United States Department of Agriculture

Natural Resources Conservation Service
Corvallis Plant Materials Center

2013 Annual Technical Report

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Amy Bartow, Plant and Seed Production Manager
Annie Young-Mathews, Conservation Agronomist
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Vanessa East, Biological Sciences Technician

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Mary Beuthin, Biological Sciences Technician (resigned 2/15/13)
Kevin Robb, Farmer (resigned 7/1/13)
Dale Darris, Conservation Agronomist (retired 1/1/14)
John Knox, Biological Sciences Technician (term ended 2/1/14)

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Introduction

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 of Washington, Oregon and northern California; the Willamette Valley of Oregon; the Puget Sound Lowlands of Washington; and the Olympic, Cascade, and Siskiyou Mountains.

2013 Growing Season Weather Summary

Precipitation was only 59% of normal for the year, with an especially dry spring, and most of Oregon was in a drought. However, September was one of the wettest on record, with nearly 3 inches of rain in one thunder and lightning storm on 6 Sept. 2013, and another 3 inches at the end of the month. An Arctic front in early December brought about 8 inches of snow, with temperatures that dipped as low as 2°F, and stayed below 32°F for 6 days straight, forcing weeklong shutdowns of many schools and activities, and damage to plumbing in the PMC office and farm.

Climate

The Corvallis PMC is located in the Willamette Valley of western Oregon, between the Coast Range and the Cascade Range, about 40 miles from the Pacific Ocean. The climate is relatively mild throughout the year, with cool wet winters and warm dry summers. Annual precipitation is approximately 43 inches, falling mainly from October through April. The frost-free growing season averages 150 days, from mid-May to early October. December and August are the coldest and warmest months, respectively.

Temperature and Precipitation Data 2012-2013§ for Corvallis PMC

Year	Month	Average Daily Maximum (°F)	Average Daily Minimum (°F)	Precipitation (in)	Snow (in)
2012	October	66.1	43.1	5.00	
	November	54.0	41.6	8.75	
	December	47.6	36.5	8.56	
2013	January	41.3	30.9	1.71	
		47.1	34.2	6.40	
	February	50.7	35.4	1.99	
		50.9	34.7	5.11	
	March	57.1	37.1	2.58	
		56.1	37.3	4.44	
	April	63.0	40.7	1.99	
		60.8	39.6	2.91	
	May	69.5	46.6	2.27	
		67.2	44.1	2.31	
	June	75.5	49.6	1.28	
		73.2	48.5	1.52	
	July	86.8	51.9	0.00	
		81.7	51.8	0.49	
	August	83.4	53.6	0.33	
		82.6	51.1	0.53	
	September	74.8	52.4	7.06	
		77.0	47.7	1.25	
	October	63.1	39.6	1.17	
		64.7	41.7	3.10	
	November	52.5	37.8	2.73	
		52.6	37.9	6.94	
	December	41.7	27.7	2.04	4.5
		45.8	33.4	7.71	
2013	**Annual**	63.3	41.9	25.15	
		63.4	41.9	42.71	

§Weather data are from the OSU Hyslop Weather Station, ½ mile from the Corvallis PMC (44°38'03" Lat., 123°11'24" Long., Elevation: 230').

¥30-year climate normals, 1981-2010, from PRISM Climate Group, Oregon State University.

2013 Corvallis PMC Publications

Copies of the following publications are available at:
http://www.nrcs.usda.gov/wps/portal/nrcs/publications/plantmaterials/pmc/west/orpmc/pub/

Plant Guides and Plant Fact Sheets

Beuthin, M. 2013. Plant Guide: Big Leaf Lupine (*Lupinus polyphyllus*). Corvallis Plant Material Center, Corvallis, OR. March 2013. 4p.

Beuthin, M. 2013. Plant Guide: Idaho blue-eyed grass (*Sisyrinchium idahoense*). Corvallis Plant Materials Center, Corvallis OR. March 2013. 3p.

Beuthin, M. 2013. Plant Guide: Western Buttercup (*Ranunculus occidentalis*). Corvallis Plant Materials Center, Corvallis, OR. March 2013. 4p.

Hemmingway, M. 2013. Plant Guide: *Eriogonum nudum* (Naked buckwheat). Corvallis Plant Materials, Corvallis, OR. 3p.

Hoffman, R. 2013. Plant Guide: Hookspurred Violet (*Viola adunca*). Corvallis Plant Materials Center, Corvallis OR. March 2013. 4p.

Hoffman, R. 2013. Plant Guide: Poverty Rush (*Juncus tenuis*). Corvallis Plant Materials Center, Corvallis, OR. March 2013. 3p.

Ross, T. 2013. Plant Guide: Oregon Saxifrage (*Saxifraga oregana*). Corvallis Plant Materials Center, Corvallis OR. March 2013. 3p.

Ross, T and A. Bartow. 2013. Plant Guide: Grassy Tarweed. Corvallis Plant Materials Center, Corvallis, OR. March 2013. 3p.

Ross, T. and A. Bartow. 2013. Plant Guide: Mountain Tarweed (*Madia glomerata*). Corvallis Plant Materials Center, Corvallis, OR. March 2013. 3p.

Young-Mathews, A. 2012. Plant Fact Sheet: Farewell to Spring (*Clarkia amoena*). ORPMC, Corvallis, OR. October 2012. 2p.

Young-Mathews, A. 2012. Plant Fact Sheet: Shortspur Seablush (*Plectritis congesta*). ORPMC, Corvallis, OR. October 2012. 2p.

Young-Mathews, A. 2012. Plant Fact Sheet: Sulphur-flower Buckwheat (*Eriogonum umbellatum*). ORPMC, Corvallis, OR. October 2012. 2p.

Young-Mathews, A. 2013. Plant Guide: Crimson Clover (*Trifolium incarnatum*). Corvallis, OR PMC, Corvallis, OR. February 2013. 6p.

Conservation Plant Release Brochures

Darris, D. 2013. Release brochure for ‘Arlington’ blue wildrye (*Elymus glaucus*). NRCS Corvallis Plant Materials Center, Corvallis, OR. September 2013. 2p.

Darris, D. 2013. Release brochure for ‘Elkton’ blue wildrye (*Elymus glaucus* ssp. *jepsonii*). NRCS Corvallis Plant Materials Center, Corvallis, OR. September 2013. 2p.

Darris, D. 2013. Release brochure for Baskett Slough Germplasm California oatgrass (*Danthonia californica*). NRCS Corvallis Plant Materials Center, Corvallis, OR. September 2013. 2p.

Darris, D. 2013. Release brochure for Jackson-Frazier Germplasm meadow barley (*Hordeum brachyantherum*). NRCS Corvallis Plant Materials Center, Corvallis, OR. September 2013. 2p.

Darris, D. 2013. Release brochure for Skamania Germplasm Sitka alder (*Alnus viridis* ssp. *sinuata*). NRCS Corvallis Plant Materials Center, Corvallis, OR. September 2013. 2p.

Darris, D. 2013. Release brochure for Tillamook Germplasm tufted hairgrass (*Deschampsia cespitosa*). NRCS Corvallis Plant Materials Center, Corvallis, OR. September 2013. 2p.

Darris, D. 2013. Release brochure for Willamette Germplasm tufted hairgrass (*Deschampsia cespitosa*). NRCS Corvallis Plant Materials Center, Corvallis, OR. September 2013. 2p.

Darris, D. and A. Young-Mathews. 2013. Release brochure for 'Clatsop' Hooker willow (*Salix hookeriana*). NRCS Corvallis Plant Materials Center, Corvallis, OR. September 2013. 2p.

Darris, D. and A. Young-Mathews. 2013. Release brochure for 'Mason' western redosier dogwood (*Cornus sericea* ssp. *occidentalis*). NRCS Corvallis Plant Materials Center, Corvallis, OR. September 2013. 2p.

Darris, D. and A. Young-Mathews. 2013. Release brochure for 'Multnomah' Columbia River willow (*Salix sessilifolia*). NRCS Corvallis Plant Materials Center, Corvallis, OR. September 2013. 2p.

Darris, D. and A. Young-Mathews. 2013. Release brochure for 'Placer' erect willow (*Salix ligulifolia*). NRCS Corvallis Plant Materials Center, Corvallis, OR. 2013. 2p.

Darris, D. and A. Young-Mathews. 2013. Release brochure for 'Plumas' Sitka willow (*Salix sitchensis*). NRCS Corvallis Plant Materials Center, Corvallis, OR. September 2013. 2p.

Darris, D. and A. Young-Mathews. 2013. Release brochure for 'Rogue' arroyo willow (*Salix lasiolepis*). NRCS Corvallis Plant Materials Center, Corvallis, OR. September 2013. 2p.

Other Publications

Corvallis PMC Staff. 2013. Corvallis Plant Materials Center 2012 Annual Technical Report. USDA NRCS Corvallis Plant Materials Center, Corvallis, OR. April 30, 2013. 136p.

Corvallis PMC Staff. 2013. Corvallis PMC Newsletter - Spring 2013. Corvallis Plant Materials Center, Corvallis, OR. April 2013. 4p.

Corvallis PMC Staff. 2013. Corvallis PMC Newsletter - Summer 2013. USDA NRCS Corvallis Plant Materials Center, Corvallis, OR. August 2013. 2p.

2013 Corvallis PMC Presentations

Title: Woody Plant Workshop
Location: Corvallis Plant Materials Center
Date presented: 2/20/2013

- **Presenter:** Dale Darris **Topic:** Winter twig identification of native shrubs
- **Presenter:** Kathy Pendergrass **Topic:** Traits of woody natives
- **Presenter:** Dale Darris **Topic:** Basics of propagating and planting native woody plants from hardwood cuttings
- **Presenter:** A. Young-Mathews & D. Darris **Topic:** How to make hardwood cuttings and slips
- **Presenter:** Tyler Ross & Staff **Topic:** Handling and planting woody plant stock

Title: Pacific Northwest Seed Production Manual Poster
Location: National Native Seed Conference, Santa Fe, NM
Date presented: 4/10/2013
Presenter: Amy Bartow

Title: Soil Health Workshop: Mixed Species Cover Crops for Soil Health
Location: Corvallis Plant Materials Center
Date presented: 5/2/2013
Presenter: Annie Young-Mathews

Title: 5th Annual Farmscaping Field Day
Location: Corvallis Plant Materials Center
Date presented: 6/18/2013

- **Presenter:** Dale Darris **Topic:** Native Grasses
- **Presenter:** Amy Bartow & Tyler Ross **Topic:** Native Forbs for Pollinators & Equipment Demo.
- **Presenter:** Kathy Pendergrass **Topic:** Hedgerow Species and Seeding Calculations
- **Presenter:** Annie Young-Mathews **Topic:** Direct Seeded Wildflower Mixes

Title: NRCS Plant Materials Program National Soil Health Study - Year 1, 2012-2013
Location: National webinar
Date presented: 9/11/2013
Presenter: Annie Young-Mathews

FY 2013 Seed and Vegetative Production

Production of NRCS Conservation Plant Releases by ORPMC

Release Name	Species	Foundation Seed (lbs)	Certified Seed (lbs)	Unrooted Cuttings
Skamania Germplasm	*Alnus viridis* ssp. *sinuata*	0	1	0
Mason	*Cornus sericea* ssp. *occidentalis*	0	0	125
Baskett Slough Germplasm	*Danthonia californica*	12	0	0
Tillamook Germplasm	*Deschampsia caespitosa*	0	0	0
Willamette Germplasm	*Deschampsia caespitosa*	0	0	0
Arlington	*Elymus glaucus* ssp. *glaucus*	0	0	0
Elkton	*Elymus glaucus* ssp. *jepsonii*	200	0	0
Klamath Mountains Germplasm	*Festuca roemeri*	0	8	0
Northwest Maritime Germplasm	*Festuca roemeri*	0	0	0
Puget Germplasm	*Festuca roemeri*	0	9	0
San Juan Germplasm	*Festuca roemeri*	0	7	0
Willamette Valley Germplasm	*Festuca roemeri*	0	12	0
Jackson-Frazier Germplasm	*Hordeum brachyantherum*	12	0	0
Hederma	*Lupinus rivularis*	0	0	0
Clatsop	*Salix hookeriana*	0	0	100
Rogue	*Salix lasiolepis*	0	0	100
Placer	*Salix ligulifolia*	0	0	100
Multnomah	*Salix sessilifolia*	0	0	260
Plumas	*Salix sitchensis*	0	0	50
	Total	**224**	**37**	**735**

Discontinued Releases in 2013:

- 'Bashaw' Douglas spirea (*Spiraea douglasii*)
- 'Nehalem' Pacific willow (*Salix lucida* ssp. *lasiandra*)

Other Production for ORPMC

This is information for all non-NRCS release production at the PMC

Seed Production for:			
Field Planting:	45 lbs.		
Demonstration:	5 lbs.		
On Center Use:	5 lbs.		
Reimbursable:	750 lbs.		
Vegetative Production:			
Stock Type	**Amount**	**Purpose**	**Comment**
Container	60000	reimbursable	
Propagules	4000	reimbursable	western lily bulbs
Propagules	2500	field planting	camas bulbs
Cuttings-Unrooted	240	on center use	creation of hedgerow on farm

Pollinator/Insectary Forb Seeding Trial
Study number: ORPMC-T-1110-WL (2010–2013) ~ 2013 Progress Report
Annie Young-Mathews

Objective

The Corvallis PMC partnered with Mace Vaughan and Eric Mader of The Xerces Society for Invertebrate Conservation to design and install a seeding trial of native forbs for use in pollinator plantings to evaluate their establishment success and persistence in single-species and mixed-species plantings (early season, late season, and all species mixes). 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.

Establishment and Maintenance

The trial is located in Field 6-1 of the Corvallis PMC Schmidt Farm. It is a completely randomized design (CRD) with 3 replicates of 15 treatments (12 single-species plots and 3 mixes; Table 1). Plots are 18 x 44 ft, with 6-ft aisles separating all plots. Site preparation consisted of plowing, disking, and rolling 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. The field was shallowly cultivated with a roterra to break the surface crust and plots were hand-sown on 15 November 2010. Aisles have been maintained weed-free with a roterra cultivator as needed. Problematic weeds (Canada thistle and Himalayan blackberry) have been spot treated 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 in late fall of 2012. All plots that didn't contain late-blooming aster and gumweed were mowed again in late fall of 2013. Due to the failed establishment of the showy milkweed plots, in early February of 2013 they were sprayed out, raked, and hand sown with bluehead gilia.

Table 1. *Native forb species included in the Corvallis PMC seeding trial.*

Plot #	Species	Common name	Willamette Valley bloom	Mix	seeds/lb	Rate (seeds/ft^2)	Rate (lb/acre)
1	*Lupinus rivularis*	riverbank lupine	Apr.–July	Early	50,000	35	30.5
2	*Sidalcea campestris*	meadow checkerbloom	May–July	Early	100,000	35	15.2
3	*Eriophyllum lanatum*	Oregon sunshine	May–July	Early	1,150,000	50	1.9
4	*Prunella vulgaris* ssp. *lanceolata*	lance selfheal	Apr.–July	Early	400,000	50	5.4
5	*Potentilla gracilis*	slender cinqefoil	June–July	Early	1,417,500	50	1.5
6	*Asclepias speciosa*	showy milkweed	May–Aug.	Late	72,000	35	21.2
6*	*Gilia capitata*	bluehead gilia	Apr.–June	--	900,000	278	9.3
7	*Eriogonum umbellatum*	sulphur-flower buckwheat	June–July	Late	140,500	35	10.9
8	*Grindelia integrifolia*	Puget Sound gumweed	June–Sept.	Late	130,000	35	11.7
9	*Symphyotrichum chilense*	Pacific aster	June–Nov.	Late	1,300,000	50	1.7
10	*Solidago canadensis*	Canada goldenrod	July–Sept.	Late	4,600,000	50	0.5
11	*Plectritis congesta*	shortspur seablush	Mar.–June	Early	1,311,700	50	1.7
12	*Clarkia amoena* ssp. *lindleyi*	farewell to spring	June–Aug.	Late	1,031,800	50	2.1
13	*Early to Mid-season blooming Mix*					49	6.7
14	*Mid- to Late-season blooming Mix*					42	9.3
15	*All Species Mix*					36	8.6

*Plots sprayed out and reseeded with new species in Feb. 2013, but not included in any of the mixes.

Figure 1. *Oregon sunshine, shortspur seablush, riverbank lupine, and meadow checkerbloom flowering in an "Early to Mid-season Mix" plot on 13 May 2013.*

Figure 2. *Pacific aster, farewell to spring, and Puget Sound gumweed flowering in a "Mid- to Late-season Mix" plot on 12 July 2013.*

Results

During the third season of this study in 2013, 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. Best single-species coverage in the third season was seen in the riverbank lupine, lance selfheal, Pacific aster, Puget Sound gumweed, and Oregon sunshine plots. There was a huge recruitment of new riverbank lupine seedlings in the spring, and most of those biennial plants are expected to flower in 2014. The annuals (farewell to spring and shortspur seablush) provided good first season coverage and weed suppression, acting as a nurse crop for slow-growing perennials, but there was lower recruitment and cover in the second and third years with lack of disturbance and more competition from perennials (Figure 1). Shortspur seablush plots had more weeds and sparser stands in the third season. Interestingly, seablush plants were taller, more abundant, and had more flowers in areas around volunteer lupines, suggesting they may have been suffering from low soil nutrient levels.

Although they didn't flower much this year, the riverbank lupine continued to dominate the Early- to Mid-season Mix and All Species Mix, crowding out many of the slower growing perennials. For future seedings, we would recommend that the seeding rate for riverbank lupine be significantly lowered to a target rate of about 1 seed/m^2, or 0.1 seed/ft^2, but this species appears to be a great choice for weed suppression and N-fixation. Farewell to spring dominated the Mid- to Late-season Mix in the first year, but has now declined, making space for a fairly balanced mix of Pacific aster, Puget Sound gumweed, and Canada goldenrod (Figure 2). This mix seems to be a good way to ensure establishment of late-season species that didn't show-up as much in the All Species Mix with the lupines.

Other perennials were slow to establish and did not achieve dominant cover, but were still present in the mixes (Canada goldenrod, meadow checkerbloom, and slender cinquefoil). The cinquefoil had poor cover even in single-species plots and few flowers even by the third season; it may show better establishment and quicker growth on a wetter site. Sulphur-flower buckwheat and showy milkweed had very poor establishment in single-species and mixed plots, appearing unable to compete with weeds and other aggressive species. Showy milkweed is a hardy, persistent (even aggressive) plant once established, but it might best be established in a pollinator planting from a few strategically placed rhizomes or container plants rather than from seed. The short statured buckwheat plants were overwhelmed by weeds or taller, more aggressive species, and might be better suited to planting as container stock in hedgerows on well-drained soils with little understory competition (especially in southwest Oregon).

We saw fairly poor establishment and very little flowering from the newly planted bluehead gilia plots this year, perhaps due to the dry spring, lack of seedbed preparation, and the overwhelming weed seedbank in the soil. However, some plants were able to flower and set seed, so we hope to see greater cover and bloom in 2014.

Although this study was originally planned as a three-year study ending in 2013, Xerces and PMC staff decided to keep it in for at least another year in order to continue to monitor the mixed species plots for cover, persistence, and bloom.

Evaluation of springbank clover as a native leguminous cover crop
Study No. ORPMC-T-1203 (2012 – 2015) ~ 2013 Progress Report
Annie Young-Mathews

The purpose of this study was to perform an initial evaluation of springbank clover (*Trifolium wormskioldii* Lehm.) for use as a native perennial cover crop in Oregon and California. Our objectives were 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. Two common, non-native cover crop species, white clover (*T. repens*) and strawberry clover (*T. fragiferum*), were used as controls to compare their establishment and productivity to those of *T. wormskioldii* under simulated cover crop conditions.

The trial was set up as a randomized complete block design with 6 treatments (3 species seeded at two different seeding rates, 60 and 120 seeds/ft^2) and 4 replicated blocks at both the Corvallis, OR PMC and the Lockeford, CA PMC. Corvallis PMC plots were broadcast seeded on 9 October 2012. Cover, height, and plant density data were collected on 9 April 2013, and plots were mowed twice (April and July) to keep down weed biomass and prevent weeds from going to seed. Statistical analysis was performed using a factorial AOV and Tukey HSD means comparisons at P<0.05 in Statistix 8.1.

At six months after planting, both clover plant density and percent cover were significantly affected by seeding rate and species (Table 1). Clover plant density was nearly double in plots seeded at the higher rate (mean of 15 plants/ft^2 at 120 seeds/ft^2 vs. 8 plants/ft^2 at 60 seeds/ft^2). Overall, strawberry and white clover plots had greater plant densities than the springbank clover plots (averages of 15 and 13 vs. 7 plants/ft^2, respectively), perhaps because of a greater percentage of hard seed or other dormancy in the springbank clover.

Table 1. *Cover, height, and plant density data for three clovers seeded at two rates in the Corvallis PMC cover crop trial collected on 9 Apr. 2013 (6 months after planting). Means in each column followed by the same letter are not different at P<0.05 in Tukey HSD tests.*

Species	Seeding rate (seeds/ft^2)	Clover density (plants/ft^2)	Clover height (cm)	Clover cover	Weed cover	Bare ground
Springbank clover	**60**	3.4 c	1.0 b	0.0% c	97.3% a	2.7% a
	120	9.6 bc	0.9 b	0.0% c	99.0% a	0.0% a
White clover	**60**	9.2 bc	8.0 a	10.7% b	88.3% a	1.1% a
	120	15.8 ab	7.5 a	22.9% a	76.0% b	0.5% a
Strawberry clover	**60**	12.1 ab	7.2 a	5.4% bc	93.1% a	1.6% a
	120	17.9 a	8.3 a	10.6% b	88.8% a	0.5% a

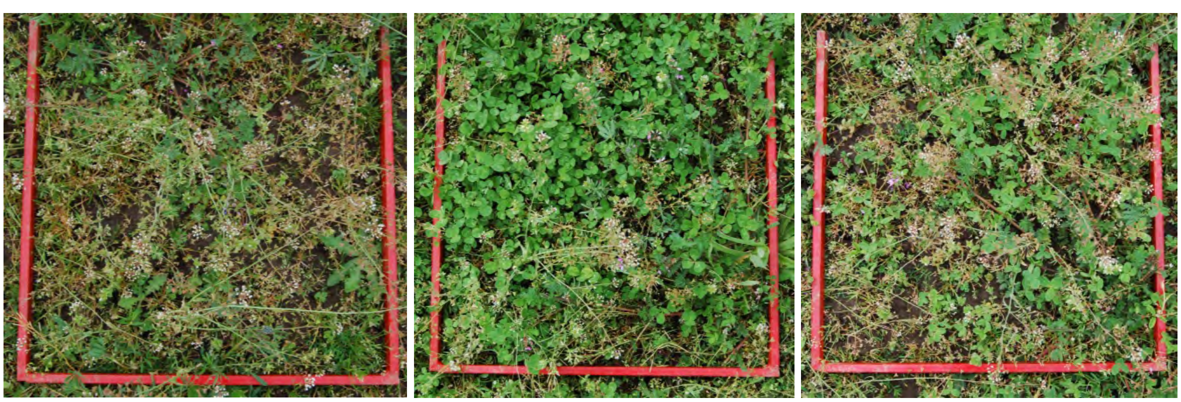


Figure 1. *Cover in plots on 9 April 2013 (182 days after planting): springbank clover overrun by weeds (left), white clover (middle), and strawberry clover (right), all seeded at 120 seeds/ft^2.*

Percent cover of the planted clover was highest in the white clover plots seeded at the higher rate and lowest in the springbank clover plots, with the lower rate of white clover and the strawberry clover plots having intermediate percent cover (Table 1, Figure 1). Springbank clover plants averaged only 1 cm tall, while the white and strawberry clover plants were about 8 cm tall, and were wider and leafier. Cover data points were collected every 6 inches along diagonal transects in the plots, so the size difference among the three species of clovers probably accounts for the lack of springbank clover cover since the weeds were bigger than the springbank clover so we never hit any of them on the transects (Figure 2). There was less weed cover in the white clover plots seeded at 120 seeds/ft^2 than all the other treatments, probably due to the quick establishment of the relatively broadleaved white clover plants.

Figure 2. *Springbank clover seedling (circled in red) surrounded by weeds on 9 April 2013 in one of the plots in the cover crop trial at the Corvallis PMC.*

By mid-May the white and strawberry clover plots had filled in more and begun to flower (Figure 3), while the springbank clover plants remained small and overwhelmed by the weeds. The white and strawberry clovers continued to flower throughout the summer, but the springbank clover remained vegetative. By late September, plots seeded at both rates of white and strawberry clover appeared to have reached well over 50% cover by visual observations, but vole damage was beginning to be apparent. The vole damage was quite extensive in some plots by early December (Figure 3). In 2014, plots will be monitored for cover, height, biomass, weeds, and insect/disease problems.

Figure 3. *White clover in plot 4-2 seeded at 120 seeds/ft^2 at the Corvallis PMC: beginning to flower on 13 May 2013 (left), with good cover but some vole damage on 25 Sept. 2013 (middle), and showing areas of extensive vole damage on 5 Dec. 2013 (right).*

Scarification and Seed Longevity of Three Native Legumes
Study No. ORPMC-S-1204 (2012–2015) ~ 2013 Progress Report
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 determine whether "ready to go" seed mixes may be scarified in advance for restoration needs 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*). Two storage treatments are being evaluated: 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 26 April 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. Seed viability was tested by tetrazolium (TZ) tests at the OSU Seed Laboratory at the beginning of the experiment in May 2012 and at 6 months in November 2012. Due to inconsistencies in TZ results from the OSU Lab, the 1-year tests were sent to both OSU and Tangent Seed Lab. The 2-year tests will be sent to the Tangent Seed Lab in May 2014.

Results

Seed viability for the three species tested did not appear to decline appreciably after one year, regardless of scarification or storage conditions (Table 1). There continue to be inconsistencies in the TZ test results, as some seed lots apparently have higher viability now than when the experiment started, bringing into question the reliability of the baseline data. However, regardless of these problems with TZ testing, all seed lots have obviously maintained a high level of viability so far, suggesting that "ready to go" scarified legume seed might be maintained for at least a year, even under less than ideal storage conditions.

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

			-----------------------TZ %-----------------------------				
Species	**Seed treatment**	**Storage conditions**	**Baseline (5/2/12)**	**6 months (11/5/12)**	**6 mo retest (12/27/12)**	**1 yr OSU (5/7/13)**	**1 yr Tangent (5/6/13)**
Lotus aboriginus	non-scarified	cooler (45°F, 30% rh)	96	97	96	94	92
		headhouse (uncontrolled)	95	97	97	94	91
	scarified	cooler (45°F, 30% rh)	97	95	83	94	97
		headhouse (uncontrolled)	97	95	94	97	96
Lupinus latifolius	non-scarified	cooler (45°F, 30% rh)	83	98	93	65	96
		headhouse (uncontrolled)	90	97	94	63	97
	scarified	cooler (45°F, 30% rh)	78	95	81	65	93
		headhouse (uncontrolled)	81	97	92	40	95
Lupinus rivularis	non-scarified	cooler (45°F, 30% rh)	87	92	80	49	95
		headhouse (uncontrolled)	86	96	77	68	91
	scarified	cooler (45°F, 30% rh)	80	97	76	62	94
		headhouse (uncontrolled)	74	96	85	63	94

Cover Crop Mixes for Soil Health

USDA-NRCS Corvallis Plant Materials Center

Annual Progress Report prepared by Annie Young-Mathews, January 2014

Introduction and Methods

In 2012-2013, the Corvallis Plant Materials Center (PMC) completed the first year of a 3-year national study looking at the effects of different cover crop mixes and seeding rates on soil health. Similar studies are being carried out at PMCs in CA, WA, MO, ND, MD, and FL. The results from this study will help inform local recommendations for effective cover crop mixes and seeding rates to control weeds and add organic matter, N, and biological activity to depleted soils. This report is just a preliminary analysis of data from the first year of the study, and conclusions may change over the next two years as more data are collected.

Three mixes are being tested along with a non-cover cropped control (Table 1). Each mix was seeded at three rates: 20, 40, and 60 seeds per square foot, which, depending on the mix, ends up being a total seeding rate of about 35 to 110 pounds per acre.

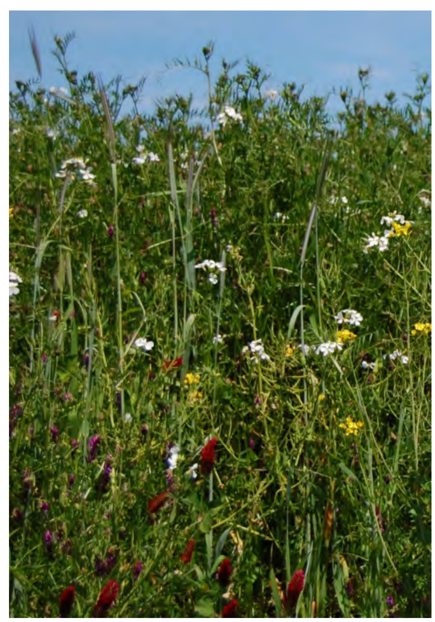
We drilled the cover crops on 6-inch spacing in early October after the first rains and terminated them 6 months later in early May by rolling and then spraying them prior to no-till seeding sweet corn in early June.

Table 1. *Cover crop mixes in Corvallis PMC Soil Health Study (% mix is on seed number basis, not weight basis).*

Mix	Grasses	Legumes	Brassicas
2-species	50% cereal rye	50% crimson clover	-
4-species	45% cereal rye	22.5% crimson clover, 22.5% hairy vetch	10% forage radish
6-species	22.5% cereal rye, 22.5% oats	22.5% crimson clover, 22.5% hairy vetch	5% forage radish, 5% turnips

Summary of Preliminary Results

- All cover crop mixes reached 95% total cover by 60 days after planting, except the 2-species mix seeded at 20 or 40 seeds/ft^2, which had only slightly over 80% cover
- Weed cover and biomass was lowest in the mixes that contained brassicas (4- and 6-species) seeded at 40 or 60 seeds/ft^2
- Cover crops increased soil organic carbon levels, decreased compaction, and increased the Soil Health Tool score
- At cover crop termination, soils were cooler and wetter in cover cropped plots than the non-cover cropped control plots
- All treatments produced about 4.5 tons dry matter per acre, but the 2-species mix had a lower N content
- Sweet corn yields were highest in the plots with the 4-species mix at 40 seeds/ft^2; the 2013 seed cost for this mix was about $62/acre
- Slug control appears to be a major challenge in successfully managing a no-till cover cropped rotation in the Willamette Valley
- There are tradeoffs in managing complex cover crop cocktails between gaining more total biomass and plant available nitrogen by terminating later in the spring (early May), and keeping brassicas from going to seed after they flower in March



Results and Discussion

Early Cover and Weed Suppression

Cover crops are often planted in order to hold soil in place and provide cover to help prevent erosion from wind and rain, as well as to suppress weeds (Clark, 2007). The brassicas (radish and turnip) in our plots were quick to germinate and grow in the fall. Their broad leaves provided early cover and helped out-compete many of the usual annual winter weeds. Total cover at 30 days after planting (DAP) averaged 62% for all of the cover crop mixes, which was almost twice that of the weedy control at only 35% cover (Figure 1). By 62 DAP, both seed mix and seeding rate had significant effects on total percent cover. The 4- and 6-species mixes containing the brassicas had the most total cover at 95%, while the 2-species mix seeded at 20 and 40 seeds/ft^2 had an average of only 82% cover, and the control had only 65% cover. This early broadleaf cover presumably made those plots more resistant to erosion and surface crusting from rain drop impaction over the winter.

The different seeding rates and cover crop mixes also significantly affected weed cover (Figure 2). At 30 DAP, weed cover was already higher in the plots seeded at the lowest rate and in those with the 2-species mix. By 62 DAP, those differences were more obvious, and remained so until the legumes took off in spring (around 151 DAP in March). By 97 to 123 DAP, the higher rates of the 4- and 6-species mixes had a cover crop canopy that was almost completely closed in over the weeds that germinated initially. The 20 seeds/ft^2 rate appeared to be too light to suppress or out-compete early weeds. The 2-species mix was also ineffective at controlling weeds, perhaps because the crimson clover and cereal rye didn't provide the early leaf cover that the brassicas (especially the radish) provided in the other mixes.

At cover crop termination in May, weed biomass as a percentage by weight of the total aboveground cover crop biomass was almost three times greater in the 2-species mix and the lowest seeding rate (Table 2). Because there were no significant differences in weeds between the 4- and 6-species mix or the 40 and 60 seeds/ft^2 rates, it appears that a 4-species mix at 40 seeds/ft^2 is sufficient from a weed suppression standpoint, and would provide a cost savings over a more complex mix or higher seeding rate. Better early cover for erosion control may have been achieved by planting earlier (mid-September) when soil temperatures were warmer, but this would have required irrigation since our first rains in 2012 didn't fall until mid-October.

Figure 1. *Effect of 3 cover crop mixes and 3 seeding rates on total percent cover from November 2012 through April 2013 in Corvallis PMC trial.*

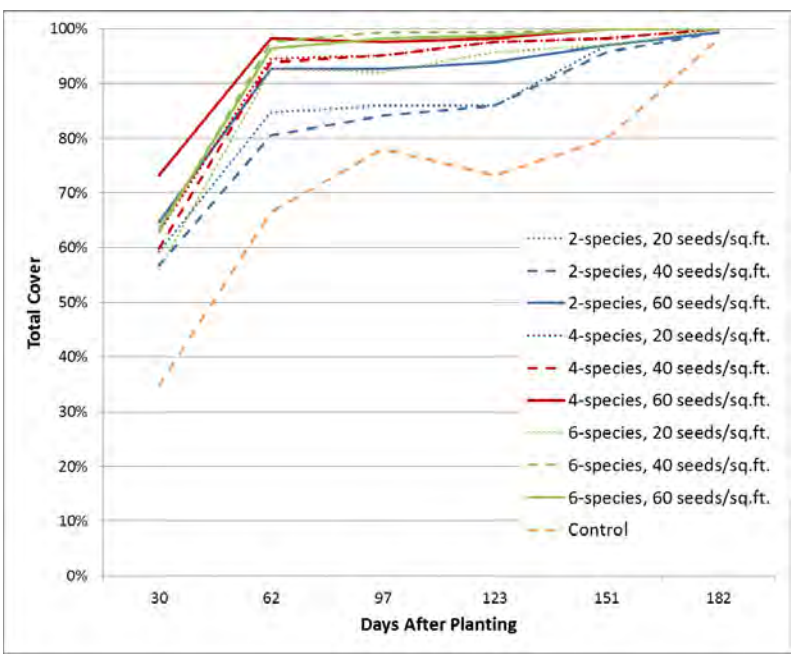
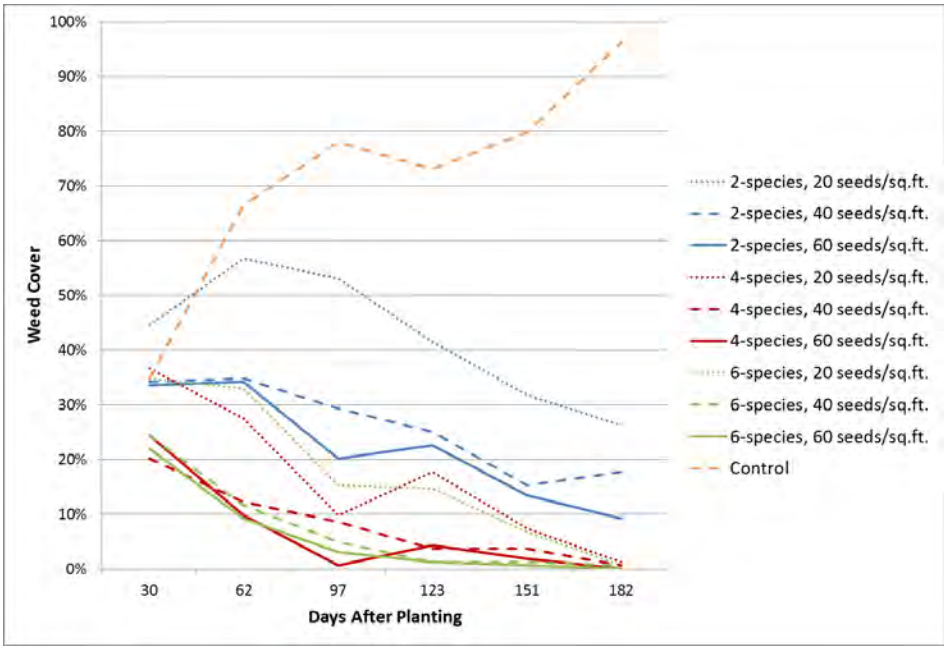


Figure 2. *Effect of 3 cover crop mixes and 3 seeding rates on weed cover from November 2012 through April 2013 in Corvallis PMC trial.*



Nitrogen Benefits and Improved Bottom Line

An important benefit of leguminous cover crops is their ability to provide plant-available nitrogen (PAN) to the subsequent cash crop, thus reducing costs on purchased N inputs such as fertilizer, compost, and manure (Sullivan and Andrews, 2012). At cover crop termination in early May, all three cover crop mixes had produced an average of 4.5 tons dry matter (DM) per acre, which was over twice the weedy biomass production from the non-cover cropped plots (Table 2). The N content of the aboveground DM was higher in the 4- and 6-species mixes than the 2-species mix or the control. According to the OSU cover crop calculator (Andrews et al., 2012), that would result in an estimated PAN of 13 lbs/acre for the 2-species mix, 54 lbs/acre for the 4-species mix, and 59 lbs/acre for the 6-species mix, assuming the cover crop was tilled to incorporate it at the time of termination. However, since our cover crops were killed by rolling and spraying, residue was left on the surface to decompose, and it is likely that the PAN was released to the corn crop more slowly than if it had been incorporated.

Table 2. *Comparisons of average aboveground biomass dry matter, N content, and percent composition according to three cover crop mixes (2-, 4-, and 6-species) and 3 seeding rates (20, 40, and 60 seeds/ft^2) at the Corvallis PMC in 2013. Values within the same column followed by the same letter are not significantly different in Tukey HSD means comparisons at α=0.05.*

Treatment	Dry Matter (tons/ac)	% N in Dry Matter	Cover Crop Biomass Composition			
			Grasses	Legumes	Brassicas	Weeds
2-species	4.41 a	1.4 b	63% a	27% b	0% b	10% a
4-species	4.63 a	2.2 a	28% b	44% a	24% a	4% b
6-species	4.55 a	2.3 a	29% b	44% a	24% a	3% b
20 seeds/ft^2	4.44 a	2.0 a	37% a	38% a	16% a	9% a
40 seeds/ft^2	4.68 a	1.9 a	40% a	38% a	18% a	4% b
60 seeds/ft^2	4.48 a	1.9 a	43% a	38% a	15% a	4% b
Control	2.17 b	1.9	-	-	-	100%

Figure 3. *Corn plants 40 days after planting in plots previously seeded with: (left) 6-species cover crop mix at 40 seeds/ft^2; (middle) 2-species mix at 40 seeds/ft^2; and (right) non-cover cropped control plot. No chemical fertilizer was added to plots prior to planting the corn.*

Almost immediately there were dramatic differences in the growth of the sweet corn planted into the different treatments, presumably largely due to these differences in PAN. Plots planted with 40 or 60 seeds/ft^2 of the 4- and 6-species mixes produced tall healthy corn with dark green leaves, while the control, 20 seeds/ft^2, and 2-species mixes showed varying degrees of stunting and yellowing (Figure 3).

Sweet corn was harvested from all plots in early September, and the highest yielding treatment at 5.7 tons/acre was the 4-species mix seeded at 40 seeds/ft^2 (Figure 4). While this yield is about half the average sweet corn yield for western Oregon of 10 to 12 tons/acre (Hart et al., 2010), it was achieved without the addition of any purchased fertilizers, relying solely on nitrogen fixed by the legumes in the cover crop. This cover crop nitrogen benefit presumably could translate into substantial savings on fertilizer costs in a commercial system. Any savings on inputs would of course have to be balanced against the costs of the cover crop seed (Table 3) and associated costs for planting and terminating the cover crop.

There are also some tradeoffs in deciding when to kill complex cover crop mixes such as these. In order to maximize legume growth and PAN from the legumes, it is best to wait until late April or early May when the legumes are at the budding growth stage, but PAN from the cereal residues peaks at tillering stage (mid- to late March) and then declines quickly and is actually negative by the time cereal heads are visible in late May to June (Sullivan and Andrews, 2012). Brassicas provide PAN when killed at flowering growth stage (March), and can become a weed problem in subsequent crops if allowed to set seed, which they did in our trial by early May.

Figure 4. *Average sweet corn yield following one season of cover cropping according to 3 cover crop mixes (2-, 4-, and 6-species mix) and 3 seeding rates (20, 40, and 60 seeds/ft^2) at Corvallis PMC in 2013. Means with the same letter above the bar are not significantly different in Tukey HSD comparisons at α=0.05.*

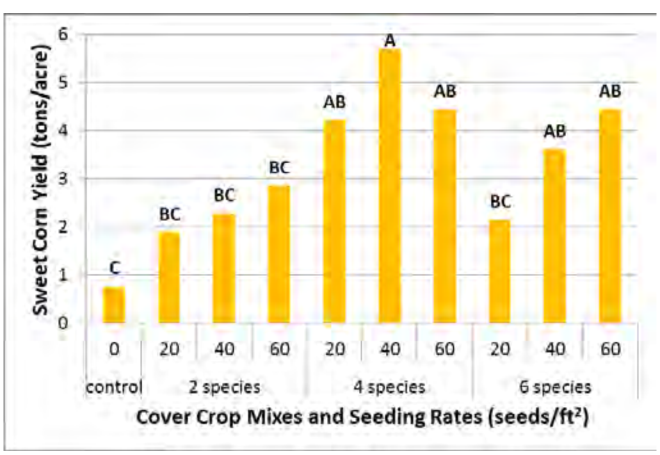


Table 3. *Approximate costs of the different cover crop seed mixes and seeding rates in the Corvallis PMC trial. Costs are based on 2013 quotes from commercial vendors in the Willamette Valley.*

Cover Crop Mix	Seeding Rate (seeds/ft^2)	Seed Cost (per acre)
2-species	20	$12.78
	40	$25.57
	60	$38.35
4-species	20	$31.20
	40	$62.39
	60	$93.59
6-species	20	$34.41
	40	$68.82
	60	$103.24
Control	0	$0.00

Enhancing Soil Health

Cover crops are often planted to improve soil health, including enriching soil organic matter, enhancing nutrient cycling, and improving soil structure. However, building soil health is a slow process and changes aren't expected to happen overnight. Most soil parameters in our trial did not show significant differences according to treatments (seeding rates and mixes) after only one year of cover cropping. However, there were some overall improvements in soil organic carbon, C:N ratios, soil compaction, and Soil Health Calculation values.

Soil organic carbon levels increased in all cover cropped treatments from an average of 96 ppm prior to cover crop planting to 218 ppm at cover crop termination. The soil organic carbon to nitrogen ratio (C:N) also increased from 9.6 to 11.7 after one season of cover cropping. At cover crop termination, the 2-species mix had a higher organic C:N ratio than the 4- and 6-species mixes (12.2 vs. 11.5, $P<0.05$), probably due to the dominant rye cover which has a lower N content and leaves more residual matter than the legumes or brassicas.

We measured the firmness (compaction) of the soil over three depth increments with a soil compaction tester. A resistance of 300 pounds per square inch (psi) generally limits root growth, but roots may still penetrate the soil if natural pores or cracks are present. By May 2013, surface soil compaction in the 0–6" layer decreased from an average of 291 to 78 psi, and sub-surface compaction at the 6–12" depth decreased from 284 to 226 psi, while deep soil compaction (12–18") increased slightly from 333 to 371 psi. Subsoil compaction at the 6–12" depth was significantly less in plots seeded with the 4- and 6-species mixes (average resistance of 213 and 209 psi, respectively) than in those with the 2-species mix (257 psi). This decreased compaction in the 4- and 6-species mixes could be due to a "tillage" effect from the large taproots of the radish and turnip.

While it can be difficult to quantify the overall health of a soil system, Dr. Rick Haney of USDA-ARS developed a Soil Health Tool (SHT) that attempts to do just that (Woods End Laboratories, 2014). The SHT incorporates the balance of organic soil carbon and nitrogen and their relationship to microbial activity. A soil health calculation number can vary from 0 to over 50, and should increase over time if the soil is being managed sustainably. In our trial, the Soil Health Calculation increased significantly from 3.98 at cover crop planting to 6.70 at termination ($P<0.001$), but there were no distinguishable differences among treatments yet. We will continue to monitor this number over the next two years of the study to gauge the effects of our different management practices.

Figure 5. *Photos of Corvallis PMC plot 106 with 4-species cover crop mix seeded at 40 seeds/*ft^2*. In mid-December (left) 62 days after planting (DAP), there was about 95% cover. By mid-March (middle), at 151 DAP, the radishes were in full bloom. In early May (right), 207 DAP and immediately before cover crop termination, the rye was heading out and the crimson clover and hairy vetch were flowering.*

Delayed Commodity Crop Planting Concerns

One potential drawback of planting cover crops is that they generally delay soil warming and drying in the spring, which may delay tillage and planting of the commodity crop. At cover crop termination in May 2013, our non-cover cropped control plots were indeed warmest and driest at 71°F and 17.3% moisture. Plots seeded with the 2-species mix were warmer and drier than the 4- and 6-species mixes (64° vs. 61 and 60°F, respectively, and 17.3% vs. 18.9 and 18.8% gravimetric water content, respectively). However, the sweet corn commodity crop wasn't planted until a month later in early June, and by that time some of the soil temperature and moisture differences may not have been as pronounced. Unfortunately we don't have temperature and moisture data for commodity crop planting in June, but we plan to collect that data in 2014.

Slug Predation

Slugs are a consistent problem for seedlings in the rainy fall and winter conditions of western Oregon and Washington, but are especially problematic in no-till and conservation till systems where the surface residue provides the ideal humid habitat for slugs to feed and breed. According to the Pacific Northwest Insect Management Handbook, "tillage is the best way to manage slugs" and "control is proportional to tillage frequency, depth, and efficiency" (Dreves and Fisher, 2013). Thus, in systems where tillage is being reduced for soil health benefits, slug pressure that can't be managed economically via biological control (predation by birds and soil predators such as beetles and nematodes) will have to be done through chemical control using slug bait.

We had very high slug pressure on both the no-till sweet corn seedlings in June and the second year no-till cover crop seeding in October of 2013. We applied metaldehyde slug bait shortly after emergence of both crops, but there was already extensive localized damage to the young seedlings and the swollen cereal seeds in the cover crop. Bait may be more effective if applied at the time of seeding to prevent early damage to germinating seedlings. However, slug bait is expensive and is a cost that should be considered in the total cost-benefit analysis of no-till or reduced-tillage systems. For example, Deadline® metaldehyde bait applied at the recommended 10-40 lbs/acre costs $18.50 to $74.00 per acre, while Organic-certified Sluggo® iron phosphate bait applied at the recommended 24-44 lbs/acre costs about $51.50 to $94.40 per acre.

References

Andrews, N., D. Sullivan, J. Julian, and K. Pool. 2012. Organic fertilizer and cover crop calculator. Oregon State Univ. Small Farms. http://smallfarms.oregonstate.edu/calculator

Clark, A., editor. 2007. Managing cover crops profitably, 3rd ed. National SARE Outreach Handbook Series Book 9. National Agric. Laboratory, Beltsville, MD. http://www.sare.org/Learning-Center/Books/Managing-Cover-Crops-Profitably-3rd-Edition

Dreves, A.J., and G. Fisher. 2013. Slug control. In: Pacific Northwest insect management handbook. Pacific Northwest Extension, Oregon State Univ., Washington State Univ., and Univ. of Idaho. http://pnwhandbooks.org/insect/ipm/slug-control

Woods End Laboratories. 2014. Overview of Soil Health Tool Box. Mt Vernon, ME. http://woodsend.org/soil-health-tool/overview/

Hart, J.M., D.M. Sullivan, J.R. Myers, and R.E. Peachey. 2010. Nutrient management guide: sweet corn (western Oregon). EM 9010-E. Oregon State Univ. Extension Service, Corvallis. http://ir.library.oregonstate.edu/xmlui/bitstream/handle/1957/19064/em9010.pdf

Sullivan, D.M., and N.D. Andrews. 2012. Estimating plant-available nitrogen release from cover crops. PNW 636. Pacific Northwest Extension, Oregon State Univ., Washington State Univ., and Univ. of Idaho. http://ir.library.oregonstate.edu/xmlui/bitstream/handle/1957/34720/pnw636.pdf

Cover crop species/variety trials ~ 2013 Summary
USDA-NRCS Corvallis Plant Materials Center
Annie Young-Mathews

We planted a number of informal cover crop trials in the fall of 2012, and spring and summer of 2013. The purpose of these trials was to evaluate the growth characteristics of a number of cover crop varieties for inclusion in future cover crop mixes or for specific single species uses within the Willamette Valley growing region. All plantings were non-replicated single demonstration blocks of 0.1 – 2 acres in size. The species evaluated, seeding rates, and cover/biomass observations are given in Table 1. Brassica and the Frost Master pea seed was kindly donated by Weaver Seed of Oregon. All other seed was purchased from local distributors.

According to the SARE publication *Managing Cover Crops Profitably*, “brassica cover crops are known for their rapid fall growth, great biomass production, and nutrient scavenging ability.” After a few irrigations in late September and early October (necessary because of our dry fall), the brassicas in our trial were quick to germinate and their broad leaves provided good early cover. The Soil Buster radish provided the best cover by 50 days after planting in early November, followed by the purple top turnip and Shogoin turnip (Figure 1). Saturated soil conditions followed by a hard frost in early January caused substantial dieback in the purple top turnips, as well as moderate dieback in the Shogoin turnips and kale, but only minimal dieback in the radish, mustard, and rutabaga. All species appeared to eventually recover from the winter dieback.

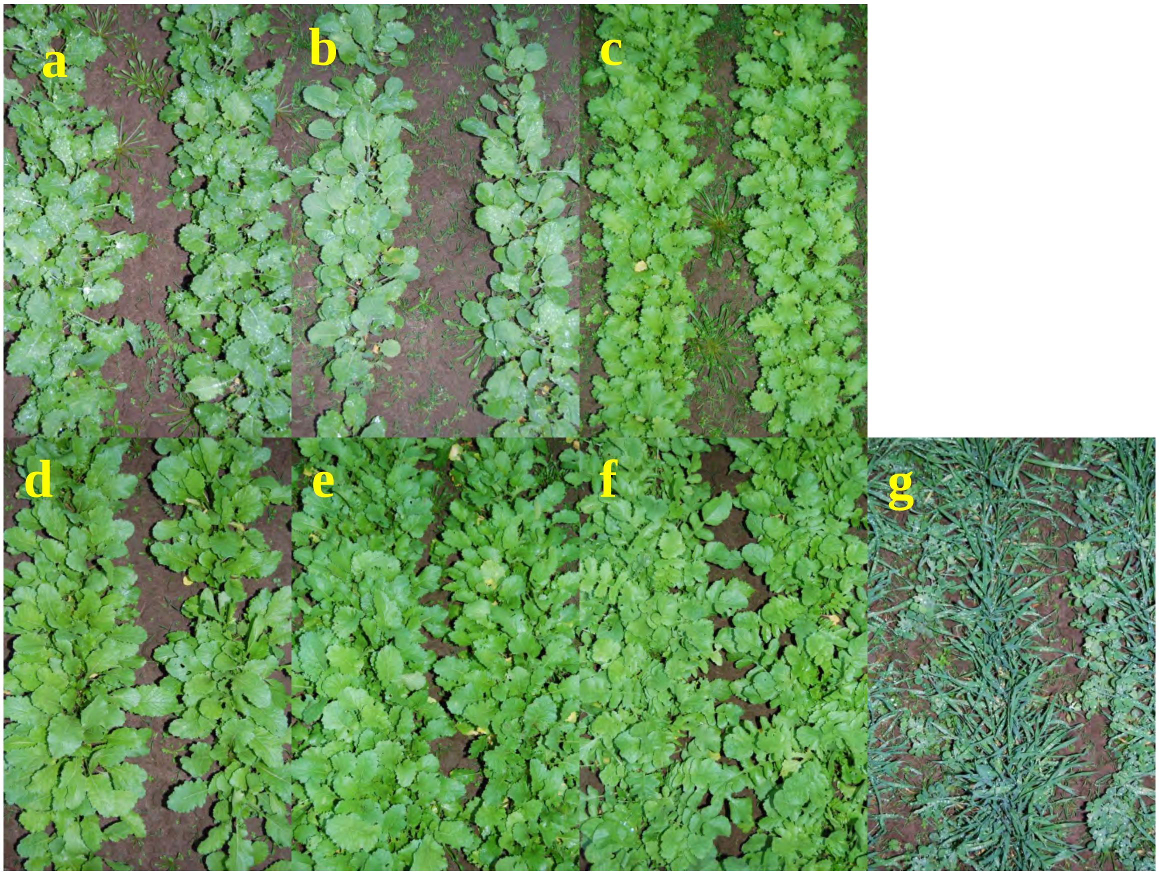


Figure 1. *Cover crop trials planted on 12-inch spacing at Corvallis PMC on 8 Nov. 2012, 50 days after planting: a) dwarf Siberian kale, b) American purple top rutabaga, c) southern giant curled mustard, d) Shogoin turnip, e) purple top turnip, f) ‘Soil Buster’ radish, g) ‘Frost Master’ peas and cereal rye (6-inch spacing).*

Species	Common Name	Variety	Seeding rate lb/ac	Seeding Method	Seeding Date	Flowering	Biomass/cover observations
Seeded Individually							
Raphanus sativus	radish	'Soil Buster'	2.5	cone seeder	9/20/2012	late March	best early cover
Brassica rapa var. *rapa*	turnips	purple top	5	cone seeder	9/20/2012	early April	good early cover; partial winter kill in Jan.
Brassica rapa var. *rapa*	turnips	Shogoin	5	cone seeder	9/20/2012	early March	decent early cover; good branched root system
Brassica campestris	mustard	Southern giant curled	5	cone seeder	9/20/2012	late April	nice broad leaves but minimal root system
Brassica napus	rutabaga	American purple top	5	cone seeder	9/20/2012	mid-April	slow cover but decent root growth
Brassica napus	kale	Dwarf Siberian	5	cone seeder	9/20/2012	late April	partial winter kill in Jan.; minimal cover/biomass
Melilotus officinalis	yellow blossom sweetclover	VNS*	8	drilled	10/17/2012	N/A	no germination; bad seed lot?
Fagopyrum esculentum	buckwheat	Koma	50	drilled	4/23/2013	early June	quick germ.; thin cover because of wide spacing/light seeding rate; great seed production
Sorghum bicolor ssp. *drummondii*	Sudangrass	VNS	21	no-till drill	6/13/2013	late August	good biomass & cover where fertilized; mowed 3 times
2-way Mix							
Pisum sativum	winter peas	'Frost Master'	50	cone seeder	9/20/2012	early May	substantial winter kill in Jan.; minimal cover; most growth in Apr.
Secale cereale	cereal rye	VNS	70	cone seeder	9/20/2012	early May	quick early cover; good winter hardiness
4-way Mix							
Avena sativa	oat	Walken	26	broadcast & rolled	10/10/2012	None	slower growth over winter
Secale cereale	ryegrain	VNS	26	broadcast & rolled	10/10/2012	early May	good growth over winter
Trifolium incarnatum	crimson clover	VNS	2.5	broadcast & rolled	10/10/2012	early May	most biomass produced in April
Vicia villosa	hairy vetch	VNS	14	broadcast & rolled	10/10/2012	early May	most biomass produced in April

*VNS = variety not stated (common seed)

Figure 2. *Brassica cover crops at 130 days after planting (DAP) on 29 Jan. 2013 (left) and 168 DAP on 8 March 2013 (right).*

Another potential benefit of certain brassicas is their large taproots that can help alleviate soil compaction as well as scavenging nutrients. The Soil Buster radish had, by far, the largest roots in both late January and early March (Figure 2). Both of the turnips also appeared to have good root biomass and deep taproots, with Shogoin having a more branched structure and purple top having a larger bulb near the surface and deep taproot below. Shogoin turnip was the first brassica to flower in early March, followed by the Soil Buster radish in late March and purple top turnip in early April. The mustard, rutabaga, and kale did not flower until mid- to late April. The early bloom time of many of these brassicas is problematic if using them in a cover crop mix since there are isolation distance issues with canola and other brassica seed crops in the Willamette Valley, and the brassicas can even set seed by late April to early May, increasing potential weediness issues. Leguminous cover crop components such as crimson clover and hairy vetch put on significant growth in April and reach their peak biomass and plant available nitrogen (PAN) levels when they begin to flower in late April or early May, making it difficult to manage a mixed-species cover crop containing brassicas and legumes.

Yellow blossom sweetclover is a drought-tolerant biennial legume that produces abundant biomass even on soils with marginal fertility and is recommended for its deep, fibrous root system that loosens topsoil and subsoil compaction. We seeded a 1-acre field in mid-October, but never saw any germination. Sweetclover has notoriously hard seed, so it could be that we'll see some volunteers popping up in the field in future years.

The Frost Master peas interseeded with cereal rye germinated quickly, but the peas put on minimal fall and winter growth before many of them had substantial dieback in late December to early January when the soil was saturated for an extended period. The cereal rye provided most of the cover throughout the fall, winter and early spring, but wide row spacing meant that it didn't provide very good weed suppression. Due to limitations in our seeding equipment, we seeded it not as a mix but in alternate single-species rows with approximately 6-inch spacing. Early cover and weed suppression would likely be improved by seeding the two species together on 6 to 8-inch spacing. Some of the peas were able to recover by late spring and climbed the cereal rye flowering stalks to a height of about 2 to 3 feet before they began to flower in early May (Figure 3). This or a similar pea-cereal grain mix would probably be more productive on a well-drained soil.

Figure 3. *Frost Master peas interseeded with cereal rye on 9 May 2013 just prior to cover crop termination (rolling and spraying).*

Buckwheat is a very quick-growing broadleaf cover crop often used for weed suppression in short windows between other crops. The recommended seeding rate ranges from 50 to 200 lb/acre depending on the soil type and degree of weed suppression desired. We were only able to locate a few small bags of seed, so we decided to try it out on wider row spacing (12 inches) at a lighter seeding rate (50 lb/acre) to encourage secondary branching and flowering so we could harvest seed from the field for future cover crop use at the PMC. We planted the plot in late April and irrigated it ½ to 1 inch per week in May and early June since precipitation during this period was negligible. Germination and growth was uniform and quick, and plants were in full bloom by 60 days after planting in mid-June (Figure 4). We harvested the 0.3 acre field with a combine in mid-July and had an impressive yield of 300 pounds of seed, or about 1000 pounds per acre, which was achieved without any fertilizer application.

Figure 4. *Buckwheat field 20 days after planting on 13 May 2013 (left) and in full bloom at the PMC Field Day on 20 June 2013 (right).*

We have a field (7-5 on Schmidt Farm) that has had troubles over the past couple of years with poor drainage and very poor crop establishment and performance. In an attempt to remedy the problem, the field was deep ripped in the late summer of 2012, a traditional seedbed was prepared with a disk and roterra, and it was planted to a triticale cover crop in the fall of 2012. Establishment was decent, but again plants appeared stunted and did not produce much biomass. The triticale was terminated in the spring by flail mowing, and then we decided to try no-till planting Sudangrass on the field over the summer to add more organic matter to the soil and provide deep, fibrous roots to help alleviate subsoil compaction. The Sudangrass was seeded in mid-June, irrigated about 1 inch per week over the course of the summer, fertilized once in mid-July, and flail mowed three times over the course of the summer (approximately once/month when it reached a height of about 3 to 4 feet or when it started to flower) to return organic matter to the soil and encourage more tillering and root growth (Figure 5). The Sudangrass grew well and produced abundant biomass, especially in bands where the fertilizer was accidentally applied more heavily and in places on the field that received a little extra water. After the final fall mowing, the Sudangrass was sprayed out and we no-till planted a 6-way cover crop mix of radish, turnip, crimson clover, hairy vetch, oats, and cereal rye onto the field. We hope that a rotation of diverse cover crops and minimal soil disturbance will restore this to a good seed production field within the next couple of years.

Figure 5. *Third mowing of Sudangrass field on 29 Sept. 2013.*

References

Clark, A., editor. 2007. Managing cover crops profitably, 3rd ed. National SARE Outreach Handbook Series Book 9. National Agric. Laboratory, Beltsville, MD. http://www.sare.org/Learning-Center/Books/Managing-Cover-Crops-Profitably-3rd-Edition/Text-Version

The 2013 Seed and Plant Propagation report for Eugene BLM

Introduction:

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.

The Rivers to Ridges Partnership (formerly known as West Eugene Wetlands) collects wild seed and sows it in 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 2013, this agreement was renewed. The seed increase field of *Juncus occidentalis* was discontinued this year due to an abundance of seed produced in previous years. Seed increase was renewed on 24 of the species from the 2012 contract. This agreement will be amended and renewed through 2014.

Activities in 2013 included establishing and maintaining seed increase plantings, seed harvesting and seed cleaning.

Accessions

Table 1. Accessions included in 2013 agreement with Eugene District of the BLM.

Species	Common name	Accession	Activity in 2013[1]
Carex feta	greensheath sedge	9079315	Sfp
Carex tumulicola	splitawn sedge	9079291	Sfp, dlv
Castilleja tenuis	hairy Indian paintbrush	9079254	Sfp, pxn, dlv
Cicendia quadrangularis	Oregon timwort	9079312	Sfp, pxn
Dichanthelium acuminatum	western panicgrass	9079303	Sfp
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
Gentiana sceptrum	king's scepter gentian	9079311	Sfp, dlv
Gratiola ebracteata	bractless hedgehyssop	9079436	Sfp, pxn
Lasthenia glaberrima	smooth goldfields	9079293	Sfp, pxn, dlv
Lotus formosissimus	seaside bird's-foot trefoil	9079294	Sfp,
Lupinus polycarpus	miniature lupine	9079250	Sfp, pxn
Madia glomerata	mountain tarweed	9079437	Sfp, dlv
Montia linearis	narrowleaf minerslettuce	9079295	Sfp, dlv
Myosotis laxa	bay forget-me-not	9079253	Sfp, pxn
Navarretia intertexta	needleleaf navarretia	9079378	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, pxn
Rorippa curvisiliqua	curvepod yellowcress	9079257	Sfp, pxn, dlv
Veronica peregrina	neckweed	9097439	Sfp, pxn, dlv

1 spf= seed production, pxn= plant production, dlv=plant materials delivery

Plant Propagation

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 in the late fall such as *Nemophila menziesii* and *Montia linearis* and others do better when grown in a greenhouse and then transplanted out as plugs into the seed increase plots in the spring. Species like *Madia glomerata* and *Lupinus polycarpus* are affected greatly by spring weather, and since spring weather cannot be predicted, half the plot is planted using transplants and the other half is seeded directly in late February. This should reduce complete plot failures due to unpredictable spring weather.

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 agreement at the Corvallis PMC in 2013.

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
Lupinus polycarpus	5	300	Scarified, heated greenhouse
Madia glomerata	2	200	Heated greenhouse
Myosotis laxa	3	400	Heated greenhouse
Navarretia intertexta	11	500	2 wks cold, Heated greenhouse
Orthocarpus bracteosus	1	400	90 days cold, Heated greenhouse
Phlox gracilis	2	200	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

Seed Increase Activities:

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. The plants are over five years old and are still producing a large amount of seed for the size of the plot. 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.

Figure 1. Green sheath sedge (*Carex feta*) flowering in the PMC shadehouse.

A 0.1 acre field of *Dicanthelium acuminatum* was established in the spring of 2010 using plugs. The plants seemed smaller this year; this could be a result of the age of the plants or the drier spring we experienced in 2013. The seed ripening was also more uniform than in previous years, this allowed us to directly combine the field. After combining, the field was seed stripped to pick up seed that had fallen on the weed fabric. This method was the most efficient one we've tried for this field, producing high yields considering the field produced less seed this year than in previous years.

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.

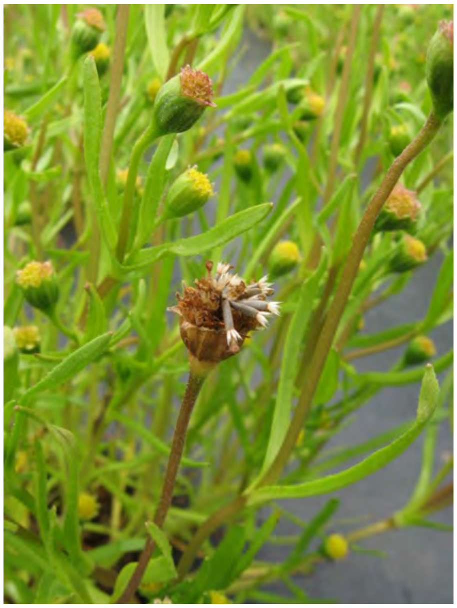


Figure 2. When seeds of smooth goldfields (*Lasthenia glaberimma*) are mature, they are easily dislodged from the plant.

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, and 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*, *Nemophila menziesii*, and *Phlox gracilis* 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 *P. gracilis* seedlings were devoured by slugs twice in the early spring and the few remaining seedlings became infected with powdery mildew. They were sprayed with neem oil, a natural fungicide, which provided no control of the mildew. Plants remained small and weak, but still managed to produce some seed. Our *R. curvisiliqua* plants often become eaten by flea beetles, so this year, as soon as transplants were placed in the plot, it was covered with a floating row cover. This provided a physical barrier to keep the flea beetles from attacking the plants, plus it created a slightly warmer environment. Both of these factors probably contributed to the best looking and highest yielding *R. curvisliqua* plot we've ever had.

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. During the cleaning process, it was noticed that there was very little filled seed in the *M. laxa* harvest. There was so little seed in the lot that it was decided to not finish cleaning it. There were only a few hundred seeds and the lot contained weeds that couldn't be separated from the few seeds.

Figure 3. In production fields, mountain tarweed (*Madia glomerata*) plants are large and bushy.

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 Winterstieger plot combine fitted with a reel 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 made it much easier to vacuum the seeds from the fabric without the added debris from the combine.

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

Species	Method	Dates	Yield
Carex feta	hand	15-Aug	2 lbs
Carex tumulicola	hand	20-Jul	15 g
Castilleja tenuis	hand	July 30	66 g
Cicendia quadrangularis	hand	April 10-25	5 g
Dichanthelium acuminatum	moon rover/vac	30-Jul	20 lbs
Downingia elegans	cut/vac	25-Aug	2.3 lbs
Downingia yina	cut/vac	25-Aug	3 lbs
Eryngium petiolatum	direct combine/vac	24-Sep	1.54 lbs
Galium trifidum	cut/vac	23-Sep	2 lbs
Gentiana sceptrum	hand	August 10- 25	105 g
Gratiola ebracteata	hand	5-Apr	31 g
Lasthenia glaberrima	vac	June 10-25	115 g
Lupinus polycarpus	vac	12-Jul	2.2 lbs

Madia glomerata	direct combine/vac	20-Sep	1.6 lbs
Montia linearis	vac	30-May	112 g
Navarretia intertexta	cut/vac	27-Aug	1 lb
Nemophila menziesii	vac	29-Jul	93 g
Rorippa curvisiliqua	vac	29-Jul	5 lbs
Veronica peregrina	vac	June 10-25	2 lbs

Small seed increase plots of *Carex tumulicola* and *Gentiana sceptrum* are maintained in large plastic tubs filled with potting media 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 low 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.

Gratiola ebracta, Cicendia quadrangularis, Castilleja tenuis and *Orthocarpus bracteosa* are small annual species that show no increase in seed production when transplanted into a field and can live out their life cycle while in 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 *C. tenuis* and *O. bracteosus* seeds had poor germination, survival, and vigor in the past few years. It was thought that this was due to seed age, but further investigation showed that the media was quite acidic. A different slow release fertilizer has been used in recent years, and the PMC has noticed much lower rates of survival and vigor especially in seedlings that have been stratifying in the cooler then are moved to a warm greenhouse. This is causing rapid release of fertilizer and the tiny seedlings are not large enough to uptake the nitrogen. The delicate seedlings are also not thoroughly watered while they are germinating, which also allows the nitrogen to build up in the media. The pH of the media was measured and some containers were as low as 4.8. PMC staff are trialing new media mixes and have switched to fertigating to apply only the amount of fertilizer needed for each species at each stage of growth. This is more time-consuming for our greenhouse staff, but will result in higher quality plants in the long-run.

A puzzling “weed” appeared on the PMC farm this year in the area where empty cones/pots are dumped. Surprising amounts of *C. tenuis* and *O. bracteosus* appeared in areas that had been prepared as a new edible thistle planting. In the fall, the field was tilled to smooth out all the potting soil that had been dumped on the area over the past couple seasons. This potting soil included past years conetainers of *C. tenuis* and *O. bracteosus*. In early February, the area was sprayed with glyphosate to prepare it for new transplants of edible thistle. After the thistles were transplanted, they were covered with a floating row cover to keep out pests such as seed weevils and stem borers. This cover also can create a slightly warmer/moister environment.

The thistles grew vigorously under the floating row cover, and when it was removed for weeding, hundreds of *C. tenuis* plants were growing under the cover. The areas between the row cover had been tilled to loosen dirt to be shoveled on top of the cover. No paintbrushes or owl clovers were noticed in the tilled areas or in the fallow areas next to the thistles (where cones may also have been dumped. It is amazing that so many viable seeds could have been present in the dumped cones. And that those seeds were not buried when the area was tilled. The field prep could have favored the germination and establishment of the seedlings by removing the weedy plant cover (spraying in February) and then adding the floating row cover, which creates a better environment for a tiny seedling. There are no other *C. tenuis* or *O. bracteosus* plants on the PMC farm, so it was assumed that these plants were of Eugene origin and most likely were from wild seed or at least one generation from the wild (if seedlings were from cones that had contained mother plants that had dropped seeds all over the conetainer). After failing at growing these little gems in the containers this spring, it was a wonderful (yet confusing) surprise to find them all blooming under the row cover. PMC staff hand harvested seed from these plants this year.

Figure 4. Hairy indian paintbrush (*Castijela tenuis*) established as a "weed" in areas where used media was dumped.

Delivery and Storage:

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 2013. 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 2013.

Species	Symbol	Seed lot	Weight
Carex tumicola	CATU	SG1-13-EB291	15g
Castilleja tenuis	CATE26	SG2-13-EB254	66 g
Downingia elegans	DOEL	SG1-13-EB432	1040 g
Downingia yina	DOYI	SG1-13-EB433	3 lbs
Eryngium petiolatum	ERPE7	SG1-12-EB431	699 g
Gentiana sceptrum	GESC	SG1-12-EB311	123 g

Table 4. Seed delivered to BLM staff in the fall of 2013 (con't).

Species	Symbol	Seed lot	Weight
Lasthenia glaberrima	LAGL3	SG1-13-EB293	115g
Madia glomerata	MAGL2	SG1-12-EB437	1720g
Montia linearis	MOLI4	SG1-13-EB295	112 g
Navarretia intertexta	NAIN2	SG1-13-EB378	450g
Nemophila menziesii	NEME	SG1-13-EB378	93 g
Rorippa curvisiliqua	ROCU	SG1-13-EB257	5 lbs
Veronica peregrina	VEPE2	SG1-13-EB439	867 g

Table 5. Seeds in storage at the Corvallis PMC as of December 30, 2013.

Species	Seed lot	Weight
Carex feta	SCO-13-EB315	2 lbs
Cicendia quadrangularis	SCO-13-EB254	5 g
Dichanthelium acuminatum	SCO-13-EB303	20 lbs
Eryngium petiolatum	SCO-13-EB431	1.54 lbs
Galium trifidum	SCO-13-EB317	2 lbs
Gentiana sceptrum	SCO-13-EB311	105 g
Gratiola ebracteata	SCO-13-EB436	31 g
Lupinus polycarpus	SCO-13-EB250	2.2 lbs
Madia glomerata	SCO-13-EB437	1.6 lbs

2013 Propagation Report for the Medford BLM district

Figure 1. Fragrant popcornflower (Plagiobothryrus figuratus) flowering at the Corvallis PMC.

Introduction

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 2013. It was agreed that the PMC would maintain seed increase fields of two legumes and four forbs. Eleven new species were added this year, including one grass and ten forbs.

Species in Production in 2013

Accessions included for the Medford District BLM in 2013 are listed in Table 1. This table also displays activities performed by PMC staff.

Table 1. Accessions involved for Medford District BLM cooperative agreement with Corvallis Plant Materials Center in 2013.

Species	**Common name**	**Symbol**	**Accession**	**Activity in 2013**[1]
Agastache urticifolia	horsemint	AGUR	9109177	Trl, Pxn, Sfp
Asclepias speciosa	showy milkweed	ASSP	9109175	Trl, Pxn, Sfp
Clarkia rhomboidea	diamond clarkia	CLRH	9109180	Sfp
Delphinium nudicaule	red larkspur	DENU	9109182	Trl, Pxn
Erigonum umbellatum	sulphur-flower buckwheat	ERUM	9079425	Sfp
Eschscholzia caespitosa	dwarf poppy	ESCA	9109183	Trl, Pxn, Sfp
Festuca subulata	bearded fescue	FESU	9109197	Trl, Pxn, Sfp
Grindelia nana	low gumweed	GRNA	9109176	Trl, Pxn, Sfp
Hackelia setosa	bristly stickseed	HASE	9109178	Trl, Pxn, Sfp
Iris douglasiana	Douglas iris	IRDO	9079417	Sfp
Plagiobothyrus figuratus ssp. *corallocarpus*	fragrant popcorn flower	PLFIC	9109184	Trl, Pxn, Sfp
Potentilla glandulosa	sticky cinquefoil	POGL9	9079427	Sfp
Rupertia physodes	forest scurf-peas	RUPH3	9079323	Sfp
Sanguisorba annua	western burnet	SAAN	9109181	Trl, Pxn, Sfp
Senecio triangularis	arrowleaf groundsel	SETR	9109179	Trl, Pxn, Sfp
Sisryinchium bellum	western blue eyed grass	SIBE	9079420	Sfp

[1-] Trl= germination trials, Pxn= plant production, Sfp= seed increase

Propagation Experiments

Most of the forb species that were new to the agreement this year had never been propagated previously at the center. Germination trials were performed on these species to determine propagation protocols. Seeds were counted out in 100 seed sets and placed in plastic germination boxes on moistened germination paper. Boxes were placed in either a warm growth chamber set at 75°F days and 50°F nights (“warm” treatment), room temperature (boxes were placed by a sunny window, temperatures ranged from 60-75° days to 50-60° nights) or a walk-in cooler set at a constant 38°F for 45 or 90 days, followed by the warm growth chamber (“cold” treatment). Boxes that received the warm treatment but showed little or no germination were then placed in the cooler for 90 days (warm/cold).

Table 2. Results of germination trials on new species for the Medford BLM agreement in 2013.

Species	Treatment	Average % Germination
Agastache urticifolia		
	warm	**90**
	room temp	78
	45 day strat	69
	90 day strat	36
Asclepias speciosa		
	warm	12
	room temp	**34**
	45 day strat	17
	90 day strat	17
Eschscholzia caespitosa		
	warm	6
	room temp	4
	45 day strat	46
	90 day strat	49
Grindelia nana		
	warm	**86**
	room temp	38
	45 day strat	89
	90 day strat	89
Plagiobothyrus figuratus ssp. corallocarpus		
	warm	8
	room temp	12
	45 day strat	13
	90 day strat	17
Delphinium nudicaule		
LIGHT	warm	0
	room temp	0
	45 day strat	8
	90 day strat	**85**
	warm/cold	66

Species	Treatment	Average % Germination
Festuca subulata		
	warm	44
	room temp	84
	45 day strat	95
	90 day strat	97
Romanzoffia californica		
	warm	2
	room temp	**52**
	45 day strat	0
	90 day strat	0
Senecio triangularis		
	warm	**60**
	room temp	30
	45 day strat	61
	90 day strat	67
Sanguisorba annua		
	warm	14
	room temp	8
	45 day strat	12
	90 day strat	**53**
Hackelia setosa		
	warm	0
	room temp	2
	45 day strat	6
	90 day strat	**13**
Delphinium nudicaule		
DARK	warm	0
	room temp	0
	45 day strat	20
	90 day strat	**92**

Only a few of the species needed a cold stratification period to break dormancy; these species had no or very little germination when placed directly in the warm growth chamber (*Hackelia setosa, Sanguisorba annua* and *Delphinium nudicaule*). Seeds of other species (*Agastache urticifolia, Senecio triangularis,* and *Grindelia nana*) are not dormant and germinated best at warm temperatures. *Eschscholzia caespitosa* germinated best in temperatures that were lower than room temperatures, whereas the *Plagiobothyrus figuratus* ssp. *corallocarpus* germinated in the cooler and at room temperature, but slightly less in the warm temperatures. The bearded fescue seeds had the highest germination in the 45 day cold stratification treatment. Seeds began germinating in the cooler after about three weeks. In the cooler, germination was rapid and uniform. The room temperature germination was a bit lower and less uniform. The seeds that were stratified were the only treatments to reach 100% germination. Three weeks of stratification would be the optimum germination treatment, since rapid germination occurred in the cooler after about three weeks (this was also observed when seeds were planted into media and placed into a walk-in cooler).

Figure 1. *Eschscholzia caespitosa* germination over time under different temperature treatments.

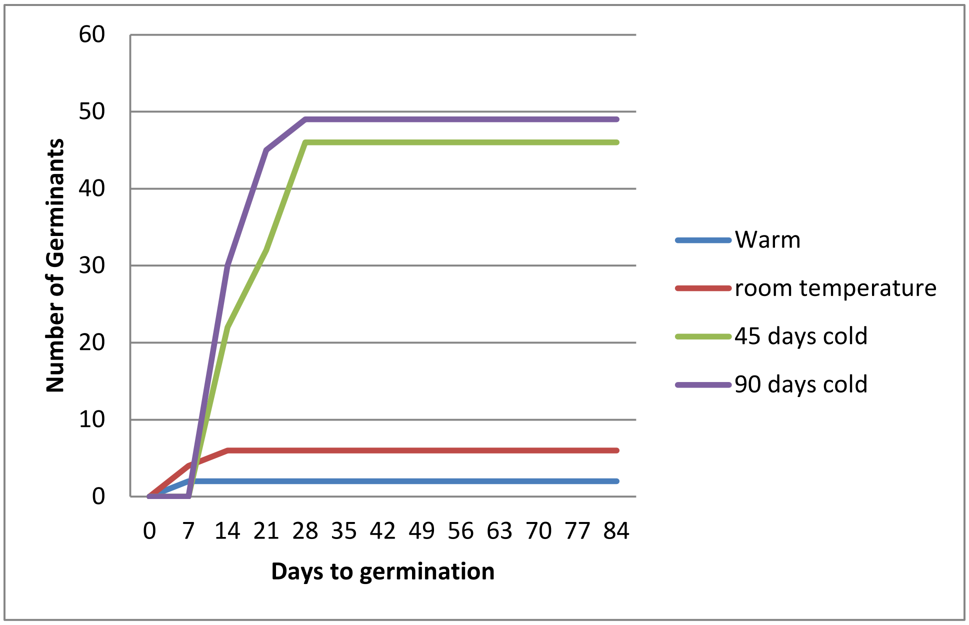
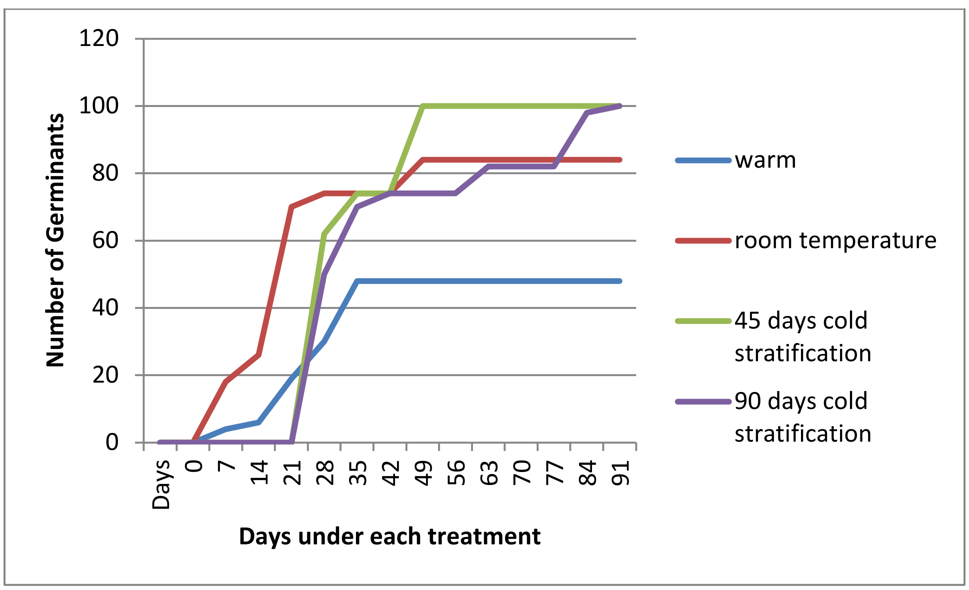


Figure 2. Bearded fescue (Festuca subulata) germination over time under different temperature regimes.

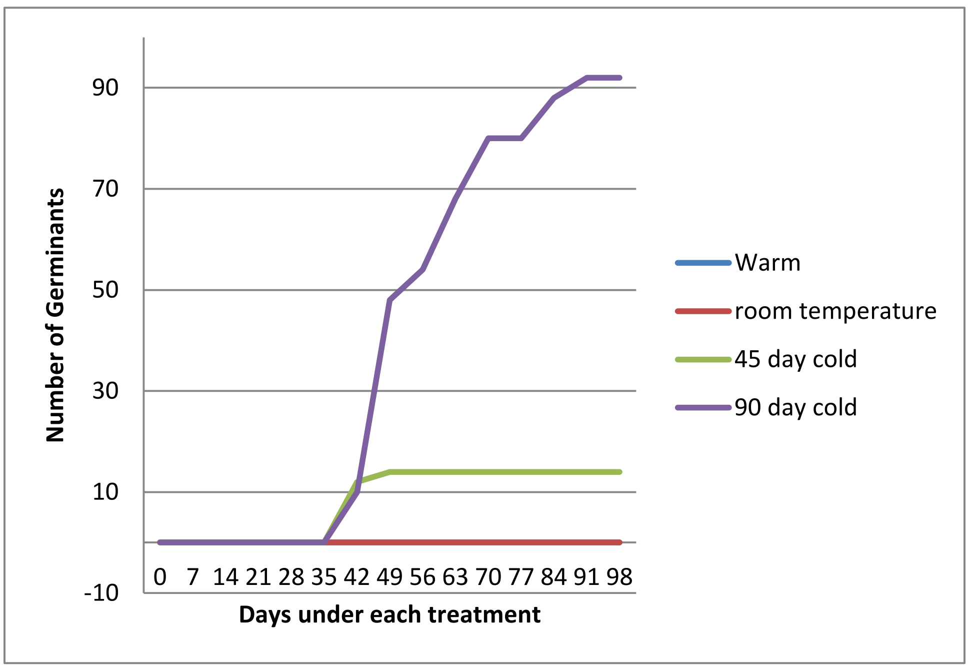


The milkweed seeds did not germinate in the cooler and stratification did not improve germination rates. It may be that milkweed seeds prefer fluctuating temperatures to trigger higher levels of germination. More trials need to be performed on this species to fully understand its germination requirements. Germination rates appear to be higher when seeds are sown in media and subjected to similar treatments in this study.

Romanzoffia californica seeds clearly germinated best with the room temperature regime. Seedlings slowly germinated over 6 weeks. Germination requirement are not fully understood at this time. Trials were only performed in germination boxes; no further work was performed on this species where it was sown in media and watched for germination.

For some species it may be misleading to look at total germination per treatment without considering what temperatures actually triggered germination. Compare the data in Table 2 for *Delphinium nudicaule* (light) and *Eschscholzia caespitosa*. It may appear that both of these species benefited from a cold treatment. Figure 2 shows that all the germination for *E. caespitosa* occurred during the first few weeks in the cold treatments. No germination occurred when exposed to warm temperatures. The most efficient way to get this species to germinate is to expose them to cool temperatures; they will germinate within 15 to 35 days. Figure 3 shows that *D. nudicaule* (light treatment) seeds also did not germinate in warm temperatures, but it appears that no germination occurred in the cold treatments until about 6 weeks. It is very interesting to watch these seeds which are placed in an artificial environment, absent of actual environmental cues, yet, they seem programmed to germinate. The 45 day cold treatment was scheduled to be removed just as the seeds began to germinate. Once they we were moved to a warm environment, germination halted. The 90-day treatment had a higher rate of germination than the 45 day treatment. A 60 or 70 day cold treatment is probably the best length of stratification for this species and it would be best if the seeds were exposed to temperatures between 40-60°F after stratification to maximize germination.

Figure 2. *Delphinium nudicaule* germination over time under different temperature treatments.



Plant Propagation

Using the preliminary data from the germination trials, 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 were wrapped in plastic bags and placed in a walk-in cooler (if stratification was needed to break dormancy). All species had good germination except *Hackelia setosa.* The PMC staff has attempted to grow this species for other projects with similarly poor results. It is not known if the seeds naturally have low viability, seeds are damaged in the cleaning process, or if the seeds have another form of dormancy.

Table 3. Plants produced in 2013 for the Medford BLM.

Species	Start date	Treatment	Amount produced
Agastache urticifolia	1-Dec	warm greenhouse	1000
Asclepias speciosa	15-Oct	warm greenhouse	800
Delphinium nudicaule	15-Oct	2 weeks warm+ 90 days cold strat	800
Eschscholzia caespitosa	1-Dec	cool greenhouse	600
Festuca subulata	15-Oct	45 days cold strat	1000
Grindelia nana	21-Nov	45 days cold strat	1000
Hackelia setosa	15-Oct	2 weeks warm+ 90 days cold strat	50
Plagiobothyrus figuratus ssp. *corallocarpus*	1-Dec	cool greenhouse	600
Sanguisorba annua	15-Oct	90 days strat	1000
Senecio triangularis	15-Oct	90 days strat	1000


Figure 3. Stop it, poppies, if you're flowering now, you're going to die when you go outside and it snows on you.

Plants were grown in a heated greenhouse throughout the winter, until they were moved to an unheated greenhouse in late February to acclimate them to outdoor temperatures and harden them for transplanting. Some of the annual poppy and popcorn flower plants had started blooming before they were moved into the unheated greenhouse, and the cooler temperatures probably triggered them to think it was fall, rather than spring. They did not thrive in the cooler greenhouse, most likely because they thought it was time to die. It is recommended that annuals should be directly seeded in the fall or early spring. The deciduous species (milkweed and larkspur), apparently also thought it was fall and began entering dormancy. The larkspur plants were very small so were not transplanted into fields, but instead were maintained in a shadehouse throughout the growing season in cone-tainers. All other containerize plants were transplanted into seed increase fields in March.

Seed Increase Activities

Many new species were included in this agreement in 2013. Some species were known to establish well from direct sowing, such as *Clarkia rhomboidea.* A few other species were directly sown for experimental purposes. Most new species were grown out in containers and transplanted out in the spring. Annuals such as poppy and popcorn flower should be direct seeded in the fall or early spring, however, the PMC received such small amounts of wild collected seed that it seemed more prudent to use the seed to grow transplants, rather than risk total failure if seeds were directly sown.

Figure 4. *Agastache urticifolia* bloomed later than most Willamette Valley species and was a favorite hangout for bumblebees.

Agastache urticifolia was chosen for establishing by experimentally direct sowing and transplants. Fall sown seed did not germinate until March. Seedlings remained small and did not grow a lot after soil moisture levels dropped in July. Transplants were added to the field in late March. These plants were already very large and lush. They established well, and remained much larger throughout the summer. Plants established from both methods did flower in 2013. However, transplanted plants produced multiple large stalks with many seed heads, while direct seeded plants had one small stalk with a couple heads, or no flower stalks. From these results, it seems that there is a large advantage to create fields using transplants, based on plant vigor and first year seed production. There was not an advantage in weed control, because both areas could be sprayed out in March, before seedlings emerged or transplants were installed.

The horsemint seemed to attract bumblebees, and was one of the few species that was flowering in July and August. On these summer mornings there were many sleeping bumblebees across the field. Seed ripening was highly variable so early seed was harvested by hand as it matured. Once the early ripening seedheads were harvested, the field was directly combined. Combining was very efficient, but the seed does not appear to after ripen, so seed fill was low.

Sanguisorba annua was also chosen for establishment via experimental direct sowing and transplanting. Spring results were similar to the *A. urticifolia;* the seeds did not germinate until March, so a large transplant was placed alongside a tiny seedling. However, by mid-summer there was no difference in the size or vigor of the plants that were directly sown or established via transplant. The *S. annua* continued to grow in the hot, dry part of summer and plants were quite lush and green, even in September. No plants flowered in 2013. From these results, there seems to be no advantage in using transplants to establish a field.

Previous work at the PMC has shown that *Asclepias speciosa* does not establish well from direct seeding. The field was established using transplants that had gone dormant in late February. In April, plants re-emerged, and grew a small amount before going dormant again. This species can take a few seasons to get established, but then is generally very hardy.

Figure 5. The seed capsules of clarkia contain a sticky substance when they are green and should not be combined (unless you need a reason to powerwash the inside of your combine).

The clarkia field was directly sown in the fall. It is important to sow this species as early as possible in the fall, because plants germinate in cool fall temperatures and can put on significant growth in winter. The field looked average and was harvested in August using the moon rover. The material was placed on tarps to dry and then was fed through the combine.

The poppy and popcorn flower fields were established in late March using transplants. The transplants did not acclimate well to outdoor conditions. The poppy plants had weak root systems and were damaged during the transplanting process. If the original collections had been larger, these species would have been directly sown. The transplants had moderate establishment success. However, the plants that did survive were very vigorous and produced a large amount of seed. The poppies were harvested by hand three times per week during the harvest period. The popcorn flowers do not drop their seed, so they were harvested once, by hand at the end of the season when all the seed was mature.

The *Grindelia nana*, *Festuca subulata*, and *Senecio triangularis* fields were established in late March using transplants. All of the fields looked great after transplanting. The gumweed and fescue plants grew well all summer, but did not flower their first year, which is typical for these species. The *Senecio* plants, however, became infested with a leaf rust during a very rainy spell in April. This commonly happens with this species when it is grown in containers in a greenhouse. Typically, the leaves are dusted with sulfur powder and the plants recover. This was attempted on the plants in the field, but they shriveled up and lost their leaves.

Figure 6. The Senecio plants growing in the PMC greenhouses.

Table 3. Establishment of seed increase fields for the Medford BLM in 2013.

Species	Method	date planted	spacing	Size (ac)	Establishment rating
Agastache urticifolia	direct seeding	15-Oct	1 ft rows	0.05	Low
Agastache urticifolia	transplants	15-Mar	1 ft X 2 ft	0.05	High
Asclepias speciosa	transplants	15-Mar	2ft X 2 ft	0.05	Medium
Clarkia rhomboidea	direct seeding	15-Oct	1 ft rows	0.05	High
Eschscholzia caespitosa	transplants	15-Mar	1ft X 2 ft	0.05	Low
Festuca subulata	transplants	15-Mar	1 ft X 2 ft	0.1	High
Grindelia nana	transplants	15-Mar	1 ft X 2 ft	0.1	High
Hackelia setosa	transplants	15-Mar	1 ft X 2 ft	0	0 survival
Plagiobothyrus figuratus sp. corallocarpus	transplants	15-Mar	1 ft X 2 ft	0.05	Low
Sanguisorba annua	direct seeding	15-Oct	1 ft rows	0.05	High
Sanguisorba annua	transplants	15-Mar	1 ft X 2 ft	0.05	High
Senecio triangularis	transplants	15-Mar	1ft X 2 ft	0.1	0 survival

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. This year, the early spring was a bit drier and warmer, and the plants looked better than they have in the past couple years. Flowers were abundant and seed fill was moderate. Seeds were harvested by hand.

The *Potentilla glandulosa* field appears to be in prime production, and yields continue to increase every year. Seed production was very high for this little plot! Direct combining is the most efficient harvest method that the PMC has tried.

Table 4. Yields from seed increase fields at the Corvallis Plant Materials Center in 2013.

Species	**Harvest date**	**Method**	**Field size (ac)**	**Yield**
Agastache urticifolia	24-Aug	hand/ direct combine	0.1	1.4 lbs
Clarkia rhomboidea	25-Jul	direct combine	0.5	4.5 lbs
Eriogonum umbellatum	6-Jul	hand	0.5	5 lbs
Eschscholzia caespitosa	June 20- July 15	hand	0.05	0.8 lbs
Iris douglasiana	July 20-25	hand	0.03	7 lbs
Plagiobothyrus figuratus ssp. *corallocarpus*	15-Jul	hand	0.05	5 lbs
Potentilla glandulosa	5-Jul	direct combine	0.05	6 lbs

Plots of *Sisyrinchium bellum* and *Iris douglasiana* were established in March of 2008 using transplants that were grown in 2007. The iris plants are producing well and the drier weather in June probably aided seed production. The blue-eyed grass plants were covered in rust and did not flower this year.

Delivery/Inventory

No deliveries were made this year and all seed will be stored in the PMC seed storage facilities.

Table 5. Seed in storage at the Corvallis Plant Materials Center as of December 31, 2013

Species	**Seed lot**	**Weight**
Agastache urticifolia	SG1-13-MB177	1.4 lbs
Agastache urticifolia	Wild collected 2012	258 g
Clarkia rhomboidea	SG1-13-MB180	4.5 lbs
Delphinium nudicaule	Wild collection 2012	51 g
Eriogonum umbellatum	SG1-13-MB425	5 lbs
Eschscholzia caespitosa	SG1-13-MB183	0.80 lbs
Eschscholzia caespitosa	Wild collection 2012	15g
Festuca subulata	Wild collection 2012	95 g
Grindelia nana	Wild collection 2005	46g
Iris douglasiana	SG1-13-MB417	7 lbs
Plagiobothyrus figuratus ssp. *corallocarpus*	SG1-13-MB184	5 lbs
Plagiobothyrus figuratus ssp. *corallocarpus*	Wild collection 2012	29g
Romanzoffia californica	Wild collection 2012	4 g
Sanguisorba annua	Wild collection 2012	4 g
Senecio triangularis	Wild collection 2012	24 g
Potentilla glandulosa	SG1-13-MB427	6 lbs

2013 Seed and Plant Production Report for the Roseburg District BLM

USDA NRCS Corvallis Plant Materials Center

Figure 1. The dense sedge (*Carex densa*) field was harvested using the PMC's self-propelled swather.

Introduction

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 2013 no new species were added, although six species from previous years were continued.

Activities in 2013 included maintenance and harvest of seven seed increase fields (three grasses, one forb, one sedge, and one legume).

II. Accessions Involved

Accessions included for the Roseburg District of the BLM in 2013 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 2013.

Species	Common name	Symbol	Accession	Activity in 2013[1]
Acnathrum lemmonii	Lemmon's needlegrass	ACLE8	9109066	Sfp
Carex densa	dense sedge	CADE8	9109063	Pxn,Sfp
Danthonia californica	California oatgrass	DACA3	9079415	Sfp
Festuca californica	California fescue	FECA	9079494	Sfp
Gilia capitata	bluehead gilia	GICA5	9109062	Sfp
Lupinus bicolor	miniature lupine	LUBI	9109067	Sfp
Madia gracilis	grassy tarweed	MAGR3	9109061	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 plants in both fields looked good this year. The *Carex* field was a soil mat of seed heads. The needlegrass is never a robust grass, and this field looks average. Both fields were weeded twice early in the growing season. The *Carex* field was harvested using the PMC's self-propelled swather which is probably the most efficient method for this species. The needlegrass was harvested by hand twice in July.

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

Figure 2. The dense sedge (*Carex densa*) was at peak production in 2013.

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 *M. elegans*. There was no germination from the seeds that were sown into the holes in February. It is unclear what happened. It is possible the seeds germinated and slugs at the seedlings, but no seedlings were ever observed.

Figure 3. Grassy tarweed (*Madia gracillis*) grows very well at the PMC, and usually stands 5 feet tall by June.

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 2013were comparable to 2012, but both were lower than 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 (mid-March) due to standing water, so this could have influenced the lower yields.

Table 4. Seed yields for the Roseburg District BLM cooperative agreement with the Corvallis Plant Materials Center in 2013.

Species	Field size	Harvest Date	Method	Yield (lbs)
Achnathrum lemmonii	0.01	8-Jul	hand	0.5
Danthonia california	0.48 ac	2-Jul	seed stripper, swath/combine	n/a
Festuca californica	0.23 ac	24-Jun	seed stripper	18.5
Gilia capitata	0.1 ac	26-Aug	direct combine	5
Madia gracilis	0.1 ac	21-Aug	direct combine	14
Carex densa	0.07 ac	27-Jun	moon rover	20
Lupinus bicolor	0.1 ac	Aug 1-19	hand, sweep weed fabric	20

Figure 4. California fescue (*Festuca californica*) prefers well-drained soils but grows moderately well at the PMC.

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. The field is patchy and weedy, but the plants produced a moderate amount of seed.

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.

V. Delivery of Plant Materials

There were no deliveries made for this project in 2013.

Figure 5. We had the best establishment of miniature lupine (*Lupinus bicolor*) this year due to aggressive slug control.

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 2013.

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	
Festuca californica	SG2-13-RB494	18.5 lbs	52.5 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	SG2-13-RB415	n/a	
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	
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	
Gilia capitata	SG1-13-RB062	5 lbs	39 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	
Madia gracilis	SG1-13-RB063	14 lbs	64.8 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 lbs	
Lupinus bicolor	SG1-13-RB067	20 lbs	27.5 lbs
Carex densa	SG1-12-RB063	1 lb	
Carex densa	SG1-13-RB063	20 lbs	21lbs
Achnatherum lemmonii	SG1-13-RB066	0.5 lbs	

The Central Coast Oregon Silverspot Butterfly Seed Increase Project

US Fish and Wildlife Service and US Forest Service

1/1/2014
USDA NRCS Corvallis Plant Materials Center
Amy Bartow

I. Brief Introduction of the 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. Grasses such as sand fescue and California oatgrass are produced to be used as matrix species in restoration sites. Most of the forbs included in this project are nectar sources for the adult butterflies; other species are included to add diversity to restored coastal meadows.

Activities in 2013 included maintenance and harvest of two grass and seven forb seed increase plots. New seed increase fields of four forbs for Mt Hebo were also added in 2013.

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 2013[1]
Achillea millefolium	western yarrow	ACMI2	9079448	Dlv
Anaphalis margaritacea	pearly everlasting	ANMA	9079451	Dlv
Artemisia suksdorfii	coastal wormwood	ARSU4	9079560	Sfp, Dlv
Aster chilensis	Pacific aster	ASCH2	9079449	Sfp, Dlv
Cirsium edule	edible thistle	CIED	9079620	Dlv
Danthonia californica	California oatgrass	DACA	9079601	Sfp
Festuca ammobia	sand fescue	FEAM5	9079450	Sfp, Dlv
Solidago canadensis	Canada goldenrod	SOCA6	9079497	Sfp, Dlv
Solidago spathulata	dune goldenrod	SOSP	9079561	Sfp, Dlv
Tanacetum camphoratum	camphor tansy	TACA2	9079559	Sfp, Dlv
Trifolium wormskioldii	sand clover	TRWO	9079619	Sfp, Dlv
Viola adunca	early blue violet	VIAD	9079406	Sfp, Dlv
Viola adunca (Mt Hebo)	early blue violet	VIAD	9109147	Sfp
Achillea millefolium (Mt Hebo)	western yarrow	ACMI2	9109205	Sfp
Anapahalis margaritacea (Mt Hebo)	pearly everlasting	ANMA	9109207	Pxn
Cirsium edule (Mt Hebo)	edible thistle	CIED	9109208	Pxn
Solidago elongata (Mt Hebo)	west coast Canada goldenrod	SOEL4	9109206	Pxn

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

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. The plants are fertilized with 30 lbs/ac N 16-16-16 once a year, usually in mid-March (timed with mild rain and moderate temperatures) and this seems to greatly increase flowering and seed set. 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 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. These plants are over five years old and still maintain high yields.

Figure 1. The Canada goldenrod (*Solidago canadensis*) seed increase field is always a favorite field for pollinator identification at PMC field days.

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 and usually require one quick weeding mid-spring. After hand weeding, the goldenrod and aster fields are fertilized in April. The Canada goldenrod plants began to bloom earlier than usual in 2013 and seed maturity was much more uniform. All late blooming plants (aster, goldenrod, etc.) were much smaller than in previous years, including other fields on the PMC farm that are not a part of this agreement. The aster field is very stunted, flowers very late, and produces little seed. The goldenrod is still flowering profusely and maintaining fairly high yields. These fields were seed stripped two times during the summer and fall. In late fall, we attempted to deeply till small strips in the aster field (where the tractor tires drive and smash plants anyway) to create looser soil and possibly reinvigorate the plants. The soil was wet when we attempted this and we were not able to till as deeply or thoroughly as we had hoped. We will attempt to till again as early as possible when the soils are dry enough this spring.

Table 2. Seed production information for USFWS Oregon Silverspot seed increase project

Species	**Method**	**Harvest Date**	**Area (ac)**	**Yield (bulk lbs)**
Aster chilensis	seed stripper	9/30-10/20	0.3	4.5
Circium edule	hand, direct combine	6/15-7/ 20	0.05	2
Danthonia californica	hand	7-Jul	0.01	2.3
Festuca ammobia	seed stripper	10-Jul	0.51	60
Solidago canadensis	seed stripper	12-Aug	0.2	47.5
Tanacetum camphoratum	direct combine	25-Aug	0.08	33
Trifolium wormskioldii	cut, combine	10-Aug	0.2	63
Viola adunca	vac weed fabric	15-Aug	0.2	20
Viola adunca (MtHebo)	vac weed fabric	23-Aug	0.15	11

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 year for harvest, we tried cutting and collecting all the material, drying it, then feeding it

Figure 2. The sand clover (*Trifolium wormskioldii*) field was creatively harvested using the "Brady Chopper" which flail mows, collects (left), then dumps the material (right).

into a combine. We used our “Brady chopper”, which is basically a mower that vacuums the material as it cuts it, then shoots it into a collection wagon that is towed behind. This machine was used because it can cut very low, and the vacuuming action “lifted” the spreading clover stems which collected more seed heads than other methods. The huge piles of material were placed on tarps to dry. The piles were very thick and had to be turned often so they didn’t become moldy or begin composting. After a couple weeks, the material was pitchforked into a combine. Combining this shredded material was slow and very dirty. The Brady chopper did a great job of scalping the plants, but it also sucked up a huge amount of dirt. Combining all this dirt was a terrible idea. Amy drew the short straw that day and had to work at the back of the combine, pitchforking the chaff away from the machine. The plant material that had been mowed, then combined, came out of the back of the combine as a fine, rust-colored dust, which stuck to our sweaty arms and faces. We looked like we had spray-on tans. And, after all that work, our yields were about half of what they were the previous years. In short, it was not our best choice for a harvest method.

Figure 3. Combining the flail mowed clover material was one of the dirtiest jobs we've had at the PMC.

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 since then, the vigor of the dune goldenrod plants had steadily declined. The field has also been taken over by volunteer aster plants. The field was mowed to control weeds and not harvested this year. The tansy field is still vigorous and produces a lot of seed. It was harvested in late August by using our new plot combine. It worked very well. Our older combine had a wire concave and the seed heads would poke through it and would not be crushed enough to release the seed. The new combine has a solid concave and could easily dislodge the seeds. It is still very difficult to clean this seed to high purity levels. It is almost impossible to distinguish unfilled seed from filled seed, and small pieces of leaves are quite dense and cannot be screened or blown out.

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. In the spring of 2013, the sage field was incredibly weedy (probably from weed seed that was washed in during the flooding that occurred the previous winter). The field was heavily spot-sprayed, which greatly reduced weed cover, but did harm some plants. By fall, the plants were very tall and healthy; some flowered, but did not produce seed.

The *F. ammobia* field was not needed by USFWS or USFS anymore since a private grower has a larger field in production. The *F. ammobia* field at the PMC was funded for 2013 by US Army. The field has recovered from the burning that occurred in the fall of 2011 and had moderate yields in 2013.

Figure 4. The sand fescue field was burned in the fall of 2011. It slowly greened up in April of 2012 (top), flowered moderately in July 2012 (middle), then completely recovered in summer of 2013 (bottom). Blue arrows show distance between rows (approximately 1 foot). Burning could be a successful management tool for this grass.

Two new fields were established in the spring of 2012. A small plot of California oatgrass was created using transplants that were grown in fall/winter 2011/2012. This plot flowered in 2013 and produced about 2 lbs of seed. This plot is very small and the 2012 harvest was used to start more plugs to establish a larger field. The new field was created in March of 2013. These plants did not flower in 2013. A 0.15 acre plot of violets from Mt Hebo was also planted into a field covered with weed fabric. The violets flowered and produced seed this year, and 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. This field is very close to OSU's Hyslop farm buildings which have piles of wheat, barley and other seeds nearby that attract the large populations of pigeons. Therefore this violet field is subjected to the highest levels of dove and pigeon predation.

Cirsium edule is an important pollinator plant for a variety of bees, wasps, and flies. Although it is very easy to grow, seed production of this species has been very difficult. This is no surprise, as the two most difficult issues with native seed production are usually weed control and harvest. A large field was tried in the past, but PMC staff found it was cumbersome to weed between the prickly plants. To obtain the highest yields, seed had to be collected by hand as each head ripened. This was time consuming and painful. But the thistles are also plagued with pests. A seed weevil decimated the harvest, what little seed remained was devoured by goldfinches, and a fair number of plants were damaged by a stem borer. They are also a biennial which means we have to care for them for two seasons, but only get one crop. To manage all of these issues we devised a new approach:

1. Grow giant overwintered plants that can act as annuals (breaks up the stem borer life cycle and shortens the field maintenance between planting and harvest).
2. Plan for space between rows for prick-free weeding and harvesting.
3. Cover plants with floating row cover to block weevils and goldfinches (one row of thistles was left uncovered as a "control").
4. Fertilize the plants early in the growing season for bigger plants with lots of flowers.

Figure 5. Floating row cover was used on the edible thistle plot this year in an attempt to reduce seed predation by weevils and goldfinches.

Most of these techniques were successful. The large transplants grew well and a high percent flowered in their first growing season. Only a few plants in the uncovered row died from stem borers, but this was much less than we noticed when the plants were grown as biennials. Having more space between the rows made working in the field much more comfortable. The floating row cover greatly reduced the weevil and goldfinch predation. In the uncovered row, weevils were plentiful and they destroyed a lot of seed. What little seed was left was eaten by the goldfinches. The floating row cover blocked the weevils and the goldfinches, but created a great habitat for aphids and blocked pollinators from accessing the thistles. After the peak in weevil activity, the covers were removed periodically to harvest ripe seed and were left off for a couple hours to provide pollinators access to the flowers. If the covers were left off for too long, the goldfinches started to move in. The ripe heads were collected twice weekly by hand from late June through mid-July. It was a lot of work taking the covers off and on every couple days. As seed was collected it was piled in a kid's plastic swimming pool covered with a piece of shade cloth to keep the seeds from blowing away. After the peak harvest the plot was directly combined. This was a great harvest method, but since it is a one-time harvest it can only harvest the seed that is ripe at that time, which would result in low yields if it was the only method used at the peak ripening time. The material that was combined was laid in the greenhouse to dry.

Figure 6. Seed weevils are very damaging to native thistles, greatly reducing the amount of viable seed a plant can produce.

Normally, the PMC greenhouse is used as a drying room in the summer, and turned back into a greenhouse for the fall and winter. Due to the government shutdown, this turnover was delayed and drying plant material was left in the greenhouse for much longer than usual. After the shutdown, the harvested thistle material was placed in plastic barrels to be stored until they could be cleaned. PMC staff noticed a large amount of shells (seed covers with no seeds) in the materials, along with mouse droppings. During the shutdown, the mice probably moved into the greenhouse and ate a fair bit of seed. When the seed was cleaned there were less than 3 lbs, but we suspect that there may have been between 5 and 10 pounds of good seed before the mice ate it.

IV. Container Plant Production

Figure 7. Edible thistle (*Cirsium edule*) (top left), goldenrod (*Solidago elongata*) (top right) and pearly everlasting (*Anaphalis margaritacea*) were grown in plugs to establish seed increase fields of these species for restoration projects on Mt Hebo.

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 were transplanted out into the seed increase field in spring of 2013.

New seed increase fields for Mt Hebo were requested for 2013. Plugs of pearly everlasting, edible thistle, and goldenrod were sown in the summer of 2013 for out-planting in the winter/spring of 2014. The plugs are very vigorous and are overwintering in an unheated greenhouse until the field is prepped for planting in March. A new field of western yarrow was established by direct sowing in the fall of 2013. The yarrow field germinated in the cool fall temperatures, but grew very little over the winter.

Table 3. New fields established for species from Mt Hebo in 2013.

Species	Method	Date planted/ sowed	Spacing	Size of field (ac)
Achillea millefolium	direct seed	26-Oct	2 ft rows	0.1
Anaphalis margaritacea	transplants	5-Sep	1 ft by 1 ft	0.1 (est)
Cirsium edule	transplants	5-Sep	2 ft by 3 ft	0.1 (est)
Solidago elongata	transplants	5-Sep	1 ft by 1 ft	0.1 (est)

V. Delivery of Materials

Most of the seed that was delivered this year was to grow violet plugs. The Oregon Zoo, the Salmon-Drift Creek watershed council, and two facilities in the sustainable prisons program requested seed to grow violets for captive rearing or restoration projects.

Catherine Pruett, Executive Director of the Salmon-Drift Creek Watershed Counsel, provided this update of how the seed was used:

- " January 15th - Under the guidance of Celeste Lebo at the Northwest Oregon Restoration Partnership in Tillamook, Oregon Youth Authority inmates filled 300 trays with planting medium. Each tray accommodates 72 plants, making our goal 21,600 violets. The Nature Conservancy paid for materials.
- January 16th - David Pickering delivered the trays to our nursery at Taft High School, where six high school students from Career Tech High School's Natural Resources Crew, five 1st - 5th grade students from the Taft Elementary School After School Program, and several adult chaperones helped us plant over 1,100 violets.
- January 18th - 11 adult volunteers, representing organizations including the City of Lincoln City, Devils Lake Water Improvement District, Salmon Drift Creek Watershed Council, The Nature Conservancy, and U.S. Forest Service, helped plant almost 17,000 violets.
- January 29th - We plan to have approximately 48 6th grade students from Taft Elementary School and several adult chaperones plant the remaining 2,000+ violets."

The Institute for Applied Ecology also worked with inmates in the fall of 2013 to grow plugs of violets and pearly everlasting:

- Approximately 20 inmates at the Coffee Creek Correctional Facility sowed violet seed into 36,000 cone-tainers for out-planting at the Nestucca Wildlife Refuge.
- Thirty-seven young women at the Oak Creek Youth Authority sowed 2,160 violets for out-planting at Rock Creek.
- Thousands of pearly everlasting plugs will be produced with the Coffee Creek Correctional Facility in the summer of 2014 for out-planting at Nestucca Wildlife Refuge.

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. There are two mixes 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. One bag was provided to Marty Bray in the spring of 2013 and the other was delivered to Debbie Pickering in late winter of 2013.

Table 4. Seed delivered in 2013 for the Oregon Silverspot seed increase project.

Species	Seed lot	Amount	Recipient
Achillea millefolium	SG1-10-OS448	9 lbs	IAE- Cannery Hill
Artemisia suksdorfii	SG1-11-OS560	2 lbs	IAE- Cannery Hill
Cirsium edule	SG1-13-OS620	500 g	IAE- Cannery Hill
Festuca ammobia	SG1-10/11-OS450	190 lbs	IAE- Cannery Hill
Solidago canadensis	SG1-09/10-OS497	11 lbs	IAE- Cannery Hill
Aster chilense	SG1-10-OS449	13 lbs	IAE- Cannery Hill
Trifolium wormskioldii	SG1-12-OS619	8 lbs	IAE- Cannery Hill
Viola adunca	SG1-11-OS406	2 lbs	IAE- sustainable prisons program
Anaphalis margaritacea	SG1-10-OS451	25 g	IAE- sustainable prisons program
Violet, fescue, nectar mix		26 lbs	TNC- Debbie Pickering
Viola adunca	SG1-11-OS406	1 lb	USFWS- Anne Walker
Viola adunca	SG1-11-OS406	3 lbs	USFS- Marty Bray
Viola adunca	SG1-11-OS406	100 g	Oregon Zoo

Table 5. Seed in storage at the Corvallis PMC for the Oregon Silverspot seed increase project.

Species	Seed lot	Amount (lbs)	Total/species (lbs)
Achillea millefolium	SG1-08-OS448	7	
Achillea millefolium	SG1-09-OS448	10	
Achillea millefolium	SWC-07-OS448	0.5	17.5
Anapahalis margaritacea	SG1-10-OS451	2.3	2.3
Artemisia suksdorfii	SG1-11-OS560	23	23
Aster chilensis	SG1-10-OS449	2.4	
Aster chilensis	SG1-11-OS449	36	
Aster chilensis	SG1-12-OS449	15	
Aster chilensis	SG1-13-OS449	4.5	58
Cirsium edule	SWC-10-OS620	0.5	
Cirsium edule	SG1-13-OS620	0.5	1
Danthonia californica	SG2-13-OS601	2.3	2.3
Festuca ammobia	SG1-10-OS450	5	
Festuca ammobia	SG1-11-OS450	15	
Festuca ammobia	SG1-12-OS450	25	45
Solidago canadensis	SG1-10-OS497	5	
Solidago canadensis	SG1-11-OS497	77	
Solidago canadensis	SG1-12-OS497	26.5	
Solidago canadensis	SG1-13-OS497	47.5	156
Solidago spathulata	SG1-10-OS561	1.7	

Solidago spathulata	SG1-11-OS561	1	2.7
Tanacetum camphoratum	SG1-09-OS559	12	
Tanacetum camphoratum	SG1-10-OS559	17	
Tanacetum camphoratum	SG1-12-OS559	80	
Tanacetum camphoratum	SG1-13-OS559	33	142
Trifolium wormskioldii	SG1-10-OS619	6.5	
Trifolium wormskioldii	SG1-11-OS619	90.5	
Trifolium wormskioldii	SG1-12-OS619	134	
Trifolium wormskioldii	SG1-12-OS619	63	294
Viola adunca	SG1-11-OS406	35.5	
Viola adunca	SG1-12-OS406	25	
Viola adunca	SG1-13-OS406	20	80.5
Viola adunca (Mt Hebo)	SG1-12-MH147	9	
Viola adunca (Mt Hebo)	SG1-13-MH147	11	20
Achillea millefolium (Mt Hebo)	SWC-12-MH205	0.5	
Anapahalis margaritacea (Mt Hebo)	SWC-12-MH207	0.5	
Cirsium edule (Mt Hebo)	SWC-12-MH208	0.3	
Solidago elongata (Mt Hebo)	SWC-12-MH206	0.75	

2013 Progress Report: Lassen Volcanic National Park

Figure 1. Ragwort (*Senecio* sp.) plants growing at the Corvallis Plant Materials Center.

Introduction:

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 2013 included plant production (by seed) of three forb, one grass, and one legume species. Approximately 1,200 plants were produced and delivered to the Park this year.

Accessions:

Table 1. Accessions involved in the Lassen Volcanic National Park Agreement in 2013.

Species	Common name	Symbol	Accession number	Activity in 2013[1]
Lupinus obtusilobus	bluntlobe lupine	LUOB	9079501	Pxn, Dlv
Silene sp.	catchfly	SILEN	9079637	Pxn, Dlv
Senecio aronicoides	rayless ragwort	SEAR4	9079640	Pxn, Dlv
Calamagrostis canadensis	bluejoint	CACA4	9109082	Pxn, Dlv
Achillea millefolium	common yarrow	ACMI2	9109203	Pxn, Dlv

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

Plant Propagation Activities:

All species were sown from seed in early May 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 outside in a shadehouse (average daily temp is about 65°F). Plants were watered and fertilized overhead as needed. Two weeks before delivery plants were slowly exposed to direct sunlight to acclimate them.

All plants grew well in the shade house all summer. The grasses 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.

Delivery and Storage:

On September 21, 2013, PMC staff traveled to the Park to deliver the plants.

Table 4. Plants delivered to Lassen Volcanic National Park, September 21, 2013, for the Visitors' Center agreement.

Species	Accession number	Number of plants
Lupinus obtusilobus	9079501	15
Silene sp.	9079637	9
Senecio aronicoides	9079640	98
Calamagrostis canadensis	9109082	1035
Achillea millefolium	9109203	48

North Coast Oregon Silverspot Butterfly Seed Increase Project for the US Fish and Wildlife Service:
2013 Annual Report

Prepared by Amy Bartow
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Figure 1.Western yarrow (Achilliea millefolium) seed increase field at the Corvallis Plant Materials Center, June 11, 2013.

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 2013 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 2013.

Speices	Common name	Accession number	Activity in 2013[1]
Achillea millefolium	yarrow	9079609	Sfp
Aster subspicatus	Douglas aster	9109117	Sfp, Col
Carex pansa	sanddune sedge	9079563	Sfp,
Festuca rubra	Coastal red fescue	9079617	Sfp, Col
Sanicula arctopoides	footsteps of spring	9109070	Sfp,
Solidago spathulata	dune goldenrod	9079532	Sfp, Col
Viola adunca	early blue violet	9079558	Sfp, Dlv

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

III. Seed Collections

During the summer of 2013 Bill Vagt (OMD) collected seed from the wild at Camp Rilea and West Sand Island. This seed can be used in the future for producing plugs or establishing seed increase fields. These collections were brought to the PMC for cleaning and storage.

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 and the new area produced seed in 2013. Yields were average for this field in 2103.

Figure 2. At the Corvallis Plant Materials Center, dune sedge (*Carex pansa*) produces a fraction of the seed it makes in the wild.

The *Carex pansa* field produced a tiny 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. The yields have been lower each year since the third growing season, even though the plants still are large and appear vigorous. It would be more efficient to collect seed from the wild where seed is abundant rather than maintaining and harvesting the tiny amount of seed off these robust plants.

Table 5. Seed produced at the Corvallis Plant Materials Center for the North Coast Oregon Silverspot Butterfly Seed Increase Project in 2013.

Species	Acres	Date	Method	Yield
Aster subspicatus	0.25	Sept 10-Oct 20	Seed stripper	5 lbs
Achillea millefolium	0.1	August 20	Direct combine	32 lbs
Carex pansa	0.56	July 26	hand	0.5 lbs
Festuca rubra	0.20	July 9	Seed stripper	n/a
Solidago spathulata	0.25	Sept 4-Oct 15	hand, seed stripper	5 lbs
Viola adunca	0.15	July 25, Sept 3	vacuum	9 lbs

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 once in late August.

The asters from the North Coast are very tall compared to the Central Coast ecotype. It can be difficult to harvest the asters because of the variation in height. The seed increase field was mowed at 18 inches in early May to increase branching and lower height of the tallest asters. The mowing seemed to lower the overall height of the asters and it may have increased branching, but not significantly. 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 2013. 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 two times in September and October.

Bill Vagt requested creating a new seed increase field using shorter asters. The field was monitored for low-growing asters and seed was collected from the short, sprawling asters. OMD may find that these asters are more suitable for areas that are mowed periodically during the summer.

The goldenrod field has had high survival and vigor, yet it does not seem to produce very much seed. The plants flower abundantly, but filled seed is difficult to find. The field was harvested using the seed stripper twice in the fall.

Figure 3. Late blooming species like dune goldenrod (*Solidago spathulata*) are important for pollinators.

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. In 2013, they were the tallest yarrow plants we've ever seen on the farm. The field was harvested using the new Winterstieger plot combine. It was very effective.

In the spring of 2013, some *Sanicula arctopoides* plants that were left over from germination trials were transplanted out into a prepared field at the PMC to monitor their success and survival. About 25 plants were transplanted into a small square on 2 ft by 2 ft spacing. The plants did not grow after transplanting and quickly dried up. It did not look like they went dormant, it was thought that they died. But over half of them emerged in late winter. These plants will be monitored to assist a private grower who is establishing a field of them in the Willamette Valley.

V. Delivery of Materials

Seed was delivered to Institute for Applied Ecology to be used in the Sustainable Prisons program and to the Northwest Oregon Restoration Partnership to grow violet plugs for outplanting into restoration sites in the fall of 2014.

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 2013.

Species	Seed lot	Weight	Recipient
Viola adunca	SG1-11-NC558	1 lb	IAE sustainable prisons program
Viola adunca	SG1-11-NC558	1 lb	Northwest Oregon Restoration Partnership

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

Species	Seed lot	Amount
Achillea millefolium	SG1-13-NC558	32 lbs
Aster subspicatus	SG1-12-NC117	n/a
Aster subspicatus	SG1-13-NC117	5 lbs
Carex pansa	SG1-12-NC563	2 lbs
Carex pansa	SG1-13-NC563	0.5 lbs
Festuca rubra	SG1-12-NC617	54 lbs
Festuca rubra	SG1-13-NC617	n/a
Solidago spathulata	SG1-12-NC532	11 lbs
Solidago spathulata	SG1-13-NC532	15 lbs
Viola adunca	SG2-11-NC558	5.3 lbs
Viola adunca	SG2-12-NC558	26 lbs
Viola adunca	SG2-13-NC558	9 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

Seed and Plant Increase of Threatened and Endangered Species: 2013 Annual Report

Prepared by Amy Bartow
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Figure 1. Golden paintbrush (*Castilleja levisecta*) plants grow with western yarrow (*Achillea millefolium*) "hosts" in containers in the Corvallis Plant Materials Center greenhouse, March 25, 2013.

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. In 2013, another Willamette Valley daisy seed increase field was established and plug production of the daisy and Kincaid's lupine were performed.

II. Accessions Involved

Table 1. Accessions involved in the Threatened and Endangered Species Seed Increase project at the Corvallis Plant Materials Center in 2013.

Species	**Common name**	**Population Source**	**Accession #**	**Activity in 2013**[1]
Erigeron decumbens var. *decumbens*	Willamette Valley daisy	Eugene West	9109148	Pxn
Erigeron decumbens var. *decumbens*	Willamette Valley daisy	Corvallis East	9109185	Sfp
Lomatium cookii	Cook's lomatium	Serpentine	9109136	Pxn
Lomatium cookii	Cook's lomatium	Upland/oak gaps	9109132	Pxn
Lupinus oreganus	Kincaid's lupine	Eugene West	9079186	Pxn, dlv
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 plugs of *Castilleja levisecta, Lupinus oreganus* and *Erigeron decumbens* var. *decumbens* for delivery in spring of 2013. A second set of *E. decumbens* was also grown in plugs to use to establish a seed increase field. 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. Racks of cones were wrapped in plastic bags and placed in a walk-in cooler for 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 these 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.

Species	Source	Start date	Treatment	Number produced
Erigeron decumbens var. *decumbens*	Eugene West	15-Oct	120 days cold stratification	1350
Erigeron decumbens var. *decumbens*	Corvallis East	15-Oct	120 days cold stratification	440
Lupinus oreganus	Eugene West	15-Nov	8 weeks cold stratification	850
Castilleja levisecta	Mixed pops	15-Nov	6 weeks cold stratification	5000

All the species grew well and experienced no major issues except for the paintbrushes. After a couple weeks of being exposed to the new temperatures the paintbrush seedlings began to look weak, pale, or reddish. Plants were lightly sprayed with a foliar treatment of 16-16-16. They did not improve. The pH of the soil was measured and found to be 4.8. The pH was monitored for many other cone-tainers that had been under different stratification techniques. It was discovered the paintbrushes had the lowest pH of all the containers currently in the greenhouse. We theorize that the slow release fertilizer begins to break down while in the moistened media during stratification. The cone-tainers are not watered while in stratification, which can lead to buildup of excess fertilizer. Once the cone-tainers are moved to a warm greenhouse, fertilizer is rapidly released by the slow-release pellets. Paintbrush seedlings are tiny and cannot be watered heavily or it will dislodge them. Heavy watering could help leach out some of the fertilizer. The plants are not large enough to take up all the fertilizer that is in the media. We think this is contributing to the acidic media. Once we realized this, we thoroughly leached the cone-tainers. This was repeated once a week and appeared to help the seedlings that had survived. Next year, slow release fertilizer will not be used to see if survival and pH is higher.

Figure 2. Kincaid's lupine (*Lupinus oreganus*) grew very well in the greenhouse this year.

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 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. In 2013, the hosts we used were: *Danthonia californica, Eriophyllum lanatum, Achillea millefolium, Potentilla gracilis, Erigeron decumbens var decumbens.*

Seeds of Cook's lomatium were provided to the PMC in fall of 2011. Seeds were planted in deep propagation flats that 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. 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. They were stored in moistened peat in a walk in cooler until planting time.

IV. Field Seed Increase Activities

Cook's lomatium- The serpentine tubers were planted into field on Jan 5th. A trench was dug about 6 inches deep and tubers were place upright in the trench and covered with soil, with the growing point just at the surface. The upland gap tubers were not planted until late January. They had begun to grow and were difficult to plant without damaging them. Both fields were monitored for above ground growth two weeks after they had been planted and the field containing the upland gap tubers was infested heavily with slugs. We think the slugs were a major factor in us finding zero emerged plants. The plot was monitored many times during the spring and again in the winter of 2013, but no plants were ever noticed. We figure the field to be total loss ☹. The serpentine field, however, emerged within weeks of planting, and grew slowly during the spring. The plants went dormant in summer and re-emerged in the winter of 2013. They probably will be vegetative again in 2014, but should produce seed in 2015.

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.

The field was much weedier in 2012 and due to 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. The clover was sprayed out in the fall of 2012 and again in the early spring of 2013. This killed all paintbrushes in the area too, if they were lurking under the clover. Plants were replaced using extra plants for outplanting. Overall, the paintbrushes were less vigorous in 2013. Because of the weeds and the loss of vigor, it might be best to start a new field for 2014.

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 Hammermill to break them open, and debris was separated from seeds in a small air-screen machine.

Willamette Valley daisy- A new Eugene West 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 were planted out in a seed increase field in March of 2013. The field was weeded many times during the growing season. The plants bloomed slowly for most of the summer. Seed was collected, by hand, three times a week through July and August.

Figure 3. Willamette Valley Daisy (*Erigeron decumbens* var *decumbens*) growing vigorously in the Corvallis PMC greenhouse.

Plugs were grown over the winter for a new field of Corvallis East plants. They were transplanted into a field in late March. The field was weeded by hand twice during the growing season. The plants grew well over the summer but did not flower.

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 4. Nelson's checkermallow (*Sidalcea nelsoniana*) attracts many native pollinators, such as bumblebees.

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.

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. This species of checkermallow is susceptible to a leaf rust. It can be quite damaging to the plants and can cut yields in half. *Sidalcea campestris* plants that occur in the field are unaffected by the rust. The rust is controlled by two applications of fungicide in the spring. Both fields were healthy and vigorous this year, and were harvested by direct combining.

Table 4. Harvest information for the Threatened and Endangered Species Seed Increase Project at the Corvallis Plant Materials Center in 2013.

Species	**Accession**	**Field size (ac)**	**Date harvested**	**Method**	**Yield**
Erigeron decumbens var. *decumbens*	Eugene West	0.05	July 10-August 30	vacuum	29 g
Castilleja levisecta	Mixed	0.04	3-Jul	hand	2.25 lbs
Sidalcea nelsoniana	Salem West	0.3	16-Jul	combine	105 lbs
Sidalcea nelsoniana	Corvallis West	0.3	19-Jul	combine	138 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	SG1-13-NS625	2.25lbs

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 2013.

Species	**Source**	**Seed lot**	**Amt**
Erigeron decumbens var. *decumbens*	Eugene West	SG1-13- EW148	29g
Castilleja levisecta	Mixed	SG1-12-NS625	267 g
Castilleja levisecta	Mixed	SG1-11-NS625	139g
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	Salem West	SG1-13-NS600	105 lbs
Sidalcea nelsoniana	Corvallis West	SG1-10-NS600	19 lbs
Sidalcea nelsoniana	Corvallis West	SG1-13-NS600	138 lbs

Seed and Plant Production for US Forest Service: 2013 Annual Report

Prepared by Amy Bartow
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Figure 1 Cardwell's penstemon (*Penstemon cardwellii*) at the Corvallis Plant Materials Center, May 13, 2013

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 2013, 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 2013 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 2013.

Scientific Name	Common name	Forest District	Accession #	Activity in 2013[1]
Alopecurus geniculatus	water foxtail	SIU	9109193	Sfp
Lotus purshianus	Spanish clover	Mt Hood	9109201	Sfp
Carex obnupta	slough sedge	OLY	9079623	Sfp
Spariganium emersum	burr reed	OLY	9079624	Sfp
Aristida longiseta	three awn	WA-WH	9109139	Sfp
Hesperostipa comata	needle and thread	WA-WH	9109137	Sfp
Festuca viridula	Green fescue	WA-WH	9109140	Sfp
Trifolium longipes	long stalk clover	WILL	9109138	Sfp
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, pxn= plant production

III. Field Seed Increase Activities

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.

Figure 2 The flowers of Oregon iris (*Iris tenax*) in the field for the Willamette National Forest are much paler than those grown from populations within the Willamette Valley.

The *P. cardwellii* plants have grown considerable and flowered profusely this year. The seed capsules were harvested by hand on two harvest dates as they ripened. 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.

Iris tenax typically does not flower until it is three years old. It was expected to flower in 2013 and it did. This collection contained many plants with white or pale lavender compared to collections from the Willamette Valley. The seed pods were collected by hand twice weekly during the months of June and July. *E. lanatum* plants looked more vigorous this year, but flowered very weakly and did not set seed. Usually, this species flowers in its second growing season. 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 and one plant flowered! I was thinking that this species may not be adapted to the dry, full sun conditions of the PMC farm, but it is slowly growing and becoming established. I look forward to watching what the plants to do in 2014.

Figure 3. A three year old big deervetch plant (*Lotus crassifolius*) finally flowers!

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. This year, we did not plant seed in every row (planted in 1ft by 2 ft spacing), in order to create more space between the plants and hopefully deter mice predation. Seeds germinated quickly and the seedlings grew very slowly until the soils warmed in the late spring. The plants were large and quickly Flowering began in June and continued all summer, more seed pods were formed this summer. At the end of the season, the plants were cut down and the fabric was swept. Seed production was higher than last year, but still low. Mice may have contributed to the low yields since some dropping were found on the weedfabric with the seed (mice traps were set in the plot, but none were caught).

A new field of *Lotus purshianus* was established for the Mt Hood district using their wild collected seed. The field was created using wider spacing (2 ft X 2 ft) to see if this method could increase yields

Table 2. Seed production results in 2013 for the US Forest Service.

Species	District	Field size	Harvest Date	Method	Yield
Lotus purshianus	***Willamette***	0.03 ac	5-Sep	vac	30 g
Penstemon cardwellii	***Willamette***	0.03 ac	July 12-Sept 11	hand	3 lbs
Lotus purshianus	***Mt Hood***	0.1	15-Sep	vac	4 lbs
Iris tenax	***Willamette***	0.03	June 12- July 10	hand	4.5 lbs
Alopecurus geniculatus	***Siuslaw***	0.05	July 10-15	hand	0.5 lb

Figure 4. One slough sedge (*Carex obnupta*) plant flowered this year in the seed increase tub.

Seed increase tubs of *Spariganium emersum* and *Carex obnupta* were established in the spring of 2012. The sedge are large and vegetative and sent up a few flowering stems. The burr reed remained vegetative in 2013, but still looks vigorous. This method is not reliably producing seed and should be discontinued.

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 seedlings emerged in spring and the field was pretty well filled in. The field was harvested by hand on three different occasions as seed matured. If the seed maturity was more uniform, mechanical methods such as seed stripper could be used on this species which would be much more efficient than hand harvesting.

Plugs of *Aristida longiseta, Hesperostipa comata, Festuca viridula,* and *Trifolium longipes* were grown in the summer of 2012 for establishing seed increase fields. 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 were overwintered in the PMC shadehouse and were transplanted into seed increase plots in early spring (except the clover, it did not survive the winter or it was an annual). Most of the grasses grew moderately in the summer of 2013. A few of the *H. comata* and *A. longiseta* plants sent up a flowering stalk. It was not enough to harvest, but it gave us some hope that the plants might be able to be productive here. 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.

V. Delivery of Plant Materials

There were no plant material deliveries made in 2013. Seed in storage at the Corvallis PMC is listed in Table 4.

Table 4. Seed in storage at the Corvallis PMC for the US Forest Service in 2013.

Species	Seed lot	Forest	Weight
Glyceria elata	SG1-11-FS618	Malheur	160 g
Glyceria elata	SG1-12-FS618	Malheur	3.5 lbs
Lotus purshianus	SG1-13-MT146	Mt Hood	4 lbs
Sparganium emersum	SWC-09-OF624	Olympic	15 g
Alopecurus geniculatus	SG1-13-FS193	Siuislaw	0.5lbs
Eriogonum heracloides	SWC-07-UM523	Umatilla	130 g
Eriogonum heracloides	SG1-09-UM523	Umatilla	194 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
Aristida longiseta	SWC-11-FS139	Wallowa-Whitman	140 g
Aristida longiseta	SWC-11-FS141	Wallowa-Whitman	90 g
Festuca viridula	SWC-11-FS140	Wallowa-Whitman	2 lbs
Hesperostipa comata	SWC-11-FS137	Wallowa-Whitman	250 g
Iris tenax	SG1-13-FS120	Willamette	4.5 lbs
Lotus purshianus	SG1-12-FS146	Willamette	52 g
Lotus purshianus	SG1-13-FS146	Willamette	30g
Pesntemon cardwellii	SG1-13-FS128	Willamette	3 lbs

Seed and Plant Production for Projects in Collaboration with the Institute for Applied Ecology: 2013 Annual Report

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Figure 1. Oregon iris (Iris tenax) seed increase field at the Corvallis PMC, May 6, 2013.

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. New species were added to this agreement in 2012 and 2013. 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. The PMC produced plants for other federal agencies in 2013 that were delivered to IAE since IAE was outplanting the plants. Production details of these plants are included in this report as well as the progress reports with the other agency. Activities in 2013 included plant production of eleven forbs 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 2013.

Table 1. Accessions in the Willamette Valley Seed Increase Project at the Corvallis Plant Materials Center in 2013.

Species	Common name	Accession #	Activity in 2013[1]
Allium amplectens	narrowleaf onion	9109133	Pxn, Dlv
Balsamorhiza deltoidea	deltoid balsamroot	9109134	Pxn, Dlv
Iris tenax	Oregon iris	9109191	Pxn, Dlv
Eriophyllum lanatum(GB)	Oregon sunshine	9109192	Pxn, Dlv
Calochortus tolmiei	Tolmie star-tulip	9109135	Pxn
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, Dlv
Sidalcea virgata	rose checkermallow	9079536	Sfp, Dlv
Symphyotrichum hallii	Hall's aster	9079540	Sfp, Dlv
Eriophyllum lanatum (MP)	Oregon sunshine	9109189	Pxn, Dlv
Penstemon cardwelli	Cardwell's penstemon	9109187	Pxn, Dlv
Castelija hispida	harsh paintbrush	9109188	Pxn, Dlv
Achilliea milnefolium	western yarrow	9109222	Pxn, Dlv
Viola adunca	early blue violet	9079406	Pxn, Dlv
Anaphalis margaritacea	pearly everlasting	9079451	Pxn, Dlv
Danthonia californica	California oatgrass	9079601	Sfp

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.

Table 2. Plant Production in 2013 for the Willamette Valley Seed Increase Project at the Corvallis Plant Materials Center.

Species	Amount	Treatment	Start date
Allium amplectens	10 racks	2 weeks warm + 90 day cold strat	1-Nov
Balsamorhiza deltoidea	10 racks	90 day cold strat	15-Nov
Calochortus tolmiei	10 racks	2 weeks warm + 90 day cold strat	1-Nov
Eriophyllum lanatum (GB)	11 racks	90 day cold strat	1-Mar
Eriophyllum lanatum (MP)	9 racks	90 day cold strat	1-Mar
Iris tenax	11 racks	2 weeks warm + 90 day cold strat	1-Dec
Penstemon cardwelli	9 racks	90 day cold strat	1-Mar
Castelija hispida	4 racks	over seeded into PECA	15-Apr
Achilliea milnefolium	6 racks	none	1-Jun
Viola adunca	120 racks	120 day cold strat	1-Mar
Anaphalis margaritacea	52 racks	none	1-Jun

Figure 2. Narrowleaf onions (*Allium amplectans*) flowered on their second growing season at the Corvallis PMC.

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. PMC staff determined that there may not be enough bulbs and tubers to meet the contract requirements. So another round of seed was sown, and this time it was allowed to stratify overwinter. Germination, again, was fair, but not great. Seedlings grew slowly over the spring and went dormant in the summer. Very few *B. deltoidea* seedings were produced.

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. The field was covered with flowers in 2013! The seed maturity was more uniform this year and it was decided to harvest the field with the modified swather. It can only cut and collect the heads that are standing. Many of the pods were heavy, and bent down to the ground, so after harvesting with the swather, we went back and harvested the remaining pods by hand. This was time consuming, but probably added 40 pounds of seed to the harvest! The piles of cut material were placed on many large tarps in the sun to

Figure 3. Three year old Oregon iris (*Iris tenax*) plants were covered in blooms in early May.

dry. It had to be turned daily to keep it from molding. When material was dry, it was fed through a combine. This field yielded an impressive 160lbs!

The *E. lanatum* field was looking less vigorous in 2012, but it bounced back in 2013. The field was harvested using the Winterstieger combine. Many of the seeds were small, but filled. It is much more difficult to clean the seed lot when it contains different sized seeds. It contains much more chaff. We used the indent cylinder to reduce chaff and remove small weed seeds.

Juncus tenuis plants are fully mature and had been maintaining a high level of seed production until 2013. It was a fairly dry spring compared to the last three years, which may have contributed to the lowered yields. The field was much shorter and has fewer flowers. 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 conveyor belt where it can be collected into large bags. After being harvested, material was laid on tarps inside an open greenhouse to dry. The material was then fed through the combine. This method may create more loss of seed than the other methods we’ve tried, but the loss is probably less than 5%.

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 better, but still not very impressive. The plants were fertilized twice during the spring which may have helped. It was easier to find filled seed on the plants this year. We also had heavy rain in early September, when the plants were in the process of producing seed, this boost of rain may have helped them.

Table 2. Seed harvest in 2013 at the Corvallis Plant Materials Center.

Species	Date	Method	Area	Yield
Danthonia californica	July 7	hand	0.004	2.3
Eriophyllum lanatum	25-Aug	Swath/combine	0.3	75
Iris tenax	July 6	Hand	0.28	160
Juncus tenuis	5-Jul	Moon rover	0.1	42
Plectritis congesta	June 10-July 3	hand/vac	0.1	4
Sidalcea virgata	2-Jul	direct combine	0.25	70
Symphyotrichum hallii	Sept 10-Oct 21	seed stripper	0.25	5

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. They were fertilized again in early March. The plants looked greener than in previous years, but flowering was still about normal. The field was directly combined and it was immediately apparent that the field was producing more seed. The barrels used to collect the seed were full and were too heavy to be lifted into the back of the truck. The field produced 70 lbs this year, its highest yield ever!

Figure 4. Rose checkermallow (*Sidalcea virgata*) is my favorite checkermallow.

This year, the *P. congesta* field was established by sprinkling seeds into the holes in weed fabric, then lightly covering them with compost. Some volunteers germinated in the fall and were much larger in the spring than the ones we had planted. The volunteers flowered earlier and were larger than the spring sown ones and flowered for a longer time period. The seeds were harvested using vacuums to collect them off the fabric. They were harvested weekly for three weeks in June.

Figure 5. The various age classes in the seablush (*Plectritis congesta*) field created a longer harvest window than normal.

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 2013. The seed was harvested by hand when ripe. Plugs that were produced in 2012 were transplanted into a field in the spring of 2013. The field was maintained through the summer, but it did not produce any seed.

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 2013 aster and *E. lanatum* seed was not available at planting time and remains in the PMC seed storage facilities.

Table 3 . Seed delivery amounts in 2013.

Species	Seed lot	Bulk lbs
Eriophyllum lanatum	SG1-12-NS583	36
Iris tenax	SG1-13-NS120	160
Juncus tenuis	SG1-13-NS535	42
Sidalcea virgata	SG1-13-NS536	4
Symphyotrichum hallii	SG1-12-NS540	20

Table 4. Plant delivery amounts and types for 2013.

Species	Size	Amount	Date
Allium amplectens	2-year bulbs	500	13-Nov
Balsamorhiza deltoidea	2 year tubers	8	13-Nov
Iris tenax	stubby cones	765	13-Nov
Eriophyllum lanatum (GB)	stubby cones	665	13-Nov
Eriophyllum lanatum (MP)	stubby cones	538	5-Nov
Penstemon cardwelli	stubby cones	172	5-Nov
Castelija hispida	stubby cones	3	5-Nov
Achilliea millefolium	stubby cones	943	5-Nov
Viola adunca	stubby cones	11,200	25-Oct
Anaphalis margaritacea	stubby cones	5292	25-Oct

Table 4. Seed in storage at the Corvallis Plant Materials Center, December 30, 2013.

Species	Seed lot	Yield (lbs)
Eriophyllum lanatum	SG1-13-NS583	75
Symphyotrichum hallii	SG1-13-NS540	5

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Figure 1. California oatgrass (*Danthonia californica*) seed increase field in bloom at the Corvallis Plant Materials Center.

Introduction

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 2013 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 was needed to meet goals for the needlegrass. This year's harvest of oatgrass will hopefully make up for the smaller amount of needlegrass, since the needlegrass field has not been producing as much as planned.

Accessions

Accessions included for the restoration of Marin Headlands are listed in Table 1. This table also displays activities performed by PMC staff in 2013.

Table 1. Accessions for the Marin Headlands restoration project with the Corvallis Plant Materials Center in 2013.

Species	Common name	Code	Accession	Activity in 2013[1]
Danthonia californica	California oatgrass	DACA3	9079621	Sfp , Dlv
Nassella lepida	foothill needlegrass	NALE2	9079622	Sfp

1-Sfp= seed field production, Dlv= delivery

Seed Increase Activities

The *Nassella* field appeared vigorous this 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 2013, but not as impressive as in 2011. All *Danthonia* fields on the PMC farm were not as vigorous or as tall as they were in 2011. This field seems to be maintaining fairly high yields as it approaches its 5th year. California oatgrass is a very long-lived species and fields can remain productive for over ten years. Even though the goals have been met for this project, it may be worthwhile to keep this field in production another year if there is any other planned disturbance in the park where this seed lot would be appropriate to use.

Table 2. Seed yields for the Marin Headlands project with the Corvallis Plant Materials Center in 2013.

Species	Harvest Date	Harvest Method	Field size (ac)	Yield
Nassella lepida	June 16	seed stripper	0.2	10 lbs
Danthonia californica	July 3, July 25	seed stripper, swath/combine	0.5	94 lbs

Delivery and Storage

In June of 2013, 100 lbs of oatgrass was shipped to the park. All remaining 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 2013.

Species	Seed lot	Amount
Nassella lepida	SG1-10-GG622	3 lbs
Nassella lepida	SG1-12-GG622	8.5 lbs
Nassella lepida	SG1-13-GG622	10 lbs
Danthonia californica	SG1-12-GG621	100 lbs
Danthonia california	SG1-13-GG621	94 lbs