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PLANT MATERIALS TECHNICAL NOTE

STUCKY RIDGE COMPARATIVE EVALUATION PLANTING
ABSTRACT

The Development of Acid/Heavy-Metal Tolerant Releases (DATR) project began in 1995 with the goal of determining if native, indigenous plant materials collected from areas impacted by historic mining and smelting activities in the Upper Clark Fork River watershed, were better adapted than non-local seed sources for restoring native plant communities in the Anaconda area. In May 2003, the Stucky Ridge Comparative Evaluation Planting (CEP) was established to compare the performance of indigenous versus non-local plant materials, and to test four different seed mixtures for survival and establishment success. Superior local collections were to be increased and released for commercial production. The study is located in Deer Lodge County two miles northeast of Anaconda, Montana, on a stream terrace above Lost Creek, at an elevation of 5,308 feet.

At the deep-plowed, lime-amended, and fertilized site, the performance of 36 grass accessions representing 9 grass genera, 14 forb accessions representing 5 forb genera, 2 sub-shrub accessions representing 1 sub-shrub species, and 4 seed mixtures representing 2 seed mixture formulations were planted and evaluated. The study was arranged as three separate trials (grass, forb/subshrub, and seed mixture) each in a Randomized Complete Block Design replicated four times.

Although high site variability sometimes appeared to contribute to a lack of statistical separation of indigenous versus non-local seed sources, some differences in the 2008 data (last year of evaluation) did emerge. Copperhead Germplasm slender wheatgrass and accession 9081621 (another local collection) had statistically better vigor than ‘Pryor’, ‘Revenue’, and ‘San Luis’. Similarly, Copperhead was significantly better than Revenue and San Luis for percentage stand, and Copperhead had the highest, overall mean percentage stand of the slender wheatgrasses tested. Opportunity Germplasm Nevada bluegrass was significantly taller than ‘Canbar’, and had the highest overall mean height of the bluegrasses tested. Opportunity had significantly greater biomass, and the highest overall mean biomass of the bluegrasses tested. Opportunity had significantly better percentage stand than ’Sherman’, Canbar, and 9081322 (Lewis and Clark County, MT), and had the highest overall mean percentage stand of all bluegrasses tested. In several cases, when statistical differences could not be made, mean performance of the local ecotypes was greater than or equal to non-local materials. Superior performing indigenous species, in terms of mean performance alone, included the forbs 9081632 silverleaf phacelia, *Phacelia hastata*, and Old Works Germplasm fuzzytongue penstemon, *Penstemon eriantherus.*

The species that performed well in the reclaiming of the Anaconda Smelter site have also be used to reclaim other critically disturbed areas. Farmers in the area use several of the same species in their field plantings.

The Developed Waste Management Area (WMA) mix had the greatest seedling density in the seed mix trials during the establishment year. By fall of the second year, the stands of all the mixes had increased, but the Experimental mixes were still significantly better than the Developed mixes. The Experimental mixes were dominated by Copperhead Germplasm slender wheatgrass, while the Developed mixes were dominated by ‘Revenue’ slender wheatgrass and

'Critana' thickspike wheatgrass, *Elymus lanceolatus*. The Waste Management Experimental mix exceeded all mixes in biomass production.

I. INTRODUCTION

Challenges incurred during reclamation efforts at the Anaconda Smelter Superfund Site, in southwestern Montana, are typical of the challenges associated with other hardrock mines throughout the west. Hardrock minelands pose problems for revegetation, primarily: steep slopes; unfertile soil media (low cation exchange capacity, low water-holding capacity, low organic matter); extreme moisture, temperature, and wind fluctuations; acidic soils; and heavy metal contamination. To accelerate rehabilitation, proper plant selection on these harsh sites is crucial. Current reclamation efforts to revegetate abandoned mine sites rely primarily on commercial seed sources as opposed to locally adapted or indigenous native seed collections.

Although the Surface Mining Control and Reclamation Act of 1977 allows the use of introduced species, State and Federal regulatory agencies, recognizing the importance of adaptation and biological diversity, frequently require the re-establishment of a permanent vegetative cover using the same species native to the area (Roundy et al., 1997). Scientists emphasize it is crucial to select indigenous native plant species since they are evolutionary products of that specific environment and presumably the best adapted. Native indigenous species have a long history of genetic sorting and natural selection by the local environment. Over the long-term, these plants are often better able to survive, grow, and reproduce under the environmental extremes of the local area than introduced plants originating in other environments (Brown, 1997; Munshower, 1994). For this reason, when statistical analyses of plant performance did not show a significant difference between accessions of a plant species, the recommendation was to use the native indigenous species.

The utilization of tolerant species, even on amended sites, is recommended because the subsoil is often a major portion of the root zone materials. Species exhibiting acid/heavy metal tolerances may also reduce the need for lime. These tolerant species could survive in areas where there was poor mixing of amendments with the acidic wastes.

To address the lack of well-adapted, local seed, the Development of Acid/Heavy Metal-Tolerant Cultivars Project was initiated in 1995 with the purpose of collecting, testing, and selecting seed sources of plants (ecotypes) found growing naturally on impacted sites in the Anaconda area. The theory was that these seed sources are inherently adapted to the harsh edaphic and climatic conditions characteristic of the Anaconda area, and possibly other hardrock minelands in western Montana. The goal was to release superior selections of plants to the commercial seed market for production.

In May 2003, the Stucky Ridge Comparative Evaluation Planting (CEP) plot was established to test four different seed mixtures for survival and establishment success. The study is located in Deer Lodge County two miles northeast of Anaconda, Montana, on a stream terrace above Lost Creek, at an elevation of 5,308 feet, and covers most of the relatively flat ground on the east end of Stucky Ridge (see Figure 1).

The average annual precipitation at the site ranges from 10 to 13 inches with most of the precipitation occurring in late spring to early summer. The average frost-free period is 90 to 105 days. The parent material is alluvium. The soil texture is a gravelly loam, and is well drained. The slope at the plot site averages 5 to 10 percent.

Current and historic use of this area primarily consists of agricultural grazing, recreation, and open space/wildlife habitat (see Figure 2).

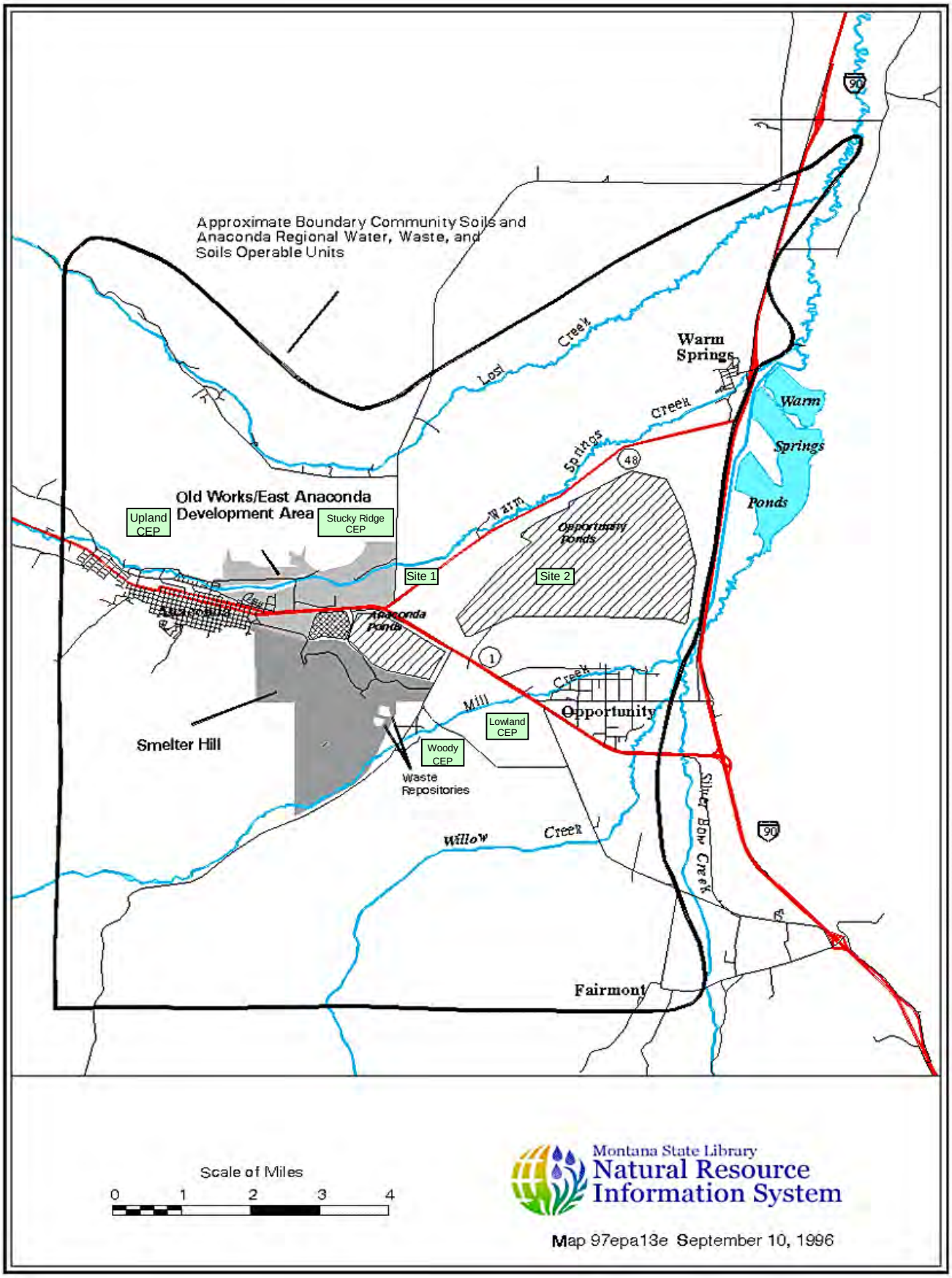

Figure 1. Anaconda Superfund Study Locations. Map by NRCS.

Figure 2. Grazing, recreational, and wildlife habitat near Stucky Ridge overlooking Anaconda. Photograph by NRCS.

II. METHODS AND MATERIALS

Stucky Ridge Pretreatment Soil Conditions

On August 27, 2001, prior to plowing, four soil samples were collected by bulking (0- to 6-inch) composite subsamples taken from separate quadrants of the plot (see Figure 3). The soil samples were analyzed for pH, oxidation/reduction potential (Eh), as well as total arsenic (As), cadmium (Cd), copper (Cu), lead (Pb), and zinc (Zn) concentrations. A randomly chosen sample was analyzed for electrical conductivity and soil texture.

Figure 3. Sampling soil. Photograph by NRCS.

Laboratory analysis of the four soil samples indicated that the average (0- to 6-inch) composite pH was 5.7 (Table 1, addendum). Arsenic and metal levels were generally moderate with the exception of copper. Copper concentrations ranged from 485 to 706 mg/kg and averaged 560 mg/kg. Soil contaminants in this area are concentrated in the upper 2 inches of the soil profile.

Soil Treatment

Prior to planting, 22 tons per acre of lime kiln dust was disked to a 6-inch depth on November 2002. In the spring of 2003, commercial fertilizer (12% N, 16% P_2O_5, 30% K_2O) was applied at 500 bulk pounds per acre and incorporated to 6 inches with a chisel plow.

Planting Design

On May 13, 2003, each seed lot was planted with a 4-row Kincaid™ cone drill with 14-inch between-row spacing and a 0.5-inch planting depth, in the same manner as the Uplands seeding pictured below (see Figure 4). The seeding rate for the grass and forb/subshrub trials was 50 Pure Live Seeds (PLS) per linear foot of row. The seeding rate for the seed mixture trial was based on a total seeding rate of 50 PLS per square foot. Each component of the mix was calculated as a percentage of the seed/ft^2 rate.

Figure 4. Drill seeding plots in the Uplands Study near Stucky Ridge, October 24, 2001. Photograph by NRCS.

The study was arranged as three separate trials (grass, forb/subshrub, and seed mixture) each in a Randomized Complete Block Design with four replications. Each treatment block had eight 25-foot rows. The three trials were situated adjacent to each other as shown in Figure 5. The grass trials (0.96 acre), forb/subshrub trials (0.44 acre), and seed mixture trial (0.14 acre), occupied a 1.54 acre plot. In the grass and forb/subshrub trials, each treatment block was planted with a single accession. Between each replication, as well as between trials, an 8-foot strip of 'Pryor' slender wheatgrass, *Elymus trachycaulus,* was planted to minimize edge effect (see Figure 6). A single-strand, smooth wire fence was installed around the perimeter of the plot to designate plot boundaries and restrict vehicular trespassing. In mid-July and again in mid-September, volunteer Canadian thistle was spot sprayed with a 3% solution of 2,4-D amine followed with a 3% solution of clopyralid applied with a backpack sprayer.

Figure 5. Layout of the grass, forb/subshrub, and seed mixture trials at the Stucky Ridge Comparative Evaluation Planting near Anaconda, Montana.

Grass Trials			
Rep 1	**Rep 2**	**Rep 3**	**Rep 4**
4 ACHY Nezpar	16 ELTR San Luis	30 POSE Sherman	20 LECI Magnar
24 PASM Rosana	32 POSE 9081635	23 PASM Rodan	36 ELWA Secar
19 LECI Washoe	22 PASM 9081968	29 POSE Opportunity	11 DECE Nortran
28 POAL 9082266	2 ACHY 9081629	35 PSSP Goldar	18 LECI 9081625
26 POAL 9082259	15 ELTR Revenue	32 POSE 9081635	10 DECE 9082260
21 LECI Trailhead	36 ELWA Secar	7 AGGI 9076266	8 AGGI Streaker
16 ELTR San Luis	13 ELTR 9081621	21 LECI Trailhead	4 ACHY Nezpar
25 POAL 9016273	1 ACHY 9081628	5 AGGI 9076276	30 POSE Sherman
11 DECE Nortran	6 AGGI 9081619	1 ACHY 9081628	35 PSSP Goldar
27 POAL Gruening	26 POAL 9082259	26 POAL 9082259	23 PASM Rodan
14 ELTR Pryor	3 ACHY Rimrock	3 ACHY Rimrock	16 ELTR San Luis
10 DECE 9082260	19 LECI Washoe	27 POAL Gruening	25 POAL 9016273
3 ACHY Rimrock	12 ELTR Copperhead	13 ELTR 9081621	29 POSE Opportunity
12 ELTR Copperhead	27 POAL Gruening	34 PSSP 9081636	12 ELTR Copperhead
30 POSE Sherman	17 LECI 9081624	10 DECE 9082260	9 DECE 9076290
17 LECI 9081624	5 AGGI 9076276	15 ELTR Revenue	27 POAL Gruening
36 ELWA Secar	30 POSE Sherman	18 LECI 9081625	6 AGGI 9081619
7 AGGI 9076266	10 DECE 9082260	12 ELTR Copperhead	5 AGGI 9076276
22 PASM 9081968	11 DECE Nortran	25 POAL 9016273	13 ELTR 9081621
6 AGGI 9081619	34 PSSP 9081636	2 ACHY 9081629	32 POSE 9081635
8 AGGI Streaker	18 LECI 9081625	8 AGGI Streaker	2 ACHY 9081629
13 ELTR 9081621	8 AGGI Streaker	16 ELTR San Luis	33 POSE 9081322
29 POSE Opportunity	33 POSE 9081322	22 PASM 9081968	26 POAL 9082259
18 LECI 9081625	21 LECI Trailhead	11 DECE Nortran	7 AGGI 9076266
33 POSE 9081322	29 POSE Opportunity	4 ACHY Nezpar	15 ELTR Revenue
15 ELTR Revenue	9 DECE 9076290	33 POSE 9081322	22 PASM 9081968
35 PSSP Goldar	14 ELTR Pryor	28 POAL 9082266	28 POAL 9082266
1 ACHY 9081628	23 PASM Rodan	24 PASM Rosana	31 POSE Canbar
9 DECE 9076290	28 POAL 9082266	20 LECI Magnar	14 ELTR Pryor
31 POSE Canbar	24 PASM Rosana	36 ELWA Secar	24 PASM Rosana
34 PSSP 9081636	31 POSE Canbar	6 AGGI 9081619	19 LECI Washoe
32 POSE 9081635	4 ACHY Nezpar	31 POSE Canbar	34 PSSP 9081636
2 ACHY 9081629	35 PSSP Goldar	14 ELTR Pryor	17 LECI 9081624
5 AGGI 9076276	20 LECI Magnar	17 LECI 9081624	3 ACHY Rimrock
23 PASM Rodan	7 AGGI 9076266	9 DECE 9076290	1 ACHY 9081628
20 LECI Magnar	25 POAL 9016273	19 LECI Washoe	21 LECI Trailhead

Seed Mixture Trial			
Rep 1	**Rep 2**	**Rep 3**	**Rep 4**
4 WMA Developed	3 WMA Experimental	4 WMA Developed	1 UP Experimental
1 UP Experimental	2 UP Developed	1 UP Experimental	4 WMA Developed
2 UP Developed	1 UP Experimental	3 WMA Experimental	3 WMA Experimental
3 WMA Experimental	4 WMA Developed	2 UP Developed	2 UP Developed

Forb / Subshrub Trial	
Rep 1	**Rep 2**
10 PHHA 9081632	8 PEST Bandera
12 POGI 9081679	5 KRLA Open Range
1 EROV 9082098	4 KRLA NCD
14 SYCH 9078675	15 SYCH 9081678
16 SYCH 9082274	9 PEVE Clearwater
6 PEER Old Works	1 EROV 9082098
4 KRLA NCD	6 PEER Old Works
9 PEVE Clearwater	7 PEEA Richfield
7 PEEA Richfield	3 ERUM 9082273
11 PHHA 9082275	12 POGR 9081679
3 ERUM 9082273	11 PHHA 9082275
15 SYCH 9081678	10 PHHA 9081632
8 PEST Bandera	2 ERUM 9082271
13 POHI 9076274	13 POHI 9076274
5 KRLA Open Range	16 SYCH 9082274
2 ERUM 9082271	14 SYCH 9078675
Rep 3	**Rep 4**
12 POGI 9081679	11 PHHA 9082275
9 PEVE Clearwater	10 PHHA 9081632
5 KRLA Open Range	5 KRLA Open Range
4 KRLA NCD	13 POHI 9076274
16 SYCH 9082274	6 PEER Old Works
13 POHI 9076274	8 PEST Bandera
10 PHHA 9081632	15 SYCH 9081678
15 SYCH 9081678	7 PEEA Richfield
11 PHHA 9082275	4 KRLA NCD
8 PEST Bandera	12 POGR 9081679
2 ERUM 9082271	2 ERUM 9082271
1 EROV 9082098	9 PEVE Clearwater
6 PEER Old Works	1 EROV 9082098
3 ERUM 9082273	14 SYCH 9078675
7 PEEA Richfield	16 SYCH 9082274
14 SYCH 9078675	3 ERUM 9082273

Figure 6. Stucky Ridge CEP 2005. Photograph by NRCS.

Grass Trials

Thirty-six grass accessions representing 9 grass genera (Table 3, addendum) were drill planted. Each genus tested includes at least one accession originating from metalliferous soil sites in the proximity of the Anaconda Smelter Site.

Forb / Subshrub Trials

Fourteen forb accessions representing 5 forb genera, 2 subshrub accessions representing 1 subshrub species were planted. (Table 2, addendum). Neither of the two winterfat, *Krascheninnikovia lanata*, accessions originated from metalliferous soils.

Seed Mix Trials

Twenty-one grass accessions representing 15 grass genera, and 6 forb genera were used to construct the four mixes (Table 4, addendum). Species for the seed mixes were chosen based on their predicted performance and potential ability to create a diverse plant community.

Sampling Methods

Seedling density was the growth response variable used to assess performance during the first growing season (2003). Measurements were taken using an 11.8-inch x 19.7-inch (30-cm x 50-cm) quadrat frame that was randomly placed at five sample locations within each (8-ft x 25-ft) treatment block. The quadrat was situated with its long axis perpendicular to the seeded rows so each sampling measurement included two rows. Seedlings rooted within the quadrat frame were counted. Seeded seedlings, as well as non-seeded seedlings, were counted and recorded separately. Seedling density data was collected on June 24, 2003, to assess emergence and initial establishment, and on August 25, 2003, to assess subsequent establishment and/or die off.

Data Analysis

Differences in height, vigor, biomass and stand percentage among grass accessions and cultivars by species was analyzed with an analysis of variance (ANOVA) model for a randomized complete block design at the P< 0.05. Only the 2008 data was evaluated because the long-term survival of the plantings was of utmost interest.

III. RESULTS

The results of the ANOVA are summarized in Tables 12 through 20 in the addendum. The interpretation of the results that follows is based on the differences observed between the means of the data collected in 2003-2007. Although the means may indicate a difference in performance among accessions, differences can only be attributed by inherent accession traits when indicated by a p-value less than 0.05 ($p<0.05$). Otherwise, performances differences could be caused by other factors.

A. Grass Trials

Grass Trial 2003

Average seedling density data measured on June 24, 2003, was 5.4 seedlings/ft^2, ranging from 15.0 to 0 seedlings/ft^2 (Table 5, addendum). Three accessions of slender wheatgrass, *Elymus trachycaulus*, ('Pryor', Copperhead Germplasm, and 'San Luis') had the greatest seedling densities at 15.0, 14.1, and 13.6 seedlings/ft^2, respectively. Slender wheatgrass is recognized for its excellent seedling vigor, and quick establishment and growth on a variety of soil types. Seedling density collected two months later on August 25, 2003, indicated that these three *E. trachycaulus* accessions had greater densities than 86% of the accessions tested.

Western wheatgrass, *Pascopyrum smithii*, ('Rosana' and 9081968) had 13.3 and 12.7 seedlings/ft^2 respectively, on June 24 (see Table 5). *P. smithii* is an aggressively rhizomatous, long-lived, perennial grass known to be adapted to a wide range of soil types from acidic to basic. Seedling density data collected on August 25 indicated that the aforementioned *P. smithii* accessions had greater densities than 86% of the accessions tested.

Seedling density data from the June evaluation indicated that 9081624 basin wildrye, *Leymus cinereus,* had greater density (7.76 seedlings/ft^2) than 80.5% of the accessions including the four other *Leymus cinereus* accessions (see Table 5). This accession's success is somewhat unexpected due to the species' poor to fair seedling vigor and slow seedling establishment. This species has been reported to be tolerant of elevated arsenic and heavy metal concentrations (Munshower, 1998). Basin wildrye also established well on a reclaimed gas exploration well pad near Pinedale, Wyoming (Jacobs et al., 2013).

The bluebunch wheatgrass, *Pseudoroegneria spicata,* accessions ('Goldar' and 9081636) also performed in the top third of the entries in June and August (see Table 5). In August, both accessions had better seedling densities than over 50% of the accessions. The local accession *P. spicata* 9081636 did not perform significantly better than *P. spicata* 'Goldar'. *P. spicata* is reported to have fair seedling vigor and establishment with tolerances for acidic to slightly alkaline soils.

The grand mean for the June 24, evaluation was 5.4 seedlings/ft^2. The grand mean for the August 25, 2003, evaluation was 4.1 seedlings/ft^2 (see Table 5). This indicates that seedling density declined by 1.3 seedlings/ft^2 or 24.1% between the June and August evaluations.

Grass Trials 2004

Considering the number of new seedlings observed in 2004, it appears many seeds failed to germinate during the 2003 growing season. The most notable species were Indian ricegrass, *Achnatherum hymenoides;* basin wildrye, *Leymus cinereus*; and western wheatgrass, *Pascopyrum*

smithii. Indian ricegrass has a seed dormancy mechanism, which requires fall dormant seeding to overcome dormancy and germinate the next spring. The basin wildrye and western wheatgrass may have delayed germination because of the combination of a relatively late spring planting date and subsequent hot, dry weather. The increase in new seedlings was expressed in relatively higher stand percentage, but was not revealed in the biomass production, as seedlings were still quite small at the time of the late summer biomass sampling.

At the early summer sampling June 30, the top performing accession was Copperhead Germplasm slender wheatgrass, *Elymus trachycaulus,* with a 61.1% stand, 21.4 inch average height, and a 2.1 vigor rating. Other 'local source' accessions that exhibited good survival, stand, and vigor included Opportunity Germplasm Nevada bluegrass, *Poa secunda;* 9081621 slender wheatgrass, *Elymus trachycaulus*; 9081968 western wheatgrass, *Pascopyrum smithii*; 9081624 basin wildrye, *Leymus cinereus*; 9081628 Indian ricegrass, *Achnatherum hymenoides*; 9081635 and Canby bluegrass, *Poa secunda*; and 9081636 bluebunch wheatgrass, *Pseudoroegneria spicata* (see Tables 6, 7, 9).

Toward the end of the growing season, September 22 sampling date, there was very little change in the top performing accessions (see Tables 6, 7, 8, 9). Of the top 16 accessions in the early summer evaluation, 15 were still ranked as the top performing accessions. The Copperhead slender wheatgrass remained the top performer by a substantial margin. Of the 'local source' accessions, Opportunity Germplasm Nevada bluegrass, 9081968 western wheatgrass, 9081635 Canby's bluegrass, 9081624 basin wildrye, and 9081636 bluebunch wheatgrass all performed well. Fall biomass production was relatively low. Copperhead slender wheatgrass produced 1860 lb/acre biomass, which is 67% higher than redtop, the second highest producing grass in the trial in 2004 (see Table 8).

Grass Trials 2005

The grasses were evaluated and sampled on August 30. Although there had been some mortality, the top performers of 2003 and 2004 continued to exhibit their ability to withstand the harsh edaphic conditions characteristic of the site. Copperhead slender wheatgrass was the top performer with an average stand of 75% (see Table 6), average plant height of 34.4 inches (see Table 7), and average biomass production of 7332 lb/acre (see Table 8). Other superior accessions included Opportunity Germplasm Nevada bluegrass (stand-43.4%, biomass-2238 lb/acre), 9081621 slender wheatgrass (stand-34.1%, biomass-3661 lb/acre), 9081635 Sandberg bluegrass (stand-25.9%, biomass-809 lb/acre), 9081968 western wheatgrass (stand-21.9%, biomass-714 lb/acre), and 9081624 basin wildrye (stand-22.2%, biomass-1647 lb/acre). The released cultivars, 'Secar' Snake River wheatgrass, 'Pryor' slender wheatgrass, 'San Luis' slender wheatgrass, 'Rosana' western wheatgrass, and 'Trailhead' basin wildrye were among the top performers; but, in most cases, performance was slightly less than their indigenous counterparts.

Grass Trials 2006

The evaluation of grasses at Stucky Ridge took place on August 28 of this year. Copperhead slender wheatgrass continued to have the best stand percentage with 78.1%. In biomass production, Copperhead slender wheatgrass (2063.8 lb/acre) fell behind 9081621 slender wheatgrass (4370.7 lb/acre) and 9081624 basin wildrye (2351.6 lb/acre) in 2006 (see Table 8). Copperhead slender wheatgrass remained in the top two in its vigor rating of 3.3 (see Table 9). Trailhead basin wildrye, Opportunity Germplasm Nevada bluegrass, and 9081624 basin wildrye continued to rank high in all of the performance parameters (% stand, height, biomass, vigor) measured in 2006 (see Tables 6, 7, 8, 9).

Grass Trials 2007

This was the fourth year of evaluation of the grasses since planting in 2003. The grasses were evaluated and sampled on August 22, 2007. The grasses surviving after 4 years in these harsh site conditions will likely to continue to thrive at this site. Opportunity had the best percentage stand at 47.2%, followed by Copperhead at 41.3% (see Table 6). The accessions with the greatest height were Copperhead slender wheatgrass at 44.9 inches, and 9081621 slender wheatgrass at 41.2 inches (see Table 7). All of the basin wildrye accessions were the top producers of biomass for 2007 (see Table 8).

Grass Trials 2008

This was the final year of evaluation. The basin wildrye accessions had the highest biomass production in 2008. Washoe with 2,118.4 lb/acre and Trailhead with 3,319.0 lb/acre were the top producers of biomass among the five accessions of basin wildrye. The accession with the greatest stand percentage among the nine species was Opportunity Germplasm Nevada bluegrass (63.8%) (see Table 6). The basin wildrye accessions, 9081624 (34.3 inches), Washoe (29.4 Inches), and Trailhead (28.6 inches) had the greatest height readings among all species (see Table 7). The species with the best overall vigor rating was 90812621 slender wheatgrass (3.4), followed closely by Copperhead slender wheatgrass (3.5) (see Table 9).

The 2008 data were analyzed using Statistix 8 software. An analysis of variance test (ANOVA) was performed on all of the 2008 data. Tables 12 through 20 in the addendum show a summary of the results of these analyses, as well as observations of the differences between the means of each accession for height, vigor, biomass production, and stand percentage.

There was no significant difference in height, vigor, biomass production, and stand percentage among the 4 accessions of *Achnatherum hymenoides*, the 4 accessions of *Agrostis gigantea,* the 3 accessions of *Deschampsia cespitosa,* the 5 accessions of *Leymus cinereus,* the 3 accessions of *Pascopyrum smithii,* the 4 accessions of *Poa alpina,* or the 2 accessions of *Pseudoroegneria spicata.*

Copperhead Germplasm slender wheatgrass and accession 9081621 (another local collection) had statistically better vigor than ‘Pryor’, ‘Revenue’, and ‘San Luis’. Similarly, Copperhead was significantly better than Revenue and San Luis for stand, and Copperhead had the highest, overall mean stand of the slender wheatgrasses tested. Opportunity Germplasm Nevada bluegrass was significantly taller than ‘Canbar’, and had the highest overall mean height of the bluegrasses tested. Opportunity had significantly greater biomass than the other bluegrasses tested, and had the highest overall mean biomass of the bluegrasses tested. Opportunity had significantly better stand establishment than ‘Sherman’, ‘Canbar’, and 9081322 (Lewis and Clark County, MT), and had the highest overall mean stand of all bluegrasses tested.

Stand establishment, as measured by stand percentage, is an especially valuable parameter to consider when determining the appropriateness of an accession for critical area restoration. The accession with the highest percentage stand in 2008 was *Poa secunda*, Opportunity Germplasm (63.8%), Deer Lodge County, MT. The second highest-ranking accession was *Elymus trachycaulus*, Copperhead Germplasm (57.5%), Deer Lodge County, MT. The species / accessions that had the best cover, biomass production, height, and vigor are listed in Table 21. This table shows the ranking of the species/accessions by the order of the three highest means for each parameter evaluated.

B. Forb/Subshrub Trial

Ten of the 16 forb/subshrub entries had no emergence, and 15 of the 16 entries had less than 0.50 seedlings/ft^2 in 2003, the year of seeding (see Table 10). By the second growing season (2004), only plants of Open Range winterfat, *Kraschenninnikovia lanata;* and 9081632-silverleaf phacelia, *Phacelia hastata,* remained alive. There was no sign of new emergence of any of the accessions/species in the

spring of 2004. After the third growing season (2005), plants of Open Range winterfat, 9081632-silverleaf phacelia, Old Works Germplasm fuzzytongue penstemon, *Penstemon eriantherus;* Richfield firecracker penstemon, *Penstemon eatonii;* and Northern Cold Desert winterfat, *Krascheninnikovia lanata,* were found surviving. New plants of fuzzytongue penstemon had germinated two years after being planted. The surviving plants of Open Range winterfat and 9081632 silverleaf phacelia exhibited good vigor, cover, and seed production.

C. Stucky Ridge Seed Mix Evaluations

The forbs included in the seed mixture plots did not emerge in 2003; therefore, densities reflect only emergent grass seedlings (see Table 11). During the establishment year (2003), the Developed Waste Management Area (WMA) mix had the greatest seedling density with 10.5 seedlings/ft^2 (see Table 11). The Experimental WMA mix had the lowest density with 6.3 seedlings/ft^2. The two Developed mixtures averaged 9.9 seedlings/ft^2. The two Experimental mixtures averaged 6.3 seedlings/ft^2.

At the start of the second growing season (2004), the two Experimental mixes had greater stand percentages (Upland Exp.-39.4% and Waste Mgmt. Exp.-38.1%) than did the Developed mixes (Upland Dev.-17.3% and Waste Mgmt. Dev.-15.0%). By fall of the second year, the stands of all the mixes had increased, but the Experimental mixes were still greater than the Developed mixes. Biomass production of the Experimental mixes was also greater than that of the Developed mixes.

During the third year (2005), the stand percentage of all mixes increased only slightly, but the biomass production was much higher. The Experimental mixes were dominated by Copperhead slender wheatgrass, while the Developed mixes were dominated by Revenue slender wheatgrass and Critana thickspike wheatgrass. The Waste Management Experimental mix topped all mixes with 7977.2 lb/acre production (see Table 11).

The fourth year of the study (2006) showed an increase in stand percentage for all of the mixes except the Upland Experimental mix. The greatest increase in height was in the Waste Management Developed Area. All of the seed mixes showed a decrease in biomass production for 2006 (see Table 11).

In 2007, the percentage stand was down an average of 37.75%. The average height decreased 0.5%, and the biomass had an average 35.25% reduction. The Waste Management Area Developed mix had the greatest biomass reduction (58%).

A comprehensive discussion of the species composition of the mixtures, their relative proportions in the mix, and a detailed statistical analysis of the mixture performance is presented in Montana Plant Materials Technical Note, MT-99, *Seed Mixes for Acid and Heavy Metal Contaminated Sites in the Anaconda, Montana Area.* This Technical Note is posted on the NRCS Plant Materials web site, http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/mt/plantsanimals/?cid=nrcs144p2_057725.

IV. CONCLUSIONS/DISCUSSION

Not all of the viable seeds germinated the first year (2003). The record high temperatures and low precipitation in July and August, along with the late spring planting date (May 13), are considered the primary factors affecting the incomplete germination and emergence during the 2003 growing season. There was a significant amount of new grass seedling emergence detected during the second season at the June 30, 2004 evaluation, particularly in the Indian ricegrass, western wheatgrass, big bluegrass, and basin wildrye plots, and some new germination of forbs in 2005.

Forbs planted at Stucky Ridge did not establish as well as the grasses. The lack of forb emergence may be due to the May 13 planting date. Some of the forb species in the study have a physiological

(after ripening) or physical (hard seed coat) seed dormancy that require a dormancy breaking treatment, such as cold, moist chilling. To overcome seed dormancy, several of the tested forbs require several weeks (8 to 14 weeks) of cold chilling, a condition that would not have been met until the following spring. By 2005, Old Works fuzzytongue penstemon, *Penstemon eriantherus*, was the forb with the best establishment followed by 9081632 silverleaf phacelia, *Phacelia hastata.*

The effect of the seed mix treatment on plant foliar cover varied by the year sampled but there were no significant differences in percentage cover among mixes in any year. The analysis of the Stucky Ridge Seed Mix Trial Results provides little support for the theory that progeny of locally collected plants establish and survive better, at least in the short term, on remediated site conditions than progeny of plants released through standard Plant Materials Program evaluation, selection and testing process. It is important to take into account that long-term survival and performance of indigenous seed sources was not tested in this study, and may prove superior to non-indigenous seed sources.

The overall performance on the Stucky Ridge plots was quite variable. The 'Pryor' slender wheatgrass strips between replications showed areas of good and poor establishment and performance. It was thought that the incorporation of the amendments might have created strips with varying soil pH. Soil samples were taken under four stands of slender wheatgrass that varied in percentage cover and vigor, in an attempt to explain this variability. Soil analysis for pH indicated no substantial differences in pH (all 6.8 to 7.3) under the varying stands of slender wheatgrass, suggesting the variable plant performance observed may have been caused by some other soil parameter such as a specific metal or metal concentration.

Species selection for restoration of a disturbed site can be challenging. The results of this study may help when selecting species for critical area restoration. A combination of grasses, forbs, and woody species is necessary for supporting plant community diversity, enhancing function, and optimizing conservation benefits. Restoration will be more successful over the long-term when species diversity is great.

Since Copperhead slender wheatgrass established earliest of all species in the study, and Opportunity Nevada bluegrass persisted the greatest over the length of the study, it is recommended to plant disturbed sites with a mix that includes Copperhead slender wheatgrass, for rapid site stability, and Opportunity Nevada bluegrass, for lasting cover.

Although this Technical Note presents potential species and seed mixes for re-vegetating or restoring native plant communities on smelter-impacted sites in the Anaconda-Butte area of Montana, these same species have been used to restore other critically impacted sites in areas of similar environmental conditions as Stucky Ridge. Some of the species that performed well in the acid/heavy metal soils around Anaconda perform equally well in traditional agricultural plantings.

The results of a variety of studies at the Anaconda Superfund site, and resultant plant selections, are summarized in Montana Plant Materials Technical Note, MT-97, *Acid and Heavy Metal Tolerant Plants for Restoring Plant Communities in the Upper Clark Fork River Basin*. This document provides information on each plant selection, including a general description, its origin, conservation uses, and stand establishment techniques. Additionally, woody plant species were tested at the Mill Creek Woody CEP at the Anaconda site. They are described in Montana Plant Materials Technical Note, MT-98, *A Summary of the Results of the Mill Creek Woody Comparative Evaluation Planting*. This report summarizes the performance of seven woody species consisting of 19 different accessions planted in a study plot severely impacted by past smelter emissions fallout. Plant Materials Technical Note No. MT-46 (Rev. 4) could be helpful when developing seed mixes and calculating seeding rates, especially when seeding Critical Area Plantings and/or broadcasting the seed, as these situations warrant seeding rate increases. These Technical Notes are posted on the NRCS Plant Materials web site.

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Addendum

Table 1. Pre-plow (0- to 6-inch) composite soil analysis results for total metals, pH, oxidation/reduction potential, electrical conductivity, and soil texture.

Sample No.	pH	Eh	As	Cd	Cu	Pb	Zn	Conductivity	Soil Texture
	s.u.	*mv*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mmhos/cm*	
US-1	5.0	287.0	90.0	2.0	491.0	41.0	127.0	-----	-----
US-2	5.1	288.0	117.0	3.0	706.0	49.0	170.0	-----	-----
US-3	6.9	214.0	89.0	3.0	485.0	38.0	130.0	0.41	SCL
US-4	5.7	245.0	97.0	3.0	557.0	40.0	145.0	-----	-----
Average	5.7	259.0	98.3	2.8	559.8	42.0	143.0	-----	-----

Table 2. Forb and subshrub treatments included in the forb/subshrub trial near Anaconda, Montana, Stucky Ridge Comparative Evaluation Planting.

Species ID	Genus & Species	Accession/Variety	Origin
1	*Eriogonum ovalifolium*	9082098	Deer Lodge County, MT
2	*Eriogonum umbellatum*	9082271	Utah
3	*Eriogonum umbellatum*	9082273	Idaho
4	*Krascheninnikovia lantana*	Northern Cold Desert	Composite from UT & ID
5	*Krascheninnikovia lantana*	Open Range	Composite from MT & WY
6	*Penstemon eriantherus*	Old Works Germplasm	Deer Lodge County, MT
7	*Penstemon eatonii*	Richfield Selected	Sevier County, UT
8	*Penstemon strictus*	'Bandera' 477980	Torrance County, NM
9	*Penstemon venustus*	Clearwater Selected	Clearwater River area, ID
10	*Phacelia hastata*	9081632	Deer Lodge County, MT
11	*Phacelia hastata*	9082275	California
12	*Potentilla gracilis*	9081679	California
13	*Potentilla hippiana*	9076274	Deer Lodge County, MT
14	*Symphyotrichum chilense*	9078675	Deer Lodge County, MT
15	*Symphyotrichum chilense*	9081678	Colorado
16	*Symphyotrichum chilense*	9082274	California

Table 3. Grass treatments included in the grass trial at the Stucky Ridge CEP near Anaconda, Montana, USDA-NRCS Bridger Plant Materials Center.

Species ID	Genus & Species	Accession/Variety	Origin
1	*Achnatherum hymenoides*	9081628	Deer Lodge County, MT
2	*Achnatherum hymenoides*	9081629	Deer Lodge County, MT
3	*Achnatherum hymenoides*	'Rimrock'	Yellowstone County, MT
4	*Achnatherum hymenoides*	'Nezpar'	White Bird, ID
5	*Agrostis gigantea*	9076276	Deer Lodge County, MT
6	*Agrostis gigantea*	9081619	Deer Lodge County, MT
7	*Agrostis gigantea*	9076266	Deer Lodge County, MT
8	*Agrostis gigantea*	'Streaker'	Illinois
9	*Deschampsia cespitosa*	9076290	Silver Bow County, MT
10	*Deschampsia cespitosa*	9082260	California
11	*Deschampsia cespitosa*	'Nortran'	Alaska
12	*Elymus trachycaulus*	Copperhead Germplasm (9081620)	Deer Lodge County, MT
13	*Elymus trachycaulus*	9081621	Deer Lodge County, MT
14	*Elymus trachycaulus*	'Pryor'	Carbon County, MT
15	*Elymus trachycaulus*	'Revenue'	Saskatchewan, Canada
16	*Elymus trachycaulus*	'San Luis'	Rio Grande County, CO
17	*Leymus cinereus*	9081624	Deer Lodge County, MT
18	*Leymus cinereus*	9081625	Deer Lodge County, MT
19	*Leymus cinereus*	Washoe Germplasm (9081627)	Deer Lodge County, MT
20	*Leymus cinereus*	'Magnar'	Saskatchewan, Canada
21	*Leymus cinereus*	'Trailhead'	Musselshell County, MT
22	*Pascopyrum smithii*	9081968	Deer Lodge County, MT
23	*Pascopyrum smithii*	'Rodan'	Morton County, ND
24	*Pascopyrum smithii*	'Rosana'	Rosebud County, MT
25	*Poa alpina*	9016273	Gallatin County, MT
26	*Poa alpina*	9082259	British Columbia, Canada
27	*Poa alpina*	'Gruening'	France/Switzerland
28	*Poa alpina*	9082266	Unknown
29	*Poa secunda*	Opportunity Germplasm (9081633)	Deer Lodge County, MT
30	*Poa secunda (ampla)*	'Sherman'	Sherman County, OR
31	*Poa secunda (canbyi)*	'Canbar'	Columbia County, WA
32	*Poa species*	9081635	Deer Lodge County, MT
33	*Poa species*	9081322	Lewis & Clark County, MT
34	*Pseudoroegneria spicata*	9081636	Deer Lodge County, MT
35	*Pseudoroegneria spicata*	'Goldar'	Asotin County, WA
36	*Elymus wawawaiensis*	'Secar'	Washington

Table 4. Stucky Ridge Seed Mix Formulations near Anaconda, Montana USDA-NRCS Bridger Plant Materials Center.

Upland Areas – Experimental Seed Mix Formulation - Mix 1					
Scientific Name	**Common Name**	**Accession or Variety**	**Origin**	**% Mix PLS by Weight**	**Full Stand Seeding Rate** *PLS lb./acre*
Grasses					
Achnatherum hymenoides	Indian ricegrass	9081629	Deer Lodge Co., MT	15.0	5.0
Elymus trachycaulus	slender wheatgrass	Copperhead	Deer Lodge Co., MT	15.0	7.0
Leymus cinereus	basin wildrye	Washoe	Deer Lodge Co., MT	15.0	7.0
Pascopyrum smithii	western wheatgrass	9081968	Deer Lodge Co., MT	5.0	10.0
Poa alpina	alpine bluegrass	9016273	Gallatin Co., MT	10.0	13.0
Poa secunda (*ampla*)	big bluegrass	Opportunity	Deer Lodge Co., MT	15.0	2.0
Pseudoroegneria spicata	bluebunch wheatgrass	9081636	Deer Lodge Co., MT	15.0	7.0
Forbs					
Symphyotrichum chilense	Pacific aster	9078675	Deer Lodge Co., MT	2.5	2.0
Penstemon eriantherus	fuzzytongue penstemon	Old Works	Deer Lodge Co., MT	5.0	3.0
Potentilla hippiana	woolly cinquefoil	9076274	Silverbow Co., MT	2.5	NA
Upland Areas – Developed Seed Mix Formulation - Mix 2					
Scientific Name	**Common Name**	**Accession or Variety**	**Origin**	**% Mix PLS by Weight**	**Full Stand Seeding Rate** *PLS lb./acre*
Grasses					
Achnatherum hymenoides	Indian ricegrass	'Nezpar'	White Bird, ID	5.0	5.0
Elymus lanceolatus	thickspike wheatgrass	'Critana'	Hill County, MT	15.0	7.0
Elymus trachycaulus	slender wheatgrass	'Revenue'	SK, Canada	15.0	7.0
Festuca ovina	*sheep fescue*	'Covar'	central Turkey	10.0	2.0
Leymus cinereus	basin wildrye	'Magnar'	SK, Canada	15.0	7.0
Pascopyrum smithii	western wheatgrass	'Rosana'	Rosebud Co., MT	10.0	10.0
Poa secunda (*ampla*)	big bluegrass	'Sherman'	Sherman Co., OR	14.5	2.0
Pseudoroegneria spicata	bluebunch wheatgrass	'Goldar'	Asotin Co., WA	10.0	7.0
Forbs					
Achillea millefolium	western yarrow	Great Northern	Flathead Co., MT	2.5	0.5
Artemisia frigida	fringed sagebrush	9082258	unknown	0.5	0.3
Linum lewisii	Lewis flax	'Appar'	Custer Co., SD	2.5	3.5

Table 4. Stucky Ridge Seed Mix Formulations (continued).

Waste Management Areas - Experimental Seed Mix Formulation - Mix 3					
Scientific Name	**Common Name**	**Accession or Variety**	**Origin**	**% Mix PLS by Weight**	**Full Stand Seeding Rate** *PLS lb./acre*
Grasses					
Agrostis gigantea	redtop	9076276	Deer Lodge Co., MT	15.0	0.5
Deschampsia cespitosa	*tufted hairgrass*	9076290	Silverbow Co., MT	10.0	0.8
Elymus trachycaulus	slender wheatgrass	9081620	Deer Lodge Co., MT	15.0	7.0
Leymus cinereus	basin wildrye	Washoe	Deer Lodge Co., MT	15.0	7.0
Pascopyrum smithii	western wheatgrass	9081968	Deer Lodge Co., MT	5.0	10.0
Poa secunda (ampla)	big bluegrass	9081633	Deer Lodge Co., MT	10.0	10.0
Hesperostipa comata	needle & thread grass	9078314	Deer Lodge Co., MT	10.0	9.0
Forbs					
Symphyotrichum chilense	Pacific aster	9078675	Deer Lodge Co., MT	10.0	2.0

Waste Management Areas - Developed Seed Mix Formulation - Mix 4					
Scientific Name	**Common Name**	**Accession or Variety**	**Origin**	**% Mix PLS by Weight**	**Full Stand Seeding Rate** *PLS lb./acre*
Grasses					
Thinopyrum intermedium	intermediate wheatgrass	'Greenar'	Former USSR	10.0	10.0
Bromus inermis	smooth brome	'Manchar'	Manchuria, China	15.0	8.0
Elymus lanceolatus	thickspike wheatgrass	'Critana'	Hill County, MT	10.0	7.0
Elymus trachycaulus	slender wheatgrass	'Revenue'	SK, Canada	15.0	7.0
Leymus cinereus	basin wildrye	'Magnar'	SK, Canada	15.0	7.0
Poa secunda (ampla)	big bluegrass	'Sherman'	Sherman Co., OR	10.0	2.0
Nassella viridula	green needlegrass	9082255	Washington	10.0	6.0
Forbs					
Medicago sativa	alfalfa	'Ladak'	Kashmir, India	15.0	5.0

Table 5. Seedling density (*Seedlings/ft²*) sampled on June 24 and August 25, 2003 at the CEP site near Anaconda, Montana USDA-NRCS Bridger Plant Materials Center.

Genus & Species	Accession	Common Name	Species ID		June 24	August 25
					Seedlings/ft²	
Achnatherum hymenoides	'Nezpar'	Indian ricegrass	4		8.88	6.49
Achnatherum hymenoides	'Rimrock'	Indian ricegrass	3		1.27	0.90
Achnatherum hymenoides	9081629	Indian ricegrass	2		0.78	0.28
Achnatherum hymenoides	9081628	Indian ricegrass	1		0.59	0.59
Agrostis gigantea	9081619	Redtop	6		2.42	2.27
Agrostis gigantea	9076276	Redtop	5		1.74	1.46
Agrostis gigantea	9076266	Redtop	7		0.81	0.96
Agrostis gigantea	'Streaker'	Redtop	8		0.75	0.34
Deschampsia cespitosa	9076290	Tufted hairgrass	9		1.33	0.44
Deschampsia cespitosa	'Nortran'	Tufted hairgrass	11		0.99	0.87
Deschampsia cespitosa	9082260	Tufted hairgrass	10		0.56	0.37
Elymus trachycaulus	'Pryor'	Slender wheatgrass	14		14.88	11.43
Elymus trachycaulus	Copperhead Germplasm	Slender wheatgrass	12		14.01	14.38
Elymus trachycaulus	'San Luis'	Slender wheatgrass	16		13.54	13.35
Elymus trachycaulus	9081621	Slender wheatgrass	13		9.29	6.06
Elymus trachycaulus	'Revenue'	Slender wheatgrass	15		8.70	8.32
Elymus wawawaiensis	'Secar'	Snake River wheatgrass	36		9.41	6.52
Leymus cinereus	9081624	Basin wildrye	17		11.18	7.76
Leymus cinereus	'Magnar'	Basin wildrye	20		6.09	2.98
Leymus cinereus	'Trailhead'	Basin wildrye	21		5.78	4.88
Leymus cinereus	9081625	Basin wildrye	18		3.82	2.33
Leymus cinereus	Washoe Germplasm	Basin wildrye	19		3.63	2.14
Pascopyrum smithii	'Rosana'	Western wheatgrass	24		13.23	11.93
Pascopyrum smithii	9081968	Western wheatgrass	22		12.64	11.52
Pascopyrum smithii	'Rodan'	Western wheatgrass	23		5.62	5.71
Poa alpina	9016273	Alpine bluegrass	25		2.33	0.90
Poa alpina	9082266	Alpine bluegrass	28		1.71	1.24
Poa alpina	9082259	Alpine bluegrass	26		0.65	1.03
Poa alpina	'Gruening'	Alpine bluegrass	27		0.34	0.53
Poa secunda	Opportunity Germplasm	Nevada bluegrass	29		7.08	5.12
Poa secunda	'Sherman'	Big bluegrass	30		3.11	2.33
Poa secunda	9081635	Sandberg bluegrass	32		1.86	1.09
Poa secunda	9081322	Sandberg bluegrass	33		1.31	0.71
Poa secunda	'Canbar'	Canby bluegrass	31		1.21	0.47
Pseudoroegneria spicata	9081636	Bluebunch wheatgrass	34		12.30	7.11
Pseudoroegneria spicata	'Goldar'	Bluebunch wheatgrass	35		9.04	7.21
			Overall Average		5.40	4.10

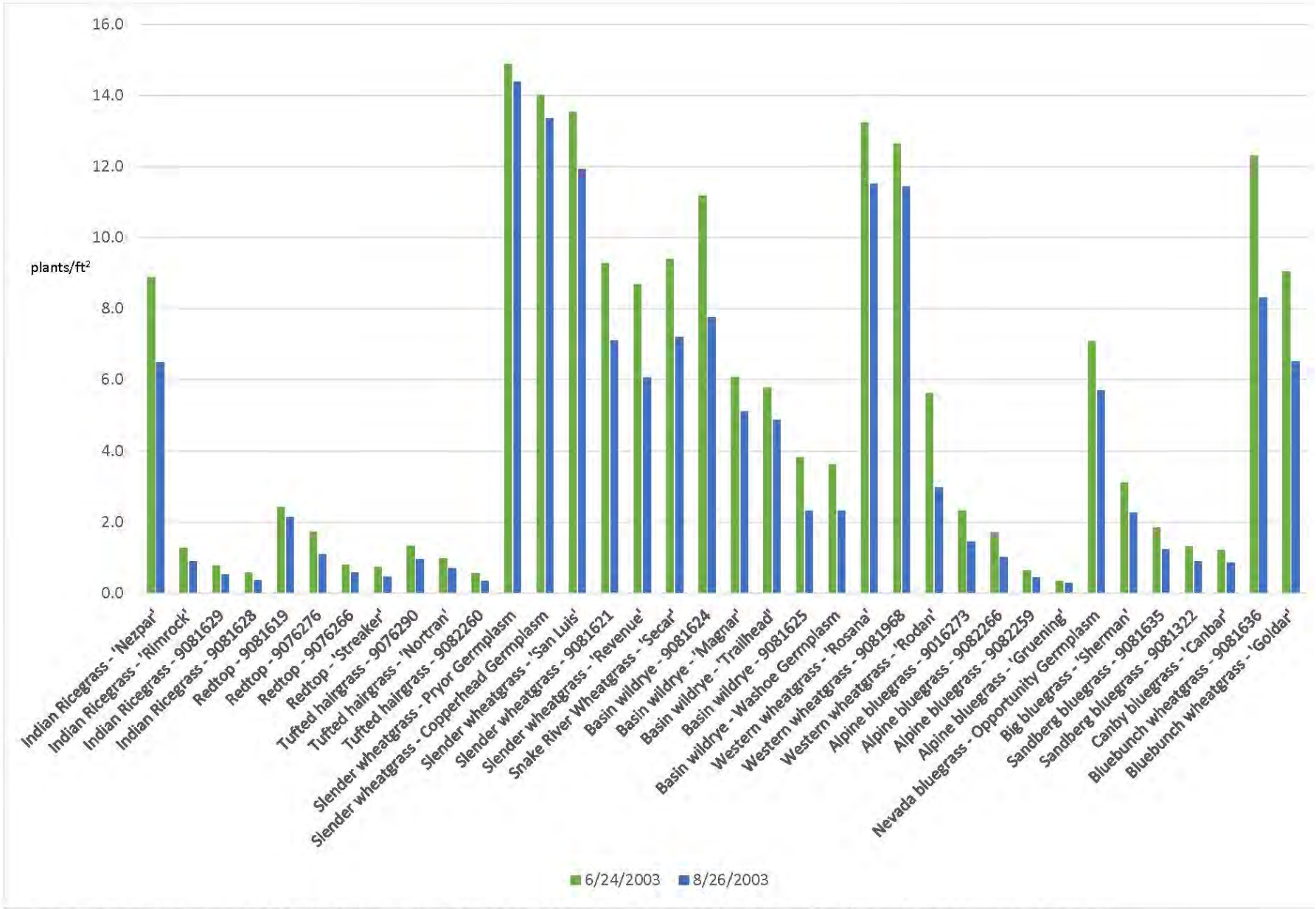

Figure 7. Density of Grasses at Stucky Ridge CEP in 2003 near Anaconda, Montana USDA-NRCS Bridger Plant Materials Center.

Table 6. Stand Percentage Cover of Grass Trials on Stucky Ridge Plots 2004 – 2008 near Anaconda, Montana USDA-NRCS Bridger Plant Materials Center.

Genus & Species	Accession	Common Name	% Stand				
			2004	2005	2006	2007	2008
Achnatherum hymenoides	'Nezpar'	Indian ricegrass	18.4	11.9	9.7	10.3	11.3
Achnatherum hymenoides	'Rimrock'	Indian ricegrass	23.4	14.1	14.1	14.1	25.3
Achnatherum hymenoides	9081628	Indian ricegrass	14.4	14.1	5.9	9.1	11.6
Achnatherum hymenoides	9081629	Indian ricegrass	11.3	6.4	4.7	8.8	5.9
Agrostis gigantea	9081619	Redtop	17.8	13.4	29.4	18.8	34.7
Agrostis gigantea	9076276	Redtop	15.9	13.1	21.6	15.3	23.8
Agrostis gigantea	9076266	Redtop	7.8	9.0	11.3	15.0	28.8
Agrostis gigantea	'Streaker'	Redtop	1.9	0.4	5.9	19.4	16.9
Deschampsia cespitosa	9076290	Tufted hairgrass	6.3	10.6	0.6	0.0	1.6
Deschampsia cespitosa	'Nortran'	Tufted hairgrass	0.4	1.6	2.8	0.0	5.9
Deschampsia cespitosa	9082260	Tufted hairgrass	1.9	0.9	2.8	0.0	2.5
Elymus trachycaulus	Copperhead Germplasm	Slender wheatgrass	61.1	75.0	78.1	41.3	57.5
Elymus trachycaulus	9081621	Slender wheatgrass	30.0	34.1	41.3	31.9	47.8
Elymus trachycaulus	'Pryor'	Slender wheatgrass	26.3	23.1	22.2	16.9	30.6
Elymus trachycaulus	'Revenue'	Slender wheatgrass	23.8	11.9	10.6	6.6	15.9
Elymus trachycaulus	'San Luis'	Slender wheatgrass	19.1	20.9	26.6	14.1	22.8
Elymus wawawaiensis	'Secar'	Snake River wheatgrass	19.2	21.6	25.3	39.7	31.3
Leymus cinereus	9081624	Basin wildrye	22.8	22.2	28.1	36.6	41.6
Leymus cinereus	Washoe Germplasm	Basin wildrye	14.1	13.4	9.1	12.8	25.3
Leymus cinereus	'Trailhead'	Basin wildrye	20.0	16.2	19.4	31.9	44.4
Leymus cinereus	9081625	Basin wildrye	11.6	13.8	10.9	22.5	25.0
Leymus cinereus	'Magnar'	Basin wildrye	13.4	10.9	7.2	23.8	13.1
Pascopyrum smithii	9081968	Western wheatgrass	28.4	21.9	12.8	7.5	21.9
Pascopyrum smithii	'Rosana'	Western wheatgrass	26.3	20.6	17.2	10.0	18.1
Pascopyrum smithii	'Rodan'	Western wheatgrass	16.6	16.2	10.6	8.8	22.8
Poa alpina	9082259	Alpine bluegrass	8.4	3.9	2.8	1.6	3.1
Poa alpina	9016273	Alpine bluegrass	5.2	3.0	3.4	0.3	0.9
Poa alpina	'Gruening'	Alpine bluegrass	1.1	0.8	4.7	0.0	0.9
Poa alpina	9082266	Alpine bluegrass	4.4	3.6	1.9	0.2	0.9
Poa secunda	Opportunity Germplasm	Nevada bluegrass	37.2	43.4	63.1	47.2	63.8
Poa secunda	9081635	Big bluegrass	24.1	25.9	23.8	24.4	35.9
Poa secunda	'Sherman'	Sandberg bluegrass	12.2	12.5	13.4	5.3	15.6
Poa secunda	9081322	Sandberg bluegrass	11.9	10.0	4.1	7.5	14.4
Poa secunda	'Canbar'	Canby bluegrass	0.0	0.1	2.5	0.9	5.9
Pseudoroegneria spicata	'Goldar'	Bluebunch wheatgrass	13.4	11.1	10.9	13.1	25.0
Pseudoroegneria spicata	9081636	Bluebunch wheatgrass	17.5	13.8	3.4	8.4	22.5

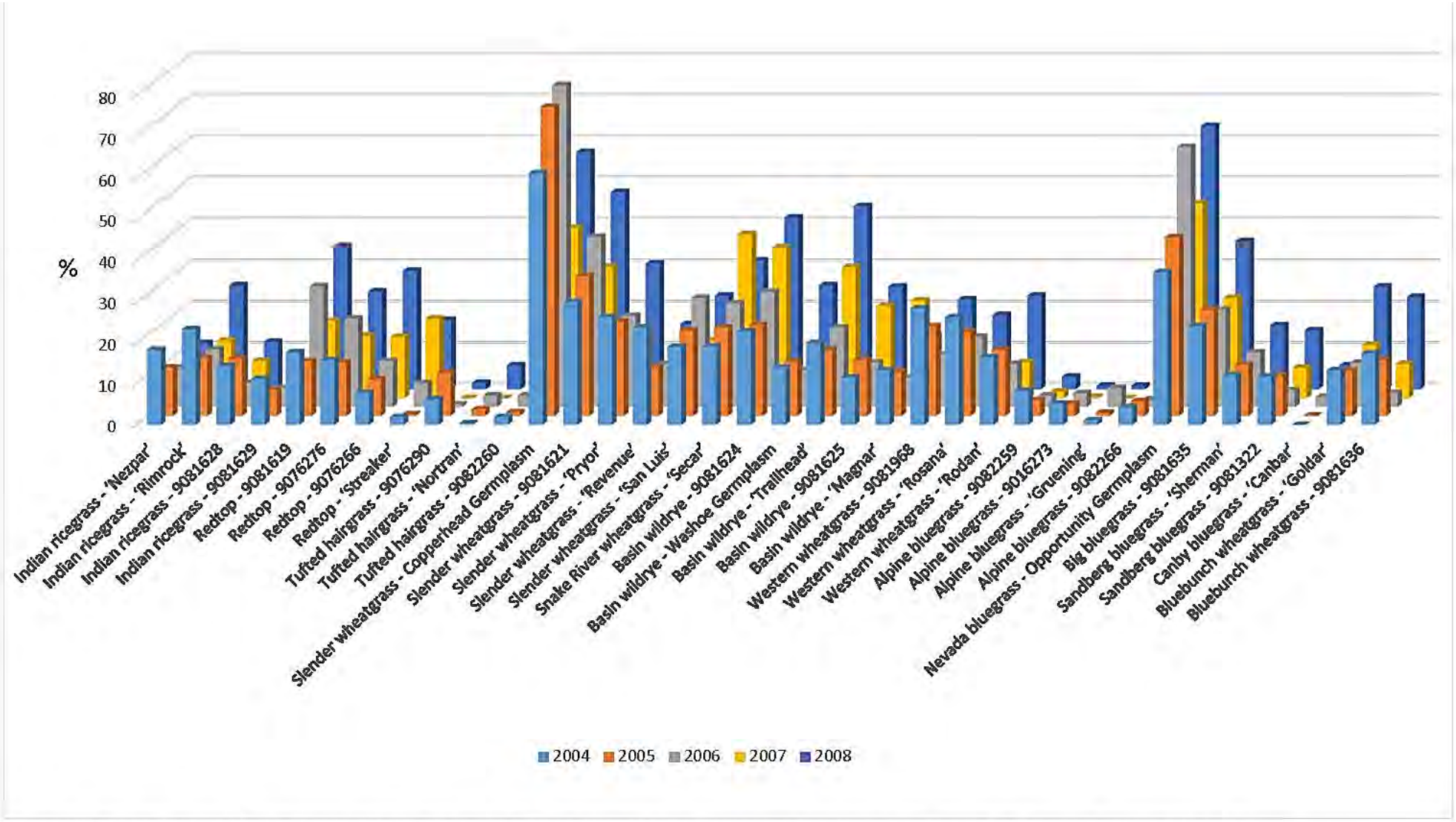

Figure 8. Stand Percentage of Grasses at Stucky Ridge CEP 2004 to 2008 near Anaconda, Montana USDA-NRSC Bridger Plant Materials Center.

Table 7. Average Plant Height of Grasses in Stucky Ridge Plots 2004 – 2008 near Anaconda, Montana USDA-NRCS Bridger Plant Materials Center.

Genus & Species	Accession	Common Name	Height - inches				
			2004	2005	2006	2007	2008
Achnatherum hymenoides	'Nezpar'	Indian ricegrass	6.7	17.6	23.9	24.3	15.6
Achnatherum hymenoides	'Rimrock'	Indian ricegrass	5.1	14.5	20.7	21.6	15.2
Achnatherum hymenoides	9081628	Indian ricegrass	3.6	9.7	18.2	19.1	9.8
Achnatherum hymenoides	9081629	Indian ricegrass	3.0	9.0	17.9	18.5	5.8
Agrostis gigantea	9076276	Redtop	13.1	23.3	30.7	41.0	13.0
Agrostis gigantea	9081619	Redtop	10.7	22.8	30.4	35.0	14.0
Agrostis gigantea	9076266	Redtop	8.3	18.3	26.1	25.7	14.8
Agrostis gigantea	'Streaker'	Redtop	4.1	11.7	18.3	19.2	12.6
Deschampsia cespitosa	9076290	Tufted hairgrass	5.7	15.6	22.4	21.9	2.0
Deschampsia cespitosa	9082260	Tufted hairgrass	2.8	8.0	17.5	13.3	3.8
Deschampsia cespitosa	'Nortran'	Tufted hairgrass	2.4	5.9	13.0	0.0	6.0
Elymus trachycaulus	Copperhead Germplasm	Slender wheatgrass	21.4	34.4	30.9	44.9	20.1
Elymus trachycaulus	9081621	Slender wheatgrass	13.5	30.0	30.9	41.2	21.9
Elymus trachycaulus	'Pryor'	Slender wheatgrass	7.3	17.9	25.3	25.4	17.0
Elymus trachycaulus	'San Luis'	Slender wheatgrass	5.7	15.6	22.5	23.0	15.7
Elymus trachycaulus	'Revenue'	Slender wheatgrass	5.6	15.3	21.6	21.8	18.2
Elymus wawawaiensis	'Secar'	Snake River wheatgrass	9.4	19.2	27.6	27.8	22.6
Leymus cinereus	9081624	Basin wildrye	7.0	17.9	24.6	24.8	34.3
Leymus cinereus	'Trailhead'	Basin wildrye	6.3	17.2	22.6	23.2	28.6
Leymus cinereus	'Magnar'	Basin wildrye	5.0	14.4	20.0	21.6	23.0
Leymus cinereus	Washoe Germplasm	Basin wildrye	4.9	14.4	20.0	21.6	29.4
Leymus cinereus	9081625	Basin wildrye	4.2	11.9	18.5	20.0	24.6
Pascopyrum smithii	'Rosana'	Western wheatgrass	5.3	15.0	21.4	21.7	7.0
Pascopyrum smithii	'Rodan'	Western wheatgrass	4.8	13.7	19.7	21.0	8.6
Pascopyrum smithii	9081968	Western wheatgrass	4.4	12.2	19.0	20.4	8.0
Poa alpina	9016273	Alpine bluegrass	2.3	4.3	12.9	0.0	2.5
Poa alpina	'Gruening'	Alpine bluegrass	1.8	3.5	11.8	0.0	6.1
Poa alpina	9082266	Alpine bluegrass	1.5	0.0	10.4	0.0	1.0
Poa alpina	9082259	Alpine bluegrass	3.2	9.4	18.0	18.7	6.2
Poa secunda	Opportunity Germplasm	Nevada bluegrass	10.4	19.8	29.1	34.8	17.4
Poa secunda	9081635	Big bluegrass	9.2	18.8	27.5	27.7	14.7
Poa secunda	9081322	Sandberg bluegrass	6.9	17.8	24.4	24.6	11.5
Poa secunda	'Sherman'	Sandberg bluegrass	2.7	6.7	16.7	9.0	10.3
Poa secunda	'Canbar'	Canby bluegrass	2.4	6.1	15.5	8.6	3.8
Pseudoroegneria spicata	'Goldar'	Bluebunch wheatgrass	8.9	18.5	26.7	26.5	17.7
Pseudoroegneria spicata	9081636	Bluebunch wheatgrass	4.7	13.3	19.2	20.6	18.4

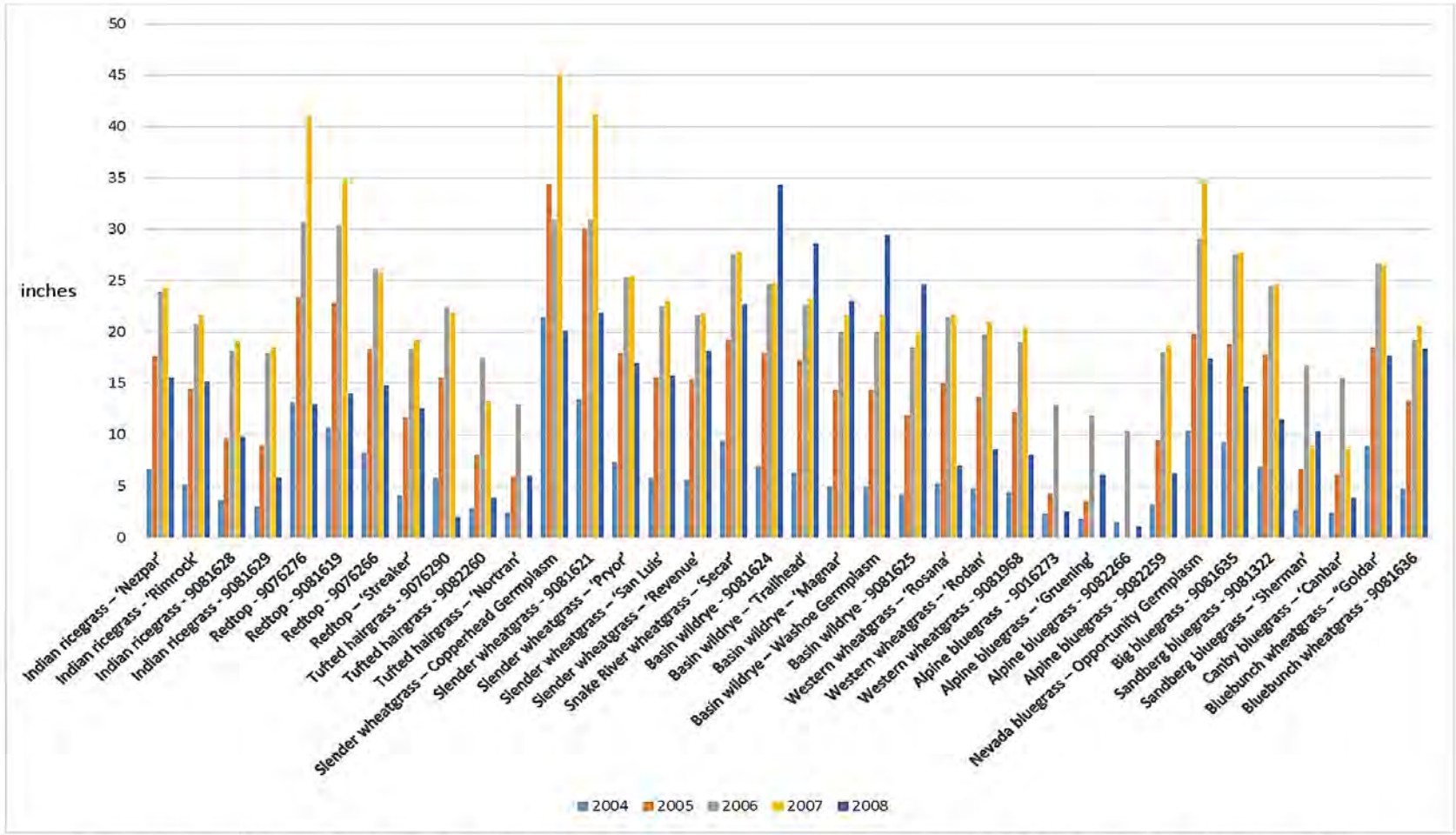

Figure 9. Height of Grasses at Stucky Ridge CEP 2004 to 2008 near Anaconda, Montana USDA-NRCS Bridger Plant Materials Center.

Table 8. Biomass production of grasses in Stucky Ridge Trials 2004 – 2008 near Anaconda, Montana USDA-NRCS Bridger Plant Materials Center.

Genus & Species	Accession	Common Name	Biomass lb/acre				
			2004	2005	2006	2007	2008
Achnatherum hymenoides	'Nezpar'	Indian ricegrass	150.9	778.7	912.8	525.9	188.5
Achnatherum hymenoides	'Rimrock'	Indian ricegrass	75.0	302.7	605.3	520.9	560.6
Achnatherum hymenoides	9081628	Indian ricegrass	30.4	54.5	411.8	570.5	788.8
Achnatherum hymenoides	9081629	Indian ricegrass	20.5	54.5	124.0	327.4	119.1
Agrostis gigantea	9081619	Redtop	630.5	1954.8	2966.7	838.4	1379.2
Agrostis gigantea	9076276	Redtop	256.3	1820.8	1384.2	491.2	749.1
Agrostis gigantea	9076266	Redtop	165.2	1220.7	1086.5	580.5	679.7
Agrostis gigantea	'Streaker'	Redtop	0.0	108.9	555.6	491.2	431.6
Deschampsia cespitosa	9076290	Tufted hairgrass	172.3	753.7	69.5	0.0	0.0
Deschampsia cespitosa	'Nortran'	Tufted hairgrass	65.2	0.0	79.4	0.0	49.6
Deschampsia cespitosa	9082260	Tufted hairgrass	7.1	25.0	34.7	0.0	5.0
Elymus trachycaulus	Copperhead Germplasm	Slender wheatgrass	1860.1	7332.4	2063.8	828.5	1984.4
Elymus trachycaulus	9081621	Slender	485.8	3661.3	4370.7	1349.4	1270.0
Elymus trachycaulus	'Pryor'	Slender	344.7	1409.2	893.0	659.8	942.6
Elymus trachycaulus	'Revenue'	Slender	237.5	516.2	1136.1	406.8	644.9
Elymus trachycaulus	'San Luis'	Slender	89.3	555.4	694.6	868.2	456.4
Elymus wawawaiensis	'Secar'	Snake River	368.8	1151.1	1938.8	1066.6	2311.9
Leymus cinereus	9081624	Basin wildrye	297.4	1646.7	2351.6	3199.9	2803.0
Leymus cinereus	Washoe Germplasm	Basin wildrye	258.1	322.4	1776.1	1795.9	2118.4
Leymus cinereus	'Trailhead'	Basin wildrye	171.5	1984.2	2014.2	2019.2	3319.0
Leymus cinereus	9081625	Basin wildrye	110.7	382.2	1572.7	1969.6	3383.5
Leymus cinereus	'Magnar'	Basin wildrye	67.0	570.6	1384.2	1309.7	689.6
Pascopyrum smithii	9081968	Western	113.4	714.4	406.8	109.1	178.6
Pascopyrum smithii	'Rosana'	Western	84.8	580.5	262.9	109.1	267.9
Pascopyrum smithii	'Rodan'	Western	75.9	168.8	823.5	302.6	178.6
Poa alpina	9082259	Alpine bluegrass	82.2	20.5	158.8	124.0	29.8
Poa alpina	9016273	Alpine bluegrass	71.4	45.5	64.5	9.9	24.8
Poa alpina	'Gruening'	Alpine bluegrass	13.4	0.0	74.4	0.0	24.8
Poa alpina	9082266	Alpine bluegrass	6.3	25.0	5.0	39.7	5.0
Poa secunda	Opportunity Germplasm	Nevada bluegrass	364.3	2237.9	2063.8	1126.2	2351.6
Poa secunda	9081635	Big bluegrass	192.9	809.1	1026.9	620.1	1086.5
Poa secunda	'Sherman'	Sandberg	163.4	168.8	272.9	248.1	312.6
Poa secunda	9081322	Sandberg	21.4	208.1	396.9	277.8	243.1
Poa secunda	'Canbar'	Canby bluegrass	0.0	0.0	109.1	59.5	79.4
Pseudoroegneria spicata	'Goldar'	Bluebunch	147.3	242.9	957.5	759.1	1121.2
Pseudoroegneria spicata	9081636	Bluebunch	86.6	283.1	357.2	382.0	625.1

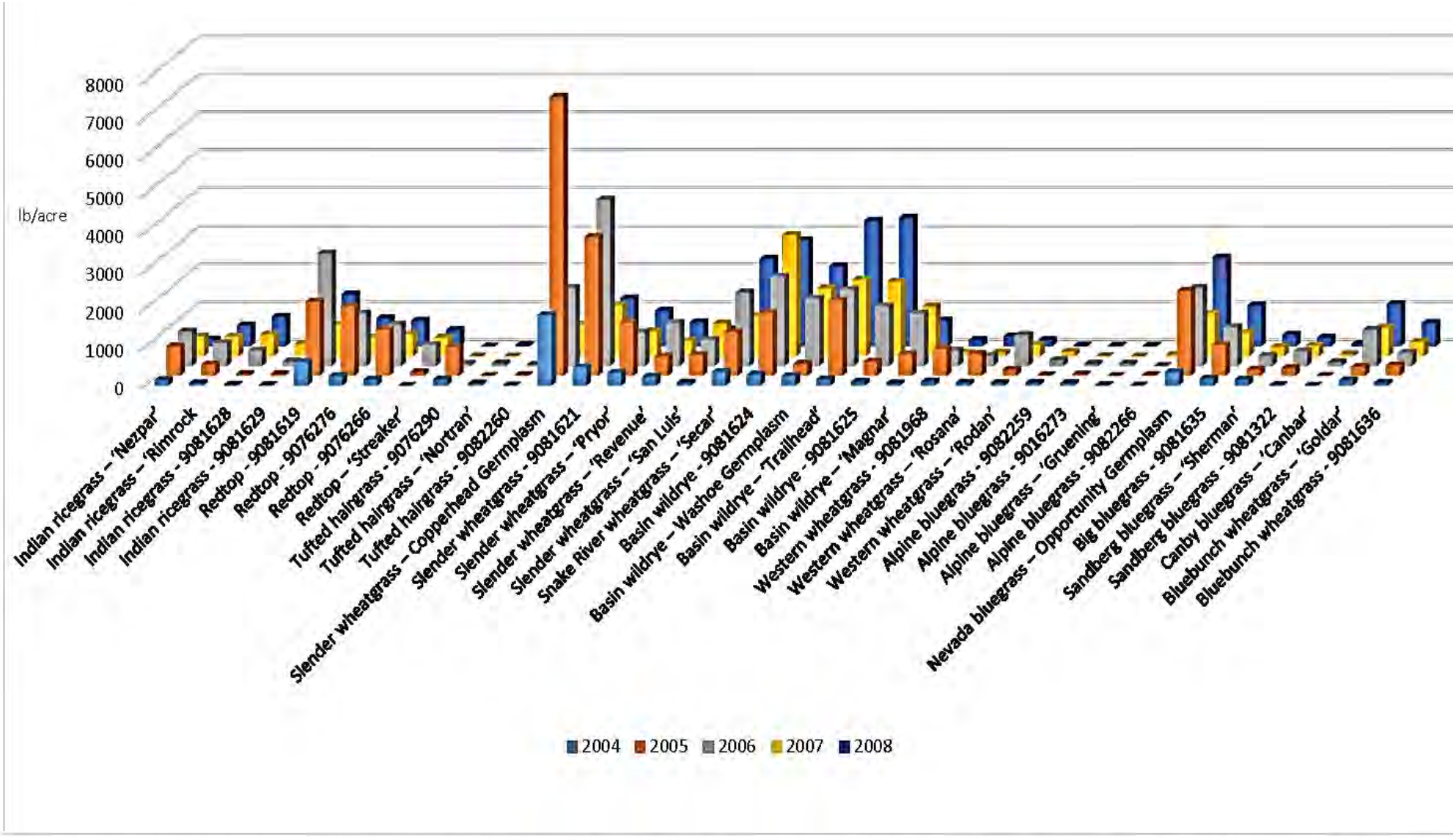

Figure 10. Biomass of Grasses at Stucky Ridge CEP 2004 to 2008 near Anaconda, Montana USDA-NRCS Bridger Plant Materials Center.

Table 9. Vigor Rating of Grass Trials on Stucky Ridge Plots 2004 – 2008 near Anaconda, Montana USDA-NRCS Bridger Plant Materials Center.

Genus & Species	Accession	Common Name	Vigor rating: 1 = best vigor: 4 = average vigor; 9 = dead				
			2004	2005	2006	2007	2008
Achnatherum hymenoides	'Nezpar'	Indian ricegrass	5.4	4.6	3.9	5.7	3.8
Achnatherum hymenoides	'Rimrock'	Indian ricegrass	4.8	4.5	4.4	4.9	4.1
Achnatherum hymenoides	9081628	Indian ricegrass	4.8	5.3	4.5	5.3	4.6
Achnatherum hymenoides	9081629	Indian ricegrass	4.3	5.7	4.0	6.8	4.5
Agrostis gigantea	9081619	Redtop	5.0	3.2	4.9	5.5	4.1
Agrostis gigantea	9076276	Redtop	5.3	3.7	4.6	6.2	4.7
Agrostis gigantea	9076266	Redtop	4.2	4.0	5.5	6.0	3.9
Agrostis gigantea	'Streaker'	Redtop	6.2	1.5	5.0	0.0	4.4
Deschampsia cespitosa	9076290	Tufted hairgrass	4.8	3.9	5.1	6.0	5.3
Deschampsia cespitosa	'Nortran'	Tufted hairgrass	5.3	3.8	6.1	9.0	5.0
Deschampsia cespitosa	9082260	Tufted hairgrass	4.0	3.8	5.2	0.0	5.7
Elymus trachycaulus	Copperhead Germplasm	Slender wheatgrass	2.1	2.1	3.3	4.0	3.5
Elymus trachycaulus	9081621	Slender wheatgrass	3.3	2.7	3.4	4.5	3.4
Elymus trachycaulus	'Pryor'	Slender wheatgrass	4.9	5.3	4.8	5.2	4.6
Elymus trachycaulus	'Revenue'	Slender wheatgrass	5.1	5.4	4.7	4.0	4.8
Elymus trachycaulus	'San Luis'	Slender wheatgrass	4.6	4.6	5.0	4.3	4.7
Elymus wawawaiensis	'Secar'	Snake River	4.4	4.3	4.1	5.1	4.1
Leymus cinereus	9081624	Basin wildrye	4.9	3.8	4.6	4.5	3.5
Leymus cinereus	Washoe Germplasm	Basin wildrye	5.2	4.8	4.5	5.0	4.5
Leymus cinereus	'Trailhead'	Basin wildrye	4.8	4.3	4.7	5.4	4.3
Leymus cinereus	9081625	Basin wildrye	3.3	5.5	5.5	4.6	5.0
Leymus cinereus	'Magnar'	Basin wildrye	2.9	5.2	4.4	5.1	4.3
Pascopyrum smithii	9081968	Western wheatgrass	5.0	4.5	4.0	5.2	4.7
Pascopyrum smithii	'Rosana'	Western wheatgrass	4.8	4.7	3.7	5.1	5.0
Pascopyrum smithii	'Rodan'	Western wheatgrass	5.6	5.0	5.0	4.8	4.0
Poa alpina	9082259	Alpine bluegrass	4.5	5.0	5.4	5.5	6.2
Poa alpina	9016273	Alpine bluegrass	4.5	3.8	4.8	8.0	5.0
Poa alpina	'Gruening'	Alpine bluegrass	5.2	1.5	5.0	0.0	4.5
Poa alpina	9082266	Alpine bluegrass	4.0	5.3	5.5	7.5	6.7
Poa secunda	Opportunity Germplasm	Nevada bluegrass	4.8	4.8	2.9	4.7	3.2
Poa secunda	9081635	Big bluegrass	3.4	3.3	3.3	3.2	4.4
Poa secunda	'Sherman'	Sandberg bluegrass	3.2	4.0	4.4	4.6	4.5
Poa secunda	9081322	Sandberg bluegrass	3.3	4.2	4.9	5.0	4.6
Poa secunda	'Canbar'	Canby bluegrass	5.5	8.0	4.5	0.0	4.0
Pseudoroegneria spicata	'Goldar'	Bluebunch wheatgrass	5.7	4.6	5.2	5.0	3.5
Pseudoroegneria spicata	9081636	Bluebunch wheatgrass	5.2	4.5	4.0	4.9	3.7

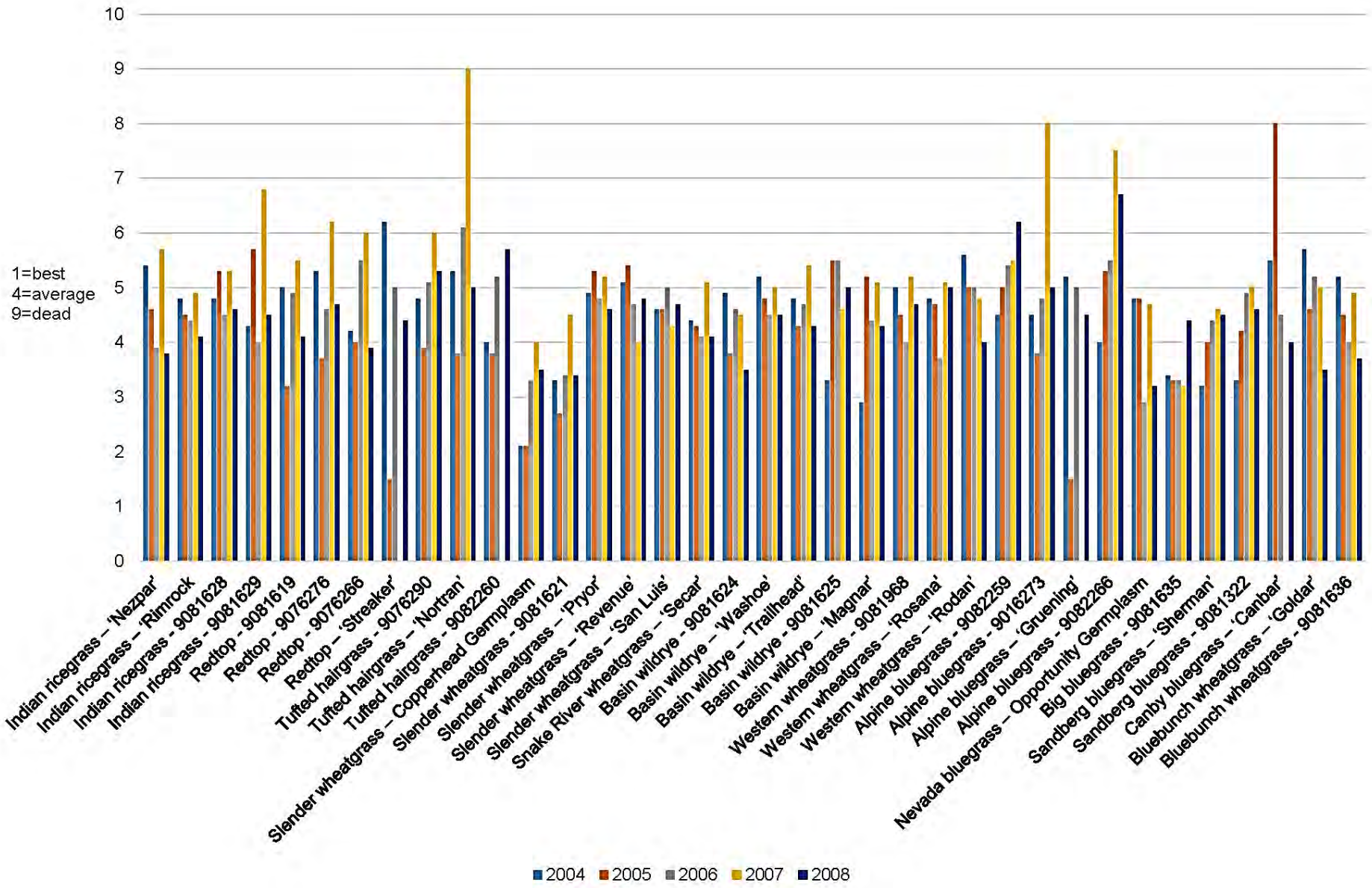

Figure 11. Vigor of Grasses at Stucky Ridge CEP 2004 to 2008 Anaconda, Montana, USDA-NRCS Bridger Plant Materials Center.

Table 10. Seedling density (2003), stand percentage (2004), and total plant density (2005) of forb and subshrub accessions near Anaconda, Montana USDA-NRCS Bridger Plant Materials Center.

Genus & Species	Variety/Accession	Species ID	2003 Density *Seedlings/ft²*		2004 Stand *%*		2005 *Avg. Plants/ Plot*
			6/24	8/25	6/30	9/22	8/30
Kraschenninnikovia lanata	Open Range Germplasm	5	9.5	6.8	5.5	4.5	20.0
Phacelia hastata	9081632	10	0.3	0.2	0.5	0.5	6.0
Kraschenninnikovia lanata	Northern Cold Desert Germplasm	4	0.2	0.2	0.0	0.0	0.3
Penstemon strictus	'Bandera'	8	0.2	0.0	0.0	0.0	0.0
Eriogonum umbellatum	9082271	2	0.1	0.0	0.0	0.0	0.0
Penstemon venustus	Clearwater Selected	9	0.0	0.0	0.0	0.0	0.0
Eriogonum umbellatum	9082273	3	0.0	0.0	0.0	0.0	0.0
Penstemon eatonii	Richfield Select	7	0.0	0.0	0.0	0.0	0.8
Eriogonum ovalifolium	9082098	1	0.0	0.0	0.0	0.0	0.0
Penstemon eriantherus	Old Works Germplasm	6	0.0	0.0	0.0	0.0	15.0
Phacelia hastata	9082275	11	0.0	0.0	0.0	0.0	0.0
Potentilla gracilis	9081679	12	0.0	0.0	0.0	0.0	0.0
Potentilla hippiana	9076274	13	0.0	0.0	0.0	0.0	0.0
Symphyotrichum chilense	9078675	14	0.0	0.0	0.0	0.0	0.0
Symphyotrichum chilense	9081678	15	0.0	0.0	0.0	0.0	0.0
Symphyotrichum chilense	9082274	16	0.0	0.0	0.0	0.0	0.0

(Evaluated June 24, 03, August 25, 03, June 30, 04, September 22, 04, and August 30, 05).

Table 11. Stucky Ridge Seed Mixture Trial near Anaconda, Montana USDA-NRCS Bridger Plant Materials Center.

Mix	Density seedlings/ft²		Stand %					Height inches				Biomass lb/acre			
	6/03	8/03	6/04	9/04	8/05	8/06	8/07	2004	2005	2006	2007	2004	2005	2006	2007
Upland Experimental	6.4	7.4	39.4	45.9	60.6	49.7	27.8	18.1	31.1	29.7	26.8	705.5	5,303.5	1,220.7	967.4
Upland Developed	9.3	7.0	17.3	24.4	25.9	35.9	27.2	5.8	18.6	22.7	27.8	192.0	1,795.8	1,592.2	1,503.2
Waste Mgmt. Experimental	6.3	6.9	38.1	46.9	59.7	65.0	34.1	17.7	32.5	30.1	26.4	1,077.0	7,977.2	3,666.7	1,582.6
Waste Mgmt. Developed	10.5	8.0	15.0	23.8	28.4	38.1	26.3	7.8	22.3	28.5	26.8	273.3	4,013.1	2,956.7	1,240.3

Table 12. *Achnatherum hymenoides*.

Accession/ Species ID	Species Symbol	Genus & Species	Accession
1	ACHY	*Achnatherum hymenoides*	9081628
2	ACHY	*Achnatherum hymenoides*	9081629
3	ACHY	*Achnatherum hymenoides*	'Rimrock'
4	ACHY	*Achnatherum hymenoides*	'Nezpar'
Height	- No significant difference between accessions for height. - Accession 4 had the highest mean height followed by accessions 3, 2, 1.		
Vigor	- No significant difference between accessions. - Accession 3 had the highest mean vigor followed by accessions 4, 1, 2.		
Biomass	- No significant difference between accessions. - Accession 4 had the highest mean biomass, followed by accessions 3, 1, 2.		
Stand	- No significant difference between accessions. - Accession 3 had the highest mean stand, followed by accessions 1, 4, 2.		

Table 13. *Agrostis gigantea*.

Accession/ Species ID	Species Symbol	Genus & Species	Accession
1	AGGI	*Agrostis gigantea*	9076276
2	AGGI	*Agrostis gigantea*	9081619
3	AGGI	*Agrostis gigantea*	9076266
4	AGGI	*Agrostis gigantea*	'Streaker'
Height	- No significant difference between accessions for height. - Accession 4 had the highest mean height followed by accessions 3, 2, 1.		
Vigor	- No significant difference between accessions. - Accession 4 had the highest mean vigor followed by accessions 3, 1, 2.		
Biomass	- No significant difference between accessions. - Accession 4 had the highest mean biomass, followed by accessions 3, 1, 2.		
Stand	- No significant difference between accessions. - Accession 3 had the highest mean stand, followed by accessions 1, 4, 2.		

Table 14. *Deschampsia cespitosa*.

Accession/ Species ID	Species Symbol	Genus & Species	Accession
1	DECE	*Deschampsia cespitosa*	9076290
2	DECE	*Deschampsia cespitosa*	9082260
3	DECE	*Deschampsia cespitosa*	'Nortran'
Height	- No significant difference between accessions for height. - Accession 1 had the highest mean height followed by accessions 3, 2.		
Vigor	- No significant difference between accessions. - Accession 1 had the highest mean vigor followed by accessions 3, 2.		
Biomass	- No significant difference between accessions. - Accession 1 had the highest mean biomass, followed by accessions 3, 2.		
Stand	- No significant difference between accessions. - Accession 3 had the highest mean stand, followed by accessions 2, 1.		

Table 15. *Elymus trachycaulus*.

Accession/ Species ID	Species Symbol	Genus & Species	Accession
1	ELTR	*Elymus trachycaulus*	Copperhead Germplasm
2	ELTR	*Elymus trachycaulus*	9081621
3	ELTR	*Elymus trachycaulus*	'Pryor'
4	ELTR	*Elymus trachycaulus*	'Revenue'
5	ELTR	*Elymus trachycaulus*	'San Luis'
Height	- No significant difference between accessions for height. - Accession 2 had the highest mean height followed by accessions 1, 4, 3, 5.		
Vigor	- Accessions 1 and 2 are significantly different than accessions 3, 4, 5. - Accession 2 had the highest mean vigor followed by accessions 1, 3, 5, 4.		
Biomass	- No significant difference between accessions. - Accession 1 had the highest mean biomass, followed by accessions 2, 3, 4, 5.		
Stand	- Accession 1 is significantly different than accessions 4 & 5. - Accession 1 had the highest mean stand, followed by accessions 2, 3, 5, 4.		

Table 16. *Leymus cinereus*.

Accession/ Species ID	Species Symbol	Genus & Species	Accession
1	LECI	*Leymus cinereus*	9081624
2	LECI	*Leymus cinereus*	9081625
3	LECI	*Leymus cinereus*	Washoe Germplasm
4	LECI	*Leymus cinereus*	'Magnar'
5	LECI	*Leymus cinereus*	'Trailhead'
Height	- No significant difference between accessions for height. - Accession 1 had the highest mean height followed by accessions 3, 4, 5, 2.		
Vigor	- No significant difference between accessions. - Accession 1 had the highest mean vigor followed by accessions 5, 4, 3, 2.		
Biomass	- No significant difference between accessions. - Accession 2 had the highest mean biomass, followed by accessions 5, 1, 3, 4.		
Stand	- No significant difference between accessions. - Accession 5 had the highest mean stand, followed by accessions 1, 3, 2, 4.		

Table 17. *Pascopyrum smithii*.

Accession/ Species ID	Species Symbol	Genus & Species	Accession
1	PASM	*Pascopyrum smithii*	9081968
2	PASM	*Pascopyrum smithii*	'Rodan'
3	PASM	*Pascopyrum smithii*	'Rosana'
Height	- No significant difference between accessions for height. - Accession 2 had the highest mean height followed by accessions 3, 1.		
Vigor	- No significant difference between accessions. - Accession 2 had the highest mean vigor followed by accessions 3, 1.		
Biomass	- No significant difference between accessions. - Accession 3 had the highest mean biomass, followed by accessions 1, 3.		
Stand	- No significant difference between accessions. - Accession 2 had the highest mean stand, followed by accessions 1, 3.		

Table 18. *Poa alpina*.

Accession/ Species ID	Species Symbol	Genus & Species	Accession
1	POAL	*Poa alpina*	9016273
2	POAL	*Poa alpina*	9082259
3	POAL	*Poa alpina*	'Gruening'
4	POAL	*Poa alpina*	9082266
Height	- No significant difference between accessions for height. - Accession 3 had the highest mean height followed by accessions 2, 1, 4.		
Vigor	- No significant difference between accessions. - Accession 3 had the highest mean vigor followed by accessions 4, 1, 2.		
Biomass	- No significant difference between accessions. - Accession 2 had the highest mean biomass, followed by accessions 1, 3, 4.		
Stand	- No significant difference between accessions. - Accession 2 had the highest mean stand, followed by accessions 1, 3, 4.		

Table 19. *Poa secunda*.

Accession/ Species ID	Species Symbol	Genus & Species	Accession
1	POSE	*Poa secunda*	Opportunity Germplasm
2	POSE	*Poa secunda*	'Sherman'
3	POSE	*Poa secunda*	'Canbar'
4	POSE	*Poa secunda*	9081635
5	POSE	*Poa secunda*	9081322
Height	- Accession 1 is significantly greater than accession 3. - Accession 1 had the highest mean height followed by accessions 3, 5, 4, 2.		
Vigor	- No significant difference between accessions. - Accession 1 had the highest mean vigor followed by accessions 3, 2, 4, 5.		
Biomass	- Accession 1 is significantly greater than the other four accessions. Accessions 1, 2, 4 are significantly different than accessions 3 & 5. - Accession 1 had the highest mean biomass, followed by accessions 4, 2, 5, 3.		
Stand	- Accession 1 is significantly different than accessions 2, 3, & 5. - Accession 1 had the highest mean stand, followed by accessions 4, 2, 5, 3.		

Table 20. *Pseudoroegneria spicata*.

Accession/ Species ID	Species Symbol	Genus & Species	Accession
1	PSSP	*Pseudoroegneria spicata*	9081636
2	PSSP	*Pseudoroegneria spicata*	'Goldar'
Height	- No significant difference between accessions for height. - Accession 1 had the highest mean height followed by accession 2.		
Vigor	- No significant difference between accessions - Accession 1 had the highest mean vigor followed by accession 2.		
Biomass	- No significant difference between accessions. - Accession 1 had the highest mean biomass, followed by accession 2.		
Stand	- No significant difference between accessions. - Accession 2 had the highest mean stand, followed by accession 1.		

Table 21. Species/Accession Performance Ranking from the Comparative Evaluation Planting near Anaconda, Montana.

Year	Rank	Three Highest Means			
		Stand	Biomass	Height	Vigor
2004	1	*Elymus trachycaulus* slender wheatgrass Copperhead	*Elymus trachycaulus* slender wheatgrass Copperhead	*Elymus trachycaulus* slender wheatgrass Copperhead	*Elymus trachycaulus* slender wheatgrass Copperhead
	2	*Poa secunda* Nevada bluegrass Opportunity	*Agrostis gigantea* redtop 9081619	*Elymus trachycaulus* slender wheatgrass 9081621	*Leymus cinereus* basin wildrye 'Magnar'
	3	*Elymus trachycaulus* slender wheatgrass 9081621	*Elymus trachycaulus* slender wheatgrass 9081621	*Agrostis gigantea* redtop 9076276	*Poa secunda* big bluegrass 'Sherman'
2005	1	*Elymus trachycaulus* slender wheatgrass Copperhead	*Elymus trachycaulus* slender wheatgrass Copperhead	*Elymus trachycaulus* slender wheatgrass Copperhead	*Elymus trachycaulus* slender wheatgrass Copperhead
	2	*Poa secunda* Nevada bluegrass Opportunity	*Elymus trachycaulus* slender wheatgrass 9081621	*Elymus trachycaulus* slender wheatgrass 9081621	*Agrostis gigantea* redtop 'Streaker'
	3	*Elymus trachycaulus* slender wheatgrass 9081621	*Poa secunda* Nevada bluegrass Opportunity	*Agrostis gigantea* red top 9076276	*Poa alpina* alpine bluegrass 'Gruening'
2006	1	*Elymus trachycaulus* slender wheatgrass Copperhead	*Elymus trachycaulus* slender wheatgrass 9081621	*Elymus trachycaulus* slender wheatgrass Copperhead	*Poa secunda* Nevada bluegrass Opportunity
	2	*Poa secunda* Nevada bluegrass Opportunity	*Agrostis gigantea* redtop 'Streaker'	*Elymus trachycaulus* slender wheatgrass 9081621	*Elymus trachycaulus* slender wheatgrass Copperhead
	3	*Elymus trachycaulus* slender wheatgrass 9081621	*Leymus cinereus* basin wildrye 9081624	*Agrostis gigantea* redtop 9076276	*Poa secunda* Canbyi bluegrass 9081635
2007	1	*Poa secunda* Nevada bluegrass Opportunity	*Poa secunda* Nevada bluegrass Opportunity	*Elymus trachycaulus* slender wheatgrass Copperhead	*Poa secunda* Sandberg bluegrass 'Canbar'
	2	*Elymus trachycaulus* slender wheatgrass Copperhead	*Elymus trachycaulus* slender wheatgrass Copperhead	*Elymus trachycaulus* slender wheatgrass 9081621	*Poa alpina* alpine bluegrass 'Gruening'
	3	*Elymus wawawaiensis* Snake River wheatgrass 'Secar'	*Elymus wawawaiensis* Snake River wheatgrass 'Secar'	*Agrostis gigantea* redtop 9076276	*Agrostis gigantea* redtop 'Streaker'
2008	1	*Poa secunda* Nevada bluegrass Opportunity	*Leymus cinereus* basin wildrye 9081625	*Leymus cinereus* basin wildrye 9081624	*Poa secunda* Nevada bluegrass Opportunity
	2	*Elymus trachycaulus* slender wheatgrass Copperhead	*Leymus cinereus* basin wildrye 'Trailhead'	*Leymus cinereus* basin wildrye Washoe	*Elymus trachycaulus* slender wheatgrass 9081621
	3	*Elymus trachycaulus* slender wheatgrass 9081621	*Leymus cinereus* basin wildrye 9081624	*Leymus cinereus* basin wildrye 'Trailhead'	*Elymus trachycaulus* slender wheatgrass Copperhead