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Corvallis Plant Materials Center

2012 Annual Technical Report

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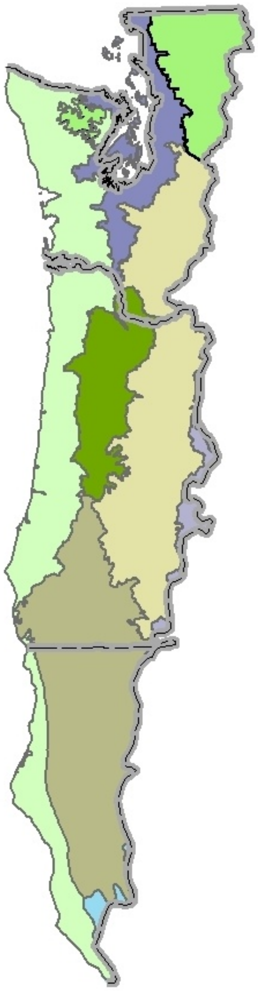
Table of Contents

Introduction



Corvallis PMC Service Area of western Washington, western Oregon, and northwestern California.

Since 1957, the Corvallis Plant Materials Center (PMC) has selected and developed conservation plants and planting technology to solve resource concerns critical to the Pacific Northwest.

A unit of the USDA Natural Resources Conservation Service (NRCS), the PMC works in partnership with local, state, federal, and private organizations to develop new technology in plant propagation and establishment, seed production, re-vegetation, restoration, and erosion control. Plant specialists test and release new plant sources used to restore and protect streamside areas, wetlands, uplands, cropped lands, and critical wildlife habitats. A vast majority of the work focuses on native grasses, forbs, and shrubs.

The Corvallis PMC service area includes the northern Pacific Coast Range, Willamette Valley and Puget Sound, as well as the Olympic, Cascade, and Siskiyou Mountains.

2012 Corvallis PMC Publications

Publications available on the Corvallis PMC website: http://plant-materials.nrcs.usda.gov/orpmc/publications.html

Plant Guides and Plant Fact Sheets

Darris, D., and A. Young-Mathews. 2012. Plant Fact Sheet: Riverbank Lupine (*Lupinus rivularis*). ORPMC, Corvallis, OR. March 2012.

Darris, D., S. Johnson, and A. Bartow 2012. Plant Fact Sheet: Roemer's fescue (*Festuca roemeri*). USDA NRCS Corvallis Plant Materials Center, Corvallis, Oregon. July 2012.

Young-Mathews, A., and E. Eldredge. 2012. Plant Fact Sheet: Showy Milkweed (*Asclepias speciosa*). Corvallis Plant Materials Center and Great Basin Plant Materials Center, Corvallis, OR and Fallon, NV. August 2012.

Young-Mathews, A. 2012. Plant Fact Sheet: Lance Selfheal (*Prunella vulgaris* ssp. *lanceolata*). ORPMC, Corvallis, OR. April 2012.

Young-Mathews, A. 2012. Plant Fact Sheet: Meadow Checkerbloom (*Sidalcea campestris*). ORPMC, Corvallis, OR. June 2012.

Young-Mathews, A. 2012. Plant Fact Sheet: Puget Sound Gumweed (*Grindelia integrifolia*). ORPMC, Corvallis, OR. April 2012.

Young-Mathews, A. 2011. Plant Fact Sheet: Pacific Aster (*Symphyotrichum chilense*). ORPMC, Corvallis, OR. December 2011.

Young-Mathews, A. 2012. Plant Fact Sheet: Slender Cinquefoil (*Potentilla gracilis*). ORPMC, Corvallis, OR. June 2012.

Young-Mathews, A. 2012. Plant Guide: Field Mustard (*Brassica rapa* var. *rapa*). USDA NRCS Corvallis Plant Materials Center, Corvallis, OR. August 2012.

Young-Mathews, A. 2012. Plant Guide: Rose Checker-mallow (*Sidalcea virgata*). ORPMC, Corvallis, OR. May 2012.

Conservation Plant Release Notices and Brochures

Darris, D., and A. Young-Mathews. 2012. Notice of release of Klamath Mountains Germplasm Roemer's fescue. NRCS Corvallis, OR, Corvallis, OR. July 2012.

Darris, D., and A. Young-Mathews. 2012. Notice of release of Northwest Maritime Germplasm Roemer's fescue. NRCS, Corvallis Plant Materials Center, Corvallis, OR. July 2012.

Darris, D., and A. Young-Mathews. 2012. Notice of release of Puget Germplasm Roemer's fescue. NRCS, Corvallis Plant Materials Center, Corvallis, OR. July 2012.

Darris, D., and A. Young-Mathews. 2012. Notice of release of San Juan Germplasm Roemer's fescue. NRCS Corvallis Plant Materials Center, Corvallis, Oregon. July 2012.

Darris, D., and A. Young-Mathews. 2012. Notice of release of Willamette Valley Germplasm Roemer's fescue. NRCS Corvallis Plant Materials Center, Corvallis, Oregon. July 2012.

Darris, D.C., and A. Young-Mathews. 2012. Plant Release Brochure: Klamath Mountains Germplasm Roemer's fescue. USDA NRCS Corvallis Plant Materials Center, Corvallis, Oregon. July 2012.

Darris, D.C., and A. Young-Mathews. 2012. Plant Release Brochure: Northwest Maritime Germrplasm Roemer's fescue. NRCS, Corvallis Plant Materials Center, Corvallis, Oregon. July 2012.

Darris, D.C., and A. Young-Mathews. 2012. Plant Release Brochure: Puget Germplasm Roemer's fescue. USDA NRCS Corvallis, Oregon, Corvallis, Oregon. July 2012.

Darris, D.C., and A. Young-Mathews. 2012. Plant Release Brochure: San Juan Germplasm Roemer's fescue. USDA NRCS Corvallis Plant Materials Center, Corvallis, Oregon. July 2012.

Darris, D.C., and A. Young-Mathews. 2012. Plant Release Brochure: Willamette Valley Germplasm Roemer's fescue. USDA NRCS Corvallis Plant Materials Center, Corvallis, Oregon. July 2012.

Young-Mathews, A. 2012. Release brochure for 'Hederma' riverbank lupine (*Lupinus rivularis*). ORPMC, Corvallis, OR. Updated March 2012.

Other Publications

Darris D., A. Bartow, A. Young-Mathews, K. Pendergrass, and J. Williams. 2012. Corvallis Plant Materials Center 2012 Progress Report of Activities. USDA NRCS Corvallis Plant Materials Center, Corvallis, OR. September 2012.

Darris, D.C., and A. Young-Mathews. 2012. Effects of Nitrogen Fertilizer Timing and Rates on Seed Production of Jackson-Frazier Germplasm Meadow Barley (*Hordeum brachyantherum*). 2011 Seed Production Research at Oregon State University, USDA-ARS Cooperating, W.C. Young (ed.), Salem, OR. April 2012.

Darris, D.C., and A. Young-Mathews. 2012. Effects of Nitrogen Fertilizer Timing and Rates on Seed Production of Roemer's Fescue (*Festuca roemeri*). 2011 Seed Production Research at Oregon State University, USDA-ARS Cooperating, W.C. Young (ed.), Salem, OR. April 2012.

Darris, D.C., and A. Young-Mathews. 2012. Effects of Post-Harvest Residue Management on Seed Production of Roemer's Fescue (*Festuca roemeri*). 2011 Seed Production Research at Oregon State University, USDA-ARS Cooperating, W.C. Young III (ed.), Corvallis, OR. April 2012.

Seifert, K., D. Darris, and M. Mellbye. 2011. Native grasses revisited. Update - people helping people grow. Linn County Extension Association, Albany, OR. Vol. 31, No. 12. December 2011.

Natural Resources Conservation Service. 2012. Corvallis Plant Materials Center 2011 Technical Report. USDA NRCS Corvallis Plant Materials Center, Corvallis, OR. July 2012. 230p.

The Effect of Different Rates and Timing of Nitrogen Fertilization on Seed Production of Willamette Germplasm Tufted Hairgrass (study no. 40-dece-sf)

Dale Darris

Introduction

Willamette Germplasm tufted hairgrass (*Deschampsia cespitosa*) is a selected class natural germplasm that was released by the USDA-Natural Resources Conservation Service, Corvallis Plant Materials Center (PMC) and the Oregon State University Agricultural Experiment Station in 2001. It is a tall native bunchgrass intended primarily for revegetation of seasonally wet sites, enhancement of wetlands and riparian zones, shoreline erosion control, and wildlife habitat at low elevations in western Oregon and western Washington (Darris and Lambert, 2001). The germplasm has been under seed production since 1990. However, there are no nitrogen fertilizer recommendations based on research trials for this selection or similar ecotypes. Suggestions rely primarily on anecdotal information gained from on farm seed increase and extrapolation from fertilizer guides used for other grasses grown for seed (Darris et al., 1995). The purpose of this study was to determine the optimal timing and rates of nitrogen fertilizer application for seed production of Willamette Germplasm tufted hairgrass.

Methods and Materials

A preexisting seed production field of Willamette Germplasm tufted hairgrass (accession 9019737) on field 7-7 at the Corvallis PMC's Schmidt Farm was used for the study. The 0.35-acre field (80 x 190 ft.) was sown in April of 1990 on 24-inch row spacing. Irrigation water was only applied during the first summer for establishment purposes. A standard regime of herbicides recommended for volunteer grass and broadleaf weed control in grasses grown for seed was applied annually, both prior to and during the experiment. Through 1996, annual fertilization consisted of 75-100 lb/ acre of actual nitrogen (N) applied as granular urea (46-0-0) each spring. No lime or other fertilizers were applied.

The experimental rates of nitrogen fertilizer were applied to plots for three consecutive years according to 17 treatments beginning in October of 1997 with the first fall application (Table 1). All spring applications were made 24 to 30 days apart each month. All rates are actual N applied as granular urea (46-0-0).

Each plot was 8 ft. wide and 20 ft. long (Figure 1). Seedheads of tufted hairgrass were hand harvested from a 1-m^2 (10.76 ft^2) subplot each July when mature. The seed was threshed with a hammermill and cleaned with a table top air-screen machine (office Clipper). Each plot was also measured at maturity (early July) for stem (culm) height and scored for foliage abundance and stem (fertile tiller) abundance on a scale of 1-10

(10=highest). Seed germination was not tested. Experimental design was a randomized complete block with four replications. Data analysis consisted of ANOVA and Tukey HSD means comparison performed in Statistix 8.1.

Table 1. Nitrogen fertilization treatments for Willamette Germplasm tufted hairgrass seed production study conducted three years (1998-2000) at the Corvallis PMC.

Treatment	Nitrogen application rate and timing
1	Control (no fertilizer)
2	25 lb/ac-Oct
3	50 lb/ac-Feb
4	50 lb/ac-Mar
5	50 lb/ac-Apr
6	25 lb/ac-Oct + 50 lb/ac-Feb
7	25 lb/ac-Oct + 50 lb/ac-Mar
8	25 lb/ac-Oct + 50 lb/ac-Apr
9	100 lb/ac-Feb
10	100 lb/ac-Mar
11	100 lb/ac-Apr
12	50 lb/ac-Feb + 50 lb/ac-Mar
13	50 lb/ac-Feb + 50 lb/ac-Apr
14	50 lb/ac-Mar + 50 lb/ac-Apr
15	25 lb/ac-Oct + 50 lb/ac-Feb + 50 lb/ac-Mar
16	25 lb/ac-Oct + 50 lb/ac-Feb + 50 lb/ac-Apr
17	25 lb/ac-Oct + 50 lb/ac-Mar + 50 lb/ac-Apr

Figure 1. Tufted hairgrass plots fertilized with nitrogen (granular urea) according to experimental design.

Results and Discussion

Mean seed yields of Willamette Germplasm tufted hairgrass for each treatment over the three years of the study are presented in Table 2. Treatment 15, the application of 25 lb N/ac in October, with 50 lb N/ac in February, and 50 lb N/ac in March, ranked highest in seed yield each year, although yields were not significantly greater (P=0.05) than a number of other treatments. Yields for Treatment 10, 100 lb N/ac in March, were unexpectedly low. March applications of nitrogen often favor higher seed yields for grasses in western Oregon (Doerge et al., 2000; Gingrich et al., 2003; Hart et al., 2005). Results of this experiment are considered applicable to tufted hairgrass fields grown with a row spacing of 25 inches and possibly wider. Yields of this species have been depressed when narrower rows are used (Darris and Stannard, 1997).

The top yields of 250 to 500 lb/ac in this study were considerably greater than reported for Willamette Germplasm tufted hairgrass under field scale, machine production. Average yield obtained by swathing and combining was only 102 lb/ac at the Corvallis PMC (Darris and Lambert, 2001). Plot sampling by hand probably retained substantially more seed per unit of area and contained higher inert matter after cleaning compared to large scale methods. Inclusion of more inert material added to the “seed yield” amount.

Table 2. Annual seed production of Willamette Germplasm tufted hairgrass under 17 nitrogen fertilization treatments for three years at the Corvallis PMC.[/1]

1998		1999		2000	
Treatment	**lb/acre**	**Treatment**	**lb/acre**	**Treatment**	**lb/acre**
15	410 a	15	499 a	15	358 a
12	371 ab	12	382 ab	13	283 ab
16	370 ab	17	304 abc	17	264 abc
6	340 abc	16	304 abc	9	247 abc
13	339 abc	9	296 abc	4	232 abc
9	250 abcd	13	291 abc	7	231 abc
7	243 abcd	11	288 abc	12	219 bc
14	238 abcd	3	281 abc	10	217 bc
17	238 abcd	14	266 abc	6	201 bc
4	236 abcd	6	234 abc	14	191 bcd
8	226 abcd	8	226 abc	16	176 bcd
3	199 bcd	7	210 bc	8	176 bcd
11	176 cd	10	156 bc	3	172 bcd
5	154 cd	5	148 bc	11	144 cd
10	135 d	4	133 bc	2	140 cd
2	115 d	2	117 bc	5	137 cd
1	81 d	1	94 c	1	63 d

[/1] Means with the same letter are not significantly different (Tukey HSD [P=0.05]).

Data for foliage abundance and stem abundance in 1999 and 2000 are shown in Table 3 (1998 data are not shown). Differences among most fertilization treatments for both variables were difficult to visually discern resulting in few significant differences. Treatment 15 (25 lb/ac-Oct + 50 lb/ac-Feb + 50 lb/ac-Mar) ranked first or second in foliage and stem abundance both years, coinciding with the highest seed yields (Table 2). The control, October only fertilization, and April only fertilization (50 lb N/acre) treatments consistently ranked lowest in foliage and stem abundance both years which generally corresponded with the lowest seed yields. There were no significant differences in stem (culm) height for any fertilization treatment (data not shown). Unlike certain other grasses, the stems and seedheads of tufted hairgrass did not lodge, even at the highest fertilization rates.

Table 3. Foliage and stem (fertile tiller) abundance of Willamette Germplasm tufted hairgrass under 17 nitrogen fertilization treatments at the Corvallis PMC.[/1,/2]

1999				2000			
TMT	**FAB**	**TMT**	**SAB**	**TMT**	**FAB**	**TMT**	**SAB**
12	7.3 a	15	7.8 a	10	7.0 a	15	7.8 a
15	7.0 ab	12	7.5 a	15	7.0 a	7	7.5 ab
9	6.8 ab	17	7.3 a	13	6.8 ab	13	7.5 ab
10	6.8 ab	14	7.0 ab	7	6.5 ab	12	7.0 ab
11	6.8 ab	13	6.8 ab	9	6.5 ab	9	7.0 ab
13	6.8 ab	9	6.5 ab	12	6.5 ab	10	6.8 ab
14	6.8 ab	10	6.5 ab	3	6.3 abc	17	6.8 ab
17	6.5 ab	16	6.5 ab	6	6.3 abc	6	6.8 ab
16	6.3 ab	8	6.3 abc	14	6.3 abc	3	6.3 abc
8	6.0 ab	11	6.3 abc	17	6.3 abc	14	6.3 abc
3	5.8 ab	7	5.8 abc	8	5.8 abc	16	6.3 abc
7	5.8 ab	4	5.5 abc	11	5.8 abc	4	6.0 abc
6	5.5 abc	6	5.5 abc	16	5.8 abc	11	6.0 abc
4	5.0 abcd	3	5.3 abc	4	5.5 abc	8	6.0 abc
5	4.8 bcd	5	4.5 bcd	5	5.5 abc	2	5.3 abc
2	3.3 cd	2	3.8 cd	2	4.8 bc	5	5.0 bc
1	3.0 d	1	2.5 d	1	4.3 c	1	3.8 c

[/1] Means with the same letter are not significantly different (Tukey HSD [P=0.05]).
[/2] TMT=treatment, FAB =Foliage abundance, SAB=stem abundance. FAB and SAB based on visual score of 1-10 (10=highest).

The combined three year average seed yield for each nitrogen fertilization treatment is shown in Figure 2. While the merged data like the annual data is not conclusive, it reveals additional significant differences (P=.05) among treatments and suggests certain trends when ranked. Of the top seven treatments (those resulting in seed yields of 250 lb/acre or more), six were fertilized in February, either with a single application of

100 lb N/acre (treatment 9) or an application of 50 lb N/acre in combination with 25, 50, or 75 lb N/acre applied on one or two other dates (treatments 6, 12, 13, 15 and 16). In contrast, fertilization in March or April without a February component generally yielded less regardless of rate. Total rate was also important, as a single February application of 50 lb N/acre ranked 10th among 17 treatments.

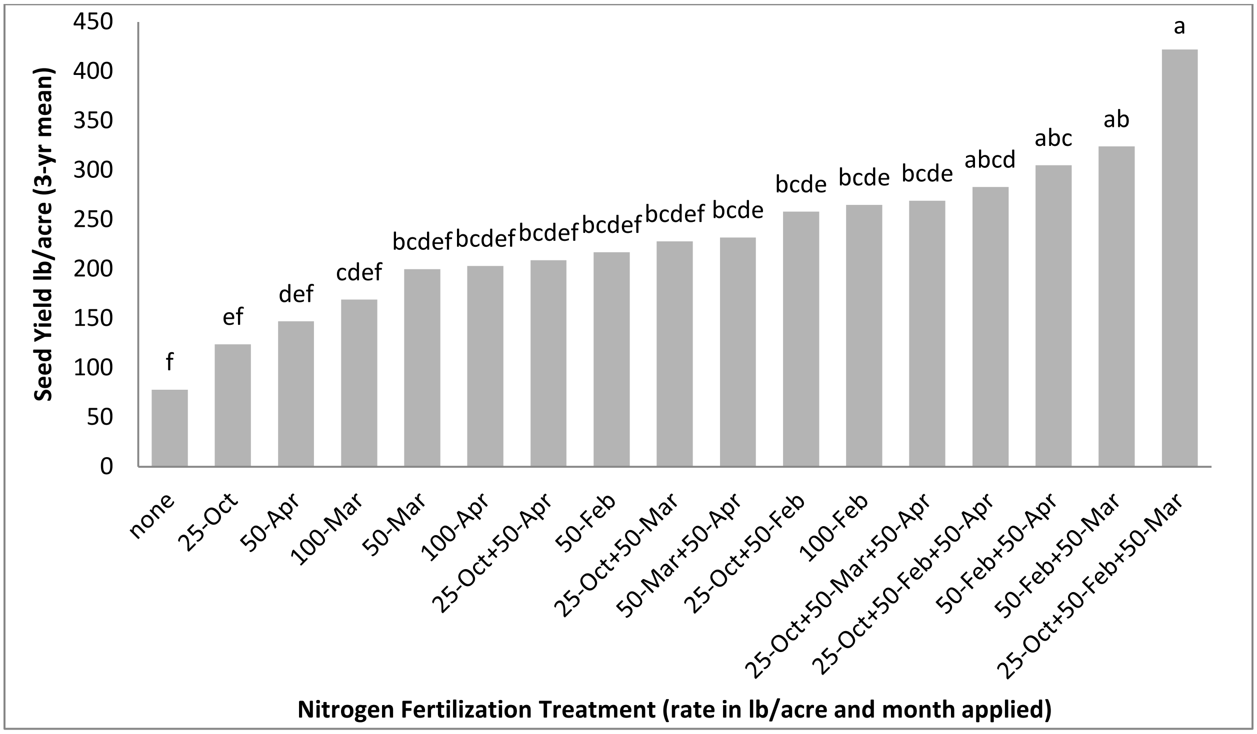


Figure 2. Three year average seed production of Willamette Germplasm tufted hairgrass under 17 nitrogen fertilization treatments (columns with the same letters are not significantly different at P=0.05, Tukey HSD).

Conclusions

Trends in the data suggest that for the highest seed yields of Willamette Germplasm or similar populations of tufted hairgrass, fields should be fertilized annually at the rate of 100-125 lb N/acre with at least 50 lb of the total amount applied in February. Split applications, especially 50 lb N/acre in February and 50 lb N/acre in March, appear to be as good as or better than a single spring application of 100 lb N/acre in February. March and April only applications of 50 to 100 lb N/acre appear ill-timed or insufficient. An October application of 25 lb N/acre in combination with one or more spring N applications appears optional, since similar yields were obtained without this fall component.

Literature cited

Darris, D., and S. Lambert. 2001. Fact sheet on Willamette germplasm tufted hairgrass. USDA Natural Resources Conservation Service, Corvallis, OR.

Darris, D., S. Lambert, and W. Young III. 1995. Seed production of tufted hairgrass. Plant Materials Technical Note 16. USDA Natural Resources Conservation Service, Portland, OR.

Darris, D., and M. Stannard. 1997. The effect of row spacing on yield of tufted hairgrass. In: William Young III (editor), 1996 seed production research at Oregon State University, USDA-ARS cooperating. Dep. of Crop and Soil Science, Oregon State Univ., Corvallis.

Doerge, T., H. Gardner, T.L. Jackson, and H. Youngberg. 2000 (reprint). Fertilizer guide – orchard grass seed (western Oregon – west of Cascades). FG 45. Oregon State Extension Service, Corvallis, OR.

Gingrich, G.A., J.M. Hart, D.A. Horneck, W.C. Young III, and T.A. Silberstein. 2003 (revised). Fertilizer guide – fine fescue seed (western Oregon – west of Cascades). FG 6-E. Oregon State Extension Service, Corvallis, OR.

Hart, J.M., M.E. Mellbye, D.A. Horneck, G.A. Gingrich, W.C. Young III, and T.A. Silberstein. 2005 (revised). Fertilizer guide – tall fescue grown for seed (western Oregon). FG-36E. Oregon State Extension Service, Corvallis, OR.

Acknowledgements

The author wishes to thank Nan Scott, former instructor in the Crop and Soil Science Department at Oregon State University, for contributing the experimental design of this study.

Ability of Camas (*Camassia* spp.) to Establish from Seed in a Wetland under Two Hydrologic Conditions Following Different Site Preparation and Planting Treatments

Study no. 50-caqu-es (1998–2007)

Dale Darris and Steve Northway[1]

[1]Corvallis Chapter, Native Plant Society of Oregon

Introduction

When successful, establishing native herbaceous plants from seed in order to enhance or restore wetlands is more cost effective than using live plants. This should be true of camas (*Camassia* spp.) as well. The genus is an important wetland species and cultural food source for indigenous people of the Pacific Northwest. Camas perennates from a lily like, laminate bulb but can also produces a reliable seed crop once it reaches flowering age (at least four years old). However, direct seeding of seasonal wetlands has sometimes met with failure. Therefore, this study was undertaken to compare different site treatments that might improve camas establishment when direct seeded. More specifically, the purpose of this study was to evaluate the establishment of *Camassia* spp. from seed in a seasonal wetland according to the effect of (1) three site preparation methods: burning, mowing, and tilling, (2) two soil hydrologic conditions: a higher zone versus lower, wetter zone, and (3) several planting methods, including simple surface sowing, raking in the seed, initial weed control with glyphosate, and mulching with one or more different materials. A total of six allied experiments were seeded simultaneously in 1998 at the same location and monitored through 2007. The study was planned and installed with the assistance of the Corvallis Chapter of the Native Plant Society of Oregon.

Methods and Materials

Seed of one population of *Camassia quamash* (common or small camas, accession 9056362, collected 6/31/98 near Crystal Lake Drive in Corvallis, Benton Co., OR) and one population of *Camassia leichtlinii* (great or large camas, accession 9056365, collected 7/2/98 along Muddy Creek, Benton Co., OR) were assembled for this study. The study site was a 0.5-acre area within Mary's River Park and Nature Preserve (73.86 acres) near Brooklane Drive in Corvallis, Benton Co., OR (44°32.14' N lat, 123°17.25' W long). The Park is a floodplain and wetland enrolled in the NRCS Wetland Reserve Program. It is owned and managed by the City of Corvallis, Parks and Recreation Department. Restoration goals were to establish a wet prairie community with vernal pool and marsh inclusions, as well as areas of forested wetland and riparian zones.

The study area near the center of the Park was subdivided into two distinct plant communities and hydrologic zones: a "high" zone situated 10-20 cm (4-8 inches) higher in elevation and dominated by upland and facultative plants (annual ryegrass, velvet grass, bluegrass, broadleaf weeds), and a “low”, wetter zone (that often remained ponded into April) dominated by facultative wetland plants, especially tufted hairgrass (Figure 1). A duplicate experiment was conducted in each zone. The area is mapped as a moderately well-drained Coburg silty clay loam. However, the study area, particularly the low zone, may well be an inclusion of Waldo, a poorly drained silty clay loam, or it may be the site of a perched water table. The low zone also appears to function as a very shallow waterway across the floodplain, Park, and study area.

Three separate site preparation treatments were applied to the study area in September 1998: 1) rotary mowing existing grasses and broadleaf weeds to a 5 cm (2 inch) height, 2) rototilling and harrowing the soil to create level, smooth bare ground, and 3) open field burning the existing plant community (Figure 1). These treatments were not replicated or randomized, so each area was dealt with as a separate experiment. A fourth area of untreated high and low zones was used for demonstration as a “control”. The prescribed fire for the burn site preparation area was conducted by the Corvallis Fire Department with assistance from the Oregon Department of Forestry (Figure 2).

Within each site preparation treatment, one square meter plots were broadcast seeded with camas between September 21 and October 2, 1998. Planting was done in the fall in order to overcome physiological seed dormancy and allow for typical late winter germination. All plots were sown at the rate of 215 live seeds per square meter (20 live seeds per square foot). For demonstration purposes only, plots in the untreated “control” area were broadcast sown at the rate of 215 and 645 live seeds per square meter (20 and 60 seeds per square foot). Common camas was used for the main body of the study. Finally, a few additional plots in each area and zone were sown with great camas for demonstration.

Four methods of planting (experimental treatments) were used in the mowed and burned areas: 1) broadcasting the seed on the surface, 2) raking the seed into the soil with a garden rake, 3) raking the seed into the soil then mulching the surface with 1.5 tons/acre of tufted hairgrass straw mulch, and 4) spraying glyphosate herbicide then raking the seed into the soil. A fifth method (5), surface seeding without raking then mulching with tufted hairgrass straw, was used for the burned area.

Planting methods for the tilled site preparation area included the previous five plus four additional experimental treatments: 6) surface seeding then applying coir fabric, 7) surface seeding then applying woven straw blanket, 8) spraying glyphosate herbicide then surface sowing, and 9) spraying glyphosate herbicide, surface sowing, then mulching with tufted hairgrass straw. Plans to mow plots in late fall (post planting) for initial weed suppression in 1998 (in all 3 site preparation areas), and hand weed other plots (annually in the tilled area only) as additional treatments were cancelled, resulting in twice the number of replications of some treatments.

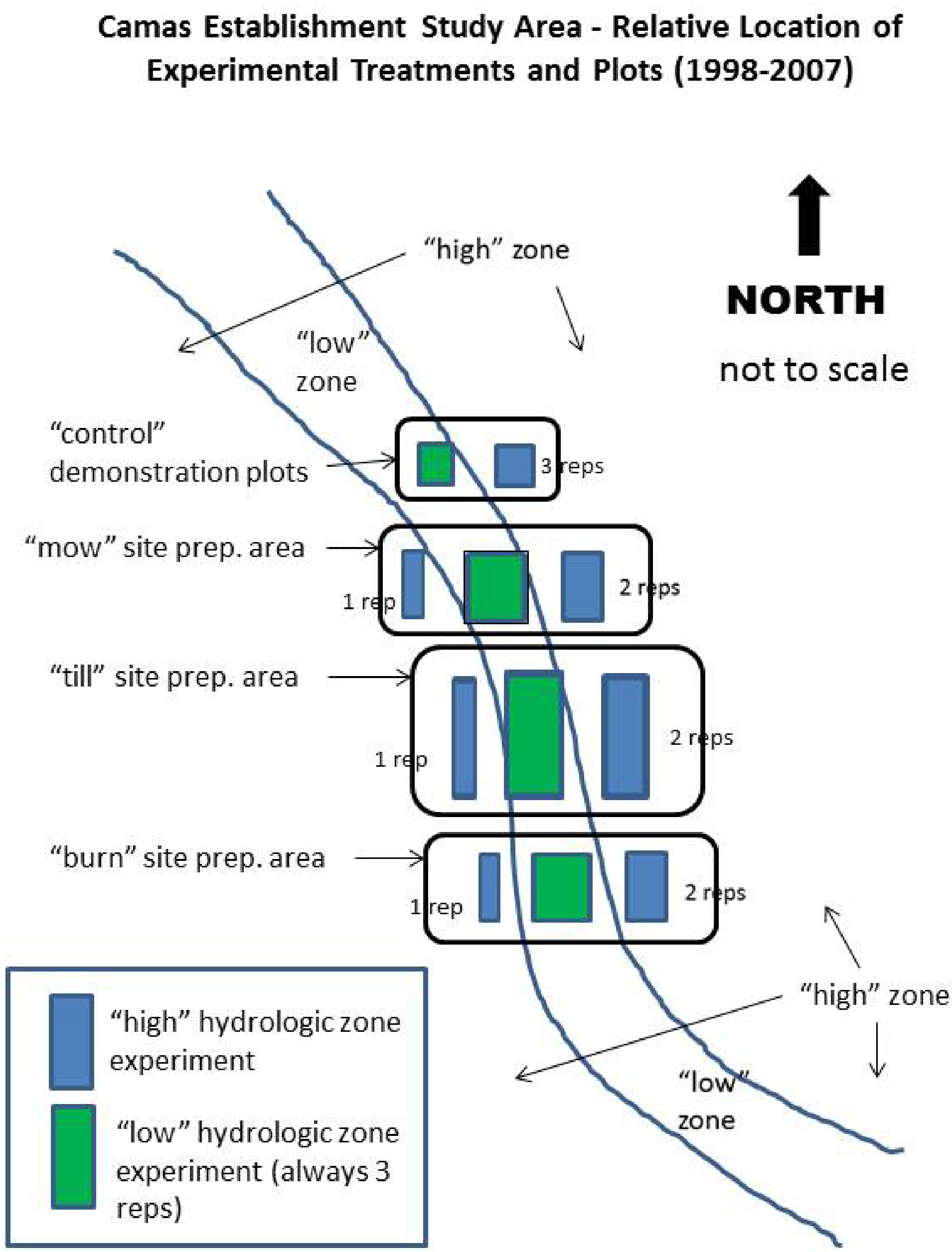


Figure 1. General layout of mow, till and burn site preparation areas as well as control demonstration area at the Mary's River Nature Preserve, Corvallis, OR. Each area was subdivided into a "high" hydrologic zone and a "low" hydrologic zone. One experiment was conducted within each zone.

Experimental design was a randomized complete block with 3 replications. A total of 6 experiments were conducted simultaneously, not including the control site: 3 site preparation treatments (burn, mow, till) times 2 hydrologic conditions (high zone and low zone) (Figure 1).

Figure 2. Burned site preparation area in October 1998, about one month after camas plots were sown. The lower hydrologic zone experiment is in the center and the higher hydrologic zone experiment is in the upper right.

Data collection included camas plants per square meter (plant density), camas foliage height, weed competition score, mulch/ plant residue abundance score, and rodent (vole) damage score. Scoring was on a scale of 1 (least) to 10 (most). Data were collected annually in April or May from 1999 through 2005, with a final data set collected in 2007. However, rodent damage was only recorded in 2001, 2002, and 2004. To determine plant density from 1999 to 2001, a random, 0.19 m^2 (2 ft^2) area within each plot was sampled. From 2002 to 2007, the entire area of each plot (1 m^2) was sampled.

Results and Discussion

Common camas establishment data (density in plants/m^2) for the burn, mow, and till site preparation treatments in 1999, 2002, and 2007 are shown in Tables 1 through 6. Each treatment area was subdivided into separate experiments for the High and Low hydrologic zones. Camas density data for the “control” area in 1999, 2002, and 2005 is presented in Table 7. Rodent damage to camas for 2002 is shown in Table 8. All visual scoring data for mulch/plant residue and weed competition are not reported. Likewise, data from the minor number of great camas demonstration plots sown are not presented.

Table 1. Camas establishment response to 5 planting methods: Burn Site – High Zone

Treatment	**Plants/m^2 1999**	**Plants/m^2 2002**	**Plants/m^2 2007**
Seed	48	18	18
Seed+Rake	40	23	18
Seed+Rake+Mulch	93	34	17
Seed+Mulch	81	27	18
Glyphosate+Seed+Rake	52	17	9
ANOVA F value	0.60	1.02	0.86
ANOVA P value	0.67 (NS)	0.44 (NS)	0.52 (NS)

Table 2. Camas establishment response to 5 planting methods: Burn Site – Low Zone

Treatment	**Plants/m^2 1999**	**Plants/m^2 2002**	**Plants/m^2 2007**
Seed	41	6	0
Seed+Rake	0	2	0
Seed+Rake+Mulch	18	7	0
Seed+Mulch	11	8	0
Glyphosate+Seed+Rake	30	5	0
ANOVA F value	1.31	1.03	NA
ANOVA P value	0.32 (NS)	0.43 (NS)	NA (NS)

Table 3. Camas establishment response to 4 planting methods: Mow Site – High Zone

Treatment	**Plants/m^2 1999**	**Plants/m^2 2002**	**Plants/m^2 2007**
Seed	25	26	12
Seed+Rake	59	23	13
Glyphosate+Seed+Rake	31	14	25
Seed+Rake+Mulch	32	20	11
ANOVA F value	0.82	0.67	1.72
ANOVA P value	0.51 (NS)	0.59 (NS)	0.22 (NS)

Table 4. Camas establishment response to 4 planting methods: Mow Site – Low Zone

Treatment	**Plants/m^2 1999**	**Plants/m^2 2002**	**Plants/m^2 2007**
Seed	18	7	6
Seed+Rake	28	7	1
Glyphosate+Seed+Rake	13	12	5
Seed+Rake+Mulch	20	3	3
ANOVA F value	0.37	0.82	0.92
ANOVA P value	0.77 (NS)	0.51 (NS)	0.46 (NS)

Table 5. Camas establishment response to 9 planting methods: Tilled Site – High Zone

Treatment	**Plants/m^2 1999**[/1]	**Plants/m^2 2002**	**Plants/m^2 2007**
Seed	16 c	19 a	14
Seed+Rake	38 c	18 a	14
Seed+Rake+Grass Mulch	58 c	40 a	19
Seed+Grass Mulch	61 bc	15 a	11
Seed+Coir Fabric	154 ab	14 a	19
Seed+Woven Straw Blanket	165 a	21 a	25
Glyphosate+Seed	68 bc	17 a	9
Glyphosate+Seed+Grass Mulch	34 c	18 a	10
Glyphosate+Seed+Rake	54 c	28 a	7
ANOVA F value	7.99	2.31	1.91
ANOVA P value	0.00 (S)	0.049 (S) [/2]	0.098 (NS)

[/1] Means with same letter are not significantly different (Tukey HSD, P=0.05).

[/2] Tukey HSD test did not identify any subsets of means as distinct homogenous groups (P=0.05) such as "a" versus "b" despite P value from ANOVA indicating a marginal but significant difference (P=0.049).

Table 6. Camas establishment response to 9 planting methods: Tilled Site – Low Zone

Treatment	**Plants/m^2 1999**[/1]	**Plants/m^2 2002**	**Plants/m^2 2007**
Seed	16 b	15	4
Seed+Rake	40 ab	12	3
Seed+Rake+Grass Mulch	29 ab	10	3
Seed+Grass Mulch	25 ab	12	2
Seed+Coir Fabric	86 a	16	5
Seed+Woven Straw Blanket	61 ab	23	18
Glyphosate+Seed	25 ab	10	<1
Glyphosate+Seed+Grass. Mulch	15 b	9	<1
Glyphosate+Seed+Rake	25 ab	8	2
ANOVA F value	2.74	1.15	2.24
ANOVA P value	0.02 (S)	0.36 (NS)	0.054 (NS)

[/1] Means with same letter are not significantly different (Tukey HSD, P=0.05).

For four of six experiments (Tables 1-4), there were no significant differences in camas density among planting methods (P=0.05) in any year. A typical well established plot after nine years is shown in Figure 3. Plant densities among replications for any one planting method often varied widely in each experiment. This suggests uncontrolled experimental differences occurred on a micro scale within each site preparation area and hydrologic zone. For example, vole activity differed among plot replications annually and over time, as did the composition of competing vegetation which was initially more uniform. The reason for the nearly complete failure of the “seed+rake” planting method in burn area, Low Zone is unknown (Table 2).

Figure 1. Well established plot of common camas in the “High” hydrologic zone within the mowed site preparation area. The planting method was “seed+rake+mulch”. Photo from May 2008.

Only the two experiments in the tilled site preparation area showed any significant differences (P=0.05) among planting methods (Tables 5 & 6). The use of a woven straw blanket and coir fabric ranked as the top two treatments for camas establishment one year after seeding (1999) in both the High and Low Zones. However, plant density for these two treatments was not significantly higher than certain other planting methods and all significant differences disappeared by 2002. In 2007, the treatment using the woven straw blanket again ranked highest in plant density in both the High and Low Zones. While the improvement was not significant compared to all other planting methods (P=0.054), survival by 2007 was still more than three times higher than the second highest method (18 plants/m^2 vs. 5 plants/m^2 for the coir fabric) in the tilled Low Zone (Table 6), suggesting this method may still be useful on more flood prone or erodible sites.

Since each site preparation treatment (burn, mow and till) was analyzed as a separate experiment, direct comparisons based on statistical analysis cannot be made. Nevertheless, there does not appear to be any trends in the data to suggest that one of the three site preparation treatments improved establishment and survival of camas over any another, even when similar planting methods are considered. Regardless of which of the three site preparation methods was used, simple surface sowing appeared to be just as effective in establishing camas as was shallow incorporation of the seed by raking, mulching with grass straw, or applying glyphosate for additional weed control prior to planting.

Camas also established by broadcasting seed into standing, untreated, live vegetation (Table 7, “control” plots). Surprisingly, there were no significant differences between the two seeding rates (P=0.05). In comparison to the areas with site preparation, plant density was in the low range using the standard experimental seeding rate of 215 seeds per square meter. By 2005, survival in the control area High Zone was already well below the final survival in the High Zones of either the mowed, tilled, or burned site preparation areas, suggesting some initial, pre-planting suppression of existing vegetation may be useful.

Table 7. Camas establishment using 2 seeding rates in untreated high and low “control” zones

Treatment	**Plants/m^2 1999**	**Plants/m^2 2002**	**Plants/m^2 2005**[/1]
215 seeds/m2, High Zone	13	24	3
645 seeds/m2, High Zone	31	40	4
ANOVA F value	0.89	1.67	0.16
ANOVA P value	0.45 (NS)	0.33 (NS)	0.76 (NS)
215 seeds/m2, Low Zone	9	3	<1
645 seeds/m2, Low Zone	7	20	3
ANOVA F value	0.18	9.84	0.43
ANOVA P value	0.71 (NS)	0.088 (NS)	0.58 (NS)

[/1] Plot markers were missing in part of the control area after 2005; therefore 2007 data were not available.

For all six experiments and the “control” demonstration plots, camas stand density typically declined over the eight year period, as expected. Ongoing mortality could have resulted from a number of common factors such as inter- and intra-plant species competition, lack of soil adaptation, diseases, insects, and predation by animals. Nearly every spring during the nine years of monitoring, foliage damage (camas leaves clipped off, presumably from foraging voles) was commonly observed, most notably in the High Zone plots. The pattern of rodent damage in 2002 (Table 8) was typical. Repeated defoliation over time may also have contributed to declining survival.

In a few experimental cases, stand density temporarily increased over time (for example, Table 2 “seed+rake”, Table 3 “seed”, and Table 3 “glyphosate+seed+rake).

These anomalies may have resulted from the change in sampling method (subplot counts in 1999 to whole plot in 2002 and 2007), delayed emergence due to prolonged dormancy in some seeds, severe defoliation of plants that consequently went undetected one year but not the next, natural regeneration (by 2004 some camas were flowering and producing seed), or other factors. Likewise, plant density increased in the control demonstration plots in three of four cases from 1999 to 2002 (Table 7.), probably for similar reasons. Additionally, some camas seedlings may have been obscured in 1999 by taller preexisting vegetation in this untreated area, but later became visible with age.

Table 8. Rodent (vole) damage to camas recorded April 2002 according to High and Low hydrologic zones within each site preparation area (burn, mow, till).[/1]

	Burn Area Vole Damage		Mow Area Vole Damage		Till Area Vole Damage	
Treatment	**High**	**Low**	**High**	**Low**	**High**	**Low**
Seed	3.0	1.0	4.7	1.3	5.2	1.2
Seed+Rake	3.3	1.0	4.7	2.0	5.7	1.3
Seed+Rake+Grass Mulch	3.0	1.3	4.8	2.0	5.2	1.5
Glyphosate+Seed+Rake	3.0	1.0	4.0	1.7	4.3	1.3
Seed+Grass Mulch	3.0	1.0	-	-	5.3	1.3
Seed+Coir Fabric	-	-	-	-	4.7	1.0
Seed+Woven Straw Blanket	-	-	-	-	4.3	1.0
Glyphosate+Seed	-	-	-	-	5.0	1.3
Glyphosate+Seed+Grass Mulch	-	-	-	-	4.5	1.5
ANOVA F value	0.14	1.37	0.23	1.56	0.84	0.58
ANOVA P value	0.97 (NS)	0.31 (NS)	0.87 (NS)	0.25 (NS)	0.56 (NS)	0.78 (NS)

[/1] Data based on visual ratings using a scale of 1-10 (10=highest).

In general across the three site preparation areas and control area, initial and final plant densities were lower in the Low Zone compared to the High Zone. This was despite less rodent damage in the Low Zone (Table 8). Conditions in the Low Zone were apparently less suitable for the tunneling and foraging activity of voles compared to the High Zone. Since the Low Zone functions as a shallow waterway, lower initial establishment of camas in 1999 may have been caused by a substantial flood during the first winter. Flowing water could have dislodged more camas seed or emerging seedlings in Low Zone plots compared to High Zone plots. Furthermore, prolonged standing water (often into April) and anoxic conditions associated with poor soil drainage in the Low Zone may also have contributed to higher mortality compared to the High Zone. However, the level of tolerance of camas to similar prolonged wet or anoxic conditions is not precisely defined. Even though the elevation difference between the High and Low Hydrologic Zones was only a matter of 10-20 cm (4-8 inches), its influence on the composition of the preexisting plant communities and final camas populations appeared to be an important factor.

Conclusions

The results of these experiments suggest some initial suppression of existing vegetation as part of site preparation such as mowing, tilling, or burning, may be warranted prior to broadcast seeding camas on a seasonal wetland. However once accomplished, simply surface sowing camas in the fall can be just as effective in establishment as shallow incorporation of the seed, applying straw mulch, or initially controlling vegetation with glyphosate. As an exception, the use of mulch similar to or the same as the woven straw blanket used in this study may be advisable on more flood prone, erosive sites, especially on tilled ground. Results reaffirm how minor differences in elevation within a wetland (in this case 10-20 cm) can have an important influence on a species establishment and survival. Further experimentation under more uniform and controlled environmental conditions with greater replication may be helpful in ascertaining clearer differences among treatments.

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Mass selection of sand fescue (*Festuca ammobia*) for low maintenance turf and perennial cover (study no. ORPMC-P-0907-UR)

Dale Darris

Introduction

Traditional lawn management requires significant chemical inputs, irrigation, equipment use, and labor (VanDerZanden and Cook, 2000) sometimes leading to unwanted off-site effects, such as fertilizer and pesticide runoff into streams. Therefore, in order to reduce the cost of turf maintenance and diminish potential negative environmental impacts, interest in the testing and development of low input sustainable turf has increased. The target use is home lawns, parks, industrial and residential greenways, schools, highway right-of-ways, and golf course roughs. The goal of research is to identify and breed grasses that provide reasonably good turf quality under conditions of limited or no supplemental water, no fertilizer, and no pesticides following establishment. Turf quality is commonly defined by a species' persistence and uniformity, as well as by the amount of disease and insect damage, color, and turf density under reduced mowing (Watkins et al., 2011). Weed suppression or exclusion should also be considered. Such qualities can complement the use of a turf grass as perennial cover in sustainable agricultural systems including vineyards, orchards, and berry farms.

Recent research at Midwest universities has identified the best grasses at present for low-input turf in that region. They are hard fescue, tall fescue, sheep fescue and colonial bentgrass. Possible future options include tufted hairgrass, hybrid bluegrass, blue grama, and prairie junegrass (Watkins et al., 2011). While a number of these species have potential in western Oregon and western Washington, there are significant climatic and soil differences between the Midwest USA and Pacific Northwest requiring localized testing and variety development. While most low-input turf plantings are monocultures of grass, work at Oregon State University has focused on eco-lawns comprised of a mixture of less competitive grasses and lower growing broadleaf species such as strawberry clover, yarrow, and English lawn daisy (Cook, 2005; Savonen and Cook, 2003). Surprisingly, Cook (2005) considers perennial ryegrass and Kentucky bluegrass, both species with high nitrogen requirements, as the best choices for eco-lawns because they compete less with the broadleaves in the mix. "Grasses with low fertility requirements tend to out-compete the broadleaf plants." In this scenario, the poorest choices are chewings fescue and bentgrass. Another option for low input turf is the no-mow lawn. In some states like California, introduced fine fescues (creeping red, chewings, hard, and sheep fescues) are being promoted and used for no-mow grassy cover. Differences in cultivar performance within each species are apparent (Harivandi, 2010).

Among the grasses adapted to western Oregon with potential for use as low-input sustainable turf are the introduced fine fescues, as well as native Roemer's, red, Idaho, and sand fescues. In particular, sand fescue (*Festuca ammobia*) has a combination of characteristics which give it higher potential for such use. As a species that spreads slowly from short rhizomes, it may fill in to produce a more uniform continuous sod, unlike bunch-type fine fescues which can have a clumpy, uneven appearance. Some specimens of sand fescue have short seedheads (culms at or below foliage height or less than 10 inches) suggesting selection potential for a short "no mow" population (Figure 1). Shorter culms may also be less likely to lodge.

Figure 1. Blue-green sand fescue plant with seedheads at and below foliage height.

Leaf color in sand fescue may be important characteristic for selection because it may be related to drought tolerance. While sand fescue in Oregon is almost entirely green in winter, foliage color varies from green to powder blue or blue-grey in summer. This seasonal color change appears due in part to a greater buildup of a white waxy coating or bloom on the leaves and stems of some plants compared to others (Darris, per. obs.). Also known as glaucousness, it may be indicative of a thicker or more reflective layer of wax over the cuticle, traits which in turn have been implicated in reduced transpiration, lessened heat stress, or greater drought resistance in some varieties of species (Sáncheza et al., 2001; Saneoka and Ogata, 1987). According to Qariani, et al. (2000) “glaucousness is a trait that may be useful to improve WUE (water use efficiency) in dryland conditions and it would be worthwhile to screen plants for this trait.”

Sand fescue is endemic to coastal areas of Oregon, Washington, and California, but may be adapted to adjacent climatic zones in the Pacific Northwest and northern California with cool wet winters and warm, dry summers. Sand fescue tolerates many soil types besides sands, including silty clay loams with low fertility. Coastal types have presumed tolerance to salt spray and preference for moderately acidic to neutral, well- to moderately well-drained soils. Drought tolerance may exceed that of other closely related red fescues (Darris, 2011), but remains to be tested. The cultivar ‘Molate Blue’, a natural blue form of sand fescue selected from a population near San Francisco, is already in use as low-input turf in California. While several other populations of this species are under commercial seed increase, none appear to be highly selected or bred, at least not specifically for use in western Oregon and western Washington.

Sand fescue is presumed to be a highly cross-pollinated species similar to the closely allied red fescues. Therefore, genetic improvement should be possible through simple mass selection or recurrent phenotypic selection. The purpose of this study was to improve a highly diverse sand fescue population originating from coastal Oregon by conducting several cycles of mass selection according to the phenotypic performance of each generation. Criteria for selection included low levels of leaf and stem rusts (*Puccinea* spp.), short culm height, and blue-grey foliage color for possibly greater drought tolerance, as well as aesthetic value.

Methods and Materials

Sand fescue accession 9079450 was used as the starting population for mass selection. It was comprised of a bulk mixture of several populations collected as seed in 2006 from meadows along the immediate Oregon coastline from Yachats to Florence in Lane County. An original G1 (F0) seed increase field (PMC field 7-8) made up of individually spaced plants of this accession was used for initial selection in June 2007. All 630 plants in the field were visually scored for leaf rust, blue color, and foliage abundance on a scale of 1 (least) to 10 (most). Of these, 51 plants were selected based on a rust score of 2 or less and a blue color score of 8 or more. Mean rust and color scores for all plants were 4.2 and 3.4 respectively (data not shown). Foliage abundance was not used as a deciding factor in the selection.

In March 2008, the 51 (F0) select parent plants were vegetatively transplanted to field 2-2 at the OSU Hyslop Field Research Laboratory in order to establish an isolated crossing block. Plants flowered in May 2008. Seed collected off each plant in July 2008 was bulked and used to grow approximately 500 seedlings. The seedlings were subsequently transplanted into field 2-2 in November 2008 to form the F1 generation (identified as accession 9109122). During 2009 the original 51 F0 parents were removed to prevent backcrossing. Approximately 25% of the F1 plants were rogued out in August 2009 if they were green in color, had more leaf rust, or both. The F1 plants remained vegetative in 2009. During stem elongation and early panicle emergence (April), but prior to anthesis in 2010, an additional 10% of the plants were rouged out for having visual signs of stem rust, taller culms, or both. By the end of May 2010 the remaining plants all flowered and were allowed to freely cross-pollinate. Seed was harvested from each plant in July 2010.

The remaining F1 plants were divided into three groups: accession 9109123 with low rust and "late" maturity, accession 910124 with low rust and "average" maturity, and 9109125 with moderate rust and "average" maturity. Seed collected from each plant within each group was bulked and the three selections were directly sown in October 2010 in separate isolated fields at the PMC (field 2-2 [0.04 acre], field 6-13 [0.08 acre], and field 5-1 [0.04 acre], respectively) to form three F2 populations (Figure 2). Seeding rate was 1.5 pounds per acre. Spacing was 12 inches between rows and plants were thinned to a 6-12 inch spacing within row so that individual specimens could be observed. Each field remained vegetative in 2011. In September of 2011 approximately 25% of the plants in each field were rogued using the same criteria as the F1: plants with green foliage, moderate to high rust infection, or both, were removed. A final rogueing of an additional 10% of the plants in each field occurred in April 2012 prior to anthesis in order to eliminate plants with taller culms or higher levels of stem rust. F1 plants were removed from Field 2-2 prior to anthesis in order to prevent the F2 from backcrossing.

In May 2012 all plants within each field flowered and were allowed to randomly cross-pollinate. By mid-July 2012 seed was harvested from each of the three fields using a flail-vac seed stripper. Observations suggested that differences in rust levels and seed maturity dates among the three F2 populations were minor. Therefore, all three seed harvests were bulked together and the single seed lot assigned a new accession (9109152). Grow out of plants from this lot constitute the F3 generation.

Results and Discussion

Apparent progress toward increasing alleles for blue-grey foliage color was evidenced through visual inspection of the sand fescue plants after each cycle of selection. The frequency of powder blue and blue-grey plants appeared to increase from the F0 to the F1 generation and from the F1 to the F2 generation. Selection for blue color had to be done in August-September when the white waxy coating (bloom) was fully developed on the foliage. Blue-grey and powder blue plants of sand fescue were favored for ornamental reasons and for the possible greater drought tolerance the white-waxy coating may impart.

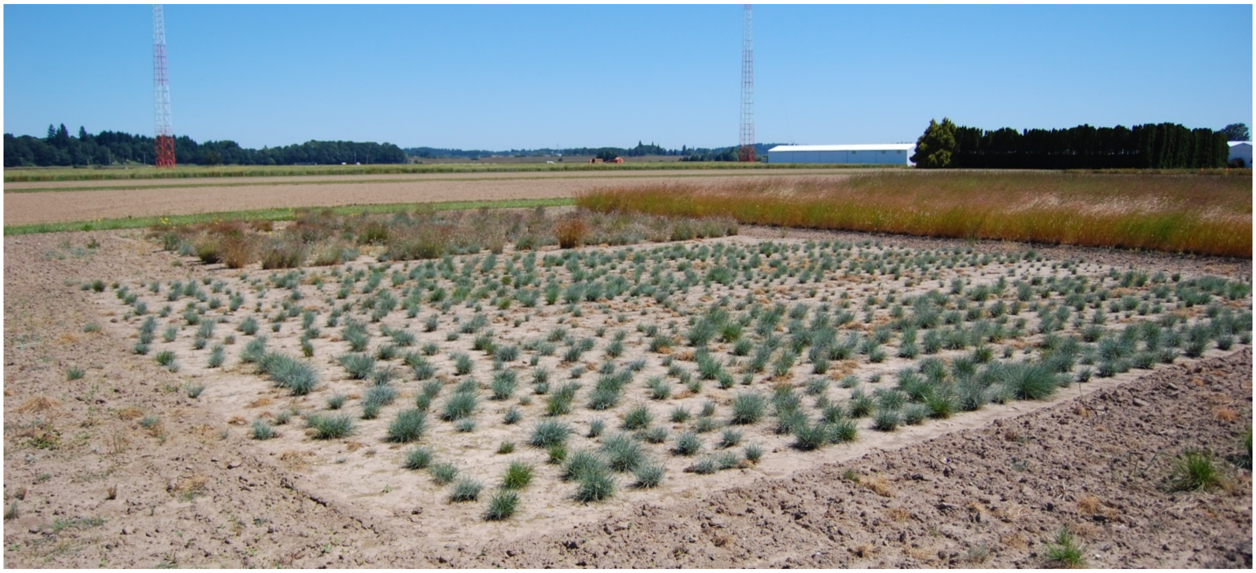


Figure 2. F2 selection and crossing block of sand fescue in 2011 (PMC-Hyslop Farm field 2-2). Approximately 25% of the plants have been rogued out. Plants did not flower until May of 2012.

While leaf rust appeared to be less prevalent in the F1 compared to the F0, no similar reduction was observable in the F2 compared to the F1. Without manual inoculation of each plant with rust, observed differences in infection levels may simply be the result of random chance. Also, differences between two generations may be the result of differences in climate or spore abundance from one year to the next. Therefore, no improvement in leaf or stem rust resistance can be inferred without additional study.

Other qualities of turf were not used as selection criteria in this study. Given the short duration of each selection cycle (1½ growing seasons), persistence and rate of rhizome spread were not assessed.

The seed of sand fescue was suited to harvesting with a flail-vac seed stripper. Total bulk seed for 9109152 for the three fields combined was 33 pounds and the total area harvested was 0.16 acre. Therefore, the yield was 206 pounds per acre in 2012. Substantially higher yields may be expected under production conditions that eliminate the large gaps found between plants in the three fields. Due to the sparse number of plants in field 5-1, this field was removed after seed harvest in 2012. Fields 2-2 and 6-13 remain intact.

Future Work

It is suggested that both fields (2-2 and 6-13) of 9109152 sand fescue remain in production and the seed be used for both low input sustainable turf trials and perennial cover crop trials in comparison with other grass species/cultivars. Other qualities of turf such as persistence under various types of low-input management, density, rate of spread by rhizomes, and weed exclusion should be evaluated. Achieving low culm height and eliminating all progeny with green foliage may require additional cycles of selection of sand fescue. One study with sand fescue conducted at the PMC indicated that a single mowing in September at 1½ to 2½ inches in height can substantially injure the crown. Anecdotal observations from seed increase fields that have been flail mowed after harvest suggest the same. Therefore, tolerance to different frequency, dates, and heights of mowing needs further study. Despite the sensitivity to low mowing, higher mowing heights or "no-mow" turf could still be viable management options without further breeding of sand fescue.

Literature Cited

Cook, T. 2005. Low maintenance turf? Oregon State Univ., Corvallis, OR. http://horticulture.oregonstate.edu/node/587

Darris, D. 2011. Plant fact sheet for sand fescue (*Festuca ammobia*). USDA Natural Resources Conservation Service, Corvallis, OR.

Harivandi, A. 2010. No-mow fineleaf fescue grasses for California urban landscapes. Publication 8391. Univ. of California, Oakland.

Qariani L., El Jaafari, M. Dekkaki, and J.L. Araus. 2000. Cuticular conductance, water use efficiency and drought tolerance of durum wheat isolines of differing glaucousness. Durum wheat improvement in the Mediterranean region: new challenges. Opt. Méditerr. A - Sém. Méditerr. 40:315-318.

Sáncheza, F.J., M. Manzanaresa, E.F. de Andrésa, J.L. Tenoriob, and L. Ayerbe. 2001. Residual transpiration rate, epicuticular wax load and leaf color of pea plants in drought conditions. Influence on harvest index and canopy temperature. Euro. J. Agron. 15(1):57-70.

Saneoka, H., and S. Ogata. 1987. Relationship between water use efficiency and cuticular wax deposition in warm season forage crops grown under water deficit conditions. Soil Sci. Plant Nutr. 33(3):439–448.

Savonen, C., and T. Cook. 2003. Ecolawns require less fertilizer, water and weed control. Oregon State Univ. Extension Serv. http://extension.oregonstate.edu/gardening/node/543 (accessed 15 Mar. 2013).

VanDerZanden, A.M., and T. Cook. 2000. Maintaining a healthy lawn in western Oregon. EC1521. Oregon State Univ. Extension Serv., Corvallis.

Watkins, E., S. Fei, D. Gardner, J. Stier, S. Bughrara, D. Li, C. Bigelow, L. Schleicher, B. Horgan, and K. Diesburg. 2011. Low-input turfgrass species for the north central United States. Appl. Turfgrass Sci. doi:10.1094/ATS-2011-0126-02-RS.

Pollinator/Insectary Forb Planting Trial

Study No. ORPMC-T-1110-WL (2010–2013)
2012 Summary prepared by Annie Young-Mathews
Cooperators: Mace Vaughan & Eric Mader, The Xerces Society

Objective

The Corvallis PMC partnered with The Xerces Society for Invertebrate Conservation (Xerces) to design and install a seeding trial of native forbs used in pollinator plantings to evaluate their establishment success and persistence in single-species and mixed-species plantings (early season, late season, and all species). Twelve species were chosen to be included in the trial based on the following criteria: readily available from commercial sources; hardy in unmanaged settings and can handle some abuse; usually covered in pollinators, especially native bees; and a mix of species that cover a range of bloom times from early to late season (Table 1).

Establishment and Maintenance

The trial is located in Field 6-1 of the PMC Schmidt Farm. It was set up as a completely randomized design (CRD) with 3 replicates of 15 treatments (12 species plus 3 mixes) for a total of 45 plots. Plots are 18 ft wide by 44 ft long, with 6 ft aisles separating all plots. Site prep prior to planting consisted of plowing and preparation of a seed bed in spring 2010, followed by treatment with a broad spectrum herbicide three times throughout the summer of 2010 to control newly germinated weeds. In early November the field was cultivated with a roterra to break the surface crust and plots were hand-sown on November 15, 2010 according to seeding rates in Tables 1 & 2. Aisles were maintained weed-free with a roterra cultivator as needed throughout the spring, summer, and fall of 2011 and 2012. The only weed control after sowing was spot treatment of Canada thistle and blackberries as needed. Half of each plot was mowed in November of 2011 (except plots containing riverbank lupine, which were not mowed since this would likely have killed the lupines) and all plots were mowed to approximately 6-inch stubble height on Nov. 5, 2012. Due to the failed establishment of the *Asclepias speciosa* plots, in early February of 2013 they were sprayed out with Glyphosate and were raked and hand sown with bluehead gilia (*Gilia capitata*) at a rate of 278 seeds/ft^2, or 9.3 lb/acre. Establishment and persistence of this annual species will be monitored in future years.

Farewell to spring plot showing fall 2011 strip mowing (left) and summer 2012 reestablishment and bloom (right).

Results

Initial establishment in 2011 was generally good for all species except showy milkweed. The biennial riverbank lupine and annual shortspur seablush and farewell to spring had the best first year stands, while the perennials had slower first year growth. The early blooming and all species mixed plots were

Table 1. *Native forb species included in PMC seeding trial, with single-species plot seeding rates.*

Plot #	Species	Common name	Willamette Valley bloom	seeds/lb	Rate (seeds/ft^2)	Rate (lb/acre)
1	*Lupinus rivularis*	riverbank lupine	Apr.–July	50,000	35	30.5
2	*Sidalcea campestris*	meadow checkerbloom	May–July	100,000	35	15.2
3	*Eriophyllum lanatum*	Oregon sunshine	May–July	1,150,000	50	1.9
4	*Prunella vulgaris* ssp. *lanceolata*	lance selfheal	Apr.–July	400,000	50	5.4
5	*Potentilla gracilis*	slender cinqefoil	June–July	1,417,500	50	1.5
6	*Asclepias speciosa*	showy milkweed	May–Aug.	72,000	35	21.2
7	*Eriogonum umbellatum*	sulphur-flower buckwheat	June–July	140,500	35	10.9
8	*Grindelia integrifolia*	Puget Sound gumweed	June–Sept.	130,000	35	11.7
9	*Symphyotrichum chilense*	Pacific aster	June–Nov.	1,300,000	50	1.7
10	*Solidago canadensis*	Canada goldenrod	July–Sept.	4,600,000	50	0.5
11	*Plectritis congesta*	shortspur seablush	Mar.–June	1,311,700	50	1.7
12	*Clarkia amoena* ssp. *lindleyi*	farewell to spring	June–Aug.	1,031,800	50	2.1

dominated by the riverbank lupine, which essentially formed a monoculture crowding out all other species (including weeds), while the late blooming mix was dominated by the farewell to spring.

In 2012, many of the perennial species showed significant growth and had good bloom, especially the lance selfheal, Oregon sunshine, Pacific aster, Canada goldenrod, and Puget Sound gumweed. Saturated soils and a late snow in April killed one riverbank lupine plot and parts of two Oregon sunshine plots, and damaged partial stands of farewell to spring and a couple of the mixed species plots. Riverbank lupine plants not damaged by the cold wet spring flowered and produced copious amounts of seed. Shortspur seablush plots had more weed competition and sparser stands in their second year, but fall mowing appeared to somewhat aide reestablishment. Farewell to spring plots responded well to fall mowing, with far more reestablishment and bloom in the mowed half of the plots (see photos below). Sulphur-flower buckwheat plants showed limited growth and their short stature allowed them to become engulfed in weeds by the end of the summer.

In October 2012, a rough visual estimation of target species and weed cover showed riverbank lupine to be the unquestionable winner for persistence and competition with weeds (Table 3). Lance selfheal, Pacific aster, and Puget Sound gumweed also had good cover, averaging over 60%, with fairly good weed suppression. The mixes containing riverbank lupine had the best target species cover and lowest percentages of weeds, and although the riverbank lupine was dominant, other seeded species were observed and may show more growth and establishment in 2013 as the biennial lupines die and reseed.

Table 2. *Seeding rates for the three native forb mixes included in the PMC seeding trial.*

Plot #	Common name	seeds/lb	Rate (seeds/ft^2)	Rate (lb/acre)
Early to mid-season blooming mix				
13	riverbank lupine	50,000	3	2.6
13	meadow checkerbloom	100,000	5	2.2
13	Oregon sunshine	1,150,000	7	0.3
13	lance selfheal	400,000	7	0.8
13	slender cinqefoil	1,417,500	7	0.2
13	shortspur seablush	1,311,700	20	0.7
		Total:	49	6.7
Mid- to late-season blooming mix				
14	showy milkweed	72,000	7	4.2
14	sulphur-flower buckwheat	140,500	7	2.2
14	Puget Sound gumweed	130,000	7	2.3
14	Pacific aster	1,300,000	7	0.2
14	Canada goldenrod	4,600,000	7	0.1
14	farewell to spring	1,031,800	7	0.3
		Total:	42	9.3
All species mix				
15	riverbank lupine	50,000	3	2.6
15	meadow checkerbloom	100,000	3	1.3
15	Oregon sunshine	1,150,000	3	0.1
15	lance selfheal	400,000	3	0.3
15	slender cinqefoil	1,417,500	3	0.1
15	showy milkweed	72,000	3	1.8
15	sulphur-flower buckwheat	140,500	3	0.9
15	Puget Sound gumweed	130,000	3	1.0
15	Pacific aster	1,300,000	3	0.1
15	Canada goldenrod	4,600,000	3	0.0
15	shortspur seablush	1,311,700	3	0.1
15	farewell to spring	1,031,800	3	0.1
		Total:	36	8.6

Table 3. *Average cover of target species and weeds in 3 replicated plots at the Corvallis PMC, determined in October, 2012 (two years after planting).*

Species	Species code	Species cover	Weed cover	Dominant Weed(s)
Lupinus rivularis, riverbank lupine	LURI	95%*	<5%	fluvellin, willowherb
Prunella vulgaris ssp. *lanceolata*, lance selfheal	PRVU	82%	35%	bird's-foot trefoil (cat's ear)
Symphyotrichum chilense var. *chilense*, Pacific aster	SYCH	80%	38%	cat's ear, willowherb, annual bluegrass
Grindelia integrifolia, Puget Sound gumweed	GRIN	63%	58%	cat's ear, annual bluegrass, willowherb
Solidago canadensis, Canada goldenrod	SOCA	39%	80%	cat's ear (willowherb)
Clarkia amoena, farewell to spring	CLAM	32%	78%	bird's-foot trefoil (cat's ear, willowherb)
Eriophyllum lanatum, Oregon sunshine	ERLA	32%	>100%	bird's-foot trefoil (willowherb)
Sidalcea campestris, meadow checkerbloom	SICA	8%	>100%	cat's ear, willowherb
Potentilla gracilis, slender cinquefoil	POGR	4%	>100%	cat's ear, willowherb (annual bluegrass, bird's-foot trefoil)
Plectritis congesta, shortspur seablush	PLCO	#	>100%	cat's ear (bird's-foot trefoil, willowherb)
Eriogonum umbellatum, sulphur-flower buckwheat	ERUM	<1%	>100%	bird's-foot trefoil, cat's ear, willowherb, annual bluegrass
Asclepias speciosa, showy milkweed	ASSP	<1%	>100%	bird's-foot trefoil, cat's ear, willowherb
Early-mid season mix	67% LURI, 2% PRVU, 2% SICA, 2% ERLA, 1% CLAM, <1% SYCH & SOCA		35%	bird's-foot trefoil (willowherb, prickly lettuce)
Mid-late season mix	33% GRIN, 18% SYCH, 12% CLAM, 1% SOCA, <1% LURI		53%	bird's-foot trefoil (cat's ear, willowherb)
All species	87% LURI, 5% CLAM, 2% PRVU, 1% SYCH, 1% ERLA, 1% GRIN, <1% SOCA, SICA & POGR		14%	bird's-foot trefoil (willowherb)

* One LURI plot died in winter flood (not included in average cover).

PLCO was completely senesced at time of sampling, so not possible to estimate cover.

The growth and tillering response of sand fescue to a single fall mowing at three different heights (study no. ORPMC-T-1111)

Dale Darris

Introduction

Sand fescue (*Festuca ammobia*) is a dense, fine textured, medium- to long-lived, perennial cool season grass closely related to red fescues (*Festuca rubra*). It spreads slowly from rhizomes and seed. Foliage is primarily basal and typically green, with some individuals or populations turning blue-grey in summer. The prototypical native sand fescue is found on beaches, rock crevices, meadows, gravelly sites, and streambanks in full sun to partial shade primarily along the Pacific Coast. It occurs only at lower elevations on moist to moderately dry soils from California to Washington (Darris, 2011).

Sand fescue has characteristics which make it a possible candidate for low input sustainable turf and perennial cover. These characteristics include fine texture, persistence, low stature, and rhizomatous growth, and potential qualities such as tolerance to drought and low fertility. Compatible, persistent cover crops are still needed for orchards, vineyards, and berry crops, and other farm and landscape uses in the Pacific Northwest. However, as a lesser known and seldom utilized native grass, information is lacking on management needs and adaptability of sand fescue for such uses, including tolerance to mowing. Height, timing, and frequency of mowing under different levels of input (fertilizers, pesticides) should be tested. The purpose of this study was to evaluate the growth, potential injury, and fertile tillering of sand fescue in response to a fall mowing at three different heights.

Methods and Materials

The experiment was superimposed onto a plant nursery previously used for selection and crossing of sand fescue (accession 9109122 selected from 9079450). Each row of individual plants within the nursery was designated a separate plot (Figure 1). Plants were originally established from container grown plugs transplanted to the field in November 2008. Spacing was 24 inches between rows and 6 to 18 inches within row. The nursery was fertilized each March with 50 lb of nitrogen per acre and weeds were controlled by hoeing and the use of a broadleaf weed control herbicide.

Experimental design was a randomized complete block with four replications. Four treatments were applied as a single annual clipping on September 20, 2010: 1) control (no mow), 2) low mow (at a foliage height of 1-2 inches), 3) medium mow (at a foliage height of 2.5-3.5 inches), and 5) high mow (at a foliage height of 4-5 inches). Mowing was done with a 20 inch wide, rotary lawnmower with collection bag to remove clippings.

Figure 1. Sand fescue plots (rows of individual plants) mowed at three different heights in September 2010, plus controls (no mow plots).

Each plot was visually scored for injury/dieback (April 27, 2011), vigor (April 27, 2011), and fertile tillering (May 25, 2011) on a scale of 1-9 with 9 as highest. Percent injury (April 27, 2011) was the percent of plants in a treatment row (plot) with visible signs of dieback to all or a portion of the crown or base. Data were collected in April to provide seven months of recovery after mowing (September). Data analysis consisted of ANOVA and a comparison of means using Tukey HSD at P=0.05.

Results and Discussion

The results of the sand fescue mowing experiment are presented in Table 1. Whether documented by visual score or percentage of plants injured, sand fescue injury was significantly higher (P=0.05) for the low mow treatment compared to the medium mow treatment, which in turn had injury that was significantly higher than the high mow treatment. Damage was typically focused toward the center of the plant. Lateral tillers were shorter and more prostrate or decumbent compared to those in the center which allowed them to escape closer removal. Little if any injury was sustained by high mow plots. In most cases there were no significant differences between the high mow and control plots. Vigor or the relative health of above growth plant growth was greatest in the controls and high mow treatment, followed by the medium mow treatment and the low mow treatment. Likewise, mowing higher or not at all resulted in the greatest number of fertile tillers per plant. This result was contrary to expectations for many if not most fine fescues but not creeping red fescue (*Festuca rubra* var. *rubra*). Fine fescues like Roemer's fescue (*Festuca roemeri*) (Darris and Young-Mathews, 2012) and chewings fescue (*Festuca rubra* var. *commutata*) (Chastain et al., 1999) under agronomic seed production produce more fertile tillers (and thus more seed) the year following close mowing or other methods of extensive non-thermal removal of post-harvest residue. The late summer removal of "residue" (seed stalks and foliage clippings) from sand fescue in this experiment was not unlike that process. In contrast, creeping red fescue can respond negatively to non-thermal residue removal treatments (Chastain, et al., 1999) as did sand fescue.

Table 1. Injury, plant vigor, and fertile tillering of sand fescue in response to a single clipping (September 20, 2010) at different mowing heights.[/1]

Treatment	**Injury[/2]**	**% injured**	**Vigor[/2]**	**Fertile tillers[/2]**
Control (no mowing)	1.0 D	0 C	7.3 A	7.8 A
Low mow (1-2 inch ht.)	5.5 A	59 A	4.3 B	3.0 C
Medium mow (2.5-3.5 inch ht.)	4.0 B	37 B	5.8 AB	4.8 BC
High mow (4-5 inch ht.)	2.3 C	10 C	6.8 A	6.8 AB

[/1] Means with the same letter are not significantly different (Tukey HSD, P=0.05)

[/2] Data based on visual scoring using a scale of 1-9 (9=highest)

Conclusions

In short, results indicate that sand fescue can respond more negatively in terms of injury, plant vigor, and fertile tillering the lower it is mowed in fall. This could have important implications for how this species is managed for turf, perennial cover, and even seed production. Under the management used in this study (including 50 lb N/acre in spring and weed control), it appears that fall mowing of sand fescue, if desired, should be done at least four inches above ground. However, results are not conclusive since the experiment was only conducted for one year and individually spaced plants may respond differently than typical turf or perennial cover plantings. Further testing is needed to evaluate the response of sand fescue to mowing at different times and frequencies under different fertilization and weed control regimes, including practices representative of low input sustainable turf.

Literature cited

Chastain, T.G., W.C. Young III, G.L. Kiemnec, C.J. Garbacik, G.A. Gingrich, and G.H. Cook. 1999. Post-harvest residue management for fine fescue seed crops in Oregon. pp. 55-56 (session 25). In J.G. Buchanan-Smith et al. (ed.) Proc. XVIII International Grassland Congress, Winnipeg and Saskatoon, Canada. 8-17 June 1997. Association Management Centre, Calgary, Canada.

Darris, D. 2011. Plant fact sheet for sand fescue (*Festuca ammobia*). USDA Natural Resources Conservation Service, Corvallis, OR.

Darris, D.C and A. Young-Mathews. 2012. Effects of post-harvest residue management on seed production of Roemer's fescue (*Festuca roemeri*). In: Young, W.C. (ed.). 2011 Seed Production Research at Oregon State University, USDA-ARS Cooperating. Dept. of Crop and Soil Science. Oregon State Univ., Corvallis, OR.

Springbank Clover Common Garden Study

Study No. ORPMC-T-1202 (2011–2016) ~ 2012 Progress Report

Annie Young-Mathews

In 2011, we began a study to make wild collections of springbank clover (*Trifolium wormskioldii* Lehm.) throughout its native range in western Washington, Oregon, and northwestern California in order to establish a common garden trial at the Corvallis PMC. The purpose of this common garden study is to evaluate differences in establishment, biomass production, pest and disease resistance, and seed production among different populations of springbank clover to evaluate its suitability for cover crop or other uses. Superior accessions may later be used for selection and development of a pre-varietal germplasm release. Seed is not currently available on the commercial market.

Springbank clover (also known as cows clover, coast clover, or sand clover) is a native legume that shows potential as a new pollinator-attracting, nitrogen-fixing, perennial cover crop for vineyards, orchards, and cane berries. It is an herbaceous, rhizomatous perennial that is found throughout the western United States from sea level to elevations of 10,500 ft (Calflora, 2012; Stevens, 2007; USDA-NRCS, 2012). Stems are decumbent or ascending and grow up to 2½ ft long. In the Pacific Northwest and California this species is considered a facultative wetland plant (FACW), meaning it usually is a hydrophyte, but is occasionally found in uplands (USFWS, 1988, 1993). However, it has been grown successfully at the Corvallis PMC for the last three years on an upland location without any supplemental irrigation and plants are continuing to thrive and produce seed.

We chose to pursue collections from populations in the western Pacific Northwest at elevations below 4,000 ft as we felt these populations would be most likely to be adapted to use as a cover crop in our service area. In 2011, we requested distributions of seed from 10 accessions of springbank clover available from the USDA-ARS National Plant Germplasm System (NPGS), as well as one accession from the Desert Legume Program (Table 1). Starting in the spring of 2012, we attempted to locate inland populations in the Willamette Valley and foothills/interior valleys of southern Oregon using herbarium records and historical botanists' notes. Despite visiting over a dozen locations, were unsuccessful in locating any current inland populations in Oregon, but we did make two inland collections from the Siskiyou-Trinity Mountains of Northern California, as well as three coastal California collections, and two coastal Oregon collections (Table 1). Marty Chaney of the NRCS Olympia Service Center also made two collections from coastal Washington and the Puget Sound area. Figure 1 is a map illustrating the locations of the 21 accessions of springbank clover that we have collected or acquired so far.

Figures 2 and 3 depict some of the variations in growth habit that populations of this species display in different habitats and climates. It will be interesting to see how many of those differences are genetic versus environmental when they are grown together in the common environment of the Corvallis PMC. The common garden study was not installed as planned during the winter/spring of 2012-2013 due to uncertainty about the future of the Corvallis PMC. Additional seed collections may be solicited in the spring/summer of 2013, and plans for the trial will be reevaluated in the fall of 2013.

Figure 2. Springbank clover in lush growth on a moist, sandy roadside near Crescent City, CA (left), and dwarfed plants growing on a sandy coastal cliff near Eureka, CA (right), June 2012.

Figure 3. Springbank clover (not yet in bloom) growing along a small perennial mountain stream in Trinity Co., CA (left), and in a wet meadow in Jackson Co., OR (right), June 2012.

Table 1. *Trifolium wormskioldii* accessions for the common garden trial at the Corvallis PMC.

Accession	Lot Number	State	County	Location	MLRA	Collection Date	Quantity	Collector
9079619	SWC-09-OS619	OR	Lincoln	Cummins Creek	4A	7/30/2009	1 g	M. Stein, USFS
9109131	SWC-11-131	WA	Pacific	near Olympia	2	7/1/2011	1.3 g	M. Chaney, WA NRCS
9109154	SWC-12-154	CA	Trinity	Davis Creek	5	8/13/2012	1.6 g	A. Young-Mathews, PMC
9109155	SWC-12-155	CA	Siskiyou	Miner's Creek	5	8/14/2012	0.1 g	A. Young-Mathews, PMC
9109156	SWC-12-156	CA	Del Norte	Pacific Shores	4B	8/15/2012	2.1 g	A. Young-Mathews, PMC
9109157	SWC-12-157	OR	Coos	Cape Arago State Park	4A	8/15/2012	2.2 g	A. Young-Mathews, PMC
9109158	SWC-12-158	CA	Del Norte	Pt. Saint George Park	4B	8/15/2012	2.2 g	A. Young-Mathews, PMC
9109159	SWC-12-159	OR	Curry	Otter Pt. State Wayside	4A	8/15/2012	0.2 g	A. Young-Mathews, PMC
9109160	SWC-12-160	CA	Humboldt	Table Bluff	4B	8/13/2012	0.5 g	A. Young-Mathews, PMC
9109161	SWC-94-161	CA	Solano	Suisun	16	7/1/1994	30 seeds	NPGS distribution
9109162	SWC-94-162	OR	Lane	Bob Creek Wayside	4A	7/30/1994	30 seeds	NPGS distribution
9109163	SWC-94-163	OR	Lane	Washburne State Park	4A	7/30/1994	30 seeds	NPGS distribution
9109164	SWC-94-164	OR	Lane	sand dunes, Florence	4A	7/30/1994	30 seeds	NPGS distribution
9109165	SWC-94-165	CA	Sonoma	Bodega Bay	15	6/4/1994	30 seeds	NPGS distribution
9109166	SWC-94-166	CA	Monterey	Pacific Grove	15	6/7/1994	30 seeds	NPGS distribution
9109167	SWC-97-167	WA	Grays Harbor	Ocean City	4A	8/1/1997	30 seeds	NPGS distribution
9109168	SWC-94-168	OR	Lane	N of Florence	4A	7/30/1994	30 seeds	NPGS distribution
9109169	SWC-97-169	OR	Clatsop	Arcadia Beach	4A	8/1/1997	30 seeds	NPGS distribution
9109170	SWC-97-170	OR	Lincoln	Seal Rock	4A	8/1/1997	30 seeds	NPGS distribution
9109171	SWC-94-171	WA	Whatcom	Nooksack River Delta	2	1994	20 seeds	Desert Legume Program, AZ
9109172	SWC-12-172	WA	Grays Harbor	Westport	4A	8/4/2012	8.8 g	M. Chaney, WA NRCS

References

Calflora: Information on California plants for education, research and conservation, based on data contributed by dozens of public and private institutions and individuals, including the Consortium of Calif. Herbaria. 2012. *Trifolium wormskioldii* Lehm. [web application]. Available http://www.calflora.org/ (accessed 29 Feb 2012). The Calflora Database [a non-profit organization], Berkeley, CA.

Stevens, M. 2007. Plant guide for springbank clover (*Trifolium wormskioldii*). USDA-NRCS National Plant Data Center, Davis, CA.

USDA-NRCS. 2012. *Trifolium wormskioldii* Lehm., cows clover. In: The PLANTS Database. Available http://plants.usda.gov (accessed 29 Feb 2012). National Plant Data Team, Greensboro, NC.

USFWS. 1988. National list of vascular plant species that occur in wetlands. U.S. Fish & Wildlife Service Biological Report 88 (26.9).

USFWS. 1993. 1993 supplement to list of plant species that occur in wetlands: Northwest (Region 9). Supplement to U.S. Fish & Wildlife Service Biological Report 88 (26.9).

Evaluation of springbank clover as a native leguminous cover crop

Study No. ORPMC-T-1203 (2012 – 2015) ~ 2012 Progress Report

Annie Young-Mathews

The purpose of this study is to perform an initial evaluation of springbank clover (*Trifolium wormskioldii* Lehm.) for use as a perennial cover crop in Oregon and California. Our objectives are to: 1) evaluate germination and establishment (1st year), phenology, rate of spread and stand persistence over three years; 2) quantify wet and dry biomass accumulation over the course of the growing season over three years with no supplemental management (irrigation will be applied at CAPMC); 4) identify insect and disease susceptibility of the species; and 5) evaluate ability of the species to compete with and/or suppress weeds.

Springbank clover is a native perennial legume that shows potential as a new pollinator-attracting, nitrogen-fixing perennial cover crop for vineyards, orchards, and cane berries (Figure 1). Seed is not currently available on the commercial market, but a 2010 planting at the Corvallis PMC established quickly and has produced an abundance of seed for the last two years. This germplasm (accession 9079619) was originally collected in 2009 at Cummins Creek, USFS Siuslaw NF, Lincoln County, OR. Seed from the 2011 harvest of this germplasm (lot # SG1-11-OS619) was generously donated by the USFS for use in this trial. Two common, non-native cover crop species, white clover (*T. repens*) and strawberry clover (*T. fragiferum*), are being used as controls to compare their establishment and productivity to those of *T. wormskioldii* under simulated cover crop conditions.

This trial is taking place at the Corvallis, OR PMC and the Lockeford, CA PMC. The plots at the Corvallis PMC are located on field 7-12 of Schmidt Farm. The trial was set up as a randomized complete block design with 6 treatments (3 species seeded at two different seeding rates) and 4 replicated blocks (Figures 2 & 3). Plots were seeded on October 9, 2012 using the small seed box of a Truax drop seeder followed by rolling with a tine roller to improve seed to soil contact. Corvallis PMC plots will receive no supplemental irrigation, fertilizer, or weed control other than one to two summer mowing operations as needed to keep down weed biomass and prevent weeds from going to seed.

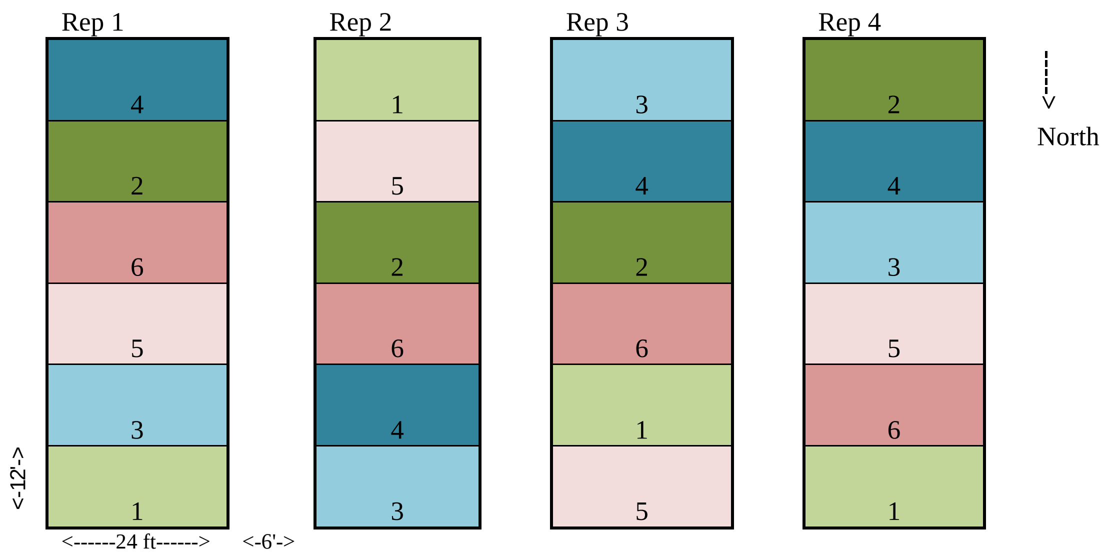
Data will be collected for the next three years on establishment, spread, stand persistence, weed competition, and biomass production of the three clover species, as well as any disease or pest problems.

Figure 1. *Seed production field of springbank clover at the Corvallis PMC, with white clover in foreground, June 2012.*

Figure 2. *Species and seeding rates for perennial clover cover crop trial seeded in October, 2012.*

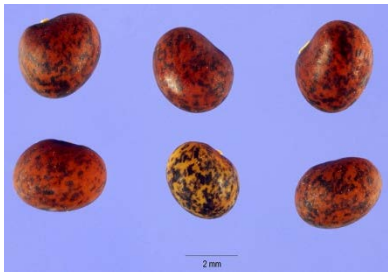
Trt #	Species	Common name	seeds/lb	PLS rate seeds/ft^2	PLS rate lb/acre	PLS rate g/ft^2	Purity	Germ	Bulk rate g/ft^2
1	*Trifolium wormskioldii*	springbank clover	348,000	60	7.5	0.08	95.26%	88%	0.09
2			348,000	120	15.0	0.16	95.26%	88%	0.19
3	*Trifolium repens*	white clover	776,000	60	3.4	0.04	65.63%	95%	0.06
4			776,000	120	6.7	0.07	65.63%	95%	0.11
5	*Trifolium fragiferum*	strawberry clover	300,000	60	8.7	0.09	65.98%	97%	0.14
6			300,000	120	17.4	0.18	65.98%	97%	0.28

Figure 3. *Plot layout of perennial clover cover crop trial in field 7-12 of the Corvallis PMC Schmidt Farm.*



Scarification and Seed Longevity of Three Native Legumes
Trial No.: ORPMC-S-1204 (2012–2015)
Annie Young-Mathews and Kathy Pendergrass

Introduction



Seed mixes are often needed at short notice for revegetation of retired logging roads, road cuts, or for other erosion control plantings, and many native legumes used for such plantings require scarification in order to obtain good germination rates. However, little is known about the longevity or storage requirements of scarified legume seed. In 2012, the PMC and the Bureau of Land Management (BLM)–Salem Office began a study to look at how long seed can remain viable when scarified and stored under different storage conditions. The outcome of this study will help BLM determine whether they may scarify seed in advance and have it "ready to go" for restoration needs and without a great loss of viability, and whether refrigerated storage is needed to maintain seed viability.

Methods and Materials

The species being evaluated are rosy bird's-foot trefoil (*Lotus aboriginus*), broadleaf lupine (*Lupinus latifolius*), and riverbank lupine (*Lupinus rivularis*), and the two storage treatments are a controlled environment (walk-in cooler set at 45°F and 30–40% relative humidity) and an un-controlled warehouse-like environment (PMC headhouse with no temperature or humidity control). Seed lots used in this trial were provided by Salem BLM from 2008 harvests. On April 26, 2012, seed lots for scarified treatments were run through a Westrup seed scarifier at medium-high speed for about 6-8 minutes, until seeds looked dulled and seed coats were nicked. Initial tetrazolium (TZ) viability was tested at the OSU Seed Laboratory for all seed lots at the beginning of the experiment in May 2012, and again at 6 months in November 2012. Seed will be tested periodically over the course of 3 years to determine how quickly scarified seed loses viability compared to un-scarified seed.

Preliminary Results

There did not appear to be any significant loss in seed viability after 6 months for scarified seed, regardless of storage conditions (Table 1). However, TZ tests at 6 months unexpectedly showed some seed lots having higher viability than when the experiment started, so the tests were rerun in December, but still had inconsistent results. Some variability/uncertainty in viability numbers (perhaps ±5%) is expected from differences within the seed lot and the subjectivity of the TZ tests (seed analysts must determine whether each seed is viable based on the degree of staining along a continuum of pink stain). However, the observed 10-20% differences in some of the lupine seed lots seems questionable, so the 1-year TZ tests will be sent to another seed lab to see if results are more consistent.

Table 1. *Viability of scarified and non-scarified seed of three native legumes stored under different conditions at the Corvallis PMC.*

				------------Seed viability (TZ)-----------		
Species	**Seed treatment**	**Storage conditions**	**Lot Number**	**5/2/2012**	**11/5/2012**	**Retest 12/27/12**
Lotus aboriginus	non-scarified	cooler (45°F, 30% rh)	SCO-08-149NC	96%	97%	96%
	non-scarified	headhouse (uncontrolled)	SCO-08-149NH	95%	97%	97%
	scarified	cooler (45°F, 30% rh)	SCO-08-149SC	97%	95%	83%
	scarified	headhouse (uncontrolled)	SCO-08-149SH	97%	95%	94%
Lupinus latifolius	non-scarified	cooler (45°F, 30% rh)	SCO-08-150NC	83%	98%	93%
	non-scarified	headhouse (uncontrolled)	SCO-08-150NH	90%	97%	94%
	scarified	cooler (45°F, 30% rh)	SCO-08-150SC	78%	95%	81%
	scarified	headhouse (uncontrolled)	SCO-08-150SH	81%	97%	92%
Lupinus rivularis	non-scarified	cooler (45°F, 30% rh)	SCO-08-151NC	87%	92%	80%
	non-scarified	headhouse (uncontrolled)	SCO-08-151NH	86%	96%	77%
	scarified	cooler (45°F, 30% rh)	SCO-08-151SC	80%	97%	76%
	scarified	headhouse (uncontrolled)	SCO-08-151SH	74%	96%	85%

Effect of Mixed Species Cover Crops on Soil Health

Study No. ORPMC-T-1301 (2012–2015) ~ Project Summary April 2013

Annie Young-Mathews

Figure 1. Six-species mix (rye, crimson clover, radish, hairy vetch, oats, turnip) seeded at 60 seeds/ft^2 6 months after planting (April 2013).

Goals

1. Document the effects of cover crop species composition on changes in soil health.
2. Determine optimum seeding rates for cover crop mixes to improve soil health.
3. Demonstrate the use of cover crops in rotation with a commodity crop.

Cooperators

NRCS Plant Materials Program: John Englert, Ramona Garner, Joel Douglas, Jim Briggs, PMC staff
Oregon NRCS: Ron Raney, Dave Johnson
NRCS Kellogg National Soil Survey Laboratory, Lincoln, NE: Larry West, Rebecca Burt
USDA-ARS, Grassland Soil & Water Research Laboratory, Temple, TX: Dr. Rick Haney
Benton County SWCD: Teresa Matteson

Materials and Methods

This study consists of 3 years of cover crops and 3 years of a commodity crop, with the cover crop plots in the same location each year to determine cumulative effects of the treatments. Similar trials are being simultaneously conducted across the country at six other NRCS Plant Materials Centers in Brooksville, FL, Beltsville, MD, Elsberry, MO, Bismarck, ND, Pullman, WA, and Lockeford, CA. At the Corvallis PMC the trial was installed on field 6-11 of Schmidt Farm in October 2012. Soils are Woodburn silt loam, 0 to 3% slopes. Each plot measures 30 by 30 ft. The experimental design is a 2-factor randomized complete block design with 4 replications. The two treatment factors are species composition (un-seeded control and 2-, 4-, and 6-species mixes) and seeding rate (20, 40, and 60 seeds/ft^2) (Table 1). All plots will be no-till planted to sweet corn as a commodity crop each summer.

Table 1. *Cover crop mixes and seeding rates used for Corvallis PMC 2012 soil health study.*

Common Name	Variety	Species	% of mix	20 seed/ft² lbs/acre	40 seed/ft² lbs/acre	60 seed/ft² lbs/acre
2-Species Mix: Rye and Crimson Clover						
Grasses						
cereal rye	winter rye, vns*	*Secale cereale*	50	23.99	47.97	71.96
Legumes						
crimson clover	vns*	*Trifolium incarnatum*	50	2.9	5.81	8.71
4-Species Mix: Rye, Crimson Clover, Hairy Vetch and Radish						
Grasses						
cereal rye	winter rye, vns*	*Secale cereale*	45	21.59	43.18	64.76
Forbs						
radish	Soil Buster	*Raphanus sativus*	10	2.56	5.12	7.69
Legumes						
crimson clover	vns*	*Trifolium incarnatum*	22.5	1.31	2.61	3.92
hairy vetch	UNC	*Vicia villosa*	22.5	12.01	24.02	36.03
6-Species Mix: Rye, Crimson Clover, Hairy Vetch, Radish, Oats, Turnip						
Grasses						
cereal rye	winter rye, vns*	*Secale cereale*	22.5	10.79	21.59	32.38
oats	Walken (treated)	*Avena sativa*	22.5	10.1	20.21	30.31
Forbs						
radish	Soil Buster	*Raphanus sativus*	5	1.28	2.56	3.84
turnip	Shogoin	*Brassica rapa* var. *rapa*	5	0.28	0.56	0.83
Legumes						
crimson clover	vns*	*Trifolium incarnatum*	22.5	1.31	2.61	3.92
hairy vetch	UNC	*Vicia villosa*	22.5	12.01	24.02	36.03

* variety not stated

Data Collection

1. *Soil Characterization*—At the beginning of the study, a complete soil characterization of the study area was conducted by the Oregon soils staff.
2. *Soil Bulk Density*—Prior to cover crop planting each year, bulk density will be determined on 2 replicates per plot at 0–2 and 2–4 inch depths.
3. *Soil Biological Assessment*—At the time of cover crop planting and cover crop termination each year, a composite soil sample from 0–6 inches will be collected from each plot and sent to Dr. Rick Haney, ARS for biological assessment. Dr. Haney's lab will analyze samples for N-P-K, biological activity (Solvita 1-day CO_2-C), organic C, organic N, organic P, and a "Soil Health" calculation from those results.
4. *Soil Indicators*—Prior to cover crop planting each year, soil samples will be collected from 0–2 and 2–6 inch depths in each plot and sent to the Kellogg Soil Survey Laboratory for analysis. Tests will include total C, N, and S, pH, extractable cations (Ca, Mg, Na, K), cation exchange capacity, KCl-extractable Al, extractable P, active C, particulate organic matter, β-glucosidase, and particle size distribution (initial sampling only).
5. *Soil Temperature*—At the time of cover crop planting and cover crop termination each year, soil temperature will be recorded at a depth of 3 inches from 3 randomly distributed samples from each plot.
6. *Soil Moisture*—At the time of cover crop planting and cover crop termination each year, soil moisture will be recorded at a depth of 7 inches from 3 randomly distributed samples from each plot.
7. *Soil Resistance*—At the time of cover crop planting and cover crop termination each year, soil resistance will be measured at 5 randomly distributed samples from each plot using a penetrometer to record resistance at depths of 0–6 inches, 6–12 inches, and 12–18 inches.
8. *Cover Crop Photo Documentation*—Every 15 days after cover crop seeding until cover crop termination, standardized photos will be taken of each plot in a single replication to document progress of cover crop development over time.

9. *Cover Crop Percent Live Cover & Plant Height*—Every 30 days after cover crop seeding, cover data will be recorded at 1-ft intervals along a diagonal transect of each plot. Height of lush canopy growth will be taken from 5 representative measurements in each plot.
10. *Cover Crop Biomass & Species Composition*—At the time of cover crop termination each spring, aboveground biomass and radish roots will be collected from 0.5-m^2 subplots in each plot to determine dry matter composition by species and N analysis.
11. *Commodity Crop Yield*—At the time of corn maturity, 10 linear feet from two interior rows of each plot will be hand harvested and weighed**.**

Preliminary Results

Baseline soil physical and biological assessment parameters were collected October 4-11, 2012, prior to seeding the cover crop, and results are summarized for all 40 plots in Table 2. Soil test results from the Kellogg Soil Survey Lab had not been received at the time of this report.

One month after cover crop planting all treatments were showing good establishment, but bare ground and weeds were the dominant cover types (Figure 2). Early weed control appeared to be best in the higher seeding rates (40 and 60 seeds/ft^2) of the 4- and 6-species mix. By January (97 days after planting) this trend was much more apparent, with the forbs (largely radish) accounting for the majority of the cover in the 4- and 6-species mixes, but with weed cover still significantly higher at the lightest seeding rate (20 seeds/ft^2), especially in the rye-clover mix (Figure 3). By April, the composition of the 4- and 6-species mixes was about 50% forbs (radish and/or turnip), 33% legumes (largely hairy vetch), and 15% grasses (mostly cereal rye), with negligible cover from weeds and almost no bare ground (Figures 1 & 4). Meanwhile the rye-clover plots had about 50% rye and 30% clover cover, with more weeds and bare ground, especially at the lower seeding rates. The un-seeded control plots ended up in April with 95% vegetative cover (weeds), similar to the seeded cover crop plots, but in November the controls had 65% bare ground as opposed to only 25 to 45% bare ground in the cover cropped plots (Figure 5).

By April, canopy height (a preliminary indicator of biomass production) was higher in the 4- and 6-species mixes than in the rye-clover mix, and all cover crop treatments were significantly taller than the control plots (Figure 6). Final biomass and composition by species will be determined at cover crop termination which is planned for early May 2013; sweet corn will be planted 2-3 weeks later in late May.

Table 2. *Baseline soil parameters for Corvallis PMC soil health study taken prior to cover crop planting in October, 2012.*

Soil Parameter	Sampling Depth (inches)	Min.	Max.	Mean ± stdev	Recommended level
Temperature (°F)	3	69.2	73.0	70.4 ± 0.7	
Moisture (g/g)	0-2	0.04	0.14	0.09 ± 0.02	
	2-4	0.15	0.19	0.17 ± 0.01	
Bulk Density (g/cm^3)	0-2	1.12	1.36	1.23 ± 0.05	< 1.3
	2-4	1.12	1.31	1.21 ± 0.05	< 1.3
Resistance (psi)	0-6	243	330	291 ± 24	< 200
	6-12	208	333	282 ± 31	< 200
	12-18	313	364	334 ± 12	< 200
Plant available N (lb/acre)	0-6	62.0	137.1	92.5 ± 17.7	175
Plant available P_2O_5 (lb/acre)	0-6	31.7	89.0	47.4 ± 10.1	120
Plant available K_2O (lb/acre)	0-6	53.3	266.5	91.7 ± 46.2	100
Solvita 1-day CO_2-C (ppm)	0-6	11.27	41.79	19.48 ± 7.03	higher is better
Organic C:N	0-6	6.8	11.4	9.7 ± 1.0	8:1 to 15:1
Soil Health Calculation	0-6	2.6	5.8	4.0 ± 0.9	higher is better, 0-50+
Total N (lb/acre)	0-6	75.2	161.1	104.3 ± 17.9	
Inorganic N (lb/acre)	0-6	57.6	136.2	84.1 ± 16.7	
Organic N (lb/acre)	0-6	14.1	32.3	20.2 ± 3.3	
Total P (lb/acre)	0-6	58.2	128.6	81.0 ± 11.7	
Inorganic P (lb/acre)	0-6	29.7	84.5	44.3 ± 10.0	
Organic P (lb/acre)	0-6	26.7	49.0	36.7 ± 4.8	

Figure 1. *Average percent cover of cover crops by functional group 30 days after planting in November 2012.*

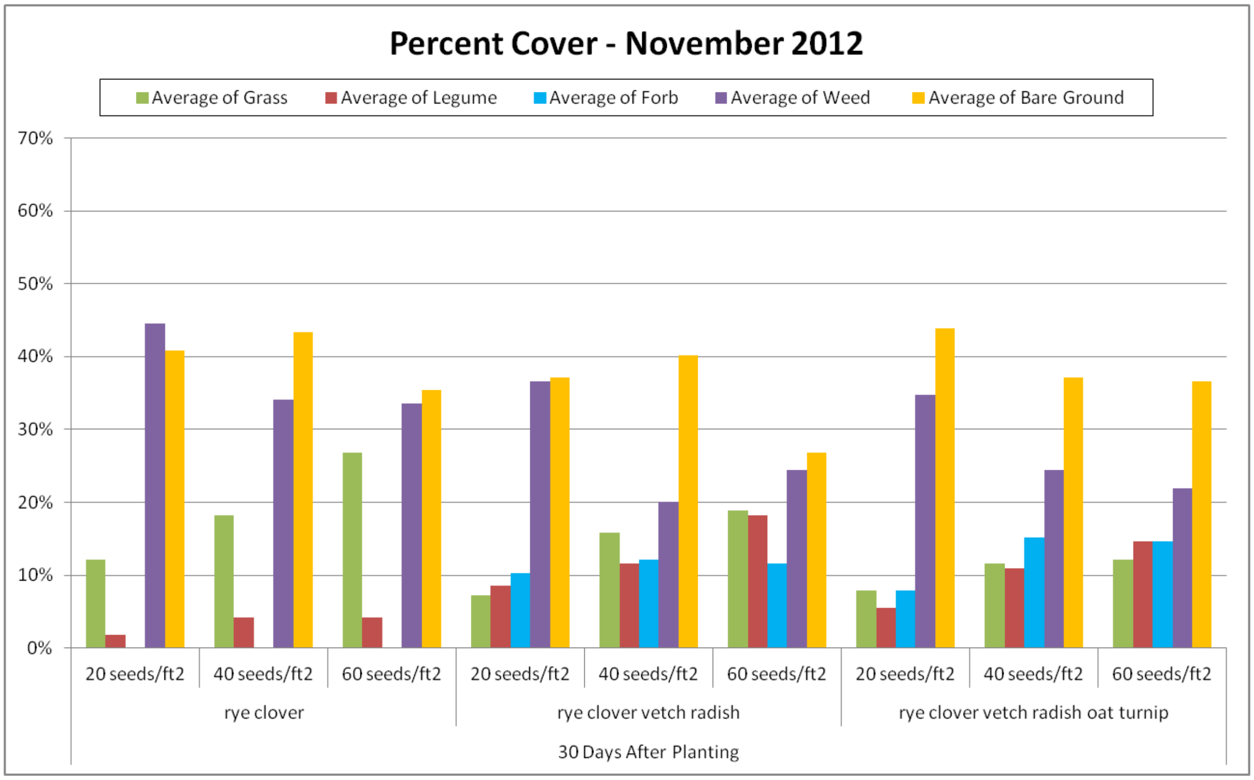


Figure 2. *Average percent cover of cover crops by functional group 97 days after planting in January 2013.*

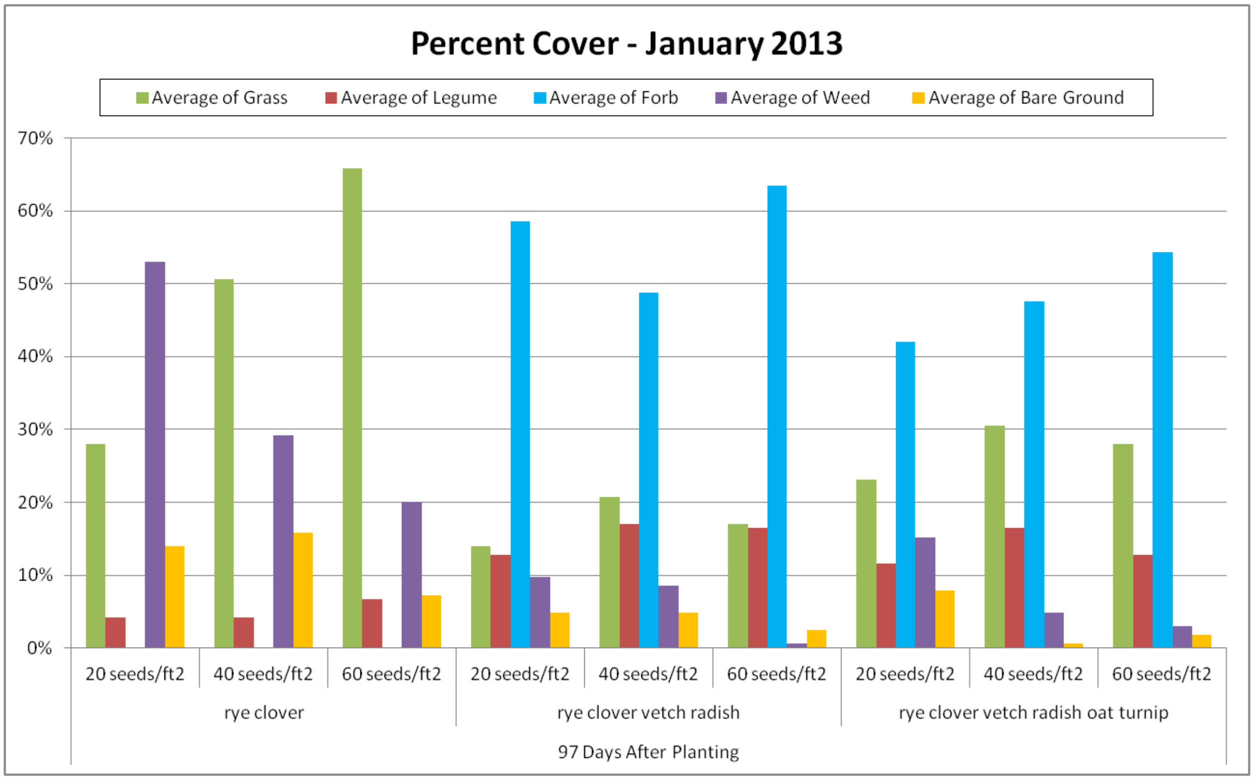


Figure 3. *Average percent cover of cover crops by functional group 182 days after planting in April 2013.*

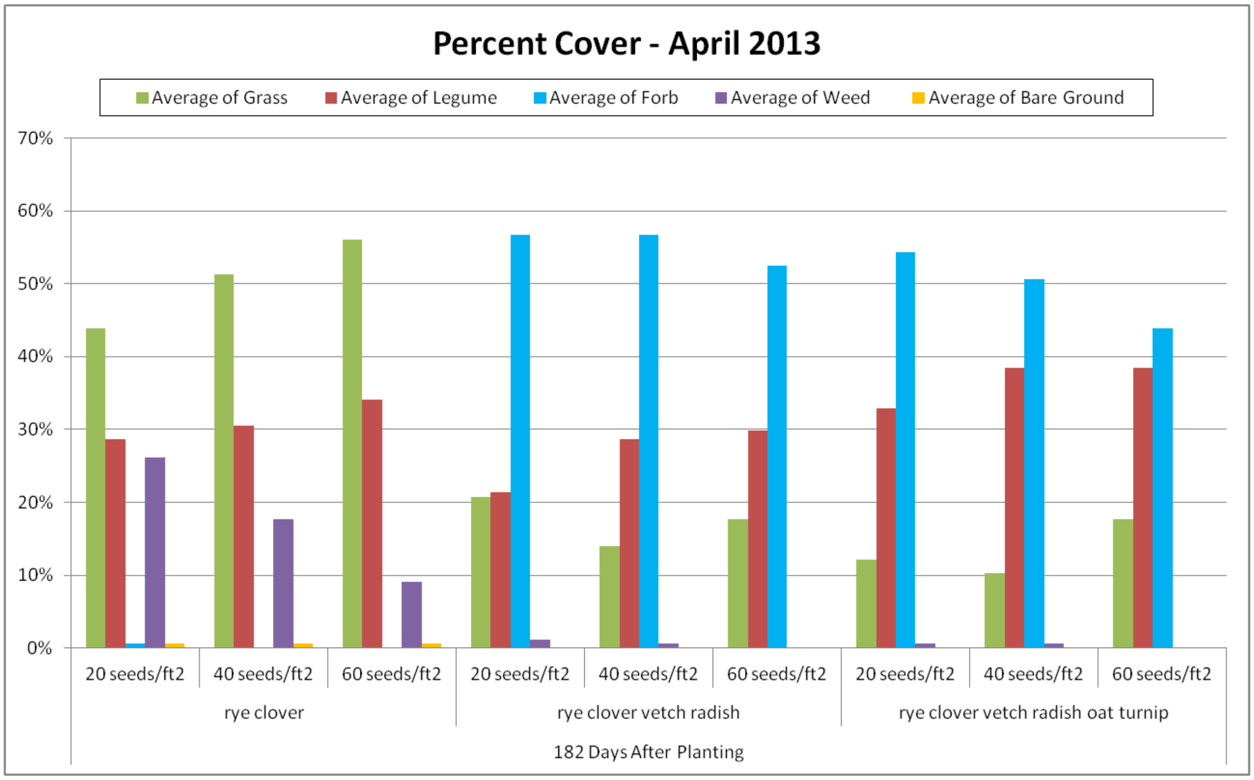


Figure 4. *Average percent cover in un-seeded control plots from November 2012 to April 2013.*

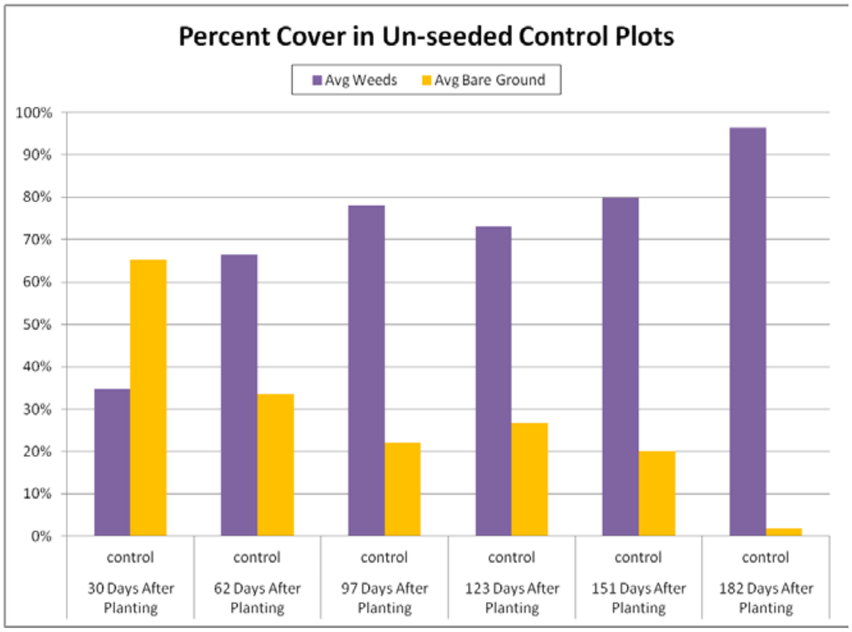
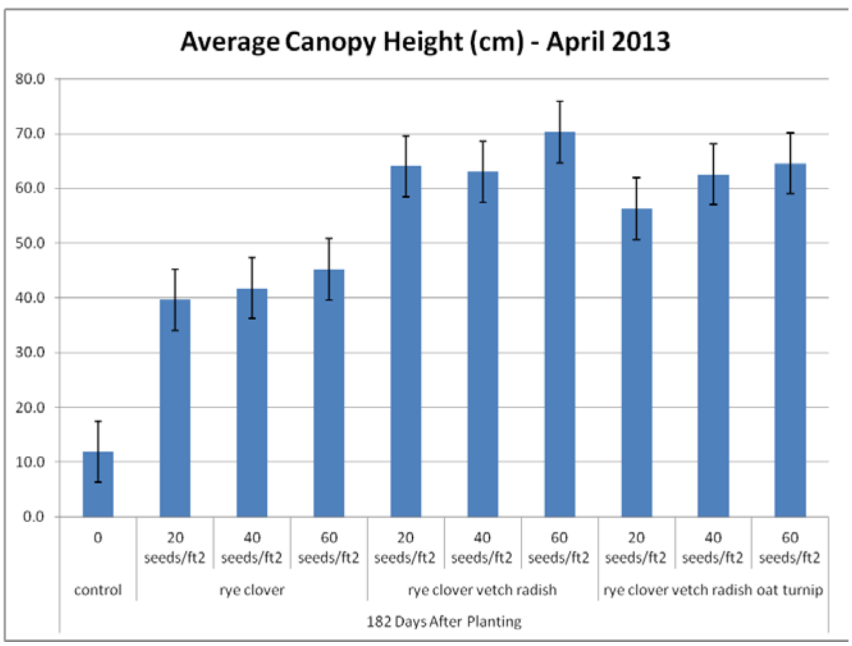


Figure 5. *Average canopy height (± std error) of control and cover crop plots in April 2013, 182 days after planting.*



Cascade Seeding Trial

Conservation Trial No.: ORPMC-F-0803 (2009–2014)

Kathy Pendergrass and Annie Young-Mathews

Figure 1. *Vegetation establishment on BLM Cascade roadbed seeding trial in Lane Co., OR, July 2010 (left) and August 2012 (right).*

Introduction

The NRCS Oregon Plant Materials Program entered into an interagency agreement with the Bureau of Land Management (BLM) and Forest Service (FS) on the west side of Oregon in 2008. The NRCS, BLM, and FS have an interest in developing native plant seeding recommendations and mixes for various erosion control purposes. The objective of this study was to look at different broadcast seeding rates (15 or 30 lbs/acre) of blue wildrye (*Elymus glaucus*) with and without a legume, big deervetch (*Lotus crassifolius*) (also at roughly 15 and 30 lbs/acre), to determine which rate and composition performed better and/or proved to be more cost-efficient while still effectively stabilizing disturbed sites. A longer-term goal of this study is to determine whether BLM and FS should develop various legume seed availability for land rehabilitation.

In July 2012 it was determined that the legume that was supplied by BLM and planted on the site was in fact rosy bird's-foot trefoil (*Lotus aboriginus*), a native herbaceous perennial very similar in appearance and growth habit to *Lotus crassifolius*, but generally found in the Coast Range rather than the Cascades. However, the *L. aboriginus* appeared to be doing well on the site, so it was left where it had been seeded and plots will continue to be evaluated.

Methods

In the fall of 2009, a decommissioned roadbed from a forest thinning project was seeded with different rates of blue wildrye and rosy bird's-foot trefoil. The road (Bear Creek thinning spur road B) is located on BLM land at about 2,500 ft elevation in the Cascade foothills, Lane County, OR.

The roadbed length accommodated four 1/16th acre plots. Different seed mixes were broadcast onto each 1/16th acre plot: 1)15 lbs/ac of blue wildrye alone, 2) 15 lbs/ac of blue wildrye with 14 lbs/ac of rosy bird's-foot trefoil, 3) 30 lbs/ac of blue widlrye alone, and 4) 30 lbs/ac of blue widlrye with 26 lbs/ac of rosy bird's-foot trefoil. This equated, respectively, to about 1) 48 seeds/ft^2 blue wildrye, 2) 48 seeds/ft^2 blue wildrye plus 25 seeds/ft^2 of rosy bird's-foot trefoil, 3) 97 seeds/ft^2 blue wildrye, and 4) 97 seeds/ft^2 blue wildrye plus 47 seeds/ft^2 of rosy bird's-foot trefoil.

Three permanent 1-m^2 plots were randomly established in each treatment for field measurements of percent cover of all species, and counting densities of blue wildrye and *Lotus* plants in 0.01-m^2 plots within the upper left corner of the 1-m^2 frame. Cover and density counts were taken in July 2010 and August 2011; only cover estimates were reevaluated in August 2012. Data were analyzed using 2-way ANOVAs of seeding rate and legume presence/absence, with rock cover as a covariate since some treatments had significantly more rock cover than others.

Results

By August 2012, a majority of the roadbed had good cover of blue wildrye, rosy bird's-foot trefoil, and/or other volunteer seedlings in all treatment plots (Figures 1 & 3). In 2012, there were no significant differences in blue wildrye cover according to seeding rate ($p = 0.28$) or the presence of the legume ($p = 0.16$), but total vegetation cover was higher in plots seeded with the legume than in those without (99 vs. 54%, respectively, $p < 0.05$; Figure 2c).

Where rosy bird's-foot trefoil was seeded, its cover was higher in 2012 than 2010, while 2011 was intermediate (55 vs. 5%, and 34%, respectively, $p < 0.01$; Figure 2). Density of rosy bird's-foot trefoil was greater at the higher 30 lbs/acre seeding rate ($p < 0.05$), but cover did not differ significantly by seeding rate ($p = 0.15$).

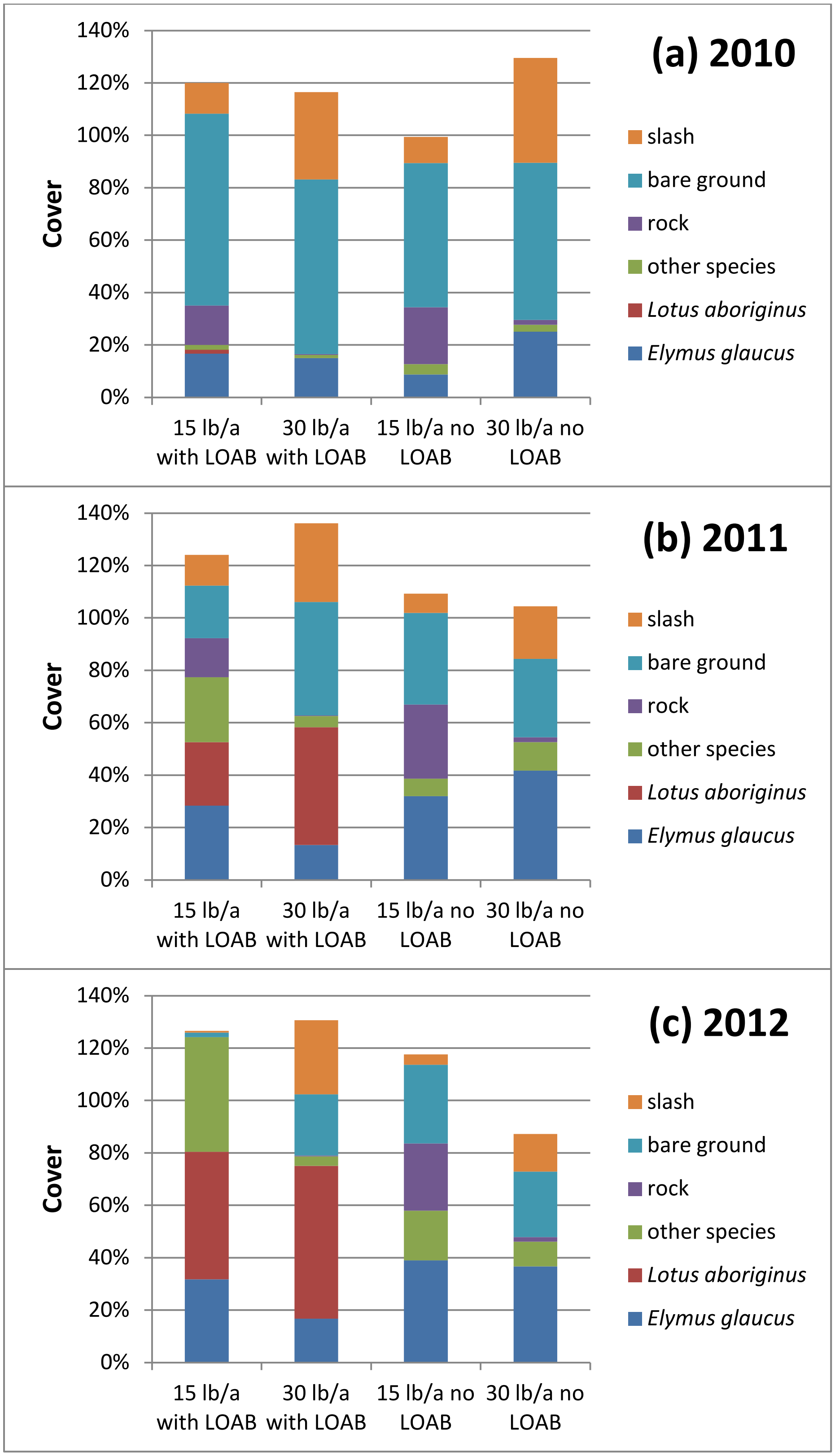
Pooling data from all three years, there was no significant difference between blue wildrye cover when planted at 15 vs. 30 lbs/acre (29 and 21%, respectively, $p = 0.26$), but blue wildrye cover was almost twice as great when it was planted without the legume than when the legume was present (32 vs. 19%, respectively, $p < 0.05$). However, total vegetation cover was higher in plots seeded with the legume than in plots where blue wildrye was seeded alone (64% vs. 40% cover, respectively, $p < 0.01$). As would be expected, total vegetation cover was greater in 2012 and 2011 than in 2010 (76, 58 and 21%, respectively, $p < 0.001$). There was also a greater average number of species per plot in 2012 (9.6) than in 2011 and 2010 (7.5 and 5.8, respectively, $p < 0.001$). There were significantly less species in plots seeded at the higher 30 lbs/acres rate with legumes present than in the other three treatments (5.3 vs. 8.4 species per plot, respectively, $p < 0.05$).

Preliminary Conclusions

Data from this trial suggest that seeding blue wildrye with a legume at a rate of 15 lbs/acre may be sufficient to provide adequate soil cover and species diversity after three years. Seeding at the lower rate would provide a substantial cost savings for restoration compared to seeding at 30 lbs/acre with both species ($5,450 compared to $10,300 per acre seeding cost, based on $20/lb for local-sourced blue wildrye and $180/lb for rosy bird's-foot trefoil). Results of this study support the BLM standard practice of broadcast seeding 30 lbs/acre of blue wildrye on reclaimed roadbeds as being relatively effective and cost-efficient, although greater cover and species diversity might be achieved with a lower rate of blue wildrye and with the legume added. The trial will continue to be monitored in future years to track stand persistence and recruitment over time.

Figure 3. *Vegetation establishment in plot with 30 lb/ac rate of blue wildrye and Lotus on July 2010 (left) and August 2012 (right).*

Figure 2. *Average percent cover in each of four seeding treatments (blue wildrye seeded with or without rosy bird's-foot trefoil at 15 or 30 lb/acre) at the BLM Cascade seeding trial evaluated in 2010 (a), 2011 (b), and 2012 (c). Averages are from 3 plots per treatment (cover may total more than 100% if there were overlapping vegetation canopies).*



Field Trial: Native Cover Crops for Vineyards

Trial number: ORPMC-F-1201 (2011–2014) ~ 2012 Summary

Annie Young-Mathews

The Corvallis PMC staff seeded a new native cover crop field trial at Coast Fork Vineyard and Berry Farm, Cottage Grove, OR on Nov 1, 2011. The purpose of the field trial is to evaluate the establishment and longevity of a number of native species for use as perennial vineyard cover crops. Northwest Maritime Germplasm Roemer's fescue (*Festuca roemeri*, a new release by the Corvallis PMC) was seeded on 14 vineyard rows, alternating with "Shade and Sun Mix" red creeping/Chewings fescue as a standard (Table 1). The fescues were seeded with an ATV pulling a Truax broadcast seeder with covering chains. Two additional shorter rows were hand seeded with lance selfheal (*Prunella vulgaris* ssp. *lanceolata*) and springbank clover (*Trifolium wormskioldii*), native wildflowers that may benefit vineyards or nearby cane berries by attracting native pollinators and beneficial insects.

Figure 1. *Lance selfheal plot in vineyard cover crop field planting, Cottage Grove, OR, July 2012.*

On July 31, 2012, small plots (50 cm x 50 cm) were evaluated for plant density and cover (Table 1). Establishment of Northwest Maritime Germplasm Roemer's fescue appeared to be comparable to (or better than) the standard creeping red/Chewings fescue mix, especially in the shaded rows with more mature vine canopies. The lance selfheal showed great first year establishment, creating more than 50% cover and competing well with weeds. The springbank clover plants were abundant, but very small (less than 1 inch tall), so did not create much cover the first year, but we're hoping they will take off this winter and compete better with weeds by next year. Plots will be evaluated for density and cover again in the summer of 2013.

Table 1. *Species and seeding rates used for Nov 1, 2011 field planting in Cottage Grove, OR. Plant density and cover were measure on 50 cm x 50 cm plots on July 31, 2012.*

Species	Comon name/variety	Seeding rate lb/ac (seeds/ft^2)	Area evaluated	2012 Avg. Density plants/m^2	2012 Avg. Cover
Trifolium wormskioldii	springbank clover	unknown	1 row-1600 sq.ft. (4 plots)	96	0.5%
Prunella vulgaris ssp. *lanceolata*	lance selfheal	32.0 (556)	1 row-1600 sq.ft. (4 plots)	no data	61%
Festuca roemeri	Northwest Maritime Germplasm Roemer's fescue	21.1 (242)	4 rows-1200 sq.ft. ea (4 plots)	155	47%
			Sunny rows (2 plots)	160	32%
			Shady rows (2 plots)	150	63%
Festuca rubra var. *rubra* & *F. rubra* var. *commutata*	"Shade & Sun Mix"-- red creeping & Chewings fescue	13.4 (154)	4 rows-1200 sq.ft. ea (4 plots)	97	30%
			Sunny rows (2 plots)	108	25%
			Shady rows (2 plots)	86	35%

Native Cover Crops for Berry Farms

Conservation Trial No. ORPMC-F-1302 (2012–2016)

Annie Young-Mathews, Dale Darris and Kathy Pendergrass

The purpose of this Conservation Field Trial is to evaluate the effectiveness of different native perennial grasses as cover crops on a berry farm. The farm owner's goals for a successful cover crop for the inter-row areas between the berry rows are the following: 1) outcompete weeds, 2) stabilize soil to allow machinery access, 3) relatively short species to minimize mowing frequency, and 4) native species/mix that fits into integrated pest management plan.

This trial is taking place on the Hopville-Columbia Farm operated by Hopville Farms, LLC in Clatskanie, Columbia Co., OR (Figure 1). The farm was historically a hybrid poplar plantation, but is in the process of being converted to berries. Soils are Wauna and Locoda silt loams with 7.5 to 16.6% organic matter and pH in a range from 4.2 to 5.0. The farm totals nearly 400 acres, with 102 acres in blueberries, 135 acres in blackcaps, and 4 acres in red raspberries, with plans to expand blackcap production to an additional 42 acres in the spring of 2013. The most problematic weeds have been blackberries, Canada thistle, and horsetail. Currently weeds in the inter-rows are managed by mowing and/or spraying with glyphosate, but the farm is certified Salmon Safe, so they have to stay within the guidelines for herbicide selection and use.

Two native fine-leaved fescues were chosen for this trial–Roemer's fescue (*Festuca roemeri*) and sand fescue (*Festuca ammobia*) –as well as a commercial Sun & Shade lawn mix of 50% introduced creeping red fescue (*Festuca rubra* ssp. *rubra*) and 50% Chewing's fescue (*Festuca rubra* ssp. *fallax*) as a standard of comparison (Table 1). Roemer's fescue is a fine-textured native bunchgrass with 24- to 36-inch tall seed heads that tolerates moderately low mowing (1-2 inches) one to three times per year. The Corvallis PMC release used in this trial, Northwest Maritime Germplasm, is more robust and leafy than many inland populations of Roemer's fescue, increasing its potential to compete with weeds. Sand fescue is a slowly spreading rhizomatous fine leaf fescue; its rhizomatous nature may make this species better than Roemer's fescue at competing with weeds in the long run. Sand fescue has shorter seed heads than Roemer's fescue (12-18 inches), but is less tolerant of low mowing (mowing height should be at least 3½ to 4 inches).

On October 17, 2012, Oregon Plant Materials Specialist Kathy Pendergrass and PMC Manager Joe Williams met with the farm managers to deliver PMC seed for the field trial and to discuss other potential collaboration between NRCS and the farm.

On October 18, 2012, the grower seeded strips of Roemer's and sand fescue on four fields (Figure 2) using a broadcast seeder with a cultipacker. The remaining rows were broadcast seeded with the Sun & Shade Mix the following day. The introduced Chewing's and creeping red fescues germinated within 20 days of planting (Figure 3), but the Roemer's and sand fescues are generally slower to germinate, so their establishment and survival will be monitored over the coming years.

Once the stands are fully established (year 2), additional experiments may include different mowing frequencies (once or twice each spring) and/or different mowing heights (e.g., 2 and 4 inches) to evaluate the effects on stand persistence and weed control.

Figure 1. *Aerial photo of Hopville-Columbia Farm in Columbia County, OR. Trials were established on fields C-26, C-31, C-34, and C-35.*

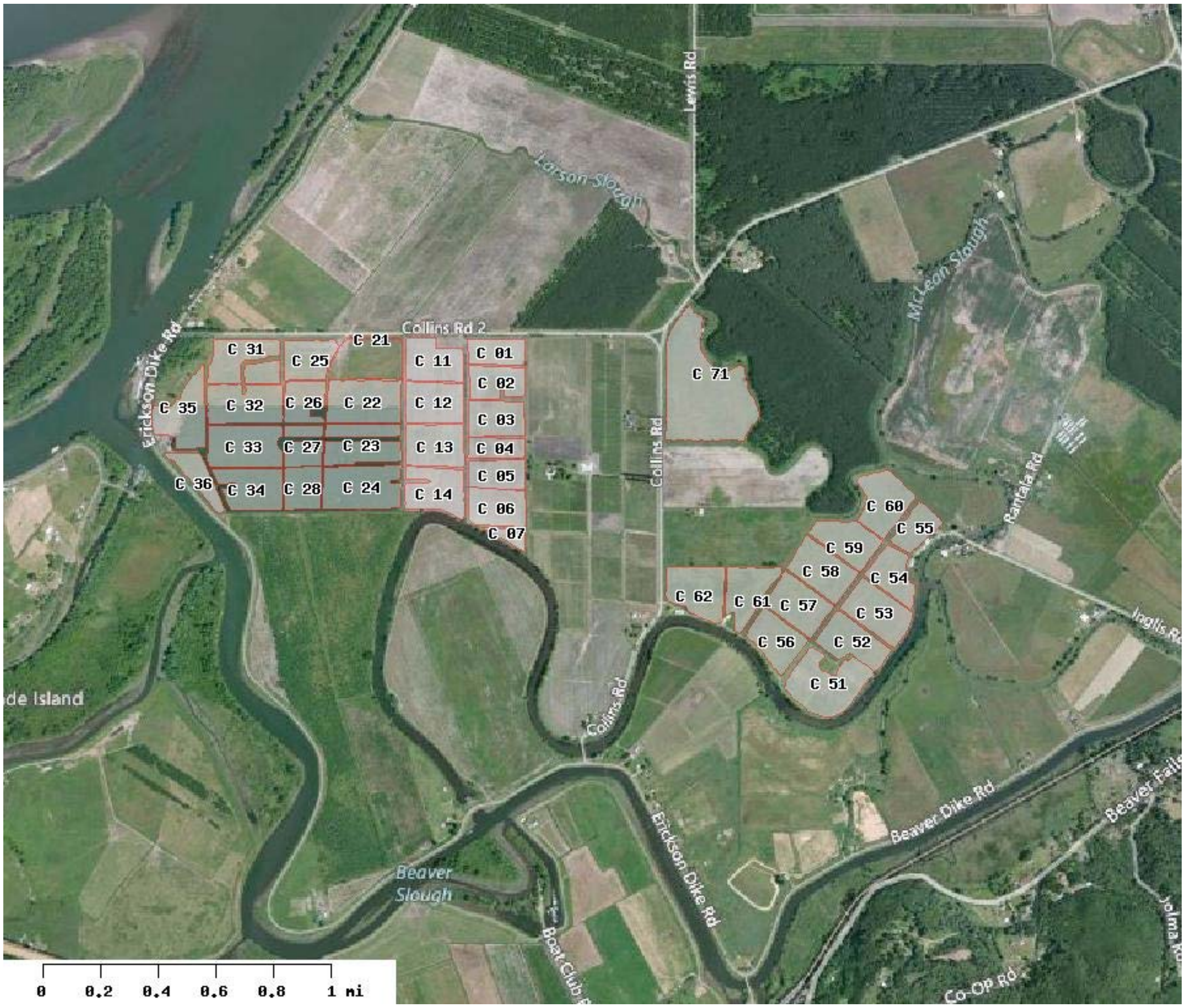
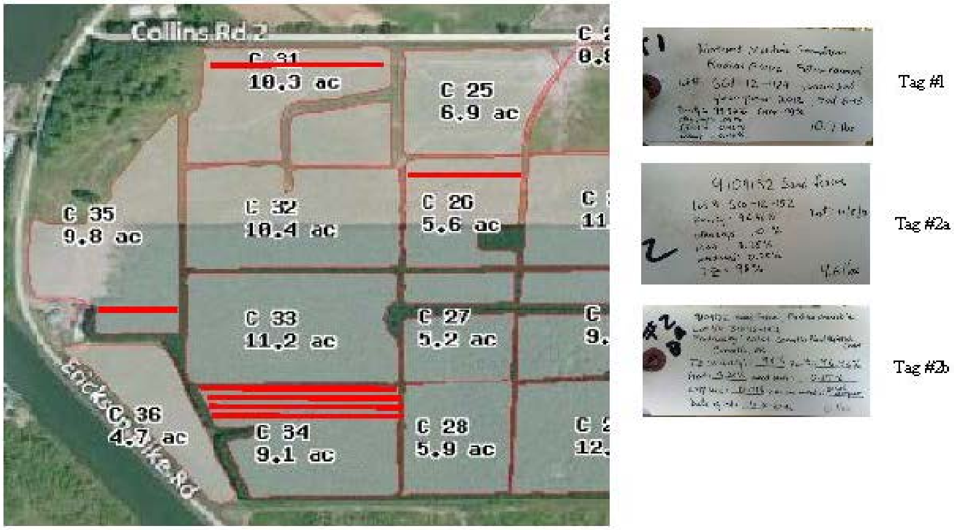


Figure 2. *Map depicting areas seeded to Roemer's and sand fescue at Hopville-Columbia Farm on Oct. 18, 2012.*



TAG #	TYPE	DATE
1	Roemers Fescue 10.7 lbs	18-Oct
2a	Sand Fescue 4.6 lbs	18-Oct
2b	Sand Fescue 6 lbs	18-Oct

Figure 3. *Initial trial establishment (20 days after planting) of standard creeping red/Chewing's fescue mix (greening up, left rows) and Roemer's fescue (flagged row, right, not yet emerged), November 7, 2012.*

Table 1. *Species and seed lots used in 2012 Hopville-Columbia Farm conservation field trial.*

Species	Common name	Variety	Accession	Lot No.	Purity	Viability	Bulk shipped	PLS shipped	Seeding rate (lb/a)
Festuca roemeri	Roemer's fescue	Northwest Maritime Germplasm	9079484	SG1-12-484	99.52%	94%	10.7 lb	10 lb	20
Festuca ammobia	sand fescue	n/a	9109152	SCO-12-152	96.46%	98%	10.6 lb	10 lb	20
Festuca rubra* ssp. *rubra	creeping red fescue	Sun & Shade Mix	commercially available seed mix purchased by grower; purity/viability unknown						20
Festuca rubra* ssp. *fallax	Chewing's fescue								

The 2012 Bureau of Land Management Annual Report:

West Eugene Wetlands

Corvallis Plant Materials Center
USDA Natural Resources Conservation Service
Corvallis, Oregon
Amy Bartow
December 15, 2012

I. Brief Background of Project

The Corvallis Plant Materials Center (PMC) entered into an agreement in the spring of 2002 with the Bureau of Land Management (BLM) to perform seed germination trials and seed increase of native wetland and wet prairie species.

Figure 1. Miniature lupine (*Lupinus polycarpus)* at the Corvallis PMC, June 20, 2012.

The West Eugene Wetlands (WEW) program collects wild seed and sows it in wetland restoration projects. Some species have been difficult to establish or have very high labor costs associated with hand collection. The PMC agreed to research and document seed propagation techniques for these species and to evaluate their potential for agronomic seed increase. Over the years, the WEW has settled on a suite of species that are best produced at the PMC.

In 2012, this agreement was renewed. Two species, *Agoseris grandiflora* and *Saxifraga oregana*, were discontinued at the PMC, and shifted to private growers. Seed increase

was renewed on 24 of the species from the 2011 contract. This agreement will be amended and renewed through 2013.
Activities in 2012 included establishing and maintaining seed increase plantings, seed harvesting and seed cleaning.

II. Accessions Included in 2012 Agreement

Table 1. Accessions included in 2012 agreement with Eugene District of the BLM.

Species	Common name	Accession	Activity in 2012[1]
Carex feta	greensheath sedge	9079315	Sfp, dlv
Carex tumulicola	splitawn sedge	9079291	Sfp, dlv
Castilleja tenuis	hairy Indian paintbrush	9079254	Sfp, pxn
Cicendia quadrangularis	Oregon timwort	9079312	Sfp, pxn
Dichanthelium acuminatum	western panicgrass	9079303	Sfp, dlv
Dodecatheon hendersonii	Henderson's shootingstar	9079615	Pxn
Downingia elegans	elegant calicoflower	9079432	Sfp, pxn, dlv
Downingia yina	cascade calicoflower	9079433	Sfp, pxn, dlv
Eryngium petiolatum	coyote thistle	9079431	Sfp, dlv
Galium trifidum	threepetal bedstraw	9079317	Sfp, pxn, dlv
Gentiana sceptrum	king's scepter gentian	9079311	Sfp, dlv
Gratiola ebracteata	bractless hedgehyssop	9079436	Sfp, pxn, dlv
Juncus tenuis	poverty rush	9079626	Sfp, dlv
Lasthenia glaberrima	smooth goldfields	9079293	Sfp, pxn, dlv
Lotus formosissimus	seaside bird's-foot trefoil	9079294	Sfp, dlv
Lupinus polycarpus	miniature lupine	9079250	Sfp, dlv
Madia glomerata	mountain tarweed	9079437	Sfp, dlv
Montia linearis	narrowleaf minerslettuce	9079295	Sfp, dlv
Myosotis laxa	bay forget-me-not	9079253	Sfp, pxn, dlv
Navarretia intertexta	needleleaf navarretia	9079378	Sfp, pxn, dlv
Navarretia willamettensis	Willamette navarretia	9109145	Sfp, pxn, dlv
Nemophila menziesii	baby blue eyes	9079379	Sfp, dlv
Orthocarpus bracteosus	rosy owl's-clover	9079502	Sfp, pxn
Phlox gracilis	slender phlox	9079299	Sfp
Rorippa curvisiliqua	curvepod yellowcress	9079257	Sfp, pxn, dlv
Veronica peregrina	neckweed	9097439	Sfp, pxn, dlv

1- sfp= seed increase, pxn= container production, dlv= delivered plant materials

III. Plant Production

Each of the species in this year's agreement has been successfully grown by the PMC in previous years. We have found that some species perform better when directly sown and others do better when grown in a greenhouse and then transplanted out as plugs into the seed increase plots. *Nemophila menziesii* and *Montia linearis* seeds were directly sown into the soil through holes in the weed fabric in late November and *Madia glomerata* and *Lupinus polycarpus* were sown in late February.

Other annual species were sown into cone-tainers, grown in the greenhouse in late winter, and then transplanted out into the seed increase plots in March.

Table 2. Plant production for the Eugene BLM WEW agreement at the Corvallis PMC in 2012.

Species	**Seed used (g)**	**Plugs produced**	**Treatment**
Castilleja tenuis	1	400	90 days cold[1], Heated greenhouse[2]
Cicendia quadrangularis	1	400	Heated greenhouse
Downingia elegans	1	400	Heated greenhouse
Downingia yina	1	400	Heated greenhouse
Galium trifidum	1	100	Heated greenhouse
Gratiola ebracteata	2	500	Heated greenhouse
Lasthenia glaberrima	2	200	Heated greenhouse
Madia glomerata	5	200	Heated greenhouse
Myosotis laxa	3	400	Heated greenhouse
Navarretia willamettensis	11	500	2 wks cold, Heated greenhouse
Orthocarpus bracteosus	1	400	90 days cold, Heated greenhouse
Phlox gracilis	2	400	2 wks cold, Heated greenhouse
Rorippa curvisiliqua	1	300	Heated greenhouse
Veronica peregrina	1	400	Heated greenhouse

1= 35°-40° F; 2= 65°-80° F

IV. Field Plantings

The *Carex feta* seed increase plot is located in the PMC constructed ponds. They are seasonally flooded to mimic the natural habitat of the species. Massive flooding occurred in March of 2012 which dumped a huge amount of weed seed and debris in the PMC ponds. The *Carex* plot was weeded many times before they flowered. Seedheads were cut from the plants using rice knives when the seeds were mature, but before they had shattered. Plant material was dried in a greenhouse, threshed using a small brush machine, and then cleaned by air screen machine.

Two 0.1-acre fields of *Juncus tenuis* and *Dicanthelium acuminatum* were established in the spring of 2010 using plugs. The *Juncus* plants were very large again this year, but they were not as vigorous as last year. Seed was harvested using the “moon rover” (a self-propelled swather) and material was laid to dry on tarps in a shed. Once it was dry, material was fed through a brush machine and cleaned using an air screen machine. The plants in the *D. acuminatum* field were large again this year, which made harvesting very difficult. This year, the “moon rover” was used to cut the stems and remove them from the weed fabric. They were laid on tarps in a shed to dry. A large amount of seed had shattered onto the fabric and was collected using two shop-vacs powered by a generator.

After the cut stems were dry, the material was fed into a stationary combine. This entire harvest process was very labor intensive, but it yielded an impressive amount of seed for the size of the field. It also minimized genetic selection than can occur with a single harvest method.

Figure 2. Western panicgrass (*Dicanthelium acuminatum*) is one of the few native warm season grasses in Oregon.

Seed increase of many annual species was performed using weed fabric as a passive seed collector. Three 15 by 170 ft sheets of weed fabric were stapled down onto a field that had been previously sprayed with glyphosate herbicide. Small squares were cut out of the weed fabric slightly larger than the size of the cones in order to transplant the cone-tainer plants. The weed fabric is reused from year to year.

Small, battery-powered hand vacuums were used twice a week to collect seed of *Veronica peregrina* and *Lasthenia glaberrima*. The seeds of these species easily shatter from the plant, but can blow off the weed fabric. The seeds were swept and vacuumed and the material placed in bags in an open greenhouse to dry, and then cleaned with small air-screen machines.

Lupinus bicolor, *Lotus formosissimus*, *Rorippa curvisiliqua*, *Montia linearis*, and *Nemophila menziesii* were harvested once. The seeds of these species fall or shatter readily from the plants as they ripen, but remain on the fabric. Seeds were swept and vacuumed, leaving the plants intact. The seeds were cleaned with a small air-screen machine. The *N. menziesii* plants were very weak and small this year. They produced very little seed. The lack of vigor may have been due to seed age (seed was from 2006) and using fresh seed will alleviate this problem in 2013.

For species with seed that does not shatter as readily (*Navarretia intertexta*, *Downingia elegans*, *Downingia yina*, *Gallium trifidum*, and *Myosotis laxa*), plots were harvested by pulling or cutting entire plants, then feeding them into a brush machine to separate seeds from the plants prior to cleaning the seeds. These plots were also swept and vacuumed to recover the seed that had shattered onto the fabric. Separate collections of *N. intertexta* and *N. willamettensis* were made in 2010 by WEW staff. When the *N. willamettensis* collection was grown out in 2011, the plot contained both species. It is possible that *N. intertexta* plants volunteered in the plot, even though the plots are thoroughly weeded prior to transplanting. *Navarretia willamettensis* plants were flagged while they were flowering (when they could be correctly identified), and were harvested separately. Both collections (WEW2010 wild + PMC field selection 2011) of *N. willamettensis* were grown out in 2012. The plants grown from the PMC field selection were very small and weak compared to the wild collection made by WEW staff, but they did not contain ANY *N. intertexa*. The plants grown from the two collections were planted separately, but side by side. The wild collected *N. willamettensis* contained a fair amount of *N. intertexta*. The *N. willamettensis* plants were harvested separately in an attempt to create a pure collection from the plot. The amount and quality of seed produced this year was much higher than last year.

Figure 3. Mountain tarweed (*Madia glomerata*) flowering in a seed increase plot at the Corvallis Plant Materials Center, July 5, 2012.

The *Phlox gracilis* plants looked less vigorous than usual this spring, and then became infected with powdery mildew. The plants were so damaged by the mildew that they died before setting seed. The seed that was used to grow this year's crop was from 2006. Hopefully using new seed in 2013 will create a vigorous crop.

Most of the plots for this project are not large enough to warrant the use of a combine. However, the *Eryngium petiolatum* and *Madia glomerata* plots have a large amount of plant material and seeds that are difficult to dislodge from the seedheads. These plots were experimentally harvested using the Hege plot combine fitted with a reel head to cut the material while it was standing. This method was extremely effective and efficient. The weed fabric was also vacuumed after combining to recover seeds that shattered on the fabric. A tarp was tied to the back of the combine to catch all the debris so it did not fall on the weed fabric. This extra step makes it much easier to vacuum the seeds from the fabric without the added debris from the combine.

Figure4. Coyote thistle (*Eryngium petiolatum)* plants grow into a solid mass when in cultivation, July 12, 2012.

V. Seed Increase Tubs

Some perennial species were maintained in tubs in the PMC shadehouse. Plants were monitored daily for disease and pests as well as seed maturity. Plantings were overhead watered as needed.

The *Carex tumulicola* tub was

established from cone-tainers seeded in 2003. Seed heads were clipped when mature. When over 80% of seed heads were ripe at the same time, the entire tub was cut back and all the clippings were dried in a greenhouse on a tarp. Seed production was moderate this year.

Gentiana sceptrum plants were transplanted into the tub in late summer of 2004. Seeds from the tub were collected when capsules began to turn papery and tan. Some seed predation by seed weevils has been observed for the past several years, but not enough to seriously affect the harvest.

Table 3. Harvest dates and yields for seed increase tubs and plots.

Species	Method	Dates	Yield
Carex feta	hand	Aug 30	810 g
Carex tumulicola	hand	July 20	71 g
Cicendia quadrangularis	hand	April 10-25	7 g
Dichanthelium acuminatum	moon rover/vac	July 30	48 lbs
Downingia elegans	cut/vac	Sept 3	880 g
Downingia yina	cut/vac	Sept 3	757 g
Eryngium petiolatum	direct combine/vac	Oct 15	2 lbs
Galium trifidum	cut/vac	Oct 10	981 g
Gentiana sceptrum	hand	Sept 5-30	123 g
Gratiola ebracteata	hand	April 5	51 g
Juncus tenuis	moon rover	July 5	57 lbs
Lasthenia glaberrima	vac	June 4-July 11	900 g
Lotus formosissimus	vac	Sept 3	45 g
Lupinus polycarpus	vac	July 12	1609 g
Madia glomerata	direct combine/vac	Oct 15	1720 g
Montia linearis	vac	May 21	648 g
Myosotis laxa	cut/vac	Aug 27	985 g
Navarretia intertexta	cut/vac	Aug 27	56 g
Navarretia willamettensis	cut/vac	Aug 27	51 g
Nemophila menziesii	vac	Aug 27	111 g
Rorippa curvisiliqua	vac	Sept 3	197 g
Veronica peregrina	vac	June 27-July 11	1360 g

Additional 2012 Seed Increase Notes

Some annual species show no increase in seed production when transplanted into a field and can live out their life cycle while in cone-tainers. *Gratiola ebracteata* plants flowered in their cone-tainers. Small battery-powered grass clippers were used to cut the plants like a mini-swather. Seeds were dried in an open greenhouse. Mature *Cicendia quadrangularis* capsules were cut and dried in an open greenhouse. Capsules were separated from the seed using hand screens.

The *Castilleja tenuis* and *Orthocarpus bracteosus* crops were grown in containers this year. The seed used to grow these plants is getting old. The *C. tenuis* and *O. bracteosus* seeds had poor germination, survival, and vigor. The plants flowered, but did not produce seed in 2011 or 2012. Fresh seed was received in 2012 and will be used to grow plants in 2013.

VI. Plant Materials Delivery

Seed was requested for delivery in late September in order to be available for fall sowing on restoration sites. Some plantings were still producing seed at this time. Seed lots that had been harvested and cleaned were picked up by BLM staff in September 2012. All remaining seed lots are being stored at the PMC seed storage facilities until requested.

Table 4. Seed delivered to BLM staff in the fall of 2012.

Species	Symbol	Seed lot	Weight
Carex feta	CAFE4	SG1-12-EB	810 g
Dichanthelium acuminatum	DIAC2	SG1-12-EB303	48 lbs
Downingia elegans	DOEL	SG1-12-EB432	880 g
Downingia yina	DOYI	SG1-12-EB433	757 g
Eryngium petiolatum	ERPE7	SG1-11-EB431	7 lbs
Galium trifidum	GATR2	SG1-11-EB317	1100g
Galium trifidum	GATR2	SG1-12-EB317	981 g
Gentiana sceptrum	GESC	SG1-11-EB311	193 g
Gratiola ebracteata	GREB	SG1-12-EB436	51 g
Juncus tenuis	JUTE	SG1-12-EB	57 lbs
Lasthenia glaberrima	LAGL3	SG1-12-EB293	900 g
Lotus formosissimus	LOFO2	SG1-12-EB294	45 g
Lupinus polycarpus	LUPO3	SG1-12-EB250	1609 g
Madia glomerata	MAGL2	SG1-11-EB437	1803 g
Montia linearis	MOLI4	SG1-12-EB295	648 g
Myosotis laxa	MYLA	SG1-12-EB253	985 g
Navarretia intertexta	NAIN2	SG1-12-EB378	218 g
Navarretia willamettensis	NAWI	SG1-12-EB145	51 g
Nemophila menziesii	NEME	SG1-12-EB378	111 g
Rorippa curvisiliqua	ROCU	SG1-12-EB257	197 g
Veronica peregrina	VEPE2	SG1-12-EB439	1360 g

Table 5. Seeds in storage at the Corvallis PMC.

Species	Symbol	Seed lot	Weight
Carex tumulicola	CATU3	SG1-12-EB291	71 g
Cicendia quadrangularis	CIQU3	SG1-12-EB254	7 g
Eryngium petiolatum	ERPE7	SG1-12-EB431	2 lbs
Gentiana sceptrum	GESC	SG1-12-EB311	123 g
Madia glomerata	MAGL2	SG1-12-EB437	4 lbs

CORVALLIS PLANT MATERIALS CENTER
USDA NATURAL RESOURCES CONSERVATION SERVICE
CORVALLIS, OREGON
Amy Bartow

December 20, 2012

THE 2012 OLYMPIC NATIONAL PARK ANNUAL REPORT:
Elwha River Ecosystem and Fisheries Restoration

Figure 1. PMC staff members Amy Bartow and John Knox, with half of the seed that was delivered to the Park , September 24, 2012.

I. Brief Background of Project

The Corvallis Plant Materials Center (PMC) entered into an agreement with Olympic National Park in 2004 to provide native plant materials for the ecological restoration of Lake Mills and Lake Aldwell following the removal of two high head dams on the Elwha River. The PMC agreed to produce 4,355 lbs of four grass species, 450 lbs of two sedge species, and 430 lbs of three forb species. The PMC completed the requirements of the agreement this year and exceeded production by over 1,000 lbs!

Activities in 2012 included maintenance and harvest of seed production fields including two grasses, one forb, and two sedges. A very large shipment of seed was delivered to the Park in September. Park staff will be seeding the restoration sites throughout the fall and again in the spring. PMC staff also visited the restoration sites while delivering seed. They were able to view the seed mixes that were applied to the site in March of 2012.

II. Accessions Involved

Accessions included for the Elwha River Ecosystem and Fisheries Restoration Cooperative Agreement are listed in Table 1. This table also displays activities performed by PMC staff in 2012.

Table 1. Accessions involved and activities performed in 2012 for the Elwha River Ecosystem and Fisheries Restoration Cooperative Agreement at the Corvallis Plant Materials Center.

Species	Common name	PLANTS Symbol	Accession number	2012 Activity*
Achillea millefolium	yarrow	ACMI2	9079349	Dlv
Agrostis exarata	spike bentgrass	AGEX	9079401	Dlv
Artemesia suksdorfii	coastal wormwood	ARSU4	9079400	Dlv
Bromus complex	brome complex	BR spp.	9079332	Sfp, Dlv
Carex deweyana	Dewey sedge	CADE9	9079330	Sfp, Dlv
Carex pachystachya	thick-headed sedge	CAPA14	9079329	Sfp, Dlv
Deschampsia elongata	slender hairgrass	DEEL	9079335	Dlv
Eriophyllum lanatum	wooly sunflower	ERLA6	9079441	Sfp, Dlv
Elymus glaucus	blue wildrye	ELGL	9079334	Sfp, Dlv

* Sfp= seed increase, Dlv= delivered plant materials

III. Field Production Activities

Figure 2. The PMC's Hege plot combine was fitted with a reel header for direct combining the brome field.

January through March of 2012 was unusually wet and many fields at the PMC were flooded. Some fields were continuously under water for two to three months. Many plants can withstand periods of saturation while they are dormant, but as they begin to grow again in the spring they can be damaged by too much water. The brome field had long-standing pools of water for a couple months. Once the water receded in early April, it appeared that the plants in the wet areas had died. But as the soil dried and warmed, the plants slowly began to grow again. The field was not as tall or vigorous as it was in 2011, and the areas that were underwater took longer to flower and set seed, but overall the field looked fair. Seed maturity was more even across the field than in 2011 (except for the wet areas). We tried a new harvest method this year to prevent losses occurring during drying after the field has been swathed. The field was directly combined, meaning that it was combined while still standing and slightly green. This method worked very well and produced the highest yields from this field in three years, even though this years' field probably produced the least amount of seed. The only down-side to this harvest method is that the seed is still quite damp and needs to be laid out in the sun to dry and cure. This requires a lot of space to lay the seed out on tarps, labor to constantly turn it, and a close eye on the weather (to keep the seed from geting rained on!). The field was combined on two occasions due to the slower growth of the areas that were wetter.

Table 2. Seed harvest in 2012 for the Elwha River Ecosystem and Fisheries Restoration Cooperative Agreement at the Corvallis PMC.

Species	**Area (acre)**	**Date(s)**	**Method**	**Yield (lbs)**
Elymus glaucus	3.1	July 10-12	swath/combine	1550
Bromus carinatus	2.25	June 27-July 11	direct combine	872
Carex deweyana	0.2	July 6	hand	22
Carex pachystachya	0.5	June 27	moon rover	270
Eriophyllum lanatum	0.3	August 25	swath/combine	88

The blue wildrye field wasn't as vigorous in 2012 as it was in 2011, but it still produced a lot of seed. It was swathed in early July and combined a week later after it had dried sufficiently. PMC staff tried out the new Wintersteiger plot combine on this field and it worked wonderfully. The combine is small, but handled the thick material without clogging. One of the best features of this combine is the pick-up belt. The fingers gently pick up the swaths without dislodging the seed. This is a great combine for native grasses.

Figure 3. The blue wildrye (*Elymus glaucus*) field for this project produced over 700 lbs of seed per acre in 2011. This was the highest yield ever recorded for this species at the PMC.

The older *C. pachystachya* field still appears healthy and vigorous and the newer section reached peak production in 2012. The "moon rover" was used again this year to harvest both portions of the field. This method seems to produce the highest yields. And 2012 was a great year for this species! The fields produced 270 lbs on a half acre.

The *C. deweyana* plot was expanded in the fall of 2010. The new plants grew vigorously and produced a fair amount of seed for their first growing season. The field was hand harvested on two occasions. This species does not seem well adapted to the growing conditions at the Corvallis PMC.

Figure 5. Wooly sunflower (*Eriophyllum lanatum*) seed increase field at the Corvallis PMC, June 13, 2012.

The *E. lanatum* field was established at two different times. One area was established in the spring of 2009 using transplants and one was direct seeded in the fall of 2009. Winter survival in the area that was direct seeded was much lower than in the area that was established from plugs. It is not fully understood why this occurred. This species tends to be shallowly rooted, but when grown in cone-tainers the roots grow to the bottom of the cone-tainer rather than laterally, so transplants tend to have deeper roots than direct sown plants. This difference may have caused the transplants to be less susceptible to cold weather. Even with fewer plants in the field, the seed yield was still high because the remaining plants grew into the extra space. The field was swathed in late August and combined two weeks later when the plant material had dried.

V. Field Production Notes for 2012

Weed control in all fields was primarily performed by hoeing and by spot application of glyphosate. Fields were walked many times during the year, especially at times when weedy perennial grasses look very different than the crop (late September and April). Weeds were wiped with herbicide using spot applicators. Field borders were tilled. Broadleaf herbicides (Bison and Banvel) were applied to grass fields in April. All fields were fertilized with 50 lbs/acre Nitrogen (urea) in March.

VII. Delivery of Plant Materials

Seed mixes were created to be sown on de-watered areas in the lake beds last fall. These seed mixes were not applied to the sites until March. PMC staff visited the Park in late September and toured the dam removal sites and evaluated the seed mixes. All of the species in the mixes were present on the site. Plant establishment was very high for all mixes and plant vigor was also high for all species except for *E. lanatum*. It was inspiring to witness how these native species performed in the absence of non-native weeds.

The majority of the seed produced for this project was delivered to the Park in late September. Park staff plan to seed the remaining sites throughout the fall and spring. Over 5,400 lbs of seed was delivered and another 1,500 lbs remain at the PMC in the seed storage facilities. The PMC exceeded the project goals by over 1,000 lbs!

Figure 4. The west side of Lake Mills (left of photo) was seeded with mixes in March of 2012. The east side (right) was not seeded, leaving the sediments bare throughout the summer. September 24, 2012.

Table 5. Seed mixes designed for trials for the Elwha River Ecosystem and Fisheries Restoration Cooperative Agreement.

	lbs/ac	PLS lbs used	bulk lbs used	seeds/sq.ft.
Mix 1: Forbs				
ACMI2	1	0.5	0.7	69
ERLA6	4	2	4	66
ARSU4	0.5	0.25	0.5	42
total	5.5	2.75	5.2	177
Mix 2: Aggressive grass mix				
Brome	8	4	4.3	15
ELGL	12	6	6.3	36

	lbs/ac	PLS lbs used	bulk lbs used	seeds/sq.ft.
total	20	10	10.6	51

	lbs/ac	PLS lbs used	bulk lbs used	seeds/sq.ft.
Mix 3: Slow grasses/sedges				
CADE9	1	0.5	0.73	17
CAPA14	2	1	1.31	36
DEEL	2	1	1.38	120
AGEX	1	0.5	0.52	114
total	6	3	3.94	287
Mix 4: All species				
ACMI2	0.14	0.07	0.09	10
ERLA6	1	0.5	0.98	14
ARSU4	0.1	0.05	0.2	12
Brome	5	2.5	2.74	10
ELGL	5	2.5	2.63	16
CADE9	0.25	0.13	0.19	4
CAPA14	0.5	0.25	0.33	10
DEEL	0.14	0.07	0.09	10
AGEX	0.1	0.05	0.52	10
total	12.23	6.12	7.77	96

Seed inventory is summarized in Table 6. Our seed lot numbers describe the generation of the field (SG0 or SWC is wild collected seed, SG1 is seed that is produced from the plants that were grown using wild collected seed). The middle numbers of a seed lot note the year in which the seed was produced. The last portion of the seed lot describes which project the seed is for (ER is for Elwha River) and the last three digits of the accession number that has been assigned to this species specifically for this project. All seed for this project was delivered except for the 2012 harvest of *Elymus glaucus* (1,550 lbs), which will be held in the PMC seed storage facilities until requested.

Table 6. Seed delivered to the Olympic National Park for the Elwha River Restoration Cooperative Agreement, September 24, 2012.

Species	Harvest year	Weight (lbs)	Total pounds per species
Bromus spp	2006	156	
	2007	64	
	2010	495	
	2011	468	
	2012	884	2,067
Elymus glaucus	2007	134	
	2010	500	

	2011	2163	2,797
Carex pachystachya	2008	52	
	2007-2010	52	
	2011	74	
	2012	270	360
Eriophyllum lanatum	2009	16	
	2010	43	
	2011	54	
	2012	88	238
Deschampsia elongata	2006/2007	32	32
Carex deweyana	2006-2012	28	28
Agrostis exarata	2007	17	17
Artemesia suksdorfii	2009	1	1
			5,540

Seed production for Medford District Bureau of Land Management: 2012 Annual Report

Prepared by Amy Bartow
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Figure 1. Queen bumble bees flock to the *Rupertia physodes* seed increase field at the PMC farm, June 13, 2012.

I. Brief Background of Project

The Corvallis Plant Materials Center (PMC) entered into an agreement with the Medford District of the Bureau of Land Management (BLM) in 2004 to provide native plant materials for ecological restoration. The agreement was continued in 2012. It was agreed that the PMC would maintain seed increase fields of two legumes and four forbs.

II. Accessions Involved

Accessions included for the Medford District BLM in 2012 are listed in Table 1. This table also displays activities performed by PMC staff. Activities in 2012 included maintenance and harvest of seed increase fields of a legume and four forbs.

Table 1. Accessions involved for Medford District BLM cooperative agreement with Corvallis Plant Materials Center in 2012.

Species	Common name	Code	Accession #	Activity in 2012[1]
Eriogonum umbellatum	sulphur-flower buckwheat	ERUM	9079425	sfp
Iris douglasiana	Douglas iris	IRDO	9079417	sfp
Potentilla glandulosa	sticky cinquefoil	POGL9	9079427	sfp
Rupertia physodes	forest scurfpea	RUPH3	9079323	sfp
Sisyrinchium bellum	western blue-eyed grass	SIBE	9079420	sfp

1- sfp= seed increase

III. Field Seed Increase

In 2009, *R. physodes* plants were transplanted into fields covered with weed fabric. The plants have been increasing in size over the years. This spring the plants emerged in late March. During this time, the PMC farm experienced very cold, wet conditions including 6 inches of snow. Within weeks the stems of the *Rupertia* began to wilt and die. Some of the plants managed to send up a couple new stalks and flower, but the field looked small and weak. Seed was harvested by cutting plants with a sickle-bar mower after all seed had shattered onto the fabric. Cut material was raked and pitchforked off the fabric. The fabric was vacuumed using two shop-vacs hooked to a gas-powered generator. In late summer, all the plants began growing and looked very healthy; by late fall when they went dormant. Hopefully the plants will emerge in the spring of 2013 and will have fully recovered from the cold damage last spring.

Table 2. Yields from seed increase fields at the Corvallis Plant Materials Center in 2012.

Species	Harvest date	Method	Field size (ac)	Yield
Eriogonum umbellatum	July 9	hand	<0.1	4 lbs
Potentilla glandulosa	July 6	Direct combine	<0.1	9 lbs
Sisyrinchium bellum	July14-25	hand	<0.1	740 g
Iris douglasiana	July10-23	hand	<0.1	4.6 lbs
Rupertia physodes	July 31	vac weed fabric	0.15	4 lbs

When the *Eriogonum umbellatum* plants were first established in 2005, the PMC typically had warm, dry spring weather which favored establishment and seed production of this species. The spring weather since 2008 has been very wet and cool. The spring of 2012 wasn't as wet or cold in June as it was in previous years, but it still is affecting seed production. Plants flowered, but did not seem to produce many filled seeds. Seeds were cut from the plants and dried in a greenhouse.

The *Potentilla glandulosa* field flowered later than usual; these plants appear to be at prime production, and yields continue to increase every year. Seed production was very high for this little plot! PMC staff decided to try some mechanical harvest methods on this species. Direct combining is a good technique for *P. glandulosa* because the seed matures uniformly and doesn't have a lot of green plant material that needs to be cut with the seed stalks. The reel on the front of the combine had to be carefully adjusted so it did not shatter all the seed when the stalks were being fed into the combine. All other adjustments were simple and the seed that came out of the combine was VERY clean. Some seed was lost as the reel fed the material into the combine, but it was minimal. This technique was very effective.

Figure 2. PMC staff use a Hege plot combine to experimentally direct combine forbs in 2012.

Plots of *Sisyrinchium bellum* and *Iris douglasiana* were established in March of 2008 using transplants that were grown in 2007. The iris plants finally flowered in 2010, but really weren't mature until 2011. Both fields were fertilized this year and had higher production than last year. The fields were harvested by hand three times a week while the seeds were maturing.

IV. Delivery of Plant Materials

BLM staff picked up all the seed that had been in storage prior to this year, as well as this year's harvest.

Table 4.Seed delivered to BLM staff in 2012.

Scientific Name	Origin	seed lot	Produced by PMC	Provided by BLM
Rupertia physodes	E Evans Creek	SG2-10-MB323	11 lbs	
Rupertia physodes	E Evans Creek	SG2-11-MB323	32 lbs	
Rupertia physodes	E Evans Creek	SG2-12-MB323	4 lbs	
Poa secunda	Hyatt lake	SG2-09-MB394	261 lbs	
Achnatherum lemmonii	Granite	SCO-07-MB398	180 g	
Iris douglasiana	Box O	SG1-10-MB417	26g	72 g
Iris douglasiana	Box O	SG1-11-MB417	3 lbs	
Iris douglasiana	Box O	SG1-12-MB417	4.6 lbs	
Penstemon roezlii	Box O	SG1-08-MB419	202g	
Penstemon roezlii	Box O	SG1-08-MB419	194g	

Table 4. Seed delivered to BLM staff in 2012 (Cont').

Scientific Name	**Origin**	**seed lot**	**Produced by PMC**	**Provided by BLM**
Sisyrinchium bellum	Box O	SG1-09-MB420	290g	8g
Sisyrinchium bellum	Box O	SG1-10-MB420	56g	
Sisyrinchium bellum	Box O	SG1-11-MB420	370 g	
Sisyrinchium bellum	Box O	SG1-12-MB420	740 g	
Eriogonum umbellatum	Grizzly Peak	SG1-09-MB425	1585g	5g
Eriogonum umbellatum	Grizzly Peak	SG1-10-MB425	0.5 lbs	
Eriogonum umbellatum	Grizzly Peak	SG1-11-MB425	10 lbs	
Eriogonum umbellatum	Grizzly Peak	SG1-11-MB425	4 lbs	
Lupinus adsurgens	I-5 Merlin Exit	SG1-08-MB426	228g	1 g
Lupinus adsurgens	I-5 Merlin Exit	SG1-10-MB426	17 lbs	
Lupinus adsurgens	I-5 Merlin Exit	SG1-11-MB426	12 lbs	
Potentilla glandulosa	Soda Mt	SG1-07-MB427	24 g	5 g
Potentilla glandulosa	Soda Mt	SG1-08-MB427	295 g	
Potentilla glandulosa	Soda Mt	SG1-09-MB427	2.5 lbs	
Potentilla glandulosa	Soda Mt	SG1-10-MB427	9 lbs	
Potentilla glandulosa	Soda Mt	SG1-11-MB427	11.5 lbs	
Potentilla glandulosa	Soda Mt	SG1-11-MB427	9 lbs	
Clarkia rhomboidea	Buckhorn	SG1-09-MB595	1 lb	
Clarkia rhomboidea	Buckhorn	SG2-10-MB595	28 lbs	
Lomatium macrocarpum	Pelton Rd	wild collected		129 g
Festuca romeri	Indigo Creek	SCO-07-MB326	1 lb	
Festuca romeri	Indigo Creek	SCO-05-MB326	1 lb	
Xerophyllum tenax	35-9-11 Biscuit	wild collected		226 g
Scirpus microcarpus	Parsnip lakes	wild collected		33 g
Juncus tenuis	Obenchain Rd	wild collected		13 g
Cimicifuga elata	Grizzly Mt	wild collected		12 g
Darlingtonia californica	Biscuit fire	wild collected		4 g
Achnatherum lemmonii	Granite	SCO-07-MB398	180 g	
Festuca californica	Anatuvak	SCO-04-MB499		836 g
Penstemon roezlii	Box O	SG1-08-MB419	202 g	
Penstemon roezlii	Box O	SG1-08-MB419	194 g	
Triteleia hyacinthina	Box O	wild collected		8 g
Festuca elmeri	Gall's Creek	SG1-06-MB422	24 g	26 g
Polemonium carneum	Grizzly Peak	SG1-08-MB424	4 g	1 g

Seed production for Roseburg District Bureau of Land Management: 2012 Annual Report

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Figure 1**.** Common madia **(***Madia elegans*) in a seed increase field at Corvallis Plant Materials Center, July 10, 2012. Petals of this ecotype lack the brown-spotted base and maroonish disk flowers.

I. Brief Background of Project

The Corvallis Plant Materials Center (PMC) entered into an agreement with the Roseburg District of the Bureau of Land Management (BLM) in 2005 to provide native plant materials for ecological restoration. Over the past six years, numerous species have been added and dropped from the agreement. In 2012 no new species were added, although 12 species from previous years were continued.

Activities in 2012 included maintenance and harvest of 11 seed increase fields (three grasses, four forbs, one sedge, and two legumes) and plant production of one sedge.

II. Accessions Involved

Accessions included for the Roseburg District of the BLM in 2012 are listed in Table 1. This table also displays activities performed by the PMC staff.

Table 1. Accessions involved for Roseburg District BLM cooperative agreement with Corvallis Plant Materials Center in 2012.

Species	Common name	Symbol	Accession	Activity in 2012[1]
Achnatherum lemmonii	Lemmon's needlegrass	ACLE8	9079429	Sfp
Achnatherum lemmonii	Lemmon's needlegrass	ACLE8	9109066	Sfp
Carex densa	dense sedge	CADE8	9109063	Pxn,Sfp
Danthonia californica	California oatgrass	DACA3	9079415	Sfp
Danthonia californica	California oatgrass	DACA3	9079428	Sfp
Festuca californica	California fescue	FECA	9079494	Sfp
Gilia capitata	bluehead gilia	GICA5	9109062	Sfp
Lupinus bicolor	miniature lupine	LUBI	9109067	Sfp
Madia elegans	common madia	MAEL	9109065	Sfp
Madia gracilis	grassy tarweed	MAGR3	9109061	Sfp
Sisyrinchium hitchcockii	Hitchcock's blue-eyed grass	SIHI4	9079491	Sfp

1- Sfp= seed increase, Pxn=plant production

II. Field Seed Increase Activities

New fields of *Carex densa* and *Achnathrum lemmonii* (from serpentine soils) were established in the fall of 2011 using six-month-old transplants. The fields were very weedy in the spring of 2012 and the needlegrass plants were difficult to locate. The needlegrass plot was mowed using a flail chopper with a collection attachment. This machine removed most of the annual weeds (and the foliage of the needlegrass). After mowing, the needlegrass grew new foliage and since the plants were easy to find the plot was weeded without damaging the grasses. The plants did not flower in 2012The *C. densa* field was hand weeded twice during the growing season. The plants flowered in late spring and seed was collected by hand in late June.

The annual species involved in this agreement are established using wild seed in late fall or early spring. *Madia gracilis* seed is sown directly into holes in weed fabric in November; these seeds germinate best in cool temperatures and plants grow considerably in the cool months of late fall and winter. They are also not damaged by standing water or saturated soils, which are very common at the PMC farm. *Lupinus bicolor* seeds also germinate best in cool temperatures, but do not have high growth rates in winter. They also are highly damaged by slugs and standing water, therefore, we find it is best to sow scarified seed into holes in weed fabric in February. Seedlings emerging in March have a much higher chance of survival than those in November. *Gilia capitata* seedlings have germination requirements and growth habits that are similar to *M. gracilis* (fall germinator + high winter growth), yet these plants are damaged by saturated soils and standing water. In drier climates, the seed should be sown in late fall, but at the PMC, highest rates of establishment occur when seeds are sown in February. *Madia elegans* naturally germinates in March, so we sow it into holes in weed fabric in late February.

All species appeared to be growing well in spring except for the *G. capitata*. The seedlings were reddish and stressed. March 2012 was exceptionally wet and cold at the PMC. The field dried out in May and the plants began to thrive, but were smaller than last year's plants. Fields of annuals were weeded by hand many times in the growing season.

Figure 2. Common madia (*Madia elegans*) and bluehead gilia (*Gilia captata*) seed increase plots at the Corvallis Plant Materials Center, July 10, 2012.

The *Sisyrinchium hitchcockii* field appeared less vigorous in 2012 than the previous year. In past years, the field was harvested using the moon rover which cuts all the standing material before all the capsules have opened. The cut material was laid on tarps to dry, and finally fed through a combine to thresh and roughly clean the seed. This method requires a lot of time and space for handling the cut material, so this year we experimented with direct combining. Our Hege combine can be used for "direct combining", where standing material is cut and fed through the combine in the same operation. This method is much quicker than harvesting with the moon rover, but seed shatter can be higher depending on how variable the ripening is across the field. Our fields also are covered with weed fabric, so if shatter is high, we can recover the seeds through vacuuming or seed stripping the fabric. Shatter was low on the *S. hitchcockii* field, so it was not vacuumed or seed stripped after combining.

We also experimented with direct combining both *Madia* spp. and the *G. capitata* fields. As we were combining, material coming out of the back was collected on a tarp and dumped off the field. It was much easier to vacuum the seeds off the fabric without the extra material from the combine. Two shop vacs powered by a generator were used to vacuum the seeds off the fabric and out of the holes. The combining worked excellently with the *G. capitata*; seeds did not shatter easily when plants were cut, capsules opened in the combine, and relatively clean seed came out of the combine. The *Madia* fields were not as successful. The plants were so tall and bushy that a large amount of seed shattered as the reel pushed the cut plants into the combine. The *Madia* seeds are also enclosed in a Velcro-like sheath that makes it difficult to determine filled from non-filled seed and separate the seeds from other material. The sheaths also caused more seed to spill out the back of the combine since they do not easily fall through the screens. Overall, combining was much faster than other harvest methods, but if weed fabric had not been used, yields probably would have been very low. Direct combining appeared to result in equal or slightly lower yields, but this small loss was greatly offset by the efficiency of the harvest method. Hours spent hand harvesting and threshing in 2011, totaled 20 hrs, compared to 4 hours spent combining (including cleaning the combine).

The *Danthonia californica* seed increase fields that were sown in the fall of 2007 are still producing well. Yields in 2012 were not as high as they were in 2011. Past studies at the PMC have shown that perennial native grass fields produce the highest seed yields when fertilized in late February. Fields were fertilized later in 2012 (early April) due to standing water, so this could have influenced the lower yields.

The *Achnatherum lemmonii* field that was started from plugs in 2006 is still growing well and remains robust. This field was hand harvested in 2012. Its yields have remained steady for the past five years. Even though this species is planted into a field that has poor drainage and saturated soils in winter, the plants are doing quite well. This species can tolerate wet conditions if healthy transplants are established in spring.

Table 4. Seed yields for the Roseburg District BLM cooperative agreement with the Corvallis Plant Materials Center in 2012.

Species	Field size	Harvest Date	Method	Yield (lbs)
Sisyrinchium hitchcockii	0.1 ac	Aug 24	direct combine	13.5
Danthonia california	0.48 ac	July 2	seed stripper, swath/combine	110
Danthonia california	0.23 ac	July 5	seed stripper, swath/combine	51
Achnatherum lemmonii	0.04 ac	June 29	hand	7.5
Festuca californica	0.23 ac	June 24	seed stripper	22.5
Gilia capitata	0.1 ac	Aug 26	direct combine	15
Madia elegans	0.1 ac	Aug 26	direct combine	31.5
Madia gracilis	0.1 ac	Aug 21	direct combine	22
Carex densa	0.07 ac	June 27	hand	1
Lupinus bicolor	0.1 ac	Aug 1-19	hand, sweep weed fabric	7

The *Festuca californica* field that was sown in 2009 often seems to struggle in the wet soils of the PMC farm. Plants survive, but sometimes appear reddish in early spring. Yields were higher this year than in previous years. The seeds had a much higher rate of fill this year, which could be due to lack of rain during pollination.

The *Lupinus bicolor* field was extremely vigorous this year. Establishment was very high due to aggressive slug control and weeding. Plants were fertilized in late April which definitely caused a spurt of growth in late spring and probably boosted seed yields. The field was so thick that it was difficult to walk through to harvest without damaging plants or seed pods. Therefore, the field was only harvested once, late in the season. Plants were removed by hand, then fabric was swept and holes were vacuumed. One drawback to waiting until all the seed had shattered was that mice discovered the seeds laying on the fabric. There was a fair amount of mice droppings on the fabric which indicates that they were most likely eating the seeds.

Figure 3. Miniature lupine (*Lupinus bicolor*) seed increase field at the Corvallis Plant Materials Center, July 10, 2012.

V. Delivery of Plant Materials

There were no deliveries made for this project in 2012.

All seed that was not delivered will remain in the Corvallis PMC seed storage facilities until requested. Our seed lot numbers describe the generation of the field (SG0 or SWC is wild collected seed, SG1 is seed that is produced from the plants that were grown using wild collected seed, i.e. generation 1). The middle numbers of a seed lot denote which year the seed was produced. The last portion of the seed lot describes which project the seed is for (RB is for Roseburg BLM) and the last three digits of the accession number that has been assigned to this species specifically for this project.

Table 5. Seeds in storage at the Corvallis Plant Materials Center for the Roseburg District BLM cooperative agreement in 2012.

Species	**Lot number**	**Weight**	**Total per accession**
Eriogonum nudum	SWC-06-RB489	99 g	
Eriogonum nudum	SG1-08-RB489	26 lbs	
Eriogonum nudum	SG1-11-RB489	33 lbs	59 lbs
Eriophyllum lanatum	SWC-06-RB490	234 g	
Eriophyllum lanatum	SG1-08-RB490	48.5 lbs	
Eriophyllum lanatum	SG1-09-RB490	40 lbs	89.5 lbs
Sisyrinchium hitchcockii	SG1-09-RB491	0.5 lbs	
Sisyrinchium hitchcockii	SG1-10-RB491	1 lb	
Sisyrinchium hitchcockii	SG1-11-RB491	62 lbs	
Sisyrinchium hitchcockii	SG1-12-RB491	13.5 lbs	77 lbs
Lotus micranthus	SWC-06-RB493	11 g	
Lotus micranthus	SG1-08-RB493	1.7 lbs	
Lotus micranthus	SG2-09-RB493	10 lbs	
Lotus micranthus	SG3-10-RB493	7 lbs	
Lotus micranthus	SG3-11-RB493	6 lbs	24.7 lbs
Festuca californica	SWC-06-RB494	4 g	
Festuca californica	SG2-11-RB494	11.5 lbs	
Festuca californica	SG2-12-RB494	22.5 lbs	34 lbs
Silene hookeri* ssp. *hookeri	SWC-06-RB495	23 g	
Silene hookeri* ssp. *hookeri	SG1-07-RB495	72 g	95 g
Danthonia californica	SG2-07-RB415	100g	
Danthonia californica	SG2-08-RB415	8 lbs	
Danthonia californica	SG2-09-RB415	61 lbs	
Danthonia californica	SG2-10-RB415	116 lbs	
Danthonia californica	SG2-11-RB415	230 lbs	
Danthonia californica	SG2-12-RB415	110 lbs	525 lbs
Danthonia californica	SG2-07-RB428	39 g	
Danthonia californica	SG2-08-RB428	4 lbs	
Danthonia californica	SG2-09-RB428	7.5 lbs	
Danthonia californica	SG2-10-RB428	28 lbs	
Danthonia californica	SG2-11-RB428	33 lbs	
Danthonia californica	SG2-12-RB428	51 lbs	123.5 lbs
Elymus elymoides	SG1-06-RB416	5 lbs	
Elymus elymoides	SG1-07-RB416	12 lbs	
Elymus elymoides	SG2-09-RB416	75 lbs	92 lbs
Lupinus rivularis	SG1-06-RB430	475 g	
Lupinus rivularis	SG2-08-RB430	11 lbs	
Lupinus rivularis	SG2-09-RB430	176 lbs	188 lbs
Achnatherum lemmonii	SG2-07-RB429	213 g	

Table 5. Seeds in storage at the Corvallis Plant Materials Center for the Roseburg District BLM cooperative agreement in 2012 (con't).

Species	**Lot number**	**Weight**	**Total per accession**
Achnatherum lemmonii	SG2-09-RB429	6 lbs	
Achnatherum lemmonii	SG2-10-RB429	2.3 lbs	
Achnatherum lemmonii	SG2-11-RB429	7 lbs	
Achnatherum lemmonii	SG2-12-RB429	7 lbs	22 lbs
Gilia capitata	SG1-11-RB062	19 lbs	
Gilia capitata	SG1-12-RB062	15 lbs	34 lbs
Madia elegans	SG1-11-RB065	0.5 lbs	
Madia elegans	SG1-12-RB065	31.5 lbs	32 lbs
Madia gracilis	SG1-11-RB063	3.8 lbs	
Madia gracilis	SG1-12-RB063	22 lbs	50.8 lbs
Clarkia amoena	SG1-11-RB121	7.5 lbs	7.5 lbs
Lupinus bicolor	SG1-11-RB067	0.5 lbs	
Lupinus bicolor	SG1-12-RB067	7	7.5 lbs
Carex densa	SG1-12-RB063	1 lb	1 lb

Oregon Silverspot Butterfly Seed Increase Project: 2012 Annual Report

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Figure 1. A robust 4-5 month old early blue violet (*Viola adunca*) seedling found in the Area 7 restoration site, August 6, 2012.

I. Brief Background of Project

The Corvallis Plant Materials Center (PMC) entered into an agreement with the US Fish and Wildlife Service (USFWS) in 2005 to increase seed of early blue violet (*Viola adunca*) for use in recovery efforts for the Oregon silverspot butterfly (*Speyeria zerene hippolyta*). In 2007, the Siuslaw District of the United States Forest Service (USFS) became a new partner in the agreement with USFWS. The butterfly has become threatened due to the degradation and loss of its coastal meadow habitat. The early blue violet is the obligate host for the silverspot caterpillars, and has been negatively impacted in its coastal meadow ranges by the encroachment of tall, spreading, exotic plants. Coastal red fescue, recently renamed sand fescue (*Festuca ammobia),* is included in this agreement as a matrix species in the coastal meadows. Most of the forbs included in this project are nectar sources for the adult butterflies.

Activities in 2012 included maintenance and harvest of two grass and seven forb seed increase plots, as well as development and application of seed mixes on sites in the Critical Habitat Area.

II. Accessions Involved

The following table lists the accessions involved in this project.

Table 1. Accessions in the USFWS Oregon Silverspot seed increase project.

Species	**Common name**	**Symbol**	**Accession**	**Activity in 2012**[1]
Achillea millefolium	common yarrow	ACMI2	9079448	Dlv
Anaphalis margaritacea	pearly everlasting	ANMA	9079451	Dlv
Aster chiliensis	Pacific aster	ASCH2	9079449	Sfp, Dlv
Danthonia californica	California oatgrass	DACA	9079601	Sfp
Solidago canadensis	Canada goldenrod	SOCA6	9079497	Sfp, Dlv
Festuca ammobia	sand fescue	FEAM5	9079450	Sfp, Dlv
Viola adunca	early blue violet	VIAD	9079406	Sfp, Dlv
Solidago spathulata	dune goldenrod	SOSISP	9079561	Sfp, Dlv
Tanacetum camphoratum	camphor tansy	TACA2	9079559	Sfp, Dlv
Artemisia suksdorfii	coastal wormwood	ARSU4	9079560	Sfp, Dlv
Trifolium wormskioldii	sand clover	TRWO	9079619	Sfp, Dlv
Cirsium edule	edible thistle	CIED	9079620	Dlv

1- sfp= seed increase, dlv=delivered plant materials

III. Seed Increase

A large seed increase plot of *V. adunca* was established in the spring of 2009 using 4,200 plants that were produced in 2008. A sheet of weed fabric was stapled down over the field, then holes were cut in the fabric and plants were transplanted into the ground through the holes. As the violet plants grew, they spread out onto the weed fabric. When they flowered and seed pods matured, the pods released the seed onto the weed fabric. The plants are still large and vigorous. Growing these plants is very easy, but keeping pests from stealing all the seeds is difficult. As soon as seed pods appear on the plants, mouse traps are set all over the plot and to prevent mice from caching the pods. A “wind fence” is erected around the plot using fence posts and weed fabric to keep seeds from blowing off the fabric. Bird netting is also installed over the plot to keep birds from eating seed off the fabric. If pests can be excluded, seeds pile up on the fabric and can be vacuumed up after the plants are done producing seed. The plants bloom and set seed over a long period in the summer. Usually, most of the plants are done flowering by July and vacuuming begins in late July. PMC staff used a gas-powered generator and two shop-vacs to harvest the seed from the fabric. Yields in 2012 were lower than in 2011, this may be due to late snow in March which appeared to affect seed production of early blooming plants on the PMC farm.

Seed increase plots of *Aster chilensis* and *Solidago canadensis* were established using plugs in the spring and fall of 2009. After two years of intensive weeding, the fields are considerably less weedy. After hand weeding in April, the goldenrod, aster, and violet fields were fertilized.

The Canada goldenrod plants began to bloom earlier than usual in 2012 and seed maturity was much more uniform. All late blooming plants (aster, goldenrod, ect) were much smaller than in previous years, including other fields on the PMC farm that are not a part of this agreement. The seed stripper appears to damage goldenrod flowers, so the field was not seed stripped until all the plants had finished flowering. All the early maturing flower heads were hand harvested once. The field was seed stripped two times during the summer and fall.

Figure 2. Canada goldenrod (*Solidago canadensis*) bloomed much more uniformly than in previous years at the PMC farm in 2012.

The aster field matures later and it is also seed stripped. This field was about two feet shorter than usual and seemed to produce much less viable seed. Since this was common in 2012 in so many fields at the PMC it is concluded that environmental conditions may have been the cause.

Table 2. Yields in 2012 for the USFWS Oregon Silverspot seed increase project

Species	**Code**	**Method**	**Harvest Date**	**Area (ac)**	**Yield (bulk lbs)**
Viola adunca	VIAD	vac weed fabric	8/25	0.2	25
Tanacetum camphoratum	TACA2	swath/combine	9/12	0.08	40
Aster chiliensis	ASCH	seed stripper	9/20-10/20	0.3	15
Solidago canadensis	SOCA6	hand, seed stripper	8/15	0.2	30
Trifolium wormskioldii	TRWO	seed stripper	7/25	0.2	134
Festuca ammobia	FEAM	seed stripper	7/9	0.51	25
Danthonia californica	DACA	hand	7/20	0.01	164 g
Viola adunca (MtHebo)	VIAD	vac weed fabric	9/5	0.15	9
Solidago spathulata	SOSIS4	hand	10/12-11/13	0.08	1

The sand clover, *Trifolium wormskioldii*, seed increase field was established in the spring of 2010 and different harvesting techniques have been explored as the field grows and fills in. This species is highly rhizomatous and has the capability of spreading as much as 8 feet in a growing season in summer irrigated soils. The seed increase field is not irrigated and plants have been spreading at a rate of 2 feet per year. Originally, the plugs were planted in rows that were 28 inches apart. The rows have completely grown together and plants are beginning to grow taller.

This opens up other harvest techniques such as direct combining. The plants were direct combined by cutting as low as possible and setting the fingers of the reel so they would “comb” the plants up slightly as they approached the cutter bar. Even the best adjustment still left a lot of seed heads attached to the lowest stems. It was decided that the field would also be seed stripped at a later date to harvest these remaining seeds. The back of the combine had to be “diapered” to keep the debris from falling out the back and smother the remaining seed heads on the field (also to not have all the material picked up by the seed stripper). This extra step took a bit more time, but it made seed stripping easier and much more effective. The clover debris also made great compost!

Figure 3. Prolonged standing water in PMC fields during the winter/spring of 2012 damaged the coastal wormwood (*Artemisia suksdorfii*) seed increase field. Plants eventually recovered in late summer. April 25, 2012.

The dune goldenrod and tansy fields were established using plugs in the spring of 2008. Both fields reached their peak seed production year in 2010, and need to be fertilized every other year in order to maintain this level of production. The tansy was harvested in September by swathing and combining, and the dune goldenrod was harvested by hand multiple times very late in the summer and in early fall. The dune goldenrod blooms so late on the PMC farm that pollination can easily be interrupted by cool temperatures and rain in the fall.

Figure 4. Portions of the sand fescue (*Festuca ammobia*) seed increase field showing the unmowed (left) and high mow treatments. April 25, 2012.

The coastal wormwood (*Artemisia suksdorfii)* field was established from plugs in the fall of 2009. It did not flower in 2010, but it did in 2011. The winter of 2011/2012 was very wet and the sage field had standing water for almost two months. Areas of the field appeared dead in late spring, but in early summer, many of the plants began growing again. By fall, the plants looked alive and well, but did not flower.

The *F. ammobia* field was infested with non-native bentgrass and ryegrass. Multiple times per year the field is walked and weedy grasses are wiped with a glyphosate mixture. The field has become much cleaner in the last two years. As the plants mature, the crowns are growing together. It is not known how this will affect seed production. Yields were higher this year than they were last year. Post harvest management also seems to affect seed yields with this species. Studies on other fescues at the PMC have shown that seed yields can decrease in the growing season after a low mowing in the fall. Since there is an abundance of seed in storage of this species and the field at the PMC is large, an experiment was overlaid on the production field in the fall of 2011. A large portion was burned in the fall, and the other portion was mowed at various heights or not mowed at all. The plants were set back quite a bit by the burn. A few plants had new growth in the fall but, mostly, the field looked dead. By spring, all the plants had some new growth. The burning was a poor choice for post-harvest residue management in seed production fields, but burning could be a very important restoration tool in areas where fescue has become very thick and is crowding out violets. By fall, the plants had recovered but they produced very little seed. Low mowing treatments also damaged crowns and reduced seed yield. Plots that were not mowed or mowed above 4" had the highest seed production.

Figure 5. Sand fescue field grew very slowly in spring following burn treatments that were applied in the fall. Some new growth began to appear in April (right). Plants were actively growing and filling in by late June (left).

Two new fields were established in the spring of 2012. A small plot of California oatgrass was created using transplants that were grown the following fall. A 0.15 acre plot of violets from Mt Hebo was also planted into a field covered with weed fabric. Both species flowered this year. The oatgrass was harvested by hand in late July. The violets were vacuumed once late in the season. Even though the violet field was enclosed by a bird net, a flock of pigeons was very persistent about getting inside the enclosure. It had to be checked twice a day to remove birds. Eventually, the birds moved on, but they managed to eat a fair amount of seed. The bird net will be put on earlier next year. If the bird net is put up well before any seed appears on the fabric it may be easier to keep the birds out. Once they know the seed is there, it can be difficult to keep them out.

IV. Container Plant Production

In the fall of 2012, the remaining wild collected seed of *Danthonia californica* and the 2012 harvest were used to sow more containers to expand the field. The seeds grew over the winter in the greenhouse and will be transplanted out into the seed increase field in spring of 2013.

Figure 6. A new field of California oatgrass (*Danthonia californica*) was established in the spring of 2012 using transplants.

V. Delivery of Materials

In 2010, about an acre of salal was mowed and chipped in Area 7 (south of Yachats, near Big Creek). Chips were left on site and were too thick for seedlings to get established, so chips were removed in the fall of 2011 leaving bare ground. This site was sown in the fall of 2011with three different mixes: a mix that can tolerate mowing and also has a high amount of violets, a higher growing mix of mostly nectar species that is less tolerant of mowing and does not include violet, and a heavy mix of fescue and sand clover as a border to help slow weed invasion. Two large sections of this site were also heavily planted with violet plugs.

Figure 7. The edges are the Area 7 restoration site were not scraped and contained a high level of topsoil and debris. These areas were seeded heavily in the fall of 2012. Sand fescue, yarrow, and edible thistle established very well in this area and may be able to slow the invasion of weeds present on the edge. August 6, 2012.

Figure 8. Some areas in the restoration site in Area 7were scraped, removing some of the topsoil. Native species that were seeded on the site in the fall of 2012 established relatively well. Plants were small, but seem more competitive than the non-native weeds in these soil conditions.

Table 3. Seed mixes sown in October 2011, for the recovery of the Oregon silverspot butterfly.

Mix	Species	Bulk lbs/ac	seeds per Sq ft
Area 7	*Solidago spathula*	1	50
mow	*Trifolium wormskioldii*	1	15
	Festuca ammobia	2	40
	Viola adunca	2	50
	Tanacetum camphoratum	1	30
Area 7	*Festuca ammobia*	2	40
no mow	*Solidago canadensis*	2	200
	Aster chilensis	1	50
	Achillea millefolium	1	60
	Cirsium edule	1	

PMC staff assisted with the planting of the sites after the seed mixes were prepared. Sites were sown using a hand-crank fertilizer spreader in mid-October. Sites were visited in late March. The Area 7 site showed patchy establishment of natives and very little weeds. Establishment was lowest on areas that appeared to have all topsoil removed. The fall/winter of 2011 was also very wet and heavy rains definitely moved seed around on the site. More seeds were applied to the site in April. Only spring germinating species goldenrod and pearly were added to the bare patches. PMC staff visited the site again in late July and was happy to see how the native seedlings were establishing. In areas with top soil, plants were robust and flowering. In areas with little topsoil, seedlings were small but established. Areas with no topsoil that were re-seeded in the spring had low establishment. Overall, this site has very little weeds and a high level of established native plants from the seeding efforts. Overtime, these plants should grow and fill in the site and hopefully resist some weed invasion.

A site at Big Creek had been cleared by removing large spruce trees. This left a site that was mostly bare (vegetatively) but had a thick layer of duff. It was not seeded in the fall of 2011, except for an area that was used as a road or skid trail for the logging. When the site was visited in the spring of 2012, most of the duff had broken down and soil was exposed. In the areas that were seeded in the fall of 2011, there were much less weeds present and the native species were growing quickly, especially the fescue and yarrow. The seeds that were sown on site in April are listed in Table 5 under "Big Creek". While the site was seeded, PMC, USFS, and TNC staff helped pull Australian burn weed that had become established on the site. Huge piles of weeds were stacked and covered with tarps for quick decomposition. By late summer, velvet grass (*Holcus lanatum*) was dominant on the site, but small native seedlings were present. The site will be visited in the spring of 2013.

Figure 9. A small area with bare soil was seeded at the Big Creek site in the fall of 2012. Plants were establishing nicely in April of 2012 (right) and appeared to have less weeds than unseeded areas in August 2012 (front of photo on left).

All seed that has been produced for this project and has not been delivered will remain in the PMC seed storage facilities until requested. Samples of seed produced from the PMC fields were sent to the Oregon State University Seed Lab for purity and germination testing. This information is important for calculating pure live seed amounts (PLS) for each seed lot.
Our seed lot numbers describe the generation of the field (SG0 or SWC is wild collected seed, SG1 is seed that is produced from the plants that were grown using wild collected seed). The middle number of a seed lot indicates which year the seed was produced. The last portion of the seed lot describes which project the seed is for (OS is for the Oregon Silverspot butterfly) and

includes the last three digits of the accession number that has been assigned to this species specifically for this project. Aside from individual bags of seed, there are also two seed mixes that were prepared but not delivered. They remain in the seed storage facilities and will hopefully be sown on sites in the fall of 2012. There are two bags which each contain 10 lbs of violet, 4 lbs of fescue, 1 lb of yarrow, 4 lbs of Canada goldenrod, 4 lbs of aster, 3 lbs of thistle, and 0.3 lbs of pearly everlasting. Each bag was prepared to sow an acre.

Table 4. Seed delivered in 2012 for the Oregon Silverspot seed increase project.

Species	**Seed lot**	**Amount delivered**	**Recipient**
Festuca ammobia	SG1-09-OS450	4.5 lbs	Big Creek
Solidago canadensis	SG1-10-OS497	5 lbs	Big Creek
Aster chilensis	SG1-09-OS449	2 lbs	Big Creek
Achillea millefolium	SG1-07-OS448	0.75 lb	Big Creek
Tanacetum camphoratum	SG1-10-OS559	1.3 lbs	Big Creek
Trifolium wormskioldii	SG1-11-OS619	3.5 lbs	Big Creek
Anaphalis margaritacea	SG1-09-OS451	100 g	Big Creek
Festuca ammobia	SG1-10-OS451	30 lbs	Ian Silvernail (IAE)
Anaphalis margaritacea	SG1-09-OS451	3.5g	Oregon Zoo
Aster chilensis	SG1-09-OS449	2 g	Oregon Zoo
Viola adunca	SG1-10-OS406	50 g	Oregon Zoo
Solidago canadensis	SG1-10-OS497	3 g	Oregon Zoo
Tanacetum camphoratum	SG1-09-OS559	2 g	Oregon Zoo
Cirsium edule	SG1-10-OS620	7 g	Oregon Zoo

Table 5. Seed in storage at the Corvallis Plant Materials Center for the Oregon Silverspot seed increase project.

Species	**Code**	**Seed lot**	**Weight (lbs)**	**Total pounds per species**
Achillea millefolium	ACMI2	SG1-10-OS448	9	
Achillea millefolium	ACMI2	SG1-09-OS448	10	
Achillea millefolium	ACMI2	SG1-08-OS448	7	
Achillea millefolium	ACMI2	SWC-07-OS448	0.5	26.5
Viola adunca	VIAD	SG1-12-OS406	25	
Viola adunca	VIAD	SG1-11-OS406	37	62
Viola adunca (Mt Hebo)	VIAD	SG1-12-OS147	9	9
Tanacetum camphoratum	TACA2	SG1-10-OS559	17	
Tanacetum camphoratum	TACA2	SG1-09-OS559	12	
Tanacetum camphoratum	TACA2	SG1-11-OS559	39	

Tanacetum camphoratum	TACA2	SG1-12-OS559	41	109
Anaphalis margaritacea	ANMA	SG1-10-OS451	2.3	2.3
Aster chiliensis	ASCH	SG1-10-OS449	10	

Table 5. Seed in storage at the Corvallis Plant Materials Center for the Oregon Silverspot seed increase project (con't).

Species	**Code**	**Seed lot**	**Weight (lbs)**	**Total pounds per species**
Aster chiliensis	ASCH	SG1-11-OS449	36	
Aster chiliensis	ASCH	SG1-12-OS449	15	51
Solidago canadensis	SOCA6	SG1-10-OS497	5	
Solidago canadensis	SOCA6	SG1-09-OS497	1	
Solidago canadensis	SOCA6	SG1-11-OS497	77	
Solidago canadensis	SOCA6	SG1-12-OS497	30	113
Festuca ammobia	FEAM5	SG1-12-OS450	25	
Festuca ammobia	FEAM5	SG1-10-OS450	69	
Festuca ammobia	FEAM5	SG1-11-OS450	148	242
Solidago spathulata	SOSIS4	SG1-10-OS561	5.2	
Solidago spathulata	SOSIS4	SG1-11-OS561	1	6.2
Cirsium edule	CIED	SWC-10-OS620	275g	0.5
Artemisia suksdorfii	ARSU4	SG1-11-OS560	23	23
Trifolium wormskioldii	TRWO	SG1-10-OS619	6.5	
Trifolium wormskioldii	TRWO	SG1-11-OS619	90.5	
Trifolium wormskioldii	TRWO	SG1-12-OS619	134	231

CORVALLIS PLANT MATERIALS CENTER
USDA NATURAL RESOURCES CONSERVATION SERVICE
CORVALLIS, OREGON
Amy Bartow

December 30, 2012

THE 2012 LASSEN VOLCANIC NATIONAL PARK ANNUAL REPORT:
Visitors' Center Landscape and Disturbed Lands Project

I. Brief Background of Project

The Corvallis Plant Materials Center (PMC) entered into an agreement with Lassen Volcanic National Park in 2009 to provide additional native plant materials for planting around the new Visitors' Center and in the restoration of historically disturbed lands in the Park. This agreement was extended in 2012. Activities in 2012 included vegetative propagation of one shrub species and production (by seed) of 1 tree, 1 legume, 1 rush, 3 grass and 1 sedge species. Approximately 2,200 plants were produced and delivered to the Park this year.

II. Accessions Involved

Table 1. Accessions involved in the Visitors Center Landscape Project in 2012.

Species	Common name	Code	Accession	Activity in 2012[1]
Arctostaphylos nevadensis	pinemat manzanita	ARNE	9079498	pxn,dlv
Carex sp (dry)	sedge	CAREX	9109083	pxn, dlv
Danthonia californica	California oatgrass	DACA3	9109108	pxn,dlv
Deschampsia sp.	hairgrass	DESCH	9109105	pxn,dlv
Luzula comosa	Pacific woodrush	LUCO6	9109104	pxn, dlv
Panicum acuminatum	western panicgrass	DIACA	9109081	pxn,dlv
Trifolium longipes	longstalk clover	TRLO	9109103	pxn, dlv
Tsuga mertensiana	mountain hemlock	TSME	9109079	pxn, dlv

1-pxn=produced plants, dlv=delivered plant materials

III. Experimental Propagation

There was no experimental propagation for this project in 2012. PMC staff have previously grown all the species involved in this year's project.

IV. Plant Propagation

About 800 *Actostaphylos nevadensis* cuttings were collected at the Park by Park staff on December 5, 2011. Target materials were stems that were at least six inches long, non-branching, current season's growth, and disease-free. Cuttings were delivered to the PMC, packed with moistened vermiculite and stored in a walk-in cooler (38°F) until January 5, 2012. The cuttings were prepared for rooting by stripping the leaves from the lower 4 inches, making a fresh basal cut, dipping the base in an 0.8% IBA rooting powder, and sticking them 4 inches deep into moist perlite in propagation flats. Flats were treated with beneficial nematodes to help reduce fungus gnat larvae in the media (which worked very well!). Flats were placed on heat mats set at 70°F in a heated greenhouse and lightly watered weekly or as needed. Cuttings rooted within four months and then were transplanted to D40 cone-tainers filled with moistened media. In previous years, rooted cuttings were planted into the PMC standard media mix (Sunshine #4 with micronutrients and a balanced slow-release fertilizer). Most plants thrive in this mix, yet PMC staff struggle to keep potted Manzanita plants healthy and green during the growing season. This year, the manzanitas were planted into the standard mix without micronutrients or slow release fertilizer. Plants were fertilized every two weeks with a Peter's 20-20-20 solution throughout the growing season. These plants were greener and had a much higher survival rate than plants from previous years. We assume this may have something to do with less nutrient availability as the peat-based media experiences changes in pH.

Figure 1. Rooted cuttings of pinemat manzanita (*Arctostaphylos nevadensis*) in the PMC shade house.

All other species were sown from seed in February or early May depending on dormancy treatment (Table 2). Seeds were sown into racks of Ray Leach "stubby" cone-tainers filled with moistened media (Sunshine #4 mix amended with a balanced slow-release fertilizer and micronutrients). Flats were placed in a heated greenhouse or walk-in cooler for 90 days. The *Luzula comosa* seed needs warm temperatures followed by moderate temperatures in order to initiate germination. This is achieved by soaking seeds in hot water (100°F) then sowing them into cone-tainers filled with media and placing them outside in a shadehouse in May (average daily temp is about 65°F).

Table 2. Plant production for Lassen Volcanic National Park in 2012.

Species	Start date	Treatment	Number Produced
Arctostaphylos nevadensis	5-Jan	cuttings	328
Carex sp. (dry)	25-Feb	90 day cold	185
Danthonia californica	25-Feb	90 day cold	171
Deschampsia sp.	May 1	Warm GH	587
Luzula comosa	25-Feb	Hot water/outside	181
Panicum acuminatum	May 1	Warm GH	389
Trifolium longipes	25-Feb	90 day cold	272

The hemlocks were grown from seed in 2011, but were still very small in the fall, so they were overwintered in a walk-in cooler at the PMC (to keep them as cold as possible and slightly dry). The trees were removed from the cooler and placed in an open greenhouse in April when daytime temperatures were reaching 60°F. All plants grew well in the shade house all summer . The grasses, sedges, and rushes were trimmed to 2-inches prior to delivery. This makes stacking and handling the racks of cone-tainers easier, and can help reduce water stress after transplanting.

V. Delivery of Plant Materials

On September 18, 2012, PMC staff traveled to the Park to deliver the plants.

Table 4. Plants delivered to Lassen Volcanic National Park, September 18, 2012, for the Visitors' Center agreement.

Species	Size	Number Produced
Arctostaphylos nevadensis	D40	328
Carex sp. (dry)	Stubby cone	185
Danthonia californica	Stubby cone	171
Deschampsia sp.	Stubby cone	587
Luzula comosa	Stubby cone	181
Panicum acuminatum	Stubby cone	389
Tsuga mertensiana	D40	87
Trifolium longipes	Stubby cone	272
		2,200

North Coast Oregon Silverspot Butterfly Seed Increase Project for the US Fish and Wildlife Service:
2012 Annual Report

Prepared by Amy Bartow
Corvallis Plant Materials Center
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Figure 1. Douglas aster *(Aster suspicatum)* seed increase field at the Corvallis Plant Materials Center, July 25, 2012.

I. Brief Background of Project

The Corvallis Plant Materials Center (PMC) entered into an agreement in 2010 with the United States Fish and Wildlife Service (USFWS) in Washington to increase seed of early blue violet (*Viola adunca*) for use in recovery efforts for the Oregon silverspot butterfly (*Speyeria zerene hippolyta*). The butterfly is thought to be extirpated from its northern range due to the loss of disturbance in its coastal meadow habitat. The early blue violet is the obligate host for the silverspot caterpillars, and has also been negatively impacted in its coastal meadow ranges by the encroachment of tall, spreading, exotic plants. Seed increase of the violets, nectar species, and matrix species of coastal meadows will provide seed for Oregon silverspot butterfly habitat enhancement and restoration.

II. Accessions Involved

The table below lists the accessions involved in this project. Activities in 2012 included seed collection, seed cleaning of wild collected seed, and establishment, harvest, and maintenance of six seed increase fields (one grass, one sedge, and four forbs).

Table 1. Accessions in the North Coast Oregon Silverspot Butterfly Seed Increase Project in 2012.

Speices	Common name	Accession number	Activity in 2012[1]
Achillea millefolium	yarrow	9079609	Sfp
Aster subspicatus	Douglas aster	9109117	Sfp, col, dlv
Triteleia hyacinthina	white brodiaea	9109115	Col
Brodiaea coronaria	crown brodiaea	9109200	Col
Carex pansa	sanddune sedge	9079563	Sfp, dlv
Danthonia californica	California oatgrass (Camp Rilea)	9109142	Col
Danthonia californica	California oatgrass (Mt. Hebo)	9109144	Col
Euthamia occidentalis	western goldentop	9109199	Col
Festuca rubra	Coastal red fescue	9079617	Sfp, dlv
Hieracium albiflorum	white hawkweed	9109198	Col
Lupinus littoralis	seashore lupine	9109071	Col
Luzula multiflora	common woodrush	9079611	Col
Ranunculus occidentalis	western buttercup	9079610	Col
Sanicula arctopoides	footsteps of spring	9109070	Dlv
Sisyrinchium californicum	yellow-eyed grass	9109075	Col
Solidago spathulata	dune goldenrod	9079532	Sfp, dlv
Viola adunca	early blue violet	9079558	Sfp

1- col= wild seed collection, sfp= seed production, dlv= delivered plant materials

III. Seed Collections

Throughout the summer of 2012, Mike Patterson, a private seed collector, was hired to collect seed of many species that were candidates for seed or plant production. Collections were made all over the North Coast area from Seaside, OR, up to Ledbetter Point, WA. These collections were brought to the PMC, bulked, cleaned, and stored in the PMC seed storage facilities.

Table 2. Cleaned amount of wild seed collected in 2012 for the North Coast Oregon Silverspot Butterfly Seed Increase Project.

Species	Common name	Amt collected
Aster subspicatus	Douglas aster	42 g
Triteleia hyacinthina	white brodiaea	1 g
Brodiaea coronaria	crown brodiaea	3 g
Danthonia californica	California oatgrass (Camp Rilea)	1 g
Danthonia californica	California oatgrass (Mt. Hebo)	36 g

Species	Common name	Amt collected
Euthamia occidentalis	western goldentop	16 g
Hieracium albiflorum	white hawkweed	17g
Lupinus littoralis	seashore lupine	62 g
Luzula multiflora	common woodrush	4 g
Ranunculus occidentalis	western buttercup	36 g
Sisyrinchium californicum	yellow-eyed grass	13 g
Viola adunca	early blue violet	3 g

IV. Seed Production

The red fescue field is three years old and finally producing a decent amount of seed. The field was expanded in the fall of 2011 but the fall sown plants won't produce seed until 2013.

The *Carex pansa* field produced a small amount of seed this year. This species doesn't seem to be a viable candidate for agronomic seed production. It has very low seed yields, and is not easy to establish on sites by direct sowing. It is a very vegetative plant, sending out many rhizomes each year. These could be used to establish new plants on restoration sites, rather than attempting seed increase and direct sowing.

Table 5. Seed produced at the Corvallis Plant Materials Center for the North Coast Oregon Silverspot Butterfly Seed Increase Project in 2012.

Species	Acres	Date	Method	Yield
Aster subspicatus	0.25	Sept 10-Oct 20	Seed stripper	4 lbs
Carex pansa	0.56	July 26	Moon rover	2 lbs
Festuca rubra	0.20	July 9	Seed stripper	54 lbs
Solidago spathulata	0.25	Sept 4-Oct 15	hand, seed stripper	11 lbs
Viola adunca	0.15	July 25, Sept 3	vacuum	26 lbs

Figure 2. Healthy plugs of early blue violet (*Viola adunca*) plants can grow up to 6 inches in diameter when grown at the Corvallis PMC.

The plugs of dune goldenrod, Pacific aster, and violet were transplanted into fields in March 2011. Therefore, 2012 was the first year that the plants were expected to have sizable harvests. The violets were covered with blooms in May and June and as seed pods formed, mice traps were placed within the plots and bird nets were erected over the entire field. The doves were determined to get into the enclosure and it had to be checked twice daily to remove any doves that had found their way inside. Eventually, they stopped getting in, but they may have eaten a fair amount of seed. The weed fabric was vacuumed twice during the growing season, once in late July and again in early September.

The asters from the North Coast are very tall compared to the Central Coast ecotype. PMC staff contacted Ken Chambers, a taxonomist at OSU who has worked on aster species to help us determine which species are present in the fields. The main difference between *Aster subspicatus* and *Aster chilensis* is chromosome number, which cannot be determined by looking at the plants.

Figure 3. Amy Bartow standing next to a very tall Douglas aster (*Aster subspicatus*) plant at the Corvallis PMC farm, July 25, 2012.

The only morphological difference is in the floral bracts: *A. subspicatus* has thin, pointy bracts, whereas *A. chilensis* has wider, blunt bracts. We found a gradient of bracts present in both fields, but generally the Central Coast ecotype tended to be more like *A. chilensis* and the North Coast ecotype resembled *A. suspicatus*. For the purpose of these projects, the seeds from these fields will be named according to this determination. But it is likely that both fields have both species present.

The aster field had plenty of flowers and pollinators, yet filled seed was difficult to find. All other aster fields on the PMC farm had this same issue in 2012. It is not understood why this occurred, but it seemed consistent with all late-blooming aster and goldenrod species that were grown on the PMC farm. The asters were seed stripped many times during the long, warm fall. It was difficult to seed strip the plants due to the major difference in heights among the plants. In

2013, tall plants will be cut back to promote shorter, bushier plants which may increase seed production as well as assist with harvest.

A portion of the goldenrod field was underwater for at least two months during the very wet winter/spring of 2012. Because the plants were dormant, they seemed unaffected by the water. Plants grew well in the late spring and summer and flowered in July. Plants matured unevenly, so they were hand harvested as the seeds ripened. This was very time consuming, but increased yields. Beginning in mid-September, the plants were seed stripped to remove the later ripening seed.

Figure 4. Corvallis PMC staff selectively hand harvesting dune goldenrod (*Solidago spathulata*).

The 0.1 acre yarrow field that was directly sown in the spring of 2012 had great establishment and plants were quite large by fall. The field should produce an adequate seed crop in 2013.

V. Delivery of Materials

Our seed lot numbers describe the generation of the field (SWC is wild collected seed, SG1 is seed that is produced from the plants that were grown using wild collected seed). The middle numbers of a seed lot indicate which year the seed was produced. The last portion of the seed lot describes which project the seed is for (or an abbreviation for the seed source) and the last three digits of the accession number that has been assigned to this species specifically for this project.

Table 6. Seed delivered to partners in the North Coast Oregon Silverspot Butterfly Seed Increase Project in 2012.

Species	Seed lot	Weight	Recipient
Aster subspicatus	SG1-11-NC117	9 lbs	Bill Ritchie USFWS
Sanicula arctipoides	SWC-11-NC070	22 g	Bill Vagt, OMD
Carex pansa	SG1-11-NC563	4.5 lbs	Bill Ritchie USFWS
Festuca rubra	SG1-11-NC617	8 lbs	Bill Ritchie USFWS
Solidago spathulata	SG1-11-NC117	4.8 lbs	Bill Ritchie USFWS

Table 7. Seed in storage from field increase for the North Coast Oregon Silverspot Butterfly Seed Increase Project.

Species	Seed lot	Amount
Aster subspicatus	SG1-12-NC117	4 lbs

Carex pansa	SG1-12-NC563	2 lbs
Festuca rubra	SG1-12-NC617	54 lbs
Solidago spathulata	SG1-12-NC532	11 lbs
Viola adunca	SG2-11-NC558	6.3 lbs
Viola adunca	SG2-12-NC558	26 lbs

Table 8. Wild collected seeds in storage for the North Coast Oregon Silverspot Butterfly Seed Increase Project.

Species	**Seed lot**	**Amount**
Achillea millefolium	SWC-10-NC609	24 g
Anaphalis margaritacea	SWC-10-NC118	79 g
Angelica hendersonii	SWC-10-NC074	30 g
Angelica lucida	SWC-10-NC076	671 g
Armeria maritima	SWC-10-NC069	150 g
Aster subspicatus	SWC-11-NC117	127 g
Brodiaea coronaria	SWC-11-NC200	3 g
Carex pansa	SWC-08-NC563	515 g
Cirsium brevistylum	SWC-11-NC073	55 g
Cirsium edule	SWC-10-NC612	86 g
Conioselinum pacificum	SWC-10-NC068	20 g
*Danthonia californica (*Camp Rilea*)*	SWC-11-NC144	23 g
*Danthonia californica (*Mt Hebo*)*	SWC-11-NC142	70.6 g
Euthamia occidentalis	SWC-12-NC199	15.9 g
Festuca rubra	SWC-11-NC617	1 lb
Hieracium albiflorum	SWC-12-NC198	17 g
Lupinus littoralis	SWC-10-NC071	157 g
Lupinus sp.	SWC-11-NC143	44 g
Luzula multicosta	SWC-08-NC611	10 g
Ranunculus occidentalis	SWC-08-NC610	69 g
Sanicula arctopoides	SWC-11-NC070	22 g
Sidalcea hendersonii	SWC-10-NC072	3 g
Sisyrinchium californicum	SWC-10-NC075	19 g
Sisyrinchium idahoense	SWC-10-NC075	196 g
Solidago canadensis	SWC-10-NC116	120 g
Solidago spathulata	SWC-10-NC532	170 g
Tanacetum bipinnatum	SWC-10-NC613	421 g
Trifolium wormskioldii	SWC-10-NC077	119 g
Triteleia hyacinthina	SWC-10-NC115	1 g
Viola adunca	SWC-09-NC558	11 g

CORVALLIS PLANT MATERIALS CENTER
NATURAL RESOURCES CONSERVATION SERVICE
CORVALLIS, OREGON
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December 30, 2012

THE 2012 SAN JUAN ISLANDS NATIONAL HISTORICAL PARK ANNUAL REPORT: *American Camp Prairie Restoration Project*

I. Brief Background of Project

Figure 1. Blue wildrye (*Elymus glaucus*) seed increase field (front field) and Sitka brome (Bromus sitchensis) seed increase field (lighter colored field in back) for the American Camp Prairie Restoration Project with Corvallis Plant Materials Center, June 15, 2010.

The Corvallis Plant Materials Center (PMC) entered into a new agreement with San Juan Islands National Historical Park in 2009 to provide native plant materials for the restoration of the American Camp Prairie. It was agreed that the PMC would produce a minimum of 900 lbs (PLS) of *Elymus glaucus*, 900 lbs (PLS) of *Bromus sitchensis*, and 440 lbs (PLS) of *Festuca roemerii*. The project was expected to be completed in 2013 but now has been put on hold indefinitely. The Corvallis PMC received no funding for this project in 2012, but continued to maintain and harvest two of the grass fields. The Brome field was not harvested due to weed and smut issues.

II. Accessions Involved

Accessions included for the restoration of American Camp Prairie are listed in Table 1. This table also displays activities performed by PMC staff in 2012.

Table 1. Accessions involved for the restoration of American Camp Prairie project with Corvallis Plant Materials Center in 2012.

Species	Common name	Code	Accession	Activity in 2012[1]
Elymus glaucus	blue wildrye	ELGL	9079607	sfp
Bromus sitchensis	sitka brome	BRSI	9079606	sfp
Festuca roemerii	Roemer's fescue	FERU	9079605	sfp

1- sfp= seed field production,

III. Seed Increase

The San Juan Island ecotypes seem to be suffering slightly in the wet spring months at the PMC. Plants were reddish and looked sick through most of the spring. It was an unusually wet and cool spring which didn’t help these fields. The Brome field had severe smut issues and was very weedy since the PMC did not receive funding, the field was not harvested. The blue wildrye and fescue fields were both relatively weed-free and vigorous. Usually grass seed production fields should be fertilized in late February. In 2012, the fields were fertilized in April. This application seemed well timed, the fields were slow to grow due to the cool temperatures so the late application of fertilizer came at a time when they were starting to grow vigorously.

The blue wildrye field did not grow in early spring, but grew fast and flowered moderately as the fields dried out and the temperatures increased. The field matured evenly and the field was directly combined. This technique hadn’t been tried before, but seemed moderately effective. It took very little time, but some seed shattered during the combining. Overall, it appeared that less seed was lost with direct combining compared to the more common practice of swathing the green material into windrows, then combining it when dry.

Table 2. Seed increase field yields in 2012 for the restoration of American Camp Prairie project with the Corvallis Plant Materials Center.

Species	Accession	Field size(ac)	Date	Method	Yield
Festuca roemerii	9079605	0.45	7/5	seed stripper	60 lbs
Elymus glaucus	9079607	0.4	7/16	direct combine	76 lbs

The fescue field was harvested using the seed stripper. The yield in 2012 was fairly high for a Roemer’s fescue seed increase field. The field was much cleaner due to fall applications of pre-emergent herbicides. Fields were also walked many times during the spring and early summer to remove weedy perennial grasses.

All fields were fertilized in April. Weed control within the plots was mainly performed by hand-hoeing, spot applications of glyphosate, and using broadleaf herbicides. Field borders were cultivated periodically throughout the year. In the fall, fields were mowed with a flail chopper and a pre-emergent herbicide was applied.

VI. Delivery of Plant Materials

There were no deliveries in 2012. All seed will remain in the PMC seed storage facilities until requested.

Table 3. Seed in storage in 2012 for the American Camp Prairie Restoration Project with Corvallis Plant Materials Center.

Species	**Seed lot**	**Bulk Wt**	**PLS Wt**	**Purity**	**Germination**
Elymus glaucus	SG1-10-SJ607	53 lbs	44 lbs	99.34%	84%
Elymus glaucus	SG2-11-SJ607	202 lbs	181 lbs	99.90%	90%
Elymus glaucus	SG2-12-SJ607	76 lbs			
Bromus sitchensis	SG1-10-SJ606	63 lbs	52 lbs	98.99%	84%
Bromus sitchensis	SG1-11-SJ606	143 lbs	143 lbs	99.10%	98%
Festuca roemerii	SG1-11-SJ605	47 lbs	41 lbs	97.21%	90%
Festuca roemerii	SG1-12-SJ605	60 lbs			

Seed and Plant Production for US Forest Service: 2012 Annual Report

Prepared by Amy Bartow
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Figure 1. Spanish clover (*Lotus purshianus*) at the Corvallis Plant Materials Center, July 13, 2012.

I. Brief Background of Project

The Corvallis Plant Materials Center (PMC) entered into a new agreement with the United States Forest Service (USFS) in 2007 to provide native plant materials for ecological restoration. This agreement is mainly for research and development of species for which germination and or seed production protocols are unknown. Multiple forest districts can use this "umbrella" agreement. In 2012, the PMC worked with five districts to develop germination and seed increase protocols for three forbs, three legumes, four grasses, one sedge, and one rush.

II. Accessions Involved

Accessions included for the USFS in 2012 are listed in Table 1. This table also displays activities performed by PMC staff.

Table 1. Accessions involved for the USFS cooperative agreement with Corvallis Plant Materials Center in 2012.

Scientific Name	Common name	Forest District	Accession #	Activity in 2012[1]
Alopecurus geniculatus	water foxtail	SIU	9109193	Sfp
Glyceria elata	tall managrass	MAL	9079618	Sfp
Carex obnupta	slough sedge	OLY	9079623	Sfp
Spariganium emersum	burr reed	OLY	9079624	Trl, sfp
Aristida longiseta	three awn	WA-WH	9109139	Pxn
Hesperostipa comata	needle and thread	WA-WH	9109137	Pxn
Festuca viridula	Green fescue	WA-WH	9109140	Pxn
Trifolium longipes	long stalk clover	WILL	9109138	Pxn
Lotus crassifolius	big deervetch	WILL	9109129	Sfp
Lotus purshianus	spanish clover	WILL	9109146	Sfp
Penstemon cardwellii	Cardwell's beardtongue	WILL	9109128	Sfp
Iris tenax	toughleaf iris	WILL	9109120	Sfp
Eriophyllum lanatum	Oregon sunshine	WILL	9109126	Sfp

1- sfp= seed increase, trl=germination trials, pxn= plant production

III. Field Seed Increase Activities

All seed increase plots were weeded many times during the growing season. The managrass field was fertilized in April, as well as sprayed with an herbicide to remove broadleaf weeds. In the fall of 2009, a field of *Glyceria elata* was sown. The plants are large and vigorous, but have had very low seed production in previous years. Seed yields were higher in 2012, although field management has remained the same. The increase in seed yields could be due to weather or plant maturity.

Horning Seed Orchard grew out plugs of three forbs and two legumes which were delivered to the PMC on June 9, 2011. These plugs were used to establish seed increase fields. The *Lotus crassifolius* and *Penstemon cardwellii* were put into fields in the fall of 2011 using a mechanical transplanter. The other species were transplanted by hand in March of 2012. Field sizes are noted in Table 2.

The *P. cardwellii* plants flowered in 2012. The seed capsules were harvested individually by hand as they ripened. The plot is quite small so this was not very labor intensive. If the plot were very large, it could be harvested with machinery such as a combine, or a modified swather that collects material as it is cut. These machines would work well for large-scale seed increase of this species due to its seed retention and even maturity.

Figure 2. Big deervetch (*Lotus crassifolius*) emerging from the ground in late spring at the Corvallis PMC farm, May 13, 2012.

Three of the new plots did not flower this year: *Iris tenax, Eriophyllum lanatum,* and *Lotus crassifolius*. *Iris tenax* typically does not flower until it is three years old. These plants grew vigorously in 2012 and should flower in 2013. *E. lanatum* plants look weak and did not flower in 2012. Usually, this species flowers in its second growing season. Many of the plants that overwintered in the PMC shadehouse last winter did not survive. It would be worthwhile to grow more plants to increase the size of the plot and hopefully produce more vigorous plants. The *L. crassifolius* plants grew steadily in the early spring, but appeared to struggle when the hot, dry summer settled in. They did not flower in 2012. This species may not be adapted to the dry, full sun conditions of the PMC farm.

Scarified seed of *Lotus purshianus* was directly sown in early March into a field that was covered with weed fabric. Holes were cut on 1ft by 1 ft spacing. Seed was sprinkled into holes and covered with fine vermiculite. The seeds germinated quickly and the seedlings grew very slowly until the soils warmed in the late spring. The plants were large and quickly grew into a solid mat (Figure 3). Flowering began in June and continued all summer, but very few seed pods were observed. The few pods that formed appeared to make viable seed. The seed shattered onto the weed fabric, but did not amount to much. At the end of the season, the plants were cut down and the fabric was swept. Seed production was very low, and mice droppings were found on the fabric,

Figure 3. Spanish clover (*Lotus purshianus*) plants grew vigorously at the Corvallis PMC farm this year, July 13, 2012.

under the plants. Mice may have contributed to the low yields, but pod formation was extremely low given the size and health of the plants. In 2013, plants will be spaced out more; this may help with seed production and will create a less favorable habitat for mice (and space for mouse traps).

Table 2. Seed production results in 2012 for the US Forest Service.

Species	**Field size**	**Harvest Date**	**Method**	**Yield**
Glyceria elata	0.22 ac	June 28	hand	3.5 lbs
Spariganium emersum	10 sq ft	July 23	hand	5 g
Lotus purshianus	0.03 ac	Sept 30	vac weed fabric	52 g
Penstemon cardwellii	0.03 ac	July 12-Sept 11	hand	37 g

Figure 4. Oregon iris (*Iris tenax*) transplants did not flower in 2012 at the Corvallis PMC farm, July 13, 2012.

Seed increase tubs of *Spariganium emersum* and *Carex obnupta* were established in the spring of 2012. The sedge did not flower, but appears very healthy! Some of the burr reed did flower and produce seed. Seeds were collected by hand as they ripened.

In the fall of 2012, a new field of *Alopecuris geniculatus* was sown for the Suislaw National Forest. The seed was sown at a rate of 4 lbs per acre on approximately 0.1 acre. The seeds should germinate in early spring as soils begin to warm.

IV. Plant Production/ Germination Trials

Seeds of *Spariganium emersum* were mailed to the PMC in the fall of 2009. Over the past three years, the PMC has performed germination trials with varying degrees of success. *S. emersum* had the highest germination (22%) after 45-days cold moist stratification followed by warm/wet conditions (when seed was about 3 months old). More germination trials were conducted in 2011 (when seed was almost a year and a half old). Scarification and light/dark treatments were added, but no germination was noted in any trial in 2011. An internet search suggested that *Spariganium* seed germinates best when fresh and should not be completely dried as this may reduce viability. The plants at the PMC flowered and produced a small amount of seed in 2012. This seed was collected, slightly dried at room temperature for a couple weeks, and then immediately placed in germination trials. Only two treatments were performed, based on previous trials. Seeds were either placed directly into a warm treatment or received a 45-day cold-moist treatment before being placed in warm conditions. Seed in the warm treatment germinated periodically over the 45 day period, with totals averaging about 29%. Seeds that received the cold treatment germinated immediately once they were placed in the warm treatment with totals averaging 76%. This suggests that seed should be collected, not fully dried and used within a couple months of harvest. Seeds need to be exposed to cold-moist conditions followed by warm temperatures for maximum germination. When sowing into a restoration site, seed should be sown at a time when it can receive at least 45 days of cold exposure, but will not germinate until late spring.

Table 3. Plant propagation for the US Forest Service in 2012.

Scientific Name	**Sow date**	**Treatment**	**Amt produced**
Aristida longiseta	1-May	none	1000
Hesperostipa comata	1-Mar	90 days cold	1000
Festuca viridula	1-Mar	90 days cold	1000
Trifolium longipes	1-Mar	scarification + 45 days cold	500

Plugs of *Aristida longiseta*, *Hesperostipa comata, Festuca viridula*, and *Trifolium longipes* were grown in the summer of 2012 for establishing seed increase fields. Seeds were sown into racks of stubby cone-tainers filled with Sunshine # 1 (a peat-based soilless media) amended with a slow-release fertilizer (*T. longipes* seed was scarified prior to sowing). Racks of *H. comata*, *F. viridula*, and *T. longipes* were then placed in plastic bags in a walk-in cooler for stratification. The *A. longiseta* does not require stratification to break dormancy, so racks were placed directly into an outdoor shadehouse. Racks that were placed in the cooler were removed at various intervals (based on trials that were performed last year) and then placed in an outdoor shadehouse. Plants germinated well and grew steadily throughout the summer. Once the clover began to bloom, it was apparent that two different species were growing in the cone-tainers. They were identified not as *T. longipes*, but rather as the clovers *T. cyathiferum* and *T. variegatum* (Figure 5).

Plugs of all species except the clovers? will overwinter in the PMC shadehouse for transplanting into seed increase plots in early spring. Transplanting usually occurs in March. It is unknown if these species will thrive at the PMC farm. The soils are usually completely saturated during winter and temperatures are mild. These species may not become fully dormant in our mild winters and may not tolerate the heavy, wet soils of the PMC farm. Establishing fields using healthy transplants in spring has proven to give maladapted plants the best chance at successfully establishing.

Figure 5. Two different clovers were present in the seed lot "*Trifolium longipes*". The clovers were later identified as *T. cyathiferum* (left) and *T. variegatum* (right).

V. Delivery of Plant Materials

There were no plant material deliveries made in 2012.

Table 4. Seed in storage at the Corvallis PMC for the US Forest Service in 2012.

Species	**Seed lot**	**Forest**	**Weight**
Aristida longiseta	SWC-11-FS139	Wallowa-Whitman	140 g
Aristida longiseta	SWC-11-FS141	Wallowa-Whitman	90 g
Eriogonum heracloides	SWC-07-UM523	Umatilla	130 g
Eriogonum heracloides	SG1-09-UM523	Umatilla	194 g
Festuca viridula	SWC-11-FS140	Wallowa-Whitman	2 lbs
Glyceria elata	SG1-11-FS618	Malheur	160 g
Glyceria elata	SG1-12-FS618	Malheur	3.5 lbs
Hesperostipa comata	SWC-11-FS137	Wallowa-Whitman	250 g
Lotus purshianus	SG1-12-FS146	Willamette	52 g
Monardella odoratissima	SWC-06-UM525	Umatilla	55 g
Monardella odoratissima	SG1-08-UM525	Umatilla	34 g
Penstemon fruticosus	SWC-07-UM524	Umatilla	260 g
Penstemon fruticosus	SG1-09-UM524	Umatilla	88 g
Penstemon procerus	SWC-06-UM526	Umatilla	33 g
Penstemon procerus	SWC-07-UM526	Umatilla	249 g
Penstemon procerus	SG1-11-UM526	Umatilla	144 g
Penstemon procerus	SG1-12-UM526	Umatilla	143 g
Sparganium emersum	SWC-09-OF624	Olympic	15 g

Seed and Plant Production for Projects in Collaboration with the Institute for Applied Ecology: 2012 Annual Report

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Figure 4. Oregon iris (*Iris tenax*) seed increase field at the Corvallis PMC, May, 17, 2012.

I. Brief Background of Project

The Corvallis Plant Materials Center (PMC) entered into an agreement with the US Fish and Wildlife Service (USFWS) in 2007 to increase seed of Willamette Valley forbs to be used on restoration sites. The Institute for Applied Ecology (IAE) collected seed from remnant wet prairies across the Willamette Valley in 2005, 2006, and 2007 to create composite collections to be released to growers for seed increase. Traditional agronomic seed increase techniques were not successful for some species; these species were brought to the PMC for research and development. Wild collected seed was very limited for a few species; these species were also brought to the PMC. Three new species were added to this agreement in 2012. The PMC is to produce bulbs and tubers of these new species. *Calochortus tolmiei* plot will be established at the PMC, and the other bulbs and tubers will be delivered to IAE in the fall if 2013. Activities in 2012 included plant production of four forbs and one grass as well as harvest and maintenance of seven seed increase fields.

II. Accessions Involved

The following table lists the accessions involved in the Willamette Valley Seed Increase Project at the Corvallis Plant Materials Center in 2012.

Table 1. Accessions in the Willamette Valley Seed Increase Project at the Corvallis Plant Materials Center in 2012.

Species	Common name	Accession #	Activity in 2012[1]
Allium amplectens	narrowleaf onion	9109133	Pxn
Balsamorhiza deltoidea	deltoid balsamroot	9109134	Pxn
Calochortus tolmiei	Tolmie star-tulip	9109135	Pxn
Danthonia californica	California oatgrass	9079601	Pxn, Sfp
Eriophyllum lanatum	Oregon sunshine	9079538	Sfp,Dlv
Iris tenax	Oregon iris	9109120	Sfp, Dlv
Juncus tenuis	poverty rush	9079535	Sfp,Dlv
Plectritis congesta	rosy plectritis	9109119	Sfp
Sidalcea virgata	rose checkermallow	9079536	Sfp, Dlv
Symphyotrichum hallii	Hall's aster	9079540	Sfp, Dlv

1- sfp= seed increase, pxn=plant production, dlv= delivered plant materials

III. Plant Production

The PMC received seed of *Calochortus tolmiei, Allium amplectens,* and *Balsamorhiza deltoidea* in the fall of 2011. Seed was sown into 12” X 12” X 5” deep propagation flats filled with moistened media (Sunshine #4- a peat-based media) amended with micronutrients and a slow-release fertilizer. Flats of *C. tolmiei* and *A. amplectans* were placed into a warm greenhouse for two weeks then covered with plastic bags and moved to a walk-in cooler for 90-days of cold stratification. *B. deltoidea* flats did not receive a two week warm treatment, but was placed directly into the walk-in cooler after sowing. Seeds of *Plectritis congesta* were also sown into plug trays at this time and trays were placed outside. The *P. congesta* seeds germinated within three weeks and they were moved into a cool greenhouse to grow slowly throughout the winter.

Table 2. Plant Production in 2012 for the Willamette Valley Seed Increase Project at the Corvallis Plant Materials Center in 2012.

Species	Amount	Treatment	Start date
Allium amplectens	5 flats	2 weeks warm + 90 day cold strat	1-Nov
Balsamorhiza deltoidea	9 flats	90 day cold strat	15-Nov
Calochortus tolmiei	5 flats	2 weeks warm + 90 day cold strat	1-Nov
Plectritis congesta	1500 plugs	outside 2 weeks	1-Nov
Danthonia californica	3400 plugs	90 day cold strat	15-Sep

The flats were removed from the cooler in mid winter and placed in a warm greenhouse. Initial germination was fair, but seedlings grew slowly and appeared to be dying or senescing after two months in the greenhouse. Seedlings were dug up and it was determined that they were senescing. Blubs were small but not rotten or diseased. Flats were moved outside in early spring. Most seedlings went dormant and remained so throughout the summer.

Danthonia californica seeds from this year's seed increase plot (2012) were used to grow more plugs to expand the current seed production plot. Seeds were sown into plug trays in early September and placed in a walk-in cooler for stratification. They will be removed in December and plugs will be transplanted into a field in spring of 2013.

IV. Seed Increase

Oregon iris (*Iris tenax*) was added to the production list in the fall of 2010. This species can be slow to establish and produce seed, so PMC staff decided to grow greenhouse plugs and transplant them into a seed increase field rather than directly sow the seed in the field. The plugs were transplanted out into a field in the spring of 2011 and grew vigorously throughout the summer. At least 90% of the plants flowered in 2012. In early July, pods began to ripen. They were collected by hand twice weekly throughout July. This was labor intensive, but worth the yields. A one-time harvest would have only captured a small amount of seed. Upon ripening, pods split open and the seeds spill out. The plants flowered for a surprisingly long period. In future years, as the plants mature, their flowering and seed maturation may be more synchronized, which would cut down on labor costs.

Figure 2. A two-year old Oregon iris (*Iris tenax*) plant at the Corvallis Plant Materials Center, April 25, 2012.

The *E. lanatum* field looked more sparse and shorter than it ever has. Yet, it flowered well and produced a decent amount of seed. Plants have not died, the plants simply appeared less vigorous year. The winter of 2011/2012 was very wet at the PMC and fields were not fertilized until April. This may have attributed to the lack of vigor. The field was swathed at the end of August and combined a few weeks later when the material had dried. Seeds were small, but filled. Seed was cleaned using an air screen machine. The small seed size this year made it much more difficult to clean out plant material of similar size, so this seed lot is less pure than ones from previous years. Last year's tests showed that lighter seeds are not less viable than heavier seeds. So this year, just the basic chaff and other plant materials were removed as well as very small or very flat seeds.

Juncus tenuis plants are fully mature and seem to maintain a high level of seed production. The field was weeded by hand a couple times during the growing season. The plants flowered and the seed matured relatively evenly across the entire field. Therefore the field was harvested by a self-propelled swather, nick-named the "moon rover". This machine cuts and sends all material up a

Figure 3. Poverty rush (*Juncus tenuis*) seed increase field at the Corvallis Plant Materials Center, June 10, 2012.

conveyor belt where it can be collected into large bags. After being harvested, material was laid on tarps inside an open greenhouse to dry. All the material was fed through the brush machine by hand to remove the seed from the capsules. This threshing method was labor intensive, but it definitely increased the amount of seed that was recovered from the field. It also makes the seed lot less pure because it breaks up the plant material more than a thresher would.

The *Symphyotrichum hallii* field was established in April of 2008, and since then the field has had a problem with a weedy annual *Epilobium* sp. The field has to be weeded several times during the growing season. This frequent scraping of the ground also keeps the aster plants from getting crowded and reduced the number of volunteer aster seedlings that can establish. Compared to other asters on the PMC farm, the Hall's aster is the least robust and has the lowest seed production. Last year the plants flowered weakly and produced little seed, this year was very simliar. The fall was dry and warm, which greatly extends the harvest period for a late species like aster. The field was seed stripped three times in the fall. This field may benefit from an application of fertilizer late in the growing season.

Table 2. Seed harvest in 2012 at the Corvallis Plant Materials Center.

Species	Date	Method	Area	Yield
Danthonia californica	July 20	hand	0.004	164 g
Eriophyllum lanatum	Aug 25	Swath/combine	0.3	81lbs
Iris tenax	July 2- July 25	Hand	0.28	20 lbs
Juncus tenuis	July 5	Moon rover	0.1	93 lbs
Plectritis congesta	June 28-July 10	hand/vac	0.1	99 g
Sidalcea virgata	July 2	direct combine	0.25	24 lbs
Symphyotrichum hallii	Sept 10-Oct 15	seed stripper	0.25	20 lbs

The *Sidalcea virgata* field was established in 2007, and since then the yields have not been stellar. The plants are large and usually covered with flowers in the spring. Pollinators have been abundant at times during flowering, yet there is a large amount of empty seed evident during cleaning. This field is comprised of plants from many small isolated populations all over the Willamette Valley. PMC staff began to wonder if there was a breeding problem with the field or an environmental problem. To rule out some possible environmental problems, the weed fabric

was removed from the majority of the field. Weed control is no longer an issue in the field, and improvements have been made in harvesting techniques without weed fabric. Staff thought that the weed fabric might be reducing the number of blooms per plant due to the flowering stems growing under the weed fabric. *S. virgata* tends to have a more spreading habit and new stems grow laterally, and consequently, under the fabric. It is a lot of work for PMC staff to crawl over the field, carefully pulling all the stems out from under the fabric. Many stems are broken in this process and most of these stems are flowering stems. Instead of pulling all the stems out from under the fabric this year, the fabric was removed, which left the stems intact. The weed fabric was left on a few rows and the stems were pulled from under the fabric. This left some plants to compare with the non-weed fabric plants. In 2012, the side of the field with no weed fabric was slow to grow in the spring. The side with the weed fabric began growing much earlier in the spring and plants on this side continued to appear larger throughout the spring. The field was fertilized in April and flowered later than usual due to the cool spring. Once the field flowered, very little difference in flower abundance and seed production was noticed between the side with weed fabric and the side without. The field was combined on July 2nd.Yeilds were similar to other years, except last year, which was the highest yield for this year so far, but was most likely due to weather conditions. This species is considerably more winter active than most native species, so it may benefit from earlier fertilization than what has currently been provided. In November, 2012, just as the plants were greening up and beginning to grow again, the plants were fertilized. This seemed to give them an extra boost before heading into winter.
This year, the *P. congesta* field was established using transplants. The seeds were started outdoors and moved to an unheated greenhouse to grow throughout the winter. The plants grew faster than expected and by February, they were flowering in the greenhouse. The plants were trimmed to keep plants from flowering and setting seed. Plants were transplanted out in late March, but soon after transplanting, the weather turned unseasonably cold and 7 inches of snow fell on the new transplants. The plants were properly hardened to withstand normal March/April temperatures, but not the snow. Many transplants died, but a small percent survived. Too many transplants had been produced for the size of the field and the extra plants were maintained until late April then transplanted into the field to replace some of the earlier-planted ones. Most of these survived and produced seed. Seeds were collected every other day since there were so few plants in the plot. Next year, seeds will be directly sown into a field covered with weed fabric.

Figure 4. California oatgrass (*Danthonia californica*) in flower at the Corvallis Plant Materials Center.

The *D. californica* field was established in the spring of 2012 using plugs that were produced in the summer of 2011. The field was very small, consisting of only a couple hundred plants. But they grew well and flowered in 2012. The seed was harvested by hand when ripe. The small amount of seed that they produced was used to produce more plugs in the fall of 2012.

V. Delivery of Materials

Most of the seed that was produced this year and the aster and *E. lanatum* from last year was delivered to IAE in the fall. The 2012 aster and *E. lanatum* seed was not available at planting time and remains in the PMC seed storage facilities.

Table 3 . Seed delivery amounts and purity and germination tests results.

Species	**Seed lot**	**Bulk lbs**	**Purity**	**Germ**	**PLS lbs**
Eriophyllum lanatum	SG1-11-NS583	45	91.84	70	29
Iris tenax	SG1-12-NS120	20	99.39	94	19
Juncus tenuis	SG1-12-NS535	93	80.5	95	71
Sidalcea virgata	SG1-12-NS536	24	97.42	83	19
Symphyotrichum hallii	SG1-11-NS540	13	29.6	38	1.5

Table 4. Seed in storage at the Corvallis Plant Materials Center, December 30, 2012.

Species	**Seed lot**	**Yield**
Eriophyllum lanatum	SG1-12-NS583	81 lbs
Plectritis congesta	SG1-12-NS119	0.5 lbs
Symphyotrichum hallii	SG1-12-NS540	20 lbs

CORVALLIS PLANT MATERIALS CENTER
USDA NATURAL RESOURCES CONSERVATION SERVICE
CORVALLIS, OREGON
Amy Bartow

December 30, 2012

THE 2012 GOLDEN GATE NATIONAL PARK ANNUAL REPORT:
Marin Headlands Revegation Project

Figure 1. Foothills needlegrass (*Nassella lepida*) seed increase field at the Corvallis PMC, June 13, 2012.

I. Brief Background of Project

In 2009, the Corvallis Plant Materials Center (PMC) entered into an agreement with Golden Gate National Park to provide native plant materials for ecological restoration following road construction in the Marin Headlands. The PMC has agreed to produce 250 pounds of two grasses.

Activities in 2012 included maintenance and harvest of two grass seed increase fields. The PMC met the contract goals for the oatgrass seed in 2012, but production in 2013 is needed to meet goals for the needlegrass.

II. Accessions Involved

Accessions included for the restoration of Marin Headlands are listed in Table 1. This table also displays activities performed by PMC staff in 2012.

Table 1. Accessions involved for the restoration in the Marin Headlands project with the Corvallis Plant Materials Center in 2012.

Species	Common name	Code	Accession	Activity in 2012[1]
Danthonia californica	California oatgrass	DACA3	9079621	Sfp
Nassella lepida	foothill needlegrass	NALE2	9079622	Sfp

1- Sfp= seed field production

III. Seed Increase Activities

The *Nassella* field looked the same or slightly better than last year. The spring/summer of 2012 was just as wet as the previous year. The field was hand-weeded many times to remove the rattail, but as the *N. lepida* plants grew taller and began to flower it was difficult to find the rattail. The weedy bentgrass plants were wiped with canes filled with glyphosate. The needlegrass was harvested using a flail-vac seed stripper in early July and again in late July.

The *Danthonia* field looked great again in 2012, but not as impressive as last year. All *Danthonia* fields on the PMC farm were not as vigorous or as tall as they were in 2011. The PMC farm experienced heavy flooding in January and March of 2012, and this may have affected the plants, although none of the fields for this project had standing water on them.

Figure 2. California oatgrass (*Danthonia californica*) seed increase field before flowering at the Corvallis PMC, April 21, 2012.

Table 2. Seed yields for the Marin Headlands project with the Corvallis Plant Materials Center in 2012.

Species	Harvest Date	Harvest Method	Field size (ac)	Yield
Nassella lepida	June 19	seed stripper	0.2	8.5lbs
Danthonia californica	June 28, July 25	seed stripper, swath/combine	0.5	136 lbs

V. Delivery of Plant Materials

There were no deliveries to the Park in 2012. All seed will be stored in the PMC seed storage facilities until requested by the Park.

Table 3. Seed in storage for the Marin Headlands project with the Corvallis Plant Materials Center in 2012.

Species	Seed lot	Amount
Nassella lepida	SG1-10-GG622	3 lbs
Nassella lepida	SG1-12-GG622	8.5lbs
Danthonia californica	SG1-11-GG621	62 lbs
Danthonia californica	SG1-12-GG621	136 lbs

Seed and Plant Increase of Threatened and Endangered Species: 2012 Annual Report

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Figure 1. Golden paintbrush *(Castilleja levisecta)* seed increase field at the Corvallis Plant Materials Center, May 20, 2012.

I. Brief Background of Project

The Corvallis Plant Materials Center (PMC) has entered into agreements with the United States Fish and Wildlife Service (USFWS) to produce seed and plants of threatened and endangered species. The PMC also works in a close partnership with the Institute for Applied Ecology (IAE) to establish the PMC-grown plants and seeds at restoration sites. Two seed increase fields of Nelson's checkermallow began in 2009. This project will help reach recovery goals by producing seeds, plants, and rhizome pieces to be planted out in various restoration projects on protected sites. In 2010, an agreement to produce seeds and plants of golden paintbrush was added. This plant is thought to have been extirpated from Oregon, and the products of this project will be used to establish new populations in Oregon according to recovery goals. In 2012, Cook's lomatium and a new field of Willamette Valley daisy were added to the PMC's seed production list.

II. Accessions Involved

Table 1. Accessions involved in the Threatened and Endangered Species Seed Increase project at the Corvallis Plant Materials Center in 2012.

Species	**Common name**	**Population Source**	**Accession #**	**Activity in 2012**[1]
Erigeron decumbens var. *decumbens*	Willamette Valley daisy	Eugene West	9109148	Pxn
Erigeron decumbens var. *decumbens*	Willamette Valley daisy	Baskett Butte	9079509	Sfp
Lomatium cookii	Cook's lomatium	Serpentine	9109136	Pxn
Lomatium cookii	Cook's lomatium	Upland/oak gaps	9109132	Pxn
Sidalcea nelsoniana	Nelson's checkermallow	Salem West	9079600	Sfp, dlv
Sidalcea nelsoniana	Nelson's checkermallow	Corvallis West	9079597	Sfp, dlv
Castilleja levisecta	golden paintbrush	Western Washington	9079625	Pxn, sfp, dlv

1- sfp= seed increase, pxn= plant production, dlv= delivery of plant materials

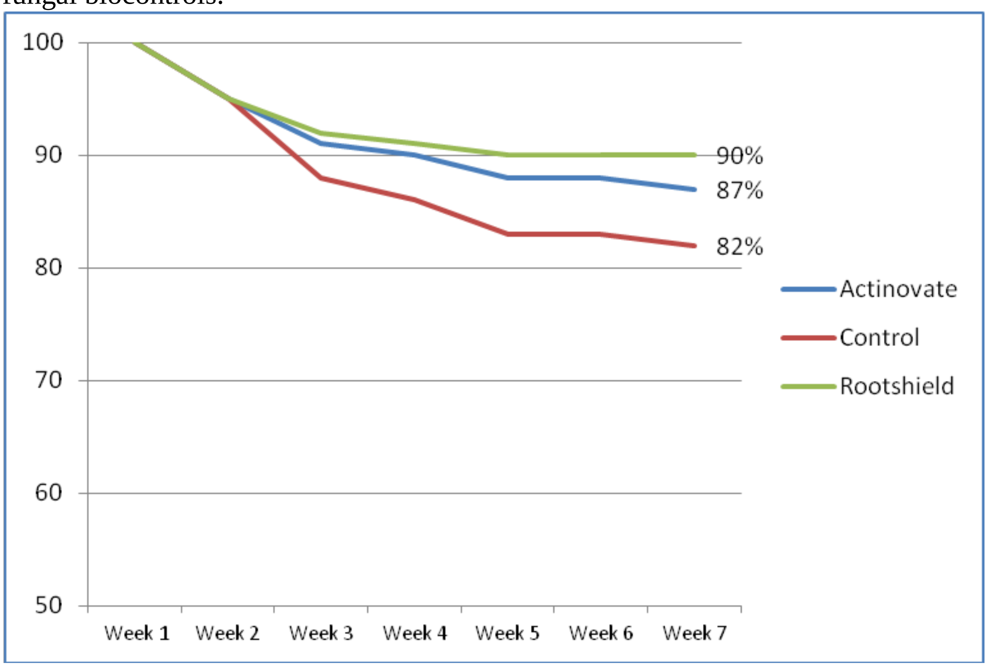
III. Plant Production

The PMC agreed to produce 5,000 plugs of *Castilleja levisecta* for delivery in spring of 2012. Using the seed that was produced by the seed increase field in 2010, plugs were started in late October 2011. Seeds were sown into Ray Leach stubby "cone-tainers" filled with Sunshine #1 (a sterile soil-less, peat-based media) amended with micronutrients and a balanced slow release fertilizer. In previous years, we have had outbreaks of root rot caused by *Pythium.* Instead of using fungicides, we tried using two different types of bio controls. Rootshield® and Actinovate® work in the same manner; they both are strains of bacteria that occupy the same niche as *Pythium,* except these strains of bacteria are not harmful to roots. In theory, it is more difficult for *Pythium* to get established on the root tips if the other bacteria are already established. Both biocontrols also claim that the bacteria will attack fungal pathogens. While mixing the media, batches were made with Actinovate or Rootshield added. As racks were filled, they were labeled to keep track of which racks had which biocontrol. Ten racks did not have any biocontrol, 30 had Actinovate and 30 had Rootshield. All media was amended with predatory nematodes to control fungus gnats. This is the best treatment we have found for fungus gnats and shore flies in the greenhouse.

Racks of cones were wrapped in plastic bags and placed in a walk-in cooler for six weeks of cold-moist stratification. After coming out of the cooler, racks were placed inside a cool greenhouse (set at about 60°F). Seedlings emerged within two weeks after being removed from the cooler. Previous work with this species has suggested that seeds germinate at higher percentages if seeds are in moderate temperatures (50-60°F) rather than warm temperatures (65-75°F). Seedlings were thinned down to two seedlings per cone-tainer and greenhouse temperatures were increased to 75°F to speed up the growth of the seedlings. After a month, white fuzzy mold was noticed on the top of the soil in some containers and many of the paintbrushes were looking pale. A 1:10 solution of Zero-tol (hydrogen peroxide) was sprayed on the soil to control the mold. It seemed to control the mold within days and no adverse affects were noticed on the plants. A few containers were left untreated for comparison and the mold persisted but the plants looked the same as the ones that had been sprayed. After the mold was controlled, a weak solution of Peter's 20-20-20 fertilizer was sprayed on the plants. They greened up slightly and we sprayed with Zero-tol again the following week. These issues occurred randomly (mold) or were widespread (paleness) and did not seem correlated with any treatment.

Once a week for seven weeks, data were collected on the presence or absence of a plant in every cone-tainer (Figure 2). After seven weeks, the Rootshield and Actinovate both had higher rates of survival (90 and 87%, respectively) than the control (82%). These differences in container production are large enough to justify the cost of Actinovate, but probably not Rootshield, which is more expensive and did not appear to perform much better than Actinovate. Species will likely respond differently to the various strains used in each biocontrol product, but for *C. levisecta* both biocontrols appeared to be very helpful in reducing fungal infections.

Figure 2. Comparisons of percent survival of *Castilleja levisecta* seedlings planted with various fungal biocontrols.



In January, seeds of host plants were added to the *Castilleja* containers. Hosts grew at various rates depending on the species. From what we have learned in previous years, it's best to plant the hosts at different times depending on how fast they grow. Since many

Figure 3. Golden paintbrush (*Castilleja levisecta*) plants growing with rose checkermallow (*Sidalcea virgata*) host in the Corvallis PMC greenhouse.

host species have different germination requirements than what was provided in the greenhouse, the seeds were placed in germination boxes and exposed to treatments to break dormancy or trigger germination. Seeds of *Danthonia californica, Sidalcea virgata, Plectritis congesta, Ranunculus occidentalis* and *Eriophyllum lanatum* germinated in the boxes and were transplanted into cones with existing *Castilleja* plants. This worked well for the hosts, but is much more labor intensive than directly seeding. Other host species were directly seeded into cones. Before adding hosts, racks of paintbrushes were sorted by most vigorous to least vigorous. When hosts were added, we attempted to provide each host with a similar amount of high and low vigor plants. Hosts were not assigned racks based on biocontrol treatment. Survival data after outplanting will be collected by IAE to assess differences among hosts.

Table 2. Golden paintbrush plants produced in 2012 according to hosts.

Species	**Host**	**Number**
Castilleja levisecta	*Elymus trachycaulus*	369
Castilleja levisecta	*Prunella vulgaris* ssp. *lanceolata*	587
Castilleja levisecta	*Koeleria cristata*	471
Castilleja levisecta	*Plectritis congesta*	458
Castilleja levisecta	*Festuca roemeri*	501
Castilleja levisecta	*Achillea millefolium*	472
Castilleja levisecta	*Danthonia californica*	437
Castilleja levisecta	*Sidalcea virgata*	562
Castilleja levisecta	*Eriophyllum lanatum*	280
Castilleja levisecta	*Ranunculus occidentalis*	462
Castilleja levisecta	no host	1350
	total	5949

Seeds of Cook's lomatium were provided to the PMC in fall of 2011. Seeds were planted in deep propagation flats (5by 12 by 12 inches) filled with Sunshine #1 amended with micronutrients, a balanced slow release fertilizer, and predatory nematodes. Most flats also received an additional treatment of Actinovate. Some populations had enough seeds to fill multiple flats, so those seed lots were divided equally between two flats. Seeds were lightly covered with vermiculite. Flats were wrapped in plastic bags and placed in a walk-in cooler for 90 days, and then transferred to an unheated greenhouse (50°F days/40°F nights). Seeds germinated quickly and flats seemed very full of plants. Some damping off was noticed and flats were sprayed with a copper solution. It seemed to help the disease from spreading but it did not cure plants that were already affected. The plants were moved to a warm greenhouse (75°F) and grew slowly for a couple months, then appeared to senesce before summer. We dug up a few plants to see if they had senesced due to disease, but they appeared healthy and had grown small slender tubers. Flats were moved outside to a shadehouse for the summer. In fall, all tubers were dug up from the flats and counted. Many tubers were very thin. The tubers will be transplanted into two separate seed increase fields; one will be comprised of populations from upland/oak gaps, and the other will be from populations associated with serpentine soils.

Table 3. Cook's lomatium tubers produced per population in 2012.

Population	**Region**	**Amt seed used (g)**	**# tubers produced**
Reeve's Creek 805	Upland/oak gaps	5.0	314
Reeve's Creek 802	Upland/oak gaps	0.5	18
Reeve's Creek 821	Upland/oak gaps	0.04	5
Reeve's Creek 803	Upland/oak gaps	1.22	37
Reeve's Creek 822	Upland/oak gaps	0.42	9
Reeve's Creek 804	Upland/oak gaps	5.7	338
		total	721
Cave's Hwy	Serpentine	2.8	185
French Flat Mid	Serpentine	20.0	908
French Flat North	Serpentine	0.13	18
Piney Woods	Serpentine	4.3	161
French Flat South	Serpentine	22.0	447
Indian Hill	Serpentine	2.0	158
Rough N Ready	Serpentine	7.0	163
		total	2040

The final delivery of *Sidalcea nelsoniana* plugs was scheduled for the fall of 2012. Scarified seeds were sown into Ray Leach stubby "cone-tainers" filled with Sunshine #1 amended with micronutrients and a balanced slow release fertilizer. Racks of cones were wrapped in plastic bags and placed in a walk-in cooler for 12 weeks. Germination usually begins in the cooler and continues after the racks are moved to an outdoor shadehouse. Plants were thinned down to no more than two seedlings per cone-tainer. They remained in the shadehouse all summer and were trimmed twice to reduce water stress during August and September. A small batch of plants was picked up in late November and the rest will be picked up by IAE staff in March for outplanting at restoration sites.

A new Willamette Valley daisy plot was to be established at the PMC from plugs that were provided by IAE. When the plants were received, we deemed them too small to transplant. The plants were cared for in the PMC shadehouse for the summer to increase their size and they will be planted out in a seed increase field in March of 2013.

IV. Field Seed Increase Activities

Golden paintbrush- In April 2010, 1,851 plugs with a fescue host were transplanted into a field on the PMC farm. Each row consisted of one population and the rows were alternated throughout the field. This makes it possible to make visual qualitative assessments of the growout and production of the different populations. A field map was made and labels were kept at the head of each row.

Figure 4. Golden paintbrush (*Castilleja levisecta*) in bloom at the Corvallis PMC farm. This rare plant is thriving in a cultivated setting.

The field was much weedier than in previous years and the very wet spring we had in 2012 left us few opportunities for early weeding and spraying. White clover became established in one corner of the plot, smothering the paintbrushes and the host plants. It is very difficult to remove, especially without damaging the paintbrushes. It was fairly easy to remove the rest of the weeds in the plot, but since the paintbrushes are parasitic, it was not known how the removal of the weeds would affect the paintbrushes. The plot was carefully weeded, except the areas with white clover. With the exception of the areas with the clover, the plants were very large and robust.

Harvesting the paintbrushes with hosts is more complicated than single species plots. The fescue heads were cut off before the seeds were ripe so they would not shatter all over the field. The fescue seedheads were tall enough to cut them off without hitting the *C. levisecta* seed heads. After removing the fescue seeds, all the flowering paintbrush stems were cut and dried in an open-air greenhouse. The pods were fed through a Wintersteiger stationary thresher to break them open, and debris was separated from seeds in a small air-screen machine. The thresher did de-hull many seeds, but this doesn't seem to harm them. After the plants had gone dormant in late October, the clover was sprayed with glyphosate. The clover appeared weakened but not completely dead, so it was sprayed again in mid December. Any missing paintbrushes or hosts will be replaced in the spring, to keep the field the same size, but plants might be placed in other areas with less clover.

Figure 5. Willamette valley daisy (*Erigeron decumbens* var. *decumbens*) at the Corvallis PMC, June 25, 2012.

Willamette Valley daisy- This was the fifth growing season for the remaining daisy plot. In late January, the plants emerged from dormancy and began to grow vigorously. The plot was weeded by hand and field borders were tilled. As the seeds ripen, they are vacuumed from the plants twice a week.

Salem West (SW) and Corvallis West (CW) Nelson's checkermallows- These fields were established in mid-March of 2009 using plugs that were grown from wild collected seed. The two seed increase fields were isolated from each other by three miles.

Figure 6. Corvallis West accession of Nelson's checkermallow (*Sidalcea nelsoniana*) at the Corvallis PMC, June 24, 2012.

Weed fabric was installed on the SW field, but not on the CW field. Originally, it was planned that both fields would have weed fabric, but the CW field had a large amount of glass, sharp rocks, and other debris that could make crawling on weed fabric dangerous for PMC employees. Also, having a checkermallow field without weed fabric gives the PMC an opportunity to compare the seed increase fields.

In the winter of 2011-2012, rhizomes were harvested from the Corvallis West field. This activity was performed by IAE staff and contracted labor. A portion of each field was dug up and mother plants were divided. Small pieces of the mother plants still remained in the field, and in the spring many new leaves were seen emerging from the edges of the holes where the plants had been dug out.

The CW field was very weedy in 2012. The entire field was weeded twice by hand during the growing season and also spot sprayed with glyphosate to remove weedy clover plants. Field borders were tilled. The SW field was weeded once by hand and the borders of the field were sprayed with glyphosate. The SW field (with weed fabric) was larger in spring than the CW field. This may be due to the warming effect that the fabric has on the soil; the same effect has been noticed in other fields with weed fabric at the PMC. But the differences in the fields disappeared in June when air temperatures were warmer. Both fields were healthy and vigorous this year, and were harvested by direct combining. The yield on the CW field (without weed fabric) was nearly double the yield of the SW field (with weed fabric), but no obvious differences were observed in the fields this year.

Table 4. Harvest information for the Threatened and Endangered Species Seed Increase Project at the Corvallis Plant Materials Center in 2012.

Species	**Accession**	**Field size (ac)**	**Date harvested**	**Method**	**Yield**
Erigeron decumbens var. *decumbens*	Baskett Butte	0.006	July 10-30	vacuum	208 g
Castilleja levisecta	Mixed	0.04	3-Jul	hand	3.7 lbs
Sidalcea nelsoniana	Salem West	0.3	16-Jul	combine	60 lbs
Sidalcea nelsoniana	Corvallis West	0.3	19-Jul	combine	123 lbs

V. Delivery of Plant Materials

Seed was delivered in the fall to IAE staff. The remaining seed will be kept in the PMC seed storage facilities until requested.

Table 5. Seed delivered for the Seed Increase of Threatened and Endangered Species Project in 2012.

Species	**Source**	**Seed lot**	**Weight**
Castilleja levisecta	Mixed	SG1-12-NS625	3.2 lbs
Sidalcea nelsoniana	Salem West	SG1-12-NS600	60 lbs
Sidalcea nelsoniana	Corvallis West	SG1-12-NS600	123 lbs

Our seed lot numbers describe the generation of the field (SG0 is wild collected seed, SG1 is seed that is produced from the plants that were grown using wild collected seed). The middle numbers of a seed lot indicate which year the seed was produced. The letters in the last portion of the seed lot describe which project the seed is for (or an abbreviation for the seed source) and the numbers are the last three digits of the accession number that has been assigned to this species specifically for this population source.

Table 6. Seed in storage for Seed Increase of Threatened and Endangered Species Project in 2012.

Species	Source	Seed lot	Amt
Erigeron decumbens var. *decumbens*	Allan & Allan Farm	SG1-09-AA508	43 g
Erigeron decumbens var. *decumbens*	Baskett Butte	SG1-08/12-BB509	1 lb
Castilleja levisecta	Mixed	SG1-12-NS625	267 g
Castilleja levisecta	Mixed	SG1-11-NS625	2 lb
Castilleja levisecta	Mixed	SG1-10-NS625	90 g
Sidalcea nelsoniana	Salem West	SG1-09/10-NS600	11 lbs
Sidalcea nelsoniana	Salem West	SG1-10-NS600	38 lbs
Sidalcea nelsoniana	Salem West	SG1-11-NS600	41 lbs
Sidalcea nelsoniana	Corvallis West	SG1-10-NS600	19 lbs

The 2012 U.S. Fish and Wildlife Service Annual Report: Western Lily (*Lilium occidentale*) Bulb Production Project

USDA Natural Resources Conservation Service
Corvallis Plant Materials Center
Corvallis, Oregon
Tyler C. Ross
January 16, 2012

Figure 1. Western lilies growing at the Corvallis PMC.

I. Brief Background of Project

In 2009 the Corvallis Plant Materials Center (PMC) entered into an agreement with the United States Fish and Wildlife Service to produce 1,000 Western lily (*Lilium occidentale*) bulbs to be planted out onto restoration sites. In 2010, the Corvallis PMC agreed to produce 1,000 more bulbs. The bulbs are to be provided for out-planting within 5 years from the start of each agreement.

The Western lily has been a federally listed endangered species since 1994. It is only found in a narrow band, about 200 miles in length, along the coast of southern Oregon and northern California. This potentially long-lived lily species has become endangered primarily due to loss of habitat. The Western lily seems to only thrive in coastal grasslands scattered with small shrubs. The soil should have a perched water table caused by a naturally occurring hardpan which functions to keep the soil moisture high for most of the growing season. When settlers of the Pacific Northwest coast started suppressing fires in the area, large shrubs and trees began to encroach on Western lily habitat. These larger plants were able to shade out the Western lily over time, but more importantly, their vast roots grew deep and punctured the hardpan which drained the perched water table in the area making it difficult for the Western lily to thrive. Furthermore, a reduction in grazing by elk, deer, and livestock has helped to speed the encroachment of the forest. More recently, the spike in demand for cranberries has triggered farmers to convert critical habitat into cranberry bogs. Western lily habitat also proves to be excellent cranberry habitat. The man-made bogs displace the Western lily as well as drain the perched water table.

Figure 2. Western lilies in spring at the Corvallis PMC.

Activities in 2012 included germination studies, bulb production, inventory, and delivery.

II. Germination Study Activities

During the winter of 2011, a new germination study was conducted. The goal of the study was to determine whether or not the seed dormancy is caused by an impermeable seed coat. Seeds of Western lily appear to be waxy and seem to repel water. G1 seed saved from the bulb production was used for the study. Seeds were nicked using a scalpel. If dormancy is caused by a hard seed coat, then nicking it will allow water to enter the seed and trigger germination the treatments for this study were as follows: nicked+30 day warm then cold, nicked cold, un-nicked+30 day warm then cold, and un-nicked cold.

It quickly became apparent that the nicking treatment was not a viable method to assist in breaking dormancy because all of the nicked seeds in the warm and the cold treatment became moldy and rotten within the first 30 days of the trial. The un-nicked 30 day warm then cold began to germinate about 45 days after they were moved to cold conditions and eventually reached 80 percent germination after 100 days of being in the cold. The un-nicked+cold had no germination during the length of the study. Only the nicked seeds became moldy and rotten. It is highly unusual for the seeds of this species to mold in a germ box. Seeds have been kept in moist, cold stratification for over 1 year with no signs of mold.

This study did not reveal any new seed dormancy information; however, it did demonstrate that the seed coats must remain intact in order for germination to take place. When mechanically cleaning seed lots of Western lily, it is very important to use care to not damage seed coats or the seed lot will have very poor germination.

III. **Bulb Production Activities.**

In March of 2012, the western lily bulbs were removed from the cooler and planted back into the 14" square flats that they had been growing in previously. The old roots never died back and some new roots were starting to grow. It was no longer necessary to keep track of the bulbs by mother, so bulbs were tracked by population. Bulbs were planted 25 to a flat and evenly spaced. This should allow more room for bulbs to continue growing and provide the opportunity for the small bulbs to expand.

Figure 3. Western lily bulb up close.

The flats of bulbs were placed outside in one of the PMC's shadehouses. A rodent proof cage was constructed around them using screen and 2-by-12 boards. Within a month, the bulbs were beginning to send up leaves. The plants were very large this year. They began to flower in early June and continued through most of July. Some of the plants had five blossoms per stem.

It was observed that there was an abundance of variation in blossom size and color. At first glance it was believed that some of the variation was due to hybridization with *Lilium columbianum*. Western lilies are distinguished from other lilies based on the yellow-green center star and its anthers which are usually paralell to the stigma (not spreading). Flower color can range from a very dark red to a reddish-orange. Spots are usually confined to the yellow star, but not always. We noticed that when flowers first opened, these traits were very obvious: the center of most flowers contained a green star and stamens that were paralell to the stigma, but as flowers aged, the green star turned to yellow and the stamens began to spread away from the stigma. Upon close examination and much more thought, the conclusion was reached that most of the unusual looking flowers were actually just *Lilium occidentale.* The variation can be seen in Figures 4-7. The Cape Blanco population had 4 to 6 obvious *Lilium columbianum* plants, so they were flagged for removal. The unusual plants that were flagged earlier were unflagged. The *Lilium columbianum* had their leaves in distinct whorls around the stem and all other plants from the different populations did not show this trait.

Figure 4. Left: flower with a brown center and yellow that radiates out far from the center. Right: flower with yellow coloring only in the center and deep red petals.

Figure 5. These pictures show the difference in spot size. The flower on the left has much larger and more pronounced spots than the one on the right. Both flowers show spreading anthers.

Figure 6. Left: flower with yellow star bordered sharply by red. Spots are contained within the yellow star. Right: flower where the yellow coloring slowly fades to orange then to red and spots not confined to yellow star.

Figure 7. Left: flower with a green center absent of spots, anthers spreading. Right: flower with a green center filled with many brown spots, anthers spreading.

Figure 8. Flower with doubled tepals, pistols, and stamens.

Germinants from the previous germination studies planted in the 4410 Ray Leach "stubby" cone-tainers™ were left outside over the winter in 2012 to observe how cold hardy they were. They had no protection from the weather. In the spring they began to grow leaves at the same time as the rest of the Western lily bulbs that were protected from extreme low temperatures that would cause the bulbs to freeze solid. The bulbs in the cone-tainers™ flowered but the stalks were more slender and contained less buds than the ones growing in the flats. It appears that the confined growing space of a cone-tainer™ stunts the growth of the bulb which results in smaller plants. However, bulbs do appear to tolerate very cold temperatures.

IV. **Bulb scale reproduction activities**

When the bulbs were lifted, many scales crumbled off. The scales were saved and kept separate by population. They were placed in plastic bags with moist vermiculite and kept in a walk-in cooler. After about a month, no new growth appeared nothing was happening with them so they were moved to the 70°F greenhouse. Within a few weeks the bulb scales began to form tiny bulblets at the base where they were broken loose from the bulb. Once the bulblets formed, they began to grow roots. At that point they were, planted into 4410 Ray Leach "stubby" cone-tainers™. The first leaf started to grow within a month and continued to do well once they were moved to a shade house for the summer. They produced bulbs that were between 0.5 and 1.0 inch in diameter.

Figure 9. Bulblet forming on a bulb scale from a Western lily bulb

V. **Delivery**

In the winter of 2012/2013, the bulbs were lifted from the boxes and cones and sorted into three different size groups: small, medium, and large. If the bulbs were smaller than 1 inch in diameter they were considered to be small. If they were between 1 and 1.5 inches they were mediums. Bulbs larger than 1.5 inches were considered to be large. There was a total of 2,400 bulbs. They were kept separate by population and were placed in large plastic bags and stored in a walk-in cooler until delivery.


Figure 10. Three of the large sized bulbs (> 1.5 inches).

In January 2013, staff from the PMC traveled to the southern Oregon coast and met up with people from the Oregon Department of Agriculture to plant the bulbs out on the sites. Bulbs were planted along transects within 1 meter square plots on either side of the transects. Areas with dense shrubs were not planted. Holes were dug using sharp shooter shovels and hand shovels. Bulbs were planted at a depth of between 2 and 6 inches depending on their size. In all, 2,300 bulbs were planted. Some of the populations will be more than doubled in size from these planting activities depending on survival. Past plantings of Western lily bulbs have shown a very low outplanting survival rate but the bulbs were smaller and were planted very deep. In the production environment at the PMC, it was observed that the bulbs remain near the soil surface and do not migrate down like many other bulb-forming species so it is possible that planting them too deep could reduce the chance of them emerging in the spring.

Figure 11. Planting bulbs along a transect.

VI. 2012 Conclusion

The Corvallis PMC is ahead of schedule on fulfilling the agreement with the United States Fish and Wildlife Service. More than 2,000 bulbs will be ready for delivery in the winter of 2012-2013.

Figure 12. PMC staff digging holes to plant lily bulbs