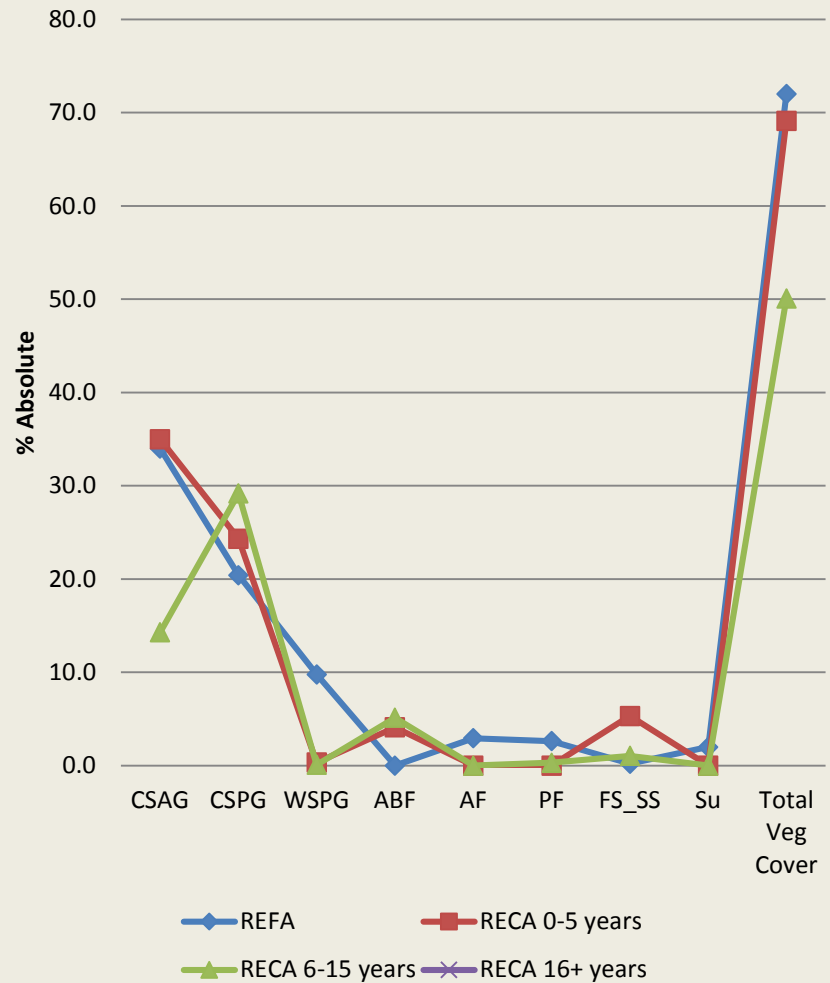
### % Absolute Vegetation Cover RECA vs. REFA for 2001



## BSS % Absolute Vegetation Cover REFA vs. RECA 2008

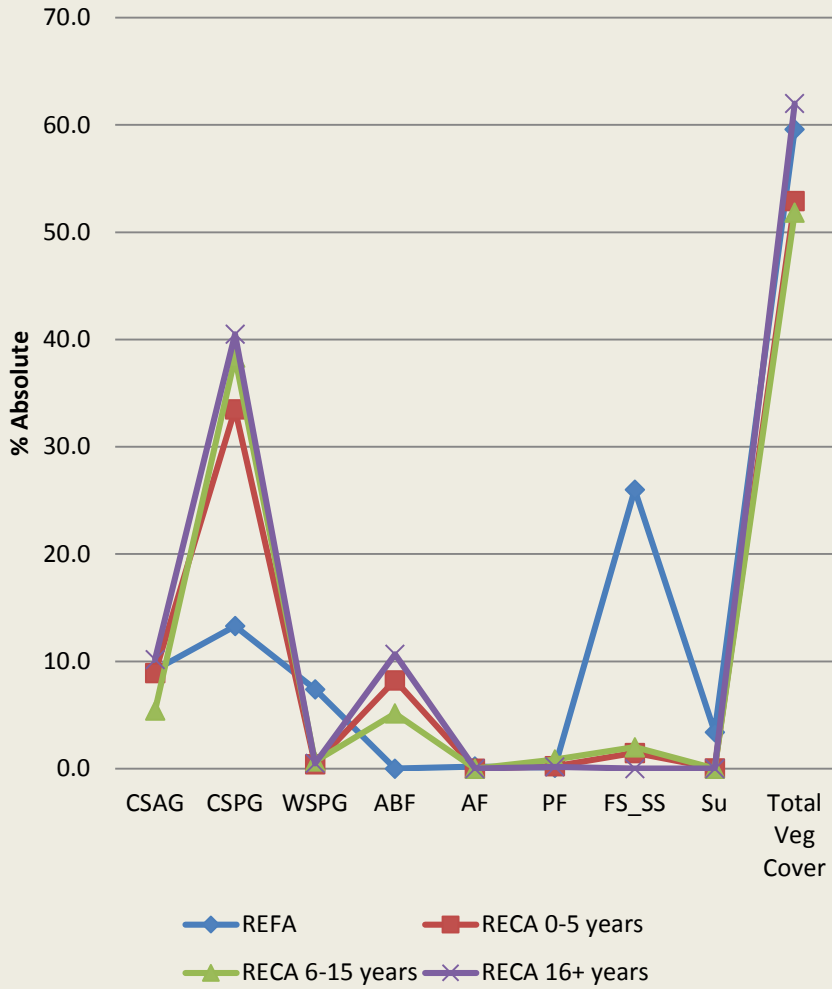


## UG % Absolute Vegetation Cover REFA vs. RECA 2008

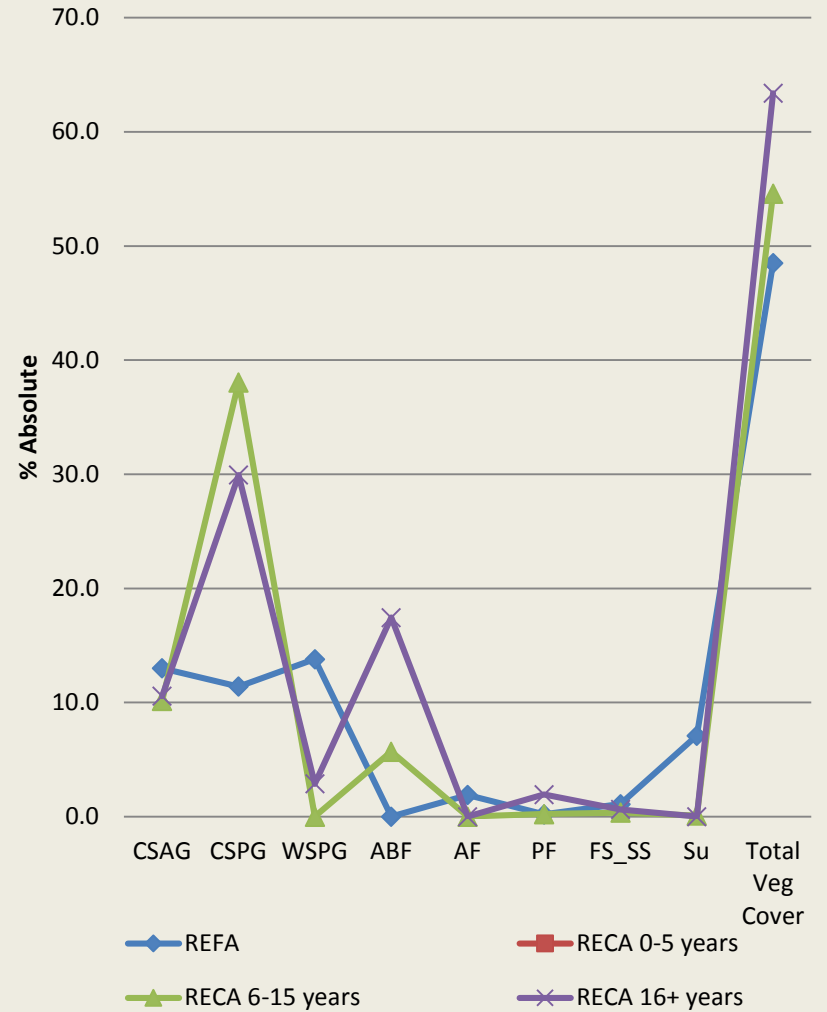


Changed to Limited Reference Area in 2008

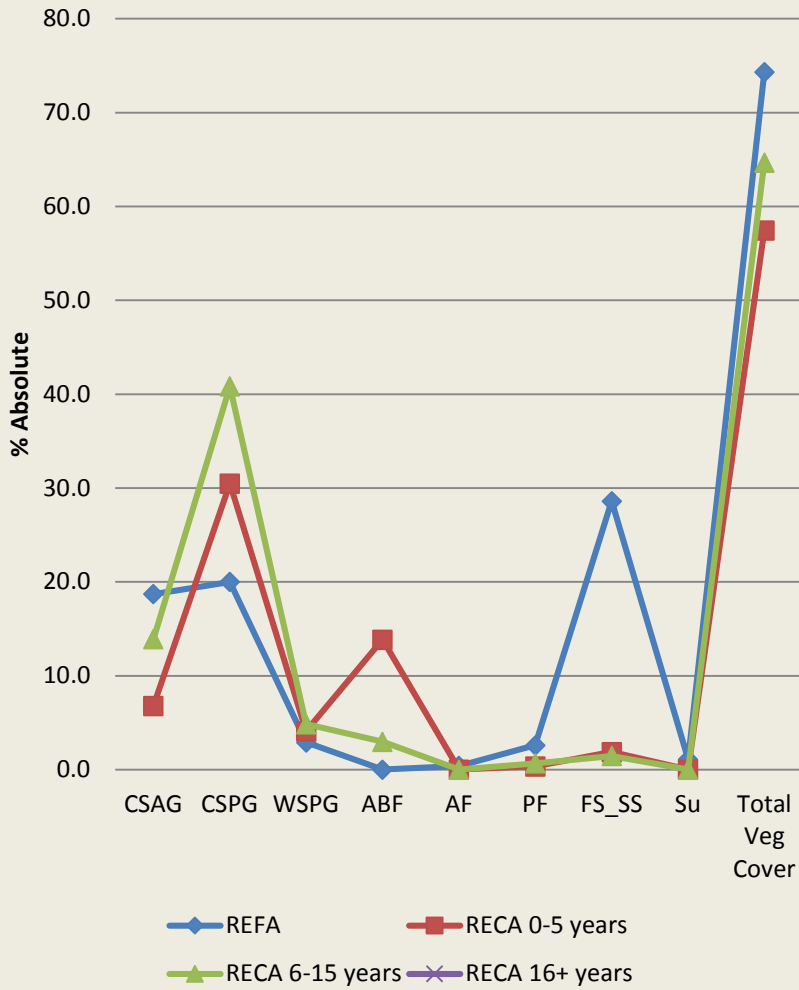
**BSS**  
**% Absolute Vegetation Cover**  
**REFA vs. RECA 2009**



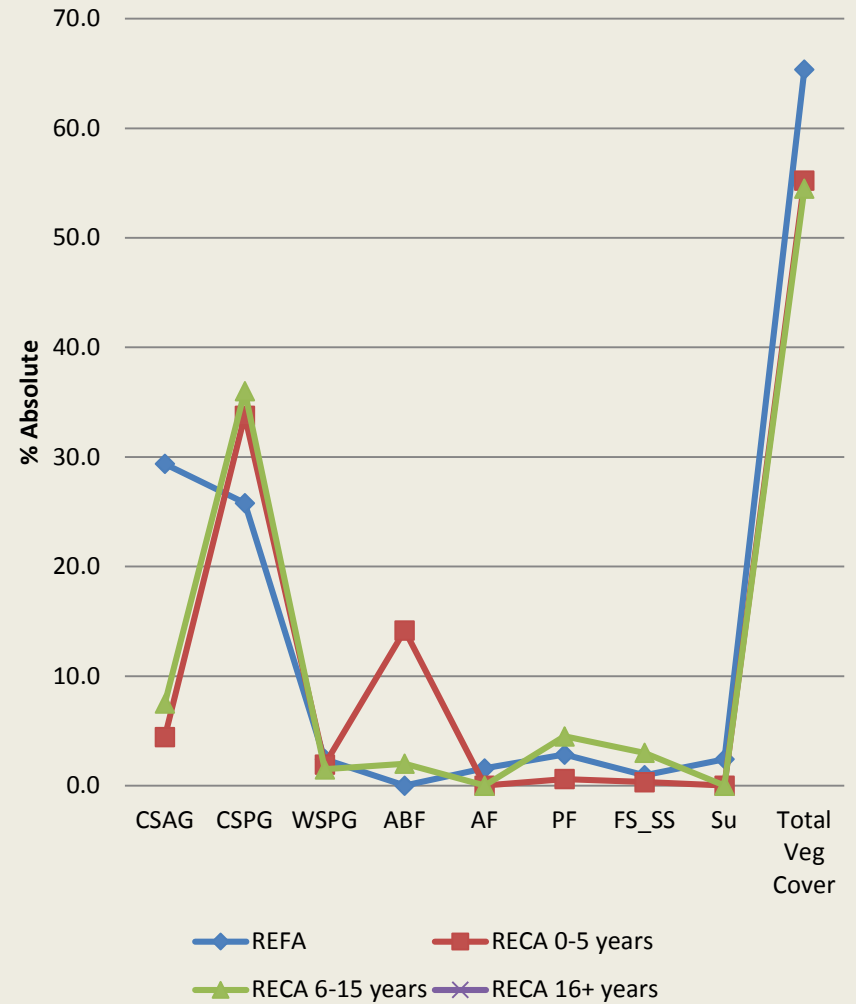
**UG**  
**% Absolute Vegetation Cover**  
**REFA vs. RECA 2009**



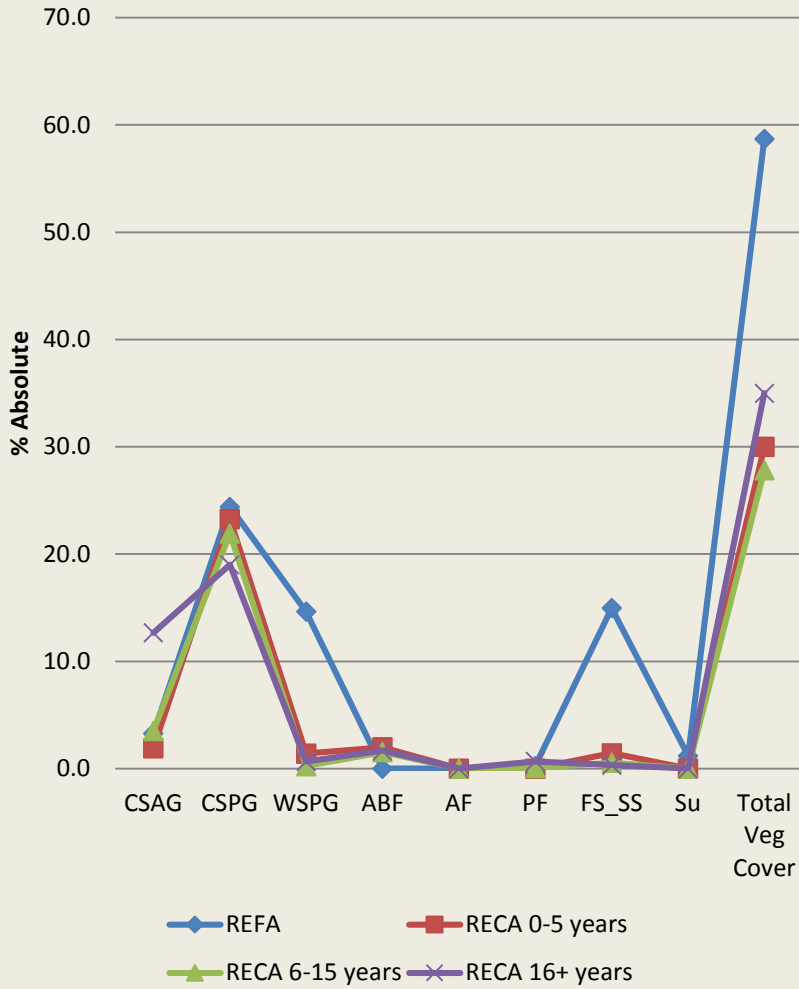
**BSS**  
**% Absolute Vegetation Cover**  
**REFA vs. RECA 2010**



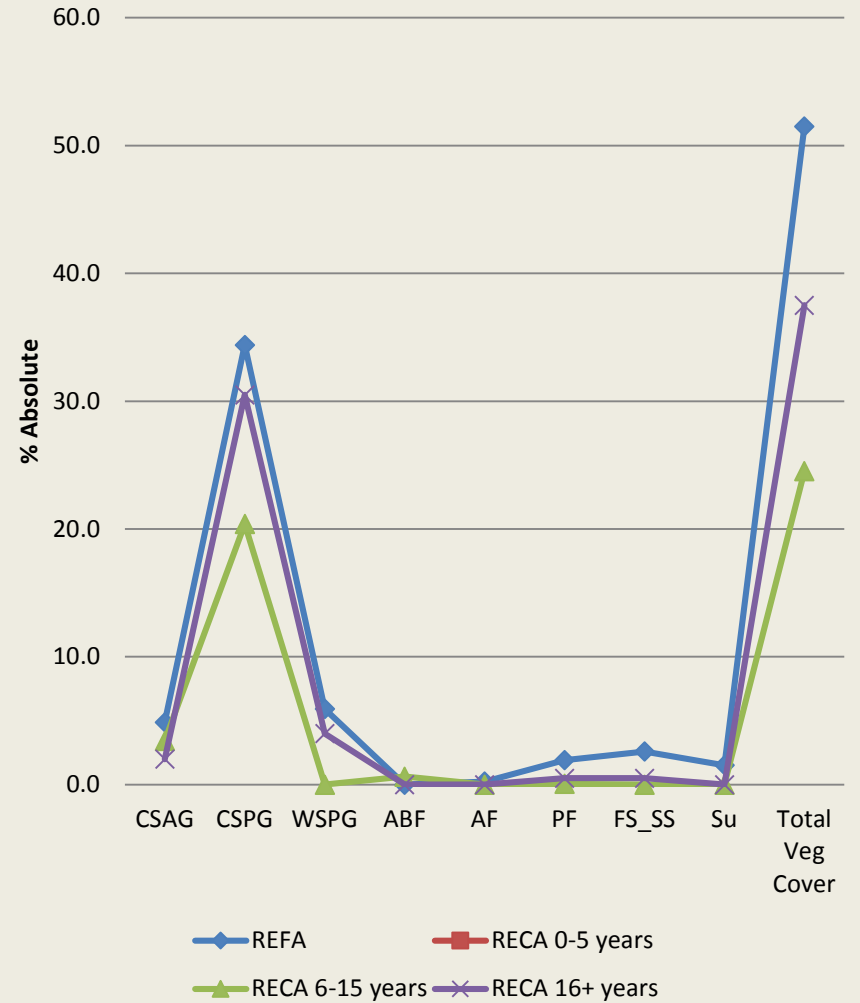
**UG**  
**% Absolute Vegetation Cover**  
**REFA vs. RECA 2010**



**BSS**  
**% Absolute Vegetation Cover**  
**REFA vs. RECA 2012**



**UG**  
**% Absolute Vegetation Cover**  
**REFA vs. RECA 2012**



# Summary of General Comparison

- Do reclaimed areas mirror their selected reference area over time in terms of lifeform cover?
  - UG RECA more follows the UG REFA trend over time
  - BSS RECA generally have more CSPG cover and less shrub cover than the BSS REFA but can somewhat reverse with time



# Possible Reasons for Fluctuations in Liform Cover over Time\*

- Change in reference area type and location due to mining progression
- Changes in precipitation totals and patterns
- Changes in age of reclamation
- Grazing
- Changes in native are communities over time, e.g., cheatgrass
- Reclamation practice changes

# Questions????



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