

## CURLEW NATIONAL GRASSLAND OFF-CENTER EVALUATION: 2014 PROGRESS REPORT

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### ABSTRACT

In 2010, 63 accessions of 35 species of native and introduced grasses, forbs and shrubs were planted in a replicated display nursery at the Curlew National Grassland in Power County, Idaho. Introduced bunchgrasses, such as Russian wildrye (*Psathrostachys juncea*), Siberian wheatgrass (*Agropyron fragile*), and crested wheatgrass (*A. cristatum*), exhibited superior establishment and persistence over native grass species. However, several native grasses including bottlebrush squirreltail (*Elymus elymoides*) had fair to good establishment. Native and introduced forbs had poor establishment and plant densities decreased over time. The locally collected Bonneville big sagebrush had the highest rated stand establishment and persistence of all evaluated shrub entries. Volunteer crested wheatgrass densities decreased with higher establishment rates of target species; however no difference in density of annual bromes could be detected regardless of target species density.

### INTRODUCTION

In November of 2010, the Aberdeen Plant Materials Center (PMC) installed a multi-species planting at an off-center test site located on the USDA-Forest Service Curlew National Grassland located approximately 30 miles south of American Falls, Idaho in cooperation with the Caribou/Targhee National Forest. The trial contains 63 accessions of 35 species of native and introduced grasses, forbs and shrubs adapted for use in MLRA 13 Eastern Idaho Plateaus (13 to 18-inch plus precipitation areas (Table 1). The goal of this trial is to evaluate the adaptability of new conservation releases in mid-elevation big sagebrush/grass ecosystems and compare their establishment, production, and longevity against traditionally recommended released plant materials. The site will also serve as a display nursery for the Forest Service and other conservation practitioners to view plant species and releases in a natural setting.

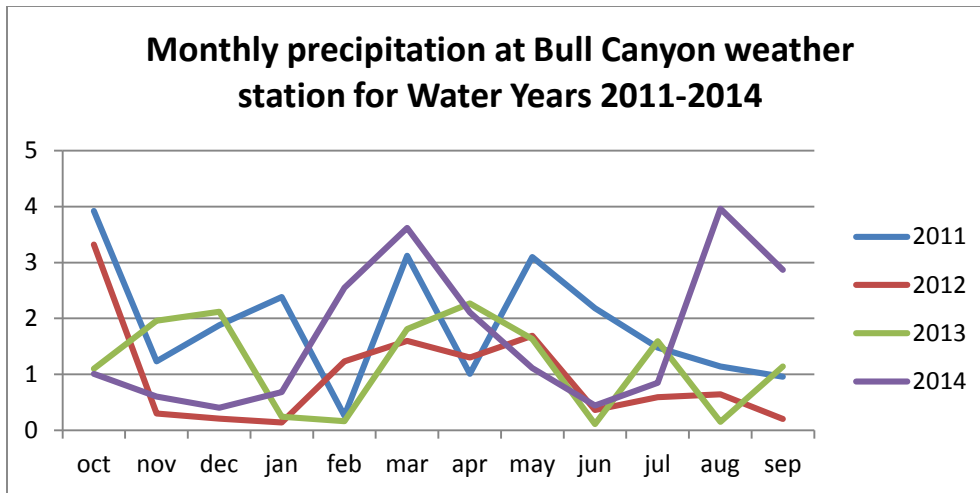
The Curlew test site historically supported a Bonneville big sagebrush/bluebunch wheatgrass plant community. For several decades, however, it has been dominated by crested wheatgrass and bulbous bluegrass. Climatic conditions are semi-arid with mean annual precipitation ranging from 12 to 25 inches. The frost free period is approximately 90 days or less. The soil at the site is classified as a Samaria-Pollynot complex, 4 to 12 percent slopes, silt loam, well-drained and deep (> 80 inches to limiting layer). The elevation is 5,216 ft.

#### *Weather*

There are no weather stations located near the Curlew site or in nearby locations with similar elevation and conditions. The closest weather station is the Bull Canyon weather station located 11 miles north of the Curlew study site at an elevation of 6,418 ft. During water year 2011, Bull Canyon recorded 22.7 inches of precipitation. The Curlew study site, being lower in elevation,

probably received less precipitation than Bull Canyon, but the Curlew test site received normal to above normal precipitation for the year (University of Utah, 2012).

Precipitation was very low throughout the Intermountain West in 2012. The Bull Canyon weather station recorded below average precipitation with a cumulative total of 11.58 inches through September, 2012. Water year 2013 was somewhat better for precipitation in the region with a cumulative total of 14.3 inches through September 4, 2013 at the Bull Canyon station. During 2014 the Bull Canyon station reported 20.2 inches of precipitation, much of that coming from an abnormally wet August in which the region received nearly four inches of rain.



## MATERIALS AND METHODS

The study area was burned by wildfire in 2006. In the fall of 2009 the study site was plowed and packed, followed by applications of 16 oz/ac 2, 4-D and 64 oz/ac glyphosate on June 18, 2010 and July 29, 2010. The trial was planted on November 17, 2010 using a modified Tye® seed drill with a width of 80 inches (8 rows at 10 inch spacing). Experimental design is a randomized complete block with three replications. Appendix 1 is a plot map of the planting. Each plot is one drill width wide (80 in) and 20 ft long. Seeding depths are dependent on species and were planted according to Ogle et al (2010). Species were seeded at a target rate of 20 to 30 pure live seeds (PLS) per ft<sup>2</sup> for large seeded species (<500,000 seeds per pound) and 40 to 50 PLS/ft<sup>2</sup> for smaller seeded species (>500,000 seeds/lb). Pure live seed values were determined by seed lab results or best estimates when lab results were not available. All seed was mixed with rice hulls as an inert carrier to improve seed flow according to St. John et al (2005).

Disturbed areas adjacent to the trial were planted to seed mixture consisting of 40% Anatone bluebunch wheatgrass, 20% Sherman big bluegrass, 15% Bannock thickspike wheatgrass, 10 percent Magnar basin wildrye, 5% Maple Grove Lewis flax, 5% Richfield firecracker penstemon, 5% Great Northern western yarrow, and 0.25 lbs/ac Snake River Plains fourwing saltbush.

The plots were mowed to a height of approximately four inches on September 29, 2011 for weed control.

### *Plant Density*

Plant densities of target species were measured using a frequency grid based on that described by Vogel and Masters (2001). The grid measured approximately 40 x 41 inches, having four ten-inch columns (to incorporate 1 drill row per column) and five rows, totaling 20 cells. The first grid was laid on the rows approximately one grid length (40 inches) into the plot. Counts were made of the cells that contained at least one plant. The grid was then flipped repeatedly into the plot and densities recorded four more times for a total of five. Total area for one grid is approximately 1m<sup>2</sup>. Total area evaluated is therefore approximately 5m<sup>2</sup>. A conservative estimate of plant density (plants/m<sup>2</sup>) is the total number of cells containing at least one plant divided by five. It is important to note that because cells with plants were counted and not the number of plants per cell, the best possible score is 100 hits per five frames which converts to 20 plants/m<sup>2</sup> or 1.85 plants/ft<sup>2</sup>. Actual plant density may be higher than the numbers indicated below. For plants/ft<sup>2</sup>, divide by 10.76.

Data were analyzed using the Statistix 8 Analytical software and subjected to an analysis of variance with a significance level of  $p < 0.05$ . In cases where significance was detected, means were separated using a Least Significant Difference (LSD) all pairwise comparison. Analyses were broken into five groups: 1) all species, 2) native grasses, 3) introduced grasses, 4) forbs, and 5) shrubs. All tables have been arranged with accessions ranked from highest to lowest plant density at the time of the 2011 evaluation.

Initial plant establishment was measured on July 11, 2011. Plant density data were also collected on June 14, 2012, June 20, 2013 and June 27, 2014. Seeded crested wheatgrass plots were not evaluated in 2014, as it had become too difficult to discern target plants from volunteers.

Densities of volunteer crested wheatgrass (*Agropyron cristatum*) and annual bromes (*Bromus* spp.) were evaluated in the test plots with frequency grids on August 13, 2012 and June 27, 2014. One density frame was evaluated for each accession in the center of the plots of replications 1 and 3. These data will be used to track long term persistence and competition of introduced perennial and annual grasses among the seeded species.

Establishment and performance of the cover crop seeding mixture was evaluated on August 14, 2012 and June 20, 2013. Eight density frames (two on each side of the planting) were evaluated. Cover class frequency data was also recorded on August 14, 2012 using a 60 meter (200 ft) line-intercept transect on each side of the planting.

### *Forage Production*

On June 26, 2013, biomass clippings were taken from all accessions with densities greater than 5.4 plants/m<sup>2</sup> (0.5 plants/ft<sup>2</sup>). Five representative plants were clipped from plots in each replication. The plants were air dried for 10 days and then weighed. Plant density values were then used to calculate lbs/acre (table 8).

## Table 1. Species and accessions

### Bluebunch wheatgrass (*Pseudoroegneria spicata*)

- Anatone
- Goldar
- P-7
- P-33

### Snake River wheatgrass (*Elymus wawawaiensis*)

- Secar
- Discovery

### Western wheatgrass (*Pascopyrum smithii*)

- Recovery
- Rosana
- Arriba

### Slender wheatgrass (*Elymus trachycaulus*)

- First Strike
- Pryor

### Basin wildrye (*Leymus cinereus*)

- Washoe
- Magnar
- Trailhead
- Continental

### Bluegrass (*Poa* spp.)

- Sherman big bluegrass
- Opportunity Nevada bluegrass
- Mt. Home Sandberg bluegrass
- High Plains Sandberg bluegrass
- Reliable Sandberg bluegrass

### Green needlegrass (*Nassella viridula*)

- Cucharas

### Fescue (*Festuca* spp.)

- 9076469 Idaho fescue
- Covar sheep fescue
- Durar hard fescue

### Streambank/Thickspike wheatgrass (*Elymus lanceolatus*)

- Sodar
- Bannock
- Critana

### Squirreltail (*Elymus elymoides* and *E. multisetus*)

- Fish Creek bottlebrush squirreltail
- Sand Hollow big squirreltail
- Toe Jam Creek bottlebrush squirreltail
- Wapiti bottlebrush squirreltail
- 9019219 bottlebrush squirreltail
- 9092275 bottlebrush squirreltail

### Forbs

- Maple Grove Lewis flax (*Linum lewisii*)
- Appar blue flax (*Linum perenne*)
- Richfield firecracker penstemon (*Penstemon eatonii*)
- Great Northern western yarrow (*Achillea millefolium*)
- Antelope prairie clover (*Dalea candida*)
- Silverleaf phacelia (*Phacelia hastata*)
- 9076577 Douglas' dustymaiden (*Chaenactis douglasii*)
- NBR-1 basalt milkvetch (*Astragalus filipes*)
- Don falcata alfalfa (*Medicago sativa* ssp. *falcata*)
- Timp northern (Utah) sweetvetch (*Hedysarum boreale*)
- Delar small burnet (*Sanguisorba minor*)
- Sainfoin (*Onobrychis viciifolia*)
- Lutana cicer milkvetch (*Astragalus cicer*)
- Stillwater prairie coneflower (*Ratibida columnifera*)

### Shrubs

- Bonneville big sagebrush (*Artemisia tridentata* subsp. *X bonnevillensis*)
- Snake River Plains fourwing saltbush (*Atriplex canescens*)
- Wytana fourwing saltbush (*A. canescens*)
- Northern Cold Desert winterfat (*Krascheninnikovia lanata*)

### Altai wildrye (*Leymus angustus*)

- Mustang

### Crested wheatgrass (*Agropyron cristatum*)

- Ephraim
- Hycrest
- Hycrest II
- Nordan

### Russian wildrye (*Psathrostachys juncea*)

- Bozoisky Select
- Bozoisky II

### Siberian wheatgrass (*Agropyron fragile*)

- Vavilov
- Vavilov II

### Meadow brome (*Bromus biebersteinii*)

- Regar
- Cache

## RESULTS AND DISCUSSION

2011

Establishment densities ranged from essentially zero plants to 13 plants/m<sup>2</sup> in 2011 (Table 4). Eight out of the top ten species to establish were introduced grasses, four of which were crested wheatgrass accessions. The highest ranking native grasses were Fish Creek bottlebrush squirreltail and Pryor slender wheatgrass, both of which are short-lived perennials commonly used as a nurse crop with longer lived species in a seed mixture. In general, forbs had moderate establishment success, while the shrub accessions, with the exception of Bonneville big sagebrush, had low establishment numbers during the first year of evaluation.

Native grasses had a broad range of establishment densities (Table 5) ranging from 0.2 plants/m<sup>2</sup> for Sand Hollow Germplasm big squirreltail (*Elymus multisetus*) to 11.6 plants/m<sup>2</sup> for Fish Creek Germplasm bottlebrush squirreltail (*E. elymoides*) in 2011. Introduced grasses all had excellent establishment (Table 6). The lowest plant density recorded was 6.7 plants/m<sup>2</sup> from Bozoisky Russian wildrye. Cache meadow brome had the highest density with 13.0 plants/m<sup>2</sup>. Forbs (Table 7) generally had lower establishment numbers than the grasses; however good stands were observed in many plots. All shrub species had low initial establishment (Table 8). No significant differences were detected between means.

2012

Despite drought conditions in 2012, plant densities of native grasses did not generally show dramatic decreases. Slender wheatgrass and squirreltail accessions, known to be short lived perennials, decreased or maintained 2011 densities. Bluebunch wheatgrass densities stayed essentially the same as 2011, with the exception of Anatone which increased in density from 7.6 to 9.5 plants/m<sup>2</sup>. The rhizomatous grass species western wheatgrass, thickspike wheatgrass, and streambank wheatgrass all increased in density from 2011 to 2012.

Introduced grass species accessions either increased or decreased in densities from 2011 to 2012. The highest densities were obtained by Hycrest II, Ephraim, and Hycrest crested wheatgrass with 14.1, 12.5 and 11.7 plants/m<sup>2</sup> respectively. However these numbers may be inflated due to volunteering from the existing soil seed bank. Cache and Regar meadow brome both decreased under drought stress although Cache maintained a good stand with 10.7 plants/m<sup>2</sup>. Vavilov II Siberian wheatgrass maintained approximately 7 plants/m<sup>2</sup> while Vavilov decreased from 9.6 plants/m<sup>2</sup> to 4.2 plants/m<sup>2</sup>.

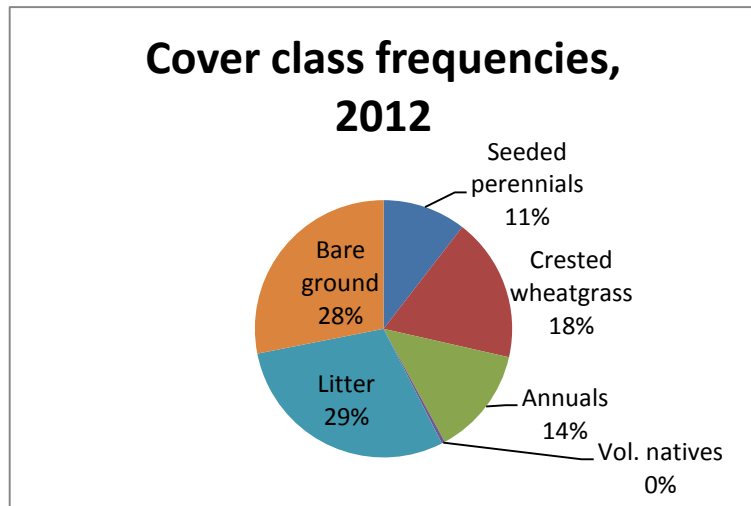
Forb densities declined significantly from 2011 to 2012 with many accessions being nearly eliminated from the plots. Don falcate alfalfa and Appar blue flax (both introduced species) maintained the best stands with 3.3 and 3.2 plants/m<sup>2</sup> respectively.

Among the shrub entries, Bonneville big sagebrush and Snake River Plains fourwing saltbush had fair stands with 2.0 and 0.7 plants/m<sup>2</sup> respectively.

Densities of volunteer crested wheatgrass and annual bromes are listed in tables 5-8. These data will be used to track persistence and expansion of introduced species over time. The average density of crested wheatgrass and annuals bromes throughout all of the evaluated plots in 2012

was 7.0 plants/m<sup>2</sup> and 5.7 plants/m<sup>2</sup> respectively. No relationship between target species density and density of crested wheatgrass or annual bromes was discernable during 2012.

In the cover crop areas surrounding the test plots, seeded perennials made up 11% of the cover (6% bluebunch wheatgrass, 2% big bluegrass, 2% thickspike wheatgrass, and 1% blue flax) during 2012. Other seeded cover crop species were observed but not recorded in the line-intercept transects. Bare ground and litter made up the majority of the cover classes with 28 and 29% respectively. Volunteer crested wheatgrass accounted for 18% of the total cover. Annual grasses, including bulbous bluegrass (*Poa bulbosa*), cheatgrass (*Bromus tectorum*) and an unidentified annual brome comprised 14% of the ground cover. Incidental volunteer native forbs including tapertip hawksbeard (*Crepis acuminata*) and lesser rushy milkvetch (*Astragalus convallarius*) made up less than 1% of the total cover. Plant density measurements for the cover crop are provided in table 3.



**Table 2. Dry forage biomass yields from the entries with the top 15 plant density values in 2013.**

	June 26, 2013
	---(lbs/acre)---
Hycrest II	2,400 a
Vavilov II	1,480 b
Hycrest	1,480 b
Bozoisky II	1,280 b-c
Nordan	1,040 b-d
Bozoisky Select	1,020 b-d
Ephraim	940 c-d
Cache	560 d-e
Bannock	440 e
P-7	420 e
Anatone	400 e
Discovery	340 e
Fish Creek	300 e
Rosana	260 e
Arriba	120 e
LSD (0.05)	500

2013

Seven of the top ten recorded densities in 2013 were from introduced grasses. Crested wheatgrass and Russian wildrye varieties appear well-adapted to the site conditions. Most introduced grasses decreased slightly but seem to be well-established. The Russian wildrye

accessions, however, both increased in density from 2012 to 2013. This species is known to take time for establishment and increases over the first few years are expected.

Several native grasses appeared to be holding at acceptable densities. Fish Creek bottlebrush squirreltail continued to look good and had the highest plant density for native species followed by Rosana western wheatgrass and Anatone bluebunch wheatgrass. Short-lived perennials such as slender wheatgrass are steadily decreasing and giving way to longer lived species as would be expected. Rhizomatous perennials such as western wheatgrass and thickspike/streambank wheatgrass are increasing in density as plants spread.

Forbs continued to show low plant densities in general. Appar blue flax had the best density with 3.0 plants/m<sup>2</sup> in 2013, but due to high variability was not statistically different from other accessions.

In 2013 Bonneville big sagebrush had significantly greater plant density than all other shrubs with an average density of 2.9 plants/m<sup>2</sup>, nearly five times the density of the next best shrub accession.

In total, eight introduced and seven native grasses had densities over 5.4 plants/m<sup>2</sup> (0.5 plants/ft<sup>2</sup>) and were clipped and weighed for forage yield (Table 2). The introduced grasses all had higher forage yields than the native grasses. Hycrest II crested wheatgrass had significantly greater forage produced than all other accessions with an average of 2,400 lbs/acre. In contrast, Bannock thickspike wheatgrass had the best forage yields among the native accessions with 440 lbs/acre.

The native seed mixture that was applied to the areas surrounding the test site was evaluated in 2011 and 2013. Crested wheatgrass densities decreased from 9.9 to 5.1 plants/m<sup>2</sup> between 2011 and 2013 (Table 3). Similarly, annual bromes decreased from 9.3 to 1.1 plants/m<sup>2</sup> in the same time period. Bulbous bluegrass densities remained essentially unchanged. Many of the seeded natives also showed decreases in density from 2011 to 2013; however two forbs, western yarrow and Lewis flax, both increased. Overall totals showed a large decrease in volunteer species from 2011 to 2013 (23.1 plants/m to 9.8 plants/m<sup>2</sup>). Seeded natives exhibited a much less dramatic decrease from 10.0 to 6.4 plants/m<sup>2</sup>.

**Table 3. Species densities (plants/m<sup>2</sup>) found in the seed mixture<sup>1</sup> planted area adjacent to the demonstration plots.**

	Density <sup>2</sup>	
	July 11, 2011	June 20, 2013
Volunteer species	----- (plants/m <sup>2</sup> )-----	
Crested wheatgrass	9.9	5.1
Cheatgrass	9.3	1.1
Bulbous bluegrass	3.4	3.6
Bonneville big sagebrush	0.5	0.0
Total	23.1	9.8
Seeded species		
Bluebunch wheatgrass	5.3	2.6
Big bluegrass	2.5	1.4
Thickspike wheatgrass	2.0	1.1
Western yarrow	0.1	0.9
Douglas' dustymaiden	0.1	0.0
Lewis flax	0.0	0.4
Total	10.0	6.4

<sup>1</sup> Seeding mix included: 40% Anatone bluebunch wheatgrass, 20% Sherman big bluegrass, 15% Bannock thickspike wheatgrass, 10 percent Magnar basin wildrye, 5% Maple Grove Lewis flax, 5% Richfield firecracker penstemon, 5% Great Northern western yarrow, and 0.25 lbs/ac Snake River Plains fourwing saltbush.

<sup>2</sup> Not analyzed for statistical significance

## 2014

Fish creek bottlebrush squirreltail had highest plant density with 10.4 plants/m<sup>2</sup>; significantly greater than all other entries with the exception of Bozoisky II. Other native species accessions in the top ten densities included Discovery Snake River wheatgrass (6.1 plants/m<sup>2</sup>), Sodar streambank wheatgrass (5.8 plants/m<sup>2</sup>), Toe Jam Creek bottlebrush squirreltail (5.6 plants/m<sup>2</sup>), and Rosanna western wheatgrass (3.9 plants/m<sup>2</sup>). Almost all entries in the trial decreased in density from 2013 to 2014. Exceptions include two bottlebrush squirreltail accessions (Fish Creek and Toe Jam Creek), Discovery Snake River wheatgrass, and two sod-forming grasses (Sodar Streambank wheatgrass and Critana thickspike wheatgrass), which are expected to spread via rhizomes. Introduced cultivars of Russian wildrye and Siberian wildrye all scored in the top ten densities. Cache meadow brome continued to decline in density from 6.8 to 3.9 plants/m<sup>2</sup>, but was still in the top ten.

Bonneville sagebrush again had significantly greater establishment density than all other shrub accessions ( $p=0.02$ ). With a plant density of 2.9 plants/m it had not changed since 2013. Though not measured for statistical significance, Bonneville sagebrush plots had the lowest densities of annual bromes, approximately one-third as many plants/m as the remaining shrub entries. Densities of crested wheatgrass however, appeared to be comparable among the shrub plantings.

Forb densities were low with no significant differences detected. Maple Grove Lewis flax had the highest plant density with 0.8 plants/m<sup>2</sup>. Six other accessions were observed with at least one plant in the evaluated frames: Appar blue flax, Timp northern sweetvetch, Great Northern yarrow, Delar small burnet, sainfoin and NBR-1 basalt milkvetch. Several entries had zero plants/m<sup>2</sup>: Antelope prairie clover, Douglas' dustymaiden, Don alfalfa, Lutana vetch, Phacelia, Richfield firecracker penstemon, and Stillwater prairie coneflower.



Significant differences in crested wheatgrass were detected when all species were compared, ( $p=0.01$ ). In general, more established target species resulted in fewer crested wheatgrass plants/m. No significant differences were detected in annual brome establishment regardless of target species densities ( $p=0.09$ ). However, six of the top ten target densities scored in the bottom ten annual brome densities.

**Table 4. Plant density (plants/m<sup>2</sup>) for all entries from 2011-2014.**

Accession	Density				Accession (cont.)	Density			
	July 11, 2011	June 14, 2012	June 20, 2013	June 27, 2014		July 11, 2011	June 14, 2012	June 20, 2013	June 27, 2014
	----- (plants/m <sup>2</sup> )-----					----- (plants/m <sup>2</sup> )-----			
Cache	13.0 a	10.7 a-d	6.8 a-f	3.9 c-h	Recovery	4.3 h-q	5.8 e-n	4.5 e-l	1.7 h-l
Hycrest II	12.1 a-b	14.1 a	9.9 a	--	NBR-1	4.0 i-q	0.0 q	0.5 o-p	0.1 l
Fish Creek	11.6 a-c	9.1 b-f	9.8 a	10.4 a	Durar	3.9 i-q	5.5 e-o	3.2 g-p	1.0 h-l
Nordan	11.6 a-c	8.7 b-g	6.5 a-g	--	9076469	3.8 i-q	2.9 i-q	0.1 p	0.0 l
Pryor	11.5 a-d	2.0 k-q	0.1 p	0.0 l	Bannock	3.6 j-q	6.5 d-k	6.1 b-h	3.1 d-l
Ephraim	11.1 a-e	12.5 a-b	9.7 a	--	Opportunity	3.5 j-q	4.4 f-q	0.3 o-p	0.1 l
Vavilov	9.6 a-f	4.2 g-q	4.7 d-k	6.7 b-c	Washoe	3.5 j-q	0.7 p-q	0.5 o-p	0.3 k-l
Bozoisky II	9.5 a-g	9.0 b-f	9.9 a	7.3 a-b	Phacelia	3.3 k-q	0.7 p-q	0.1 p	0.0 l
Hycrest	9.0 a-h	11.7 a-c	8.1 a-d	--	Secar	3.3 k-q	4.9 e-p	3.3 g-p	3.4 d-k
Covar	8.5 a-i	8.9 b-g	2.1 i-p	1.3 h-l	9019219	3.1 k-q	2.6 j-q	1.8 j-p	0.8 h-l
Delar	8.1 b-j	1.2 n-q	1.2 l-p	0.2 l	Sherman	3.1 k-q	4.2 g-q	1.7 j-p	1.1 h-l
Maple Grove	8.1 b-j	1.3 n-q	1.1 l-p	0.8 h-l	Trailhead	3.1 k-q	2.5 j-q	2.9 h-p	2.5 f-l
Anatone	7.6 b-k	9.5 a-e	6.9 a-f	3.8 c-j	Continental	2.4 l-q	1.8 l-q	2.8 h-p	2.5 f-l
Don	7.6 b-k	3.3 h-q	1.7 j-p	0.0 l	High Plains	2.4 l-q	2.5 j-q	3.2 g-p	2.6 f-l
Timp	7.6 b-k	0.6 p-q	1.2 l-p	0.4 k-l	9092275	2.3 l-q	0.9 o-q	0.1 p	0.0 l
Regar	7.5 b-k	4.5 f-q	2.5 i-p	0.3 k-l	Magnar	2.3 l-q	0.5 p-q	1.1 l-p	0.4 k-l
Vavilov II	7.5 b-k	7.7 c-h	9.1 a-b	5.1 b-g	Bonneville sage	1.5 m-q	2.0 k-q	2.9 h-p	2.9 d-l
Appar	7.0 c-l	3.2 h-q	3.0 h-p	0.5 k-l	Great Northern	1.5 n-q	0.9 o-q	0.9 m-p	0.3 k-l
Mustang	6.8 d-l	2.5 j-q	2.5 i-p	1.9 g-l	Richfield	1.5 n-q	0.4 p-q	0.5 o-p	0.0 l
Bozoisky	6.7 e-l	5.7 e-n	7.5 a-e	6.7 b-c	Wapiti	1.3 o-q	0.1 q	0.1 p	0.0 l
Sodar	6.7 e-l	7.4 c-i	3.9 f-n	5.8 b-e	Lutana	1.2 o-q	0.1 q	0.1 p	0.0 l
Critana	6.6 e-l	6.4 d-l	3.7 f-o	3.9 c-i	Stillwater	1.1 p-q	0.1 q	0.0 p	0.0 l
First Strike	6.3 f-m	2.0 k-q	0.6 n-p	0.0 l	Cucharas	0.9 q	0.5 p-q	0.2 p	0.9 h-l
P-7	6.2 f-n	6.7 d-j	5.5 c-i	2.7 e-l	Mt. Home	0.9 q	1.0 o-q	1.9 j-p	1.6 h-l
Sainfoin	5.9 f-o	0.5 p-q	0.7 n-p	0.2 l	Reliable	0.7 q	1.3 n-q	1.5 k-p	1.2 h-l
P-33	5.8 f-p	4.5 f-q	4.3 e-m	2.9 d-l	Snake River Plains	0.5 q	0.5 p-q	0.6 n-p	0.7 j-l
Goldar	4.7 g-q	6.1 d-m	2.7 i-p	1.2 h-l	Wytana	0.3 q	0.1 q	0.3 o-p	0.7 j-l
Rosana	4.5 h-q	8.2 b-g	8.7 a-c	3.9 c-h	Sand Hollow	0.2 q	0.0 q	0.0 p	0.1 l
Toe Jam	4.5 h-q	5.7 e-n	5.1 d-j	5.6 b-f	Antelope	0.1 q	0.0 q	0.0 p	0.0 l
Dustymaiden	4.4 h-q	1.7 l-q	0.3 o-p	0.0 l	NCD Winterfat	0.1 q	0.1 q	0.0 p	0.0 l
Discovery	4.4 h-q	5.5 e-o	5.4 c-i	6.1 b-d					
Arriba	4.3 h-q	8.7 b-g	5.5 c-i	3.8 c-j					
LSD (0.05)	4.8	4.7	3.5	3.1					

**Table 5. Plant density (plants/m<sup>2</sup>) for native grasses, volunteer crested wheatgrass and introduced annual bromes from 2011-2014.**

Accession	Target Species Density				Crested Wheatgrass Density <sup>1</sup>		Annual Brome Density <sup>1</sup>	
	July 11, 2011	June 14, 2012	June 20, 2013	June 27, 2014	August 13, 2012	June 27, 2014	August 13, 2012	June 27, 2014
	----- (plants/m <sup>2</sup> )-----				----- (plants/m <sup>2</sup> )-----		----- (plants/m <sup>2</sup> )-----	
Fish Creek	11.6 a	9.1 a	9.8 a	10.4 a	4	3.9	5.5	5.4
Pryor	11.5 a	2.0 c-h	0.1 j-k	0.0 d	2.5	8.1	3	12.9
Anatone	7.6 a-c	9.5 a	6.9 a-c	3.8 b-c	6	5.1	3.5	8.9
Sodar	6.7 a-d	7.4 a-c	3.9 c-i	5.8 b	7.5	6.5	2	11.3
Critana	6.6 a-d	6.4 a-e	3.7 c-j	3.9 b-c	5.5	4.6	9.5	9.9
First Strike	6.3 a-e	2.0 c-h	0.6 i-k	0.0 d	10.5	6.7	4.5	9.4
P-7	6.2 a-f	6.7 a-d	5.5 b-e	2.7 b-d	7	4.9	6.5	9.4
P-33	5.8 b-f	4.5 a-h	4.3 c-h	2.9 b-d	9.5	6.5	7.5	11.9
Goldar	5.7 b-g	6.1 a-f	2.7 d-k	1.2 c-d	11	7.9	4	11.3
Rosana	4.5 b-g	8.2 a-b	8.7 a-b	3.9 b-c	6.5	5.4	4	8.5
Toe Jam Creek	4.5 b-g	5.7 a-h	5.1 c-g	5.6 b	5	5.1	4.5	7.3
Discovery	4.4 b-g	5.5 a-h	5.4 b-f	6.1 b	7.5	6.1	2	10.5
Arriba	4.3 b-g	8.7 a	5.5 b-e	3.8 b-c	7	4.8	1	12.2
Recovery	4.3 b-g	5.8 a-g	4.5 c-h	1.7 c-d	5	5.7	4	10.0
9076469	3.8 b-g	2.9 b-h	0.1 k	0.0 d	9	6.2	8.5	12.2
Bannock	3.6 b-g	6.5 a-e	6.1 b-d	3.1 b-d	10	6.7	5	10.9
Opportunity	3.5 b-g	4.4 a-h	0.3 j-k	0.1 d	3.5	7.8	8.5	6.2
Secar	3.3 b-g	4.9 a-h	3.3 c-k	3.4 b-d	4.5	5.1	11	12.6
Sherman	3.1 b-g	4.2 a-h	1.7 g-k	1.1 c-d	8.5	6.9	2	10.5
9019219	3.1 b-g	2.6 b-h	1.8 g-k	0.8 c-d	6.5	5.9	10.5	12.3
High Plains	2.4 c-g	2.5 b-h	3.2 d-k	2.6 b-d	11.5	9.1	3	10.0
9092275	2.3 c-g	0.9 e-h	0.1 j-k	0.0 d	9	7.9	7	10.0
Wapiti	1.3 d-g	0.1 g-h	0.1 k	0.0 d	7	5.9	7.5	12.3
Cucharas	0.9 e-g	0.5 f-h	0.2 j-k	0.9 c-d	7.5	6.4	3	10.2
Mountain Home	0.9 e-g	1.0 d-h	1.9 f-k	1.6 c-d	6	5.1	11	13.8
Reliable	0.7 f-g	1.3 d-h	1.5 g-k	1.2 c-d	7	5.6	1.5	5.8
Sand Hollow	0.2 g	0.0 h	0.0 k	0.1 d	4.5	5.8	12.5	15.2
LSD (0.05)	5.5	5.7	3.5	3.6				

<sup>1</sup> Not analyzed for statistical significance

**Table 6. Plant density (plants/m<sup>2</sup>) for introduced grasses, volunteer crested wheatgrass and introduced annual bromes from 2011-2014.**

Accession	Target Species Density				Crested Wheatgrass Density <sup>1</sup>		Annual Brome Density <sup>1</sup>	
	July 11, 2011	June 14, 2012	June 20, 2013	June 27, 2014	August 13, 2012	June 27, 2014	August 13, 2012	June 27, 2014
	----- (plants/m <sup>2</sup> )-----				---- (plants/m <sup>2</sup> )----		---- (plants/m <sup>2</sup> )----	
Cache	13.0 a	10.7 a-c	6.8 a-c	3.9 a-c	2.5	4.1	2.5	6.3
Hycrest II	12.1 a-b	14.1 a	9.9 a	--	NA	--	5.5	--
Nordan	11.6 a-c	8.7 a-d	6.5 a-c	--	NA	--	2.5	--
Ephraim	11.1 a-c	12.5 a-b	9.7 a	--	NA	--	6.5	--
Vavilov	9.6 a-c	4.2 d-e	4.5 b-c	6.7 a-b	0.5	3.5	2.5	5.1
Bozoisky II	9.5 a-c	9.0 a-d	9.9 a	7.3 a	2	1.3	3	2.0
Hycrest	9.0 a-c	11.7 a-b	8.1 a-b	--	NA	--	14	--
Covar	8.5 a-c	8.9 a-d	2.1 c	1.3 b-c	10	7.8	3	7.9
Regar	7.5 b-c	4.5 d-e	2.5 c	0.3 c	3.5	6.8	1.5	6.3
Vavilov II	7.5 b-c	7.7 b-e	9.1 a-b	5.1 a-c	NA	2.4	3	5.7
Mustang	6.8 c	2.5 e	2.5 c	1.9 b-c	8.5	4.7	4	11.2
Bozoisky	6.7 c	5.7 c-e	7.5 a-b	6.7 a-b	6.5	3.3	2	4.2
Durar	3.9 c	5.5 c-e	3.2 b-c	1.0 b-c	7	5.9	4	8.3
LSD (0.05)	5.0	5.7	4.8	5.1				

<sup>1</sup> Not analyzed for statistical significance

**Table 7. Plant density (plants/m<sup>2</sup>) for all forbs, volunteer crested wheatgrass and introduced annual bromes from 2011-2014.**

Accession	Target Species Density				Crested Wheatgrass Density <sup>1</sup>		Annual Brome Density <sup>1</sup>	
	July 11, 2011	June 14, 2012	June 20, 2013	June 27, 2014	August 13, 2012	June 27, 2014	August 13, 2012	June 27, 2014
	----- (plants/m <sup>2</sup> )-----				----- (plants/m <sup>2</sup> )-----		----- (plants/m <sup>2</sup> )-----	
Delar	8.1 a	1.2	1.2	0.2	2	6.1	10.5	10.5
Maple Grove	8.1 a	1.3	1.1	0.8	5.5	4.1	12	17.9
Don	7.6 a-b	3.3	1.7	0.0	7.5	6.1	2	12.1
Timp	7.6 a-b	0.6	1.2	0.4	9.5	8.3	11	11.0
Appar	7.0 a-c	3.2	3.0	0.5	5	4.1	15	14.3
Sainfoin	5.9 a-d	0.5	0.7	0.2	10	8.1	12	7.5
Douglas' dustymaiden	4.4 b-e	1.7	0.3	0.0	6	10.2	1	9.0
NBR-1	4.0 c-e	0.0	0.5	0.1	10.5	7.2	2	12.5
Phacelia	3.3 d-f	0.7	0.1	0.0	10.5	7.3	4.5	8.5
Great Northern	1.5 e-f	0.9	0.9	0.3	7	5.5	8	16.6
Richfield	1.5 e-f	0.4	0.5	0.0	5	3.5	10.5	12.5
Lutana	1.2 e-f	0.1	0.1	0.0	3	5.1	14.5	12.1
Stillwater	1.1 e-f	0.1	0.0	0.0	7	4.8	3	12.4
Antelope	0.1 f	0.0	0.0	0.0	10	8.3	5	5.8
LSD (0.05)	3.4	N/A	N/A	N/A				

<sup>1</sup> Not analyzed for statistical significance**Table 8. Plant density (plants/m<sup>2</sup>) for shrubs, volunteer crested wheatgrass and introduced annual bromes from 2011-2014.**

Accession	Target Species Density				Crested Wheatgrass Density <sup>1</sup>		Annual Brome Density <sup>1</sup>	
	July 11, 2011	June 14, 2012	June 20, 2013	June 27, 2014	August 13, 2012	June 27, 2014	August 13, 2012	June 27, 2014
	----- (plants/m <sup>2</sup> )-----				----- (plants/m <sup>2</sup> )-----		----- (plants/m <sup>2</sup> )-----	
Bonneville big sagebrush	1.5	2.0	2.9 a	2.9 a	8.5	5.9	1.5	3.9
Snake River Plains	0.5	0.7	0.6 b	0.1 b	6.5	4.7	4.5	10.6
Wytana	0.3	0.1	0.3 b	0.7 b	5.5	7.1	6.5	11.6
Northern Cold Desert	0.1	0.1	0.0 b	0.0 b	10	6.4	1.5	10.5
LSD (0.05)	N/A	N/A	1.4	1.5				

<sup>1</sup> Not analyzed for statistical significance

## CONCLUSION

High densities of volunteer crested wheatgrass at the Curlew seeding are noteworthy. A second year of chemical fallow prior to planting the test accessions to control crested wheatgrass and annual weeds may have significantly reduced competition and led to a more complete plant community conversion. However, deferring planting until the fall of 2011 may have resulted in decreased germination rates of seeded species due to inadequate moisture during the establishment period.

Introduced bunchgrasses have shown excellent establishment and persistence, but should only be recommended in highly-disturbed, critical area plantings.

Most native species did not perform as well as their introduced counterparts, but several grasses have performed well enough to be recommended. Fish Creek and Toe Jam Creek bottlebrush squirreltail both appear to be well-adapted to site conditions on Curlew National Grassland. Bottlebrush squirreltail is a short-lived, early-seral species which can be used in seeding mixtures to capture a site and allow slower growing species to establish. It should not be planted as a single species or as a large component of a seed mixture as the plants are expected to decrease over time. Other natives with fair performance include accessions of several bunchgrasses and rhizomatous sod-forming grasses.

Forbs have done poorly with low establishment and very little persistence with all forb species averaging less than 1 plant/m<sup>2</sup> in 2014. Locally collected Bonneville big sagebrush had excellent establishment and persistence and should be the most broadly recommended shrub. Other shrub species have fared poorly in this trial.

This progress report documents data from the first four growing seasons at the Curlew off-center evaluation. The site will be excluded from grazing and evaluated again in 2019.

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Fence

Anatone	9076469	Timp	Rosanna	Critana	Secar	Stillwater	Don	Magnar
Goldar	Covar	Delar	Antelope	Cucharas	Wapiti	NBR-1	Maple Grove	Hycrest
P-7	Sodar	Sainfoin	Sand Hollow	Don	Wytana	Sherman	Rosanna	Timp
P-33	Bannock	Lutana	N. C. Desert	Washoe	MACA	Antelope	Great Northern	Bozoisky Sel.
Secar	Critana	MACA	Pryor	Maple Grove	Magnar	High Plains	Secar	Sand Hollow
Discovery	Fish Creek	Stillwater	CHDO	Great Northern	Nordan	9076469	9019219	Wapiti
Recovery	Sand Hollow	WY big sage	Sherman	Anatone	Arriba	Sainfoin 2 bu	Mt. Home	P-7
Rosanna	Toe Jam	S. R. Plains	NBR-1	Trailhead	Durar	First Strike	Critana	S. R. Plains
Arriba	Wapiti	N. C. Desert	Reliable	Timp	Opportunity	Mustang 2 bu	Sodar	Pryor
First Strike	9019219	Wytana	Hycrest	Appar	Sainfoin	Goldar	Phacelia	Cucharas
Pryor	9092275	Mustang	P-33	9019219	P-7	Ephraim	Trailhead	Wytana
Washoe	Maple Grove	Ephraim	Sodar	Recovery	Covar	Bannock	Toe Jam	WY big sage
Magnar	Appar	Hycrest	Mustang	Phacelia	Bozoisky II	Appar	P-33	Discovery
Trailhead	Richfield	Hycrest II	High Plains	Mt. Home	Stillwater	Continental 2 bu	Opportunity	Vavilov
Continental	Great Northern	Nordan	Vavilov	WY big sage	Fish Creek	Hycrest II	Delar 2 bu	Lutana
Sherman	Durar	Bozoisky Sel.	9092275	First Strike	Bozoisky Sel.	Recovery	Anatone	Reliable
Opportunity	Antelope	Bozoisky II	Delar	Ephraim	Cache	Cache	Bozoisky II	Regar
Mt. Home	Phacelia	Vavilov	Discovery	9076469	Goldar	9092275	Richfield	Durar
High Plains	CHDO	Vavilov II	Richfield	Regar	S. R. Plains	N. C. Desert	Covar	CHDO
Reliable	NBR-1	Regar	Lutana	Toe Jam	Vavilov II	Vavilov II	Fish Creek	Arriba
Cucharas	Don	Cache	Bannock	Hycrest II	Continental	Washoe	MACA 2 bu	Nordan

Rep. 3

Rep. 2

Rep. 1

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