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Revegetation Monitoring Sites: GVH-01, GVH-05 & Reference Areas

2014

Centennial Mine
Carbon County, Utah

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INTRODUCTION

The Centennial Mine is located on the Book Cliffs Plateau, about 10 miles northeast of the town of Price, Utah. The coal mine went into 'temporary cessation' in 2008. Because it was a very deep mine, a number of boreholes had been drilled in strategic locations to vent "gob" gas as a safety precaution during mining operations. Since that time, several of these drill sites have been reclaimed.

In most cases, prior to land disturbance caused for drill pad construction, the existing vegetation was quantitatively measured along with "reference areas" that were left undisturbed to be used for final revegetation success standards following reclamation of the sites. However, some emergency borehole drill sites were constructed in the winter months, or before vegetation sampling could be conducted. *Reference areas* for those sites were chosen later. Reference areas are native plant communities similar to those that have been impacted by mine-related operations, then left undisturbed so they can be used later as standards for final revegetation success.

Constructed in the winter of 2005, GVH-01 and GVH -05 were two such emergency drill sites. The boreholes at these sites were used to vent gob gas as necessary, then reclaimed in 2009. The vegetation at these sites was sampled to monitor revegetation success in the growing season of 2014. This report provides the sample results as well as previous recorded data of the applicable reference areas for comparisons purposes.

METHODS

Transect Placement

Transect lines for quantitative sampling were randomly placed throughout the study areas. From these transect lines, sample locations were chosen using random numbers on both sides and at right angles to them.

Cover, Frequency & Composition

Cover estimates were made by ocular methods using meter square quadrats. Species composition and relative frequencies were also assessed from the quadrats. Plant nomenclature follows "*A Utah Flora*" (Welsh et al. 2008).

Density

Density estimates for the woody plant species on the reclaimed and reference areas were made employing a distance method called the point-quarter technique. In this method, random points were placed on the sample sites and divided into four quarters. The distances to the nearest woody plant species were then recorded in each quarter. The average point-to-individual distance was equal to the square root of the mean area per individual. Final calculations resulted in the number of individual woody plants per acre.

Photographs, Sample Location Map & Site Coordinates

Color photographs were taken of the sample areas, some of which have been included in this report. An aerial image map showing the sample sites has also been included.

Coordinates of the study sites are shown below.

Revegetation Monitoring Sites (2014)		
SITE NAME	**GPS NAME**	**COORDINATES** (meters; NAD 27)
GVH-01	ANGVH1	12 S 523627 4397698
GVH-05	ANGVH5	12 S 523623 4398178
Aspen/Grass Reference Area	AGVH8R	12 S 522002 4398050
Sagebrush/Grass Reference Area	AGVHSR	12 S 522309 4398459

RESULTS

Site: GVH-01

GVH-04

In 2014, reclaimed site GHV-01 was dominated by western wheatgrass (*Elymus smithii*) by quite a large margin. Other important plant species in the sample quadrats were: smooth brome (*Bromus inermis*), Sandberg's bluegrass (*Poa secunda*) and sagebrush (*Artemisia tridentata*). For a list of all species encountered in the samples, refer to Table 1.

The total living cover at this site was estimated at 63.25%, and all of it was understory cover (Table 2-A). The composition of this cover was comprised mostly of grasses at 91.09%. Shrub and forbs made up the remainder at 8.41% and 0.50%, respectively (Table 2-B).

Woody species density was relatively low with a total of 272 individuals per acre (Table 3). The only two shrubs in the density measurements were sagebrush and rubber rabbitbrush (*Chrysothamnus nauseosus*).

Site: GVH-05

Reclaimed site GHV-05 was dominated by sagebrush, smooth brome, Sandberg's bluegrass and western wheatgrass (Table 4).

The total living cover at this site was 61.00% (Table 5-A); it was comprised of 64.94% grasses, 34.30% shrubs and 0.77% forbs (Table 5-B).

GVH-05

The total woody species density at GHV-05 was estimated at 3,658 plants per acre, all of which was sagebrush (Table 6),

Reference Area: Aspen/Grass

The aspen/grass reference area chosen for future standards was located in the vicinity of the disturbed aspen/grass communities. The only tree present in the overstory cover was aspen (*Populus tremuloides*). The dominant plants in understory cover were: snowberry (*Symphoricarpos oreophilus*), lupine (*Lupinus argenteus*), Kentucky bluegrass (*Poa pratensis*) low rabbitbrush (*Chrysothamnus viscidiflorus*) and aspen (Table 7).

Aspen/Grass Reference Area (2005)

The total living understory cover in this community was 52.00%, while the total combined overstory and understory cover was 76.25% (Table 8-A). Trees and shrubs dominated the cover composition at 58.95%, whereas forbs and grasses were equally represented at 20.79% and 20.26%, respectively (Table 8-B).

The total woody species density was estimated at 3,702 individuals per acre and was dominated by snowberry, broom snakeweed (*Gutierrezia sarothrae*) and aspen (Table 9).

Reference Area: Sagebrush/Grass

A native, undisturbed sagebrush/grass plant community was chosen to represent future revegetation success standards for similar communities that were impacted by the drilling activities, such as GVH-05.

The dominant plant species of this reference area by cover and frequency were big sagebrush and Kentucky bluegrass (Table 10).

This reference area has a total living cover estimated at 61.75% (Table 11-A). Within this total living cover measurement, 63.36% of was from shrubs, 26.70% from grasses, and 9.94% were forbs (Table 11-B).

Woody species density was estimated at 6,335 individuals per acre (Table 12) and was comprised of big sagebrush, viscid rabbitbrush (*Chrysothamnus viscidiflorus*), snowberry, and Wood's rose (*Rosa woodsii*).

Sagebrush/Grass Reference Area (2006)

SUMMARY & DISCUSSION

Gas vent sites GVH-01 and GVH-05 were reclaimed in 2009. In 2014, vegetation at the sites was quantitatively sampled to monitor the progress of plant establishment. Reference areas were sampled previously to represent revegetation success standards following reclamation. Results from the 2014 sample period have been provided in this report. Additionally, earlier datasets for applicable reference areas have been included herein to provide general comparisons to the reclaimed areas.

Plant Species Establishment

All plants present in the sample quadrats of **GVH-01** and **GVH-05** were desirable species with no "weedy", exotics.

Total Living Cover

The total living cover value of **GVH-01** was somewhat less, but getting close to the value of the **Aspen/Grass Reference Area**. In fact, when the understory values of the two areas were compared, the reclaimed site was higher than that of the reference area.

When to total living cover of **GVH-05** was compared to the **Sagebrush/Grass Reference Area**, the values were nearly identical.

Woody Species Density

When the total woody species density of **GVH-01** was compared to that of its reference area, the latter was significantly greater.

The woody species density of reclaimed site **GVH-05** was also less than its reference area, but not by as large of a margin. This difference may become less as the site becomes better established.

CONCLUSIONS

The reclaimed sites are progressing well as far plant establishment, especially when the species present and total living covers are considered. Woody species density especially in GVH-01, was significantly less than its reference area.

Because there are more reclaimed drill sites that will soon need to be studied, and because bond release considerations are forthcoming, it may be timely to review and assess the goals for final revegetation success at these drill sites. For example, a review of the language in the Mining & Reclamation Plan (MRP) regarding them, considerations for wildlife habitat and livestock grazing, determinations of which parameter(s) should be measured against reference areas and finally, the expectations of the landowners for the postmining land uses should be considered.

Table 1: Centennial Mine. Living Cover and Frequency by Plant Species (2014).

Reclaimed Area: GVH-01 Aspen/Grass			n=20
	Mean Percent	**Standard Deviation**	**Percent Frequency**
SHRUBS			
Artemisia tridentata	3.25	7.95	15.00
Chrysothamnus nauseosus	1.25	5.45	5.00
Purshia tridentata	0.50	2.18	5.00
FORBS			
Penstemon strictus	0.25	1.09	5.00
GRASSES			
Bromus inermis	9.25	8.98	65.00
Elymus smithii	37.50	19.65	90.00
Elymus trachycaulus	2.25	5.58	15.00
Poa secunda	9.00	17.51	25.00

Table 2: Centennial Mine. Total Cover and Composition (2014).

Reclaimed Area: GVH-01 Aspen/Grass		n=20
A. TOTAL COVER	**Mean Percent**	**Standard Deviation**
Understory	63.25	9.39
Litter	8.80	4.04
Bareground	17.70	8.92
Rock	10.25	4.87
B. % COMPOSITION		
Shrubs	8.41	15.49
Forbs	0.50	2.18
Grasses	91.09	15.37

Table 3: Centennial Mine. Woody Species Density (2014).

Reclaimed Area: GVH-01 Aspen/Grass	n=20
SPECIES	**Individuals/Acre**
Artemisia tridentata	200.56
Chrysothamnus nauseosus	64.59
TOTAL	**271.94**

Table 4: Centennial Mine. Living Cover and Frequency by Plant Species (2014).

Reclaimed Area: GVH-05 **Sagebrush/Grass**			n=20
	Mean Percent	**Standard Deviation**	**Percent Frequency**
SHRUBS			
Artemisia tridentata	23.25	21.64	65.00
FORBS			
Linum lewisii	0.50	2.18	5.00
GRASSES			
Bromus inermis	19.75	20.03	70.00
Elymus smithii	5.00	8.37	35.00
Elymus spicatus	2.00	8.72	5.00
Elymus trachycaulus	4.25	5.07	50.00
Poa secunda	6.25	16.80	15.00

Table 5: Centennial Mine. Total Cover and Composition (2014).

Reclaimed Area: GVH-05 **Sagebrush/Grass**		n=20
A. TOTAL COVER	**Mean Percent**	**Standard Deviation**
Understory	61.00	10.79
Litter	6.75	2.38
Bareground	22.75	10.30
Rock	9.50	5.45
B. % COMPOSITION		
Shrubs	34.30	29.75
Forbs	0.77	3.35
Grasses	64.94	30.82

Table 6: Centennial Mine. Woody Species Density (2014).

Reclaimed Area: GVH-05 **Sagebrush/Grass**	n=20
SPECIES	**Individuals/Acre**
Artemisia tridentata	3658.32
TOTAL	**3658.32**

Table 7: Centennial Mine. Living Cover and Frequency by Plant Species (2005).

Reference Area: Aspen/Grass			n=20
	Mean Percent	Standard Deviation	Percent Frequency
OVERSTORY			
Populus tremuloides	24.25	17.77	75.00
UNDERSTORY			
TREES/SHRUBS			
Artemisia tridentata	1.25	3.49	15.00
Chrysothamnus viscidiflorus	6.00	10.07	35.00
Populus tremuloides	6.50	11.84	35.00
Rosa woodsii	4.75	11.01	25.00
Symphoricarpos oreophilus	12.75	17.06	50.00
FORBS			
Achillea millefolium	0.25	1.09	5.00
Cynoglossum officinale	0.25	1.09	5.00
Lupinus argenteus	9.25	6.76	85.00
GRASSES			
Bromus carinatus	0.50	2.18	5.00
Elymus spicatus	1.50	4.50	15.00
Poa pratensis	8.25	13.44	50.00
Stipa columbiana	0.75	1.79	15.00

Table 8: Centennial Mine. Total Cover and Composition (2005).

Reference Area: Aspen/Grass		n=20
A. TOTAL COVER	Mean Percent	Standard Deviation
Overstory (o)	24.25	17.77
Understory (u)	52.00	13.55
Litter	27.10	14.70
Bareground	19.65	18.42
Rock	1.25	0.89
o + u	76.25	18.43
B. COMPOSITION		
Trees & Shrubs	58.95	28.06
Forbs	20.79	18.28
Grasses	20.26	19.17

Table 9: Centennial Mine. Woody Species Density (2005).

Reference Area: Aspen/Grass	n=20
SPECIES	**Individuals Per Acre**
Artemisia tridentata	185.12
Gutierrezia sarothrae	879.32
Populus tremuloides	833.04
Rosa woodsii	462.80
Symphoricarpos oreophilus	1342.12
TOTAL	**3702.40**

Table 10: Centennial Mine. Living Cover and Frequency by Plant Species (2006).

Reference Area: Sagebrush/Grass			n=20
	Mean Percent	Standard Deviation	Percent Frequency
TREES & SHRUBS			
Amelanchier utahensis	0.50	2.18	5.00
Artemisia tridentata	26.25	13.12	85.00
Chrysothamnus viscidiflorus	9.15	8.70	70.00
Rosa woodsii	0.85	2.59	10.00
Symphoricarpos oreophilus	2.75	5.12	25.00
FORBS			
Achillea millefolium	0.50	2.18	5.00
Astragalus sp.	0.50	1.50	10.00
Lupinus argenteus	3.75	5.89	35.00
Penstemon watsonii	1.00	2.55	15.00
Taraxacum officinale	0.25	1.09	5.00
GRASSES			
Festuca thurberi	0.25	1.09	5.00
Poa pratensis	16.00	8.89	100.00

Table 11: Centennial Mine. Total Cover and Composition (2006).

Reference Area: Sagebrush/Grass		n=20
A. TOTAL COVER	Mean Percent	Standard Deviation
Understory	61.75	7.79
Litter	16.75	6.18
Bareground	12.90	6.46
Rock	8.60	5.81
B. % COMPOSITION		
Shrubs	63.36	17.55
Forbs	9.94	10.59
Grasses	26.70	14.79

Table 6: Centennial Mine. Woody Species Density (2006).

Reference Area: Sagebrush/Grass	n=20
SPECIES	Individuals Per Acre
Artemisia tridentata	3880.37
Chrysothamnus viscidiflorus	1821.40
Rosa woodsii	237.57
Symphoricarpos oreophilus	395.96
TOTAL	6335.30


Sagebrush/Grass Reference
GVH-05
Aspen/Grass Reference
GVH-01
Revegetation Monitoring
Study Areas
2014
Centennial Mine
Carbon County, Utah
Mt. Nebo Scientific, Inc.
Springville, Utah
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Google earth