Great Basin Native Plant Selection and Increase Project FY04 Progress Report

USDI Bureau of Land Management (Nevada, Idaho, Utah, Oregon)
USDA Forest Service, Shrub Sciences Laboratory, Provo, UT and Boise, ID
Utah Division of Wildlife Resources, Ephraim, UT
USDA Agricultural Research Service
- Forage and Range Research Laboratory, Logan, UT
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Utah Crop Improvement Association, Logan, UT
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March 2005

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Introduction

The use of native plants for rehabilitation after wildfires and restoration of disturbed wildlands is being encouraged by various BLM programs, initiatives, and policies. Examples include the 2001 Interior Appropriations Bill, the Great Basin Restoration Initiative, Departmental guidance (DOI Emergency Stabilization and Rehabilitation Manual), Executive Order 13112 (Invasive Species – 2/99) and the BLM's Standards for Rangeland Health. This project integrates several proposals to increase native plant production and use within the Great Basin, utilizing an applied science approach in a collaborative project.

Original partners in this proposal include BLM (Utah, Idaho, and Nevada); USDA Forest Service, Rocky Mountain Research Station, Shrub Sciences Laboratory (Provo, UT and Boise, ID); Utah Crop Improvement Association (Logan, UT); USDA Agricultural Research Service, Forage and Range Research and Bee Biology and Systematics Laboratories (both Logan, UT); and the Utah Division of Wildlife Resources, Great Basin Research Center (Ephraim, UT). Additional cooperators have been included to address specific research issues as needed. We thank our collaborators for their expertise and in kind contributions that have made it possible to address the many issues involved in plant materials development.

This document provides a review of work completed in 2004. Appendix I summarizes ongoing research and the principal investigators for each species.

Project Priorities

The proposal covers selection of native plant materials, culture, seed increase, and use on degraded rangelands. Priorities are: 1) increase of native plant materials available for restoration; 2) management or re-establishment of seed sources and technology to improve the diversity of introduced species monocultures; 3) technology transfer; and 4) genetic research.

The BLM representatives recommend that following identification of a funding level for this proposal, the BLM representatives, with input from the cooperators, will develop priorities, given the available funding. Studies and activities will focus on maximizing the increase in native plant materials available for rehabilitation and restoration of Great Basin rangelands.

Funding Strategy

This effort requires sustained funding over a long period to be successful. To meet this need, an Interagency Agreement will transfer the majority of the approved funds to the USDA Forest Services' Rocky Mountain Research Station, Shrub Sciences Laboratory in Provo, Utah via an Interagency Agreement. Mike Pellant, Great Basin Restoration Initiative Coordinator, is the Contracting Officer's Representative for this Interagency Agreement. The Shrub Sciences Laboratory will prepare or amend agreements with the other cooperators on this project and will distribute funding to these other entities per the Interagency Agreement and annual task orders. The Shrub Sciences Laboratory will assess a reasonable 12% indirect charge used internally to administer this assistance agreement with BLM. Additional funding for BLM coordination of this project will be needed starting in FY02 to assist in state level coordination on the project. An estimated 20 WM's per year will be required from FY02-06 for BLM coordination in the states of Utah, Oregon and Nevada, however, BLM will pursue these needs outside of this agreement.

Funding period: FY01– FY06

Funding received:

FY01:	$1,080,000
FY02:	1,500,000
FY03:	790,000
FY03(NIFC-BLM):	250,000
FY04:	725,500
TOTAL	**$4,345,500**

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APPENDICES

Project Title: Toward selected releases of *Agoseris*, *Astragalus*, *Lupinus*, *Phlox*, *Tragopogon* and *Stipa*.

Project Location: Shrub Sciences Laboratory, Provo, UT.

Principal Investigator: **Scott Jensen,** Botanist, USDA-FS-RMRS Shrub Sciences Laboratory, 735 N. 500 E., Provo, UT 84606-1865, phone: 801.356.5128, fax: 801.375.6968, sljensen@fs.fed.us

Project Description: Annual wildland seed collections from the Great Basin region beginning in 2002 have amassed numerous accessions of the native species *Agoseris glauca, Astragalus utahensis, Lupinus argenteus, Lupinus sericeus, Phlox longifolia, Stipa comata,* and the introduced species *Tragopogon dubius*. Each species poses a distinctive set of challenges in preparation for commercial release. The RMRS staff at Boise, ID and Utah Division of Wildlife Resources staff at Ephraim, UT greatly assisted with site identification and seed collection for the species included in this portion of the project.

Project Status:

Equipment. A hooded row sprayer and Hege 1000 Series Drill were purchased in 2004. The small plot combine is currently out for bid. We expect to take delivery by fall 2005.

Container Propagation Protocols.
Overview: A Joint Venture Agreement between the Shrub Sciences Lab (Susan Meyer, Scott Jensen) and Brigham Young University (Phil Allen, Brad Geary) was initiated with funding from the Joint Fire Sciences program and later augmented with funding from this project.

Many native forbs are readily grown as container stock, but there are some that have proven problematic in this context. This project proposes to develop propagation protocols for two groups of problem forbs, using a subset of species in each of these groups to examine factors that may be influencing propagation success. These two groups are native perennial legumes and spring-ephemeral perennials with a pattern of summer dormancy.

For the summer-dormant perennials, we will examine the following factors: temperature and photoperiod during the period of initial growth, presence or absence of mycorrhizal inoculum, and length of chilling period needed to stimulate regrowth. Our goal for the summer-dormant species will be to produce plants within a few months of a size that would require several growing seasons in the field. Summer-dormant species to be included in the study are: *Agoseris glauca, Balsamorhiza sagittata, Crepis acuminata, Lomatium grayi*, and *Phlox longifolia*. Our work on the legumes will focus primarily on the possible importance of nitrogen-fixing symbionts. We will also include temperature, photoperiod, and mycorrhizal inoculation as variables in our work with the legume species. Study species will include *Astragalus utahensis* and *Lupinus polyphyllus*.

Individual Species Status:

Agoseris glauca

Agoseris has proven to be one of the more difficult species to locate and collect in the Great Basin. Several factors contribute to this. Populations of many species are most readily located while in full flower. This is imperative with *Agoseris* due to its diminutive size, tendency to occur in low abundance and flower for only a brief period early in the growing season. It is also ephemeral in time, present one year but not the next. Our field effort is typically just beginning as *Agoseris* is in full flower at mid elevation sites. Fortunately seed set is relatively uniform and much of the population can be harvested on a single date. However, being wind dispersed, seed retention time is abbreviated once ripe.

Good moisture conditions and an early concerted effort to monitor known sites will be important for collecting in 2005. Thus far 31 *Agoseris* sites have been located. *Agoseris glauca* occurs at approximately two-thirds of these sites and has been collected at 8. Other *Agoseris* species occur at the remaining sites where 10 colelctions have been made. Seed was provided to BYU for a series of cultural practice studies and allocated to an effort to grow plugs for common garden evaluation. Both of these efforts met with failure as we have been unable to establish plants with any regularity. Do to the small amount of seed harvested in any one year, perpetual collection will likely be necessary for this species to ensure availability of seed necessary for various studies. Our current efforts with this species are two fold: first to develop container propagation protocols, and second to increase several existing lots through 2004 plantings at Fountain Green and Nephi.

Astragalus utahensis

We have located 37 *Astragalus utahensis* sites ranging in elevation from 4060 to 7400 ft. and collected seed at 33 of them. At 19 sites we were able to collect seed over multiple years. No other species has afforded this luxury. We have completed a series of germination studies documenting viability, seed weight, seed coat hardness, and response to 3 chill treatments. We have refined a seed coat scarification technique and identified a potential symbiotic fungal relationship eliminating the chill requirement. Seed and transplant stock was provided to BYU for a series of cultural practice studies. One common garden was planted at Wells, NV in 2004 and additional plants are currently growing for spring 2005 planting.

Astragalus utahensis is part of our Container Propagation Protocol Studies. Our primary interest here is identifying mycorrhizae and rhizobium species that aid establishment and survival. If determined beneficial we hope to develop a rhizobium inoculant to aid in nitrogen fixation. Early data suggest fungal components in native soil greatly improve germination and initial seedling establishment well before rhizobium are able to form nodules and benefit nitrogen uptake. We suspect this relationship is mycorrhizal in nature and the seed may benefit from a mycorrhizal inoculant as well.

Lupinus

Four species of *Lupinus* have been collected at 24 of 63 sites. Though widespread in the Great Basin, *L. argenteus* and *L. sericeus* both exhibit indeterminate flowering. Two additional species found in the region, *L. arbustus* and *L. polyphyllus,* appear more determinate. This characteristic facilitates easier harvest in a production setting. Ongoing work continues with all four species.

Initial attempts at direct seeding were unsuccessful and container propagation has proven problematic. Future work focuses on both of these areas.

Phlox longifolia

Phlox is widespread, but seed volume any particular year is a limiting factor. We have identified 61 sites and collected seed at 22 of them. Plants and seed were provided to BYU for a series of cultural practice studies. A common garden was established at Wells, NV and increase plots were planted at Nephi and Fountain Green, UT. Additional common gardens will be planted at up to three sites with current production. Studies involving seed weight, viability and response to stratification are nearing completion. *Phlox* is included in our container propagation protocol studies.

Tragopogon dubius

Tragopogon has been collected at 20 of 25 identified sites. Seed and plants were provided to BYU for a series of cultural practice studies. Basic germination studies are complete. Common gardens were established at Nephi, UT, and Wells and Orovada, NV. Data has been collected on duration of flowering and seed ripening periods, biomass production, and seed production and flowering uniformity. A plot was established at Fountain Green to assess harvesting methods.

Pending continued end user interest in this species, a subset of the most promising lines require further field evaluation, additional harvesting trials and production field establishment trials before seed is released for commercial production.

Stipa comata

Stipa has been collected at 45 of 89 sites. Common gardens were established at Wells, NV and Nephi, UT. Spring 2005 transplants are planned for Orovada and Fountian Green, UT. Seed weight, viability, and response to stratification work are nearing completion. Seed and plants were provided to BYU for a microcalorimetry study that promises to aid in deciphering appropriate seed transfer zones.

Technology Transfer:

Organized a project insect identification and collection field day/workshop that was conducted near Logan, UT.

Presentations:

Jensen. S.L. 2004. Plant materials work in the Great Basin. Visiting Afghanistan scientists; March 17; Provo, UT.

Jensen, S.L. 2004. Propagation issues of select Great Basin forbs. Intermountain Native Plant Summit; November 2-4; Boise, ID.

Jensen, S.L. 2004. Shrub Sciences Lab plant materials status report. Great Basin Native Plant Materials Coordination Meeting; March 9-10; Salt Lake City, UT.

Publications:

Jensen, Scott. Spring 2004. Racquets, hoppers and felt boards: Low-tech devices for collecting and processing seeds. Native Plants Journal 5: 50-51.

Project Title: Forb and Shrub Genetics Research

Project Location: Shrub Sciences Laboratory, Provo, UT

Principal Investigators: **Durant McArthur,** USDA-FS-RMRS Shrub Sciences Laboratory, 735 N. 500 E., Provo, UT 84606-1865, phone: 801.356.5112, fax: 801.375.6968, dmcarthur@fs.fed.us

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Reporting for work funded, in part, by both the USDI Bureau of Land Management Native Plant Selection and Increase Project and USDA Forest Service National Fire Plan (Cooperators USDA Forest Service Rocky Mountain, Pacific Northwest, and Pacific Southwest Research Stations; Utah Division of Wildlife Resources, and Brigham Young University).

Description of Project: This work is designed to determine the levels of genetic variation of plant species used or with potential for use in rehabilitation and restoration of fire impacted and other disturbed sagebrush steppe and pinyon-juniper ecosystems. Additional genetics work is also underway in delimiting seed transfer zones for restoration plant materials. The genetic variation research is designed to explore both within and between population variation by using isozyme and molecular genetic markers. It also explores the possible genetic consequences of past revegetation plantings by comparing the genetic architecture of source populations, seeded populations, and indigenous populations adjacent to the seeded populations. Work to date suggests that genetic patterns need to be assessed on a species by species basis and take into account pollination systems and population size. We briefly summarize the initial results from isozymes, DNA-based molecular genetics, revegetation plantings, gene flow, and seed transfer zones.

Isozymes (Hipkins): Twenty-six species have been examined so far [*Artemisia tridentata, Astragalus utahensis, Atriplex canescens, Balsamorhiza sagittata, Bromus carinatus, Chrysothamnus nauseosus (Ericameria nauseosa),Ceratoides lanata, Crepis acuminata, Crepis occidentalis, Erigeron pumilus, Eriogonum umbellatum, Lathyrus brachycalyx, Lomatium dissectum, Lomatium grayi, Lupinus argenteus, Lupinus sericeus, Oryzopsis hymenoides, Penstemon acuminatus, Penstemon deustus, Penstemon speciosus, Phlox longifolia Purshia tridentata, Stipa comata (Hesperostipa comata), Tragopogon dubius, Vicia americana, and Viguiera multiflora (Heliomeris multiflora)*]. These species are all common perennial species of the Intermountain West with use or potential use in habitat restoration projects.

About 2,400 individuals were sampled between 2001 and 2004. DNA extraction was carried out on leaf tissue using either the (1) DNeasy-96 Frozen Leaf Tissue Protocol, or DNeasy Plant Mini Kit following manufacturer's instructions with tissue homogenization achieved via the Mixer Mill 300 (Qiagen), or (2) FastPrep DNA Extraction (Bio-101). DNA quantity was assessed by fluorometry, and quality determined by visualizing all samples against 50 ng of Lambda DNA standard on 0.8% agarose gels stained with EtBr under UV light. DNA samples were shipped overnight on dry ice to Richard Cronn, PNW, USDA Forest Service. Isozyme

preparation followed the NFGEL Standard Operating Procedures. Extracts were electrophoresed on 11% starch gels and stained for a suite of enzyme systems.

Statistics regarding differentiation and inferred gene flow among populations vary widely among species. We are currently performing the synthesis of all collected samples. In all species for which it could be calculated, genetic identity of conspecific populations averaged above 0.9—the expected value, except in *Lupinus argenteus,* where genetic identities averaged 0.88. Morphological diversity among *Lupinus* samples suggests that some were misidentified. Data for *Stipa comata* may seem contradictory because genetic identities were as expected for conspecific populations (averaging 0.907) but Fst was very high (0.78). This resulted from the fact that each population in this selfing species was extremely uniform. The species was monomorphic at most loci, but there were fixed differences among populations at certain loci.

DNA-based molecular genetics (Cronn): The molecular genetic analysis is being performed on the same species that are being analyzed for isozymes. It appears that the two approaches are complementary.

Molecular genetics results including previous work reveals some interesting patterns. The herbaceous plant populations have distinctive haplotypes, i.e., populations from different geographic areas are distinctive in terms of molecular genetic patterns, but the landscape dominant wind pollinated shrubs *Atriplex canescens* and *Artemisia tridentata* haplotypes are widespread among population, subspecies, and races. These patterns have implications for development of seed zones. We (Miglia et al.) have evidence of AFLP markers specific for sagebrush subspecies even though deeper, older genetic markers on ribosomal and chloroplast DNA are shared widely among taxa and populations. This suggests that the AFLP markers may be much more recent that the ribosomal and chloroplast DNA markers.

Comparison between allozymes and DNA-based molecular genetics: Comparisons of population heterozygosity between allozyme and chloroplast (cp) DNA markers show minimal correspondence: a population can show high allozyme heterozygosity with no cpDNA variation while others exhibit low allozyme and substantial CPDNA heterozygosity. Estimates of genetic partitioning (F_{ST}) at allozyme and cpDNA markers yield insights into historical processes (bottlenecks, admixture), and the relative importance of pollen and seed as agents of gene flow. Complete analyses of these data are needed to understand their importance and implications.

Revegetation plantings gene flow: Several species are being examined in this portion of the study. Preliminary results for *Linum, Sphaeralcea, Penstemon,* and *Atriplex* are available. *Linum perenne,* in the form of 'Appar' blue flax, has been seeded widely in revegetation plantings. This germplasm was initially thought to be native but has since been shown to have derived from a naturalized population. A native species is *L. lewisii.* The two taxa do not hybridize either under controlled conditions or in juxtaposed seeded and indigenous populations, suggesting that prudent use of 'Appar' does not impact the genetic architecture of native *L. lewisii* populations (the need for a native germplasm of blue flax is being addressed by the testing and probable release of 'Maple Grove' blue flax, a *L. lewisii* germplasm). *Sphaeralcea* (globemallow) is a native genus which apparently frequently hybridizes. Both seeded and natural populations of globemallow species (*S. grossulariifolia, S. ambigua, S. munroana*) appear to form hybrid swarms (evidence from allozymes and molecular genetic—ISSR markers—give support for introgression). So far we have found no genetic evidence for

introgression of the seeded 'Cedar' Palmer penstemon (*Penstemon palmeri*) into native adjacent sympatric *Penstemon* populations but this work is in its early stages. Our work with *Atriplex* and other shrub species is also preliminary. However fourwing saltbush (*Atriplex canescens*) source, revegetation planting, and indigenous populations show remarkable overall similarity with both allozyme and molecular genetic markers but with more similarity between the source and seeded populations than either had with the indigenous population growing near the seeding location.

Publications:

Cronn, R., E. D. McArthur, and V. Hipkins. 2005. Patterns of nuclear and cytoplasmic differentiation in Intermountain restoration species: tales form two genomes. p. 31, abstr. 31, CD, 58th Annual Meeting Society for Range Management, Fort Worth, Texas.

Garcia, S., M. Sanz. T. Garnatje, A. Kreitschitz, E. D. McArthur, and J. Vallès. 2004. Variation of DNA amount in 47 populations of the subtribe Artemisiinae and related taxa (Asteraceae, Anthemideae): karyological, ecological, and systematic implications. Genome 47: 1004-1014.

Mahalovich, M. F. and E. D. McArthur. 2004. Sagebrush (*Artemisia* spp.) seed and plant transfer guidelines. Native Plants 5: 141-148.

McArthur, E. D., D. C. Freeman, J. H. Graham, and S. C. Sanderson. 2004. The role of hybridization and genetics in landscapte dominant sagebrushes (*Artemisia*). Abstract, CD, XXII International Congress of Entomology, Brisbane, Australia.

McArthur, E. D. and S. B. Monsen. 2004. Chenopod shrubs. p. 467-491 *in* S. B. Monsen, R. Stevens, and N. L. Shaw, comps. Restoring western ranges and wildlands, vol 2. USDA Forest Service, Rocky Mountain Research Station, Gen. Tech. Rep. RMRS-136. Fort Collins, Colorado.

McArthur, E. D. and R. Stevens. 2004. Composite shrubs. p. 493-537 *in* S. B. Monsen, R. Stevens, and N. L. Shaw, comps. Restoring western ranges and wildlands, vol 2. USDA Forest Service, Rocky Mountain Research Station, Gen. Tech. Rep. RMRS-136. Fort Collins, Colorado.

McArthur, E. D., and J. R. Taylor. 2004. *Artemisia arbuscula* Nutt., *A. bigelovii* Gray, *A. cana* Pursh, *A. filifolia* Torr., *A. frigida* Willd., *A. longiloba* (Osterhout) Beetle, *A. nova* A. Nels., *A. pygmaea* Gray, *A. rigida* (Nutt.) Gray, *A. spinescens* Eaton, *A. tripartita* Rydb., p. 47-51, 57-68, 72-78, 82-84, 88-90 *in* J. K. Francis, ed. Wildland shrubs of the United States and its territories: thamnic descriptions, vol. 1. USDA Forest Service, International Institute of Tropical Forestry and Rocky Mountain Research Station, Gen. Tech. Rep. IITF-GTR-26. San Juan, Puerto Rico and Fort Collins, Colorado.

McArthur, E. D., and J. R. Taylor. 2004. *Chrysothamnus nauseosus* (Pallas ex Pursh) Britt., *C. parryi* (Gray) Greene, *C. viscidiflorus* Nutt., p. 203-211. *in* J. K. Francis, ed. Wildland shrubs of the United States and its territories: thamnic descriptions, vol. 1. USDA Forest Service, International Institute of Tropical Forestry and Rocky Mountain Research Station, Gen. Tech. Rep. IITF-GTR-26. San Juan, Puerto Rico and Fort Collins, Colorado.

Sanderson, S. C., E. D. McArthur, and J. R. Taylor. 2004. *Atriplex confertifolia* (Torr. & Frém.) S. Wats. p. 96-98. *in* J. K. Francis, ed. Wildland shrubs of the United States and its territories: thamnic descriptions, vol. 1. USDA Forest Service, International Institute of Tropical Forestry and Rocky Mountain Research Station, Gen. Tech. Rep. IITF-GTR-26. San Juan, Puerto Rico and Fort Collins, Colorado.

Shaw, N. and E. D. McArthur. 2005. The Great Basin Native Plant Selection and Increase Project: progress and recent initatives. p. 155, abstract 315 CD, 58th Annual Meeting Society for Range Management, Fort Worth, Texas.

Taylor, J. R. and E. D. McArthur. 2004. *Artemisia ludoviciana* Nutt. p. 69-71. *in* J. K. Francis, ed. Wildland shrubs of the United States and its territories: thamnic descriptions, vol. 1. USDA Forest Service, International Institute of Tropical Forestry and Rocky Mountain Research Station, Gen. Tech. Rep. IITF-GTR-26. San Juan, Puerto Rico and Fort Collins, Colorado.

Project Title: Plant Material Development, Seed Technology and Seed Production of Great Basin Forbs

Project Location: USDA-FS-RMRS Shrub Sciences Laboratory, Boise, ID

Principal Investigators: **Nancy Shaw,** Research Botanist, USDA-FS-RMRS, 316 E. Myrtle, Boise, ID 83702, phone: 208.373.4360, fax: 208.373.4391, nshaw@fs.fed.us

Ann DeBolt, Botanist, USDA-FS-RMRS, 316 E. Myrtle, Boise, ID 83702, phone: 208.373.4366, fax: 208.373.4391, adebolt@fs.fed.us

Project Description: Although forbs are components of most native communities, their use in revegetation has been limited. This work is being conducted to provide plant materials, seed supplies, and seed transfer guidelines for common forb species of the Great Basin. Seed production practices and seed and seeding technology, essential for the use of these species, are also being developed. Efforts in Boise focus on seven species in three families: *Eriogonum umbellatum* (Polygonaceae); *Lomatium dissectum, L. grayi,* and *L. triternatum* (Apiaceae); *and Penstemon acuminatus, P. deustus*, and *P. speciosus* (Scrophulariaceae). The Great Basin Native Plant Selection and Increase Project and the USDA Forest Service, National Fire Plan provide partial funding for this research.

Project Status:

Development of field locations.

Niagra Springs. A testing site on sandy soil was established through an MOU with the Idaho Department of Fish and Game and a weather station was installed.

Boise State University Horticulture Program. A 0.8-ha test site was leased through an agreement with the Boise State University, Larry Selland College of Applied Technology. The site was cleared, leveled, and prepared for planting. A deer fence was constructed around the site and a weather station was installed.

Lucky Peak Shrub Garden**.** The rush skeletonweed (*Chondrilla juncea*) project is being continued in this 16-ha enclosure administered by the Boise National Forest. Spot treatments of herbicide were applied as needed and brush and debris were cleared to reduce the risk of fire.

Seed collections. We collected 136 seed lots of 19 species in 2004. This included 90 collections of Boise research species, 43 collections of Ephraim and Provo research species, and three collections for the AOSCA project. To date we have mapped 1,131 populations of research forb species and other forbs and grasses of interest to GBNPSIP cooperators.

DNA sample collections. In accordance with the USDA National Forest Genetic Electrophoresis Lab (NFGEL) protocols and procedures, we collected 13 samples for DNA

analysis in Idaho, Oregon, and Nevada (see McArthur and Sanderson report). The species and number of samples collected from include *Balsamorhiza sagittata* (1), *Erionomum umbellatum* (4), *Lomatium dissectum* (1), *L. grayi* (1), *Lupinus sericeus* (1), *Penstemon acuminatus* (1), *P. deustus* (2), and *P. speciosus* (2).

Status of research species.

Penstemon spp.
We made nine field collections of *Penstemon acuminatus*, 13 of *P. deustus*, and three of *P. speciosus* in 2004.

Phenology, morphology, growth, and seed production data were collected from irrigated common gardens established in 2003 at Geertson's (*P. acuminatus*) and Snaveley's (all three species). The *Penstemons* did not appear pollinator limited, and all produced good seed crops. *P. acuminatus,* a species adapted to sandy soils, and *P. deustus*, a species of rocky sites, appeared healthy on the loamy soils of the farm fields.

Weekly sweep net insect sampling (diurnal and nocturnal) was conducted during the growing season. Insects were sent to project cooperators Bob Hammon (Colorado State University Extension Office) and Jim Cane (ARS Bee Biology & Systematics Laboratory) for determination.

Container stock of the three *Penstemons* were grown at the Lucky Peak Nursery greenhouse in winter 2003/2004 and planted in spring 2004. Plantings:

- Niagra Springs (dryland): *P. acuminatus* common garden.
- Orchard Research Site (dryland): *P. acuminatus* demonstration area and *P. deustus* common garden.
- Orovada Enclosure, NV (dryland): *P. speciosus* common garden.
- Boise State University (irrigated): *P. deustus* demonstration area and *P. speciosus* common garden.

Establishment and growth data were collected from all first year plantings.

Effects of a prechill period, exposure to liquid smoke treatments, pretreatment in gibberellic acid and combinations of these treatments on germination total and rate were evaluated for 2002 and 2003 seed of each *Penstemon* species. Physiological dormancy is released by prolonged prechilling treatments. Gibberellic acid treatments reduce the prechill requirement.

Lomatium spp.
We made 25 field collections of *Lomatium dissectum*, nine of *L. grayi*, and 12 of *L. triternatum* in 2004.

Common gardens of all three *Lomatium* species were planted from seed at Boise State University in fall 2004. Holes were burned in weed barrier cloth using the technique recommended by Chris Hoag, USDA NRCS Aberdeen Plant Materials Center. Seed was planted about 1-2 cm deep in each hole. Emergence of all three species began in late February 2005, and a high percentage of the seeding spots now contain seedlings.

Effects of a prechill period, exposure to liquid smoke treatments, pretreatment in gibberellic acid and combinations of these treatments on germination total and rate were evaluated for 2002 and 2003 seed of each *Lomatium* species. Dormancy in *Lomatium* may be morphophysiological in nature, resulting from a combination of physical restraint imposed by the endosperm and embryo dormancy. A prolonged prechill releases dormancy. *L. grayi* requires about 8 weeks of prechill while accessions of *L. triternatum* and *L. dissectum* require 9 to 10 weeks. Germination occurs at low temperatures (<10^{o}C) and does not require light. Dormancy is not relieved by gibberellic acid treatments. Research in 2005 will examine the effects of warm and cool prechills on endosperm integrity and embryo development.

***Eriogonum umbellatum*.**

Nineteen seed lots were collected in 2004 providing a total of 30 collections from the 37 sites identified to date. Collection will continue in 2005. We are growing a small number of container seedlings in the Lucky Peak Nursery greenhouse to develop propagation practices and to provide stock for a spring 2005 demonstration planting.

Seed distribution.

Seed lots provided to cooperators 1-3 below were first cleaned, tested at the Oregon State University Seed Laboratory, and source-identified through the Idaho State Seed Certification program. Uncleaned seed lots were provided to Ephraim and Provo.

1. One lot of each of the seven research species was sent to the USDA NRCS Aberdeen Plant Materials Center for seed increase.
2. Seed of each research species was provided to the Oregon State University, Malheur Experiment Station for herbicide and drip irrigation research.
3. Seed samples of *Eriogonum umbellatum* (22 sources); *Lomatium dissectum* (13 sources); *Lomatium grayi* (5 sources); *Lomatium triternatum* (5 sources); *Penstemon acuminatus* (15 sources); *Penstemon deustus* (21 sources); and *Penstemon speciosus* (8 sources) were sent to Victor Vankus at the National Tree Seed Laboratory for determination of seed weight, weight of seed required for purity testing and germination protocols.
4. Forty-three seed lots of nine research species were sent to Ephraim and Provo.

Catalog, manual, brochure, and website.

Rangeland Revegetation Equipment Catalog. This web-based catalog describes types and operation of equipment designed or adapted for range and wildlife habitat improvement and disturbed land rehabilitation. Completed chapters are now online (reveg-catalog.tamu.edu). Contractor Harold Wiedemann (Texas A&M University, retired) is preparing the catalog. Shaw, Mike Pellant, and Steve Monsen provide reviews and recommendations; Shaw administers the contract.

Field Guide to Intermountain Cyperaceae (excluding *Carex*) (SSL-Boise). This is the third in a series including the Field Guide to Intermountain Rushes (GTR-INT-306) and the Field Guide to Intermountain Sedges (RMRS-GTR-10). The guides will assist specialists and nonspecialists working with wetland plants in the Great Basin and surrounding areas. The draft was completed in 2004. (Hurd, Shaw, Smith, DeBolt)

Great Basin Native Plant Selection and Increase Project Project brochure. A color brochure and a logo were developed for the project. The brochure was printed and distributed to cooperators in October 2004; the logo was made available electronically (DeBolt).

The Great Basin Native Plant Selection and Increase Project website is now functional; updates and improvements are ongoing. It is hosted on the Boise RMRS Lab website at: http:/www.fs.fed.us/rm/boise/ then scroll to Shrubland Biology. (DeBolt)

Administration. We managed 16 agreements, contracts, and MOUs with Great Basin Native Plant Selection and Increase Project cooperators, compiled the 2003 report, and developed the 2004 taskorder.

A Request for Information was prepared and distributed to solicit research proposals for developing practices for increasing shrub seed production in wildland stands and to improve diversity in crested wheatgrass stands. BYU (Anderson, Roundy, and Johnson, Woolstenhulme) was funded to conduct shrub seed production research. Study sites were identified in Utah, Idaho, and Nevada. BYU (Roundy, Anderson, Johnson) and Utah Division of Wildlife Resources (Walker) were funded to conduct crested wheatgrass diversification research. Two study sites were selected in Utah. Related research may be initiated in Oregon and Idaho in 2005.

Shaw and McArthur organized a half-day symposium "Selecting and Increasing Native Plant Materials for the Great Basin" for the Society for Range Management 58th Annual Meeting and Trade Show.

Publications:

Mealor, Brian A.; Hild, Ann L.; Shaw, Nancy L. 2004. Native plant community and population response to long-term weed invasion. Western North American Naturalist. 64: 403-513.

Monsen, S.B., R. Stevens, and N.L. Shaw, comps. 2004. Restoring western ranges and wildlands. Gen. Tech. Rep. RMRS-GTR-136.Vols.1-3. USDA-FS Rocky Mountain Research Station, Fort Collins, CO. 884 p. plus index.

Monsen, S.B., R. Stevens, and N. Shaw. 2004. Ch. 18. Grasses, p. 295-424. In: Monsen, S.B., R. Stevens, and N.L. Shaw, comps. Restoring western ranges and wildlands. RMRS-GTR-136. Vol. 2. USDA-FS Rocky Mountain Research Station, Fort Collins, CO.

Monsen, S.B., R. Stevens, and N.L. Shaw. 2004. Ch. 23. Shrubs of other families, p. 597-698. In: Monsen, S.B., R. Stevens, and N.L. Shaw, comps. Restoring western ranges and wildlands. RMRS-GTR-136. Vol. 2. USDA-FS Rocky Mountain Research Station, Fort Collins, CO.

Shaw, N.L. 2004. Ch. 29. Production and use of planting stock, p. 745-768. In: Monsen, S.B., R. Stevens, and N.L. Shaw, comps. Restoring western ranges and wildlands. RMRS-GTR-136. Vol. 3. USDA-FS Rocky Mountain Research Station, Fort Collins, CO.

Shaw, N.L., S.B. Monsen, and R. Stevens. 2004. Ch. 22. Rosaceous shrubs, p. 539-596. In: Monsen, S.B., R. Stevens, and N.L. Shaw, comps. Restoring western ranges and wildlands. RMRS-GTR-136. Vol 2. USDA-FS Rocky Mountain Research Station, Fort Collins, CO.

Published Abstracts.

Wiedemann, H.T., Shaw, N.L**.,** Pellant, M., and Monsen, S.B. 2004. Revegetation Equipment Catalog Preparation. In: Abstracts: Society for Range Management 57th Annual Meeting. Salt Lake City, UT. 57: 186-87. Abstract 394.

Shaw, N.L.; Lambert, S.M. 2004. Increasing native forb seed supplies for the Great Basin. Western Nurseryman's Conference. USDA-FS, Medford, OR. Abstract.

Pellant, M.; Pyke, D.; Shaw, N.; Nowak, R; McIver, J. 2004. Linking science and management to accomplish restoration in the Great Basin Desert, p. 394-395. Ecological Society of America 89th annual meeting. Portland, OR. Abstract.

Shaw, N.L. 2004. Seed sources and supplies for the Great Basin, p. 12. In: SERCAL's eleventh annual conference: expanding the center: sustainable restoration and its intersection with social, economic, and ecological capital. Kings Beach, CA. Abstract.

DeBolt, A.M.; Shaw, N.L.; Lowry, G.H. 2005. Biscuitroot, beardtongue, buckwheat and beyond. In: Abstracts: Society for Range Management 58th Annual Meeting. Fort Worth, TX. Abstract 74.

Pellant, M.; Lambert, S.; Shaw, N.L. 2005. The Great Basin Native Plant Selection and Increase Project: origin, objectives, and cooperators. In: Abstracts: Society for Range Management 58th Annual Meeting. Fort Worth, TX. Abstract 260.

Shaw, N.L.; McArthur, E.D. 2005. The Great Basin Native Plant Selection and Increase Project: Progress and recent initiatives. In: Abstracts: Society for Range Management 58th Annual Meeting. Fort Worth, TX. Abstract 315.

Roundy, B.; Shaw, N.L. 2005. Challenges and progress in rangeland restoration. In: Abstracts: Society for Range Management 58th Annual Meeting. Fort Worth, TX. Abstract 294.

Young, S.; DeBolt, A.; Lowry, G.H. 2005. Native plant source-identified stock seed increase. In: Abstracts: Society for Range Management 58th Annual Meeting. Fort Worth, TX. Abstract 386.

Project Title: Native Plant Material Development and Seed and Seeding Technology for Native Great Basin Forbs and Grasses

Project Location: Great Basin Research Center, Ephraim, UT.

Grant Agreement Period: March 1, 2004 through February 28, 2005

Principal Investigators: **Jason Vernon,** Project Leader, Utah Division of Wildlife Resources, Great Basin Research Center, 542 N. Main Street, Ephraim, UT 84627, phone: 435.283.4441, fax: 435.283.5616, jasonvernon@utah.gov

Therese Meyer, Wildlife Biologist, Utah Division of Wildlife Resources, Great Basin Research Center, 542 N. Main Street, Ephraim, UT 84627, phone: 435.283.4441, fax: 435.283.5616, theresemeyer@utah.gov

Scott C. Walker, Former Project Leader, now at Northern Regional Office, Utah Division of Wildlife Resources, 515 E. 5300 S., Ogden, UT, 84116, phone: 801.476.2776, scottwalker@utah.gov

Project description and status:
Species: Arrowleaf balsamroot (*Balsamorhiza sagittata*: BASA), Biscuitroot (*Lomatium nuttallii* - species discussion below), Globemallows (*Sphaeralcea grossulariifolia*: SPGR and *S. coccinea*: SPCO2), Cushion buckwheat (*Eriogonum ovalifolium*: EROV), Tapertip hawksbeard (*Crepis acuminata*: CRAC), Northern sweetvetch (*Hedysarum boreale*: HEBO) and Western sweetvetch (*H. occidentale,* HEOC), Great Basin Wildrye (*Elymus cinereus*: ELCI), Bluebunch wheatgrass (*Pseudoregneria spicata*: AGSP), and Needle-and-thread grass (*Stipa comata*: STCO3 = *Hesperostipa c.)*

We continued work on field identification, collection and testing of plant materials, and native plant increases. Early spring rain contributed to better seed production throughout most of our collection range. Plant populations were weakened, however, by previous years of drought, and mid-summer precipitation was less than desired, so overall seed output was reduced. GBRC staff made 62 wildland seed collections in 2004 of 15 species of forbs and grasses in Utah and Nevada, totaling approximately 6 kilograms of cleaned seed (most of what we collected was sent to cooperators in Boise and Provo and is not counted in our weight). The focus has been to increase the amount of seed of certain accessions for which there was insufficient seed for germination work and common garden plantings, and to obtain seed from newly identified locations. The database now registers 717 collections of 31 species of forbs and grasses.

We collected 12 specimens of insects at plant collection sites, and sent them to Jim Cane at USU and some to Bob Hammond of Colorado Extension Service for rearing and identification.

Seed cleaning, inventory, and database work was continued.

Through plant voucher identification we have correctly keyed several of our collections as species other than those we were attempting to collect. This has also brought to our attention some taxonomic/nomenclatural problems. Our group was charged with collecting *Lomatium nuttallii*: Cronquist (1997) elucidates much confusion associated with this name, concluding that true *L. nuttallii* would not be found in our region (it would be found in Nebraska and possibly Wyoming), and specimens from our region labeled as *L. nuttallii* are referred to *L. graveolens* var. *graveolens* (S. Watson) Dorn & R.L. Hartm, (or, in Welsh, et al, *L. kingii* var. *kingii*). GBRC has one collection of *L. graveolens* var.*graveolens* from northern Utah. The bulk of our collections are of another Apiaceae: *Perideridia bolanderi*, common name from the Native American "Yampah" or "Olasi", the roots constituted an important food for Native Americans and the early European pioneers in the Great Basin. Since this species appears to be widespread and well adapted to the plant community our project targets, we will continue to include *Perideridia bolanderi* in studies.

Also on our species list are two *Sphaeralceas*, *S. grossularifolia* and *S. coccinea*. We have a total of 54 collections from 50 sites, and three collections from one site are now identified as *S. parvifolia*. Inasmuch as Bureau of Land Management personnel from the area of this collection are interested in this species, we will continue to include these collections in our studies.

In cooperation with Agricultural Research Service in Logan, we maintained a *Hedysarum* trial in Ephraim and took readings for 12 weeks, and sent the data to Michael Peele. We have collected 11 accessions of *Hedysarum boreale* and *H. occidentale* and will include these and currently available releases of *H. boreale* in common gardens. The aim is to evaluate wider germplasm collections for improved seed production (less seed shatter), drought tolerance, and resistance to insect predation.

As part of the work toward development of planting guidelines and equipment for establishment of selected species in wildland settings, we are studying germination, dormancy, and planting depth.

Germination experiments are complete on the following: CRAC—26 accessions; HEBO and HEOC--30 accessions; EROV and ERUM--21 accessions; BASA--27 accessions; *Lomatiums* and *Perideridia*--10 accessions; *Sphaeralcea* (SPGR and SPCO) 29 accessions.

We have experimented with seed dormancy-breaking pretreatments for *Sphaeralcea* by immersion in boiling water for a short time. Two minutes submersion produced 20-30% germination, but three minutes was too long. No heat pretreatment produced 32% germination: hence future plantings will use no heat pretreatment to avoid danger of overheating.

Planting depth studies on *Crepis acuminata* and *Sphaeralcea* show that ¼" to ¾" depth is best for these species. Only three accessions of CRAC and one accession of SPCO2 have been tested in depth studies, but all accessions of *Sphaeralcea* have now been direct seeded into flats in the

greenhouse at ¼" to ½" depth, with excellent emergence, confirming the preliminary experimental finding.

Greenhouse propagation for common gardens: Seedlings from germination tests were planted into flats in the greenhouse for common garden plug production. Currently (Feb. 2005) we have 250 flats (up to 72 plugs per flat) representing 10 species planted in the greenhouse. The *Lomatiums, Perideridia, Balsamorhiza*, and *Crepis* all went into a dormancy after a month or so of growth to the first or second true leaf stage (with the exception of the *Perideridia*, which seems to have a genetic freeze on first true leaf formation, and did not produce any, but did form a storage organ on the root: the "biscuit" of "Biscuitroot"). The plugs will be transplanted to a field in Ephraim at Snow College and in Fountain Green at the WMA in spring of 2005. A deer exclosure fence has been requisitioned for approximately 25 acres of the Fountain Green WMA to protect experimental plantings from predation.

We have observed in our plug production that none of our species produce a mass of roots to hold the planting media intact for easy field transplanting. They typically have fibrous taproots or brittle roots. This complicates transplanting into the field, since the fragile roots preclude use of a tree planter implement. We will have to hand plant these types of plugs. We will be interested in the results of Scott Jensen's tests of new planting systems to remedy this problem.

We are growing 29 flats (~2100 plants) of *Linum lewisii* 'Maple Grove' for a foundation field planting in the Fountain Green exclosure.

Direct seed for forb common gardens: seed packets are prepared for direct seeding into three common gardens (Fountain Green, Utah, and Wells, Nevada, and a third location not yet chosen) in early spring 2005, and fall 2005. Each common garden will have approximately 10 forb species, with a total of more than 110 accessions, with each accession in five repeat blocks per garden.

Trial plots of Great Basin Wildrye and bluebunch wheatgrass seeded in fall of 2003 at the Orovada site were unsuccessful. Further attempts at establishment of common gardens of these grasses will be made using plug transplants.

As part of the AOSCA Grower Early Release program and for Seed Ecology Studies, seed was distributed to cooperators and other entities:

a) Michael Peel, Agricultural Research Service, Logan, UT. We maintained *Hedysarum* trials in Ephraim and took readings for 12 weeks, then collected seed from the plants and sent seed and data to principal investigator.

b) Stan Young, Utah Crop Improvement Assocation, Logan, UT. Provided 2 seed lots to growers for the AOSCA Cooperative Seed Increase Programa (BASA, CRAC).

c) Terry Dunfield, Nevada Department of Agriculture: Provided 2 seed lots to growers for the AOSCA Cooperative Seed Increase Programa (EROV and CLLU).

d) Victor Vankus, National Tree Seed Laboratory, Dry Branch, GA: Provided seed of CRAC from three separate elevations at one site to develop seed germination testing rules.

e) Bruce Roundy, Robert Johnson and Val Jo Anderson, Brigham Young University, Provo, UT. Provided seed of CRAC, BASA and EROV for seed ecology work.

Meetings, publications, presentations, posters:

a) May: T. Meyer attended one-day Insect workshop in Brigham City with other members of the Interagency Task Force to learn how to collect insects at plant material collection sites for predation and pollinator studies. T. Meyer attended two-day Interagency Plant Materials Committee in Boise and made short presentation about the new Ephraim seed warehouse and greenhouse.

b) July: T. Meyer attended three-day Botanical Society of America meetings in Snowbird, Utah: presented her research on *Xylorhiza*: Meyer, Therese and Windham, M. D. – "Distinct species or hybrid swarm?: Investigating the taxonomic status of Cronquist's Woodyaster".

c) September: T. Meyer staffed the DWR display at the Utah State Fair for four hours. T. Meyer and J. Vernon attended one-day Intermountain Native Plant Collectors and Growers meeting at Snow College organized by Stan Young of Utah Crop Improvement Association where T. Meyer gave a presentation about Division efforts to increase the crop potential of native plant materials, and J. Vernon reported on the Great Basin Research Center warehouse and seed mixing capability.

d) November: T. Meyer and S. Walker attended three-day Intermountain Native Plant Summit in Boise. S. Walker gave a presentation about Division of Wildlife Resources contribution to range restoration and T. Meyer presented two posters: "Forb Accession Germination Studies", and "Wildland Seed Longevity".

e) February 2005: T. Meyer and J. Vernon attended Society for Range Management national annual meeting in Fort Worth, Texas. T. Meyer presented an update on GBRC work on the Native Plant Selection and Increase Project.

Work locations:

- Project Headquarters - Great Basin Experimental Station, Ephraim, Sanpete County, Utah.
- USFS Shrub Sciences Laboratory, Provo, Utah.
- Utah field work: Box Elder, Tooele, Millard, Beaver, Iron, Washington, Garfield, Summit, Kane, Sevier, Piute, Rich, Wasatch, Emery, Carbon, Grand, San Juan, Duchesne, Uintah, Juab, Sanpete, Cache, Daggett and Utah counties.
- Nevada field work: Utah, Lander, Elko, Humboldt, Eureka, Pershing, and Lincoln counties.

Project Title: Native Plant Genetics, Ecophysiology, Plant Materials Development, and Seed Increase

Project Location: USDA-ARS Forage and Range Research Laboratory, Logan, UT

Principal Investigators: **Douglas Johnson,** Research Plant Physiologist, USDA-ARS Forage and Range Research Laboratory, Utah State University, Logan, UT 84322-6300, phone: 435-797-3067, fax: 435.797.3075, daj@cc.usu.edu

Michael Peel, Research Geneticist, USDA-ARS Forage and Range Research Laboratory, Utah State University, Logan, UT 84322-6300, phone: 435-797-3288, fax: 435-797-3075, mpeel@cc.usu.edu

Steve Larson, Research Geneticist, USDA-ARS Forage and Range Research Laboratory, Utah State University, Logan, UT 84322-6300, phone: 435-797-1703, fax: 435-797-3075, stlarson@cc.usu.edu

Tom Monaco, Research Ecologist**,** USDA-ARS Forage and Range Research Laboratory, Utah State University, Logan, UT 84322-6300, phone: 435-797-3288, fax: 435-797-3075, tmonaco@cc.usu.edu

Tom Jones, Research Geneticist, USDA-ARS Forage and Range Research Laboratory, Utah State University, Logan, UT 84322-6300, phone: 435-797-3082, fax: 435-797-3075, tomjones@cc.usu.edu

This is a summary of research related to the BLM Great Basin Native Plant Selection and Increase Project that is being conducted at the USDA-ARS Forage and Range Research Lab at Logan with partial funding provided by the BLM Great Basin Native Plant Selection and Increase Project administered through the USDA Forest Service Rocky Mountain Research Station.

Project Description:

Jones' funding was designated for seed increase of pending germplasm releases, germplasm development, and needle-and-thread (*Hesperostipa comata*) germplasm collection. Larson's funding was designated for genetic (DNA) analysis of bluebunch wheatgrass (*Pseudoroegneria spicata*), *Leymus* wildryes, squirreltail (*Elymus elymoides* and *E. multisetus*), Indian ricegrass (*Achnatherum hymenoides*), and Utah sweetvetch (*Hedysarum boreale)*. Johnson's funding was designated for collection and evaluation of basalt milkvetch (*Astragalus filipes*). Peel's funding was designated to develop improved germplasm of globemallow (*Sphaeralcea grossulariifolia*

and *S. munroana*). Monaco's funding was designated for physiological and ecological evaluation of bluebunch wheatgrass and squirreltail accessions.

Project Status:

Seed Increase and Collection of North American Grasses (Jones)

- The first commercial seed harvest of Fish Creek and Toe Jam Creek bottlebrush squirreltail germplasms was produced in 2004, but most of the seed was used to plant additional fields. Seed is expected to be on the market in the fall of 2005.
- Selection work continued on bottlebrush squirreltail material originating in Elmore Co., ID. Progeny of selected plants from three accessions collected in the vicinity of Mountain Home, ID were transplanted to a replicated field test in April 2003. Data were collected in 2003 and 2004.
- Expedition Snake River wheatgrass and Columbia bluebunch wheatgrass were harvested for seed for the first time in 2004. They were planted in evaluation trials in fall 2004. Expedition and Columbia will be proposed for release in 2005.
- White River Indian ricegrass was harvested for seed in 2003 and 2004. It was recommended for release in 2005.
- Star Lake Indian ricegrass seed was distributed to growers and is expected to be planted in spring 2005.
- Needle-and-thread grass collections were made in UT, CO, and WY in 2003 and ID and OR in 2004.

Genetic Analyses of *Leymus* Grasses and Utah Sweetvetch (Larson)

- Over 60 *Leymus* wildrye seed collections were made in ID, NV, and OR in 2004.
- Assembled test plates containing 768 *Leymus* wildrye DNA samples, including nine North American species and 304 North American collection sites. Materials include 55 GBRC collections, four Berta Youtie collections, and 61 new FRRL collections described above.
- Identified chromosome regions controlling adaptive traits (salt-tolerance, seed dormancy, plant height, flowering period, growth habit, and mineral content) in North American *Leymus* wildryes. Initiated experiments to use high density Affmetrix DNA microarrays (22,000 expressed gene sequences) to evaluate DNA variation in North American *Leymus* wildryes.
- Analyzed DNA profiles from 376 Utah sweetvetch genotypes (plants) representing 21 seed collections including at least 10 GBRC collections and 2 RMRS-SSL collections.

Sphaeralcea Collection and Evaluation (Peel)

- In the spring of 2004 a total of 28 lines of *S. munroana* and *S. grossulariifolia* were planted at two locations. Most are lines selected for improved plant vigor, persistence and seed production while others are from original collections made in 2002 and 2003.
- Twenty six lines of *S. coccinea* were also planted at two locations in the spring of 2004. These are all selections for improved plant vigor, persistence and seed production.

- Established materials will be evaluated for seed production, vigor and persistence. Promising materials will be selected for further testing and possible germplasm/cultivar release or used to generate a subsequent breeding cycle.
- Aditional collections of *S. grossulariifolia* and *S. munroana* will be made during the summer of 2005. These will be evaluated for the traits of interest. Promising germplasm will be used to augment the current breeding materials.

Basalt Milkvetch Collection and Evaluation (Johnson)

- During the summer of 2004, intensive efforts were again mounted to collect seed of basalt milkvetch. Supplemental seed collections were made from sites in a six-state area of the western U.S., where seed production or quality was poor in 2003. In addition, six seed collections were made in British Columbia, Canada to represent the furthest north extension of this species. This brings the total seed collections for basalt milkvetch to 83.
- Detailed passport data (latitude, longitude, elevation, slope, soils data, associated species, etc.) for each of the species was entered into Excel format to document each collection. Seed of each of the collections and accompanying passport data will eventually be entered into the U.S. National Plant Germplasm System.
- Soil samples from each of the basalt milkvetch sites for the 2003 seed collections were brought back to the lab, pooled with soils from all the sites, screened and homogenized, and added to greenhouse-grown seedlings. Fresh root nodules were harvested and sent by overnight mail to the Nitragin Company in Wisconsin. A total of six rhizobial strains were isolated from the nodules and will be tested in the greenhouse for their infectiveness and effectiveness at nitrogen fixation.
- Greenhouse-grown seedlings of each of 2003 collections of basalt milkvetch were transplanted in replicated common garden plots at two sites in northern Utah. Plants in the common gardens will be evaluated for their morphological, physiological, and ecological attributes during 2005-2006. Possible characteristics for evaluation include: seedling establishment, plant vigor, forage yield/quality, grazing tolerance, persistence, and seed yield.
- Forage samples from each of the new collections of basalt milkvetch made in 2004 were ground, extracted, and analyzed for toxic properties by Dr. Dale Gardner at the USDA-ARS Poisonous Plant Research Laboratory at Logan. As observed in 2003, amounts of nitrotoxins (3-nitropropanol), selenium, and swainsonine (compound that causes loco poisoning in animals and a product of a fungal-endophyte association) were either non-detectable or extremely low for all collections of basalt milkvetch. As a result, these collections do not appear to have any major livestock or wildlife toxicity problems.
- About 100 plants from each of the 83 basalt milkvetch accessions are currently being started in a greenhouse at Logan. Depending on the establishment of the 2003 common-garden plots, these plants will be used to establish common gardens to examine all collections of basalt milkvetch.
- Collaborations are continuing with Jim Cane at the USDA-ARS Bee Biology and Systematics Lab at Logan to study pollination and seed predation in basalt milkvetch. All 2004 seed collections were treated with pest strips after collection, and Jim examined

all collections for seed predator presence. True weevils and seed beetles were found in most samples and are currently being taxonomically verified.
- Seed from 30 collection sites was sent to Victor Vankus at the USDA-FS National Tree Seed Lab in Dry Branch, Georgia, to develop rules for testing seed of basalt milkvetch. This will aid in commercial marketing of basalt milkvetch seed.

Physiology and Ecology of Bluebunch Wheatgrass and Squirreltail (Monaco)

- Initial measurements of water relations, gas exchange, and 13C discrimination were made in 2004 on bluebunch wheatgrass and squirreltail. Plants established in a rain-out shelter were monitored for these variables in April, May and June to compare accessions exposed to soil-water availability gradients.
- Experiments were conducted in replicated plots to evaluate the relationship between plant defoliation, neighbor plant removal, and physiological response to these integrated plant stresses in an accession of bluebunch wheatgrass and squirreltail.
- A series of greenhouse experiments were initiated to evaluate the temporal variation in physiological mechanisms to cope with water limitation and competition with downy brome for select accessions of bluebunch wheatgrass, squirreltail, and Snake River wheatgrass accessions.

Products:

Fish Creek bottlebrush squirreltail germplasm
Toe Jam Creek bottlebrush squirreltail germplasm
White River Indian ricegrass germplasm
Star Lake Indian ricegrass germplasm

Publications:

Johnson, D. A., T. A. Jones, J. H. Cane, D. R. Gardner, and M. D. Peel. 2005. Basalt milkvetch and globemallows: North American forbs for rehabilitation, conservation, and forage production. Society for Range Management Annual Meeting, Fort Worth, TX. (abstract)

Jones, T. A., D. C. Nielson, S. L. Caicco, G. A. Fenchel, and S. A. Young. 2005. Registration of Star Lake Indian ricegrass germplasm. Crop Sci. 45 (accepted).

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 Sci. 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 Sci. 44:1880-1881.

Larson, S. R., T. A. Jones, and K. B. Jensen. 2004. Population structure of *Pseudoroegneria spicata* (Poaceae: Triticeae) modeled by Bayesian clustering of AFLP genotypes. Am. J. Bot. 1:1778-1800.

Larson, S.R. 2004. Phylogeography of bluebunch wheatgrass. *In* Proceedings, Intermountain Native Plant Summit III, Boise, ID. 2004. (abstract)

Thygerson, T., T. A. Monaco, and D. A. Johnson. 2005. Ecological significance of drought resistance in *Pseudoroegneria spicata* and *Elymus elymoides*. Society for Range Management Annual Meeting, Fort Worth, TX. (abstract)

Project Title: Pollinator and Seed Predator Studies

Project Location: USDA-ARS Bee Biology and Systematics Lab, Logan, UT

Principal Investigator: **Jim H. Cane,** Research Entomologist, USDA-ARS Bee Biology and Systematics Lab, Utah State University, Logan, UT 84322-5310, phone: 435.797.3879, fax: 435.797.0461 jcane@biology.usu.edu

Description of Project:

I expect native bees and/or honeybees are needed to pollinate most of the wildflower species considered for Great Basin rehabilitation. The pollinator faunas of many of these candidate plant genera include one or more bee genera with potentially manageable species. Pollinator needs are being evaluated by comparing fruit and seed sets at caged flowers, openly visited flowers, and manually pollinated flowers. If plant reproduction proves to be pollinator limited, then native bee faunas will be surveyed and evaluated at managed and wild flowering populations. If bees are sufficiently abundant, then single-visit pollination efficiencies at previously caged flowers can directly evidence each bee species' contribution to seed production. Concurrently, drilled wooden nesting blocks will be placed in these habitats to acquire captive populations of one or more promising cavity-nesting pollinators. Currently managed bee species (alfalfa leaf-cutting bees, blue orchard bees, alkali bees, honey bees) will be evaluated for their pollination prowess with each of the target plant species as well, probably using managed stands maintained by BLM and USFS collaborators on this proposal. Practical management protocols and materials will be developed to sustainably manage pollinators on-farm.

Status Report:

Preliminary systematic censuses of bees (as individuals per 100 flowering plants) were sampled at *Crepis acuminata, Lomatium dissectum, Lupinus argenteus,* and *Astragalus filipes*, with additional censuses at *Balsamorhiza sagittata* and *Hedysarum boreale*.

We now have planted out 20' x 20' plots (to fit our field pollination cages) with established 2-year-old plants of *Hedysarum boreale, Penstemon speciosus*, *Eriogonum umbellatum*, and *Dalea purpurea* (a surrogate for *D. ornata*), one-year-old plants of *Astragalus filipes*, and annual stands of *Cleome serrulata* and *C. lutea*. All but the *Cleome* are planted through melted holes in weed barrier fabric (the Aberdeen method), and will be used with captive populations of cavity-nesting bees from the 2004 trap nesting program.

Pollinators, particularly bees, will be needed for seed production at most of the native forbs chosen for this project from the Great Basin flora. In 2003, we found that autopollination rarely if ever yielded seed at *Hedysarum* or *Balsamorhiza* (the first such data for the tribes to which they belong). In 2004, painstaking manual pollinations of wee *Dalea purpurea* flowers revealed that autopollination yielded a meager 2% seed set, manual selfing resulted in 20% seed set, and outcrossing more than doubled selfing (45% seed set), the first such data for this large genus and its tribe, the Amorpheae. All of the matured seed had endosperm in our seed x-rays. Preliminary

data for both *Cleome serrulata* and *C. lutea* indicate that they will be largely self-fertile but benefit from insect visitation; their prodigious nectar production makes them highly attractive to bees, wasps and butterflies, so pollination should be easily accomplished.

In general, it appears that **bees are the essential pollinators** for the selected wildflower species. We found that **sweetvetch** hosts a rich diversity and abundance of bee species, including those of the genus *Osmia* (21 species and counting thus far), *Megachile* (*Delomegachile*), *Hoplitis* (3 spp), *Bombus* (bumblebees) and *Apis* (honeybees). Excepting honeybees (which sought only nectar), most of these carry pure loads of *Hedysarum* pollen (n=16 bees sampled), indicative of their fidelity and preference for this species in mixed meadows. Several of the more common species consistently contact the stigma with pollen-laden hairs on every floral visit, encouraging evidence for their pollination value. The widespread species *Megachile melanophaea* was found to be especially consistent in delivering pollen loads to sweetvetch stigmas in excess of the total ovules per flower; bumblebees were likewise effective. *Osmia, Hoplitis and Megachile* also contain some species that nest above-ground in cavities, and therefore have management potential. Bumblebees, though avid visitors too, are not practical to manage outdoors.

At Wind River Seed, we released a population of the blue orchard bee, *Osmia lignaria*, which fared well and provisioned exclusively with sweetvetch pollen (the sole legume host of this managed apple pollinator is redbud). The species pollination efficacy and sustainability will be evaluated this spring. At both Wind River Seed and two local plantings, we found several ground-nesting species of bees avidly working *Hedysarum* bloom and nesting in the field. Their numbers should only increase over the years at such plantings, so managed bees may only be needed as a bridge until wild faunas on farms become populous. This summer-flowering native plant's popularity with diverse native bees at our field sites also promises that revegetation with sweetvetch will feed many native bee species wherever it is used for rehabilitation of the summer montane fauna.

Our pollination experiments with this plant yielded mixed results. Clearly, no pods or seeds result from auto-pollination. Our careful attempts at manual pollination (self, cross, and wide outcross) yielded some pods (8-18% pod set) and seeds, but fell far short of the 51% pod set at freely visited flowers. We obtained an average of 28 good seeds per freely visited raceme of sweetvetch (2.6 seeds per pod). One likely hypothesis is that sweetvetch requires at least two visits, the first to break a pellicle that may cover the stigma, and the second to deliver pollen. This phenomenon has precedent with some other papillionaceous legumes. We will redouble our efforts at understanding sweetvetch breeding biology (particularly stigma receptivity), compare select bee species for single-visit pollen deposition on stigmas, and widen our survey of its pollinator fauna to include wild and managed populations in Wyoming. Pollination efficacy of the blue orchard bee also will be evaluated this spring, but in the greenhouse, and our ability to manage the species sustainably in sweetvetch will be evaluated in a field plot managed by Rick Dunne near Lanner, WY (despite snowfall on bloom upon our arrival). The species will only be useful for pollinating early-blooming populations, as overwintering bees cannot be held much past mid-May.

Systematic samples of bee faunas continue, targeting six floral hosts sampled at nineteen locations in five states. Species of the bee genus *Osmia* dominated faunas at *Hedysarum, A.*

filipes, Crepis, Lupinus and *Balsamorhiza*. I extended fieldwork with *A. filipes* this year, systematically sampling its bee faunas around the margins of its range in northeastern California, southcentral Idaho and eastern Nevada. It is relatively attractive to bees, including some of the same genera and species that visit the other legumes included in this project. There is promise that the same managed pollinator will be versatile enough to use on any of these three legumes. Snowfall in northeastern California just prior to bloom precluded pollination experiments there with *A. filipes*. Trap-nesting for its local bees there was also unsuccessful, owing to miscommunicated directions as to the location of the local host population. Trap-nesting of *Hedysarum* bees east of the Tetons amid patches of host was equally unsuccessful owing to their continuing drought.

We were again successful trap-nesting bees in the mountains of northern Utah (Bear River Range), where we placed drilled wooden nesting blocks and nesting stems for cavity-nesting bees at 15 sites across a wide elevation gradient this past summer, obtaining some of the bee species that are visiting flowers of our target forb species. Occupied straws have been pulled and x-rayed; representative individuals will be pulled for the arduous identifications in the coming few months, and matched to the faunas obtained at flowers.

From last year's trap-nested fauna, we evaluated three species of *Hoplitis* bees as manageable pollinators for *H. boreale*. In large field cages, they happily foraged at sweetvetch, provisioning nest cells with its pollen and producing progeny. Preliminary single-visit pollination experiments reveal that they are good pollinators. However, when not confined to a cage, emerging females were prone to disperse away from provided nesting materials. We successfully managed and increased populations of the native bee *Osmia californica* for pollinating wild stands of balsamroot, estimating that perhaps 300 females will be needed per acre for seed production. We also increased a managed population of *Osmia montana* on *Crepis*, which should therefore be the suitable pollinator for producing outcrossed seed on tapertip hawksbeard.

Recognizing the **need for practical, affordable nesting management systems** for any cavity-nesting bees used to pollinate these forbs on farms, I have designed and field tested a prototype nesting shelter to be used for drilled blocks or other nesting substrates. The shelter is versatile, made from the nesting plastic totes used by the US Post Office. The metal bracket system, which quickly attaches to a T-post, is made by a California manufacturer of grape arbor equipment. The entire unit should cost ca. $25 each and endure for five or more years. It is quick for a single person to deploy, and stores in stacks. For managing the bee *Osmia californica* to pollinate a field of balsamroot, which I trialed this year, two shelters per acre should house sufficient bees to do the job.

Native herbivorous insects have the potential to become pests of seed production on each of the wildflower species studied to date. Caterpillars of a gelechiid moth, *Filatima xanthuris,* uses silk to web together and devour flowering racemes and upper foliage of sweetvetch. The caterpillars drop from the plant to pupate in the soil. We found that infestations were persistent. Infested racemes rarely produced seeds, and at one site, 25% of racemes have been infested for two sequential years. Seed set at uninfested racemes of the same plants was unaffected. Left uncontrolled, this sweetvetch pest could therefore result in seed losses of at least 25%. It also infests lupine racemes. The species was previously unknown from *Hedysarum*.

Seed weevils were found to attack green pods of the legumes, their larvae developing in the individual drying seeds. Two species of seed weevil of the genus *Acanthoscelides* in the subfamily Bruchinae (Chrysomelidae) have now been found. Seeds of sweetvetch were attacked by *A. fraterculus*, a new host genus record for this species. From *Astragalus filipes* seed obtained this year, we identified *A. fraterculus* as well as another species, *Acanthoscelides pullus*, both new host records too. Developing seeds of *A. filipes* sampled at 30 locations in 4 states are also host to two species of true weevil in the genus *Tychius*, which were present at 95% of the locations. Seed sampled from 12 populations of *Dalea ornata* occasionally hosted *Acanthoscelides* (but a different species, *A. dalaea*, a new host record), but more commonly another weevil in the genus *Apion* that was widespread and predominant in samples (probably *A. amaurum*, a new host record for this *Dalea* specialist). This represents yet a third family of seed-feeding weevil for these legumes. In addition, a species of *Smicronyx* weevil was found infesting green seed of *Lomatium dissectum*.

Our primary focus will be on establishing life histories for these and other herbivorous species that attack buds, flowers and seeds (adults are needed for ID). We will evaluate their abilities to travel and reproductively cycle in dried seed. As needed, I will help Bob Hammon at Colorado State to develop practical, safe and effective means of avoiding, excluding or treating each of these insects for future use when these wildflowers are grown in row crop agriculture. Certainly, his recommendation of using small squares of Vapona no-pest strips in seed collecting bags was 100% effective in killing all stages of these beetles in hand-collected seed lots (up to a pound or two of seed per site).

Publications:

Cane, J.H. 2005. Pollination needs of arrowleaf balsamroot, *Balsamorhiza sagittata* (Heliantheae: Asteraceae)**.** Western North American Naturalist (in press).

Cane, J.H. 2005. Bees for seeds of rehabilitation forbs in the Great Basin. *In* Symposium on Fire Rehabilitation Management. Society for Range Management, Salt Lake City, UT. Invited (publ. abstract).

Cane, J.H. 2005. Bees and seed production for native plant restoration in wildlands. *In* Symposium on Bee health and management. Entomol. Soc. Amer., National meeting, Salt Lake City, UT. Invited (publ. abstract)

Project Title: Establishment and Maintenance of the Buy-Back Program for Certified Seed

Project Location: Utah Crop Improvement Association, Utah State University

Principle Investigators: **Stanford Young**, Utah Crop Improvement Association, Utah State University, Logan, UT 84322-4855, phone: 435.797.2082, fax: 435.797.3376, sayoung@mendel.usu.edu

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Project Description: This project is funded through a Memorandum of Understanding between the USFS-RMRS in Boise and the Utah Crop Improvement Association (UCIA), initiated in the fall of 2003 and renewed with additional funds in the fall of 2004. Seed was distributed using the Buy-back option, a mechanism for obtaining a portion of the seed increased by private growers back to the UCIA for redistribution to the original and additional seed growers for further seed increase.

Project Status: An explanation of the protocols and procedures of the Buy-back Program follows on the next two pages (dated February 24, 2005). This program encourages and allows seed growers to benefit economically in a more timely manner as an incentive to participate in the program. It will help accelerate the increase in stock seed supplies and ultimately increase seed supplies in the open market for commercial revegetation use. Tables 1 and 2 list forb and grass seed acquisitions, distributions, inventory and field planting status for species germplasm included in the UCIA Stock Seed Buy-back Program from 2002-2004. Forb species included in the program to date include: *Achillea millefolium* (western yarrow; Eagle germplasm), *Balsamorhiza hookeri* (Hooker balsamroot), *Crepis acuminata* (tapertip hawksbeard), *Lomatium dissectum* (giant lomatium), *L. triternatum* (ternate lomatium), *Penstemon acuminatus* (sharpleaf penstemon), *P. cyaneus* (blue penstemon), *P. deustus* (hotrock penstemon), *P. pachyphyllus* (thickleaf penstemon), *Sphaeralcea grossulariifolia* (gooseberryleaf globemallow), *S. parvifolia* (Nelson globemallow), and *Tragopogon dubius* (yellow salsify). Grasses included in the program to date include: *Achnatherum hymenoides* (Indian ricegrass; Star Lake germplasm), *Elymus elymoides* ssp. *californicus* (bottlebrush squirreltail; Toe Jam Creek germplasm), *E. elymoides* ssp. *elymoides* (bottlebrush squirreltail; Fish Creek germplasm), *E. multisetus* (big squirreltail; Sand Hollow germplasm), *Nassella viridula* (green needlegrass; Cucharas germplasm), (*Poa secunda* (Sandberg bluegrass; Mountain Home germplasm), and *Pseudoroegneria spicata* (bluebunch wheatgrass; P7 and Anatone germplasms).

Presentation:

Young, S.; DeBolt, A.; Lowry, G.H. 2005. Native plant source-identified stock seed increase. In: Abstracts: Society for Range Management 58th Annual Meeting. Fort Worth, TX. Abstract 386.

Great Basin Native Plant Selection and Increase Project (GBNPSIP)

Utah Crop Improvement Association (UCIA) Stock Seed Buy-back Program

February 24, 2005 Update

This program update encourages and allows seed growers to benefit economically in a more timely manner as an incentive to participate in the UCIA Stock Seed Buy-back Program. The program will help accelerate the increase in stock seed supplies and ultimately increase seed supplies on the open market.

The purpose of the UCIA Stock Seed Buy-back Program, funded through the GBNPSIP, is: 1) to facilitate development of a seed market for formal germplasm releases developed through the GBNPSIP prior to 2003; 2) to reward initial seed growers financially for the risks they have assumed to participate in the program; 3) to document germplasm identity through the seed increase process by utilizing seed certification protocols; and 4) to increase stock seed available for potential secondary seed growers. This program is administered through the Utah Crop Improvement Association.

The mechanisms for purchasing stock seed from growers and redistributing it for further increase are as follows:

1. Utah Crop Improvement Association (UCIA) offers for free or for sale (depending on seed generation and availability) stock seed to seed growers.
2. After harvest of the first seed production year, the grower will be required to return to the UCIA (for inventory reserve) up to twice the original amount of stock seed he/she received. More may be returned if mutually negotiated. The grower will be compensated 125% of the standardized market price (SMP, see Table A) for all seed returned to UCIA. SMP will be updated as needed.
3. UCIA may negotiate to buy all or part of the seed from any subsequent years of seed production back from seed grower at 125% SMP.
4. UCIA offers the grower the option to immediately buy back the seed sold to the UCIA (except for the inventory reserve) at 100% SMP. The grower thus realizes an immediate 25% premium incentive to expand plantings and remain in the program. This seed must be planted for seed production and entered into the local seed certification program either by original seed grower or another seed grower recruited by the original seed grower. If this seed is instead sold commercially, the UCIA reserves the right to recover the 25% premium paid for the seed.
5. All seed offered to the UCIA, bought, or sold shall be certified or certified eligible.
6. UCIA agrees to pay for shipping and seed analysis costs. Seed purchasing, shipping, and seed analysis costs are to be reimbursed to the UCIA through GBNPSIP program funds.
7. If seed is unconditioned when purchased by the UCIA, the seed grower may be charged for conditioning costs, or in certain circumstances these costs may be paid by the UCIA and reimbursed by the GBNPSIP.

Notes:

1. Seed quantity and quality (lbs PLS) of original stock seed provided to the seed grower will be determined on a case by case basis in order to determine the amount of seed that must be returned to the UCIA from the first harvestable crop by the seed grower.
2. When the original seed grower sells to the UCIA and/or buys back seed (as in points 3 and 4 above) the amount of seed (lbs PLS) will typically be verified through the applicable state seed certification agency. Some instances may require special negotiation.

Table A. Standardized Market Price (SMP) list example. This table includes seed distributed to growers by Great Basin Native Plant Selection and Increase Project cooperators (UCIA Stock Seed Buy-back Program) in the fall of 2002.

Common Name	Scientific Name		2003 SMP
Hooker's balsamroot	*Balsamorhiza hookeri*	$	40.00
Tapertip hawksbeard	*Crepis acuminata*	$	140.00
Giant lomatium	*Lomatium dissectum*	$	40.00
Ternate lomatium	*Lomatium triternatum*	$	40.00
Sharpleaf penstemon	*Penstemon acuminatus*	$	40.00
Blue penstemon	*Penstemon cyaneus*	$	40.00
Hot-rock penstemon	*Penstemon deustus*	$	40.00
Thickleaf penstemon	*Penstemon pachyphyllus*	$	35.00
Nelson globemallow	*Sphaeralcea parvifolia*	$	80.00
Gooseberryleaf globemallow	*Sphaeralcea grossulariifolia*	$	80.00
Yellow salsify	*Tragopogon dubius*	$	30.00

Note: Other species will be added as appropriate for subsequent years' distribution.

Table 1. Utah Crop Improvement Association (UCIA) forb seed acquisition, distribution inventory, and field planting status for species germplasms included in the Great Basin Native Plant Selection and Increase Project, UCIA Stock Seed Buy-back Program.

Kind & Variety/Germplasm	Lot/Source	Seed acquisition & production status	Generation	Added to Inventory	Date	Distributed from Inventory	Date	Inventory 12/31/2004
FORBS				**bulk**		**bulk**		**bulk**
Achillea millefolium Western Yarrow Eagle Germplasm	NSW4-1-EMY1-1	*3	G2	5 lbs	11/10/04	0		5 lbs
Balsamoriza hookeri Hooker Balsamroot	BAHO B1-02	*1*2	G0	271g	Fall 2002	271 g	Fall 2002	0
Crepis acuminata Tapertip Hawksbeard	CRAC U11-02	*1*2	G0	50 g	Fall 2002	50 g	Fall 2002	0
Lomatium dissectum Giant Lomatium	LODI B7-02 LODI B14-02 LODI PS-04	*1*2 *1*2 *3	G0 G0 G1	39 g 96 g 60 g	Fall 2002 Fall 2002 11/30/04	39 g 96 g 0	Fall 2002 Fall 2002	0 0 60 g
Lomatium triternatum Ternate Lomatium	LOTRT B2-02	*1*2	G0	446 g	Fall 2002	446 g	Fall 2002	0
Penstemon acuminatus Sharpleaf Penstemon	PEAC2 B4-02 PEAC2 B1-01	*1*2 *1*2	G0 G0	102 g 37 g	Fall 2002 Fall 2002	102 g 37 g	Fall 2002 Fall 2002	0 0
Penstemon cyaneus Blue Penstemon	PECY2 B6-02 PPI-04-1	*1*2 *3	G0 G1	968 g 3 lbs	Fall 2002 1/6/05	968 g 0	Fall 2002	0 3 lbs
Penstemon deustus	PEDE B11-02	*1*2	G0	150 g	Fall 2002	150 g	Fall 2002	0

Hotrock Penstemon	PEDE B10-02	*1*2	G0	123 g	Fall 2002	123 g	Fall 2002	0
Penstemon pachyphyllus	PEPA2 U6-99	*1*2	G0	1020 g	Fall 2002	1020 g	Fall 2002	0
Thickleaf Penstemon	PEPA PS-04	*3	G1	345 g	11/30/04	0		345 g
Sphaeralcea grossulariifolia	SPGR U19-02	*1*2	G0	150 g	Fall 2002	150 g	Fall 2002	0
Gooseberryleaf Globemallow	SPGR PS-04	*3	G1	130 g	11/30/04	0		130 g
	SPGR U13-01	*1*2	G0	150 g	Fall 2002	150 g	Fall 2002	0
Sphlaeralcea parvifolia	SPPA U14-02	*1*2	G0	150 g	Fall 2002	150 g	Fall 2002	0
Nelson Globemallow	S04-2-4	*3	G1	1.44 lbs	8/19/04	0		1.44 lbs
Tragopogon dubius	TRDU U2-02	*2	G0	5.44 lbs	Fall 2002	5.44 lbs	Fall 2002	0
Yellow Salsify	TRDU DW-04	*3	G1	201 g	9/15/04	0		201 g
			subtotal	23.69 lbs		13.29 lbs		10.3 lbs

Table 2. Utah Crop Improvement Association (UCIA) grass seed acquisition, distribution inventory, and field planting status for species germplasms included in the Great Basin Native Plant Selection and Increase Project, UCIA Stock Seed Buy-back Program.

Kind & Variety/Germplasm	Lot/ Source	Seed acquisition & production status	Generation	Added to Inventory	Date	Distributed from Inventory	Date	Inventory 12/31/2004
GRASS				**bulk lbs**		**bulk lbs**		**bulk lbs**
Bluebunch Wheatgrass								
P7 Germplasm	BB-3207, UCIA 84	*2	G4	450.0	10/15/03	0.00		450.0
Anatone Germplasm	JA-03, UCIA 44	*3	G2	300.0	3/4/04	300.0	3/17/04	0
Green Needlegrass								
Cucharas Germplasm	2000	*2		10.8	2/5/02	0.0		10.8
	2001	*2		9.2	2/5/02	0.0		9.2

Indian Ricegrass								
Star lake Germplasm	GV LOW, ARS 14	*1*2	G2	5.0	3/15/04	5.0	4/14/04	0
	GV MED	*1*2	G2	4.0	10/19/04	0.0		4.0
Sandberg Bluegrass								
Mountain Home Germplasm	557-215-31A	*3	G2	304.0		254.2		49.8
Squirreltail (Bottlebrush)								
Sand Hollow Germplasm	SH ET-02	*2	G2	25.4	11/15/02	0.0		25.4
Toe Jam Creek Germplasm	2001-02	*1*2	G3	5.8	11/30/02	5.8	8/31/03	0
	LHS1B2G-335	*3	G4	40.0	11/12/04	0.0		40.0
Fish Creek Germplasm	1999-2002	*1*2	G3	4.8	11/30/02	4.8	8/31/03	0
	LHS1B2H-335	*3	G4	47.0	11/12/04	0.0		47.0
			subtotal	1206.0		569.8		636.2
			Total	1229.7		583.1		646.5

*1 Currently under Stock Seed Increase contract with grower/cooperators
*2 Seed acquired at no charge from GBRI Cooperators
*3 Cost of seed reimbursed to UCIA through USFS joint venture Buy-back Program agreement.

Project Title: The AOSCA Cooperative Native Seed Increase Program

Project Location: Idaho, Nevada, Utah, Oregon, Washington

Principal Investigators: **Ann DeBolt,** Botanist, USDA-FS-RMRS-Boise, 316 E. Myrtle, Boise, ID 83702, phone: 208.373.4366, fax: 208.373.4391, adebolt@fs.fed.us

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Project Description: In May 2003, Greg Lowry, AOSCA executive vice president, invited the Great Basin Native Plant Selection and Increase Project to submit a proposal to work through that national organization towards the development of a multi-state approach for increasing native forb seed supplies for Great Basin restoration. The program involves distribution of wildland collected seed to growers via the Foundation Seed Programs of states producing seed for the Great Basin (Idaho, Nevada, Oregon, Utah, Washington, and surrounding areas). The emphasis is generally on species not on the research species list (though several research species have been included to attempt to "jump-start" their availability), but on other species of interest to BLM Districts in the Great Basin. In November 2003, RMRS and AOSCA drafted and signed an agreement implementing this program.

Project Status: The first seed lots were distributed in March 2004, with additional lots distributed in late summer. A total of 14 lots representing 11 species have been distributed to 8 growers in 5 states. The table below lists species, accession data, and state to which the seed lots were distributed.

Program Manager Name & State	Species	Lot Number	Seed Origin	Weight (g)	Distribution Date
Kathy Stewart-Williams (ID)	Thurber needlegrass	ACHTHU2-BSE-03	NV	13.6	August 2004
	Sulfur buckwheat	ERUM U9-03	NV	99	
	Sagebrush penstemon	PENSPE9A-BSE-03	OR	212	
Gary Cross (NV)	Yellow beeplant	CLLU U1-01	NV	300	August 2004
	Oval-leaf buckwheat	EROV U9-02	NV	10	
Stanford Young (UT)	Arrowleaf balsamroot	BASA U32-02	NV	735	March 2004
	Tapertip hawksbeard	CRAC U10-01	NV	110	
	Wyeth buckwheat	ERIHER1-BSE-03	ID	43	
	Fernleaf biscuitroot	LOMDIS18-BSE-03	ID	488	
	Fernleaf biscuitroot	LODI 11-B7-03	OR	91	
	Sagebrush penstemon	PENSPE1-BSE-03	ID	92	
Lee Schweitzer (OR)	Arrowleaf balsamroot	BalSag55-BSE-04	OR	390	September 2004
	Munro globemallow	SphMun3-BSE-04	OR	45.2	
Jerry Robinson (WA)	Royal penstemon	Pecy1-B6-02	ID	300	October 2004

2004 Products:
- Program coordination meeting with BLM, USFS-RMRS, the AOSCA Executive Vice President, Idaho Foundation Seed Program manager, and 2 seed producers (February 4, 2004).

- Presentation:
Young, S.; DeBolt, A.; Lowry, G.H. 2005. Native plant source-identified stock seed increase. In: Abstracts: Society for Range Management 58th Annual Meeting. Fort Worth, TX. Abstract 386.

2005 Work Plans: Additional species' seed lots will be collected this year. Species of potential interest include *Machaeranthera canescens* (hoary aster), *Eriogonum microthecum* (slenderleaf buckwheat), *Crepis occidentalis* (western hawksbeard), *Chaenactis douglasii* (Douglas false-yarrow), *Erigeron pumilus* (shaggy fleabane), and *Trifolium macrocephalum* (bighead clover). Seed will be cleaned, tested and source identified prior to distribution to state foundation seed program managers.

A program coordination meeting will be held in April with participants from BLM, RMRS, the new AOSCA Executive Vice President, and at least two state foundation seed managers.

Additional information about the program will be added to the USFS RMRS web site.

Project Title: Establishment and Maintenance of Certified Generation 1 (G1) Seed

Project Location: NRCS Aberdeen, ID Plant Materials Center

Principal Investigators: **Loren St. John**, Center Manager, USDA-NRCS Aberdeen Plant Materials Center, P.O. Box 296, Aberdeen, ID 83210, phone: 208.397.4133, Loren.Stjohn@id.usda.gov

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Description of Project: Production of Certified Generation 1 (G1) seed of Maple Grove Germplasm Lewis flax; Anatone Germplasm bluebunch wheatgrass; Snake River Plains Germplasm fourwing saltbush; and Northern Cold Desert Germplasm winterfat; to facilitate commercial seed production. Evaluate procedures for production of rooted cuttings of fourwing saltbush. Establish demonstration planting near Boise, ID.

Status Report:

Seed Production

Maple Grove Germplasm Lewis Flax – Officially released July 22, 2004. Seeded 1.8 acre field on May 31, 2002. Produced 615 pounds of seed in 2003. Shipped 240 pounds of Certified seed to commercial seed growers in 2004. Due to windstorm after swathing in 2004, only 30 pounds of seed was salvaged. Seed field plowed due to weed competition. New seed field to be established spring, 2005.

Anatone Germplasm bluebunch wheatgrass – Released officially March 5, 2004. Seeded 1.0 acre field on May 31, 2002. Produced 240 pounds of seed in 2003. Shipped 20 pounds of Certified seed to commercial seed growers in 2004. Produced 472 pounds in 2004 (seed analysis pending). New seed field (2.4 acres) established in May 2004.

Snake River Plains Germplasm fourwing saltbush – Produced 45 pounds of seed in 2003 and 2004. Shipped 2 pounds of Certified seed to commercial growers in 2004.

Northern Cold Desert Germplasm winterfat - Produced 15 pounds of seed in 2003 and 10 pounds in 2004. Shipped 8 pounds of Certified seed to commercial growers in 2004.

Propagation Studies

Propagation of rooted fourwing saltbush from cuttings:

On August 12, 2004 cuttings were taken from mature fourwing saltbush (*Atriplex canescens*) Snake River Plains Germplasm at the Aberdeen Plant Materials Center home farm. Cuttings were made with the base approximately 1/8-3/16" diameter. Cuttings were placed in 5 gallon

buckets lined with wet burlap sacs to prevent drying, and transported to the greenhouse for trimming. Field cuttings were trimmed to approximately 7 inches long and all leaves and shoots were removed except the apical shoot. Cuttings were then dipped in Rootone® rooting hormone with fungicide and placed in 40 cubic inch conetainers filled with a 1:1:1 soil mixture of peat, sand and perlite. Each conetainer contained two cuttings. Total elapsed time between cutting in the field and planting into soil was under 2 hours. Containers were then soaked manually with a hose and garden mist nozzle to field capacity. Planted cuttings were left in the headhouse overnight before moving into greenhouse.

Plants were maintained in the PMC greenhouse between 70 and 85 degrees F. Supplementary lighting was employed from 1900 to 2300 daily.

The trial was divided into two treatments involving different watering regimes. The first treatment, called hereafter traditional, was a watering schedule of 30 minutes of overhead spray on Tuesday and 60 minutes on Thursday of each week. The second treatment, misting, involved repeated mistings of 15 seconds every 20 minutes during the warm portions of the day (0700 to 2300).

Survival 9/27/04 (cutting + 6 weeks)

Misting resulted in an overall survival of 52 percent versus 13 percent survival for the cuttings under traditional irrigation.

MIST	Survival	%	TRADITIONAL	Survival	%
♀	32/38	84	♀	0/40	0
♀	22/40	55	♀	12/40	30
♀	22/40	55	♀	8/40	20
♀	15/40	38	♀	0/40	0
♂	12/40	30	♂	5/40	13
TOTAL	103/198	52		25/200	13

Greenhouse seedling establishment study: The objective is to evaluate fourwing saltbush seedling emergence based upon number of propagules planted per cell (5 versus 10 per cell) and to identify the number of days to emergence, growth rates and transplant dates. As reported in 2002, 75 percent of the seedlings had red stems and 25 percent had white stems at the time of transplanting. The question arose as to whether or not this phenological difference could be an indication of the sex of the plant. Plants are being maintained in the field to determine if this is possible.

Establishment of Demonstration Planting near Boise

The BLM burned a 1-acre site at the Orchard Research Area in fall of 2002. The site was sprayed by the PMC in May of 2003 and 2004 with Roundup and 2,4-D at 64 oz and 16 oz. per acre, respectively. Excellent kill was achieved. Due to limited breakdown of dead grass clumps that would inhibit proper seed placement with the drill and to ensure a clean seedbed, the

decision was made to lightly cultivate the site with a culti-packer the day before seeding. The demonstration planting was seeded November 16, 2004. There are 82 accessions of 27 native and introduced grass, forb and shrub species planted in 7 x 60 foot plots. Plots will be evaluated in 2005 to document establishment and plant performance. A plot map and description of the accessions planted were developed as a self-guided tour of the demonstration nursery. They are provided in Appendix 2.

Project Titles: - Seed Collecting Practices and Shrub Manipulations to Improve Sustainable Seed Yield in Wildland Shrub Stands
- Crested Wheatgrass Diversification
- Heat Accumulation Study
- Forb Production Cultural Practices

Project Location: Brigham Young University, Provo, UT

Principal Investigators: **Bruce Roundy,** Professor, Department of Integrative Biology**,** Brigham Young University, 495 WIDB, Provo, UT 84602, phone: 801.422.8137, bruce_roundy@byu.edu

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Seed Collecting Practices and Shrub Manipulations to Improve Sustainable Seed Yield in Wildland Shrub Stands

The schedule of proposed work in 2004 was delayed because of the slower than anticipated funding process that didn't make funds available until mid-July. Added to this was a labored process of obtaining clearances before enclosures could be constructed and treatments effected. Nonethless, we were successful in 2004 to get clearances on sites in Utah (Utah State Lands), Nevada (USFS) and Idaho (BLM) where bitterbrush and Wyoming big sagebrush were growing in relatively close proximity (see attached maps). Work began on sites the last 2 weeks in August and continued on weekends through fall semester as weather permitted with student crews. Unfortunately, bitterbrush seed had shattered by the time sites were approved and we missed the seed collection treatment window. Sagebrush seed collection, however, was completed at all sites in the fall of 2004.

In Nevada, the 1 acre enclosures were erected at both sites and vegetation clearing, shrub pruning and fertilizer application was completed on the bitterbrush site. Except for pruning, all other treatments were completed on the sagebrush site. This treatment will occur in February 2005.

In Idaho, enclosures at both sites were constructed and all treatments were completed on the sagebrush site. On the bitterbrush site, vegetation was cleared but pruning and fertilization treatments will be completed in February 2005.

On the Utah sites, all treatments for both species were completed, however the enclosures are only partially complete with most of the posts in place. The netting can't be installed until it is dry enough to get equipment back on the site (probably April).

This project will be back on the proposed schedule by May 2005 except for the bitterbrush seed collection.

Crested Wheatgrass Diversification Study

Two study sites in Utah were selected in early fall of 2004 by Bruce Roundy and BLM officials. We have been working with BLM officials since that time to obtain the required archeological and wildlife clearances, but have not yet been approved for fence construction. This project should be on schedule for fence building and baseline inventories in summer 2005 with treatments occurring in fall 2005.

Heat Accumulation Study

The heat accumulation study is underway using less sensitive and more available species to develop the model. Once a working model is in place and seed for the targeted forb species is readily available, the target forbs will be subjected to the model.

Forb Production Cultural Practices

Wildland Collections

In 2004, part of our responsibility was to make wildland collections of some of our forb research species. This was required because of low seed availability from seed collected in earlier years. Scott Jensen identified populations of the various forbs and tasked us with the collection. We collected *Phlox longifolia* and *Agoseris glauca* from Santaquin Canyon, UT, *Crepis acuminata* from just north of Winnemucca, NV, *Eriogonum ovalifolium* from north of Wendover, NV, and *Sphaeralcea coccinea* and *S. grossulariifolia* from Cedar Valley, UT.

Herbicide Tolerance Evaluation

Even though seed availability remained low during 2004, herbicide trials were conducted for four species that were either not tested the previous year or not completely tested. Those species include: *Agoseris glauca, Eriogonum ovalifolium, Crepis acuminata,* and *Sphaeralcea munroana.*

Seedling emergence was conducted on all four species with preliminary results generalized as follows:

Agoseris glauca – least sensitive to Plateau

Eriogonum ovalifolium – least sensitive to Prowl; overall low germination requires repeat
Crepis acuminata - overall low germination requires repeat
Sphaeralcea munroana – least sensitive to Buctril

The effect of herbicides on seedlings was evaluated for *A. glauca and S. munroana.* Preliminary results are as follows:

Agoseris glauca – equally resistant to Plateau, Prowl, and Pursuit at all rates.
Sphaeralcea munroana – equally resistant to Buctril, Prowl, and Pursuit at all rates, and Plateau at medium and low rates.

A second year of data for these species will be collected during spring 2005, as well as imposing 5 new herbicides on the forb species under investigation. Except for *Eriogonum ovalifolium*, we were able to wild collect or harvest adequate seed to accomplish the 2005 objectives.

Seeding Depth Evaluation

A second year of seeding depth trials was conducted during 2004. Depth trials were conducted from both sandy-loam and clay-loam soils (Figures 1 and 2 below).

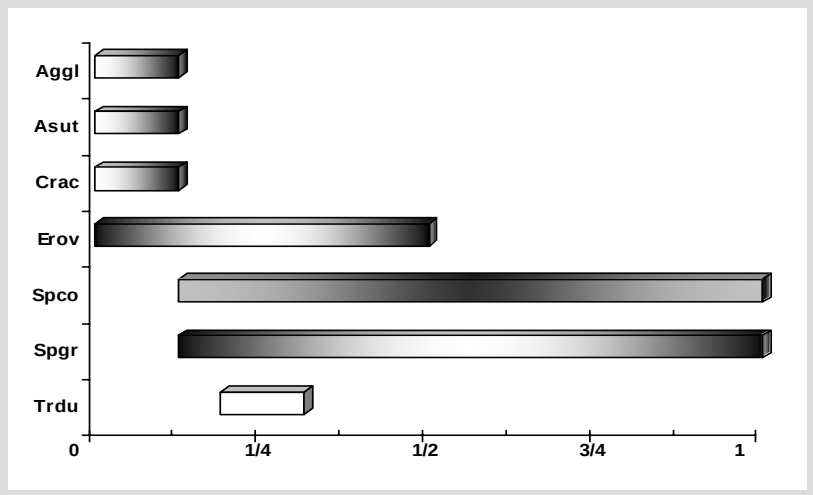

Figure 1. Optimum seeding depth for sandy loam soil

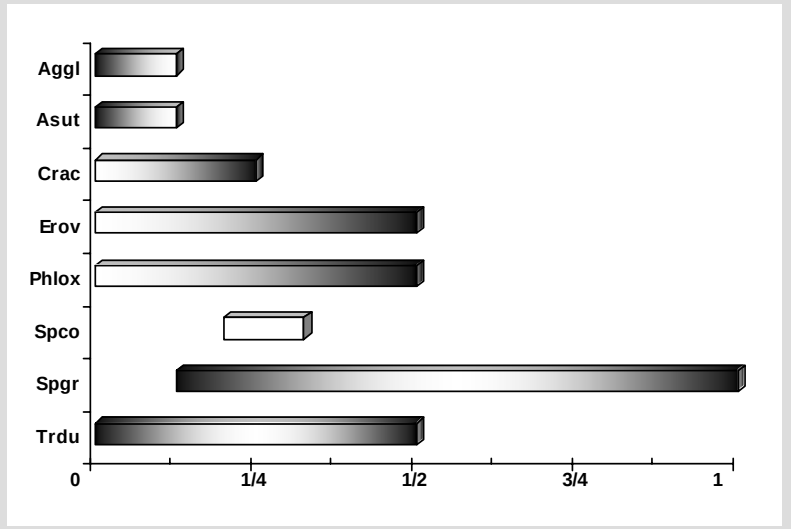

Figure 2. Optimum seeding depth for clay loam soil

Cultural Requirements for Eight Native Forbs

Plants were replanted in spring of 2004 to ensure a balanced design with all species in all treatments the same age. Inadequate plant availability the previous year necessitated replanting. During the first season, four of the eight species flowered and produced seed. Seed was harvested and analyzed for yield. Yield results are summarized below:

Sphaeralcea munroana
Peak production: mid August
Order of seed production/plant by spacing (greatest to least): 18", 12", 6"
Order of seed production/acre by treatment (greatest to least): plastic mulch, no mulch, fabric mulch, paper mulch.

Sphaeralcea grossulariifolia
Peak production: mid August
Order of seed production/plant by spacing (greatest to least): 18", 12", 6"
Order of seed production/acre by treatment (greatest to least): plastic mulch, fabric mulch, no mulch, paper mulch.

Sphaeralcea coccinea
Peak production: early-mid September
Order of seed production/plant by spacing (greatest to least): 12", 6"
Order of seed production/acre by treatment (greatest to least): fabric mulch, plastic mulch, no mulch.

Tragopogon dubius
Peak production: mid August
Order of seed production/plant by spacing (greatest to least): 18", 12", 6"
Order of seed production/acre by treatment (greatest to least): plastic mulch, paper mulch, no mulch, fabric mulch.

Tragopogon dubius performed as an annual so will no longer be evaluated. The other species should reach their maximum performance during 2005. Seed will again be collected and evaluated. The species that did not produce seed in 2004 are expected to do so in 2005. The irrigation system which was laid out on the ground surface will require repair due to exposure to the elements.

Evaluation of Drill Seeding Rates

To date, seed availability has precluded implementation of this study. For some species, sufficient seed was collected in 2004 or harvested from plots to implement the study. Adequate seed of the two *Sphaeralcea* species, *Tragopogon,* and *Crepis acuminata* have been procured. Seed shortages still include *Phlox longifolia*, *Eriogonum ovalifolium*, *Agoseris glauca*, and *Astragalus utahensis.*

Presentations/Published Abstracts:

Armstrong, J.C., R.L. Johnson and V.J. Anderson. 2005. Environmentally induced dormancy in *Bromus tectorum*. Presented at the Society for Range Management annual meeting, Abstract #9, Fort Worth, TX.

Coleman, J.K., V.J. Anderson and R.L. Johnson. 2005. The effect of seeding depth and soil type on emergence and seedling vigor of 8 forbs. Presented at the Society for Range Management annual meeting, Abstract # 60, Fort Worth, TX.

Johnson, R.L., V.J. Anderson and B.A. Roundy. 2005. Investigations into cultural practices to raise native forbs. Presented at the Society for Range Management annual meeting, Abstract #182, Fort Worth, TX.

Roberts, F.L., V.J. Anderson and R.L. Johnson. 2005. The effect of seven herbicides on eight native rangeland forbs in greenhouse trials. Presented at the Society for Range Management annual meeting, Abstract # 287, Fort Worth, TX.

Johnson, R.L. and V.J. Anderson. 2004. Native plant research for restoration application. Presented at the Intermountain Native Plant Summit III. Boise, ID.

Krebs, T., V.J. Anderson and R.L. Johnson. 2004. The effect of seeding depth and soil type on emergence and seedling vigor of 6 forbs. Presented at the Society for Range Management annual meeting, Abstract pg. 96, Salt Lake City, UT.

Marchant, L.H., V.J. Anderson and R.L. Johnson. 2004. Seedling response of several native forbs to varied rates of 7 herbicides. Presented at the Society for Range Management annual meeting, Abstract pg. 110, Salt Lake City, UT.

Voss, J.C., V.J. Anderson and R.L. Johnson. 2004. Response of established plants of native forbs to varied rates of 7 herbicides. Presented at the Society for Range Management annual meeting, Abstract pg. 179, Salt Lake City, UT.

Project Title: Development of Germination Protocols, Seed Weight, Purity, and Seed Conditioning/Cleaning Protocols for Great Basin Grasses and Forbs

Project Location: USDA-FS National Tree Seed Laboratory, Dry Branch, GA

Principal Investigators: Robert Karrfalt, Director, USDA-FS National Tree Seed Laboratory, 5675 Riggins Mill Road, Dry Branch, GA 31020, phone: 478.751.3551, rkarrfalt@fs.fed.us

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Project Description:

The National Tree Seed Laboratory is collaborating with other members of the Great Basin Native Plant Selection and Increase Project to develop seed testing protocols for research species. This includes determination of AOSA minimum purity weight recommendations and protocols for germination and purity determinations. This work is essential for eventual development of AOSA rules if seeds are marketed in multiple states. Seed test results are important to buyers and sellers for product labeling, to growers for plant production and to seed control officials for enforcement of state and federal seed laws. Seed testing rules for these species will be necessary as their seed enters the marketplace.

Species and number of collections received from cooperators to date include: *Astragalus filipes* 30*, Crepis acuminata* 3*, Eriogonum umbellatum* 22, *Lomatium dissectum* 13, *Lomatium grayi* 5, *Lomatium triternatum* 5, *Penstemon acuminatus* 15, *Penstemon deustus* 21, and *Penstemon speciosus* 8.

We are conducting seed counts to determine purity and seed weight. Germination trials are being designed using recommendations provided by the cooperator, or literature on the species or a related species. Germination trials are generally conducted with or without light, with or without a prechill, and at two temperatures.

Project Status:
Results are being posted on our website (http://www.ntsl.fs.fed.us/great_basin_native_plants.html). Germination or other testing data or protocols developed by members of the Great Basin Native Plant Selection and Increase Project can also be posted on this site. This provides a means of communicating with their users, and with seed laboratories that are members of the AOSA Tree, Shrub, and Native Forb Committee (TSNF) (this includes the state seed laboratories in Utah, Idaho, and Oregon as well as private laboratories). Data will also be submitted to the AOSA reference base "Suggested purity and /or germination procedures for species without AOSA testing rules" (http://www.aosaseed.com/reference.html). Successful, duplicated germination methods will be submitted to AOSA for inclusion in the AOSA reference base. As greater quantities of seed

become available for a particular species, ring tests can be conducted between a few AOSA and research laboratories. Rule proposals developed and submitted to AOSA will be based on this ring test data.

The NTSL will communicate with the other AOSA seed testing laboratories to share information and to request feedback on our germination trials. Information on our purity and germination trials will be submitted to the AOSA reference base later this spring. The AOSA TSNF group will also discuss this work at our June 2005 meeting.

Project Title: Insect Pests of Selected Grass and Forb Species in the Great Basin

Project Location: Colorado State University Cooperative Extension, Tri-River Area, Grand Junction, CO

Principal Investigators: **Robert Hammon**, Extension Agent, Colorado State University Cooperative Extension, Tri-River Area, P.O. Box 20,000-5028, Grand Junction CO 81502-5028, phone: 970.244.1834, fax: 970.244.1700, bhammon@co.mesa.co.us

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Project Description: Insects attacking native plants are still relatively poorly known unless the plant species is exploited for some economic use. When plants are utilized for new purposes, native insects become important and, in some instances, must be controlled for various reasons. Insect identification and life history must be known before management techniques can be developed. This project is designed to identify and learn life histories of insects affecting collected and field-grown seed of plant species of interest. General insect sampling from seed collection sites were conducted with sweep nets and visual surveys. Several seed predators were reared from infested seed. Samples were photographed before storage for future reference and educational programs. Specimens were forwarded to taxonomic specialists for identification when necessary. Voucher specimens are currently stored at the Tri River Cooperative Extension Office in Grand Junction, CO, the USDA-ARS Bee Biology and Systematics Lab in Logan UT, or with the taxonomist responsible for identification of the particular taxa.

Project Status: A summary of insect pests collected from wildland sites and field plantings, as well as those mentioned in the scientific literature, is provided in Table 1. Seed feeding weevils in the families Curculionidae, Brentidae or Bruchidae were found on all legume species sampled, and were widely distributed geographically. It appears that these seed feeding beetles could be significant pests capable of destroying entire seed crops if not managed. Nine species of seed attacking beetles were identified from the Project on four species of legumes (*Lupinus argenteus, Hedysarum boreale, Astragalus filipes, Dalea ornata*) in 2004. Several more species are mentioned in the scientific literature, and there are certainly many more that have not yet been identified in the Great Basin. Fruit flies (Diptera: Tephritidae) were found on both composite species (*Balsamorhiza sagitatta* and *Crepis acuminata*), and the damage potential appears to be significant. Seed feeding weevils and several species of defoliators were collected from *Lomatium dissectum.*

Future research efforts will focus on continuing identification of insects attacking plant species of interest, and evaluation of techniques regarding their management. A listing of pesticides (insecticides, herbicides, fungicides) currently registered for seed production has been developed and is available at: http://www.coopext.colostate.edu/TRA/SeedProduction.html. This

list will be updated at regular intervals as more registrations are discovered. Communications are ongoing with pesticide manufacturers to develop labeling for "forbs grown for seed", since there are no pesticides currently labeled for that use.

Table 1. Insects and diseases found or reported on plant species of interest. References in bold were found in conjunction with Project seed collection. References in normal type are from the scientific literature.

Plant species	**Pest**	**Order:Family**	**Attacks:**	**Reference**
Astragalus sp.	*Cleonidius trivittatus*	Coleoptera:Curculionidae	Root/crown	Pomerinke & Thompson 1995
Astragalus sp.	Seed feeding caterpillar	Lepidoptera: Tortricidae	Seeds	Youtie & Miller 1986
Astragalus sp.	Seed feeding caterpillar	Lepidoptera: Pyralidae	Seeds	Youtie & Miller 1986
Astragalus sp.	*Acanthoscelides aureolus*	Coleoptera: Bruchidae	Seeds	Owen 1993
Astragalus sp.	*Tychius* sp.	Coleoptera: Curculionidae	flower/fruit	Kaye 1999
Astragalus filipes	*Acanthoscelides* sp	Coleoptera: Bruchidae	Seeds	**Cane & Johnson 2004**
Astragalus filipes	*Acanthoscelides pullus*	Coleoptera: Bruchidae	Seeds	**Cane & Johnson 2004**
Astragalus filipes	*Acanthoscelides fraterculus*	Coleoptera: Bruchidae	Seeds	**Cane & Johnson 2004**
Astragalus filipes	*Acanthoscelides aureolus*	Coleoptera: Bruchidae	Seeds	**Cane & Johnson 2004**
Astragalus filipes	*Tychius tectus* leConte	Coleoptera: Curculionidae	Seeds	**Cane 2004**
Astragalus filipes	*Tychius semisquamosus*	Coleoptera: Curculionidae	Seeds	**Cane 2004**
Balsamorhiza sagitatta	*Trupanea jonesi*	Diptera: Tephritidae	Head/seed	**Hammon 2004**
Balsamorhiza sagitatta	*recepticle feeding fly*	Diptera: Ceciomyiidae	Receptacle	**Hammon 2004**
Crepis acuminata	Rust		Whole plant	**Hammon & Shaw 2004**
Crepis acuminata	*Seed feeding fly*	Diptera:Tephritidae	Head/seed	**Hammon & Shaw 2004**
Dalea ornata	*Acanthoscelides oregonensis*	Coleoptera: Bruchidae	Seeds	**Cane & Johnson 2004**
Dalea ornata	*Acanthoscelides daleae*	Coleoptera: Bruchidae	Seeds	**Cane & Johnson 2004**
Dalea ornata	*Apion* spp	Coleoptera: Brentidae	Seeds	**Cane 2004**
Dalea ornata	*Lycaeides melissa*	Lepidoptera:Lycaenidae	Flowers	**Cane 2004**
Dalea ornata	*Acanthosceliedes* sp.	Coleoptera: Bruchidae	Seeds	**Cane & Johnson 2004**
Eriogonum umbellatum	Seed feeding caterpillar	Lepidoptera	Seeds	**DeBolt 2004**
Hedysarum boreale	*Acanthoscelides fraterculus*	Coleoptera: Bruchidae	Seeds	**Hammon, Johnson 1991**
Hedysarum boreale	*Filatima xanthuris*	Lepidoptera:Gelechiidae	Foliage	**Cane & Lee**
Lomatium dissectum	*Smicronyx* sp.	Coleoptera: Curculionidae	Seeds	**Cane 2004**
Lomatium dissectum	*Depressaria multifidae*	Lepidoptera: Oecophoridae	Flowers	**Cane 2004**
Lomatium dissectum	*Depressaria leptotaeniae*	Lepidoptera: Oecophoridae	Leaves	Thompson 1983, 1998
Lomatium dissectum	*Contarinia* sp	Diptera: Cecidomyiidae	Flowers	Thompson 1998
Lomatium dissectum	*Phytomyza sp.*	Diptera: Agromyzidae	Leaves	Thompson 1998
Lomatium dissectum	*Puccinia*	Fungal rust	Foliage	Thompson 1998
Lomatium dissectum	*Aphis heraclella*	Homoptera: Aphididae	Heads	**Cane 2004**
Lomatium sp.	*Smicronyx (cinereus??)*	Coleoptera: Curculionidae	Seeds	Ellison & Thompson 1987
Lupinus argenteus	*Apion oedorhycum*	Coleoptera: Curculionidae	Seeds	Ellison & Thompson 1987
Penstemon sp.	*Kushelinea barbarae*	Coleoptera:Chrysomelidae	Foliage	**Hammon & DeBolt 2004**
Penstemon sp.	*Hesperobaris ovulum*	Coleoptera: Curculionidae	Stems/crown	**Hammon & O'Brien**
Penstemon sp.	*Penstemona* sp.	Lepidoptera: Sessidae	Seems/crown	**Hammon & Cane**
Leymus cinereus	Seed fly	Diptera: Ottididae	Seeds	**Hammon & Young**
Leymus cinereus	*Crambus* sp.	Lepidoptera: Pyralidae	Seeds	**Hammon 2004**
Bromus marginatus	*Diuraphis nodulus*	Homoptera: Aphididae	Foliage	Hammon & Peairs 1998
Bromus marginatus	Head smut		Seeds	Hammon

Native Plant Seed Production Literature:

Center, T.D & C.D Johnson. 1974. Coevolution of some seed beetles (Coleoptera: Bruchidae) and their hosts. Ecology 55(5):1096-1103.

Clark, W.E. 1977. The curculionid genus *Tychius* Germar: Natural history and coevolution with leguminous host plants. Southwest Entomol. 2(3):106-126

Clarke, J.F.G. 1933. Notes and new species of Microlepidoptera from Washington state. Can. Entomol. 84-93

Ellison, R.L. & J.N. Thompson. 1987. Variation in seed and seedling size: The effects of seed herbivores on *Lomatium grayi* (Umbelliferae). Oikos 49 (3):269-280.

Foote, R.H., F.L. Blanc, & A.L. Norrbom. 1993. Handbook of the fruit flies (Diptera: Tephritidae) of America North of Mexico. Comstock Publishing Associates, Ithica, NY. 571 p.

Hammon, R.W. & F.B. Peairs. 1998. Natural history of *Diuraphis* (Homoptera: Aphididae) species occurring in western Colorado.*In:* Quisenberry, S.S. & F.B. Peairs.(eds). Response model for an introduced pest - The Russian wheat aphid. Thomas Say Publications, Entomological Society of America, Lanham, MD. pp 280-287.

Johnson, C.D. 1990. Confirmation of *Hedysarum boreale* Nuttall (Leguminosae) as a host plant for *Acanthoscelides fraterculus* (Horn) (Coleoptera: Bruchidae). Pan-Pac. Entomol. 66 (2):175-176

Kaye, T.N. 1999. From flowering to dispersal: reproductive ecology of an endemic plant, *Astragalus australis* var. *olympicus* (Fabaceae). Am. J. Bot. 86 (9):1248-1256.

Kindler, S.D., & R.W. Hammon. 1996. Comparison of host suitability of western wheat aphid with the Russian wheat aphid. J. Econ. Entomol. 89 (6):1621-1630.

Kissinger, D.G. 1988. New host and distribution records for Apionidae from North and Central America. Coleopterists Bulletin 42(3):302-304.

Owen, W.R. 1991. New host for *Acanthoscelides aureolus* Horn (Coleoptera:Bruchidae). Pan-Pacific Entomol. 67(1):73

Owen, W.R. 1993. Host plant preferences of *Acanthoscelides aureolus* (Horn) (Coleoptera: Bruchidae). Pan-Pac Entomol. 69 (1):41-50.

Palmer, M.A. 1952. Aphids of the Rocky Mountain Region. Thomas Say Foundation Vol V. A.B. Hirschfeld Press, Denver CO. 452 p.

Pomerinke, M.A. & D.C. Thompson. 1995. *Cleonidius trivittatus* feeds exclusively on woolly locoweed in northwestern New Mexico. Southwest. Entomol. 20 (1):107-110.

Pomerinke, M.A., D.C. Thompson, & D.L. Clason.1995. Bionomics of *Cleonidius trivittatus* (Coleoptera: Curculionidae): Native biological control of purple locoweed (Rosales: Fabaceae). Environ. Entomol. 24 (6):1696-1702.

Quist, J.A. 1978. A revised list of the aphids of the Rocky Mountain region. Colo. St. Univ. Agric. Exp. Sta. Bull 567S. 77p.

Schwegman, J.E. 1998. Some aspects of the life history and population dynamics of *Astragalus tenesseensis*. Castanea 63 (1):63-67.

Stoetzel, M.B. & R.W. Hammon. 1992. New collections of sexuales of Diuraphis (Homoptera: Aphididae) in North America. Proc. Entomol. Soc. Wash. 94 (4):598-599.

Thompson, J.N. 1983. The use of ephemeral plant parts on small host plants: How *Depressaria leptotaenia* (Lepidoptera: Oecophoridae) feeds on *Lomatium dissectum* (Umbelliferae). J. Anim. Ecol. 52 (1):281-291.

Thompson, J.N. 1998. Coping with multiple enemies: 10 years of attack on *Lomatium dissectum* plants. Ecology 79:2550-2554

Youtie, B.A., & R.F. Miller. 1986. Insect predation on *Astragalus filipes* and *A. purshii* seeds. Northwest Sci. 60 (1): 42-46.

Publications:

Hammon, R. & J. Cane. 2005. Managing insects affecting production of native legume seed in the Great Basin. Abstract 150, pg 69. Society of Range Management, 58th Annual Meeting, Fort Worth, TX.

Project Title: Genetic Diversity Patterns of *Allium acuminatum* in the Great Basin

Project Location: Western Regional Plant Introduction Station, Pullman, WA

Principal Investigators: **R.C. Johnson**, Research Agronomist, USDA-ARS, Western Regional Plant Introduction Station, Box 646402, Washington State University, Pullman WA 99164, phone: 509.335.3771, fax: 509.335.6654, rcjohnson@wsu.edu

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Project Description: The conservation and utilization of native plant resources in the western United States is becoming increasingly important ecologically and economically. Yet genetic information to identify seed collection sites used for restoration and reclamation is generally lacking. An understanding of the geographic and ecological distance that plant material should be transferred from original source populations is critically needed. Studies using molecular (AFLP) and morphological attributes will be conducted to determine the extent and structure of genetic variation of *Allium acuminatum*, an important forb native to the Great Basin. Genetic resource management strategies based on biological conservation principals will be developed leading to identification of candidate in-situ reserves (sites on federal lands where key populations are located). Populations maintained in-situ would provide conservation of genetic variation representing eco-geographic areas in the Great Basin. In addition, ex-situ conservation will be carried out at the USDA's Agricultural Research Service gene bank at Washington State University, Pullman, WA. Gene bank conservation will provide 1) readily available, source-identified genetic resources for research and increase and 2) security back-up of in-situ sites. Overall, this project will provide information to federal agency policy makers, Plant Material Centers, and commercial collectors/producers to improve genetic quality and production efficiency of this species.

Objectives:

1. Collect and maintain native *Allium acuminatum* (Taper-tip onion) for use in restoration and reclamation on western public lands.
2. Link ecological-geographic variation with genetic variation of *Allium acuminatum* to identify key populations for conservation and to delineate seed transfer zones.
3. Identify candidate in-situ sites for the conservation of *Allium acuminatum* genetic variation representing eco-geographic areas in the Great Basin.

Project Status: This project was funded in the summer of 2004. Since then we have determined collection protocol, identified numerous collection sites, completed preliminary collection of nine *A. acuminatum* populations, planted these in both the field and greenhouse, extracted DNA and completed preliminary molecular analysis of five populations.

Preliminary collections: In 2004, nine populations of *A. acuminatum* were collected for use in developing protocols for field and greenhouse culture and for developing methods for producing and analyzing molecular markers (Table 1). To date five populations had produced sufficient leaf material in the greenhouse for tissue collection and DNA extractions. It is expected that greenhouse and field planting will continue to develop and that information along with phenotypic characteristics will be recorded. Molecular analysis showed *A. acuminatum* was highly polymorphic. We are now working to determine the best system for developing molecular profiles. Because of the highly polymorphic nature of the species it may be necessary to use additional bases in the AFLP selective amplification or utilize RAPD's in a polyacrylamide gel system; both these techniques are ways to reduce the band number to produce markers with high clarity.

Table 1. Preliminary collections of *Allium acuminatum* in 2004. Five populations produced leaves under greenhouse conditions from which DNA was extracted and used to develop molecular protocols.

Pop.	2004 date collected	No. bulbs collected	Location (gps data not shown)	No. field planted	No. greenhouse planted	Leaf DNA extraction and loc. code
1	7/01	25	Harriman Trail, SNRA, Blaine Co., ID	11	12	
2	6/20	14	Alkali Flat, Malheur Co., OR	5	6	
3	6/20	27	Long Gulch Rd, Malheur Co., OR	13	13	Yes (LG)
4	6/20	15	S. of Adrian, Malheur Co., OR	7	7	Yes(SA)
5	6/19	20	Jackson Creek Summit Rd, Malheur Co., OR	10	11	
6	7/01	25	Easley Campground, SNRA, Blaine Co., ID	18	16	
7	5/27	25	Sand Hollow, Payette Co., ID	11	11	Yes(SH)
8	5/28	26	Between Midvale & Cambridge, Washington Co., ID	14	14	Yes(MC)
9	6/28	39	Keene Ridge, Malheur Co., OR	14	15	Yes(KR)

A preliminary result for RAPD markers is shown in Fig. 1. Although groupings did appear to occur these were not generally strongly associated with collection sites, suggesting that for this initial material the variation within site populations exceeded the variation among populations. This will be compared with AFLP profiles and with larger populations.

Future plans: In 2005 an intensive effort will be undertaken to collect as many populations as possible across the Great Basin. This material will form the basis of our work to analyze the phenotypic and molecular variation among and within collection. For phenotypic studies common garden studies will be established and leaf DNA will be collected for molecular analysis. Data will be analyzed using univariate, multivariate, and ordination statistics, and related to ecological factors. If variation within sites is dominant then this implies that fewer populations, grouped over larger areas would be sufficient for conservation. However, if the site component is strong then seed transfer zones and future *in situ* conservation will require smaller, more compact site groupings. As data becomes available, the information will be presented at meetings and published in appropriate journals.

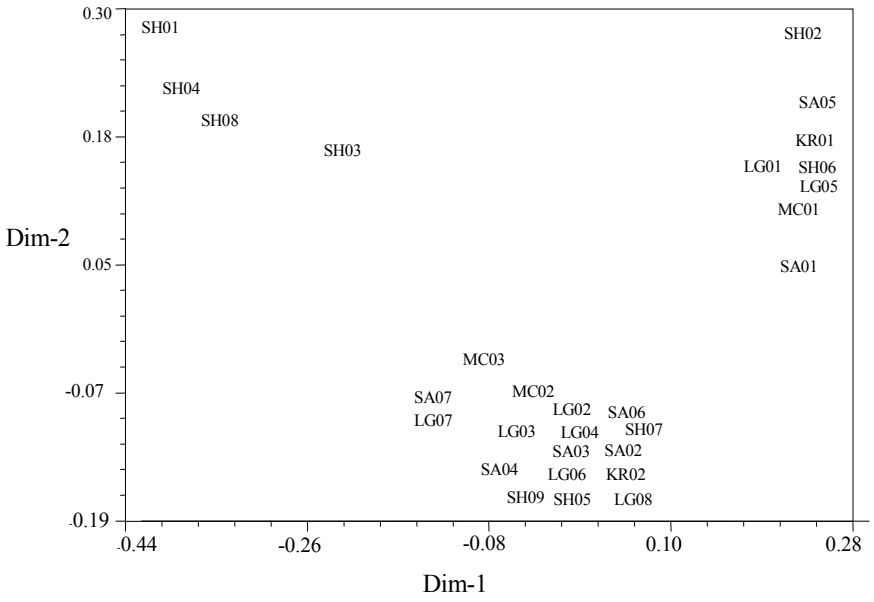

Fig. 1. Principal component analysis in two dimensions from 315 RAPD markers using a Beckman CEQ 8000 capillary electrophoresis system. Each population is coded as shown in Table 1.

Project Title: Cultural Practices for Native Forbs

Project Location: Oregon State University, Malheur Experiment Station, Ontario, OR

Principal Investigators: Clint Shock, Superintendent and Professor, Oregon State University, Malheur Experiment Station, 595 Onion Avenue, Ontario, OR 97914, phone: 541.889.2174, fax: 541.889.7831, clinton.shock@oregonstate.edu,

Corey Ransom, Assistant Professor, Oregon State University, Malheur Experiment Station, 595 Onion Avenue, Ontario, OR 97914, phone: 541.889.2174, fax: 541.889.7831, corey.ransom@oregonstate.edu

Project Description:

Identification of herbicides for use in native forb seed production

Native forb seed is needed to restore the rangelands of the Intermountain West. Commercial seed production is necessary to provide the quantity of seed needed for restoration efforts. A major limitation to commercial production of native forb seed is the ability to control weeds within the seed crop. Weeds compete with crop plants reducing establishment, vigor, and seed production. In addition, some weed seeds can contaminate the seed crop, reducing its value or introducing weeds to reclamation areas.

A three phase approach is being used to develop herbicide options for the production of native forb seed. The forbs that will be evaluated include but are not limited to: fernleaf biscuitroot (*Lomatium dissectum*), Gray's biscuitroot (*Lomatium grayi*), nineleaf biscuitroot (*Lomatium triternatum*), sulfur-flower buckwheat (*Erigonum umbellatum*), sand penstemon (*Penstemon acuminatus*), scabland pentemon (*Penstemon deustus*), and sagebrush penstemon (*Penstemon speciosus*). Seed for each phase of the project will be provided by the USDA-Forest Service.

Phase I. Initial Herbicide Tolerance Screen. In the greenhouse, each forb species will be screened for tolerance to a minimum of ten herbicides. Herbicides will be selected based on the potential for selectivity determined through literature reviews and our own understanding of different modes of action and principles of selectivity. Forbs will be evaluated for tolerance to herbicides applied either pre- or post-emergence.

Phase II. Herbicide Rate Response Screen. Once herbicides have been identified that have selectivity on the different forb species, a more detailed experiment in the greenhouse will examine the level of tolerance by testing the herbicides at rates of 0, ½, 1, 2, and 4 times the standard use rate. This "dose response" is critical to identify the level of safety that a herbicide has on the species it is being used on.

Phase III. Field Testing. Herbicides identified in greenhouse tests will be evaluated in the field to determine safety to the forbs and efficacy in controlling weeds under field conditions.

Herbicides will be evaluated alone and when possible in combinations with each other to determine if weed control can be increased and crop safety maintained. The scale of field trials will depend on the number of candidate herbicides identified in the previous research phases.

Subsurface drip irrigation (SDI) for stable, efficient native forb seed production using small amounts of supplemental irrigation water

Native forb seed is needed to restore rangelands of the Intermountain West. Commercial seed production is necessary to provide the quantity of seed needed for restoration efforts. A major limitation to commercial production of native forb seed is stable and consistent seed production over years. Variations in the climate result in highly unpredictable water stress at seed set and development. Excessive water stress during seed set and development is known to compromise yield and quality of seed crops. Both surface and furrow irrigation promote seed production, but risk the encouragement of weeds. Furthermore, surface and furrow irrigation can lead to the loss of plant stand and seed production to fungal pathogens.

Native forb seed production will be evaluated under SDI. Species will include but not be limited to: fernleaf biscuitroot (*Lomatium dissectum*), Gray's biscuitroot (*Lomatium grayi*), nineleaf biscuitroot (*Lomatium triternatum*), sulfur-flower buckwheat (*Erigonum umbellatum*), sand penstemon (*Penstemon acuminatus*), scabland pentemon (*Penstemon deustus*), and sagebrush penstemon (*Penstemon speciosus*). Seed for each phase of the project is provided by the USDA-Forest Service.

Native species are being established in the field at the Malheur Experiment Station, which has been designed for seed production research using SDI and partial irrigation. The field is irrigated with drip tape (T-Tape TSX 515-16-340) buried at 0.3-m (12-inch) depth and spaced 1.52 m apart. Two rows of forbs are planted 0.3 m distant to both sides of the drip tape. The flow rate for the drip tape is 0.34 gal/min/100 ft at 8 psi with emitters spaced 0.4 m (16 inches) apart, resulting in a water application rate of 1.7 mm/hr (0.066 inch/hour). Water is filtered through sand media filters and applications are controlled with automated controls. Soil water content and the water applied will be measured. After forb establishment, plants would receive three irrigation treatments: 0 mm/yr, sparing (up to 100 mm/yr, 4 inches/yr) or modest (up to 200 mm/yr, 8 inches/yr) supplemental irrigation. Water will be applied so that the soil surface is not appreciably moistened. Water will be applied in small increments during flowering and seed formation. Forbs will be evaluated for stand survival, seed productivity, and seed quality as a function of their irrigation treatment.

Project Status:

Seed was provided in fall 2004 for both the SDI and herbicide treatments (Tables 1 and 2). Field plots have been seeded and container seedlings are being grown in the greenhouse for these studies.

Table 1. Forb accessions included in herbicide studies.

Accession	Species	Origin
ERUM01	*Eriogonum umbellatum*	Hwy 21, Boise Co., Idaho
LODI08	*Lomatium dissectum*	Cambridge, Washington Co., Idaho
LOGR05	*Lomatium grayi*	Little City of Rocks, Gooding Co., Idaho
LOTR06	*Lomatium triternatum*	Johnson Hill, Gooding Co., Idaho
PEAC07	*Penstemon acuminatus*	King Hill Exit, Elmore Co., Idaho
PEDE07	*Penstemon deustus*	N of Council, Adams Co., Idaho
PESP23	*Penstemon speciosus*	N of Burns, Harney Co., Oregon

Table 2. Forb accessions included in irrigation studies.

Accession	Species	Origin
ERUM14	*Eriogonum umbellatum*	Little Jack's Creek, Owyhee Co., Idaho
LODI05	*Lomatium dissectum*	Mann Creek Res., Washington Co., Idaho
LOGR03	*Lomatium grayi*	Weiser River Rd., Washington Co., Idaho
LOTR41	*Lomatium triternatum*	Lakeview, Lake Co., Oregon
PEAC08	*Penstemon acuminatus*	Bliss, Elmore Co. Idaho
PEDE27	*Penstemon deustus*	Blacks Creek Road, Ada Co., Idaho
PESP09	*Penstemon speciosus*	Leslie Gulch, Malheur Co., Oregon

APPENDICES

Appendix 1. Great Basin Native Plant Selection and Increase Project: Status of Research Species.

Family Species	Common Name	Great Basin Project Research									Private Sector	
		Selection, seed increase, seed transfer guidelines	Shrub transfer guidelines	Genetic variability	Pollinators and predators	Cultural practices	Seed germination, testing	AGCR diversification	Wildland shrub seed collection	Releases	Buy-back Program (UCIA)	AOSCA
Apiaceae												
Lomatium dissectum	Fernleaf biscuitroot	SSL-B, Aberdeen		SSL-P	BBSL, CSU	SSL-B, OSU	SSL-B, NTSL				X	X
L. grayi	Gray's biscuitroot	SSL-B, Aberdeen		SSL-P		SSL-B, OSU	SSL-B, NTSL					
L. triternatum	Nineleaf biscuitroot	SSL-B, Aberdeen				SSL-B, OSU	SSL-B, NTSL				X	
Perideridia bolanderi	Yampah	UDWR				UDWR	UDWR					
Asteraceae												
Achillea millefolium	Western yarrow									SSL-B	X	
Agoseris glauca	Pale agoseris	SSL-P				SSL-P, BYU	SSL-P					
Artemisia arbuscula	Low sagebrush		SSL-P									
A. argillosa			SSL-P									
A. bigelovii	Bigelow sagebrush		SSL-P									
A. cana	Silver sagebrush		SSL-P									
A. longiloba	Little sagebrush		SSL-P									
A. nova	Black sagebrush		SSL-P									
A. pygmaea	Pygmy sagebrush		SSL-P									
A. rigida	Stiff sagebrush		SSL-P									
A. rothrockii	Timberline sagebrush		SSL-P									
A.tridentata tridentata	Basin big sagebrush		SSL-P									
A. tridentata vaseyana	Mountain big sagebrush		SSL-P									

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A. tridentata wyomingensis	Wyoming big sagebrush		SSL-P						BYU, SSL-P			
A. tripartita	Three-tip sagebrush		SSL-P									
Balsamorhiza hookeri	Hooker balsamroot										X	
B. sagittata	Arrowleaf balsamroot	UDWR		SSL-P	BBSL, CSU	UDWR	UDWR					X
Chrysothamnus nauseosus	Gray rabbitbrush		SSL-P									
Crepis acuminata	Tapertip hawksbeard	UDWR		SSL-P	BBSL, CSU	UDWR, BYU	UDWR NTSL				X	X
C. occidentalis	Western hawksbeard			SSL-P								
Erigeron pumilus	Shaggy fleabane			SSL-P		UDWR						
Viguiera multiflora	Showy goldeneye			SSL-P								
Capparidaceae												
Cleome lutea	Yellow spiderflower				BBSL							X
C. serrulata	Rocky Mountain beeplant				BBSL							
Chenopodiaceae												
Atriplex canescens	Four-wing saltbush	Aberdeen	SSL-P									
A. confertifolia	Shadscale		SSL-P									
A. torreyi	Torrey's saltbush		SSL-P									
Krascheninnikovia lanata	Winterfat	Aberdeen	SSL-P									
Fabaceae												

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Astragalus eremiticus	Hermit milkvetch	SSL-B					NTSL					
A. filipes (A. stenophyllus)	Threadstalk milkvetch	FRRL		FRRL	BBSL, CSU	FRRL	NTSL					
A. utahensis	Utah milkvetch	SSL-P		SSL-P		SSL-P, BYU	SSL-P					
Dalea ornata		FRRL		FRRL	BBSL, CSU							
Hedysarum boreale	Boreal sweetvetch	FRRL		FRRL, SSL-P	BBSL, CSU		UDWR					
H. occidentale	Western sweetvetch	FRRL		FRRL		UDWR	UDWR					
Lathyrus brachycalyx	Sweetpea			SSL-P								
Lupinus argenteus	Silvery lupine	SSL-P		SSL-P	BBSL, CSU	SSL-P	SSL-P					
L. sericeus	Silky lupine	SSL-P		SSL-P		SSL-P, BYU	SSL-P					
Vicia americana	American vetch			SSL-P								
Liliaceae												
Allium acuminatum	Tapertip onion			Pullman		Pullman						
Calochortus macrocarpus	Green-banded star tulip											
C. nuttallii	Sego lily											
C. gunnisonii	Gunnison's mariposa lily											
Linaceae												
Linum lewisii lewisii	Blue flax	Aberdeen		SSL-P						SSL-P		
L. perenne	Blue flax			SSL-P								

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Malvaceae												
Sphaeralcea spp.	Globemallow											
S. coccinea	Scarlet globemallow	UDWR				UDWR, BYU	UDWR					
S. grossulariifolia	Gooseberryleaf globemallow	UDWR		SSL-P, FRRL		UDWR, BYU	UDWR				X	
S. munroana	Munro's globemallow	FRRL		FRRL								X
S. parvifolia	Small-flower globemallow										X	
Poaceae												
Achnatherum hymenoides	Indian ricegrass	FRRL		SSL-P, FRRL							X	
A. thurberianum	Thurber needlegrass	SSL-B		FRRL						SSL-B	X	X
Agropyron cristatum	Crested wheatgrass							BYU				
Bromus carinatus	California brome			SSL-P								
B. marginatus	Mountain brome			SSL-P	CSU							
Elymus elymoides	Squirreltail grass	FRRL		FRRL						FRRL		
E. elymoides brevifolia	Bottlebrush squirreltail	FRRL		FRRL							X	
E. multisetus	Big squirreltail	FRRL		FRRL								
E. wawawaiensis	Snake River wheatgrass	FRRL		FRRL								
Hesperostipa comata	Needle-and thread	UDWR, SSL-P, FRRL		SSL-P, FRRL		UDWR, SSL-P	UDWR, SSL-P					

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Leymus cinereus	Basin wildrye	UDWR FRRL		FRRL	CSU	UDWR						
L. triticoides	Beardless wildrye	FRRL		FRRL								
Nassella viridula	Green needlegrass										X	
Pascopyrum smithii	Western wheatgrass	FRRL		FRRL								
Poa secunda	Sandberg bluegrass	FRRL		FRRL						SSL-B	X	
Pseudoroegneria spicata	Bluebunch wheatgrass	UDWR, Aberdeen, FRRL		FRRL						SSL-B	X	
Polemoniaceae												
P. longifolia	Longleaf phlox	SSL-P		SSL-P		SSL-P, BYU	SSL-P					
Polygonaceae												
Eriogonum heracleoides	Wyeth buckwheat											X
E. ovalifolium	Cushion buckwheat	UDWR				UDWR, BYU	UDWR					X
E. umbellatum	Sulfur-flower buckwheat	SSL-B, Aberdeen		SSL-P	BBSL, CSU	SSL-B	SSL-B, NTSL					X
Rosaceae												
Purshia tridentata	Bitterbrush	SSL-P	SSL-P						BYU, SSL-P			
Scrophulariaceae												
Penstemon acuminatus	Sharpleaf penstemon	SSL-B, Aberdeen		SSL-P	CSU	SSL-B, OSU	SSL-B, NTSL, OSU				X	

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P. cyaneus	Royal penstemon										X	X
P. deustus	Scabland penstemon	SSL-B, Aberdeen		SSL-P		SSL-B, OSU	SSL-B, NTSL, OSU				X	
P. pachyphyllus	Thickleaf penstemon										X	
P. palmeri	Palmer penstemon			SSL-P								
P. speciosus	Sagebrush penstemon	SSL-B, Aberdeen		SSL-P	BBSL, CSU	SSL-B, OSU	SSL-B, NTSL, OSU					X

NOTES:

Aberdeen = Natural Resources Conservation Service Plant Materials Center, Aberdeen, ID (St. John, Ogle)

AOSCA = Association of Official Seed Certifying Agencies Cooperative Native Seed Increase Program

BBSL = USDA-ARS Bee Biology and Systematics Laboratory (Cane)

BYU = Brigham Young University (Anderson, Roundy, Johnson)

CSU = Colorado State University, Cooperative Extension, Tri-River Area (Hammon)

FRRL = USDA-ARS Forage and Range Research Laboratory (Johnson, Jones, Larson, Monaco, Peel)

NTSL = National Tree Seed Laboratory (Karrfalt, Vankus)

OSU = Oregon State University, Malheur Experiment Station (Shock, Ransom)

Pullman = ARS, Western Regional Plant Introduction Station, Pullman, WA (Johnson, Hellier)

SSL-B = USDA-FS-RMRS Shrub Sciences Laboratory - Boise (Shaw, DeBolt)

SSL-P = USDA-FS-RMRS Shrub Sciences Laboratory - Provo (McArthur, Jensen)

UCIA = Utah Crop Improvement Association (Young)

UDWR = Utah Division of Wildlife Resources (Meyer, Vernon)

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Note: Seed zones - only *Atriplex, Artemisia*, and *Purshia* were identified in the original Task Order as McArthur and Sanderson were in the process of publishing their work. Everyone is working in some manner on variability in their species which should contribute to development of seed zones.

Note: Cultural practices - UDWR (Meyer, Vernon), SSL-P (Jensen), BYU (Johnson), SSL-B (Shaw, DeBolt), OSU Malheur (Shock, Ransom)

Note: Seed germination and testing: We are working with the National Tree Seed Laboratory. Most cooperators are doing some germination work with their species out of necessity.

Note: Crested wheatgrass diversification: BYU (Roundy) and ARS-Burns (Mangold)

Appendix 2.

NRCS Aberdeen Plant Materials Center
Display Nursery, Orchard Research Site, Idaho

(Planted November 16, 2004)

←	N	*=Introduced species	

White River Indian Ricegrass	Thurber's Needlegrass
Nezpar Indian Ricegrass	Sherman Sandberg Bluegrass
Paloma Indian Ricegrass	High Plains Sandberg Bluegrass
Rimrock Indian Ricegrass	Mountain Home Sandberg Bluegrass
Ribstone Indian Ricegrass	Toole County, MT Sandberg Bluegrass
Sand Hollow Bottlebrush Squirreltail	Hanford Source Sandberg Bluegrass
Fish Creek Bottlebrush Squirreltail	Nordan Crested Wheatgrass*
Toe Jam Bottlebrush Squirreltail	Hycrest Crested Wheatgrass*
9019219 Bottlebrush Squirreltail	CD-II Crested Wheatgrass*
Shaniko Plateau Bottlebrush Squirreltail	Ephraim Crested Wheatgrass*
Bannock Thickspike Wheatgrass	Douglas Crested Wheatgrass*
Sodar Thickspike Wheatgrass	Roadcrest Crested Wheatgrass*
Critana Thickspike Wheatgrass	P-27 Siberian Wheatgrass*
Schwendimar Thickspike Wheatgrass	Vavilov Siberian Wheatgrass*
Pryor Slender Wheatgrass	Luna Pubescent Wheatgrass*
San Luis Slender Wheatgrass	Manska Pubescent Wheatgrass*
Revenue Slender Wheatgrass	Greenleaf Pubescent Wheatgrass*
Rosana Western Wheatgrass	Rush Pubescent Wheatgrass*
Rodan Western Wheatgrass	Eejay Altai Wildrye*
Arriba Western Wheatgrass	Pearl Altai Wildrye*
Goldar Bluebunch Wheatgrass	Prairieland Altai Wildrye*
Anatone Bluebunch Wheatgrass	Tetracan Russian Wildrye*
Columbia Bluebunch Wheatgrass	Bozoisky Select Russian Wildrye*
Jim Creek Bluebunch Wheatgrass	Syn-A Russian Wildrye*
Wahluke Bluebunch Wheatgrass	Mankota Russian Wildrye*
P-5 Bluebunch Wheatgrass	Eagle Western Yarrow
P-7 Bluebunch Wheatgrass	Great Northern Western Yarrow
P-12 Bluebunch Wheatgrass	Timp Utah Sweetvetch
P-15 Bluebunch Wheatgrass	Richfield Selection Firecracker Penstemon
Secar Snake River Wheatgrass	Scarlet Globemallow
Expedition Snake River Wheatgrass	Maple Grove Lewis Flax
E-26 Snake River Wheatgrass	Appar Blue Flax*
SERDP Snake River Wheatgrass	Wyoming Big Sagebrush
Magnar Basin Wildrye	Snake River Plains 4-Wing Saltbush
Trailhead Basin Wildrye	Wytana 4-Wing Saltbush
Washoe Basin Wildrye	Rincon 4-Wing Saltbush
U70-01 Basin Wildrye	9016134 Gardner's Saltbush
U108-02 Basin Wildrye	Northern Cold Desert Winterfat
U100-01 Basin Wildrye	Hatch Winterfat
Initial Point Sheep Fescue	Open Range Winterfat
Covar Sheep Fescue	Immigrant Forage Kochia*

On November 16, 2004 the Aberdeen Plant Materials Center and the Idaho/Utah Plant Materials Specialist planted a new display nursery at the Orchard test site southeast of Boise. The display nursery is in cooperation with the Great Basin Native Plant Selection and Increase Project.

The Great Basin Native Plant Selection and Increase Project is a group of cooperators from the Bureau of Land Management, Forest Service, Agricultural Research Service, Utah Division of Wildlife Resources, Utah Crop Improvement Association and the Natural Resources Conservation Service who are collaborating to develop and increase native plant materials for the Great Basin and Intermountain West.

There are 82 accessions of 27 native and introduced grass, forb and shrub species planted in 7 X 60 foot plots. The purpose of this display nursery is to allow agency personnel and land owners to view these plants in action and see firsthand how the plants perform in the low precipitation environment (10 – 12 inch annual precipitation) of southwestern Idaho. The display will also be useful in comparing different releases from within a species or in comparing native and introduced species with similar environmental requirements. The following descriptions begin at the northeastern corner plot and proceed west. Descriptions pick up again at the southeastern corner and return westward.

Ricegrass, Indian (*Achnatherum hymenoides=Oryzopsis hymenoides=Stipa hymenoides*)
White River, test material from Logan, UT ARS
'Nezpar' released by Aberdeen, ID PMC, 1978
'Paloma' released by Los Lunas, NM PMC, 1974
'Rimrock' released by Bridger, MT PMC, 1996
Ribstone Germplasm released by Logan, UT ARS, 2004
A native perennial, very drought tolerant bunchgrass adapted to well-drained sandy to clayey soils and dry desert ranges. Seed is very slow to germinate due to a thick seed coat resulting in high seed dormancy. To improve seed germination, the seed can be treated in sulfuric acid, mechanically scarified, or dormant planted in fall to allow for a cool moist stratification. Untreated seed requires a greater depth of planting than most species to promote seed germination. Recommended sites are sunny exposures in 7 inches or more precipitation zones with sandy or gravelly soils (10 inch plus rainfall areas result in most successful seedings). It grows on raw subsoil from lowlands into high mountains. Recommended planting depth is 1.5 inches in loamy soils to 3 inches on sandy to gravelly soils. It is very palatable, considered excellent winter forage, and the seed production enhances forage value because of high protein and fat content in the seed. It is also considered an excellent plant for wildlife habitat seedings. Good grazing management is necessary if stands are to persist. 'Nezpar' is a northern variety with improved germination characteristics. 'Paloma' is best adapted to southern semi-desert areas. 'Rimrock' and Ribstone Germplasm are northern varieties selected for better seed retention characteristics. White River comes from northwestern Colorado and was selected for high germinability. Average seeds per ft^2 at 1 lb/acre rate is 5. Recommended pure stand rate is 6 lb/acre.

Squirreltail, Bottlebrush (*Elymus elymoides* ssp. *elymoides* or ssp. *californicus* and *Elymus multisetus*)
Sand Hollow Germplasm released by Logan, UT ARS, 1996
Fish Creek Germplasm released by Logan, UT ARS, 2003
Toe Jam Creek Germplasm released by Logan, UT ARS, 2003
9019219, test material from Bridger, MT PMC

Shaniko Plateau, Source-identified release from L&H Seed
Bottlebrush squirreltail is a short-lived perennial, drought tolerant, cool season, native bunchgrass. It is short to medium sized (6 to 22 inches tall), tufted and has fair forage value in winter and spring and poor forage value in summer when seedheads are present. The bristly awns are objectionable to grazing animals and cause difficulties in seed handling, planting and harvesting. This species is often an increaser on poor condition to improving rangelands. It is adapted to a wide variety of soils including saline soils in the 8-18 inch precipitation zones. It is hoped it will have attributes that will enable it to establish a foothold in annual rangelands dominated by cheatgrass or medusahead rye. ARS and NRCS have released three squirreltail accessions, Sand Hollow Selected Germplasm (*E. multisetus)* in 1996; Toe Jam Selected Germplasm (*E. elymoides* ssp. *californicus)* in 2003; and Fish Creek Selected Germplasm (*E. elymoides* ssp. *elymoides)* in 2003. Sand Hollow is best adapted to sandy foothill rangelands receiving 12 inches or more annual precipitation in the lower Snake River Plain. Toe Jam is best adapted to loam to sandy loam soils in the Great Basin and lower to middle Snake River Plain areas receiving 8-14 inches of precipitation. Fish Creek is best adapted to sandy loam to silt loam to clay loam soils receiving 10 inches or more annual precipitation in the middle to upper Snake River Plain. Average seeds per ft^2 at 1 lb/acre seeding rate is 4. Seeding rate is 7 lb/acre.

Wheatgrass, Thickspike (*Elymus lanceolatus* ssp. *lanceolatus=Agropyron dasystachyum)*
'Bannock' released by Aberdeen, ID PMC, 1995
'Sodar' released by Aberdeen, ID PMC, 1954
'Critana' released by Bridger, MT PMC, 1971
'Schwendimar' released by Pullman, WA PMC 1994
A long-lived, native mildly sod-forming grass widely distributed in the northern part of the Intermountain Region. Drought tolerance, early spring growth, fair palatability, but low forage production characterizes this species. More drought tolerant than western wheatgrass, it is well suited for wind erosion control on medium to coarse-textured soils. It is best utilized as forage until early fall. It tolerates moderate grazing and considerable trampling. Adapted to disturbed range sites and dry areas subject to erosion, roadsides, and waterways in the 8-18 inch precipitation zones. Use as a native component in rangeland mixes. Planting depth 1/4 to 1/2 inch. Improved varieties include 'Bannock', 'Schwendimar', 'Critana' and 'Elbee'. Bannock is noted for its rapid establishment, moderate sod formation and greater forage production. Critana is more drought tolerant, exhibits good seedling vigor and readily establishes on critical areas. Schwendimar is noted for quick stabilization of coarse textured soils along the Columbia River. Average seeds per ft^2 at 1 lb/acre rate is 3. Recommend pure stand rate is 6 lb/acre.

Wheatgrass, Slender (*Elymus trachycaulus trachycaulus=Agropyron trachycaulum)*
'Pryor' released by Bridger, MT PMC, 1988
'San Luis' released by Upper Colorado Environmental Plant Center, 1984
'Revenue' released by Canada Department of Agriculture, 1970
Slender wheatgrass is a short-lived perennial (3-5 years) native bunchgrass with good seedling vigor and moderate palatability. It is valuable in erosion-control seed mixes because of its rapid development, moderate salt tolerance, and compatibility with other species. It is well adapted as a cover crop to improve soil tilth and to increase organic matter in saline sites. It tolerates a wide range of conditions and adapts well to high altitude ranges and more favorable sites on mountain brush areas receiving 10 inches or more annual precipitation. It is excellent in aspen and tall mountain brush areas and is shade tolerant. Planting depth 1/2 to 3/4 inch. 'Revenue' is a Canadian variety, selected for salinity tolerance, seed set, and forage yield. 'San Luis' is a

southern variety adapted to high elevations. 'Pryor' is a northern variety, selected for superior salt tolerance, drought tolerance, and seedling vigor. Average seeds per ft^2 at 1 lb/acre rate is 3.0. Recommend pure stand rate is 6 lb/ac. Limit slender wheatgrass to 1 pound PLS per acre in native mixes. Higher rates effect the establishment of slower developing native species.

Wheatgrass, Western (*Pascopyrum smithii=Agropyron smithii)*
'Rosana' released by Bridger, MT PMC, 1972
'Rodan' released by ND ARS, 1983
'Arriba' released by Los Lunas, NM PMC, 1973
A long-lived, late maturing, widely distributed, winter hardy, strongly rhizomatous, native grass with coarse blue-green leaves. Western wheatgrass begins spring growth later than most wheatgrasses and is typified by poor germination and low seedling vigor. When used as pasture it is considered to be an excellent source of spring and early summer forage with protein content of 16 to 18 percent. However, forage quality rapidly declines as plants mature. It provides winter grazing if protein supplements are provided. Protein content of western wheatgrass is usually a little higher (4-5 percent) than other wheatgrasses once cured. Plantings usually result in scattered stands that spread in 3 to 4 years to site dominance. Western wheatgrass is the most aggressive native sod grass available. Once established, it becomes very persistent and provides excellent soil binding erosion control characteristics. It is productive native hay in above normal precipitation years, under water spreading, and other supplemental water irrigation systems. It is particularly productive in clayey swales and silty waterways, and has moderate to high salt tolerance. Adapted to lowlands prone to early season flooding with precipitation at or above 12 inches (use 14 inch + for areas that receive 50 percent or greater winter precipitation) and most mountain brush areas. Planting depth 1/4 to 1/2 inch. Adapted varieties include 'Rosana' (northern variety), 'Rodan' (northern variety), and 'Arriba' (southern variety). Other releases include 'Barton', 'Flintlock', and 'Walsh'. Average seeds per ft^2 at 1 lb PLS/acre rate is 3. Recommended pure stand seeding rate is 6 PLS lb/acre. Not recommended in pure stands. Recommended 50% mixed stand seeding rate is 3.0 lb/acre.

Wheatgrass, Bluebunch (*Pseudoroegneria spicata =Agropyron spicatum)*
'Goldar' released by Aberdeen, ID PMC, 1989
'Anatone' released by Aberdeen, ID PMC, 2004
'Columbia' released by Logan, UT ARS, 2004
Wahluke Source Identified release from BFI Seed, 2002
P-5, test material from Logan, UT ARS
'P-7' released by Logan, UT ARS, 2001
P-12, test material from Logan, UT ARS
P-15, test material from Logan, UT ARS
A long-lived, drought-tolerant, widespread native bunchgrass. It begins growth early in spring and again with the onset of fall rains. It is highly palatable and recovers rapidly after grazing but has low resistance to repeated or heavy grazing. It is not recommended as a hay crop. Several years are required for stands to obtain full productivity due to poor seedling vigor. Allow seedings to reach maturity (seedhead development) before grazing. Recommended sites include foothills and valleys with 10-20 inches precipitation, sagebrush, ponderosa pine, mountain brush and juniper-pinyon ranges. Low plant vigor results in poor stands on sites above 6500 ft. elevation. Planting depth 1/4 to 1/2 inch. Adapted varieties are 'Anatone' for use above 10" precipitation and 'Goldar' and 'P7' for use above 12" precipitation. P-12 and P-15 are predecessor populations for the ARS release 'Columbia'. Both were collected near Lind, WA in a 10" precipitation area.

'Secar' (See Snake River Wheatgrass), previously considered to be bluebunch wheatgrass but found to be a subspecies of thickspike wheatgrass, is more drought tolerant than bluebunch wheatgrass in lower precipitation areas (8-12"). Wahluke is a source identified release collected from a 6" precipitation site in Franklin County, WA. Average seeds per ft^2 at 1 lb/acre rate is 3. Recommend pure stand rate is 7.0 lb/acre.

Wheatgrass, Snake River (*Elymus wawawaiensis* formerly *Pseudoroegneria spicata)*
'Secar' released by Pullman, WA PMC, 1980
Expedition, test material from Logan, UT ARS
SERDP, test material from Logan, UT ARS
Jim Creek Source Identified release from BFI Seed, 2000
E-26, test material from Logan, UT ARS
Snake River wheatgrass is a native of the canyons of the Snake River and its tributaries in Washington, eastern Oregon, and western to northern Idaho. It is similar in appearance to bluebunch wheatgrass, but differs morphologically in having narrower, acuminate (pointed) to aciculate (needle-like) glumes, a more imbricate (overlapping) spike, and glabrate (without hairs) basal leaf sheaths. It is adaptable to most bluebunch wheatgrass areas but is best suited for the lower precipitation areas (8 to 12 inches). (See bluebunch wheatgrass). The only variety is 'Secar'. It is an early maturing bunchgrass with good seedling vigor and establishes well in native seed mixes. Secar is considered more drought tolerant than previously released bluebunch wheatgrasses. Expedition is said to have improved seedling establishment under drought stress compared to 'Secar' and is slated for release in the near future. Average seeds per ft^2 at 1 lb/acre rate is 3. Recommend pure stand rate is 7 lb/acre.

Wildrye, Basin (*Leymus cinereus=Elymus cinereus)*
'Magnar' released by Aberdeen, ID PMC, 1979
'Trailhead' released by Bridger, MT PMC, 1991
Washoe Germplasm, released by Bridger, MT PMC 2002
U70-01, test material from Great Basin Research Center, UTDWR
U108-02, test material from Great Basin Research Center, UTDWR
U100-01, test material from Great Basin Research Center, UTDWR
A slowly spreading, robust, large native bunchgrass. Basin wildrye is tall, coarse, long-lived, and highly palatable early in spring, but becomes low in palatability as it matures. It is useful for calving pasture and wildlife forage and cover. Poor seedling vigor usually results in sparse stands, but is one of the highest producing species once established. Do not graze new seedings until seedheads are evident or no sooner than the end of the second growing season. Mature plants are unpalatable and need to be managed for use at earlier periods with grazing management scheduled to maintain a 10 to 12 inch stubble height to avoid removing the growing points of this species. Great care must be taken to avoid close grazing or clipping which may result in plant loss in a single season. Winter grazing with protein supplements utilizes old coarse growth. Best adapted to moderately saline or alkaline lowlands, flood plains, and flow-in areas with high water holding capacity. Especially suited to deep, fine-textured clayey to loamy soils that receive 8-12 inches precipitation. Plantings have been established in rainfall areas as low as 5 inches, however basin wildrye plantings are not recommended in areas with less than 8 inches of annual precipitation. Basin wildrye is particularly well suited for many juniper areas; it performs well throughout the mountain brush zone and in aspen openings. Planting depth is 1/2 to 3/4 inch. Adapted cultivars are 'Magnar' (blue-green upright leaves) and 'Trailhead' (green overhanging leaves) selected for excellent drought tolerance. 'Washoe' was selected for it's high tolerance to acidic conditions and

should be useful in mine reclamation situations. Average seeds per ft^2 at 1 lb/acre rate is 3. Recommended pure stand seeding rate is 7 lb/acre. Basin wildrye is highly recommended for native species mixtures.

Fescue, Sheep (*Festuca ovina)*
Initial Point, source identified test material collected by Idaho BLM
'Covar' released by Pullman, WA PMC, 1977
A long-lived short stature introduced bunchgrass with short leaf blades. It is more drought tolerant than other fescues. Production is low, but groundcover and root production is excellent. It is used for turf, highway plantings, airport landing strips, burned over timberland and reclamation areas where a long-lived, persistent, competitive ground cover is needed. Not recommended for pasture or hay. Sheep fescue is best adapted to 10+ inch precipitation zones. A very good erosion control and understory species that competes well with weeds. Early spring seedings are recommended. Only pure stands or mixtures with hard fescue are recommended. Planting depth 0-1/4 inch. Adapted varieties are 'Covar' and 'Bighorn'. Average seed per ft^2 is 16 at a 1 lb/acre rate. Recommended pure stand rate is 4 lb/acre.

Needlegrass, Thurber's (*Achnatherum thurberianum=Stipa thurberiana)*
Orchard, test material from USDA FS Intermountain Shrub Lab
A medium height, cool season, native bunchgrass. It is very drought tolerant and often found on well-drained, rocky sites and southern exposures in the 8-16 inch rainfall zones. It has fine leaves and is fair to good forage in the early spring when most species are not productive and can green-up in fall with rainfall. It is currently under development by the Forest Service. Native seed collections should specify "Source Identified" seed. Average seeds per ft^2 at 1 lb/acre rate is 3. Seeding rate is 7 lb/acre.

Bluegrass, Sandberg (*Poa secunda =P. sandbergii=P. ampla)*
'Sherman' released by Pullman, WA PMC, 1945
High Plains Germplasm released by Bridger, MT PMC 2000
Mountain Home, test material from USDA FS Intermountain Shrub Lab
Toole County, MT, source identified release from L&H Seed
Hanford Source, source identified release from L&H Seed
Sandberg bluegrass is a small, low producing, very drought tolerant, native, perennial bunchgrass that grows in small tufts usually no larger than 6-8 inches in diameter. It is widely distributed throughout western range plant communities where it is considered an important grass for soil stabilization and forage for wildlife. It is best adapted to medium to heavy textured soils. It is found from 1,000 feet in Washington to 12,000 feet in northern New Mexico. It is adapted to 8-20 inches of moisture annually. It is tolerant of heavy trampling. Forage yields are very low, seed viability is generally poor, and forage quality declines rapidly in mid to late spring as it matures. It is one of the first grasses to green-up in the spring. Due to its low stature, Sandberg bluegrass can withstand heavy grazing pressure. On large areas of western semi-desert rangelands, overgrazing has depleted most of the desirable bunchgrasses except Sandberg bluegrass. It provides little to no forage in summer and fall unless fall rains occur. 'High Plains' Selected Class Germplasm is a recent release from Bridger PMC. 'Sherman' is a large statured plant previously released as big bluegrass (*Poa ampla*). Plant at 1/4 inch or less depth. Average seeds/ft^2 at 1lb rate is 21. Recommended pure stand seeding rate is 2 lb/acre. It is best utilized in low rainfall area native mixes.

Wheatgrass, Crested Standard type-AGDE2 (*Agropyron desertorum)*
'Nordan' released by ND AES, 1953
A very long-lived, drought tolerant bunchgrass adapted to a wide range of sites and precipitation zones as low as 9-10 inches. Growth begins early in the spring and again with fall moisture. Palatability is excellent in the spring and late fall, less during summer dormancy and after seed formation. It has very vigorous seedlings. Adapted to foothills with 9-16 inches precipitation, sagebrush, ponderosa pine, mountain brush, and juniper-pinyon ranges. Expect low vigor and poor stands above 6500 feet elevation. This species is more drought tolerant than Fairway type crested wheatgrasses. Planting depth 1/4 to 1/2 inch. Adapted varieties are 'Nordan' and 'Summit'. Average seeds per ft^2 at 1 lb/acre rate is 4. Recommend pure stand rate is 5 lb/acre.

Wheatgrass, Crested CD-II and Hycrest-hybrids (*Agropyron cristatum x A. desertorum)*
'Hycrest' released by Logan, UT ARS, 1984
'CD-II' released by Logan, UT ARS, 1996
A hybrid cross between Standard type and induced tetraploid Fairway type crested wheatgrass. Seedlings are extremely vigorous during germination and early establishment. Survives under greater competition than other crested wheatgrasses. Yields more forage (15-20%) in younger stands; is an outstanding seed producer, but more stemmy. Occupies same sites as standard and Fairway crested wheatgrass. Especially useful in drier sagebrush - cheatgrass sites. Survives in areas with 9-16 inches precipitation. Does not persist as well as Standard type crested wheatgrass or Siberian wheatgrass in very droughty sites. Planting depth 1/4 to 1/2 inch. Cultivars include 'CD-II' and 'Hycrest'. Average seeds per ft^2 at 1 lb/acre rate is 4. Recommend pure stand rate is 5 lb/acre.

Wheatgrass, Crested Fairway type-AGCR (*Agropyron cristatum)*
'Ephraim' released by USFS, 1983
'Douglas' released by Logan, UT ARS, 1994
'Roadcrest' released by Logan, UT ARS, 1998
A very long-lived, drought-tolerant, vigorous introduced bunchgrass. Similar to standard crested wheatgrass but shorter, earlier maturing, with finer stems and leaves. Establishes on similar sites (10-18 inches precipitation) as standard and grows more effectively than standard at higher elevations. This species does not survive as well as standard crested wheatgrass under severe drought conditions. Planting depth 1/4 to 1/2 inch. Adapted varieties are 'Fairway' and 'Ephraim'. 'Ephraim', is a tetraploid variety of *A. cristatum* that is weakly rhizomatous in higher rainfall areas. 'Roadcrest' is a turf-type with short rhizomes and is recommended for low maintenance lawns. 'Douglas' crested wheatgrass is the first hexaploid on the market. Douglas is characterized as having larger seed, broader leaves and remains green longer into the early summer than other types mentioned above, but requires 14 inches of precipitation or more for long-term survival. It also establishes easily, but it produces less forage. Because it stays green longer than other types, it is a preferred forage selection. Douglas is not as drought resistant as Nordan, Summit, Hycrest or CD-II. Other cultivars available but less adapted include 'Parkway', 'Kirk' and 'Ruff'. Average seeds per ft^2 at 1 lb/acre rate is 4. Recommended pure stand rate is 5 lb/acre.

Wheatgrass, Siberian (*Agropyron fragile =A. sibericum)*
'P-27' released by Aberdeen, ID PMC, 1953
'Vavilov' released by Logan, UT ARS, 1994
Similar to crested wheatgrass, Siberian wheatgrass has finer leaves, and retains its greenness and palatability later into the summer than crested wheatgrass. It yields less than most crested

wheatgrass cultivars. It occupies sites where standard crested wheatgrass will grow but is more drought tolerant (7-16 inches of precipitation) and is especially useful on juniper sites. Once established, it is reported to be well adapted to light-sandy, droughty soils and can withstand extended periods of drought better than crested wheatgrasses. Planting depth 1/4 to 1/2 inch. Adapted varieties include 'P-27' and 'Vavilov' (improved seedling vigor). Average seeds per ft^2 at 1 lb/acre rate is 4. Recommend pure stand rate is 6 lb/acre.

Wheatgrass, Pubescent (*Thinopyrum intermedium=Elytrigia intermedia=Agropyron trichophorum)*
'Luna' released by Los Lunas, NM PMC, 1963
'Manska' released by ARS, ND, 1992
'Greenleaf' released by Canada Department of Agriculture, 1966
'Rush' released by Aberdeen, ID PMC, 1994
A long-lived, late maturing, introduced, sod-forming grass adapted to low-fertility sites and coarse to medium textured soils. Very similar to intermediate wheatgrass (pubescence on leaves and seed heads) but slightly more drought-resistant, alkali tolerant, and somewhat less palatable. It is better adapted for pasture than for hay. Its ability to remain green during the summer, when soil moisture is limited, is a significant characteristic. Adapted to foothills with 11-18 inches precipitation, this species is excellent for situations where only one to two irrigations are possible, because it readily responds to irrigation with increased forage production, but can also withstand extended drought periods when irrigation water is not available. Useful on disturbed sites for soil stabilization and erosion control. It is not shade tolerant, but is moderately tolerant of saline soil conditions. It is very useful for erosion control on a wide range of sites. Suggested varieties are 'Luna' (most commonly used), 'Rush' (released for high seedling vigor and establishment) as well as 'Manska' and 'Greenleaf'. Average seeds per ft^2 at 1 lb/acre rate is 2. Recommend pure stand rate is 8 lb/acre.

Wildrye, Altai (*Leymus angustus=Elymus angustus)*
'Eejay' released by Agriculture Canada, 1989
'Pearl' released by Agriculture Canada, 1989
'Prairieland' released by Agriculture Canada, 1976
A winter hardy, drought resistant, long-lived, cool season introduced bunchgrass, sometimes with short rhizomes. It is known to root and use moisture to depths of 15 feet. Basal leaves are somewhat coarse, but very palatable during the late summer and early fall (protein levels of 8 percent are common in standing winter-feed). In northern regions it is commonly swathed into windrows and utilized as forage for winter feeding operations. Adapted to moderately deep to deep loams to clay loams with 14 inch or greater rainfall. It can withstand saline conditions almost as well as tall wheatgrass and is also almost as productive as tall wheatgrass on saline sites. Seedlings develop slowly and good seedbed preparation and weed control is essential. 'Eejay', 'Pearl', 'Mustang' and 'Prairieland' are released varieties. Average seeds per ft^2 at 1 lb/acre rate is 2. Recommended pure stand rate is 10 lb/acre.

Wildrye, Russian (*Psathyrostachys juncea=Elymus junceus)*
'Tetracan' released by Agriculture Canada, 1988
'Bozoisky-Select' released by Logan, UT ARS, 1984
'Mankota' released by ND, ARS, 1991
Syn A, test material from Logan, UT ARS

A long-lived introduced very drought tolerant bunchgrass. Grows rapidly in the spring and produces abundant basal leaves that remain green and palatable through summer and fall as long as soil moisture is available. It endures close grazing better than most grasses. It cures well on the stump (better than most cool season grasses) and makes excellent late fall and winter feed. Russian wildrye is not suited for hay production due to the predominance of basal leaves, which makes it difficult to harvest. Once established, it competes effectively against undesirable plants and it withstands drought as effectively and is more palatable than crested wheatgrass. However, most varieties have been erratic in establishment, demonstrate poor seedling vigor, and provide poor soil protection. Seed in areas receiving at least 8 inches of precipitation. Adapted to sagebrush, mountain brush, juniper-pinyon, and moderately saline sites. Useful on soils too alkaline for crested wheatgrass and too dry for tall wheatgrass. Planting depth 1/4 to 1/2 inch; and is very sensitive to deeper placement. Highest production occurs in wide row spacing of >18 inches. On steep slopes it should be planted on the contour. 'Vinall', an earlier variety, has poor seedling vigor and is not recommended. Canadian releases include 'Swift', which was selected for seedling vigor, and 'Cabree', selected both for seedling vigor and reduced seed shattering. U.S. releases include 'Bozoisky-Select', selected for increased seedling vigor and forage production and 'Mankota', selected for establishment from deeper seeding depths. In plantings in the Intermountain West, Bozoisky-Select and Mankota should be the varieties of choice. Average seeds per ft^2 at 1 lb/acre rate is 4. Recommend pure stand seeding rate is 6 lb/acre.

Yarrow, Western (*Achillea millefolium)*
Eagle, source identified release from Geertson Seed Farms
Great Northern released by Bridger, MT PMC, 2004
Western yarrow is a perennial forb (member of the sunflower family) and is one of the most widely distributed forbs in the western United States. Native ecotypes are white flowered while Eurasian ecotypes are pink to yellow flowered. It can be found from the valley bottoms to the subalpine zone. Greatest areas of occurrence are mountain brush, aspen, and open timber. It has some shade, drought, and grazing tolerance and can be found in sandy to loamy soils ranging from weakly basic to weakly acid. Yarrow spreads by seed and rhizomes; it does an especially good job on disturbed and depleted areas. It may invade adjacent areas that have proper growing conditions. Fall seeding is recommended. Depth of seeding should not exceed 1/4 inch. Western yarrow should be seeded in mixtures with other species. It is easily transplanted. It has been successfully used in plantings that receive as little as 8 inches effective precipitation. Bridger PMC has recently released Great Northern Germplasm from a source in northwestern Montana. Average seeds per ft^2 at 1 lb/acre rate is 95. Pure stand seeding rate is 0.25 lb/acre. Not recommended for pure stands.

Sweetvetch, Utah (Northern) (*Hedysarum boreale)*
'Timp' released by Upper Colorado Environmental Plant Center, 1994
Utah or Northern sweetvetch is a native perennial legume. This species occurs in the foothills and upland areas that receive 10 or more inches of precipitation. Sweetvetch prefers well-drained soils ranging from rocky, gravelly, and sandy to heavy clay. Its deep taproot enables it to take advantage of deep soil moisture that results in considerable drought resistance and winter hardiness. Seed should be fall seeded at 1/8 inch to 3/4 inch deep. It is very slow to establish in mixed stands and requires alternate row planting to provide optimum establishment. Livestock and big game graze this species when available. Spring green up occurs early, and basal leaves remain green throughout the winter. 'Timp' is a release from Meeker PMC. Average seeds per ft^2 at 1 lb/acre rate is 2. Pure stand seeding rate is 18 lb/acre. Not recommended for pure stands.

Penstemon, Firecracker (*Penstemon eatonii*)
Richfield Selected Germplasm, released by Aberdeen, ID PMC, 1994
A perennial, erect, cool season, short-lived, good reseeder, native forb that has a fibrous root system, stems that are decumbent or reclining, leaves that are slightly pubescent, flowers on upright stems that are bright red and bloom in mid summer through early fall. It is adapted to sagebrush, juniper and ponderosa pine zones at 3,300 to 8,000 feet elevation in 10-16 inch precipitation zones. It does best in full sunlight and can survive cold winter temperatures if snow insulates the plant. It does not do well in poorly drained areas. Potential uses include erosion control, diversity and beautification. The Richfield Selection is a release of firecracker penstemon from Aberdeen PMC. Due to hard seed, plant penstemon species in late fall-early winter at soil surface to 1/8-inch depth. Average seeds per ft^2 at 1 lb/acre rate is 7. Not recommended in pure stands.

Globemallow, Scarlet (*Sphaeralcea coccinea)*
Test material from Great Basin Research Center
Scarlet globemallow is a native, low-spreading perennial with creeping rhizomes. This species has considerable drought resistance with greatest area of occurrence between 7 and 12 inches annual precipitation. It establishes especially well on disturbed sites. It is an excellent soil stabilization species in native species mixtures on harsh sites. Fall seeding is recommended. A hard seed coat often prevents germination. Seed should not be planted deeper than 1/4 inch. Average seeds per ft^2 at 1 lb/acre rate is 17. Pure stand seeding rate is 3 lb/acre. Not recommended in pure stands.

Flax, Lewis and Blue (*Linum lewisii and Linum perenne)*
Maple Grove Germplasm, released by Aberdeen, ID PMC, 2004
'Appar' released by Aberdeen, ID PMC, 1980
Blue flax is an introduced, perennial, semi-evergreen, blue-flowered forb that prefers well-drained soils that range from moderately basic to weakly acidic. It prefers growing in the open, but does have some shade tolerance. It is intolerant of poor drainage, flooding and high water tables. This species grows well in 10-18 inch precipitation areas including all three big sagebrush types, juniper and mountain brush communities. It has been successfully seeded in the salt desert shrub type. Flax does well seeded in mixtures with other species. It can be surface seeded on a disturbed seedbed and should not be seeded deeper than 1/8 inch. This semi-evergreen forb is eaten readily by big game especially during spring and winter and upland game and songbirds relish its seeds. This species does well seeded on disturbed sites. 'Appar' was released for its superior forage and seed production and palatability to livestock and wildlife. Recent research has identified 'Appar' as introduced from European origins. Maple Grove Germplasm (*Linum lewisii)* is a new native release by the USDA FS and Aberdeen PMC. Average seeds per ft^2 at 1 lb/acre rate is 6. Pure stand seeding rate is 4 lb/acre. Not recommended in pure stands.

Sagebrush, Wyoming Big (*Artemisia tridentata* ssp.*wyomingensis)*
Test material from BLM Seed Warehouse, Boise, ID
Big sagebrush with its 4 major subspecies (basin, Wyoming, mountain, spicate) is a widely occurring, landscape dominating native shrub ranging in height from 1 to 15 feet. The lower forms generally have several main stems arising from the base; the tall forms often have a single trunk. Big sagebrush grows in a variety of soils on arid plains, valleys, and foothills to mountain slopes in the 8-18 inch rainfall areas. It is frequently associated with such shrubs as shadscale, rubber rabbitbrush, green rabbitbrush, fourwing saltbush, spiny hopsage, gray horsebrush,

winterfat, broom snakeweed, antelope bitterbrush, snowberry, and serviceberry. Big sagebrush is one of the more nutritious shrubs on western winter game ranges. Palatability of the different populations of this shrub to mule deer, sheep, and other animals varies widely. It is one of the best shrubs available for use in revegetation of depleted winter game ranges in the Intermountain West. Big sagebrush establishes rapidly from direct broadcast seeding on disturbed surfaces. It is useful for stabilizing washes, gullies, road-cuts, and other raw, exposed sites. It is widely seeded on big game improvement projects. Plants spread well by natural seeding and furnish considerable browse soon after seeding. Big sagebrush is aggressive and persistent and sometimes forms closed stands, which require control measures to improve species diversity. 'Hobble Creek' is a robust, palatable form of mountain big sagebrush adapted to areas with 14 inches or more precipitation and deeper soils. 'Gordon Creek' is a release of Wyoming big sagebrush adapted to 10-14 inches precipitation. Wildland seed collection is a common practice and Source Identified seed is recommended when using wildland collected seed. Use of freshly harvested seed is also recommended. Seed at 0-1/8 inch depth. Average seeds per ft^2 at 1 lb/acre rate: Basin 39, Mountain 45, Wyoming 39. Not recommended for pure seedings. Recommended rates in mixes are approximately 1/40 lb PLS/acre.

Saltbush, Fourwing (*Atriplex canescens)*
Snake River Plains Germplasm, released by Aberdeen, ID PMC, 2001
'Wytana' released by Bridger, MT PMC, 1976
'Rincon' released by USDA FS, 1983
Fourwing saltbush is an upright native shrub from 1 to 6 feet tall depending on site conditions and genotype. It occurs as pistillate (female), staminate (male), or more rarely monoecious (female and male) bushes. The species grows in a variety of soil types from valley bottoms and plains to mountainous areas. It is well suited to deep, well-drained sandy soil, sand dunes, gravelly washes, mesas, ridges, and slopes, but vigorous plants have been found in heavy clays as well. It is frequently found intermixed with numerous shrub and grass species. It is primarily found in the 8-16 inch precipitation zones. Fourwing saltbush is one of the most valuable forage shrubs in arid rangelands because of its abundance, accessibility, palatability, size, evergreen habitat, nutritive value, rate of growth, and large volume of foliage. Its leaves, stems, and utricles provide browse in all seasons. It withstands extremely heavy browsing and often appears to be stimulated by use. Research indicates that some ecotypes of this species may resprout following fire. This species is also one of the most important shrubs for use in rehabilitation of depleted rangelands and in soil stabilization projects. It can be established by direct seeding and by bare root and container transplanting. Fall seeding results in the best stands. The cultivar 'Rincon' is a strain best adapted to the warmer-southern big sagebrush and juniper zones but also does well in the more mesic portions of salt desert shrub areas. Another cultivar is 'Wytana', a natural hybrid of fourwing saltbush and Gardner saltbush, with lower stature. It is best adapted to higher elevation northern Great Plains on clayey saline soils. The most recent release by Aberdeen PMC, Snake River Plains Germplasm has better cold tolerance than Rincon and is recommended for southern Idaho, northern Nevada and northern Utah. Wildland seed collection is a common practice and Source Identified seed is recommended when using wildland collected seed. Plant at 1/4-3/4 inch depth. Average seeds per ft^2 at 1 lb/acre rate is 1.2. Not recommended for pure stands. Recommended rate in mixes is approximately 1/4 lb PLS/acre of dewinged seed.

Saltbush, Gardner or Nuttall (*Atriplex gardneri =A. nuttallii)*
9016134 test material from Bridger, MT PMC

Gardner saltbush is a low growing perennial shrub that is widespread throughout the Intermountain West including salt desert shrublands. It is usually found on saline heavy textured soils in drier sites than sagebrush or fourwing saltbush, but may be in association with them and is most common in areas receiving 6-12 inches of precipitation. On adapted sites, this species establishes and grows rapidly where few other species exist. It is sensitive to over grazing and many sites that historically supported this species are now lost. It produces excellent browse for wildlife and livestock in all seasons. Wildland seed collection is a common practice and Source Identified seed is recommended when using wildland collected seed. Plant at 1/4-3/4 inch depth. Average seeds per ft^2 at 1 lb/acre rate 2.6. Not recommended for pure stands. Recommended rate in mixes is approximately 1/4 lb PLS/acre. It is best to plant Gardner saltbush in separate rows from other species.

Winterfat (*Krascheninnikovia lanata=Ceratoides lanata=Eurotia lanata)*
Northern Cold Desert Germplasm released by Aberdeen PMC, 2001
'Hatch' released by USDA FS, 1985
Open Range Germplasm, released by Bridger, MT PMC, 2002
Winterfat is an erect or spreading native sub-shrub that shows wide variation in stature from dwarf forms less than 8 inches in height to larger forms to 4 feet in height. The dwarf forms are herbaceous above with a woody base; taller forms tend to be woody throughout. Winterfat is most abundant on lower foothills, plains, and valleys with dry saline to alkaline soils that receive 7 inches or more precipitation. Winterfat is a superior nutritious winter browse for livestock and big game. Sheep, cattle, antelope, elk, deer, and rabbits utilize winterfat. Even though it is relatively tolerant to browsing, over grazing has greatly reduced and even eliminated winterfat in some areas. Winterfat seed maintains viability for relatively short periods of time (6 months to 2 years) without special treatment. Seeds require an after-ripening period for maximum germination and germinate best at warm temperatures (77 to 80^{o}F). Winterfat may be established by seed or by transplanting in 9 inch or greater rainfall areas (attempts to establish winterfat in lower rainfall zones commonly fail). Young seedlings are generally vulnerable to spring frosts. The upright variety, 'Hatch', is best adapted to southern ranges and produces rapid growth. The most recent release by Aberdeen PMC, Northern Cold Desert Germplasm has better cold tolerance than past releases and is recommended for southern Idaho, northern Nevada and northern Utah. Bridger PMC released Open Range Selected Germplasm in 2002 for use in the Northern Rocky Mountains and Great Plains. Wildland seed collection is a common practice and Source Identified seed is recommended when using wildland collected seed. Average seeds per ft^2 at 1 lb/acre rate is 2.8. Not recommended for pure stands. Recommended rates in mix are approximately 1/40 lb PLS/acre.

Kochia, Forage (*Kochia prostrata)*
'Immigrant' released by USDA FS, 1984
A semi-evergreen perennial sub-shrub introduced from southern Eurasia. On many desert and semidesert ranges, in Russia, it is considered a valuable forage shrub often associated with crested wheatgrass. It has been seeded in the Western United States for many years as a forage and reclamation plant on semiarid locations.

Forage kochia is adapted to basic soils but not suitable for neutral or acid soils. Successful plantings have occurred on soils ranging from sandy loam to heavy clay, with the most successful plantings on heavier soils. This shrub develops a fibrous root system with a large deep taproot, and has been established in areas that receive 5 to 27 inches of annual precipitation.

Forage kochia has demonstrated its adaptability to the juniper, basin big sagebrush, Wyoming big sagebrush, and greasewood-shadscale habitats. Important characteristics: ability to establish and persist on disturbed harsh soils, high salinity and drought tolerance, tolerance of extreme temperatures (-25^{o}C to 104^{o}C), low oxalate levels (lower than winterfat and fourwing saltbush), ability to spread slowly from seed, high seed production, moderate shade tolerance, fair palatability for livestock and big game, food and cover for upland game birds, good fire tolerance, compatibility with other perennials, competitiveness with annuals, and ability to increase fall and winter forage quality of perennial grass stands. The lower one-third of the plant remains green and succulent year around. The upper stems and seed stalks turn brown to red and dry after seed shatter (November to December).

Protein content during winter (upper dry stems 6%, lower green stems 8-9%) is higher than what occurs in antelope bitterbrush and true mountain mahogany. Summer protein content has been found to be over 13%. Sheep and deer find this shrub palatable year around. When established in annual communities such as halogeton or cheatgrass, forage kochia can compete with annuals by reducing their dominance, density, forage, and seed production. In perennial communities, this shrub fills in interspaces but has not been observed to reduce the density of established perennials.

It is compatible in mixtures with drought tolerant grasses. Direct seeding on rangeland is best accomplished in the fall or winter by broadcasting on top of disturbed or undisturbed soil. Seed viability is generally limited to one year and use of fresh seed with a current germination analysis is highly recommended. If drill seeded, seed should not be seeded deeper than 1/16-inch. Seeding can be in combination with other perennial species. One cultivar, 'Immigrant' has been released. Average seeds per ft^2 at 1 lb/acre rate is 9.0. Recommended full seeding rate is 1 lb/acre. It is not recommended for pure stands. Recommended rates in mix is approximately 1/40 lb PLS/acre.