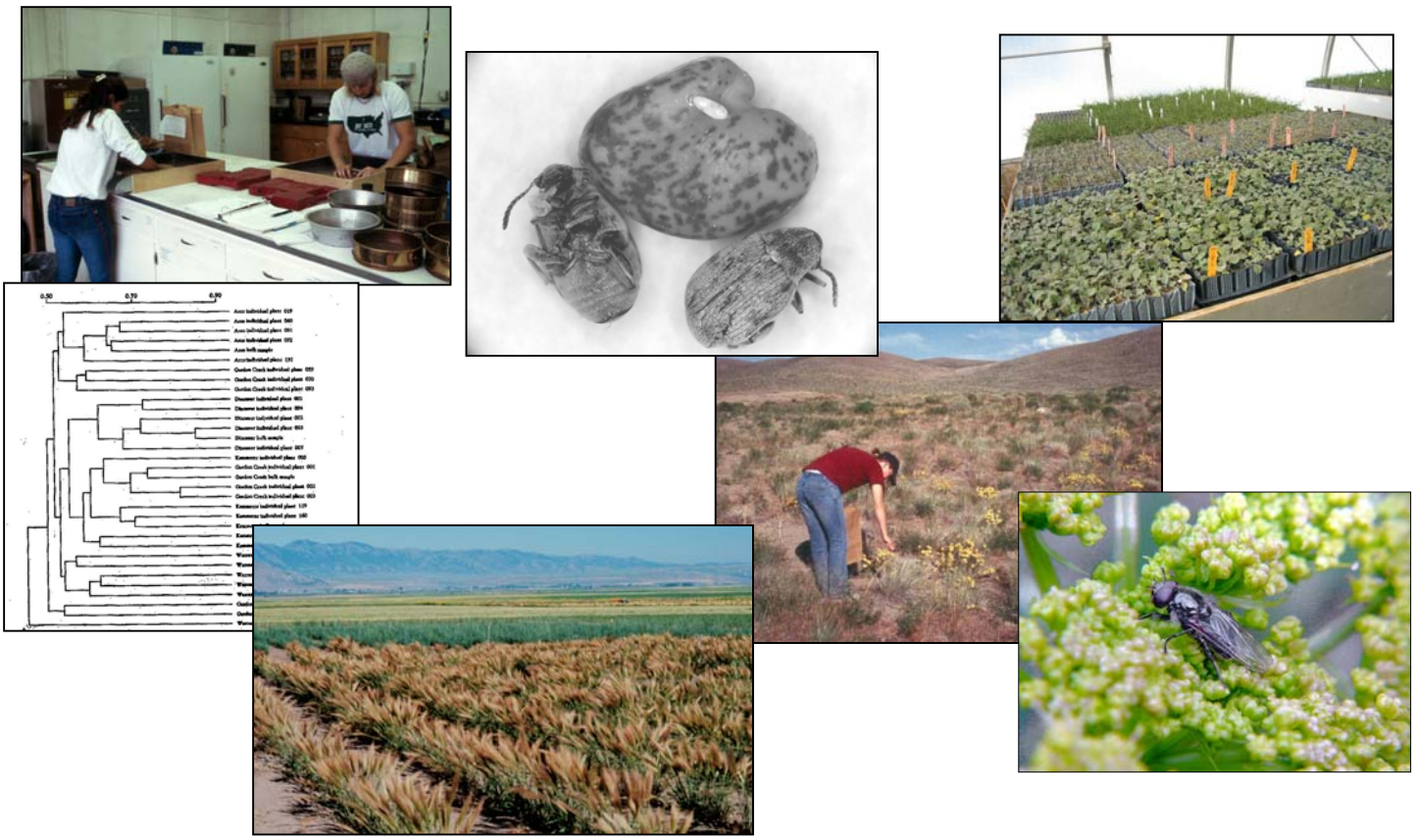
Great Basin Native Plant Selection and Increase Project FY03 Progress Report



USDI Bureau of Land Management (Nevada, Utah, Idaho)
USDA Forest Service, Shrub Sciences Laboratory
Provo, Utah and Boise, Idaho
Utah Division of Wildlife Resources, Ephraim, Utah
USDA Agricultural Research Service, Forage and Range Research Laboratory, Logan, Utah
USDA Agricultural Research Service, Bee Biology and Systematics Laboratory, Logan, Utah
Utah Crop Improvement Association
USDA Natural Resources Conservation Service,
Idaho, Utah, and Nevada
Brigham Young University, Provo, Utah

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Cooperators:

USDI Bureau of Land Management (Nevada, Utah and Idaho) (BLM)
USDA Forest Service, Rocky Mountain Research Station, Shrub Sciences Laboratory, Provo and Boise (SSL-P and SSL-B)
Utah Division of Wildlife Resources (UDWR)
USDA Agricultural Research Service, Forage and Range Research Laboratory (ARS-FRRL)
USDA Agricultural Research Service, Bee Biology and Systematics Laboratory (ARS-BBSL)
Utah Crop Improvement Association (UCIA)
USDA Natural Resources Conservation Service (Idaho and Utah) (NRCS Aberdeen)
Brigham Young University (BYU)

Introduction

The use of native plants for rehabilitation after wildfires and restoration of disturbed wildlands is being encouraged by various BLM programs, initiatives, and policies. Examples include the 2001 Interior Appropriations Bill, the Great Basin Restoration Initiative, Departmental guidance (DOI Emergency Stabilization and Rehabilitation Manual), Executive Order 13112 (Invasive Species – 2/99) and the BLM's Standards for Rangeland Health. This project integrates several proposals to increase native plant production and use within the Great Basin utilizing an applied science approach in a collaborative project. Original partners in this proposal include BLM (Utah, Idaho, and Nevada); USDA Forest Service, Rocky Mountain Research Station, Shrub Sciences Laboratory (Provo, UT and Boise, ID); Utah Crop Improvement Association (Logan, UT); USDA Agricultural Research Service, Forage and Range Research and Bee Biology and Systematics Laboratories (both Logan, UT); and the Utah Division of Wildlife Resources, Great Basin Research Center (Ephraim, UT). Additional cooperators have been added to address specific research issues as needed.

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 and cooperators recommend that a funding level for this proposal be identified and the BLM representatives, with input from the other cooperators, can develop priorities given the available funding. Studies and activities will be focused on maximizing the increase in native plant materials available for rehabilitation of burned rangelands and restoration of degraded rangelands in the Great Basin.

Funding Strategy

This effort requires sustained funding over a long period of time to be successful. To meet this need, the majority of the approved funds will be transferred to the USDA Forest Services' Rocky Mountain Research Station, Shrub Sciences Laboratory in Provo, Utah via an Interagency Agreement. Mike Pellant, Great Basin Restoration Initiative Coordinator, is the Contracting Officer's Representative for this Interagency Agreement. The Shrub Sciences Laboratory has 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 to be used internally administer this assistance agreement with BLM. Additional funding for BLM coordination of this project will be needed starting in FY02 to assist in state level coordination on the project. An estimated 20 WM's per year will be required from FY 02-05 for BLM coordination in the states of Utah, Oregon and Nevada, however, these needs will be pursued by BLM outside of this agreement.

Funding period: FY01– FY05

Funding received:

FY01:	$1,080,000
FY02:	1,500,000
FY03:	790,000
NIFC-BLM (FY03):	250,000
TOTAL	**$3,620,000**

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

Project Location: USDA-FS-RMRS Shrub Sciences Laboratory, Provo, UT and Boise, ID; Utah Division of Wildlife Resources, Ephraim, UT

Principal Investigators: Nancy Shaw, Scott Walker, Scott Jensen, Tyler Thompson, and Ann DeBolt

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Tyler Thompson, Utah Division of Wildlife Resources, Great Basin Research Center, Ephraim, UT (Tyler transferred to a UDWR position in Cedar City in fall 2003. His position will be filled in April 2004)

Ann DeBolt, USDA-FS-RMRS, Shrub Sciences Laboratory-Boise, 316 E. Myrtle, Boise, ID 83702, 208.373.4366, fax 208.373.4391, adebolt@fs.fed.us

Description of Project: To develop plant materials and seed and seeding technology for 15 native forbs of the Great Basin (UDWR, SSL-P, SSL-B and cooperators. Boise work is partially funded by the USDA Forest Service, National Fire Plan).

Provo Seed Collections: Identifying representative populations and seed collection of the 20 identified species was the main emphasis of the program from 2000-2003. Drought conditions in 2000-2002 resulted in less than ideal conditions for seed production and collection. Much of the Great Basin experienced some relief from the extended drought during 2003 resulting in good seed production for early maturing species. As the growing season progressed dry conditions resulted in poorer seed set for later maturing seed. We added 140 grass and forb collection in 2003. This brings the total to 533 which include 224 grass collections and 295 forb collections. 2003 marked the end of our major emphasis on field collections. The geographic distribution of several species is now well represented in seed collections. For a few species, additional collections will be needed in 2004 to bolster representation or seed volume. Databases have been created that include GPS, site description, and seed records for each site.

Ephraim Seed Collections: Wildland seed collection continued this summer with mixed success. A wet spring allowed many of the early seeding species to be successfully collected while a dryer summer led to challenges for all remaining species. However, we were able to make 75 collections totaling about 400 lbs of unclean seed. Significantly larger collections of many species were made possible with the use of the reel type seed harvester purchased before the field season.

Common Gardens: Trial plots of Great Basin wildrye and bluebunch wheatgrass were planted at the Orovada site in the fall 2003. Plugs of *Tragopogon dubius, Astragalus utahensis* and *Phlox longifolia* are presently growing for transplant at common garden sites in 2004.

Germination Research: Work on germination trials and seed weights were initiated on all species. This work will continue in 2004.

Boise Seed Collections: We collected 180 seed lots of 22 native forb and grass species in southern Idaho, eastern Oregon, and northern Nevada. Seed production was generally better than in 2002 due to spring rains, but it was still poor for certain genera (*Lupinus, Sphaeralcea, Eriogonum*). Twelve of the 22 species were collected for research and nine were collected for distribution to growers for increase (table 1). Seed was distributed to species research leads accordingly (i.e. AGGL, TRDU to RMRS-Provo; all BASA, CRAC, EROV, SPGR to UDWR). RMRS-Boise research species and those for private growers were cleaned and tested; those for private growers were source identified. Additional collections will be added in 2004 with the focus on *Lomatiums*, *Eriogonum umbellatum*, and species required for the AOSCA program and Provo or Ephraim research. Where possible, larger collections will be made for research on cultural practices.

Table 1. Summer 2003 seed collections, SSL-Boise.

Scientific Name	Common Name	Number of Seed Collections	Purpose
Achillea millefolium	Western yarrow	2	P
Agoseris glauca	Pale agoseris	1	R
Balsamorhiza sagittata	Arrowleaf balsamroot	17	R
Balsamorhiza hookeri	Hooker balsamroot	4	P
Crepis acuminata	Tapertip hawksbeard	26	R
Crepis occidentalis	Western hawksbeard	2	P
Eriogonum heracleoides	Wyeth buckwheat	1	P
Eriogonum ovalifolium	Oval-leaf buckwheat	7	R
Eriogonum umbellatum	Sulfur buckwheat	8	R
Eriogonum microthecum	Slenderbush buckwheat	1	P
Eriogonum sp.	Unk. Buckwheat	4	Tbd
Lithospermum ruderale	Stoneseed	1	P
Lomatium dissectum	Fernleaf biscuitroot	28	R
Lomatium grayi	Gray's biscuitroot	5	R
Lomatium triternatum	Nineleaf biscuitroot	13	R
Penstemon acuminatus	Sand penstemon	14	R
Penstemon cyaneus	Dark-blue penstemon	1	P
Penstemon deustus	Hotrock penstemon	22	R
Penstemon speciosus	Sagebrush penstemon	9	R

Stipa comata	Needle-and-thread grass	3	P
Stipa thurberiana	Thurber needlegrass	4	P
Tragopogon dubius	Salsify	7	R
Total		**180**	**12 R; 9 P; 1 tbd**
R = Research; P = AOSCA project; tbd= to be determined			

Common Gardens: Common gardens were established for *Penstemon acuminatus, P. deustus,* and *P. speciosus* on irrigated sites in spring 2003. Growth and survival data were recorded in 2003. Evaluations will continue in 2004. Data on flowering, seed production, herbivory/pollinator observations, diseases and plant growth will be recorded for the three penstemon species. Weekly sweep netting will be done during the growing season to provide insects for identification by Bob Hammon (Colorado State University). Pollinators will be sent to Jim Cane or other experts for determination. Four additional common garden sites in Idaho and Nevada were prepared for planting in spring 2004. *Penstemon* species will be spring planted and *P. deustus* and *Lomatium* species will be fall 2004 or spring 2005 planted.

Germination Research: Germination studies for the *Penstemon* and *Lomatium* species are ongoing. All three *Penstemon* species (*Penstemon acuminatus, P. deustus,* and P. speciosus) are dormant at harvest and require moist prechilling for 8 to 12 weeks to relieve dormancy. The prechilling requirement for P. *speciosus* is reduced by liquid smoke treatment. Pretreatment with gibberellic acid (250 ppm) is as effective as greater concentrations for relieving dormancy of all three species with the species requiring the longest cold treatment (*P. deustus*) most sensitive to gibberellic acid treatment. Treatments permitting more rapid and uniform germination are desirable for production of nursery stock and establishment of seed production fields where natural prechilling following fall planting may be inadequate to release dormancy or when seeds are spring planted.

Little research on germination of *Lomatium* species has been completed, but publications are available for some members of the Apiaceae. Seeds of *Lomatium* species contain immature embryos and require prolonged moist prechilling (8 to 12 weeks) for embryo maturation and germination. *L. triternatum* accessions are generally less dormant than those of *L. dissectum*. Dormancy is not readily relieved by gibberellic acid treatments. Germination occurs at low temperatures ($<10^{o}$C) and does not require light. A 24 hour presoak in water is as effective as other pretreatments tested for relieving fungal problems encountered during seed incubation.

The transfer of all native seed collection records from the USDA-FS Rocky Mountain Research Station and UDWR to electronic files was completed. The physical transfer of seed from RMRS was delayed pending the completion of our new facility.

Equipment:

Ephraim, Provo. Equipment purchased this fiscal year includes: field tractor – 80hp, Reel type seed harvester including hydraulic pump and other modification to the tractor used with its operation. Product research was completed for all future purchases of equipment including: combine harvester, transport trailer for combine, precision spray unit, raised bed mulch layer, and field wheel transplanter.

Growth chamber room at Lucky Peak Nursery (SSL-Boise)

Plans for a room were drawn up. Construction will be delayed until arrangements for an offsite storage area are completed in conjunction with the move to a new laboratory building.

Facilities: Establish field or wildland testing sites for evaluation of additional native grasses, forbs, and shrubs.

- **Ephraim:** Construction of a production greenhouse and head house was bid out and construction began in October with planned completion date of April 2004.

- **Utah sites (DWR Ephraim)**

UDWR was assigned maintenance and upkeep of three wildland testing sites: Gunnison, Nephi, and Fountain Green. All sites were cleared and kept weed free to prepare for future transplants and seeding trials.

Work began on expanding the snow field station sprinkler irrigation system

Plans to lease a 20 acre field were delayed pending the final decision of Snow College on whether or not to build a football stadium on snow field.

- Nevada sites (Shrub Sciences Lab [SSL] – Provo and Boise)

Winnemucca (Orovada). The climatic station was installed and weeds are being controlled on the planting area.

Wells. Clearances were completed and the area fenced. The climatic station was installed and weeds are being controlled on the planting site.

- Idaho sites (SSL – Boise)

Orchard Research Site (enhancement of an ongoing cooperative project) SSL-Boise and cooperators). Perimeter fencing is kept in repair and a plot for forb plantings is being maintained by SSL–Boise. Weather stations are maintained by the USDA-ARS Northwest Watershed Research Center and the USDA-NRCS. Trespass problems are being handled by the USDI-BLM Lower Snake River Office.

Lucky Peak Shrub Garden (SSL-Boise). The multi-year rush skeletonweed (*Chondrilla juncea*) project is being continued. Spot treatments were applied as needed on areas treated in 2002 and additional areas were treated. Fuels management was also instituted and will be expanded in 2003. The site is used in cooperation with the Boise National Forest.

Niagra Springs (SSL–Boise). The site was cleared and staked for spring planting in 2004. Cooperation is through an MOU with the Idaho Department of Fish and Game.

Boise Botanic Garden (SSL-Boise). Two acres have been leased for forb research through a Research Joint Venture Agreement with the Selland College of Applied Technology Horticulture Program, Boise State University. The site will be prepared for planting and a deer fence installed in spring 2004.

Leased private land (SSL-Boise). Private land was leased for establishment of three irrigated *Penstemon* common gardens in the Ontario, Oregon area**.**

Technology Transfer position (SSL-Boise): The Botanist/Technology Transfer position (term appointment) was filled by Ann DeBolt at the USDA-FS Rocky Mountain Research Station Laboratory, Boise, Idaho in April 2003.

Native grass development:

1. Anatone bluebunch wheatgrass select germplasm was released in December 2003. Foundation seed is being managed by the Aberdeen Plant Materials Center.

2. Thurber needlegrass seed was collected from the Orchard area in summer 2004 for establishment of a 1-acre field for seed increase.

3. Yarrow was collected from the Eagle area in summer 2004 and placed in storage until the germplasm is released.

4. The Utah Crop Improvement Association purchased 80 pounds of Sandberg bluegrass (G1) from the Mt. Home Air Force Base, Bruneau Training Area and will be held until the germplasm is released.

Products:

Manuals and Catalogues:

Restoring Western Ranges and Wildlands (SSL-Provo and Boise, UDWR and cooperators). This book provides background on philosophy, processes, plant materials selection, and seed and seeding technology for revegetatin disturbed rangelands, emphasizing native species. Steve Monsen (SSL-Provo) and Richard Stevens (USWR, retired) are compilers. The text was completed in 2003 and is now going through final editing. Publication costs will be provided through this agreement and Forest Service R1/R4, National Fire Plan, Native Plant Program funding.

Rangeland Revegetation Equipment Catalog (SSL-Boise, Provo, BLM and Revegetation Equipment and Technology Committee). Harold Wiedemann (retired professor, Texas A& M University) was awarded the contract for writing a revegetation equipment catalog describing types and operation of equipment designed or adapted for range and wildlife habitat improvement and disturbed land rehabilitation. Categories of equipment include: tractors; implements for controlling vegetation using fire, mechanical, or chemical methods; seedbed preparation; fertilizing and mulching; seeders and drills; specialized planters; seed

collection; seed processing; and transport. The text is now half complete. The website will be established in 2004 and part of the text will be placed on the site for testing. Project completion is scheduled for summer 2005.

Seed production, harvesting, cleaning, and storage of wildland grasses, forbs, and shrubs of the Intermountain area (UDWR, SSL-Provo and Boise, Utah Crop Improvement Association). The publication discusses seed technology and seed characteristics for 54 shrubs, 40 forbs, and 14 grasses. It also discusses the wildland seed industry, seed testing, and seed certification. The text will be completed in spring 2004.

Field Guide to Intermountain Cyperaceae (excluding *Carex*) (SSL-Boise). This is the third in a series including the Field Guide to Intermountain Rushes (GTR-INT-306) and the Field Guide to Intermountain Sedges (RMRS-GTR-10). The guides are designed to assist specialists and nonspecialists working with these groups of plants in the Great Basin and surrounding areas. The text will be completed in 2004.

Website:
Great Basin Native Plant Selection and Increase Project web site initiated.
http://www.fs.fed.us/rm/boise/ then scroll to Shrubland Restoration and Ecology

Cooperative Research to Manage or Restore Seed Sources and Develop Technology to Improve the Diversity of Introduced Grass Seedings:

A Request for Information has been distributed for each of the research areas described below. Proposals are due March 15 and selection of successful submissions will occur in April 2004. Both are fully funded.

1. **Wildland shrub seed collection areas:** Protect and manage selected wildland stands to enhance seed production. Management may include fence construction, stand thinning or pruning, fertilization, weed control, and removal of competing shrubby species. The species and sites proposed for protection and management include:
   Wyoming big sagebrush – southern Idaho, northcentral Nevada and central Utah
   Antelope bitterbrush – Sanpete County, Utah; Boise Front, Idaho; Elko, Nevada

2. **Increase native plant diversity in crested wheatgrass monocultures to improve community health and wildlife habitat values.**

Publications:

Booth, D.T., S.E. Meyer, and N.L. Shaw. *Purshia* DC. ex Poir. 2003. In: Bonner, F.T. and R.G. Nisley. Woody Plant Seed Manual. USDA Forest Service, Washington, DC. http://wpsm.net/index.html

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Monsen, S.B., S.G. Kitchen, K. Memmott, N.Shaw, M. Pellant, S. Young, D. Ogle, L. St.John. 2003. Notice to release Anatone Germplasm bluebunch wheatgrass (Selected Class natural population). USDA Forest Service, Provo, UT.

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Shaw, N.L. and C.M.Waters. 2003. Native shrub seed industries in the western United States and Australia: Status and outlook. African Journal of Range & Forage Science 20: 1251-1253.

Waters, C.M. and N.L. Shaw. 2003. Developing native grass seed industries for revegetation in Australia and the western United States: A contrast in production and adoption. African Journal of Range & Forage Science 20:1152-1160.

Wambolt, C.L.; A.J. Harp, B.L. Welch, B.L., N.L. Shaw, J.W. Connelly, K.P. Reese, C.E. Braun, D.A. Klebenow, E.D.McArthur, J.G. Thompson, L.A. Torell, J.A. Tanaka. 2002. Conservation of greater sage-grouse on public lands in the Western United States: Implications of recovery and management policies. PACWPL Policy Paper SG-02-02. Policy Analysis Center for Western Public Lands, Caldwell, ID. 41 p. http://ndow.org/wild/sg/resources/sage_grouse_policy.pdf

Francis, J.K. Wildland Shrubs of the United States and its Territories: Thamnic Descriptions. 2003. Gen. Tech. Rep. IITF-WB-1. USDA Forest Service, International Institute of Tropical Forestry and Shrub Sciences Laboratory, Ogden, UT. http://www.fs.fed.us/global/iitf/wildland_shrubs.htm:
Chapters:

DeBolt, A. *Celtis reticulata* Torr.
Shaw, N.L. *Chamaebatiaria millefolium* (Porter) Maxim.
Shaw, N.L. *Holodiscus discolor* (Pursh) Maxim.
Shaw, N.L. *Holodiscus dumosus* (Nutt.) Heller
Shaw, N.L. *Philadelphus lewisii* Pursh
Shaw, N.L. and S.B. Monsen. *Purshia tridentata* (Pursh) DC.
Shaw, N.L. and A.M. DeBolt. *Rhus trilobata* Nutt. In T. & G.

Project Title: Agronomic and Cultural Care of Wildland Plants

Project Location: Brigham Young University

Principal Investigators: Bruce Roundy, Val Jo Anderson, and Robert Johnson

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Robert Johnson, Brigham Young University, Provo, UT 84602, 801.422.3311, robert_johnson@byu.edu

Description of Project: There are four components to this study, designed to assist growers of native seed. They include: A) herbicide tolerance evaluations, B) seeding depth studies, C) seeding rate studies, and D) spacing and production methodology development. Individual projects were initiated in spring 2003 to the extent seed and plant material were available. Limitations in plant material and seed quantity prevented completion of some project aspects and repeat treatments.

A. Herbicide Tolerance: A major challenge facing growers in the production of herbaceous forb seed is the control of weeds. Weeds are problematic during the establishment phase of desired forbs, and equally so during seed harvest when weed seed contamination encumbers seed certification. The use of selective herbicides for weed control is an essential element in agricultural production. While herbicide selectivity is known relative to many common agricultural crops, little is known of the effects on native plant species. The purpose of this project was to evaluate varying rates of a suite of herbicides on multiple growth stages of selected native plant species. The following variables were incorporated as elements of the study design:

Native plant species: mountain dandelion (*Agoseris glauca*); Utah milkvetch (*Astragalus utahensis*); tapertip hawksbeard (*Crepis acuminata*); oval-leaved buckwheat (*Eriogonum ovalifolium*); longleaf phlox (*Phlox longifolia*); scarlet globemallow (*Sphaeralcea coccinea*); gooseberry-leaf globemallow (*Sphaeralcea grossulariifolia*); yellow salsify (*Tragopogon dubius*).
Plant growth stages: pre-germination (seed stage); seedling; mature plant.
Herbicides: BuctrilTM (bromoxynil); KarmexTM (diuron); OustTM (sulfometuron-methyl); PlateauTM (imazapic); ProwlTM (pendimethalin); PursuitTM (imazethapyr); VelparTM (hexazinone).
Herbicide rates: high (twice the recommended rate); medium (recommended rate); low (half the recommended rate).

Methods: Herbicide was applied at designed rates as plant material representing required growth stages became available. The effect of herbicides on seed germination and emergence was tested using native soil, while seedling and mature plants were tested using plant material

grown in potting soil. 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. Plant material was maintained for 1 month following herbicide application to measure mortality and effects on vigor. Experiments were replicated five times.

Initial Results: Pre-emergent application of herbicide was conducted on three species. Overall emergence was highest with the herbicide Buctril. Emergence of *Astragalus utahensis* was also successful with Plateau. Velpar had the poorest emergence results, though more data are needed for Pursuit and Oust.

	Control	Buctril		Prowl		Pursuit		Plateau		Oust		Velpar	
GERMINATION/EMERGENCE (relevant to control)	emerg	rel. emerg	vigor	rel. emerg	vigor	rel. emerg	vigor	rel. emerg	vigor	rel. emerg	vigor	rel. emerg	vigor
Astragalus utahensis	18.2	**128%**	o	90%	o			**148%**	o			20%	-
Sphaeralcea grossulariifolia	38.6	**115%**	o	70%	-			19%	- -			7%	- -
Tragopogon dubius	95.0	**62%**	+	55%	-	49%	o	4%	-	0%	o	0%	o
5 remaining species	deficient plant material - redo in 2004												
1 remaining herbicide	redo - 2004												

- - (strong negative effect on vigor)
- (negative effect on vigor)
o (no effect on vigor)
+ (positive effect on vigor)
bold (indicates best results)

Affects of herbicide on seedling mortality indicate greatest resistance to Buctril. *Sphaeralcea* spp. and *Tragopogon* are equally resistant to Prowl and Pursuit. *Phlox longifolia*, *Sphaeralcea grossulariifolia*, and *Tragopogon* are additionally resistant to Plateau.

SEEDLING SURVIVAL RESULTS	Buctril			Karmex			Oust			Plateau			Prowl			Pursuit			Velpar		
	high	med	low	high	med	low	high	med	low	high	med	low	high	med	low	high	med	low	high	med	low
Eriogonum ovalifolium	**46%**			0%			7%			20%			40%			**47%**			20%		
Phlox longifolia	80%	**100%**	100%	20%	80%	100%	20%	0%	20%	**100%**	**100%**	100%	80%	60%	80%	60%	60%	80%	0%	0%	80%
Sphaeralcea coccinea	**100%**			40%			53%			73%			**100%**			**100%**			73%		
Sphaeralcea grossulariifolia	**100%**	**100%**	100%	20%	80%	100%	20%	20%	80%	80%	**100%**	100%	**100%**	**100%**	100%	**100%**	**100%**	100%	0%	0%	80%
Tragopogon dubius	**100%**	**100%**	100%	**100%**	**100%**	100%	20%	60%	100%	**100%**	**100%**	100%	**100%**	**100%**	100%	**100%**	**100%**	80%	20%	80%	100%
3 remaining species	deficient plant material - redo in 2004																				

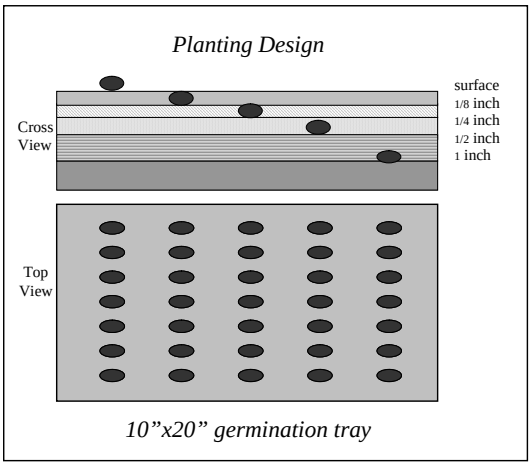
bold (indicates best results)

Affect of herbicides on mature plants revealed no-significant difference for both rate and herbicide brand for *Tragopogon* and *Sphaeralcea grossulariifolia*. Those were the only two species tested as mature plants.

Project Status: Every phase of the project will be repeated in 2004 to fill data gaps and verify results. Stratification of seed is currently underway. Application of herbicide to all species as mature plants will occur this year.

B. Seeding Depth: This project was 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. The following variables were incorporated as elements of the study design:

Native plant species: the same 8 species as listed for Herbicide Tolerance treatments.
Seeding depth: surface; 1/8 inch; 1/4 inch; 1/2 inch; 1 inch.
Soil type: clay loam and sandy loam.



Methods: Seeds were either acid scarified, cold stratified or non-treated and arranged in depth strata according to design and soil type. Emergence was recorded until emergence ceased.

Preliminary Results: Only five species emerged in sufficient quantity to evaluate statistically. The best depth was 1/8 inch overall. Exceptions to this were *Tragopogon*, which performed best at ¼ inch, and *Astragalus*, which performed equally well from the surface. Surface sown seed may still end up with soil coverage as a result of overhead watering, especially for heavier seed. In sandy loam soils, *Sphaeralcea grossulariifolia* performed equally well in ¼ and ½ inch depths.

SEEDING DEPTH & EMERGENCE	0		1/8		1/4		1/2		1		
	sandy loam	clay loam	sandy loam	clay loam	sandy loam	clay loam	sandy loam	clay loam	sandy loam	clay loam	
Agoseris glauca		32%		**35%**		2%		7%		0%	no treatment
Astragalus utahensis	**38%**	**31%**	**39%**	**29%**	36%	19%	27%	26%	17%	11%	acid scarification
Sphaeralcea coccinea	18%	21%	**36%**	**52%**	**36%**	27%	23%	23%	16%	32%	acid scarification
Sphaeralcea grossulariifolia	75%	30%	**94%**	**83%**	**100%**	70%	**98%**	76%	74%	65%	acid scarification
Tragopogon dubius	71%	49%	66%	61%	**79%**	**68%**	75%	51%	60%	25%	no treatment
3 remaining species	insufficient germination - redo in 2004										
bold (indicates best results)											

Project Status: Every phase of the project is being repeated in 2004 in order to fill data gaps and verify results.

C. Seeding Rate: This project will evaluate optimal seeding rates. Commencement of the project is dependent upon seed availability.

D. Spacing and Production Methodology: This project is designed to determine optimal plant spacing, mulching, and irrigation for maximum seed yield. The irrigation system was set up in 2003 to provide drip and overhead watering. The bulk of plant material was inadequate to initiate field planting and will thus begin in 2004.

Project Title: Forb and Shrub Genetics Research

Project Location: Shrub Sciences Laboratory, Provo, UT

Principal Investigators: Durant McArthur and Stewart Sanderson

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

Isozymes (Hipkins): Twelve species have been examined so far, [*Artemisia tridentata, Astragalus utahensis, Bromus carinatus, Chrysothamnus nauseosus (Ericareria nauseosa) Atriplex canescens, Crepis acuminata, Erigeron pumilus, Eriogonum umbellatum, Lupinus argenteus, Stimpa comata, Vicia americana, and Viguiera multiflora (Heliomeris multiflora)*]. Additonal populuations have been added to the study as has *Balsamorhiza sagitatta*. These species are all common perennial species of the Intermountain West with use or potential use in habitat restoration projects (Appendix II).

A total of 1,612 individuals were sampled between 2001 and 2003. DNA extraction was carried out on leaf tissue using either the (1) DNeasy-96 Frozen Leaf Tissue Protocol, or DNeasy Plant Mini Kit following manufacturer's instructions with tissue homogenization achieved via the Mixer Mill 300 (Qiagen), or (2) FastPrep DNA Extraction (Bio-101). DNA quantity was assessed by fluorometry, and quality determined by visualizing all samples against 50 ng of Lambda DNA standard on 0.8% agarose gels stained with EtBr under UV light. DNA samples were shipped overnight on dry-ice to Richard Cronn, PNW, USDA Forest Service. Isozyme preparation followed the NFGEL Standard Operating Procedures. Extracts were electrophoresed on 11% starch gels, and stained for a suite of enzyme systems.

To date, a total of 1,034 individuals in 52 populations of ten species were analyzed for isozymes. Material collected during the 2003 field season has not yet been analyzed for isozyme variation.

Descriptive statistics for populations varied widely. Percent polymorphic loci vary from 4.6% in *Stipa comata,* a cleistogamous selfer, and 7% in *Bromus carinatus* and one population of *Atriplex canescens,* to 91% in a population of *Lupinus,* which may be a mixed collection, 73.7% in *Erigeron pumilus,* and 72.2% in *Eriogonum umbellatum*. Alleles per locus follow a similar pattern. Observed heterozygosity was somewhat less than the expected heterozygosity, suggesting some degree of selfing, except in one *Crepis acuminata* population, two *Erigeron pumilus* populations, three *Lupinus* populations, and *Vicia* sp.

Descriptive statistics for species were also variable. Percent polymorphic loci varied from 19% in largely selfing *Bromus carinatus* to 84% in *Erigeron pumilus* and 100% in *Lupinus,* which may include two species. Alleles per locus varied from 1.2 in *Stipa comata* to 2.8 in *Lupinus.* Observed heterozygosity was less than expected except in *Vicia americana*.

Statistics regarding differentiation and inferred gene flow among populations are provided for diploids and plants that were treated as diploids for analysis. Fst varied greatly, from 0.05 between two bona fide *Eriogonum umbellatum* populations to 0.78 in *Stipa comata.* (When the three populations of *Eriogonum* are analyzed together, Fst = 0.44.) Inferred gene flow varied inversely with Fst.

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

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

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

Revegetation plantings gene flow: Several species are being examined in this portion of the study. Preliminary results for *Linum, Sphaeralcea, Penstemon,* and *Atriplex* are available. *Linum perenne* in the form of 'Appar' blue flax has been seeded widely in revegetation plantings. This germplasm was initially thought to be native but has since been shown to have derived from a naturalized population. A native species is *L. lewisii.* The two taxa do not hybridize either under controlled conditions or in juxtaposed seeded and indigenous populations suggesting that prudent use of 'Appar' does not impact the genetic architecture of native *L.*

lewisii populations (The need of a native germplasm of blue flax is being addressed by the testing and probable release of 'Maple Grove' blue flax, a *L. lewisii* germplasm). *Sphaeralcea* (globe mallow) is a native genus which apparently frequently hybridizes. Both seeded and natural populations of globemallow species (*S. grossulariifolia, S. ambigua, S. munroana*) appear to form hybrid swarms (evidence from allozymes and molecular genetic—ISSR markers—give support for introgression) So far we have found no genetic evidence for introgression of the seeded 'Cedar' Palmer penstemon (*Penstemon palmeri*) into native adjacent of sympatric *Penstemon* populations but this work is in its early stages. Our work with *Atriplex* and other shrub species is also preliminary. However fourwing saltbush (*Atriplex canescens*) source, revegetation planting, and indigenous populations show remarkable overall similarity with both allozyme and molecular genetic markers but with more similarity between the source and seeded populations than either had with the indigenous population growing near the seeding location.

Publications:

Matheson, T., L. A. Johnson, and E. D. McArthur. 2004. Assessing genetic variation within and between natural and reseeded populations of two native forbs. Abstract 204, p. 113, Abstracts, Society for Range Management, 57th Annual Meeting, Salt Lake City, Utah.

McArthur, E. D. 2003. Consideration of seed transfer guidelines and importance of seed sources for Intermountain shrubs and forbs. p. 59-60 in proceedings, Improvement and Management of Sagebrush Communities in Wyoming. Wyoming Game and Fish Department, Cheyenne, Wyoming. 211 p.

McArthur, E. D. 2003. Genetics of subgenus Tridendatae of Artemisia: Implications for management and taxonomy. Abstract 159, p. 62, Society for Range Management, 56th Annual Meeting, Casper, Wyoming.

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Mahalovich, M. F. and E. D. McArthur. in review. Sagebrush (*Artemisia* spp.) seed transfer guidelines. Native Plant Journal.

Project Title: Seed Increases, Genetic Variation and Ecophysiological Traits of Native Grasses

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

Principal Investigators: Thomas A. Jones, Steven R. Larson, Thomas A. Monaco, and Douglas A. Johnson

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Description of Project: Genetic diversity among accessions will be characterized for 8 native grass species using Amplified Fragment Length Polymorphism (AFLP) DNA markers. Measurements of ecophysiological traits of accessions selected to represent AFLP variation will be used to provide an ecophysiological interpretation of the genetic array delineated by the DNA data.

Seed of Fish Creek (origin: Blaine Co., ID) and Toe Jam Creek (origin: Elko Co., NV) natural-track bottlebrush squirreltail germplasms was distributed by the Utah Crop Improvement Association to two seed growers apiece for increase under the buy-back option. The four fields were established in September 2003 and the first seed harvest is anticipated for 2004.

Selection work continues on bottlebrush squirreltail material orginating in Elmore Co., ID. Progeny of selected plants from three accessions collected in the vicinity of Mountain Home, ID were transplanted to a replicated field test in April 2003. Establishment data were collected in 2003 and additional data will be collected in 2004.

Harvest of G1 seed of Seven Devils Snake River wheatgrass and Columbia bluebunch wheatgrass genetically manipulated germplasms (to be proposed for release in 2004) was precluded by a freeze in late May 2003. Harvest is planned for 2004. Both of these germplasms are to be proposed for release in 2004.

Seed of White River Indian ricegrass (origin: Rio Blanco Co., CO) was harvested in 2003 for the first time. A seed-increase field of Bonneville Indian ricegrass (origin: Tooele Co., UT) and a second field of White River were established from transplants in 2003. These genetically

manipulated germplasms were subjected to mass selection on the basis of high seed yield and high germinability from wildland collections identified as high in germinability upon comparison with many others. Both of these germplasms are to be proposed for release in 2004.

Star Lake Indian ricegrass genetically manipulated germplasm (origin: McKinley Co., NM), also noted for high seed yield and germinability, was approved for release in 2003. Seed is available for distribution upon formal release.

Accessions of Idaho fescue and its coastal congener, Roemer's fescue were analyzed for genetic identity using AFLP profiles. A clear distinction was seen between Idaho and Roemer's fescue accessions, but the two taxa are very closely related. A subset of the Roemer's fescue accessions corresponded to those identified as the "klamathensis" type.

A total of 158 accessions was collected in three collection trips in 2003, the first to northeastern Utah, northwestern Colorado, and western Wyoming, the second to western Idaho and eastern and central Oregon, and the third to central Oregon and northeastern California. Numbers of accessions collected include 14 for basin wildrye (4-OR, 10-CA), 3 for beardless wildrye (1-OR, 2-CA), 5 for basalt milkvetch (5-OR), 16 for Indian ricegrass (1-ID, 2-UT, 4-WY, 8-OR, 1-NV), 9 for bottlebrush squirreltail ssp. *elymoides* (1-ID, 7-OR, 1-NV), 3 for bottlebrush squirreltail ssp. californicus (2-OR, 1-NV), 12 for bottlebrush squirreltail ssp. *brevifolius* (10-OR, 1-NV, 1-CA), 3 for bottlebrush squirreltail ssp. mixed or not identified (2-OR, 1-CA), 19 for big squirreltail (7-ID, 11-OR, 1-CA), 16 for bluebunch wheatgrass (3-ID, 13-OR), 53 for needle-and-thread (2-ID, 12-UT, 10-CO, 27-WY, 2-OR).

2003/2004 Publications:

Jones, T. A. The restoration gene pool concept: Beyond the native vs. non-native debate. Restor. Ecol. 11:281-290. 2003.

J. A. Young, C. D. Clements, and T. Jones. Germination of seeds of big and bottlebrush squirreltail. J. Range Manage. 56:277-281. 2003.

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Submitted Publications:

Jones, T. A. Native seeds: Genetics, adaptation, and commerce. Native Plants J. 5: . (2004).

Jones, T. A., D. C. Nielson, S. R. Larson, D. A. Johnson, T. A. Monaco, S. L. Caicco, D. G. Ogle, and S. A. Young. Registration of Fish Creek bottlebrush squirreltail germplasm. Submitted to Crop Science.

Jones, T. A., D. C. Nielson, S. R. Larson, D. A. Johnson, T. A. Monaco, S. L. Caicco, D. G. Ogle, S. A. Young, and J. R. Carlson. Registration of Toe Jam Creek bottlebrush squirreltail germplasm. Submitted to Crop Science.

Project Title: Patterns of Genetic Variation in Native Grasses

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

Principal Investigator: Steve Larson

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Description of Project: DNA fingerprinting North American range grasses

The squirreltail study described at the 2003 Great Basin Native Plant Selection and Increase Project meeting was published in the Canadian Journal of Botany (citation below). This compares genetic identity and genetic diversity within and among 22 *Elymus elymoides* subsp. *elymoides*, 24 *E. elymoides* subsp. *brevifolius*, and 13 *Elymus multisetus* accessions including cultivated seed sources from Maughn and Barton Seed, Granite Seed, Raineer Seed, the Forage and Range Research Laboratory (i.e. Sand Hollow big squirreltail and Fish Creek bottlebrush squirreltail). Reprints will be available at the 2004 annual meeting.

The *Bromus carinatus* sensu lato DNA study was submitted to the Native Plant Journal as an invited research paper that will hopefully be published in a special "Genetics" issue of this journal (www.nativeplantnetwork.org). This study compares genetic identity among cultivated seed increases of *B. marginatus* from Routte NF and White River NF (USDA-NRCS, Meeker Plant Materials Center), the new Garnet variety released by the USDA-NRCS, Bridger Plant Materials Center, and approximately 20 other natural germplasm sources from western North America. At least 4 geographically significant groups were identified, however the taxonomic status of *B. marginatus* seemed questionable. We elected to treat all North American *Bromus* sect. *Ceratochloa* collections as *B. carinatus* sensu lato. Interestingly, DNA profiles from the variety Cucamonga (2n=84) were very unusual relative to other *B. carinatus* and *B. marginatus* accessions. We concluded that Cucamonga is not *B. carinatus* (2n=56), as was previously believed.

The bluebunch wheatgrass DNA study, briefly described in last years annual meeting, was finally submitted to the American Journal of Botany (citation below). This paper compares genetic identity and genetic diversity within and among 82 sites (565 plants) across western North America, and included cultivated sources of Goldar, Whitmar, P-7, and Anatone. Since the preliminary report last year, approximately 15,000 CPU hours were used to evaluated various models of population structure. The best model of population structure included 21 genetic groups, which generally displayed well-defined geographic distributions. A final report (PowerPoint presentation) will be provided at the 2004 annual meetings.

In cooperation with Dr. Michael Peel, efforts are underway to characterize genetic identity and genetic diversity within and among 16 putative *Hedysarum boreale* and 5 putative *H. occidentale* accessions, including the cultivated Timp *H. boreale* variety. These natural germplasm sources include 2 collections from the USDA Forest Service Shrub Lab and 12 collections made by the Utah DWR, Great Basin Reseach Center. We have obtained highly informative DNA profiles from 20 individual plants from most of the 21 accessions (379 individual plants). In actuality, only three accessions displayed what appears to be *H. occidentale* DNA profiles: U1-01 (19/20 *H. occidentale*), U3-01 (2/4 *H. occidentale*), and U5-01 (20/20 *H. occidentale*). The U1-01 was labeled as *H. occidentale*, U3-01 was labeled as *H.*

occidentale, and U5-01 was labeled as *H. occidentale*. Evidently, the U3-01 and U5-01 *H. occidentale* collections are mixed accessions of *H. occidentale* and *H. boreale*. Moreover, two other accessions labeled as *H. occidentale* (U2-01 and U51-01) displayed DNA profiles similar to *H. boreale*.

Finally, we are just beginning a new *Leymus* wildrye research project. From a seed production standpoint, *L. cinereus* is the most important North American *Leymus* wildrye. However, *L. triticoides* is also used in many revegetation projects. This project aims to characterize genetic identity and genetic diversity in the *Leymus* wildrye collection maintained at the USDA Forage and Range Research Lab including cultivated and natural germplasm sources of North American *Leymus* wildryes [*L. cinereus* (200), *L. triticoides* (30). *Leymus salinus* (9), *L. ambiguous* (9), *L. mollis* (2), *L. innovatus* (2), *L. condensatus* (2), *L. flavescens* (2), and *L. mojavensis* (2)] and related Euarasian *Leymus* wildryes (*L. angustus* (2), *L. arenarius* (2), *L. ramosus* (2), *L. racemosus* (3), *L. multicaulis* (2), *L. secalinus* (5), *L. akmolinensis* (2), *L. subulosus* (2), and *L. chinensis* (2)]. We aim to analyze DNA profiles from 7 individual plants from each accession.

Publications:

Larson, S.R., Jones, T.A., McCracken, C.L., and Jensen, K.B. 2003. Amplified fragment length polymorphism in *E. elymoides, E. multisetus*, and other *Elymus* taxa. Can. J. Bot. 81:789-804.

Massa, A.N. and Larson, S.R. 2004. DNA polymorhism among mountain bromes (*Bromus carinatus*) of western North America. Native Plants Journal.

Larson, S.R., Jones, T.A., and Jensen, K.B. 2004. Population structure in *Pseudoroegneria spicata* (Poaceae: Triticeae) modeled by Bayesian clustering of AFLP genotypes. American Journal of Botany (submitted 2/18/2004).

Project Title: Collection and Evaluation of *Astragalus filipes* from Western North America

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

Principal Investigators: Douglas A. Johnson and Kevin J. Connors

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Description of Project: Based on discussions with land managers from the BLM and Forest Service as well as literature searches, it was determined that *Astragalus filipes* (basalt milkvetch or threadstalk milkvetch) was a good candidate species for use in restoration and revegetation efforts in the Intermountain West. Location data were collected from specimen sheets from herbaria in the western United States and the New York Botanical Garden to identify potential collection sites in the Intermountain Region.

During the summer of 2003, intensive efforts were initiated to collect seed of basalt milkvetch. Seed collections were made from 72 sites across a six-state area of its distribution. Detailed passport data (latitude, longitude, elevation, slope, soils data, associated species, etc.) were obtained for each collection. Basalt milkvetch occurs on a wide diversity of sites ranging from 5" annual precipitation in Nevada to more than 20" precipitation in northeast California. Elevations at the collection sites ranged from 663' to 8,350'. An abundance of collections originated in central and eastern Oregon, and only one collection was from Utah.

This species is a good seed producer, except that seed weevils were prevalent on plants at many of the collection sites. High densities of plants occurred in burned areas in Oregon, and Nevada. Field observations indicated that plants were grazed by both livestock and wildlife. At Clarno, Oregon, basalt milkvetch was successfully growing and competing in dense stands of cheatgrass and medusahead. Green- and red-stem biotypes co-occurred on some sites, but the significance of these differences is unknown.

Root nodules were collected from plants at 16 sites, and desiccated root nodules were sent to the Nitragin Company in Milwaukee, Wisconsin for plating, culturing, and isolation of rhizobial strains. These strains will be tested in a greenhouse to determine which strains are most infective and effective at nitrogen fixation. Forage and soil samples were also collected at each site for forage toxicity analysis. Forage samples were ground, extracted, and analyzed for toxic properties by Dr. Dale Gardner at the USDA-ARS Poisonous Plant Research Laboratory at Logan. Amounts of nitrotoxins (3-nitropropanol), selenium, and swainsonine (a compound that causes loco poisoning in animals and a product of a fungal-endophyte association) were either non-detectable or extremely low for all collections of basalt milkvetch. As a result, these collections of basalt milkvetch do not appear to have any major livestock or wildlife toxicity problems.

Seeds from each of the collection sites were threshed, cleaned, scarified, and planted in conetainers for subsequent germination and seedling establishment in a greenhouse. All conetainers were inoculated with composite soil samples homogenized from the various

collection sites to allow plants to select appropriate rhizobial strains. At about 7 weeks of age, plant roots of six accessions of basalt milkvetch were removed from the conetainers, washed free of soil, and sent to the Nitragin Company for plating, culture, and isolation of rhizobial strains. About 150-250 plants of each of 68 accessions are currently growing in a greenhouse at Logan. These plants will be established in common garden sites at Evans Farm and Cornish in northern Utah, and possibly other locations. Possible selection characteristics for this species might include seedling establishment, plant vigor, forage yield/quality, competitive interactions with other species, grazing tolerance, persistence, and seed yield.

Collaborations were established with Jim Cane at the USDA-ARS Bee Biology and Systematics Lab at Logan to study pollination and seed predation in basalt milkvetch. This work will include an analysis of the proportion of seed that is self-pollinated compared to cross-pollinated, and whether basalt milkvetch is nectar-producing or not.

During 2004, we will be initiating seed collection of *Dalea ornata*.

Publications:

Gilmanov, T.G., D.A. Johnson, and N.Z. Saliendra. 2003. Growing season CO_2 fluxes in a sagebrush-steppe ecosystem in Idaho: Bowen ratio/energy balance measurements and modeling. Basic Applied Ecol. 4: 167-183.

Monaco, T.A., D.A. Johnson, J.M. Norton, T.A. Jones, K.J. Connors, J.B. Norton, and M.B. Redinbaugh. 2003. Contrasting responses of Intermountain West grasses to soil nitrogen. J. Range Manage. 56: 282-290.

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Project Title: Pollinator and Seed Predator Studies

Project Location: USDA-ARS Bee Biology and Systematics Lab

Principal Investigator: James H. Cane

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

Status Report: Abundant wild populations of *Crepis acuminata* were found locally, as were those of the newly added species (*Lomatium dissectum, Lupinus sericeus, Astragalus filipes*). Additional wild populations of northern sweetvetch were also located on federal land east of the Tetons but drought limited bloom. We now have planted out 20' x 20' plots (to fit our field pollination cages) with 16-month-old plants of *Hedysarum boreale* and *Penstemon speciosus* that we started from seed, and a mix of seed and plants of *Eriogonum umbellatum* and *Crepis acuminata*. All of these are planted through melted holes in weed barrier fabric (the Aberdeen method) with pre-emergent herbicide, and can be used with captive populations of cavity-nesting bees from the 2003 trap nesting program.

Pollinators, particularly bees, will be needed for seed production of most of the native forbs chosen for this project from the Great Basin flora. Autopollination never yielded seeds for *Hedysarum* (n=754 flowers). For *Balsamorhiza*, autopollination rarely set plump achenes (Fig 1 and text below). Possible exceptions include *C. acuminata*, which nonetheless was found to attract bees, a fact that may be useful if a more genetically diverse seed stock is desired. Biscuitroot (*Lomatium dissectum*) is sparsely visited, but only by bees, primarily a small, native ground-nesting species in the genus *Andrena* (possibly *Micrandrena,* which are mostly specialists on members of the carrot family like *Lomatium*). A close relative that flowers concurrently, *L. grayii,* is visited solely by flies (Appendix III).

In general, it appears that **bees are the essential pollinators** for the selected wildflower species. Our most detailed evidence for pollination need comes from this year's experiments with **balsamroot** (Fig. 1), illustrated in the figure below. Although all 6,739 ovules yielded an achene, only 4,544 achenes were plump, and we found that only plump achenes contained endosperm (by our X-ray analysis of seeds). Furthermore, only plump achenes have thus far germinated for us. As the figure shows, virtually no plump achenes result at flowers from which

bees have been excluded. Our manual pollinations show that this species is self-compatible, but flower heads with comparable numbers of florets will set more seed if they are outcrossed by us or freely visited by bees (Fig 1). These results are robust and consistent across individuals

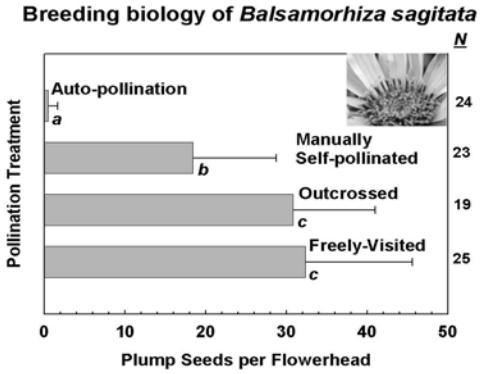

Fig. 1. Pollination needs of arrowleaf balsamroot, comparing seed set resulting from auto-pollination, self-compatability, outcrossing and pollination service by its native bee fauna.

(n=47) and sites (n=3). The primary manageable bees for pollinating balsamroot are two species of spring-flying *Osmia*, *O. californica* and *O. montana* (Appendix III), both of which are specialists for members of the sunflower family like balsamroot. Through our trap-nesting program, we acquired populations of both species, which readily visited balsamroot flowers and prospered reproductively despite the cool weather of spring. Nests of these two bee species can be made available to growers whenever they have bloom in need of pollination, although several years of lead time would help us to build up the captive population to some hundreds of individuals. Reproductive and pollination study of this species now stands complete.

We found that **sweetvetch** hosts a rich diversity and abundance of bee species, including those of the genus *Osmia* (21 species and counting thus far), *Megachile* and *Hoplitis*. Most of these carry pure loads of *Hedysarum* pollen (n=16 bees sampled), indicative of their fidelity and preference for this species in mixed meadows. Several of the more common species consistently contact the stigma with pollen-laden hairs on every floral visit, encouraging evidence for their pollination value. These three bee genera also contain some species that nest above-ground in cavities, and therefore have management potential. Identification is arduous, however, something that we will complete by spring for these bees from last year's collections and trap-nesting efforts. Bumblebees visit it avidly too, but are not practical to manage outdoors. This summer-flowering native plant's popularity with diverse native bees at our field sites promises that revegetation with sweetvetch will feed many native bee species wherever it is used for rehabilitation of the summer montane fauna.

Our pollination experiments with this plant yielded mixed results. Clearly, no pods or seeds result from auto-pollination (n=754 flowers). Our careful attempts at manual pollination (self, cross, and wide outcross) yielded some pods (8-18% pod set) and seeds, but fell far short of the pod and seed production resulting at freely visited flowers (51% of 676 flowers set a pod). We obtained an average of 28 good seeds per freely visited raceme of sweetvetch (2.6 seeds per pod). We will redouble our efforts at understanding breeding biology (particularly stigma

receptivity), widen our survey of its pollinator fauna to include wild and managed populations in Wyoming, and evaluate pollinator service and suitability of the blue orchard bee for pollinating a field plot managed by Rick Dunne near Lanner, Wyoming.

I commenced fieldwork with *Astragalus filipes* this year, accompanying Doug Johnson to eastern Nevada. Several species of *Anthidium* and *Osmia* (Appendix III) were the most common visitors at Pequop Summit, again both genera with some cavity-nesting species. We will be planting seedlings from Doug's work in one of our prepared 20' x 20' plots for field pollinator trials, and I intend to greatly expand pollinator/pollination work with this species next summer to establish its breeding biology as well as to better sample its pollinator fauna, probably focusing at sites on the western edge of the Great Basin where the species grows amid forested areas with nesting opportunities for *Osmia* bees (for which we will deploy nesting blocks). With luck, this species will share a manageable pollinator with *Hedysarum* and *Lupinus sericeus*. The latter species will especially need this, as it provides no nectar to foragers but is an obligate outcrosser, and thus must be planted with a companion nectar-producing species within flight range of a shared pollinator.

We placed drilled wooden nesting blocks and nesting stems for cavity-nesting bees at 10 sites across a wide elevation gradient this past summer, in hopes of obtaining some of the bee species that are visiting flowers of our target forb species. Occupied straws have been pulled and x-rayed; representative individuals will be pulled for identification in the coming few months, and matched to the faunas obtained at flowers. This effort will be intensified and focused, with additional effort spent in the eastern Sierra Nevada and possibly the Blue Mountains and other areas where these forbs meet conifer forest.

Native herbivorous insects have the potential to become pests of seed production on each of the wildflower species studied to date. Caterpillars of a gelechiid moth use silk to web together and devour flowering racemes of sweetvetch. The caterpillars drop from the plant to pupate in the soil. We reared some to adulthood, so that they could be identified by the only specialist for the genus (at Mississippi State University). The species is *Filatima xanthuris*, previously unknown from *Hedysarum*. Another species was found webbing flowering umbels of *Lomatium*; I am overwintering several pupae now in hopes of obtaining adults to identify. It will likely belong to a genus of the Oecophoridae known to attach members of the carrot family. Tiny maggots of a tephritid fly were found commonly feeding in the flower heads of balsamroot. They were reared to adulthood and identified as *Tropanea jonesi*, a species known to attack *Balsamorhiza*. Overwintering fall armyworm caterpillars devoured foliage and flower buds of *Balsamorhiza* too. Seed weevils were found to attack green pods of the legumes, their larvae developing in the individual drying seeds. Species were identified by the world expert on this genus *Acanthoscelides* (Clarence Johnson). Seeds of sweetvetch were attacked by *A. fraterculus*, a new host genus record for this species, which is otherwise known from *Astragalus.* From *Astragalus filipes* seed obtained this year, he identified two seed weevils, *A. pullus* and *A. fraterculus*. These are all in the family Bruchidae.

Our primary focus will be on establishing life histories for these and other herbivorous species that attack buds, flowers and seeds (adults are needed for ID). We will evaluate their abilities to travel and reproductively cycle in dried seed. With the help and expertise of Bob Hammon at Colorado State, we hope to develop practical, safe and effective control treatments for each of these insects for future use when these wildflowers are grown in row crop agriculture.

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

Project Location: NRCS Aberdeen, ID, Plant Materials Center

Principal Investigators: Loren St. John, Center Manager
Dan Ogle, NRCS Plant Materials Specialist, Boise, ID

Contact Information: **Loren St. John**, Aberdeen Plant Materials Center, P.O. Box 296, Aberdeen, ID 83210, Loren.Stjohn@id.usda.gov

Dan Ogle, Plant Materials Specialist, USDA-NRCS, 9173 West Barnes Drive, Suite C, Boise, ID 83709, Dan.Ogle@id.usda.gov

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

Seed Production

Maple Grove Flax - Seeded 1.8 acres field 3 on May 31, 2002. Field swathed July 22, combined July 28, 2003. Produced 615 pounds (342 pounds per acre), bushel weight 38.8 pounds. Seed analysis pending.

Anatone bluebunch wheatgrass - Seeded 1.0 acres field 11 on May 31, 2002. Field direct combined July 11, 2003. Produced 240 pounds (240 pounds per acre), bushel weight 22.1 pounds. Seed analysis pending.

Snake River Plains Germplasm fourwing saltbush - Produced approximately 98 pounds (seed analysis pending). Shipped 5 pounds Certified seed.

Northern Cold Desert Germplasm winterfat - Produced approximately 15 pounds (seed analysis pending). Shipped 3 pounds Certified seed.

Propagation Studies

Propagation of rooted fourwing saltbush from cuttings

Based upon cutting trials conducted in 2002, four hundred cuttings (320 female and 80 male) were harvested on August 18, 2003. Cuttings were treated with rooting hormone and planted into 40 inch^3 deep pots and placed in the greenhouse. One half of the cuttings were set on heat pads set at 85º F to evaluate the need for bottom heat. Following is a summary of rooting success and growth rates evaluated November 7, 2003:

Leader length (cm)

	% rooted	minimum	average	maximum
Female cuttings (bottom heat)	28.75	1.75	5.70	36
Female cuttings (no heat)	20.60	0.50	9.25	38
Male cuttings (bottom heat)	27.50	1.00	9.00	25
Male cuttings (no heat)	7.50	12.00	15.00	23

There appears to be some advantage to bottom heat during root development. The best rooting success (50 percent) was achieved from cuttings harvested August 19, 2002 which was significantly greater than achieved in 2003. In 2002, cuttings were propagated under mist as compared to overhead irrigation used in 2003. It appears there is a need to evaluate irrigation strategies to improve rooting success.

Greenhouse seedling establishment study: to evaluate fourwing saltbush seedling emergence based upon number of propagules planted per cell (5 versus 10 per cell) and to identify number of days to emergence, growth rates and transplant dates.

As reported in 2002, 75 percent of the seedlings had red stems and 25 percent had white stems at time of transplant. The question arose as to whether or not this phenological difference could be an indication of the sex of the plant. Plants are being maintained to determine if this is possible.

Idaho Native Plant Demonstration Area, Area, Orchard Research Site (NRCS Aberdeen Plant Materials Center, Loren St. John and Dan Ogle). BLM burned the site in fall of 2002. Site was sprayed by PMC on May 1, 2003 with Roundup and 2,4-D at 64 oz and 16 oz. per acre respectively. Spot treatment was applied May 13, 2003. Excellent kill was achieved. Due to limited breakdown of dead grass clumps that would inhibit proper seed placement with drill and to ensure a clean seedbed, the decision was made to delay seeding until the fall of 2004. The delay will allow another opportunity to apply herbicide and allow for further breakdown of the dead grass clumps. Seed of 76 accessions were obtained and a planting plan developed.

Project Title:	Cooperative Native Seed Increase through AOSCA State Foundation Seed Program Managers and Private Growers
Project Location:	Idaho, Nevada, Utah, Oregon, Washington
Principal Investigators:	Ann DeBolt and Nancy Shaw (USFS-RMRS-SSL-Boise) and Greg Lowry (AOSCA)
Contact Information:	**Greg Lowry,** Association of Official Seed Certifying Agencies (AOSCA), 55 SW Fifth Avenue, Suite 150, Meridian, ID 83642, 208.884.8225, ghlowry@aol.com

Project Description: Greg Lowry, AOSCA executive vice president, invited the Great Basin Native Plant Selection and Increase Project to submit a proposal to work through that national organization towards the development of a multi-state approach for increasing native forb seed supplies for Great Basin restoration. The program involves distribution of wildland collected seed to growers via the Foundation Seed Programs of states producing seed for the Great Basin (Washington, Oregon, California, Nevada, Utah, and surrounding areas). The emphasis will generally be on species not on the research species list, but on lists of species of interest to BLM Districts in the Great Basin states. We will work with private growers to provide available seed production data for each species or related species and accumulate basic information on seed production technology for publications and development of protocols that will be posted on the website. Foundation Seed programs will contract for purchase of part or all of the seed produced by the growers during the first 2 years and distribute the increase to additional growers. This concept was presented at the Interagency Plant Materials meeting in Reno, Nevada in June 2003. The draft proposal was presented at the national AOSCA meeting in Charleston, South Carolina in July 2003 and AOSCA's board approved the proposal in August.

Twenty-three seed lots of species with medium to high priority for the USDI-BLM were harvested in Nevada, Utah, Idaho, and Oregon in summer 2003. All collections were cleaned, tested, source-identified, and prepared for distribution. The program concept was presented at the Nevada Wildland Seed Producers Association meeting in September, and a program brochure has been developed (DeBolt and Shaw 2003). Time required for program authorization and implementation, communication with grower groups, and modification of the program format delayed seed distribution until spring 2004.

A poster describing the program presented at the Trade Show during the Society for Range Management annual meeting in January 2004 facilitated contacts with additional growers. A coordination meeting held on February 4, 2004 was attended by Greg Lowry, the Idaho State Foundation Seed Program Manager, two seed producers, Scott Lambert, Nancy Shaw, and Ann DeBolt. We reduced our original list to species with the largest lot size and those of the most interest to BLM. Program administration was further refined and the list has been resubmitted to State Foundation Seed Program managers for grower consideration (see table). We have since heard from UT, OR, and ID, and will distribute seed sometime in the next 1 to 6 months. Most 2003 seed will not be sown until fall 2004 giving interested growers time to plan and prepare

their fields. It is possible that a few additional high priority species collected in summer 2003 or 2004 will be included in this distribution.

2004 Work Plans:

Seed lots listed in the table below will be distributed and Foundation Seed Program Managers will develop grower contracts. We will attempt to augment the following lots with supplemental collections in summer 2004.

Wyeth buckwheat (ERIHER1-BSE) Yarrow (ACHMIL2-BSE)
Fernleaf biscuitroot (LODI11-B7) Tapertip hawksbeard (CRAC U10)
Thurber needlegrass (ACHTHU2-BSE)

Additional species and other source-identified lots will be collected for development of a seed bank for future distribution as dictated by BLM priorities and grower interest. Examples include *Senecio multilobatus* (SEMU B1), *Viguiera multiflora* (VIMU B3), *Machaeranthera canescens*, annual *Epilobium* and/or *Gayophytum* spp., and *Eriogonum microthecum* (ERMI1-BSE). We plan to continue in this direction over the next several years. Data collected will be used to develop publications and manuals and for incorporation into the web site in collaboration with the growers and Foundation Seed Program managers.

2003 Products:

- Research Joint Venture Agreement between RMRS and AOSCA signed November 2003.
DeBolt, A. and N. Shaw. 2003. Cooperative native seed increase program (tri-fold color brochure).
- Shaw, N., DeBolt, A., Jensen, S. and others. 2004. Cooperative native seed increase program. Society for Range Management annual meeting, Salt Lake City, UT (Trade Show poster).

Presentations:

- Interagency Plant Materials meeting, Reno, NV June 2003
- National Association of Official Seed Certifying Agencies, Charleston, SC, July 2003
- Nevada Wildland Seed Producers Association meeting, Fallon, NV, September 2003

Table 1. Seed lots harvested in 2003 for AOSCA forb increase program

Species	Common name	Lot no.	Origin	Lot weight (g)	TZ (%)	PLS	No. live seeds	No. acres	Expected production (lbs)
Achillea millefolium	Western yarrow	ACHMIL2-BSE-03	ID	29	83	0.02	52,115	0.58	52
Achnatherum thurberiana	Thurber needlegrass	ACHTHU2-BSE-03	NV	23	59	0.02	3,094	0.07	13
Balsamorhiza sagittata	Arrowleaf balsamroot	BASA U32-02	NV	735	75	1.10	48,660	0.20	18
Crepis acuminata	Tapertip hawskbeard	CRAC U10-01	NV	110	30*	0.06	34,890	0.10	9.4
Eriogonum heracleoides	Wyeth buckwheat	ERIHER1-BSE-03	ID	54	36	0.01	668	0.01	0.6
E. umbellatum	Sulfur buckwheat	ERUM-09-03	NV	99	68	0.15	30,827	0.13	36
Lomatium dissectum	Fernleaf biscuitroot	LOMDIS18-BSE-03	ID	536	87	0.91	80,445	0.19	53
L. dissectum	Fernleaf biscuitroot	LODI11-B7-03	OR	138	63	0.18	15,672	0.04	10
Penstemon speciosus	Sagebrush penstemon	PENSPE1-BSE-03	ID	166	83	0.25	109,495	0.25	62
P. speciosus	Sagebrush penstemon	PENSPE9A-BSE-03	OR	206	89	0.36	158,136	0.36	25
*Sphaeralcea munroana***	Munro globemallow	SPMU U14-03	UT	908	89	1.42	854,400	1.40	140

* No data available; estimates based on similar or related species.

** While BLM prefers *Sphaeralcea grossulariifolia* (gooseberry-leaf globemallow), *S. munroana* is the species currently available.

Project Title: Increasing Seed Supplies of Native Grass and Forb Releases for the Great Basin

Project Location: Utah Crop Improvement Association

Principal Investigator: Stanford A. Young

Contact Information: **Stanford Young,** UCIA, Utah State University, Logan, UT, 84322-4855, 435.797.2082, fax 435.797.3376, sayoung@mendel.usu.edu

Description of Project: To improve the process for multiplication and distribution of early generation seed supplies of native grass and forb releases for the Great Basin.

Project Implementation:

UCIA will:

a. Allocate/distribute/track seed of native plant accessions (provided by RMRS and other cooperating public agencies) to private seed growers utilizing the UCIA buy-back option seed increase agreement.

b. Implement the official seed certification program (isolation requirements, field inspections, seed sampling, seed analysis) to maintain genetic identity and purity of the native plant accessions through the production process.

c. Negotiate seed prices and execute buy-back option seed increase purchases from growers according to market prices and demand for additional seed production.

d. Allocate and distribute this stock seed increase to secondary growers, utilizing the buy-back agreement as necessary to obtain further seed stocks as needed.

Status Summary:

1. A list of native forb seed shipments to Great Basin growers (Table 1).
2. The Application for Stock Seed form is included in Appendix IV.
3. A bulletin published by the Association of Official Seed Certifying Agencies, "The AOSCA Native Plant Connection", is available from UCIA. The principle investigator for this project, Stanford Young, is the corresponding author of the AOSCA publication. It describes seed certification nomenclature and labeling for plant germplasm types and how the genetic origin and purity of a germplasm accession are maintained by third party official certifying agencies through field increase and marketing.

Table 1. 2002 Seed lots shipped to growers for Buy-back Program

Species	Lot Number	Origin
Balsamorhiza hookeri	BAHO B1-02	Indian Creek, ID
Crepis acuminate	CRAC U11-02	Prospect Springs
Crepis acuminate	CRAC U10-02	Coyote Hills
Crepis acuminate	CRAC U3-02	Mile marker 356 (I-80)
Lomatium dissectum	LODI B8-02	Brownlee, ID
Lomatium dissectum	LODI B7-02	Birch Creek, OR
Lomatium dissectum	LODI B14-02	Mountain Home, ID
Lomatium triternatum	LOTR B2-02	Johnson Hill, ID
Penstemon acuminatus	PEAC B4-02	King Hill, ID
Penstemon acuminatus	PEAC B1-01	Bruneau Sand Dunes, ID
Penstemon cyaneus	PECY B6-02	Richfield, ID
Penstemon deustus	PEDE B10-02	Hwy. 95, ID
Penstemon deustus	PEDE B11-02	Mesa Meadows, ID
Penstemon pachyphyllus	PEPA2 U6-99	Pine Hollow Canyon, UT
Sphaeralcea munroana (sent as Spgr but later det. as Spmu)	SPGR U14-02	South of Moab, UT
Sphaeralcea grossulariifolia	SPGR U19-02	West of Battle Mtn, NV
Sphaeralcea grossulariifolia	SPGR U13-01	Jct. Hwy. 191 & 211
Tragopogon dubius	TRDU U2-02	Lavon Jones, UT or NV origin

Appendix I. Cooperative Great Basin native forb research.

Great Basin Native Plant Selection and Increase Project Research and BLM Priority Species for Revegetation.														
		Great Basin Project Research					Related Research			BLM Priority Species				
Family *Species*	**Common Name**	**Selection & seed increase**[1]	**Genetic variability**[2]	**Pollinators**[3]	**Seed zones**	**SSL & UDWR releases**[4]	**Seeded and source genetics**[5]	**USDA-ARS FRRL**[6]	**Chicago Botanic Garden**[7]	**BLM GB Task Order**[8]	**Idaho (Shoshone)**[9]	**Nevada**[10]	**Oregon (Vale)**[11]	**Sage-grouse**[12]
Apiaceae														
Lomatium dissectum	Fernleaf biscuitroot	SSL-B		BBSL						X				X
L. grayi	Gray's biscuitroot	SSL-B												
L. macrocarpum	Bigseed lomatium													X
L. nuttallii	Nuttall desert parsley	UDWR												
L. triternatum	Nineleaf biscuitroot	SSL-B												X
Achillea millefolium	Western yarrow					SSL						X		
Agoseris glauca	Pale agoseris	SSL-P												X
Agoseris heterophylla	Annual agoseris													X
Antennaria spp.	Pussytoes													X
Antennaria microphylla	Rosy pussytoes									X				X
Artemisia arbuscula	Low sagebrush											X		
Artemisia nova	Black sagebrush											X		
Artemisia tridentata tridentate	Basin big sagebrush						X					X	X	
A. tridentata vaseyana	Mountain big sagebrush						X					X		
A. tridentata wyomingensis	Wyoming big sagebrush				SSL		X					X	X	
Balsamorhiza hookeri	Hooker balsamroot									X	X			X
Balsamorhiza sagittata	Arrowleaf balsamroot	UDWR	SSL	BBSL						X				X
Chrysothamnus nauseosus							X							
Crepis acuminata	Tapertip hawksbeard	UDWR	SSL	BBSL						X	X			X
C. occidentalis	Longflower hawksbeard													X
Erigeron spp.	Old man in the spring													X
Erigeron chrysopsidis	Dwarf yellow fleabane													X
Erigeron linearis *Erigeron pumilus*	Desert yellow fleabane Shaggy fleabane		SSL							X				X X

Great Basin Native Plant Selection and Increase Project Research and BLM Priority Species for Revegetation.

Family *Species*	**Common Name**	**Great Basin Project Research**					**Related Research**			**BLM Priority Species**				
		Selection & seed increase[1]	**Genetic variability**[2]	**Pollinators**[3]	**Seed zones**	**SSL & UDWR releases**[4]	**Seeded and source genetics**[5]	**USDA-ARS FRRL**[6]	**Chicago Botanic Garden**[7]	**BLM GB Task Order**[8]	**Idaho (Shoshone)**[9]	**Nevada**[10]	**Oregon (Vale)**[11]	**Sage-grouse**[12]
Lactuca spp.	Lettuce													X
Lygodesmia spp.	Skeletonplant													X
Macheranthera canescens	Hoary aster									X				
Microseris nutans	Nodding microseris													X
Stephanomeria spp.	Wirelettuce													X
Tragopogon dubius	Yellow salsify	SSL-P								X				X
Viguiera spp.	Goldeneye													X
Viguiera multiflora	Showy goldeneye		SSL											X
Wyethia amplexicaulis	Mule-ears													X
Brassicaceae														
Schoencrambe linifolia	Slenderleaf schoencrambe									X				X
Schoencramble speciosus	Plains mustard									X				X
Capparidaceae														
Cleome lutea	Yellow spiderflower													X
C. serrulata	Rocky Mountain beeplant													X
Chenopodiaceae														
Atriplex canescens	Four-wing saltbush				SSL		X					X		
Atriplex confertifolia	Shadscale											X		
Atriplex torreyi	Torrey's saltbush											X		
Krascheninnikovia lanata	Winterfat											X		
Fabaceae														
Astragalus spp.	Milkvetch													X
Astragalus eremiticus	Hermit milkvetch	SSL-B												

Great Basin Native Plant Selection and Increase Project Research and BLM Priority Species for Revegetation.

Family *Species*	**Common Name**	**Great Basin Project Research**					**Related Research**			**BLM Priority Species**				
		Selection & seed increase[1]	**Genetic variability[2]**	**Pollinators[3]**	**Seed zones**	**SSL & UDWR releases[4]**	**Seeded and source genetics[5]**	**USDA-ARS FRRL[6]**	**Chicago Botanic Garden[7]**	**BLM GB Task Order[8]**	**Idaho (Shoshone)[9]**	**Nevada[10]**	**Oregon (Vale)[11]**	**Sage-grouse[12]**
Astragalus filipes (A. stenophyllus)	Threadstalk milkvetch		FRRL	BBSL										X
Astragalus lentiginosus	Freckled milkvetch							X		X				X
Astragalus purshii	Woollypod milkvetch									X			X	X
Astragalus utahensis	Utah milkvetch	SSL-P	SSL											X
Hedysarum boreale	Boreal sweetvetch		FRRL, SSL	BBSL			X			X				
Lathyrus brachycalyx	Rydberg sweetpea									X				X
Lotus utahensis	Utah deervetch									X				
Lupinus argenteus	Silvery lupine	SSL-P		BBSL						X				X
Lupinus sericeus	Silky lupine	SSL-P	SSL											X
Lupinus wyethii	Wyeth's lupine													X
Trifolium macrocephalum	Largehead clover													X
T. variegatum	Whitetip clover													X
T. gymnocarpon	Hollyleaf clover													X
Vicia americana	American vetch		SSL							X				X
Liliaceae														
Allium acuminatum	Tapertip onion									X				X
Calochortus macrocarpus	Green-banded star tulip													X
Calochortus nuttallii	Sego lily													X
Calochortus gunnisonii	Gunnison's mariposa lily													X
Linaceae														
Linum lewisii lewisii	Blue flax					SSL						X	X	
Linum perenne	Blue flax		SSL				X							
Malvaceae														

Great Basin Native Plant Selection and Increase Project Research and BLM Priority Species for Revegetation.

Family *Species*	**Common Name**	**Great Basin Project Research**					**Related Research**			**BLM Priority Species**				
		Selection & seed increase[1]	**Genetic variability**[2]	**Pollinators**[3]	**Seed zones**	**SSL & UDWR releases**[4]	**Seeded and source genetics**[5]	**USDA-ARS FRRL**[6]	**Chicago Botanic Garden**[7]	**BLM GB Task Order**[8]	**Idaho (Shoshone)**[9]	**Nevada**[10]	**Oregon (Vale)**[11]	**Sage-grouse**[12]
Sphaeralcea spp.	Globemallow													X
Sphaeralcea coccinea	Scarlet globemallow	UDWR								X		X		X
S. grossulariifolia	Gooseberryleaf globemallow	UDWR	SSL				X							X
S. munroana	Munro's globemallow												X	
Poaceae														
Achnatherum hymenoides	Indian ricegrass		FRRL				X					X	X	
Achnatherum speciosum	Desert needlegrass											X		
Achnatherum thurberianum	Thurber needlegrass	SSL-P	FRRL			SSL					X	X	X	
Bromus carinatus	California brome		SSL											
Hesperostipa comata	Needle and thread	UDWR, SSL-P	FRRL				X					X		
Elymus elymoides	Squirreltail		FRRL										X	
E. elymoides brevifolius	Squirreltail											X		
Elymus macrourus	Thickspike wheatgrass											X		
Elymus wawawaiensis	Snake River wheatgrass											X		
Leymus cinereus	Basin wildrye	UDWR	FRRL				X					X	X	
Pascopyrum smithii	Western wheatgrass		FRRL											
Poa secunda	Sandberg bluegrass		FRRL			SSL						X	X	
Pseudoroegneria spicata	Bluebunch wheatgrass	UDWR	FRRL			SSL	X					X	X	
Polemoniaceae														
Collomia linearis	Narrowleaf collomia									X				X
Microsteris gracilis	Slender phlox													X
Phlox hoodii	Hood's phlox													X
P. longifolia	Longleaf phlox	SSL-P								X			X	X

Great Basin Native Plant Selection and Increase Project Research and BLM Priority Species for Revegetation.

Family *Species*	**Common Name**	**Great Basin Project Research**					**Related Research**			**BLM Priority Species**				
		Selection & seed increase[1]	**Genetic variability**[2]	**Pollinators**[3]	**Seed zones**	**SSL & UDWR releases**[4]	**Seeded and source genetics**[5]	**USDA-ARS FRRL**[6]	**Chicago Botanic Garden**[7]	**BLM GB Task Order**[8]	**Idaho (Shoshone)**[9]	**Nevada**[10]	**Oregon (Vale)**[11]	**Sage-grouse**[12]
Polygonaceae														
Eriogonum cernuum var. *cernuum*									X					
Eriogonum microthecum var. *laxiflorum*									X					
Eriogonum ovalifolium	Cushion buckwheat	UDWR								X				
E. ovalifolium var. *ovalifolium*									X					
E. umbellatum	Sulfur-flower buckwheat	SSL-B	SSL	BBSL										X
E. vimineum	Annual buckwheat									X				
Rosaceae														
Purshia glandulosa	Desert bitterbrush											X		
Purshia mexicana	Mexican cliffrose											X		
Purshia stansburiana	Stansbury cliffrose											X		
Purshia tridentata	Bitterbrush				SSL		X					X	X	
Saxifragaceae														
Lithophragma bulbifera	Bulbiferous prairiestar													X
Lithophragma parviflora	Small flowered fringe cup													X
Scrophulariaceae														
Castilleja applegatei	Wavyleaf Indian paintbrush												X	
Collinsia parviflora	Blue-eyed Mary									X				X
Penstemon acuminatus *P. cyaneus*	Sharpleaf penstemon	SSL-B									X			X

Great Basin Native Plant Selection and Increase Project Research and BLM Priority Species for Revegetation.

Family *Species*	**Common Name**	**Great Basin Project Research**					**Related Research**			**BLM Priority Species**				
		Selection & seed increase[1]	**Genetic variability**[2]	**Pollinators**[3]	**Seed zones**	**SSL & UDWR releases**[4]	**Seeded and source genetics**[5]	**USDA-ARS FRRL**[6]	**Chicago Botanic Garden**[7]	**BLM GB Task Order**[8]	**Idaho (Shoshone)**[9]	**Nevada**[10]	**Oregon (Vale)**[11]	**Sage-grouse**[12]
P. deustus	Scabland penstemon	SSL-B												
P. deustus var. *pedicellatus*									X					
P. pachyphyllus var. *congestus*									X					
P. palmeri	Palmer's penstemon		SSL				X							
P. rostriflorus									X					
P. speciosus	Sagebrush penstemon	SSL-B	SSL	BBSL									X	X
P. spectabilis	Showy penstemon									X				X

1 FRRL = USDA-ARS Forage and Range Research Laboratory (Johnson, Jones)
UDWR = Utah Division of Wildlife Resources (Thompson, Vernon, Walker)
SSL = USDA-FS-RMRS Shrub Sciences Laboratory, Provo and Boise (Shaw, Jensen, DeBolt)
2 SSL = McArthur
FRRL = Larson, Johnson
3 BBSL = USDA-ARS Bee Biology and Systematics Laboratory (Cane)
4 SSL, UDWR and cooperators
5 Durant McArthur, Shrub Sciences Laboratory, Provo (National Fire Plan Funding)
6 Doug Johnson and others, USDA-ARS Forage and Range Research Laboratory, Logan
7 Andrea Tietmeyer, Chicago Botanic Garden (BLM funding)

Lists provided by:
8 Mike Pellant, BLM, Great Basin Restoration Initiative Coordinator, Boise, Idaho
9 Julie Hilty, BLM, Botanist, Shoshone, Idaho
10 Ted Angle, BLM, Weed Program Coordinator, Nevada State Office, Reno, Nevada
11 Jean Findley, BLM, Botanist, Vale, Oregon
12 Scott Lambert, BLM, Regional Seed Coordinator, Boise, Idaho

Appendix II. Populations collected for isoenzyme and molecular genetic analysis.

Species	Locality	County	State	Collection No.	Date Collected	Source, Indigenous, or Seeded
Artemesia tridentate	Top of Maple Canyon (source for Carr Ford Seeding)	Sanpete	Utah	2616	12-Aug-02	source
Artemesia tridentate	Carr Fork Wildlife Management Area	Tooele	Utah	2796	06-Jun-03	indigenous
Artemisia tridentata	Carr Fork Wildlife Management Area	Tooele	Utah	2797	06-Jun-03	seeded
Astragalus utahensis	Wolverine Canyon	Bingham	Idaho	2715	15-May-02	indigenous
Astragalus utahensis	Jake's Valley	White Pine	Nevada	2572	29-May-01	indigenous
Astragalus utahensis	Mt. Moriah, Snake Range	White Pine	Nevada	2735	31-May-02	indigenous
Astragalus utahensis	Orem	Utah	Utah	2700	30-Apr-02	indigenous
Astragalus utahensis	Carr Fork Wlildlife Management Area	Tooele	Utah	2795	03-Jun-03	indigenous
Atriplex canescens nevadensis	Tonopah	Nye	Nevada	2730	30-May-02	indigenous
Atriplex canescens occ.	East Side of Panaca	Lincoln	Nevada	2721	17-May-02	indigenous
Atriplex canescens occ. (native)	Twist Hollow Wash	Washington	Utah	2725	17-May-02	indigenous
Atriplex canescens occ. (seeded)	Sand Pit Area, Twist Hollow	Washington	Utah	2724	17-May-02	seeded
Atriplex canescens pioche	Wilson Creek Road	Lincoln	Nevada	2723	17-May-02	indigenous
Atriplex canescens, 2x	Little Sahara Recreation Area, on dunes	Juab	Utah	2702	30-Apr-02	indigenous
Atriplex canescens, 4x	Little Sahara Recreation Area, on flat	Juab	Utah	2704	01-May-02	indigenous
Atriplex canescens, 2x, *angustifolia*	mi 26, US 380, 25 mi E. of San Antonio	Corro	New Mexico	2736	04-Jun-02	indigenous
Atriplex canescens vallis, 6x	1/2 mi S of Bernardo (source for Grantsville—2831)	Corro	New Mexico	2737	07-Jun-02	source
Atriplex canescens	1 miles SE of Wales	Sanpete	Utah	2729	22-May-02	source
Atriplex canescens tooelensis	East Side of Grantsville	Tooele	Utah	2831	19-Aug-03	seeded
Atriplex canescens, occ	Grantsville	Tooele	Utah	2832	19-Aug-03	indigenous
Atriplex canescens, occ (4x)	1 mile S of Grantsville	Tooele	Utah	2848	01-Sep-03	indigenous
Atriplex canescens (6x)	Near Grantsville, Utah Highway 138, I-80 West Exit		Utah	2847	01-Sep-03	indigenous
Atriplex canescens brevis	1 mi N. of East end of Cerro del Olla	Taos	New Mexico	2738	07-Jun-02	indigenous
Balsamorhiza sagittata	Summit, Clear Creek Canyon, Exit 8, I-70	Sevier	Utah	2806	03-Jun-03	indigenous
Balsamorhiza sagittata	Toiyabe Range, Toiyabe NF, near Austin	Lander	Nevada	2800	17-Jun-03	indigenous
Balsamorhiza sagittata	Boise Front	Ada	Idaho	2801	08-Jul-03	indigenous
Bromus carinatus	Broad Canyon, East Tintic Mountains	Utah	Utah	2578	17-Jul-01	indigenous
Bromus carinatus	Little Valley, W. of Panguitch	Garfield/Iron	Utah	2615	09-Jul-02	indigenous
Chrysothamnus nauseosus	Near Orem	Utah	Utah	2617	12-Aug-02	indigenous
Chrysothamnus nauseosus	Box Springs, Henry Mountains	Garfield	Utah	2833	24-Aug-03	seeded
Chrysothamnus nauseosus	Box Springs, Henry Mountains	Garfield	Utah	2834	24-Aug-03	indigenous

Chrysothamnus nauseosus	Salt Creek Canyon (source for Box Springs)	Juab	Utah	2815	01-Sep-03	source
Chrysothamnus nauseosus	Near Ephraim	Sanpete	Utah	2618	12-Aug-02	indigenous
Crepis acuminate	Near Woodruff	Oneida	Idaho	2712	14-May-02	indigenous
Crepis acuminate	Jake's Valley	White Pine	Nevada	2571	29-May-01	indigenous
Crepis acuminate	Kingston Canyon, Toiyabe Range	Lander	Nevada	2731	30-May-02	indigenous
Crepis acuminate	Grouse Creek Mountains	Box Elder	Utah	2610	05-Jun-01	indigenous
Crepis acuminate	Below Black Rock Canyon, East Tintic Mountains	Tooele	Utah	2706	30-Apr-02	indigenous
Crepis occidentalis	Summit, Clear Creek Canyon, Exit 8, I-70, Sevier	Sevier	Utah	2807	03-Jun-03	indigenous
Erigeron pumilis	Crystal Ice Caves Road	Power	Idaho	2717	16-May-02	indigenous
Erigeron pumilis	Near Welcome	Elko	Nevada	2719	16-May-02	indigenous
Erigeron pumilis	Jake's Valley	White Pine	Nevada	2570	29-May-01	indigenous
Erigeron pumilis	Sheep Creek, Panguitch area	Garfield	Utah	2607	2001	indigenous
Erigeron pumilis	Topaz Mountain	Juab	Utah	2705	01-May-02	indigenous
Erigeron pumilis	Cedar Grove	Wayne	Utah	2611	11-Jul-01	indigenous
Erigeron pumilis	Below Black Rock Canyon, East Tintic Mountains	Tooele	Utah	2707	30-Apr-02	indigenous
Erigonum umbellatum	Crystal Ice Caves Road	Power	Idaho	2716	16-May-02	indigenous
Erigonum umbellatum	Underdown Canyon, Shoshone Mountains	Lander	Nevada	2573	31-May-01	indigenous
Erigonum umbellatum	Upper Indian Peaks WMA	Beaver	Utah	2612	2001	indigenous
Erigonum umbellatum	Upper Broad Cyn., East Tintic Mountains	Utah	Utah	2579	17-Jul-01	indigenous
Erigonum umbellatum	Lower Broad Cyn., East Tintic Mountains	Utah	Utah	2701	30-Apr-02	indigenous
Erigonum umbellatum?	Near Inkom	Bannock	Idaho	2714	15-May-02	indigenous
Lupinus argenteus/sericeus	Crystal Ice Caves Road	Power	Idaho	2718	16-May-02	indigenous
Lupinus argenteus/sericeus	Oak Springs Summit	Lincoln	Nevada	2720	16-May-02	indigenous
Lupinus argenteus/sericeus	Jake's Valley	White Pine	Nevada	2733	30-May-02	indigenous
Lupinus argenteus/sericeus	Lost Peak, Enterprise area	Washington	Utah	2608	31-Jul-01	indigenous
Lupinus argenteus/sericeus	Near Eureka	Utah	Utah	2703	01-May-02	indigenous
Lupinus argenteus/sericeus	Jackson Ridge, La Sal Mountains	San Juan	Utah	2581	17-Jul-01	indigenous
Oryzopsis hymenoides	Moore Road Area, Swan Falls	Ada	Idaho	2802	08-Jul-03	indigenous
Lupinus argenteus/sericeus	Salt Cave Hollow, Salt Creek Canyon	Juab	Utah	2586	24-Jul-01	indigenous
Purshia tridentate	Wallsburg Burn Wildlife Management Area	Wasatch	Utah	2798	10-Jun-03	seeded
Purshia tridentate	Wallsburg Burn Wildlife Management Area	Wasatch	Utah	2799	10-Jun-03	indigenous
Purshia tridentate	Mt. Pleasant (Source for Wallsburg Burn Seeding)	Sanpete	Utah	2827	19-Aug-03	source
Purshia tridentate	Slaughter Flats	San Juan	Utah	2829	18-Aug-03	seeded
Purshia tridentate	Preston (Source for Slaughter Flats)	Franklin	Idaho	2830	26-Aug-03	source
Stipa comata	N of Modena, just S. of State Highway 56	Iron	Utah	2613	06-June-02	indigenous
Stipa comata	UDWR Horse Pasture, NW of Cisco	Grand	Utah	2614	11-June-02	indigenous
Stipa comata	Jake's Valley	White Pine	Nevada	2732	30-May-02	indigenous
Stipa comata	Kanab	Kane	Utah	2791	06-May-03	indigenous

Stipa comata	W. of Boulder	Garfield	Utah	2792	21-May-03	indigenous
Vicia Americana	Egan Mountains	White Pine	Nevada	2734	31-May-02	indigenous
Vicia Americana	Lost Peak, Enterprise area	Washington	Utah	2609	31-Jul-01	indigenous
Vicia Americana	Jackson Ridge, La Sal Mountains	San Juan	Utah	2580	17-Jul-01	indigenous
Vicia Americana	Road to South Hollow, Caanan Mountain	Garfield	Utah	2793	01-Jun-03	indigenous
Vicia Americana	Salt Cave Hollow, Salt Creek Canyon	Juab	Utah	2794	02-Jun-03	indigenous
Vicia Americana	Pinto Canyon, Pine Valley Mountain	Washington	Utah	2811	04-Jun-03	indigenous
Vicia Americana	Black Rock Canyon, East Tintic Mountains	Tooele	Utah	2814	18-Jun-03	indigenous
Viguiera multiflora	Caselton	Lincoln	Nevada	2813	09-Jun-03	indigenous
Viguiera multiflora	Rachel	Lincoln	Nevada	2569	11/31-May-01	indigenous
Viguiera multiflora	Castleton Turnoff	Lincoln	Nevada	2722	17-May-02	indigenous
Viguiera multiflora	Broad Canyon, East Tintic Mountains	Utah	Utah	2575	17-Jul-01	indigenous
Viguiera multiflora	Nebo Loop Road, Uinta NF	Juab	Utah	2825	28-Jul-03	indigenous
Viguiera multiflora	Great Basin Experimental Range	Sanpete	Utah	2826	28-Jul-03	indigenous

Appendix IV.

UTAH CROP IMPROVEMENT ASSOCIATION

Utah State University • 4855 Old Main Hill • Logan, UT 84322-4855 • (435) 797-2082 • fax (435) 797-3376

e-mail: sayoung@mendel.usu.edu

APPLICATION FOR STOCK SEED

Grower/Company_____ Phone/Cell _____

Mailing Address _____ FAX _____

_____ E-mail _____

Variety/Germplasm & Crop _____ Pounds _____

Acreage _____ ( ) Dryland ( ) Irrigated Proposed Planting Date _____

Proposed Location of Field _____ County _____
(from nearest town)

Does acreage meet land and isolation requirements? _____
(Refer to Seed Certification Requirements and Standards of appropriate seed certification agency)

I wish to obtain this stock seed to plant for the production of a class of certified seed. I have read the following statements of allocation, warranty, and seed increase. I accept the terms of the warranty and the contractual agreement regarding disposition of seed increase.

Signed _____ Date _____

STATEMENTS OF ALLOCATION, WARRANTY, AND

SEED INCREASE FOR STOCK SEED

I. ALLOCATION

A. To ensure consideration by the allocation committee (UCIA and plant germplasm developers associated with the Utah Agricultural Experiment Station), due dates for applications are: (1) Spring planted varieties, February 20; (2) Late summer planted varieties, August 1; (3) Fall planted varieties, Sept. 15. Late or amended applications or requests for early allocation will be considered as inventory allows.

B. Allocation to qualified certified seed producers will generally be on a first come-first served basis. However, stock seed demand for new varieties/germplasms may greatly exceed the sometimes small seed supply available. In these cases, growers/companies known to be potentially interested in stock seed will be notified of the opportunity to request an allocation. Those growers/companies qualified (see C below) will form a pool from which one or more (depending on the seed supply and best interests of the specific variety/germplasm) will be selected randomly by lottery.

C. Allocation priority will be given to experienced seed growers with favorable soil and climatic conditions for the particular species. Those with small plot growing experience will be favored for new releases with

extremely small amounts of seed available. Preference may be given to certified seed growers in Utah (for varieties/germplasms released by Utah state agencies) or certified seed growers in any state (for varieties/germplasms released by Federal agencies).

II. WARRANTY

A. The Utah Crop Improvement Association (UCIA) warrants that stock seed produced under its contractual control has been produced, conditioned, and labeled in compliance with the UCIA Seed Certification Requirements and Standards. Stock seed distributed by UCIA but produced by another entity is accompanied only by the warranty from the originating entity.

B. Without limiting the foregoing, it is expressly agreed that UCIA makes no warranty, expressed or implied, as to seed quality or other factors affecting yield of the resultant crop. In any case, UCIA liability for loss shall be limited solely to the amount charged for the seed.

III. SEED INCREASE CONTRACT

A. The grower agrees to plant the seed the season (see I.A.) following receipt of the seed, or return the seed promptly unless an extension is expressly granted by the UCIA. The grower also agrees to apply for certification for fields planted with stock seed, and to follow good agronomic practices and be in compliance with seed certification requirements and standards for stand establishment and seed production for the species. Specifically, progeny shall not be planted within the isolation distance of the stock seed field such that the stock seed field generation would be downgraded.

B. For varieties applied for or granted Plant Variety Protection (Title 5), any seed crop for which certification is not completed as a class of Certified seed (whether due to field or seed rejection or grower decision) shall not be sold or otherwise distributed as seed. Such seed crop must be disposed of (with prior notification of UCIA) by mixing with a like commercial commodity or other method as agreed to by the UCIA. Other state certification agencies may act as agent for UCIA in this matter.

C. Check box that applies and initial here: Grower _____ UCIA _____

~ In order to perpetuate desirable early generation seed lots, UCIA reserves first right to purchase quantities needed (up to 75% of the total production from the first and second harvest of the stand, 50% thereafter) from selected fields planted with such lots. The price paid by UCIA is negotiable according to market prices for the particular kind and variety/germplasm within six months after harvest. However, the price paid by UCIA will not exceed 125% of the established market price or 75% of the price per PLS pound charged the grower for the original seed, whichever is less. The UCIA shall be informed of seed quantity harvested within one week after harvest each year, and UCIA will inform the grower of seed quantity needed (cleaned or uncleaned) within one month after harvest.

~ As an alternate to the above, seed in some instances may be provided to the grower at no charge, but UCIA requires _____ pls pounds of seed returned to UCIA from the grower upon first harvest(s) of the variety/germplasm herein agreed to propagate.

~ No formal increase agreement required (stock seed supply currently adequate).

IV. COMPLIANCE

A. Stock seed not accepted under the terms of the warranty and the seed increase contract must be returned to UCIA at once in original unopened containers and the amount charged for the seed (less freight and handling costs) will be refunded.

B. Failure to abide by the terms of the seed increase contract may disqualify the grower from future allocations of stock seed and/or membership in the Utah Crop Improvement Association.