Great Basin Native Plant Selection and Increase Project FY05 Progress Report

USDI Bureau of Land Management Great Basin Restoration Initiative
USDA Forest Service, Rocky Mountain Research Station,
Shrub Sciences Laboratory, Provo, UT and Boise, ID
Utah Division of Wildlife Resources, Great Basin Research Center, Ephraim, UT
USDA Agricultural Research Service, Forage and Range Research Laboratory, Logan, UT
USDA Agricultural Research Service, Bee Biology and Systematics Laboratory, Logan, UT
Utah Crop Improvement Association, Logan, UT
Association of Official Seed Certifying Agencies, Moline, IL
USDA Natural Resources Conservation Service - Idaho, Utah, Nevada,
and the Aberdeen Plant Materials Center, Aberdeen, ID
Brigham Young University, Provo, UT
USDA Forest Service, National Seed Laboratory, Dry Branch, GA
Colorado State University Cooperative Extension, Tri-River Area, Grand Junction, CO
USDA Agricultural Research Service, Western Regional Plant Introduction Station, Pullman, WA
Oregon State University, Malheur Experiment Station, Ontario, OR
USDA Agricultural Research Service, Eastern Oregon Agricultural Research Center, Burns, OR

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March 2006

COOPERATORS

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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 2001-2006 Interior Appropriations Bills, 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 Laboratory, Logan, UT; USDA Agricultural Research Service, Bee Biology and Systematics Laboratories, 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.

This document provides a review of work completed in 2005. 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 and the seed, seed production and seeding technology required for using them.

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. 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 for in-house funding. No indirect charge is assessed on pass-through funds to cooperators as of FY05 (12% was assessed from FY02-04). 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.

Acknowledgments

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 and use. A special thanks to Ann DeBolt, Danielle Scholten, and Jan Gurr for assistance in compiling this report.

Nancy Shaw, Team Leader
Great Basin Native Plant
Selection and Increase Project

Mike Pellant, Coordinator
Great Basin Restoration Initiative

Table of Contents

APPENDICES

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 and Contact Information:

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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).

Project Status:

Development of field locations:
Lucky Peak Nursery. A 0.5 acre site was leased through an agreement with Lucky Peak Nursery. The site was prepared for planting in October 2005.

Lucky Peak Shrub Garden. The rush skeletonweed (*Chondrilla juncea*) control project is being continued in this 16-ha enclosure administered by the Boise National Forest. Spot treatments of herbicide were applied as needed on sites previously treated and an additional 2 ha were given initial treatments in 2005.

Orovada. A 2-ha area was sprayed with Round-up in spring 2005 in preparation for future common garden plantings. The existing 2-ha exclosure fence was reconstructed to ensure livestock exclusion.

Seed collections. We collected 153 seed lots of 17 species in 2005. This included 140 collections of Boise research species, six collections of Ephraim and Provo research species, and 9 collections for the AOSCA project. We emphasized larger collections in 2005 for our research, for Oregon State University Malheur Field Station irrigation and herbicide studies, and for the NRCS Aberdeen Plant Materials Center for seed increase.

Status of research species.

Penstemon spp.
In 2005, we made 23 field collections of *P. acuminatus* (5.5 kg seed), 19 of *P. deustus* (1.9 kg seed), and 21 of *P. speciosus* (2 kg seed).

Phenology, morphology, and growth data were collected from irrigated common gardens established in 2003 at Snavely's (*P. deustus*, *P. speciosus*) and in 2004 at Boise State University (*P. speciosus*). Data were also collected at dryland common gardens established in 2004 at Niagra Springs (*P. acuminatus*), Orovada (*P. speciosus*), and the Orchard Research site (*P. acuminatus*, *P. deustus*). *P. acuminatus*, a species adapted to sandy soils, died out during the winter of 2004-2005 at two irrigated common garden sites (Geertson's, Snavely's), possibly because the soils were not well drained enough. The following table summarizes our *Penstemon* common garden status.

Species	Site Name	Irrigated/Wildland (I or W)	Planting Year(s)
Penstemon acuminatus	Geertson, Niagra, Orchard	I, W, W	2003, 2004, 2004
P. deustus	Snavely, Orchard	I, W	2003, 2004
P. speciosus	Snavely, BSU, Orovada, Orchard	I, W, I, W	2003, 2004, 2004, 2006

A limited amount of insect sampling (diurnal and nocturnal) was conducted at common garden and wildland sites. Insects were sent to project cooperators Bob Hammon (Colorado State University Extension Office) and Jim Cane (ARS Bee Biology & Systematics Laboratory) for determination and an assessment of their potential effect (beneficial or adverse) on a given species.

Container stock of *P. speciosus* is being grown at the Lucky Peak Nursery greenhouse in winter 2005/2006 for a 2006 spring common garden planting at the Orchard Research Site.

Lomatium spp.
In 2005, we made 34 field collections of *L. dissectum* (30.7 kg seed), 14 of *L. grayi* (9.2 kg seed), and 15 field collections of *L. triternatum* (1.7 kg seed).

Morphology and growth data were collected from irrigated common gardens established by direct sowing all 3 *Lomatium* species (*L. dissectum, L. grayi, L. triternatum*) in fall 2004 at growing fields managed by the Horticulture Program at Boise State University. No flowering occurred during the first growing season but most accessions appeared to establish and grow.

Fall 2005 plantings:

> Lucky Peak Nursery (irrigated): *L. dissectum* common garden, direct sown.
> Lucky Peak Nursery (irrigated): *L. dissectum* direct sown for bare root seedling production and transplanting to Orchard Research Site (dryland) in fall 2006.
> Lucky Peak Nursery (irrigated): As a pilot project, 2 accessions each of *L. grayi* and *L. triternatum* were direct sown for bare root seedling production and transplanting to Orchard Research Site in fall 2006.

The following table summarizes our *Lomatium* common garden status.

Species	Site Name	Irrigated/Wildland (I or W)	Planting Year(s)
Lomatium dissectum	BSU, Lucky Peak, Orchard	I, I, W	2005, 2005, 2006
L. grayi	BSU, Lucky Peak	I, I	2005, 2005
L. triternatum	BSU	I	2005

***Lomatium* Seed Physiology, Germination, and Seedling Establishment**
Melissa Scholten (RMRS), Marcelo Serpe (Boise State University), Nancy Shaw (RMRS)

- *Lomatium dissectum, L. grayi, L. triternatum* prechilling requirements – studies completed.

Ongoing:

- *Lomatium dissectum*
- Development of surface sterlization procedure
- Seed physiology – embryo development during prechilling, endosperm breakdown
- Effects of afterripening, warm stratification, prechilling and combinations on seed germination
- Environmental factors affecting germination and seedling establishment
- Factors inducing secondary dormancy and seedbank development

***Eriogonum umbellatum*.**
In 2005, we made 14 field collections of *E. umbellatum* (1.7 kg seed). Container stock of *E. umbellatum* is being grown at the Lucky Peak Nursery greenhouse in winter 2005/2006 for a 2006 spring common garden planting at Lucky Peak Nursery where it would be irrigated.

Revegetation Equipment Catalog

- Catalog completed by Harold Wiedemann (retired Texas A&M), edited by N. Shaw
- Catalog is online (www.reveg-catalog.tamu.edu) and will be updated quarterly
- 2006 emphasis will be on publicity for the website

Collaborative Research Initiated:

<u>Crested Wheatgrass Diversification</u>
Field studies in Utah and Oregon initiated
Cooperators:

- Brigham Young University (Bruce Roundy, Val Jo Anderson, Brad Jessup, Robert Anderson)
- USDA ARS Eastern Oregon Agricultural Research Center (Jane Mangold, Clare Poulson)
- USDA NRCS Aberdeen Plant Materials Center (Loren St. John, Brent Cornforth)
- Truax Company (Jim Truax)
- Field studies in Nevada will be initiated in 2006 by University of Nevada – Reno (Kent McAdoo)

National Seed Laboratory

- Seed germination protocols
  Seed cleaning protocols (*Chaenactis douglasii, Erigeron pumilus, Balsamorhiza hookeri, Crepis occidentalis*)
- Long-term storage requirements for selected forbs
- Seed harvesting equipment for selected forbs
- Ex-situ germplasm conservation

USDA ARS LARRL

Competitive dynamics among crested wheatgrass and native forbs and grasses

Publications:

Burgess, L. M.; Hild, A. L.; Shaw, N. L. 2005. Capsule treatments to enhance seedling emergence of *Gaura neomexicana* ssp. *coloradensis*. Restoration Ecology 13: 8-14.

Parkinson, H.; DeBolt, A. 2005. Eleven plant propagation protocols prepared for the UI Native Plants Network (http:/nativeplants.for.uidaho.edu.network). Species: *Penstemon acuminatus, P. deustus, P. speciosus, Eriogonum umbellatum, E. microthecum, Lomatium dissectum, L. grayi, L. triternatum, Lithospermum ruderale, Machaeranthera canescens, Chaenactis douglasii.*

Shaw, N. L.; Haferkamp, M. R.; Hurd, E. G. 2004. *Grayia spinosa* (Hook.) Moq. In: Francis, J. K., ed. Wildland shrubs of the United States and its territories: thamnic descriptions: vol.1. Gen. Tech. Rep. IITF-GTR-26. San Juan, PR: U.S. Department of Agriculture, Forest Service, International Institute of Tropical Forestry, and Fort Collins, CO: U.S. Department of Agriculture, Rocky Mountain Research Station: 361-362.

Shaw, N. L.; Pendleton, R. L.; Hurd, E. G. 2004. *Zuckia brandegei* (Gray) Welsh & Stutz ex Welsh. In: Francis, J. K., ed. Wildland shrubs of the United States and its territories: thamnic descriptions: vol.1. Gen. Tech. Rep. IITF-GTR-26. San Juan, PR: U.S. Department of Agriculture, Forest Service, International Institute of Tropical Forestry, and Fort Collins, CO: U.S. Department of Agriculture, Rocky Mountain Research Station: 806-807.

Shaw, N. L.; DeBolt, A. M.; Rosentreter, R. 2005. Reseeding big sagebrush: techniques and issues. In: Shaw, N. L.; Monsen, S. B.; Pellant, M., comps. Sage-grouse habitat restoration symposium proceedings. Proc. RMRS-P-38. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: 99-108.

Shaw, N. L., Lambert, S. M.; DeBolt, A. M.; Pellant, M. 2005. Increasing native forb seed supplies for the Great Basin. In: Dumroese, R. K.; Riley, L. E.; Landis, T. D., tech. coords. National proceedings: Forest and Conservation Nursery Associations – 2004. Proc. RMRS-P-35. Fort Collins, CO: U. S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: 94-102.

Shaw, N. L.; Monsen, S. B.; Pellant, M., comps. 2005. Sage-grouse habitat restoration symposium proceedings; Boise, ID. Proc. RMRS-P-38. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 130 p.

Shaw, N. L.; Monsen, S. B.; Pellant, M. 2005. Sage-grouse habitat improvement symposium. (Introduction). In: Shaw, N. L.; Monsen, S. B.; Pellant, M., comps. Sage-grouse habitat restoration symposium proceedings. Proc. RMRS-P-38. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: 1-2.

Walker, S. C.; Shaw, N. L. 2005. Current and potential use of broadleaf herbs for re-establishing native communities. In: Shaw, N. L.; Monsen, S. B.; Pellant, M., comps. Sage-grouse habitat restoration symposium proceedings. Proc. RMRS-P-38. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: 56-61.

Wiedemann, H. 2005. Revegetation Equipment Catalog. Shaw, N. L., ed. Rangeland Technology and Equipment Council, BLM Great Basin Restoration Initiative and UDA-FS RMRS Great Basin Native Plant Selection and Increase Project. Online: http://reveg-catalog.tamu.edu

Presentations:

DeBolt, A. 2005. Landscaping with native plants. Boise State University Renaissance Institute, Extended Studies Office, Boise, ID.

DeBolt, A. 2005. Landscaping with native plants. Southwest Idaho Birder's Association, Nampa, ID.

DeBolt, A.; Shaw, N. L. 2005. Great Basin native forbs: progress in the development of penstemons, biscuitroots, and buckwheat. Ecology and management of pinyon-juniper and sagebrush communities, Montrose, CO: Uncompaghre Plateau Project: 78.

Rosentreter, R.; DeBolt, A. 2005. Restoring vegetation structure and diversity on rangelands. Department of Integrative Biology, Brigham Young University, Provo, UT.

Shaw, N. L. 2005. Developing native plant materials for the Great Basin and sagebrush steppe. In: 2005 Idaho Rare Plant Conference; Boise, ID. Boise, ID: Idaho Native Plant Society.

Shaw, N. L. 2005. Invasive species and native plants. Workshop - managing the desert. Desert Studies Institute, Boise State University, Boise, ID.

Shaw, N. L.; Lambert, S. M. 2005. Progress in the development and use of native species for community restoration in the interior West. In: Ecology and management of pinyon-juniper and sagebrush communities; Montrose, CO: Uncompaghre Plateau Project: 29.

Workman, B.; Parkinson, H.; DeBolt, A. 2005. Native turf alternatives for Idaho homeowners. Idaho Earth Institute, Boise, ID.

Technology Transfer

Fact Sheets and Brochures

Fact Sheets (DeBolt):

a. Shrubland Biology and Ecology - Boise

b. Shrubland Biology and Ecology Publications - Boise

c. Shrubland Biology and Ecology Publications – Boise & Provo

U.S. Department of Agriculture, Forest Service. 2005. Great Basin Native Plant Selection and Increase Project. Boise, ID: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 2 leaves, revised. (brochure, DeBolt)

Poster presentations

DeBolt, A.; Shaw, N. L. 2005. Native beardtongue, biscuitroot, and buckwheat for southern Idaho restoration. Presented at:

a. Great Rift Science Symposium; Pocatello, ID.

b. Inland Northwest Restoration Conference; Pullman, WA.

Shaw, N. L.; McArthur, E. D.; Jensen, S.; DeBolt, A.; Meyer, T.; Vernon, J.; Walker, S.; Johnson, R.; Roundy, B; Anderson, V. J. 2005. Development of native forbs for the Great Basin. Presented at:

a. Idaho Wildlife Society Annual Meeting, Boise, ID.
b. USDA Forest Service Region 4 Integrated Resources Workshop: Working Together Towards Healthy Forests, Ogden, UT.
c. USDA Forest Service, Regional Training Academy, University of Montana; Missoula, MT.

Shaw, N. L., Pellant, M. 2005. The Great Basin Native Plant Selection and Increase Project: A collaborative research effort. In: Ecology and management of pinyon-juniper and sagebrush communities; Montrose, CO: Uncompaghre Plateau Project: 79. Also presented at:

a. Great Rift Science Symposium; Pocatello, ID
b. Inland Northwest Restoration Conference; Pullman, WA.

Meetings, Committees and Field Tours - Planning and Participation

DeBolt: Gave overview presentation on GBNPSIP and led tour of native forb study and production fields for Oregon State University, Malheur Experiment Station Field Day, Ontario, OR.

DeBolt: Attended Western Regional AOSCA Annual Meeting; Las Cruces, NM.

Shaw and DeBolt: Arranged tour (May 3-11) to visit field sites and GBNPSIP cooperators for Dr. Shen Xihuan, Beijing Forestry University; Dr. Zhuang Weiling, Jianxi Agricultural University, and Bob Karrfalt, USDA-FS State and Private Forestry.

Shaw and DeBolt**:** Provided research updates at the Tri-state Interagency Plant Materials Committee annual meeting, Provo and Ephraim, Utah.

Shaw: Planning committee for WERA21 meeting and field tour, Lucky Peak Nursery and Reynolds Creek Watershed.

Shaw and E. D. McArthur: Organized and conducted a half-day symposium "Development of Native Plant Materials for the Great Basin" for the Society for Range Management 58th Annual Meeting, Fort Worth, TX. Twelve papers were presented providing an update on activities of the Great Basin Native Plant Selection and Increase Project.

Shaw: Attended National Seed Laboratory Advisory Group meeting, Macon, GA.

Training sessions

Shaw: Instructor for Class 1730-12 Selecting Native Plant Material to Meet Management Goals, Salt Lake City, UT, sponsored by BLM National Training Center.

Website

DeBolt: Continued website development for Shrub Lab-Boise and Great Basin Native Plant Selection and Increase Project.

Project Title: Forb and Shrub Genetics Research

Project Location: USDA Forest Service, Shrub Sciences Laboratory, Provo, UT

Principal Investigators and Contact Information:

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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).

Project Description:
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.

Project Status:
Isozymes (Hipkins)**:** Nineteen species have been examined so far, [*Artemisia tridentata, Astragalus utahensis, Atriplex canescens, Balsamorhiza sagitatta, Bromus carinatus, Chrysothamnus nauseosus (Ericamreria nauseosa), Crepis acuminata, Erigeron pumilus, Eriogonum umbellatum, Lomatium dissectum, L. grayi, Lupinus argenteus, L. sericeus, Penstemon deustus, P. speciosus, Phlox longifolia, Stipa comata, Vicia americana, and Viguiera multiflora (Heliomeris multiflora)*].

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.

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.

The work of the above studies is progressing toward a summary status. The first significant output will be a Rocky Mountain Station General Technical Report summarizing all the collection and research information. From that summary more detailed publications will be developed and submitted to peer reviewed outlets. The methods were reported in previous annual reports.

Development, culture, and characterization of selected native forbs for Intermountain Region National Forest System lands: This is a new complementary study funded by the National Forest Systems Native Plant Earmark program. Durant McArthur and Susan Meyer are the principal investigators. The species being studied are *Potentilla gracilis, Castilleja miniata, Geranium richardsonii, Eriogonum heracleoides, Polemonium viscosissimum, Mertensia ciliata, Iliamna rivularis, Erigeron speciosus, Delphinium occidentale,* and *Chamerion angustifolium*.

Publications:
Garcia, S.; Sanz, M.; Garnatje, T.; Kreitschitz, A.; McArthur, E. D.; Vallès, J. 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 transfer guidelines. Native Plant Journal 5:141-147.

McArthur, E. D. 2005. Sagebrush, common and uncommon, palatable and unpalatable. Rangelands 27(4): 47-51.

McArthur, E. D.; Monsen, S. B. 2004. Chenopod shrubs. p. 467-492 *In* S. B. Monsen, R. Stevens, and N. L. Shaw (compilers). Restoring western ranges and wildlands. General Technical Report RMRS-GTR-136-volume 2. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

McArthur, E. D.; Stevens, R. 2004. Composite shrubs. p. 493-537 *In* S.B. Monsen, R. Stevens, and N. L. Shaw (compilers). Restoring western ranges and wildlands. General Technical Report RMRS-GTR-136-volume 2. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

McArthur, E. D.; Taylor, J. R. 2004. *Artemisia arbuscula* Nutt. p. 47-49. *In* J. K. Francis (ed.). Wildland Shrubs of the United States and its territories: thamnic descriptions: volume 1. General Technical Report IITF-GTR-26. U.S. Department of Agriculture, Forest Service, International Institute of Tropical Forestry, San Juan, PR and Rocky Mountain Research Station, Fort Collins, CO.

McArthur, E. D.; Taylor, J. R. 2004. *Artemisia bigelovii* Gray. p. 50-51. *In* J. K. Francis (ed.). Wildland Shrubs of the United States and its territories: thamnic descriptions: volume 1. General Technical Report IITF-GTR-26. U.S. Department of Agriculture, Forest Service, International Institute of Tropical Forestry, San Juan, PR and Rocky Mountain Research Station, Fort Collins, CO.

McArthur, E. D.; Taylor, J. R. 2004. *Artemisia cana* Pursh. p. 57-59. *In* J. K. Francis (ed.). Wildland Shrubs of the United States and its territories: thamnic descriptions: volume 1. General Technical Report IITF-GTR-26. U. S. Department of Agriculture, Forest Service, International Institute of Tropical Forestry, San Juan, PR and Rocky Mountain Research Station, Fort Collins, CO.

McArthur, E. D.; Taylor, J. R. 2004. *Artemisia frigida* Willd. p. 63-65. *In* J. K. Francis (ed.). Wildland Shrubs of the United States and its territories: thamnic descriptions: volume 1. General Technical Report IITF-GTR-26. U.S. Department of Agriculture, Forest Service, International Institute of Tropical Forestry, San Juan, PR and Rocky Mountain Research Station, Fort Collins, CO.

McArthur, E. D.; Taylor, J. R. 2004. *Artemisia filifolia* Torr. p. 60-62. *In* J. K. Francis (ed.). Wildland Shrubs of the United States and its territories: thamnic descriptions: volume 1. General Technical Report IITF-GTR-26. U.S. Department of Agriculture, Forest Service, International Institute of Tropical Forestry, San Juan, PR and Rocky Mountain Research Station, Fort Collins, CO.

McArthur, E. D.; Taylor, J. R. 2004. *Artemisia longiloba* (Osterhout) Beetle. p. 66-68. *In* J. K. Francis (ed.). Wildland Shrubs of the United States and its territories: thamnic descriptions: volume 1. General Technical Report IITF-GTR-26. U.S. Department of Agriculture, Forest Service, International Institute of Tropical Forestry, San Juan, PR and Rocky Mountain Research Station, Fort Collins, CO.

McArthur, E. D.; Taylor, J. R. 2004. *Artemisia nova* A. Nels. p. 72-74. *In* J. K. Francis (ed.). Wildland Shrubs of the United States and its territories: thamnic descriptions: volume 1. General Technical Report IITF-GTR-26. U.S. Department of Agriculture, Forest Service, International Institute of Tropical Forestry, San Juan, PR and Rocky Mountain Research Station, Fort Collins, CO.

McArthur, E. D.; Taylor, J. R. 2004. *Artemisia pygmaea* Gray. p. 75-76. *In* J. K. Francis (ed.). Wildland Shrubs of the United States and its territories: thamnic descriptions: volume 1. General Technical Report IITF-GTR-26. U.S. Department of Agriculture, Forest Service, International Institute of Tropical Forestry, San Juan, PR and Rocky Mountain Research Station, Fort Collins, CO.

McArthur, E. D.; Taylor, J. R. 2004. *Artemisia rigida* (Nutt.) Gray. p. 77-78. *In* J. K. Francis (ed.). Wildland Shrubs of the United States and its territories: thamnic descriptions: volume 1. General Technical Report IITF-GTR-26. U.S. Department of Agriculture, Forest Service, International Institute of Tropical Forestry, San Juan, PR and Rocky Mountain Research Station, Fort Collins, CO.

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Presentations:

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Project Title: Toward Selected Releases of *Agoseris, Astragalus, Lupinus, Phlox,* and *Stipa*

Project Location: USDA Forest Service, Shrub Sciences Laboratory, Provo, UT

Principal Investigators and Contact Information:

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Project Description:
Annual wildland seed collections from the Great Basin region beginning in 2002 have amassed numerous accessions of the natives *Agoseris glauca, Astragalus utahensis, Lupinus argenteus, L. sericeus, Phlox longifolia,* and *Hesperostipa comata*. Each species poses a distinctive set of challenges in preparing it 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: At the initiation of the GBNPSIP, specialized planting and harvesting equipment was identified as crucial to the success of the project. Annually, funds were allocated to purchase essential equipment items. To date we have acquired several tractors, a Woodward Flail –Vac, a small plot combine, a hooded row sprayer and a precision cone seeder. Through a Joint Venture Agreement these items were purchased by the USDA Forest Service Shrub Sciences Laboratory and reside at the UDWR'S Great Basin Research Center, Ephraim, UT. For research purposes, these items facilitate wildland seed collection as well as establishment and seed harvest on ecotype evaluation and increase plots. Another primary reason these items were purchased was to assist private individuals in establishing and harvesting plant materials made available through the GBNPSIP. Most private growers specialize in typical agronomic crops and do not have access to equipment best suited to the species this project purports to release. To this end the following equipment items can be loaned to both project cooperators and private growers. Note that research uses receive scheduling priority and the equipment will generally be delivered by an operator who will oversee its use.

Hooded Row Sprayer: This 5 head sprayer has 20" wide hoods covering the spray nozzles. The intended use of the sprayer is weed control between established rows. The sprayer is set for 36" row spacing.

Hege 1000 Series Drill: This 4 cone seeder is adjustable for planting up to 4 rows on 18"or 24"spacing or 3 rows at 36" spacing. Row length is adjustable from approximately 5 to over 100 feet. The seeder is also equipped with 4 individual fluted feed boxes for planting longer rows or banding applications.

Wintersteiger Classic Small Plot Combine: The combine is equipped with appropriate concaves and shakers for harvesting a variety of forbs and grasses and has a 5 ft wide header.

Ag-Renewal Woodward Flail-Vac. The flail-vac is a relatively gentle harvester that removes ripened seed with minimal damage to the plant. This is of particular importance for indeterminate flowering crops where multiple harvests add value. This 6-foot model works best where seed height is relatively uniform.

In 2005 the Shrub Lab's aging 3 tractor fleet was replaced with two new Kubota models of 37 and 45 HP.

Plant Material Evaluation Test Sites: Beginning in 2004, as plant material collections began to approximate the Great Basin distribution of individual species, common gardens were planted to evaluate ecotypes. Prior to these plantings, and annually since, small scale seeding trials have been conducted to evaluate various planting methods and establish increase plots. The following summarizes those efforts.

Fountain Green:
<u>Common Garden Establishment:</u>
Astragalus utahensis – Planted 32 ecotypes from plugs 4/05.
Hesperostipa comata – Planted 32 ecotypes from plugs 5/04. Direct seeded 59 ecotypes 11/05.
Lupinus species-

- *argenteus* –11 ecotypes direct seeded 11/05.
- *arbustus* – 14 ecotypes direct seeded 11/05.
- *caudatus* – 5 ecotypes direct seeded 11/05.
- *polyphyllus* – 2 ecotypes direct seeded 11/05.
- *sericeus* – 3 ecotypes direct seeded 11/05.

<u>Increase Plots- Project priority species:</u>
Astragalus utahensis - Transplanted 04/05.
Phlox longifolia – Transplanted 11/04

<u>Increase Plots- Opportunistic collections:</u>
2005 Direct Seed- *Enceliopsis nudicaulis, Penstemon pachyphyllus, Penstemon palmeri, Cleome lutea.*
2004 Direct Seed- *Ipomopsis aggregata, Heliomeris multiflora, Penstemon palmeri, Packera multilobata, Penstemon pachyphyllus, Crepis intermedia, Lupinus arbustus, Enceliopsis nudicaulis, Oenothera elata*.
2004 Transplants- *Ipomopsis aggregata, Enceliopsis nudicaulis, Oenothera elata.*

<u>Other studies:</u>
Astragalus utahensis fungal study field trials planted in cooperation with Dr. Brad Geary of BYU.

Nephi, UT:
<u>Common Garden Establishment:</u>
Tragopogon dubius – 22 ecotypes transplanted 03/04. Seed production volume and ripening phenology monitored. Plants harvested for biomass study.
Hesperostipa comata – 34 ecotypes transplanted 12/04. Poor establishment – removed. 59 ecotypes direct seeded 11/05.

<u>Increase Plots- Project priority species:</u>
2004 Broadcast and Rake-*Tragopogon dubius, Agoseris aurantiaca, Lupinus arbustus.*

<u>Increase Plots- Opportunistic collections:</u>
2004 Direct Seed- *Ipomopsis aggregata, Packera multilobata, Penstemon palmeri, Heliomeris multiflora, Penstemon pachyphyllus, Crepis intermedia, Enceliopsis nudicaulis.*
2004 Broadcast and Rake - *Heliomeris multiflora.*

Wells, NV:
<u>Common Garden Establishment:</u>
Astragalus utahensis – 12 ecotypes transplanted 04/04
Phlox longifolia – 7 ecotypes transplanted 10/04
Hesperostipa comata – 40 ecotypes transplanted 10/04
Tragopogon dubius – 22 ecotypes transplanted 03/04. Seed production volume and ripening phenology monitored. Plants harvested for biomass study.

The Wells site will be expanded in size by 5 acres in 2006.

Orovada, NV:
<u>Common Garden Establishment:</u>
Hesperostipa comata –17 ecotypes transplanted 03/05
Tragopogon dubius – 22 ecotypes transplanted 03/04. Seed production volume and ripening phenology monitored. Plants harvested for biomass study.

This site is located in a fire tract dominated by annual weeds and grasses. Plant survival has been less than desirable for most species planted or transplanted here and weed control continues to be a difficult task. All unplanted areas were tilled and seeded with Sandberg bluegrass in the spring of 2005 in an effort to reclaim the site from weeds and reestablish a more diverse soil microflora. Future plots will be established by tilling appropriately sized parcels within the Sandberg bluegrass planting.

Ely, NV:
A new 10 acre test site will be established near the Hwy 6/318 Junction west of Ely, NV in 2006. The Ely BLM office is assisting with clearances and preparations.

Container Propagation Protocols: This work is structured as a joint venture agreement between the Shrub Sciences Lab (Susan Meyer, Scott Jensen) and Brigham Young University (Phil Allen, Brad Geary). Overall objectives were outlined in last year's annual report.

Progress has been made in each work area. In the spring-ephemeral perennials section, several *Agoseris* species were successfully reared to flowering in a greenhouse setting. In the native perennial legumes section, nodulation was achieved with *Astragalus utahensis* in pots using native soil as a carrier for rhizobium, and potting media are being screened for acceptance by *Lupinus and Phlox*. Other aspects of the study are ongoing.

Individual Species Status:
***Agoseris glauca*:** 2005 efforts with this species were threefold - to increase the geographic representation of collected materials, initiate work on container propagation protocols, and increase several existing lots through plantings at Fountain Green and Nephi.

A number of new sites and seed collections were added in 2005, particularly from western Nevada, helping to better represent the geographic distribution of the genus. Container trials were successful in rearing three *Agoseris* species to flowering in a greenhouse this spring. Broadcast seeded increase plots planted last fall at Fountain Green and Nephi, UT failed to establish.

Efforts in 2006 will focus on locating additional sites, making more seed collections, additional trials and replication of container propagation protocol studies, and establishing increase plots with transplanted plugs.

***Astragalus utahensis*:** 2005 efforts with this species were to plant additional common gardens with transplanted stock, establish an increase/harvest plot as part of the container propagation protocols series of studies to evaluate seedling establishment and survival using rhizobium and mycorrhizal treatments, and to evaluate several species of fungi as germination accelerators.

Survival of container grown stock permitted establishment of one additional common garden at Fountain Green, UT. The increase/harvest plot was eaten by deer and will be reestablished in 2006. In the container propagation studies, nodulation was achieved using native soil as a source of rhizobium. Establishing this allows further work in this area.

A brief outline of the fungal interaction work and early results are noted below:
Increased germination of *Astragalus utahensis* with *Aspergillus* and *Alternaria* fungi. **–**
Joint venture research between the Shrub Sciences Lab and Brigham Young University.
Sean Eldredge, Brad Geary, Scott Jensen and John Gardner.

The quick germination and establishment of some invasive plant species frequently hamper revegetation of burned areas by native species. Use of a natural promoter to accelerate germination of native plants would augment their competitive abilities against invasive species, allowing quicker growth and establishment in the post-fire ecosystem. The purposes of the studies undertaken were: 1) to delineate a germination response relationship manifest when seeds of *Astragalus utahensis*, a native Utah plant potentially useful in revegetation projects, are inoculated with two separate fungi isolated from *A. utahensis* seeds, and 2) to define the nature of this interaction by tracking the triggering mechanisms (chemical or physical) and their origins (fungal or seed). Fungi from the genera *Alternaria* and *Aspergillus* were cultured on artificial media and used to inoculate *A. utahensis* seeds after scarification in sulfuric acid. Germination, counted as radical emergence, was monitored in a sterile, wet environment and recorded. Both fungi accelerated germination percentages by at least 10% over the control seed. The majority of *Aspergillus* treatments accelerated germination by at least 19% and *Alternaria* by at least 60%. Preliminary light microscopy points to fungal penetration as the triggering mechanism for accelerated germination. Groundwork tests show that there is no chemical trigger involved.

Efforts in 2006 will focus on additional common garden establishment through transplanting, continued work evaluating the effects of rhizobium and mycorrhizae, further fungal interaction work, and establishment of a harvest/increase plot to evaluate harvest methods.

***Lupinus*:** Seed of five *Lupinus* species; *L. argenteus, L. arbustus, L. caudatus, L. polyphyllus* and *L. sericeus* have been collected throughout the Great Basin.

Last year's efforts were to locate and collect additional seed sources for all *Lupinus* species, develop methods to successfully rear lupines in containers, and experiment with direct seeding trials.

Numerous additional collections were made and populations identified in 2005. Trials screening lupine tolerance to various potting media were conducted as were methods to scarify seed. Feeding damage by minute insects known as thrips is particularly problematic to young *Lupinus* plants in a greenhouse setting. A single common garden of all *Lupinus* source material was direct seeded at Fountain Green, UT and plugs are being grown to establish a second common garden this spring. Ongoing container propagation work focuses on refinement of container rearing protocols and evaluating mycorrhizal and rhizobium benefits to establishment, survival and seed set of *Lupinus* spp.

Phlox longifolia: 2005 objectives with this species focused on augmenting seed collections, establishing additional common gardens, and refining container propagation protocols. This was a poor year for progress on *Phlox*. While flowering was generally abundant, native populations throughout the region set little seed. A complete failure occurred with greenhouse grown transplant stock while trying a new technique.

Work in 2006 will focus on successful rearing of container stock, additional collections, and establishment of increase plots should current attempts at production prove successful.

Tragopogon dubius: End user interest in this species has waned so work has been arrested.

Hesperostipa comata: A major emphasis was placed on collecting additional populations of this grass in 2005. A series of seed biology studies were completed and common gardens were both direct seeded and transplanted at several sites in 2005.

In 2006 we expect to add more collections particularly from the southern and western portions of the Great Basin and evaluate materials at common garden sites.

Presentations:
Jensen. S. L. 2005. Plant Materials in the Pipeline from the Great Basin Native Plant Selection and Increase Project. Southeast Idaho Environmental Network. Pocatello, ID.

Technology Transfer:
Jensen, S.L., V.J. Anderson. 2004. The Road to Release for *Astragalus utahensis*. Ecology and Management of Pinyon-Juniper and Sagebrush Communities, Montrose, CO.

Jensen, S.L., T. Thompson, J. Vernon. Using Technology to Organize Plant Materials Collecting Tasks. Ecology and Management of Pinyon-Juniper and Sagebrush Communities, Montrose, CO.

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

Principal Investigators and Contact Information:

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Project Description:
Selection, testing and development of adapted plant species and/or ecotypes for improving wildlife habitat in Utah.

Species: Arrowleaf balsamroot (*Balsamorhiza sagittata*), Biscuitroot or yampah *(Perideridia bolanderi),* Stinking lomatium (*Lomatium graveolens* var. *graveolens*), Globemallows (*Sphaeralcea grossulariifolia*, *S. parvifolia*, and *S. coccinea*), Cushion buckwheat (*Eriogonum ovalifolium*), Tapertip hawksbeard (*Crepis acuminata*), Northern and Western Sweetvetch (*Hedysarum boreale*, *H. occidentale*), Great Basin wildrye (*Elymus cinereus*), and Bluebunch wheatgrass (*Pseudoroegneria spicata*).

Project status:
Collection and Testing: We continued work on field identification, mapping, collection and testing of plant materials and native plant seed increases. GBRC staff made 83 wildland seed collections in 2005 of 24 species of forbs and grasses in Utah and Nevada, totaling approximately 3.2 kilograms of cleaned seed. The addition of a collector specifically targeting western Nevada (Roger Mongold) allowed GBRC staff to focus our collections in Utah and eastern Nevada. Our cooperators collected another 3 kilograms of our species. The goal was to take advantage of the good precipitation that occurred prior to the growing season in collecting as much seed of known accessions as possible, and to expand the collections to include new sites when appropriate.

Seed cleaning, inventory, and database work was continued. The database now registers 850 collections of 44 species of forbs and grasses. During this reporting cycle we transferred our database into Access, a software program with greater speed and capacity than the HanDBase system we had been using.

In-house germination tests were completed on the following: *C. acuminata* --33 accessions; *E. ovalifolium* --19 accessions; *B. sagittata* —7 accessions; Apiaceae including *P. bolanderi* --12 accessions; *Sphaeralcea* (S. *grossulariifolia* , *S. parvifolia* , *S. coccinea*)--32 accessions. These tests were conducted both to determine viability levels to guide seeding rates in plantings, and to experiment with dormancy-breaking treatments. Three lots of *C. acuminata* seed were sent to the State Seed Laboratory to test viability, purity, and weed seed content and to evaluate their suitability for the AOSCA program.

Our studies have shown that these forbs require cold moist seed stratification in order to break seed dormancy (if not specified, treatment was incident light):
C. acuminata: 5 weeks 4°C dark moist chill; then 15° C light
B. sagittata: 8-19 weeks continuous 4°C moist chill
E. ovalifolium: 4-8 weeks in dark 4°C moist chill; then 15° C alt. 12 hr light, 12hr dark
Lomatium graveolens var. *graveolens*: 10-16 weeks continuous 4°C moist chill
P. bolanderi: 10-16 weeks continuous 4°C moist chill

Our studies have shown that these species germinate without pretreatment: S. *grossulariifolia*, *S. parvifolia*, *S. coccinea*, *H. boreale*, *H. occidentale*.

Our experience has also demonstrated that if *B. sagittata* and *C. acuminata* seedling plugs go into dormancy (lose leaves and fail to re-grow leaves) in the greenhouse, they require several weeks of ~5°C chilling to break root dormancy so that they begin to leaf out again. Dormant plugs (healthy roots; no leaves) planted in the field in early March or mid-May in Sanpete County, Utah, did not leaf out. Similar plugs placed into a ~5°C cold-room leafed out after 4 weeks.

Field trial common gardens: Greenhouse propagation for common gardens continued and several trials were planted: Plug seedlings were produced in the greenhouse for field trials of *Sphaeralcea* (32 accessions), *Eriogonum* (22 accessions), *Balsamorhiza* (18 accessions), *Crepis* (23 accessions), *Lomatium* and *Perideridia* (8 accessions). Seedlings were either generated from germination tests, or from stratification of seed in the laboratory, which were then planted into flats in the greenhouse, or seed was directly sown into flats. The plugs were planted in Ephraim at the Snow College field and in Fountain Green at the WMA from March to May, 2005. Accessions were planted in five random repeat blocks when sufficient plants were available. Plots were 21 ft. long on 2.5 ft centers and plugs were planted either 1 or 2 feet apart, depending on species. A deer exclosure fence was completed around 25 acres of the Fountain Green WMA to protect experimental plantings from predation. Both areas have sprinkler irrigation capability.

We also planted several direct seeded common gardens in Fountain Green, and one small plot in the Wells, NV exclosure. Of six species groups planted, only *Hedysarum* germinated well in the first year and I was able to get some trait data from the trial.

A large trial plot of bluebunch wheatgrass using plug transplants produced by the ARS was successfully established at the Wells, NV exclosure in March of 2005.

Seeding Technology: 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. The above-described dormancy-breaking studies fulfill part of this work. Direct-seeded trials also contribute to this aspect of our knowledge.

At the Fountain Green experimental farm, we direct-seeded a large trial of all research forb accessions in early March of 2005 using the Hege 1000 precision planter. This trial had a design similar to the plug trial. There was not enough cold, wet weather after the planting to successfully stratify the seed, so, except for *Hedysarum*, there were very few germinants during the year. We attempted to repeat this planting in Wells, Nevada in March and April 2005, but between finding the ground frozen, and then a few weeks later finding the ground too dry, with little expectation of rain, we scaled this planting down to one row of each forb species. This Nevada trial also resulted in only *Hedysarum* germinating. These trials were maintained (weeded, irrigated) with the hope that some of the seed will germinate in the spring of 2006. The experiences with direct-seeding correlate well with my laboratory experiments on stratification requirements of the species as put forth above.

Seed Increase and Cooperator Studies: Seed and/or seedlings/plugs were distributed to cooperators and other entities to be used for seed increase and research purposes:

a) Janett Warner of Wildland Nursery in Joseph, UT, for research seed increase: *Sphaeralcea grossulariifolia* and *Perideridia bolanderi* seedlings/plugs and *Crepis acuminata* seed. She successfully stratified the CRAC seed and has seedling plugs growing in the lath house for field planting in the spring of 2006. The SPGR and PEBO2 plugs were planted out in June 2005 but only a few plants survived.

b) Stan Young of the Utah Crop Improvement Association in Logan, UT. We offered foundation seed to growers as part of the AOSCA seed grower program: CRAC accession U36-04 demonstrated a very high seed viability rate in State Seed Laboratory tests, and was offered to growers. No growers signed up for the seed lot.

c) Lawrence L. Cook, Department of Biological Sciences, Idaho State University: 1000 seeds of CRAC accession B12-03 for a research study on Cesium uptake by native plants for bioremediation of nuclear research sites.

d) Stephen L. Love, University of Idaho, Aberdeen Research & Extension Center: 19 accessions of *Sphaeralcea* for research on use of native plants in home landscaping.

Other Cooperative Projects: About 2100 plants of *Linum lewisii* 'Maple Grove' were grown in our greenhouse for a seed increase field planting in the Fountain Green exclosure. Planted in mid-May 2005, these flowered and produced a small amount of seed during the first season.

Presentations:

January 3, 2006: T. Meyer gave Powerpoint presentation to Utah Native Plant Society in Salt Lake City about the GBNPSIP, including about A. Whittaker's knapweed studies.

Technology Transfer:

February 2005: T. Meyer contributed text and images to a "Weeds of Utah 2006" calendar produced by Skyline Cooperative Weed Management Area and the Castleland Resource Conservation & Development Council, Inc. that is distributed statewide through the Soil Conservation Districts and other agencies. Great Basin Research Center is featured in December with photos of native seed field production and our new seed mixer and seed warehouse storage.

May 4-5, 2005: J. Vernon, A. Whittaker and T. Meyer attended the Tri-State Interagency Plant Materials Committee meeting in Provo, UT, presented an update on our work, and led a tour of our facility and trial plantings in Ephraim.

May 16-17, 2005: J. Vernon attended the Uncompaghre Project meeting in Montrose, CO; T. Meyer prepared two posters: "Response of *Eriogonum* to Light and Stratification Treatments" and "*Elymus cinereus* (Basin Wildrye) Planting Depth Study".

May 26, 2005: T. Meyer attended Utah Weed Awareness Group meeting in Richfield. Their goal is to develop an education campaign for the State of Utah to help curb the spread of noxious weeds.

June 15, 2005: Elaine York of The Nature Conservancy and Janet Gorrell of Utah Division of Wildlife Resources visited our facility to learn what we do here and to explore project funding.

July 20, 2005: Hosted Utah Weed Awareness Group in Ephraim.

August 26, 2005: T. Meyer attended the Utah Weed Awareness Group in Salt Lake City.

September 22, 2005: T. Meyer and A. Whittaker attended the Intermountain Native Plant Collectors and Growers meeting at Snow College organized by Stan Young of the Utah Crop Improvement Association. T. Meyer provided plant specimens from field trials to support Michael Piep's presentation about *Sphaeralcea* identification.

December 12, 2005: T. Meyer met with Panoramaland RC&D in Richfield and talked about growing native seeds as an alternative, high-value crop. Handouts on DWR native seed purchases and use in restoration were prepared and ditributed.

January 10, 2006: T. Meyer prepared and emailed information packets about DWR native seed purchases and use in wildland restoration to Jan Anderson of Utah Farm Bureau and Utah Partners for Conservation, and to Elaine York of The Nature Conservancy.

January 24, 2006: *Perideridia bolanderi* propagation protocol submitted to Native Plant Network database.

February 22-23, 2006: T. Meyer will head a workshop session on growing native seed as a crop at the Third Annual Diversified Agriculture Conference in Cedar City organized by Utah State University Extension.

Project Title: Agronomic and Cultural Care of Wildland Plants

Project Location: Brigham Young University, Provo, UT

Principal Investigators and Contact Information:

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Project Description : There are four components to this study, designed to assist growers of native seed in field establishment and seed production. They include: A) herbicide tolerance evaluations, B) seeding depth studies, C) seeding rate studies, and D) spacing and production methodology development.

A. Herbicide Tolerance:

Project Status: This project is designed to evaluate the sensitivity of native plant species to a broad array of herbicides in order to determine which chemicals can be used for weed control and not damage the native species. In 2005, herbicide trials for *Agoseris glauca, Astragalus utahensis, Crepis acuminata, Eriogonum ovalifolium, Phlox longifolia*, *Sphaeralcea coccinea*, and *Sphaeralcea grossulariifolia* were conducted using the herbicides Axiom® (flufenacet + metribuzine), Poast® (Sethoxydim), Pursuit® (imazethayr), Raptor® (imazomox), and Pendulum® (pendimethalin). Herbicide trials included effects on germinating seeds and effects on seedlings at the second true leaf stage. This new array of chemicals was to augment those trialed in the previous year, namely BuctrilTM (bromoxynil), KarmexTM (diuron), OustTM (sulfometuron-methyl), PlateauTM (imazapic), ProwlTM (pendimethalin), PursuitTM (imazethapyr), and VelparTM (hexazinone). To date a total of 12 herbicides have been wholly or partially evaluated.

Methods used were consistent with other years except for a change in application method**.** Previously, herbicide rates were differentially applied using a single concentration for the "low rate," with repeated application to generate the required volume of active ingredient representing "medium" and "high" rates. In 2005, actual concentrations were prepared eliminating the requirement for repeated application to reach medium and high rates. Herbicide was applied to plant material at three life stages, namely, germinating seeds, seedlings at the second true leaf stages, and mature plants. Seed was prepared for germination by employing an appropriate treatment- either cold stratification or acid scarification in concentrated sulfuric acid. Seed was planted in native soil. Plant material was maintained for 1 month following herbicide application to measure mortality and effects on vigor. Experiments were replicated five times. Plans for 2006 include finishing some herbicide application on mature plants, and filling any data gaps.

B. Seeding Depth

Project Status: This project is designed to identify optimum planting depths for an assortment of native plant species. Two different soils were used to account for differences in soil types expected at regional farmlands. All phases of this project were successfully repeated in 2005. The experimental phase of this project is finished and the results will be prepared for publication in 2006.

C. Seeding Rate

Project Status: This project will evaluate optimal seeding rates of the eight forb species being investigated through this project. Project Status: Seed will be planted for those species which we have available seed as soon as soil is workable late winter 2006. Other species are dependent upon seed availability.

C. Spacing and Production Methodology

Project Status: This project is designed to determine optimal plant spacing, mulching, and irrigation treatments for maximum seed yield. 2005 was the first year when data was collected on mature plants. Three species of *Sphaeralcea (S. cocciea, S. grossulariifolia, S. munroana)* performed very well with abundant seed yield (fig. 1). The other forb species had poor performance with negligible seed yield. Both *Astragalus utahensis,* and *Eriogonum ovalifolium* continue to suffer from high mortality, likely due to their inability to adapt to the clay soils which exist on the farm. *Phlox longifolia* had initial poor establishment, but surviving plants are persisting, though not experiencing vigorous growth or appreciable seed production. Results from initial analysis of the *Sphaeralcea* species indicate high yield potential under agricultural production for all treatments; however, 6-inch within-row spacing (30 in between-row spacing) produces the most seed per acre. Conversely, the largest plant spacing consistently produces the most seed per plant, but the space requirements cannot compensate in production per unit area over closer spacing. Also, the 6-inch spacing had the added benefit of shading out weed competition on bare soil. Mulch treatments were variable in their response depending upon species.

Data will be collect again for all seed producing species in 2006. Plots will receive regular weeding and irrigation.

Figure 1. 2005 results of *Sphaeralcea* seed production (SPCO=*S. cocciiea*; SPGR= *S. grossulariifolia*; SPMU= *S. munroana)*

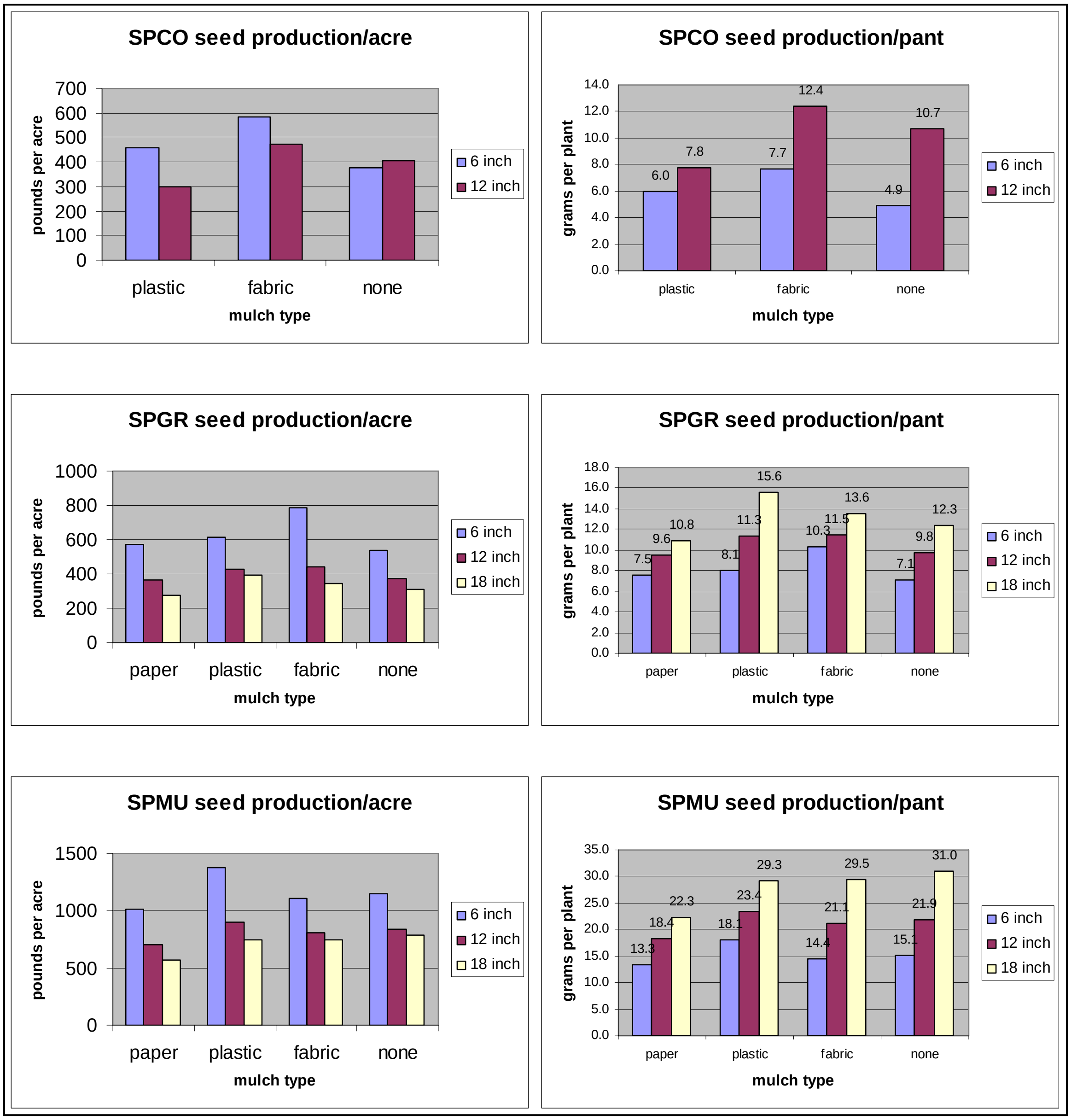

fig. 1

Presentations:

*Johnson, R.L., V.J. Anderson, J. Voss. 2005. *Herbicide resistance of select forbs native to the Great Basin.* BASF 2005 Technical Interchange, San Diego, CA.

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

*Johnson, R.L., V.J. Anderson and B.A. Roundy. 2005. *Investigations into cultural practices to raise native forbs*. Society for Range Management Annual Meeting, Abstract #182, Fort Worth, TX.

Johnson, R.L. and V.J. Anderson. 2003. *Herbicide Effect on Seed Germination, Seedlings, and Mature Plants on Select Native Species,* and *Affects of Soil Type and Seeding Depth on the Emergence of Select Native Species.* Great Basin Native Plant Selection and Increase Project, Salt Lake City, UT.

Taylor, B., R.L. Johnson, V.J. Anderson, B. Roundy. 2005. *Cultural practices on seed production of three Sphaeralcea species.* Utah Section of the Society for Range Management. 2005 Annual Conference, Midway, UT.

*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*. Society for Range Management Annual Meeting, Abstract # 60, Fort Worth, TX.

*denotes published abstracts

Project Title: Subsurface Drip Irrigation for Native Forb Seed Production

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

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Project Description:
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 economically viable commercial production of native forb seed is stable and consistent seed productivity over years. Variations in spring rainfall and soil moisture 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 other seed crops.

Native forbs are not competitive with crop weeds. Both sprinkler and furrow irrigation promote seed production, but risk the encouragement of weeds. Furthermore, sprinkler and furrow irrigation can lead to the loss of plant stand and seed production to fungal pathogens. This project tests buried drip tapes for timely irrigation to supply only limited amounts of water. By burying drip tapes at 30-cm (1-foot) depth, and avoiding wetting of the soil surface, we hope to assure flowering and seed set without encouraging weeds or opportunistic diseases.

Materials and Methods: Seed of the seven forb species (Table 1) was received in late November in 2004 from the Rocky Mountain Research Station (Boise, ID). The plan was to plant the seed in the fall of 2004, but due to excessive rainfall in October, the completion of ground preparation and planting was postponed to 2005. To ensure germination in the spring of 2005, the seed was submitted to a cold stratification treatment. The seed was soaked overnight in distilled water on January 26, 2004. After soaking, the water was drained and the seed soaked for 20 minutes in a 10% by volume solution of 13% bleach in distilled water. The water was drained and the seed placed in a thin layer in plastic containers. The plastic containers had lids with holes drilled to allow air movement. The seed containers were placed in a cooler set at approximately 34 ^{0}F. Every few days the seed was stirred and, if necessary, distilled water added to maintain moisture. In late February, seed of *Lomatium grayi* and *L. triternatum* had started sprouting.

The field was bedded into 30-inch rows. In late February, 2005, drip tape (T-Tape TSX 515-16-340) was buried at 0.3-m (12-inch) depth and spaced 1.52 m (5 feet) apart. The drip tape was buried on alternating inter-row spaces. The flow rate for the drip tape was 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 0.066 inch/hour. Water was filtered through sand media filters and application durations were controlled automatically. Water applied was measured.

On March 3, seed of all species (Table 1) was planted in 30-inch rows using a custom made plot grain drill with disk openers. Two rows of forbs were planted 0.38 m (15 inches) to each side of the drip tape. All seed was planted at 20-30 seeds per foot of row. The *Eriogonum umbellatum* and *Penstemon* spp. were planted at 0.25 inch depth and the *Lomatium* spp. at 0.5 inch depth. The trial was irrigated with a minisprinkler system (R10 Turbo Rotator, Nelson Irrigation Corp., Walla Walla, WA) for even stand establishment from March 4 to April 29. The trial was irrigated on March 4 (5 hours), March 8 (3 hours), March 11 (2 hours), March 14 (2 hours), April 12 (4 hours), April 15 (3 hours), April 26 (4 hours), April 29 (3 hours). Risers were spaced 25 ft apart along the flexible polyethylene hose laterals that were spaced 30 ft apart and the water application rate was 0.10 inch/hour. The drip irrigation system was used in June and July.

Results and Discussion: *Eriogonum umbellatum*, *Lomatium triternatum*, and *L. grayi* started emerging on March 29. All other species, except *L. dissectum*, emerged by late April. Very few *Lomatium dissectum* ever emerged.

Heavy weed populations emerged with the sprinkler irrigation and spring rains. Weeds were controlled by cultivation and hand weeding. Appropriate herbicides for weed control are urgently needed to reduce production costs.

A total of 1.72 inches of water was applied with the minisprinkler system. Starting June 24, the field was irrigated using the drip system. A total of 3.73 inches of water was applied with the drip system from June 24 to July 7. Thereafter the field was not irrigated. Preliminary results indicate that relatively little irrigation water will be needed to sustain native forbs.

Plant stands for *Eriogonum umbellatum*, *Penstemon acuminatus, P. deustus*, *Lomatium triternatum*, and *L. grayi* were acceptable but not perfect. In early October, 2005, more seed was received from the Rocky Mountain Research Station for replanting. The *Eriogonum umbellatum* and *Penstemon* spp. plots had the blank lengths of row replanted by hand. The *Lomatium* spp. plots had the entire row lengths replanted using the planter. The seed was replanted on October 26, 2005 for germination in the spring of 2006.

Forbs established in 2005 will receive three irrigation treatments: 0 mm/yr, low (up to 100 mm/yr, 4 inches/yr), or modest (up to 200 mm/yr, 8 inches/yr) supplemental irrigation in 2006. 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. Four replicates of each forb and each irrigation rate will be established. The first measurements of seed yield will occur in 2006. This research effort is expected to require at least two seed harvest years. The current work is funded through 2006.

Table 1. Forb species planted in the irrigation trial at the Malheur Experiment Station, Ontario, Oregon, 2005.

Species	**Common name**	**Origin**	**Collection Year**
Eriogonum umbellatum	Sulfur buckwheat	Shoofly Road	2004
Penstemon acuminatus	Sand penstemon	Bliss Dam	2004
Penstemon deustus	Hotrock penstemon	Black Cr. Rd.	2003
Penstemon speciosus	Sagebrush penstemon	Leslie Gulch	2003
Lomatium dissectum	Fernleaf biscuitroot	Mann Creek	2003
Lomatium triternatum	Nineleaf desert parsley	Hwy 395	2004
Lomatium grayi	Gray's lomatium	Weiser R. Road	2004

Technology Transfer:
The concept of producing native forb seed as a crop and the initial planting described above was presented to growers and fieldmen at the Malheur Experiment Station Field Day, July 13, 2005.

Project Title: Identification of Herbicides for Use in Native Forb Seed Production

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

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Project Description:

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.

Selective weed control products are needed for reliable native forb seed production at reasonable cost. A three phase approach will be used to develop herbicide options for the production of native forb seed. Herbicides will be screened for plant tolerance, product rates will be tested, and field performance will be evaluated. The results from each phase will shape the design of the successive phases.

Phase I. Initial Plant Tolerance to Herbicides. In the greenhouse, each forb species will be screened for tolerance to herbicides. Herbicides for screening will be selected based on their potential for selectivity determined through literature reviews and our understanding of different modes of action and principles of selectivity. Forbs will be evaluated for their tolerance to herbicides applied either pre-emergence 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 verify their safety to the forbs and their 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 and the availability of seed.

Materials and Methods:

Two initial screening trials were initiated in 2005 at the Malheur Experiment Station, one in the greenhouse and one in the field.

Greenhouse herbicide screening trial

Sunshine all purpose potting soil was mixed with silt loam from field A-1 at the Malheur Experiment Station and was used to fill 224 half trays (0.28 m x 0.28 m). On October 13 and 14, seven native species were planted in 32 half trays at 50 seed per tray with planting depth dependent upon the species (Table 1). Seed were equally spaced at 5 x 5 locations with 2 seed per location.

Table 1. Forb species planted in the greenhouse herbicide screening trial at the Malheur Experiment Station, Ontario, Oregon, 2005.

Species	Common name	Depth, mm, (inches)
Eriogonum umbellatum	Sulfur buckwheat	3, (1/8)
Penstemon acuminatum	Sand penstemon	3, (1/8)
Penstemon deustus	Hotrock penstemon	3, (1/8)
Penstemon speciosus	Royal or Sagebrush penstemon	3, (1/8)
Lomatium dissectum	Fernleaf biscuitroot	12, (½)
Lomatium triternatum	Nine leaf desert parsley	12, (½)
Lomatium grayi	Gray's lomatium	12, (½)

The trays were saturated October 17 and drained. The next day the trays were moved into a cooler set at 1° C (34° F). The room was also humidified to reduce the need for frequent irrigation. The trays were saturated November 4 and returned to the cooler.

On November 15 all trays were moved to the greenhouse head house for spraying. Four replicate trays of each of specie received 8 herbicide treatments (Table 2). Products were applied in a spray chamber at 19.2 gal/acre of water with an 8002E nozzle at 30 psi moving at 2 mph. The air temperature was 53° F and 50% RH. On November 16 each tray received 1/8 inch of water to incorporate the herbicide and the trays were returned to the cooler at 34° F.

On November 21 *Lomatium triternatum, Lomatium grayi,* and *Eriogonum umbellatum* were moved to the greenhouse. On November 28, supplemental light was added to the greenhouse for 10 hours per day. On December 12 the other forbs were moved to the greenhouse. Forbs were irrigated as needed and plant stands were counted twice a week.

Field herbicide screening trial

The field was prepared in October, 2005 and bedded into 30-inch rows. On October 23, drip tape (T-Tape TSX 515-16-340) was buried at 0.3-m (12-inch) depth and spaced 1.52 m (5 feet) apart. Two rows of forbs were planted 0.38 m (15 inches) to each side of the drip tape. Each species (Table 1) was planted in a single row for a length of over 400 feet. The drip tape was buried on alternating inter-row spaces. The flow rate for the drip tape was 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 0.066 inch/hour. The drip tape will be supplied with water filtered through sand media filters. Application durations can be controlled automatically and soil water content and water applied can be measured.

None of the species had emerged by January 5, 2006. The same herbicide products used in the greenhouse screening trial were applied at the same rates in the field on January 5. Five foot wide plots were assigned to the 8 treatments in Table 2, perpendicular to the direction of the plant rows, with 4 replicates. A spray boom with three 8002 E nozzles 20 inches apart covered the 5 foot plot width. Applications were based on 20 gpa, 30 psi, at 2.63 mph. The conditions were air temperature of 42º F, soil surface temperature 43º F, 10 percent cloud cover and wind at 2 mph from the east.

Since the field was infested with blue mustard, common mallow, and wheat the field was sprayed with Roundup Ultra Max at 1.01 lb ai/ac on January 6.

Table 2. Herbicides screened for forb tolerance at the Malheur Experiment Station, Ontario, Oregon, 2005-2006.

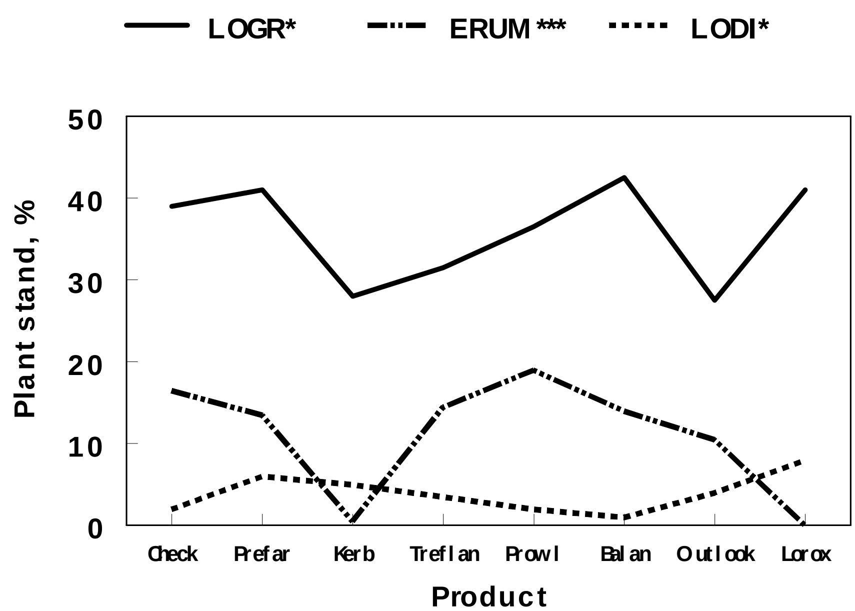
Treatment	Product rate	Rate	Plant stands, %		
		lb ai/acre	*Lomatium grayi* Dec. 12	*Eriogonum umbellatum* Jan 10	*Lomatium dissectum* Dec. 30
Check	none	none	39.0	16.5	2.0
Prefar 4.0 EC	5 qt/ac	5	41.0	13.5	6.0
Kerb 50 WP	2 lb/ac	1	28.0	0.5	5.0
Treflan HFP	0.75 pt/ac	3/8	31.5	14.5	3.5
Prowl 3.8 SC	1.58 pt/ac	3/4	36.5	19.0	2.0
Balan 60 DF	2 lb/ac	1.2	42.5	14.0	1.0
Outlook 6.0 EC	14 fl oz/ac	2/3	27.5	10.5	4.0
Lorox 50 DF	1 lb/ac	1	41.0	0.0	8.0
LSD (0.05)			10.8	8.5	3.8

Results and Discussion

By late January reliable plant stands had been established for three species, *Lomatium dissectum, Lomatium grayi*, and *Eriogonum umbellatum,* from the greenhouse screening trial. These plant stands showed significant differences between herbicide treatments (Table 2). *Lomatium triternatum* emerged slowly.

In this preliminary screening trial the forb species are tolerating different herbicides (Fig 1). Prefar, Balan and Lorox look promising for *Lomatium grayi*. Prowl has potential for *Eriogonum umbellatum.* Lorox, Prefar and Kerb look promising for *Lomatium dissectum.* These preliminary results should not be used as a basis for field treatments.

Figure 1. Plant stand of three forb species treated with seven herbicides.



* Treatment differences significant at *P*=0.05, *** Treatment differences significant at *P*=0.001.

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

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Project Description:
The USDA Forest Service, National Seed Laboratory (NSL) is collaborating with other members of the Great Basin Native Plant Selection and Increase Project to develop seed cleaning and testing protocols for research species. Seed cleaning protocols involve using screens, aspirators, debearders and other equipment to separate seed from other material collected. Seed testing work includes determination of AOSA minimum purity weight recommendations and protocols for germination and purity determinations. The seed testing work is essential for eventual development of AOSA rules if seeds are going to be marketed. 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 these seeds enter the market.

Project Status:
The NSL has received collections of five species for seed cleaning protocols, *Balsamorhiza hookeri*, *Chaenactis douglasii*, *Crepis acuminata*, *Erigeron pumilis*, and *Penstemon deustus*. Guidelines and recommendations for cleaning collections of these species have been developed and are posted on the NSL website, www.nsl.fs.fed.us/great_basin_native_plants.html, and at the Native Plant Program website, www.nativeplants.for.uidaho.edu/network.

Species and number of collections received from cooperators for seed testing protocols include: *Agoseris gluaca* 4, *Astragalus filipes* 30, *Crepis acuminatas* 3, *Eriogonum umbellatum* 18, *Lomatium dissectum* 23, *Lomatium grayi* 10, *Lomatium triternatum* 7, *Penstemon acuminatus* 36, *Penstemon deustus* 35, and *Penstemon speciosus* 20. All collections submitted for seed testing procedure development were received in 2004.

Seed counts and recommended minimum purity test weights have been developed. Information is available on the NSL website and will be available at the Association of Official Seed Analysts (AOSA) website for Species without Seed Testing Procedures, www.aosaseed.com/reference.htm.

The first round of germination trials for all collections has been completed. Seed was tested with and without prechill, with and without light, and using two sets of temperatures for germination, 15^o-25^o C and 20^o-30^o C, two temperature regimes commonly used at many seed laboratories. Results indicate that further trials are needed with varying lengths of prechill and with lower temperature regimes for germination. Results will be posted at the NSL website and preliminary germination information will also be available at the Association of Official Seed Analysts (AOSA) website for Species without Seed Testing Procedures.

Seed weight and germination work will begin on seed collected in 2005 of the same species from the same and different locations and seed collections of additional species.

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 NSL will continue to work with AOSA to promote the standardization of seed testing methods for native species. The NSL is a member of the AOSA Native Species Seed Task Force formed in 2005 and will continue working with this group in 2006, participating in a Native Seed Workshop at Omaha, NE and at the AOSA annual conference at Indianapolis, IN.

Products

Presentations:

Germination data reported at the annual GBNPSIP coordination meeting along with the procedures used to clean the seeds. At least two members at the coordination meeting appeared be able to immediately use this cleaning information.

Technology Transfer:

Attended the Association of Official Seed Analysts (AOSA) annual meeting in June 2005. Discussions at the conference related to GBNPSIP work with other seed testing laboratories contributed to the establishment of a Native Species Seed Task Force to address the issue of standardization of seed testing and reporting procedures at seed testing laboratories

Data as it becomes available is posted to the internet at www.nsl.fs.fed.us/great_basin_native_plants.html and www.nativeplants.for.uidaho.edu/network

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

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

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Project Description:
Jones' funding was designated for seed increase of pending germplasm releases, germplasm development, and needle-and-thread germplasm collection. Johnson's funding was designated for collection and evaluation of basalt milkvetch. Peel's funding was designated for development of improved germplasms of globemallows, particularly *Sphaeralcea grossulariifolia* and *S. munroana*. Larson's funding was designated for genetic (DNA) analysis of bluebunch wheatgrass, *Leymus* wildryes, squirreltail, Indian ricegrass, and Utah sweetvetch. These funds partially cover the research costs that are itemized in this report. Remaining costs, which are considerable, must be covered by in-house ARS funds.

Project Status:

<u>North American Grasses</u>

- Selection work was completed on bottlebrush squirreltail *Elymus elymoides* ssp. *elymoides* material originating in Elmore Co., ID. Rattlesnake Germplasm was proposed for release. (Jones)
- Seed of White River Germplasm Indian ricegrass was increased in 2005. It was approved for release and is awaiting signatures. (Jones)
- A genetic identity problem with the Bonneville Indian ricegrass material was corrected to put this item back on track. Plans are to establish a seed-increase block in 2006. (Larson and Jones)
- Forty-eight wildland seed collections were made in southern Idaho and just across the Oregon border, including bluebunch wheatgrass (19), Thurber's needlegrass (9), bottlebrush squirreltail (4), needle-and-thread (4), Sandberg bluegrass (3), Columbia needlegrass (3), big squirreltail (2), Indian ricegrass (2), and big bluegrass (2). Of particular interest were a bottlebrush squirreltail ssp. *californicus* accession (Gooding Co., ID) and a bluebunch wheatgrass accession (Twin Falls Co., ID). Plans are to collect needle-and-thread in the Upper Snake River Plain in 2006. (Jones)
- One cycle of selection for greater seedhead production was completed in the Atomic (INL, ID) bluebunch wheatgrass population. An evaluation/crossing block was established with nine accessions collected in the Owyhee Plateau of western Idaho/eastern Oregon. (Jones)
- An evaluation of 36 accessions of bottlebrush squirreltail ssp. *brevifolius* race C from Idaho and Oregon was established. (Jones)
- The Lahontan population of basin wildrye was synthesized from the eight best of 20 accessions evaluated from the northern Great Basin. (Jones)
- Data analysis of accessions of six squirreltail taxa evaluated under a precipitation gradient in a rain-out shelter has been completed, and a manuscript is being prepared. Data collection of a similar study for bluebunch wheatgrass was also completed. (Monaco, Jones, Johnson).

<u>Basalt Milkvetch (*Astragalus filipes*)</u>

- During the summer of 2005, seed collections of basalt milkvetch were made at 70 sites across Utah, Idaho, Nevada, California, Oregon, and Washington. These collections were undertaken to supplement existing collections from previous years that had minimal amounts of seed remaining. This brings the total seed collections for basalt milkvetch to 84. (Johnson)
- Six rhizobial strains isolated by the Nitragin Company were tested in the greenhouse for their effectiveness at nitrogen fixation with six different collections of basalt milkvetch. The six strains were compared with no-nitrogen and nitrogen treatments to identify the rhizobial strain resulting in the largest nitrogen pool. This strain will be used by Nitragin in producing a commercial inoculant for basalt milkvetch. (Johnson)
- Plants previously established in common garden plots at Evans Farm and Millville sites were evaluated for their morphological characteristics, plant vigor, forage yield and quality, seed yield, and regrowth after defoliation during the summer of 2005. Data are currently being statistically analyzed. (Johnson)

- Greenhouse-grown seedlings of each of the 2003-2004 collections of basalt milkvetch were transplanted in replicated common garden plots at Millville and North Park in northern Utah. Seedlings grown in Q-plugs exhibited the least transplanting shock and gave the best establishment results. (Johnson)
- Seedlings of the top performing basalt milkvetch accessions (based on 2005 common garden results) will be established in the greenhouse for transplanting to two common garden sites in 2006. These elite experimental strains will allow the development of a selected class pre-variety germplasm of basalt milkvetch. (Johnson)
- 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. Maps summarizing true weevil and beetle distributions in basalt milkvetch collections were prepared for publication and oral presentations. (Johnson)

Globemallows (*Sphaeralcea* spp.)

- Thirty one families/collections were evaluated during the 2005 growing season which included both *S. munroana* and *S. grossulariifolia*. These were grown at nurseries located at the Utah State University's Bluecreek and Evans research farms. (Peel)
- Twenty six lines of *S. coccinea* were evaluated during 2005 in nurseries located at Utah State University's Bluecreek and Evans research farms. (Peel)
- All *Sphaeralcea* material was evaluated for growth habit, leaf type, persistence, vigor, and most importantly, seed production. Insufficient data on relative seed production were collected on the *coccinea* types to separate genotypes. Consequently, no selections were made from this material in 2005. A total of 23 selections were made from the *munroana/ grossulariifolia* types with extra emphasis towards good seed production. (Peel)
- Selected material will be established in observation nurseries in the spring of 2006. In 2007 after plants are established, seed from the best plants will be bulked for testing and eventual cultivar release. (Peel)
- *S. coccinea* will be evaluated again in 2006, particularly for seed production, whereupon selections will be made. (Peel)

Genetic Diversity Analyses

- The DNA analysis of bluebunch wheatgrass and squirreltail has been effectively completed, published, and documented in previous project reports. (Larson)
- Two research assistantships for Utah State Unversity graduate students were filled by Mae Culumber and Parminder Kaur, both working on projects related to natural genetic variation and breeding of North American *Leymus* wildryes. (Larson)
- DNA samples from 768 *Leymus* wildrye plants (two plants from each of 384 accessions) were genotyped with three multilocus AFLP primer combinations. This data set encompasses nine North American species and 304 North American collection sites. Materials include 55 GBRC collections, four Berta Youtie collections, and 61 new FRRL wildland seed collections from 2004. The *psbA-trnH* chloroplast intergenic spacer DNA region was sequenced from one plant of each accession (384). Preliminary results will be reported at INPS IV in the spring of 2006. We will begin preparing a manuscript in 2006 for submission to a peer-reviewed scientific journal. (Larson)

- We evaluated growth habit in clonally replicated field evaluations, genotyped about 20 AFLP markers and several gene sequences, and constructed linkage groups for dissecting previously described growth habit QTLs (quantitative trait loci = chromosome regions controlling quantitative traits) in five experimental populations (approximately 500 segregating genotypes) derived from experimental hybrids of North American *Leymus cinereus* (basin wildyre) and *L. triticoides* (creeping wildyre). Our objective is to identify genes controlling growth habit (caespitose vs. rhizomatous) in perennial grasses using the caespitose basin wildyre and the rhizomatous creeping wildrye as a model system. This is a unique model system specifically developed for genetic research of functionally important traits in perennial range grasses. (Larson)
- In cooperation with Mike Peel and Shaun Bushman, we analyzed DNA profiles and prepared a manuscript describing DNA variation within and between 21 *Hedysarum boreale* accessions (384 plants), including two accessions from the USFS Shrub Sciences Laboratory and 10 accessions from the UDWR Great Basin Research Center. (Larson)
- We analyzed RAPD DNA profiles from 20 North American Indian ricegrass accessions and submitted a manuscript to *Western North American Naturalist*. Additional work is being planned for Indian ricegrass. (Larson and Jones)

Products:
Four M.S. and two Ph.D. students have been supported in part through these funds.

Publications:
Jones, T. A. 2005. Genetic principles for the use of native seeds. Native Plants Journal 5:14-24.

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 Science. 45:1666.

Jones, T. A. 2005. Native seeds in commerce. Native Plants Journal. 6:286-293.

Jones, T. A., and T. A. Monaco. A restoration practitioner's guide to the Restoration Gene Pool Concept. Ecological Restoration. (accepted 11/16/05)

Jones, T. A., and S. R. Larson. Development of native western North American Triticeae germplasm in a restoration context. Cz. J. Genet. Plant Breed. 41. (accepted 11/28/05)

Larson, S. R., X. Wu, T. A. Jones, K. B. Jensen, N. J. Chatterton, B. L. Waldron, J. G. Robins, S. B. Bushman, and A. J. Palazzo. Growth habit, height, and flowering QTLs reveal footprints of speciation between North American *Leymus* wildryes. Crop Science. (submitted)

Jones, T. A., M. G. Redinbaugh, Y. Zhang, S. R. Larson, and B. D. Dow. Genetic variation and lineage of Indian ricegrass seed morphs. Western North American Naturalist. (submitted).

Technology Transfer:
Presentations were made by Doug Johnson and Tom Jones at the GBNPSIP symposium at the SRM meeting in February (Ft. Worth, TX).

Project Title: Pollinator and Seed Predator Studies

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

Principal Investigator and Contact Information:

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Project Description:
Native bees and/or honey bees are proving to be 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. When plant reproduction proves to be pollinator limited, native bee faunas are being 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 and nest sticks are being 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) are being evaluated for their pollination prowess with each of the target plant species as well, using our own nursery plots or those of the collaborators on this proposal. Practical management protocols and materials are being developed to sustainably manage pollinators on-farm.

Project Status:
Preliminary systematic censuses of bees (as individuals per 100 flowering plants) were sampled at *Dalea ornata, D. searlsiae, Cleome lutea,* and *Lomatium dissectum*, with additional censuses at *Balsamorhiza sagittata* and *Hedysarum boreale,* in states not before sampled. A cold, wet spring prevented further bee sampling.

We prepared raised, subirrigated seed beds for this year's experimental plantings. We then seeded as well as transplanted seedlings and tubers of *Lomatium dissectum* for future breeding biology research. We also planted out our potted greenhouse populations of 2-yr-old *Dalea ornata* and 1-yr-old *D. searlsiae* for 2006 breeding biology studies. Additional *H. boreale* were also transplanted to the field for pollinator evaluations.

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 2005, we focused our studies of breeding biologies on our 20' x 20' planted field arrays, using established 3-year-old plants of *Penstemon speciosus* and 2-year-old plants of *Astragalus filipes*.

For ***Astragalus filipes***, it was evident that some to many pods were seedless from our pollination experiments, so we partitioned the results of our pollination treatments in terms of pod set per flower pollinated, the proportion of seedless pods, and seed counts among those pods with seeds. For open-visit treatments, we also received pod samples for freely-visited wild plants by Ann DeBolt (ID) and Scott Jensen (NV), plus we had comparable pods from our plants visited solely by bumblebees. We could compare not only simple outcrossing but also wide outcrossing from replicated seed populations represented in the plot that had been acquired from Idaho, Oregon and Nevada by Doug Johnson. Broad biogeographic comparisons are exceedingly rare in breeding biology studies of native plants. Results for each treatment (250-370 pollinations each) ranged widely by treatment. Autopollination yielded dismal seed production (only 25% of flowers setting pods, 17% were seeded, averaging 0.4 seeds per pod). Outcrossing and wide-outcrossing were far more productive (60% of flowers setting pods, 47% seeded, averaging 1.5 seeds per pod). The species is self-fertile, but outcrossing triples seed production. As always, bees outperformed us, further doubling the seed production. No comparable study exists for any other *Astragalus* species. Bumblebees found *A. filipes* attractive and were very proficient pollinators.

For ***Penstemon speciosus***, it must first be stated that 2nd year plants produced spectacular numbers of flowers and racemes. The count of seeds produced per capsule regresses nicely on capsule sizes; a set of many big capsules promises a lot of seed, although for large capsules, it is not an accurate predictor for the actual seed counts. Manual pollen transfer more than doubles the weight and count of seed per capsule compared with autopollination. Outcrossing yields 5x more seed than selfing, and bumblebee pollination enhances seed production a further 25%. Autopollination rarely yielded big, seedy capsules (and these may have resulted from our bumping them in the tight confines of our field cage), whereas open pollinated and outcrossed treatments rarely had any puny capsules. Hence, pollinators will be essential for commercial production, but for this plant, none are practical to manage. At L&H Seed, hived honeybees amid planted *P. speciosus* eschewed its bloom in favor of distant *Dalea ornata*, but wild bumblebees and ground-nesting solitary species were attracted from surrounding wildlands.

We also complemented our painstaking manual pollinations of wee ***Dalea purpurea*** flowers with analyses of pollination service provided by a mix of honey bees, managed alfalfa leaf-cutting bees, and wild bees. This species, and presumably its Great Basin relatives, attracts more species of bees than any of the other target forbs. Further, it is avidly sought out by readily managed species, including the above-mentioned bees, a conclusion borne out by bee observations at our field plots as well as at a commercial planting of *D. ornata* at L&H Seed. Prodigious seed production is possible: our small plants averaged 110 racemes each, 200 seeds per raceme (n=10), so 22,000 seeds possible per young plant.

We have begun evaluating the pollination needs of ***Lomatium dissectum***, this year comparing seed production at paired umbels, one bagged, the other openly visited, on 50 wild plants. Open umbels averaged 32 mature seeds each, far in excess of the ½ seed averaged on umbels caged to exclude pollinators. This biscuitroot is incapable of autopollination.
At Wind River Seed, bloom was nearly a month later than in 2004. As a result, we had to hold back the population of the blue orchard bee, *Osmia lignaria*, that we intended to release again.

Such prolonged refrigeration sapped the vitality of the bees, resulting in terrible emergence. Meanwhile, our nesting blocks attracted a species of native bee that provisioned exclusively with *Hedysarum* pollen. It is *Osmia sanrafaelae*. We have the resultant progeny in hand, and will evaluate their pollination prowess with sweetvetch in our Logan caged field plots.

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 and am now publishing about a nesting shelter and supporting bracket to be used for drilled blocks or other nesting substrates of cavity-nesting bees. The shelter is versatile and cheap ($14), made from the nesting plastic totes used by the US Post Office. The metal bracket system, which quickly attaches to a T-post, was designed with a California manufacturer of grape arbor equipment ($4). It is now available for sale. The entire unit costs under $25 each and has so far endured for 3 years of field use with another *Osmia* that I am managing as a commercial raspberry pollinator. It is quick for a single person to deploy, and stores in stacks. For most of these target forbs, two shelters per acre should house sufficient bees to pollinate.

Native herbivorous insects have the potential to become pests of seed production on many of the wildflower species studied to date. Seed weevils were found to attack green pods of the legumes, their larvae developing in the individual drying seeds. Now four species of seed weevil of the genus *Acanthoscelides* in the subfamily Bruchinae (Chrysomelidae) have been found attacking seeds of legumes studied in this project. Most are new host records. Seeds of *A. filipes* sampled at 30 locations in 4 states are also host to two species of <u>true</u> weevil in the genus *Tychius*, which were present at many locations. Seed sampled from 12 populations of *Dalea ornata* commonly yielded another weevil relative, *Apion amaurum*, that was widespread and predominant in samples. These represent new state and host records for this *Dalea* specialist. In a few cases, the majority of seeds were infested. A manuscript with distribution maps is being prepared with Doug Johnson, Bob Hammon and taxonomists from Arizona, Alabama and Mexico.

Publications:

Cane, J.H. 2005. Pollination needs of arrowleaf balsamroot, *Balsamorhiza sagittata* (Heliantheae: Asteraceae). Western North American Naturalist 65 (3): 359-364.

Cane, J.H. in press. The Logan Beemail shelter: a practical, portable unit for managing cavity-nesting agricultural pollinators. American Bee Journal.

Cane, J.H. Pollination needs of purple prairie-clover, *Dalea purpurea* (Fabaceae: Amorpheae). American Midland Naturalist (submitted).

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

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Project Description:
Insects affecting seed production of native plants are relatively unknown. Insect identification and life history must be known before management techniques can be developed. Insect species vary considerably when a particular plant species is grown in different regions. This project is designed to identify and learn life histories of insects affecting field collected and field-grown seed for the Great Basin Project. Seed predators and other insects affecting plants species of interest are collected and reared from collection and increase sites throughout the Great Basin. Samples are photographed before storage for future reference and educational programs. Specimens are 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. Field research plots are now established in western Colorado for seed production research in cooperation with the Uncompahgre Plateau Project.

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. Two previously unknown insects were added to the pest list in 2005. A previously undescribed species of *Acanthosceliedes* was discovered feeding on *Hedysarum boreale* in Utah, and an unidentified tephritid fly was discovered feeding on *Lupinus argenteus* in Colorado. In addition, samples taken from small seed increases in southern Idaho have shown that *Lygus* bugs are a significant seed production pest on many species of forbs. A management strategy for these generalist feeders will have to be developed for each seed increase site.

Seed increase fields of *Hedysarum boreale*, *Linum lewisii*, *Sphaeralcea coccinea*, *Bromus marginatus*, *Heterostipa comata*, *Elymus elymoides*, *Leymus cinerus*, *and Poa secunda* were established during 2005 at the Western Colorado Research Center at Rogers Mesa, near Hotchkiss CO (Delta County) as part of the Uncompahgre Plateau Project. These fields will be utilized in the future for pest management research which will be utilized by seed growers associated by both projects.

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	*receptacle 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	*Acanthoscelides* sp.	Coleoptera: Bruchidae	Seeds	**Cane 2006**
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
Lupinus argenteus		Diptera: Thepritidae	Seeds	**Hammon 2006**
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

Products

A. Publications: **Web Page:** Pesticides for Native Plant/Plant Materials Seed Production:
http://www.coopext.colostate.edu/TRA/SeedProduction.html

B. Presentations: Radio presentation, KVNF Paonia CO, March 11, 2005, Restoration of western wildlands
Colorado State University, Bioagricultural Science and Pest Management Department Seminar Series, March 23, 2005, Insects Affecting The Production Of Native Plant Seed

C. Technology Transfer: Poster Presentation: Insects Affecting the Production of Native Forb Seed. At: Ecology & Management Of Pinyon/Juniper Communities, Montrose CO, May 16-19, 2005.

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.
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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

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

Project Status:
This project was funded in the summer of 2004. Preliminary collections and molecular analyses were completed in 2004. In 2005 we hired a support technician, Robert Adair, who collected bulbs throughout eastern Oregon, southern Idaho and northeastern Nevada, recorded bulb characteristics from the collected material, planted the bulbs in the greenhouse for tissue collection and future use in common garden studies, and established a molecular marker system for identifying genetic diversity.

Collections: *Allium acuminatum* bulbs were collected from 55 populations throughout eastern Oregon, southern Idaho and northeastern Nevada (Figure 1). Potential population locations were gathered from herbaria data and US Forest Service and Bureau of Land Management personnel. This information was organized into a spreadsheet for field use and entered into a GIS-based map to aid in collection planning. We had two collecting teams of two persons each, one focused on Oregon and Idaho, the other team collected in Nevada. Each team followed the same collection protocol. First the population size and area were estimated. Then 40 to 50 bulbs per population were collected from across the given population. We only collected from populations with 250 or more individuals. Collections were made from June 17 to July 2, 2005. The collection area spanned 1430 m (4692 ft) of elevation and covered approximately 620 km (385 mi.) east-west and 445 km (277 mi.) north-south, between N 39° to 44° latitude and W 114º to 119º longitude. *A. acuminatum* was collected in 20 of the Level IV Omernick Ecoregions (Table 1) for the Great Basin.

Bulb characteristics: The bulbs from the 55 collection sites were counted, measured (diameter), and assigned a shape description. They were then stored at the Western Regional Plant Introduction Station in a temperature-controlled room at 15 °C. A total of 3,107 *A. acuminatum* bulbs were sampled. Average bulb diameter was 1.0 cm with a standard deviation of 0.2 cm for the entire collection. The maximum bulb diameter was 2.1 cm and minimum diameter was 0.3 cm, and the maximum and minimum site means were 1.2 and 0.9 cm, respectively. Of the bulbs collected, 91.1% were single bulbs, 8.7% were cloved bulbs, and 0.2% were 3-cloved bulbs. Most of the bulbs were globed shaped (90.3%), 6.8% were classified as flat-globe, and 1.9% high-globe (Figure 2).

Greenhouse planting: All the collected *A. acuminatum* bulbs were planted in rootrainers into a media mix of 75% Sunshine Mix #4 and 25% perlite. The bulbs were planted October 1 to 3, 2005 and kept in the greenhouse for 4 weeks. They were then moved to a walk-in growth chamber for vernalization at 4ºC.

Molecular marker work: Initially we thought that AFLP's would be the most efficient marker system, but the AFLP's produced so many markers in preliminary work they were cluttered and difficult to score. We have subsequently developed Sequence Related Amplified Polymorphisms (SRAP) as a marker system for *A. acuminatum*. Using DNA from plant material collected in 2004, we have optimized the protocol for SRAP's. So far we have identified five primer pairs producing 61 reproducible and easily scored markers.

Future plans: In 2006 DNA will be extracted from leaf tissue of plants from the 55 populations collected in 2005. Data on molecular variation within and among populations will be collected using SRAP markers. We will also establish common garden plots in contrasting environments, one at the Central Ferry, WA Research Station and one at Pullman, WA. Data will be collected for leaf, scape, flower and umbel characteristics. Phenotypic variation within and among populations will be determined and compared with molecular variation using multivariate statistics. This will show if and to what extent molecular and phenotypic evaluation data correlate. The phenotypic data will be analyzed to understand patterns of variation across the Great Basin in relation to climatic and ecological factors. This information will be used to guide conservation and revegetation decisions for *A. acuminatum* in the Great Basin.

Figure 1. Distribution of *A. acuminatum* collection sites across the Great Basin.

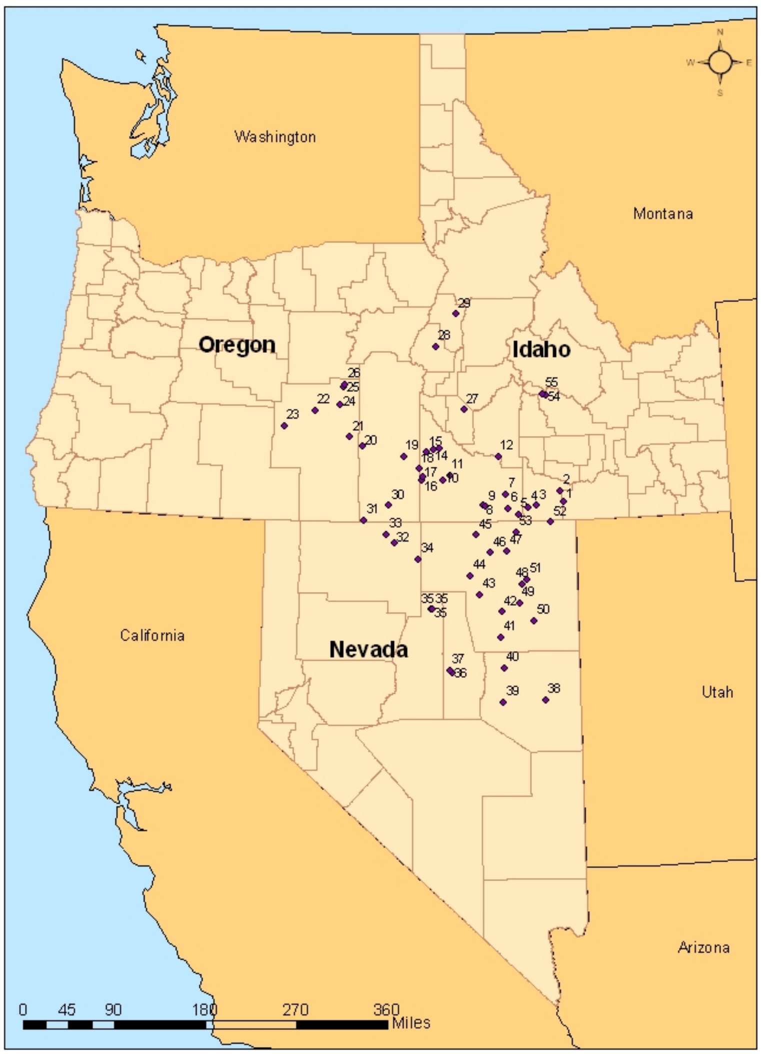
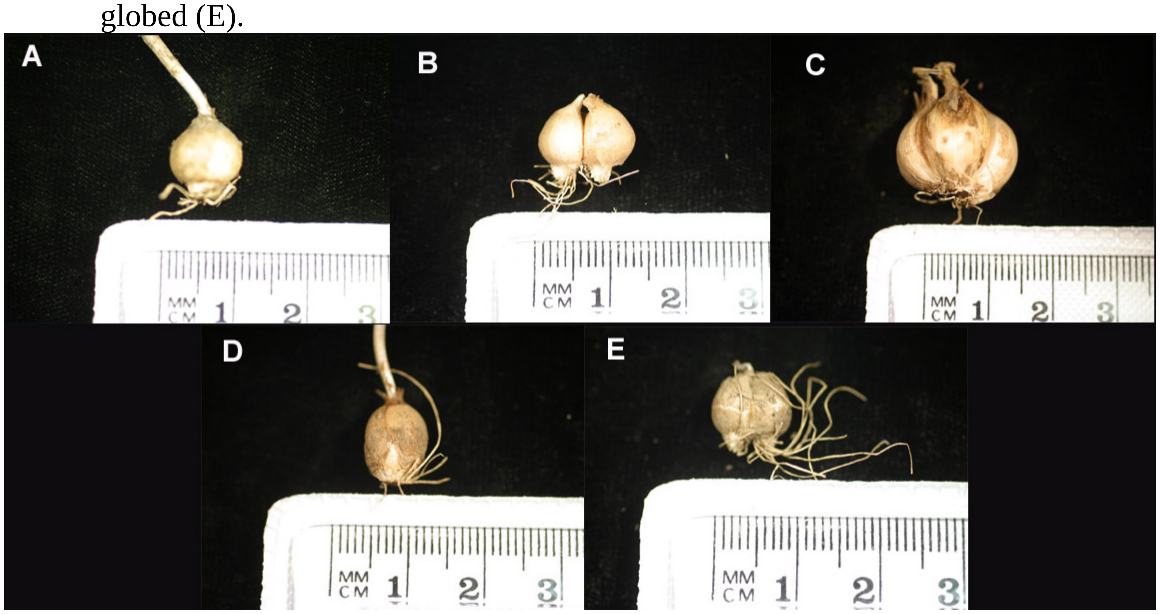


Table 1. Number of *A. acuminatum* populations collected within Level IV Omernick Ecoregions (Omernick 1987).

Level 4 Ecoregion	Collection sites
Semiarid Hills and Low Mountains	1
Southern Forested Mtns/Dry Partly Wooded Mtns	1
Mountain Home Uplands	1
Southern Forested Mountains	1
Pluvial Lake Basins	1
High Desert Wetlands	1
Continental Zone Foothills	1
Unwooded Alkaline Foothills	1
Semiarid Foothills	1
High Glacial Drift-Filled Valleys	1
Central Nevada Mid-Slope Woodland and Brushland	1
Central Nevada High Valleys	1
Carbonate Woodland Zone	2
Carbonate Sagebrush Valleys	2
Mid-Elevation Ruby Mountains	3
Semiarid Uplands	4
High Lava Plains	5
Upper Humboldt Plains	6
Owyhee Uplands and Canyons	8
Dissected High Lava Plateau	13

Figure 2. Bulb morphology. Single globed (A), cloved (B), 3-cloved(C), high-globed (D), flat-globed (E).



Acknowledgment: Special thanks to Robert Adair for his excellent and thoughtful technical assistance.

Publications:

Adair, R., R.C. Johnson, B.C. Hellier, W. J. Kaiser. Collecting taper- tip Onion (*Allium acuminatum* Hook.) in the Great Basin using traditional and GIS methods. Native Plant Journal (submitted).

Project Title: Establishment and Maintenance of Certified Generation 1 (G1) Seed
Propagation of Native Forbs and Native Plant Display Nursery
Develop Technology to Improve the Diversity of Introduced Grass Stands

Project Location: NRCS, Plant Materials Center, Aberdeen, ID

Principal Investigators and Contact Information:

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Project Description:
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. Propagation of native forbs for evaluation and seed increase. Evaluation of display nursery near Boise, ID. Assist in development of technology to improve the diversity of introduced grass stands by evaluating methods to introduce native species into established plant communities.

Project Status:

Seed Production:
Maple Grove Germplasm Lewis flax: Original seed field established May 2002 was plowed out due to declining production and increasing weed competition. Established a new 3.2 acre field on May 23, 2005. Shipped 280 pounds of Certified seed to commercial growers in 2005.

Anatone Germplasm bluebunch wheatgrass: Established new 1.8 acre field on May 24, 2005. Currently 5.2 acres are in production. Estimated seed yield from 2005 seed crop is 865 pounds. Shipped 250 pounds of Certified seed to commercial growers in 2005.

Snake River Plains Germplasm fourwing saltbush: Estimated seed yield from 2005 crop is 35 pounds. Shipped 16 pounds of Certified seed to commercial growers in 2005.

Northern Cold Desert Germplasm winterfat: Estimated seed yield from 2005 crop is 9 pounds. Shipped 20 pounds of Certified seed to commercial growers in 2005.

Propagation Studies: The plan was to propagate a total of 8,000 plants of *Lomatium dissectum* (LODI), *Lomatium grayi* (LOGR), *Lomatium triternatum* (LOTR), *Eriogonum umbellatum* (ERUM), *Penstemon deustus* (PEDE), *Penstemon acuminatus* (PEAC) and *Penstemon speciosus* (PESP). Approximately 1000 plants each of ERUM and LOTR were to be transplanted at the PMC and remaining plants were to be made available to cooperators for transplanting at field sites. Due to no plant establishment of *Lomatium* species and minimal success with greenhouse propagation of *Penstemon* species, no plants were made available to cooperators.

On December 13, 2004, imbibed LODI, LOGR, LOTR, ERUM, PEAC, PEDE and PESP seed was placed in cloth bags which were then placed in 1 gallon Ziploc bags filled with wet sand. Ziploc bags were placed in a secure outdoor location for natural winter temperature stratification for 10 weeks. On February 24, 2005, all seed was planted into 20 $in.^3$ conetainers and placed in the PMC greenhouse. By March 2, ERUM and LOGR seedlings were beginning to emerge. By mid-March, there was little or no emergence of the *Penstemon* species and LOGR seedlings were dying from unknown causes. *Penstemon* seed leftover from the original planting in the greenhouse was treated with 500 ppm GA_3, planted into trays and as plants emerged, transplanted into containers.

On May 10, 2005 a plant count was taken in the greenhouse:

Species	No. Plants
ERUM	1500
PEDE	750
PESP	70

Weed barrier fabric was installed in field 12 at the PMC with holes placed in a 9 x 9 in spacing. On June 22, 2005, we planted 824 ERUM seedlings in this grid. Approximately 675 ERUM plants were too small for transplanting.

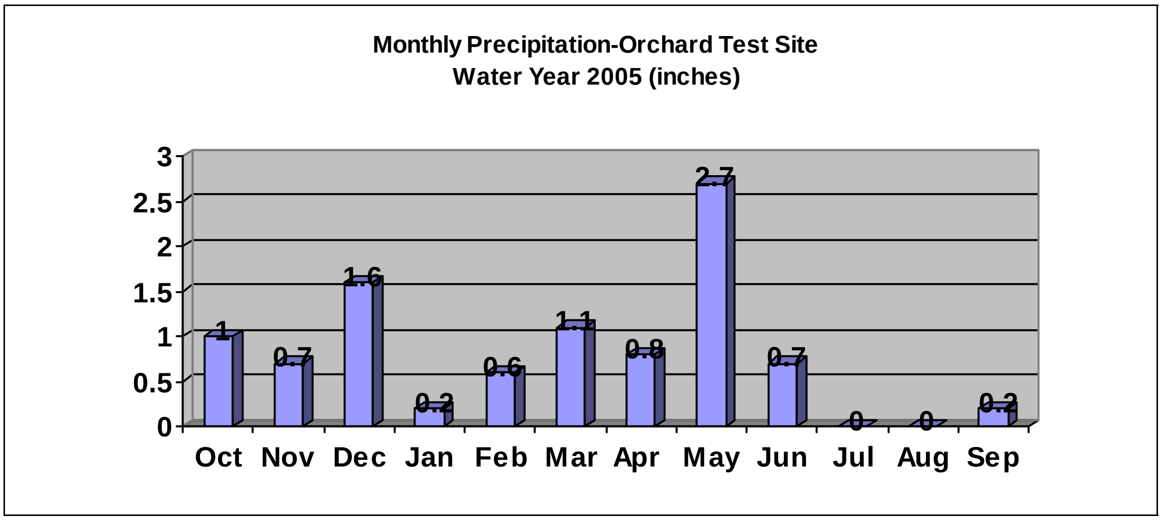
On August 9, 2005 the remaining ERUM, PEDE, PEAC and PESP plants were transplanted from the greenhouse to field 12 with weed barrier fabric and 9 x 9 inch spacing.

On October 7, 2005 transplants were evaluated:

Species	No. Planted	Percent survival	Canopy width (inches)
ERUM	992	89	1-8
PEDE	464	91	2-8
PEAC	392	96	1-6
PESP	68	87	1-6

In early November 2005, ERUM, 3 Lomatium accessions and 3 Penstemon accessions were direct seeded into weed barrier fabric in field 12 at the PMC.

Orchard Display Nursery Establishment Year (2005) Evaluations: The Orchard Display Nursery was seeded on November 16, 2004 in cooperation with the Great Basin Native Plant Selection and Increase Project. The nursery contains 82 accessions of 27 native and introduced grass, forb and shrub species planted in 7 x 60 foot plots. See Tilley et al. (2005) for descriptions of the species and accessions used. The remaining area was planted to a cover crop mix of 50% Anatone bluebunch wheatgrass, 20% Bannock thickspike wheatgrass, 20% Magnar basin wildrye and 10% Snake River Plains fourwing saltbush. The test site is located on a loamy 10-12 inch precipitation ecological site that historically supported a Wyoming big sagebrush - bluebunch wheatgrass – Thurber's needlegrass plant community. Total precipitation at the Orchard Test Site for water year 2005 was 9.6 inches (USDA 2005).



The Bureau of Land Management (BLM) burned the site in the fall of 2002. The site was later sprayed by the PMC in May 2003 and May 2004 with a Roundup/2,4-D mix to create a weed free seedbed. Due to limited breakdown of dead grass clumps that would inhibit proper seed placement with a drill and to ensure a clean seedbed, the decision was made to cultivate the site with a culti-packer just prior to seeding. Plots were evaluated on April 27 and May 25, 2005. During the first evaluation most plots contained high numbers of Russian thistle (*Salsola* sp.) and moderate amounts of bur buttercup (*Ranunculus testiculatus*). Russian thistle plants were approximately 2 to 3 inches tall and the buttercup had already flowered. At the time of the second evaluation, there was a heavy infestation of tumble mustard (*Sisymbrium altissimum*). Plots were sprayed again on June 9, 2005 with 16 oz. 2,4-D and 8 oz. Clarity per acre to control the mustard.

Materials and Methods: The first evaluation of the plots was conducted on April 27, 2005 using a frequency grid based on that described by Vogel and Masters (2001). The grid measured approximately 40 x 41 inches, with four 10 inch columns (to incorporate 1 drill row per column) and five rows, totaling 20 cells. The first grid was laid on the rows approximately two grid lengths (80 inches) into the plot. Counts were made of the cells that contained at least one plant. Grids were subsequently flipped and evaluated three more times giving a total of 80 evaluated cells. Total area for one grid is approximately 1m². Total area evaluated is therefore approximately 4 m². A conservative estimate of plant density (plants/m²) is thus the total number of cells containing at least one plant divided by four.

The second evaluation occurred on May 25, 2005. The methods followed were the same as above, but the frame was evaluated five times for a total of 100 cells in 5 m^2. Total counts were then divided by five for approximate plants/m^2. Numbers for approximate plants/m^2 were then divided by 10.8 to calculate approximate plants/ft^2. It is important to note that because cells with plants were counted and not number of plants per cell, the best possible score is 100 hits per five frames which converts to 20 plants/m^2 or 1.85 plants/ft^2. Some actual densities, therefore, may be (and almost certainly are) higher than the numbers indicated below. All tables have been arranged with accessions ranked from highest plant density to the lowest at the time of the second evaluation.

Native Grasses: There were forty-seven accessions of native grasses planted. Overall the native grasses established well considering the limited amount of precipitation received over the winter and early spring. Especially good stands were seen in the bluebunch wheatgrass and Snake River wheatgrass plots. There was a marked decrease in plant density between the first and second evaluations with some notable exceptions. Seven of nine bluebunch wheatgrass accessions and three of four Snake River wheatgrass accessions increased in density from the first evaluation to the second. This is possibly due to receiving 2.5 inches of precipitation during that period and/or from a lack of pressure by black grass bugs (*Labops* sp.).

The best performing Indian ricegrass accession was White River, having a plant density of 0.56 plants/ft^2 at the first evaluation and 0.17 plants/ft^2 at the second evaluation. Rimrock had the best density at the second evaluation with 0.20 plants/ft^2. Fish Creek was the highest rated squirreltail accession with 0.97 plants/ft^2 in April and 0.54 plants/ft^2 in May. Bannock thickspike wheatgrass had a density of 1.04 plants/ft^2 and increased slightly to 1.07 plants/ft^2 at the second evaluation. Of the slender wheatgrass accessions, Revenue performed best with 1.00 plants/ft^2 recorded at the first evaluation and 0.93 plants/ft^2 at the second evaluation. Western wheatgrass accessions were all doing poorly during the first evaluation with the best performing accession being Rodan at 0.28 plants/ft^2. By the second evaluation plant density for Rodan had risen to 0.35 plants/ft^2. In April, bluebunch wheatgrass accession P-12 rated highest at 1.34 plants/ft^2 followed by Columbia (1.30) and Wahluke (0.97). At the second evaluation both P-12 and Wahluke had increased in density (1.59 and 1.26 plants/ft^2 respectively) while Columbia had decreased to 1.23 plants/ft^2. The best Snake River wheatgrass was Expedition with 1.27 plants/ft^2 which increased to 1.44 plants/ft^2 at the second evaluation. Trailhead was the highest rated basin wildrye accession at the first evaluation with 0.60 plants/ft^2; however, by the second evaluation it had decreased to 0.52 plants/ft^2 and was surpassed by U108-02 at 0.57 plants/ft^2. Accessions of sheep fescue did poorly with Initial Point and Covar being respectively rated at 0.04 and 0.00 plants/ft^2 at the second evaluation. The single accession of Thurber's needlegrass had zero germinants recorded at both evaluations. Sandberg bluegrass accessions had zero emergence with the exception of High Plains which had 0.25 plants/ft^2 in April. At the second evaluation no Sandberg bluegrass accession germinants were recorded.

		4/27/05	**5/25/05**
Species	**Name or accession**	**Plants/ft²**	**Plants/ft²**
Indian ricegrass	Rimrock	0.37	0.20
	White River	0.56	0.17
	Nezpar	0.42	0.17
	Ribstone	0.14	0.09
	Paloma	0.05	0.00
Squirreltail	Fish Creek	0.97	0.54
	Shaniko Plateau	0.81	0.52
	Sand Hollow	0.37	0.20
	Toe Jam Creek	0.58	0.17
	9019219	0.02	0.02
Thickspike wheatgrass	Bannock	1.04	1.07
	Critana	0.90	0.56
	Schwendimar	0.69	0.52
	Sodar	0.37	0.30
Slender wheatgrass	Revenue	1.00	0.93
	San Luis	0.60	0.69
	Pryor	0.30	0.30
Western wheatgrass	Rodan	0.28	0.35
	Rosana	0.05	0.20
	Arriba	0.16	0.15
Bluebunch wheatgrass	P-12	1.34	1.59
	Wahluke	0.97	1.26
	Columbia	1.30	1.23
	P-7	0.93	1.15
	Anatone	0.81	1.15
	Jim Creek	0.83	1.02
	P-15	0.60	0.93
	P-5	0.42	0.61
	Goldar	0.51	0.37
Snake River wheatgrass	Expedition	1.27	1.44
	Secar	1.00	1.11
	SERDP	1.02	0.94
	E-26	0.21	0.23
Basin wildrye	U108-02	0.56	0.57
	Trailhead	0.60	0.52
	U100-01	0.53	0.41
	U70-01	0.30	0.22
	Magnar	0.28	0.22
	Washoe	0.21	0.09
Sheep fescue	Initial Point	0.21	0.04
	Covar	0.16	0.00
Thurber’s needlegrass	Thurber’s	0.00	0.00

		4/27/05	5/25/05
Species	**Name or accession**	**Plants/ft²**	**Plants/ft²**
Sandberg bluegrass	High Plains	0.25	0.00
	Sherman	0.00	0.00
	Mountain Home	0.00	0.00
	Toole County, MT	0.00	0.00
	Hanford Source	0.00	0.00

Introduced Grasses: Although many of the introduced grass accessions had a fair percentage of germination, we noted an outbreak of black grass bugs at the time of the first evaluation. The infestation appeared limited to the introduced grass section of the nursery. Plants were covered with yellow spots making the plants appear yellow-green overall.

The crested wheatgrass accessions Nordan and Roadcrest both had densities of 1.30 plants/ft^2 at the first evaluation; however, at the time of the second evaluation Nordan had maintained a high plant density of 1.19 plants/ft^2 while Roadcrest had reduced dramatically to 0.07 plants/ft^2. Vavilov was the best Siberian wheatgrass with 0.65 and 0.20 plants/ft^2 for the two evaluations. The pubescent wheatgrass accessions all performed similarly with all three having densities from 0.54 to 0.65 plants/ft^2 at the second evaluation. Prairieland Altai wildrye was the best performer in its category with 0.56 plants/ft^2 in April and 0.39 plants/ft^2 in May. The Russian wildrye accession, Bozoisky-Select, had the best rating at 0.72 plants/ft^2 and 0.54 plants/ft^2 for the two evaluations.

		4/27/05	5/25/05
Species	**Name or accession**	**Plants/ft²**	**Plants/ft²**
Crested wheatgrass	Nordan	1.30	1.19
	Ephraim	0.65	0.28
	Hycrest	0.39	0.24
	CD-II	0.56	0.24
	Roadcrest	1.30	0.07
	Douglas	0.28	0.04
Siberian wheatgrass	Vavilov	0.65	0.20
	P-27	0.09	0.02
Pubescent wheatgrass	Manska	0.69	0.65
	Greenleaf	0.60	0.59
	Luna	0.79	0.54
Intermediate wheatgrass	Rush	0.60	0.56
Altai wildrye	Prairieland	0.56	0.39
	Eejay	0.16	0.28
	Pearl	0.35	0.15
Russian wildrye	Bozoisky Select	0.72	0.54
	Mankota	0.46	0.28
	Tetracan	0.42	0.20
	Syn-A	0.21	0.13

Forbs: Most of the forbs did poorly in comparison to the grasses. One notable exception was Eagle western yarrow which maintained a density of 0.50 plants/ft^2. Appar blue flax also began well with a density of 0.90 plants/ft^2, but fell to 0.26 plants/ft^2 by the second evaluation.

		4/27/05	**5/25/05**
Species	**Name or accession**	**Plants/ft²**	**Plants/ft²**
Western yarrow	Eagle	0.51	0.50
	Great Northern	0.19	0.09
Utah sweetvetch	Timp	0.14	0.02
Firecracker penstemon	Richfield Selection	0.02	0.02
Scarlet globemallow		0.00	0.00
Lewis flax	Maple Grove	0.42	0.15
Blue flax	Appar	0.90	0.26

Shrubs: Only two accessions of shrubs showed any germinants within the frames. Wyoming big sagebrush held a density of 0.02 plants/ft^2 while Hatch winterfat performed moderately better with ratings of 0.28 and 0.17 plants/ft^2.

		4/27/05	**5/25/05**
Species	**Name or accession**	**Plants/ft²**	**Plants/ft²**
Wyoming big sagebrush		0.02	0.02
Fourwing saltbush	Snake River Plains	0.00	0.00
	Wytana	0.00	0.00
	Rincon	0.00	0.00
Gardner's saltbush	9016134	0.00	0.00
Winterfat	Hatch	0.28	0.17
	Northern Cold Desert	0.00	0.00
	Open Range	0.00	0.00
Forage kochia	Immigrant	0.00	0.00

Cover Crop: The cover crop consisted of a four species mix which contained: 50% Anatone bluebunch wheatgrass, 20% Bannock thickspike wheatgrass, 20% Magnar basin wildrye and 10% Snake River Plains fourwing saltbush. Four grids were examined during the first evaluation, one on each side of the nursery, and five grids were used at the time of the second evaluation. Total plant density was estimated at 0.37 plants/ft^2 at the first evaluation and 0.57plants/ft^2 at the second evaluation. The increase in density was presumably due to an increase in the two wheatgrasses.

Discussion: Despite large amounts of Russian thistle, native and introduced grasses had fair to good germination and plant density. Germination and emergence probably would have increased with more precipitation during March and April, but germination was good with the rain that was received. Plants that survived through April received well above average rainfall in May. Of major concern is the black grass bug outbreak. Plants subjected to black grass bug are normally affected by decreased seed yield and a reduction in palatability to cattle. Infestations rarely result in the death of established plants, but in low water years establishing plants may be under enough stress to kill them (Hammon and Peairs 2001). The decrease in plant density recorded for Roadcrest crested wheatgrass may be an indication of this. Future evaluations will provide more information on plant establishment, persistence and longevity. The PMC will continue to evaluate plant performance at the site.

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Develop Technology to Improve the Diversity of Introduced Grass Stands: The PMC assisted Brigham Young University (BYU) and the Agricultural Research Service (ARS) Burns, OR in developing technology to improve the diversity of introduced grass stands by evaluating methods to introduce native species into established introduced plant communities. The PMC modified a Truax Roughrider range drill, mixed the seed and rice hull mixtures and completed the seedings at the sites in Utah and Oregon.

On September 7, 2005 a new Truax Roughrider range drill and transport trailer were delivered to the PMC. PMC Technicians Boyd Simonson and Brent Cornforth made modifications to the drill to improve seed flow and placement. They improved the design and function of the drop tubes, reconfigured the chain and sprocket assembly to improve calibration of seed delivery, made major adjustments to the drill openers and realigned the packer wheels. While seeding both in Utah and Oregon the PMC technicians met with Jim Truax (drill manufacturer) to demonstrate modifications to the drill under field conditions. Many of the modifications that the PMC Technicians made are being incorporated into new drills by the manufacturer.

The seed and rice hulls for this project were purchased by the cooperators and delivered to the PMC in early October. Preliminary testing of seed and rice hull mixtures were conducted to determine flowability of the mixtures. Based on the preliminary tests, seed and rice hulls were mixed for the actual seedings. The drill is designed to both broadcast and drill seed in the same pass so species that require broadcasting or very shallow planting depth were broadcast and the deeper seeded species were drilled in alternating rows. The following table lists the seed and rice hull mixtures:

Utah Broadcast Mix

Species	Pounds PLS/ac	Pounds Bulk Seed/ac
Wyoming big sagebrush	0.20	0.94
Rubber rabbitbrush	0.25	0.75
Eagle yarrow	0.20	0.24
"OR" Sandberg bluegrass	0.75	0.95
Rice hulls		7.41

Utah Drill Mix

Species	Pounds PLS/ac	Pounds Bulk Seed/ac
Fourwing saltbush	1.00	3.48
Appar blue flax	0.75	0.83
Munro globemallow	0.50	0.84
Anatone bluebunch wheatgrass	3.00	3.16
Sanpete bottlebrush squirreltail	2.00	2.82
Nezpar Indian ricegrass	2.00	2.13
Rice hulls		4.58

Oregon Broadcast Mix

Species	Pounds PLS/ac	Pounds Bulk Seed/ac
Wyoming big sagebrush	0.20	0.91
Rubber rabbitbrush	0.25	2.06
Eagle yarrow	0.20	0.26
Mtn. Home Sandberg bluegrass	0.75	1.18
Rice hulls		4.90

Oregon Drill Mix

Species	Pounds PLS/ac	Pounds Bulk Seed/ac
Fourwing saltbush	1.00	2.28
Appar blue flax	0.75	1.00
Munro globemallow	0.50	0.61
Anatone bluebunch wheatgrass	3.00	3.52
Toe Jam bottlebrush squirreltail	2.00	2.17
Nezpar Indian ricegrass	2.00	2.08
Rice hulls		4.74

The Utah sites (Skull Valley and Lookout Pass) were seeded the week of October 17 and the Oregon site (Burns) was seeded the week of October 31, 2005. 12.5 acres were seeded at each site. Seedings will be repeated in the fall of 2006 on additional plots at these same locations. A new site near Elko, NV is also tentatively planned for seeding next fall.

Project Title: Diversification of Crested Wheatgrass Stands and Seedling Establishment Modeling

Project Location: Brigham Young University, Provo, UT

Principal Investigators and Contact Information:

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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 undergraduate mentoring funds, Brigham Young University.

Project Description:
This work is designed to determine effective ways to control crested wheatgrass and establish native species while minimizing weed invasion. It is also designed to help develop a heat accumulation, soil water potential threshold model of seedling establishment. We will report on progress of both activities and state directions for the coming year.

Project Status:
Crested wheatgrass diversification:
Two sites in Tooele Co., Utah were selected for large scale manipulation of crested wheatgrass stands. The Skull Valley site, which borders the U.S. Army Dugway Proving Ground, is at an elevation of 1524 m, receives 200-254 mm of precipitation annually, and has Medburn fine sandy loam soils. The Lookout Pass site is approximately 45 miles southeast from the Skull Valley site and located on the eastern side of the Onaqui Mountains. It is slightly higher in elevation (1676 m) and precipitation (254-305 mm) than the Skull Valley site and has Taylorsflat loamy soil. Both sites were seeded to crested wheatgrass monocultures more than 10 years ago

following wildfires. The crested wheatgrass stand in Skull Valley is not as vigorous as the Lookout Pass site and has an abundance of cheatgrass.

The study is replicated in both time and space and is set up as a randomized block split plot design with 5 blocks. Within each block, 1 acre main plots were either left undisturbed or received a mechanical (1-way or 2-way disking) or herbicide treatment (16 oz/ac. or 44 oz/ac. Roundup Original Max) to reduce (partial control) or eliminate (full control) crested wheatgrass. Following wheatgrass control, main plots were divided into ½ ac subplots that were either seeded or unseeded. Herbicide treatments were applied in late May 2005 while mechanical treatments were applied in early June. Plots were seeded with a Truax Rough Rider rangeland drill in October 2005. The drill was specially configured to drill or broadcast seed in alternating rows with the goal of drilled species being planted no deeper than 1.3 cm. Brillion packer wheels placed immediately after the drop tubes pressed broadcast species into the ground. With the exception of 'Appar' flax, all species used in the seed mix are native and where possible collected or grown in proximity to the study sites. Utah Division of Wildlife Resources supplied all seed for the study except for 'Eagle' yarrow.

Table 1. Crested wheatgrass diversification study seed mix.

Drill Mix

SPECIES		PLS lbs/acre	Bulk lbs/acre
Bluebunch wheatgrass - 'Anatone'		3.00	3.16
Squirreltail - 'SID Sanpete'		2.00	2.82
Indian ricegrass - 'Nezpar'		2.00	2.13
Fourwing saltbush		1.00	3.48
Lewis flax - 'Appar'		0.75	0.83
Munroe globemallow		0.50	0.84
	Total	**9.25**	**13.26**

Broadcast Mix

SPECIES		PLS lbs/acre	Bulk lbs/acre
Sandberg bluegrass - 'SID OR'		0.75	0.95
White stemmed rabbitbrush		0.25	0.75
Wyoming big sagebrush		0.20	0.94
Yarrow – 'Eagle'		0.20	0.24
	Total	**1.40**	**2.88**

To assess the effectiveness of the treatments at reducing or eliminating crested wheatgrass, seed production data were collected 5 months post treatment. Within each treatment, wheatgrass was clipped from ten, 0.25m^2 quadrats and the number of fertile seeds counted. The counting process has not been completed but preliminary results indicate a reduction in seed production in all treatments.

For partial control of crested wheatgrass it appears that the 1-way disk treatment was more effective than the low rate herbicide. We observed less than 10% mortality in partial control herbicide plots while 1-way disking appeared to remove about 50%. In full control plots 2-way disking eliminated >80% of the crested wheatgrass while herbicide sprayed at the high rate appeared to kill about 50-75%. These estimates are based solely on observation and are subject to change once data have been collected this spring.

Revegetation success can be hindered by undesirable species found in the seed bank. To determine seed bank potential, within each block we took ten, 1 in^3 soil samples in each treatment, grew the samples in a greenhouse and counted the number of seedlings that emerged. Both sites have substantial weed and crested wheatgrass seed in the seed bank. At Skull Valley, across all treatments bur buttercup averaged 15,608 seeds per 0.25 m^2, while cheatgrass and crested wheatgrass averaged 6,107 and 1,798 seeds per 0.25 m^2 respectively. At Lookout Pass bur buttercup was the most prominent species in the seed bank averaging 8,758 seeds per 0.25 m^2, but there was more crested wheatgrass than cheatgrass in the seed bank (1,891 to 481 seeds per 0.25m^2 respectively). Because of the high amount of undesirable species in the seed bank we anticipate that a follow up treatment will be necessary. We propose retreating a portion of the unseeded full control herbicide plots from year 1 and seeding them. Approximately half (1/4 ac) of the unseeded plot would be sprayed in early spring at the high herbicide rate (44 oz/ac) to kill newly emerged seedlings and then seeded in October. This would enable us to determine if a follow-up treatment is necessary and how effective the treatment is at controlling weedy species and crested wheatgrass.

For the coming year, field crews will assess seeding success and crested wheatgrass mortality in year 1 plots during May/June. Additionally, this study will be replicated in its entirety. Both the herbicide and mechanical treatment will be applied in April and plots will be seeded in October.

Seedling establishment modeling:
Heat accumulation models for germination have been developed for 14 species or collections. Test collections include 8 native species desirable for revegetation including Secar and Anatone bluebunch wheatgrass, Sanpete bottlebrush squirreltail grass, white and Eagle yarrows, Lewis flax, longspur lupine, and nakedstem sunray. Also included are 3 introduced species used in revegetation, including Nordan and Hycrest crested wheatgrasses, and Appar blue flax. In addition, cheatgrass populations collected from 3 sites, including BYU Spanish Fork Farm, Utah Valley; Lookout Pass, Rush Valley; and Skull Valley, Utah were also tested. Heat summation modeling requires that seeds be germinable by having little or no dormancy, or by having been pre-treated to overcome dormancy such as by chilling, prior to testing. Seeds were incubated in subpopulations of 25 per Petri dish at constant temperatures of 5, 10, 15, 20, 25, and 30 °C. Linear and second order polynomial regression analyses were used to quantify the relationships between constant temperature and 1/days to 50% germination. Almost all species had a base temperature (no heat accumulation toward germination) near 0 °C. The cheatgrass collections germinated fastest at cooler temperatures, as has been shown by others. Many of the other species had similar germination rate responses to temperature, suggesting that many native species should germinate as well as the introduced species at cooler temperatures. The lupine and nakedstem sunray had some dormancy problems, but the germination behavior of the other collections and species fit the heat summation model quite well (R^2 values for linear regressions from 5-20 °C = 0.84-0.99, and for polynomial regressions from 15-30 °C used for >20°C predictions = 0.12- 0.94, with most above 0.5).

Heat summation model estimates of days to 50% germination were compared with actual days to 50% germination for these species at 2 diurnal fluctuating temperatures from field studies and programmed into a ramping temperature incubator. For both the cooler and warmer diurnal curves, the model tended to overestimate days to 50% germination by 0-4 days.

Seeds of 6 of the collections (Anatone bluebunch, Sanpete squirreltail, Appar blue flax, Eagle yarrow, and 2 collections of cheatgrass) were also sown in 4 replicate blocks adjacent to crested wheatgrass diversification study plots at the Lookout Pass and Skull Valley sites. Seeds were sown in 1 m rows at 1.3 cm depth for all but yarrow, which was sown at about 0.5 cm depth. Seeds were sown at an equivalent rate of 15 kg pure live seed/ha into 1.2 by 1.8 m subplots in undisturbed, partial herbicide, and full herbicide control treatments. Soil water and temperature sensors were also buried in 3 sown plots on each of 4 blocks for each of the 3 treatments and for 3 of the sown species at depths of 1-3, 13-15, and 28-30 cm and read continuously to produce hourly averages of soil water potential and temperature. Seedbags of the 6 collections were also buried in 4 blocks treated for full herbicide control of crested wheatgrass. Seedbags contained 25 PLS of each collection and 4 bags of 18 sets of each species were buried to allow 18 subsequent retrievals. Seedbags were buried and small plots were sown on 15 October 2005. Seedbags and soil water and temperature data were retrieved on 6 December 2005 and the numbers of germinated seeds were counted. Around 50% of seeds in the bags had germinated by this retrieval date at both study sites, but practically none of the seeds sown separately in small plots had produced seedling emergence. Only the yarrow had little germination in the seedbags at both sites. Soil water potential and hourly temperature averages at 1-3 cm depth for each study site were input into a model to calculate progress toward germination based on regression equations developed from laboratory tests as described above. Using a water potential threshold for heat accumulation of -1.5 MPa, the heat summation models predicted that all collections should have had 50% germination after 15 October and before 6 December at Lookout Pass, but that only cheatgrass would germinate during that time at Skull Valley. By raising the water potential threshold to -1 MPa, insufficient wet days and heat accumulation were predicted for 50% germination at either site during this period. The heat summation model seems to be working, but some tuning may be necessary. Soil water sensors at 1-3 cm may be more representative of seeds in seedbags than those buried separately in sown plots. Also, the failure of yarrow to germinate in seedbags when the other collections did needs additional investigation.

Two BYU undergraduate students will be presenting these results in the undergraduate paper session of the Society for Range Management in February 2006. Future studies this year will include burial of additional seedbags in late February and subsequent retrieval in the spring. Seedling emergence and survival in spring will be measured on small sown plots, and additional comparisons of predicted germination from field seedbed temperature and water data to that of seedbag germination and sown-plot emergence will be made. In addition, seminal root growth responses (days to 15 cm root growth) will be modeled in the growth chamber as a function of temperature, just as has been done for germination for these collections. Seedbags will be buried and small plots will be sown again this fall. We expect to have good comparisons of modeled and actual field germination for 2 springs and 2 falls for this study.

Project Title: Reestablishing Native Plant Diversity in Crested Wheatgrass Stands in the Great Basin

Project Location: Burns, Oregon

Principal Investigators and Contact Information:

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Project Description:
This project investigates the feasibility of increasing native plant diversity in established crested wheatgrass stands in the Great Basin. The study location is 80 km south of Burns, OR, on the Malheur National Wildlife Refuge in a stand of crested wheatgrass approximately 25 years old (Fig.1). Objectives include: 1) determine the effect of crested wheatgrass control methodologies and revegetation on crested wheatgrass density and cover, 2) determine the effect of crested wheatgrass control methodologies and revegetation on establishment of native species, 3) determine the effect of crested wheatgrass control methodologies and revegetation on cheatgrass density and cover, and 4) determine the effects of crested wheatgrass control methodologies and native plant establishment on seed bank and soil nitrogen and water content.

Procedures include varying the method and intensity of crested wheatgrass control, followed by seeding a mix of native shrubs, grasses, and forbs. Control strategies are being tested in a randomized block, split-plot design with control strategy and intensity as whole plots and seeded vs. unseeded as split-plots. Control methods include mechanical (disking), chemical (glyphosate application), or undisturbed (no crested wheatgrass control). Control intensity is varied by the number of passes with the disk (partial = one pass, full = two passes) and the rate of glyphosate application (partial = quarter rate, full = full rate). Half the plot is seeded and half the plot is left unseeded following control treatment. The five treatments (full mechanical control, partial mechanical control, full chemical control, partial chemical control, undisturbed) are replicated across five blocks each year on 0.4 ha (1 acre) plots for a total of approximately 10 ha (25 acres) being treated annually (5 ha (12.5 acres) seeded, 5 ha unseeded). Procedures will be repeated in 2006 on additional plots.

Surface soil and litter will be collected in the spring and fall of each year and bioassayed for seedbank potential of crested wheatgrass, native residuals, seeded species, and cheatgrass. Soil sampling will occur twice each year, once in early April and once when vegetation is sampled at peak standing crop (June). Cover and density of unseeded and seeded species will be collected at peak standing crop for two years on plots established in 2005 and for one year on plots established in 2006.

Project Status:

Accomplishments 2005

Plot lay-out

Plots were established for 2005 and 2006 in early June 2005 using ArcMap software and hand-held GPS units, marking plot corners with steel T-posts. Plots were approximately 30 m x 70 m. A 30 m buffer was established between each block. Due to space restrictions, some blocks had to be split (Fig. 2).

Control treatments

Chemical control treatments were applied July 12, 2005. Glyphosate was applied at 4.8 l/ha (44 oz. per acre) for full control or 2.4 l/ha (10 oz. per acre) for partial control using an ATV-mounted boom sprayer, delivering 95 l/ha (10 gal/a) water. Conditions were 26 ˚C, wind 6 km/h, and 28% relative humidity.

Mechanical control treatments were applied October 17-18, 2005 using a tractor-mounted 4.2 m (14-feet) off-set disk with 50 cm (20 inch) disks. Partial control plots were disked once (Fig. 3a) and full control plots were disked twice (Fig. 3b).

Seed bank and soil sampling

Pre-treatment seed bank and soil nitrogen was sampled. The seed bank was sampled on June 30-July 1, 2005. Five-50 cm^3 sub-samples were collected from the top 2 cm of soil in each plot (Year 1 plots only). Samples are being stored at the Eastern Oregon Agricultural Research Center (EOARC) for further analysis. Soil was sampled for nitrogen on June 29-30 by collecting 2 cm-diameter soil cores, 15 cm deep. Five sub-samples were collected and composited to make one sample per plot (Year 1 plots only). Soil samples were sent to Central Analytical Lab at Oregon State University where they were analyzed for nitrate-nitrogen and ammonium-nitrogen (Appendix A).

Seeding

Plots were seeded on October 31-November 1, 2005. Plots were seeded using a modified Truax Rough Rider no-till drill. Two seed mixes were used, one large-seeded and the other small-seeded. Large seeds were put in a cool-season box while small seeds were put in a fluffy seed box. Alternating drops were used from the cool-season and fluffy boxes. The cool-season box fed the seeding disks, and the fluffy box dropped seeds onto the soil surface where they were rolled over by Brillion wheels. The large-seeded mix included four-wing saltbush, Lewis flax, Munro globemallow, bluebunch wheatgrass, bottlebrush squirreltail, and Indian ricegrass. The small-seeded mix included Wyoming big sagebrush, white-stemmed rabbitbrush, western yarrow, and Sandberg bluegrass. Species, kind/variety, commercial source and seeding rates are listed in Table 1. Seeding conditions were approximately 13 ˚C, partly sunny, breezy, and dry.

Plans for 2006

Control treatments

Control treatments for Year 2 plots will be applied using the same methods as for Year 1 plots in 2005. We anticipate applying the chemical control in mid-late June rather than mid-July.

Sampling
Vegetation cover and density of Year 1 plots will be sampled at peak standing crop (mid-late June). Seed bank and soil nitrogen will be sampled using the same methods as in 2005. Seed bank samples will be collected in April and October. Soil nitrogen samples will be collected in April and at the time of vegetation sampling. Seed bank samples will be analyzed in a greenhouse at EOARC shortly after collection.

Seeding
Year 2 plots will be seeded using the same procedures as for Year 1 plots in 2005. We anticipate seeding as close to the same dates as in 2005.

Products:

Publications: A description of the project was entered into the Center for Invasive Plant Management Restoration Resource Database.

Presentations: The project was described in an invited undergraduate lecture at the University of Idaho (Range 357 Rangeland and Riparian Habitat Assessment).

Technology Transfer: None at this time.

Tables and Figures

Table 1. Seeded species, including their origin and commercial source, and seeding rates.

Species	Kind/ Variety	Commercial Source	Seeding Rate (lb. PLS/acre)
Wyoming big sagebrush (*Artemisia tridentata wyomingensis*)		Maple Leaf	0.20
Four-wing saltbush (*Atriplex canescens*)		L&H Seed	1.0
White-stemmed rabbitbrush (*Chrysothamnus nauseosus albicaulis*)		Maple Leaf	0.25
Lewis flax (*Linum lewisii*)	Appar	Maple Leaf	0.75
Western yarrow (*Achillea millefolium*)	Eagle	Landmark Seed	0.20
Munro globemallow (*Sphaeralcea munroana*)		Maple Leaf	0.50
Bluebunch wheatgrass (*Pseudoroegneria spicata*)	Anatone	Landmark Seed	3.0
Sandberg bluegrass (*Poa secunda*)	Mountain Home	Landmark Seed	0.75
Squirreltail (*Elymus elymoides californica*)	Toe Jam Creek	Landmark Seed	2.0
Indian ricegrass (*Achnatherum hymenoides*)	Nezpar	Landmark Seed	2.0

Figure 1. Study site, approximately 80 km south of Burns, OR, on Malheur National Wildlife Refuge.

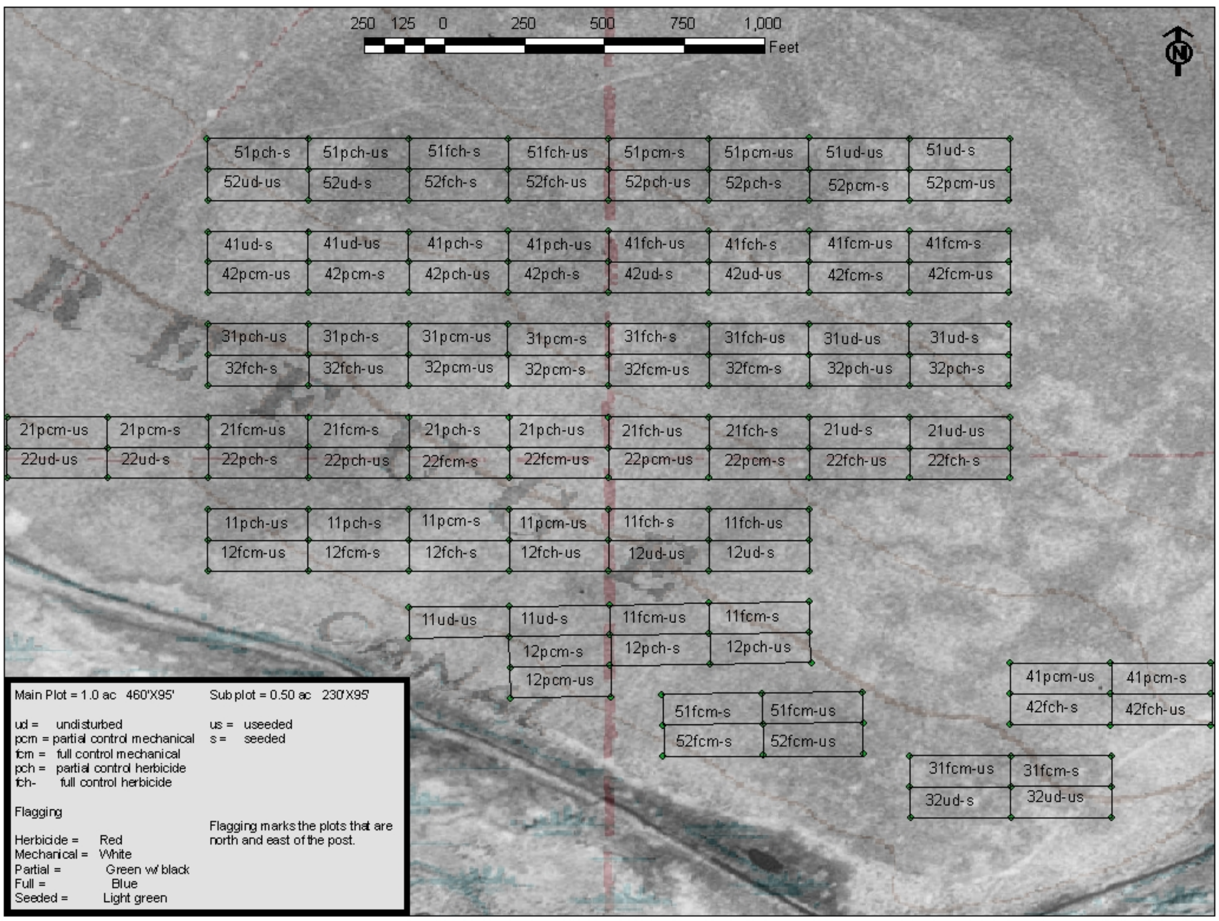

Figure 2. Map of crested wheatgrass diversification plots, Malheur National Wildlife Refuge.

a) b)

Figure 3. Mechanical control treatments: a) partial control and b) full control.

Appendix A. Results of soil nitrogen analyses.

Block	Treatment	NO_3-N (ppm)	NH_4-N (ppm)
1	fch-s	0.9	1.4
2	fch-s	0.9	1.7
3	fch-s	0.8	1.5
4	fch-s	0.6	2.4
5	fch-s	1.1	2.9
mean		0.86	1.98
1	fch-us	0.6	1.4
2	fch-us	0.9	1.6
3	fch-us	1	2.1
4	fch-us	1	2.3
5	fch-us	0.9	2.7
mean		0.88	2.02
1	fcm-s	0.9	1.9
2	fcm-s	1.2	2.4
3	fcm-s	0.6	1.6
4	fcm-s	1.2	1.8
5	fcm-s	1	2.4
mean		0.98	2.02
1	fcm-us	0.9	1.4
2	fcm-us	1.2	2.1
3	fcm-us	0.8	1.9
4	fcm-us	1.1	2.7
5	fcm-us	0.9	3.1
mean		0.98	2.24
1	pch-s	0.9	1.3
2	pch-s	0.7	1.7
3	pch-s	0.8	1.4
4	pch-s	0.9	1.8
5	pch-s	0.8	1.7
mean		0.82	1.58
1	pch-us	0.8	1.4
2	pch-us	0.6	1.6
3	pch-us	0.7	1.5
4	pch-us	0.7	2.3
5	pch-us	1	2.4
mean		0.76	1.84
1	pcm-s	0.7	1.4
2	pcm-s	0.8	1.2
3	pcm-s	0.7	1.6
4	pcm-s	0.8	2.3
5	pcm-s	1.8	3.6

Treatment Codes*

fch=full control herbicide
fcm=full control mechanical
pch=partial control herbicide
pcm=partial control mechanical
ud=undisturbed
s=seeded
us=unseeded
*Soil samples taken prior to any treatment application. Therefore, we do not expect differences between treatments.

Block	Treatment	NO_3-N (ppm)	NH_4-N (ppm)
mean		0.96	2.02
1	pcm-us	0.7	1.5
2	pcm-us	0.9	1.6
3	pcm-us	1	1.7
4	pcm-us	1.2	3.1
5	pcm-us	1.6	2.6
mean		1.08	2.1
1	ud-s	0.9	1.9
2	ud-s	1.1	1.5
3	ud-s	1.2	1.9
4	ud-s	0.6	2.3
5	ud-s	1.3	3.3
mean		1.02	2.18
1	ud-us	1.1	1.9
2	ud-us	0.9	1.5
3	ud-us	1	1.5
4	ud-us	1	2.4
5	ud-us	0.9	1.8
mean		0.98	1.82

Project Title: **Development of the Truax Rangeland Drill**

Principal Investigators and Contact Information:

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Project Description:
The Truax Rangeland Drill evolved from a discussion between Mike Pellant, Steve Monsen, and Jim Truax at the Billings Mine Symposium in 2000. They identified the need for seeding equipment that would stand up to the rigors of rugged site conditions yet place a variety of seed types at a shallow depth in virtually an undisturbed seedbed.

A radical change in drill design was needed in order to introduce perennial species into range sites without disturbing the soil and encouraging exotic species. The existing and historical rangeland drills share several shortfalls, which limits their effectiveness under most conditions.

The following are common limitations:

1. Existing drills typically deep furrow the soil and do not have adjustable seed depth control.
2. All current rangeland drills have the planters in a single row with a very small gap between individual planters. On sites with surface litter the drill becomes a large rake which affects planter performance.
3. The use of hydraulics has been limited to an occasional lift mechanism to raise the planters. None of the drills have hydraulic down pressure to transfer the machine weight to the planter units.
4. The bearings used on existing rangeland drills are typically ball bearings or roller bearings used by the industry prior to the advent of tapered roller bearings. Tapered roller bearings are now the industry standard in both agriculture equipment and the automotive industries.
5. A common feature of the typical drill has been the use of concave discs arranged to throw toward the middle of the drill. This further limits the amount of surface trash that will pass between the discs without plugging.
6. The typical rangeland planter assembly has a vertical travel of less than 10 inches before hitting the machine skid plate, thereby raising the drill and losing disc contact with the soil surface.

With these needs in sight we made it our mission to overcome the problems of existing rangeland drills as well as add a few extra features including manual hydraulics, larger seed box capacity, ease of filling seed boxes, and a transport system to move the drill.

With significant input from researchers, field technicians, and range specialists from the USDA NRCS Aberdeen Plant Materials Center, Purdue University, the US Air Force, contractors, private ranchers and others, we designed the Truax Rough Rider Rangeland Drill and continue to fine tune the drill to meet the customer's needs.

To achieve these goals we have focused on the following issues:

1. In 2000 we created a design that allowed the individual planters to move vertically in a 24-inch plane.
2. Planters were placed in two ranks with 24 inches between planters within the rank and 48 inches between the ranks for maximum trash clearance.
3. Hydraulics was added to not only raise the planters for transport, but to also transfer machine weight to the planters for increased penetration on hard ground.
4. A 4-inch wide adjustable depth gauge wheel was added to control planting depth in 1/4-inch increments from surface planting to 2-1/2 inches deep.
5. A 2-inch wide semi-pneumatic press wheel firms the soil around the newly planted seed.
6. Tapered roller bearings are used for both the disc blade and the attached gauge wheel assembly. These industry standard, off-the-shelf bearings, are both forgiving and readily available.
7. The flat disc blades are canted to both the vertical and the horizontal with the throw to the outside to provide maximum trash flow.

From this early design we continued to fine tune and improve drill functions.

1. By 2004 the single planter lift arm was replaced with a parallelogram which now raises the planters in a straight line. This allows the seed to more accurately drop into the opened seed slot.
2. We added a mudguard to the back of the gauge wheel rim to reduce the buildup of mud between the disc and the gauge wheel.
3. The seed boot was repositioned to achieve a straighter seed drop.
4. The press wheel arm was reinforced.

Project Status:

In the spring of 2005, Rough Rider Rangeland Drills were sent to Purdue University and the Aberdeen Plant Materials Center.

1. These drills were equipped with the parallelogram planter arms and the gauge wheel inside mudguards.
2. Spring work at Purdue showed a need for larger openings from the seed boot. This change was made on the Aberdeen PMC drill. In early fall 2005, during planting east of the Dugway Proving Grounds, Utah, it became evident that the seed boot opening needed additional work to allow for an even larger seed drop opening.
3. A new seed boot with a round body was developed and installed before plantings at Burns, Oregon. This new round shape proved to be the answer that we had been looking for. The seed flow improved and seed was planted without plugging the seed boot.
4. After the plantings were completed we manufactured several of the new boots, incorporating additional refinements. A sample has been sent to Aberdeen PMC for evaluation.

5. During fall plantings west of Tooele, Utah a new style seed imprinter was field-tested. This design came from a Steve Monsen suggestion that we develop a single row imprinter using rings from a Brillion cultipacker roller. This unit can be used to replace the standard planting units on the Truax Rangeland Drill. This unit has a seed drop immediately in front of the imprinter. The drill operator has the flexibility of applying from 0-800 pounds of down pressure on each row based on site conditions.
6. A second imprinter unit was built using John Deere rotary hoe segments. To my knowledge these have not been field-tested. They are designed to be more aggressive and to lightly disturb a crusted soil surface.

After completing work at Tooele, Utah; Burns, Oregon; and a site west of Reno, Nevada, a list of problem areas and suggested improvements was developed. Items we still need to address include:

1. Better alignment of press wheels to planting discs.
2. A flexible press wheel arm.
3. A new attachment bolt for the shift quad controlling the gauge wheel position.
4. A wind shield for the seed cups.
5. A retaining pin for the parking jack.
6. Tension spring of seed boot to blade.
7. Reduce gap between blade and seed boot.
8. Add mounting point for optional drag chains.
9. Level bottom of seed boot relative to ground surface.
10. Heavy-duty shifter on cool season box.
11. Locking nuts on telescoping seed tube mounts.
12. Match size of seed boot top and telescoping seed tube.

In summary, it is now apparent that the importance of seed placement on range sites cannot be overshadowed by the site conditions and the shear scope of the acres to be planted. By accessing and studying the trials and experiences of others, we have developed, designed, and begun manufacturing a rangeland drill that uses some of the things learned in no-till agriculture, several features used in native grass drills, and the on-going stream of thoughts from range scientists working in the field. This has resulted in a machine that not only meters the seed, but will also plant into very heavy, trashy sites over rocky, unleveled conditions. Achieving this while maintaining a consistent seed placement has been our goal. Additional problems will pop up and they will be dealt with in due course.

Project Title: Revegetation Equipment Catalog Project

Project Location: College Station, Texas

Principal Investigators and Contact Information:

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Project Description:

Prepare and publish an equipment catalog describing types and operations of equipment designed or adapted for rangeland vegetation manipulation, wildlife habitat improvement, and disturbed land rehabilitation. Categories will include all types of implements used in brush and weed control, site preparation, seeding and planting, seed collection and processing, and related equipment such as tractors, all-terrain vehicles, global positioning systems, trailers, and miscellaneous items. Photographs, special features, and suppliers (including website addresses and other contact information) will be listed for each type of equipment. The final product will be a web-based publication allowing for updates and new advances in technology. It will likely be used throughout the United States and internationally.

Project Status:

The Revegetation Equipment Catalog text was completed and placed on the World Wide Web. It was officially announced at the Rangeland Technology and Equipment Council (RTEC) meeting during the Society for Range Management Annual Meeting in Ft. Worth, Texas in February 2005. The catalog has been publicized at numerous range ecology, management, and conservation meetings throughout the western states and Texas.

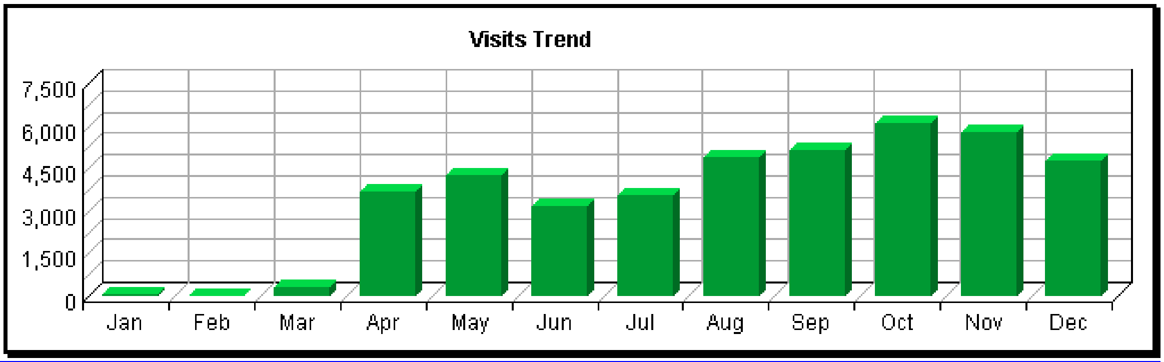
Our publicity and listing in the Google search engine has resulted in significant use of the catalog. Tracking software has logged 41,717 visitors with 83% coming from the United States and Canada and 17% from international sources. Top states were California, Virginia, and Texas. Top regions were North America, Europe, and Australia. There were 16 different geographical regions recorded worldwide. Different domain entities are also listed. Hits on images probably indicate the use of photos for classroom power point presentations. Graphs listing the data are attached.

The catalog is being used in restoration classes at Brigham Young and Oregon State Universities. A restoration class taught at the BLM National Training Center in Phoenix has utilized the catalog. Information about equipment and its use has been included in handbooks by the Florida NRCS and Colorado Game Department. Rangeland West http://rangelandswest.org, the BLM Great Basin Restoration Initiative http://www.fire.blm.gov/gbri/links.html, and the Society for Range management http://www.rangelands.org/links_ plant_resources.html have a link to the catalog's website. Additionally, several requests for special information have been received from ranchers and government field personnel.

There have been a few minor corrections (<10) that were easily changed. This demonstrates the advantages of the book being published on the web and the author's proximity to the Biological & Agricultural Engineering Department at Texas A&M University who are currently hosting the website.

Graphs:

Overview Dashboard



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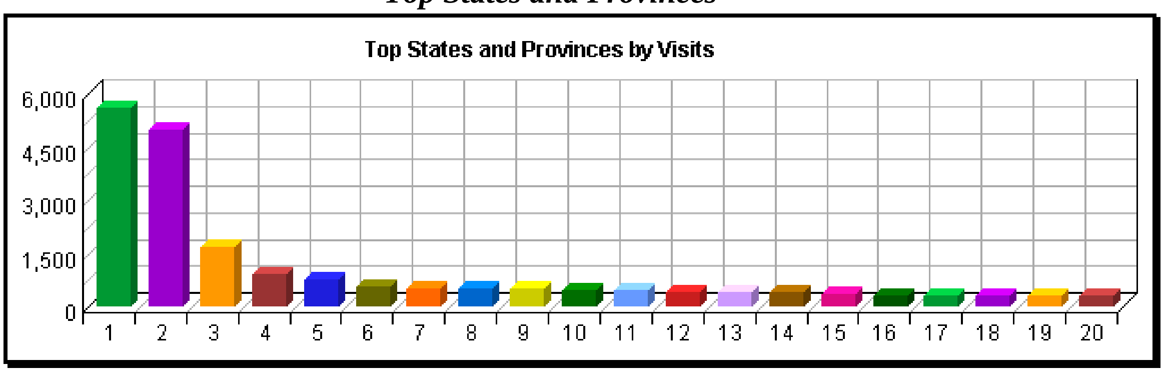
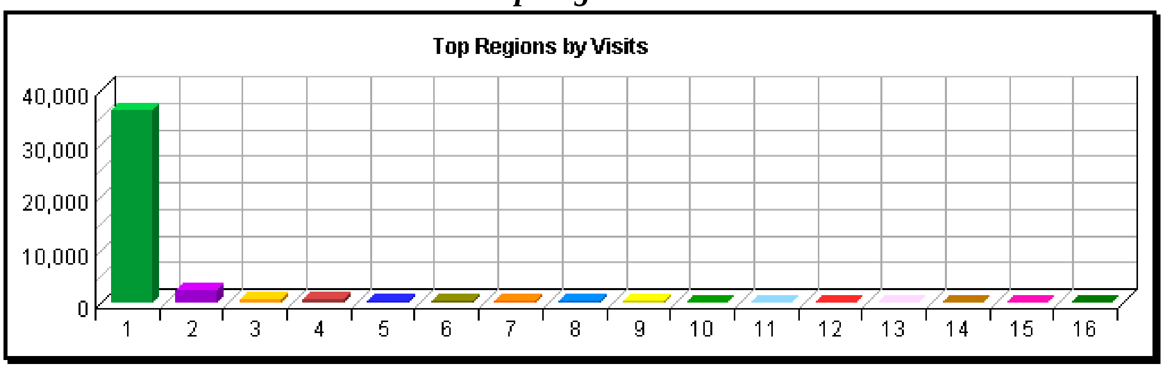
Top States and Provinces



Top States and Provinces			
	States and Provinces	**Visits**	**%**
1.	California	5,611	23.13%
2.	Virginia	4,972	20.50%
3.	Texas	1,674	6.90%
4.	Colorado	928	3.83%
5.	Georgia	768	3.17%
6.	Massachusetts	543	2.24%
7.	New Jersey	521	2.15%
8.	Ontario	502	2.07%

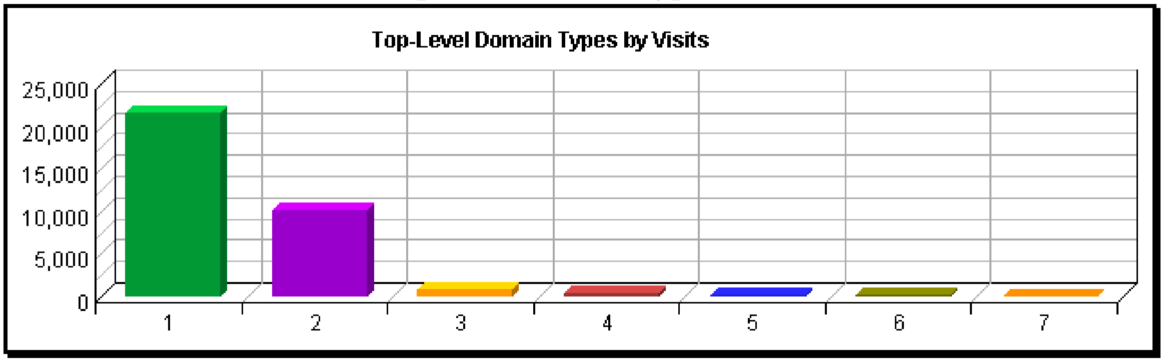
Top States and Provinces			
	States and Provinces	**Visits**	**%**
9.	Illinois	487	2.01%
10.	Florida	454	1.87%
11.	Pennsylvania	440	1.81%
12.	Washington	427	1.76%
13.	New York	422	1.74%
14.	Missouri	406	1.67%
15.	D.C.	341	1.41%
16.	Minnesota	326	1.34%
17.	Michigan	312	1.29%
18.	Ohio	296	1.22%
19.	Wisconsin	286	1.18%
20.	Alberta	283	1.17%
	Subtotal	19,999	82.44%
	Other	4,260	17.56%
	Total	**24,259**	**100.00%**

Top Regions



Top Regions			
	Geographic Regions	**Visits**	**%**
1.	North America	36,120	86.58%
2.	Western Europe	2,493	5.98%
3.	Australia	714	1.71%
4.	Asia	512	1.23%
5.	Middle East	391	0.94%
6.	South America	361	0.87%
7.	Northern Europe	333	0.80%
8.	Eastern Europe	326	0.78%
9.	Southern Africa	205	0.49%
10.	Pacific Islands	86	0.21%
11.	Caribbean Islands	58	0.14%
12.	Western Africa	47	0.11%
13.	Northern Africa	46	0.11%
14.	Eastern Africa	14	0.03%
15.	Central America	10	0.02%
16.	Central Africa	1	0.00%
	Total	**41,717**	**100.00%**

Top-Level Domain Types



Top-Level Domain Types				
	Top-Level Domain Types	**Visits**	**%**	**Hits**
1.	Commercial	21,702	64.80%	109,079
2.	Network	10,207	30.48%	154,386
3.	Education	790	2.36%	14,334
4.	Government	345	1.03%	7,724
5.	Military	281	0.84%	3,289
6.	Organization	151	0.45%	2,642
7.	ARPANET	14	0.04%	172
	Total	**33,490**	**100.00%**	**291,626**

Publications:
Wiedemann, H.T. 2005. Revegetation Equipment Catalog, 14 chapters. College Station, TX. Online: http://reveg-catalog.tamu.edu.

Presentations:
Wiedemann, H.T. 2004. Revegetation Equipment Catalog preparation. Abstracts of the 57th Annual Meeting of the Society for Range Management. Abstract 394. Salt Lake City, UT.

Wiedemann, H.T. 2005. Revegetation Equipment Catalog Progress. Abstracts of the 58th Annual Meeting of the Society for Range Management. Abstract 374. Ft. Worth, TX.

Wiedemann, H.T. 2005. Revegetation Equipment Catalog. Texas Section of the Society for Range Management, South Padre Island, TX. (poster presentation and website demonstration)

Wiedemann, H.T. 2005. Revegetation Equipment Catalog. Texas Section of the American Society of Agricultural and Biological Engineers, Grapevine, TX. (poster presentation and website demonstration)

Project Title: VegSpec Seeding Guide

Project Location: USGS, Corvallis, Oregon

Principal Investigators and Contact Information:

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Cooperators: BLM, NRCS, and US Army Corp of Engineers

Project Description:
VegSpec is a web-based decision support application that assists land managers in the planning and design of vegetative establishment practices. VegSpec utilizes soil, plant, and climate data to select plant species that are (1) site-specifically adapted and (2) suitable for the selected purposes and objectives for which the planting is intended. Incorporating a horticultural database of over 2500 plants and specific climate and soils information, the VegSpec application has the ability to determine site-specific adaptability of plant species. VegSpec helps revegetation projects succeed by reducing costs and improving plant selection for the site and objectives desired. VegSpec contributors include the National Resources Conservation Service, US Army Corps of Engineers, USGS, and BLM. The web address for VegSpec is http://vegspec.nrcs.usda.gov/vegSpec/index.jsp .

Plants that are selected by VegSpec for a particular project should be reviewed by persons who are knowledgeable about the use of plants for revegetation and additional information about plants proposed by VegSpec should be sought. VegSpec does not include horticultural or gardening plants. VegSpec contains limited data on cultivar and germplasm releases.

Project Status:
Modifications to VegSpec are needed to expand the scope of Great Basin species in the database, especially the native forbs being developed for release in the Great Basin Native Plant Selection and Increase Project (GBNPSIP). Other modifications proposed for VegSpec and funded via GBNPSIP includes modification of seeding rate calculations, inclusion of a species selection list based upon ecological site information, a spatial component of the database to plan large scale seedings, improving usability by revising portions of the format, adding latitude/longitude capabilities for identifying seeding areas and adding new practices to the suite of practices already in the model.

Products:
Products include the modifications to the model described in the Project Status section. These modifications will be made on a priority basis and as additional funding becomes available. Priorities to be accomplished with the FY06 GBNPSIP funds are focused on the seeding rate calculations, addition of new practices, adding priority Great Basin species to the database, and enhancing ease of use of the website.

Publications:
Publications will include a new manual for the use of the VegSpec website.

Project Title: Manipulations to Sustain Seed Yield in Wild Shrub Stands

Project Location: Brigham Young University, Provo, UT

Principal Investigators and Contact Information:

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Project Description:
Seed from wild collected shrubs is the primary source for shrub seed for reclamation in the Great Basin. Management of good quality shrub stands for sustainable and/or increased seed harvest can be an option equally viable to or preferable to agricultural production. This project investigates imposing common agricultural practices used to promote shrub seed production but in wildland settings. Bitterbrush *(Purshia tridentata)* and Wyoming big sagebrush *(Artemisia tridentata wyomingensis)* were selected as test subjects. Treatments included fertilizer application, pruning, and competition reduction in all combinations compared against a control group. Treatments were carried out at three sites in Utah, Nevada, and Idaho. The effect of annual seed harvest from shrubs at the same sites is also being investigated. A comparison of beating vs. hand harvesting will be made to measure the long-term effect of repetitive harvests on seed production and seed bank maintenance.

Project Status:
Treatments were implemented at all sites in fall 2004 and winter 2005. Harvest of seed from bitterbrush occurred in spring 2005. Harvest of seed from Wyoming big sagebrush during the fall of 2005 was challenging due to premature seed shatter and treatment effects on seed ripening. To offset missed seed harvesting, treatment effects on shrub leader growth and inflorescence length and biomass was sampled and will be used to correlate seed production. We revised our future

seed collecting plans to ensure capturing seed production by bagging a subsample of branches on shrubs well in advance of seed ripening. We can then collect the seed after shattering without any loss.

Project Title: The Association of Official Seed Certifying Agencies Cooperative Native Seed Increase Program

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

Principal Investigators and Contact Information:

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Chet Boruff, Chief Executive Officer
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Project Description:
In May 2003, the Association of Official Seed Certifying Agencies (AOSCA) executive vice president invited the Great Basin Native Plant Selection and Increase Project to submit a proposal to work through their 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). Initially the emphasis was on species not included on the principal research list but on other forb species of interest to BLM districts in the Great Basin. However, in 2005, principal research species were included on the list of offerings to bolster efforts to "jump-start" their increased availability as well. To implement this program, RMRS and AOSCA drafted and signed an agreement in 2003. Recently expired, this agreement is currently being revised to continue this program's efforts for at least another 3 years.

Project Status:
As of February 2006, sixteen seed lots have been distributed representing 12 species (11 forbs, 1 grass) (Table 1). The first seed lots were distributed in March of 2004. No seed has yet been purchased by state Foundation Seed Programs, though at least two lots could be produced in 2006. Several additional non-dormant seed lots will be distributed in spring 2006. Seed is cleaned, tested and source-identified prior to distribution to state Foundation Seed Program managers and growers.

- Seed lots distributed in 2005 -
    - LomDis56-BSE-05 (fernleaf biscuitroot, *Lomatium dissectum*) (350 g) – Idaho grower (contract: ID Foundation Seed)
    - LomDis18-BSE-03 (454 g) – Idaho grower (contract: WA Foundation Seed)
    - PenSpe43-BSE-05 (95 g) (royal penstemon, *Penstemon speciosus*) – Idaho grower (contract: WA Foundation Seed)

- Several non-dormant 2005 Asteraceae lots will be distributed for spring 2006 sowing:
    - Douglas’ dustymaiden (*Chaenactis douglasii*)
    - Hoary tansyaster (*Machaeranthera canescens*)
    - Shaggy fleabane (*Erigeron pumilus*)
- Several additional large seed lots are available for fall 2006 sowing; a table listing these was provided to the states in October 2005.
- Seed that may be purchased by Foundation Seed Programs in 2006:
    - Blue penstemon (*Penstemon cyaneus*)
    - Fernleaf biscuitroot *(Lomatium dissectum*)
- In 2006, we will be working towards consistency of grower contracts with participating state Foundation Seed Programs.

Brochures

U.S. Department of Agriculture, Forest Service. 2005. Cooperative Native Seed Increase Program. Boise, ID: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. Tri-fold brochure, revised (November 2005).

Meetings and Field Tours - Planning and Participation

DeBolt: Attended Western Regional AOSCA Annual Meeting; Las Cruces, NM (March 2005).

DeBolt: Gave overview presentation on GBNPSIP and the Cooperative Native Seed Increase Program and led a tour of native forb study and production fields as part of the Oregon State University, Malheur Experiment Station, Annual Field Day, Ontario, OR (July 2005).

Table 1. Cooperative Native Seed Increase Program accessions distributed to growers March 2004 - February 2006.

Program Manager Name & State	Scientific Name	Common Name	Lot Number	Seed Origin	Weight (g)	Distribution Date
Kathy Stewart-Williams (ID)	*Achnatherum thurberianum*	Thurber needlegrass	ACHTHU2-BSE-03	NV	13.6	Aug-04
	Eriogonum umbellatum	Sulfur buckwheat	ERUM U9-03	NV	99.0	Aug-04
	Penstemon speciosus	Sagebrush penstemon	PENSPE9A-BSE-03	OR	212.0	Aug-04
	Lomatium dissectum	Fernleaf biscuitroot	LOMDIS56-BSE-05	ID	350.0	Dec-05
Gary Cross (NV)	*Cleome lutea*	Yellow beeplant	CLLU U1-01	NV	300.0	Aug-04
	Eriogonum ovalifolium	Oval-leaf buckwheat	EROV U9-02	NV	10.0	Aug-04
Stanford Young (UT)	*Balsamorhiza sagittata*	Arrowleaf balsamroot	BASA U32-02	NV	735.0	Mar-04
	Crepis acuminata	Tapertip hawksbeard	CRAC U10-01	NV	110.0	Mar-04
	Eriogonum heracleoides	Wyeth buckwheat	ERIHER1-BSE-03	ID	43.0	Mar-04
	Lomatium dissectum	Fernleaf biscuitroot	LOMDIS18-BSE-03	ID	488.0	Mar-04
	Lomatium dissectum	Fernleaf biscuitroot	LODI 11-B7-03	OR	91.0	Mar-04
	Penstemon speciosus	Sagebrush penstemon	PENSPE1-BSE-03	ID	92.0	Mar-04
Lee Schweitzer (OR)	*Balsamorhiza sagittata*	Arrowleaf balsamroot	BALSAG55-BSE-04	OR	390.0	Sep-04
	Sphaeralcea munroana	Munro globemallow	SPHMUN3-BSE-04	OR	45.2	Sep-04
Jerry Robinson (WA)	*Penstemon cyaneus*	Royal penstemon	PECY1-B6-02	ID	300.0	Oct-04
	Penstemon speciosus	Sagebrush penstemon	PENSPE43-BSE-06	ID	95.0	Jan-06
	Lomatium dissectum	Fernleaf biscuitroot	LOMDIS18-BSE-03	ID	454.0	Dec-05

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

Project Location: **Utah Crop Improvement Association, Utah State University**

Principle Investigators and Contact Information:

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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:
A synopsis of the Buy-back Program follows (dated January 31, 2006). Table 1 lists forb and grass seed acquisitions, distributions, inventory, field status, and whether seed has been harvested for species germplasms included in the UCIA Stock Seed Buy-back Program from 2002-2005. It is expected that in 2006 several additional forbs and grasses will be included in the program. Table 2 lists the standardized market price for contract negotiations.

Project Synopsis: Great Basin Native Plant Selection and Increase Project (GBNPSIP) and Utah Crop Improvement Association (UCIA) Stock Seed Buy-back Program, January 31, 2006. This program encourages and allows seed growers to benefit economically in a timely manner as an incentive to participate in the UCIA Stock Seed Buy-back Program. The program helps accelerate the increase in stock seed supplies and ultimately increase seed supplies on the open market for commercial revegetation use.

The purpose of the UCIA Stock Seed Buy-back Program, funded through the GBNPSIP, is: 1) to facilitate development of a seed market for specific germplasm accessions and formal germplasm releases developed through GBNPSIP; these include all germplasms prior to 2003 and certain others assigned through 2005 (see Table 1); 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. 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 2) 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 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.

Publications and Presentations:

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.

Young, S.A. "Calculating the Deductible for Seed Assurance." American Seed Trade Association Environmental and Conservation Seed Committee Meeting, Nov. 6, 2005, Kansas City, MO. PowerPoint Presentation.

Jones, T.A. and S.A. Young. 2005. Native Seeds in Commerce: More Frequently Asked Questions. Native Plants Journal, Vol. 6, No. 3, p. 286-293.

Young, S.A. "Diversifying Seed Crops for Conservation Efforts and Vegetation Management." 1st Annual Flaming Gorge Business Development Conference, April 7, 2005, Manila, UT. PowerPoint Presentation and Discussion.

Young, S.A. "The UCIA Program and Opportunities for New Seed Growers." Great Salt Lake RC&D Coordinator Meeting, Aug. 2, 2005, Provo, UT. PowerPoint Presentation and Discussion.

Table 1. 2005 Update. Utah Crop Improvement Association (UCIA) forb and grass seed aquisition, distribution, inventory, and field planting status for species germplasms included in the Great Basin Native Plant Selection and Increase Project, UCIA Stock Seed Buyback Program

Kind & Variety / Germplasm	Lot/ Source	Seed acquisiton and production status	Generation	Added to Inventory	Date	Distributed from Inventory	Date	Inventory 12/31/2005	State distributed to	Field Status	Seed Harvested
FORBS & SHRUBS				**bulk**		**bulk**		**bulk**			
Achillea millefolium											
Western Yarrow											
Germplasm (Eagle Mountain)	NSW4-1-EMY1-1	*3	G2	6.5	9/23/04	6.5	9/14/05	0	WA WY	Established	yes
	NWS-1-YAR-FDN	*3	G2	13	9/20/05	0		13			
Balsamoriza hookeri	BAHO B1-02	*1*2	G0	271g	Fall 2002	271g	Fall 2002	0.0	CO ID	Seedling	no
Hooker Balsamroot											
Crepis acuminata	CRAC U11-02	*2	G0	50g	Fall 2002	50g	Fall 2002	0.0	ID	Established, taken out	yes
Taperstip hawksbeard											
Lomatium dissectium	LODI B7-02	*2	G0	39g	Fall 2002	39g	Fall 2002	0.0	ID	Established, taken out	yes
Giant Lomatium	LODI B14-02	*2	G0	96g	Fall 2002	96g	Fall 2002	0.0	NV	unsuccessful	no
	LODI PS-04	*3	G1	60g	11/30/04	0		60g *4			
Lomatium triternatum	LOTRT B2-02	*2	G0	446g	Fall 2002	446g	Fall 2002	0.0	ID OR	Established, taken out	yes
Ternate lomatium											
Penstemon acuminatus	PEAC2 B4-02	*1*2	G0	102g	Fall 2002	102g	Fall 2002	0.0	ID	established	yes
Sharpleaf Penstemon	PEAC2 B1-01	*2	G0	37g	Fall 2002	37g	Fall 2002	0.0	NV	unsuccessful	no
Penstemon cyaneus	PECY2 B6-02	*2	G0	968g	Fall 2002	968g	Fall 2002	0.0	ID CO	Established	yes (shoshone office)
Blue Penstemon	PPI-04-1	*1*3	G1	3 lbs	1/6/05	3	9/16/05	0.0	ID	Seedling	no
	2004.0448	*1*3	G1	16	2/2/05	16	2/2/05	0.0	CO	Seedling	no
Penstemon deustus	PEDE B11-02	*1*2	G0	150g	Fall 2002	150g	Fall 2002	0.0	ID	Established	yes
Hotrock Penstemon	PEDE B10-02	*1*2	G0	123g	Fall 2002	123g	Fall 2002	0.0	OR	?	

Table 1 cont. 2005 Update. Utah Crop Improvement Association (UCIA) Forb and grass seed aquisition, distribution,inventory, and field planting status for species germplasms included in the Great Basin Native Plant Selection and Increase Project, UCIA Stock Seed Buyback Program

Kind & Variety / Germplasm	Lot/ Source	Seed acquistion and production status	Generation	Added to Inventory	Date	Distributed from Inventory	Date	Inventory 12/31/2005	State distributed to	Field Status	Seed Harvested
				bulk		**bulk**		**bulk**			
Penstemon pachyphyllus	PEPA2 U6-99	*1*2	G0	1020g	Fall 2002	1020g	Fall 2002	0.0	ID OR NV	Various	yes
Thickleaf Penstemon	PEPA PS-04	*3	G1	345g	11/30/04	0		345g *4			
	A5-4-P1	*3	G1	50lbs	6/7/05	7	Fall 2005	43.0	UT ID	Seedling	no
Sphlaeralcea parvifolia	SPGR U19-02	*2	G0	150g	Fall 2002	150g	Fall 2002	0.0	OR	Unsuccessful	no
Small Flower Globemallow	SPGR U13-01	*2	G0	150g	Fall 2002	150g	Fall 2002	0.0	OR	unsuccessful	no
	SPPA U14-02	*1*2	G0	150g	Fall 2002	150g	Fall 2002	0.0	CO	Established	yes
	S04-2-4	*3	G1	1.44lbs	8/19/04	0		1.44lbs			
	SPGR PS-04	*3	G1	130g	11/30/04	0		130g *4			
Tragopogon dubius	TRDU U2-02	*2	G0	5.44lbs	Fall 2002	5.44lbs	Fall 2002	0.0	ID CO	Established, taken out	yes
Yellow Salsify	TRDU DW-04	*3	G1	201g	9/15/04	0		201g			
			subtotal	105.2lbs		46.8lbs		59lbs			
GRASS											
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	0.0	WA	Various	yes
Indian Ricegrass											
Star lake Germplasm	GV LOW, ARS 14	*1*2	G2	5.0	3/15/04	5.0	4/14/04	0.0	WA	Established	no
	GV MED	*2	G2	4.0	10/19/04	0.0		4.0			
Sandberg Bluegrass											
Mountain Home Germplasm	557-215-31A	*3	G2	304.0	8/20/03	254.2	9/15/03	54.9	UT ID WA	various	yes
Mountain Home Germplasm	557-215-31A	*3	G2	0.0		54.9	9/15/05	0.0	ID WA WY	seedling	no
Squirreltail (Bottlebrush)											
Sand Hollow Germplasm	SH RI-98	*2	G2	25.4	11/15/02	0.0		25.4			

Table 1 cont. 2005 Update. Utah Crop Improvement Association (UCIA) Forb and grass seed aquisition, distribution, inventory, and field planting status for species germplasms included in the Great Basin Native Plant Selection and Increase Project, UCIA Stock Seed Buyback Program

Kind & Variety / Germplasm	Lot/ Source	Seed acquistion and production status	Generation	Added to Inventory	Date	Distributed from Inventory	Date	Inventory 12/31/2005	State distributed to	Field Status	Seed Harvested
				bulk		**bulk**		**bulk**			
Toe Jam Creek Germplasm	LHS1B2J-336	*3	G4	127.5	9/19/05	127.5	9/19/05	0.0	WA	Seedling	no
	LHS1B2G-335	*3	G4	41.0	11/12/04	41.0	9/19/05	0.0	WA	Seedling	no
Fish Creek Germplasm	LHS1B2K-336	*3	G3	113.5	9/14/05	113.5	9/14/05	0.0	WA	Seedling	no
	LHS1B2H-335	*3	G3	47.0	10/28/04	47.0	9/19/05	0.0	WA WY	Seedling	no
			subtotal	1417.4		943.1		534.3			
			Total	1522.6		989.9		593.3			

*1 Currently under Stock Seed Increase contract with grower/cooperators

*2 Seed aquired at no charge from GBRI Cooperators

*3 Cost of seed reimbursed to UCIA through USFS joint venture buy-back program agreement.

*4 Seed not certified, can be used for demonstration plots

Table 2. Standardized Market Price for Contract Negotiation, Great Basin Native Plant Selection and Increase Project-Utah Crop Improvement Association Buy-back Program.

Scientific Name	**Common Name**		**2005 Suggested Market Price**
Forbs			
Achillea millefolium	Western yarrow	Eagle Accession	$5.00
Balsamorhiza hookeri	Hooker's balsamroot	Ada Idaho Accession	$40.00
Balsamorhiza sagittata	Arrowleaf balsamroot	USFS Accession	$35.00
Crepis acuminata	Taper-tip hawksbeard	Humboldt Nevada Accession	$140.00
Lomatium dissectum	Giant lomatium (parsley or biscuitroot)	Various USFS Accessions	$40.00
Lomatium triternatum	Nineleaf lomatium	Camas Idaho Accession	$40.00
Penstemon acuminatus	Sharpleaf penstemon	Elmore Idaho Accession	$40.00
Penstemon cyananthus	Wasatch penstemon		$40.00
Penstemon cyaneus	Blue penstemon	Lincoln Idaho Accession	$40.00
Penstemon deustus	Hot-rock penstemon	Adams Idaho Accession	$40.00
Penstemon pachyphyllus	Thickleaf penstemon	Beaver Utah Accession	$40.00
Penstemon palmeri	Palmer penstemon	Cedar	$25.00
Sphaeralcea munroana	Munro globemallow		$60.00
Sphaeralcea grossulariifolia	Gooseberry-leaved globemallow		$60.00
Sphaeralcea parviflora	Small-flower globemallow	San Juan Utah Accession	$60.00
Tragopogon dubius	Yellow salsify	Box Elder Utah Accession	$30.00
Grasses			
Achnatherum thurberianum	Thurber needlegrass	Orchard Idaho Accession	$40.00
Elymus elymoides	Bottlebrush squirreltail	Fish Creek Germplasm	$25.00
Elymus elymoides	Bottlebrush squirreltail	Toe Jam Creek Germplasm	$25.00
Poa secunda	Sandberg bluegrass	Mountain Home Accession	$12.00

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[1]	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, NSL				X	X
L. grayi	Gray's biscuitroot	SSL-B, Aberdeen		SSL-P		SSL-B, OSU	SSL-B, NSL					
L. triternatum	Nineleaf biscuitroot	SSL-B, Aberdeen				SSL-B, OSU	SSL-B, NSL				X	
Perideridia bolanderi	Yampah	UDWR				UDWR	UDWR, NSL					
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	Coaltown sagebrush		SSL-P									
A. bigelovii	Bigelow sagebrush		SSL-P									
A. cana	Silver sagebrush		SSL-P									
A. longiloba	Alkali 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									

Appendix 1. Great Basin Native Plant Selection and Increase Project: Status of Research Species.												
		Great Basin Project Research									Private Sector	
Family **Species**	**Common Name**	**Selection, seed increase, seed transfer guidelines[1]**	**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**
A. tridentata wyomingensis	Wyoming big sagebrush		SSL-P						BYU, SSL-P			
A. tripartita	Three-tip sagebrush		SSL-P									
Balsamorhiza hookeri	Hooker balsamroot						NSL				X	
B. sagittata	Arrowleaf balsamroot	UDWR		SSL-P	BBSL, CSU	UDWR	UDWR, NSL					X
Chaenactis douglasii	Douglas false-yarrow						NSL					
Chrysothamnus nauseosus	Gray rabbitbrush		SSL-P									
Crepis acuminata	Tapertip hawksbeard	UDWR		SSL-P	BBSL, CSU	UDWR, BYU	UDWR NSL				X	X
C. occidentalis	Western hawksbeard			SSL-P			NSL					
Erigeron pumilus	Shaggy fleabane			SSL-P		UDWR	NSL					
Machaeranthera canescens	Hoary aster						NSL					
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									

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Family Species	Common Name	Great Basin Project Research									Private Sector	
		Selection, seed increase, seed transfer guidelines[1]	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
Krascheninnikovia lanata	Winterfat	Aberdeen	SSL-P									
Fabaceae												
	Hermit milkvetch	SSL-B					NSL					
A. filipes (A. stenophyllus)	Threadstalk milkvetch	FRRL		FRRL	BBSL, CSU	FRRL	NSL					
A. utahensis	Utah milkvetch	SSL-P		SSL-P		SSL-P, BYU	SSL-P					
Dalea ornata	Prairie clover	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		

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

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		Selection, seed increase, seed transfer guidelines[1]	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
L. perenne	Blue flax			SSL-P								
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, EOARC, NRCS, BLM[2]				
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 grass	UDWR, SSL-P,		SSL-P, FRRL		UDWR, SSL-P	UDWR, SSL-P					

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

Family Species	Common Name	Great Basin Project Research: Selection, seed increase, seed transfer guidelines[1]	Shrub transfer guidelines	Genetic variability	Pollinators and predators	Cultural practices	Seed germination, testing	AGCR diversification	Wildland shrub seed collection	Releases	Private Sector: Buy-back Program (UCIA)	AOSCA
		FRRL										
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, NSL					X
E. umbellatum	Sulfur-flower buckwheat	SSL-B, Aberdeen		SSL-P	BBSL, CSU	SSL-B	SSL-B, NSL					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, NSL, OSU				X	

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		Selection, seed increase, seed transfer guidelines[1]	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
P. cyaneus	Royal penstemon										X	X
P. deustus	Scabland penstemon	SSL-B, Aberdeen		SSL-P		SSL-B, OSU	SSL-B, NSL, 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, NSL, OSU					X

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)
EOARC = USDA-ARS Eastern Oregon Agricultural Research Center (Mangold)
FRRL = USDA-ARS Forage and Range Research Laboratory (Johnson, Jones, Larson, Monaco, Peel)
NSL = National 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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		Great Basin Project Research									Private Sector	
Family Species	Common Name	Selection, seed increase, seed transfer guidelines[1]	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

Notes:

1. Seed zones - *Atriplex, Artemisia*, and *Purshia* were identified in the original Task Order (McArthur and Sanderson research). Plant selection research will contribute to seed transfer guidelines for the remaining species.