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THE
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NATURAL RESOURCES CONSERVATION SERVICE
SCIENCE AND TECHNOLOGY
WASHINGTON, D.C.

and

MONTANA AGRICULTURAL EXPERIMENT STATIONS
MONTANA STATE UNIVERSITY
BOZEMAN, MONTANA

and

WYOMING AGRICULTURAL EXPERIMENT STATIONS
UNIVERSITY OF WYOMING
LARAMIE, WYOMING

in cooperation with the

DEER LODGE VALLEY CONSERVATION DISTRICT
DEER LODGE, MONTANA

NOTICE OF RELEASE OF OPPORTUNITY GERmplasm BIG BLUEGRASS SELECTED CLASS OF NATURAL GERmplasm

The U.S. Department of Agriculture Natural, Resources Conservation Service-Bridger Plant Materials Center, Montana Agricultural Experiment Stations-Montana State University, and Wyoming Agricultural Experiment Stations-University of Wyoming in cooperation with the Deer Lodge Valley Conservation District, announce the selected class pre-varietal release of Opportunity Germplasm big bluegrass *Poa secunda* J. Presl (formerly *Poa ampla*) for the intermountain foothills and mountains of Montana and Wyoming, with particular emphasis on areas characterized by low pH and contamination by heavy metals. This selection was evaluated and selected by the staff from the USDA/NRCS Plant Materials Center, Bridger, Montana, and the Deer Lodge Valley Conservation District.

As a selected class release, this selection will be referred to as Opportunity Germplasm big bluegrass, NRCS accession number 9081633.

Justification for this alternative release procedure is based on a critical need for well-adapted plant materials for acidic and heavy-metal contaminated sites in low to mid-mountain elevations in the foothills of central Montana and Wyoming. A lack of tested and adapted germplasm and the potential use of non-adapted seed sources further support selected class release. Additionally, this selection originates from a northern Rocky Mountain seed source that should prove well adapted to the conditions in the intended geographic area of use. Opportunity Germplasm big bluegrass was selected for superior percentage stand cover, vigor rating, mean plant height, and biomass production relative to other *Poa secunda* accessions tested. Opportunity Germplasm big bluegrass can also be used in other conservation applications such as post-fire reclamation, native range restoration, wildlife habitat enhancement, logging road revegetation, and mined land reclamation.

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Collection Site Information: The original Opportunity Germplasm big bluegrass (accession number 9081633) seed collection was made in 1998 near the Wisdom Junction along Highway 1, 1.5 km (0.93 miles) east of Anaconda, Montana. Seed was collected from at least 10 individual plants. The collection site was severely contaminated with heavy metals from smelter fallout, surface wind and water transport, as well as historic overflow from the waste canal that supplied the Opportunity Sediment Ponds. Surface pH of the soil was 4.3. The original donor plants were found growing in association with slender wheatgrass *Elymus trachycaulus*, redtop *Agrostis gigantea*, scarlet globemallow *Sphaeralcea coccinea*, and western wheatgrass *Pascopyrum smithii*. Reshaping and replanting of the original site has occurred since the collection was made.

Description: Opportunity Germplasm big bluegrass has the same general botanical (floral, foliage, fruit, and seed) and phenological attributes as the species and variety. When descriptive information is specific to Opportunity Germplasm, it is noted as such. It is assumed Opportunity Germplasm traits are heritable and that the progeny from this selection will appear and perform in a similar manner. Big bluegrass is a long-lived perennial bunchgrass. The donor plants of this selection reached 61 to 122 cm (2 to 4 feet) in height by early July. Opportunity Germplasm big bluegrass reached a mean plant height of 62.4 cm (24.5 inches) on the pH adjusted test site in a 355 millimeter (14 inches) precipitation zone four years after planting. Big bluegrass is a medium-stature, cool season grass with numerous basal leaves reaching 20.3 to 40.6 cm (8 to 16 inches) in length. Big bluegrass leaves are smooth, deep blue-green and folded with keel-shaped tips typical of bluegrasses. The species inflorescence is a narrow panicle up to 20.3 cm (8 inches) long.

Method of Selection: Opportunity Germplasm big bluegrass is being released as a 'Natural-Track' germplasm, i.e., it is being increased without purposeful manipulation. This selection was compared to two *Poa secunda* seed sources collected from acid/heavy-metal impacted sites; accession number 9081635 collected on Stucky Ridge north of Anaconda, Montana, and accession number 9081322 originating in Marysville, Montana. Opportunity Germplasm was also tested against two released *Poa secunda* cultivars; 'Canbar' (Washington state), and 'Sherman' (collected in Sherman County, Oregon). Taxonomically, all five accessions are currently listed as *Poa secunda*, although some accessions were originally described as different and/or distinct species. Opportunity Germplasm and 'Sherman' big bluegrass were originally classified as *Poa ampla*. Accession number 9081635 and 'Canbar' were originally classified as *Poa canbyii*, whereas accession number 9081322 was originally classified as *Poa sandbergii*. All five collections were field tested for four years at one upland site in the Anaconda, Montana, area that was deep plowed and amended with lime. Opportunity Germplasm big bluegrass exhibited superior seedling emergence, percentage stand cover, vigor rating, mean plant height, biomass production, and seedling and stand survival on lime-amended, acid/heavy-metal impacted sites under the ambient climatic conditions of the Upper Clark Fork Watershed (Deer Lodge County, Montana).

Testing: Testing was conducted on Stucky Ridge, Anaconda, Montana, (an acid/heavy-metal impacted site) each year for four growing seasons. Seedling density was evaluated in the summer and fall of 2003, establishment year, whereas percentage stand cover, vigor rating, mean plant height, and dry biomass were evaluated in 2004 through 2006. The test site is located on Stucky Ridge, approximately 3.2 km (2 miles) northeast of Anaconda, Montana, in Deer Lodge County. The legal description and geographic position of the study site is the SW 1/4 of the SW 1/4 of Section 30, Range 11 West, Township 5 North and North 46°09'09"/ West 112°54'30", respectively. The study plot occupies 0.61 hectares (1.5 acres) in sub-polygon OWSR-013.09, which is part of the Stucky Ridge Remedial Design Unit (RDU) #1 within the Anaconda Regional Water, Waste, and Soils Operable Unit.

RDU #1 encompasses 98 hectares (242 acres) of approximately 5,261 hectares (13,000 acres) of upland terrestrial vegetation contaminated by emission fallout from the Washoe, Upper, and Lower Works smelters. Contamination identified in the Stucky Ridge RDU includes elevated arsenic concentrations in surface soils, barren or sparsely vegetated areas due to low pH and elevated contaminant concentrations, and steep slopes with high erosion potentials (ARCO 2002, May) (Table 1). Current and historic use of this area consists primarily of agricultural grazing, recreational, open space, and wildlife habitat.

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The test plot is situated on a stream terrace above Lost Creek at an elevation of 1,618 meters (5,308 feet) above sea level, and is sited on relatively flat ground on the east end of Stucky Ridge. Sparse vegetation cover includes scattered groves of quaking aspen *Populus tremuloides*, shrublands dominated by Wood's rose *Rosa woodsii*, currant *Ribes* species, rubber rabbitbrush *Chamerion nauseosa*, horsebrush *Tetradymia canescens*; and grasslands dominated by redtop *Agrostis gigantea* and basin wildrye *Leymus cinereus*. Annual precipitation at the site ranges from 254 to 356 mm (10 to 14 inches) with most of the precipitation occurring in the spring. The parent material is alluvium. The soil has a gravelly loam texture and is well drained. The slope at the plot site averages approximately 5 to 10 percent.

Stucky Ridge Comparative Evaluation Planting: The entire Stucky Ridge Comparative Evaluation Planting (CEP) site was deep plowed in September 2002, followed by amendment with approximately 20 metric tons per hectare of lime. The lime was incorporated into the soil by disking (four passes) the surface 30 cm (12 inches) of the soil profile. Pre- and post-treatment soil analyses, as well as phytotoxicity standards for pH, arsenic, cadmium, copper, lead, and zinc appear in Tables 1 through 3. Although soil contaminant level and pH varied by depth and location, pre-treatment soil analyses suggested potentially phytotoxic levels of arsenic, copper, and zinc, as well as pH levels unacceptable for growth. Post-treatment soil analyses suggest generally acceptable plant growth levels of arsenic, cadmium, and lead, with acceptable soil pH values. Copper levels were potentially phytotoxic at all sample locations. Soil zinc levels were variable, ranging from acceptable to potentially phytotoxic depending on sample location.

Table 1. Pre-treatment soils analyses, Stucky Ridge CEP area, Anaconda, Montana (ARCO 2002).

Soil Sample Station	Depth <i>inches</i>	As <i>mg/kg</i>	Cu <i>mg/kg</i>	Zn <i>mg/kg</i>	Sat. Paste pH <i>s.u.</i>
94S-SR-71	0-2	-----	-----	-----	4.70
94S-SR-71	2-8	-----	-----	-----	4.90
94S-SR-73	0-2	-----	-----	-----	4.30
94S-SR-73	2-8	-----	-----	-----	4.60
99-098A	0-2	495.0	1660.0	419.0	-----
99-098B	2-6	163.0	1320.0	276.0	-----
99-098C	0-6	-----	-----	-----	4.20
99-098D	6-12	-----	-----	-----	7.60
99-098E	12-18	-----	-----	-----	7.80
99-099A	0-2	489.0	1370.0	303.0	-----
99-099B	2-6	95.8	1020.0	245.0	-----
99-099C	0-6	-----	-----	-----	4.00
99-099D	6-12	-----	-----	-----	7.30
99-099E	12-18	-----	-----	-----	7.70
99-123A	0-2	656.0	1530.0	425.0	-----
99-123B	2-6	167.0	1530.0	332.0	-----
99-123C	0-6	-----	-----	-----	4.40
99-123D	6-12	-----	-----	-----	4.80
99-123E	12-18	-----	-----	-----	6.30
99-163A	0-2	537.0	2180.0	493.0	-----
99-163B	2-6	256.0	1430.0	365.0	-----
99-163C	0-6	-----	-----	-----	4.00
99-163D	6-12	-----	-----	-----	6.20
99-163E	12-18	-----	-----	-----	-----
Phytotoxicity Range		136-315	236-750	196-240	<5

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Table 2. Post-treatment soil analyses (0- to 6-inch composite), grass trials, Stucky Ridge CEP, Anaconda, Montana.

Sample ID.	Sample Description.	pH	As	Cd	Cu	Pb	Zn
		<i>s.u.</i>	<i>mg/kg</i>	<i>mg/kg</i>	<i>mg/kg</i>	<i>mg/kg</i>	<i>mg/kg</i>
GR1	Grass Trial, Rep. 1	8.2	120	1	797	35	174
GR2	Grass Trial, Rep. 2	8.1	117	1	906	34	177
GR3	Grass Trial, Rep. 3	7.9	132	1	833	43	195
GR4	Grass Trial, Rep. 4	8.0	212	2	985	61	228
GDR1	Grass Trial, Rep. 1, Duplicate	7.7	121	1	703	39	153
GDR3	Grass Trial, Rep. 3, Alternate	7.7	178	1	845	57	201
	Phytotoxicity Range	<5	136-315	5.1-20.0	236-750	94-250	196-240

Table 3. Summary mean and composite pre- and post-treatment soil analyses and phytotoxicity standards for the Stucky Ridge CEP, Anaconda, Montana.

Mean Values	pH	As	Cd	Cu	Pb	Zn
		<i>mg/kg</i>	<i>mg/kg</i>	<i>mg/kg</i>	<i>mg/kg</i>	<i>mg/kg</i>
Pre-treatment (0 - 2 in)	4.5	544	NA	1685	NA	410
Pre-treatment (2 - 6 in)	4.4	170	NA	1325	NA	305
Pre-treatment (0 - 6 composite)	4.4	357	NA	1505	NA	358
Post-treatment (0 - 6 composite)	7.8	145	1.3	832	43	194
Phytotoxicity Range	<5	136-315	5.1-20.0	236-750	94-250	196-240

In April 2003, fertilizer was applied and incorporated at a rate of 67 kilograms per hectare (60 pounds per acre) nitrogen, 90 kilograms per hectare (80 pounds per acre) P₂O₅, and 280 kilograms per hectare (250 pounds per acre) K₂O. On May 13, 2003, the test planting was installed comparing the performance of 36 accessions of grasses (11 species), 16 accessions of forbs (11 species), and four grass/forb mixtures. This CEP included three collections of indigenous and two cultivated releases of bluegrass. The planting was installed with a four-row cone-seeder equipped with double-disk openers and adjustable depth bands. Eight, 7.6-meter (25-foot) long rows of each accession were planted 12.7 millimeters (0.5 inches) deep, with 30.5 centimeter (1 foot) space between rows.

A total of five *Poa secunda* seed sources were included in the Stucky Ridge CEP. The entire study consisted of 36 grass accessions (9 genera), 14 forb accessions (5 genera), 2 sub-shrub accessions (1 species), as well as 4 seed mixtures representing 2 seed mixture formulations. The 15 genera included in the CEP had all performed well in previous Development of Acid/Heavy Metal-Tolerant Cultivars (DATC) Project studies. Each test genus included at least one accession collected from a heavy metal contaminated site in the proximity of the Anaconda Smelter NPL Site, with the exception of two winterfat *Krascheninnikovia lanata* accessions that did not. Evaluation data from the grass species in the CEP appears in Appendices 1 through 12.

Seedling density was the only growth response variable used to assess performance during the first growing season (2003). Data was collected from within a 30- x 50-cm (11.8- x 19.7-inch) sampling frame that was randomly placed at five sample locations within each 2.4- x 7.6-meter (8- x 25-foot) treatment

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block. Sampling frames were located randomly along row numbers 2 and 3, as well as rows 6 and 7 to prevent edge-effect error. The sampling frame was situated with its long axis perpendicular to the seeded rows so that each sampling measurement included two rows. Only seedlings rooted within the sampling frame were counted and used to calculate seedling density. Seeded and non-seeded seedlings were counted and recorded separately. Photographs of each treatment block were taken during sampling events. Seedling density data was collected on June 24, 2003, to assess emergence and initial establishment and again on August 25, 2003, to assess subsequent establishment and survival.

In 2004 through 2006, test plots were evaluated on June 30 and July 1, 2004, September 22 and 23, 2004, August 29 and 30, 2005, and August 28 and 29, 2006. A 30- x 50-cm (11.8- x 19.7-inch) sampling frame was randomly placed in four locations within each test plot. For summer evaluations, plants rooted within the sampling frame were evaluated for percentage stand cover, plant vigor rating, and mean plant height. Sampling frames were located randomly along row numbers 2 and 3, as well as rows 6 and 7 to prevent edge-effect error. For fall evaluations, the same random frame locations were used to estimate percentage stand cover, plant vigor rating, mean plant height, as well as sample biomass production. If it was estimated that the total weight of the four biomass samples did not yield at least 10 grams of material, additional plant tissue was sampled to assure enough biomass for tissue analysis. All biomass samples were oven dried at 60°C (140°F) for 24 hours and then weighed. Grab samples were taken from each sample, processed into small pieces, packaged in plastic zip-lock bags, and then delivered to an analytical laboratory for heavy metal analysis. All tissue samples were unwashed, so the heavy-metal results represent a combination of intercellular and surface tissue accumulations.

Results and Discussion

Stucky Ridge CEP *Poa secunda* Performance Results

2003

Seedling density data for all *Poa secunda* accessions tested at the Stucky Ridge CEP on June 24, 2003 appear in Table 4. Seedling density data for all grass species tested at the Stucky Ridge CEP on June 24, 2003 appears in Appendix 1. Opportunity Germplasm big bluegrass (9081633) had significantly greater seedling density (7.13 seedlings per square foot) than all other big bluegrass accessions evaluated on June 24, 2003. By comparison, the grand mean density of all grass species tested in the Stucky Ridge CEP was 5.4 seedlings per square foot, ranging from 14.97 ('Pryor' slender wheatgrass) to 0.3 ('Gruening' alpine bluegrass) seedlings per square foot (see Appendix 1).

Table 4. Seedling density of *Poa secunda* accessions, Stucky Ridge CEP, June 24, 2003, Anaconda, Montana.

Species	Accession Number Or Cultivar	Test ID	Seedling Density <i>seedlings/ft²</i>	Mean Separation
<i>Poa secunda</i> (<i>P. ampla</i>)	9081633 (Opportunity)	29	7.13	DEFG
<i>Poa secunda</i> (<i>P. ampla</i>)	'Sherman'	30	3.13	HIJ
<i>Poa secunda</i>	9081635	32	1.88	IJ
<i>Poa secunda</i>	9081322	33	1.31	IJ
<i>Poa secunda</i>	'Canbar'	31	1.22	IJ

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By the August 25, 2003 evaluation (see Table 5), seedling density for Opportunity Germplasm had declined to 5.16 seedlings per square foot, but was still significantly higher than all other *Poa secunda* accessions tested on that date. The grand mean seedling density of all grasses on the August 25 evaluation was 4.3 seedlings per square foot, ranging from 14.47 (slender wheatgrass 9081620) to 0.31 (Indian ricegrass 9081629) seedlings per square foot (see Appendix 2). This indicates that overall grass seedling density declined by 1.1 seedlings per square foot or 20.4 percent between the June and August evaluations.

Table 5. Seedling density of *Poa secunda* accessions, Stucky Ridge CEP, August 25, 2003, Anaconda, Montana.

Species	Accession Number Or Cultivar	Test ID	Seedling Density <i>seedlings/ft²</i>	Mean Separation
<i>Poa secunda</i> (<i>P. ampla</i>)	9081633 (Opportunity)	29	5.16	CDE
<i>Poa secunda</i> (<i>P. ampla</i>)	'Sherman'	30	2.34	EF
<i>Poa secunda</i>	9081635	32	0.91	F
<i>Poa secunda</i>	9081322	33	0.72	F
<i>Poa secunda</i>	'Canbar'	31	0.47	F

2004

Percentage stand cover, vigor rating, and mean plant height data for all *Poa secunda* accessions tested at the Stucky Ridge CEP on June 30, 2004 appears in Table 6. Percentage stand cover, vigor rating, and mean plant height data for all grass species tested at the Stucky Ridge CEP on June 30, 2004 appears in Appendices 3 and 4. Opportunity Germplasm big bluegrass had significantly higher percentage stand cover (31.3 percent) than all other *Poa secunda* accessions tested. Similarly, Opportunity Germplasm had a vigor rating (3.3) as good, or better, than all other *Poa secunda* accessions tested, and significantly greater mean plant height (26.5 centimeters) than all other *Poa secunda* accessions tested.

Table 6. Percentage stand cover, vigor rating, and mean plant height of *Poa secunda* accessions, Stucky Ridge CEP, June 30, 2004, Anaconda, Montana.

Species	Accession Number Or Cultivar	Percentage Stand Cover %	Vigor Rating (1-9) [†]	Mean Plant Height <i>cm</i>
<i>Poa secunda</i> (<i>P. ampla</i>)	9081633 (Opportunity)	31.3 b	3.3	26.5 cdef
<i>Poa secunda</i>	9081635	15.0 efghij	3.3	23.3 efgh
<i>Poa secunda</i> (<i>P. ampla</i>)	'Sherman'	6.2 ijklm	4.8	6.8 nop
<i>Poa secunda</i>	9081322	3.6 klm	4.3	17.5 fghijkl
<i>Poa secunda</i>	'Canbar'	0.4 m	6.2	6.3 op

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Percentage stand cover and vigor rating data for all *Poa secunda* accessions tested at the Stucky Ridge CEP on September 22, 2004 appears in Table 7. Percentage stand cover and vigor rating data for all grass species tested at the Stucky Ridge CEP on September 22, 2004 appears in Appendix 5. Opportunity Germplasm big bluegrass had significantly higher percentage stand cover (37.2 percent) than all other *Poa secunda* accessions tested. Similarly, Opportunity Germplasm had the best vigor rating (2.4) of all *Poa secunda* accessions tested.

Table 7. Percentage stand cover and vigor rating of *Poa secunda* accessions, Stucky Ridge CEP, September 22, 2004, Anaconda, Montana.

Species	Accession Number Or Cultivar	Percentage Stand Cover %	Vigor Rating (1-9) [†]
<i>Poa secunda</i> (<i>P. ampla</i>)	9081633(Opportunity)	37.2 c	2.4
<i>Poa secunda</i>	9081635	24.1 def	2.8
<i>Poa secunda</i> (<i>P. ampla</i>)	'Sherman'	12.2 hijklm	4.1
<i>Poa secunda</i>	9081322	11.9 ijklm	2.9
<i>Poa secunda</i>	'Canbar'	0 op	9.0

[†] 1 = Highest vigor; 4 = average; 9 = worst or dead

Biomass production data for all *Poa secunda* accessions tested at the Stucky Ridge CEP on September 22, 2004 appears in Table 8. Biomass production for all grass species tested at the Stucky Ridge CEP on September 22, 2004 appears in Appendix 6. Opportunity Germplasm big bluegrass had significantly greater biomass production (408 kilograms per hectare; 364 pounds per acre) than all other *Poa secunda*

Table 8. Biomass production of *Poa secunda* accessions, Stucky Ridge CEP, September 22, 2004, Anaconda, Montana.

Species	Accession Number Or Cultivar	Biomass Production kg/ha
<i>Poa secunda</i> (<i>P. ampla</i>)	9081633 (Opportunity)	408 cdef
<i>Poa secunda</i> (<i>P. ampla</i>)	'Sherman'	115 ef
<i>Poa secunda</i>	9081635	100 f
<i>Poa secunda</i>	9081322	34 f
<i>Poa secunda</i>	'Canbar'	0 f

accessions tested. Percentage stand cover, vigor rating, and mean plant height data for all *Poa secunda* accessions tested at the Stucky Ridge CEP on August 30, 2005 appears in Table 9. Percentage stand cover and vigor rating for all grass species tested at the Stucky Ridge CEP on August 30, 2005 appears in Appendix 7. Mean plant height data for all grass species tested at the Stucky Ridge CEP on August 30, 2005 appears in Appendix 8. Opportunity Germplasm big bluegrass had significantly higher percentage stand cover (43.4 percent) than all other *Poa secunda* accessions tested. Similarly, Opportunity Germplasm had the best vigor rating (2.1) of all *Poa secunda* accessions tested, and the significantly greatest mean plant height (59.0 centimeters; 23.0 inches).

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Table 9. Percentage stand cover, vigor rating, and mean plant height of *Poa secunda* accessions, Stucky Ridge CEP, August 30, 2005, Anaconda, Montana.

Species	Accession Number Or Cultivar	Percentage Stand Cover %	Vigor Rating (1-9) [†]	Mean Plant Height cm
<i>Poa secunda</i> (<i>P. ampla</i>)	9081633 (Opportunity)	43.4 b	2.1	59.0 b
<i>Poa secunda</i>	9081635	25.9 cd	3.3	45.6 bcdef
<i>Poa secunda</i> (<i>P. ampla</i>)	'Sherman'	12.5 efghijkl	4.0	30.4 fghi
<i>Poa secunda</i>	9081322	10.0 ghijklm	4.2	36.9 defgh
<i>Poa secunda</i>	'Canbar'	0.1 m	8.0	0 l

[†] 1 = Highest vigor; 4 = average; 9 = worst or dead

Biomass production data for all *Poa secunda* accessions tested at the Stucky Ridge CEP on August 30, 2005 appears in Table 10. Biomass production for all grass species tested at the Stucky Ridge CEP on August 30, 2005 appears in Appendix 9. Opportunity Germplasm big bluegrass had significantly greater biomass production (2,506 kilograms per hectare; 2,235 pounds per acre) than all other *Poa secunda* accessions tested.

Table 10. Biomass production of *Poa secunda* accessions, Stucky Ridge CEP, August 30, 2005, Anaconda, Montana.

Species	Accession Number Or Cultivar	Biomass Production kg/ha
<i>Poa secunda</i> (<i>P. ampla</i>)	9081633 (Opportunity)	2,506 c
<i>Poa secunda</i>	9081635	906 defgh
<i>Poa secunda</i>	9081322	233 gh
<i>Poa secunda</i> (<i>P. ampla</i>)	'Sherman'	189 gh
<i>Poa secunda</i>	'Canbar'	0 h

2006

Percentage stand cover, vigor rating, and mean plant height data for all *Poa secunda* accessions tested at the Stucky Ridge CEP on August 29, 2006 appears in Table 11. Percentage stand cover and vigor rating data for all grass species tested at the Stucky Ridge CEP on August 29, 2006 appears in Appendix 10. Mean plant height data for all grass species tested at the Stucky Ridge CEP on August 29, 2006 appears in Appendix 11. Opportunity Germplasm big bluegrass had significantly higher percentage stand cover (63.1 percent) than all other *Poa secunda* accessions tested. Similarly, Opportunity Germplasm had the best vigor rating (2.9) of all *Poa secunda* accessions tested, and the significantly greatest mean plant height (62.4 centimeters; 24.5 inches).

Table 11. Percentage stand cover, vigor rating, and mean plant height of *Poa secunda* accessions, Stucky Ridge CEP, August 29, 2006, Anaconda, Montana.

Species	Accession Number Or Cultivar	Percentage Stand Cover %	Vigor Rating (1-9) [†]	Mean Plant Height cm
<i>Poa secunda</i> (<i>P. ampla</i>)	9081633 (Opportunity)	63.1 a	2.9	62.4 abc
<i>Poa secunda</i>	9081635	23.7 bcdefg	4.1	44.9 cdef
<i>Poa secunda</i> (<i>P. ampla</i>)	'Sherman'	13.4 cdefghij	4.4	41.7 cdefg
<i>Poa secunda</i>	9081322	4.1 hij	4.0	14.9 hij
<i>Poa secunda</i>	'Canbar'	2.5 j	5.0	15.2 hij

[†] 1 = Highest vigor; 4 = average; 9 = worst or dead

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Biomass production data for all *Poa secunda* accessions tested at the Stucky Ridge CEP on August 29, 2006 appears in Table 12. Biomass production for all grass species tested at the Stucky Ridge CEP on August 29, 2006 appears in Appendix 12. Opportunity Germplasm big bluegrass had significantly greater biomass production (2,311 kilograms per hectare; 2,061 pounds per acre) than all other *Poa secunda* accessions tested.

Table 12. Biomass production of *Poa secunda* accessions, Stucky Ridge CEP, August 29, 2006, Anaconda, Montana.

	Accession Number	Biomass
Species	Or Cultivar	Production
		kg/ha
<i>Poa secunda</i> (<i>P. ampla</i>)	9081633 (Opportunity)	2311.1 bcd
<i>Poa secunda</i>	9081635	1150.0 cdefgh
<i>Poa secunda</i>	9081322	444.4 fgh
<i>Poa secunda</i> (<i>P. ampla</i>)	'Sherman'	305.6 gh
<i>Poa secunda</i>	'Canbar'	122.2 gh

Summary evaluation data for all *Poa secunda* accessions tested all years appears in Appendix 15.

Stucky Ridge CEP Results

Plant Tissue Analysis

Following the fall 2004, 2005, and 2006 Stucky Ridge CEP evaluations, individual plots were sampled for biomass production. Ten gram or greater grab samples were collected from the dried biomass clippings and submitted to an analytical laboratory for determination of heavy-metal concentrations in and on plant tissue samples. Metal loads (concentration in and on the plant tissue) can be compared to maximum tolerable levels of dietary minerals for domestic animals (National Research Council 1980). The dietary level of cadmium for domesticated animals is based on human food residue considerations (NRC, 1980), and the need to avoid increases of cadmium in the food supply of the United States. High residue levels (>0.50 mg/kg) for short periods of time would not be expected to be harmful to animal health nor limit human food use, particularly if the animals were slaughtered at a young age. For the purposes of this release, the classification developed by Kabata-Pendias and Pendias (1992) is used to categorize plant tissue levels as "Deficient", "Sufficient or Normal", and "Excessive or Toxic" (Appendices 13 and 14). Tissue samples represent non-replicated composites of samples from random plants selected in all four replications of the Stucky Ridge CEP. Metal loads in the sampled tissue were generally below toxic levels.

Arsenic (As): Arsenic was detected in 19 of the 39 samples in 2004, in 32 of the 40 samples in 2005, and 3 of the 42 samples in 2006 with levels ranging from 5 to 35 mg/kg. This is below the tolerable level for domestic livestock (50 mg/kg) and wildlife (50 mg/kg). However, plant tissue levels ranked in the "Excessive or Toxic" level for plants.

Cadmium (Cd): Cadmium was only detected in one sample (Rimrock Indian ricegrass) in 2004 and in 5 samples (including 3 Indian ricegrass) in 2005. In 2006 there was no detection of cadmium in any plant tissue sample. The plant tissue levels found in 2004 and 2005 (1 to 2 mg/kg) are at the tolerable levels for domestic livestock (0.5 mg/kg) and wildlife (2 mg/kg).

Copper (Cu): Copper was detected in all plant tissue samples ranging from 5 to 307 mg/kg. Only 3 samples tested in 2004 and 5 samples tested in 2005 exceeded the tolerable level for domestic livestock (100 mg/kg), but 15 samples (2004), 19 samples (2005), and 1 sample (2006) exceeded the tolerable level for wildlife (55 mg/kg). No samples tested in 2006 exceeded the tolerable level for domestic livestock (100 mg/kg). Since this copper smelting was the primary activity in the impacted area, high levels of copper are to be expected.

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Lead (Pb): Lead was only detected in one sample of ten-petal blazing star (*Mentzelia decapetala*) in 2004, at a level of 9 mg/kg, well below the tolerable levels for domestic livestock and wildlife. In 2005 lead was detected in only four samples and at very low levels. In 2006 lead was detected in two samples and one sample rated in the “Excessive or Toxic” level in plants.

Zinc (Zn): Zinc was detected in all samples, ranging from 9 to 175 mg/kg, well below the tolerable levels for domestic livestock (500 mg/kg) and wildlife (300 mg/kg).

All Opportunity Germplasm big bluegrass plant tissue samples were within the maximum tolerable limits for arsenic, cadmium, copper, lead, and zinc for domestic livestock and wildlife each test year (see Appendices 13 and 14). In 2004 only, the arsenic level in or on Opportunity Germplasm tissue (9 mg/kg) were rated as “Excessive or Toxic”. In 2005 and 2006, there were no detectable levels of arsenic in or on Opportunity Germplasm tissue samples. There was no detectable level of cadmium in or on Opportunity Germplasm tissue in 2004 through 2006. In 2004 and 2005, the copper level in or on plant tissue was rated as “Excessive or Toxic” (49 and 52 mg/kg, respectively), whereas in 2006, cadmium level (19 mg/kg) was rated as “Sufficient or Normal”. There was no detectable level of lead in or on Opportunity Germplasm tissue in 2004 through 2006. In 2004 through 2006, zinc levels in Opportunity Germplasm tissue were rated as “Sufficient or Normal” or less.

It is worth noting that heavy metal concentrations were highest in and/or on alpine bluegrass *Poa alpina*, silverleaf phacelia *Phacelia hastata*, winterfat *Krascheninnikovia lanata* and fuzzytongue penstemon *Penstemon eriantherus*. High metal concentrations in these species probably reflects greater exposure of these low stature plants to dust, as well as high levels of leaf and stem pubescence that result in greater trapping of dust and metal particles on these surfaces.

Seed Increase: Two seed production increase fields of Opportunity Germplasm big bluegrass were in production at the Plant Materials Center, Bridger, Montana, from 2001 through 2003. Both fields were planted on 91-cm (36-inch) between-row spacing, clean cultivated, irrigated, and fertilized. Maximum production at peak performance (second growing season, first crop) was only 30.5 kilograms per hectare (27.2 pounds per acre). Production in 2006 (first crop) from a seed increase field established in 2005 was 243 kilograms per hectare (217 pounds per acre). The average number of seeds per kilogram of commercially produced seed of big bluegrass cultivars is approximately 1,942,731 seeds (882,000 seeds per pound). The 2006 seed lot of Opportunity Germplasm big bluegrass averaged 2,267,574 seeds per kilogram (1,029,000 seeds per pound). Maximum production can be expected by maintaining seed production fields 50- to 60-cm (20- to 24-inch) between-row spacing, clean cultivation, with supplemental irrigation and fertilization. Average date of harvest of Opportunity Germplasm big bluegrass at the Plant Materials Center, Bridger, Montana, ranges from about June 25 to July 5 each year. Seed production fields are swathed when the seeds are in the firm dough stage, allowed to cure in the windrow (approximately 22 percent seed moisture), and then combined.

Ecological Considerations and Evaluation: Big bluegrass is a long-lived cool season perennial bunchgrass. It initiates growth (greens up) early in the spring, reaching maturity by July. It is a prolific seed producer, but is not weedy. Big bluegrass stands perpetuate themselves through seed shatter, but should not be grazed heavily within the first two years of growth or the stand will deteriorate rapidly. This species is very tolerant to cold temperatures, but does not do as well as other cool season grasses under drought conditions. Light to medium textured soils with moist conditions and light are favored, but must have good drainage for optimum performance and survival. It is very important that native reclamation species adapted to the Upper Clark Fork watershed be made commercially available for use on areas impacted by mining and smelting in the northern Rocky Mountain region. Opportunity Germplasm big bluegrass passed the NRCS Plant Materials Program, Environmental Evaluation of Plant Materials Releases for potential invasiveness.

Anticipated Conservation Use: Opportunity Germplasm big bluegrass is intended for use on severely impacted sites with moderately acidic to slightly alkaline soil pH. This selection can also tolerate

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moderate to high soil concentrations of certain heavy metals. Big bluegrass is used for reseeding of burned forest lands because of its ability to produce roots which suppress growth of weeds. Big bluegrass makes excellent spring grazing and cover and nesting grounds for upland game birds because of its early spring growth. Opportunity Germplasm big bluegrass can also be used in other conservation applications such as post-fire reclamation, native range restoration, other wildlife habitat enhancement practices, logging road revegetation, and general mined land reclamation.

Anticipated Area of Adaptation: Opportunity Germplasm big bluegrass originated in the upper Clark Fork River basin of western Montana where a native stand was found growing on soil impacted by acid/heavy-metal contamination resulting from historic copper smelter emissions, and currently by wind and surface water erosion. The testing of this selection has been limited to the immediate area of its origin and at the Bridger Plant Materials Center in south-central Montana where it has performed well. Based on its performance in the Stucky Ridge CEP, other non-reported field trials, and in its native range, Opportunity Germplasm big bluegrass is best adapted to elevations of 2,000 to 6,000 feet, performing less favorably on lower elevation (valley) sites. This selection should prove well adapted for use on drastically disturbed acidic and heavy-metal impacted areas of low to mid-mountain elevations in the northern Rocky Mountain region, given other favorable climatic conditions. As a seed source found growing naturally in the northern Rocky Mountains, it is assumed that this selection will perform well in other mountainous regions of the Intermountain West with similar environments and climates.

Increase and Distribution: Generation G₁ (Foundation) seed of Opportunity Germplasm big bluegrass will be available from the USDA-Natural Resources Conservation Service (NRCS), Plant Materials Center in Bridger, Montana, through the Foundation Seed Stocks Program at Montana State University-Bozeman or the University of Wyoming. Limited G₁ seed stock will be available in the spring of 2008.

Prepared by: Shannon Majerus, Development of Acid/Heavy Metal-Tolerant Releases Project Leader, Deer Lodge Valley Conservation District, Deer Lodge, MT; and Mark E. Majerus Manager (retired) USDA-NRCS Plant Materials Center, 98 South River Road, Bridger, MT 59014.

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Signatures for release of:

Opportunity Germplasm big bluegrass *Poa secunda* (formerly *Poa ampla*)

Dave White
State Conservationist
NRCS
Bozeman, Montana

Date

Adolfo Perez
State Conservationist
NRCS
Casper, Wyoming

Date

Director
Montana Agricultural Experiment Station
Montana State University
Bozeman, Montana

Date

Director
Wyoming Agricultural Experiment Station
University of Wyoming
Laramie, Wyoming

Date

Director
Ecological Sciences Division
NRCS
Washington, DC

Date

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Appendix 1. Seedling density, Stucky Ridge CEP, June 24, 2003, Anaconda, Montana.

Species	Accession or Cultivar	Species ID	Seedling Density seedlings/ft ²	Mean Separation
<i>Elymus trachycaulus</i>	'Pryor'	14	14.97	A*
<i>Elymus trachycaulus</i>	9081620	12	14.09	AB
<i>Elymus trachycaulus</i>	'San Luis'	16	13.63	AB
<i>Pascopyrum smithii</i>	'Rosana'	24	13.31	AB
<i>Pascopyrum smithii</i>	9081968	22	12.72	AB
<i>Pseudoroegneria spicata</i>	9081636	34	11.75	BC
<i>Leymus cinereus</i>	9081624	17	11.25	BC
<i>Elymus wawawaiensis</i>	'Secar'	36	9.47	CD
<i>Elymus trachycaulus</i>	9081621	13	9.34	CD
<i>Pseudoroegneria spicata</i>	'Goldar'	35	9.09	CDE
<i>Achnatherum hymenoides</i>	'Nezpar'	4	8.94	CDEF
<i>Elymus trachycaulus</i>	'Revenue'	15	8.75	CDEFG
<i>Poa secunda</i>	9081633	29	7.13	DEFG
<i>Leymus cinereus</i>	'Magnar'	20	6.13	EFGH
<i>Leymus cinereus</i>	'Trailhead'	21	5.81	FGH
<i>Pascopyrum smithii</i>	'Rodan'	23	5.66	GH
<i>Leymus cinereus</i>	9081625	18	3.84	HI
<i>Leymus cinereus</i>	Washoe Germplasm	19	3.66	HIJ
<i>Poa secunda</i>	'Sherman'	30	3.13	HIJ
<i>Agrostis gigantea</i>	9081619	6	2.38	IJ
<i>Poa alpina</i>	9016273	25	2.34	IJ
<i>Poa secunda</i>	9081635	32	1.88	IJ
<i>Agrostis gigantea</i>	9076276	5	1.75	IJ
<i>Poa alpina</i>	1858 (9082266)	28	1.72	IJ
<i>Poa secunda</i>	9081322	33	1.31	IJ
<i>Achnatherum hymenoides</i>	'Rimrock'	3	1.28	IJ
<i>Deschampsia caespitosa</i>	9076290	9	1.28	IJ
<i>Poa secunda</i>	'Canbar'	31	1.22	IJ
<i>Deschampsia caespitosa</i>	'Nortran'	11	1.00	IJ
<i>Agrostis gigantea</i>	9076266	7	0.81	IJ
<i>Achnatherum hymenoides</i>	9081629	2	0.78	IJ
<i>Agrostis gigantea</i>	'Streaker'	8	0.75	IJ
<i>Poa alpina</i>	01-13-1 (9082259)	26	0.66	IJ
<i>Achnatherum hymenoides</i>	9081628	1	0.59	IJ
<i>Deschampsia caespitosa</i>	13970176 (9082260)	10	0.56	IJ
<i>Poa alpina</i>	'Gruening'	27	0.34	J

* Means followed by the same letter are not significantly different at the 0.05 significance level using the Duncan's Multiple Range Test.

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Appendix 2. Seedling density, Stucky Ridge CEP, August 25, 2003, Anaconda, Montana.

Species	Accession or Cultivar	Species ID	Seedling Density seedlings/ft ²	Mean Separation
<i>Elymus trachycaulus</i>	9081620	12	14.47	A*
<i>Elymus trachycaulus</i>	'San Luis'	16	13.44	A
<i>Elymus trachycaulus</i>	'Pryor'	14	12.13	A
<i>Pascopyrum smithii</i>	'Rosana'	24	12.00	A
<i>Pascopyrum smithii</i>	9081968	22	11.59	A
<i>Elymus trachycaulus</i>	'Revenue'	15	8.38	B
<i>Leymus cinereus</i>	9081624	17	7.81	BC
<i>Pseudoroegneria spicata</i>	'Goldar'	35	7.28	BC
<i>Pseudoroegneria spicata</i>	9081636	34	7.16	BC
<i>Elymus wawawaiensis</i>	'Secar'	36	6.56	BC
<i>Achnatherum hymenoides</i>	'Nezpar'	4	6.53	BC
<i>Elymus trachycaulus</i>	9081621	13	6.09	BC
<i>Pascopyrum smithii</i>	'Rodan'	23	5.75	BCD
<i>Poa secunda</i>	9081633	29	5.16	CDE
<i>Leymus cinereus</i>	'Trailhead'	21	4.91	CDE
<i>Leymus cinereus</i>	'Magnar'	20	3.00	DEF
<i>Leymus cinereus</i>	9081625	18	2.44	EF
<i>Poa secunda</i>	'Sherman'	30	2.34	EF
<i>Agrostis gigantea</i>	9081619	6	2.28	EF
<i>Leymus cinereus</i>	Washoe Germplasm	19	2.16	EF
<i>Agrostis gigantea</i>	9076276	5	1.47	F
<i>Poa alpina</i>	1858 (9082266)	28	1.25	F
<i>Poa alpina</i>	01-13-1 (9082259)	26	1.03	F
<i>Agrostis gigantea</i>	9076266	7	0.97	F
<i>Achnatherum hymenoides</i>	'Rimrock'	3	0.91	F
<i>Poa alpina</i>	9016273	25	0.91	F
<i>Poa secunda</i>	9081635	32	0.91	F
<i>Deschampsia caespitosa</i>	'Nortran'	11	0.88	F
<i>Poa secunda</i>	9081322	33	0.72	F
<i>Achnatherum hymenoides</i>	9081628	1	0.59	F
<i>Poa alpina</i>	'Gruening'	27	0.53	F
<i>Poa secunda</i>	'Canbar'	31	0.47	F
<i>Deschampsia caespitosa</i>	9076290	9	0.44	F
<i>Deschampsia caespitosa</i>	13970176 (9082260)	10	0.38	F
<i>Agrostis gigantea</i>	'Streaker'	8	0.34	F
<i>Achnatherum hymenoides</i>	9081629	2	0.31	F

* Means followed by the same letter are not significantly different at the 0.05 significance level using the Duncan's Multiple Range Test.

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Appendix 3. Percentage stand cover and vigor rating, Stucky Ridge CEP, June 30, 2004, Anaconda, Montana.

Species	Accession or Cultivar	Percentage Stand Cover %	Vigor Rating (1 – 9) [†]
<i>Elymus trachycaulus</i>	9081620	61.3 a*	3.4
<i>Achnatherum hymenoides</i>	Rimrock	31.3 b	4.8
<i>Poa secunda</i>	9081633	31.3 b	3.3
<i>Elymus trachycaulus</i>	9081621	28.4 bc	4.8
<i>Elymus trachycaulus</i>	Pryor	26.9 bcd	4.8
<i>Pascopyrum smithii</i>	9081968	26.7 bcd	4.9
<i>Achnatherum hymenoides</i>	Nezpar	25.3 bcde	5.0
<i>Leymus cinereus</i>	9081624	20.8 bcdef	4.4
<i>Elymus wawawaiensis</i>	Secar	20.0 bcdefg	4.6
<i>Elymus trachycaulus</i>	Revenue	19.7 cdefg	4.8
<i>Elymus trachycaulus</i>	San Luis	18.6 cdefgh	4.8
<i>Achnatherum hymenoides</i>	9081628	18.3 cdefgh	5.6
<i>Pascopyrum smithii</i>	Rosana	16.9 defghi	4.7
<i>Leymus cinereus</i>	Trailhead	15.1 efghij	4.8
<i>Poa secunda</i>	9081635	15.0 efghij	3.3
<i>Pseudoroegneria spicata</i>	9081636	14.5 efghijk	5.3
<i>Leymus cinereus</i>	Washoe	12.8 fghijkl	5.0
<i>Leymus cinereus</i>	Magnar	12.2 fghijkl	5.3
<i>Pascopyrum smithii</i>	Rodan	11.8 fghijklm	5.3
<i>Agrostis gigantea</i>	9081619	10.7 fghijklm	3.2
<i>Leymus cinereus</i>	9081625	10.1 fghijklm	5.5
<i>Pseudoroegneria spicata</i>	Goldar	10.0 fghijklm	5.0
<i>Achnatherum hymenoides</i>	9081629	8.6 ghijklm	5.7
<i>Agrostis gigantea</i>	9076276	8.1 hijklm	2.6
<i>Poa secunda</i>	Sherman	6.2 ijklm	4.8
<i>Poa alpina</i>	01-13-1 (9082259)	4.1 jklm	3.3
<i>Deschampsia caespitosa</i>	9076290	4.0 jklm	4.2
<i>Poa secunda</i>	9081322	3.6 klm	4.3
<i>Poa alpina</i>	9016273	3.3 klm	4.6
<i>Agrostis gigantea</i>	9076266	3.1 klm	2.5
<i>Poa alpina</i>	1858 (9082266)	1.4 lm	4.5
<i>Deschampsia caespitosa</i>	Nortran	0.6 m	2.1
<i>Poa alpina</i>	Gruening	0.5 m	4.0
<i>Agrostis gigantea</i>	Streaker	0.4 m	5.2
<i>Poa secunda</i>	Canbar	0.4 m	6.2
<i>Deschampsia caespitosa</i>	13970176 (9082260)	0.2 m	5.3

* Means followed by the same letter are not significantly different at the 0.05 significance level using the LSD Mean Comparison method.

[†] - 1 = Best vigor; 4 = average; 9 = worst or dead.

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Appendix 4. Mean plant height, Stucky Ridge CEP, June 30, 2004, Anaconda, Montana.

Species	Accession or Cultivar	Mean Plant Height	<i>cm</i>
<i>Elymus trachycaulus</i>	9081620	54.4	a*
<i>Elymus trachycaulus</i>	9081621	34.2	c
<i>Agrostis gigantea</i>	9076276	33.3	cd
<i>Agrostis gigantea</i>	9081619	27.1	cde
<i>Poa secunda</i>	9081633	26.5	cdef
<i>Elymus wawawaiensis</i>	Secar	24.0	defg
<i>Poa secunda</i>	9081635	23.3	efgh
<i>Pseudoroegneria spicata</i>	Goldar	22.5	efghi
<i>Agrostis gigantea</i>	9076266	21.0	efghij
<i>Elymus trachycaulus</i>	Pryor	18.5	efghijk
<i>Leymus cinereus</i>	9081624	17.9	efghijkl
<i>Poa secunda</i>	9081322	17.5	fghijkl
<i>Achnatherum hymenoides</i>	Nezpar	16.9	ghijklm
<i>Leymus cinereus</i>	Trailhead	16.1	ghijklmn
<i>Elymus trachycaulus</i>	San Luis	14.5	hijklmno
<i>Deschampsia caespitosa</i>	9076290	14.5	hijklmno
<i>Elymus trachycaulus</i>	Revenue	14.3	hijklmno
<i>Pascopyrum smithii</i>	Rosana	13.5	ijklmno
<i>Achnatherum hymenoides</i>	Rimrock	13.0	jklmnop
<i>Leymus cinereus</i>	Magnar	12.8	jklmnop
<i>Leymus cinereus</i>	Washoe	12.5	jklmnop
<i>Pascopyrum smithii</i>	Rodan	12.3	jklmnop
<i>Pseudoroegneria spicata</i>	9081636	12.0	jklmnop
<i>Pascopyrum smithii</i>	9081968	11.3	klmnop
<i>Leymus cinereus</i>	9081625	10.6	klmnop
<i>Agrostis gigantea</i>	Streaker	10.3	klmnop
<i>Achnatherum hymenoides</i>	9081628	9.1	lmnop
<i>Poa alpina</i>	01-13-1 (9082259)	8.1	mnop
<i>Achnatherum hymenoides</i>	9081629	7.6	mnop
<i>Deschampsia caespitosa</i>	13970176 (9082260)	7.0	nop
<i>Poa secunda</i>	Sherman	6.8	nop
<i>Poa secunda</i>	Canbar	6.3	op
<i>Deschampsia caespitosa</i>	Nortran	6.0	op
<i>Poa alpina</i>	9016273	5.8	op
<i>Poa alpina</i>	Gruening	4.5	p
<i>Poa alpina</i>	1858 (9082266)	3.9	p

* Means followed by the same letter are not significantly different at the 0.05 significance level using the LSD Mean Comparison method.

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Appendix 5. Percentage stand cover and vigor rating, Stucky Ridge CEP, September 22, 2004, Anaconda, Montana.

Species	Accession and Cultivar	Percentage Stand Cover %	Vigor Rating (1 – 9) [†]
<i>Elymus trachycaulus</i>	9081620	61.3 a*	1.8
<i>Poa secunda</i>	9081633	37.2 c	2.4
<i>Elymus trachycaulus</i>	9081621	30.0 cd	2.7
<i>Pascopyrum smithii</i>	9081968	28.4 cde	4.0
<i>Elymus trachycaulus</i>	Pryor	27.5 cde	4.6
<i>Pascopyrum smithii</i>	Rosana	26.3 de	3.6
<i>Achnatherum hymenoides</i>	Rimrock	24.1 def	4.2
<i>Poa secunda</i>	9081635	24.1 def	2.8
<i>Elymus trachycaulus</i>	Revenue	23.8 defg	4.3
<i>Leymus cinereus</i>	9081624	22.8 defgh	3.6
<i>Leymus cinereus</i>	Trailhead	20.0 defghi	4.0
<i>Elymus wawawaiensis</i>	Secar	19.2 defghi	4.0
<i>Elymus trachycaulus</i>	San Luis	19.1 defghi	4.4
<i>Achnatherum hymenoides</i>	Nezpar	18.4 efghij	4.1
<i>Pseudoroegneria spicata</i>	9081636	17.9 efghij	3.8
<i>Agrostis gigantea</i>	9081619	17.8 efghij	2.1
<i>Pascopyrum smithii</i>	Rodan	16.6 fghijk	4.5
<i>Agrostis gigantea</i>	9076276	15.9 fghijk	2.7
<i>Achnatherum hymenoides</i>	9081628	14.4 ghijkl	4.9
<i>Leymus cinereus</i>	Washoe	14.1 ghijkl	4.6
<i>Leymus cinereus</i>	Magnar	13.4 ghijkl	4.7
<i>Pseudoroegneria spicata</i>	Goldar	13.4 ghijkl	4.1
<i>Poa secunda</i>	Sherman	12.2 hijklm	4.1
<i>Poa secunda</i>	9081322	11.9 ijklm	2.9
<i>Leymus cinereus</i>	9081625	11.6 ijklmn	4.1
<i>Achnatherum hymenoides</i>	9081629	11.3 ijklmno	5.4
<i>Poa alpina</i>	01-13-1 (9082259)	8.4 jklmnop	3.6
<i>Agrostis gigantea</i>	9076266	7.8 jklmnop	2.1
<i>Deschampsia caespitosa</i>	9076290	6.3 klmnop	2.8
<i>Poa alpina</i>	9016273	5.2 lmnop	3.6
<i>Poa alpina</i>	1858 (9082266)	4.4 lmnop	3.6
<i>Agrostis gigantea</i>	Streaker	1.9 mnop	4.0
<i>Deschampsia caespitosa</i>	13970176 (9082260)	1.9 mnop	3.3
<i>Poa alpina</i>	Gruening	1.1 op	3.3
<i>Deschampsia caespitosa</i>	Nortran	0.4 op	3.0
<i>Poa secunda</i>	Canbar	0 op	9.0

* Means followed by the same letter are not significantly different at the 0.05 significance level using the LSD Mean Comparison method.

[†] - 1 = Best vigor; 4 = average; 9 = worst or dead.

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Appendix 6. Biomass production, Stucky Ridge CEP, September 22, 2004, Anaconda, Montana.

Species	Accession or Cultivar	Biomass Production	
		<i>kg/ha</i>	
<i>Elymus trachycaulus</i>	9081620	2,083	a*
<i>Agrostis gigantea</i>	9081619	706	cd
<i>Elymus trachycaulus</i>	9081621	544	cde
<i>Poa secunda</i>	9081633	408	cdef
<i>Elymus trachycaulus</i>	Pryor	386	cdef
<i>Elymus wawawaiensis</i>	Secar	346	def
<i>Leymus cinereus</i>	9081624	216	ef
<i>Leymus cinereus</i>	Trailhead	192	ef
<i>Elymus trachycaulus</i>	Revenue	172	ef
<i>Leymus cinereus</i>	Washoe	148	ef
<i>Agrostis gigantea</i>	9076276	148	ef
<i>Poa secunda</i>	Sherman	115	ef
<i>Elymus trachycaulus</i>	San Luis	100	f
<i>Poa secunda</i>	9081635	100	f
<i>Deschampsia caespitosa</i>	9076290	99	f
<i>Pseudoroegneria spicata</i>	9081636	97	f
<i>Pascopyrum smithii</i>	Rosana	95	f
<i>Achnatherum hymenoides</i>	Rimrock	84	f
<i>Leymus cinereus</i>	9081625	52	f
<i>Pascopyrum smithii</i>	Rodan	45	f
<i>Pseudoroegneria spicata</i>	Goldar	43	f
<i>Poa secunda</i>	9081322	34	f
<i>Agrostis gigantea</i>	9076266	29	f
<i>Poa alpina</i>	01-13-1 (9082259)	14	f
<i>Pascopyrum smithii</i>	9081968	11	f
<i>Achnatherum hymenoides</i>	Nezpar	9	f
<i>Deschampsia caespitosa</i>	13970176 (9082260)	8	f
<i>Poa alpina</i>	9016273	7	f
<i>Achnatherum hymenoides</i>	9081629	4	f
<i>Achnatherum hymenoides</i>	9081628	4	f
<i>Leymus cinereus</i>	Magnar	3	f
<i>Poa alpina</i>	1858 (9082266)	2	f
<i>Poa alpina</i>	Gruening	2	f
<i>Deschampsia caespitosa</i>	Nortran	1	f
<i>Agrostis gigantea</i>	Streaker	trace	f
<i>Poa secunda</i>	Canbar	0	f

* Means followed by the same letter are not significantly different at the 0.05 significance level using the LSD Mean Comparison method.

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Appendix 7. Percentage stand cover and vigor rating, Stucky Ridge CEP, August 30, 2005, Anaconda, Montana.

Species	Accession or Cultivar	Percentage Stand Cover %	Vigor Rating (1 – 9) [†]
<i>Elymus trachycaulus</i>	9081620	75.0 a*	2.1
<i>Poa secunda</i>	9081633	43.4 b	2.1
<i>Elymus trachycaulus</i>	9081621	34.1 bc	2.7
<i>Poa secunda</i>	9081635	25.9 cd	3.3
<i>Elymus trachycaulus</i>	Pryor	23.1 cde	5.3
<i>Leymus cinereus</i>	9081624	22.2 cdef	3.8
<i>Pascopyrum smithii</i>	9081968	21.9 defg	4.5
<i>Elymus wawawaiensis</i>	Secar	21.6 defg	4.3
<i>Elymus trachycaulus</i>	San Luis	20.9 defgh	4.6
<i>Pascopyrum smithii</i>	Rosana	20.6 defgh	4.7
<i>Leymus cinereus</i>	Trailhead	16.2 defghi	4.3
<i>Pascopyrum smithii</i>	Rodan	16.2 defghi	5.0
<i>Achnatherum hymenoides</i>	9081628	14.1 defghij	5.3
<i>Achnatherum hymenoides</i>	Rimrock	14.1 defghij	4.5
<i>Leymus cinereus</i>	9081625	13.8 defghij	5.5
<i>Pseudoroegneria spicata</i>	9081636	13.8 defghij	4.5
<i>Agrostis gigantea</i>	9081619	13.4 efghijk	3.2
<i>Leymus cinereus</i>	Washoe	13.4 efghijk	4.8
<i>Agrostis gigantea</i>	9076276	13.1 efghijk	3.7
<i>Poa secunda</i>	Sherman	12.5 efghijkl	4.0
<i>Achnatherum hymenoides</i>	Nezpar	11.9 efghijklm	4.6
<i>Elymus trachycaulus</i>	Revenue	11.9 efghijklm	5.4
<i>Pseudoroegneria spicata</i>	Goldar	11.1 efghijklm	4.6
<i>Leymus cinereus</i>	Magnar	10.9 fghijklm	5.2
<i>Deschampsia caespitosa</i>	9076290	10.6 fghijklm	3.9
<i>Poa secunda</i>	9081322	10.0 ghijklm	4.2
<i>Agrostis gigantea</i>	9076266	9.0 hijklm	4.0
<i>Achnatherum hymenoides</i>	9081629	6.4 ijklm	5.7
<i>Poa alpina</i>	01-13-1 (9082259)	3.9 jklm	5.0
<i>Poa alpina</i>	1858 (9082266)	3.6 jklm	5.3
<i>Poa alpina</i>	9016273	3.0 jklm	3.8
<i>Deschampsia caespitosa</i>	Nortran	1.6 klm	3.8
<i>Deschampsia caespitosa</i>	13970176 (9082260)	0.9 lm	3.8
<i>Poa alpina</i>	Gruening	0.8 lm	1.5
<i>Agrostis gigantea</i>	Streaker	0.4 m	1.5
<i>Poa secunda</i>	Canbar	0.1 m	8.0

* Means followed by the same letter are not significantly different at the 0.05 significance level using the LSD Mean Comparison method.

[†] - 1 = Best vigor; 4 = average; 9 = worst or dead.

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Appendix 8. Mean plant height, Stucky Ridge CEP, August 30, 2005, Anaconda, Montana.

Species	Accession or Cultivar	Mean Plant Height	
			<i>cm</i>
<i>Elymus trachycaulus</i>	9081620	87.5	a*
<i>Elymus trachycaulus</i>	9081621	76.3	a
<i>Poa secunda</i>	9081633	59.0	b
<i>Leymus cinereus</i>	9081624	58.0	bc
<i>Elymus trachycaulus</i>	Pryor	47.0	bcd
<i>Elymus wawawaiensis</i>	Secar	46.5	bcde
<i>Elymus trachycaulus</i>	San Luis	46.3	bcde
<i>Poa secunda</i>	9081635	45.6	bcdef
<i>Leymus cinereus</i>	9081625	44.0	bcdef
<i>Agrostis gigantea</i>	9081619	43.8	bcdef
<i>Leymus cinereus</i>	Trailhead	42.9	cdefg
<i>Achnatherum hymenoides</i>	Rimrock	39.5	defg
<i>Elymus trachycaulus</i>	Revenue	36.9	defgh
<i>Poa secunda</i>	9081322	36.9	defgh
<i>Leymus cinereus</i>	Washoe	36.1	defgh
<i>Agrostis gigantea</i>	9076276	35.0	defgh
<i>Achnatherum hymenoides</i>	Nezpar	33.4	defgh
<i>Pseudoroegneria spicata</i>	Goldar	33.1	defgh
<i>Pseudoroegneria spicata</i>	9081636	31.5	efgh
<i>Leymus cinereus</i>	Magnar	30.9	fghi
<i>Poa secunda</i>	Sherman	30.4	fghi
<i>Pascopyrum smithii</i>	Rosana	28.6	ghi
<i>Pascopyrum smithii</i>	Rodan	27.5	ghi
<i>Agrostis gigantea</i>	9076266	26.3	ghi
<i>Pascopyrum smithii</i>	9081968	24.7	hi
<i>Deschampsia caespitosa</i>	9076290	22.8	hi
<i>Achnatherum hymenoides</i>	9081628	20.8	hij
<i>Achnatherum hymenoides</i>	9081629	15.9	ijk
<i>Poa alpina</i>	01-13-1 (9082259)	6.4	jkl
<i>Deschampsia caespitosa</i>	Nortran	5.7	jkl
<i>Poa alpina</i>	9016273	5.4	kl
<i>Deschampsia caespitosa</i>	13970176 (9082260)	4.5	kl
<i>Poa alpina</i>	1858 (9082266)	4.1	kl
<i>Poa alpina</i>	Gruening	1.1	kl
<i>Agrostis gigantea</i>	Streaker	0.9	kl
<i>Poa secunda</i>	Canbar	0.0	l

* Means followed by the same letter are not significantly different at the 0.05 significance level using the LSD Mean Comparison method.

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Appendix 9. Biomass production of grasses in Stucky Ridge Trials (clipped 8/30/05).

Species	Accession or Cultivar	Plant Biomass Production	
		<i>kg/ha</i>	
<i>Elymus trachycaulus</i>	9081620	8,211	a*
<i>Elymus trachycaulus</i>	9081621	4,100	b
<i>Poa secunda</i>	9081633	2,506	c
<i>Leymus cinereus</i>	Trailhead	2,222	cd
<i>Agrostis gigantea</i>	9076276	2,189	cd
<i>Agrostis gigantea</i>	9081619	2,039	cde
<i>Leymus cinereus</i>	9081624	1,844	cdef
<i>Elymus trachycaulus</i>	Pryor	1,578	cdefg
<i>Agrostis gigantea</i>	9076266	1,367	cdefgh
<i>Elymus wawawaiensis</i>	Secar	1,289	cdefgh
<i>Poa secunda</i>	9081635	906	defgh
<i>Achnatherum hymenoides</i>	Nezpar	872	defgh
<i>Deschampsia caespitosa</i>	9076290	844	defgh
<i>Pascopyrum smithii</i>	9081968	800	defgh
<i>Pascopyrum smithii</i>	Rosana	650	efgh
<i>Leymus cinereus</i>	Magnar	639	efgh
<i>Elymus trachycaulus</i>	San Luis	622	efgh
<i>Elymus trachycaulus</i>	Revenue	578	fgh
<i>Leymus cinereus</i>	9081625	428	fgh
<i>Leymus cinereus</i>	Washoe	361	gh
<i>Achnatherum hymenoides</i>	Rimrock	339	gh
<i>Pseudoroegneria spicata</i>	9081636	317	gh
<i>Pseudoroegneria spicata</i>	Goldar	272	gh
<i>Poa secunda</i>	9081322	233	gh
<i>Pascopyrum smithii</i>	Rodan	189	gh
<i>Poa secunda</i>	Sherman	189	gh
<i>Agrostis gigantea</i>	Streaker	122	h
<i>Achnatherum hymenoides</i>	9081628	61	h
<i>Achnatherum hymenoides</i>	9081629	61	h
<i>Poa alpina</i>	9016273	51	h
<i>Poa alpina</i>	1858 (9082266)	28	h
<i>Deschampsia caespitosa</i>	13970176 (9082260)	28	h
<i>Poa alpina</i>	01-13-1 (9082259)	23	h
<i>Poa alpina</i>	Groening	0	h
<i>Deschampsia caespitosa</i>	Nortran	0	h
<i>Poa secunda</i>	Canbar	0	h

* Means followed by the same letter are not significantly different at the 0.05 significance level using the LSD Mean Comparison method.

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Appendix 10. Percentage stand cover and vigor rating, Stucky Ridge CEP, August 28, 2006, Anaconda, Montana.

Species	Accession or Cultivar	Percentage Stand Cover	Vigor Rating
		%	(1 – 9) [†]
<i>Elymus trachycaulus</i>	9081620	78.1 a*	3.2
<i>Poa secunda</i>	9081633	63.1 a	2.9
<i>Elymus trachycaulus</i>	9081621	41.2 b	3.4
<i>Agrostis gigantea</i>	9081619	29.4 bc	3.2
<i>Leymus cinereus</i>	9081624	28.1 bcd	4.8
<i>Elymus trachycaulus</i>	San Luis	26.6 bcde	4.6
<i>Elymus wawawaiensis</i>	Secar	25.3 bcdef	4.0
<i>Poa secunda</i>	9081635	23.7 bcdefg	4.1
<i>Elymus trachycaulus</i>	Pryor	22.2 cdefgh	5.0
<i>Agrostis gigantea</i>	9076276	21.6 cdefghi	3.6
<i>Leymus cinereus</i>	Trailhead	19.4 cdefghij	4.7
<i>Pascopyrum smithii</i>	Rosana	17.2 cdefghij	5.0
<i>Achnatherum hymenoides</i>	Rimrock	14.1 cdefghij	4.5
<i>Poa secunda</i>	Sherman	13.4 cdefghij	4.4
<i>Pascopyrum smithii</i>	9081968	12.8 cdefghij	5.5
<i>Agrostis gigantea</i>	9076266	11.2 cdefghij	4.0
<i>Leymus cinereus</i>	9081625	10.9 cdefghij	4.8
<i>Pseudoroegneria spicata</i>	Goldar	10.9 cdefghij	4.5
<i>Elymus trachycaulus</i>	Revenue	10.6 cdefghij	4.6
<i>Pascopyrum smithii</i>	Rodan	10.6 cdefghij	4.4
<i>Achnatherum hymenoides</i>	Nezpar	9.7 defghij	3.8
<i>Leymus cinereus</i>	Washoe	9.1 efg hij	4.7
<i>Leymus cinereus</i>	Magnar	7.2 fghij	5.2
<i>Achnatherum hymenoides</i>	9081628	5.9 ghij	4.4
<i>Agrostis gigantea</i>	Streaker	5.9 ghij	5.1
<i>Achnatherum hymenoides</i>	9081629	4.7 hij	4.9
<i>Poa alpina</i>	Gruening	4.7 hij	5.5
<i>Poa secunda</i>	9081322	4.1 hij	4.0
<i>Pseudoroegneria spicata</i>	9081636	3.4 hij	5.4
<i>Poa alpina</i>	9016273	3.4 hij	5.5
<i>Poa alpina</i>	01-13-1 (9082259)	2.8 ij	4.7
<i>Deschampsia caespitosa</i>	Nortran	2.8 ij	6.1
<i>Deschampsia caespitosa</i>	13970176 (9082260)	2.8 ij	5.2
<i>Poa secunda</i>	Canbar	2.5 j	5.0
<i>Poa alpina</i>	1858 (9082266)	1.9 j	5.0
<i>Deschampsia caespitosa</i>	9076290	0.6 j	4.5

* Means followed by the same letter are not significantly different at the 0.05 significance level using the LSD Mean Comparison method.

[†] - 1 = Best vigor; 4 = average; 9 = worst or dead.

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Appendix 11. Average plant height of grasses in Stucky Ridge plots (measured 8/28/06).

Species	Accession or Cultivar	Mean Plant Height
		<i>cm</i>
<i>Elymus trachycaulus</i>	9081621	78.56 a*
<i>Elymus trachycaulus</i>	9081620	77.31 ab
<i>Leymus cinereus</i>	9081624	64.88 abc
<i>Poa secunda</i>	9081633	62.38 abc
<i>Elymus wawawaiensis</i>	Secar	55.06 abcd
<i>Leymus cinereus</i>	9081625	54.31 abcd
<i>Agrostis gigantea</i>	9081619	53.13 abcd
<i>Leymus cinereus</i>	Trailhead	51.75 bcde
<i>Poa secunda</i>	9081635	44.94 cdef
<i>Agrostis gigantea</i>	9076276	44.25 cdef
<i>Elymus trachycaulus</i>	San Luis	42.13 cdefg
<i>Elymus trachycaulus</i>	Pryor	41.81 cdefg
<i>Poa secunda</i>	Sherman	41.69 cdefg
<i>Leymus cinereus</i>	Magnar	35.81 defgh
<i>Achnatherum hymenoides</i>	Nezpar	34.69 defgh
<i>Achnatherum hymenoides</i>	Rimrock	33.5 defgh
<i>Agrostis gigantea</i>	9076266	31.81 defghi
<i>Agrostis gigantea</i>	Streaker	31.19 defghi
<i>Leymus cinereus</i>	Washoe	31.00 defghi
<i>Elymus trachycaulus</i>	Revenue	29.94 defghi
<i>Pseudoroegneria spicata</i>	Goldar	26.06 efghij
<i>Poa alpina</i>	Gruening	25.25 fghij
<i>Achnatherum hymenoides</i>	9081628	22.63 fghij
<i>Poa alpina</i>	01-13-1 (9082259)	21.94 fghij
<i>Pascopyrum smithii</i>	Rosana	19.69 fghij
<i>Pascopyrum smithii</i>	9081968	17.69 ghij
<i>Pascopyrum smithii</i>	Rodan	17.5 ghij
<i>Achnatherum hymenoides</i>	9081629	15.56 hij
<i>Pseudoroegneria spicata</i>	9081636	15.25 hij
<i>Deschampsia caespitosa</i>	13970176 (9082260)	15.25 hij
<i>Poa secunda</i>	Canbar	15.19 hij
<i>Poa secunda</i>	9081322	14.94 hij
<i>Deschampsia caespitosa</i>	Nortran	14.00 hij
<i>Poa alpina</i>	9016273	12.94 hij
<i>Poa alpina</i>	1858 (9082266)	6.25 ij
<i>Deschampsia caespitosa</i>	9076290	3.31 j

* Means followed by the same letter are not significantly different at the 0.05 significance level using the LSD Mean Comparison method.

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Appendix 12. Biomass production, Stucky Ridge CEP, August 28, 2006, Anaconda, Montana.

Scientific Name	Accession or Cultivar	Plant Biomass Production
		<i>kg/ha</i>
<i>Elymus trachycaulus</i>	9081621	4894.44 a*
<i>Agrostis gigantea</i>	9081619	3322.22 ab
<i>Leymus cinereus</i>	9081624	2633.33 bc
<i>Elymus trachycaulus</i>	9081620	2311.11 bcd
<i>Poa secunda</i>	9081633	2311.11 bcd
<i>Leymus cinereus</i>	Trailhead	2255.56 bcde
<i>Elymus wawawaiensis</i>	Secar	2172.22 bcde
<i>Leymus cinereus</i>	Washoe	1988.89 bcdef
<i>Leymus cinereus</i>	9081625	1761.11 bcdefg
<i>Agrostis gigantea</i>	9076276	1550.00 cdefgh
<i>Leymus cinereus</i>	Magnar	1550.00 cdefgh
<i>Elymus trachycaulus</i>	Revenue	1272.22 cdefgh
<i>Agrostis gigantea</i>	9076266	1216.67 cdefgh
<i>Poa secunda</i>	9081635	1150.00 cdefgh
<i>Pseudoroegneria spicata</i>	Goldar	1072.22 cdefgh
<i>Achnatherum hymenoides</i>	Nezpar	1022.22 cdefgh
<i>Elymus trachycaulus</i>	Pryor	1000.00 cdefgh
<i>Pascopyrum smithii</i>	Rodan	922.22 defgh
<i>Elymus trachycaulus</i>	San Luis	777.78 defgh
<i>Achnatherum hymenoides</i>	Rimrock	677.78 defgh
<i>Agrostis gigantea</i>	Streaker	622.22 efgh
<i>Achnatherum hymenoides</i>	9081628	461.11 fgh
<i>Pascopyrum smithii</i>	9081968	455.56 fgh
<i>Poa secunda</i>	9081322	444.44 fgh
<i>Pseudoroegneria spicata</i>	9081636	400.00 fgh
<i>Poa secunda</i>	Sherman	305.56 gh
<i>Pascopyrum smithii</i>	Rosana	294.44 gh
<i>Poa alpina</i>	01-13-1 (9082259)	177.78 gh
<i>Achnatherum hymenoides</i>	9081629	138.89 gh
<i>Poa secunda</i>	Canbar	122.22 gh
<i>Deschampsia caespitosa</i>	Nortran	88.89 gh
<i>Poa alpina</i>	Gruening	83.33 h
<i>Deschampsia caespitosa</i>	9076290	77.78 h
<i>Poa alpina</i>	9016273	72.22 h
<i>Deschampsia caespitosa</i>	13970176 (9082260)	38.89 h
<i>Poa alpina</i>	1858 (9082266)	5.56 h

* Means followed by the same letter are not significantly different at the 0.05 significance level using the LSD Mean Comparison method.

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Appendix 13. Plant tissue analysis, Stucky Ridge CEP, 2004 through 2006, Anaconda, Montana (sampled 9/22/04, 8/29/05, 8/28/06).

Lot	Species	Al			As			Cd			Cu			Pb			Zn		
		2004	2005	2006	2004	2005	2006	2004	2005	2006	2004	2005	2006	2004	2005	2006	2004	2005	2006
		mg/kg			mg/kg			mg/kg			mg/kg			mg/kg			mg/kg		
1	ACHY 9081628	331	279	62	6	8	ND	ND	2	ND	39	34	6	ND	ND	ND	123	88	15
2	ACHY 9081629	288	420	101	9	8	ND	ND	2	ND	41	35	8	ND	ND	ND	111	73	12
3	ACHY Rimrock	235	332	101	ND	9	ND	5	1	ND	17	35	9	ND	ND	ND	68	38	10
4	ACHY Nezpar	276	200	54	ND	ND	ND	ND	ND	ND	16	21	5	ND	ND	ND	51	31	14
5	AGGI 9076276	258	382	158	ND	6	ND	ND	ND	ND	46	62	22	ND	ND	ND	54	41	20
6	AGGI 9081619	663	375	136	ND	ND	ND	ND	ND	ND	100	62	18	ND	ND	ND	51	64	17
7	AGGI 9076266	548	320	190	ND	6	ND	ND	ND	ND	74	39	30	ND	ND	ND	100	49	23
8	AGGI Streaker		2500	80		35	ND		ND	ND		243	16		13	ND		78	20
9	DECE 9076290	334	405	473	5	6	7	ND	1	ND	48	45	80	ND	ND	ND	63	52	35
10	DECE 13970176 (9082260)	1420	121	188	8	6	ND	ND	ND	ND	57	14	19	ND	ND	ND	87	44	24
11	DECE Nortran	336		90	8		ND	ND		ND	29		11	ND		ND	67		18
12	ELTR 9081620	242	285	151	ND	5	ND	ND	ND	ND	26	47	15	ND	ND	ND	14	16	9
13	ELTR 9081621	197	283	136	ND	ND	ND	ND	ND	ND	38	41	17	ND	ND	ND	21	22	9
14	ELTR Pryor	301	413	70	ND	8	ND	ND	ND	ND	25	62	12	ND	ND	ND	37	35	9
15	ELTR Revenue	280	445	127	ND	7	ND	ND	ND	ND	48	65	15	ND	ND	ND	50	47	11
16	ELTR San Luis	441	193	140	ND	6	ND	ND	ND	ND	45	27	16	ND	ND	ND	40	33	13
17	LECI 9081624	424	436	147	ND	5	ND	ND	ND	ND	62	73	19	ND	ND	ND	111	55	26
18	LECI 9081625	463	559	119	6	9	ND	ND	1	ND	72	76	16	ND	ND	ND	172	124	30
19	LECI Washoe	472	366	111	7	ND	ND	ND	ND	ND	47	47	14	ND	ND	ND	175	106	28
20	LECI Magnar	636	410	101	11	8	ND	ND	ND	ND	113	63	16	ND	ND	ND	84	69	23
21	LECI Trailhead	441	391	235	ND	8	ND	ND	ND	ND	35	51	25	ND	ND	207	85	93	125
22	PASM 9081968	374	315	272	6	5	ND	ND	ND	ND	45	41	32	ND	ND	ND	86	64	28
23	PASM Rodan	495	243	163	7	6	ND	ND	ND	ND	52	29	27	ND	ND	ND	56	39	14
24	PASM Rosana	210	318	186	6	9	ND	ND	ND	ND	29	47	26	ND	ND	ND	61	52	18
25	POAL 9016273	799	1740	162	7	21	ND	ND	ND	ND	50	120	18	ND	8	ND	45	64	17
26	POAL 01-13-1 (9082259)	1220	695	148	8	17	ND	ND	ND	ND	78	80	14	ND	ND	ND	49	50	15
27	POAL Gruening	706		67	ND		5	ND		ND	40		11	ND		15	36		33
28	POAL 1858 (9082266)	1190	1410	75	ND	20	6	ND	ND	ND	33	93	8	ND	9	ND	62	156	27
29	POSE 9081633	442	417	155	9	ND	ND	ND	ND	ND	49	52	19	ND	ND	ND	35	44	18
30	POSE Sherman	311	420	95	9	12	ND	ND	ND	ND	36	52	12	ND	ND	ND	94	106	19
31	POSE Canbar	no samples		43			ND			ND			6			ND			17
32	POSE 9081635	364	549	168	11	14	ND	ND	ND	ND	46	59	24	ND	ND	ND	38	44	17
33	POSE 9081322	441	346	220	ND	9	ND	ND	ND	ND	83	62	32	ND	ND	ND	57	64	33
34	PSSP 9081636	676	931	137	16	20	ND	ND	ND	ND	76	112	21	ND	ND	ND	81	84	19
35	PSSP Goldar	654	548	74	13	12	ND	ND	ND	ND	81	68	9	ND	ND	ND	77	58	19

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Appendix 13 (continued). Plant tissue analysis, Stucky Ridge CEP, 2004 through 2006, Anaconda, Montana (sampled 9/22/04, 8/29/05, 8/28/06).

Lot	Species	Al			As			Cd			Cu			Pb			Zn		
		2004	2005	2006	2004	2005	2006	2004	2005	2006	2004	2005	2006	2004	2005	2006	2004	2005	2006
36	ELWA Secar	396	635	94	ND	7	ND	ND	ND	ND	34	59	14	ND	ND	ND	68	65	17
1	UPEXP	392	266	94	ND	ND	ND	ND	ND	ND	51	43	15	ND	ND	ND	22	31	11
2	UPDEV	268	545	118	ND	12	ND	ND	ND	ND	31	69	14	ND	ND	ND	73	40	11
3	WMAEXP	374	421	84	ND	ND	ND	ND	ND	ND	35	50	11	ND	ND	ND	27	25	11
4	WMADEV	270	548	124	ND	9	ND	ND	ND	ND	26	66	15	ND	ND	ND	67	44	10
5	KRLA Op. Range	1173	372	132	7.5	ND	ND	ND	ND	ND	108	44	15	ND	ND	ND	82	47	14
6	PEER Old Works		1280	192		14	ND		ND	ND		65	15		ND	ND		31	10
10	PHHA 9081632		3720			42			ND			307			15			91	

Maximum Tolerable Levels for

Domestic livestock 1.

Wildlife 2.

Metal levels in Plants 3.

Deficient

Sufficient or

Normal

Excessive or Toxic

	50	0.5	100	30	500
	50	2	55	40	300
			2 to 5		
	1 to 1.7	0.05 to 0.2	5 to 30	5 to 10	27 to 150
	5 to 20	5 to 30	20 to 100	30 to 300	100 to 400

1. NRC 1980, 2. Ford, 1996, 3. Kabata-Pendias and Pendias 1992.

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Appendix 14. Plant tissue analysis of *Poa secunda* accessions, Stucky Ridge CEP, 2004 through 2006, Anaconda, Montana (sampled 9/22/04, 8/29/05, 8/28/06).

Species	Al			As			Cd			Cu			Pb			Zn		
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	
	2004	2005	2006	2004	2005	2006	2004	2005	2006	2004	2005	2006	2004	2005	2006	2004	2005	2006
POSE 9081633	442	417	155	9	ND	ND	ND	ND	ND	49	52	19	ND	ND	ND	35	44	18
POSE Sherman	311	420	95	9	12	ND	ND	ND	ND	36	52	12	ND	ND	ND	94	106	19
POSE Canbar	no samples		43			ND			ND			6			ND			17
POSE 9081635	364	549	168	11	14	ND	ND	ND	ND	46	59	24	ND	ND	ND	38	44	17
POSE 9081322	441	346	220	ND	9	ND	ND	ND	ND	83	62	32	ND	ND	ND	57	64	33
Maximum Tolerable Levels for																		
Domestic livestock 1.				50			0.5			100			30			500		
Wildlife 2.				50			2			55			40			300		
Metal levels in Plants 3.																		
Deficient							2 to 5											
Sufficient or Normal				1 to 1.7			0.05 to 0.2			5 to 30			5 to 10			27 to 150		
Excessive or Toxic				5 to 20			5 to 30			20 to 100			30 to 300			100 to 400		
1. NRC 1980, 2. Ford, 1996, 3. Kabata-Pendias and Pendias 1992.																		

ND= Non Detectable

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Appendix 15. Seedling density, percentage stand cover, plant vigor rating, mean plant height, and biomass production of *Poa secunda* accessions, Stucky Ridge CEP, 2003 through 2006, Anaconda, Montana.

Species	Accession or Cultivar	Seedling Density		Percentage Stand Cover				Vigor Rating				Mean Plant Height			Biomass Production		
		6/24/03 #/sq.ft.	8/26/03 #/sq.ft.	6/30/04 %	9/22/04 %	8/30/05 %	8/28/06 %	6/30/04 (1 - 9) [†]	9/22/04 (1 - 9) [†]	8/30/05 (1 - 9) [†]	8/28/06 (1 - 9) [†]	6/30/04 cm	8/30/05 cm	8/28/06 cm	9/22/04 kg/ha	8/30/05 kg/ha	8/28/06 kg/ha
<i>Poa secunda</i> (<i>ampla</i>)	Opportunity	7.13	5.16	31.3	37.2	43.44	63.13	3.3	2.4	2.13	2.94	26.5	59.06	62.38	407.61	2505.56	2311.11
<i>Poa secunda</i>	9081635	1.88	0.91	15	24.1	25.94	23.75	3.3	2.8	3.31	4.06	23.3	45.63	44.94	216.17	905.56	1150
<i>Poa secunda</i>	9081322	1.31	0.72	3.6	11.9	10	4.06	4.3	2.9	4.17	4	17.5	36.88	14.94	23.61	311.11	444.44
<i>Poa secunda</i> (<i>ampla</i>)	'Sherman'	3.13	2.34	6.2	12.2	12.5	13.44	4.8	4.1	3.98	4.38	6.8	30.38	41.69	183.33	188.89	305.56
<i>Poa secunda</i>	'Canbar'	1.22	0.47	0.4	0.0	0.0	2.5	6.2	9	0.0	5	6.3	0.0	15.19	0.0	0.0	122.22

[†] - 1 = Best vigor; 4 = average; 9 = worst or dead.