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USDA AGRICULTURAL RESEARCH SERVICE
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COLORADO STATE AGRICULTURAL EXPERIMENT STATION
FORT COLLINS, COLORADO

NOTICE OF RELEASE OF PUEBLO GERMPLASM BOTTLEBRUSH SQUIRRELTAIL SELECTED CLASS OF A NATURAL POPULATION

The Upper Colorado Environmental Plant Center; United States Department of Agriculture, Natural Resources Conservation Service; United States Department of Agriculture, Agricultural Research Service; and Colorado State Agricultural Experiment Station announce the release of a selected class of bottlebrush squirreltail (*Elymus elymoides* [Raf.] Swezey ssp. *brevifolius*) for the revegetation of disturbed sites within the natural range of this subspecies.

Because this is a selected class release (natural track), this plant will be referred to as Pueblo Germplasm bottlebrush squirreltail. This collection was assigned the Natural Resources Conservation Service (NRCS) accession number 9040187. Pueblo Germplasm is released as a selected class of certified seed (natural track).

This alternative release is justified because there is no release of the subspecies *E. elymoides* ssp. *brevifolius* from a single source. Tusas Germplasm bottlebrush squirreltail, released by Los Lunas PMC, is a composite of eight accessions originating in New Mexico. Pueblo Germplasm, along with Wapiti Germplasm, will represent the only releases of ssp. *brevifolius* from single sources. Furthermore, the subspecies *brevifolius* is the most prevalent subspecies in the Rocky Mountains. Bottlebrush squirreltail germplasms Fish Creek and Toe Jam Creek represent *E. elymoides* ssp. *elymoides* and *E. elymoides* ssp. *californicus* respectively. Seed increase of specific ecotypes, especially for use in the central Rocky Mountains, is needed for increased opportunities for site specific and site-adapted products.

Collection Site Information: Pueblo Germplasm bottlebrush squirreltail (accession 9040187) was originally collected August, 1976 by Larry Klock of the Natural Resources Conservation Service. The collection site is southwest of Pueblo, Colorado in Pueblo County (SE 1/4, SW1/4, Sec. 19, T22S, R68W). The landform consists of steep side slopes of benches, mesas and mountains. The site elevation is approximately 7200 feet and the soils are shallow and gravelly. Associated species included western wheatgrass, cheatgrass, yellow sweetclover, annual sunflower and Gambel oak.

Description: Bottlebrush squirreltail, *Elymus elymoides*, is a cool-season native perennial bunchgrass. The plant grows 8-25 inches tall, and occurs primarily on dry, gravelly or saline soils and is common on hillsides and alkaline flats. The stiff, involute leaf blades expand up to 3/16 of an inch in width and often become smooth or softly pubescent. The spikes of the inflorescence have long divergent awns and are commonly enclosed at the upper part of the sheath. The spikelets are two flowered at each node of a disarticulating rachis with the rachis breaking at the base of each joint. The spikelets drop from the seed head and are disseminated by the wind into surrounding areas.

Bottlebrush squirreltail is widely distributed spanning from Mexico to British Columbia and from the west coast to the Dakotas and south to Oklahoma and Texas. It also occupies a wide range of elevations from 4,000 to 10,500 feet. As a species, *Elymus elymoides* has good drought resistance and tolerance to saline-alkali soils. The plant is also useful for erosion control and has become an important tool for oil shale restoration and coal mine reclamation. It establishes easily and creates a good environment for succession. Bottlebrush squirreltail is also quite resistant to fire. The tussocks of squirreltail have low densities and burn quickly and at relatively low temperatures when compared to other perennial bunchgrasses such as needle-and-thread and bluebunch wheatgrass. As a result, meristematic crown tissue of burned squirreltail plants generally survives. Bottlebrush squirreltail is valuable winter forage for many domestic and wildlife species because of its long green period. Pueblo Germplasm bottlebrush squirreltail obtains a height of 12 to 18 inches, and initiates growth and matures approximately 10 days to two weeks later than the Wapiti selection of bottlebrush squirreltail.

Method of Breeding and/or Selection: A total of 8 bottlebrush squirreltail accessions were collected from sites along the east and west side of the Rocky Mountains and eastern Utah. These collections were established and initially evaluated in 1983 for survival, overall forage production, potential seed production, and seedling vigor. In 1984, the accessions were evaluated for percent stand, leaf height, vigor, leaf abundance, stem height and seed production. In 1987, the last year of the initial evaluation, two accessions were identified for further testing and seed increase. Pueblo bottlebrush squirreltail and another top accession, Wapiti, were the two chosen for further development.

Ecological Considerations and Evaluation: Pueblo Germplasm bottlebrush squirreltail was produced from 1990 to 2001 in UCEPC seed production fields and did not demonstrate a cultural concern during production. Because the seed is dispersed quite easily by wind, open, fallow fields may be subject to bottlebrush squirreltail invasion. However, the selection has met the criteria for releasing as per the Environmental Evaluation of NRCS Plant Releases (attached). This release is of a native species that is widely distributed throughout western North America, and of a subspecies that is an important range component in the central Rocky Mountains with recognized benefits to domestic livestock, wildlife and for use in reclamation and revegetation.

Conservation Use: The potential uses of Pueblo Germplasm bottlebrush squirreltail include erosion control and domestic livestock and wildlife forage production. The plant establishes easily, remains green for a long period and is palatable throughout the winter. Bottlebrush squirreltail is also an important source for fire restoration. It is quick to establish, has a proficient seed dispersal mechanism, and is resistant to fire damage. Bottlebrush squirreltail has also shown that it can become a good competitor with undesirable annual weed species. Bottlebrush squirreltail is recognized as being one native perennial bunchgrass that has potential for broad-scale application in range seedings where introduced products such as crested and Siberian wheatgrasses and Russian wildryes have been used traditionally. Excellent seed dispersal, ability to tolerate fire, and excellent seedling vigor are all attributes that will allow this selection of bottlebrush squirreltail to be used in many conservation applications.

Anticipated Area of Adaptation: Bottlebrush squirreltail is a perennial bunchgrass, commonly found on south facing slopes with a wide topographic range from the desert plains to mountain slopes. It inhabits dry, gravelly soils, but is also found on heavier soils such as saline-alkali sites, and is well adapted to harsh environments and extreme conditions. The Natural Resources Conservation Service range site descriptions for Colorado lists bottlebrush squirreltail as occurring naturally on 46 of 64 sites. Range sites supporting high densities of bottlebrush squirreltail are generally found to receive 7 to 15 inches of precipitation. The soils can be loamy, calcareous, gravelly, shallow, or salty, and the most commonly associated plant species are western wheatgrass, Indian ricegrass, galleta grass, and winterfat. Squirreltail exceeds 10 to 15 percent of the total production on range sites titled Mountain Loam, Limy Bench, Mountain Outwash, Shallow Slopes, and Salt Desert Breaks. Pueblo bottlebrush squirreltail is potentially adapted for use throughout the above areas.

Availability of Plant Materials: The Upper Colorado Environmental Plant Center will maintain G1 and G2 seed. G2 seed will be available to growers. Growers may produce one generation (G3) beyond G2 Pueblo Germplasm seed. Any seed used for certified seed production of Pueblo Germplasm must be obtained from UCEPC.

References:

"Bottlebrush Squirreltail". <http://jan.ucc.nau.edu/~plants-c/forage/bott.shtml> (1 Dec 2003).

Goodson, Danny "Bottlebrush Squirreltail – New Release in Development from the LLPMC". *Progress Report*. 2000. <http://plant-materials.nrcs.usda.gov/pubs/nmpmcprbbst.pdf> (20 Nov. 2003).

Harrington, H.D. 1964. Manual of the Plants of Colorado. Second edition. The Swallow Press Incorporated. Chicago, Illinois.

Hitchcock, A.S. 1950. Manual of the Grasses of the United States. Second edition. Revised by A. Chase. U.S. Printing Office.

Humphrey, David L. and Eugene W. Schupp 1998. Can Squirreltail (*Elymus elymoides*) Withstand Competition from Cheatgrass (*Bromus tectorum*)? Dept. of Rangeland Resources, Utah State University.

Jones, T.A. "Journal of Range Management". *Viewpoint: The present status and future prospects of squirreltail research.* 1998. <http://uvalde.tamu.edu/jrm/may98/jones.htm> (2 Dec 2003).

Jones, T.A., D.C. Nielson, J.T. Arredondo, and M.G. Redinbaugh. 2003. Characterization of diversity among three squirreltail taxa. Journal of Range Management 56(5):474-482.

Jones, T.A., D.C. Nielson, S.R. Larson, D.A. Johnson, T.A. Monaco, S.L. Caicco, D.G. Ogle, and S.A. Young. 2004. Registration of Fish Creek bottlebrush squirreltail germplasm. Crop Science 44:1879-1880.

Jones, T.A., D.C. Nielson, S.R. Larson, D.A. Johnson, T.A. Monaco, S.L. Caicco, D.G. Ogle, S.A. Young, and J.R. Carlson. 2004. Registration of Toe Jam Creek bottlebrush squirreltail germplasm. Crop Science 44:1880-1881.

Larson, S.R., T.A. Jones, K.B. Jensen, and C. L. McCracken. 2003. Amplified fragment length polymorphism in *Elymus elymoides*, *Elymus multisetus*, and other *Elymus* taxa. Canada Journal of Botany (81):789-804.

Wright, H.A. 1971. Why squirreltail is more tolerant to burning than needle-and-thread. Journal of Range Management 24277-284.

Young, J.A. and R.F. Miller. 1985. Response of *Sitanion hystrix* (Nutt.) J.G. to prescribed burning. American Midland Naturalist 113(1):183-189.

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Documentation to Support the Release of Pueblo Germplasm Bottlebrush Squirreltail

Initial Evaluation Plantings

Two planting methods were used in the initial evaluation of bottlebrush squirreltail accessions assembled by the Upper Colorado Environmental Plant Center (UCEPC). Eight materials were assembled for project 08I070H. These collections were acquired from the front range and western slopes of Colorado and from eastern Utah (see Appendix I). One planting utilized direct seeding while the second planting utilized containerized transplants. Both plantings were completed in 1983.

Evaluations were conducted annually from 1983 through 1986 on percent stand, leaf height, leaf abundance, stem height, and vigor. From the 1986 annual project report "outstanding looking plants represented accessions 9040189 and 9040187", Wapiti and Pueblo Germplasms respectively, according to Sam Stranathan, UCEPC manager. These materials were identified as excellent forage producing types with later maturity dates than the other accessions in the trial. Both were selected for further development from this initial project.

In 1989, a 0.01 acre plot of 9040187 was established in Field 25 at UCEPC for seed increase. This plot was expanded in 1991. In addition, a larger seed increase effort was also established in 1991 in UCEPC Field 17. This field produced seed from 1992 through 2001 (see Appendix II).

Field Evaluation Studies

Field evaluation plantings were conducted at two off center sites in 1995, 1996 and 1997. These plantings were done in order to determine plant material establishment, adaptability and production potential for released and experimental products near the perimeter of UCEPC's service area. The Coyote Draw Field Evaluation Planting site is located between Strawberry and Starvation Reservoirs in east-central Utah and the Soda Lake site is located in west-central, Wyoming.

Coyote Draw

A field evaluation planting was done October 20 - 22, 1997 as a continuing effort in determining plant material establishment, adaptability and production potential for use in the western part of the UCEPC service area. The UCEPC, in cooperation with Natural Resource Conservation Service personnel from the Meeker, Colorado and Roosevelt, Utah field offices, plant material specialists from Idaho and Colorado and personnel from the Aberdeen Idaho Plant Materials Center, seeded 69 accessions, including 54 grasses, in three replications in October, 1997. The included plant materials are being developed by entities within the intermountain west region and tested for their range of adaptation at the Coyote Draw field evaluation site near Duchesne, Utah.

Site Description

The site is classified as Major Land Resource Area 34D, and as a pinion-juniper range site according to the Natural Resources Conservation Service. Average annual precipitation is 20 to 30 centimeters (8 - 12 inches). Approximately 65% occurs as rain from March through September. On the average, November through February are the driest months and July through October are the wettest. The average freeze-free period is 100 to 140 days with plant growth often beginning around March 30 and ending around September 30.

Dominant grasses are usually Indian ricegrass, galleta, bottlebrush squirreltail, and needle-and-thread. Other important grasses are blue grama, red threeawn, and sand dropseed. The desert globemallows are among the most important forbs. Up to 45% of the composition can be shrubs, dominated by Wyoming big sage, winterfat, and lesser quantities of fourwing saltbush, Douglas rabbitbrush, shadscale, Mormon tea, and hopsage.

The most common range site within the project is referred to as a semi-desert loam or a Wyoming big sagebrush site. This range site occurs where the elevation ranges from 4,900 to 7,200 feet. Characteristically, the soils are deep and well-drained.

Results

Results of the Coyote Draw planting are summarized in Appendices III and IV. The three bottlebrush squirreltail accessions, all listed as numeric entries, are compared against Sand Hollow Germplasm squirreltail (*Elymus multisetus* {J.G. Smith} Burtt-Davy), 'Paloma' Indian ricegrass (*Achnatherum hymenoides*), 'Secar' Snake River wheatgrass (*Elymus lanceolatus* ssp. *wawawaiensis*), and 'Hycrest' crested wheatgrass (*Agropyron desertorum* x *cristatum*). Sand Hollow Germplasm was the only squirreltail release at the time of the planting and was used as a standard for comparison. The other named releases in the Appedix are used for reference only and represent materials that were assumed to be well suited for the site.

Appendix III shows percent cover for the seven materials mentioned above from evaluations conducted in 1998 through 2002. The percent cover for both Wapiti and Pueblo Germplasms is markedly higher than for accession 9019219 and Sand Hollow each of the first four years after planting. Vigor during the same period was also much better for Wapiti and Pueblo (Appendix IV).

Soda Lake

Site Description

The Soda Lake study site is located near Pinedale, Wyoming. The site has a 60 day growing season with annual precipitation averaging 15 inches. Soils are classified as Ryark Loamy Sand and are deep and well drained with a pH of 7.6. The range site consists of 75 percent grasses, 15 percent forbs and 10 percent woody species.

Results

Fifty accessions were planted September, 1995. In October, 1996, 33 more accessions were added to the planting. A randomized complete block design with three replications per entry was used for both plantings. The plantings were evaluated each year from 1996 through 2002. Data is summarized for average percent stand, vigor and production. Vigor is recorded with values from 1-9 with 1 being the best, 5 average and 9 the worst. Production was determined from dry matter weight of clipped plots and converted to pounds per acre.

Of the 83 accessions in the Soda Lake planting, 5 of 6 bottlebrushes were in the top half based on yield. In addition, 4 of 6 bottlebrushes, including Wapiti and Pueblo Germplasms, were among the top 20 yielding entries. Sand Hollow, the only squirreltail released at the time, performed in the lower half of the entries. One bottlebrush entry, accession 9019218, was collected in Sublette County, Wyoming at an elevation of 7,953 feet. The Soda Lake study site is located in Sublette County at 7,450 feet. Even so, the local entry was intermediate in its yield performance when compared to the Wapiti and Pueblo sources.

Only four released products representing three species yielded better than the Pueblo and Wapiti bottlebrush squirreltail sources. The results are summarized Appendix V.

Seed Quality

Seed of both Wapiti and Pueblo sources of bottlebrush squirreltail has been successfully harvested by direct combining and seed stripping with a Flail-O-Vac harvester. Seed quality of eight seed lots of Pueblo Germplasm bottlebrush squirreltail harvested and tested from1992 through 2000 indicate an average purity of 95.65% and an average viability of 86.13%. Average pure live seed for eight different seed production years for Pueblo Germplasm is 82.38 percent (see Appendix VI).

Taxonomic and Genetic Identity

Work comparing the genetic relationship of various *Elymus* taxa to the place of origin has been done by Jones and Larson. An interpretive explanation of the contents of Appendix VII, along with a list of the entries, their identity and place of collection, a map showing the DNA relationship of the entries to each other, and a geographic map identifying the place of collection are compiled as Appendix VII.

APPENDIX I
COLLECTION INFORMATION OF ELYMUS ELYMOIDES
PROJECT 08I070H

National Contol No.	Date of Collection	Area of Collection	Collector
30709	8/15/1975	Gunnison, CO	Jim Kellogg
40181	8/4/1975	Vernal, UT	Glenn Carnahan
40182	8/10/1975	Calamity Ridge, CO	Glenn Carnahan
40183	8/20/1975	Gunnison, CO	Glenn Niner
40186	8/24/1976	Telluride, CO	Jim Kellogg
40187	8/13/1976	Pueblo, CO	Larry J. Klock
40188	6/26/1981	Rangely, CO	Patrick Davey
40189	8/3/1981	Gooseberry Creek, CO	Tim Carney

APPENDIX II
PUEBLO SEED PRODUCTION

Common Name/ Variety	Scientific Name	Project No.	Accession No.	Year	Acres	Harvest Date	Field No.	Cleaned Weight
Squirreltail, bottlebrush	*Elymus elymoides*	08S195	9040187	1989	0.01		25	--
Pueblo Source				1990	0.01	24-Jul	25	1.39 lb
				1991	0.41	21-Aug	25	2.94 lb
				1992	0.75	7/28 to 8/24	17	183.00 lb
				1993	0.75	26-Aug	17	78.00 lb
				1994	0.75	18-Aug	17	25.50 lb
				1995	0.75	9-Sep	17	68.00 lb
				1996	0.75	8/22-9/10	17	42.00 lb
				1997	0.75	8/19-9/14	17	53.00 lb
				1998	0.75	13-Aug	17	17.00 lb
				1999	Plowed all but two rows	20-Aug	17	0.97 lb (now breeders block)
				2000	two rows	7-Aug	17	2.30 lb
				2001	two rows	21-Aug	17	228.00 g

APPENDIX III
COYOTE DRAW SUMMARY

% COVER

	Pueblo 9040187			Wapiti 9040189			9019219			Sand Hollow			Paloma			Secar			Hycrest		
REPS:	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1998	35	30	25	40	35	15	0	10	0	<1	0	5	15	30	15	10	15	5	30	25	40
1999	40	50	10	30	40	40	<1	20	0	0	0	<1	2	10	0*	<1	0	20	20	10	40
2001	5	20	20	0	5	5	5	0	0	0	5*	0	5	20	20	0	0	3	5	20	60
2002	20	0	3	0	0	3	0	0	0	0	0	0	35	20	60	0	0	0	20	3	0*
2004	0	0	0	0	0	0	0	0	0	0	0	0	12	20	90	0	0	0	22	20	6

AVERAGE % COVER

	Pueblo 9040187	Wapiti 9040189	9019219	Sand Hollow	Paloma	Secar	Hycrest
1998	30	30	3	2	20	10	32
1999	33	37	7	0	4	7	23
2001	15	3	2	2	15	1	28
2002	8	1	0	0	38	0	8
2004	0	0	0	0	41	0	16

APPENDIX IV
COYOTE DRAW SUMMARY

VIGOR

	Pueblo 9040187			Wapiti 9040189			9019219			Sand Hollow			Paloma			Secar			Hycrest		
REPS:	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1998	4	4	4	4	5	5	0	4	0	8	0	5	7	3	5	6	5	9	6	4	4
1999	3	5	4	7	5	2	4*	5	0	0	0	8	7	6	0*	8	0	5	5	6	4
2001	3	6	5	0	7	6	6	0	0	0	0	0	2	4	2	0	0	4	6	5	3
2002	3	0	8	0	0	5	0	0	0	0	0	0	2	7	6	0	0	0	7	8	0*
2004	0	0	0	0	0	0	0	0	0	0	0	0	2	5	7	0	0	0	3	3	5

AVERAGE VIGOR

	Pueblo 9040187	Wapiti 9040189	9019219	Sand Hollow	Paloma	Secar	Hycrest
1998	4	4.7	8	7.7	5	6.7	4.7
1999	4	4.7	6.3	9.3	7.7	7.7	5
2001	4.7	7.7	8.7	10	2.7	8	4.7
2002	7	8.3	10	10	5	10	8.3
2004	10	10	10	10	4.7	10	3.7

APPENDIX V

Soda Lake (1996-2002) Summary of Means Ranked by Yield

Key: Yellow = Bottlebrush Squirreltail
Green = Standards

Accession	Species	% Stand *	Vigor **	Yield	Yield
				Lbs/acre	Kg/Ha
ARS-1105b	Elymus elymoides	14.0	4.1	619.6	694.6
Sherman	Poa ampla	8.6	4.3	547.1	613.3
9039445	Elymus glaucus	11.3	4.8	529.0	593.1
9030446	Elymus glaucus	14.0	4.8	510.8	572.6
ARS-L4PX	Leymus hybrid	26.3	4.7	448.8	503.1
ARS-T961b	Stipa robusta	26.2	4.1	394.4	442.1
9005453	Poa ampla	7.6	4.4	355.0	397.9
ARS-636b	Leymus cinereus	32.5	4.6	339.6	380.7
9040047	Stipa nelsonii ssp. dorei	14.8	4.9	339.3	380.4
9039070	Stipa nelsonii ssp. dorei	20.6	5.0	320.0	358.7
ARS-238	Psuedoroegneria spicata	7.8	4.9	306.1	343.2
Lodorm	Nasella viridula	10.3	5.0	306.1	343.1
9040189	Elymus elymoides	6.2	5.1	305.0	342.0
9019230	Stipa nelsonii ssp. dorei	16.7	4.9	304.4	341.2
9005589	Stipa nelsonii ssp. dorei	18.2	4.7	299.3	335.5
9005460	Poa juncifolia	9.3	4.5	295.0	330.7
9019218	Elymus elymoides	5.5	5.1	289.9	325.0
Albertan	Nasella viridula	12.9	5.2	282.6	316.8
Goldar	Psuedoroegneria spicata	6.9	4.5	278.8	312.6
9040187	Elymus elymoides	5.0	5.8	271.0	303.8
PI-434231	Poa arida	8.8	4.7	251.2	281.6
Magnar	Leymus cinereus	6.6	5.6	234.0	262.3
9024804	Stipa nelsonii ssp. dorei	19.2	4.7	233.6	261.8
ARS-P2b	Psuedoroegneria spicata	8.9	4.9	231.8	259.9
Secar	Psuedoroegneria spicata	2.0	6.1	199.1	223.2
9024716	Achnatherum hymenoides	8.4	5.5	191.3	214.4
Liso	Bromus inermis	8.6	5.3	180.6	202.5
9076297	Poa sandbergii	17.9	4.2	176.0	197.3
9040137	Stipa nelsonii ssp. dorei	11.6	5.7	173.8	194.9
T-953	Achnatherum robustum	7.8	5.7	171.2	191.9
9024741	Achnatherum hymenoides	10.2	5.4	169.0	189.4
9043501	Leymus salinus	3.7	5.4	168.6	189.0
ARS-P4b	Psuedoroegneria spicata	9.2	5.5	162.9	182.6
109c	Achnatherum hymenoides	9.0	5.2	157.2	176.2
9019219	Elymus elymoides	3.2	5.5	153.6	172.2
9019117	Bromus marginatus	2.8	6.6	138.3	155.0
T-51	Achnatherum hymenoides	7.3	5.6	136.6	153.2
ARS-E-27	E. lanceolatus ssp. wawawaiensis X ssp. lan	2.8	8.8	136.1	152.6
Rush	Elytrigia intermedia	13.8	5.3	129.8	145.5
Bannock	Elymus. lanceolatus ssp. lanceolatus	5.3	5.2	129.6	145.3
Manchar	Bromus inermis	5.8	5.5	118.6	132.9
9005308	Bromus marginatus	4.4	5.3	114.6	128.4
9024715	Achnatherum hymenoides	8.4	5.7	113.9	127.7
ARS-E-20D	E. lanceolatus ssp. wawawaiensis X ssp. lan	4.9	5.6	110.1	123.4

APPENDIX V

Accession	Species	% Stand *	Vigor **	Yield	Yield
				Lbs/acre	Kg/Ha
9025897	Festuca idahoensis	2.5	4.7	108.8	122.0
9024739	Achnatherum hymenoides	6.7	6.1	105.0	117.7
Rimrock	Achnatherum hymenoides	3.4	5.9	93.2	104.5
9039066	Bromus marginatus	3.3	6.4	83.7	93.8
9025731	Festuca idahoensis	4.5	4.8	81.3	91.1
Trailhead	Leymus cinereus	5.7	6.7	77.4	86.7
Canbar	Poa secunda	7.4	5.5	76.8	86.1
Covar	Festuca ovina	2.3	5.0	75.5	84.7
9024751	Achnatherum hymenoides	4.8	5.9	73.1	82.0
9025999	Festuca idahoensis	2.2	4.8	68.2	76.5
Wytana	Atriplex canescens	1.9	4.8	64.7	72.5
Nezpar	Achnatherum hymenoides	2.8	6.1	64.5	72.3
Sand Hollow	Elymus elymoides	3.4	5.7	63.2	70.9
9025940	Festuca idahoensis	1.9	5.0	57.8	64.8
9025776	Festuca campestris	2.4	5.1	55.9	62.6
SFP-Mix	Festuca dasyclada	3.3	5.9	45.3	50.8
9005367	Festuca idahoensis	1.6	6.0	41.2	46.1
Reúbens	Poa compressa	2.1	6.4	35.7	40.0
Joseph	Festuca idahoensis	2.7	5.4	27.4	30.8
MT-2	Triticum aestivum var. durum X T. intermed	2.3	6.5	21.9	24.5
9039450	Festuca idahoensis	3.0	5.5	17.8	20.0
9016226	Leucopoa kingii	2.0	5.6	17.1	19.2
9026093	Festuca scabrella	1.9	6.0	16.1	18.1
9026079	Festuca scabrella	1.9	6.2	13.3	14.9
Redondo	Festuca arizonica	2.9	5.3	11.6	8.6
9038424	Penstemon albifluvis	7.9	4.2		
9057946	Astragalus adsurgens	1.8	7.2		
9067480	Atriplex canescens		6.0		
9067480	Atriplex canescens	1.0	5.7		
Bandera	Penstemon stictus	7.9	5.3		
Cedar	Penstemon palmeri	4.7	4.9		
Clear Water	Penstemon venustus	2.8	5.5		
Hatch	Krascheninnikovia lanata		6.0		
Lutana	Astragalus cicer	6.8	5.7		
Richfield	Penstomon eatonii	1.0	5.9		
Richfield	Penstemon eatonii	6.0	6.1		
Rincon	Atriplex canescens	1.0	4.6		

* Stand is measured in % Basal Cover

** Vigor is ranked on a 1-9 scale with 1 being the best and 9 being the worst

APPENDIX VI
BOTTLEBRUSH SQUIRRELTAIL
PUEBLO - FIELD 17 - 9040187

Production Year	Purity	Viability	PLS	Date of Test
1992	99.69%	81%	80.75%	20-Apr-93
1993	99.40%	81%	80.51%	4-Feb-94
1994	96.73%	82%	79.32%	30-Jan-95
1995	99.26%	94%	93.30%	27-Feb-96
1996	99.73%	95%	94.74%	7-Feb-97
1997	94.02%	97%	91.20%	13-Feb-98
1998	85.32%	84%	71.67%	16-Feb-99
2000	91.05%	75%	68.29%	28-Dec-00
Average Purity:	95.65%			
Average Viability:		86.13%		

Appendix VII

Interpretation Summary

Table 1 Description of Elymus taxa

Figure 1 DNA Relationship of Entries

Figure 2 Collection Sites

Interpretation Summary

High informative DNA profiles of the Pueblo and Wapiti *E. elymoides* ssp. *brevifolius* germplasms were compared with 22 *E. elymoides* ssp. *elymoides* (ELYMe), 22 *E. elymoides* ssp. *brevifolius* (ELYMb), 13 *E. multisetus* (MULT), 2 *E. canadensis* (CANA), 1 *E. hystrix* (HYST), 3 *E. glaucus* (GLAU), 6 *E. lanceolatus* (LANC), 2 *E. wawawaiensis* (WAWA) 3 *E. trachycaulus* (TRAC), 3 *E. caninus* (CANI), 1 *E. mutabilis* (MUTA), and 2 *E. sibiricus* (SIBI) accessions (Larson et al. 2003) (SRL_Table 1). These results clearly demonstrate that the Pueblo (ELYMb-05) and Wapiti (ELYMb-06) germplasms are similar to other *E. elymoides* ssp. *brevifolius* accessions from the Colorado plateau region, but different from 5 cultivated forms of *E. elymoides* ssp. *elymoides* (ELYMe-40, ELYMe-43, ELYMe-41, ELYMe-42, and ELYMe-44) and 1 cultivated form of *E. multisetus* (MULT-03) compared in this study (SRL_Figure 1). Thus, comparisons of DNA profiles demonstrate that Pueblo and Wapiti are genetically distinct from each other (SRL_Figure 1) and different from other cultivated germplasm sources of squirreltail. Most of *E. elymoides* ssp. *brevifolius* accessions, including Pueblo and Wapiti, belong to one of four genealogical lineages designated group A (SRL_Figure 1). This assemblage of *E. elymoides* ssp. *brevifolius* accessions (group A) is distributed, in part, across much of Colorado, northern New Mexico, and northeastern Utah (SRL_Figure 2). To the best of our knowledge, Pueblo and Wapiti are the only commercial germplasm sources of E. *elymoides* ssp. *brevifolius*.

Table 1. Description of *Elymus* taxa and accessions evaluated for amplified fragment length polymorphism.

Label	Taxon	Herbarium voucher[3]	Seed accession identifier(s)	Origin (°North, °West)
Sect. *Sitanion* with type species *E. elymoides*				
ELYMb-01	*E. elymoides* ssp. *brevifolius*	235878	Grandview	Grandview, Jefferson Co., OR (44.5,121.6)
ELYMb-02	*E. elymoides* ssp. *brevifolius*	235879	PI 611151[4], T-920	Turin, AB (50,112.6)
ELYMb-03	*E. elymoides* ssp. *brevifolius*	235880	PI 611152[4], T-926	Buffalo, AB (50.8,110.7)
ELYMb-04[1]	*E. elymoides* ssp. *brevifolius*	235881	PI 531605[4], D-3345, Acc1105	Gardner, Huerfano Co., CO (37.62,105.19)
ELYMb-05[1]	*E. elymoides* ssp. *brevifolius*	235882	NRCS 9040187, Acc1122	Wet Mountains, Custer Co., CO (38.05,104.8)
ELYMb-06[1]	*E. elymoides* ssp. *brevifolius*	235883	NRCS 9040189, Acc1123	Buford, Rio Blanco Co., CO (39.98,107.63)
ELYMb-07[1]	*E. elymoides* ssp. *brevifolius*	235884	PI 628688[4], NRCS 9026083, Acc1130	Savageton, Campbell Co., WY (43.82,105.8)
ELYMb-08	*E. elymoides* ssp. *brevifolius*	235885	W6 20997[4], Acc1139	Ft. Carson, El Paso Co., CO (38.5,104.8)
ELYMb-09[2]	*E. elymoides* ssp. *brevifolius*	235886	W6 20998[4], T-1180	Wagon Mound, Mora Co., NM (36.054,104.795)
ELYMb-10[2]	*E. elymoides* ssp. *brevifolius*	235887	W6 20999[4], T-1202	hwy 75 X 20, Blaine Co., ID (43.3,114.29)
ELYMb-11[2]	*E. elymoides* ssp. *brevifolius*	235888	W6 21004[4], T-1228	Colton, Utah Co., UT (39.83,110.95)
ELYMb-12[2]	*E. elymoides* ssp. *brevifolius*	235889	W6 21005[4], T-1233	Hermosa, LaPlata Co., CO (37.43,107.81)
ELYMb-13[2]	*E. elymoides* ssp. *brevifolius*	235890	W6 21007[4], T-1239	Pagosa Springs, Archuleta Co., CO (37.38,106.9)
ELYMb-14[2]	*E. elymoides* ssp. *brevifolius*	235891	W6 21009[4], T-1243	Powderhorn, Gunnison Co., CO (38.34,107.1)
ELYMb-15	*E. elymoides* ssp. *brevifolius*	235892	W6 21010[4], T-1245	Almont, Gunnison Co., CO (38.7,106.85)
ELYMb-16[2]	*E. elymoides* ssp. *brevifolius*	235893	W6 21011[4], T-1249	Sargents, Saguache Co., CO (38.4,106.47)
ELYMb-17[2]	*E. elymoides* ssp. *brevifolius*	235894	W6 21012[4], T-1260	Westcliffe, Custer Co., CO (38.11,105.46)
ELYMb-18[2]	*E. elymoides* ssp. *brevifolius*	235895	W6 21013[4], T-1264	Colmor, Colfax Co., NM (36.265,104.642)
ELYMb-19[2]	*E. elymoides* ssp. *brevifolius*	235896	W6 21016[4], T-1272	La Cueva, Santa Fe Co., NM (35.944,105.253)
ELYMb-20[2]	*E. elymoides* ssp. *brevifolius*	235897	W6 21017[4], T-1277	Tres Piedras, Rio Arriba Co., NM (36.641,105.968)
ELYMb-21[2]	*E. elymoides* ssp. *brevifolius*	235898	W6 21018[4], T-1299	Flagstaff, Coconino Co., AZ (35.339,111.557)
ELYMb-22[2]	*E. elymoides* ssp. *brevifolius*	235899	W6 21003[4], T-1206	Dixie, Elmore Co., ID (43.32,115.35)

Label	Taxon	Herbarium voucher[3]	Seed accession identifier(s)	Origin (°North, °West)
ELYMb-23[2]	*E. elymoides* ssp. *brevifolius*	235900	W6 23104[4], T-1308	Almont, Gunnison Co., CO (38.7,106.9)
ELYMb-24	*E. elymoides* ssp. *brevifolius*	235901	PI 232353[4], Acc1315	Daggett Co., UT (40.9,109.5)
ELYMe-25	*E. elymoides* ssp. *elymoides*	235902	W6 22033[4], NRCS 9041720, Acc1134	Brooks Spring, Lander Co., NV (40.74,117.31)
ELYMe-26	*E. elymoides* ssp. *elymoides*		PI 610978[4], T-1047	Leamington Canyon, Juab Co., UT (39.5,112.2)
ELYMe-27[1]	*E. elymoides* ssp. *elymoides*	235903	W6 22018[4], NRCS 9045926, Acc1108	Butte Co., ID (43.63,113.31)
ELYMe-28[1]	*E. elymoides* ssp. *elymoides*	235904	W6 22026[4], NRCS 9045937, Acc1116	Bradbury Flat, Custer Co., ID (44.41,114.16)
ELYMe-29	*E. elymoides* ssp. *elymoides*	235905	W6 22028[4], NRCS 9046458, Acc1119	Power Co., ID (42.74,112.91)
ELYMe-30[1]	*E. elymoides* ssp. *elymoides*	235906	PI 619489[4], NRCS 9019224, Acc1126	Whitehall, Jefferson Co., MT (46.13,111.98)
ELYMe-31[1]	*E. elymoides* ssp. *elymoides*	235907	PI 619555[4], NRCS 9005549, Acc1127	Warren, Carbon Co. MT (45.01,108.63)
ELYMe-32[1]	*E. elymoides* ssp. *elymoides*	235908	PI 619561[4], NRCS 9019218, Acc1128	Big Piney, Sublette Co., WY (42.8,110.4)
ELYMe-33[1]	*E. elymoides* ssp. *elymoides*	235909	NRCS 9019219, Acc1129	Ten Sleep, Washakie Co., WY (44.03,107.53)
ELYMe-34[2]	*E. elymoides* ssp. *elymoides*		PI 628747[4], T-1173	Mountain Home, Elmore Co., ID (43.03,115.56)
ELYMe-35[2]	*E. elymoides* ssp. *elymoides*	235910	PI 619553[4], T-1171	Shoshone, Lincoln Co., ID (42.97,114.29)
ELYMe-36[2]	*E. elymoides* ssp. *elymoides*	235911	W6 20989[4], T-1175	Ditto Crk. Rd., Elmore Co., ID (43.29,115.84)
ELYMe-37[2]	*E. elymoides* ssp. *elymoides*	235912	PI 628685[4], T-1191	Moffat Co., CO (40.94,108.77)
ELYMe-38[2]	*E. elymoides* ssp. *elymoides*	235913	PI 628686[4], T-1193	Superior, Sweetwater Co., WY (41.78,108)
ELYMe-39[2]	*E. elymoides* ssp. *elymoides*	235914	PI 628687[4], T-1198	Sage Junction, Rich Co., UT (41.78,111.19)
ELYMe-40[2]	*E. elymoides* ssp. *elymoides*	235915	W6 20994[4], T-1223	Fish Creek, Blaine Co., ID (43.34,113.86)
ELYMe-41	*E. elymoides* ssp. *elymoides*	235916	19 (1999) Maughn and Barton Seed	Sanpete Co., UT (39.15,111.85)
ELYMe-42	*E. elymoides* ssp. *elymoides*	235917	21171 Granite Seed	Sanpete Co., UT (39.25,111.7)
ELYMe-43	*E. elymoides* ssp. *elymoides*	235918	SIHY-18326 Rainier Seed	Oasis, Elko Co., NV (6000) (41.05,114.5)
ELYMe-44	*E. elymoides* ssp. *elymoides*	235919	SIHY-1341 Wind River Seed	Jim Bridger Trail, Washakie Co, WY (44,107.5)
ELYMe-45	*E. elymoides* ssp. *elymoides*	235920	W6 23099[4], T-1303	Dietrich, Lincoln Co., ID (42.9,114.3)
ELYMe-46	*E. elymoides* ssp. *elymoides*	235921	W6 22032[4], NRCS 9041713, Acc1133	Pershing Co., Nevada (40.09,118.86)

Label	Taxon	Herbarium voucher[3]	Seed accession identifier(s)	Origin (°North, °West)
MULT-01[1]	*E. multisetus*	235922	PI 531603[4], D-2857, Acc1103	Bodie Flat, Douglas Co., NV (38.85,119.7)
MULT-02[1]	*E. multisetus*	235923	PI 531606[4], D-3546, Acc1106	Central Ferry, Whitman Co., WA (46.6,117.8)
MULT-03	*E. multisetus*	235924	PI 595899[4], Acc1118, 'Sand Hollow'	Gem Co., ID (43.9,116.5)
MULT-04[1]	*E. multisetus*	235925	W6 20962[4], NRCS 9034042, Acc1132	Paradise Valley, Humboldt Co., NV (41.47,117.58)
MULT-05[2]	*E. multisetus*	235926	T-1165	King Hill, Elmore Co., ID (42.98,115.27)
MULT-06[2]	*E. multisetus*	235927	PI 619457[4], W6 20965, T-1177	Little Ranch, Canyon Co., ID (43.78,116.53)
MULT-07	*E. multisetus*	235928	W6 20970[4], T-1201	Dietrich, Lincoln Co., ID (42.9,114.31)
MULT-08	*E. multisetus*	235929	PI 619552[4], T-1207	Dixie, Elmore Co., ID (43.31,115.44)
MULT-09[2]	*E. multisetus*	235930	PI 619463[4], T-1209	Ditto Creek Rd., Elmore Co., ID (43.29,115.84)
MULT-10[2]	*E. multisetus*	235931	PI 619460[4], T-1216	Bogus Basin Rd., Ada Co., ID (43.66,116.19)
MULT-11[2]	*E. multisetus*	235932	PI 619465[4], T-1219	Seaman Gulch Rd., Ada Co., ID (43.71,116.26)
MULT-12[2]	*E. multisetus*	235933	PI 619454[4], T-1268	A-line canal, Gem Co., ID (43.85,116.6)
MULT-13	*E. multisetus*	235934	Acc1314	Mosier, Wasco Co., OR (45.68,121.35)
Sect. *Macrolepis* with type species *E. canadensis*				
CANA-01	*E. canadensis*	235938	PI 531565[4]	CO
CANA-02	*E. canadensis*		D-3364	UT
Sect. *Hystrix* with type species *E. hystrix*				
HYST-01	*E. hystrix*		PI 531615[4], D-3479	MO
HYST-02	*E. hystrix*	235939	D-3605	MO
Sect. *Goulardia* with type species *E. caninus*				
TRAC-01	*E. trachycaulus*	235951	PI 372650[4]	AK
TRAC-02	*E. trachycaulus*	235952	PI 442444[4]	via Belgium
TRAC-03	*E. trachycaulus*	235941	D-3270	UT
MUTA-01	*E. mutabilis*	235940	PI 564954[4], DJ-4149	Kazakhstan

Label	Taxon	Herbarium voucher[3]	Seed accession identifier(s)	Origin (°North, °West)
CANI-01	*E. caninus*	235947	PI 564912[4], DJ-4005	Russia
CANI-02	*E. caninus*		PI 564915[4], DJ-3975	Russia
CANI-03	*E. caninus*	235948	PI 252044[4]	Italy
Sect. *Elymus* with type species *E. sibiricus*				
SIBI-01	*E. sibiricus*		W6 14340[4], AJC268	Russia
SIBI-02	*E. sibiricus*	235953	PI 499464[4]	PRC
GLAU-01	*E. glaucus*	235942	PI 387917[4]	Canada
GLAU-02	*E. glaucus*	235943	D-3268	CO
GLAU-03	*E. glaucus*	235944	PI 232281[4]	CA
Sect. *Dasystachyae* with type species *E. lanceolatus*				
LANC-01	*E. lanceolatus*	235950	D-3354	
LANC-02	*E. lanceolatus*	235935	D-3627	ND
LANC-03	*E. lanceolatus*	235936	PI 531623[4]	NV
LANC-04	*E. lanceolatus*	235937	D-3626	Canada
LANC-05	*E. lanceolatus*		PI 387883[4]	AB, Canada
LANC-06	*E. lanceolatus*		PI 387886[4]	AB, Canada
WAWA-01	*E. wawawaiensis*	235945	PI 285272[4]	WA
WAWA-02	*E. wawawaiensis*	235946	PI 440921[4], 'Secar'	ID

[1] Accessions from Jones et al. (2002) assemblage one.

[2] Accessions from Jones et al. (2002) assemblage two.

[3] Utah State University Intermountain Herbarium

[4] USDA National Plant Germplasm System identifiers.

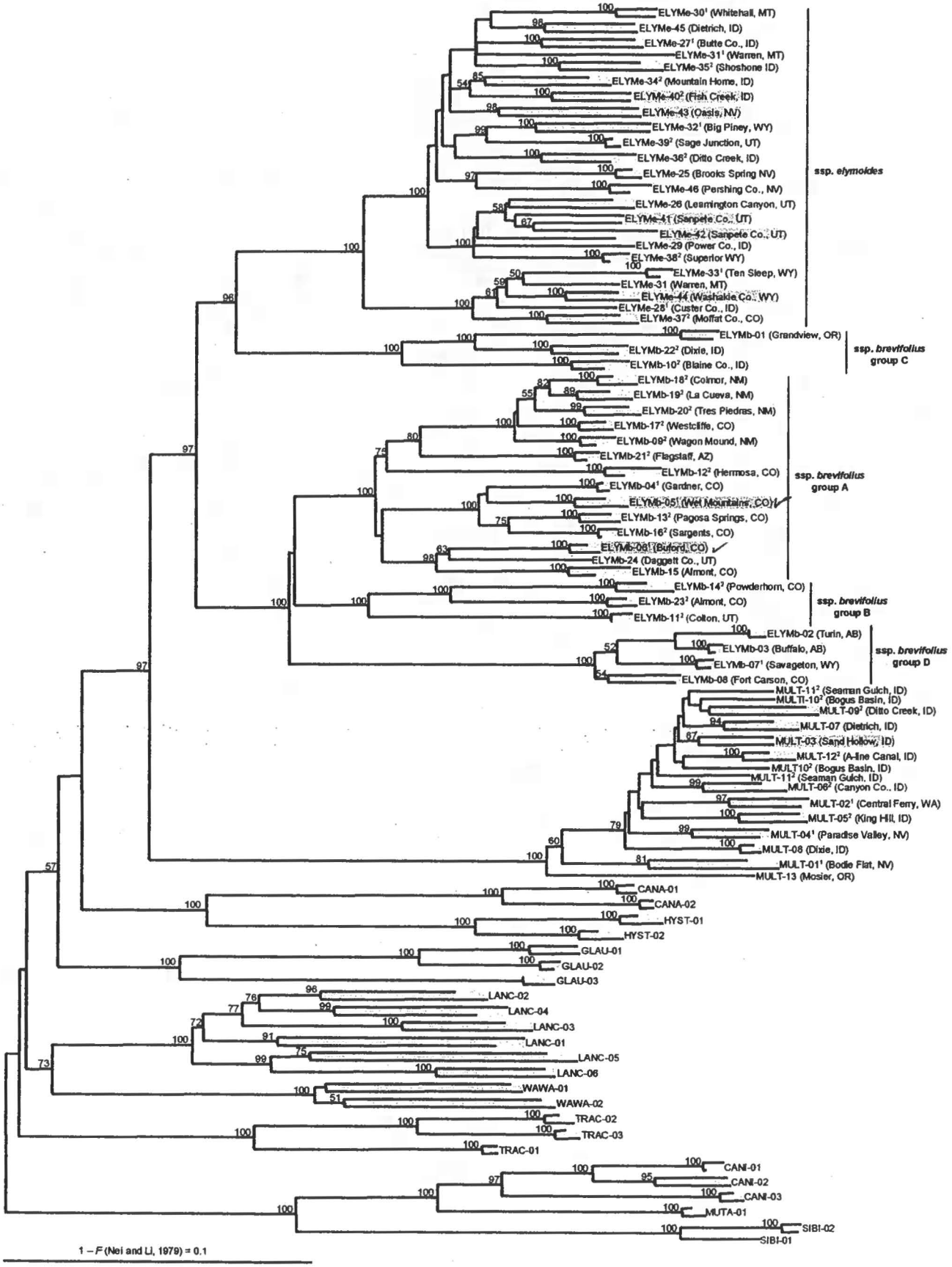

Figure 1 DNA Relationship

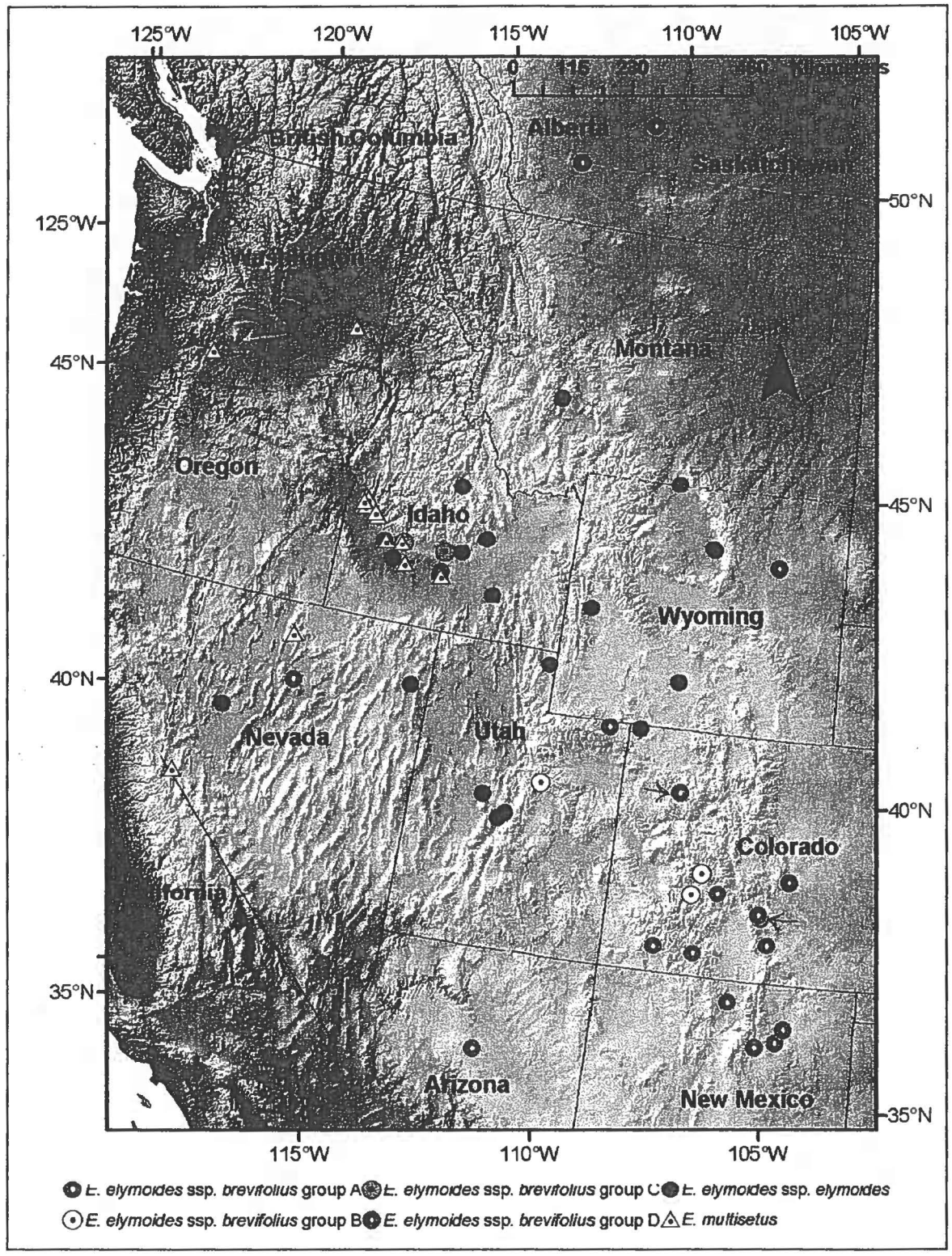

Figure 2 Collection Sites