UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE, ROCKY MOUNTAIN RESEARCH STATION
PROVO, UTAH

UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT, BOISE, IDAHO

UTAH DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WILDLIFE RESOURCES
EPHRAIM, UTAH

UTAH STATE UNIVERSITY, AGRICULTURAL EXPERIMENT STATION
LOGAN, UTAH

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
BOISE, IDAHO

UNIVERSITY OF IDAHO, AGRICULTURAL EXPERIMENT STATION
MOSCOW, IDAHO

NOTICE TO RELEASE
ANATONE GERMPLASM BLUEBUNCH WHEATGRASS
(SELECTED CLASS NATURAL POPULATION)

The United States Department of Agriculture, Forest Service, Rocky Mountain Research Station; United States Department of the Interior, Bureau of Land Management, Idaho State Office; Utah Department of Natural Resources, Division of Wildlife Resources; Utah State University Agricultural Experiment Station; United States Department of Agriculture, Natural Resources Conservation Service; University of Idaho, Agricultural Experiment Station propose the release of Anatone Germplasm bluebunch wheatgrass (*Psuedoroegneria spicata* [Pursh] A. Löve ssp. *spicata)* for restoration of disturbed sites within the natural range of this species.

Anatone is a natural, non-manipulated bluebunch wheatgrass population accession originating from Asotin County in Southeastern Washington. It is a long-lived perennial bunchgrass better adapted to low elevation, semi-arid sites with long, hot growing seasons than other bluebunch wheatgrass accessions or available releases. Its seedling vigor and establishment also exceed those of other accessions and released cultivars. Anatone's ready germination, rapid development, ability to compete with exotic annuals, and drought tolerance make it an excellent choice for restoration of cheatgrass (*Bromus tectorum* L.) infested landscapes. It can also be used to convert stands of introduced perennial grasses to native plant communities in areas where it once existed. Anatone is

widely adapted throughout the natural range of this species, and can be used to restore extensive disturbances once occupied by shrubs and bunchgrass. Bluebunch wheatgrass is one of the most common native grasses of the Intermountain West. There is a need for a release that can be used in the drier portions of the species range to improve species diversity, resilience, and habitat values.

Scientific Name: *Pseudoroegneria spicata* (Pursh) A. Löve ssp. *spicata*. Synonyms include *Festuca spicata* Pursh, *Agropyron spicatum* (Pursh) Scribner & Smith, *Elymus spicatus* Gould, and *Elytrigia spicata* (Pursh) D. Dewey.

Common Name: Bluebunch wheatgrass, 'Anatone' wheatgrass.

Germplasm Identification: The germplasm will be referred to as 'AnatoneGermplasm' bluebunch wheatgrass to identify and document the original collection site.

Identification Number: Anatone has been identified by the Forest Service as AGSP B53-88.

Origin: Extensive collections of bluebunch wheatgrass were obtained by scientists of the Natural Resources Conservation Service (formerly the Soil Conservation Service) between 1934 and 1938 from the Palouse Prairie, Snake River Canyon, and adjacent areas in Idaho, eastern Oregon, and eastern Washington. Collections from this region performed exceptionally well when planted throughout the Intermountain West. Results of this earlier work prompted further evaluations of materials from the area for big game habitat improvement in central and southern Idaho beginning in 1968. Additional collections from this area were acquired for comparative trials at low elevation, semiarid areas of the Intermountain region as a cooperative study with Idaho BLM and USDA, Forest Service, Rocky Mountain Research Station. Stanley Kitchen collected Anatone bluebunch wheatgrass in 1988 about 4.8 km (3.0 miles) east of Anatone, Asotin County, Washington (N 46^{o} 9.57' W 117^{o} 4.72'). Numerous other collections were made in close proximity from southeastern Washington, northeastern Oregon, and western Idaho area. Subsequent collections have been made from this region since 1988.

The Anatone Germplasm collection site is approximately 0.8 km (0.5 mile) south of Highway 129 near Mill Creek Road at the edge of Mill Creek Canyon. Plants occur on a series of closely related soils. Soils on the flats and ridge tops are identified by USDA-NRCS as the Neconda soil series. The Gwinly-Mallory #36 soil series dominates slopes of 3 to 30%, and the Gwinly-Mallory #37 soil series complex occupies slopes of 30 to 70%. These soils are shallow to moderately deep, well drained, and derived from weathered basalt. Surface layers are typically dark or grayish brown very stony silt loam to cobbly clay loam. Underlying soils vary in depth from 25 to 50 cm (10 to 20 inches), and depth to underlain basalt may vary from 25 to 100 cm (10 to 40 inches). Sub soils are dark grayish brown very cobbly silty clay loam. Rocky and extremely stony loam soils are common. Soils are well drained, but permeability may be slow and available water capacity is low to moderate. Soils are calcareous below a depth of about 85 cm (34

inches). Elevation at the collection site is 975 m (3,200 ft), but the Neconda soil type ranges from 975 to 1097 m (3,200 to 3,600 ft).

Other species associated with bluebunch wheatgrass at the Anatone collection site include Idaho fescue (*Festuca idahoensis* Elmer), Sandberg bluegrass (*Poa secunda* J. Presl), arrowleaf balsamroot, (*Balsamorhiza sagittata* [Pursh] Nutt.), mountain big sagebrush (*Artemisia tridentata Nutt. ssp. vaseyana* [Rydb.] Beetle), stiff sagebrush (*Artemisia rigida [Nutt.] Gray),* current (*Ribies spp*), serviceberry (*Amelanchier alnifolia* Nutt.), and Wyeth eriogonum (*Eriogonum umbellatum* Torr.).

Average annual precipitation at the collection site during the period 1951 through 1978 was 508 mm (20 inches), but in 2 of every 10 years, total annual precipitation may be as low as 440 mm or as high as 600 mm (17.5 to 23.87 inches). Precipitation is well distributed throughout the year with nearly all months receiving more than 25 mm (1.0 inch) moisture. November through January monthly precipitation averages more than 50 mm (2 inches) while February through June average slightly less. Average daily maximum temperature for the entire year is 13 ^{o}C. Maximum daily temperatures may equal or exceed 27 ^{o}C for nearly 7 months (April through October). Average daily minimal temperatures remain high throughout the year with averages minimal monthly temperatures below freezing only in December and January. The frost-free period ranges from 110 to 135 days. Based on these conditions, the region would be classified as having a long growing season with high temperatures, particularly during the summer months (NOAA 1997, USDA-NRCS, Lewiston, ID, data on file).

The collection site is classified as Major Land Resource Area B9, Palouse and Nez Perce Prairie, by the USDA-NRCS (Anonymous 1981), Intermountain Semi desert Province 342 by Bailey (1995), and EPA Level III Ecoregion 10, Columbia Plateau (U.S. Environmental Protection Agency 2000).

Description: Anatone Germplasm bluebunch wheatgrass is similar in general appearance to 'Goldar' bluebunch wheatgrass, 'Whitmar' beardless wheatgrass (*Pseudoroegneria spicata* [Pursh] A. Löve ssp. *inermis* [Scribner & J.G. Smith] A. Löve), and 'Secar' Snake River wheatgrass (*Elymus wawawaiensis* J. Carlson and Barkworth). The selection is a densely tufted perennial bunchgrass with abundant, long, narrow, light green leaves that are 45 to 50 cm (18 to 20 inches) long. Plants occur as distinct large bunches with numerous leaves creating a characteristic tufted growth habitat. Anatone is a diploid (2n=14) and cross-pollinating. Leaves are mostly basal, erect to lax. Some upper cauline leaves are flat, but mostly involute throughout their length and less than 2mm wide. Blades and sheaths are glabrous. Stems are also numerous, erect, and usually less than 1 m tall (40 inches) with very fine, narrow, lax heads. Spikes are slender, mostly 10 to 15 cm long (4 to 6 inches); spikelets are distinct but not as long as the internodes. Seeds are about 10 mm long, rarely longer than 13 mm. Glumes are short, 5 to 10 mm long, unequal in length, with slightly blunt ends narrowing to a short tip. About 70 percent of the lemmas produce a short, divergent awn that is 8 to 9 mm long.

'Whitmar', 'Goldar' and 'Secar' were all collected from southeastern Washington. Whitmar beardless bluegrass, collected from a prairie-grassland receiving 500 mm of annual precipitation, is an awnless form. It was developed by selection from a spaced planting after the ecotype had been tested in outplanting nurseries (Anonymous 1964; Hein 1958; Kelley, C. [n.d.b]). The original collection site of Whitmar is near Colton, Whitman County, Washington, and the cultivar exhibits similar adaptive traits to arid sites (Anonymous 1947; Mann 1954; Wolf and Morrison 1957) as Anatone. Goldar bluebunch wheatgrass, a cultivar with divergent awns that are 1 to 2 cm long, originated from an open park within a ponderosa pine (*Pinus ponderosa* Douglas ex P. & C. Lawson) woodland (Gibbs and Young 1989). It was collected at a higher elevation and moister climate than Anatone. P-7 is a genetically diverse, multiple-origin polycross of 25 bluebunch wheatgrass collections. Twenty-four of these are diploid while one is tetraploid. Most P-7 plants are without awns (Jones et al. 2002; Larson et al. 2000). Secar, once considered a bluebunch wheatgrass, but later recognized as a new allotetraploid species, Snake River wheatgrass, is awned (Carlson and Barkworth 1997; Jones et al. 1991; Kelley [n.d.b]; Morrison 1981). It is distinguished from bluebunch wheatgrass by its more compact spikelets, shorter internodes, lanceolate glumes, and smaller seeds.

Method of Selection: Anatone Germplasm bluebunch wheatgrass was selected from a series of comparative field trials involving approximately 80 collections from eight Western states: Washington, Oregon, Idaho, Nevada, Utah, Wyoming, Colorado, and Montana. Field plantings of 53 collections, including Goldar and Secar Snake River wheatgrass were established at the Orchard Research Site near Boise, Idaho, and at Nephi, Utah, in the spring of 1989 and 1990 (Monsen et al. 1999). Plantings were evaluated to compare and evaluate establishment, growth habit, growth rate, seasonal growth, vigor, plant stature, seed production, and survival. Seeds of 47 natural populations were examined to determine optimum germination at near freezing temperatures (Kitchen and Monsen 1994, 1999). In addition, greenhouse trials were conducted to develop an index of seedling vigor based on germination and emergence in relation to planting depth. Seed production and seed quality studies were conducted at the Spanish Fork Station, Brigham Young University Field Center in conjunction with wildland and nursery collections from the Orchard and Nephi sites. The USDA-ARS Forage and Range Research Laboratory in Logan, Utah conducted direct seedlings at Blue Creek and Green Canyon, Utah involving 48 perennial grass accessions including Goldar, Secar, P-7, and Anatone. Scientists from the USDA, ARS Forage and Range Research Laboratory, Logan, Utah also conducted DRN tests of a wide array of collections throughout the West, including Anatone and many other sources furnished by the USDA, Forest Service, Shrub Laboratory. Seed production fields varying in size from 0.4 to 40 ha have been established in Utah (1997, 1998, and 1999); Colorado (1998); Washington (1999), and Idaho (2002).

Environmental Considerations and Evaluation: This release is a native species that is widely distributed throughout the western United States. The collection site is in close proximity to the collection locations of Goldar bluebunch wheatgrass and Whitmar beardless wheatgrass and the closely related Secar Snake River wheatgrass. Study sites

have been established and maintained under similar ecological conditions in which bluebunch wheatgrass naturally exists. No attempt has been made to segregate or eliminate genetic characteristics inherent to this ecotype. No definitive attributes have been reported that would suggest this selection would interfere with or prevent natural recovery of associated plants existing in native plant communities. Seed production fields established under cultivation have not demonstrated cultural problems. This species is not regarded as having any adverse negative characteristics that would preclude its use (see attached Environmental Evaluation of Plant Materials Releases). It is an important species that is widely used to restore disturbed areas and re-establish native plant communities.

Anticipated Use: Anatone Germplasm bluebunch wheatgrass can be used to restore extensive areas once dominated by big sagebrush/bluebunch wheatgrass communities and foothill regions dominated by bunchgrass communities in western North America. It is particularly useful for seeding semiarid regions supporting only remnant populations of this species. Anatone is better able to establish on dry sites than other bluebunch wheatgrass cultivars, and it competes relatively well with exotic annuals. It can be used in conjunction with other native plants to re-establish native communities in areas presently occupied by exotic annuals or sites where stands of introduced perennial grasses have been established if the site is properly prepared. It is an important species for re-establishing native communities to regain species diversity, increase seasonal forage quality, improve wildlife habitat, and reduce the incidence of extensive and destructive wildfires. It is also a key species in the successional recovery of important shrub and woodland communities.

Area of Adaptation: Anatone Germplasm bluebunch wheatgrass is widely adapted to the Palouse Prairie, Snake River drainage, southern Idaho, northern Nevada, northern Utah and other areas where the species naturally exists. It is recommended for areas receiving at least 250 to 300mm (10 to 12 inches) of annual precipitation, and it is particularly well adapted to sites with long growing seasons. Whitmar and Secar are recommended for areas receiving similar amounts of annual precipitation, although Secar can be used on sites receiving as little as 200 mm (8 inches) (Ogle and others 2003). Anatone does well on sites that receive fall rains prompting regrowth. It also establishes well and persists on exposed slopes where growth may begin early in the season and where extremely high daily temperatures may occur during the summer and fall months. Anatone is adapted to light and medium-textured soils that are normally well drained and may dry early in the growing season, but it will grow and remain green well into the summer if soil moisture is available. It is adapted to a broad range of sites occupied by big sagebrush. Anatone can be planted on sites supporting mountain big sagebrush (*Artemisia tridentata* Nutt. ssp. *vaseyana* [Rydb.] Beetle), basin big sagebrush (*A. tridentata* Nutt. ssp. *tridentata)* or Wyoming big sagebrush (*A. tridentata* Nutt. spp. w*yomingensis* Beetle & Young). It is also well adapted to upper bench lands and mountain slopes with antelope bitterbrush (Purshia tridentata [Pursh] DC.), Idaho fescue (*Festuca idahoensis* Elmer), bitter cherry (Prunus emarginata [Dougl.] Walp.). It can also be seeded on shallow and rocky soils supporting stiff sagebrush (*Artemisia rigida* Nutt) It has survived well when seeded on heavy-textured soils previously occupied by

black greasewood (*Sarcobatus vermiculatus* [Hook.] Torr.), but it would not be recommended as a replacement for species in salt desert shrub communities.

Increase and Distribution: The USDA Natural Resources Conservation Service, Plant Materials Center, Aberdeen, Idaho will maintain Generation 1 seed. This seed can be requested from the Utah Crop Improvement Association and the Idaho Foundation Seed Program. Growers may produce G2, G3, and G4 generations of seed.

Prepared by: This Notice for the Release of Anatone Germplasm bluebunch wheatgrass was prepared by Stephen B. Monsen (retired), Stanley G. Kitchen, Kelly Memmott, Botanists, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Provo, UT, and Nancy Shaw, Botanist, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Boise, ID; Mike Pellant, Coordinator, Great Basin Restoration Initiative, USDI, Bureau of Land Management; Boise, ID; Stanford Young, Secretary/Manager, Utah Crop Improvement Association, Utah State University, Logan, UT; Dan Ogle, Plant Materials Specialist, USDA Natural Resources Conservation Service, Boise, ID; Loren St. John, Team Leader, USDA Natural Resources Conservation Service, Aberdeen Plant Materials Center, Aberdeen, ID; and as a joint release by these agencies and Utah Department of Natural Resources, Division of Wildlife Resources; University of Idaho, Agricultural Experiment Station; and Utah State University, Agricultural Experiment Station.

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SIGNATURES FOR RELEASE OF:

ANATONE GERMPLASM BLUEBUNCH WHEATGRASS (SELECTED CLASS NATURAL POPULATION) *Pseudoroegneria spicata* (Pursh) A. Löve ssp. *spicata* (synonyms include *Festuca spicata* Pursh, *Agropyron spicatum* (Pursh) Scribner & J.G. Smith, *Elymus spicatus* Gould, and *Elytrigia spicata* (Pursh) D. Dewey

USDA-FS	**Director, Rocky Mt. Exp. Stn.**	**Date**
USDI-BLM	**Idaho State Director**	**Date**
State of Utah	**Director, DWR**	**Date**
Utah State Univ.	**Director, Utah Ag. Exp. Stn.**	**Date**
Univ. of Idaho	**Director, Idaho Ag. Exp. Stn.**	**Date**
USDA-NRCS	**Idaho State Conservationist**	**Date**
USDA-NRCS	**Director ESD, Washington, DC**	**Date**

Environmental Evaluation of Plant Materials Releases

Name of person scoring:	**Loren St. John Dan Ogle**	**Date of scoring:**	**3/19/03**
Scientific Name:	**Pseudoroegneria spicata spicata**	**Common Name:**	**Bluebunch Wheatgrass**
Release Name:	**Anatone**		

Is the plant native to the US?	**Yes**
Is the plant native to the area of intended use?	**Yes**
Authority used to determine native status:	**NRCS PLANTS Database**
What is the intended area of use for this plant?	**Intermountain west**
What is the intended use for this plant?	**Erosion control, rangeland restoration**
Areas in which the release is known to be invasive or has a high probability of being invasive:	**None**

Summary of Criteria from Section A	**Score**
Part 1. Impact on Habitats, Ecosystems, and Land Use	**3**
Part 2. Ease of Management	**14**
Part 3. Conservation Need and Plant Use	**8**
Part 4. Biological Characteristics	**28**

Final Determination of Release Based on the Environmental Evaluation:

X ☐ **OK to Release**

☐ **OK to Release but qualify use and intended area of use***

☐ **Do Not Release - NPL determines if release is made***

☐ **Do Not Release - document and destroy materials**

I certify that this Environmental Evaluation was conducted with the most accurate and current information possible.

/s/ Loren St. John 3/19/03

Signature of Person Scoring Date

Signature of NPL indicating that it is OK to make the release:

National Program Leader, PM **Date**

Section A. Scoring of Criteria for Impact, Management, Need and Biological Characteristics

Circle the appropriate number for each of the following criteria. Add up the scores for each part and record at the end of each part. Comments which clarify answers or provide supporting information may be included in the right margin of the worksheet or attached on a separate sheet of paper.

Part 1: Impact on Habitats, Ecosystems, and Land Use

This section assesses the ability of the species or release to adversely affect habitats, ecosystems, and agricultural areas.

1) **Ability to invade natural systems where the species does not naturally occur**
   a) Species not known to spread into natural areas on its own 0
   b) Establishes only in areas where major disturbance has occurred in the last 20 years (e.g., natural disasters, highway corridors) **3**
   c) Often establishes in mid- to late-successional natural areas where minor disturbances occur (e.g., tree falls, streambank erosion), but no major disturbance in last 20-75 years 6
   d) Often establishes in intact or otherwise healthy natural areas with no major disturbance for at least 75 years 10

2) **Negative impacts on ecosystem processes** (e.g., altering fire occurrence, rapid growth may alter hydrology)
   a) No perceivable negative impacts **0**
   b) Minor negative impacts to ecosystem processes 2
   c) Known significant negative impacts to ecosystems processes 6
   d) Major, potentially irreversible, alteration or disruption of ecosystem processes 10

3) **Impacts on the composition of plant communities where the species does not naturally occur**
   a) No negative impact; causes no perceivable changes in native populations **0**
   b) Noticeable negative influences on community composition 5
   c) Causes major negative alterations in community composition 10

4) **Allelopathy**
   a) No known allelopathic effects on other plants **0**
   b) Demonstrates allelopathic effects on seed germination of other plants 3
   c) Demonstrates allelopathic effects to mature stages of other plants 5

5) Impact on habitat for wildlife or domestic animals (aquatic and terrestrial), including threatened and endangered species (coordinate with USFWS and state Heritage Programs as appropriate)

a) No negative impact on habitat, or this criteria not applicable based on intended use for the plant **0**
b) Minor negative impact on habitat (e.g., decreased palatability; lower wildlife value; decreased value for undesirable animal species) 2
c) Significant negative impact on habitat (e.g., foliage toxic to animals; significantly lower value for wildlife; excludes desirable animal species from an area) 5

6) Impact on other land use

a) No negative impacts on other land uses **0**
b) Minor impacts (plant could invade adjacent areas and decrease its value) 3
c) Significant impacts (plant may alter the system or adjacent lands significantly enough to prevent certain uses) 5

Total Possible Points 45

Total Points for Part 1 3

Part 2. Ease of Management

This part evaluates the degree of management which might be needed to control the species or release if it becomes a problem, or eradicate the species or release if it is no longer desirable.

1) Level of effort required for control

a) Effective control can be achieved with mechanical treatment 0
b) Can be controlled with one chemical treatment **2**
c) One or two chemical or mechanical treatments required or biological control is available or practical 5
d) Repeated chemical or mechanical control measures required 10

2) Effectiveness of community management to potentially control the plant release

a) No management is needed, the plant release is short-lived and will significantly decrease or disappear within 5 years under normal conditions without human intervention 0
b) Routine management of a community or restoration/preservation practices (e.g., prescribed burning, flooding, controlled disturbance, pasture renovation) effectively controls the release **2**
c) Cultural techniques beyond routine management can be used to control the release 4
d) The previous options are not effective for managing or controlling the release 10

3) Side effects of chemical or mechanical control measures

a) Control measures used on release will have little or no effect on other plants — 0
b) Control measures used on release will cause moderate effects on other plants — **3**
c) Control measures used on release will cause major effects on other plants — 5

**If spreads by seed, or both seed and vegetative means, go to #4
**If spreads by vegetative means only, go to #5

4) Seed banks

a) Seeds viable in the soil for 1 year or less — 0
b) Seeds remain viable in the soil for 2-3 years — 1
c) Seeds remain viable in the soil for 4-5 years — **3**
d) Seeds remain viable in the soil for more than 5 years — 5

5) Vegetative regeneration under natural conditions

a) Regeneration from resprouting of cut stumps — **1**
b) Regeneration from pieces of the root left in the soil — 3
c) Regeneration from root or stem parts left in the soil — 5

6) Resprouts after cutting above-ground parts

a) Does not resprout or resprouts but the release is sterile and does not produce seed — 0
b) Resprouts and produces seed in future years — **3**
c) Resprouts and produces seed in same year — 5

Total Possible Points 40
Total Points for Part 2 14

Part 3. Conservation Need and Plant Use

This part evaluates the importance of the species or release to meet a conservation need.

1) Potential Use(s) of the Plant Release

a) Used for low-priority issues or single use — 1
b) Has several uses within conservation — **2**
c) Has many uses within conservation as well as outside of conservation — 4
d) Has high-priority use within conservation — 5

2) Availability of Other Plants to Solve the Same Need

a) Many other plants available — 1
b) Few other plants available — **3**
c) No other plants available — 5

3) Consequences of Not Releasing This Plant

a) No impact to conservation practices	0
b) Minor impact on one or more conservation practice	1
c) Serious impact on one conservation practice	**3**
d) Serious impact on more than one conservation practices	5
Total Possible Points	**15**
Total Points for Part 3	**8**

Part 4. Biological Characteristics

This part evaluates the biological properties which indicate the natural ability of the species or release to propagate and maintain itself under natural conditions. Note: these criteria relate to the species under natural conditions, as opposed to the species under managed conditions used to increase the species, i.e. seed increase programs, or specific propagation methods which do not normally occur in nature.

1) Typical mode of reproduction under natural conditions

a) Plant does not increase by seed or vegetative means (skip to #11)	0
b) Reproduces almost entirely by vegetative means	1
c) Reproduces only by seeds	**3**
d) Reproduces vegetatively and by seed	5

2) Reproduction (by seed or vegetative) in geographic area of intended use

a) Reproduces only outside the geographic area of intended use	1
b) Reproduces within the geographic area of intended use	3
c) Reproduces in all areas of the United States where plant can be grown	**5**

3) Time required to reach reproductive maturity by seed or vegetative methods

a) Requires more than 10 years	1
b) Requires 5-10 years	2
c) Requires 2-5 years	3
d) Requires 1 year	**5**

** If reproduces only by seed, skip to #5

4) Vegetative reproduction (by rhizomes, suckering, or self-layering)

a) Vegetative reproduction rate maintains population (plant spreads but older parts die out)	1
b) Vegetative reproduction rate results in moderate increase in population size (plant spreads <3' per year)	3
c) Vegetative reproduction rate results in rapid increase in population size (plant spreads >3' per year)	5

** If reproduces only vegetatively, skip to #11

5) Ability to complete sexual reproductive cycle in area of intended use

a) Not observed to complete sexual reproductive cycle in the geographic area of intended use, but completes sexual reproduction in distant areas of the United States 1

b) Not observed to complete sexual reproductive cycle in the geographic area of intended use, but completes sexual reproduction in adjoining geographic areas 3

c) Observed to complete the sexual reproductive cycle in the geographic area of intended use **5**

6) Frequency of sexual reproduction for mature plant

a) Almost never reproduces sexually 0

b) Once every five or more years 1

c) Every other year 3

d) One or more times a year **5**

7) Number of viable seeds per mature plant each reproductive cycle

a) None (does not produce viable seed) 0

b) Few (1-10) 1

c) Moderate (11-1,000) **3**

d) Many-seeded (>1,000) 5

8) Dispersal ability

a) Limited dispersal (<20') and few plants produced (<100) **1**

b) Limited dispersal (<20') and many plants produced (>100) 3

c) Greater dispersal (>20') and few plants produced (<100) 7

d) Greater dispersal (>20') and many plants produced (>100) 10

9) Germination requirements

a) Requires open soil and disturbance to germinate **1**

b) Can germinate in vegetated areas but in a narrow range or in special conditions 5

c) Can germinate in existing vegetation in a wide range of conditions 10

10) Hybridization

a) Has not been observed to hybridize outside the species **0**

b) Hybridizes with other species in the same genera 3

c) Hybridizes with other genera 5

11) Competitive ability (of established plants)

a) Poor competitor for limiting factors	**0**
b) Moderately competitive for limiting factors	5
c) Highly competitive for limiting factors	10
Total Possible Points	**70**
Total Points for Part 4	**28**

References

Many of the criteria used in this rating system were adapted from the following sources:

Hiebert, Ron D. and James Stubbendieck. 1993. Handbook for Ranking Exotic Plants for Management and Control. US Department of the Interior, National Park Service, Denver, CO.

Randall, John M., Nancy Benton, Larry E. Morse, and Gwendolyn A. Thornhurst. 1999. Criteria for Ranking Alien Wildland Weeds. The Nature Conservancy, Arlington, VA.

Section B. Scoring and Interpretation

Based on the scores from above, circle the points range you scored to determine the appropriate interpretation. The interpretation will be used to determine the course of action for the release.

Part	Points Scored	Interpretation
Part 1. Impacts on Habitats, Ecosystems, and Land Use	0-15	**Low** chance plant is going to affect the environment
	16-25	**Mod**erate chance plant is going to affect the environment
	26-45	**High** chance plant is going to affect the environment
Part 2. Ease of Management	0-20	**Easy** to control
	21-30	**Mod**erate to control
	31-40	**Diff**icult to control
Part 3. Conservation Need and Plant Use	0-5	**Low** need
	6-9	**Mod**erate need
	10-15	**High** need
Part 4. Biological Characteristics	0-25	**Low** chance plant is going to propagate and increase itself
	26-40	**Mod**erate chance plant is going to propagate and increase itself
	41-70	**High** chance plant is going to propagate and increase itself

Release Documentation

For

Anatone Bluebunch Wheatgrass

Site Adaptability Studies

Seed Collection:

Eighty native seed collections of bluebunch wheatgrass (*Pseudoroegneria spicata* [Pursh] A. Löve ssp. *spicata*) and Snake River wheatgrass (*Elymus wawawaiensis* J. Carlson and Barkworth) were obtained in 1988 and 1989. Bluebunch wheatgrass was acquired in eight western states from principal locations in Idaho, Colorado, Montana, Nevada, Oregon, Utah, Washington, and Wyoming. Snake River wheatgrass was also collected from southeastern Washington and northeastern Oregon. A primary objective was to select and develop plant materials adapted to the more arid areas of the species range, particularly sites in the Lower Snake River Plain and portions of the Great Basin. Plants exhibiting good seedling vigor, adaptability to arid sites, and competitive attributes to compete with annual weeds were also emphasized. Unaltered germ plasm was emphasized to provide material that would be native to specific regions. Previous site adaptability trials in central Idaho beginning in 1979 reveled that material from the Palouse Prairie exhibited these characteristics, and collections were concentrated from this region. 'Goldar' and 'Whitmar' bluebunch wheatgrass are currently the only two released cultivars available, and both originate from this region. Goldar does not have sufficient drought tolerance to persist in the more arid regions where the species naturally occurs. Whitmar is an awnless form selected, in part, for this trait. Limited selection was made to promote this cultivar, yet it exhibits many of the seedling vigor and drought tolerance traits of Anatone. The selection processes used to develop this cultivar may have diminished some adaptive traits.

Field Evaluation Studies

Field plantings were established to evaluate initial establishment, survival over time, annual growth, plant vigor, seed production, and phenological growth responses on arid study sites naturally occupied by this species. Containerized seedlings of 53 of the bluebunch wheatgrass and Snake River wheatgrass collections were planted at the Orchard Research Site, Ada County, Idaho, and at Nephi, Juab County, Utah, in the spring 1989 and 1990. At each field location, plantings were arranged in three blocks with a completely randomized block design. Within blocks, a plot of 24 plants represented each accession. Data were collected during the years of 1989, 1991, 1993, 1994, 1995, and 2001.

<u>Orchard Research Study Site Description</u>

The site is located on the Lower Snake River Plain, about 32 km southeast of Boise, Idaho at an elevation of about 955 m. Mean annual precipitation is 200 to 300 mm and the average frost-free season is 140 to 190 days, Appendix 1. Soils are sandy, mixed, mesic Xeric Torriorthents. Native vegetation at the site was dominated by basin big sagebrush (*Artemisia tridentata* Nutt. ssp. *tridentata*), Wyoming big

sagebrush (*Artemisia tridentata* Nutt. ssp. *wyomingensis* Beetle & Young*)*, Sandberg bluegrass (*Poa sandbergii* J. Presl), Thurber needlegrass (*Achnatherum thurberianum* [Piper] Barkworth), and bluebunch wheatgrass. This area is typical of the drier regions of the Snake River Plain and portions of the Great Basin supporting big sagebrush and native bunch grasses including bluebunch wheatgrass. During the period of field evaluations, the area was subjected to periods of extremely low precipitation.

Description of Nephi/Levan Research Study Site

The Nephi site is 13 km southwest of Nephi, UT, on the Utah State University Agricultural Experiment Station's Nephi farm. Elevation is 1,580 m. The soil is deep with a clay loam texture and located on a 0 to 2 percent slope. Mean annual precipitation is 340 mm with 67 percent occurring from November to May, Appendix 2. Monthly precipitation during the first growing season was slightly below normal, particularly during the months of April, May, and June when transplants were becoming established. Mean annual temperature is 9.7 ^{o}C. This study site initially supported some basin big sagebrush, Wyoming big sagebrush, antelope bitterbrush (*Purshia tridentate [Pursh] DC.*), bluebunch wheatgrass, and western wheatgrass (*Pascopyrum smithii [Rydb.] Love)*. The site has been used for testing dryland grains, oil crops, numerous introduced and native forage grasses, broadleaf herbs, shrubs, and some seasonal livestock grazing trials.

Results -- Plant Establishment and Survival

Orchard Study Site - All five collections of Snake River wheatgrass, 'Secar' (B24); Enterprise, OR (B51); Colton, WA (B66); Wawawai, WA (B79); Penawawa, WA (B82), established and persisted better than most all collections of bluebunch wheatgrass, Table 1. With the exception of the Asotin (B54) collection that is in close proximity to the Anatone (B53) and Colton (B67) collection sites, total survival in 2001 of each Snake River wheatgrass collections exceeded any other collection of bluebunch wheatgrass under study. Total survival is a percentage of plants actually alive at the 2001, and is based on the numbers alive in 1990. Accessions with high initial establishment percentages are more likely to record high total survival rates. Collections of bluebunch wheatgrass from southeastern Washington, northeastern Oregon, and extreme western Idaho established better under arid conditions than collections from any other region. Bluebunch wheatgrass collections with the highest total survival in 2001 consisted of material from Asotin, WA (B54); Dodge, WA (B7); Colton, WA (B67); and Levan, UT (B34). Total survival percentages of these collections were not significantly different from the five collections of Snake River wheatgrass.

Persistence of plants that initially established is an important index of the adaptability of each accession to the individual study site. All five Snake River wheatgrass collections including Secar ranked in the top eight positions for survival in 2001. Collections of bluebunch wheatgrass from Colton, WA (B67); Brownlee Dam. ID (B49); Pataha, WA (B77); Dodge, WA (B76); Roosevelt, WA (B74); Asotin, WA (B54); Grande Ronde, WA (B52); and Anatone, WA (B53) recorded the highest survival percentages in 2001 of all bluebunch wheatgrass accessions under test. Survival percentages were not significantly different among these accessions or among the Snake River wheatgrass accessions. However, percent survival for the Colton accession was 97 percent compared with 79 percent for the Anatone accession.

All southeastern Washington/northeastern Oregon/western Idaho collections of bluebunch wheatgrass are within a radius of about 100 kilometers. Most collections from southwestern Washington are located within 20 to 40 kilometers from the Anatone collection site, and appear as similar genetic material.

Although the origin of Goldar bluebunch wheatgrass is from Asotin County in southeastern Washington, the total or long-term survival of this cultivar (B25) was significantly lower at the Orchard site than other collections assembled from this same region. Total survival of many other accessions of bluebunch wheatgrass from other regions also surpassed that of Goldar (B25). In addition, Goldar plants exhibited poor survival during the period between 1990 and 2001. Of the initial plants that established in 1990, only 32 percent survived for the 11-year period. In comparison, survival percentages of other accessions from southwestern Washington ranged from 97 percent Colton (B67) to 79 percent Anatone (B54).

Establishment and persistence of material collected from local stands in close proximity of the Orchard study site included Birds of Prey (B26) and Crows Nest (B 27). These accessions failed to establish or survive at even moderate percentages. In addition, collections from central Utah, Levan (B34), failed to persist well from the time of initial establishment (1990) to 2001.

Table 1. Percent survival of bluebunch wheatgrass and Snake River wheatgrass accessions planted at the Orchard study site in 1989. Within years accessions followed by different letters differ at <0.05. Survival at the juvenile stage in 1990 and the mature stage in 1995 are based on the plants surviving from the previous stage. Survival in 2001 is based on the number of plants alive in 1990. Overall survival is the percent of plants to survive through the 2001 season. **Bold print designates Snake River wheatgrass accessions.**

Origin	Accession Number Survival	1989 Transplant Survival	1990 Juvenile Survival	1995 Adult Survival	2001 Adult	Total Survival
Enterprise, OR	**B51**	**75 ab**	**85 a**	**95 a**	**93 a**	**79 a**
Penawawa, WA	**B82**	**79 a**	**81 ab**	**95 a**	**84 a**	**71 ab**
Wawawai, WA	**B79**	**63 abcd**	**72 abcd**	**95 a**	**88 a**	**64 abc**
Asotin, WA	B54	71 abc	75 abc	87 a	82 a	60 abcd
Colton, WA	**B66**	**53 abcde**	**56 abcde**	**100 a**	**98 a**	**54 abcde**
Secar	**B24**	**60 abcde**	**65 abcde**	**89 a**	**86 a**	**54 abcde**
Dodge, WA	B76	58 abcde	63 abcde	100 a	83 a	53 abcde
Colton, WA	B67	46 abcde	50 abcde	100 a	97 a	49 abcdef
Lavan, UT	B34	61 abcd	68 abcde	73 a	69 a	47 abcdefg
Roosevelt, WA	B74	47 abcde	54 abcde	94 a	82 a	44 bcdefgh
Grand Gorge, WA	B52	47 abcde	54 abcde	78 a	80 a	43 bcdefghi
Pataha, WA	B77	49 abcde	50 abcde	86 a	86 a	43 bcdefghi
Anatone, WA	B53	44 abcde	46 abcde	86 a	79 a	38 bcdefghij
Baker, OR	B68	44 abcde	56 abcde	78 a	65 a	35 bcdefghij
Connell, WA	B80	38 abcde	46 abcde	55 a	63 a	35 bcdefghij
Snowville, UT	B45	49 abcde	57 abcde	79 a	50 a	33 cdefghij
Lewiston, ID	B55	51 abcde	54 abcde	73 a	62 a	33 cdefghij
Crows Nest, ID	B27	42 abcde	56 abcde	52 a	52 a	32 cdefghij
Colton, WA	B83	46 abcde	47 abcde	63 a	59 a	31 cdefghij
Walla Walla, WA	B75	29 abcde	38 abcde	65 a	74 a	28 cdefghij
Maryhill, WA	B72	38 abcde	44 abcde	58 a	56 a	26 cdefghij
Salmon, ID	B57	40 abcde	46 abcde	55 a	55 a	24 defghij
Livingston, WA	B81	33 abcde	42 abcde	68 a	59 a	23 defghij
Lamoille Cyn, NV	B43	33 abcde	44 abcde	52 a	58 a	22 defghij
Roosevelt, WA	B73	51 abcde	53 abcde	65 a	42 a	21 defghij
Denio, NV	B41	28 abcde	31 bcde	82 a	76 a	21 defghij
Goldar	B25	47abcde	56 abcde	60 a	32 a	21 deghij
Riggins, ID	B64	47 abcde	46 abcde	55 a	39 a	19 efghij
Council, ID	B48	42 abcde	40 abcde	43 a	42 a	18 efghij
Dingle, ID	B61	53 abcde	51 abcde	33 a	22 a	17 efghij
Brownlee Dam, ID	B49	19 cde	19 de	91 a	88 a	17 efghij
Arco, ID	B60	15 de	31 bcde	78 a	45 a	17 efghij
Yakima, WA	B84	21 cde	32 bcde	66 a	38 a	13 fghij
Salt Lake City, UT	B30	46 abcde	46 abcde	27 a	19 a	10 fghij
Wallowa Mtns., OR	B50	29 abcde	38 abcde	48 a	20 a	8 fghij
Pittsburg Landing, ID	B46	17cde	19 de	68 a	68 a	8 fghij
Immigrant Pass, NV	B42	26 abcde	32 bcde	38 a	29 a	8 fghij
Riggings, ID	B65	29 abcde	31 bcde	45 a	39 a	7 ghij
Mona, UT	B33	44 abcde	43 abcde	46 a	18 a	7 ghij
Pittsburg Landing, ID	B47	17 cde	17 e	30 a	34 a	7 ghij
Lindon, UT	B31	22 bde	19 de	74 a	18 a	6 hij

Table 1 continued

Hyde Park, UT	B32	18 cde	24 cde	18 a	16 a	4 hij
Yuba Dam, UT	B28	29 abcde	32 bcde	39 a	22 a	4 hij
Birds of Prey, ID	B26	13 de	15 e	77 a	43 a	4 hij
Fairfield, ID	B63	24 bcde	22 cde	25 a	11 a	4 hij
Provo, UT	B29	25 bcde	15 e	64 a	27 a	4 hij
Grandview Cyn., ID	B58	22 bcde	25 cde	53 a	27 a	4 hij
Yuba Dam, UT	B62	38 abcde	39 abcde	44 a	16 a	4 hij
Pequop Summit, NV	B44	6 e	14 e	57 a	8 a	3 hij
The Dalles, OR	B71	24 bcde	29 bcde	5 a	5 a	1 hij
Arco, ID	B59	19 cde	21 de	50 a	17 a	1 hij
Paradise Valley, NV	B40	18 cde	18 de	42 a	7 a	1 hij
Frisco, UT	B36	35 abcde	31 bcde	27 a	0	0 j

Nephi Study Site - Bluebunch wheatgrass accessions survived much better at the Nephi study site than any accessions of Snake River wheatgrass, indicating that bluebunch wheatgrass is better adapted to more mesic sites within the range of this species and Snake River wheatgrass is better adapted to more arid conditions. Accessions of bluebunch wheatgrass from Anatone, WA (B53) and Colton, WA (B67) survived and preformed better than any other accession including material from southeastern Washington/northeastern Oregon/western Idaho. Total survival of accessions from Council, ID (B48); Colton, WA (B67); Yuba Dam, UT (B28); Wallowa, OR (B50); and Anatone, WA (B53) exceeded 50 percent. However, plant survival of the Anatone (B53) accession from 1990 to 2001 exceeded the other accessions. Total survival of plants from the Council, ID (B48) accession exceeded any other accession under study, but significant loss of plants occurred from 1990 to 2001 indicating persistence of this accession is only fair or poor.

Selections of bluebunch wheatgrass from Utah populations near the Nephi planting site were much better adapted to this location than accessions from most other regions. Accessions from Yuba Dam, UT (B28), Levan, UT (B34), and Provo, UT (B29) had high total survival and persisted well during the study period. However, survival of accessions from the Anatone region equaled or excelled the Utah and all other accessions.

Goldar (B25) bluebunch wheatgrass preformed much better at this site as it receives higher amounts of precipitation than the Orchard study site. However, total survival and survival from 1990 to 2001 of Goldar (B25) was both lower than Anatone (B53) and three Utah accessions. Based on plantings at the Idaho and Utah study sites, the Anatone, WA and Colton, WA accessions demonstrated better adaptability to a wider range of sites than accessions from other regional locations.

Table 2. Survival percentages of bluebunch wheatgrass and Snake River wheatgrass Accessions planted at the Nephi study site in 1989. Within years accessions followed by different letters differ at <0.05. Survival at the juvenile stage in 1990 and the adult stage in 1995 is based on the plants surviving from the previous stage. Survival in 2001 is based on the number of plants alive in 1990. Overall or total survival is the percent of plants to survive through the 2001 season. **Bold print designates Snake River wheatgrass accessions.**

Accession Number	Origin	1989 Transplant Survival	1990 Juvenile Survival	1995 Adult Survival	2001 Adult Survival	Total Survival
B48	Council, ID	63 abcdef	40 abcdefg	74 a	54 ab	60 a
B83	Colton, WA	65 abcde	63 abc	98 a	88 ab	56 ab
B28	Yuba Dam, UT	92 a	71 ab	90 a	72 ab	53 abc
B50	Wallowa Mtns. OR	75 abc	61 abcd	94 a	78 ab	50 abc
B53	Anatone, WA	54 abcdefg	54 abcdesg	95 a	96 ab	50 abc
B29	Provo, UT	63 abcdef	51 abcdef	91 a	89 ab	47 abc
B34	Levan, UT	65 abcde	61 abcd	100 a	77 ab	46 abc
B25	Goldar	51 abcdefg	51 abcdef	88 a	84 ab	43 abc
B70	Prouder Park, CO	89 ab	86 a	90 a	50 ab	43 abc
B52	Grande Ronde, WA	57 abcdefg	56 abcde	85 a	78 ab	43 abc
B61	Dingle, ID	68 abcdef	53 abcdef	97 a	76 ab	42 abc
B43	Lamoille Cyn. NV	56 abcdefg	46 abcdefg	94 a	91 ab	40 abc
B67	Colton, WA	72 abc	57 abcde	93 a	73 ab	40 abc
B68	Baker, OR	61 abcdef	57 abcde	90 a	72 ab	40 abc
B32	Hyde Park, UT	51 abcdefg	43 abcdefg	95 a	93 ab	40 abc
B80	Connell, WA	71 abc	42 abcdefg	100 a	100 a	40 abc
B32	Conners Pass, NV	78 abc	64 abc	96 a	65 ab	39 abc
B31	Lindon, UT	61 abcdef	42 abcdefg	100 a	92 ad	39 abc
B60	Evanston, WY	72 abc	71 ab	96 a	56 ab	39 abc
B70	**Wawawai, WA**	**68 abcd**	**47 abcdefg**	**72 a**	**77 ab**	**38 abc**
B69	Meeker, CO	54 abcdgeg	47 abcdefg	94 a	74 a	36 abc
B66	**Colton, WA**	**74 abc**	**47 abcdefg**	**82 a**	**76 ab**	**36 abc**
B55	Lewiston, ID	71 abc	47 abcdefg	82 a	65 ab	35 abc
B54	Asotin, WA	50 abcdefg	54 abcdef	92 a	65 ab	38 abc
B47	Pittsburg Landing, ID	38 abcdefg	35 abcdefg	94 a	93 ab	32 abc
B75	Walla Walla, WA	50 abcdefg	43 abcdefg	88 a	72 ab	31 abc
B27	Crows Nest, ID	67 abcde	51 abcdef	85 a	54 ab	29 abc
B56	Lolo, MT	40 abcdefg	40 bcdefg	97 a	57 ab	29 abc
B49	Brownlee Dam, ID	43 abcdefg	35 bcdefg	83 a	80 ab	28 abc
B46	Pittsburg landing, ID	57 abcdefg	36 bcdefg	83 a	75 ab	26 abc
B24	**Secar**	**46 abcdefg**	**38 bcdefg**	**84 a**	**68 ab**	**25 abc**
B65	Riggins, ID	56 abcdefg	44 abcdefg	86 a	75 ab	24 abc
B64	Riggins, ID	51 abcdefg	29 bcdefg	86 a	74 ab	22 abc
B62	Yuba Dam, UT	47 abcdefg	43 abcdefg	92 a	49 ab	21 abc
B30	Salt Lake City, UT	50 abcdefg	35 bcdefg	100 a	50 ab	19 abc
B33	Mona, UT	40 abcdefg	22 cdefg	95 a	54 ab	17 abc
B45	Snowville, UT	50 abcdefg	31 bcdefg	85 a	49 ab	15 abc
B82	**Penawawa Cyn., WA**	**64 abcdef**	**28 bcdefg**	**67 a**	**60 ab**	**15 abc**
B74	Roosevelt, WA	44 abcdefg	18 cdefg	63 a	61 ab	15 abc
B59	Arco, ID	53 abcdefg	32 bcdefg	67 a	48 ab	15 abc

Table 2, continued

B41	Denio, NV	25 cdefg	14 cdefg	100 a	100 a	14 abc
B37	Grt Basin Natl. Park, NV	57 abcdefg	42 abcdefg	75 a	29 b	14 abc
B71	The Dalles, OR	47 abcdefg	31 bcdefg	88 a	55 ab	13 abc
B51	**Enterprise, OR**	**32 cdefg**	**22 cdefg**	**92 a**	**50 ab**	**11 abc**
B42	Immigrant Pass, NV	13 fg	11 defg	100 a	92 ab	10 abc
B76	Dodge, WA	42 abcdefg	25 bcdefg	73 a	36 a	8 abc
B72	Maryhill, WA	47 abcdefg	29 bcdefg	65 a	26 b	8 abc
B26	Birds of Prey, ID	46 abcdefg	19 cdefg	60 a	49 b	7 abc
B58	Grandview, ID	25 cdefg	26 bcdefg	67 a	30 b	7 abc
B36	Frisco, UT	74 abc	64 abc	63 a	8 b	6 bc
B63	Fairfield, ID	42 abcdefg	11 defg	71 a	44 b	6 bc
B57	Salmon, ID	6 g	6 efg	77 a	75 ab	4 bc
B44	Pequop Summit, WA	15 efg	13 defg	72 a	33 b	3 bc
B40	Paradise Valley, NV	18 defg	10 defg	57 a	22 b	3 bc
B77	Pataha, WA	29 cdefg	6 fg	25 a	33 b	1 bc
B84	Yakima, WA	6 g	3g	100 a	33 b	1 bc
B73	Roosevelt, WA	43 abcdefg	10 defg	57 a	6 b	1 bc
B35	Minersville, UT	54 abcdefg	17 cdefg	100 a	0	0

Plant vigor and annual growth were recorded between 1989 and 1995 and data was used to determine the health of each accession. Plant vigor, annual height, and crown measurements were summarized each year to create index values representing overall health and growth indices. Plant heights and crowns were given approximately equal value by adding the centimeters representing each together. This number was multiplied by plant vigor to provide an index of the general health of each accession. Index values were compared by year using analysis of variance. The index values for the Orchard and Nephi sites were not significantly different, thus data from both sites was combined to compare the overall differences among accessions, Table 3.

Plants from southeastern Washington/northeastern Oregon/western Idaho are larger and reach maturity faster than accessions from other regions. They also grow rather quickly in the early spring months. These growth attributes are similarly expressed in both bluebunch wheatgrass and Snake River wheatgrass collections obtained from this central region. The growth index of mature plants of Snake River wheatgrass from Enterprise, OR (B51) recorded in 1995 exceeded all other accessions in general health and plant vigor. Of all accessions under study, three of the top nine accessions were Snake River wheatgrass species. Although the index values of bluebunch wheatgrass from Grande Rhonde, WA (B52); Colton, WA (67); Anatone, WA (B54); Baker, OR (B68); Brownlee Dam, ID (B49); and Lewiston, ID (B67) are lower than the Enterprise accession, ratings are not significantly different among the entire group. The index ratings are significantly better than Secar Snake River wheatgrass, which, in turn, is significantly better than Goldar bluebunch wheatgrass.

The growth index can be used to evaluate the vigor and rate of maturation of individual accessions. Index values recorded in 1991, 1993, and 1994 indicate the vigor of young developing plants and are indicative of plant vigor and establishment capabilities, Table 3. The index values of Goldar and three accessions of Snake River wheatgrass including Secar exceed values of other accessions in 1991. By 1993, the index vales of nearly all accessions from the Washington/Oregon/Idaho region are similar and exceed values of all other accessions. As plants attain mature stature, the index values for Goldar, Secar, and a few other accessions from the same region diminish significantly. In contrast, accessions from Anatone, Colton and a few additional accessions from the same closely related location recorded high values as young and mature plants.

Table 3. Growth Index values for 25 collections of Snake River wheatgrass and bluebunch wheatgrass grown at Orchard Research Site, Ada Co., Idaho and Nephi, Juab Co., Utah. The index was derived for each accession by summing the mean height and crown dimensions (cm) and multiplying the result by a subjective vigor rating of 1-5 with 5 indicating greatest vigor. Within years, means followed by different letters differ significantly ($p<0.05$) (Monsen et al. 1999). **Bold print distinguishes Snake River wheatgrass accessions.**

	Year				
Accession	1989	1991	1993	1994	1995
Enterprise, OR	**76 b c**	**147 b c d e f g**	**510 a b c d**	**458 a b c**	**719 a**
Grande Ronde, WA	61 c d	133 c d e f g h I	528 a b c d	521 a	612 a b
Colton, WA	50 d e	151 b c d e f g	558 a b c	466 a b c	611 a b
Anatone, WA	35 e f g	163 b c d e	520 a b c d	459 a b c	610 a b
Baker, OR	82 b	155 b c d e f g	539 a b c d	532 a	601 a b
Brownlee Dam, ID	44 d e f	162 b c d e f	591 a	484 a b	600 a b
Wawawai, WA	**101 a**	**210 a**	**579 a b**	**507 a**	**586 a b**
Lewiston, ID	80 b	161 b c d e f	524 a b c d	434 a b c	586 a b
Penawawa Canyon, WA	**83 b**	**189 a b**	**486 a b c d e**	**454 a b c**	**581 a b**
Secar	**49 d e f**	**173 a b c d**	**474 a b c d e**	**423 a b c d**	**567 b c**
Colton, WA	**75 b c**	**137 c d e f g h**	**485 a b c d e**	**454 a b c**	**531 b c d**
Wallowa Mtns, OR	57 c d e	125 b c d e f g h i	427 b c d e	415 a b c d e	494 b c d
Dayton, WA	51 d e	112 e f g h i j	411 c d e f	373 b c d e	485 b c d e
Lamoille Canyon, NV	44 d e f	91 h i j	430 b c d e	348 c d e f	469 b c d e
Pittsburg Landing, ID	43 d e f	107 g h i j	507 a b c d	359 c d e f	443 c d e f
Dingle, ID	45 d e f	130 c d e f g h i	435 a b c d e	423 a b c d	441 c d e f
Goldar	26 f g	179 a b c	500 a b c d e	440 a b c	438 c d e f
Riggins, ID	61 c d	124 d e f g h i	349 e f g h	364 c d e f	399 f g
Levan, UT	46 d e f	110 f g h i j	414 c d e f	323 d e f	395 f g
Evanston, WY	42 d e f	106 g h i j	381 d e f g	314 e f	352 f g
Crows Nest, ID	46 d e f	87 h i j	281 f g h	217 g h	329 f g
Arco, ID	43 d e f	92 h i j	412 c d e f	275 f g	312 f g
Salmon, ID	42 d e f	115 e f g h i	257 g h	271 f g	302 f g
Snowville, UT	42 d e f	84 i j	281 f g h	305 f g	272 g
Birds of Prey, ID	20 g	63 j	226 h	175 h	261 g

Leaf and culm heights of all bluebunch wheatgrass and Snake River wheatgrass are similar within and among species and accessions, Table 4. The greatest differences were recorded in crown diameter. Based on crown diameter, plants from the Grande Rhonde (B52) and Anatone (B53) accessions are the largest specimens of all accessions under study. Anatone bluebunch wheatgrass plants are slightly larger than those of Goldar particularly when grown under arid conditions. Under favorable moisture conditions, Anatone plants are usually similar in leaf and stem heights as Secar, but have much larger crowns. Crown diameters of plants from Anatone also exceed those from Asotin (B54), Colton (B67), Roosevelt (73), and Connell (B80).

Seasonal periods of growth generally reflect the inherent adaptability of different populations to climatic conditions from the site of origin. Most accessions of bluebunch wheatgrass and Snake River wheatgrass begin growth early in the season and attain near maximum size within a few weeks, Table 5. Plants from the Anatone site follow this growth pattern, but continue to grow and retain some green leaves late into the summer months until soil moisture is exhausted. In comparison, plant collections from very arid regions typically senesce and become dormant in late spring or early summer as daily temperatures increase. Plants from the Anatone site also resume growth in the fall if moisture becomes available, and plants can remain green and active into the early winter months. The seasonal growth pattern of Anatone is extremely important in providing competition to the establishment and persistent of annual weeds, particularly fall germinating winter annuals such as cheatgrass. Early spring and late fall growth of Anatone furnishes competition to germinated seedlings in both the spring and fall months. In addition, plants that retain some green leaves into the summer months reduce the period when wildfires are likely to occur.

Table 4. Leaf and stem heights, crown size, and number of culms per plant of different bluebunch wheatgrass and Snake River wheatgrass accessions growing at the Nephi, UT study site, 2001. **Bold print distinguishes Snake River wheatgrass accessions.**

Accession Number	Origin	Leaf Height (cm)	Stem Height (cm)	Crown Diameter (cm)	Number Culms
B24	**'Secar'**	**46**	**81**	**79**	**74**
B25	'Goldar'	41	66	93	94
B27	Crows Nest, ID	40	71	48	27
B28	Yuba Dam, UT	41	68	67	37
B29	Provo, UT	44	76	80	43
B33	Mona, UT	43	71	88	72
B34	Levan, UT	39	78	72	63
B43	Lamoille Cyn., NV	45	76	82	96
B44	Pequop Summit, NV	45	71	58	52
B48	Council, ID	41	65	76	36
B50	Wallowa Mtns, OR	41	70	72	57
B51	**Enterprise, WA**	**46**	**88**	**77**	**108**
B52	Grande Rhonde, WA	50	76	100	84
B53	Anatone, WA	46	74	98	98
B54	Asotin, WA	45	72	82	42
B55	Lewiston, ID	52	80	91	75
B56	Lolo, MT	44	71	72	62
B60	Evanston, WY	45	68	62	66
B62	Yuba dam, UT	41	72	65	63
B66	**Colton, WA**	**44**	**81**	**69**	**50**
B67	Colton, WA	42	71	68	43
B69	Meeker, CO	44	74	92	74
B74	Roosevelt, WA	45	82	68	49
B76	Dodge, WA	44	71	88	52
B79	**Wawawai, WA**	**56**	**86**	**96**	**136**
B80	Connell, WA	45	70	84	75
B82	**Penawawa Cyn.,WA**	**49**	**86**	**84**	**80**

Table 5. Weekly growth rates of different accessions of bluebunch wheatgrass and Snake River wheatgrass, Orchard, ID study site, March 5 to March 26, 1997. **Bold print distinguishes Snake River wheatgrass accessions**.

Origin	Heights				Crowns			
	3/5	3/12	3/19	3/26	3/5	3/12	3/19	3/26
				(cm)				
B24, Secar	**30**	**38**	**34**	**33**	**49**	**54**	**47**	**53**
B25, Goldar	10	7	20	20	20	17	17	33
B27 Crows Nest	16	16	15	12*	26	28	30	33
B28 Yuba Dam	19	17	*		34	34		
B34 Levan	37	18	17	15	29	21	27	25
B43 Lamoille, NV	22	17	17	15	35	31	33	22
B45 Snowville	10	12	12	18	19	39	24	25
B50 Wallawa	12	15	17	*	25	22	20	
B51 Enterprise	**27**	**26**	**26**	**25**	**43**	**43**	**43**	**43**
B52 Grande Ronde	32	23	24	22	43	50	42	43
B53 Anatone	28	30	25	33	49	43	43	48
B54 Asotin	40	34	34	25	49	52	51	50
B60 Evanston	14	18	13	*	26	27	26	
B66 Colton	**46**	**43**	**45**	**45**	**68**	**62**	**66**	**68**
B67 Colton	52	46	49	43	58	58	58	45
B74 Roosevelt	44	47	52	40	54	61	62	60
B76 Dodge	34	33	33	27	50	53	51	58
B79 Wawawai	**41**	**44**	**43**	**30**	**69**	**67**	**60**	**60**
B82 Penawawa	**37**	**39**	**41**	**30**	**60**	**54**	**57**	**60**
B89 Antelope Island	15	10	17	17*	17	10	20	22
B90 Boise	27	23	17	24	27	26	20	26

* Plant senescence detected

Seed Features, Germination, Seedling Vigor and Establishment Studies

A series of closely related seed germination, planting depth trials, seed weight, and seed production trials were conducted and reported by Kitchen and Monsen (1994). Seeds collected from 47 naturally occurring populations of bluebunch wheatgrass and commercial collections of 'Hycrest' crested wheatgrass and Goldar bluebunch wheatgrass were germinated under laboratory conditions at 15/25 and 2 ^{o}C to determine near-optimum and near- freezing germination rates. Indices of germination rate were calculated using methods modified from Maguire (1962). In addition, greenhouse experiments were conducted to determine germination and emergence success from a planting depth of 0.4 cm. Seed weights for nine selected populations of bluebunch wheatgrass were also collected and weighed from native parental populations, common garden plantings, and field studies sites at Orchard, ID and Nephi, UT from 1988 to 1993.

Greenhouse germination rate indices varied from 25.2 to 51.2 at 15/25 ^{o}C and from 9.6 to 20.5 at 2 ^{o}C, Table 6. Cold-germination rate, seedling emergence success, and mean dry shoot weight of the Anatone accession were superior to all other accessions including Goldar. At 2 ^{o}C the germination rate index of Anatone approached that recorded for Hycrest crested wheatgrass, Table 7. Seeds of Anatone are programmed to germinate in the early spring at cool soil temperatures, which enhances seedling establishment and allows emerging seedlings to compete with early germinating weeds. Difference in germination rate is due to the rapid initiation of the coleoptile. The germination rate index of Anatone is significantly better than accessions from areas throughout the Snake River Plain and Great Basin where competition with annual weeds is a significant problem to artificial restoration and natural recruitment.

Seedling success of Anatone from a deep planting trial was superior to all bluebunch accessions and closely compared with Hycrest crested wheatgass, Tables 6, 7. In addition, the size or dry shoot weights of Anatone seedlings were also greater than any other bluebunch wheatgrass accession tested and compared favorably with Hycrest crested wheatgrass. The ability of this accession to germinate quickly at cold temperatures and emerge from deep planting trials affirms its superiority in seedling establishment and seedling vigor attributes.

Field plantings of a series of native and introduced perennial grass cultivars conducted as part of a Northern Great Plains Regional Grass Trials by scientists from the USDA, ARS Laboratory, gan, Utah included the Anatone accession, (Data on file at USDA, ARS Laboratory, Blair Waldron, Logan, UT). Direct seeding trials were established at Green Canyon, UT and Blue Creek, UT in 2000. Field ratings completed in the seedling year, 2001, recorded stand frequency and stand vigor, Table 9. Stand ratings of Anatone exceeded most accessions of bluebunch wheatgrass including Goldar, and equaled or exceeded the ratings of most other species under evaluation including many cultivars of crested wheatgrass.

Table 6. Mean germination rate, emergence percentage, dry shoot weight (mg), and number of seeds per gram for 47 collections of bluebunch wheatgrass from natural occurring populations and the cultivar, 'Goldar' (Kitchen and Monsen 1994) produced under agricultural conditions.

Geographic region	Germination rate index		Deep planting		
County, state	15/25 °C	1 °C	Emergence	Dry shoot weight	Seeds g-1
			%	mg	
Palouse Prairie					
Anatone	34.8	20.5	66	9.5	228
Asotin, WA	40.3	16.0	65	7.1	259
Garfield, WA (1)	39.1	20.3	25	4.0	276
Garfield, WA (2)	42.3	19.3	50	5.0	298
Whitman, WA	38.5	16.6	53	5.7	255
Nez Perce, ID	40.8	15.0	43	6.8	233
Snake River Canyon Area					
Adams, ID	33.1	-----	48	7.5	216
Idaho, ID (1)	34.5	14.4	39	5.6	260
Idaho, ID (2)	30.2	13.6	53	4.7	274
Idaho, ID (3)	29.7	14.6	41	4.1	243
Washington, ID (1)	33.3	14.3	43	7.2	176
Washington, ID (2)*	30.4	-----	16	2.5	240
Washington, ID (3)	36.3	16.7	53	5.4	197
Baker, OR (1)	33.9	13.3	38	5.6	196
Baker, OR (2)	28.5	11.8	25	2.7	253
Baker, OR (3)	31.7	12.8	58	5.7	176
Baker, OR (4)	27.0	15.3	59	5.7	178
Snake River Plain					
Ada, ID	33.9	14.8	40	4.0	258
Butte, ID	35.5	16.8	19	5.6	309
Clark, ID	29.7	14.6	8	0.6	437
Owyhee, ID	30.4	12.0	8	2.2	374
Malheur, OR	25.2	11.0	20	2.0	264
Western Great Basin					
Elko, NV	27.0	13.1	24	3.4	262
Eureka, NV	29.3	14.3	36	3.7	270
Humboldt, NV (1)	32.7	10.6	22	3.4	323
Humboldt, NV (2)	33.2	17.6	17	2.8	273
Eastern Great Basin					
Bear Lake, ID	32.7	14.2	25	2.7	376
Cache, UT	28.0	12.5	39	3.8	344
Davis, UT (1)	33.4	15.3	14	5.5	301
Davis, UT (2)**	29.3	12.2	-----	-----	285

Juab, UT (1)	29.8	15.0	14	3.5	343
Juab, UT (1)	33.3	13.9	12	3.3	317
Juab, UT (1)	31.5	13.0	5	5.5	403
Salt Lake, UT	28.4	12.0	8	3.3	312
Utah, UT	25.9	12.6	15	3.0	432
Utah, UT (2)	29.5	14.4	12	5.8	262
Salmon River Valley					
Custer, ID	40.1	18.1	28	2.7	352
Lemhi, ID	46.5	17.5	44	7.3	279
Bitterroot River Valley					
Missoula, MT	36.8	12.3	55	4.7	254
Ravalli, MT	37.6	15.3	39	3.6	237
Upper Colorado Plateau					
Garfield, CO	36.0	10.2	23	3.0	360
Moffat, CO	33.5	11.0	58	4.3	356
Rio Blanco, CO	33.0	10.8	34	3.9	356
Uinta, WY	32.9	13.0	6	2.5	378
Colorado Front Range					
Larimer, CO (1)	31.2	10.9	8	1.6	375
Larimer, CO (2)**	26.1	9.6	-----	------	403
Larimer, CO (3)	33.3	14.1	21	2.5	318
Cultivar					
Goldar'	51.2	17.8	47	8.4	201
Overall mean	33.4	14.2	32	4.4	291

*The 1 ^{o}C germination rate test was omitted for these accessions due to lack of seed.

**These accessions were not used in the greenhouse emergence test.

Table 7. Mean germination rate, emergence percentage, dry shoot weight (mg), and number of seeds per gram for select accessions of bluebunch wheatgrass and Hycrest crested wheatgrass (Kitchen and Monsen 1999).

This table summarizes data in Table 6 and compares performance of all bluebunch wheatgrass accessions in Table 6, Goldar, Anatone, and Hycrest crested wheatgrass. The Goldar and Hycrest seed was produced in seed fields, all other accessions were wildland collections.

	Germination Rate Index		Deep Planting		
Accession(s)	15/25 °C	1 °C	Emergence	Dry Shoot Weight	Seeds g^{-1}
			%	mg	
Mean of 48 bluebunch wheatgrass accessions	33.4	14.2	32	4.4	291
Goldar	51.2	17.8	47	8.4	201
Anatone	34.8	20.5	66	9.5	228
Hycrest	47.1	26.8	69	12.2	----

Table 8. Mean number of seeds per gram for nine accessions of bluebunch wheatgrass collected from native parent populations and from common garden and nursery sites at Orchard, Idaho and Nephi and Spanish Fork, Utah from 1988 to 1993. Within accessions means followed by the same letter are not significantly different (p>0.05) (SNK) (Kitchen and Monsen 1999).

	Seed Collection Site and Year[1]				
Accession	**P-88/89**	**P-93**	**0-93**	**N-93**	**S-93**
	----------seeds g^{-1}----------				
Brownlee, ID	175b	173b	170b	175b	136a
Anatone	228c	------	205b	194a	186a
Provo, UT	262b	263b	------	------	217a
Salmon, ID	279c	250b	------	------	186a
Asotin, WA.	------	282b	286b	------	172a
Grand Rhonde, WA	298c	------	210b	164a	------
Levan, UT	316d	254c	233b	196a	196a
Hamilton, CO	356c	256b	------	214a	211a
Meeker, CO	356d	302c	------	236b	218a

[1]P-88/89 or P-93 = Parent site or naturally occurring population collected in 1988/89 or 1993. O-93 = Orchard, ID common garden, 1993 collection. N-93 = Nephi, UT common garden 1994 collection. S-93 = Spanish Fork, UT nursery, 1993 collection.

Table 9. Performance of selected grass accessions at Green Canyon and Blue Creek, UT. Collections were seeded in November 1999 with a cone seeder at a rate of 40 PLS ft^{-2}. Data were collected in 2000 after the first growing season. Stand frequency is based on the grid method described by Vogel and Masters (2001). Dry matter yield (DMY) is expressed in kg ha^{-1}. Stand vigor: Visual rating: 1-9 (9=best). Obs=observations, 14 possible (Data provided by Blair Waldron, USDA-ARS, Logan, UT).

Species	Entry	DMY (kg ha^{-1})	Obs.	Stand freq (%)	Obs.	Stand vigor	Obs.
Bluebunch wheatgrass	ACC_238_2X	1670	6	42	6	6.2	6
Bluebunch wheatgrass	ANATONE	1855	5	54	5	7.2	5
Bluebunch wheatgrass	GOLDAR	2109	6	46	6	7.0	6
Bluebunch wheatgrass	P4_4x	2089	6	46	6	6.3	6
Bluebunch wheatgrass	P5_2X	1918	5	52	5	7.8	5
Bluebunch wheatgrass	P7_2X	1706	5	40	5	6.6	5
Crested wheatgrass	CD2	2226	6	30	6	7.3	6
Crested wheatgrass	DOUGLAS	1507	6	46	6	5.5	6
Crested wheatgrass	FAIRWAY	1693	7	39	7	6.0	7
Crested wheatgrass	HXB28	2560	6	41	6	7.8	6
Crested wheatgrass	HYCREST	3858	6	39	6	7.5	6
Crested wheatgrass	I28	2820	7	49	7	7.9	7
Crested wheatgrass	KAZAK_SIB	1471	4	32	5	4.6	5
Crested wheatgrass	NE_AC1	2024	6	37	6	5.7	6
Crested wheatgrass	NE_AC2	2574	7	50	7	6.7	7
Crested wheatgrass	NORDAN	2806	6	48	6	7.7	6
Crested wheatgrass	NORDAN_HYLD_HDMD	2566	5	36	5	6.6	5
Crested wheatgrass	P27	2192	5	46	6	5.7	6
Crested wheatgrass	PUB_SIBERIAN	1514	7	46	7	6.6	7
Crested wheatgrass	ROADCREST	1828	5	39	6	5.2	6
Crested wheatgrass	RUFF_HYLD_HDMD_C	2872	6	49	6	6.8	6
Crested wheatgrass	VAVILOV	2712	6	45	6	6.8	6
Indian ricegrass	NEZPAR_IRG	1130	3	34	6	2.5	6
Indian ricegrass	RIMROCK_IRG	568	2	35	5	2.2	5
Russian wildrye	BOZETET	1076	6	47	6	6.8	6
Russian wildrye	BOZOISKY	929	6	28	6	4.8	6
Russian wildrye	MANKOTA	743	6	31	6	4.0	6
Russian wildrye	ND_SYN_1831_2x	562	6	43	6	4.7	6
Russian wildrye	ND_SYN_1981_2x	1179	5	44	5	6.6	5
Russian wildrye	ND_SYN_1983_4x	915	5	44	5	6.8	5
Russian wildrye	SYNA	1182	3	48	4	6.5	4
Russian wildrye	TETRA1	609	4	43	5	5.6	5
Russian wildrye	TETRACAN	931	6	43	6	6.0	6
Snake River wheatgrass	E21	1436	6	34	6	6.0	6
Snake River wheatgrass	E25	1155	4	33	5	4.8	4
Snake River wheatgrass	E29	1528	6	47	6	5.7	6
Snake River wheatgrass	SECAR	605	3	44	5	3.0	4
Snake River wheatgrass	SECAR_YAKIMA	860	4	34	5	5.4	5

Squirreltail	SANDHOLLOW_ST	1437	6	33	6	5.3	6
Thickspike wheatgrass	BANNOCK	2236	5	57	5	6.4	5
Thickspike wheatgrass	CRITANA	1983	5	50	5	6.8	5
Thickspike wheatgrass	CRITANAXBANNOCK	1891	6	55	6	6.7	6
Thickspike wheatgrass	SODAR	1282	6	48	6	5.8	6
Western wheatgrass	ARRIBA	2085	5	69	5	6.6	5
Western wheatgrass	FLINTLOCK	996	5	62	6	5.2	6
Western wheatgrass	NE_EXP_1	855	5	70	5	4.8	5
Western wheatgrass	RODAN	1447	3	59	5	4.0	4
Western wheatgrass	ROSANA	748	5	61	5	6.2	5

Seed Production:

Seed production fields have been in place since 1999, and first-year harvests from nine locations report yields ranging between 168 to 195 kg ha^{-1}. Mature stands produce between 195 and 328 kg ha^{-1}, although yields as high as 563 kg ha^{-1} have been reported. Bulk seed production of Anatone (170 kg ha^{-1}) exceeded that of a same-age Goldar field (156 kg ha^{-1}) at the Aberdeen NRCS Plant Center, but seed production from much larger and mature fields in central Washington report that Anatone produced only half the rate as established fields of Secar.

Anatone seeds are relative large and easy to clean. Approximately 60 percent of all seeds support a short awn that is easily removed, and does not create problems in harvesting or processing.

Wildland stands of Anatone normally produce some seeds each year. The number of seed stocks that develop are reflective of the conditions of the planting site. Seed stocks were counted from planting sites at Orchard, ID and Nephi, UT at various years but no clear pattern was recognized among collections or annual growing conditions. Anatone plants produced about average number of stocks at the Orchard site in 1997, Table 11. Individual accessions appear to adjust to climatic conditions by reducing vegetative growth and seed stock formation. Plants from the Anatone location were able to produce seed under arid conditions in sufficient amounts to repopulate an existing stand.

Table 10. Seed production of Anatone bluebunch wheatgrass from cultivated plantings in Utah, Colorado, Idaho, and Washington

Planting Location	Hectares Planted	Age of Planting	Yields kg ha^{-1}	Comments
Sanpete Co., UT				
Spring City				
2001	2.2	2 years	168	Weedy site
2002	2.2	3 years	195	Moderate stand
2003	2.2	4 years	240	Mature stand
Ft. Green				
1999	0.6	2 years	294	Mature plants
Utah Co., UT				
Spanish Fork				
2002	1.82	2 years	0	Frost destroyed crop
2003	1.82	3 years	225	
Montezuma Co., CO				
2000	2.0	2 years	226	
2001	38.0	3 years	304	
2002	38.0	4 years	177	Drought problems
2003	42.0.	5 years	328	
Payette Co., ID				
Field 1				
2001	2.83	1 year	140	
2002	2.83	2 year	56	
2003	2.83	3 year	56	
Field 2				
2001	1.6	1 year	141	
2002	1.6	2 year	168	
2003	1.6	3 year	140	
Field 3				
2002	2.88	1 year	337	
2003	2.88	2 year	563	
Bingham Co., ID				
2002		1year	120	Spring frosts
Lincoln Co., WA				
2002	44.5	1 year	123	
2003	58.7	2 year	210	

Table 11. Number of seed stocks per plant for different accessions of bluebunch Wheatgrass and Snake River wheatgrass accessions growing at the Orchard, ID study site, 1997. **Bold print distinguishes Snake River wheatgrass accessions**.

Accession	Origin	Number Seed Stocks
B24	**'Secar'**	**63.0**
B25	'Goldar'	29.0
B27	Crows Nest, ID	71.0
B28	Yuba Dam, UT	71.0
B34	Levan, UT	50.6
B43	Lamoille Cyn., NV	108.4
B45	Snowville, UT	33.2
B50	Wallawa Mtns.,OR	33.0
B51	**Enterprise, OR**	**61.6**
B52	GrandeRonde,WA	112.9
B53	Anatone, WA	76.9
B54	Asotin, WA	46.7
B60	Evanston, WY	39.3
B66	**Colton, WA**	**63.0**
B67	Colton, WA	119.6
B74	Roosevelt, WA	87.4
B79	**Wawawai**	**138.5**
B82	Penawawa, WA	59.7
B83	**Colton, WA**	**103.0**

Areas of Adaptation

Anatone bluebunch wheatgrass demonstrates adaptability to areas outside its native region. From plantings conducted in the northern region of the Snake River Plain and central Utah, the over-all performance of Anatone was better than any other accession including Goldar. DNA studies conducted by scientists at the USDA, ARS Laboratory, Logan Utah, indicate that plant materials from Asotin, Garfield, and Whitmar Counties, Washington; Umatilla, Grant, and Wallowa Counties, Oregon; and Washington County, Idaho are genetically quite similar, Fig 1. Materials from Ada and Idaho Counties, Idaho are closely grouped together, but are also aligned with materials from southeastern Washington/northeastern Oregon/western Idaho. In addition, materials from Humboldt, Elko, Lander, and Eureka Counties, Nevada are also closely grouped together, yet are aligned as a part of a broad group with the Washington/Oregon/Idaho collections. The broad genetic relationship of bluebunch wheatgrass from these geographical regions would suggest plant materials from certain areas within the regions could have wide ecological adaptability. This has been conformed by the broad adaptability exhibited from field plantings of the Anatone selection.

Anatone is adapted to the sagebrush communities, foothill and mountainous regions where mountain brush species are intermixed with bunchgrasses. It persists in open parks and with moderate density of over story shrubs. It is adapted to well-drained and heavy texture soils, including rocky but deep profiles. It naturally grows with numerous other herbaceous species, but does persist and dominates many areas.

Table 12. Collection sites of bluebunch wheatgrass accessions included in DNA trials . Data on file Dr. Steve Larson, USDA, ARS Laboratory, Logan, Utah.

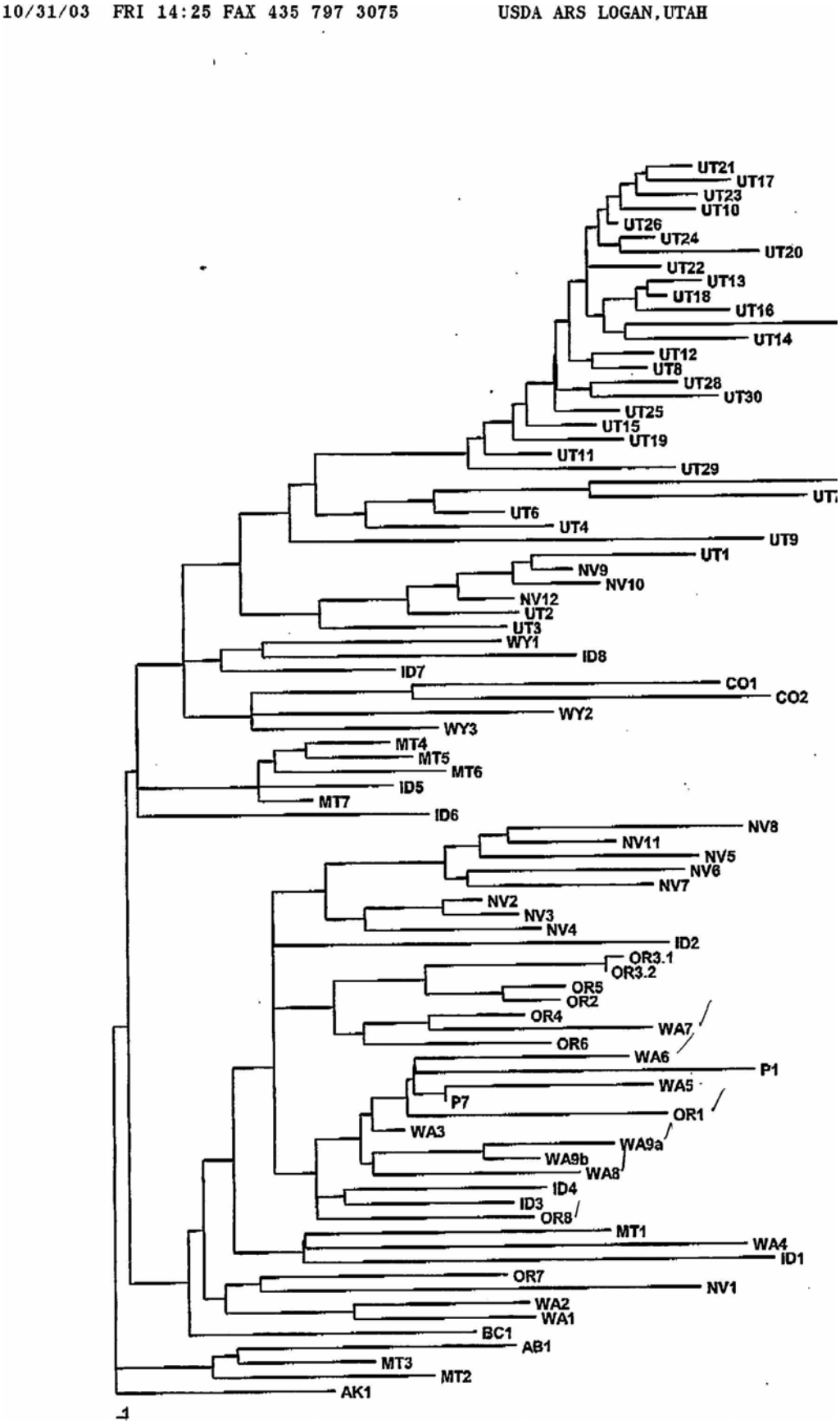
OTU Identification	Seed Origin
AB1	Old man Dam, AB
AK1	Milepost 289, Richardson Hwy
BC1	Slocan, BC
CO1	Poudre Park, Lamar Co., CO
CO2	Black Hawk, Gilpin Co., CO
ID1	Winchester, Lewis Co., ID
ID2	Brownlee Dam, Washington Co., ID
ID3	Hell's Canyon, Idaho Co., ID
ID4	Boise, Ada Co., ID
ID5	Salmon, Lemhi Co., ID
ID6	Magic Reservoir, Blaine Co., ID
ID7	Arco, Butte Co., ID
ID8	Aston Hill, Fremont Co., ID
MT1	Grinnell Glacier, Glacier N. P., MT
MT2	Lolo, Missoula Co., MT
MT3	Drummond-Garrison, Powell Co., MT
MT4	Lewis and Clark Co., MT
MT5	Broadwater Co., MT
MT6	Madison Co., MT
MT7	Livingston, Park Co., MT
NV1	Fish Springs, Washoe Co., NV
NV2	Cottonwood Creek, Humboldt Co., NV
NV3	Winnemucca, Humboldt Co., NV
NV4	Owyhee Desert, Elko Co., NV
NV5	Battle Mt. Lander Co., NV
NV6	Lone Mt., Elko Co., NV
NV7	Elko, Elko Co., NV
NV8	Eureka, Eureka Co., NV
NV9	Toano, Elko Co., NV
NV10	Montello, Elko Co., NV
MV11	Pinto Summit, Eureka Co., NV
MV12	Comins Lake, White Pine Co., NV
OR1	Hermiston, Umatilla Co., OR
OR2	Potamus Point, Marrow Co., OR

Table 12 , continued

OR3.1	Stumbough Ridge, Morrow Co., OR
OR4	Walla Walla RD., Umatilla Co., OR
OR5	Indian Creek, Grant Co., OR
OR6	Wallowa-Minam, Wallowa, OR
OR7	Burns, Harney Co., OR
OR8	Imnaha, Wallowa Co., OR
P1	Unknown
P7	Multiple Origin
UT1	Devil's Playground, Box Elder Co., UT
UT2	Curlew Junction, Box Elder Co., UT
UT3	Pinyon Flat, Box Elder Co., UT
UT4	Cold Water Canyon, Box Elder Co., UT
UT5	Logan Canyon, Box Elder Co., UT
UT6	Mantua, Box Elder Co., UT
UT7	Hardware Ranch, Cache Co., UT
UT8	Ogden Canyon, Weber Co., UT
UT9	Antelope Island, Davis Co., UT
UT10	Chriss Creek, Juab Co.,
UT11	North Tintic, Tooele Co., UT
UT12	Salt Lake City, Salt Lake Co., UT
UT13	Lindon, Utah Co., UT
UT14	Orem, Utah Co., UT
UT15	Paul Bunyan Woodpile, Juab Co., UT
UT16	Hobble Creek, Utah., UT
UT17	Mona, Juab Co., UT
UT18	Springville, Utah Co., UT
UT19	Yuba Dam, Juab Co., UT
UT20	Antelope Mt., Millard Co., UT
UT21	Spencer Fork, Sanpete Co., UT
UT22	Mud Springs, Millard Co., UT
UT23	Levan, Juab Co., UT
UT24	Mayfield, Sanpete Co., UT
UT25	Pigeon Hollow, Sanpete Co., UT
UT26	Ephraim, Sanpete Co., UT
UT27	Salina Canyon, Sevier Co., UT
UT28	Pigeon Water, Duchesne Co., UT
UT29	La Point, Uintah Co., UT
UT30	Antelope Canyon, Duchesne Co., UT
WA1	White Salmon, Klickitat Co., WA
WA2	Roosevelt, Klickitat Co., WA
WA3	Connell, Adams Co., WA
WA4	Steptoe Butte, Whitman Co., WA
WA5	Union Flat-Almota, Whitman Co., WA
WA6	Colton, Whitman Co., WA
WA7	Asotin-Wenaha, Garfield Co., WA

Table 12, continued

WA8	Asotin Co., WA
WA9a	Anatone, Asotin Co., WA
WAb	Anatone, Asotin Co., WA
WY1	Moon Lake, Sublette Co., WY
WY2	Flaming Gorge, Sweetwater Co., WY
WY3	Hiland, Natrona Co., WY


UT21
UT17
UT23
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UT26
UT24
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UT13
UT18
UT16
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UT12
UT8
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UT25
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UT11
UT29
UT7
UT6
UT4
UT9
UT1
NV9
NV10
NV12
UT2
UT3
WY1
ID8
ID7
CO1
CO2
WY2
WY3
MT4
MT5
MT6
ID5
MT7
ID6
NV8
NV11
NV5
NV6
NV7
NV2
NV3
NV4
ID2
OR3.1
OR3.2
OR5
OR2
OR4
WA7
OR6
WA6
P1
WA5
P7
OR1
WA3
WA9a
WA9b
WA8
ID4
ID3
OR8
MT1
WA4
ID1
OR7
NV1
WA2
WA1
BC1
AB1
MT3
MT2
AK1

Summary-Justification for Release

Anatone bluebunch wheatgrass is more widely adapted than any released cultivar throughout the broad region where this species naturally occurs. It is particularly adapted to mid and low elevations with more arid climatic conditions. It is superior to Goldar, and compares favorably to Secar at low elevations. Whitmar bluebunch wheatgrass was not included in any of the adaptability and survival studies. This cultivar was selected from a site near Colton, WA that is similar to the Anatone location. It has demonstrated excellent establishment traits and adaptability to arid regions. Only awnless plants were originally collected, and only certain plants within a spaced planting were selected for increase. The extent in which these selection measures may have diminished the germ plasm is not known, but it is apparent that material from this general region has superior traits that should be promoted. The objective of our selection process has been to provide an unaltered cultivar. Attempts were made to retain the genetic integrity of the native material from the Anatone location. The Anatone selection clearly demonstrates superior seedling survival and vigor from all accessions under study. Seeds germinate quickly from cold temperatures, and seedlings are much more vigorous and robust than other selections, comparing favorably with Hycrest crested wheatgrass. Under field plantings, seedling establishment and vigor exceeds accessions of other bluebunch wheatgrass and many other species. This selections provides a bluebunch wheatgrass accession that is much more drought tolerant than any cultivars currently available, and also furnishes an ecotypes with superior seed germination and seedling vigor.