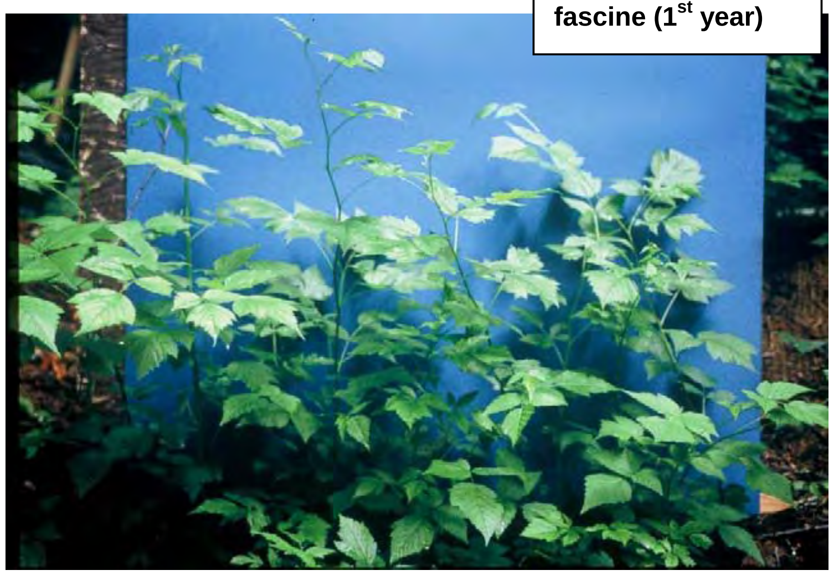
CORVALLIS PLANT MATERIALS CENTER

TECHNICAL REPORT: 2008

Skamania germplasm Sitka-alder

Oregon sunshine seed increase

Jackson-Frazier germplasm meadow barley



Salmonberry fascine (1st year)

USDA NATURAL RESOURCES CONSERVATION SERVICE
CORVALLIS, OREGON

CORVALLIS PLANT MATERIALS CENTER

ANNUAL TECHNICAL REPORT 2008

Dale Darris, Amy Bartow, Pete Gonzalves, and Joe Williams[1]

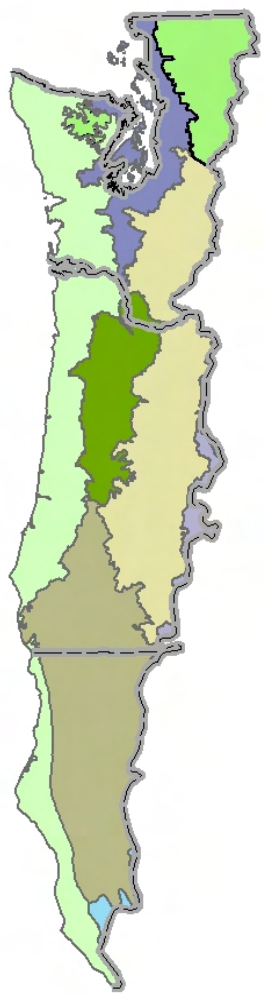
September 2008

USDA Natural Resources Conservation Service
Corvallis, Oregon

[1]Additional authors and cooperating agencies who contributed to this report are listed by specific paper.

Table of Contents

Introduction



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

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

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

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

Active Studies of the Corvallis Plant Materials Center

Study Number and Name: 14-alsi-si Seed Increase activities for Sitka alder

Study Objective: To evaluate seed increase potential for Sitka alder (9040484) and provide seed to producers upon release.

Study Number and Name: 24-daca Evaluation and increase of California oatgrass

Study Objective:
1. Evaluation, selection, increase and release of California oatgrass.
2. Production and maintenance of seed stocks (G1, G2, etc.).
3. Evaluation of germination and establishment technology.

Study Number and Name: 25-dece-si Evaluation, increase and release of tufted hairgrass

Study Objective: Evaluation, selection, increase and release of tufted hairgrass for wetland restoration and creation, streambank stabilization, and wildlife habitat improvement.

Study Number and Name: 26-elgl-si Blue wildrye

Study Objective: 1. Evaluation, selection and release of blue wildrye for woodland and critical area erosion control.
2. Maintain breeder and foundation seed as needed.

Study Number and Name: 46-hodi-pi Seed and plant increase of oceanspray

Study Objective: To evaluate seed increase and propagation methods (seed and vegetative) of oceanspray and provide propagules to producers in anticipation of the release of six ecotypes.

Study Number and Name: 49-topa-si Seed increase and evaluation of weak alkaligrass

Study Objective: To evaluate seed increase and production technology of weak alkaligrass.

Study Number and Name: 55-sbio-sc Evaluation of native shrubs for soil bioengineering along Schneider Creek

Study Objective: To evaluate and compare the ability of nine native riparian shrubs for their ability to establish and grow as live stakes and two types of fascines along a pastoral creek in western Washington state.

Study Number and Name: 5-hobr-si Evaluation and increase of meadow barley

Study Objective: 1. To collect, evaluate, propagate and release one or more sources of meadow barley.
2. To evaluate the effect of post harvest residue management (burning vs. no burning).

Study Number and Name: 61-caca-si To determine seed germination requirements and seed increase potential of pacific bluejoint

Study Objective: To evaluate seed germination requirements and seed increase potential of Pacific bluejoint, a potential competitor with reed canarygrass

Study Number and Name: 62-glel-si Evaluation of seed germination and increase potential of tall mannagrass.

Study Objective: To evaluate the seed stratification requirements and seed increase potential of tall mannagrass.

Study Number and Name: 67-shrb-cb Vegetative increase of select native shrubs for riparian and wetland restoration and erosion control

Study Objective: Establish and maintain cutting blocks of easy to root, select native shrubs (loin, syal, phca, rusp, etc.) for the Willamette Valley and Puget lowlands ecoregions.

Study Number and Name: 71-cv-cb Maintenance and harvest of woody cultivar cutting block

Study Objective: To establish and maintain cutting blocks of seven woody cultivar releases.

Study Number and Name: ORPMC-P-0604-WE Initial evaluation of *Lupinus polyphyllus*

Study Objective: Develop seed transfer guidelines as well as technology development and potential release of *Lupinus polyphyllus*.

Study Number and Name: ORPMC-P-0605-WE Initial evaluation of *Potentilla gracilis*

Study Objective: Develop seed transfer guidelines, seed increase technology and potentially/possibly a release.

Study Number and Name: ORPMC-P-0606-WE Initial evaluation of *Prunella vulgaris*

Study Objective: To develop seed transfer guidelines, seed increase technology and a release.

Study Number and Name: ORPMC-P-0607-WE Initial evaluation of *Saxifraga oregana*

Study Objective: To develop seed transfer guidelines, seed increase technology, and a release.

Study Number and Name: ORPMC-P-0608-WE Initial evaluation of *Wyethia angustifolia*

Study Objective: To develop seed transfer guidelines, seed increase technology, and a release.

Study Number and Name: ORPMC-P-0701-CP Regional comparative evaluation of tall wheatgrass for use in biofuel applications in western states

Study Objective: Comparative evaluation of tall wheatgrass for use in biofuel. Study with 9 other PMC's to test commercially available plant releases for potential applications in the western states.

Study Number and Name: ORPMC-P-0703-WE Initial evaluation of *Epilobium densiflorum*

Study Objective: To develop seed transfer guidelines and evaluate for potential releases.

Study Number and Name: ORPMC-P-0704-WE Initial evaluation of *Grindelia integrifolia*

Study Objective: Develop seed transfer guidelines and evaluate potential releases.

Study Number and Name: ORPMC-P-0705-WE Initial evaluation of *Lomatium nudicaule*

Study Objective: Develop seed transfer guidelines and evaluate for potential releases

Study Number and Name: ORPMC-P-0710-TE Plant production for critical habitat for the Oregon silverspot butterfly

Study Objective: Produce plants to be planted in a restoration site in the critical habitat of the Oregon Silverspot butterfly.

Study Number and Name: ORPMC-P-0711-CR Plant production for revegetation along roadsides in Lassen Volcanic National Park

Study Objective: Developing plant propagation and restoration technology for high elevation roadsides in Lassen Volcanic National Park.

Study Number and Name: ORPMC-P-0712-WE Initial evaluation of *Sidalcea campestris*

Study Objective: Develop seed transfer guidelines for Sidalcea campestris as research and technology development.

Study Number and Name: ORPMC-P-0713-WE Initial evaluation of *Eriophyllum lanatum*

Study Objective: Develop seed transfer guidelines and determine potential releases.

Study Number and Name: ORPMC-S-0103-WL Seed increase of Roemers fescue

Study Objective: 1. To increase and evaluate seed production potential of Roemer's fescue.

2. To evaluate post harvest residue management (burn vs. no burn) on seed production.
3. To increase seed of five composite populations for future release (from Roemers fescue common garden study).

Study Number and Name: ORPMC-S-0203-WE Seed increase and technology development of difficult wetland species for the Eugene District, BLM

Study Objective: To increase seed in small plots to evaluate agronomic potential of wetland species.

Study Number and Name: ORPMC-S-0307-CR Seed increase and evaluation of slender wheatgrass (wildrye)

Study Objective: To increase seed of slender wheatgrass and evaluate its use on upland prairies for restoration and critical areas for erosion control.

Study Number and Name: ORPMC-S-0308-WL Seed increase and evaluation of Lemmon's needlegrass

Study Objective: To increase seed of Lemmon's needlegrass and evaluate establishment requirements for upland prairie restoration and other revegetation purposes.

Study Number and Name: ORPMC-S-0401-MR Seed Increase and technology development for roadside revegetation in Mount Rainier National Park

Study Objective: To increase seed of three major grasses for roadside seeding in construction areas within Mount Rainier National Park.

Study Number and Name: ORPMC-S-0402-CR Evaluation and seed increase of Hall's bentgrass

Study Objective: 1. To evaluate seed increase methods and seed yield potential.
2. To increase seed for prairie restoration studies.

Study Number and Name: ORPMC-S-0403-CR Seed increase and technology development for Elwah River restoration

Study Objective: To produce plants and seed that will be used to stabilize slopes, control erosion, and exclude invasive weeds after dam removal on the Elwah River in Olympic National Park.

Study Number and Name: ORPMC-S-0404-WL Seed increase for fire rehabilitation in the Medford District BLM

Study Objective: Increase of grass and forb seed for restoration in the Medford Oregon District of the BLM.

Study Number and Name: ORPMC-S-0405-OT Seed increase and technology development for Hurricane Ridge, Olympic National Park

Study Objective: To increase seed for roadside seeding on Hurricane Ridge, Olympic National Park.

Study Number and Name: ORPMC-S-0602-WL Seed increase and technology development of native grasses and forbs for Roseburg BLM

Study Objective: Seed Increase and technology development of one legume and three species of grasses for wildlife habitat improvement in the Roseburg BLM District.

Study Number and Name: ORPMC-S-0603-TE Seed increase and technology development of violets and nectar sources for the Oregon silverspot butterfly

Study Objective: To increase seed and develop technology for creation and restoration of critical habitat for the endangered Oregon silverspot butterfly.

Study Number and Name: ORPMC-S-0706-TE Seed increase of two populations of Kincaid's Lupine

Study Objective: Develop seed increase technology for an endangered lupine.

Study Number and Name: ORPMC-S-0707-TE Seed increase of Willamette Valley Daisy

Study Objective: Develop seed increase technology for the endangered *Erigeron decumbens* var. *decumbens*.

Study Number and Name: ORPMC-S-0709-TE Seed Increase of *Sidalcea nelsoniana* for ODOT mitigation site

Study Objective: Plants were salvaged from a road constructions site and will be put in seed increase fields at the PMC. When mitigation site is ready plants and all seed produced will be planted on the site.

Study Number and Name: ORPMC-T-0001-WE Evaluation of seedbed amendments on production of great camas for seed and bulbs

Study Objective: 1. To determine the effect of slow release fertilizer, coir mulch and carbon banding with diuron herbicide on the establishment and growth of great camas (*Camassia leichtlini*) for seed increase and bulb production under farmed upland conditions.
2. To increase seed and bulbs of great camas for research and field plantings.

Study Number and Name: ORPMC-T-0105-OT Demonstration of native upland, woodland, wet prairie and marsh grasses and select introduced grasses and forbs

Study Objective: 1. To demonstrate the growth habit and flowering of native wetland, forest, and upland grasses in a garden planting.
2. To demonstrate growth of select introduced grasses and forbs.

Study Number and Name: ORPMC-T-0301-UR Evaluation of native upland grasses as low maintenance turf

Study Objective: To evaluate select native upland grasses for their ability to grow and function as low maintenance turf in the Willamette Valley Ecoregion.

Study Number and Name: ORPMC-T-0503-BU Evaluation of ten native wetland grasses in a grassed waterway (Linn County, Oregon)

Study Objective: To evaluate the establishment, growth, adaptation and sustainability of five to ten native wetland grasses in grassed waterways in western Oregon cropland.

Study Number and Name: ORPMC-T-0609-RI Effect of pre-soaking on root initiation in native willows, dogwood, snowberry, and black twinberry

Study Objective: 1. To evaluate the effect of 4 water temperatures on the rate of root initiation in six native willows, redosier dogwood, black twinberry, and common snowberry.
2. To repeat the experiment using two accessions of Scouler's willow and other standards of comparison and three temperature regimes.

Study Number and Name: ORPMC-T-0611-WE Evaluation of the adaptation of select native grasses and herbaceous species to variable inundation and soil moisture conditions

Study Objective: To evaluate the ability of ten native grasses, one forb and two sedges to survive under a gradient of soil moisture and flood inundation conditions.

Study Number and Name: ORPMC-T-0613-WL Evaluation of seed yield and production methods of native upland and wetland grasses

Study Objective: To evaluate the yield potential and seed increase methods for native upland and wetland grasses grown for seed.

Study Number and Name: ORPMC-T-061-RI Demonstration of using native willows, black cottonwood and redosier dogwood as live posts (western Oregon)

Study Objective: The purpose of this demonstration is to evaluate the establishment potential of live posts made from six willow species native to the Pacific Northwest, along with black cottonwood and redosier dogwood.

Study Number and Name: ORPMC-T-0701-CR Effect of small grain cover crop residues on establishment, growth, and biomass of two native grasses

Study Objective: To evaluate the effect of ten commonly used small grain species/varieties, including 'Regreen' sterile wheat x wheatgrass and 'Quickguard' sterile triticale, and their associated plant residues, on the subsequent establishment, appearance, and aboveground biomass of blue wildrye and pine bluegrass. The study consists of two experiments, one for each grass.

Study Number and Name: ORPMC-T-0702-CR The tolerance of carbon-seeded blue wildrye, Roemers fescue, riverbank lupine, meadow barley, and tufted hairgrass to preemergence applications of diuron

Study Objective: To evaluate the effect of four rates of diuron preemergence herbicide on the establishment, health, production and weed control in forbs and native grasses grown for seed. Study is cooperative with Oregon State University.

Study Number and Name: ORPMC-T-0708-TE Breeding system study on *Erigeron decumbens* var. *decumbens*

Study Objective: To study the breeding system of the endangered *Erigeron decumbens* var. d*ecumbens*. The results of this study will be used to determine viable population sizes in the recovery plan for the species.

Study Number and Name: ORPMC-T-0714-CR Evaluation of post-emergence herbicides for weed control in established stands of blue wildrye and tufted hairgrass grown for seed

Study Objective: To evaluate various post emergent herbicides on weed control in blue wildrye and tufted hairgrass grown for seed.

Study Number and Name: ORPMC-T-0801-WL Initial evaluation of pollinator hedgerow species planting

Study Objective: Hedgerow planting to evaluate potential native species for use as pollinator/beneficial insect habitat in croplands.

Study Number and Name: ORPMC-T-0802-RI The effect of timing (planting date), soil texture, and age of wood on the survival and growth of native coyote brush (*Baccharis pilularis*) and Indian plum (*Oemlaria cerasiformis*)

Study Objective: To determine ability of unrooted cuttings of coyote brush and Indian plum to survive and grow form current and two year old wood on two soils when planted at different times under a split plot, completely randomized experiment.

Study Number and Name: ORPMC-T-0803-RA Genecology of prairie junegrass (*Koeleria macrantha*)

Study Objective:
1. To explore genetic variation in putative adaptive traits in prairie junegrass from a wide range of source environments in the inland West.
2. To explore the relationships between genetic variation in putative adaptive traits and the climates of source environments.
3. To develop seed transfer guidelines and possible releases to ensure adapted populations for restoration.

Study Number and Name: ORPMC-T-O610-RI Effect of wood mulch, end sealing, and fertilizer on rooting success, growth, and survival of one evergreen and six broadleaf shrubs

Study Objective:
1. To determine the effect of wood mulch, wax sealing, and slow release fertilizer on seven native shrubs known to root well from hardwood cuttings.
2. To supplement the same experiment using salmonberry, Scouler's willow, and black cottonwood.

Propagating and Planting Tule (*Schoenoplectus acutus*) at Johnson Lake: Final Results of Cooperative Work with the Confederated Tribes of The Warm Springs Reservation of Oregon

Dale Darris

Introduction

Tule or hardstem bulrush [*Schoenoplectus acutus* (Muhl. ex Bieglow)] is an obligate, emergent, perennial wetland plant. It is ecologically important for wildlife food and cover, wastewater treatment, and the stabilization of marsh sediments and shorelines. For the Warm Springs, Paiute, and Wasco Tribes of the Confederated Tribes of the Warm Springs Reservation of Oregon, traditional uses include lodge and floor coverings, garments, and baskets as well as mats for dining, funerals, weddings, name giving ceremonies, and drying food. There is Tribal interest in restoring the species to wetland habitats where it has declined or disappeared.

The purpose of the work was to evaluate tule production practices and conduct several establishment experiments and demonstration plantings from 1997-2000 at Johnson Lake on the Reservation. Specifically, the objectives were to (1) document seed and vegetative propagation methods, (2) compare two populations in their ability to establish and spread from container stock, bareroot rhizomes, and transplants with intact native soil, and 3) make inferences regarding the possible effect of rhizome size, plant spacing, and planting season (summer vs.fall) on establishment of tule. Besides the Confederated Tribes of Warm Springs, cooperators included the Oregon State University (OSU) Cooperative Extension Service, and US Department of Interior, Bureau of Indian Affairs.

Methods and Materials

For the October 1997 experimental planting, rhizomes were first collected from two wild populations in May and July of 1997: Tule Lake (accession 357, photo 1) and the banks of Warm Springs River on the Reservation (accession 358). Container stock [C] was produced in a greenhouse by inserting 9-13 cm long rhizome pieces into 5 ½ in. (14 cm) square pots. For the same planting, rhizomes or bareroot material [R] were dug fresh in October and cut into 4-6 inch lengths. Vegetative shoots were trimmed to 24-30 in. (60-75 cm) lengths (Photos 2 and 3).

For the August 1998 experimental planting, container stock [C] was produced from seed that was collected on site from wild plants (photo 6), processed, and moist-cold stratified for 30 days in saturated peat moss at 3°C (photo 7). In the greenhouse, the 5 ½ in. square pots were fertilized and the water level maintained in tubs at the surface of the potting media (photo 8). Container stock was of transplant quality after 95 days (photo 9). Rhizomes [R] were collected, processed, and planted fresh in August the same way as the previous planting. In addition to C and R stock types, a third propagule type consisted of wild transplants [T] for accession 358 only. They were produced by excavating rhizomes with intact native soil that was roughly equivalent to the volume of the containers (photo 10). As with the rhizomes, a section of stem was left attached.

For both the October 1997 and August 1998 plantings, experimental design was a randomized complete block with three replications. The treatment factors were population (two) and propagule type. Two propagule types, C vs. R, were used in 1997, and three types, C, R and T, were used in 1998. Each plot consisted of four (1997) or nine (1998) plants. Furthermore, each experiment was conducted at two spacings, 2 ft. x 2 ft. and 3 ft. x 3 ft. (photo 11). Stock was planted into either saturated soil (photo 12) or shallow standing water (photo 13). Bareroot rhizomes were secured in place with a landscape fabric staple. During processing of rhizomes [R] for immediate planting and rhizomes for container [C] production, initial data was collected on caliper, length, the number of buds, and the number of stems for each segment (photos 3, 4 and 5). Performance data in 1998 and 1999 included plant vigor (1-10 with 10 as highest), radial spread (cm), flower abundance (1-10), shoot height (cm), and percent survival.

Data analysis consisted of two way ANOVA and mean separation using Fisher's Protected Least Significance difference (FPLSD) at the P=.05 level of significance. Only simple correlations were used for initial rhizome qualities. No additional data was collected beyond August 1999 because of livestock damage to the plot area that occurred when the exclusionary fencing was compromised.

Photo 1. Tule Lake. (T17S, R14E, Sec. 20, Wasco Co., OR., elev. 1350 ft.), Warm Springs Reservation. Appropriately named, this lake contains nearly 5 acres of tule reeds. It provided one of the two seed/rhizome sources for the study. Local tribe members periodically harvest small portions for tule mat making.


Photo 2. Clumps of tule were dug from Tule Lake in May-June 1997 for vegetative container propagation, as well as in October 1997 and August 1998 for obtaining bareroot rhizomes. Vigorous and weak or dying rhizomes were densely intertwined, making excavation and separation difficult. Similar material was obtained from a second tule population growing along the Warm Springs River. Loose sand made excavation simple. Population or source was considered an experimental factor. Pictured: Bodie Shaw.


Photo 3**.** Close up of mature, healthy rhizome**.** Note the scales and shoot bud. Calipers ranged from 9.2-23.6 mm (mean of 15.9) and segments were 2.4-9.3 cm (mean of 5.2) long. Each piece had 1-5 buds (mean of 2) and 1-5 shoots (mean of 2).

Photo 4. For each segment, rhizome length and caliper were recorded, as well as the number of mature shoots, stem buds (at base of shoot), and the presence or absence of a terminus. Most shoots grow from April-July, but a few may form in early fall. None of these variables proved to be a good predictor of performance. However, retention of shoots may be beneficial if transplanting occurs during active spring growth periods.

Photo 5. Fresh dug rhizomes [R] or bareroot materials were cut to 4-6 inch lengths. Shoots were trimmed to 24-30” lengths. If the basal 1in.(2.5 cm) or less of a shoot is pale or lacks chlorophyll, a shallow or static hydrologic condition exists. Longer lengths up to 12 in. (30 cm) are associated with fluctuating systems.

Photo 6. Tule panicles flower in July and the seed (achenes) mature in August. The seed heads can be run through a hammermill to separate seed from scales, chaff, and other floral parts. The seed is then cleaned with a simple air screen machine. Seed lots can average 300,000 seeds/lb.

Photo 7. Twenty-three day old seedling of tule. Seed germinates best with at least 30 days of cold-moist stratification. Wet peat moss at 34°F (3° C) worked well as a media to hold the seed in during chilling. Once removed from cold storage and placed in the greenhouse, seeds germinated in 8 days.

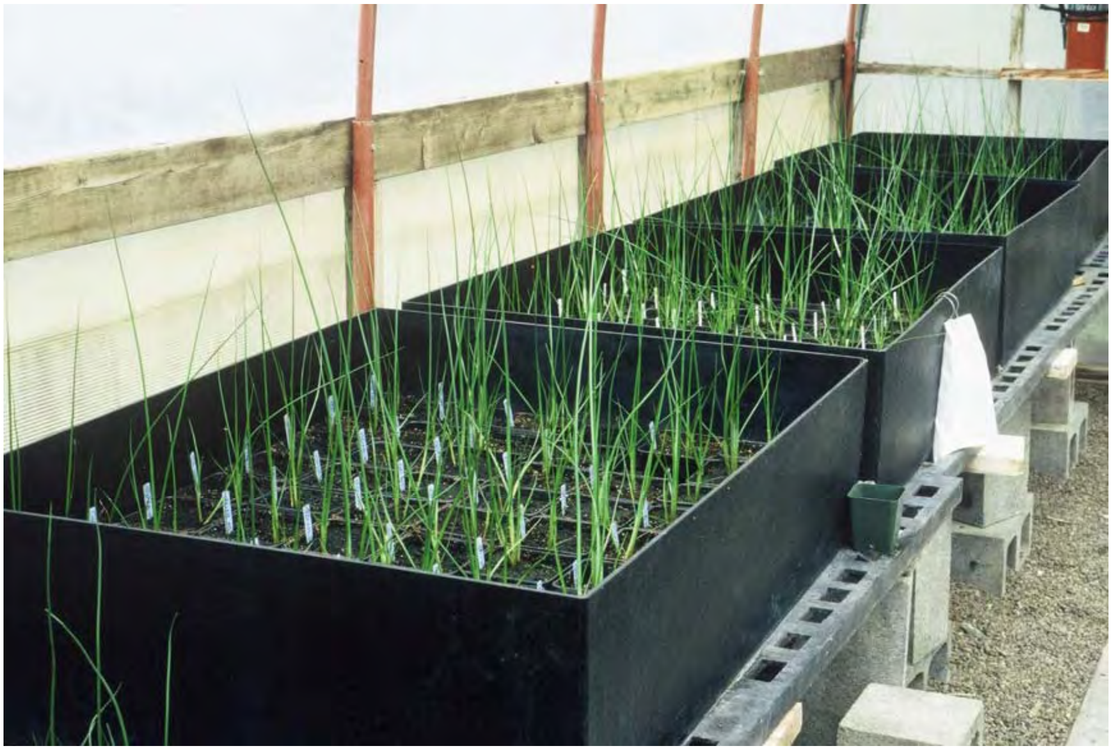


Photo 8. Fifty-five day old plants grown from seed in the greenhouse using 5½ in. (14 cm) square pots. Avoid the use of perlite in the media to reduce floatation. Water levels were maintained in the tubs at the surface of the media through germination, then eventually lowered to provide continuous subirrigation. Roots filled the containers and were transplant size after 95 days.

Photos 9 and 10. LEFT: Container [C] grown tule with a white rhizome terminal (tip) evident on the side. RIGHT: Wild transplant [T] with intact soil was the third propagule type. Undisturbed soil was roughly equivalent to the volume of the containers. Stems were left intact to aid in oxygen transport. Pictured: Leo Lucero.

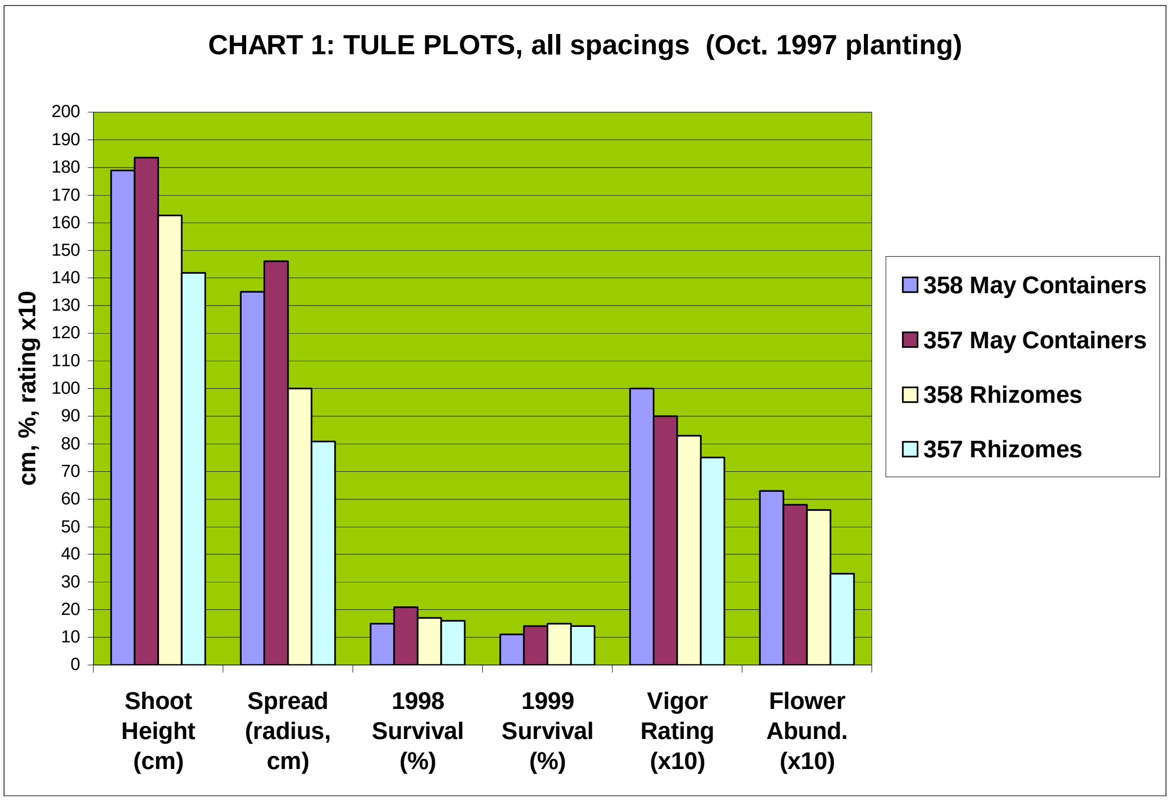
Photo 11. August 1998 experimental planting at Johnson Lake into 10 to 16 inches of standing water. Each plot consisted of nine plant squares equally aligned on 2 ft. (60 cm) [green flags] and 3 ft. (90 cm) [pink flags] spacings. Container stock was hand planted with a sharp shooter and rhizomes were pressed into a slit under water.

Photo 12.: October 1997 planting into saturated soil. Area was fenced for livestock and horse exclusion.

Results and Discussion

Container production from seed was more reliable than from rhizomes. Root-full containers (5 1/2 in. sq. pots) with transplant quality plants were reached in 70 days using rhizomes and 95 days using seed. Stock grew faster under saturated soil (media) conditions compared to freely draining conditions with constant moisture.

Chart 1 summarizes results after two growing seasons across all plots planted in October 1997. Not shown are data from container stock produced from July rhizomes which, unlike May stock, failed to establish. Plants growing from container stock [C] exceeded those from bareroot rhizomes [R] in shoot height, radial spread, vigor and flowering. Survival did not substantially differ between the two propagule types. Rhizomes of population 358 grew and flowered better than those of 357 but survival did not differ.



Charts 2 and 3 illustrate results after one growing season for the two August 1998 plantings. For the 2 ft x 2 ft spacing experiment (Chart 2), vigor, shoot number and spread of container stock [C] of both populations (357 and 358) were significantly higher (p=0.05) than plants from rhizomes [R]. Survival of rhizomes from population 358 was also significantly less. Performance of transplants with soil intact [T] was intermediate between the other two propagule types except for flower abundance where it ranked first among all propagule treatments. For the 3 ft x 3 ft experiment (Chart 3), results

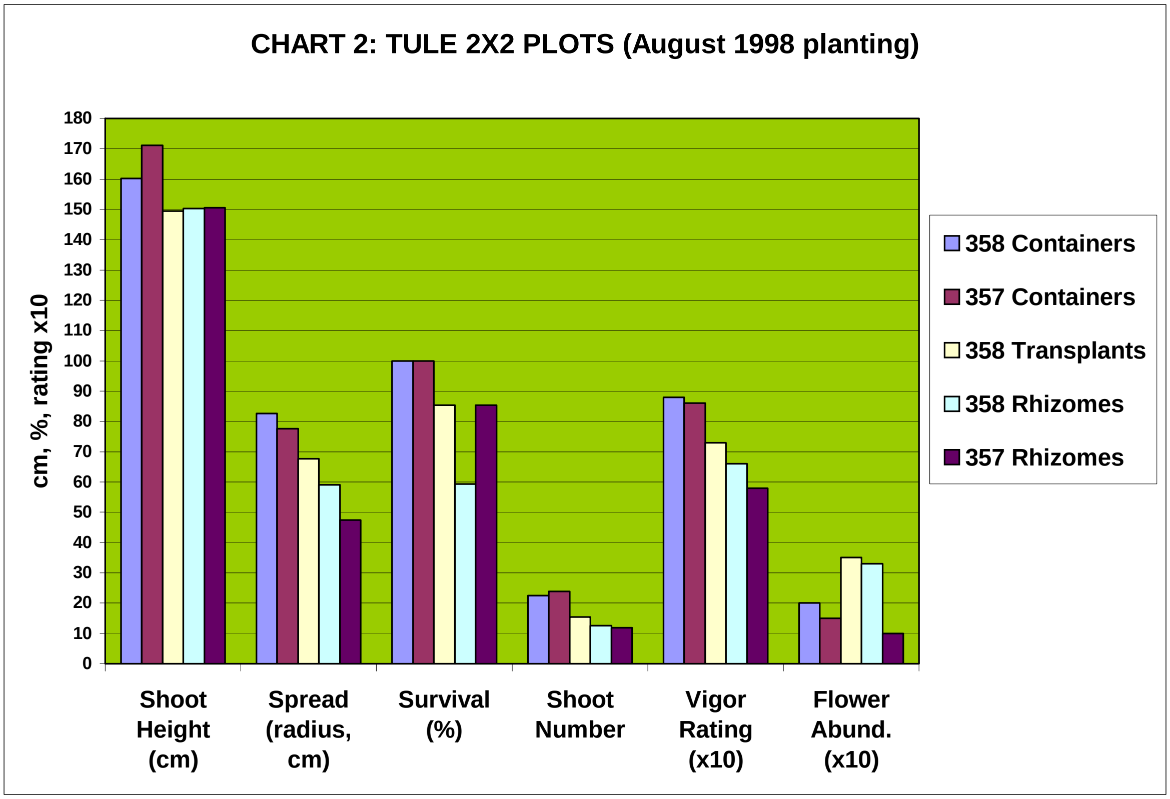


CHART 2: TULE 2X2 PLOTS (August 1998 planting)
cm, %, rating x10
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
Shoot Height (cm)
Spread (radius, cm)
Survival (%)
Shoot Number
Vigor Rating (x10)
Flower Abund. (x10)
358 Containers
357 Containers
358 Transplants
358 Rhizomes
357 Rhizomes

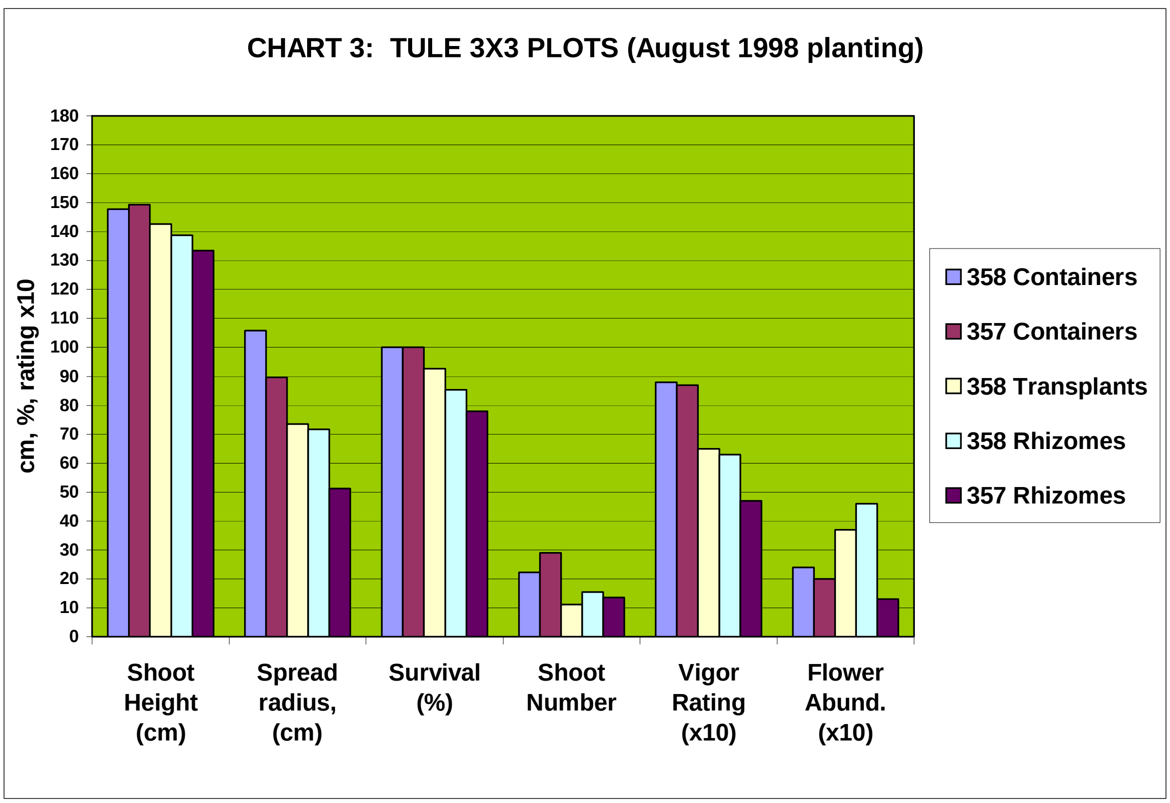


CHART 3: TULE 3X3 PLOTS (August 1998 planting)
cm, %, rating x10
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
Shoot Height (cm)
Spread radius, (cm)
Survival (%)
Shoot Number
Vigor Rating (x10)
Flower Abund. (x10)
358 Containers
357 Containers
358 Transplants
358 Rhizomes
357 Rhizomes

resembled the 2 ft x 2 ft plots for most variables recorded. Spread of population 358 container stock was significantly greater (p=.05) than rhizomes of populations 357 and 358, as well transplants of population 358. Vigor of both population 358 and population 357 container stock was significantly higher than that of all rhizomes and transplants. Survival of population 357 and population 358 containers was significantly higher than population 357 rhizomes. Highest shoot numbers were recorded for container stock for both populations. In contrast to other results where container stock performed better, flower abundance was highest with transplants and rhizomes of population 358. Appearance of surviving plots from the October 1997 planting in shown in photo 13.

Photo 13. Surviving plants and plots in 1999. Standing water at Johnson Lake dissipates in most years, but the surface soil remains saturated or moist through summer until the fall rains begin. A direct seeding experiment in October 1997 failed to establish any plants. Another demonstration compared rhizome survival with and without mature shoots along a gradient of water depth.

Conclusions and Lessons Learned

- Planting with one or more live shoots extending above the water level can be important, presumably for oxygen transport to the roots and rhizome. In one demonstration, rhizomes planted in October without shoots failed to survive, while those with intact shoots did better (11% survival) (data not shown).
- A suggested minimum rhizome length is 4 in. (10 cm). For the 1998 plantings, survival and performance corresponded weakly if at all with rhizome caliper and only slightly better with rhizome length (data not shown). It appears that rhizome caliper can be ignored.

- It is important to include at least one bud and one shoot per segment of rhizome. However, additional buds and shoots per rhizome were poor predictors of better performance.
- If water levels and soil moisture are favorable, summer planting can work as well or better than fall or dormant planting. Summer planting was far superior to fall planting (89% vs. 11% survival after 1 yr.), but expect results to vary widely.
- Population (genetic source) may make a difference. Material originating from along the Warm Springs River did nominally better than material from Tule Lake.
- If cost effective to produce, use healthy containerized stock instead of rhizomes or wild transplants with intact native soil for best results. However, site to site direct transplanting of bareroot rhizomes may still produce acceptable results.
- Propagation from seed (moist, chilled) appears to produce more predictable, more uniform, and higher quality stock compared to propagation from rhizome segments. However, it took about 15 days longer from seed versus rhizomes to produce root-full container plants of transplant quality.
- Planting material into water deeper than arms length or 18 in. (45 cm) is impractical. Research by others suggests survival and growth may decline at water depths greater than 12 in. (30 cm) during the establishment year.
- Based on the rapid rate of spread which averaged greater than 1.5 ft./yr (45 cm/yr) in a clay soil (photo 14), a spacing of 2 ft. X 2 ft. can potentially produce a nearly solid stand in one year, while a spacing of 3 ft. X 3 ft. can coalesce in two growing seasons.

Photo 14. Extensive radial spread from a single container plant after only two growing seasons in a clay soil. Rate of spread often exceeded 1.5 ft per year.

- The study area demonstrated the ability of certain native herbaceous marsh plants to rapidly return or recover within a year simply by installing sturdy fencing to exclude free ranging livestock and wild ungulates (photo 15).

Photo 15. Established tule from study. The installation of livestock exclusion fence allowed other native marsh plants to return naturally, including wapato, also known as arrowhead or duck potato (*Sagittaria latifolia*), and creeping spikerush (*Eleocharis palustris*) among others. Pictured: Leo Lucero.

ACKNOWLEDGEMENT: The author wishes to thank Leo Lucero and Bodie Shaw of the Confederated Tribes of Warm Springs, Zach Del Nero of the OSU Extension Service, Treg Owings of NRCS, and David Smith of the Bureau of Indian Affairs for their excellent cooperation and assistance which made this project possible.

Effect of Pre-soaking on Root Initiation in Native Willows, Black Cottonwood, Dogwood, Snowberry, and Black Twinberry

Pete Gonzalves and Dale Darris

Introduction

Research has shown that pre-soaking dormant hardwood cuttings in water may improve rooting and subsequent establishment of Pacific Northwest willows planted as unrooted live stakes for habitat restoration and stream bank protection projects. The pre-soaking of cuttings in a stream or pond can also provide convenient cool moist storage conditions for cuttings awaiting planting. However, if roots develop prior to planting, they may be damaged or destroyed during the installation process. The purpose of this work is to determine the effect of water temperature on the speed of callusing and rooting of dormant hardwood cuttings so that practitioners can anticipate root initiation and schedule planting activities before the cuttings become susceptible to root loss. Several additional native shrubs have also demonstrated their ability to root easily from hardwood cuttings. This study involves cuttings of 6 species of willow [Sitka, Pacific, Coast, Arroyo, River, and Scouler's (2 ecotypes)], black cottonwood, black twinberry, western redosier dogwood, and common snowberry.

Methods and Materials

Trials were conducted indoors during the winters of 2005/2006 and 2006/2007. All dormant plant material was collected from Corvallis Plant Materials Center except for Scouler's willow which was collected from natural stands in southern Benton County, Oregon. Whips of current-year growth were cut into 8-inch lengths, bundled into groups of six with rubber bands and placed into cold (3°C) storage until the experiments began.

Four replicates of bundled cuttings for each species (or selection) were placed upright in 4-inch deep water baths held at constant temperatures ranging from 4°C to 29°C or under diurnal temperature fluctuation.

Experimental design was completely randomized with 4 replications and 6 cuttings per replicate. Since each water bath regime is not replicated, the replication of this treatment may be considered pseudo-replication. The experiment was conducted in January-February (Phase 1) and December (Phase 2) of 2006.

<u>Factor A: Temperature of water bath</u>: Phase 1: Constant warm temperature (28ºC), constant room temperature (20ºC), fluctuating diurnal temperatures (16 hrs @ 10ºC, 8 hrs @ 5ºC), and constant cool temperature (3ºC). Phase 2: Constant warm temperature (29ºC), constant room temperature (20ºC), and constant cool temperature (14ºC).

<u>Factor B: Species</u>. Phase 1: A='Plumas' Sitka willow, B='Nehalem' Pacific willow, C='Clatsop' hooker willow, D='Rogue' arroyo willow, E='Multnomah' Columbia River willow, F='Placer' erect willow, G=black twinberry, H='Mason' western redosier

dogwood, and I=common snowberry. Phase 2: A=‘Plumas’ Sitka willow, B=’Nehalem’ Pacific willow, C=‘Clatsop’ hooker willow, D=‘Rogue’ arroyo willow, E=’Multnomah’ Columbia River willow, F=’Placer’ erect willow, G=Scouler’s willow- upland ecotype, H=black cottonwood, and I= Scouler’s willow- wetland ecotype.

All Phase 1 water baths with cuttings were covered and kept dark during the day and night. All water was replaced with fresh water twice every 7 days (day 3, 7, 11, 14, 18, 21, and 24). Cuttings were 8 or 9 inches long and made from 1 year old wood for consistency. Cuttings were immersed in 4.5 inches of purified water.

Phase 1: Root development was recorded after 1, 3, 7, 11, 18, and 28 days for each temperature regime treatment. Root number was estimated for each cutting on each date. The first presence of bumps along the stem may be a precursor to root formation but were not considered actual root development. Percent rooting and root length was also recorded each time. Length was determined by measuring the single longest root on each cutting. Caliper of each cutting and callus development was recorded. Phase 2: The number of cuttings per replicate with calluses and/or roots was recorded daily.

Results and Discussion

Phase 1: At 28ºC most willows rooted in fewer than 7-10 days while at 20ºC they rooted in less than 10-14 days. Hooker willow took 17 days at 20ºC. At both temperatures, callusing typically occurred 3-4 days before rooting. In the fluctuating 5-10ºC bath, root initiation took up to 45 days and Sitka, Columbia River and Piper willows still had not produced roots by the 59th day.

Redosier dogwood never rooted at any temperature, while snowberry and black twinberry took 31 and 38 days respectively at 20ºC. At 28ºC, cuttings of these species may have perished from disease or rotted before ever rooting. All species showed no activity at the coldest temperature for the duration of the study (59 days).

Phase 2: At a water temperature of 29°C callusing first appeared on day 6 (all selections except upland Scouler’s willow) followed by the first roots on cottonwood and arroyo, Columbia River, and especially erect willows on day 7. The first roots for Sitka, hooker, and Scouler’s (wetland) willows appeared on day 8 and Pacific willow showed roots on day 9. The upland selection of Scouler’s willow did not produce any roots until day 21.

When held at 20°C, the cuttings followed a similar pattern with first calluses appearing on day 7 and the first roots of most selections emerging on days 9 through 11. Pacific and Sitka willows produced roots on days 13 and 15 respectively. Upland Scouler’s produced its first roots at this temperature on day 25.

The first calluses occurred on day 12 for cuttings soaked in 13°C water and roots first appeared on erect willow on day 14. Hooker and wetland Scouler’s willows produced roots on day 17, arroyo willow and cottonwood on day 19, and Sitka and Pacific willows on day 23. Upland Scouler’s willow had yet to produce any roots by the end of the study on day 29. This experiment shows that pre-soaking of cottonwood and willow cuttings, if undertaken, should be done for no more than 14 days under ambient dormant season water temperatures. Western redosier dogwood, black twinberry and snowberry callus or root more slowly and may be pre-soaked for 3 weeks or more in cool water.

Table 1. Number of days to develop callusing and roots for dormant hardwood cuttings soaking in water baths at various temperatures. (Dash indicates no callusing or rooting by completion of experiment. X indicates the species/temperature combination was not tested)

Temperature (°C):		4	10/5	14	20	28-29
‘Plumas’ Sitka willow (*Salix sitchensis*)	First callus	-	38	18*	9	6
	First root	-	-	27*	15	9
	50% rooted	-	-	-	15	10
Piper willow (*Salix hookeriana,* formerly *Salix piperi*)	First callus	-	52	16	9	6
	First root	-	-	22*	14	10
	50% rooted	-	-	23	15	11
‘Clatsop’ hooker willow (*Salix hookeriana*)	First callus	-	38	16	8	6
	First root	-	59	19	13	8
	50% rooted	-	-	25	15	9
‘Rogue’ arroyo willow (*Salix lasiolepis*)	First callus	-	31	13	8	6
	First root	-	52	19	10	8
	50% rooted	-	-	23	13	10
‘Multnomah’ Columbia River willow (*Salix sessilifolia*)	First callus	-	56*	23	10	6
	First root	-	-	29	14	8
	50% rooted	-	-	-	17	10
‘Placer’ erect willow (*Salix ligulifolia*)	First callus	-	31	13	8	6
	First root	-	48*	16	10	7
	50% rooted	-	59	18*	10	7
Scouler’s willow [wetland] (*Salix scouleriana*)	First callus	x	x	12	8	6
	First root	x	x	19	12	9
	50% rooted	x	x	-	15	10
Scouler’s willow [upland] (*Salix scouleriana*)	First callus	x	x	-	14	9
	First root	x	x	-	-	-
	50% rooted	x	x	-	-	-
Black cottonwood (*Populus balsamifera* spp. *trichocarpa*)	First callus	x	x	13	7	6
	First root	x	x	19	10	7
	50% rooted	x	x	21	11	8
Redosier dogwood (*Cornus sericea* spp. *occidentalis*)	First callus	-	-	x	21	16*
	First root	-	-	X	-	-
	50% rooted	-	-	X	-	-
Black twinberry (*Lonicera involucrata*)	First callus	-	-	X	-	-
	First root	-	-	X	42*	-
	50% rooted	-	-	X	-	-
Snowberry (*Symphoricarpos alba*)	First callus	-	-	X	-	-
	First root	-	-	X	38	-
	50% rooted	-	-	x	45	-

* Number of days interpolated where data was not collected every day.

Literature

USDA. Natural Resources Conservation Service. Plant Materials Technical Note No. 23. 1993. How to plant willows and cottonwoods for riparian rehabilitation. Boise, ID.

USDA. Soil Conservation Service. Plant Materials Technical Note No. 1. 1989. Propagation of willows and poplars. Portland, OR.

USDA. Soil Conservation Service. Plant Materials Technical Note No. 10. 2005. Riparian revegetation - plants. Spokane, WA.

R. M. Krinard and W. K. Randall. 1979. Soaking aids survival of long, unrooted cottonwood cuttings. USDA Forest Service Tree Planters' Notes. Southern Forest Experiment Station. Asheville, NC

Phipps, H. M., E. A. Hansen and A. S. Fege. Preplant soaking of dormant Populus hardwood cuttings. USDA Forest Service North Central Forest Experiment Station. Res. Pap. NC-241. St. Paul, MN.

Demonstration of Using Native Willows, Black Cottonwood and Redosier Dogwood as Live Posts (western Oregon)

Pete Gonzalves and Dale Darris

Introduction

There is lack of information on the performance of certain native willows as live posts for soil bioengineering and other streambank and shoreline erosion control plantings. Numerous willow species make excellent live posts when planted during the dormant season, but not all species have been well tested for this purpose. Besides species, age of the trunk or branch may be a factor in performance as well, with some reports suggesting rooting capacity diminishes once the outer bark begins to develop furrows. Black cottonwood, and to a lesser degree redosier dogwood, have been used on a limited basis for dormant live post plantings also. The purpose of this demonstration is to evaluate the establishment potential of live posts made from 5 willow species native to the Pacific Northwest, along with black cottonwood and redosier dogwood.

Methods and Materials

The species/cultivars tested are:
'Placer' erect willow
(*Salix ligulifolia*)
'Rogue' arroyo willow
(*Salix lasiolepis*)
Black cottonwood
'Multnomah' Columbia River willow
(*Salix sessilifolia*)
'Plumas' Sitka willow
(*Salix sitchensis*)
'Clatsop' hooker willow
(*Salix hookeriana*)

(*Populus balsamifera* ssp. *trichocarpa*)	‘Mason’ western redosier dogwood (*Cornus sericea* var. *occidentalis*)

Three to five 3-foot posts of each species were harvested from older trees growing at the Corvallis PMC. Sections of limbs and trunks (boles) were selected without forks or furrowed bark and with a minimum of side branching. The basal ends were cut to a point for easier insertion. Material was harvested and prepared in December 2005, held in cold storage, and then planted in early February 2006 into field number 7-5 at the PMC. The soil type is a moderately well drained Woodburn silt loam.

Posts were inserted vertically into the ground by hand then gently hammered to a depth of 2 feet. Approximately 1 ft of each post remained above ground. The design consists of 7 single species, non-replicated plots with 3 to 5 posts per plot. There was no pre-soaking, hormone, or other pre-treatment of the dormant live posts prior to or after planting. No fertilizer or other amendments were applied.

Caliper at soil level and the age of each post were recorded at planting time. Final data collected in early September 2007 included survival, average number of live shoots per post, maximum plant width, maximum plant height, and overall vigor (scale of 1-10 with 10 as most).

Results and Discussion

All willow species and black cottonwood posts survived and showed adequate vigor through nineteen months after planting as unrooted dormant live posts. Four of six western redosier dogwood posts survived and these also showed adequate vigor. There was no apparent correlation between either age or caliper of wood and survival, vigor, or growth.

This study indicates that the willow cultivars tested are suitable candidates for soil bioengineering and other streambank and shoreline erosion control plantings when installed as live posts. “Mason” redosier dogwood may also be suitable for such applications. Further study will be necessary to determine maximum and optimal age and caliper of planting stock when using unrooted live posts of these species.

Table 1. Nineteen-month survival and growth of native willows, black cottonwood and western redosier dogwood planted in 2006 as unrooted dormant live posts at Corvallis Plant Materials Center, Corvallis, Oregon.

Species:	Age (years)	Starting Avg. Caliper (cm.)	Survival (%)	Number of Shoots per Post (avg.)	Width (cm.)	Height (cm.)	Vigor (scale 1-10)
'Placer' erect willow	4,7,8	5.8	100	13.33	250	200	10
'Multnomah' Columbia River willow	4,4,4,5	2.9	100	5.25	90	133	7
'Plumas' Sitka willow	6,6,7,8	4.9	100	5.25	125	163	8
'Rogue' arroyo willow	7,7,8,8, 11	6.5	100	14.40	220	165	7
'Clatsop' hooker willow	5,6,6,7, 7	4.9 *	100	11.00	245	126	7
Black cottonwood (wild)	6,6,7,8, 9	5.9	100	7.40	145	195	8
'Mason' western redosier dogwood	7,8,9, 11,12	4.6	67	7.75	72	88	7

*Estimated from average caliper of posts surviving in September 2007.

Literature

Flessner, T. 2000. Stabilization of dredge spoils along the Columbia River using pole/whip plantings of willow. USDA Natural Resources Conservation Service, Corvallis Plant Materials Center Annual Technical Report: 2000, Corvallis, OR. P. 9.

Eubanks, C. E. and D. Meadows. 2002. A Soil Bioengineering Guide for Streambank and Lakeshore Stabilization. USDA Forest Technology and Development Program. San Dimas, CA. 187 pp.

Native Shrubs as a Supplement to the Use of Willows as Live Stakes and Fascines in Western Oregon and Western Washington

Dale Darris

Summary

In the Pacific Northwest USA, native willows (*Salix* spp.) are the primary species used for soil bioengineering and related streambank protection measures, including live stakes and fascines. Field trials have also demonstrated satisfactory application of western redosier dogwood (*Cornus sericea* var. *occidentalis*) and Douglas spirea (*Spiraea douglasii*). However, other native shrubs that root readily from dormant hardwood cuttings have not been well evaluated. The purpose of this work was to test additional species for their ability to root from older wood and perform as live stakes and fascines.

Greenhouse experiments indicated that common snowberry (*Symphoricarpos albus*), Pacific ninebark (*Physocarpus capitatus*), and black twinberry (*Lonicera involucrata*) can root as well or better from three year versus one (current year) or two year old wood. Results from previous greenhouse studies have corresponded well with outdoor trials under moist, weed free, well drained conditions (2). Based on this information, these species have potential as live stakes. In contrast, salmonberry (*Rubus spectabilis*) rooted well from first year wood but more poorly from older stems. It appears to have less potential. Secondary results indicated no apparent benefit from Wood's rooting compound (IBA+NAA) and detrimental effects from bottom heat (75°F) for all four species.

In addition to greenhouse trials, these and eight other native shrubs and trees were evaluated at four streambank sites, two in western Oregon and two in western Washington. To date, common snowberry, salmonberry, Pacific ninebark, and black twinberry are performing successfully as live stakes and/or fascines at one or more of these locations. It appears all four could be used as supplemental species for soil bioengineering, and may have special application to sites less suitable for willows (i.e. salmonberry in moist shaded environments or common snowberry in summer dry environments). Ecotype (genetics), site factors, quality of stock, installation technique, and handling can substantially affect results. While unlikely to outperform native willows, these species provide options for improving habitat diversity in restoration and revegetation projects that are designed to incorporate unrooted, dormant materials. Observations at the four test sites indicate that deer browse, summer moisture, and competition from other vegetation, alone or in combination, are probably the three most limiting factors for successful establishment. For any planting or soil bioengineering installation with these species, deer exclusion or repellents should be considered. Likewise, summer irrigation and weed suppression the first two to four years may be advisable.

Several other species, including red flowering current (*Ribes sanguineum*), Indian plum (*Oemlaria cerasiformis*), red elderberry (*Sambucus racemosa*), and mock orange (*Philadelphus lewisii*) have been evaluated to a lesser extent and all but flowering currant merit further investigation. Fascines of mock orange performed the best along with those of salmonberry on a dry, sandy streambank where other species, including western redosier dogwood, failed completely. Red elderberry also failed at the one site where it was planted as live stakes and fascines, but the unrooted, harvested material had initiated bud break. It should be re-examined using earlier planting dates, as should Indian plum. Even the most promising native species need additional testing at different times of the year and under a variety of soil, moisture, hydrologic, and competitive plant conditions.

Introduction

It is widely known that most native, riparian willows (*Salix* spp.) in the Pacific Northwest USA root easily from dormant hardwood stock, including older wood, allowing for their successful use in soil bioengineering practices such as live stakes, fascines, or brush mattresses. While willows are the mainstays of these stream and shoreline protection measures, native shrubs that root easily (from hardwood cuttings) may provide restoration alternatives, improve habitat diversity, and perform as well or better in shade or other conditions less suitable for willows.

True "live" stakes require that a species root easily from branches three years of age or older. The stem must be old and sturdy enough to withstand being tapped or "pounded" into the ground. In contrast, fascines work well even if most root development is confined to current year or juvenile wood. Results from previous greenhouse experiments have corresponded well with those from outdoor rooting trials indicating that black twinberry (*Lonicera involucrata*), Pacific ninebark (*Physocarpus capitatus*), common snowberry (*Symphoricarpos albus*), and salmonberry (*Rubus spectabilis*) are among those native Northwest shrubs with the highest potential for use in soil bioengineering (2). Willows, western redosier dogwood (*Cornus sericea* var. *occidentalis*), black cottonwood (*Populus balsamifera* var. *trichocarpa*) (5), and Douglas spirea (*Spiraea douglasii*) (3) have already proven to be fair to good candidates. While other potential species are found on national and regional lists (1,4,6,7) their actual performance is not always well tested or documented. The purpose of this work was to conduct studies and demonstrations that evaluate the ability of select western Oregon and western Washington native shrubs to root from older wood and perform as live stakes and fascines under actual streambank conditions.

Figure 1 illustrates the soil bioengineering practice of "live" fascines, the method used in the evaluations. In this example, two rows of fascines (wattles or bundles 6-8 inches in diameter) are buried in shallow trenches parallel to the stream. Only the top layer of branches in the bundle remains partially exposed. Soil should also be worked into any gaps between the limbs. The fascines are anchored in the center by dead stout stakes

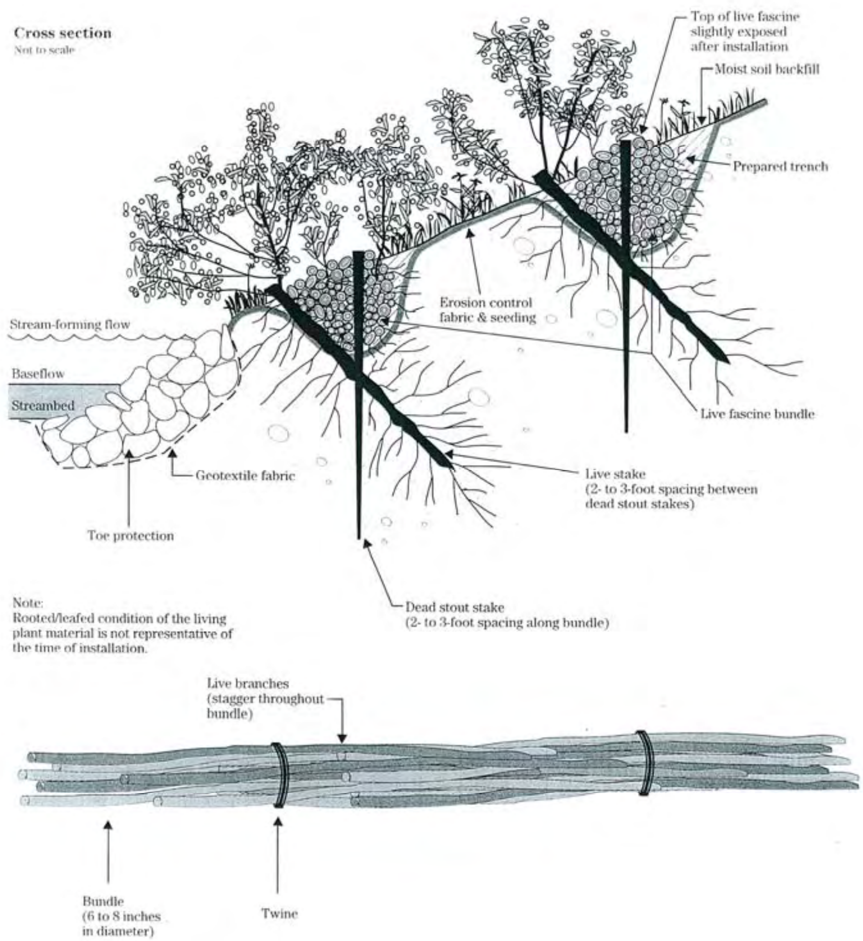


Figure 1. (from NRCS Engineering Field Handbook).

and on the down slope side by dormant live stakes. The unrooted fascines help to hold the soil on the face of the slope and create mini "terraces" that reduce slope length. Root development soon reinforces the structure. Fascines can also be placed perpendicular to the stream in order to increase channel roughness, or are used in combination with other practices such as brush mattresses (1,4,6,7). Live stakes are simply 2 ½ to 3 feet segments of older wood installed perpendicular to the soil surface. Three fourths to $4/5^{th}$ of their length should be placed below the surface, while one or more nodes must remain above ground. Live stakes are also used alone to secure erosion mats or installed with other soil bioengineering and erosion control practices. Finally, they may offer a low cost alternative to container or bareroot nursery stock in some situations.

PART I: ROOTING TRIALS

Methods and Materials

As a follow up to earlier studies, rooting experiments were conducted in a greenhouse mist bench in 2001 to test the ability of common snowberry, Pacific ninebark, black twinberry, and salmonberry to root from hardwood cuttings comprised of one (i.e. current year), two, and three year (plus) old wood (Factor C). Secondary objectives were to determine the effect of Wood's Rooting Compound (WRC: 1.03% IBA and 0.66% NAA diluted 5:1 with water)(Factor B) and bottom heat (75°F)(Factor A) on adventitious rooting. The minimum greenhouse temperature was 65°F and the day length was 16 hours. Rooting media consisted of one part peat moss to four parts perlite. Experimental design was a randomized complete block with four replications and five, 8 inch cuttings per replication. Analysis of variance (ANOVA) was conducted and Fisher's Protected Least Significant Difference test (FPLSD) was used to separate means at the P=0.05 level. Note that WRC, a mixture of two plant growth regulators (PGRs), is interchangeably referred to as "hormones" in this text.

Results and Discussion

Results for the rooting experiments appear in Table 1. For common snowberry, as with all species tested, significant differences depended on the variable measured. However, cuttings from three-year-old wood generally rooted and grew as well or better than those from one-year (current year) and two-year-old wood. Three-year-old wood without hormones and no bottom heat achieved the highest overall ranking. There were no significant factor interactions. Bottom heat (75°F) was detrimental to root formation and growth across all ages. WRC significantly improved shoot length and plant vigor for cuttings from one-year-old (current year) wood, but not for cuttings from two and three-year-old wood. Rooting was primarily nodal, but substantial amounts also formed at the basal ends and minor amounts at the internodes, regardless of age.

For Pacific ninebark, cuttings from two and three-year-old stems rooted and grew better than those from one-year-old (current year) shoots. Bottom heat appeared to diminish root development and WRC did not significantly change rooting for either one or two-year-old cuttings, regardless of the variable measured. Significant BxC factor interactions for some variables may be attributed in part to the poor rooting of three-year-old wood with bottom heat in combination with WRC. The top overall ranking was achieved by three-year-old wood without hormones or bottom heat. Rooting occurred most regularly at the nodes, but rooting also took place randomly along the internodes, regardless of age.

In contrast to the other three species under identical conditions, black twinberry appeared to produce a greater abundance of roots. Performance was consistently good regardless of age of wood (cutting) or treatment. Bottom heat decreased basal rooting, but the overall affect was minor. This species rooted primarily along the internodes with some basal rooting. As with overall performance, internodal rooting did not diminish with age.

Table 1. Effect of bottom heat, rooting compound, and age of wood on rooting ability of common snowberry (SYALL), Pacific ninebark (PHCA11) black twinberry (LOIN5), and salmonberry (RUSP) from hardwood cuttings (in a greenhouse mist bench).

Species	**Bottom Heat (A)**	**Rooting Hormone(B)**	**Age of Wood(C)**	**Caliper(mm) Minimum**	**Percent Rooted**	**No. of Shoots**	**Shoot Length (cm)**	**Root Abundance**	**Root Length (cm)**	**Plant Vigor**	**Location of Roots**	**Overall Ranking**
SYALL	No	No	1	3.6	75abcd	2.6	24.1bc	5.5bc	17.7	6.1bc	**N**,B,i	6th
	No	No	2	4.0	85ab	2.6	33.7ab	7.1ab	20.0	7.6ab	**N**,B,i	2nd
S	**No**	**No**	**3**	**5.6**	**90ab**	**3.1**	**35.7a**	**7.7a**	**22.1**	**8.3a**	**N,**b,i	**1st**
N	No	Yes	1	4.2	85ab	2.6	29.8abc	5.4bc	17.1	6.6abc	**N**,B,i	5th
O	No	Yes	2	4.6	100a	2.6	30.1abc	6.2abc	17.6	7.2ab	**N**,B,i	3rd
W	No	Yes	3	5.9	85ab	2.3	30.7abc	6.0abc	16.2	6.8abc	**N**,B,i	4th
B	Yes	No	1	4.8	50d	2.4	21.5c	4.6c	13.5	5.4c	**N,b**,i	
E	Yes	No	2	4.6	70bcd	2.3	26.7abc	4.9c	16.0	5.8bc	**N**,B,i	
R	Yes	No	3	5.1	53cd	2.5	23.5bc	4.7c	17.2	6.0bc	**N**,i	
R	Yes	Yes	1	3.9	80abc	2.5	23.0c	4.7c	15.7	5.4c	**N,b**,i	
Y	Yes	Yes	2	5.1	50d	3.2	26.5abc	5.0c	18.1	6.2bc	**N**,b,i	
	Yes	Yes	3	5.4	65bcd	2.9	24.5bc	5.0c	15.7	6.0bc	**N**,b,i	
Mean					74	2.6	27.5	5.6	17.2	6.4		
LSD					30	NS	10.4	2.1	NS	1.8		
Significant Factor (ABC) Interactions:					none	None	none	none	none	none		
PHCA11	No	No	1	6.0	60abc	1.3cde	16.4bc	5.6	16.8	6.0abc	**N**,I	6th
	No	No	2	5.2	90ab	3.1ab	20.6abc	6.3	17.2	6.9abc	**N,**I	2nd(tie)
	No	**No**	**3**	**6.9**	**89ab**	**3.9a**	**34.4a**	**7.4**	**19.8**	**8.9a**	**N,**i	**1st**
N	No	Yes	1	5.1	50cde	1.5cde	21.5abc	5.3	16.8	5.9abc	**N**,i	
I	No	Yes	2	5.8	85ab	2.0cd	31.1ab	6.8	18.6	7.5ab	**N**,I	4th
N	No	Yes	3	5.1	90ab	1.8cd	28.3ab	6.0	14.3	6.4abc	**N**,I	2nd(tie)
E	Yes	No	1	5.6	25de	1.1de	14.5bc	3.9	7.0	4.0cd	**N**,i	
B	Yes	No	2	5.2	25de	2.0cd	18.4abc	5.8	18.6	6.5abc	**N,**I	
A	Yes	No	3	4.7	55dcd	2.3bc	25.1ab	7.1	19.0	6.8abc	**N,**I	5th
R	Yes	Yes	1	7.3	25de	1.6cde	17.8abc	4.9	11.0	4.8bcd	**N**,i	
K	Yes	Yes	2	6.3	20e	2.0cd	26.6ab	6.0	21.5	6.2abc	**N**,i	
	Yes	Yes	3	5.5	30cde	0.8e	6.5c	2.8	9.1	2.7d	**N**,I	
Mean					54	1.9	21.8	5.6	15.8	6.0		
LSD					35	1.1	16.7	NS	NS	3.1		
Significant Factor (ABC) Interactions:					None	BxC	BxC	none	none	BxC		

Rooting Hormone = Experimental Factor B, Wood's Rooting Compound (WRC) at 5:1 dilution. **Minimum caliper** is the minimum caliper which rooted.

Root Abundance and **Plant Vigor** based on scale of 10=best, 1=poorest. Means with the same letter are not significantly different at P=.05. **LSD**=Least Significant Difference.

Root Location refers to location of roots on the cutting: B(b) =basal. N(n) = nodal. I(i) = internodal. Bold, upper case letters indicate predominant position of roots.

Upper case letters (not in bold) indicate 2nd most common root position. Lower case letters indicate minor location of roots. **NS** = not signficant.

Overall ranking indicates summary of ability to root based on all parameters (dependent variables) measured. Top 6 of 12 treatments.

Table 1. Continued.

Species	Bottom Heat (A)	Rooting Hormone(B)	Age of Wood(C)	Caliper(mm) Minimum	Percent Rooted	No. of Shoots	Shoot Length (cm)	Root Abundance	Root Length (cm)	Plant Vigor	Location of Roots	Overall Ranking
LOIN5	No	No	1	4.3	100a	2.2abc	16.7cd	6.8bcd	21.5bc	6.9bcd	**I**,B	
	No	No	2	4.7	95a	2.0bcde	23.1abcd	7.1bcd	22.6abc	7.2abcd	**I**,b	3rd
T	No	No	3	6.8	85ab	2.4a	29.0ab	8.1ab	27.9abc	8.0ab	**I**,b	2nd
W	No	Yes	1	4.7	100a	2.1abcd	14.8d	6.4cd	24.3abc	6.4cd	**I**,B	6th
I	No	Yes	2	4.7	95a	1.8cde	23.7abcd	7.0bcd	24.1abc	7.1bcd	**I**,b	5th
N	**No**	**Yes**	**3**	**6.6**	**90a**	**2.3ab**	**31.4a**	**8.6a**	**30.5a**	**8.6a**	**I,**b,n	**1st**
B	Yes	No	1	4.7	60cd	1.8cde	19.1bcd	5.9d	21.1c	6.3cd	**I**,B	
E	Yes	No	2	5.3	65bcd	1.6e	24.6abcd	6.7cd	26.1abc	6.9bcd	**I**	
R	Yes	No	3	6.5	50d	1.8cde	17.0cd	7.0bcd	29.3ab	6.1cd	**I**	
R	Yes	Yes	1	4.6	80abc	1.7de	14.3d	6.4cd	24.4abc	5.8d	**I**,b,n	
Y	Yes	Yes	2	5.0	80abc	1.9bcde	22.0abcd	6.4cd	27.3abc	6.8bcd	**I**,n	
	Yes	Yes	3	5.9	80abc	1.8cde	26.7abc	7.5abc	27.9abc	7.6abc	**I**,b,n	4th
Mean					82	1.9	21.8	7.0	25.6	7.0		
LSD					24	0.4	11.2	1.4	8.0	1.4		
Significant Factor (ABC) Interactions:					AxB	None	none	none	none	none		
RUSP	**No**	**No**	**1**	**6.7**	**75a**	**1.8**	**21.5a**	**6.2a**	**19.6a**	**6.7a**	**I,N**,b	**1st**
S	No	No	2	8.6	70a	1.4	13.0ab	4.4a	11.9a	4.9ab	**N,**i,b	2nd(tie)
A	No	No	3	12.4	40bc	1.4	14.6ab	6.1a	19.6a	4.9ab	**N**,i,b	4th
L	No	Yes	1	7.2	60ab	1.2	12.0b	5.3a	13.4a	5.5ab	I,N,B	2nd(tie)
M	No	Yes	2	10.0	10ef	1.3	8.6bc	4.3a	10.8ab	4.1abc	**N**,i,b	
O	No	Yes	3	11.1	25cde	1.7	7.6bc	3.8ab	16.6a	3.3bc	**N**,i	6th(tie)
N	Yes	No	1	7.0	33cd	1.3	12.6b	6.3a	17.5a	4.9ab	**I,**B**,**n	5th
B	Yes	No	2	8.8	15def	0.9	8.2bc	3.6ab	11.6a	4.2abc	**N**,i	
E	Yes	No	3	15.0	15def	1.8	14.9ab	4.5a	13.8a	6.4a	**N**	
R	Yes	Yes	1	7.3	20cdef	1.1	12.1b	4.5a	12.6a	5.1ab	**I**,N	6th(tie)
R	Yes	Yes	2	<>	0f	0.8	3.0c	1.0b	0b	1.3c	<>	
Y	Yes	Yes	3	<>	0f	0.8	2.5c	1.0b	0b	1.3c	<>	
Mean					30	1.3	10.9	4.2	12.3	4.4		
LSD					21	NS	8.9	3.1	11.2	3.1		
Significant Factor (ABC) Interactions:					none	None	none	none	none	none		

Rooting Hormone = Experimental Factor B, Wood's Rooting Compound (WRC) at 5:1 dilution. **Minimum caliper** is the minimum caliper which rooted.

Root Abundance and **Plant Vigor** based on scale of 10=best, 1=poorest. Means with the same letter are not significantly different at P=.05. **LSD**=Least Significant Difference.

Root Location refers to location of roots on the cutting: B(b) =basal. N(n) = nodal. I(i) = internodal. Bold, upper case letters indicate predominant position of roots.

Upper case letters (not in bold) indicate 2nd most common root position. Lower case letters indicate minor location of roots. **NS** = not significant.

Overall ranking indicates summary of ability to root based on all parameters (dependent variables) measured. Top 6 of 12 treatments.

Highest overall ranking was for three-year-old cuttings with hormones and without heat, but the results were not significantly higher than those without both hormones and heat.

Salmonberry rooted more poorly that the other three species, but achieved the most satisfactory results from cuttings of one-year-old (current year) wood, without hormones and without heat (top overall ranking). In general, WRC did not significantly change results regardless of age. Bottom heat in combination with the dilute hormone treatment was lethal for cuttings of two and three-year-old wood. There were no significant factor interactions. This species rooted randomly from nodes, internodes, and basal ends, but internodal rooting diminished with cuttings of two and three-year-old wood.

In summary, common snowberry, Pacific ninebark, and black twinberry generally rooted as well or better from cuttings of three-year-old wood compared to one-year-old wood, suggesting that they have good to excellent potential as live stakes, and possibly fascines. This improvement, especially in Pacific ninebark, may be the result of larger carbohydrate reserves in older, thicker cuttings. In contrast, salmonberry rooted more poorly from three-year-old cuttings and appears to have less potential for live stakes. However, it may work well as fascines. This species, unlike the other three, may lose juvenile traits as it ages or the bark thickens, becoming less likely to root along the internodes. Finally, for all four species, there appeared to be little if any benefit in the use of Wood's rooting compound (WRC). Bottom heat (at 75°F) was generally detrimental under the conditions of this experiment.

PART II: STREAMBANK SOIL BIOENGINEERING TRIALS (demonstration plantings with live stakes and fascines)

Site 1: Schneider Creek

The purpose of this demonstration was to evaluate the ability of eight native shrubs to perform as parallel and perpendicular fascines along a streambank. The planting was located along Schneider Creek on the Wynne Farm in Thurston County, WA. Installed March 17, 1999, in a silty clay loam on a gentle slope, trenches were back filled with non-native top soil, fencing was used in 2000, and deer repellent was applied once in 1999. No fertilizer or supplemental water has been applied.

Third year (2001) mean data are shown in Table 2. Despite substantial deer browse and grass competition, sprouting and growth after three growing seasons was fair to excellent for all species except red elderberry which failed to establish (1 shoot left alive). Perpendicular fascines outperformed the parallel ones, possibly because of better moisture or soil quality. Pacific ninebark, salmonberry, black twinberry, and western redosier dogwood were roughly similar in performance.

Table 2. Schneider Creek fascines – 2001 results

Species	Vigor1	Ht.(cm)	Wth.(cm)	Deer Br.[1]	Stems/m
Sitka willow 'Plumas'	9.0	150	150	3.0	33
Sitka willow (local)	9.0	154	147	1.5	40
Redosier dogwood	6.0	70	59	5.0	10
Douglas spirea	6.0	60	49	2.5	43
Black twinberry[2]	6.7	88	50	4.0	12
Pacific ninebark[2]	5.7	63	60	2.0	11
Salmonberry	6.5	70	58	3.5	16
Red elderberry	1.0	40	18	--	0.5

[1]1=lowest, 10=highest. [2]Mean of 3 plots (fascines).

As expected, growth and vigor was the highest for both populations of Sitka willow (*Salix sitchensis*), although Douglas spirea produced more stems per meter than all other species. After three growing seasons, it appeared deer browse became the most limiting factor, not soil moisture. The willows were vigorous enough to out grow the browsing, but the other species did not. Shoots had the best growth where they managed to escape notice. This site demonstrated a case where the practitioner should consider the use of repellents or temporary fencing along with or ahead of other establishment enhancement or protection measures.

Site 2: Minnehaha Creek

At a streambank site on the Willamette National Forest (Minnihaha Creek, 2:1 side slopes, elev. 3100 ft.), fascines of nine different shrubs were installed in a droughty, cobbly sand on November 9, 1998. Each fascine was replicated twice, once on a lower tier and once on an upper tier. The lower tier was installed with coir fabric and the upper tier was fertilized at planting (14-14-14 slow release). Trenches were back filled with native soil. A single application of deer repellent was made in 1999. Supplemental water was applied once each summer. The area was sown to blue wildrye (*Elymus glaucus*) grass and mulched.

After three growing seasons, mock orange and salmonberry were unexpectedly the best performing species (Table 3.). Their potential on course soils merits further evaluation. Common snowberry survived but was in poor condition, as were single fascines of Indian plum and Pacific ninebark. Red flowering current failed to sprout and western redosier dogwood and Scouler's willow (*Salix scouleriana*) died by August of the second growing season. The lower tier (rep. 2) performed slightly better than the upper tier (rep. 1). Low fertility and poor soil moisture holding capacity were probably the major limiting factors at this site, not weed competition. Deer browse was also an important factor.

Table 3. Minnehaha Creek fascines – 2001 results

Species	Vigor[1]	Ht.(cm)	Deer Browse1	Stems/m
Mock orange[2]	6.3	45	4.3	5.8
Salmonberry	6.5	42	4.0	3.5
Redosier dogwood	1.0	--	--	--
Sitka willow	4.0	58	3.0	2.8
Scouler's willow	1.0	--	--	--
Pacific ninebark[3]	3.0	27	2.0	1.3
Snowberry	2.5	17	5.0	8.5
Indian plum	2.5	49	2.0	0.5
Red flowering currant	1.0	--	--	--

[1]1=lowest, 10=highest. [2]Mean of 3 plots (fascines). [3]One plot.

Site 3: Frazier Creek

The objective of this study was to evaluate salmonberry, common snowberry, western redosier dogwood, and Pacific ninebark as both fascines and live stakes. Live stakes of black twinberry were also evaluated. The plots were installed along Frazier Creek (PMC, Benton Co., OR, elevation 225 ft., 42 in. precipitation zone) in a clay soil on February 9 and 12, 2001. Fascines were approximately 6 inches in diameter, 5 feet long, and replicated three times. Live stakes were 2 feet long and replicated twice (5 stakes per plot). Trenches were back filled with a non-native sandy loam. Slow release fertilizer (14-14-14) was used during installation and supplemental water was applied five times. The soil was a poorly drained Bashaw clay and had a high shrink-swell capacity.

First year results are shown in Table 4. Initial performance (June) was initially fair to good for all species except Pacific ninebark. Vigor, survival, and stems/meter substantially declined by October. At the end of one growing season, common snowberry fascines performed the best. Because of their construction, they may have had better soil/stem contact and fewer air pockets compared to the other three species. Snowberry may also root more rapidly or is more drought tolerant. Redosier dogwood fascines ranked second in performance, followed by salmonberry. Both showed signs of severe drought stress by early October. Only one of three Pacific ninebark fascines produced an acceptable number of shoots (15/meter) in the spring. It completely died from drought by fall. While live stakes of redosier dogwood initially survived and grew the best (June), black twinberry had the highest survival by October, followed by redosier dogwood, and common snowberry. Soil "cracks" at the insertion points, soil compaction, and grass competition may have reduced survival during the dry summer. As the soil dried out, it pulled away from the sides of the fascines, further exacerbating the moisture limitations. Other than snowberry, chances for success appeared fair to poor.

Table 4. Frazier Creek fascines – 2001 results

Species – fascines	Vigor[1]		Ht.(cm)		Wth.(cm)		Stems/m	
	Jun	Oct	Jun	Oct	Jun	Oct	Jun	Oct
Snowberry	8.0	5.3	42	36	31	36	37	34
Redosier dogwood ‘Mason’	5.3	1.7	31	38	24	38	10	2
Salmonberry	4.7	2.3	33	10	21	10	6	1
Pacific ninebark	3.3	1.0	14	--	19	--	6	--

Species – live stakes	Vigor1		Ht.(cm)		% Surviv		Stems/ls	
Snowberry	5.7	4.0	31	42	50	30	1.7	1.5
Redosier dogwood ‘Mason’	6.8	5.0	34	37	100	40	5.1	4.7
Salmonberry	3.3	1.0	15	--	50	0	1.0	--
Pacific ninebark	5.6	3.0	26	24	50	10	3.4	3.0
Black twinberry	6.8	4.5	31	32	90	78	3.1	1.9

[1] 1=lowest, 10=highest. ls=live stake. Wth.=width.

Site 4: Boyce Creek

A fourth installation consisting of salmonberry and Sitka willow fascines was made along Boyce Creek in Kitsap Co., WA, in mid-September of 2000 (elev. <100 ft). The work was completed as part of a Wildlife Habitat Incentive Program (WHIP) contract, coordinated and installed by the Kitsap County Soil and Water Conservation District and NRCS personnel. The site consisted of two planting areas with silt loam soils and 2.5:1 or flatter slopes. Area 1 had both parallel and perpendicular fascines and was shaded. Area 2 contained over 30 feet of fascines. Leaves were stripped prior to planting. Trenches were back filled with native soil and no fertilizer or supplemental water was been applied. At least initially, results suggested that salmonberry (vigor=7.4, ht= 79cm, stems/m= 24) may perform as well or better that Sitka willow (vigor=6, stems/m= 21, ht=58cm), on moist, shady banks where, unlike willows, it often thrives. Deer browse played only a minor role the first year and moisture availability during the critical spring growing season appeared to be good.

Summary

- Under typical greenhouse conditions, it appears unnecessary to use bottom heat (at 75°F) or plant growth regulators similar to Wood’s rooting compound (dilute IBA/NAA solution) to root hardwood cuttings of common snowberry, Pacific ninebark, black twinberry or salmonberry.
- Common snowberry, black twinberry, and especially Pacific ninebark can root as well or better from cuttings of 3 year old wood versus younger wood. Results suggests they have high potential as live stakes.
- Salmonberry roots best from hardwood cuttings of 1 year old (current year) stems and will probably not do well as live stakes.

- Common snowberry, Pacific ninebark, black twinberry, and salmonberry appear to have fair to good potential as fascines under favorable conditions, but will not root as fast or as predictably as willows.
- At least initially, it appears some species may have value over willows for soil bioengineering in certain environments (i.e. salmonberry on moist, shady sites or common snowberry on droughty soils).
- From observations made at four sites, it appears the most limiting factors for a successful planting of live stakes and fascines using easy to root native shrubs is summer moisture supply, deer browse, and competition from other vegetation.
- Supplemental use of common snowberry, Pacific ninebark, black twinberry, and salmonberry for soil bioengineering should provide further options for increasing habitat diversity, if limiting factors can be overcome. Consider supplemental irrigation, weed management, and deer fencing or repellent the first two to four growing seasons.
- Finally, it should be cautioned that field trial results are still preliminary and may change over time. Results will be substantially affected by ecotype (plant genetics), site conditions, installation technique, stock quality, health of the donor plant, and handling methods.

Acknowledgement

The NRCS Corvallis PMC wishes to thank D'Lynn Williams, Forestry Technician, USFS Willamette National Forest, Rigdon Ranger District, Oakridge, OR, and the Oakridge High School student work crew for helping to install lives stakes and fascines at Minnihaha Creek. The PMC also would like to thank the Soil and Water Conservation District employees and NRCS employees who completed similar work along Schneider and Boyce Creeks in western Washington.

Literature

(1) Bentrup, G. and J.C. Hoag. 1998. The practical streambank bioengineering guide. USDA Natural Resources Conservation Service. Plant Materials Center. Aberdeen, ID. 165 p.

(2) Darris, D.C., et. al. 1998. Rooting ability of fifteen native shrubs using hardwood cuttings in the field and greenhouse. IN: Symposium proceedings. Native Plants Propagating and Planting. R. Rose and D.L. Haase (editors). OSU, Nursery Technology Cooperative, Corvallis, OR. P. 60-67.

(3) Darris, D.C. and T.R. Flessner. 2000. Corvallis Plant Materials Center annual technical report. USDA Natural Resources Conservation Service, Corvallis, OR. 203 p.

(4) Georgia Soil and Water Conservation Commission. 1994. Guidelines for streambank restoration. Atlanta, GA. 52 p.

(5) King County Dept. of Natural Resources. (undated). Live stake cutting and planting tips. Water and Land Resources Division. Accessed at: http://dnr.metrokc.gov/wlr/pi/cutting.htm. 2 p.

(6) King County Dept. of Public Works. 1993. Chapter 6. Role and use of vegetation. IN: Guidelines for bank stabilization projects. Surface Water Management Division. Seattle, WA.

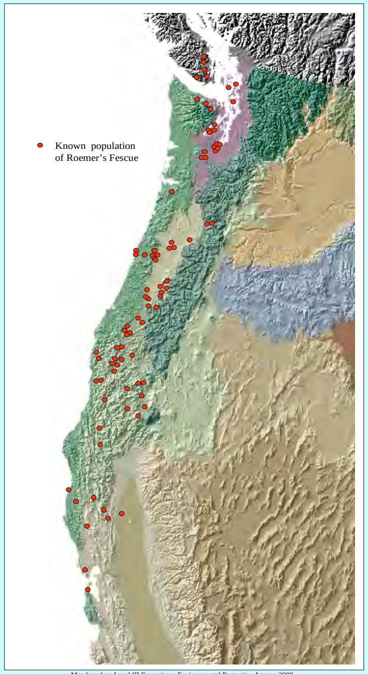
(7) USDA-NRCS. 1996. Chapter 16. Streambank and shoreline protection. IN: Engineering Field Handbook. USDA Natural Resources Conservation Service. Washington D.C.

Festuca roemeri Common Garden Study

Barbara Wilson[1]
Dale Darris[2]
Keli Kuykendall[1]
Rob Fiegener[1]
Amy Bartow[2]

[1]Native Seed Network
227 SW 6th St., Corvallis, OR 97333

[2]NRCS Corvallis Plant Materials Center
3415 NE Granger Rd., Corvallis, OR 97330



Map based on Level III Ecoregions, Environmental Protection Agency 2000

Background Information

Festuca roemeri is a community dominant bunchgrass in the gravel outwash prairies of northwest Washington, in coastal grasslands in the Puget Sound area, and in pine savanna on serpentine soils in southwest Oregon and northwest California. Its occurrence in oak savanna and in the fringes of grassy balds can be extrapolated to a formerly important role in Oregon's savanna and prairie habitat, before such habitat was reduced to its current relict status. The range has declined seriously and extant populations are fragmented.

Taxonomy

The importance of *Festuca roemeri* in native habitats has become apparent only recently, in part due to identification difficulties and taxonomic confusion. Some populations in Washington and northwest Oregon had been understood as relict west-side populations of *F. idahoensis* Elmer, but most were misidentified as *F. rubra* L., a phylogenetically distinct but morphologically similar grass. Therefore, *F. rubra* was long accepted as the dominant native grass of upland grasslands of Oregon and Washington.

As a native community dominant, *F. roemeri* is highly desirable for ecosystem restoration projects west of the Cascade Range and Sierra Nevada. As a deep-rooted perennial stress-tolerater, *F. roemeri* also has potential for erosion control. However, little *F. roemeri* seed is available for such projects. The usable seed supply is further restricted because restoration professionals and researchers are divided on the appropriate standards for seed transfer.

Goal

In order to address these concerns, the Institute for Applied Ecology (IAE), Bureau of Land Management, and the USDA Natural Resource Conservation Service initiated a common garden study of *Festuca roemeri* in 2001. The goal of this study is to plant seeds from many diverse populations throughout the range of the species in one environment and to compare their morphology, phenology, survival, and yield in that common environment.

Populations

Included in this study are populations from the Puget Sound area, the Olympia area, the southern Willamette Valley, high elevation sites in the Coast Range and the foothills of the Cascade Range, and coastal sites. It is unknown whether the groups differ from each other genetically. The USDA's Plant Material Center in Corvallis, Oregon, was chosen as the site for the *Festuca roemeri* common garden as it is within the range of Northern *F. roemeri,* in the approximate center of a cluster of small remnant populations.

Seed Collection

Seed was collected from 54 Roemer's Fescue populations in 2001 and 2002. Separate collections were made from at least 8 individual plants per population. Leaves were also collected to verify the identity of the mother plant. Many individuals and some entire populations collected were Red Fescue and were excluded from the study.

Germination Study

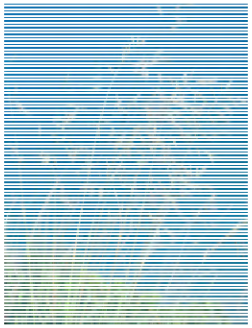
A seed germination study was conducted. Cold stratification did not increase percent germination, but did cause faster, more uniform germination. Fast germination is important because Roemer's Fescue seedlings are vulnerable to mortality due to fungus. In December 2002 seeds from 378 maternal families (48 populations) were planted in containers. After cold stratification the containers were brought into the greenhouse and checked daily to record the emergence date for each seedling. Presently we are analyzing the emergence data, as well as the distribution of albino seedlings.

Future Plans

In the spring of 2003 seedlings will be planted into a field at the Plant Materials Center. Preliminary field data will be collected in 2003. Better quality data are expected in 2004 after the plants are more established, and we hope that funding will allow further data collection and analysis. Below is a list of traits to be measured.

	Trait	**Timing**
Nursery Traits	Emergence date	greenhouse
	Early height (just before planting)	2 months after planting
Plant Traits	Mature plant height (= foliage length)	2003, 2004, 2005
	Vegetation color (glaucous vs. green)	2003, 2004
	Rust infection rate	2003, 2004
	Fall regrowth date	2003, 2004, 2005
Inflorescence Traits	Culms per plant	2004, 2005
	Culm length	2004, 2005
	Lemma length	2004
	Awn length	2004
	Spikelet length	2004
Seed Traits	Yield (weight of seeds)	2004, 2005

We hope to conduct a leaf anatomy study, as this is an important taxonomic trait in fescues, and would be useful in determining gene-based differences among populations and determining appropriate seed transfer zones for Roemer's Fescue.



Is Red Fescue Native to the Pacific Northwest?

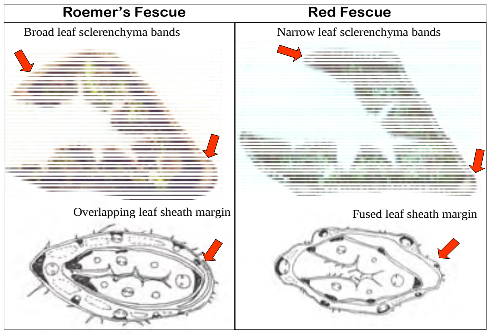
Most Red Fescues found in the Pacific Northwest are introduced from Eurasia. Most are rhizomatous. The most widespread introduced Red Fescue in the PNW is Chewings Fescue (*Festuca rubra* ssp. *Commutata = F. nigrescens*). Chewings Fescue, introduced from Europe via New Zealand, is a bunchgrass with a strong superficial similarity to native Roemer's Fescue.

Native Red Fescues probably occur in the PNW as well, but identification is extremely difficult. The coastal sand dune form (*Festuca rubra* ssp. *arenicola = F. ammobia*) is relatively distinctive due to its dense inflorescence. The other possible native taxa are very difficult to identify and their status is not confirmed.

How do I distinguish Roemer's Fescue from Red Fescue?

It's not easy! The table below indicates some key characteristics. At right are photographs and drawings of leaf cross-sections that illustrate differences. Roemer's Fescue almost always grows in mixed stands with Red Fescue. It is important that collections of Roemer's Fescue are verified.

Characteristics	***F. roemeri***	***F. rubra* ssp. *commutata***	***F. rubra*, introduced**
Origin	Native	Introduced	Introduced
Habit	Bunchgrass	Bunchgrass	Turf-forming, spreading, or forming bunches on buried rhizomes
Leaf sheath margins	Overlapping; sheaths open	Fused; sheaths closed	Fused; sheaths closed
Leaf color	Blue, sometimes green	Green	Green, rarely blue
Leaf sclerenchyma band width	Bands >2X as broad as thick	Bands <2X as broad as thick	Bands <2X as broad as thick
Inflorescence	Open	Somewhat condensed to open	Somewhat condensed to open
Lemma body length	6 - 8 (to 8.2) mm	4.8 - 5.6 mm	4.8 - 5.6 mm, to 7mm in strongly rhizomatous taxa
Longest lemma awns	2.1 - 3.5 mm, < to about = lemma body	1 - 3.2 mm, 0 to 1/2 lemma body	Variable, usually on the short side



What should I plant in west-side restoration projects?

- **Do not plant** most Red Fescue cultivars – they're not bunchgrasses.
- **Do not plant** Sheep Fescue. It's often sold as "native" *Festuca ovina*, but absolutely no *F. ovina* is native to North America. Nearly all "Sheep Fescue" cultivars are European *F. trachyphylla* (= *F. brevipila*, often called *F. longifolia*). No Sheep or Hard Fescues are native to North America.
- **Do not plant** Idaho Fescue on the west side. It is not native on the west side and will die.

- **Consider planting** Chewings Fescue (*F. rubra* ssp. *commutata*). It's non-native, but (1) it's a bunchgrass, (2) it's everywhere already, so you can't harm nearby ecosystems by planting it, (3) it's easier to distinguish from native taxa than the other fescues, (4) it grows well here, and (5) it's cheap. If you plant Chewings Fescue, strive to get the older varieties (such as Illahee or Cascade) because they are less competitive with native forbs. The very best choice is the "Western Fescue" release that is developed from a misidentified, naturalized Chewings Fescue population.

Genetic Variation & Seed Zones for Roemer's Fescue

Rob Fiegener – **Native Seed Network**
Barbara Wilson – **Institute for Applied Ecology**
Dale Darris –**NRCS Corvallis PMC**
Randy Johnson - **USDA Forest Service**

Collections

In a BLM-funded study, seeds were collected from 46 seed sources, predominately throughout Oregon and Washington, with two additional sources from the Bay Area of California. At each location, seeds were collected from 10 plants. Maternal identity of seeds and plants were maintained throughout the study. Seeds were germinated in a green house in 2001 and 12 seedlings per parent were established in a randomized design in 2002 in a field plot near Corvallis, Oregon.

Collection locations

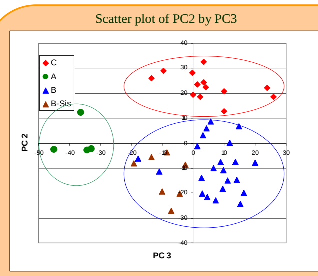
Analyses and Results

Principle component analysis was used to reduce the 13 traits to fewer traits which represent combinations of all traits. The first three principle components (PCs) accounted for 70 percent of the total variation (PC1 – 29.0%, PC2 – 22.5%, PC3 – 18.5%). These three principle components were analyzed in more detail.

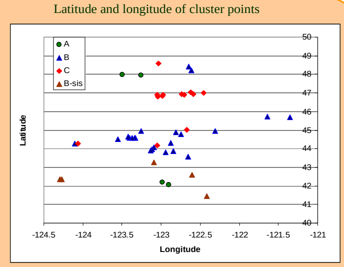
Latitude, longitude and elevation of the seed sources were used to model the PC values. Elevation impacted all 3 PCs (probability ≤ 0.05) and many of the individual traits (see table). Latitude was associated with PC2. Very little of the variation in PC1 was explained by the simple model, but 40% of the variation in PC2 and PC3 was explained. Using climatic data from PRISM, we were able to increase r-squares; the best 4-variable models yielded r-squares of 0.50 for PC1, 0.64 for PC2, and 0.70 for PC3.

We then examined the scatter plots of the three principle components and found what appeared to be 3 clusters in the plot of PC2 by PC3.

Scatter plot of PC2 by PC3



Latitude and longitude of cluster points



The "A" clusters only included high elevation sources. When the clusters are plotted on latitude and longitude coordinates, it becomes evident that the "B" clusters are predominately in Oregon and the "C" clusters in Washington. The few "B"s in Washington were low elevation sources and the "C"s in Oregon were higher elevation sources. Upon closer examination, we also found that the Siskiyou sources grouped together in cluster B and they also exhibited unique leaf morphology.

Based on the data, we have delineated three low elevation (< 2,500 ft) seed zones for Oregon and Washington. These are Washington, the Willamette Valley and surrounding mountain ranges, and the Siskiyou's. These seed zones correspond roughly to ecoregions. The natural break in the species distribution found between the two states is preserved.

The NRCS Corvallis Plant Materials Center is now developing regionally-adapted seed sources for the three low elevation seed zones. This releases will be selected for rust resistance and indirectly selected for seed production. They will capture over 95% of the genetic variation in each region.

Measurements

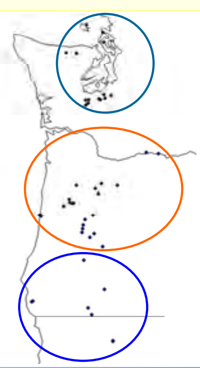
Measurements that were used in analyses:

- height of the plants (2003 and 2004)
- width of the plants (2003 and 2004)
- form (ht/width) (2003 and 2004)
- rust score in (2003)
- color score in (2003)
- day of seed shatter (Julian date in 2004)
- tiller score in (2004)
- foliage score in (2004)
- Julian date of anthesis
- phenological score reported on March 23, 2004

Heritability, Qst, and correlations of traits with physiographic variable and principle components

			Correlations					
Trait	Heritability	Qst	Latitude	Longitude	Elevation	Pc1	Pc2	Pc3
Pc1	0.43	0.20	-0.14	0.17	0.35	1.00	0.00	0.00
Pc2	0.56	0.37	0.55	0.25	-0.37	0.00	1.00	0.00
Pc3	0.57	0.34	0.08	-0.07	-0.61	0.00	0.00	1.00
Height-3	0.42	0.27	0.48	0.18	-0.54	0.22	0.56	0.67
Width-3	0.19	0.25	-0.30	0.06	0.61	0.70	-0.49	-0.05
Shatter date	0.63	0.28	-0.38	-0.16	-0.33	-0.41	-0.53	0.51
Height-4	0.56	0.24	0.36	0.10	-0.43	0.13	0.69	0.46
Width-4	0.31	0.21	-0.13	0.05	0.09	0.83	-0.09	0.47
Tiller date	0.37	0.24	-0.39	0.07	-0.08	0.72	-0.10	0.20
Foliage score	0.68	0.16	-0.03	0.00	-0.09	0.62	-0.01	0.55
Anthesis date	0.34	0.36	-0.10	-0.13	-0.46	-0.68	-0.30	0.55
Phenological score	0.39	0.21	-0.07	0.38	0.21	0.65	0.30	-0.40
Form-03	0.16	0.40	0.47	0.14	-0.73	-0.38	0.73	0.45
Form-04	0.09	0.39	0.28	0.05	-0.26	-0.53	0.62	-0.23
Rust-3	0.19	0.24	-0.13	-0.16	-0.07	-0.27	-0.48	0.41
Color-3	0.83	0.46	-0.17	-0.29	-0.22	-0.28	-0.53	0.16

Seed zones for elevations less than 2,500 ft



Festuca roemeri Common Garden Study

FINAL REPORT
April 2007

Rob Fiegener, Barbara L. Wilson, Dale Darris,
Randy Johnson and Keli Kuykendall

A Cooperative Project of:
Native Seed Network
Bureau of Land Management
Eugene, Medford, Roseburg, and Salem Districts
Natural Resources Conservation Service, Corvallis Plant Materials Center
USDA Forest Service, Pacific Northwest Research Center

This report is the result of a cooperative Challenge Cost Share project between the Institute for Applied Ecology (IAE) and the Bureau of Land Management. IAE is a non-profit organization dedicated to natural resource conservation, research, and education. Our aim is to provide a service to public and private agencies and individuals by developing and communicating information on ecosystems, species, and effective management strategies and by conducting research, monitoring, and experiments. IAE offers educational opportunities through 3-6 month internships.

Questions regarding this report or IAE should be directed to:

Rob Fiegener
Native Seed Network
Institute for Applied Ecology
563 SW Jefferson Ave.
Corvallis, Oregon 97333
phone: 541-753-3099
fax: 541-753-3098

NATIVE SEED NETWORK

This large scope project has received considerable investment of time, energy, and money. We would like to thank the Bureau of Land Management for their continued support of the Roemer's Fescue Common Garden Study. In addition, we owe a debt of gratitude to the Corvallis Plant Materials Center for their donation of space, volunteer labor and expert recommendations.

EXECUTIVE SUMMARY

- The *Festuca roemeri* common garden study investigated the genetic variability of Roemer's fescue across its geographic range in order to define seed transfer zones.

- Seed of *Festuca roemeri* from 47 wild populations was planted in a common garden at the NRCS Plant Materials Center, Corvallis, Oregon. Morphology, phenology, survival, and yield were monitored in this common environment over a three year period.

- Principal components analysis was used to detect structure in the data and relate the observed variation to environmental variables

- Genetic variation is driven by temperature and precipitation

- Variation is strongly correlated with elevation and latitude.

- We recommend that the Puget Lowland, Willamette Valley, and Klamath Mountains EPA Level III Ecoregions be used as 3 seed transfer zones for Roemer's fescue.

- Seed movement within these zones presents minimal risk of maladaptation

- The NRCS is preparing releases of Roemer's fescue for the Willamette Valley, Puget Lowland, and Siskiyou ecoregions.

BACKGROUND

The Common Garden Study

In 2001, Native Seed Network (NSN), the U.S. Department of Agriculture – Natural Resource Conservation Service (NRCS) and the Oregon Bureau of Land Management (BLM) combined forces to establish a common garden study of *Festuca roemeri*. Currently there is little commercial *Festuca roemeri* seed available in the marketplace. Suppliers are hesitant to grow this grass because restoration workers do not agree on the appropriate geographic boundaries of seed transfer zones.

Intraspecific variation has been noted in Roemer's fescue, but it is not known if this variation is due to phenotypic plasticity or underlying genetic differences. This study was designed to shed light on this issue. Seed from regional populations was planted into a single environment at the Corvallis Plant Materials Center. The goals of this study are to delineate the boundaries for transferring seed between source locations and project out-planting sites.

The Importance of *Festuca roemeri*: Key Component of Grasslands

The bunchgrass *Festuca roemeri* (Roemer's fescue) is a community dominant in the gravel outwash prairies of northwest Washington, grasslands of southern British Columbia and the Willamette Valley, coastal grasslands of Puget Sound, and the serpentine and pine savannas of southwest Oregon and northwest California. Before European settlement, Roemer's fescue grew in large interconnected populations North from British Columbia, throughout western Washington, Oregon and Northern California. Populations south of Douglas County, Oregon have been described as a distinct subtaxon, Klamath Roemer's fescue, *Festuca roemeri* var. *klamathensis* (Wilson 1999). Our study focuses on northern Roemer's Fescue because this taxon has the greatest restoration potential and cultivation demand in Oregon and Washington.

As a dominant matrix species of native grassland ecosystems, *Festuca roemeri* is highly desirable for restoration, rehabilitation and revegetation projects west of the Cascades from the Georgia Basin in the north and ranging as far south as San Francisco Bay. This deep-rooted perennial stress-tolerater (*sensu* Grime 1977) has significant erosion control properties and xeriscape capacity.

Taxonomic Difficulties

Festuca roemeri has been beset by identification difficulties and taxonomic confusion. Initially, populations in Washington and northwest Oregon had been misunderstood as *Festuca idahoensis* Elmer populations. Roemer's fescue was first described as a variety of *F. idahoensis (*Pavlick 1983). Most commonly, Roemer's fescue is confused with Red fescue (*Festuca rubra* L.) Red fescue is a morphologically similar but phylogenetically distinct grass. Therefore, *Festuca rubra* was long accepted as the dominant native grass of upland grasslands of Oregon and Washington (Franklin & Dyrness 1973).

The taxonomic difficulties surrounding the fine-leaved fescues of the Western Valleys are extraordinary. The conspecific grasses of southwest Oregon and northwest California have been variously identified as *F. idahoensis* Elmer, *F. ovina* L., *F. idahoensis* X *F. occidentalis* Hook. hybrids, *F. idahoensis* var. *oregona* (Hack.) C. L. Hitchc., and often *F. rubra* L. Many authors simply reported *Festuca* sp. (Atzet unpubl. data, Copeland 1978, Frenkel & Kiilsgaard

1984, herbarium specimens). The recognition of *Festuca roemeri* as a taxonomically separate entity occurred first when Pavlick (1983) described it as a variety of *F. idahoensis,* and 2 years later its status was elevated to that of a distinct species (Alexeev 1985). *Festuca roemeri* is now described as consisting of two subtaxa: the true species *F. roemeri* var. *roemeri* to the north of Douglas County, Oregon, and the variety *klamathensis* to the south (Wilson 1999).

Presently ITIS, the Integrated Taxonomic Information System, recognizes *Festuca roemeri* (Pavlick) Alexeev as an accepted taxon, with *Festuca idahoensis* var. *roemeri* Pavlick as a synonym. The USDA PLANTS Database, however, recognizes Roemer's fescue as a subspecies of Idaho fescue (*Festuca idahoensis* Elmer ssp. *roemeri* (Pavlick) S. Aiken). Recognized by USDA PLANTS as synonyms are *Festuca roemeri* (Pavlick) Alexeev and *Festuca idahoensis* Elmer var. *roemeri* Pavlick.

Distinction Between Varieties of *Festuca roemeri*

Northern Roemer's fescue (*F. roemeri* var. *roemeri*) has few, short hairs on the inner (adaxial) leaf surface and has a characteristic pattern of malate dehydrogenase (MDH) isozymes. Its range extends from British Columbia through western Washington and northwest Oregon south to the Douglas/Jackson County line (2002 unpubl. report to Bureau of Land Management Roseburg District) and south along the coast as far as San Francisco. Klamath Roemer's Fescue (*F. roemeri* var. *klamathensis* B. L. Wilson ined.) grows in southwestern Oregon and northwestern California, between the ranges of *F. roemeri* var. *roemeri* and *F. idahoensis,* except along the coastline where it is absent. Its many long hairs on the inner leaf surface and MDH isozyme pattern resembled *F. idahoensis,* but the phenotypic plasticity of its leaf shape resembled *F. roemeri* var. *roemeri.* Both varieties occur on serpentine as well as non-serpentine substrates. Our current study concentrates on northern *F. roemeri* var. *roemeri,* however, four populations of *F. roemeri* var. *klamathensis* are included for balance in the experimental design.

Once *F. roemeri* could be named and identified, its importance in native plant communities was quickly recognized (Wilson 1997). *Festuca roemeri* var. *roemeri* population groups are united by similar habitats and/or geographic location. Included in this study are populations from Puget Sound, Olympia, the southern Willamette Valley, high elevation sites in the Coast Range, the foothills of the Cascade Range, and coastal sites (Figure 1). With increasing knowledge about the taxonomy and range of *Festuca roemeri,* potential barriers to appropriate seed transfer became apparent. This study was designed to address those questions concerning genetic uniformity or dissimilarity between populations.

METHODS

Study Design

The USDA's Plant Material Center in Corvallis, Oregon, was chosen as the site for the *Festuca roemeri* common garden. This site is located within the approximate center of a cluster of small remnant populations. Also, the issue of *F. roemeri* seed transfer is more critical in Oregon than in northwestern Washington. In Washington, the relatively large remnant prairies provide potentially adequate sources of local seed. In Oregon, prairie remnants are small and more likely to suffer from inbreeding depression. Also, *F. roemeri* often grows in mixed populations with introduced *F. rubra,* making it difficult to collect pure seed (Wilson 1997). Therefore, the demand for *F. roemeri* seed in Oregon could be filled by transferring seed from northwestern

Washington more easily than the demand for seed in Washington could be filled with seed from Oregon.

Collected seed also provides important data for describing the genecology of *Festuca roemeri*. Lemma and awn length, for example, have been identified as two morphological traits valuable for comparisons of fescues. Seed has been processed and weighed to determine variability between populations. Yield data not only helps us understand differences between populations, but is also useful information in planning for production of *Festuca roemeri* seed on a commercial scale.

Seed Collection

Festuca roemeri seed was collected from 54 populations during 2001 and 2002. Seed collection was extended over a second seed season because 2001 was a drought year and many *F. roemeri* populations set little or no seed. Latitude, longitude, and elevation were documented for all seed collection sites.

Seed from individual plants was collected and kept separately in coin envelopes. This seed represents half-sib plants, with a common mother plant and unknown pollen source. More than 30 seeds were collected from at least 8 mother plants at each population.

Because *Festuca roemeri* is easily confused with *F. rubra,* sample identification was checked by cutting leaf cross sections from the central third of a leaf from at least one of every five families collected, plus other samples which deviated from expected *F. roemeri* morphology. Leaf cross sections were drawn freehand and stored as a record of identification. Leaves will be stored at the Institute for Applied Ecology until the end of the study.

Seed Sorting

Lemmas with filled seed were sorted from empty lemmas by hand using a light box. Lemmas were considered to contain filled seed if the seeds were opaque and stiff. Most filled seeds were also somewhat plump.

Samples from the Drano Lake, Duncan Spring, Edgewood-Weed Road, Glacial Heritage Park, San Bruno Mountain, and Skinner Butte populations became severely infested with the fungus *Aspergillus.* One week before planting (Dec. 8 & 9), these seeds were soaked in 1.5% sodium hypochlorite solution for 20 [to 50] minutes, then rinsed with distilled water and air dried. (200 ml 6% sodium hypochlorite solution (bleach) + 600 ml H20.)

Sowing

Seeds from 47 of the 54 *Festuca roemeri* populations sampled were sufficiently mature for inclusion in the study (Figure 1). Eight families per population were used (except where fewer were available, such as Abiqua Road, Memaloose Park, and Glacial Heritage Park; see Table 1). The study design included 8 individuals for each family. When sufficient seed was available, we planted three seeds in each of twelve tube containers for each family. When fewer than 36 seeds were available for a family, the number of seeds/container was adjusted downward, to a minimum of 1 seed in each of eight containers. A total of 4534 containers were sown with 12889 seeds.

Seeds were planted December 16 and 17, 2002 at the USDA-NRCS Corvallis Plant Materials Center. Flats were watered Dec. 17 and stored at 3°C in the dark until January 6, 2003, when they were placed in the greenhouse. The greenhouse was set with a 14 hour day-length. Daytime temperatures were 21°C (70°F) and nighttime temperatures were 18°C (65°F).

Thinning

In order to assure a sufficient number of plants would develop to be planted into the garden, multiple seeds were sown into each container. We did not wish for complications to arise from the presence of more than one individual in the same container, such as competition. To prevent bias in our selection for any particular trait, such as the biggest or earliest-emerging individual, excess seedlings were systematically removed based on their position relative to a marking made on the side of each container, leaving a single individual in each container.

After ten weeks in the greenhouse, plants were moved to a shade house for several weeks to harden off before being planted in the field.

Field Preparation and Planting

Plugs of *Festuca roemeri* were planted into a fallow field. A standard regimen of herbicide application was implemented to eliminate the existing seed bank. The field was then covered with three inches of bark mulch to aid in weed suppression. Slow-release fertilizer (Osmocote) was measured into each hole prior to planting each *F. roemeri* plug. Planting occurred over five days from May 8 to May 12, 2003. In total, 3009 plugs were planted into the common garden. Of these, 2767 were plants under study and 242 were planted as a border row to provide a buffer against edge effects.

Field Maintenance

The field was irrigated approximately once each month in 2003 to help the plants establish during the first summer. Fungicide was applied periodically to prevent rust infection from severely inhibiting plant growth in 2003 and 2004. In 2005 no fungicide was applied in order to assess the vulnerability of the plants to fungi.

The field was routinely inspected and weeds were controlled periodically as needed throughout the term of the study. All weed control was done by hand.

Data Collection

For a summary of all data collected, see table 2.

Germination & Early Growth

The greenhouse was checked daily for germination. Emergence date was recorded for each seedling. This required inspecting all 4534 containers for newly-emerged cotyledons every day over several weeks.

Albino seedlings were noted and recorded. Rate of albinism may be an indicator of population health. Albinos indicate a lack of reproductive success and possibly negative consequences of inbreeding.

Morphological Data

Before out-planting to the field, early growth measurements were taken. The length of the third-longest leaf and the width of the young plants were measured and recorded.

Plants in the common garden were evaluated again between July 28th and August 1st, 2003. This occurred 29 weeks after the seed began to emerge, and near the end of the first full growing season. In order to measure plant growth, the leaf length and crown diameter were measured. Plants were rated for the color of their foliage, which ranged between yellow-green and deep blue. Despite the application of fungicide, some plants showed signs of rust infection. These were noted, as well as plants with senescent foliage, indicating dormancy. Record was made of those plants that did not survive past this period.

In June 2004 plants were again measured for their size and scored for their production of leaves and culms. The width of the crown was measured to the nearest centimeter, as was the length of the longest (tallest) culm. Early June was selected because plant growth was essentially complete for the season, and culms had attained their natural maximum length. Estimates of leaf and culm abundance were also recorded at this time. These were relative measures, scored on a scale of one to ten.

In June 2005 the plants were assessed for the abundance of the foliar fungal pathogen *Puccinia*. Leaf and culm abundance were again recorded.

Phenological Data

From March to November, 2004, all plants were evaluated for their stage of growth. Each plant was scored according to the scale in table 3. Between March and August, the plot was monitored weekly. In August, after plants had reached seed maturity, sampling frequency was reduced to every two weeks. Biweekly sampling continued into the fall to monitor plant dormancy.

Seed Data

Seed was harvested selectively on a plant by plant basis at the optimal time to maximize the amount of seed collected from each plant. As plants demonstrated considerable variability, seed ripening was asynchronous throughout the plot. There is a narrow window in which the seed is mature enough to harvest but not yet so ripe that it shatters and is lost on the ground. Considerable care was taken to harvest each plant at this critical time. Having such a diverse planting as the common garden required frequent monitoring and harvesting on a plant-by-plant basis over a seven week period.

From June 3 until July 20, 2004 (typically every Monday, Wednesday, and Friday), a team of workers walked through the field and identified plants with mature seed. Seed from each plant was harvested and placed in labeled paper bags. These bags were stored in the greenhouse at the Plant Materials Center for several days until the seed moisture was low enough to ensure safe preservation.

Florets were extracted from each bag of harvested seed and retained for floret and seed morphological analyses. Later in 2004, measurements of the following were taken on three randomly-selected individuals per family: lemma length, awn length, palea length, upper and lower glume lengths, distance between the lowest branches of the inflorescence, and total inflorescence length. Seed was bulked and weighed for all individuals from the same family.

Data Analysis

All data were entered into Excel spreadsheets, managed in an Access database, and analyzed by SAS statistical software. A summary of traits measured is presented in table 3. In addition to the traits measured in the common garden, several other pieces of information were critical to the analysis. These include the latitude, longitude, and elevation of the source populations, and climatic data corresponding to those source locations.

Pair-wise correlations were performed to check variables for redundancy. Univariate correlations of all variables with latitude, longitude, and elevation of the source locations were also conducted. Principal components analysis (PCA) was used to reduce the numerous measured traits to fewer traits which represent combinations of all traits. PCA was performed on three subsets of the data: (1) morphological and phenological traits for all populations; (2) morphological, phenological, and fitness data for all populations; and (3) populations from the Willamette Valley, Oregon. Correlations of principal component axes with measured variables were evaluated, as were correlations with latitude, longitude, and elevation. Regressions of principal components with climate variables were performed to assess the strength of these associations and gain insight into what mechanisms may be influencing the observed variation. We examined scatterplots of principal components to look for clustering of populations and determine groupings that are similar or dissimilar. Groupings detected by PCA were plotted on latitude-longitude coordinate axes to assess geographic patterns of the genetic data.

RESULTS

Seedling germination trends did not show significant variation. Most seed emerged uniformly and rapidly after the seeds were brought into a favorable environment. Late-emerging seed may have been planted deeper, and therefore required more time for the germinants to become visible. Seedling emergence peaked on January 10th, four days after flats were brought into the greenhouse (Figure 2). Rates of albinism varied widely between populations. Table 4 displays summarized emergence and albino data for ecological groupings of populations in the common garden study.

Survival rates overall in the common garden were very high, until early 2006 (Figure 3). Of the 2767 specimens planted, only 17 were lost during the first year. Curiously the four populations that fared the worst were all Willamette Valley source. In the summer of 2004, over 95% of plants were still growing, and by 2005 nearly 75% remained. Population survival rates in 2005 ranged from a low of 29% (Hurricane Ridge, Olympic National Park) to a high of 98% (Cummins Creek Trail, coastal Oregon). During the winter of 2006 the common garden plot experienced severe flooding and the plants were inundated continuously for several weeks. Only 181 plants (6.5%) survived these conditions. Those populations that had the highest survival rates were from the Oregon coast and the Olympia region (11%). Again, Willamette Valley populations demonstrated that the most local seed sources aren't always the best adapted – they had the lowest survival rate of all groups in the garden (2.3%).

Growth measurements of plants in the common garden show population level differences. Plant height and width were correlated with latitude and elevation, particularly in 2003, their first year of growth. High elevation and high latitude plants were more compact, with shorter leaves and wider crowns. Plants from lower elevations and latitudes were variable, but generally longer-leaved and with narrower crowns. In 2004 culm length was measured on those plants that flowered. This data mirrored the plant height (i.e. leaf length) data, as plants from higher elevations had shorter culms than plants from low elevations. No significant correlations or trends were found for foliage in year 2004 or 2005; tiller abundance was correlated with latitude in 2004 (Table 7).

The phenological status of each plant was recorded at regular intervals from March 9 to November 9, 2004. We were surprised to see certain plants beginning to flower as early as March, and others continued flowering into June. The earliest flowering specimens were from the inland populations of Jackson County, Oregon. Seed harvest began June 3, 2004 and continued regularly until July 20, 2004 (Figure 4). Seeds matured over a longer window of time than we had anticipated. The peak harvest date for the entire garden was June 18. Within the garden, however, different ecological groupings of the plants matured at different times (Table 5). The average seed maturity dates for each ecological grouping were unexpected. Other studies have found latitudinal and elevational clines in phenology, but our data do not reflect this trend.

Anthesis and seed shatter were both significantly correlated with latitude and elevation; linear regression of these traits shows that both occur earlier in higher elevation populations, at a rate of 1.6 days per 1000' elevation (anthesis) and 0.9 days per 1000' elevation (seed shatter). Inland populations matured first, followed by high elevation sites. Willamette Valley and Puget Sound populations matured about the same time, approximately one week after the high elevation populations; plants from the Columbia Gorge were the last to mature.

We continued to monitor and rate the phenological status of the plants throughout the summer and fall, as each week we observed changes in the plants and wanted to capture the differences in the duration of their greenness and when they became dormant. Nearly every population was composed of a combination of plants that in 2004: did not flower (7%); set seed and proceeded to go dormant (15%); and set seed but did not go dormant (78%). The Cummins Creek Trail population (from the coast of Lincoln County, Oregon) was unique in that every plant flowered and set seed, but none became dormant.

Foliage color showed a high level of heritability with significant family and population differences, but the trait was not correlated with latitude, longitude, or elevation. Higher elevation populations did have a higher tendency to be blue (glaucous), but mid- and low-elevation plants displayed the full range of leaf color, from blue to green.

We expected many plants would contract rust infections over the course of the study. Rust (*Puccinia* spp.)is a fungal pathogen common to grasses in western Oregon and is known to occur on Roemer's fescue. Rust susceptibility may be an important consideration in recommending seed sources as it is a controlling factor in plant establishment and plant health in restoration settings. We monitored infection rates in the garden periodically throughout the growing season. Fungicides were applied as warranted during 2003 and 2004 in order to aid plant establishment and growth. Despite this, in 2003 when fungicides were being applied, many plants were infected nonetheless, yielding useful information about susceptibility (Figure 5).

Rust infection rates (2003) were correlated with latitude and highly associated with summer precipitation. Rates were low on southern and northern populations, and highly variable on middle latitudes (44-45 degrees North). Rust incidence was highest on populations from areas of lower summer precipitation. It is possible that populations from wetter sites have had more exposure to rust and have increased resistance. It is also noted that populations most vulnerable to rust were those from the same latitudes as the common garden plot (44-45 degrees north). It is possible that populations from farther away are less susceptible to our local strains of rust.

For the 2005 growing season we stopped all applications of fungicide to assess the vulnerability of the plants. 2005 was an unusual year, however, as the plants did not become visibly infected with rust. The uniformly low infection rates provided us with no additional information about the relative susceptibility of garden specimens to rust infection.

The first run of principal components analysis was based on physical traits and seasonal growth of all populations. The first three principal components (PCs) accounted for 70 percent of the total variation (PC1 – 29.0%, PC2 – 22.5%, PC3 – 18.5%). These three principal components were analyzed in more detail. Plant width, tiller abundance, date of anthesis, late March phenological score, and form (height to width ratio) were strongly associated with PC1. PC2 is highly correlated with height, form and shatter date. PC3 was strongly correlated with height, foliage abundance, and anthesis date (Table 6).

Latitude, longitude and elevation of the seed sources were used to evaluate geographic patterns of the data. Many traits had significant correlations with latitude and elevation, in particular (Table 7). All three principal components had significant correlations with elevation, demonstrating its profound influence (Table 8). A linear regression model was created to estimate the impact of latitude, longitude, and elevation on the PC values (Figure 6). Very little of the variation in PC1 was explained by the simple model (17%), but 40% of the variation in PC2 and PC3 was explained.

Using climatic data we were able to increase the amount of variation in the data explained by the models (r-squares); the best 4-variable models yielded r-squares of 0.50 for PC1, 0.64 for PC2, and 0.70 for PC3. PC1 was driven mostly by late summer temperatures. The best 4-variable model included latitude, August minimum and maximum temperatures, and spring frost date. PC2 was driven mostly by precipitation, with some winter temperature influence; the best 4-variable model included May and July precipitation, and February and December maximum temperatures. PC3 was driven by cold, as winter temperatures and spring and fall frost dates were important. The best 4-variable model explaining PC3 included April and August minimum temperatures, spring frost date, and June precipitation.

We then examined the scatter plots of the three principal components and found what appeared to be 4 clusters in the plot of PC2 by PC3 (Figure 7). The “A” clusters only included high elevation sources. When the clusters were plotted on latitude and longitude coordinates (Figure 8), it became evident that the “B” clusters are predominately in Oregon and the “C” clusters in Washington. The few “B” populations in Washington were low elevation sources and the “C” populations in Oregon were higher elevation sources. The fourth cluster, “D,” represents many of the southern populations except those from the highest elevations.

To quantify the impact of elevation we looked at the regressions of latitude, longitude, and elevation on the principal components. A change of 1,000 feet elevation altered the PCs by 4.0, 2.4 and 5.7 units. Thus moving 1,000 feet will change the population mean 0.36, 0.31 and 0.75 genetic units, where these are expressed in units of within-population genetic standard deviation units.

Principal components analysis was also performed on the entire set of data collected, including the fitness measures of survival and yield in the common garden. This analysis did not aggregate the populations into clearly discernable groupings. The groupings detected in the prior analysis based on phonological and morphological traits were less evident.

Similarly, PCA was conducted on a geographic subset of the data, looking only at populations from the Willamette Valley. No clustering was evident in this analysis and there were no correlations with latitude, longitude, or elevation.

Based on the data, we have delineated three low elevation seed zones for Oregon and Washington: Puget Sound region, the Willamette Valley and surrounding mountain ranges up to 2000 feet elevation, and the Klamath Mountains.

DISCUSSION

The Roemer's fescue Common Garden looked spectacular. The amount of variation was stunning. Since the plants were arranged randomly in the field, it was not easy to recognize patterns of plant characteristics. Had the plants been arranged by their family and source population, however, it would have largely given the same impression. Much of the variation observed was present within each population and even within many families.

The data collected allowed us to understand a great deal about the intraspecific variation observed in *Festuca roemeri*. Morphological and phenological traits are genetically variable among our study populations and were especially useful in detecting and describing patterns. The variation among populations was strongly associated with elevation and latitude, and only weakly related to longitude.

Genetic variation between populations corresponds to geographic position when considered at the regional scale. Including populations from diverse elevations and latitudes allows us to detect this structure. Restricting our analysis to a limited geographic area with a more uniform environment such as the Willamette Valley or Puget Lowland, we no longer detect interpretable patterns in the genetic variation. Phenotypic patterns were strongest at the regional scale, indicating that genetic variation is also organized at a broader scale.

The most obvious cluster to emerge from our analyses is the high elevation populations. Despite the considerable difference in latitude, all of the highest elevation populations cluster together. High elevation plants have many traits in common with each other and are different from plants studied that came from lower elevation. The high elevation populations were differentiated from the others along the axis of principal component 3, which is strongly driven by cold (winter minimum temperatures and spring and fall frost dates). Not surprisingly, these variables are highly correlated with elevation. In general high elevation plants tend to be wider and shorter than low elevation plants, which include narrower and taller specimens in addition to the more compact form. The magnitude of these differences is not that great, but the large number of plants measured allowed us to detect significant differences. Similarly, plants from high elevation tend to be more glaucous and therefore bluish in color than their low elevation counterparts. Low elevation populations contain a mixture of bluish plants and also greener, non-glaucous specimens.

Also evident in the plot of PC2 by PC3 is the cluster of populations labeled "B." The geographic plot of cluster B populations shows that these are nearly all from the Puget Sound region. The nine populations from the Olympia, Washington area showed a high degree of similarity to each other and a small amount of difference from Willamette Valley populations. The Willamette Valley and Puget Sound clusters are divergent along PC2, which is strongly influenced by summer precipitation and winter maximum temperature. While the Puget Sound area and the Willamette Valley both enjoy mild winters and dry summers, the Willamette Valley has somewhat warmer winters and receives less summer rainfall (figures 9a and 9b).

There is also a difference in land use history between Olympia area populations and Willamette Valley populations that may be impacting their genetic makeup. Each of the Olympia area populations is relatively large, consisting of several thousand individuals, and has been intact for centuries. Presumably gene flow has been high enough within each population, and perhaps among populations, to maintain plants that are relatively uniform in size, shape, color, phenology, and yield.

Populations from the Willamette Valley and surrounding foothills showed much higher variance than the Olympia populations. These populations are much smaller than those found in the Puget Trough, and have been small and isolated for approximately 150 years, since the native prairies of the region were converted to agricultural use.   Extant Willamette Valley populations are found on balds, bluffs, and other sites with thin soils that were not suitable cropland and escaped the plow.

When we restrict our analysis to the subset of populations from the Willamette Valley, the significant relationships disappear. While considerable genetic variability exists within Willamette Valley populations, it is not correlated with geographic and climatic variables. Lacking an apparent meaningful pattern to the variability among Willamette Valley populations, we propose that the population differences observed among this group are due to founder effects. Seed yield for these populations is variable but generally low, which may be a result of inbreeding depression in this highly outcrossing species.

Although less obvious, there appears to be segregation of two clusters along PC3, labeled “C,” and “D.” Just as the high elevation populations were distinct from all others, the Klamath populations are largely distinct from the Willamette Valley populations. The more southern populations are sufficiently different in their temperature and precipitation.

Physical traits indicate that there is genetic variation in plant form and seasonal growth that meaningfully corresponds to geographic location. PCA of all traits, including survival and yield, was less descriptive than analysis of the morphology and phenology data. Addition of these fitness-related traits made the patterns less clear. These measures indicate that some plants were more fit than others in the common garden, but their inclusion in the analysis did not enhance our understanding of how the genetic data is structured.

Most of the genetic variation measured in the common garden is well explained by differences in elevation and latitude; elevation is particularly significant. Important factors related to these variables include end of summer temperatures, frost dates, and annual precipitation. We recommend restricting seed movement based on these factors.   Our findings agree well with the EPA Level III Ecoregions and other classification schemes such as cold hardiness zones. The Willamette Valley and Klamath Mountains ecoregions are different enough that we do not recommend moving seed between them.   We find movement of seed within each of these regions to be genetically appropriate. While the Willamette Valley and Puget Lowland are quite similar in many regards, we recommend the development and use of distinct germplasms for each area.

In 2006 the Natural Resources Conservation Service – Corvallis Plant Materials Center (PMC) began establishing seed increase blocks for Roemer’s fescue. The intent of the PMC is to provide genetically diverse but ecologically appropriate germplasm. Utilizing information derived from this study, separate blocks were initiated for a Puget Sound germplasm, San Juan Islands germplasm, Willamette Valley germplasm, Siskiyou germplasm, and a Coastal germplasm. Each of these composites will be released as a natural-track, selected class germplasm. Factors of importance to the PMC in selecting populations for each selection include the flower date (will the various collections cross-pollinate?); seed production (will the plants produce a crop?); plant size and health (will the plants be vigorous and survive?); and stock seed availability (is enough seed available to start now, or do we need to re-collect?). Each increase block is planted in a Latin square design to maximize cross-pollination and will be used to produce genetically diverse germplasm. Crossing blocks have been established in various locations at the Corvallis Plant Materials Center, maintaining at least a 900 feet isolation distance between each block. Blocks are isolated to protect their genetic integrity by minimizing pollination between blocks for this out-crossing species.

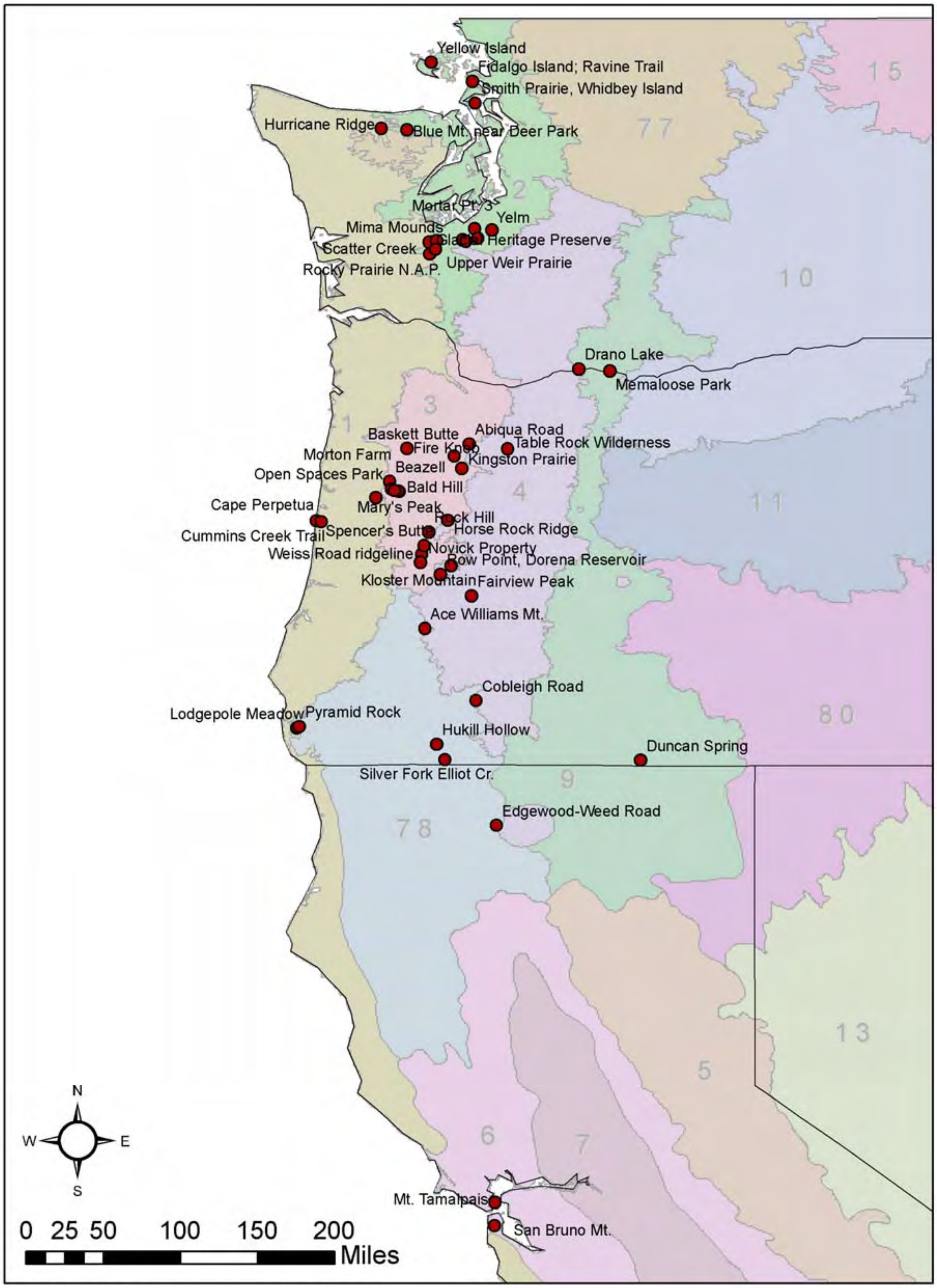


Figure 1. Populations represented in the Roemer's Fescue Common Garden Study.

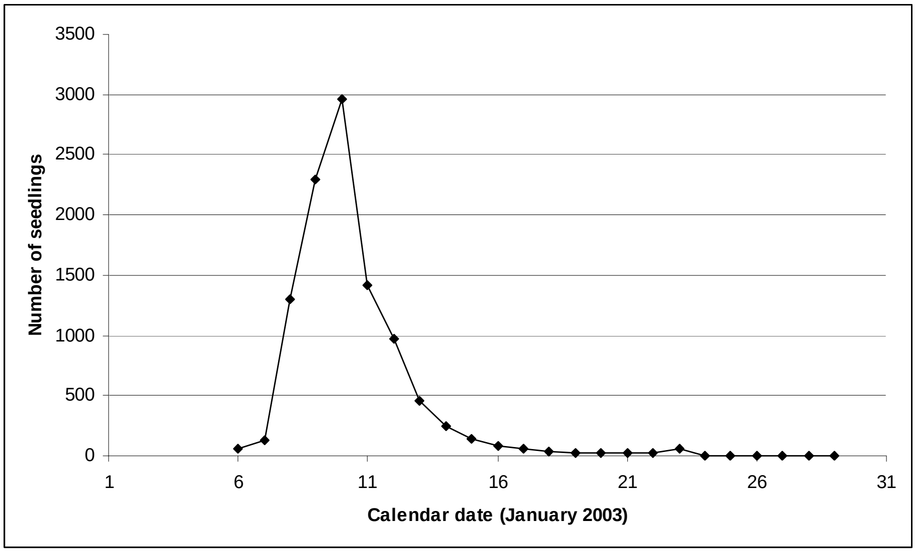


Figure 2. Seedling emergence

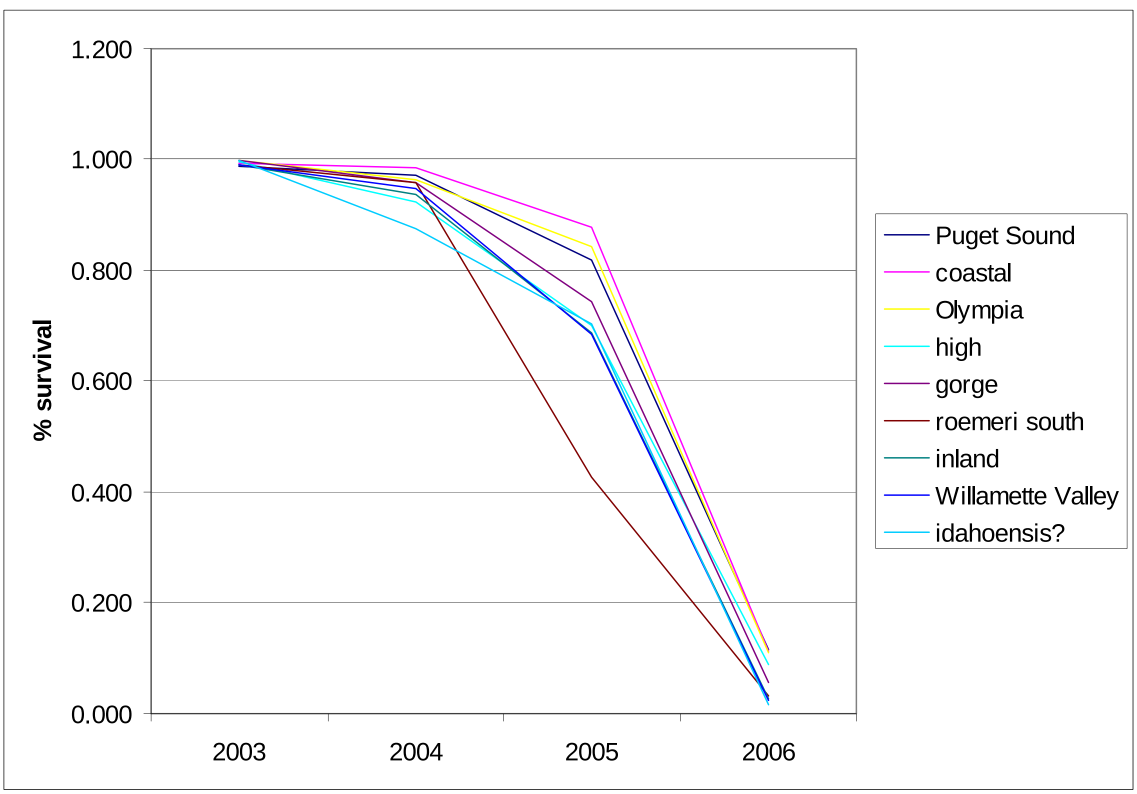


Figure 3. Mean survival values for groups.

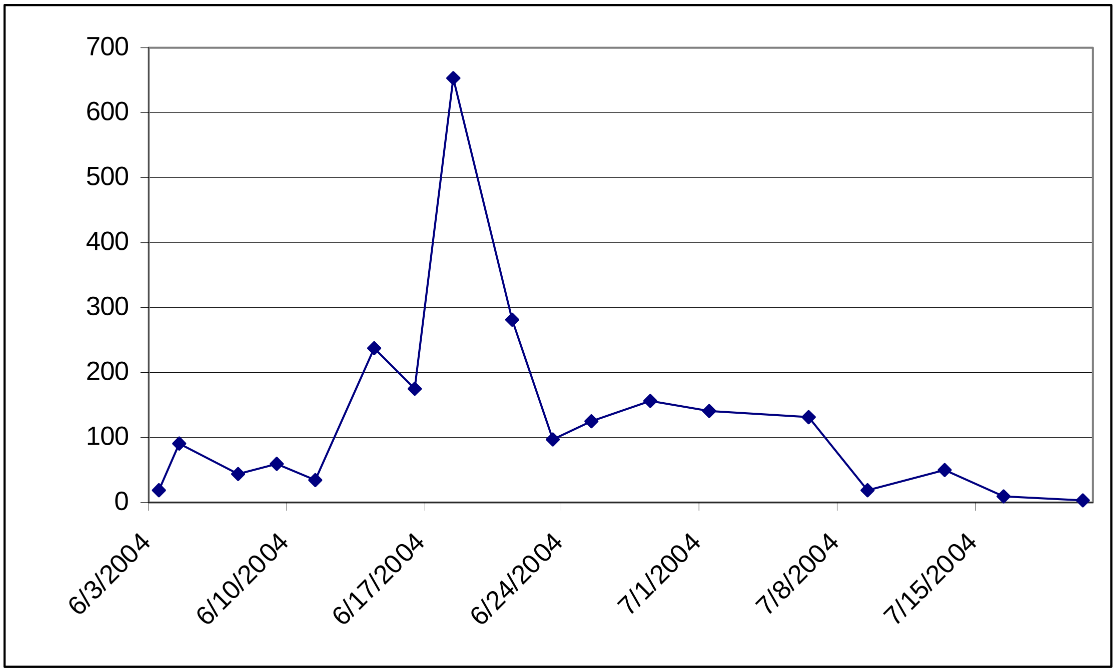


Figure 4. Seed harvest (number of plants).

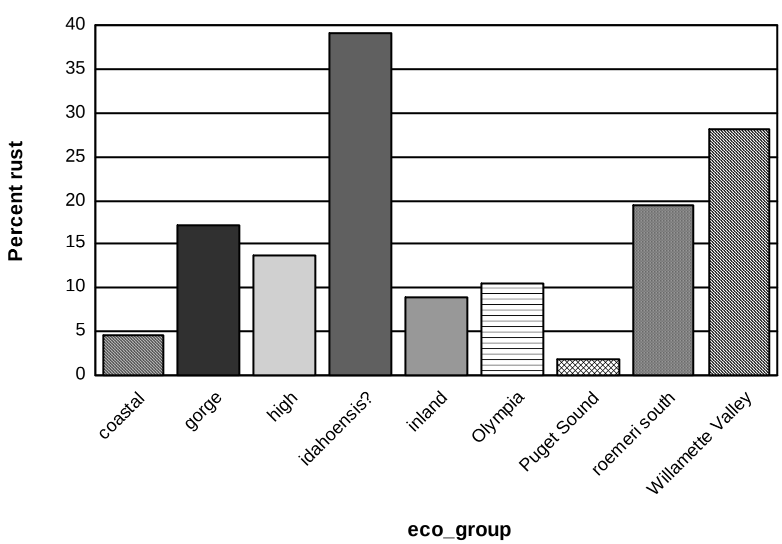


Figure 5. Rust infection rate among ecological groups.

PC1 =	918	- (0.68×LAT)	+ (7.26×LONG)	+ (0.0040×ELEV)
Prob:	*0.13*	*0.57*	*0.14*	*0.02*
$r^2 = 0.17$				
PC2 =	552	+ (3.51×LAT)	+ (5.73×LONG)	- (0.0024×ELEV)
Prob:	*0.22*	*0.01*	*0.12*	*0.05*
$r^2 = 0.40$				
PC3 =	-449	- (0.25×LAT)	- (3.81×LONG)	- (0.0057×ELEV)
Prob:	*0.28*	*0.76*	*0.26*	*0.01*
$r^2 = 0.39$				

Figure 6. Linear regressions of principal components on latitude, longitude, and elevation.

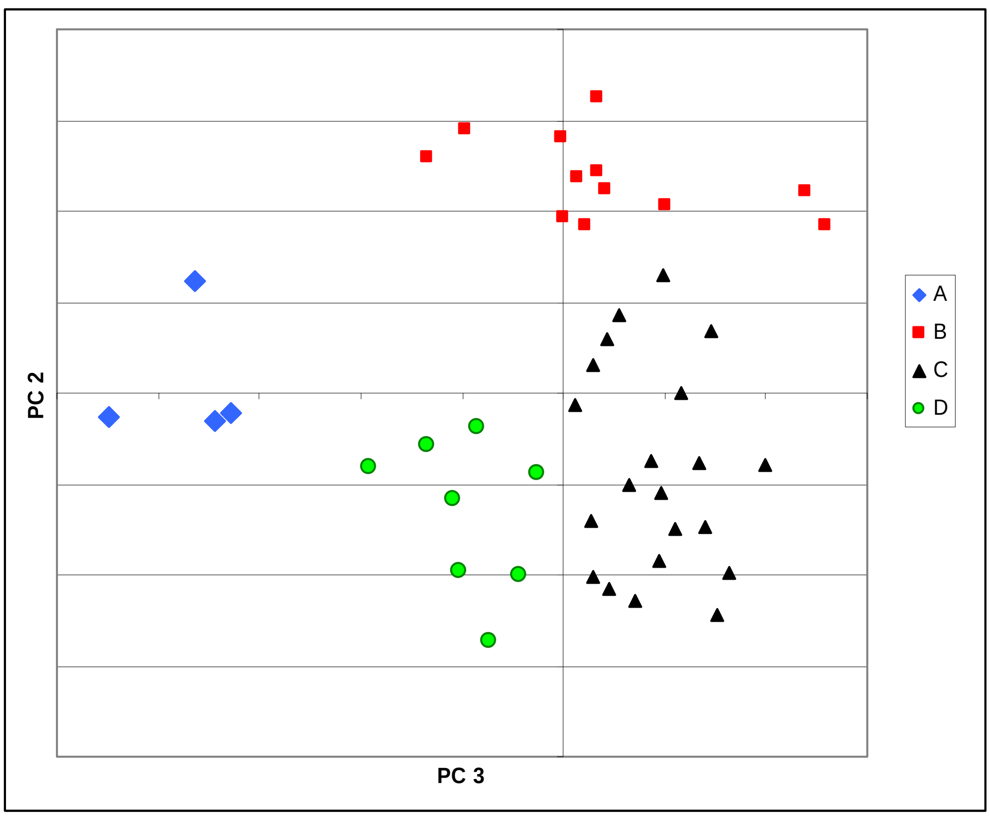


Figure 7. Scatter plot of PC2 and PC3.

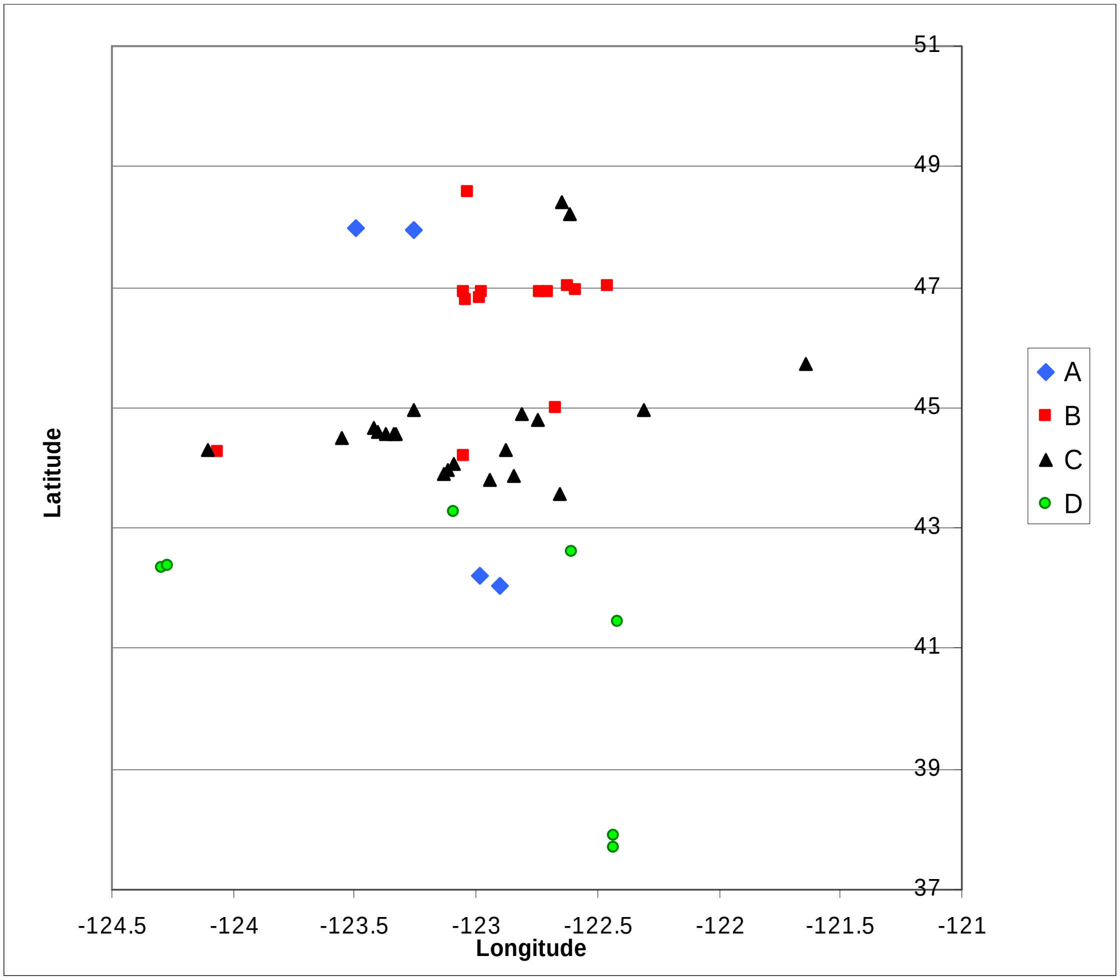


Figure 8. Latitude and longitude of cluster points

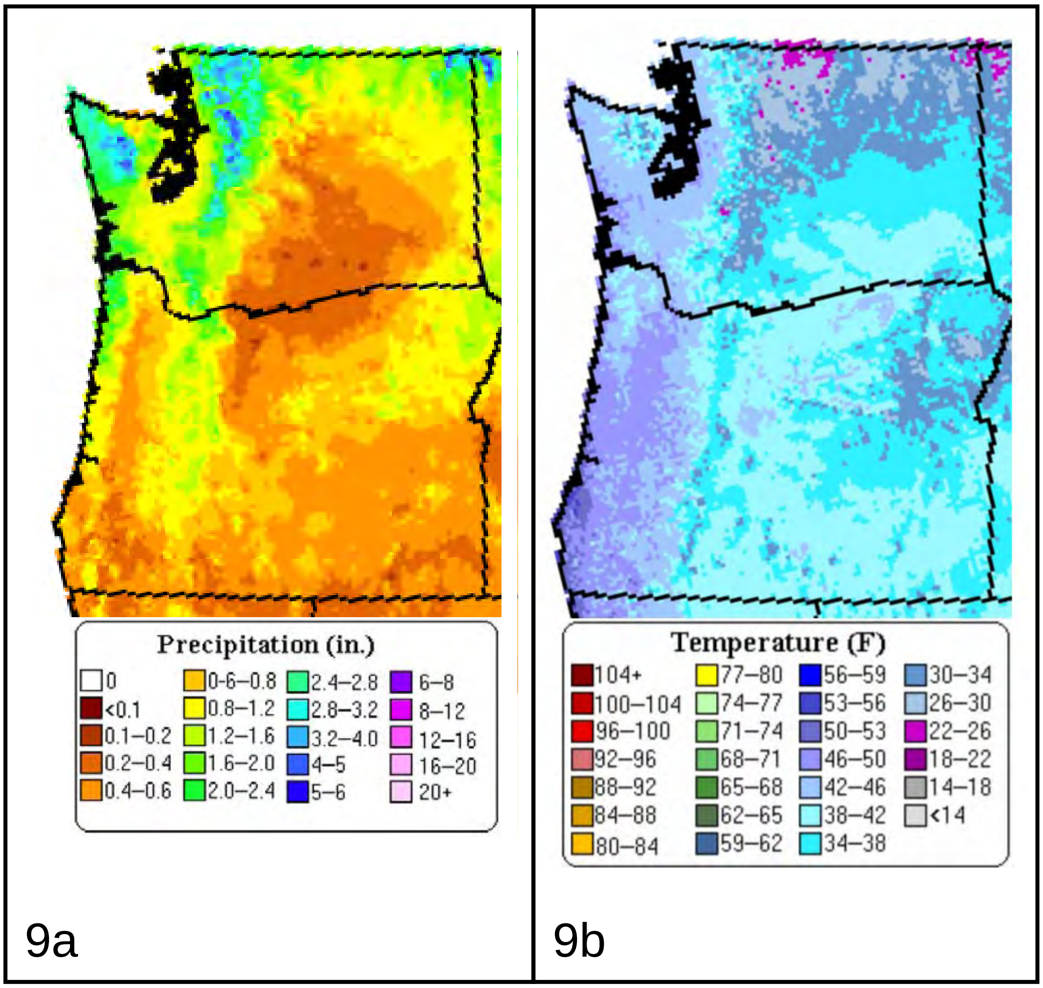


Figure 9a. February precipitation. Copyright © 2006, PRISM Group, Oregon State University, http://www.prismclimate.org Map created 6/16/2006.

Figure 9b. December maximum temperatures. Copyright © 2006, PRISM Group, Oregon State University, http://www.prismclimate.org Map created 6/16/2006.

Table 1. Plants in the common garden.

Group	Population	County	Number of plants in garden
coastal			
	Cape Perpetua	Lincoln	64
	Cummins Creek Trail	Lincoln	64
	Mt. Tamalpais	Marin	64
	San Bruno Mt.	San Mateo	64
gorge			
	Drano Lake	Skamamia	64
	Memaloose Park	Hood River	6
high			
	Blue Mt. near Deer Park	Clallam	64
	Fairview Peak	Lane	64
	Hurricane Ridge	Clallam	56
	Mary's Peak	Benton	64
idahoensis?			
	Duncan Spring	Klamath	64
inland			
	Edgewood-Weed Road	Siskiyou	64
	Hukill Hollow	Jackson	64
	Silver Fork Elliot Cr.	Jackson	64
Olympia			
	Glacial Heritage Preserve	Thurston	55
	Johnston Prairie	Thurston	64
	Mima Mounds	Thurston	64
	Mortar Pt. 3	Thurston	64
	Rocky Prairie N.A.P.	Thurston	64
	Scatter Creek	Thurston	64

Table 1. Plants in the common garden (*continued*).

Group	Population	County	Number of plants in garden
	Thirteenth Division Prairie	Pierce	61
	Upper Weir Prairie	Thurston	64
	Yelm	Thurston	62
Puget Sound			
	Fidalgo Island; Ravine Trail	Skagit	52
	Smith Prairie, Whidbey Island	Island	64
	Yellow Island	San Juan	56
roemeri south			
	Ace Williams Mt.	Douglas	64
	Cobleigh Road	Jackson	60
	Lodgepole Meadow	Curry	62
	Pyramid Rock	Curry	45
Willamette Valley			
	Abiqua Road	Marion	40
	Bald Hill southeast	Benton	64
	Bald Hill west	Benton	64
	Baskett Butte	Polk	64
	Beazell (King's Valley)	Benton	64
	Fire Knob	Marion	32
	Horse Rock Ridge	Linn	64
	Kingston Prairie	Linn	52
	Kloster Mountain	Lane	64
	Morton's property	Benton	19
	Novick property	Lane	59
	Open Spaces Park	Benton	61
	Rock Hill	Lane	64
	Row Point, Dorena Reservoir	Lane	64
	Spencer's Butte	Lane	64
	Table Rock Wilderness	Clackamas	64
	Weiss Road ridgeline	Lane	61

Table 2. Summary of traits measured.

Trait	Description
emergence date	Julian date
germination rate	ratio of seeds emerged:planted
albinism	yes/no
plant height (10 weeks)	length of longest leaf (mm)
plant width (10 weeks)	width of crown (mm)
form 03	ratio of height:width
plant height (29 weeks)	length of longest leaf (mm)
plant width (29 weeks)	width of crown (mm)
form 04	ratio of height:width
leaf color (29 weeks)	score of 1(blue) to 5(green)
rust infection (29 weeks)	score of 1 to 10
dormancy (29 weeks)	yes/no
phenological status (March – November, 2004)	scale of 1 to 10; see table for details
culm height (74 weeks)	height of tallest culm (cm from ground)
crown width (74 weeks)	width of crown (cm)
leaf abundance (74 weeks)	score of 1 to 10
culm abundance (74 weeks)	score of 1 to 10
leaf abundance (126 weeks)	score of 1 to 10
culm abundance (126 weeks)	score of 1 to 10
rust abundance (126 weeks)	score of 1 to 10
lemma length	mm
awn length	mm
palea length	mm
lower glume length	mm
upper glume length	mm
distance to lowest branch of inflorescence	cm
length of inflorescence	cm
spikelets per node	number
Total seed yield for all plants in each family (2004)	grams

Table 3. Phenological scores.

0	dormant or dead
1	vegetative - just green leaves
2	boot - thickened culms visible
3	elongation (jointing) - culms longer than general top of foliage leaves
4	first emergence of inflorescence
5	first anthesis
6	50% anthesis
7	seed milky
8	seed soft dough
9	seeds mature - culm is brown (tan/straw color)
10	dormant

Table 4. Seed data organized by ecological group.

eco_group	planted	emerged	(%)	albino	(%)
coastal	1590	1224	(77.0)	14	(1.1)
gorge	367	233	(63.5)	0	(0)
high	1152	923	(80.1)	15	(1.6)
idahoensis?	288	201	(69.8)	11	(5.5)
inland	855	711	(83.2)	11	(1.5)
Olympia	2436	1916	(78.7)	34	(1.8)
Puget Sound	824	562	(68.2)	10	(1.8)
roemeri south	576	353	(61.3)	13	(3.7)
Willamette Valley	4765	3024	(63.5)	91	(3.0)

Table 5. Average seed maturity date by ecological grouping.

eco_group	avg. seed maturity date
inland	6/13/2004
high	6/16/2004
Olympia	6/17/2004
Puget Sound	6/21/2004
Willamette Valley	6/23/2004
coastal	6/25/2004
roemeri south	6/27/2004
gorge	6/28/2004

Table 6. Correlations of traits with principal components 1-3.

	PC1	PC2	PC3
Height 2003	0.50111	0.73341	0.01807
	0.0006	<.0001	0.9084
	0.0052	<.0001	0.0012
Rust infection	-0.29711	0.00755	0.67078
	0.053	0.9617	<.0001
Color	-0.3754	0.00458	0.47535
	0.0131	0.9767	0.0013
Height 2004	0.59153	0.54193	-0.13972
	<.0001	0.0002	0.3715
Width 2004	0.78218	-0.00353	0.4366
	<.0001	0.9821	0.0034
Seed shatter date	-0.41389	0.29521	0.69238
	0.0058	0.0546	<.0001
Tiller abundance 2004	0.75202	-0.07826	0.41943
	<.0001	0.6179	0.0051
Foliage abundance 2004	0.62381	0.24391	0.32089
	<.0001	0.115	0.0359
Anthesis date	-0.58254	0.44594	0.55748
	<.0001	0.0027	0.0001
Phenological state, March 30, 2004	0.64011	-0.3579	-0.36721
	<.0001	0.0185	0.0154
Form 2003	-0.01195	0.88862	-0.34854
	0.9394	<.0001	0.022
Form 2004	-0.20015	0.22237	-0.54824
	0.1981	0.1518	0.0001
Survival 2005	0.8257	0.19617	0.01132
	<.0001	0.2074	0.9426
Survival 2006	0.55208	0.32544	-0.19609
	0.0001	0.0332	0.2076

Table 6 (*continued*). Correlations of traits with principal components 1-3.

Foliage abundance 2005	0.50403	0.48832	0.35241
	0.0006	0.0009	0.0205
Tiller abundance 2005	0.63818	-0.07793	0.08727
	<.0001	0.6194	0.5779
Seed yield	0.82361	-0.16763	0.30333
	<.0001	0.2826	0.048
Lemma	0.20147	-0.32233	0.11341
	0.1951	0.035	0.469
Awn	0.41557	0.04315	-0.14232
	0.0056	0.7835	0.3626
Palea	0.17036	-0.32911	0.15691
	0.2748	0.0312	0.315
Glume1	0.0825	-0.05914	0.06586
	0.5989	0.7064	0.6748
Glume2	0.00686	-0.10727	0.08538
	0.9652	0.4935	0.5862
Inflorescence length	0.58857	0.30043	-0.17957
	<.0001	0.0503	0.2492

Table 7. Correlations of traits with latitude, longitude, and elevation.

	Latitude	Longitude	Elevation
Height 2003	0.45414	0.21697	-0.57142
	0.0022	0.1622	<.0001
Width 2003	-0.40776	-0.02917	0.67154
	0.0066	0.8527	<.0001
Rust infection	-0.34662	-0.03288	-0.10983
	0.0228	0.8342	0.4832
Color	-0.10388	-0.31879	-0.21755
	0.5074	0.0372	0.1611
Height 2004	0.32479	0.32868	-0.50392
	0.0336	0.0314	0.0006
Width 2004	-0.07379	-0.00481	0.11896
	0.6382	0.9756	0.4474
Seed shatter date	-0.36268	-0.22073	-0.32752
	0.0168	0.1549	0.032
Tiller abundance 2004	-0.24105	-0.21075	-0.00497
	0.1194	0.1749	0.9748
Foliage abundance 2004	0.10467	-0.01864	-0.0872
	0.5041	0.9056	0.5782
Anthesis date	-0.31089	-0.04868	-0.50702
	0.0424	0.7566	0.0005
Phenological state, March 30, 2004	-0.07068	0.1893	0.315
	0.6525	0.2241	0.0396
Form 2003	0.55916	0.24898	-0.77857
	<.0001	0.1074	<.0001
Form 2004	0.18655	0.22536	-0.32152
	0.231	0.1462	0.0355
Survival 2005	0.23249	-0.0177	-0.0908
	0.1336	0.9103	0.5625
Survival 2006	0.4257	-0.13564	-0.1409
	0.0044	0.3858	0.3675

Table 7 (*continued*). Correlations of traits with latitude, longitude, and elevation.

Foliage abundance 2005	0.21473	-0.19226	-0.39223
	0.1667	0.2168	0.0093
Tiller abundance 2005	-0.2306	-0.19163	0.06132
	0.1368	0.2183	0.6961
Seed yield	-0.18547	-0.15973	0.16786
	0.2337	0.3063	0.2819
Lemma	-0.39005	-0.05438	0.27262
	0.0097	0.7291	0.0769
Awn	0.31141	-0.06147	-0.03825
	0.0421	0.6954	0.8076
Palea	-0.48223	-0.08992	0.2457
	0.0011	0.5664	0.1123
Glume1	-0.20011	-0.17739	0.05371
	0.1982	0.2551	0.7323
Glume2	-0.37253	-0.17892	0.09813
	0.0139	0.251	0.5313
Inflorescence length	0.27077	0.23981	-0.29525
	0.079	0.1214	0.0546

Table 8. Correlations of principal components with latitude, longitude, and elevation.

	Latitude	Longitude	Elevation
PC1	0.12265	0.05362	0.08646
	0.4333	0.7327	0.5815
PC2	0.45097	0.13272	-0.90175
	0.0024	0.3962	<.0001
PC3	-0.47722	-0.30268	-0.07397
	0.0012	0.0485	0.6374

REFERENCES

Aiken, S. G., and L. L. Consaul. 1995. Leaf cross sections and phytogeography: a potent combination for identifying members of Festuca subgg. Festuca and Leucopoa (Poaceae) occurring in North America. Canadian Journal of Botany 82: 1287-1299.

Alexeev, E. B. 1985. Fescues *(Festuca* L., Poaceae) of Alaska and Canada. Novosistematiki vysshikh rastenii [New Developments in Higher Plant Taxonomy] 22: 5-34. (in Russian)

Copeland, W. N. 1978. Botanical Survey of Eight Dollar Mountain (Josephine County). Unpublished report for the Oregon Natural Heritage Program, The Nature Conservancy, Portland, Oregon.

Franklin, J. F., and C. T. Dyrness. 1973. Natural Vegetation of Oregon and Washington. Oregon State University Press, Corvallis, Oregon.

Frenkel, R. E., and C. W. Kiilsgaard. 1984. Vegetation Classification and Map of the Central Siskiyou Mountains, Oregon. Unpublished report for NASA-Ames University Consortium Joint Research Interchange, Moffettfield, California.

Grime, J. P. 1977. Evidence for the existence of three primary strategies in plants and its relevance to ecological and evolutionary theory. American Naturalist 111: 1169-1194.

Pavlick, L. E.. 1983. The taxonomy and distribution of *Festuca idahoensis* in British Columbia and northwestern Washington. Canadian Journal of Botany 61: 345-353.

Pavlick, L. E. 1985. A new taxonomic survey of the *Festuca rubra* complex in northwestern North America, with emphasis on British Columbia. Phytologia 57: 1-17.

Wilson, B. L. 1997. A “new” native fescue of western Oregon prairies. pp. 153-161 *in* T. N. Kaye, A. Liston, R. M. Love, D. L. Luoma, R. F. Meinke, and M. V. Wilson, eds., Conservation and Management of Native Plants and Fungi. Native Plant Society of Oregon.

Wilson, B. L. 1999. Fescue Taxonomy in the Pacific Coast States. Unpublished Ph.D. Thesis. Oregon State University, Corvallis, Oregon.

SUPPORTING DOCUMENTATION FOR RELEASE OF JACKSON-FRAZIER GERMPLASM MEADOW BARLEY (*Hordeum brachyantherum*) (source identified class pre-varietal release, natural track)

Dale Darris
(with sections of part D co-authored by Peter Gonzalves and Oregon State University researchers)

Pre-Variety Name: Jackson-Frazier germplasm.
Experimental Designations: PI-645564 and NRCS accession number 9056373.
Species: *Hordeum brachyantherum* Nevski. Symbol: HOBR2. Synonyms include: *Hordeum brachyantherum* ssp. *brachyantherum*, *Critesion brachyantherum*, *Critesion jubatum* ssp. *breviaristatum*, *Hordeum boreale*, *Hordeum jubatum* ssp. *breviaristatum*, *Hordeum jubatum* var. *boreale*, *Hordeum nodosum*, *Hordeum nodosum* var. *boreale.* The common name is meadow barley.

A. Origin and Breeding History of the Variety (Source Identified Class Germplasm):

<u>Jackson-Frazier Germplasm</u> (9056373) meadow barley originates from a large population (several acres in size) growing in a wetland prairie within the Jackson-Frazier Wetland natural area in Benton County, Oregon: Sec 24 and 13, Township 11S, Range 5W, elevation 69 m (225 ft) above mean sea level. Coordinates: 123°14 min. 30 seconds west longitude, 44°37 min. north latitude. Mean annual precipitation: 107 cm (42 inches). Habitat: clay soil (Bashaw series), level exposure, wetland prairie plant community dominated by grass and grass-like herbaceous species including sedges (*Carex* spp.), tufted hairgrass (*Deschampsia caespitosa*), western sloughgrass (*Beckmannia syzigachne*), spiked bentgrass (*Agrostis exarata*), western mannagrass (*Glyceria occidentalis*) and cattail (*Typha latifolia*) . No information exists to suggest that this population was not naturally occurring at the time of initial and subsequent wild seed collections. Seed was originally collected In 1997 by Dale Darris then recollected in 1998 and 2000 by Dale Darris and in 2006 by Sonja Johnson.

Jackson-Frazier germplasm was not purposefully selected, bred, or hybridized. The material has not been directly compared to other populations of meadow barley but has been evaluated for seed yield, production techniques, ability to establish from seed in fields and a grassed waterway, and tolerance to soil saturation and flooding.

Jackson-Frazier Germplasm represents a single natural population consisting in large part of one predominant and one secondary phenotype with distinct morphological and phenological traits. From observations of the G0 parent population and G1 seed increase and the experimental evaluation of G2 plants and plots established from seed, there is no reason to believe growth and reproductive characteristics are not stable.

B. Description of the Variety:

Jackson-Frazier Germplasm (9056373) falls within the taxonomic limits for *Hordeum brachyantherum* Nevski described in Hitchcock and Cronquist “Flora of the Pacific Northwest” (1973) pages 645-646, Hitchcock et al. “Vascular Plants of the Pacific Northwest” (1969), Part 1, page 603, and Hickman (editor) “The Jepson Manual Higher Plants of California” (1993), page 1266. On April 8, 1998 and again on August 15, 2008, the identification of Jackson-Frazier germplasm as *Hordeum brachyantherum* was confirmed by Richard Halse, Curator of the Herbarium, Oregon State University, Corvallis, Oregon.

Jackson-Frazier germplasm meadow barley grows 24 to 54 inches (60-138 cm) tall in a loose to moderately dense tuft. Plant height is greater than typically described (20-100 cm) for meadow barley. Culms (stems) are erect to spreading and usually bent at the base. Leaves lack auricles, have a short ciliolate ligule, and are glabrous (hairless) or with a few, scattered fine hairs. Leaf blades are 2 to 9 (11) mm wide (Hitchcock 1969), and mostly basal except for 1-3 (4) short leaves midway up the culm (Guard 1995). Additional leaves occur along upright to spreading vegetative tillers arising from the base. The inflorescence (seedhead or panicle) is a narrow, flattened spike. Spikes are mostly erect, narrow, and 1.5 to 4 inches (4-10 cm) long, with three spikelets per node and one floret per spikelet. The central spikelet is fertile and sessile (stalkless) and the lateral ones reduced, on a short pedicel about 1 mm long, and usually sterile but sometimes staminate (Hitchcock, et. al. 1969, Hickman 1993). Both spikelet bracts (glumes) and fertile floret bracts (lemmas) are bristle or awn-like (USDA Forest Service 1937). The brittle central axis (rachis) of the spike easily breaks off (shatters) in segments from the top down at maturity. By mid-summer only the lowest spikelets remain (Guard 1995). Some plants of Jackson-Frazier germplasm have strictly green stems with purple joints, but the predominate phenotypes have blue-green stems (due to a bluish-white waxy coating). Seed maturity also differs by several days between phenotypes. Leaves and spikes range from green to purple-green. These colors may or may not be typical of the species. This cool season grass actively grows during the winter within its area of origin and year round if sufficient moisture is present. It may flower more than once each year under moist conditions, especially if clipped.

C. Evidence Supporting the Identity of the Variety and Statements or Claims Concerning the Variety's Performance Characteristics:

Evaluation and Increase of Three Populations of Meadow Barley

Dale Darris

Introduction

Meadow barley (*Hordeum brachyantherum* Nevski) is a native, perennial, cool season bunchgrass. Two subspecies are currently recognized: ssp. *brachyantherum* and ssp. *californicum* (Hickman 1993, USDA NRCS 2008). The latter is referred to as California barley. Older synonyms include *H. boreale* and *H. nodosum*. Another common name is little barley. This widespread and broadly adapted species occurs from central Canada and Alaska south to California and west to Montana and New Mexico, as well as parts of the midwest, northeast and southeast US. Its elevation range is from sea-level to over 12,000 ft. (3650 m) in the mountains.

Classified as a facultative wetland plant (FACW) in Regions 0 and 9 by the US Fish and Wildlife Service (Reed 1988), meadow barley tolerates poorly drained, anerobic soil conditions (USDA NRCS 2008), for lengthy, if not indefinate periods. Studies by the Corvallis Plant Materials Center indicate that mature plants of certain populations such as Jackson-Frazier germplasm can also tolerate shallow spring and summer inundation (water up to 7 inches deep for several months) or winter flooding (water up to 16 inches for five months)(manuscript). However, the ability to survive both conditions consecutively or indefinately is yet uncertain and may be unlikely. Typical habitats include moist to wet prairies, salt marshes, and streambanks, as well as drier knolls and rocky ridges (Guard 1995). Meadow barley is found on acid to alkaline soils (pH 5.5-8.5) with textures ranging from sand to clay. Salinity tolerance is considered moderate or high (USDA NRCS 2008, Forest Service 1987). High tolerance may especially be the case for ecotypes found along coastal beaches and in brackish, estuarine habitats of the Puget lowlands where it can be locally abundant. While described as long-lived (Jackman 1965), some individuals and entire stands appear to be naturally short-lived (3-5 years), even under favorable growing conditions. The species is considered shade intolerant and fire tolerant (USDA NRCS 2008).

Meadow barley grows 20-100 cm tall in a loose to moderately dense tuft. The culms (stems) are erect to spreading and usually bent at the base. The leaves lack auricles, have a short ciliolate ligule, and are glabrous (hairless) or with a few, scattered fine hairs, 2 to 9 mm wide (Hitchcock 1969), and mostly basal except for 1-2 short leaves midway up the culm (Guard 1995). Additional leaf blades extend along vegetative tillers arising from the base. The infloresence (flowerhead or panicle) is a narrow, flattened spike. Spikes are mostly erect, narrow, and 1.5-4 inches (5-10 cm) long, with three spikelets per node and one floret per spikelet. The central spikelet is fertile and sessile (stalkless) and the lateral ones reduced, on a short pedicel about 1 mm long, and usually sterile but sometimes staminate (Hitchcock, et. al. 1969, Hickman 1993). Both spikelet bracts (glumes) and fertile floret bracts (lemmas) are bristle or awn-like (USDA Forest Service 1937). The central axis (rachis) of the spike becomes brittle and the seed head easily breaks off in pieces (shatters) from the top down as it matures.

The seed heads are bristly and often purplish in color, becoming stubby at maturity which distinguishes it from timothy (Phleum pretense), meadow foxtail (Alopecuris pratensis), or other grasses with narrow spikes. It loosely resembles common barley (Hordeum vulgare) which is an annual usually confined to cultivated areas. Meadow barley is upright, while its closest relative, California barley, is shorter and more spreading.

Meadow barley readily hybridizes with other *Hordeum* species (Baum and Bailey 1990), as well as certain members of the genera *Elymus* (wildrye) and *Agropyron* (Pojar 1994, USDA NRCS 1997). Hybrids with other genera are apparently sterile, but this could be a consideration when determining isolation guidelines for certified seed production, especially with other *Hordeum* species.

As an important wetland grass in western Oregon, western Washington, and northwestern California, uses for meadow barley include restoration of native freshwater and estuarine plant communities, erosion control along streambanks and shorelines, and herbage for wildlife or livestock on poorly drained soils. Its moderate to rapid establishment and broad adaptation merits consideration as quick, competitive cover on seedbeds previously monopolized by reed canarygrass (*Phalaris arundinacea*), or in mixtures with other native wetland grasses like tufted hairgrass (*Deschampsia cespitosa*) and American sloughgrass (*Beckmannia syzigachne*). Palatability or forage ratings for livestock and grazing wildlife are listed from “low“ (USDA NRCS 2008), to “fair” (Platts 1987), to “good” or desirable prior to heading out (US Forest Service 1937). It is regarded useful as a temporary nurse crop for longer lived species on dry, infertile sites. The species is occasionally used as a vineyard cover crop in California. Meadow barley can provide wildlife cover and the leaves and large seed are potential food for small mammals and waterfowl. This is among the more broadly adapted and easier to establish of all native grasses in the western US.

Despite its potential, wider use appears restricted by a lack of available, ecoregion specific seed sources, low seed yields, and limited information on agronomic seed production. Therefore, the purpose of this study is to (1) increase and release one or more natural populations of meadow barley from, and specifically for use in, western Oregon and western Washington ecoregions, and (2) evaluate seed production, processing, germination, and establishment technology.

Methods and Materials

Seed collection:

In 1996 seed was obtained from two natural stands, one in western Oregon and one in western Washington. A third population (Jackson-Frazier wetlands near Corvallis in Benton Co., OR) was sampled in 1997, 1999, 2000, and 2006. Refer to Table 1 for accession information.

Table 1. Origin of meadow barley accessions

Accession No.	Origin	Habitat Cowardin (1979) system & other descriptors
9056344	West Eugene wetlands, Lane Co., OR	Palustrine, emergent wetland, persistent (wetland prairie)
9056345	Nisqually National Wildlife Refuge, Thurston Co., WA	Estuarine, intertidal, emergent wetland, persistent (upper tidal zone, brackish marsh)
9056373 (Jackson-Frazier germplasm)	Jackson-Frazier wetlands, Benton Co., OR (nature preserve)	Palustrine, emergent wetland, persistent (wetland prairie plus freshwater marsh) AND Palustrine, scrub-shrub, persistent

Establishment for seed production:

1997-2000: For accessions 9056344 and 9056345, an isolated G1 stand of each was established from containerized plants at the Corvallis Plant Materials Center (PMC) in May (5 rows of each) and September of 1997 (1 additional row of each). A field of accession 9056373 (Jackson-Frazier germplasm) was similarly planted from plugs in May of 1999 (3 rows) and September of 2000 (5 additional rows) at the Oregon State University, Hyslop Field Laboratory, Benton County, Oregon (elevation 225 ft.). Refer to Table 2. Soil type for fields 7-6 (9056345) and 7-12 (9056344) was a moderately well drained Woodburn silt loam and the soil for field 2-2 (9056373) was a well drained Willamette silt loam. For all three accessions, wild seed (G0) was used to start plants in 7 cubic inch stubby cell cone-tainers filled with media composed of peat, perlite, a low concentration of starter fertilzer (both major and minor nutrients), wetting agent, and dolomitic lime (Sunshine Mix #1). The seed was de-awned but no physiolgical conditioning treatment was applied. Containers were fertilized 1-2 times with a balanced liquid fertilizer and transplant quality stock was obtained within eight weeks of sowing in the greenhouse (minimum 65-70°F). No apparent insect or disease problems were noted in the greenhouse or shadehouse. Transplanting to the field was done either mechanically with a 2-row transplanter pulled behind a tractor or manually with a dibble to make the holes. In order to allow for cultivation, row spacing was 28 inches. Irrigation water was applied 3-6X during the growing season for spring transplants only. No irrigation water was used after the year of establishment.

2006-2007: In July 2006 an additional 12 oz of G0 seed of Jackson-Frazier germplasm (9065373) was collected from the Jackson-Frazier wetland in Benton County, Oregon. This seed was used to expand the existing stand on field 2-2 by sowing 6 new rows (.028 acre) in October of 2006 . Fifteen lbs of seed per acre were planted using a three row Planet Junior. Additionally, plants produced in stubby cone-tainers over winter were used to add 7 more rows (0.32 acre) in March 2007. Row spacing was 24 inches. By 2007 the combined old and new stand on field 2-2 totaled 0.10 acre. In 2007 and 2008 the seed produced from it were certified as G1 source identified class of Jackson-Frazier germplasm by the Oregon State Seed Certification Service.

In order to conduct an experiment to test the tolerance of carbon-seeded meadow barley to diuron [3-(3,4 dichlorophenyl)-1, 1-dimethylurea] and to produce noncertified G2 seed for field plantings, an additional stand (0.186 acre) of Jackson-Frazier germplasm (9056373) was sown in October of 2007 on field 5-1 of the OSU Hyslop Field Laboratory. Diuron is the most common herbicide used in conjuntion with carbon seeding for pre-emergence weed control when establishing new grass fields for seed production. A 6 row Planet Junior equipped with a tank and sprayer nozzles was used to plant the field and apply a narrow band of activated carbon over the seeded rows. The row spacing was 12 inches and the seeding rate was 16 lbs/ac. For more details on the experiment, refer to the report entitled "Carbon-seeded meadow barley tolerance to pre-emergence applications of diuron herbicide for weed control in the establishment of new seed production fields". The southern 2/3 of the field was used for the diuron experiment In 2006-2007.

For newly sown fields of meadow barley, no fertilzer was applied until the following spring when 50 lbs nitrogen (N)/ac were used.

<u>Management of seed increase fields</u>:

1997-2005: Fertilization of established fields of meadow barley consisted of 25 lbs N/ac (as granular 34-0-0-12) each fall and 50 lbs N/ac each March through 2005. Banvel (dicamba) and 2,4D amine were applied according to label instructions as needed in the spring for broadleaf weed control. Cultivation and spot spraying with glyphosate were also used to control weeds between rows, especially annual grasses and volunteer meadow barley seedlings. As a demonstration of annual grass control, an application of Karmex (diuron) at the rate of 2.3 lbs a.i./ac was applied in October 1998 to the two northern rows of meadow barley in fields 7-6 and 7-12. Leaf/stem rust (*Puccinea sp.*) was treated in some years with 1-3 applications of Bravo (chlorothalonil) and Tilt (propiconazole) according to label instructions for grass seed production. When hand harvesting, spikes infected with head smut (*Ustilago* sp.) were avoided. Occurrence of head smut was very low from year to year in Jackson-Frazier germplasm, especially in comparison to accessions 9056344 and 9056345.

<u>Herbicide trial</u>: In order to evaluate the abiliity of select heribicides to control annual bluegrass (*Poa annua*) in an established field of meadow barley grown for seed, an experiment was superimposed on to the existing field of 9056345 in October 2001.

Following research results published by the USDA Agricultural Research Service (Mueller-Warrant 1999) for perennial ryegrass (*Lolium perenne*) seed production in western Oregon, six different combinations of heribicides were chosen for a PMC study. Herbicides included Prowl (pendimethalin), Goal (oxyflourfen), Karmex (diuron), Axiom (fulfenacet + metribuzin), and Rely (glufonsinate-ammonium). Based on the results of the experiment, it was decided that fall application of Prowl (2 lbs ai/ac) plus Axiom (0.375 lbs ai/ac) was among the best treatments for control of weedy grasses and improving seed yields. Therefore, further evaluation was warranted.

The two fields of 9056344 and 9056345 were eliminated in 2001 and 2002 respectively while the stand of Jackson-Frazier germplasm was left intact. Row cultivation was discontinued in 2002 and annual grasses and volunteer seedlings were controlled in the remaining field (2-2) with experimental fall applications of Axiom plus Prowl for three of the next four years. [Prowl and Axiom were used for research purposes only. They are presently not labelled for seed production of meadow barley].

2006-2008: Fall fertilization was deemed of little or minor value for improving seed yield of Jackson-Frazier germplasm meadow barley and was discontinued. Only 50 lbs N/ac were applied each year in March to Jackson-Frazier germplasm starting in 2006 on field 2-2 and 2007 on field 5-1. The use of 2,4D amine was discontinued and only Banvel (dicamba) or Bison (MCPA plus bromoxynil) were used for broadleaf weed control. Likewise, the experimental application of Prowl plus Axiom for annual bluegrass control ended in 2005 and was replaced by Outlook (dimethenamid-P) in October 2007. The rate used in a single application to fields 2-2 and 5-1 was 18 oz ai/ac. This herbicide is labeled for control of annual weedy grasses in established fields of perennial grasses grown for seed in Oregon (BASF Corporation 2007), which can include meadow barley. Supplemental labeling expires December 31, 2009 unless renewed. Use of Tilt plus Bravo for control of leaf/stem rust was replaced in May-June of 2007 and 2008 with Quilt (azoxystrobin plus propiconazole). It was applied according to label directions. In June 2007 the rust disease on meadow barley foliage was officially diagnosed as stripe rust (*Puccinea striiformis*) by the OSU Plant Clinic.

<u>Harvesting and seed processing</u>:

Information on fields, seed lots, and harvest methods is shown in Table 2. In 1998, 9056344 and 9056345 meadow barley were both swathed on June 22 and threshed with a stationary plot thresher several weeks later. A second harvest of 9056344 only was conducted by hand on August 8 to obtain seed produced by a secondary flush of fertile tillers. In 1999, 9056344 was mechanically harvested twice (July 1 and July 6) using a six foot wide flail-vac seed stripper, while 9056345 was similarly stripped on July 9^{th} and 14^{th}. In 2000, seed of 9056344 was harvested with the flail-vac 3 times (June 21, June 26, July 6) and was 9056345 (June 27, June 30, July 7).

From 2000 through 2005, seed of Jackson-Frazier germplasm meadow barley (field 2-2) was harvested with hand sickles or rice knives between July 1 and July 12 each year. Different rates of seed maturation within the field necessitated harvesting on two separate dates, 3 to 6 days apart. Beginning in July 2006, the flail-vac seed stripper was used to harvest the field twice each year. The second harvest occurred 4 to 7 days after the first.

Small lots of manually harvested seed were run through a hammermill to break up the spikes and spikelets into individual florets of seed, brushed with a small brush machine (Westrup model LA-H huller-scarifier) to further detach bracts, sterile florets, and awns, and cleaned with a 1 or 2-screen air screen machine (Crippen). For seed that was threshed first, a coarse scalping step was added before the hammermill was used. For seed that was stripped with a flail-vac seed stripper, stems were removed by rough scalping and then the seed was run through a brush machine (using mantle number 12, 14 or 16) before cleaning.

Table 2. Seed production of meadow barley 1998-2008, Corvallis PMC

Accession No.	Field No.	Size (ac)	Seed Lot -harvest yr-	Total Yield (lbs)	Yield (lbs/ac)	Harvest Method	Residue Mgt.
9056345	7-6	.045	SCO-98-344	2.1	47	Swath, thresh	Bale, mow
		.054	SCO-99-344	2.5	46	Flail-vac (2X)	Mow, bale
		.054	SCO-00-344	12.0	222	Flail-vac (3X)	Mow, bale
3 yr Mean					105		
9056344	7-12	.044	SCO-98-345	0.81	18	Swath, thresh	Bale, mow
		.053	SCO-99-345	5.3	100	Flail-vac (2X)	Mow, bale
		.053	SCO-00-345	4.6	87	Flail-vac (3X)	Mow, bale
3 yr Mean					68		
9056373	2-2	.015	SCO-00-373	0.12	10	Hand clip	Mow, bale
Jackson-		.040	SCO-01-373	1.0	25	Hand clip	Mow, bale
Fraizer		.040	SCO-02-373	4.9	123	Hand clip	Mow, bale
germplasm		.040	SCO-03-373	5.5	138	Hand clip	Burn vs bale
		.040	SCO-04-373	4.6	115	Hand clip	Mow, bale
		.040	SCO-05-373	3.0	75	Hand clip	Mow, bale
6 yr Mean					81		
Jackson-	2-2	.040	SG1-06-373	5.0	125	Flail-vac (2X)	Field burn
Frazier		.040	SG1-07-373	9.0	225	Flail-vac (2X)	Flail chop
germplasm		.10	SG1-08-373	25	250	Flail-vac (2X)	Flail chop
3 yr Mean					196		
J-F germpl.	5-1	.186	SG2-08-373	71	382	Flail-vac (2X)	Flail chop

<u>Post harvest residue management</u>:

Residue management by field and year is shown in Table 2. Post harvest residue management through 2005 consisted of baling straw (crop aftermath) and mowing stands to a stubble height of 3-4 inches. However, in 2003 a study was superimposed onto field 2-2 of Jackson-Frazier germplasm to evaluate the effect of propane flaming versus baling and mowing. Refer to report entitled “Effect of a simulated field burn (propane flaming) on plant Injury and seed production of Jackson-Fraizer germplasm meadow barley". In 2006, crop aftermath on the same field was subject to an open field burn. For 2007 and 2008, residue was cut off and removed with a flail-type forage harvester. Remaining stubble height averaged 3 inches.

Seed germination:

A germination study was conducted in 1997 with the Oregon State University Seed Laboratory using two wild seed lots/accessions of meadow barley, SNC-96-344 and SNC-96-345. Seed of Jackson-Frazier germplasm was not included in the study. Experimental design was a completely randomized design with 4 replications of 100 seeds per replication. Seed treatments consisted of a control, 14 day moist pre-chill (4°C), KNO_3 (0.2% solution), and pre-chill plus KNO_3. Environmental conditions consisted of daily fluctuating temperatures of 15°C (16 hr dark) and 25°C (8 hr light). Statistical analysis included analysis of variance (ANOVA) and a Least Significant Difference (LSD) test at the P=0.05 level of significance. Germination counts were taken at 7, 14 and 21 days. Seed viability was determined by standard tetrazolium chloride (TZ) staining methods.

Standard germination and purity tests were run on three seed lots of Jackson-Fraizer meadow barley harvested from 2005 through 2007. A 7-day prechill was included in the 2005 and 2007 tests.

Results and Discussion

Greenhouse and container production practices:

- Sowing and container propagation methods were satisfactory. Seedling emergence was rapid in the containers, usually within seven days under warm (60-90°F) greenhouse conditions and natural daylight. No significant insect or disease pests were noted during greenhouse propagation. Given meadow barley's broad tolerances, this species is likely to perform well with a wide array of potting medias and growing conditions.

Field establishment, management, and production:

- Seed yields were low (Table 2). However, yields of Jackson-Frazier germplasm improved substantially by 2008, more than doubling in average for the last 3 years compared to the first 7. This may be due wholly or in part to improved management practices and harvest techniques. Seed yield was by far the highest (381 lbs/ac in 2008) for the G2 field of Jackson-Frazier germplasm when grown on 12 inch row spacing. If sustainable, this would suggest that a 12 inch spacing is superior to 24 inches.

- Meadow barley appears to have little if any vernalization requirement. When spring sown in containers, plants flowered without exposure to conditions important for floral induction of perennial grasses. Thus, late fall, dormant, or early spring sowing may allow for partial seed harvests the first full growing season, similar to blue wildrye (*Elymus glaucus).*

- To control annual grassy weeds and establish new stands of meadow barley for seed production, the use of the pre-emergence herbicide diuron after carbon seeding appears promising (refer to report on page 20). However, until trials are completed and a label is obtained, meadow barley must be sown without diuron into a firm, weed free seedbed.

- Different row spacings and seeding rates have not been directly compared. However, initial results suggest a narrow 12 inch spacing may produce as much or more seed per acre then a 24 inch spacing. Good stands were obtained with seeding rates of 15-16 pounds/ac.

- A late winter or early spring application of nitogen fertilizer is a general requirement for good grass seed production in western Oregon. The 50 lbs N/ac rate applied each March on meadow barley is low in comparison to introduced grasses grown for seed. Experimentation is needed to determine the optimal rate and timing to maximize seed yields of meadow barley.

- Insect pests were not a problem during the production of meadow barley, but diseases including stripe rust, ergot (*Claviceps* sp.), and head smut can be problematic in some years. Ergot was severe in 1999 (as much as 10% of the heads infected) on accessions 9056344 and 9056345, as was head smut. Infection rates for both diseases were low in 1998 and 2000 (<1%). Jackson-Frazier germplasm appeared to have lower infection rates of these two diseases. While signs of leaf and stem rust varied widely from year to year among accessions, it was still common on Jackson-Frazier germplasm. It can be controlled with a number of fungicides labelled for grass seed. Quilt (azoxystrobin plus propiconazole) appeared to be reasonably effective.

- Volunteer seedlings of meadow barley and weedy annual grasses such as annual bluegrass and rattail fescue (*Vulpia myuros*) were a problem in the established fields. The fall 1998 application of diuron at 2.3 lbs a.i./ac was effective in controlling annual bluegrass and volunteer meadow barley, but damage (stunting, dieback) was severe in one year old transplanted rows and slight to moderate in two year old rows. From the 2001-2002 herbicide experiment to control annual bluegrass in an established stand, meadow barley demonstrated good tolerance to a number of tank mixes and heribicide combinations at rates and times used, or under research for, other grass seed crops. Several treatments were effective in boosting yields and controlling annual bluegrass, including Prowl plus Axiom. Lowest seed yields and biomass production (as a result of growth suppression by weeds or herbicide injury) and highest occurrences of annual bluegrass were recorded for the control and Rely treatments (data not shown). None of the herbicides or tank mixes used in the study are presently labelled for use on meadow barley. However, the herbicide Outlook is labeled (through December 31, 2009) for established fields of grasses grown for seed in western Oregon and can be applied to meadow barley. It appeared to be very effective in controlling annual grasses and meadow barley seedlings. Crop injury was low and seed yields were high in 2008.

- Most broadleaf weeds were effectively controlled with label rate applications of Bison or Banvel during the year after fall sowing and in established fields of meadow barley. Resistant weeds will require other measures or dfferent herbicides.

- Mechanically harvesting seed produced from meadow barley required special methods. All three populations of meadow barley contained plants which matured seed at different times. Among plants of Jackson-Frazier germplasm, maturity occurred as much as 7 days apart. Furthermore, maturation on each spike is uneven and the seed shatters readily, contributing to a potential loss of yield. Seeds mature from the top of the spike downward, with corresponding disarticulation of the spikelets and segments of the rachis as time proceeds. Finally, conventional swathing (windrowing) and combining (threshing) appeared to be a poor choice because of excessive seed losses in the windrow. To address these issues, the use a flail-vac seed stripper appeared to be a good choice by allowing for mutliple harvests of the same stand. Only mature seed higher on the spike was stripped off on the first pass over the field, allowing for a second or third harvest several days later. In addition, because multiple harvesting captures seed from later maturing plants, it can help preserve genetic diversity from generation to generation.

- With a seed stripper, it was determined that harvesting should commence with the first sign of shattered (disarticulated) tips on 10-25% of the spikes, and when most of the spikes had turned from purple (or green) to tan down to their base. Depending on the stand, as much as 60-70% of the seed appeared to be harvested on the first pass. A second pass, 3-7 days later, may have typically removed another 10-20%.

- Grown on the same soil type at the PMC accession 9056344 matured about one week earlier than 9056345 in 1999 and 2000, which may reflect its more southern origin (Lane Co., OR, versus Thurston Co. WA). Maturity differences among these accessions and Jackson-Frazier germplasm were less comparable because the latter was grown on a different soil type. Soil moisture conditions during spring and early summer greatly affect seed maturition of Jackson-Frazier germplasm, with maturity occuring 2-3 weeks later each year at its origin (the Jackson-Frazier wetlands) compared to the PMC fields.

- Both accession 9056344 and Jackson-Frazier germplasm developed a secondary flush of fertile tillers in July-August in some years. This indeterminate flowering may have been stimulated by swathing or mowing and relate to favorable soil moisture conditions during certain summers. These observations suggest that exploitation of long growing seasons, clipping responses, and post harvest irrigation may provide avenues for multiple harvests and increased seed yields.

- Seed processing of meadow barley is multistep. For most drilling and mechanized broadcasting of seed, spikelets will need to be broken down into individual florets and awns removed or reduced to improve seed flow through equipment. To break apart spikelets, the hammermill was effective but time consuming. This step is not always required. Seed had to be run through a brush machine (Westrup huller-scarifier) once or twice for substantial awn removal and the breakup of spikelets. Scalping may be required prior to the use of a hammermill and brush machine. A 2-screen air screen machine is sufficient for final scalping and grading.

- For seed production of most perennial grasses, thermal or non-thermal removal of post harvest residue is important for improving seed yields the following growing season. Under this assumption, crop residues of meadow barley were removed each summer after harvest. An experiment comparing propane flaming with conventional mowing and baling was conducted in 2003-2004. Propane flaming injured plants and reduced seed yields. However, anecedotal observations from an open field burn in 2006 indicated no detrimental effects from this treatment. The use of a flail-type forage harvester was also an effective means to remove crop aftermath. An experiment comparing the most common methods is needed.

<u>Seed germination</u>:

- The seed germination study indicated that special physiological conditioning may be required for some seed lots or ecotypes (i.e. 9056345, estaurine origin) of meadow barley (Refer to Table 3.) and that 14 days of moist pre-chilling does not fulfill it. However, germination was modestly but significantly improved (P=0.05) by 4-6% with the use of KNO_3 for lot SNC-96-345, but about 40 percent of the live seed still failed to germinate. Seed may require further treatment, such as osmotic conditioning or more lengthy stratification periods. Seed lot SNC-96-344, from a freshwater population, showed little if any need for further conditioning and KNO_3 did not significantly improve germination (P=0.05). This difference suggests that further evaluation of physiological requirements for germination of meadow barley is needed. It may be that estuarine populations differ in their requirements from freshwater ones. For example, an estuarine population may be acting more as a halophyte, a plant which grows and reproduces in salty soil. NaCl treatments are known to increase (or decrease) germination in some halophytes (Baskin and Baskin 1998). Until more is known, it is suggested that seed lots be tested for total viabilty with a tetrazolium (TZ) test prior to use. For restoration, it may be advisable to only use seed of ecotypes from like environments.

- Jackson-Frazier germplasm was not tested for seed dormancy but results from standard germination tests suggest dormancy is low to nonexistent. Results of three seed germination and purity tests are shown in Table 4. Based on these results and other observations, spring seeding of this population is possible although fall seeding is generally preferred.

Table 3. Results of 1997 meadow barley seed germination study

Accession No.	Seed Lot No.	TZ[1] (%)	Seed Germination (%) by Treatment[2] No prechill H_2O	No prechill H_2O+KNO_3	14 day prechill H_2O	14 day prechill H_2O+KNO_3
9056344	SNC-96-344	92	88[a]	87[a]	90[a]	91[a]
9056345	SNC-96-345	88	44[b]	48[a]	43[b]	49[a]

[1]TZ=tetrazolium test as an indicator of total seed viability.
[2]numbers with the same letter are not significantly different (LSD test) at the P=.05 level. Letters apply to "within" seed lot data only.

Table 4. Results of seed germination and purity tests of Jackson-Frazier germplasm

Seed lot -harvest yr-	Test date	Germ. %	Purity %	Inert %	Other crop %	Weed seed %	Remarks
SG1-05-373	9/14/06	90	99.16	0.79	0.03	0.00	7 day pre-chill
SG1-06-373	4/16/08	85	97.89	1.27	0.50	0.34	No pre-chill
SG1-07-373	4/16/08	76	95.71	4.26	0.03	<0.01	7 day pre-chill

*NOTE: The use of commericial names in this report is not an endorsement by NRCS of that product***.**

.

Effect of a Simulated Field Burn (Propane Flaming) on Plant Injury and Seed Production of Jackson-Fraizer Germplasm Meadow Barley

Dale Darris and William Young III*

Introduction

Field burning is a long standing method of removing post harvest residue (crop aftermath) from several grasses grown for seed in the Willamette Valley of Oregon. Ideally, open field burning is done after seed harvest but prior to fall regrowth by the grass plant. The goals are to control certain seed diseases (blind seed, ergot) or insect pests, destroy weed and volunteer crop seed, recycle nutrients, remove straw and decadent foliage, improve effectiveness of soil applied herbicides, or increase seed yields by enhancing floral induction within the grass plant (mostly fine fescues). Concerns over air quality and smoke hazards beginning in the late1980s resulted in the phase down of open field burning and its replacement with other means of residue management such baling, raking, removal with a loafer, close mowing, composting, vacuuming, and flail chopping (Lies 2002).

While field burning and alternative non-thermal methods of post harvest residue management have been extensively investigated by University, USDA, and other researchers for several high value introduced grasses grown for seed in Oregon, little work has been done with native species in the region. The purpose of this study was to determine the effect of a single propane burn (bale + propane burn) versus a bale only treatment on plant injury and seed yield of Jackson-Frazier germplasm meadow barley (*Hordeum brachyantherum*) under cultivation for seed.

Methods and Materials

An existing 8 row, G1 seed increase field of Jackson-Frazier (9056373) meadow barley on field 2-2, Hyslop Field Laboratory, Benton County, Oregon, was used for the experiment. The field was originally established in 1999 using vegetative plugs. The study was done in cooperation with the Crop and Soil Science Dept., Oregon State University. A propane field flamer was used to apply the burn treatment on September 15, 2003 (photo). Each plot was 12 ft. wide by 18 ft. long. The meadow barley stand was mowed and baled after seed harvest and prior to burning to remove a high percentage of the residual straw load. Treatment 1 was the control (bale only) and Treatment 2 was bale + propane burn. The meadow barley seed increase field and superimposed plot area continued to be uniformly treated with the standard regime of fertilizer, before, during, and after the experiment. The regimen was 25 lbs/ac of actual nitrogen in the fall and 50 lbs/ac of actual nitrogen in March. Annual grasses and volunteer seedlings were treated for control in October 2003 with a tank mix application of Axiom (flufenacet + metribuzin) and Prowl (pendimethalin) [These herbicides were not labeled for meadow barley at the time of application but applied for experimental purposes]. There were few broadleaf weeds in 2003 requiring only minor manual control in spring and summer.

Experimental design was completely randomized with 4 replications per treatment. Data for relative seed production were collected by sub-sampling 10 randomly selected meadow barley plants per plot. Seed sampling occurred in July 2004. Additional data (March 2004) consisted of a: (1) visual score of weed abundance (1-10 with 10 having the fewest weed seedlings), (2) visual score of crop seedling volunteers (1-10 with 10 having the fewest crop seedlings), (3) visual score of recovery (vigor-abundance of spring regrowth as an indicator of burn injury on a scale of 1=dead to 10=no outward sign of burn injury, plants appear fully recovered), (4) percent mortality (based on total number of all plants in each plot with no regrowth from basal crown), and (5) percent plant injury (based on total number plants in each plot with irregular or "partial" recovery from the crown). Yield per plot and per acre was estimated by calculating the total surface area occupied by the sub-samples within each plot (8 sq. ft.). Data analysis consisted of ANOVA and the F test at the P=0.05 level of significance. Transformation of percent and scoring data was deemed unnecessary.

Burned and unburned plots of 9056373 meadow barley immediately after September 15, 2003 propane burn. Photo by Amy Bartow.

Results and Discussion

Results of the study are reported in Table 1. Seed yield was significantly less and plant injury (March 2004) significantly higher in the burn and bale treatment compared to the bale only treatment at the P=.05 level of significance. There was no statistically significant difference between the two treatments in terms of plant mortality, regrowth, and the occurrence of weeds and volunteer seedlings of meadow barley.

Table 1. Results of 2003 simulated field burn experiment with 9056373 meadow barley.

Treatment	seed yield (lbs/ac)	% mortality	% injury	weeds	crop volunteers	regrowth
Bale only	226	1.6	29.2	1.3	2.0	6.5
Bale+burn	147	3.2	41.4	1.3	1.3	6.5
P value	.0381	.196	.0491	1.00	.168	1.00
C.V.	22.9	64.8	19.9	40.0	41.7	15.4

Propane flaming of remaining stubble and crop residues occurred in mid-September after baling and prior to the commencement of fall rains and the appearance of significant new regrowth. Under the prevailing conditions of this experiment, the bale and burn method caused greater plant injury and reduced seed yields of Jackson-Frazier germplasm meadow barley the following growing season compared to the bale only treatment. Heat intensity and/or the duration of heat applied by the flamer were detrimental, despite the species' known tolerance to prescribed fire. In contrast, anecdotal observations of an actual open field burn in August of 2006 on the same field with a full straw load appeared to cause little if any injury, mortality, or reduction in seed yield compared to long term use of non-thermal residual removal methods (baling, mowing, flail chopping). In conclusion, use of a propane flamer for post harvest thermal treatment of Jackson-Frazier meadow barley is not recommended, but the use of open field burning for residue management should not be precluded at this time. Any beneficial or detrimental effect of open field burning compared to non-thermal methods remains to be determined.

Professor, Crop and Soil Science Dept., Oregon State University.

Evaluation of Summer Inundation Tolerance of 11 Wetland Grasses Under Four Static Water Depths

Dale Darris

Introduction

For many wetland plants, the ability to tolerate flood inundation and anoxic soil conditions during spring and summer may be more critical to survival than similar conditions during winter when plants are dormant or less actively growing and their oxygen demand is lower. Flooding dramatically reduces the amount of oxygen diffusion into the soil pores. Combined with aerobic plant and microbial respiration, soil oxygen levels are rapidly depleted. Plants have evolved various physiological (metabolic) and physical (anatomic) adaptations to cope with anaerobic conditions in the rhizosphere. These adaptations are known to vary among species of wetland plants, including grasses. Besides soil oxygen levels, water depth or the degree to which a plant is submerged is known to affect growth and survival as well. While other experiments have focused on plant tolerance to seasonal (winter) inundation, the purpose of this study was to evaluate the ability of one introduced and ten native wetland grasses to grow and flower during spring and summer under five static hydrologic conditions. The five conditions were: moist and freely draining soil, continuous saturation, 3.5 inches of inundation, 7 inches of inundation, and 14.5 inches of inundation. Results from such a study may benefit wetland and riparian restoration by providing additional guidance on what grasses to plant where along a shoreline or other sites with a gradation in water depth.

Methods and Materials

The study was conducted in 2005 at the Plant Materials Center, Corvallis, Oregon. Beginning in January 2005, plants of 10 native grasses and one introduced grass were grown from seed in a greenhouse. Seed was first germinated in trays then the resulting seedlings were planted into cone-tainers and finally transplanted into 5 1/2 inch square pots. Stones were placed in the bottom and on top of each pot to prevent floatation.

Species:
1. 9056346 water foxtail, *Alopecuris geniculatus* (considered an introduced species)
2. 9079263 slender hairgrass, *Deschampsia elongata*
3. 9079230 annual hairgrass, *Deschampsia danthonioides*
4. 9079303 western panicgrass, *Dichanthelium acuminatum*
5. 9079208 western mannagrass, *Glyceria occidentalis*
6. 9056312 western sloughgrass, *Beckmannia syzagachne*
7. Willamette germplasm tufted hairgrass, *Deschampsia caespitosa*
8. 9056372 fowl (tall) mannagrass, *Glyceria striata* (*Glyceria elata*)
9. Jackson-Frazier germplasm meadow barley, *Hordeum brachyantherum*
10. 9078219 spike bentgrass, *Agrostis exarata*
11. 9079193 pale false mannagrass, *Torreyochloa pallida* var. *pauciflora*

The five hydrologic treatments were:
1. freely draining moist soil . Pots watered daily.
2. saturated - water maintained at level of soil in pot. Pots held in shallow tubs.
3. 3.5 inch H_2O depth maintained above soil level in pot. Pots held in tanks.
4. 7 inch H_2O depth maintained above soil level in pot. Pots held in tanks.
5. 14.5 inch H_2O depth maintained above soil level in pot. Pots held in tanks.

Experimental Design included 3 replications with each pot equal to 1 replication. Replications and treatments could not be randomized because freely draining and saturated pots had to be maintained separately from the three “flood” treatments. Concrete bricks were used to station the plants at the designated water depths in each tank. Plants were monitored and watered daily. Data was collected on foliage length, plant vigor (1-10 with 10 as best), and growth stage (phenology) six times between May and October 2005. Mortality was considered to have occurred when “live” or green foliage was no longer detected above soil line in the pot (100% senescence) and recovery seemed unlikely if hydrologic conditions were permanently maintained. Phenology was recorded as 1=vegetative, 2=boot, 3=jointing, 4=floral emergence, 5=anthesis, 6=immature seed (milk, dough), 7=mature seed, and 8=post maturity.

Results and Discussion

While the experiment was outdoors, the pot culture, static water levels, and growing conditions (tanks) represent an artificial environment and not a natural wetland. Because the experiment was conducted during the spring and summer months, water conditions were closer to that of a permanent shallow marsh than a wetland prairie in western Oregon. Such prairies are typically droughty in summer, moist in the fall and spring and intermittently to permanently flooded with extended periods of saturated soil in winter. The use of potted specimens in this experiment may be somewhat analogous to circumstances where the plants in a wetland are "established" before inundation takes place. Such a condition may not occur in nature except in controlled wetlands or marshes that are drier one year (the establishment year) and wetter the next. Given the restrictions, extrapolation of results from this study to the natural environment is limited. However, observations can give some indication of relative flood tolerance among species. Except for meadow barley, data is not presented here.

Water foxtail maintained excellent vigor and produced seed under all conditions except the 14.5 water depth were it failed to flower and produce seed and died before October. Foliage and stem length increased in response to increasing water depth and by August the plants formed a large floating "mat" with nodal root and shoot formation occurring along submerged portions of the stems.

Tall mannagrass performed well under all treatments except at the 14.5 inch depth where vigor declined most rapidly over summer. However, foliage length was still greatest under this treatment in response to the greater water depth. Like tufted hairgrass, it failed to flower under any treatment because of a lack of vernalization. Some formation of roots occurred at the nodes along submerged portions of the stems.

Spike bentgrass performed similarly well under the freely draining, saturated soil, and shallow 3.5 inch inundation depth treatments. However, In contrast to the uniformity of these results, foliage/stem length increased substantially, mortality was higher (67%), and vigor declined more by the end of summer at the 7 inch depth. The species failed to survive past June at the 14.5 inch depth. Little or no flowering occurred under any treatment.

Pale false mannagrass maintained similar excellent vigor throughout the summer across all treatments except for the 14.5 inch depth where vigor was lower and the plants eventually died by October. Foliage length/plant height generally increased with water depth including the 14.5 inch depth.

Slender hairgrass grew best and produced seed only in the freely drained treatment. While it also produced seed in the saturated soil treatment, vigor declined steeply over the summer. For the most part this species failed to survive the summer under any inundation.

Annual hairgrass grew best and flowered under the freely draining and saturated soil treatments. In 3.5 inches of water, vigor declined drastically by the end of June but plants still managed to flower. At the two deepest water levels, the species died before the end of June and never flowered. Because the species is an annual, no plants were still alive by August, regardless of treatment.

Western panicgrass grew and flowered best under the freely draining and saturated soil treatments. Performance declined with 3.5 inches of inundation but plants still flowered. Only one plant at the 7 depth and no plants at the 14.5 inch depth survived past the end of June.

Western mannagrass grew well and produced seed under all treatments, with vigor and foliage/stem length substantially increasing with water depth. Under inundation the species produced an often abundant submerged root mass with additional shoots and roots forming at stem nodes.

The growth and vigor of western sloughgrass progressively declined with increasing saturation and water depths, yet it still survived, grew taller with increasing water depth, and reliably produced seed under all conditions except the 14.5 inch depth where two of three specimens died by August.

Tufted hairgrass survived and maintained good vigor through the summer only under the freely draining and saturated soil treatments. This suggests that this long lived wetland species is intolerant of shallow summer flooding. It did not flower under any treatment due to a strong vernalization requirement.

Results for Jackson-Frazier germplasm meadow barley appear in Table 1. Jackson-Frazier germplasm meadow barley maintained its highest vigor throughout the summer in the freely draining treatment. While vigor declined more by October in the saturated soil, 3.5 inch depth, and 7 inch depth treatments, plants still flowered and produced seed in all cases, suggesting apparent tolerance to such conditions. The population did not demonstrate a pattern of increasing or decreasing foliage length/plant height with increasing water depth. However, at the 14.5 inch level plants grew little and died by end of June indicating this depth may be beyond its adaptation range. Under the limited parameters of this study, it appears Jackson-Frazier germplasm meadow barley may tolerate spring-summer inundation better than slender hairgrass, western panicgrass, and tufted hairgrass. Flood tolerance appears similar to western sloughgrass, spike bentgrass, and water foxtail, and less than western mannagrass, tall mannagrass, and pale false mannagrass.

Table 1. Effect of soil saturation and three inundation water depths on growth and phenology of 9056373 meadow barley.

Meadow Barley Treatment	5/02/05 Day 0	5/16/05 Day 14	6/01/05 Day 30	6/28/05 Day 57	8/09/05 Day 99	10/5/05 Day 156
	Foliage Length (cm)					
Freely draining (control)	34	39	47.7	93.3	86	no data
Saturated soil	31.7	36.7	50.7	78.3	73.7	no data
3.5 in. depth	33.7	38	58	83.7	81.5	no data
7.0 in. depth	36.3	45.3	56	86.3	85.3	no data
14.5 in. depth	32	35.3	41	dead	dead	dead
	Plant Vigor (1-10)*					
Freely draining (control)	10	9	9.7	8	5.7	7
Saturated soil	10	9.7	8.3	7.7	5.7	3.3
3.5 in. depth	10	9.3	9.7	5	4	1
7.0 in. depth	10	9	7.3	5.7	5	3
14.5 in. depth	10	7	4.3	dead	dead	dead
	Growth Stage (1-8)**					
Freely draining (control)	1	2.3	3	3.7	7	no data
Saturated soil	1	3	3.3	5	7	no data
3.5 in. depth	1	2	3.3	4.3	5***	no data
7.0 in. depth	1	2	3.3	5	7	no data
14.5 in. depth	1	2	2.3	dead	dead	dead

*Plant Vigor: scale of 1-10, 10 = best. **Growth Stage: 1=vegetative, 2=boot, 3=stem elongation, 4=floral emergence, 5=anthesis, 6=immature seed (milk, dough), 7=mature seed, 8=post maturity. Data represents mean of 3 replications.

***1 of 3 plants flowered.

Carbon-Seeded Meadow Barley Tolerance to Pre-emergence Applications of Diuron Herbicide for Weed Control in the Establishment of New Seed Production Fields

Bill Brewster* and Dale Darris

Introduction

Control of both broadleaf and grassy weeds is a major factor in the successful establishment of new stands of grasses grown for seed in western Oregon, including native grasses. Application of a narrow strip of activated carbon slurry over newly sown rows (referred to as carbon banding or carbon seeding), followed by a broadcast application of diuron herbicide is a well documented, legal, and effective means of pre-emergence weed control for such plantings. However, current labels for any related diuron products do not include native species of grasses grown for seed in Oregon. In certain cases, herbicide labels may be extended to other species when supported by research data and approved through the 24C process resulting in a special local needs label. Specific experiments and documentation plus manufacturer concurrence are needed to obtain a diuron label for carbon seeding additional species, including meadow barley (*Hordeum brachyantherum*). The purpose of this study is to evaluate the tolerance of Jackson-Frazier germplasm meadow barley to four rates of diuron herbicide applied after carbon seeding. This work is cooperative between the Oregon State University Crop and Soil Science Department and the Plant Materials Center, Corvallis, OR.

Methods and Materials

The study was conducted on field 5-1 at Oregon State University's Hyslop Farm, Benton County, Oregon, in 2006 and 2007. Seeding of meadow barley occurred on October 12, 2006 at a bulk rate of15 lbs/ac to ensure a dense enough stand. Activated carbon was applied over the seed row at planting in a one inch wide band at 300 lb per treated acre. Within 24 hours, diuron was applied pre-emergence at four rates to carbon seeded plots. Stands were rated twice for crop injury (January and March 2007). In July 2007, plots were mechanically harvested and the seed cleaned to determine yield. A seed germination test was run on a 50 seed sample from each plot to evaluate herbicide effects on seed viability, if any. The experiment will be repeated in 2008.

<u>Herbicide</u>: diuron = Direx at 4 lb/gal. Chemical name: 3-(3,4-dichlorophenyl)-1,1-dimethylurea
<u>Crop</u>: *Hordeum brachyantherum,* Jackson-Frazier germplasm meadow barley
<u>Planting Method</u>: carbon seeded with 12 inch row spacing
<u>Site and Design</u>:
Plot width = 6.5 ft. Plot length = 25 ft. Replications = 4. Design: randomized complete block.
<u>Soil description</u>:
OM: 2.51 percent. Texture: silt loam. pH: 5.6. Soil Name: Woodburn. CEC: 15

<u>Application Description:</u>		<u>Application Equipment:</u>	
Application Date:	13/Oct/2006	Sprayer:	backpack with boom
Time of Day:	10:00 am	Operating pressure:	20 psi
Application Method:	spray	Nozzle type:	flat fan
Application Timing:	PRE	Nozzle spacing:	19 inches
Application Placement:	broadcast	Boom length:	6.5 ft.
Air Temperature:	65 F	Boom height:	18 inches
% Relative Humidity:	60	Ground speed:	3 mph
Wind Velocity:	4 mph	Carrier:	water
Soil Temperature:	60 F	Spray volume:	20 gallons/ac
Soil Moisture:	dry	Propellant:	CO_2
% Cloud Cover:	0		
Stage:	pre-emergence		

Results and Discussion

Table 1. Effect of diuron rates on injury, germination and seed yield of Jackson-Frazier germplasm meadow barley.

Crop Code			HOBR2	HOBR2	HOBR2	HOBR2
Rating Date			19/Jan/2007		7/Mar/2007	10/Sep/2007
Rating Data Type			Injury	Injury	Germination	Seed yield
Rating Unit			%	%	50 seeds	g/150 sq ft
Treatment No.	Name	Rate				
1	check	0 lb ai/a	0.0	0.0	44.4	63.8
2	diuron	0.8 lb ai/a	0.0	0.0	46.9	94.0
3	diuron	1.2 lb ai/a	0.0	0.0	47.1	119.3
4	diuron	2.4 lb ai/a	0.0	0.0	47.8	125.8
5	diuron	4.8 lb ai/a	0.0	0.0	48.2	134.3
LSD (P=.10)					2.21	23.42
CV					3.74	17.31

The 4.8 lb/acre rate of diuron is greater than twice the rate of currently registered uses of diuron for establishing grass stands on this soil type. No herbicide injury was observed on the meadow barley regardless of the rate of diuron applied. Control plots (check treatment) had the lowest seed yields. The seed yield mean increased as the rate of diuron rate increased. None of the treatments reduced seed germination.

**Senior Instructor, Emeritus appointment, Crop and Soil Science Department, Oregon State University, Corvallis, Oregon*.

Variation in Seasonal Flood Tolerance of Northwest Native Grasses

Dale Darris and Pete Gonzalves

Introduction

Native grass seed often represents a significant economic expense in wetland restoration and revegetation projects. Selection of site-appropriate species can help ensure a positive return on the investment. Native plant tolerance of inundation has been studied in association with coastal areas, vernal pool communities and reservoir management. However, the response of northwest USA native grass species to prolonged seasonal inundation in excess of 60 days is largely unexplored. Four native wet prairie and six native marsh grasses were evaluated at the Corvallis, Oregon Plant Materials Center for survival, vigor and seed production following various depths of inundation maintained for 149 days from November 4, 2006 to April 2, 2007.

Methods and Materials

Most grasses were seeded July 8, 2005 into 10 cu. in. cone shaped containers using potting media composed of peat moss, perlite, dolomite, gypsum plus a wetting agent (Sunshine #1, Sun Gro Horticulture Canada Ltd.) and amended with a balanced, slow release fertilizer and micro-nutrients. Due to a long seed stratification period required, rice cutgrass was started using rhizome transplants. Experimental design consisted of a randomized complete block with 3 replicates. The rhizomes and one year old seedlings were transplanted at one foot intervals into 45-plant rows two feet apart along the sandy, sloping bottoms of two artificial ponds in May 2006 and periodically irrigated through the summer. When the ponds were flooded in the fall, this created a gradient from moist soil (top 10 cm of soil drained) to 42 cm of inundation. The grasses were evaluated for vigor and seed production in mid summer of their second growing season, 14 weeks after draining the ponds (periodic irrigation was provided).

Wet Prairie Species	
Meadow barley (Jackson-Frazier germplasm)	Accession # 9056373
Hordeum brachyanherum ssp. *brachyantherum*	USDA symbol HOBRB2
Slender hairgrass	9079263
Deschampsia elongata	DEEL
Spike bentgrass	9079219
Agrostis exerata	AGEX
Tufted hairgrass	9019737
Deschampsia cespitosa	DECE

Marsh Species	
Bluejoint	Accession # 9056371
Calamogrostis canadensis	USDA symbol CACA4
Davy (slimheaded) mannagrass	9079194
Glyceria lepostachya	GLLE2
Fowl (tall) mannagrass	9056372
Glyceria striata	GLST
Pale false mannagrass	9079193
Torreyochloa pallida var. *pauciflora*	TOPAP3
Rice cutgrass	9079210
Leersia oryzoides	LEOR
Western sloughgrass	9056312
Beckmannia syzigachne	BESY

Results (2007)

Most species were initially completely submerged at the greater depths but davy mannagrass, fowl mannagrass, western sloughgrass and pale false mannagrass grew during winter and displayed good vigor plus foliage at or above water level in early spring 2007. Fowl mannagrass was the only species to actually show increasing vigor with increasing depths at that time.

Wet prairie species performed best under shallow or no flooding. Meadow barley (9056373) vigor and seed production declined with increasing flood depth but, unlike the other wet prairie species, remained significant even at the greatest depths where foliage was submerged all winter. Spike bentgrass exhibited little survival beyond 20 cm depth and slender hairgrass succumbed even where the top few centimeters of soil was drained.

Among the marsh species, the deepest bluejoint and pale false mannagrass plants showed the most summer vigor while peak vigor for fowl mannagrass and davy mannagrass correlated with 15 to 30 cm of flooding. The greatest seed production for pale false mannagrass and davy mannagrass occurred near 40 cm of inundation while it was greatest for bluejoint and fowl mannagrass near 10 cm. These results may be specific to the populations (accessions) and experimental site used in this study.

Discussion (2007)

Preliminary results suggest that anticipated duration of winter flooding at a particular restoration site should be considered when selecting native grass species. With the possible exception of meadow barley, the four wetland prairie species tested at Corvallis were unable to perform well under five months of constant winter inundation at 20 cm or greater. Survival and vigor were generally greater among the marsh species although seed production was mediocre. The project will continue in 2008.

March 29-30, 2007 Average Vigor (scale 1-10, 10 being greatest)

Depth (cm)	HOBRB2	DEEL	AGEX	DECE	CACA4	TOPAP3	BESY	GLST	GLLE2
neg 10-0	7.2	3.5	8.3	8.0	5.6	5.0	4.8	4.3	7.0
0-10	6.1	3.2	7.3	7.5	5.3	6.5	4.7	4.7	6.9
11-21	3.5	X	5.0	5.8	4.6	7.8	4.3	6.5	8.0
21-30	2.3	X	1.2	4.3	2.8	7.0	4.4	7.5	7.5
31-42	1.0	X	1.0	2.3	1.0	9.5	2.5	7.2	7.0

X = majority of plants completely submerged

March 29-30, 2007 Average Foliage Height (cm)

Depth (cm)	HOBRB2	DEEL	AGEX	DECE	CACA4	TOPAP3	BESY	GLST	GLLE2
neg 10-0	21.4	9.0	19.0	18.6	27.2	16.0	21.0	13.5	16.0
0-10	19.6	10.4	18.7	19.6	26.1	19.3	20.7	13.4	18.3
11-21	26.6	X	28.2	30.0	34.4	32.0	34.3	31.3	29.8
21-30	33.0	X	31.0	34.4	32.2	39.0	42.2	43.7	42.5
31-42	X	X	X	X	X	63.5	57.5	56.8	57.0

X = majority of plants completely submerged

July 27, 2007 Average Vigor (scale 1-10, 10 being greatest)

Depth (cm)	HOBRB2	DEEL	AGEX	DECE	CACA4	TOPAP3	BESY	GLST	GLLE2	LEOR
neg 10-0	7.6	1.7	6.3	7.2	5.8	3.7	2.0	1.0	2.6	0.0
0-10	6.7	3.2	6.4	7.6	6.3	4.4	3.7	4.0	4.2	1.0
11-21	6.2	0.4	5.0	7.6	8.0	6.4	4.7	4.5	6.0	3.5
21-30	5.0	0.0	0.8	7.1	7.5	6.0	4.8	5.2	6.3	5.0
31-42	4.8	0.0	0.6	5.3	8.6	8.0	3.5	4.4	2.5	7.0

July 27, 2007 Average Seed Production (scale 1-10, 10 being greatest)

Depth (cm)	HOBRB2	DEEL	AGEX	DECE	CACA4	TOPAP3	BESY	GLST	GLLE2	LEOR
neg 10-0	7.8	1.5	8.5	8.2	3.7	4.3	3.3	0.8	1.0	0.0
0-10	5.9	3.5	7.7	5.6	4.3	3.8	3.7	3.7	1.2	0.3
11-21	5.3	0.3	5.0	4.4	5.0	5.8	4.0	2.5	1.5	1.0
21-30	4.3	0.0	0.7	2.3	3.7	4.5	5.0	2.5	1.0	1.5
31-42	3.5	0.0	0.2	1.0	3.2	6.5	3.0	1.2	3.5	3.0

Evaluation of Select Native Wetland Grasses in Grassed Waterways in Western Oregon

Dale Darris, Mark Mellbye* and Pete Gonzalves

Introduction

Little information is available on the performance of native grasses in a grassed waterway or grass lined ditch in western Oregon. At present, introduced creeping red fescue has shown promise as a waterway grass. It is easy to maintain and can be kept free of most other grasses with the herbicide Poast (sethoxydim). However, it is intolerant of prolonged winter-spring inundation in the bottom of these watercourses. A grass species that is readily established and more tolerant of sustained soil saturation or flooding is needed. This study compares native wetland prairie and marsh grasses against creeping red fescue and ‘Seaside” bentgrass in their ability to thrive under prevailing conditions and stabilize the bottom of a waterway in Linn County, Oregon. Cooperators include Kevin Siefert with Linn Soil & Water Conservation District, and landowner George Pugh with Pugh Seed Farm of Shedd, OR.

Figure 1. Oregon State University Cooperative Extension agent Mark Mellbye evaluates Jackson-Frazier germplasm meadow barley established in a western Oregon waterway, June 2007. Photo by Dale Darris.

Methods and Materials

Native and introduced grasses and the seeding rates used for the Benton County, Oregon agricultural waterway grass trial are listed in Table 1. Experimental design is a randomized complete block with 3 replications. Bluejoint was limited to 2 plots due to the small quantity of seed available. A mixture of 95% red fescue and 5% annual ryegrass served as the standard of comparison. All plots were single species except for the standard 95%/5% red fescue/annual ryegrass mix and the rice cutgrass (75%) mixed with annual hairgrass (25%). The annual hairgrass was included to provide some winter cover. Rice cutgrass has seed dormancy and will not germinate until the following spring. The test site was scraped and re-shaped prior to planting into a clean, surface-loose to somewhat compacted seedbed. All plots were 9 ft. wide and 15 ft. long except for the 2 bluejoint plots which were only 9 ft. long. The soil is poorly drained Dayton Silt Loam with seasonal high water table at 0.5 ft above ground to 1.5 ft below ground from

Table 1. Native and introduced grass species, USDA symbol, accession number, and seeding rates for the western Oregon waterway trial.

Grass species planted September 2005	**Seeding Rate PLS/sq ft**	**Seeding Rate PLS lbs/ac**
spike bentgrass, AGEX, 9079219 *Agrostis exarata*	600	4.8
Jackson Frazier meadow barley, HOBR2, 9056373 *Hordeum brachyantherum* ssp. *brachyantherum*	200	58.1
Willamette germplasm tufted hairgrass, DECE, 9019737 *Deschampsia cespitosa*	500	12.1
'Seaside' bentgrass, AGST2 *Agrostis stolonifera*	600	3.1
slender-spiked mannagrass, GLLE2, 9079194 *Glyceria leptostachya*	500	16.8
rice cutgrass + ann. hairgrass, LEOR* + DEDA** *Leersia oryzoides* + *Deschampsia danthoniodes*	300 + 100	36.3 + 4.8
tall mannagrass, GLEL, 9056372 *Glyceria elata*	500	13.6
slender hairgrass, DEEL, 9079263 *Deschampsia elongata*	500	9.3
Canada bluejoint, CACA4, 9056371 *Calamagrostis canadensis*	500	5.4
weak alkaligrass, TOPAP3, 9079193 *Torreyochloa pallida* var. *pauciflora*	500	11.2
western sloughgrass, BESY, 9056312 *Beckmannia syzigachne*	200	36.6
red fescue + ryegrass, FERU + LOPEM2 *Festuca rubra* + *Lolium perenne* ssp. *multiflorum*	500	12.1

*LEOR accession # 9079210 **DEDA accession # 9079230

November to May. Data collected include seedling counts and visual ratings of plant vigor and stand quality (density, uniformity, size and color).

Seed was mixed with rice hulls and broadcast sown September 26, 2005 with a Scott's 3 ft. wide manual fertilizer/seed spreader (drop type), then gently raked into the soil. Each plot spanned the bottom width of the waterway but not the side slopes. Side slopes were hydroseeded with the red fescue/ryegrass mix and managed with an annual application of fertilizer in spring, fall application of Poast herbicide, and annual mowing. Study plots were not treated with herbicides or fertilizer.

Unfortunately, an unusually heavy rain event occurred September 30, 2005 washing out the bottom center portion of the experimental plots before an erosion blanket (jute netting) was applied over the top and secured with large staples. This netting subsequently failed during high winter flows allowing further washout of seeds and seedlings along the centerline of the plots. Plots which had shown some success by spring 2006 (spike bentgrass, meadow barley, tufted hairgrass, 'Seaside' bentgrass, slender hairgrass and red fescue with annual rye) were re-seeded (700 PLS/ sq. ft.) with their experimental species October 18, 2006 while the remaining plots were over-seeded with a mixture of tufted hairgrass and meadow barley. All plots were then covered with coir fabric October 20. In the fall of 2007, original plot stands were not mowed but were allowed to naturally re-seed themselves.

Most data were collected only from non-eroded portions of the experimental grass plots. However, in June 2008, seedlings appearing in the center eroded areas were counted as an indication of natural re-seeding activity.

Results and Discussion

Although the center portion of each plot was washed out in the fall and winter of 2005-2006, the remaining portions allowed for evaluation of seedling establishment, vigor and stand quality. The principle results are presented in Table 2. By 2008, introduced ‘Seaside’ bentgrass was the most successful species, due in part to its aggressive creeping habit which allowed it to spread into and “repair” the damaged center of the plot. It also began to spread into the red fescue side slopes but was controlled there by use of Poast selective herbicide. Native bunchgrasses (spike bentgrass, meadow barley, and tufted hairgrass) performed well but native marsh grasses (weak alkaligrass, slender-spiked and tall mannagrasses, Canada bluejoint, and rice cutgrass) and creeping red fescue ultimately failed to establish. Through 2008, Jackson-Frazier germplasm meadow barley maintained itself as the best performing native grass in the trial, second only to the introduced species, ’Seaside’ bentgrass.

2006

Jackson Frazier germplasm meadow barley had the highest seedling count (27/per sq. ft.) in the first year despite having the lowest seeding rate at 200 PLS/sq. ft. (same as western sloughgrass). Spike bentgrass and tufted, annual and slender hairgrass plots averaged between 6 and 13 seedlings/sq. ft. while ‘Seaside’ bentgrass averaged 4.7 seedlings/sq. ft. Annual ryegrass seedlings dominated the average 2.7 seedlings/sq. ft. in the red fescue/ryegrass plots.

2007

Casual observation in March 2007 revealed seedling establishment underway throughout the eroded centerline of the experimental plots as the result of the October 2006 seeding. However by June this area was again characterized by a ribbon of nearly bare soil. Possible explanations include 1) another rain event causing wash out, 2) loss due to frost heaving, 3) soil sedimentation on the coir fabric and burying the seedlings, and 4) agricultural herbicide runoff and injury to young plants. Because of poor establishment for a second time along this line, existing plots were not mowed in 2007 but were allowed to produce seed.

Spike bentgrass and Jackson-Frazier germplasm meadow barley were the only two native species to develop strong stands similar to ‘Seaside’ bentgrass in 2007. Tufted hairgrass and slender hairgrass produced moderate stands while the remaining species were weak or nonexistent. Vigor ratings in June 17, 2007 (not shown) generally paralleled stand quality ratings on that date although western sloughgrass plant vigor averaged a rating of 7.7 despite the mean stand quality rating of only 3.0.

2008

By spring 2008, only four species were clearly established. ‘Seaside’ bentgrass had the highest rated stand followed in order by Jackson-Frazier germplasm meadow barley, tufted hairgrass, and spike bentgrass. Six native species (spike bentgrass, meadow barley, tufted hairgrass, annual hairgrass, slender hairgrass and western sloughgrass) displayed some ability to naturally re-seed themselves at the site as evidenced by the June 2008 presence of seedlings in the washed out portions of the plots (data not shown). However, these seedlings were sparse except for those of meadow barley which averaged 6.0 seedlings per foot along the plot centerline.

Results of this study indicate Jackson-Frazier meadow barley, tufted hairgrass, and spike bentgrass may be good choices for native grass waterways in western Oregon. Annual hairgrass may be useful, but mostly for quick, temporary cover for longer lived species in a mix. Fall seeding to protect the very bottom of waterways with their erosive and/or continuous winter flows can be problematic. Possible alternatives include spring seeding when the site is dry enough to enter followed by gentle irrigation or fall planting of tightly spaced plug type seedlings where the damaged area is small enough to allow this relatively expensive approach.

Table 2. Seedling density and stand quality (mean of 3 replications) of native and introduced grass species seeded to a western Oregon waterway.

Grass species*	**Seedlings/sq.ft. May 30, 2006**	**Stand Quality (0-10; 10 best) June 18, 2007**	**Stand Quality (0-10; 10 best) June 3, 2008**
spike bentgrass*	8.7	7.7 a	6.0 b
Jackson Frazier meadow barley*	27.3	7.7 a	7.0 ab
tufted hairgrass*	10.0	6.0 ab	6.3 ab
‘Seaside’ bentgrass	4.7	8.3 a	10.0 a
slender-spiked mannagrass*	0.0	0.0 c	0.0
rice cutgrass* + ann. hairgrass*	0.0 + 13.0	1.7 c	1.0 c
tall mannagrass*	0.0	0.0 c	0.0
slender hairgrass*	6.7	5.7 ab	1.0 c
Canada bluejoint*	0.0	0.0 c	0.0
weak alkaligrass*	0.3	0.0 c	0.0
western sloughgrass*	0.2	3.0 bc	1.7 c
red fescue + ryegrass	2.7	2.7 bc	1.0 c
Critical value		48.096	varies
Coefficient of variation		40.72	30.20
* Asterisk indicates native species. Means followed by the same letter are not statistically different.			

** Mark Mellbye is an agent with the Oregon State University Linn County Cooperative Extension Service*.

Area of Adaptation:

Jackson-Frazier germplasm has not been widely field tested. Therefore, the true extent of its area of adaptation is not fully known. However, based on program objectives, the origin of the selection, ecoregion descriptions, and what is known about the species, its ecology and natural range, the "suggested area of use" for this germplasm is described as the Willamette Valley of Oregon and surrounding foothills below an elevation of 1500 ft. This is roughly equivalent to EPA Ecoregion 3 or USDA Major Land Resources Area 2, excluding the Puget valleys of western Washington. This region lies within USDA Plant Hardiness Zones 8a and 8b (Cathey 1990) and American Horticultural Society Plant Heat Zones 4 and 5 (American Horticultural Society 1997). This temporary "seed zone" may be revised as more information becomes available.

Jackson-Frazier germplasm meadow barley tolerates moderate summer drought as well as seasonal soil saturation, shallow winter flooding for up to five months, and full sun. Its range of soil adaptation has not been determined but the species is known to grow in sand to clay textured soils with a pH range of 5.5 to 8.5. Meadow barley is also recognized for its medium to high salinity tolerance and adaptation to tidal marshes and surge plains, but this cannot be inferred for Jackson-Frazier germplasm meadow barley at this time. Tolerance to fire appears high.

<u>Precautionary Notes</u>:

1. *Jackson-Frazier germplasm is not necessarily a replacement for local or on-site sources of meadow barley for restoration plantings. Individuals with a concern for a particular environment or ecosystem should make their decisions on a case-by-case basis.*
2. *Jackson-Frazier germplasm may be potentially weedy in some regions for certain crops. Yet, in landscapes that are more natural the species readily coexists with other native plants. While meadow barley can move into adjacent, moist disturbed areas, it rarely dominates and often gives way to longer-lived species.*

E. Generations of the Variety That Will be Multiplied and Length of Stand Limitation for Each Generation:

Generations G0, G1, G2, and G3 are proposed for certification. The G0 or parental generation will only be collected by the NRCS or qualified representatives under oversight of the appropriate seed certification agency and with the written permission of the Benton County Natural Areas and Parks Department, Corvallis, Oregon. A G1 seed increase field will be maintained by the NRCS for the production of G1 seed. G1, G2, or G3 production fields can be established and maintained as desired by qualified seed growers and companies. Certified seed produced from all four generations will carry a yellow tag for source identified class, natural track. Stand limitation for each generation shall be 10 years.

F. Describe How G0 Seed is Produced and the Procedure for Maintaining and Producing Additional Seed Stock:

The G0 generation is represented by a natural stand of meadow barley found at the Jackson-Frazier wetlands Natural area in Benton County, Oregon. There will be no management of the stand aside from Park maintenance within the vicinity. It is understood that any natural regeneration within the population and subsequent seed collection does not affect the status of the stand as G0.

G1 seed will be produced indefinitely by the USDA NRCS Plant Materials Center (PMC), as long as there is a demand and need for seed. Isolation distances prescribed by the Oregon State Seed Certification Service for pre-varietal seed production will be followed. Presently this is 900 ft. from other varieties of meadow barley. Adequate Isolation from other *Hordeum* and *Elymus* species may be required as well. Upon request, certified G1 seed will be distributed by the PMC to commercial growers for G2 and G3 seed production.

<u>Seed Production Methods</u>:

Seed of Jackson-Frazier meadow barley has little if any dormancy and therefore no special physiological conditioning is required. The population can be fall or spring sown in 12-24 inch rows at a rate of 6-8 pure live seed (PLS) lbs/ac. Wider rows may be needed if row cultivation is preferred. The seedbed should be firm and weed free and the seeding depth maintained between 1/8 and 1/2 inch. Fall seeding does not require irrigation, but spring planting may need it. The use of diuron pre-emergence herbicide coupled with carbon seeding is commonly used for establishing new fields of grasses grown for seed but it is not an approved method of planting and initial weed control for meadow barley at this time.

With fall seeding and ideal growing conditions, a partial seed crop can be obtained the first full growing season. Seed yields usually peak in the second or third growing season and can average 200 lbs/ac depending on cultural methods used. If seed production in 2008 (381 lbs/ac) is any indication, a 12 inch spacing may be superior to 24 inches.

No fertilizer is suggested at planting time, but fall sown fields can be treated with 50 lbs nitrogen (N)/ac the following spring. Established fields may be maintained with 50-75 lbs of N/ac applied each February or March. An optional application of 15-20 lbs of N/ac may be made in fall. Optimal fertilization rates are not known, but other nutrients including sulfur and potassium may be needed and should be applied according to soil tests.

Weed control in new and established stands is usually by hand methods, spot treatments of glyphosate, and foliar applications of broadleaf control herbicides labeled for grass seed production. For control of weedy annual grasses, the herbicide Outlook (dimethenamid-P) is labeled for use on established fields of perennial grasses grown for seed in Oregon (BASF Corporation 2007), which can include meadow barley. Supplemental labeling expires December 31, 2009 unless renewed.

Insect pests are usually not a significant problem but diseases can be. Stripe rust (*Puccinea striiformis*) is a common disease of the foliage and can infect Jackson-Frazier germplasm. Infection rates of ergot (*Claviceps purpurea*) and smut (*Ustilago* spp.) have been low but should be monitored. Refer to the latest Pacific Northwest Plant Disease Management Handbook for guidance on control methods and approved fungicides labeled for use on grasses grown for seed.

In the Willamette Valley of Oregon, Jackson-Frazier meadow typically matures seed in early July with some plants maturing as much as a week apart. The recommended method of harvest is a flail-vac seed stripper that uses a rapidly spinning brush to strip and vacuum the seed off the seedheads. Due to uneven seed maturation in the field and in the seedhead itself, a second harvest 4-7 days after the first may be useful. Direct combining or swathing and combining are not suggested methods because of greater loss of seed.

Until more is known, it is suggested that post harvest residue be removed with a baler and the field mowed or removed with a flail-type forage harvester set to leave 3-4 inches of stubble. Open field burning may be an option where and when permitted, but additional research is needed. Propane flaming is not recommended.

In order to facilitate further cleaning, improve seed flow through planting equipment, and reduce storage volume, seed should be processed with a brush machine or other device to break up the spikes and spikelets into individual florets and remove bracts and awns. It may require several runs through a brush machine to do a complete job but the risk of seed damage must be weighed.

Literature cited

American Horticultural Society. 1997. Plant heat zone map. AHS, Alexandria, VA.

BASF Corporation. 2007. Outlook herbicide for use in perennial grasses grown for seed. Supplemental label. BASF Corporation. Research Triangle Park, NC.

Baskin, C.C. and J.M. Baskin. 1998. Seeds, Ecology, Biogeography, and Evolution of Dormancy and Germination. Academic Press. San Diego and other cities..

Baum, B.R. and L. G. Bailey. 1990. Key and synopsis of North American Hordeum species. Canadian Journal of Botany. 68: 2433-2442.

Cathey, H.M. 1990. USDA plant hardiness zone map. Miscellaneous Publication 1475, USDA Agricultural Research Service, Washington, D.C.

Cowardin, L.M. et. al. 1979. Classification of Wetlands and Deepwater Habitats of the United States. Publication FWS/OBS-79/31. US Dept. of Interior, Fish and Wildlife Service. US GPO, Washington, D.C. 131 p.

Guard, B.J. 1995. Wetland Plants of Oregon and Washington. Lone Pine Publishing, Redmond, WA, Vancouver, Bristish Columbia, and Edmonton, Alberta, Canada.

Hickman, J.C. (editor). 1993. Jepson Manual, Higher Plants of California. University of California Press, Berkeley and Los Angeles, CA, and London, England.

Hitchcock, C.L. et. al. 1969. Vascular Plants of the Pacific Northwest. Part 1: Vascular cryptogams, gymnosperms, and monocotyledons. University of Washington Press, Seattle and London.

Jackman, E.R. reprinted 1965. Meadow barley. Range Leaflet #3. Cooperative Extension Service, Oregon State University, Corvallis, OR. 2 p.

Lies, M. (editor) 2002. High yield grass seed production and water quality handbook. Oregon Seed Council. Salem, OR. 23 p.

Mueller-Warrant, G. 1999. Combination of methods needed to control annual bluegrass. Seedsman Northwest. March/April, 1999. p. 20-22.

Platts, W.S. et. al. 1987. Methods for evaluating riparian habitats with applications to management. General Technical Report INT-221. USDA Forest Service, Intermountain Research Station, Ogden, UT.

Pojar, J. and A. MacKinnon (compilers and editors). 1994. Plants of the Pacific Northwest Coast. Lone Pine Publishing. Redmond, WA, Vancouver, BC, and Edmonton, Alberta, Canada.

Reed, P.B. Jr. 1988. National list of plant species that occur in wetlands: Northwest (Region 9). Biological Report 88 (26.9). US Dept. of Interior, Fish and Wildlife Service, Washington, D.C. 89 p.

USDA Forest Service. 1937 (reprint 1988). Range Plant Handbook. US GPO, Washington D.C. Reprint by Dover Publications, Mineola, NY.

USDA NRCS. 1997. A vegetative guide to selected native grasses of California. Technical Note PM-40. Davis, CA.

USDA NRCS. 2008. The PLANTS Database (http://plants.usda.gov, 7 August 2008). National Plant Data Center, Baton Rouge, LA 70874-4490 USA

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE

NOTICE OF RELEASE OF JACKSON-FRAZIER GERMPLASM MEADOW BARLEY [SOURCE IDENTIFIED CLASS - NATURAL TRACK]

The Natural Resources Conservation Service (NRCS), U.S. Department of Agriculture (USDA), announces the release of a source identified ecotype of meadow barley (*Hordeum brachyantherum* Nevski).

This plant will be referred to as Jackson-Frazier germplasm meadow barley. It has been assigned USDA NRCS accession number 9056373 and PI-645564. Jackson-Frazier Germplasm is released as a source identified class of certified seed and plants, natural track.

Origin: Seed of Jackson-Frazier germplasm meadow barley was originally collected in 1997 at the Jackson-Frazier Wetland nature preserve in Benton County, Oregon. The preserve is located in EPA Ecoregion 3 - Willamette Valley and the NRCS Major Land Resource Area A2 - Willamette and Puget Sound Valleys. The site is located at an elevation of 225 feet above mean sea level and has an average annual precipitation of 42 inches. The soil type is delineated as Bashaw clay. Meadow barley seed was collected from a large naturally occurring stand in a wet prairie and grown and tested at the Corvallis Plant Materials Center (PMC), Corvallis, Oregon.

Description: Jackson-Frazier germplasm meadow barley grows 24 to 54 inches (60-138 cm) tall in a loose to moderately dense tuft. Plant height is greater than typically described (20-100 cm) for meadow barley. Culms (stems) are erect to spreading and usually bent at the base. Leaves lack auricles, have a short ciliolate ligule, and are glabrous (hairless) or with a few, scattered fine hairs. Leaf blades are 2 to 9 (11) mm wide (Hitchcock 1969), and mostly basal except for 1-3 (4) short leaves midway up the culm (Guard 1995). Additional leaves occur along upright to spreading vegetative tillers arising from the base. The inflorescence (seedhead or panicle) is a narrow, flattened spike. Spikes are mostly erect, narrow, and 1.5 to 4 inches (4-10 cm) long, with three spikelets per node and one floret per spikelet. The central spikelet is fertile and sessile (stalkless) and the lateral ones reduced, on a short pedicel about 1 mm long, and usually sterile but sometimes staminate (Hitchcock, et. al. 1969, Hickman 1993). Both spikelet bracts (glumes) and fertile floret bracts (lemmas) are bristle or awn-like (USDA Forest Service 1937). The brittle central axis (rachis) of the spike easily breaks off (shatters) in segments from the top down at maturity. By mid-summer only the lowest spikelets remain (Guard 1995). Some plants of Jackson-Frazier germplasm have strictly green stems with purple joints, but the predominate phenotypes have blue-green stems (due to a bluish-white waxy coating). Seed maturity also differs by several days between phenotypes. Leaves and spikes range from green to purple-green. These colors may or may not be typical of the species. This cool season grass actively grows during the winter within its area of origin and year round if sufficient moisture is present. It may flower more than once each year under moist conditions, especially if clipped.

Method of selection: Jackson-Frazier germplasm meadow barley has not undergone purposeful selection and was collected from 100s of wild parental (G0) plants. As accession 9056373 and PI-645564, it has been grown for seed and tested at Corvallis, Oregon, since 1999. The population was increased and maintained because of its reliable seed production under cultivation, good seedling vigor, phenotypic and presumed genetic diversity, stable source of G0 wild seed, and natural origin centered within the Willamette Valley of Oregon. Some plants within the population show slight to moderate signs of stripe rust (*Puccinia striformis*) in certain years. Infection rates of head smut (*Ustilago* sp.) have been very low but no special resistance to the disease is inferred.

Area of suggested use: Based on general similarities in ecosystems and what is known about the species, Jackson-Frazier germplasm is presumed adapted to, and thus recommended for, the Willamette Valley and associated foothills of western Oregon below an elevation of 1500 ft. This is roughly equivalent to EPA Ecoregion 3 or USDA Major Land Resources Area 2, excluding the Puget valleys of western Washington. This region lies within USDA Plant Hardiness Zones 8a and 8b (Cathey 1990) and American Horticultural Society Plant Heat Zones 4 and 5 (American Horticultural Society 1997).

Anticipated use: Recommended uses include freshwater wetland enhancement and restoration, riparian site revegetation, streambank, waterway, and shoreline erosion control, and wetland wildlife habitat plantings. Meadow barley provides quick cover alone or in seeding mixtures with other native grasses for critical area stabilization on summer dry, moist, or wet sites, including roadside ditch banks and ditch bottoms. The species prefers full sun and occurs on course to fine textured soils with pH ranging from 5.5 to 8.5. Jackson-Frazier germplasm tolerates semi-drought in summer, prolonged soil saturation and inundation in winter, and extended periods of shallow flooding in spring. Adaptation to higher soil salinity may be population specific; therefore this germplasm is not recommended for use on high coastal marshes or tidal surge plains at this time.

Ecological impact statement: Jackson-Frazier germplasm is from a naturally occurring population of meadow barley and has not undergone purposeful selection. It has not been bred or hybridized and does not appear to differ in rate of spread, seed production, or vigor from other naturally occurring populations of meadow barley. Jackson-Frazier germplasm is recommended for use primarily within the ecoregion and elevation range from which it originated (Ecoregion 3). Within this area, the species is not considered weedy and while it can move into adjacent disturbed areas, it rarely dominates and often gives way to longer lived, more persistent species. According to the "Worksheet for Documenting an Environmental Evaluation of NRCS Plant Releases" as applied to the intended area and type of use, this population was deemed to have low adverse impact on habitats, ecosystems, and land use, be easy to control, and have a moderate level of importance for conservation use. Its biological properties reflect a moderate ability to propagate and maintain itself under natural conditions. Jackson-Frazier Germplasm is not necessarily intended to replace on-site sources of native meadow barley for ecological restoration plantings. Individuals with such concerns for a particular environment or ecosystem should make their decisions on a case by case basis. Minor to rare signs of ergot (*Claviceps purpurea*) have been observed on Jackson-Frazier meadow barley when environmental conditions are conducive. When abundant in any grass pasture, this disease may require special precautions for grazing animals due to toxicity (usually mowing or temporary exclusion).

Availability of plant materials: The USDA, NRCS, Plant Materials Center, Corvallis, Oregon, will maintain G1 generation seed. A limited quantity of source identified, certified seed (yellow tag) will be available to qualified commercial growers upon request. G0, G1, G2, and G3 seed are recommended for certification.

References:

American Horticultural Society. 1997. *Plant heat zone map*. AHS, Alexandria, VA.

Cathey, H.M. 1990. *USDA plant hardiness zone map.* Miscellaneous Publication 1475, USDA Agricultural Research Service, Washington, D.C.

Guard, J. 1995. *Wetland plants of Oregon and Washington*. Lone Pine Publishing, Redmond WA, USA, Vancouver, British Columbia., Canada, and Edmonton, Alberta, Canada.

Hickman, J.C. (Editor). 1993. *The Jepson Manual: higher plants of California*. University of California Press. Berkeley, CA, Los Angeles, CA, and London.

Hitchcock, C.L., A. Cronquist, M. Ownbey, and J.W. Thompson. 1969. *Vascular plants of the Pacific Northwest, Part I.* University of Washington Press. Seattle, Washington.

U.S. Department of Agriculture, Forest Service. 1937. *Range plant handbook*. U.S. Government Printing Office. Washington, DC.

Prepared by: Dale Darris, USDA NRCS Plant Materials Center, Corvallis, Oregon. (July 2007).

SIGNATURES for RELEASE of
JACKSON-FRAZIER GERMPLASM MEADOW BARLEY (*Hordeum brachyantherum*)

____
Robert J. Graham Date:____________________
State Conservationist, Oregon
Natural Resources Conservation Service

____
Mike Hubbs Date:____________________
Director, Ecological Sciences
Natural Resources Conservation Service

Skamania Germplasm Sitka Alder
VARIETY ACCEPTANCE REQUEST
(selected class pre-varietal release, natural track)

compiled and written by Dale C. Darris
(with additional contributions from Theresa McGovern in section D)

A. Variety Names: None. However, the ecotype of Sitka alder has approval for the designation Skamania Germplasm as a selected class, pre-varietal release following the natural track.
Experimental Designations: PI-540381 and NRCS accession numbers 9040484, T-40484, and C0-965.
Species: Sitka alder, *Alnus viridis* (Vill.) Lam. & DC. subsp. *sinuata* (Regel) A.& D. Löve. Symbol: ALVIS. Synonyms include *Alnus alnobetula*, *Alnus crispa* spp. *sinuata*, *Alnus sinuata*, *Alnus sitchensis*, and *Duschekia sinuata*. Other common names are thinleaf, mountain, wavy-leaf, and green alder.

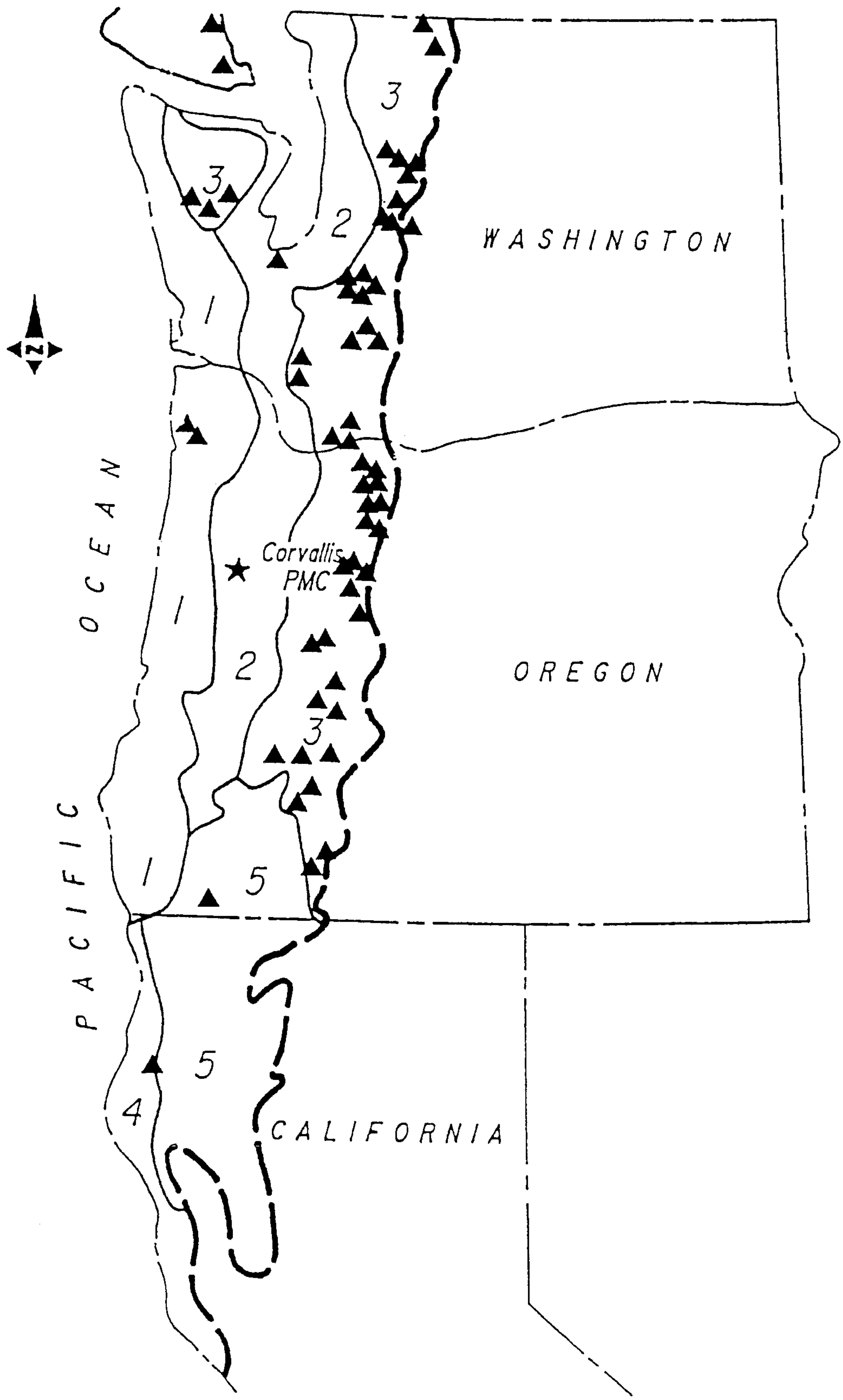
B. Origin and Breeding History of the Variety (Selected Class Germplasm):

Skamania Germplasm (9040484) Sitka alder originates from a small population (less than 6 individuals) growing in a swale near the base of Beacon Rock above the north shore of the Columbia River in Skamania County, Washington: Sec 25, Township 2N, Range 6E, elevation 61 m (200 ft) above mean sea level. Location: 122°01' west longitude, 45°38' north latitude. Mean annual precipitation: 152 to 178 cm (60-70 inches). Habitat: gravelly loam soil, NW exposure, woodland plant community of vine maple, oceanspray, snowberry, serviceberry, Douglas-fir, and western hazel. No information exists to suggest that this population was not naturally occurring at the time of collection (October 1982).

Sitka alder is monecious with separate male and female catkins on the same plant. The male catkins form late in the growing season and become exposed during winter. Female flower (catkin) buds form by midsummer, remain enclosed within buds during winter, and bloom the following spring. Unlike other alders, the catkins bloom with the leaves as opposed to beforehand. Female catkins (strobili) are cone-like and the seeds are nutlets that mature in late October or November. Skamania germplasm commenced flowering after just three growing seasons. Natural pollination is by wind. This species produces seed primarily through outcrossing, but self pollination is possible as evidenced from controlled pollinations (bagging catkins on the same plant prior to flowering).

Skamania germplasm was not bred or hybridized but was selected as the best performing accession in a common garden study (Photo 1) of 64 populations of Sitka alder assembled primarily from western Oregon and western Washington (Figure 1).

Figure 1--Collection sites for Sitka alder. Note: Six accessions not shown. Numbers indicate USDA SCS Major Land Resource Areas.



[1/] Four of five summaries of advanced evaluations in the supporting documentation section (Part D) were originally written by Theresa Flessner (Darris et al. 1994). Collections originated from elevations between 15 and 1798 m (50-5800 ft). Planted in October 1983, the study was located at the USDA Natural Resources Conservation Service, (formerly the Soil Conservation Service), Plant Materials Center, Corvallis, Oregon: elevation 72.5 m (225 ft), moderately well drained Woodburn silt loam, Benton Co., OR.

Selection was based on quantitative and qualitative measurements of overall growth, health, and reproductive capability taken between 1983 and 1990. After 8 years, offspring (G1) of the wild population (9040484) ranked in the top 16 percent or higher in seven of 10 categories, including plant vigor (1^{st}), foliage appearance (1^{st}), mean height (4^{th}), canopy width (4^{th}), lateral spread after first year (4^{th}), growth after first year (5^{th}), and first year growth (10^{th}) (tables 1 and 2). It tied nine other populations for second highest stem density (top 20%), achieved scores in the top one third for fruit production (ranked 7^{th}, top 34%), and had above average first year lateral spread (ranked 26, top 40%). Average date of leaf bud break was earlier than all but two other populations and leaf abscission (fall leaf drop) occurred later than all others.

Certain insect pests were minor to significant problems during the evaluation and seedling increase phases. Diseases were not considered an important factor during the same period. Accession 9040484 equaled eight other populations for the highest score in foliage appearance, a summary rating of foliar pest problems. However, there are no special claims for insect or disease resistance.

G0 seed from the original parent stand (G0) was collected in October 1982 by Scott Lambert, an employee of the USDA Soil Conservation Service. G0 seed was used to establish a plot within the common garden study. Clonal reproduction by stem cuttings proved unsuccessful. Therefore, in 1995 all populations except 9040484 in the common garden were removed to create an isolated seed orchard comprised of five original G1 plants (Photo 2). Half-sib and full-sib seedlings were produced and distributed for experiments, field testing, and revegetation projects between 1989 and 1995. Twenty-seven to 59 grams of full-sib G1 seed were obtained each year (1995-2004, table 8) by harvesting mature cones from the isolated seed orchard. Cones continued to be harvested annually each fall through 2004. The condition of the original G1 parents declined substantially between 2001 and 2005.

Skamania Germplasm represents a single, small population and appears to contain limited morphological and phenotypic variability. From observations of the G0 parent population, G1 plots, seedling production, and outplantings of G2 plants, there is no reason to believe growth and reproductive characteristics are not stable.

Table 1: 1983-1990 Initial Evaluation - Sitka Alder Common Garden Study - PMC Corvallis, Oregon

Accession #	Location (origin)	Survival %	Survival ranking	Height (cm)	Ranking of height	Growth after first year (cm)	Ranking of growth after 1st year	1st year growth (cm)	Ranking of 1st yr. growth	Canopy width (cm)	Ranking of canopy width
9040484	Skamania Co. WA	83	2	271	4	211	5	46	10	259	4
9037160	Clackamas Co. OR	100	1	235	20	167	34	51	5	250	6
9037132	Clatsop Co. OR	100	1	244	11	183	21	44	11	232	12
9037131	Clatsop Co. OR	100	1	213	37	156	37	40	16	238	10
9037121	Canada	83	2	235	20	163	35	54	4	238	10
9037125	Douglas Co. OR	100	1	412	1	359	1	37	19	293	1
9037127	Hood River Co. OR	100	1	323	2	247	2	59	2	262	3
9037130	Linn Co. OR	100	1	247	8	200	9	31	36	244	8
9037157	Mt. Ranier WA	100	1	189	47	142	52	29	40	189	39
9037112	Skamania Co. WA	50	4	186	49	146	47	25	52	186	42
9037152	Mt. Ranier WA	100	1	223	29	185	20	23	55	216	22
9037129	N/A	100	1	268	5	211	5	42	15	241	9
9037100	Clatsop Co. OR	83	2	213	37	152	40	47	8	232	12
9037145	Marion Co. OR	83	2	198	42	147	45	44	11	207	27
9037138	Lewis Co. WA	100	1	226	28	179	25	32	33	207	27
9037153	Mt. Ranier WA	100	1	183	51	144	50	24	53	198	34
9037110	Alaska	100	1	241	12	206	7	20	59	183	44
9037105	Lewis Co. WA	100	1	236	19	194	13	27	43	213	25
9037114	Cowlitz Co. WA	83	2	198	42	132	55	50	7	220	19
9037115	Lane Co. OR	100	1	247	8	193	14	37	19	247	7
9037133	Linn Co. OR	83	2	189	47	137	53	35	23	210	26
9037155	Skamania Co. WA	83	2	229	25	179	25	34	26	183	44
9037159	Thurston OR	100	1	238	15	204	8	17	61	207	27
9037111	Idaho	83	2	223	29	180	22	27	43	189	39
9037137	Snohomish Co. WA	83	2	229	25	178	28	34	26	220	19
9014018	Sweden	83	2	220	33	148	43	58	3	216	22
9037140	King Co. WA	100	1	195	45	156	37	23	55	180	48
9037141	King Co. WA	83	2	162	60	121	60	26	49	174	50
9037134	Lewis Co. WA	100	1	241	12	195	11	32	33	207	27
9037118	Whatcom Co. WA	83	2	162	60	117	61	27	43	162	57
9037116	Lane Co. OR	100	1	201	40	152	40	33	29	174	50
9037139	Linn Co. OR	100	1	229	25	190	16	23	55	226	16
9014774	Portugal	100	1	223	29	175	31	33	29	232	12
9037128	Hood River Co. OR	100	1	201	40	157	36	29	40	210	26
9037113	California	100	1	216	35	172	32	30	38	192	37

continued on next page

ratings scale: 1 = highest, 9 = lowest. First year growth refers to amount of new height growth added between transplanting and end of establishment year.

Table 1: 1983-1990 Initial Evaluation - Sitka Alder Common Garden Study - PMC Corvallis, Oregon
(continued)

Accession #	Location (origin)	Survival %	Survival ranking	Height (cm)	Ranking of height	Growth after 1st year	Ranking of growth after 1st year	1st year growth (cm)	Ranking of 1st yr. growth	Canopy width (cm)	Ranking of canopy width
9037099	Hood River Co. OR	83	2	183	51	143	51	27	43	183	44
9037104	Jackson Co. OR	100	1	302	3	235	3	51	5	253	5
9037151	Mason Co. WA	100	1	232	23	179	25	36	22	229	15
9037126	Douglas Co. OR	83	2	232	23	178	28	40	16	183	44
9037148	Marion Co. OR	100	1	195	45	145	49	34	26	186	42
9037103	Klamath Co. OR	100	1	241	12	198	10	26	49	195	36
9037136	Mason Co. WA	100	1	262	7	216	4	30	38	223	17
9037142	King Co. WA	100	1	235	20	186	18	35	23	220	19
9037156	Mt. Ranier WA	100	1	180	53	128	58	38	18	168	55
9037143	Mt. Ranier WA	83	2	198	42	172	32	11	63	180	48
9037135	King Co. WA	100	1	238	15	195	11	26	49	216	22
9037109	Alaska	100	1	186	49	146	47	24	53	165	56
9037108	Lane Co. OR	100	1	146	63	98	63	31	36	131	62
9040483	Benton Co. OR	100	1	220	33	155	39	47	8	189	39
9037117	Mason Co. WA	100	1	140	64	93	64	32	33	146	60
9037149	Clackamus Co. OR	100	1	177	56	129	56	33	29	171	53
9037147	Marion Co. OR	67	3	171	58	135	54	21	58	174	50
9037102	Lane Co. OR	100	1	180	53	149	43	17	61	171	53
9037107	Whatcom Co. WA	100	1	180	53	125	59	37	19	152	59
9037106	Whatcom Co. WA	100	1	204	39	147	45	43	14	207	27
9037144	Kittatas Co. WA	100	1	247	8	188	17	44	11	268	2
9037146	Linn Co. OR	100	1	238	15	193	14	27	43	207	27
9037119	Canada	100	1	238	15	186	18	35	23	192	37
9037154	King Co. WA	100	1	223	29	180	22	27	43	198	34
9030529	Oregon	83	2	171	58	152	40	3	64	137	61
9037101	Lane Co. OR	100	1	216	35	180	22	20	59	201	33
9037124	Jackson Co. OR	100	1	265	6	176	30	62	1	223	17
9037098	Clackamus Co. OR	100	1	174	57	129	56	29	40	155	58
9037097	Josephine Co. OR	50	4	155	62	107	62	33	29	131	62
Grand mean		94	na	218	na	169	na	33	na	203	na
Grand range		50		140		93		3		131	
		to		to		to		to		to	
		100		412		359		62		293	

ratings scale: 1 = highest, 9 = lowest. First year growth refers to amount of new height growth added between transplanting and end of establishment year.

Table 2: 1983-1990 Initial Evaluation - Sitka Alder Common Garden Study - PMC Corvallis, Oregon

Accession #	Lateral spread after 1st year	Ranking of lateral spread after 1st yr.	1st year lateral spread (cm)	Ranking of 1st yr. lateral spread	Vigor rating	Ranking of vigor rating	Stem density rating	Ranking of stem density	Fruit prod. rating	Ranking of fruit prod.	Bud break date	Leaf drop date	Foliage appearance rating	Ranking of foliage appearance
9040484	224	4	19	26	1	1	4	4	3	7	3/31	12/28	2	1
9037160	215	9	29	4	2	2	5	14	3	7	4/19	12/3	2	1
9037132	198	15	24	12	3	12	5	14	3	7	4/19	12/3	2	1
9037131	212	10	17	34	3	12	5	14	3	7	4/19	12/3	2	1
9037121	200	14	31	2	3	12	5	14	4	23	4/19	12/3	2	1
9037125	272	1	12	53	2	2	5	14	4	23	3/10	11/20	2	1
9037127	231	3	23	13	4	30	5	14	6	59	3/10	11/20	2	1
9037130	221	5	15	45	2	2	5	14	5	46	4/19	11/20	2	1
9037157	155	49	25	10	3	12	5	14	4	23	5/5	11/20	2	1
9037112	139	57	41	1	3	12	3	1	2	1	4/19	12/3	3	10
9037152	189	23	21	20	2	2	5	14	4	23	4/19	12/3	3	10
9037129	219	7	15	45	2	2	5	14	5	46	4/19	12/3	3	10
9037100	198	15	28	6	3	12	6	50	3	7	4/26	12/3	3	10
9037145	176	34	23	13	3	12	4	4	4	23	4/19	11/20	3	10
9037138	184	30	17	34	3	12	5	14	4	23	4/19	11/20	3	10
9037153	175	35	16	40	4	30	6	50	4	23	4/19	11/20	3	10
9037110	165	40	12	53	2	2	4	4	4	23	4/19	11/20	3	10
9037105	188	26	19	26	2	2	3	1	5	46	4/19	11/20	3	10
9037114	190	22	23	13	4	30	5	14	2	1	4/26	11/20	3	10
9037115	221	5	19	26	2	2	5	14	3	7	4/26	11/20	3	10
9037133	189	23	13	50	4	30	5	14	5	46	4/26	11/20	3	10
9037155	158	45	17	34	4	30	6	50	4	23	4/7	12/3	4	22
9037159	188	26	10	57	3	12	6	50	6	59	4/19	12/3	4	22
9037111	166	38	17	34	3	12	4	4	2	1	4/7	11/20	4	22
9037137	194	18	19	26	2	2	5	14	2	1	4/19	11/20	4	22
9014018	185	29	26	8	3	12	4	4	3	7	4/19	11/20	4	22
9037140	160	43	12	53	4	30	6	50	3	7	4/19	11/20	4	22
9037141	158	45	10	57	5	48	6	50	3	7	4/19	11/20	4	22
9037134	184	30	17	34	2	2	5	14	3	7	4/19	11/20	4	22
9037118	138	58	16	40	5	48	5	14	3	7	4/19	11/20	4	22
9037116	149	53	19	26	5	48	5	14	4	23	4/19	11/20	4	22
9037139	210	11	7	62	3	12	5	14	4	23	4/19	11/20	4	22
9014774	208	12	18	32	6	58	6	50	5	46	4/19	11/20	4	22
9037128	189	23	13	50	4	30	5	14	6	59	4/19	11/20	4	22
9037113	159	44	27	7	4	30	4	4	3	7	4/26	11/20	4	22

continued on next page

ratings scale: 1 = highest, 9 = lowest. 1st year lateral spread refers to increase in width between transplanting and end of establishment year.

Table 2: 1983-1990 Initial Evaluation - Sitka Alder Common Garden Study - PMC Corvallis, Oregon

continued

Accession #	Lateral spread after 1st year (cm)	Ranking of lateral spread after 1st year	1st yr. lateal spread (cm)	Ranking of Ist yr. lateral spread	Vigor rating	Ranking of vigor rating	Stem density rating	Ranking of stem density	Fruit prod. rating	Ranking of fruit prod.	Mean bud break date	Leaf drop date	Foliage appearance rating	Ranking of foliage appearance
9037099	163	42	15	45	4	30	3	1	3	7	4/26	11/20	4	22
9037104	217	8	29	4	4	30	5	14	5	46	4/26	11/20	4	22
9037151	207	13	14	48	3	12	4	4	3	7	4/19	12/3	5	38
9037126	154	50	23	13	3	12	5	14	4	23	4/19	12/3	5	38
9037148	152	51	26	8	4	30	6	50	4	23	4/19	12/3	5	38
9037103	169	37	20	21	4	30	5	14	4	23	4/7	11/20	5	38
9037136	193	20	22	18	3	12	5	14	2	1	4/19	11/20	5	38
9037142	194	18	20	21	4	30	6	50	4	23	4/19	11/20	5	38
9037156	145	54	18	32	5	48	6	50	4	23	4/19	11/20	5	38
9037143	164	41	8	60	5	48	4	4	4	23	4/19	11/20	5	38
9037135	193	20	14	48	3	12	5	14	4	23	4/19	11/20	5	38
9037109	143	56	16	40	4	30	5	14	5	46	4/19	11/20	5	38
9037108	101	64	23	13	6	58	5	14	5	46	4/19	11/20	5	38
9040483	158	45	22	18	3	12	6	50	5	46	4/19	11/20	5	38
9037117	120	62	20	21	6	58	5	14	5	46	4/19	11/20	5	38
9037149	145	54	20	21	5	48	6	50	6	59	4/19	11/20	5	38
9037147	158	45	10	57	4	30	6	50	7	64	4/26	11/20	5	38
9037102	152	51	12	53	5	48	5	14	4	23	4/19	12/3	6	53
9037107	126	60	20	21	4	30	4	4	2	1	4/7	11/20	6	53
9037106	172	36	30	3	5	48	5	14	3	7	4/19	11/20	6	53
9037144	235	2	25	10	4	30	4	4	4	23	4/19	11/20	6	53
9037146	182	32	16	40	3	12	5	14	5	46	4/19	11/20	6	53
9037119	166	38	19	26	4	30	5	14	4	23	4/7	11/20	7	58
9037154	177	33	13	50	5	48	5	14	4	23	4/19	11/20	7	58
9030529	125	61	4	64	6	58	5	14	5	46	4/19	11/20	7	58
9037101	188	26	6	63	5	48	5	14	5	46	3/10	10/23	7	58
9037124	197	17	16	40	6	58	5	14	7	63	3/10	10/23	7	58
9037098	131	59	17	34	6	58	5	14	4	23	4/7	10/23	7	58
9037097	117	63	8	60	6	58	5	14	3	7	4/9	10/23	8	64
Grand mean	177	na	18	na	4	na	5	na	4	na	na	na	4	na
Grand range	101		4		6		6		7				8	
	to		to		to		to		to				to	
	272		41		1		3		2				2	

ratings scale: 1 = highest, 9 = lowest. 1st year lateral spread refers to increase in width between transplanting and end of establishment year.

(**1). Botanical Description of the Variety:**

Skamania germplasm (9040484) falls within the taxonomic limits for *Alnus sinuata* (Regel) Rydb. described in Hitchcock and Cronquist "Flora of the Pacific Northwest" (1973) page 72, Hitchcock et al. in "Vascular Plants of the Pacific Northwest" (1969), Part 2, pages 74-76, and Munz in "A California Flora and Supplement" (1973), page

Photo 1. Common garden study of Sitka alder (April 1988) planted in October 1983. Skamania germplasm (featured plot) broke bud and leafed out earlier than all but two populations. The taller specimens with foliage are red alder (*Alnus rubra*).

Photo 2. Original G1 plants of Skamania germplasm retained from common garden study and maintained as isolated seed orchard for G1 seed source. (circa 1999)

900. It also concurs with the description for *A. viridis* (Chaix) DC. subsp. *sinuata* (Regal) A. Love & D. Love in “The Jepson Manual, Higher Plants of California” (1993), page 366 and the Flora of North America (Flora of North America Editorial committee 1993+). Identification was confirmed and re-confirmed by Dr. Richard Hulse, Curator of the Oregon State University Herbarium (written communications December 2, 1995 and May 2, 2004). Other references for the currently accepted scientific name are the USDA Natural Resources Conservation Service’s PLANTS database and the USDA Agricultural Research Service’s GRIN database.

Alnus viridis subsp. *sinuata,* Skamania germplasm, is an upright, deciduous shrub or small tree freely branching at the base. The older bark is thin, smooth grey to blue-grey in color. The branches are slender, glabrous, light brown to reddish brown or grey, and slightly zigzagged in appearance. Twigs are reddish to yellow brown, at first pubescent later becoming smooth with conspicuous lenticels. The winter buds are sessile on new growth, 1.2-1.4 cm long (0.5-.06 in), sharply acute, and covered with 3 to 5 (4 to 6) brownish-red to dark purple overlapping scales. The plants are monecious and have separate male and female catkins (strobili) that flower with the leaves on current year’s growth (Photos 3 and 4). The staminate inflorescence is slender, 10-14 cm (4.0-5.5 in) long at pollination, and drooping. The pistillate inflorescences are 0.7-1.0 cm (0.3-0.4 in) long in clusters of 3 to 6 per upright branch, becoming woody, cone-like structures (strobili) comprised of many leathery scales. Mature cones are 1.3-1.9 cm (0.5-0.8 in) long and half as thick, ovate to ovoid-ellipsoid in shape, and born on a slender peduncle. The fruit is a small nutlet (seed) with thin membranous wings that are twice the width of the seed. Leaf blades are thin, sticky and fragrant when young, alternate, narrowly to broadly ovate, 7-14 cm (2.8-5.5 in) long, and 3-10 cm (1.2-4.0 in) wide. They have a fine single or double serrate-denticulate to sinuate margin. The leaf surfaces are glabrous except for hairs along the major vein axils, yellow-green above, and slightly paler and shiny beneath.   The base of the leaf is rounded to subcordate while the tip is acute to slightly acuminate. The petiole is glabrous, 1.3-1.9 cm (0.5-0.8 in) long and grooved on the upper surface (Hitchcock et. al. 1969, Hickman 1993, Elias 1980).

(2). Objective Description of the Variety:

Skamania germplasm Sitka alder is a large deciduous shrub or small tree that has a multi-stemmed trunk with rounded crown. It can reach a height of 2.7 m (8.9 ft) after eight years and 4.6 m (15.1 ft) after 22 years on an upland site without irrigation. Canopy widths were 2.1 m (6.9 ft) and 4.2 m (13.8 ft) at the same ages. Greater size may be achieved under more optimal site conditions. Specimens of Skamania germplasm have survived over 22 years. Life expectancy is assumed to be normal for the species (30-50 years) under typical growing conditions. The foliage of Skamania germplasm is deeper green than some populations of Sitka alder but otherwise there are no recognized distinct morphological traits. Distinguishing features are primarily related to above ground growth potential, reproduction, and phenology.

Photo 3. Twigs of Skamania germplasm (April) with male catkins and small female flowering structures (future cones or strobili) in bloom.

Photo 4. Twig of Skamania germplasm in June showing foliage, male catkins, and current and previous year's female cones (strobili).

Skamania germplasm is a relatively unique, low elevation, high quality seed source originating from a region where the species is typically infrequent to uncommon at low altitude. Based on the principal study at Corvallis, this selection of Sitka alder grew more vigorously, taller, and faster (after the first year) than over 90% of the populations tested from the Pacific Northwest. Vigor rating was 1st, height 4th, canopy width 4th, lateral spread (after 1st year) was 4th, and 1st year growth was 10th among all 64 populations of Sitka alder evaluated over an eight year period. Fruit production ranked 7th and was more consistently rated as good from year to year compared to all other accessions. Skamania germplasm flowered and produced fruit after three full growing seasons. Its foliage appearance tied for highest score among the same assemblage of material. However, no superiority in disease or insect resistance is inferred. This selection drops its leaves later (avg. December 28) and breaks bud earlier in spring (avg. March 31) than all but two populations included in the study (tables 1 and 2). While the species is primarily found at mid to subalpine elevations in Oregon and Washington, the shorter period of winter dormancy is consistent with the low elevation origin of this population. Robust nitrogen fixation rates (42.8 micromoles per gram of nodule dry weight) recorded for inoculated seedlings of Skamania germplasm at Corvallis are comparable to rates reported elsewhere for Sitka alder.

C. Evidence Supporting the Identity of the Variety and statements or Claims Concerning the Variety's Performance Characteristics:

Initial Evaluation of Sitka Alder (common garden study)

Introduction

Sitka alder (*Alnus viridis* spp*. sinuata*) is a native deciduous shrub or small tree that grows to a height of 1-6 m (3-19 ft) in the mountains and 6-12 m (19-37ft) at low elevations. It occurs from southern and western Alaska and the Yukon southward to northern California and eastward to southwestern Alberta, western Montana, and Idaho. Sitka alder is one of three subspecies of *Alnus viridis* that form a circumpolar group distributed across northern North America, Asia, and Europe. The other subspecies are *A. viridis* subsp. *crispa and A. viridis* subsp*. fruticosa*. Sitka alder is found from sea level to above timberline, but most commonly occurs above 900 m (3000 ft) in the mountains (USDA Forest Service 1988, Elias 1980, Oregon State University 2005, Hickman 1993). [Figure 2 reproduced from the FNA website, with permission from the Flora of North America Association, FNA Editorial Committee 1993+.]

Sitka alder is thicket forming, pioneer to early seral species with moderate shade tolerance. It is well recognized as an ecologically important species for rapid stabilization and reclamation of landslide chutes, steep slopes, rock slides, streambanks, areas of flood deposition and scour, and exposed mineral soils following glacial retreat, avalanches, massive soil slumping, and other drastic disturbances. Typical habitat for Sitka alder includes moist, montane woods, rocky

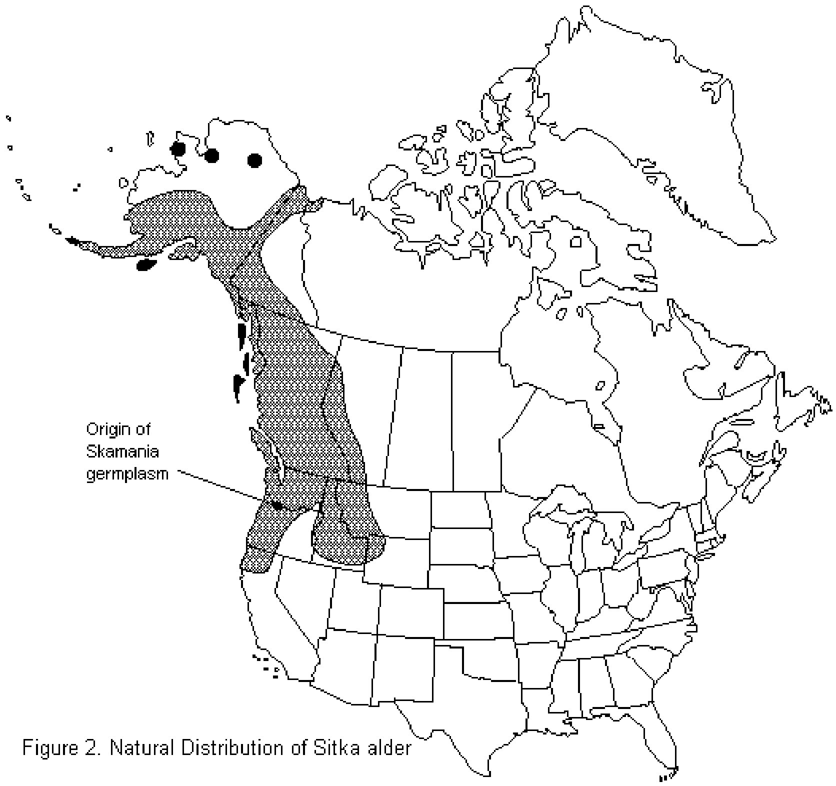


Figure 2. Natural Distribution of Sitka alder

or sandy coasts (Alaska), streambanks, lakeshores, moist talus slopes, the edges of moist meadows, and the north face of rocky outcrops or other shady aspects. The abundant leaf litter is an important source of organic matter for soil building and nutrient cycling (Uchytil 1989). The roots of Sitka alder form beneficial symbiotic relationships with both ectomychorrhizal fungi and actinobacteria (actinomycetes) in the genus *Frankia*. The later association results in the formation of root nodules which are active sites for fixation of atmospheric nitrogen. Contributions to soil nitrogen by Sitka alder in the Pacific Northwest have been estimated at 20 to 150 kg N/ha (16-122 lbs/ac) per year (Binkley 1986). Its highly fibrous root system aids in soil erosion control. Benefits to site productivity along with the ability to tolerate low nutrients, high acidity, and high exchangeable aluminum make this species a good candidate for restoration of copper mine tailings (Kramer et al. 1996-1997) as well as coal mine spoils. Sitka alder is a valuable species for streambank stabilization, erosion control on nutrient poor sites, and other land reclamation efforts where an easy to establish, deciduous shrub is desired.

The palatability of Sitka alder is considered poor and forage value low for most ungulates (Uchytil 1989), but others report that it is one of most palatable of the native alders, being rated fair to good as browse for sheep in some areas (USDA Forest Service 1988). Selective browsing of this species by moose occurs in Idaho during summer months as leaves remain green (Pierce 1984). It is also considered high-quality moose browse in British Columbia. Elk will browse the tender young shoots, while white-tailed and mule deer feed on leaves and twigs (Haeussler et. al. 1990). Alder twigs and leaves are consumed by muskrats, rabbits, snowshoe hares, squirrels, and beaver while the seeds, buds, or catkins are an important source of food in winter for numerous song and game birds (Healy and Gill 1974, Haeussler et al. 1990, Martin et al. 1951). Thickets provide thermal and hiding cover for big game and other wildlife, as well as nesting habitat for many small birds (Uchytil 1989).

Alder species including Sitka alder have numerous ethnobotanical uses. The bark was used by several tribes to make a red or brown colored dye. The dye was used to color fish nets and cedar bark. The aged bark was also used as a medicinal cure for diarrhea, constipation, and other internal ailments. The inner bark and ointments made from it were used to treat skin problems such as wounds, skin ulcers, and swelling. The Quileute eat raw cones to stop dysentery and the Klallam chew catkins as a cure for diarrhea. Fresh scraped bark juice relieves itching from skin rash and an infusion treats poison ivy. Leaf decoctions were used to treat burns and swollen wounds. Alder roots are high in tannins and the Menomini boiled and drank it as an astringent (Gunther 1973, Ellis et al. 1995). A decoction of stems was apparently also drunk as a remedy for colds or dried stems were placed in the nose or chewed for the same reason. Indications that alder was used as a fragrance or scent may have referred to Sitka alder which is known for being sticky and sweet smelling (Turner et al. 1990). Alder wood was used as firewood and was preferred for smoking salmon. Next to cedar, it was the most widely used wood for woodworking (Gunther 1973). The species was considered a sign of water and the hard wood was used for making snowshoes and bows (Turner et al. 1990).

Sitka alder reproduces naturally by seed or vegetatively by sprouting from damaged root collars or stumps. Shoots can also form from exposed roots. The species is monecious with male and female catkins forming on the same individual. Plants can commence flowering at an age of four to seven years (Uchytil 1989). The seeds or nutlets are borne within small cone-like catkins called strobili that mature in fall. They are winged and can travel long distances by wind or water (Uchytil 1989). Seed dormancy can vary by provenance, population, moisture content, or age. Dry seed may germinate at higher rates or more uniformly if it undergoes cold moist stratification for one to three months at 1-3ºC (34-38ºF) (Emery 1988). Others report using stratification periods of 14 days for *Alnus viridis* (Farmer et. al. 1985) or one month for *Alnus sinuata* (McLean 1967). Fresh seed may be less dormant than dry seed. Some state that no chilling or treatment is required (Coates et. al. 1990, Hudson and Carlson 1998). When stored under cool conditions (1-3º C or 34-38°F) in air tight containers, the seed can remain viable for at least one to two years. The species is readily adapted to container nursery production (Hudson and Carlson 1998, Wick et al. 2004) or bareroot seedling culture. For optimal growth, young seedlings and new nursery beds should be inoculated with the appropriate *Frankia* bacteria using cultured isolates or diluted slurry created from crushed (or ground) and homogenized nodules (Ahrens 1994, Subramaniam et al. 1991). Apparently the ectomychorrhizal fungi which also form a symbiotic root association, do not survive this grinding and slurry treatment.

Sitka alder can also be vegetatively propagated. Hardwood cuttings do not work (Java and Everett 1992), but some rooting success has been reported with green stem cuttings in combination with bottom heat (Carpenter, et. al. 1984) or with cuttings taken just after the leaves fall then planted outdoors in a sandy soil (Plants for a future 1997-2000). The species has also been propagated successfully using tissue culture (Tremblay and Lalonde 1984).

Purpose

Resource managers in the Pacific Northwest are increasingly interested in using hardwoods to improve and stabilize riparian areas, increase forest site productivity, control the spread of certain conifer root diseases, uptake excessive nutrients through biofiltration, and enhance wildlife habitat diversity (Miner 1990). Other species like red alder (*Alnus rubra*) and black cottonwood (*Populus balsamifera* subsp*. trichocarpa*) produce important wood and fiber crops as well. Although Sitka alder is a non-crop species, it is particularly useful for erosion control and soil building on nutrient poor, disturbed sites or newly exposed subsoils. Its low height and early slowdown in growth rate, along with symbiotic nitrogen fixation, makes it potentially desirable to interplant with conifers such as Douglas fir (*Pseudotsuga menzieii*) and lodgepole pine (*Pinus contorta*). The purpose this study was to assemble a large number of seed sources of Sitka alder from western Washington and Oregon, evaluate their growth and performance, and select one or more high quality populations for further study, release, and commercial production.

Methods and Materials

Sixty four seed sources (accessions or populations) of Sitka alder were collected and assembled for a common garden study (initial evaluation study) in 1982. Three populations of red alder (*Alnus rubra*) and Mountain alder (*Alnus tenuifolia*) were included for a total of 70 accessions. Twenty-eight wild populations were sampled from western Oregon, twenty-seven from western Washington, three from Vancouver Island, British Columbia, two from Idaho, two from Alaska, two from Europe, and one from northern California. Refer to figure 2 for a map of collection sites in the Pacific Northwest.

Seed from each accession was sown directly into 164 cc (10 cu. in.) "cone-tainers" in February-March of 1983. Seedlings were grown in a greenhouse under sprinkler irrigation and fertilized during the spring and summer months. In October of 1983, plants of all 64 accessions of Sitka alder were hand planted into strips of chemically killed hard fescue sod (*Festuca ovina* var. *duriuscula*). The common garden site was a moderately well drained Woodburn silt loam, 0-1% slope. The USDA Plant Hardiness Zone is 8b and the average frost-free growing period is 210 days. The site receives an average annual precipitation of 1050 cm (41 inches). Elevation is 69 m (226 ft.). Maintenance consisted of periodic mowing of grass alleys.

The study consisted of single row, non-replicated plots with each plot containing six plants. Spacing between rows and plants was 3.7 m (12 ft.) and 1.8 m (6 ft.), respectively. No supplemental irrigation or fertilization was applied during the evaluation period (1983-1990). Performance data included survival, height, canopy width, basal width, vigor, stem density, "cone" production, foliage appearance, and average bud break and leaf drop dates, recorded annually. Visual ratings were based on a scale of 1 to 9, with 1 being excellent and 9 poor.

Results and Discussion

Accession 9040484 (Skamania germplasm) was identified as the top performer among 64 accessions or populations of Sitka alder. Selection criteria included vigor, height, canopy width, first year and subsequent years growth rates and rates of lateral spread, stem density, cone production, foliage appearance, and average date of spring bud break and fall leaf drop. A final summary of results for all accessions is shown in tables 1 and 2. Data represent mean of each plot. Physical dimensions represent final year data (1990) unless otherwise specified.

Accession 9040484 originating from Skamania County, WA, was the only population to place in the top 16 percent or better in seven out of ten evaluation criteria (tables 1 and 2). Accessions 9037160, 9037130, 9037115, 9037136, and 9014018 placed in the top 10 percent in at least three of 10 categories (table 3). Substantial phenotypic variability in height, canopy width, growth rate, foliage appearance, and phenology occurred among accessions but little within accessions. Accession 9040484 broke bud earlier than all but two other populations and retained leaves longer than all others. Seventy percent of the populations flowered and fruited at age three (1986: beginning of 4th growing season). All remaining accessions flowered and fruited at age four (1987), except for 9037110 which did do so at age five (1988).

Table 3. Comparative growth and phenology for top six accessions of Sitka alder in common garden study (1984-1990).

Accession Number	SU %	HT cm	GR Cm	GR1 cm	CW cm	LS cm	LS1 cm	V	SD	FP	BDBK	LFDP	FA
9040484	**83**	**271**	**211**	**46**	**259**	**224**	**19**	**1**	**4**	**3**	**3/31**	**12/28**	**2**
9037160	100	235	167	51	250	215	29	2	5	3	4/19	12/03	2
9037130	100	247	200	31	244	221	15	2	5	5	4/19	11/20	2
9037115	100	247	193	37	247	221	19	2	5	3	4/26	11/20	3
9037136	100	262	216	30	223	193	22	3	5	2	4/19	11/20	4
9014018	83	220	148	58	216	185	26	3	4	3	4/19	11/20	4
Mean	94	218	169	33	203	177	18	4	5	4	--	--	4
Lowest	50	140	93	3	131	101	4	6	6	7	3/10	10/23	8
Highest	100	412	359	62	293	272	41	1	3	2	5/05	12/28	2

Su=survival, HT=height, GR=total growth after 1st yr, GR1=growth in 1st yr, CW=canopy width, LS=lateral spread after 1st yr, LS1=lateral spread in 1st yr, V=vigor, SD=stem density, FP=fruit production, BDBK=date of budbreak, LFDP=date of leaf drop, FA=foliage appearance. All data are from 1990 except for LS, LS1, GR, and GR1. V, SD, FP, and FA are based on visual scores of 1=best or highest and 9=lowest or worst. Means and low-high ranges are for all 64 accessions.

Whip Grafting of Sitka Alder Using a Hot-callusing Device

Introduction

Grafting is commonly used to establish clonal seed orchards of woody plants. Although field grafting of cultivars of alders onto the species is reportedly successful, the use of a device for hot-callusing graft unions of dormant stock is recommended to improve the grafting success of difficult-to-graft species, such as alder (*Alnus sp.*). "Hot callusing is a method used in grafting to expose the graft union to elevated temperatures for a short time to accelerate cell division" (Lagerstedt 1982). The hot-callusing device is a PVC pipe into which 12 mm slots have been routed, perpendicular to the length of the pipe. A thermostatically controlled heating cable is placed within the pipe, and the pipe may be foam-insulated. Graft unions are placed across the pipe in the slots. This device encourages callusing and allows the plant to remain dormant, thereby preventing translocation demands from being placed on the newly formed graft union. Woody plants may be either bareroot (heeled into moist sawdust) or containerized. Thus, the objective of this trial was to evaluate the effect of the hot-callusing device on whip grafts of Sitka alder [*Alnus sinuata* (Regel) Rydb].

Material and Methods

Scion wood of Sitka alder (accession 9040484) was whip-and-tongue grafted onto half-sib containerized rootstock in January, 1991. The scion wood was at least 25 cm long, 1 cm in diameter and exhibited two or more healthy buds; rootstocks were 1-2 cm in diameter. A grafting machine was used to make the slanting cuts. Scions were aligned on one side of the rootstock, and grafts were trimmed and wrapped with masking tape. Twenty-four grafted plants were placed in a lath house, on their sides, with graft unions placed in the hot-callusing tube. White plastic was draped over the pots and hot-callusing tube to keep moisture out of the tube and reflect heat and light. Stock was gently removed from the hot-callusing tube after three weeks.

Results and Discussion

After three weeks of hot-callusing, callus had begun to form on grafts. However, four weeks after removal from hot-callusing tubes (March, 1991), grafted scion wood remained dormant. Removal of grafting tape revealed tiny cracks in the graft unions; these cracks indicate (1) a longer period of hot-callusing is needed to promote greater callus formation and/or (2) removal of grafted stock from the hot-callusing tube must be done carefully to prevent tearing of delicate callus tissue. Thus, hot-callusing whip-and-tongue grafted stock of Sitka alder did not promote graft formation in this study. It is recommended that this study be repeated and include both three-week and five-week hot-callusing periods, and careful removal of union from tubes.

Vegetative Propagation of Sitka Alder from Cuttings With or Without Rooting Hormone

Introduction

Specific genotypes of Sitka alder (*Alnus sinuata*) represented within accession 9040484 (Skamania germplasm), need to be propagated vegetatively to provide clonal material for further testing and establishment of seed orchards or cutting blocks. The objectives of this study were (1) to evaluate the effect of indolebutyric acid (IBA) on rooting of summer wood cuttings of Sitka alder, and (2) to determine the effectiveness of a commercial rooting compound.

Material and Methods

Summer wood cuttings of Sitka alder (accession 9040484) were collected in July, 1988 and subjected to the following treatments:

IBA @ 2000 ppm	(49 cuttings)
IBA @ 4000 ppm	(49 cuttings)
IBA @ 10,000 ppm	(49 cuttings)
Control (no treatment)	(21 cuttings)
Hormodin # 3 (0.8% IBA)	(27 cuttings)

Treated cuttings were placed in media-filled cone-tainers under mist propagation from July through September (1988) in the greenhouse. Percent rooting and rate of root development was recorded in September.

Results and Discussion

No rooting of cuttings was detected in September, 1988. Thus, IBA and Hormodin # 3 appear to have no effect on percent rooting or rate of root development in summer wood Sitka alder cuttings.

Effect of Fertilization and Inoculation on Growth of Sitka Alder Seedlings for Riparian Plantings

Sitka alder (*Alnus sinuata*) is an excellent candidate for streambank restoration in the Pacific Northwest as it is a nitrogen-fixing, pioneer species with the ability to grow on infertile soils. However, vigorous seedlings are necessary to ensure the success of any restoration effort. Thus, a study was initiated in February, 1991 to determine the effect of inoculation and fertilization regimes on biomass production and outplanting survival of Sitka alder seedlings.

Materials and Methods

Sitka alder seedlings (accession 9040484-Skamania germplasm) were inoculated with soil (containing alder nodules) at planting, or were inoculated with a suspension of nitrogen-fixing *Frankia* sp., isolated from either (1) Sitka alder nodules, or (2) white alder (*Alnus rhombifolia*) nodules. Soil was collected from underneath a stand of young Sitka alder shrubs in the Cascade Mountain range, Oregon, and applied in a band underneath seed, at planting time. Isolates were applied in solution (0.5 ml per seedling) to four-week-old seedlings. Controls (untreated seedlings) were included for comparison. Seedlings received either no fertilizer, or a slow-release, complete (14-14-14) fertilizer (Osmocote) at planting, or were fertilized with 10mM ammonium nitrate plus 5 mM potassium chloride, 5 mM potassium phosphate, or 10mM ammonium nitrate plus 5 mM potassium phosphate, twice weekly for twelve weeks. Each seedling received 15 ml of fertilizer solution per application. Osmocote was incorporated into the potting mix at the rate of 31.1 g per 4 gallons of soil.

The experimental design was a split plot, with the whole plot factor arranged as a randomized complete block. The whole plot factor, fertilization regime, was replicated four times; the split plot factor, inoculation method, was replicated twenty times. The experimental unit consisted of six seedlings. One-half of these were used for destructive measurements; the remaining seedlings were outplanted at the PMC in November, 1992 to determine the effect of treatment on survival.

Several parameters were measured, including total shoot dry weight, vigor, and nodule abundance. Vigor and nodule abundance were rated on a scale from 9 to 1 with 9 being poor and 1, excellent and 5 to 1 with 5 being poor and 1, excellent, respectively.

Results and Discussion

Fertilization and inoculation interacted to affect shoot dry weight ($p<0.05$) (Table 4). Within controls, shoot biomass was low, and inoculation method did not differ (in terms of shoot dry weight.) Within nitrogen-fertilized seedlings, soil-inoculated seedlings produced more shoot biomass than controls, but not more than seedlings inoculated with laboratory isolates. Within phosphorus-fertilized seedlings, shoot biomass increased; soil-inoculated seedlings produced the most shoot biomass, followed by those seedlings inoculated with laboratory isolates. Both produced more biomass than controls. With nitrogen and phosphorus fertilization, shoot biomass reached its highest point; soil-inoculated seedlings produced the most, followed by laboratory isolates, then controls. With Osmocote fertilization, inoculated seedlings produced more shoot biomass than controls, but method did not differ significantly.

Thus, fertilization with nitrogen and phosphorus and inoculation promoted vigorous growth, and inoculation method was an important factor.

Table 4—Effect of fertilization and inoculation on mean shoot dry weight of Sitka alder seedlings.

FERTILIZATION	INOCULATION	SHOOT DRY WEIGHT (g)
Control	Control	0.8
Control	Sitka alder isolate (lab)	0.6
Control	White alder isolate (lab)	0.7
Control	Soil	1.0
W/ Nitrogen	Control	1.1
W/ Nitrogen	Sitka alder isolate (lab)	1.7
W/ Nitrogen	White alder isolate (lab)	1.9
W/ Nitrogen	Soil	2.5
W/ Phosphorus	Control	1.4
W/ Phosphorus	Sitka alder isolate (lab)	3.3
W/ Phosphorus	White alder isolate (lab)	3.2
W/ Phosphorus	Soil	4.9
W/ N & P	Control	5.5
W/ N & P	Sitka alder isolate (lab)	6.4
W/ N & P	White alder isolate (lab)	6.5
W/ N & P	Soil	8.1
W/ Osmocote	Control	3.5
W/ Osmocote	Sitka alder isolate (lab)	5.8
W/ Osmocote	White alder isolate (lab)	6.6
W/ Osmocote	Soil	6.0

LSD = 1.1, at alpha = 0.05

Fertilization and inoculation also interacted to affect vigor ($p<0.05$) (Table 5). Within unfertilized seedlings, inoculation with soil resulted in improved vigor. Inoculation with laboratory isolates decreased vigor, in comparison with non-inoculated seedlings. With nitrogen fertilization, inoculation improved vigor; there was no difference among inoculation methods. With phosphorus fertilization, inoculation with soil or white alder isolates best-improved vigor. With nitrogen and phosphorus fertilization, inoculation with white alder isolates decreased vigor. Within Osmocote-fertilized seedlings, inoculation improved vigor. Thus, inoculation improved vigor in conjunction with fertilization regime, and inoculation method was an important factor.

Table 5—Effect of fertilization and inoculation on mean vigor of Sitka alder seedlings.

FERTILIZATION	INOCULATION	VIGOR
Control	Control	7
Control	Sitka alder isolate (lab)	8
Control	White alder isolate (lab)	8
Control	Soil	6
W/ Nitrogen	Control	6
W/ Nitrogen	Sitka alder isolate (lab)	5
W/ Nitrogen	White alder isolate (lab)	5
W/ Nitrogen	Soil	5
W/ Phosphorus	Control	6
W/ Phosphorus	Sitka alder isolate (lab)	5
W/ Phosphorus	White alder isolate (lab)	4
W/ Phosphorus	Soil	4
W/ N & P	Control	4
W/ N & P	Sitka alder isolate (lab)	4
W/ N & P	White alder isolate (lab)	5
W/ N & P	Soil	4
W/ Osmocote	Control	5
W/ Osmocote	Sitka alder isolate (lab)	3
W/ Osmocote	White alder isolate (lab)	2
W/ Osmocote	Soil	3

RATINGS: 1 = Best; 9 = Worst
LSD = 1, at alpha = 0.05

Shoot dry weight and vigor were not correlated with nodule abundance ($p<0.05$) (Table 6). Within unfertilized seedlings, nodules were moderately abundant, and inoculation was not effective. Thus, *Frankia* was quite abundant in the environment and contamination or natural infection occurred. With nitrogen fertilization, nodules were generally less abundant; however, soil-inoculated seedlings produced more nodules than controls or isolates. With phosphorous fertilization, nodules were highly abundant in controls and inoculated groups, again indicating contamination. With both nitrogen and phosphorus fertilization, nodules were abundant; soil-inoculated seedlings produced the most nodules, followed by isolates. With Osmocote fertilization, nodules were also abundant; inoculation with soil or Sitka alder isolates best-promoted nodule formation. Thus, nodule abundance is affected by fertilization regime, most notably phosphorus level, and inoculation method becomes important when using a weekly, liquid fertilizer.

Table 6—Effect of fertilization and inoculation on mean nodule abundance of Sitka alder seedlings.

FERTILIZATION	INOCULATION	NODULE ABUNDANCE
Control	Control	3
Control	Sitka alder isolate (lab)	4
Control	White alder isolate (lab)	4
Control	Soil	4
W/ Nitrogen	Control	5
W/ Nitrogen	Sitka alder isolate (lab)	5
W/ Nitrogen	White alder isolate (lab)	5
W/ Nitrogen	Soil	2
W/ Phosphorus	Control	1
W/ Phosphorus	Sitka alder isolate (lab)	2
W/ Phosphorus	White alder isolate (lab)	1
W/ Phosphorus	Soil	2
W/ N & P	Control	4
W/ N & P	Sitka alder isolate (lab)	3
W/ N & P	White alder isolate (lab)	3
W/ N & P	Soil	2
W/ Osmocote	Control	2
W/ Osmocote	Sitka alder isolate (lab)	1
W/ Osmocote	White alder isolate (lab)	2
W/ Osmocote	Soil	1

RATINGS: 1 = best; 5 = worst
LSD = 1, at alpha = 0.05

To conclude, fertilization and inoculation interact to affect growth, vigor, and nodule abundance. Inoculation with soil containing nodules *(Frankia* sp.) prior to planting and the application of a balanced liquid fertilizer periodically or incorporation of a slow-release fertilizer at planting will produce vigorous Sitka alder seedlings.

Measurement of Symbiotic Nitrogen Fixation of Sitka alder

Introduction

The objectives of this study were (1) to determine nitrogen fixation rates of inoculated and non-inoculated Sitka alder (*Alnus sinuata*) seedlings and (2) to determine effect of inoculation on nitrogen fixation.

Materials and Methods

Nine Sitka alder seedlings (accession 9040484-Skamania germplasm) were inoculated with soil (containing Sitka alder nodules) at planting (March, 1992). Soil was collected from underneath young Sitka alder shrubs (located at the Corvallis PMC) and applied in a band underneath seed, at planting time. Controls (non-inoculated seedlings) were included for comparison. Seedlings were grown under lath house conditions for 16 weeks. Using the acetylene reduction assay of McNabb and Geist (1979), nine inoculated and five non-inoculated seedlings were assayed on August 5, 1992. Nodules were oven-dried and weighed.

Results and Discussion

Acetylene reduction rates averaged 42.8 and 11.8 micromoles per gram of nodule dry weight per hour of incubation for inoculated and non-inoculated seedlings, respectively. For comparison, Binkley (1981; 1982) reported acetylene reduction rates of 20.5 and 7.9 micromoles per gram per hour for 4-8 year old and 5 year-old Sitka alder trees, respectively. Thus, measured acetylene reduction rates for 16 week-old Sitka alder seedlings appear reasonable, and inoculation of these seedlings results in higher acetylene reduction rates (and nitrogen fixation rates) in August. Future studies should examine acetylene reduction rates of various ages of Sitka alder (9040484) throughout the growing season for better comparison with rates reported in the literature.

Effect of Cold-moist Stratification on Germination of Sitka Alder Seed

Introduction

Sitka alder (*Alnus sinuata*) may be propagated via fresh seed or cold-moist stratification of dried seed (Schopmeyer 1974). However, relatively little is known about its stratification requirements. The objective of this study was to determine the effect of a three-month cold-moist stratification period on germination of dried seed of Sitka alder.

Methods and Materials

Sitka alder seeds were collected in November, 1990 from accessions 9037151, 9037160, and 9040484 (Skamania germplasm) evaluated at the Corvallis PMC. Seeds were removed from air-dried cones, separated from debris, and stored at 3 C in plastic bags. To determine the effect of cold-moist stratification on germination of Sitka alder, 100-seed lots of each accession were subjected to one of the following treatments:

control (no treatment); stored in plastic bags.
placement in saturated peat moss, in plastic bags.
dusting with Captan (fungicide), followed by placement in saturated peat moss, in plastic bags.

Plastic bags were closed and then refrigerated at 3 C for nine weeks. Remoistening of stratified seed was not necessary. At completion of the stratification period, the seed/peat moss mixture was placed in a sieve (840 microns), and the medium was forced through the sieve with a stream of cold water. Seeds retained on the sieve were placed in 9-cm sterile plastic petri dishes containing two germination blotters saturated with distilled water. Twenty-five seeds were placed in each petri dish. Petri dishes were labeled and placed in a growth room set at 30 C for 8 hours (with light) and 20 C for 16 hours (without light) per 24-hour period. Blotters were kept moist by adding 2-3 ml of distilled water every three days, or as needed. Seeds were considered to have germinated with the emergence of the radicle. Counts were recorded at 7, 14, and 21 days after trial initiation. Germinated seeds were removed as counted.

A completely random design with four replications was used. Each petri dish was considered an experimental unit. Univariate analysis of variance (ANOVA) was performed on germination percentage at 21 days (final) for each accession. Least significant difference test (LSD) was used to separate means at the 0.05 level of probability.

Results and Discussion

Cold-moist stratification enhanced germination of dried seed of Sitka alder accessions 9037151, 9037160, and 9040484 ($p<0.05$) (Table 7). Dusting seeds with Captan prior to stratification reduced the incidence of mold in petri dishes during germination, but reduced final germination percentage ($p<0.05$). Although accession was not replicated, accession appears to influence final germination percentage (table 7).

Table 7—Effect of stratification on final germination percentage of dried Sitka alder seeds.

ACCESSION	TREATMENT	FINAL GERMINATION (%)
9037151	Control	8
9037151	Cold-moist stratification	24
9037151	Captan dust + cold-moist stratification	16
9037160	Control	32
9037160	Cold-moist stratification	52
9037160	Captan dust + cold-moist stratification	40
9040484	Control	24
9040484	Cold-moist stratification	40
9040484	Captan dust + cold-moist stratification	36

D. Area of Adaptation:

Skamania germplasm has not been widely field tested. Therefore, the true extent of its area of adaptation is not fully known. However, based on program objectives, the origin of the selection, ecoregion descriptions, and what is known about the species, its ecology and natural range, an initial “suggested area of use” is described (refer to figure 3). This temporary “seed zone” may be revised as more information becomes available.

Data from the common garden study in Corvallis, Oregon, was not analyzed to identify patterns of geographic variation within the species as they may relate to environmental factors. However, seed origin appears to be important for Sitka alder, so precautions apply to the movement of Skamania germplasm and propagules. A study in British Columbia with 28 populations of Sitka alder showed clear geographic patterns in frost hardiness, dry weight, growth, and germination parameters that related to latitude and distance from the coast (Benowicz et al. 2000). The differences are probably adaptive (Centre for Forest Gene Conservation 2002). Anecdotal information indicates local seed sources perform better in central interior British Columbia compared to those imported from the coast. Coastal material never grew above snow depth and only reached knee height after a decade (Sanborn, personal communication 2005). In the common garden study at Corvallis, the earlier bud break and later leaf fall of Skamania germplasm compared to most high elevation seed sources is consistent with expectations for a low elevation seed source from a milder growing clime.

Based on general guidelines for tree seed transfer, movement of seed or plants from one low elevation zone with a mild climate to a similar one in the same region can be less restrictive than material from higher elevations or harsh environments (Randall

Sitka Alder

Suggested Area of Use:

"Skamania Germplasm"

Recommended
(0-1500' zone)

Not recommended
(above 1500')

Unknown
(0-1500' zone)

● *Origin (nearest town or city)*

Corvallis PMC Service Area

USDA NRCS
Natural Resources Conservation Service

1996, Randall and Berrang 2002). Therefore, Skamania germplasm is predicted to be adapted to climates typical of the western interior valleys and lowlands of Oregon and Washington with the possible exception of the Rogue River Valley. Given its origin, it should be particularly well suited to watersheds of the lower Columbia River and associated tributaries below an elevation of 457 m (1500 ft.), including the lower Columbia Gorge west of Hood River, Oregon. The entire area is dominated by cool, mild winters with high rainfall, and warm, dry summers where the mean annual precipitation exceeds 35 inches. This zone is roughly equivalent to USDA NRCS Major Land Resource Areas 1, 2 and 3 and Level IV Ecoregions 1a to 1h, 2a to 2i, 3a to 3d, 4a, 4f, and 77a (Pater et. al. 1997). Climatic classifications for this same region include Sunset Western Garden Book (Brenzel 1995) Climatic Zones 3a, 4, 5, and 6, American Horticultural Society (1997) plant heat zones 2, 3 and 4, and USDA plant hardiness zones 8a, 8b and 9a (Cathey 1990). The growing season for this area is 140 to 280 days. Skamania germplasm is expected to perform reasonably well in the western interior watersheds of the Umqua, Willamette, McKenzie, Santiam, Clackamas, and Tualatin Rivers, Coast Range watersheds of Oregon and Washington (< 1500 ft elev.), the north and western Cascade Mountain lowlands and valleys (<1500 ft elev.), as well Puget Lowland watersheds from the Kalama River in southwest Washington to the Nooksack River in northwest Washington.

Sitka alder grows on soils that vary from mineral to rich, humus covered substrates, acid to neutral pH (3.8 to 7.5), and course to medium texture (rocky, gravelly, loamy sands, sandy loams, silts, loams). It also does well in heavier clay loam soils that are nutritionally poor and moist (Plants for a Future 2005). This species volunteers readily from seed on avalanche sites or other disturbances created by soil slumps, stream flow, logging, road building, fire, or retreating glaciers. In some regions, Sitka alder can be sympatric with red alder. However, Sitka alder is more likely to be found on steep sites and those with well drained, rocky or coarse textured substrates while red alder occurs on swampy areas, moist floodplains, and poorly drained soils. While listed as a facultative wetland plant (FACW) (Reed 1988) and purportedly indicative of high water tables (Uchytil 1989), Sitka alder appears more maladapted to flooding compared to red alder. Unlike red alder, Sitka alder lost substantial root and shoot biomass and did not restore growth during flooding (20 days) or recovery (10 days) (Batzli and Dawson 1997). Because of nitrogen fixation within the root nodules, sites with Sitka alder colonies generally have higher available soil nitrogen than adjacent plant communities (Haeussler and Coates 1986). This species will be found in full sun but has intermediate shade tolerance and will persist under a forest canopy (DeLong and Sanborn 2000).

<u>Anticipated Uses:</u> Skamania germplasm Sitka alder is valuable for streambank stabilization, riparian buffers, mine spoil reclamation, and erosion control following logging, avalanches, mud slides, fire, or other drastic disturbances. It represents a high quality seed source that is somewhat unique because of its low elevation origin. The species is known for substantial rates of symbiotic nitrogen fixation and leaf litter production. This increases soil nutrients and organic matter, making it useful for improving infertile, eroded sites as well as long term forest site productivity.

Compared to red alder, Sitka alder is considered potentially less competitive with young conifers because of its smaller stature and shorter height (Harrington and Deal 1982). Therefore, Skamania germplasm may be useful as a companion or nurse shrub in small scale conifer reforestation plantations while adding species diversity (Hauessler et al. 1990). Conifers should be planted several years in advance of the Sitka alder. Ideal planting densities for Sitka alder are unknown and will vary by precipitation zone, soil type, timber species, and other site factors. Skamania germplasm can also be used as a fast growing shrub row in field windbreaks. This species is not preferred browse for most ungulates, but provides food and habitat for rabbits, squirrels, and birds. Sitka alder is considered a minor to major competitor with confer seedlings in some situations (Hauessler et. al. 1990).

Precautionary Notes:

1. *Skamania germplasm is not necessarily intended to replace "local" or on-site sources of native Sitka alder for ecological restoration plantings. The Natural Resources Conservation Service (NRCS) makes no claims concerning the suitability of this selection in native plant restoration efforts. Individuals with such concerns for a particular environment or ecosystem should make their decisions on a case by case basis.*
2. *Skamania germplasm, like Sitka alder in general, has potential to be competitive with conifer seedlings, dominate sites, and actively invade drastically disturbed areas. However, without soil disturbance, not a single volunteer seedling was detected after 22 years in the original plantation at Corvallis, Oregon. In a summary rating of biological characteristics, this germplasm is considered to have only a moderate ability to reproduce and spread naturally (Lambert 2002).*
3. *Any positive or negative impact on population ecology, such as heterosis or outbreeding depression, by interplanting Skamania germplasm in the vicinity of other wild stands of Sitka alder is unknown. Nevertheless, planting large acreages of this germplasm in any one area for reforestation or reclamation may be inadvisable because of its relatively narrow gene pool.*
4. *From dieback in field plantings conducted in colder growing climes such as New York, it is anticipated that Skamania germplasm will lack winter hardiness at higher elevations and east of the Cascade ridge in Oregon and Washington. Further testing is needed.*

E. Generations of the Variety That Will be Multiplied and Length of Stand Limitation for Each Generation:

Generations G0, G1, and G2 are proposed for certification. The G0 or parental generation will only be collected by the NRCS or representatives of Oregon State University under oversight of the appropriate seed certifying agency. A G1 seed orchard will be maintained by the NRCS for the production of G1 seed and G1 seedlings. G1 or G2 seed orchards can be established and maintained as needed by nurseries or other parties interested in the production of G2 seed and seedlings. Seed collected and seedling produced from all three generations will carry a green tag for selected class release, natural track. Time constraints for the collection of seed (or cuttings) from any seed orchard will only be limited by the natural lifespan of the stand.

F. Describe How Breeder Seed is Produced and the Procedure for Maintaining and Producing Seed (or vegetative) **Stock:**

GO is presumed to be a natural stand of Sitka alder at Beacon Rock State Park near Skamania, Washington. There will be no management of the stand aside from Park maintenance within the vicinity. It is understood that any natural regeneration within the population and subsequent seed collection does not affect status as G0. G1 and G2 seed orchards should contain no fewer than 5 parents (10 to 20 or more are preferred). Sitka alder is wind pollinated and primarily outcrossed. Four hundred meters (approx.1300 ft. or ¼ mile) is the proposed minimum isolation distance from other wild or cultivated stands of *Alnus viridis* and *Alnus crispa*, regardless of subspecies. It is strongly recommended, but not required, that the collection of seed and production of seedlings or clonal propagules equally represent each specimen in the parental seed orchard. Likewise, G1 and G2 seed orchards should contain equal representation from the previous generation, whether they are initiated from sexual or clonal propagules.

<u>Seed production</u>: Seed orchards of Skamania germplasm are best established in full sun on well drained, coarse to medium textured soils with acid pH. They should be properly isolated from other subspecies and populations of *Alnus viridis* and *Alnus crispa*. Summer irrigation beyond the establishment year is desirable but not required, especially if plants are mulched for weed control and soil moisture retention. Insect and disease pests should be monitored and treated with approved integrated pest management (IPM) methods as required, according to label instructions. At the Corvallis PMC, oystershell scale (*Lepidosaphes ulmi*) and poplar-willow borer (*Cryptorhynchus lapathi*) were two pests noted in the plantation. Scales can be treated with a dormant oil spray. Borers are controlled by cutting and destroying infested limbs. Fertility management can include use of a balanced fertilizer or one lower in nitrogen and higher in phosphorus (P) and potassium (K) applied at or prior to bud break each spring.

Methods for collection, extraction, and storage of red alder seed are generally applicable to Sitka alder. The seed (winged nutlets) of Skamania germplasm is collected in late October or November when the cone-like catkins turn brown and scales begin to open. Seed may also be sufficiently mature if the “cones” are turning color and their scales easily separate by twisting the cone at the top and bottom (Hibbs and Ager 1989). They may be hand harvested or the branches flailed over a tarp. The cones are thoroughly dried at ambient temperatures by suspending them in fine mesh bags or placing them on elevated screens. The seed is removed by tumbling or shaking. Cones can also be kiln dried at 27-38°C (80-100°F) (Schopmeyer 1974). More recent recommendations are for kiln drying red alder cones at 16-27°C (60-80°F) (Hibbs and Ager 1989). At the Corvallis PMC, 95 cones yielded 27 g (~1 oz.) of clean seed in 1991. For Skamania germplasm, there are approximately 771,000 seeds/kg (1,700,000 seeds/lb) (+/- 10%). The same seed stored in paper envelopes and refrigerated at 3-5C (37-41F) has maintained a germination rate of over 50 percent after three years. Red alder seed has been stored for longer periods (10-20 years) without substantial loss in viability when dried to less than 10 percent moisture and frozen in moisture proof containers at -12º C (10°F). Appropriate conditions for long term preservation of Sitka alder seed are likely to be similar.

<u>Seedling production</u>: Skamania germplasm is primarily a seed propagated pre-varietal selection. Two months (nine weeks) of cold moist stratification of dry seed at 1-3º C (34-38°F) is recommended for maximum germination of this selection. Certain fungicide treatments like Captan may reduce germination. Fresh seed often lacks dormancy and will germinate readily without treatment if sown immediately, on the surface or only with very shallow coverage.

Containers: For containerized seedling production, the use of standard growing media that are 75 to 100 percent peat, moderate to well drained, and amended with micronutrients and slow release fertilizer are suggested. Protocol for tubeling production at the PMC included the use of a soil free mix that was 1 part Sunshine Mix #1 (70-80% sphagnum peat moss, plus perlite, gypsum, low concentration starter fertilizer), 1 part Black Gold (screened earthworm castings, sphagnum peat, pumice, oyster shell lime, balanced pH), 1 oz. Osmocote (14-14-14 slow release fertilizer), and 0.5 oz. Micromax (micronutrients-Fe, Zn, Cu, B, Mo) per bushel of media. Stratified seed may be surface sown or covered with a very thin layer of silica sand. Germination usually occurs within three weeks.

To further improve growth and development, inoculation with superior, cultured isolates of *Frankia* actinobacteria specific to Sitka alder is recommended to improve root nodulation. Cultures are raised on a special medium, harvested by centrifugation, homogenized, suspended in distilled water and applied to four week old seedlings as a soil drench (Subramaniam et al. 1991). Others suggest the inoculum be mixed with a carrier like peat and incorporated in the potting media or nursery beds (Martin et al. 1991). If cultured inocula are unavailable, fresh nodules can be obtained from the roots of donor plants. They are rinsed thoroughly with tap water, then crushed or macerated, homogenized in a blender, and stored as a slurry in a refrigerator for a short period until used. The homogenate may be filtered through muslin, diluted with water, and then applied with a watering can to containerized seedlings at four weeks or a seedbed prior to sowing (Wheeler et al. 1991, Ahrens et al. 1992). Inoculation with soil obtained beneath the canopy of existing Sitka alder stands or from a makeshift inoculum bed of older, nodulated seedlings is a third source of inocula. Work at the Corvallis PMC demonstrated that a thin band of this soil placed in the container prior to sowing, coupled with periodic application of a balanced liquid fertilizer or incorporation of a slow-release fertilizer, will produce more vigorous seedlings. Besides *Frankia*, Sitka alder can respond to inoculation treatments with appropriate species of ectomychorrhizal fungi. Methods for inoculation are described elsewhere (Castellano and Molina 1989).

Depending on the original container size, seedlings may be re-potted to 1 gallon or larger pots within a period of 12 to 18 weeks (Photo 5). Maintained outdoors, a high percentage of non-inoculated seedlings will still form N-fixing nodules by the end of growing season due to chance infection. Container plants should be maintained in a shadehouse with periodic liquid fertilization and irrigation, and then hardened off for eight weeks by fall. The Corvallis PMC used one or more applications of soluble fertilizer (Peter's 20-20-20 @ 1 tbsp./gal. of water) in spring. The Center

Photo 5. 2-0 dormant seedling of Skamania germplasm illustrating extensive fibrou

discontinued fertilization and began withdrawing water in August. Pruning, if needed, is done one or more times on soft tissue before mid-August (Hudson and Carlson 1998).

Pest management: Sitka alder can be susceptible to several fungal pathogens, including those causing leaf spots and powdery mildew. The diseases may show up in seedling stock. In red alder, top-kill caused by *Bortrytis* spp. and stem cankers caused by *Septoria alnifolia* can cause significant loss in nursery yields, requiring multiple applications of fungicide during the growing season (Ahrens et al. 1992). Sitka alder is susceptible to many of the same pathogens as red alder (Hepting 1971), so control practices may be needed on it as well. While alders can be host to a number of insect pests including aphids, scales, borers, sawflies, and leaf miners (Furniss and Carolin 1980, Johnson and Lyon 1991), only the black vine root weevil (*Otiorhynchus sulcatus*) has been troublesome during containerized nursery production at the Corvallis PMC. The grub-like larvae feed on roots while adult beetles create a notched appearance on the margin of the leaves. Insecticidal soil drenches or parasitic nematodes are useful in managing root weevil larvae, while approved foliar applied insecticides may be necessary for adult weevil control. Timing is critical in order to match treatment with the insect's life cycle (DeAngelis and Garth 1993, McGrath 1999). For larval control the PMC applied Biosafe® or Exhibit® (insect parasitic nematodes) to the potting media at least once in spring and again in late summer. Orthene® (acephate) was also applied according to label instructions once in the spring and once in early fall for control of adult weevils.

Bareroot: Sitka alder has also been successfully produced as 1-0 bareroot stock in outdoor nursery beds (Photo 6). Seedlings grown in fumigated beds have benefited from inoculation with *Frankia* just prior to seeding. While the species can be successfully spring seeded, better germination requires fall sowing or the use of pre-treated (stratified) seed. Open bed seedling densities of 60-180 seedlings/m^2 (5-15/ft^2) recommended for other alders are suggested here. Management of top growth, timing (sowing, lifting, etc.) and grading of seedlings will differ by alder species, climate, and nursery. However, general guidelines for nursery culture including inoculation, sowing, fertilization, irrigation, pest management, storage, and outplanting developed for the production red alder (Ahrens 1994, Ahrens et al. 1992, Bonner and Nisley 2005) are applicable to Sitka alder.

Photo 6. Nursery bed of 1-0 bareroot seedling production of Skamania germplasm at the Washington DNR Nursery, Bow, Washington (circa 1989). [Now known as the WACD or Lynn Brown Plant Materials Center].

Vegetative propagation: To date, vegetative propagation of Skamania germplasm has not been successful. Attempts to root hardwood cuttings of this species generally do not work. At the Corvallis PMC, summer wood cuttings taken in July and treated with hormones were unsuccessful. Work on tissue culture of Skamania germplasm at the PMC was initiated but could not be completed. Field grafting has been reported for certain cultivars of alder, but the process is generally difficult for this genera. The PMC experimented with a device for hot-callusing graft unions of dormant stock of Skamania germplasm but was unsuccessful. Sitka alder has been successfully propagated by others using greenwood cuttings (Carpenter et. al. 1984). Cuttings were dipped in a solution of 2000 ppm IBA and dusted with a mixture of Rootone 10 rooting compound and Benomyl fungicide. The rooting medium was sterile perlite and vermiculite (1:1). Cuttings were misted intermittently for 10 weeks and fertilized weekly with a liquid fertilizer during the last month. Rooting improved by applying bottom heat of 21°C (70°F).

Table 8- Seedling and seed production of Skamania germplasm, 1989-2004

Year	SEEDLING PRODUCTION (#, type, age, progeny)		SEED PRODUCTION (grams)
1989	500	bareroot (Skagit Nursery), 1-0, half-sib	0
1990	500	container tubelings, 1-0, half-sib	5
1991	1100	container tubelings, 1-0, 2-0, 3-0, half-sib	12 open + 15 self-pollinated
1992	3600	container tubelings, 1-0, full-sib + half-sib	37
1993	870	container tubelings, 1-0, half-sib	45
1994	0		113
1995	98	container tubelings, 1-0, full-sib	27 (from harvest of 95 cones)
1996	0		49
1997	0		44
1998	0		59
1999	0		14
2000	0		51
2001	0		unknown
2002	0		41
2003	200	container tubelings, 1-0, full-sib	36
2004	150	1 gal. pots, 2-0 (uppotted from '03 tubelings)	10

G. Additional Restrictions, if any, With Respect to Geographic Area of Seed Production, or other Factors Affecting Genetic Purity.

It is recommended that seed orchards or mother plants be maintained only in western Oregon or western Washington at elevations below 480 m (1500 ft).

H. Seed Sample of Skamania Germplasm Sitka alder is enclosed.

REFERENCES

Ahrens, G.R., A. Dobkowski, and D.E. Hibbs. 1992. Red alder: guidelines for successful regeneration. Special publication 24. Forest Research Laboratory, Oregon State University, Corvallis, OR. 11 p.

Ahrens, G.R. 1994. Seedling quality and nursery practices for red alder. In: Hibbs D.E., D.S. DeBell, and R.F Tarrant (editors). The Biology and Management of Red Alder. Corvallis, Oregon. p. 159-169.

American Horticultural Society. 1997. Plant heat-zone map. Compiled by Meteorological Evaluation Services Co., Inc. AHS, Alexandria, WA. 1 p.

Batzli, J. McCray and J.O. Dawson. 1997. Physiological and morphological responses of red alder and Sitka alder to flooding. Physiologia Plantarum 99: 653-663.

Benowicz, A., Y.A. El-Kassaby, R.D. Guy, and C.C. Ying. 2000. Sitka alder (*Alnus sinuata* Rydb.) genetic diversity in germination, frost hardiness, and growth attributes. Silvae Genetica 49: 206-212.

Binkley, D. 1986. Forest Nutrition Management. Wiley, New York. 290 p.
Bonner, F.T. (technical coordinator) and R.G. Nisley (editor). 2005. *Alnus* P. Mill. In: Woody Plant Seed Manual. (online draft). USDA Forest Service, Washington, D.C. Available: http://ntsl.fs.fed.us/wpsm/ (01/15/2005). 20 pp.

Brenzel, K.N. (editor). 1995. Sunset western garden book. Sunset Publishing Corporation. Menlo Park, CA. p 19-29.

Carpenter, C.V., L.R. Robertson, J.C. Gordon, and D.A. Perry. 1984. The effect of four new Frankia isolates on growth and nitrogenase activity in clones of *Alnus rubra* and *Alnus sinuata*. Canadian Journal of Forest Research. 14: 701-706.

Castellano, M.A. and R. Molina. 1989. Mychorrhizae. In: Landis, T.D., R.W. Tinus, S.E. McDonald, and J.P. Barnett. The Container Tree Nursery Manual. Volume 5. Agriculture Handbook 674. USDA Forest Service, Washington D.C. p. 101-167.

Cathey, H.M. 1990. USDA plant hardiness zone map. USDA Miscellaneous Publication No. 1475. U.S. National Arboretum, USDA Agricultural Research Service, Washington, D.C.

Centre for Forest Gene Conservation. 2002. *Alnus viridis* ssp. *sinuata* gene conservation (draft). University of British Columbia, Vancouver, B.C., Canada. URL: http://genetics.forestry.ubc.ca/cfgc/ [1/20/2005]. 3 p.

Coates, D., S. Haeussler, and J. Mather. 1990. A guide to the response of common plants in British Columbia to management treatments. British Columbia Ministry of Forests, Victoria, B.C. FRDA Handbook 008.

Darris, D.C, T.R. Flessner, and J.D. Conrod Trindle. 1994. Corvallis Plant Materials Center Technical Report: plant materials for streambank stabilization 1980-1992. USDA Natural Resources Conservation Service, Portland, Oregon. 172 p.

DeAngelis, J. and G. Garth. 1993. Management of root weevils in the nursery and landscape. The Digger. Oregon Association of Nurseries, Wilsonville, Oregon. p. 21-49.

DeLong, C. and P. Sanborn. 2000. Management of Sitka alder and willows: a strategy to minimize loss of habitat and maximize benefit to long term soil productivity. Forest Research Note No. PG-22. Forst Resources and Practices Team. Ministry of Forests, Prince Gerorge, B.C., Canada. 4 p.

Elias, T.S. 1980. The complete trees of North America. Book Division, Times Mirror Magazines, Inc.(publisher), Van Nostrand Reinhold Company, New York (distributor). p. 405-406.

Elias S., E. Ottoni, N. Verma, D. Kreuger, S. Roburn, and C. Wulff. 1995. An ethnobotany of the UBC Arboretum. University of British Columbia, Vancouver, B.C. CA. Adapted for the web 1998. URL: http://www.botany.ubc.ca/facilities/arboretum

Emery, D.E. 1988. Seed propagation of native California plants. Santa Barbara Botanic Garden, Santa Barbara, California.

Farmer, R.E. Jr., M.L. Maley, M.U. Stoehr., and F. Schnedenburger, F. 1985. Reproductive characteristics of green alder in northwestern Ontario. Canadian Journal of Botany. 63: 2243-2247.

Flora of North America Editorial Committee, eds. 1993+. Flora of North America North of Mexico. 7+ vols. New York and Oxford. URL: http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=233500044

Furniss, R.L. and V.M. Carolin. 1980. Western forest insects. Miscellaneous publication No. 1339. USDA Forest Service. U.S. Government Printing Office, Washington, D.C. 654 p.

Gunther, E. 1973. Ethnobotany of western Washington. University of Washington Press. Seattle and London. p. 27.

Harrington, C.A. and R.L. Deal. 1982. Sitka alder, a candidate for mixed stands. Canadian Journal of Forest Research. 12 (1): 108-111.

Hauessler, S. and D. Coates. 1986. Autecological characteristics of selected species that compete with conifers in British Columbia: a literature review. Land Management Report No. 33. Ministry of Forests, Informations Services Branch, Victoria, B.C. 68 p.

Hauessler, S., D. Coates, and J. Mather. 1990. Autecology of common plants in British Columbia: a literature review. FRDA Report 158. Forestry Canada & B.C. Ministry of Forests. 272 p.

Healy, W.M. and J.D. Gill. 1974. Alders. In: J.D. Gill and W.M. Healy (compilers). Shrubs and vines for Northeastern Wildlife. General Technical Report NE-9. Broomall, PA. USDA, Forest Service. p. 6-9.

Hepting, G.H. 1971. Diseases of forest and shade trees of the United States. Agriculture Handbook 386. USDA Forest Service. U.S. Government Printing Office, Washington D.C. p. 70-73.

Hibbs, D.E. and A.A. Ager. 1989. Red alder: guidelines for seed collection, handling and storage. Special Publication 18. Forest Research Laboratory, Oregon State University, Corvallis, Oregon. 6 p.

Hickman, J.C. (editor). 1993. The Jepson Manual, higher plants of California. University of California Press. Berkeley, Los Angeles, and London. p.364-366.

Hitchcock, C.L., et. al. 1969. Vascular Plants of the Pacific Northwest. Part 2: Salicaceae to Saxifragaceae. University of Washington Press. Seattle and London. p. 74-82.

Hitchcock, C.L. and A. Cronquist. 1973. Flora of the Pacific Northwest. University of Washington Press. Seattle and London. p. 634-635.

Hudson, S. and M. Carlson. 1998. Propagation of interior British Columbia native plants from seed. British Columbia Ministry of Forests, Research Program. Kalamalka Forestry Centre, Vernon, B.C., Canada. p.15.

Java, B.J. and R.L. Everett. 1992. Rooting hardwood cuttings of Sitka alder and thinleaf alder. In: W.P. Cleary, E.D. McArthur, D. Bedunah, and C.L. Wambolt (compilers). Proceedings-Symposium on Ecology and Management of Riparian Shrub Communities, Sun Valley, ID, May 1991. USDA Forest Service, Intermountain Research Station, Ogden, UT. p. 138-141.

Johnson, W.T. and H.H. Lyon. 1991. Insects that feed on trees and shrubs. Comstock Publishing Associates, Cornell University Press, Ithaca, NY, and London. 560 p.

Kramer, P.A., D. Zabowski, R.L. Everett, and G. Scherer. 1996-1997. Native plant restoration of cooper mine tailings: Part II. Field survival, growth, and nutrient use efficiency. Biosolids recycling. Research Notes. Northwest Biosolids Management Association. Seattle, WA. 2 p.

Lagerstedt, H.B. 1982. A device for hot callusing graft unions of fruit and nut trees. Technical Paper 6247. Agricultural Experiment Station, Oregon State University, Corvallis, OR. P. 151-159.

Lambert, S. 2002. Environmental evaluation of plant materials releases. Skamania germplasm Sitka alder. Completed form (exhibit 540-31). Part 540.8 National Plant Materials Manual. USDA Natural Resources Conservation Service. Washington D.C. 8 p.

Martin, K.J., Y. Tanaka, and D.D. Myrold. 1991. Peat carrier increases inoculation success with Frankia on red alder (Alnus rubra Bong.) in fumigated nursery beds. New Forests, 5: 43-50.

Martin, A.C., H.S. Zim, and A.L. Nelson. 1951. American wildlife and plants: a guide to wildlife food habits. Dover Publications, Inc. New York. P. 305-306.

McGrath, D.M. (editor). 1999. Biology and control of root weevils in nursery stock. In: Pacific Northwest Insect Management Handbook. 2003. Oregon State University, Corvallis, OR. P. 457-459.

McLean, A. 1967. Germination of forest range species from southern British Columbia. Journal of Range Management 20: 321-322.

McNabb, D.H. and J.M. Geist. 1979. Acetylene reduction assay of symbiotic N_2 fixation under field conditions. Ecology 60: 1070-1072.

Miner, C.L. 1990. Changing times for hardwoods. In: Forestry Research West. USDA Forest Service, Fort Collins, CO. p. 1-6.

Munz, P.A. 1973. A California flora and supplement. University of California Press, Berkeley, CA. p. 191.

Oregon State University. 2005. *Alnus sinuata*. In: Landscape Plants images, identification and information. Volume 1. Oregon State University, Department of Horticulture, Corvallis, Oregon. Available: http://oregonstate.edu/dept/ldplants/ [3/24/2004].

Pater, D.E., S.A. Bryce, T.D. Thorson, J. Kagan, C. Chappell, J. Omernick, S.H. Azevado, and A.J. Woods. 1997. Ecoregions of western Washington and Oregon. U.S. Geological Survey, Denver, Colorado. Map.

Pierce, J.D. 1984. Shiras moose forage selection in relation to browse availability in north-central Idaho. Canadian Journal of Zoology. 62: 2404-2409.

Plants For A Future. 1997-2000. *Alnus sinuata*. Species database. Blagdon Cross, Ashwater, Beaworthy, Devon, EX21 5DF, United Kingdom. Available: http://www.ibiblio.org/pfaf/cgi-bin/arr_html?Alnus+sinuata (02/4/2005).

Randall, W.K. 1996. Forest tree seed zones for western Oregon. Oregon Department of Forestry, Salem, OR. 81 p.

Randall, W.K. and P. Berrang. 2002. Washington tree seed transfer zones. Washington State Department of Natural Resources. 67p.

Reed, P.B. Jr. 1988. National list of plant species that occur in wetlands: Northwest (Region 9). Biological Report 88 (26.9). U.S. Department of Interior, Fish and Wildlife Service. Research and Development, Washington, D.C. 89 p.

Sanborn, P. Personal communication (2/3/2005). Associate Professor, University of Northern British Columbia, Prince George, B.C., Canada.

Schopmeyer, C.S. 1974. *Alnus* B. Ehrh. Alder. In: Schopmeyer, C.S. Seeds of woody plants in the United States. Agriculture Handbook No. 450. USDA Forest Service, Washington D.C. p. 206-211.

Subramaniam, P., I.R. Miller, and D. Burgess. 1991. Production of *Frankia* inoculated Sitka alder (*Alnus viridis* ssp. *sinuata* (Reg.) Love & Love) container stock. In: F.P. Donnelly and H.W. Lussenburg (compilers), Proceedings of the 11th Annual Conference of the Forest Nursery Association of British Columbia, September, 1991. p. 112-118.

Tremblay, F.M. and M. Lalonde. 1984. Requirements for in vitro propagation of seven nitrogen-fixing alder species. Plant Cell Tissue Organ Culture 3: 189-199.

Turner, N.J., L.C. Thompson, M.T. Thompson, and A.Z. York. 1990. Thompson ethnobotany. Knowledge and usage of plants by the Thompson Indians of British Columbia. Memoir No. 3. Royal British Columbia Museum, Victoria, B.C., Canada. p. 188.

Uchytil, R.J. 1989. *Alnus viridis* ssp. *sinuata*. In: Fire Effects Information Systems. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: http:www.fs.fed.us/database/feis/ [2004, April 28].

USDA Agricultural Research Service, National Genetic Resources Program. *Germplasm Resources Information Network - (GRIN)* [Online Database]. National Germplasm Resources Laboratory, Beltsville, Maryland. URL: http://www.ars-grin.gov2/cgi-bin/npgs/html/index.pl (March 2005).

USDA Forest Service. 1988. Range plant handbook. Dover Publications, Inc., New York. Reprint. U.S. Government Printing Office, Washington D.C. 1937. p. 581-584.

USDA Natural Resources Conservation Service. 2004. The PLANTS Database, Version 3.1 (http://plants.usda.gov). NationalPlant Data Center, Baton Rouge, LA 70874-4490 USA.

Wheeler, C.T., M.K. Hollingsworth, J.E. Hooker, J.D. McNeill, W.L. Mason, A.J. Moffat, and L.J. Sheppard. 1991. The effect of inoculation with either cultured Frankia or crushed nodules on nodulation and growth of *Alnus rubra* and *Alnus glutinosa* seedlings in Forest Nurseries. Forest Ecology Management 43:153-166.

Wick, D., T. Luna, J. Hosokawa. 2004. Propagation protocol for production of container *Alnus viridis* (Chaix.) DC. ssp. *sinuata* (Regel) Love & Love plants (3 L containers). Glacier National Park, West Glacier, MT. In: Native Plant Network. URL: http://www.nativeplantnetwork.org (accessed 20 January 2005). Moscow, ID: University of Idaho, College of Natural Resources, Forest Research Nursery. 4 p.

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE

And

OREGON STATE UNIVERSITY
AGRICULTURAL EXPERIMENT STATION
CORVALLIS, OREGON

And

WASHINGTON STATE UNIVERSITY
AGRICULTURAL EXPERIMENT STATION
PULLMAN, WASHINGTON

NOTICE OF RELEASE OF SKAMANIA GERMPLASM SITKA ALDER [SELECTED CLASS GERMPLASM - NATURAL TRACK]

The Natural Resources Conservation Service (NRCS), U.S. Department of Agriculture, Oregon State University Agricultural Experiment Station and Washington State University, Agricultural Experiment Station, announce the release of a selected ecotype of Sitka alder (*Alnus viridis* [Vill.] Lam. & DC. subsp. *sinuata* [Regel]A.&D. Love).

As a selected class release, this plant will be referred to as Skamania Germplasm Sitka alder or Skamania Germplasm. It has been assigned USDA Plant Introduction number PI-504381 and the NRCS accession number 9040484. Skamania Germplasm is released as a selected class of certified seed and plants, natural track.

Origin: Seed of Skamania Germplasm (PI-504381) was originally collected in a moist swale near the base of Beacon Rock in Skamania County, Washington. Elevation: 200 feet above mean sea level. Average annual precipitation: 60-70 inches. Ecoregion: Cascade Mountains. Major Land Resource Area: A3. Sitka alder seed was collected from a naturally occurring stand and grown and tested at the Corvallis Plant Materials Center (PMC).

Description: Sitka alder (*Alnus viridis* subsp. *sinuata*) is a deciduous, large shrub or small tree native to the Pacific Northwest that forms a symbiotic relationship with nitrogen fixing bacteria. It grows from sea level to timberline in thickets on wet slopes or along mountain streams and pond margins. Skamania germplasm is generally a slender shrub up to 15 feet in height, but may grow to 20 feet tall. The young bark is reddish-brown, the older bark is grayish-black. The leaves are thin, papery and ovate, and three to six inches long. The male catkins and immature female fruiting cones open in the spring. The fruit is a nutlet with thin membranous wings that ripens in autumn. Sitka alder most often appears as a pioneer plant along streams, lakeshores, and moist talus slopes, and in avalanche zones and areas of heavy snow accumulation and where abundant seepage water is available.

Method of Selection: A Common Garden seed source study that included 64 Sitka alder accessions primarily from collection sites in western Washington to northwestern California was established in 1983. The study was located at the NRCS, Plant Materials Center, Corvallis, Oregon. It was conducted on a moderately well-drained, Woodburn silt loam at an elevation of 225 feet. Accession 9040484 was selected as the best population in the common garden study in 1991. It was chosen for its rapid growth rate, phenological differences (early bud break and late leaf fall), stem density, vigor, size, and abundant seed production. Skamania Germplasm provides a high quality seed source for use at elevations up to 1500 feet.

Ecological impact statement: Skamania Germplasm is a selection from a naturally occurring population of Sitka alder and has undergone minimal purposeful selection. It has not been bred or hybridized and does not differ significantly in rate of spread, seed production, or vigor from naturally occurring Sitka alder. Skamania Germplasm was determined to be acceptable for release when evaluated through the "Worksheet for conducting an environmental evaluation of NRCS plant releases".

Anticipated use: Recommended uses include riparian site revegetation, streambank erosion control, critical area stabilization, and wildlife habitat plantings. Skamania Germplasm has the potential for rehabilitation of eroded, low-fertility sites and as a companion or nurse shrub in conifer plantations. Sitka alder enhances site productivity by the fixation of atmospheric nitrogen within its roots by bacteria of the *Frankia* genus. It may also be used for shrub rows in farmstead or field windbreaks on moister sites.

Caution: Skamania Sitka alder is not necessarily intended to replace "local" or on-site sources of native Sitka alder for ecological restoration plantings. NRCS makes no claims concerning the suitability of this selection for native plant restoration efforts. Individuals with such concerns for a particular environment or ecosystem should make their decisions on a case by case basis.

Area of adaptation: Western Columbia Gorge, Willamette Valley, Cascade and Olympic Mountains (<1500 ft), Coast Range and Puget lowland ecoregions, including the Umpqua Valley of Oregon (<1500 ft). This is roughly equivalent to the lower elevations of USDA Major Land Resources Areas 1, 2, and 3 within USDA Plant Hardiness Zones 8a, 8b, and 9a. Adaptation may extend to portions of MLRA's 4 and 5 in southwestern Oregon and northwestern California, but more testing is required.

Availability of plant materials: USDA, NRCS, Corvallis PMC, Corvallis Oregon will maintain G1 generation seed and plants. A limited quantity of certified seed and plants may be available to each qualified applicant for plant increase upon written request. G0 seed and G-1 and G-2 seed and plants are recommended for certification.

References:

Cathey, H.M. 1990. *USDA Plant Hardiness Zone Map.* Miscellaneous Publication 1475, USDA Agricultural Research Service, Washington, D.C.

Franklin, J.F. and C.T. Dyrness. 1973. *Natural vegetation of Oregon and Washington*. U.S. Department of Agriculture, Forest Service General Technical Report, PNW-8. U.S. Government Printing Office. Washington, DC.

Hitchcock, C.L., A. Cronquist, M. Ownbey, and J.W. Thompson. 1969. *Vascular plants of the Pacific Northwest, Part II.* University of Washington Press. Seattle, Washington.

Trappe, J.M., J.F. Franklin, R.F. Tarrant, and G.M. Hansen (Eds.). 1968. *Biology of alder*. U.S. Department of Agriculture, Forest Service. Pacific Northwest Forest and Range Experiment Station. Portland, Oregon.

U.S. Department of Agriculture, Forest Service. 1937. *Range plant handbook*. U.S. Government Printing Office. Washington, DC.

U.S. Department of Agriculture, Forest Service. 1974. *Seeds of woody plants in the United States*. Agricultural Handbook No. 450. U.S. Government Printing Office. Washington, DC.

Prepared by: Robert Tracey and Dale Darris, USDA NRCS Plant Materials Center, Corvallis Oregon; and Scott Lambert, USDA NRCS, Washington State University, Pullman Washington (2002).

SIGNATURES for RELEASE of
SKAMANIA NATIVE GERMPLASM SITKA ALDER (*Alnus viridis* ssp. *sinuata*)

____
Robert J. Graham — Date:____________________
State Conservationist, Oregon
Natural Resources Conservation Service

____
Raymond L. Hughbanks — Date:____________________
State Conservationist, Washington
Natural Resources Conservation Service

____
Lincoln E. Burton — Date: ____________________
State Conservationist, California
Natural Resources Conservation Service

____
Diane E. Gelburd — Date:____________________
Director, Ecological Sciences
Natural Resources Conservation Service

____
Thayne R. Dutson — Date:____________________
Director, Agricultural Experiment Station
Oregon State University
Corvallis, Oregon

____
Ralph Cavalieri — Date:____________________
Associate Dean and Director
Agricultural Research Center
Washington State University
Pullman, Washington

CORVALLIS PLANT MATERIALS CENTER
NATURAL RESOURCES CONSERVATION SERVICE
CORVALLIS, 0REGON
Amy Bartow

February 1, 2006

THE 2005 BUREAU OF LAND MANAGEMENT ANNUAL REPORT:
WEST EUGENE WETLANDS

I. Brief background of Project

The Corvallis Plant Materials Center (PMC) entered into a new 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 West Eugene Wetlands program has been collecting wild seed and sowing it in wetland restoration projects. Some species have been difficult to establish or have very high labor costs associated with hand collection. The PMC agreed to research and document propagation techniques from seed for these species and to evaluate their potential for agronomic seed increase.

In 2005, this agreement was renewed and 12 species were added for germination research and seed increase. Germination research continued on two of the species from 2004 that did not germinate or germination protocol was questionable. Seed increase was extended on 27 of the species from the 2003 and 2004 contracts. This agreement will be amended and renewed through 2006.
Activities in 2005 included cleaning seed provided by BLM, germination trials, establishing and maintaining seed increase plantings, seed harvesting and seed cleaning. Number of seeds per pound was also calculated for species upon request.

II. Accessions Included in 2005 Agreement (Table 1).

Table 1. Accessions involved in the 2005 BLM Eugene district agreement

Species	Common name	Code	Accession #
Balsamorhiza deltoidea	deltoid balsamroot	BADE2	9079372
Bromus carinatus	California brome	BRCA5	9079373
Cardamine penduliflora	Willamette Valley bittercress	CAPE2	9079245
Carex feta	greensheath sedge	CAFE4	9079315
Carex languinosa	woolyfruit sedge	CALA3	9079304
Carex tumulicola	splitawn sedge	CATU3	9079291
Carex vesicaria	blister sedge	CAVE6	9079316
Cicendia quadrangularis	Oregon timwort	CIQU3	9079254
Clarkia amoena	farewell to spring	CLAM	9079300
Delphinium menziesii	Menzies' larkspur	DEME	9079374
Deschampsia danthonioides	annual hairgrass	DEDA	9079382
Deschampsia elongata	slender hairgrass	DEEL	9079375
Dichanthelium acuminatum var. fasciculatum	western panicgrass	DIACF	9079303
Eleocharis acicularis	needle spikerush	ELAC	9079292
Festuca roemeri	Roemer's fescue	FERO	9079383

Table 1(con’t). Accessions involved in the 2005 BLM Eugene district agreement

Species	Common name	Code	Accession #
Galium trifidum	threepetal bedstraw	GATR2	9079317
Gentiana sceptrum	king's scepter gentian	GESC	9079311
Geranium oreganum	Oregon geranium	GEOR2	9079376
Gilia capitata	bluehead gilia	GICA5	9079377
Juncus nevadensis	Sierra rush	JUNE	9079248
Linanthus bicolor	true babystars	LIBI	9079319
Lotus formosissimus	seaside bird's-foot trefoil	LOFO2	9079294
Ludwigia palustris	marsh seedbox	LUPA	9079297
Lupinus affinis	fleshy lupine	LUAF	9079301
Luzula comosa	Pacific woodrush	LUCO6	9079251
Montia linearis	narrowleaf minerslettuce	MOLI4	9079295
Myosotis laxa	bay forget-me-not	MYLA	9079253
Myosurus minimus.	tiny mousetail	MYMI2	9079381
Navarretia intertexta	needleleaf navarretia	NAIN2	9079378
Nemophila menziesii	baby blue eyes	NEME	9079379
Perideridia gairdneri	Gardner's yampah	PEGA3	9079255
Perideridia oregana	Oregon yampah	PEOR6	9079256
Phlox gracilis	slender phlox	PHGR16	9079299
Pyrracoma racemosa	Clustered goldenweed	PYRAC2	9079446
Rorippa curvisiliqua	curvepod yellowcress	ROCU	9079257
Saxifraga oregana	Oregon saxifrage	SAOR2	9079296
Sidalcea virgata	showy wild hollyhock	SIVI3	9079305
Thalictrum fendleri	Fendler's meadow-rue	THFE	9079298
Viola praemorsa var. praemorsa	canary violet	VIPRP	9079380

III. Germination Trials

BLM staff provided seed of 12 species to PMC staff on December 15, 2004. Most seeds lots were cleaned using an air screen machine to increase purity. Species that were selected for non-replicated germination trials were sown directly into stubby cone-tainers of moistened Sunshine #1 (a peat-based, soil-less media) amended with micronutrients and a slow-release fertilizer. Three flats (294 cones) of each species were sown. One flat was placed in a warm greenhouse (70˚F day/ 55˚F night), one flat was placed in an outdoor shadehouse to be exposed to winter temperatures, and the remaining flat was covered with a polyethylene bag and placed in a walk-in cooler (34-38˚F) for cold-moist stratification.

Table 2. Optimal Germination Treatment per Species From Trials Conducted at Corvallis Plant Materials Center in 2005.

Species	Optimal treatment
Balsamorhiza deltoidea	90-days cold-moist stratification
Bromus carinatus	no treatment
Delphinium menziesii	90-days cold-moist stratification, needs light and alternating temps
Deschampsia danthonioides	no treatment
Deschampsia elongata	no treatment
Festuca roemerii	no treatment
Geranium oreganum	120-days cold-moist stratification
Gilia capitata	germinates best in cool temps, below 40
Navarretia intertexta	germinates best in cool temps, below 40
Nemophila menziesii	germinates best in cool temps, below 40
Pyrracoma racemosa	120-days cold-moist stratification
Viola praemorsapraemorsa	120-days cold-moist stratification
Myosurus minimus L.	germinates best in cool temps, below 40

Some seed lots contained only a few seeds, such as VIPR and GEOR. These were sown on moistened germination paper in plastic boxes and placed in a growth chamber set at 8 hours of light, day temperatures of 40° (F) and night temperatures of 35° (F).

Table 3. Containerized Plant Production in 2005 for Seed Increase Tubs and Field Plantings.

Species	Amt of seed sown	# of plants produced	Fate
Balsamorhiza deltoidea	6g	85	maintained
Bromus carinatus	1g	200	field planted
Cicendia quadrangularis	<1g	500	harvested annual
Clarkia amoena	<1g	100	harvested annual
Delphinium menziesii	1g	70	maintained
Deschampsia danthonioides	<1g	200	field planted, harvested annual
Deschampsia elongata	<1g	200	maintained
Festuca roemerii	4g	400	maintained
Galium trifidum	2g	100	harvested annual
Geranium oreganum	<1g	7	maintained
Gilia capitata	1g	100	field planted, harvested annual
Linanthus bicolor	1g	100	harvested annual
Ludwigia palustris	<1g	100	tub planted
Lupinus affinis	3g	100	harvested annual
Montia linearis	2g	100	harvested annual
Myosotis laxa	1g	100	harvested annual
Navarretia intertexta	2g	200	harvested annual
Nemophila menziesii	2g	100	harvested annual
Phlox gracilis	2g	200	harvested annual

Table 3 (con't). Containerized Plant Production in 2005 for Seed Increase Tubs and Field Plantings.

Species	Amt of seed sown	# of plants produced	Fate
Pyrracoma racemosa	<1g	75	Maintained
Thalictrum fendleri	1g	120	Delivered
Viola praemorsa praemorsa	<1g	7	Maintained
Myosurus minimus L.	<1g	20	harvested annual

IV. Field Plantings

A *Sidalcea virgata* field planting was established in late spring of 2003. In 2005, the plants grew vigorously and flowered in June. No weevils were detected on any of the seedheads. Plants did not seem affected by changes in soil environment due to the plastic woven weed barrier.

Seed was collected weekly from June 25 to July 30 by hand-stripping mature seeds, and also by sweeping up ones that had shattered on the ground cover. Collections were efficient and relatively little seed was lost. SIVI racemes are less upright than other sidalceas which caused the seed to fall directly on the ground cover instead of on the crown of the plant. The ground cover is a considerable aid in seed collection for the species and does not seem to be detrimental to plant growth or development. Ground cover needs to be cut back from the crowns of the sidalceas as they expand.

Harvested seed was collected in bags and dried in an open greenhouse. It was then placed in a small brush machine containing a scarifier (sandpaper) drum. Seed was further cleaned using an air screen machine.

Four grasses (*Bromus carinatus, Deschampsia elongata, Deschampsia danthonioides,* and *Festuca roemeri*) were added to the agreement in 2005. Seed was sown into conetainers in mid-February. The BRCA5 and DEDA plants filled the conetainers and were ready for field planting in early April. The DEEL and FERO plants were not as fast growing and were not large enough to be out-planted in spring. They were maintained in a lathhouse through the summer and will be planted into fields in the fall of 2005.

BRCA field was hand-watered twice during the summer and was selectively hand harvested throughout July. Considering the plants were only a couple months old, yields were impressive (586 g). Seed was de-awned using a lab-sized brush machine and cleaning using an air-screen machine.

DEDA field was hand harvested on June 20, and July 3.Even through this species usually grows in wet areas, it produced well on an upland site (572 g). Since it is an annual, it produces seed early and dies before the dry season. Seed was de-bearded using a lab-sized brush machine and cleaned using an air-screen machine.

V. Seed Increase Tubs

Seed increase was the main goal for all species included in the 2004 and 2005 agreements. Once a species was successfully propagated it was then transplanted into an appropriately sized tub. Hard plastic children's pools were purchased in various sizes and placed in a shadehouse on plastic pallets. Holes were drilled in the bottom to provide drainage and the pools were filled with 6-8" of Sunshine #1 (a peat-based, soil-less media) amended with micronutrients (MicroMax) and a slow-release fertilizer (Osmocote 14-14-14). Plants were monitored daily for disease and pests as well as seed maturity. Plantings were watered overhead as needed. Time spent harvesting seed and cleaning seed was noted and is summarized in Table 3.

***Cardamine penduliflora* (CAPE2)** - This tub was established in the summer of 2002. Plants soon went summer dormant after flowering in 2003, but re-emerged in late fall. Most of the plants flowered in early April during heavy rain, seed collection occurred from April 25 through May 30. Monitoring mature seed pods was difficult. Pods shattered quickly after becoming mature and green pods contained immature seed that did not mature after being harvested. This species requires constant, careful monitoring and hand collection.

***Carex feta* (CAFE4) -**This tub was established with spring 2004 sown-seedlings. In 2005, these plants were hearty and covered with flowering stems. In the fall of 2004, more CAFÉ plants were transplanted into experimental "ponds" at the PMC. These plants had 100% survival rate and produced a moderate amount of seed. Seed heads were clipped just as they turned from green to yellow. Seeds shatter when they still look green and immature. Seed from both tub planting and pond planting were combined.

***Carex tumulticola* (CATU3) -**This tub was established from cone-tainers seeded in 2003 that didn't germinate until spring of 2004. Plants were small in 2005 but flowered. Seed heads were clipped when mature. When over 80% of seedheads were ripe at the same time, the entire tub was cut back and all the clippings were dried in a greenhouse on a tarp. After harvest, they flowered again. Production was moderate.

***Carex vesicaria* (CAVE6) -**Seedlings that were sown in the spring of 2004 were used to establish this tub**.** Flowering in 2005 was fair, but seed set was very low. If this plot continues to produce very little viable seed, it may be advantageous to re-collect and add more diversity to the existing plot.

***Clarkia amoema* (CLAM) -** A tub was established in 2005, using seedlings that were sown in the winter of 2004. Plants grew vigorously, and flowered in August. Seeds were collected from August 28 through October 1. Seed pods were clipped from plants as they began to split. Pods were placed in paper bags to dry. Seed was cleaned using a hammer to break up pods, then an air-screen machine was used.

***Cicendia quadrangularis* (CIQU3) -** These tiny plants grew and flowered well in the cone-tainers. Plants sown in mid-December in a warm greenhouse flowered in March and seed collection began in mid-April. Capsules turn bright orange when mature and split slowly from the top, releasing tiny, grey seeds. Mature capsules were cut and placed in seed collection envelopes to dry. Seeds are tiny enough to slip out of paper bags. Capsules can be separated from the seed using handscreens. Due to the size of this plant and its seed, it would be a poor candidate for field plantings or any type of large-scale agronomic seed increase. In all likelihood, it will be limited to containerized production and hand collection procedures described here.

***Dichanthelium acuminatum* (DIAC) -** A tub of plants was established in 2003. It flowered well in the summer of 2004. Seeds were collected by hand. A small plot was also planted into weed fabric. Seed production was good and seeds fell onto the weed fabric as they matured. Weed fabric was vacuumed weekly from June 2 through August 30 with a hand-held vacuum. Seeds were collected in the filter in the vacuum and emptied into collection bags. When flowering had subsided, seed was cleaned with an air-screen machine. This seed collection technique was very effective and efficient.

***Eleocahris acicularis* (ELAC) –** Seeds were sown into1ftX1ftX4in trays and placed in a walk-in cooler for 90 days. Seeds did not germinate. Trays were left outside during the winter of 2003, and seedlings emerged in the spring of 2004. Many tiny flowerheads emerged in the late spring. They were individually clipped when mature and placed in seed collection envelopes to dry. Seeds are tiny enough to slip out of paper bags.

***Galium trifidum* (GATR2) -** Seeds were sown into cone-tainers in March. Seedlings were transplanted into 5in square pots and moved out to a shadehouse in April. Pots were watered with a drip irrigation system on 9ftX3ft plastic pallets. Using 2inX8in boards, frames were built around the pallets. Full-sized linen sheets were stapled to the frame and laid over the plants. Small slits were cut in the sheet and plants were pulled through the slit, leaving the pots underneath. Plants grew well and flowered in late May, as seed capsules matured, they shattered and seeds fell onto the sheet. Sheets were vacuumed weekly from June 2 through August 30 with a hand-held vacuum. Seeds were collected in the filter in the vacuum and emptied into collection bags. When flowering had subsided, seed was cleaned with an air-screen machine. This seed collection technique was very effective and efficient.

***Gilia capitata* (GICA5) -** Seeds were sown into cone-tainers in mid–December and placed outside in a shadehouse. They germinated outside within four weeks of sowing and grew slowly throughout the winter. In early spring they were transplanted into a field covered with weed fabric. Plants grew well and seed yields were high! Capsules shattered onto the weed fabric as they matured. Weed fabric was vacuumed weekly from June 2 through August 30 with a hand-held vacuum. Seeds were collected in the filter in the vacuum and emptied into collection bags. When flowering had subsided, seed was cleaned with an air-screen machine. This seed collection technique was very effective and efficient.

***Gentiana sceptrum* (GESC) –** This tub was established from seedling sown in winter of 2003. Plants were transplanted into the tub in late summer of 2004. Approximately 10 plants were also transplanted out into a field covered with plastic woven weed barrier. Plants in tubs and in the field both exhibited seed predation. Plants in the tub flowered more, grew taller, and were more vigorous overall. Plants in the field went dormant soon after flowering. Seeds were collected when capsule began to turn papery and tan.

***Juncus nevadensis* (JUNE) -** Plants that were produced by the PMC and the BLM in 2003 were combined and transplanted into a large 5' x 6' tub on April 2, 2004. The plants grew vigorously, but no flowering occurred. Plants will be watered heavily through-out the spring of 2006 to encourage flowering.

***Linanthus bicolor* (LIBI) -** A tub of plants was established from seedlings that were sown in the spring of 2005. Seedlings were transplanted into 5in square pots and moved out to a shadehouse in April. Pots were watered with a drip irrigation system on 9ft x 3ft plastic pallets. Using 2in x 8in boards, frames were built around the pallets. Full-sized linen sheets were stapled to the frame and laid over the plants. Small slits were cut in the sheet and plants were pulled through the slit, leaving the pots underneath. Plants grew well and flowered in late May, as seed capsules matured, they shattered and seeds fell onto the sheet. Sheets were vacuumed weekly from June 2 through August 30 with a hand-held vacuum. Seeds were collected in the filter in the vacuum and emptied into collection bags. When flowering had subsided, seed was cleaned with an air-screen machine. This seed collection technique was very effective and efficient.

***Lotus formosissimus* (LOFO2) -** A tub of plants was established in 2003. It did not overwinter well. Very few plants emerged in 2005, and they did not flower.

***Lupinus affinis* (LUAF) -** Seeds were sown into 5' pots in mid Feb. Plants were moved outside in early May and flowered in late June. Seed production was good and lasted from July 10 until September 12. Pods were clipped from plants when they turned tan and placed in paper bags to dry. An aphid infestation occurred, but was controlled with a foliar spray of soap and neem oil.

***Microsteris gracillis* (MIGR)** - Seeds were sown into cone-tainers and placed in a walk-in cooler for four weeks, then moved to a warm greenhouse in March. Seedlings were transplanted into 5in square pots and moved out to a shadehouse in April. Pots were watered with a drip irrigation system on 9ftX3ft plastic pallets. Using 2inX8in boards, frames were built around the pallets. Full-sized linen sheets were stapled to the frame and laid over the plants. Small slits were cut in the sheet and plants were pulled through the slit, leaving the pots underneath. Plants grew well and flowered in late May, as seed capsules matured, they shattered and seeds fell onto the sheet. Sheets were vacuumed weekly from June 2 through August 30 with a hand-held vacuum. Seeds were collected in the filter in the vacuum and emptied into collection bags. When flowering had subsided, seed was cleaned with an air-screen machine. This seed collection technique was very effective and efficient.

Table 4. Recorded Collection and Cleaning Times for Seed Increase Tubs.

Species	Harvest time	Cleaning time	Amount produced
Bromus carinatus	45 minutes	30 minutes	568 g
Cardamine penduliflora	30 minutes	15 minutes	1 g
Carex feta	1 hour	30 minutes	151g
Carex tumulicola	2 hours	45 minutes	22 g
Carex vesicaria	30 minutes	30 minutes	1 g
Cicendia quadrangularis	10 hours	15 minutes	13 g
Clarkia amoena	5 hours	30 minutes	50 g
Deschampsia danthonioides	15 minutes	1 hour	572 g
Dichanthelium acuminatum	1 hour	30 minutes	219 g
Eleocharis acicularis	30 minutes	15 minutes	1 g
Galium trifidum	2 hours	30 minutes	82 g
Gentiana sceptrum	30 minutes	30 minutes	3 g
Gilia capitata	1 hour	30 minutes	217 g
Linanthus bicolor	3 hours	30 minutes	78 g
Lupinus affinis	3 hours	30 minutes	227 g
Luzula comosa	3 hours	15 minutes	29 g
Montia linearis	3 hours	30 minutes	87 g
Myosotis laxa	3 hours	30 minutes	50 g
Myosurus minimus	30 minutes	15 minutes	4 g
Navarretia intertexta	15 minutes	2 hours	28 g
Nemophila menziesii	3 hours	30 minutes	287 g
Perideridia oregana	30 minutes	15 minutes	6 g
Phlox gracilis	3 hours	30 minutes	124 g
Saxifraga oregana	3hours	30 minutes	14 g
Sidalcea virgata	4 hours	2 hours	853 g

Luzula campestris **(LUCA2) -** This tub was established in 2003. Some mortality was observed over winter, but overall survival was high. Flowering began in February and seed was collected when capsules turned from green to brown (April 5- May 24). These plants grew vigorously and even flowered again in late August. All seed was collected in cloth bags and placed in a greenhouse to dry. It was further cleaned with an air screen machine.

Montia linearis **(MOLI4) -** Seeds were sown into cone-tainers in mid–December and placed outside in a shadehouse. They germinated outside within four weeks of sowing and grew slowly throughout the winter. They were brought inside a warm greenhouse in March when they began to flower. Seeds were sown into cone-tainers in March. Seedlings were transplanted into 5in square pots and moved out to a shadehouse in April. Pots were watered with a drip irrigation system on 9ftX3ft plastic pallets. Using 2inX8in boards, frames were built around the pallets. Full-sized linen sheets were stapled to the frame and laid over the plants. Small slits were cut in the sheet and plants were pulled through the slit, leaving the pots underneath. Plants grew well and flowered in late May, as seed capsules matured, they shattered and seeds fell onto the sheet. Sheets were vacuumed weekly from June 2 through August 30 with a hand-held vacuum. Seeds were collected in the filter in the vacuum and emptied into collection bags. When flowering had subsided, seed was cleaned with an air-screen machine. This seed collection technique was very effective and efficient.

***Myosotis laxa* (MYLA) -** Seeds were sown into cone-tainers in March and grown in a warm greenhouse. Seedlings were transplanted into 5in square pots and moved out to a shadehouse in late April. Pots were watered with a drip irrigation system on 9’X3’ plastic pallets. Using 2”X8” boards, frames were built around the pallets. Full-sized linen sheets were stapled to the frame and laid over the plants. Small slits were cut in the sheet and plants were pulled through the slit, leaving the pots underneath. Plants grew well and flowered, as seeds matured, they fell onto the sheet. Sheets were vacuumed weekly from June 2 through August 30 with a hand-held vacuum. Seeds were collected in the filter in the vacuum and emptied into collection bags. When flowering had subsided, seed was cleaned with an air-screen machine. This seed collection technique was very effective and efficient. Slugs became a pest in the pots. Slug bait was sprinkled in the pots to deter the slugs from feeding on the plants.

***Myosurus minimus* (MYMI2) -** Seeds were sown into cone-tainers in mid–December and placed outside in a shadehouse. They germinated outside within four weeks of sowing and grew slowly throughout the winter. They were brought inside a warm greenhouse in March and began to flower in April. “Mousetails” turn tan as the mature and seeds can be stripped off the “tail”. Due to the size of this plant and its seed, it would be a poor candidate for field plantings or any type of large-scale agronomic seed increase. In all likelihood, it will be limited to containerized production and hand collection procedures described here.

***Navarretia intertexta* (NAIN2) -** Seeds were sown into cone-tainers in mid–December and placed outside in a shadehouse. They germinated outside within four weeks of sowing and grew slowly throughout the winter. They were brought inside a warm greenhouse in March when they began to flower. Seeds were sown into cone-tainers in March. Seedlings were transplanted into 5in square pots and moved out to a shadehouse in April. Pots were watered with a drip irrigation system on 9ftX3ft plastic pallets. Plants flowered and died. Once they had dried, plants were cut from the pots and loaded into a large brush machine. This removed the seeds from the inflorescences. They were further cleaned with an air-screen machine.

***Nemophila menziesii* (NEME) -** Seeds were sown into cone-tainers in mid–December and placed outside in a shadehouse. They germinated outside within four weeks of sowing and grew slowly throughout the winter. They were brought inside a warm greenhouse in March when they began to flower. Seedlings were transplanted into 5in square pots and moved out to a shadehouse in April. Pots were watered with a drip irrigation system on 9ftX3ft plastic pallets. Using 2”X8” boards, frames were built around the pallets. Full-sized linen sheets were stapled to the frame and laid over the plants. Small slits were cut in the sheet and plants were pulled through the slit, leaving the pots underneath. Plants grew well and flowered, as seeds matured, they fell onto the sheet. Sheets were vacuumed weekly from June 2 through August 30 with a hand-held vacuum. Seeds were collected in the filter in the vacuum and emptied into collection bags. When flowering had subsided, seed was cleaned with an air-screen machine. This seed collection technique was very effective and efficient.

***Perideridia gairdneri* (PEGA3) -** This tub of plants was established in 2003 from plants that were grown in 2002. Plants in this tub did not emerge in 2005.

***Perideridia oregana* (PEOR6) -** This tub was established in 2003 from plants that were grown in 2002. Entire umbels were cut from the stems when seeds turned gray-ish brown and felt dry and crumbly. Seed were left in an open greenhouse to dry, then rubbed in a rubbing trough to break up seeds and stems. Seed was cleaned using an air-screen machine.

Saxifraga oregana (SAOR2) - This tub was established in 2004. Plants flowered in early spring and seeds were collected by hand from March 25 to May 12. Some plants re-flowered after harvest.

VI. Plant Materials Delivery

Seed was requested for delivery in late August in order to be available for fall sowing on restoration sites. Some plantings were still producing seed at this time. Seeds from plantings that had completed seed production for the season were picked up by BLM staff on September 16, 2005. All other seed produced in 2005 will be held in the PMC seed storage facilities until requested by the BLM.

Table 5. Seed Lots Delivered to BLM Staff on September 16, 2005.

Species	Code	Accession	Amount
Bromus carinatus	BRCA5	9079373	568 g
Cardamine penduliflora	CAPE2	9079245	1 g
Carex feta	CAFE4	9079315	151 g
Carex tumulicola	CATU3	9079291	22 g
Carex vesicaria	CAVE6	9079316	1 g
Cicendia quadrangularis	CIQU3	9079254	13 g
Dichanthelium acuminatum	DIACF	9079303	219 g
Deschampsia danthonioides	DEDA	9079382	572 g
Eleocharis acicularis	ELAC	9079292	1 g
Gentiana sceptrum	GESC	9079311	3 g
Gilia capitata	GICA5	9079377	217 g
Linanthus bicolor	LIBI	9079319	78 g
Lupinus affinis	LUAF	9079301	227 g
Luzula comosa	LUCO6	9079251	29 g
Montia linearis	MOLI4	9079295	87 g
Myosotis laxa	MYLA	9079253	50 g
Myosurus minimus	MYMI2	9079381	4 g
Navarretia intertexta	NAIN2	9079378	28 g
Nemophila menziesii	NEME	9079379	287 g
Perideridia oregana	PEOR6	9079256	6 g
Phlox gracilis	PHGR16	9079299	124 g
Saxifraga oregana	SAOR2	9079296	14 g
Sidalcea virgata	SIVI3	9079305	853 g

CORVALLIS PLANT MATERIALS CENTER
NATURAL RESOURCES CONSERVATION SERVICE
CORVALLIS, 0REGON
Amy Bartow

February 1, 2007

THE 2006 BUREAU OF LAND MANAGEMENT ANNUAL REPORT:
WEST EUGENE WETLANDS

I. Brief background of Project
The Corvallis Plant Materials Center (PMC) entered to 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 West Eugene Wetlands program has been collecting wild seed and sowing it in wetland restoration projects. Some species have been difficult to establish or have very high labor costs associated with hand collection. The PMC agreed to research and document propagation techniques from seed for these species and to evaluate their potential for agronomic seed increase.

In 2006, this agreement was renewed and 12 species were added for germination research and seed increase. Germination research continued on two of the species from 2004 that did not germinate or germination protocol was questionable. Seed increase was extended on 27 of the species from the 2003 and 2004 contracts. This agreement will be amended and renewed through 2006.

Activities in 2006 included cleaning seed provided by BLM, germination trials, establishing and maintaining seed increase plantings, seed harvesting and seed cleaning. Numbers of seeds per pound were also calculated for species upon request.

II. Accessions Included in 2006 Agreement (Table 1).

Species	**Common name**	**Symbol**	**Accession number**	**Activity in 2006** [1]
Bromus carinatus	California brome	**BRCA5**	9079373	sfp
Balsamorhiza deltoidea	deltoid balsamroot	**BADE2**	9079372	cont
Carex feta	greensheath sedge	**CAFE4**	9079315	sfp
Carex lanuginosa	wooly sedge	**CALA30**	9079304	cont
Carex tumulicola	splitawn sedge	**CATU**	9079291	sfp
Carex vesicaria	blister sedge	**CAVE**	9079316	sfp
Cicendia quadrangularis	Oregon timwort	**CIQU3**	9079254	sfp
Delphinium menziesii	Menzies' larkspur	**DEME**	9079374	cont
Deschampsia elongata	slender hairgrass	**DEEL**	9079375	sfp
Dichanthelium acuminatum var. Fasciculatum	western panicgrass	**DIACF**	9079303	sfp
Downingia elegans	elegant calicoflower	**DOEL**	9079432	sfp
Downingia yina	cascade calicoflower	**DOYI**	9079433	sfp

Table 1. Accessions Included in 2006 Agreement (cont')

Species	Common name	Symbol	Accession number	Activity in 2006 [1]
Eleocharis obtusa	blunt spikerush	**ELOB**	9079434	sfp, germ
Eleocharis palustris	common spikerush	**ELPA**	9079435	sfp, germ
Eryngium petiolatum	coyote thistle	**ERPE**	9079431	sfp, germ
Festuca roemerii	Roemer's fescue	**FERO**	9079488	sfp
Galium trifidum	threepetal bedstraw	**GATR2**	9079317	sfp
Gentiana sceptrum	king's scepter gentian	**GESC**	9079311	sfp
Geranium oreganum	Oregon geranium	**GEOR2**	9079376	cont
Gratiola ebracteata	bractless hedgehyssop	**GREB**	9079436	sfp
Juncus nevadensis	Sierra rush	**JUNE**	9079248	sfp
Lasthenia glaberrima	smooth goldfields	**LAGL3**	9079293	sfp
Lotus formosissimus	seaside bird's-foot trefoil	**LOFO2**	9079294	cont
Ludwigia palustris	marsh seedbox	**LUPA**	9079297	sfp
Madia glomerata	mountain tarweed	**MAGL**	9079437	sfp
Montia linearis	narrowleaf minerslettuce	**MOLI4**	9079295	sfp
Myosotis laxa	bay forget-me-not	**MYLA**	9079253	sfp
Myosurus minimus L.	tiny mousetail	**MYMI2**	9079381	sfp
Navarretia intertexta	needleleaf navarretia	**NAIN2**	9079378	sfp
Nemophila menziesii	baby blue eyes	**NEME**	9079379	sfp
Perideridia gairdneri	Gardner's yampah	**PEGA3**	9079255	sfp
Perideridia oregana	Oregon yampah	**PEOR6**	9079256	sfp
Phlox gracilis	slender phlox	**PHGR16**	9079299	sfp
Pyrrocoma racemosa	clustered goldenweed	**PYRA**	9079496	cont
Ranunculus alismaefolia	plantainleaf buttercup	**RAAL**	9079438	cont, germ
Rorippa curvisiliqua	curvepod yellowcress	**ROCU**	9079257	sfp
Saxifraga oregana	Oregon saxifrage	**SAOR2**	9079296	sfp
Sidalcea virgata	showy wild hollyhock	**SIVI3**	9079305	sfp
Veronica peregrina	neckweed	**VEPE**	9079439	sfp
Veronica scutellata	skullcap speedwell	**VESC**	9079440	cont
Viola praemorsa	canary violet	**VIPR3**	9079380	cont

1- sfp = seed increase, cont= container production, germ= germination trials

III. Germination Trials

BLM staff provided seed of 21 species to PMC staff on December 22, 2004. Most seeds lots were cleaned using an air screen machine to increase purity. Seeds were sown directly into stubby cone-tainers of moistened Sunshine #1 (a peat-based, soil-less media) amended with micronutrients and a slow-release fertilizer. Three or four flats (294 or 392 cones) of each species were sown. Flats were either placed in a warm greenhouse (70°F day/ 55°F night), an unheated greenhouse (approximately 40°-50° F day and 35°-40°

F night), or were covered with a polyethylene bag and placed in a walk-in cooler (34-38°F) for cold-moist stratification.

Table 2. Optimal Germination Treatment per Species From Trials Conducted at Corvallis Plant Materials Center in 2006.

Species	Amt used (g)	Number of cone-tainers produced	Seed lot used	Treatment
Lotus formosissimus	18	300	SNC-05-EB294	12 weeks stratification
Eleocharis obtusa	6	250	SNC-05-EB434	5 wks stratification
Eleocharis palustris	5	200	SNC-05-EB435	5 wks stratification
Madia glomerata	3	400	SNC-05-EB437	Heated greenhouse
Myosotis laxa	1	300	SNC-05-EB253	Heated greenhouse
Rorippa curvisiliqua	1	300	SNC-05-EB257	Heated greenhouse
Veronica peregrina	1	300	SNC-05-EB439	Heated greenhouse
Veronica scutellata	1	300	SNC-05-EB440	Heated greenhouse
Ranunculus alismaefolia	5	250	SNC-05-EB438	heated greenhouse (2 months), then cooler 2 weeks
Cicendia quadrangularis	15	500	SCO-05-EB312	unheated greenhouse
Myosurus minimus	4	400	SNC-04-EB381	unheated greenhouse
Navarettia intertexta	3	300	SNC-04-EB378	unheated greenhouse
Galium trifidum	4	300	SNC-05-EB317	unheated greenhouse
Montia linearis	4	300	SNC-05-EB295	unheated greenhouse
Nemophila menziesii	6	300	SCO-05-EB379	unheated greenhouse
Phlox gracilis	10	300	SNC-05-EB299	unheated greenhouse
Eryngium petiolatum	5	300	SNC-05-EB431	unheated greenhouse
Downingia elegans	7	400	SNC-05-EB432	unheated greenhouse
Downingia yina	6	400	SNC-05-EB433	unheated greenhouse
Gratiola ebracteata	1	400	SNC-05-EB436	unheated greenhouse
Lasthenia glaberrima	1	300	SNC-05-EB293	unheated greenhouse

IV. Field Plantings

A *Sidalcea virgata* field planting was established in late spring of 2003. The winter of 2005/2006 was very wet on the PMC farm. Half of the sidalceas were under water for a month. Of the plants under water, 95% died. The plants that were not under water grew normally and flowered in May. No weevils were detected on any of the seedheads. Plants did not seem affected by changes in soil environment due to the plastic woven weed barrier.

Seed was collected weekly from June 28th to July 15th by hand-stripping mature seeds, and also by sweeping up ones that had shattered on the ground cover. Collections were efficient and relatively little seed was lost. *S. virgata* racemes are less upright than other sidalceas which caused the seed to fall directly on the ground cover instead of on the crown of the plant. The ground cover is a considerable aid in seed collection for the species and does not seem to be detrimental to plant growth or development. Ground cover needs to be cut back from the crowns of the sidalceas as they expand. Harvested seed was collected in bags and dried in an open greenhouse. It was then placed in a small brush machine containing a scarifier (sandpaper) drum. Seed was further cleaned using an air screen machine.

The *Bromus carinatus* field was harvested by hand on June 18th. Pots of *Deschampsia elongata* were harvested by hand on June 22. Seeds were placed on a tarp in a greenhouse to dry and were then de-awned or de-bearded using a lab-sized brush machine and cleaned using an air-screen machine.

A new technique was implanted this year for seed production of the annual species. Two 15' X 170 sheets of weed fabric were stapled down onto a field that had been previously sprayed with glyphosate. Small squares were cut out of the weed fabric to transplant cone-tainer plants into. The squares were cut slightly larger than the size of the cone. Plants grew quickly once they were transplanted, flowered, and set seed. As seed ripened, it shattered onto the weed fabric.

Small, battery-powered hand vacuums were used to collect seed of *Montia linearis*, *Nemophila menziesii*, *Veronica peregrina*, and *Rorippa curvisiliqua*. Twice a week, the weed fabric in the planting would be vacuumed and placed in paper bags in a greenhouse.

A large leaf-blower (used in reverse, as a vacuum) was used to harvest the seed of *Myosotis laxa*, *Phlox gracilis*, *Galium trifidum*, and *Lasthenia glaberrima*. The *P. gracilis* and *L. glaberrima* plots were vacuumed multiple times. The *M. laxa* and *G. trifidum* plots were each only vacuumed once. The plants in these plots covered the weed fabric completely and held the seeds. The plots were vacuumed only once the plants had stopped producing seed and were removed. The *M. laxa* seeds seemed to be damaged by the collection bag on the leaf blower. Many seeds lost their hulls and some were broken. This seed was used to grow containers in the fall and no reduction in germination was noticed even though seeds looked a bit ragged.

Some of the plants did not drop their seed. *Navarettia intertexta*, *Downingia elegans*, and *Downingia yina* plants were cut out of the plots after all of the plants had died and were collected in large trash barrels. The plants were then fed into a large brush machine (the species were cleaned separately) equipped with a small mesh screen mantle. The brush machine opened the seed pods and separated the seeds from the larger pieces of plant material. The seed was cleaned using an air-screen machine.

The *Madia glomerata* plot was enormous. The plants stood almost 5 feet high and were each about 3 feet in diameter. The plants were cut down in late fall using a sickle-bar mower. All the large material was pitch forked onto a tarp and placed in an open shed to dry. After removing the larger material, the weed fabric was vacuumed using a leaf blower. The vacuumed seeds and chaff were fed into a large brush machine fitted with a screen mantle with large holes that the seeds could fall through. This separated the large chaff from the seeds. The tarp containing the cut madia plants was beat with pitchforks while it was drying. This “hand threshing” was repeated a couple times over three weeks until the seed was dry and had been released from the plants. The large plant parts were pitch forked off the tarp and the remaining material was then fed into the brush machine. The seed was further cleaned using a brush machine. The seed lot was large enough to be sampled for purity at the Oregon State University Seed Lab. The 16lb seed lot was found to be 94.58% pure, with 5.25% inert matter.

V. Seed Increase Tubs

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

Carex feta **(CAFE4) -**This tub was established with spring 2004 sown-seedlings. In 2006, these plants were hearty and covered with flowering stems. In the fall of 2004, more CAFÉ plants were transplanted into experimental “ponds” at the PMC. These plants had 100% survival rate and produced a moderate amount of seed. Seed heads were clipped just as they turned from green to yellow. Seeds shatter when they still look green and immature. Seed from both tub planting and pond planting were combined.

Carex tumulticola **(CATU3) -**This tub was established from cone-tainers seeded in 2003 that didn’t germinate until spring of 2004. Seed heads were clipped when mature. When over 80% of seedheads were ripe at the same time, the entire tub was cut back and all the clippings were dried in a greenhouse on a tarp. After harvest, they flowered again. Production was moderate.

Carex vesicaria **(CAVE6) -**Seedlings that were sown in the spring of 2004 were used to establish this tub**.** Flowering in 2006 was fair, but no seed was produced. If this plot continues to produce very little viable seed, it may be advantageous to re-collect and add more diversity to the existing plot.

Dichanthelium acuminatum **(DIAC) -** A tub of plants was established in 2003. It flowered well in the summer of 2006. Seeds were collected by hand. A small plot was also planted into weed fabric. Seed production was good and seeds fell onto the weed fabric as they matured. Weed fabric was vacuumed twice on July 30 through August 15 with a hand-held vacuum. Seeds were collected in the filter in the vacuum and emptied into collection bags. When flowering had subsided, seed was cleaned with an air-screen machine. This seed collection
technique was very effective and efficient.

Gentiana sceptrum **(GESC) –** This tub was established from seedling sown in winter of 2003. Plants were transplanted into the tub in late summer of 2004. Approximately 10 plants were also transplanted out into a field covered with plastic woven weed barrier. Plants in tubs and in the field both exhibited seed predation. Plants in the tub flowered more, grew taller, and were more vigorous overall. Plants in the field went dormant soon after flowering. Seeds were collected when capsule began to turn papery and tan.

Juncus nevadensis **(JUNE) -** Plants that were produced by the PMC and the BLM in 2003 were combined and transplanted into a large 5' x 6' tub on April 2, 2004. The plants grew vigorously, but no flowering occurred. Plants were watered heavily through-out the spring of 2006 to encourage flowering. Still, no flowering occurred.

Table 4. Recorded Collection and Cleaning Times for Seed Increase Tubs and Plots.

Species	**Symbol**	**Accession number**	**Harvest time**	**Cleaning time**	**Amount of seed produced**
Bromus carinatus	**BRCA5**	9079373	15 min	15 min	1569 g
Carex feta	**CAFE4**	9079315	30 min	15 min	75 g
Carex tumulicola	**CATU**	9079291	15 min	15 min	25 g
Cicendia quadrangularis	**CIQU3**	9079254	4 hours	15 min	13 g
Delphinium menziesii	**DEME**	9079374	4 hours	15 min	16 g
Deschampsia elongata	**DEEL**	9079375	30 min	15 min	73 g
Dichanthelium acuminatumvar. Fasciculatum	**DIACF**	9079303	30 min	30 min	176 g
Downingia elegans	**DOEL**	9079432	2 hours	3 hours	971 g
Downingia yina	**DOYI**	9079433	2 hours	3 hours	587 g
Eleocharis obtusa	**ELOB**	9079434	2 hours	1 hour	5 g
Eryngium petiolatum	**ERPE**	9079431	30 min	30 min	3 g
Galium trifidum	**GATR2**	9079317	1 hour	1 hour	2141 g
Gentiana sceptrum	**GESC**	9079311	45 min	15 min	52 g
Geranium oreganum	**GEOR2**	9079376	30 min	15 min	4 g
Gratiola ebracteata	**GREB**	9079436	30 min	15 min	35 g
Lasthenia glaberrima	**LAGL3**	9079293	4 hours	30 min	639 g
Madia glomerata	**MAGL**	9079437	2 hours	10 hours	16 lbs
Montia linearis	**MOLI4**	9079295	2 hours	30 min	195 g
Myosotis laxa	**MYLA**	9079253	1 hour	30 min	240 g
Myosurus minimus L.	**MYMI2**	9079381	1 hour	30 min	31 g
Navarretia intertexta	**NAIN2**	9079378	2 hours	2 hours	1185 g
Nemophila menziesii	**NEME**	9079379	2 hours	30 min	580 g
Perideridia gairdneri	**PEGA3**	9079255	30 min	30 min	103 g
Phlox gracilis	**PHGR16**	9079299	4 hours	1 hour	946 g
Pyrrocoma racemosa	**PYRA**	9079496	15 min	15 min	7 g
Rorippa curvisiliqua	**ROCU**	9079257	2 hours	1 hour	1144 g
Saxifraga oregana	**SAOR2**	9079296	1 hour	30 min	7 g
Sidalcea virgata	**SIVI3**	9079305	2 hours	30 min	451 g
Veronica peregrina	**VEPE**	9079439	4 hours	1 hour	373 g

***Perideridia gairdneri* (PEGA3) -** This tub of plants was established in 2003 from plants that were grown in 2002. Plants in this tub did not emerge in 2005.

***Perideridia oregana* (PEOR6) -** This tub was established in 2003 from plants that were grown in 2002. Entire umbels were cut from the stems when seeds turned gray-ish brown and felt dry and crumbly. Seed were left in an open greenhouse to dry, then rubbed in a rubbing trough to break up seeds and stems. Seed was cleaned using an air-screen machine.

***Saxifraga oregana* (SAOR2) -** This tub was established in 2004. Plants flowered in early spring and seeds were collected by hand from March 25 to May 12. Rain was heavy during harvesting time for this tub, which decreased yields.

***Cicendia quadrangularis* (CIQU3) -** These tiny plants grew and flowered well in the cone-tainers. Plants sown in mid-December in a warm greenhouse flowered in March and seed collection began in mid-April. Capsules turn bright orange when mature and split slowly from the top, releasing tiny, grey seeds. Mature capsules were cut and placed in seed collection envelopes to dry. Seeds are tiny enough to slip out of paper bags. Capsules can be separated from the seed using handscreens.

***Myosurus minimus* (MYMI2) -** Seeds were sown into cone-tainers in mid–December and placed outside in a shadehouse. They germinated outside within four weeks of sowing and grew slowly throughout the winter. They were brought inside a warm greenhouse in March and began to flower in April. “Mousetails” turn tan as the mature and seeds can be stripped off the “tail”.

Additional 2006 Seed Increase Notes:
Some species produced seed while they were in pots. *Delphinium menziesii*, and *Pyrrocoma racemosa* plants were overwintered from last year and flowered for the first time in 2006. *Eryngium petiolatum, Gratiola ebracteata,* and *Eleocharis obtusa* were new this year and flowered in their cone-tainers. They were too small in the spring to be transplanted out and were cared for through the summer in cone-tainers. Seed was hand harvested as it ripened from the *D. menziesii* and *P. racemosa*. Small battery-powered grass clippers were used to cut *E. petiolatum, G. ebracteata,* and *E. obtusa* like a mini-swather. Seeds were dried in small bags in an open greenhouse.

The *Balsamorhiza deltoidea* , *Festuca roemerii*, *Lotus formosissimus*, *Veronica scutellata*, *Ranunculus alismaefolia*, and *Eleocharis palustris* did not produce seed this year**.** These plants are being over-wintered at the PMC and will be planted into seed increase plots in 2007.

The *Ludwigia palustris* and *Viola praemorsa* var. *praemorsa* plants did not survive through the winter of 2005/2006. The *L. palustris* will be re-planted in the spring of 2007. The violet will be discontinued.

VI. Plant Materials Delivery

Seed was requested for delivery in late August in order to be available for fall sowing on restoration sites. Some plantings were still producing seed at this time. Seeds from plantings that had completed seed production for the season were picked up by BLM staff on September 19, 2006. Some of the later ripening seed and some dormant plants were picked up by BLM staff on October 24, 2006. All remaning seed lots are being stored at the PMC seed storage facilities until requested.

Table 5. Seed and Plants Delivered to BLM Staff in the fall of 2006.

Species	**Symbol**	**Accession number**	**Seed Delivered**	**Plants Delivered**
Bromus carinatus	**BRCA5**	9079373	1569 g	
Carex tumulicola	**CATU**	9079291	25 g	
Cicendia quadrangularis	**CIQU3**	9079254	13 g	
Clarkia amoena	**CLAM**	9079300	60 g	
Delphinium menziesii	**DEME**	9079374	16 g	49 corms
Deschampsia elongata	**DEEL**	9079375	73 g	
Downingia elegans	**DOEL**	9079432	971 g	
Downingia yina	**DOYI**	9079433	587 g	
Galium trifidum	**GATR2**	9079317	2141 g	
Gentiana sceptrum	**GESC**	9079311	52 g	
Geranium oreganum	**GEOR2**	9079376	4 g	7 5" pots
Gratiola ebracteata	**GREB**	9079436	35 g	
Lasthenia glaberrima	**LAGL3**	9079293	639 g	
Montia linearis	**MOLI4**	9079295	195 g	
Myosotis laxa	**MYLA**	9079253	240 g	
Myosurus minimus L.	**MYMI2**	9079381	31 g	
Navarretia intertexta	**NAIN2**	9079378	1185 g	
Nemophila menziesii	**NEME**	9079379	580 g	
Phlox gracilis	**PHGR16**	9079299	946 g	
Rorippa curvisiliqua	**ROCU**	9079257	1144 g	
Saxifraga oregana	**SAOR2**	9079296	7 g	
Sidalcea virgata	**SIVI3**	9079305	451 g	
Veronica peregrina	**VEPE**	9079439	373 g	

CORVALLIS PLANT MATERIALS CENTER
NATURAL RESOURCES CONSERVATION SERVICE
CORVALLIS, 0REGON
Amy Bartow

December 30, 2007

THE 2007 BUREAU OF LAND MANAGEMENT ANNUAL REPORT:
WEST EUGENE WETLANDS

I. Brief background of Project

The Corvallis Plant Materials Center (PMC) entered into an agreement in the spring of 2002 with the Bureau of Land Management (BLM) to perform seed germination trials and seed increase of native wetland and wet prairie species. The West Eugene Wetlands program has been collecting wild seed and sowing it in wetland restoration projects. Some species have been difficult to establish or have very high labor costs associated with hand collection. The PMC agreed to research and document seed propagation techniques for these species and to evaluate their potential for agronomic seed increase.

In 2007, this agreement was renewed, and three species from previous agreements were brought back to the PMC for seed increase. Seed increase was renewed on 33 of the species from the 2006 contract. This agreement will be amended and renewed through 2008.

Activities in 2007 included cleaning seed provided by BLM, establishing and maintaining seed increase plantings, seed harvesting and seed cleaning. Numbers of seeds per pound were also calculated for certain species upon request.

II. Accessions Included in 2007 Agreement

Table 1. Accessions included in 2007 agreement with Eugene District of the BLM.

Species	Common name	Code	Accession #	Activity in 2007[1]
Balsamorhiza deltoidea	deltoid balsamroot	BADE2	9079372	pxn,sfp
Carex feta	greensheath sedge	CAFE4	9079315	sfp
Carex languinosa	wooly sedge	CALA	9079304	pxn
Carex tumulicola	splitawn sedge	CATU3	9079291	sfp
Carex vesicaria	blister sedge	CAVE6	9079316	sfp
Castilleja tenuis	hairy Indian paintbrush	CATE26	9079254	pxn, sfp
Cicendia quadrangularis	Oregon timwort	CIQU3	9079254	pxn, sfp
Dichanthelium acuminatum	western panicgrass	DIACF	9079303	sfp
Downingia elegans	elegant calicoflower	DOEL	9079432	pxn, sfp
Downingia yina	Cascade calicoflower	DOYI	9079433	pxn, sfp
Eleocharis obtusa	blunt spikerush	ELOB2	9079434	pxn, sfp
Eleocharis palustris	common spikerush	ELPA3	9079435	pxn, sfp
Eryngium petiolatum	coyote thistle	ERPE	9079431	pxn, sfp

Table 1 (con't). Accessions included in 2007 agreement with Eugene District of the BLM.

Species	Common name	Code	Accession #	Activity in 2007[1]
Galium trifidum	threepetal bedstraw	GATR2	9079317	pxn, sfp
Gentiana sceptrum	king's scepter gentian	GESC	9079311	sfp
Gratiola ebracteata	bractless hedgehyssop	GREB	9079436	pxn, sfp
Lasthenia glaberrima	smooth goldfields	LAGL3	9079293	pxn, sfp
Lotus formosissimus	seaside bird's-foot trefoil	LOFO2	9079294	pxn, sfp
Ludwigia palustris	marsh seedbox	LUPA	9079297	pxn, sfp
Lupinus bicolor	miniature lupine	LUBI	9079250	pxn, sfp
Madia glomerata	mountain tarweed	MAGL	9079437	pxn, sfp
Montia linearis	narrowleaf minerslettuce	MOLI4	9079295	pxn, sfp
Myosotis laxa	bay forget-me-not	MYLA	9079253	pxn, sfp
Navarettia intertexta	needleleaf navarretia	NAIN2	9079378	pxn, sfp
Nemophila menziesii	baby blue eyes	NEME	9079379	pxn, sfp
Orthocarpus bracteosus	rosy owlclover	ORBR	9079502	pxn, sfp
Perideridia oregana	Oregon yampah	PEOR6	9079256	sfp
Phlox gracilis	slender phlox	PHGR	9079299	pxn, sfp
Pyrrocoma racemosa	clustered goldenweed	PYRA	9079496	pxn, sfp
Ranunculus alismaefolius	plantainleaf buttercup	RAAL	9079438	pxn, sfp
Rorippa curvisiliqua	curvepod yellowcress	ROCU	9079257	pxn, sfp
Saxifraga oregana	Oregon saxifrage	SAOR2	9079296	sfp
Sidalcea virgata	showy wild hollyhock	SIVI	9079305	sfp
Veronica peregrina	neckweed	VEPE2	9097439	pxn, sfp
Veronica scutellata	skullcap speedwell	VESC2	9079440	pxn, sfp

1- sfp= seed increase, pxn= container production,

III. Germination Trials

No germination trials were performed in 2007. All the species in this year's agreement have been successfully grown by the PMC in previous years. Treatments used to produce the plants for seed increase in 2007 are listed below.

Table 2. Optimal germination treatment per species from trials conducted at Corvallis Plant Materials Center in 2007.

Species	Amt used (g)	Number of cone-tainers produced	Treatment
Castilleja tenuis	1	20	90-days stratification
Cicendia quadrangularis	15	500	Unheated greenhouse
Downingia elegans	7	400	Unheated greenhouse

Table 2 (con't). Optimal germination treatment per species from trials conducted at Corvallis Plant Materials Center in 2007.

Species	Amt used (g)	Number of cone-tainers produced	Treatment
Downingia yina	6	400	Unheated greenhouse
Eryngium petiolatum	5	300	Unheated greenhouse
Galium trifidum	4	300	Unheated greenhouse
Gratiola ebracteata	1	400	Unheated greenhouse
Lasthenia glaberrima	1	300	Unheated greenhouse
Lotus formosissimus	18	300	12 weeks stratification
Lupinus bicolor	25	630	scarification/inoculation
Madia glomerata	3	400	Heated greenhouse (80°F)
Montia linearis	4	300	Unheated greenhouse
Myosotis laxa	1	300	Heated greenhouse
Navarettia intertexta	3	300	Unheated greenhouse
Nemophila menziesii	6	300	Unheated greenhouse
Orthocarpus bracteosus	1	26	90-days stratification
Phlox gracilis	10	300	Unheated greenhouse
Rorippa curvisiliqua	1	300	Heated greenhouse
Veronica peregrina	1	300	Heated greenhouse
Veronica scutellata	1	300	Heated greenhouse

IV. Field Plantings

A *Sidalcea virgata* field planting was established in late spring of 2003. The plants are still recovering from flooding last winter. No weevils were detected on any of the seedheads. Plants did not seem affected by changes in soil environment due to the plastic woven weed barrier. Rodents have not become a problem in this plot.

Seed was collected weekly from June 28th to July 15th by hand-stripping mature seeds, and also by sweeping up ones that had shattered onto the ground cover. Collections were efficient and relatively little seed was lost. *S. virgata* racemes are less upright than other sidalceas which caused the seed to fall directly on the ground cover instead of on the crown of the plant. The ground cover is a considerable aid in seed collection for the species and does not seem to be detrimental to plant growth or development. Ground cover needs to be cut back from the crowns of the sidalceas as they expand. Harvested seed was collected in bags and dried in an open greenhouse. It was then placed in a small brush machine containing a scarifier (sandpaper) drum. Seed was further cleaned using an air screen machine.

Seed increase of many annual species was performed this year using weed fabric techniques. Two 15' X 170' 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 in order to transplant the cone-tainer plants. The squares were cut slightly larger than the size of the cones. Once transplanted, plants grew quickly, flowered, and set seed. As seed ripened, it shattered onto the weed fabric.

Small, battery-powered hand vacuums were used to collect seed of *Montia linearis, Nemophila menziesii*, *Veronica peregrina*, *Lasthenia glaberrima*, *Phlox gracilis, Lupinus bicolor* and *Rorippa curvisiliqua*. Twice a week, the weed fabric in the planting would be vacuumed and the material placed in paper bags in a greenhouse.

Plots of *Myosotis laxa*, *Galium trifidum*, *Veronica scutellata* and *Madia glomerata* were harvested once. The plants in these plots covered the weed fabric completely and held the seeds on the fabric. The plots were vacuumed only when the plants had stopped producing seed and were then removed.

Some of the plants did not drop their seed. *Navarettia intertexta*, *Downingia elegans, Downingia yina,* and *Eryngium petiolatum* plants were cut out of the plots after all of the plants had died and were collected in large trash barrels. The plants were then fed into a large brush machine (each species was cleaned separately) equipped with a small mesh screen mantle. The brush machine opened the seed pods and separated the seeds from the larger pieces of plant material. The seed was cleaned using an air-screen machine.

V. Seed Increase Tubs

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

***Carex feta* (CAFE4) -** This tub was established with spring 2004-sown seedlings. In 2006, these plants were hearty and covered with flowering stems. In the fall of 2004, more CAFE plants were transplanted into artificial ponds at the PMC. These plants had a 100% survival rate and produced a moderate amount of seed. Seed heads were clipped just as they turned from green to yellow. Seeds shatter when they still look green and immature. Seed from both tub planting and pond planting were combined. The planting in the pond is growing very well and produced the majority of this year's harvest.

***Carex tumulicola* (CATU3) -** This tub was established from cone-tainers seeded in 2003 that didn't germinate until spring of 2004. Seed heads were clipped when mature. When over 80% of seedheads were ripe at the same time, the entire tub was cut back and all the clippings were dried in a greenhouse on a tarp. After harvest, they flowered again. Production was high for such a small plot.

***Carex vesicaria* (CAVE6) -** Seedlings that were sown in the spring of 2004 were used to establish this tub**.** Flowering in 2006 was fair, but no seed was produced. Seed production was better in 2007, but there seems to be much less filled seed than flowering. Most seed heads were empty.

***Dichanthelium acuminatum* (DIAC) -** A tub of plants was established in 2003. It flowered well in the summer of 2006. Seeds were collected by hand. A small plot was also planted into weed fabric. Seed production was good and seeds fell onto the weed fabric as they matured. Weed fabric was vacuumed once with a hand-held vacuum. Seeds collected in the vacuum filter were emptied into collection bags. When flowering had subsided, seed was cleaned with an air-screen machine. This seed collection technique was very effective and efficient. The weed fabric plot yields more seed than the tub because the weed fabric can catch the seeds as they mature and shatter.

***Gentiana sceptrum* (GESC)** - This tub was established from seedlings sown in winter of 2003. Plants were transplanted into the tub in late summer of 2004. Approximately 10 plants were also transplanted out into a field covered with plastic woven weed barrier. Plants in the tub flowered more, grew taller, and were more vigorous overall in previous years. Plants in the field never emerged this year. Seeds were collected when capsule began to turn papery and tan.

Table 3. Recorded collection and cleaning times for seed increase tubs and plots.

Species	**Harvest dates**	**Harvest time**	**Cleaning time**	**Amount of seed produced**
Carex feta	July 20- Aug 29	10 hours	30 min	490 g
Carex tumulicola	June 22	15 min	30 min	58 g
Castilleja tenuis	Aug 8- Sept 15	7 hours	15 min	4 g
Carex vesicaria	July 3	15 min	30 min	26 g
Cicendia quadrangularis	April 12- May 5	3 hours	15 min	1 g
Downingia elegans	August 15	2 hours	2 hours	2.9 lbs
Downingia yina	August 21	2 hours	2 hours	2.6 lbs
Eleocharis obtusa	July 25-Aug 30	3 hours	1 hour	35 g
Eryngium petiolatum	September 26	3 hours	2 hours	3 lbs
Galium trifidum	September 4	1 hour	1 hour	1.9 lbs
Gentiana sceptrum	July 7-Aug 9	2 hours	15 min	99 g
Gratiola ebracteata	July 1	15 min	30 min	77 g
Lasthenia glaberrima	May 10	2 hours	1 hour	1.7 lbs
Lupinus bicolor	July 12- Aug 7	2 hours	30 min	6.5 lbs
Madia glomerata	October 10	2 hours	3 hours	1 lb
Montia linearis	May 10	1 hour	15 min	114 g
Myosotis laxa	July 16	1 hour	15 min	100 g
Navarettia intertexta	August 8	2 hours	2 hours	2 lbs
Nemophila menziesii	June 12- June 20	2 hours	30 min	1 lb
Dichanthelium acuminatum	August 24	15 min	30 min	62 g
Orthocarpus bracteosus	Aug 12- Sept 15	7 hours	15 min	12 g
Perideridia oregana	Aug 15- Sept 30	1 hour	30 min	67 g
Phlox gracilis	June 1- July 10	2 hours	30 min	2 lbs
Pyrrocoma racemosa	Sept 5- Oct 10	1 hour	1 hour	38 g

Table 3 (con't). Recorded collection and cleaning times for seed increase tubs and plots.

Species	Harvest dates	Harvest time	Cleaning time	Amount of seed produced
Rorippa curvisiliqua	Aug 28-Sept 6	2 hours	1 hour	2 lbs
Saxifraga oregana	May 7	30 min	15 min	16 g
Sidalcea virgata	June 12- July 15	1 hour	30 min	1.35 g
Veronica peregrina	May 18- June 20	2 hours	1 hour	1.6 lbs
Veronica scutellata	September 13	30 min	1 hour	25 g

***Perideridia oregana* (PEOR6) -** This tub was established in 2003 from plants that were grown in 2002. A small plot was also planted into weed fabric in 2007. The weed fabric plot seems to be more vigorous and survival is higher. Entire umbels were cut from the stems when seeds turned grayish brown and felt dry and crumbly. Seeds were left in an open greenhouse to dry, then rubbed in a rubbing trough to break up seeds and stems. Seed was cleaned using an air-screen machine.

***Saxifraga oregana* (SAOR2) -** This tub was established in 2004. Plants flowered in early spring and seeds were collected by hand from May 7- May 12. Rain was heavy during flowering and harvest time for this tub, which decreased yields.

Additional 2006 Seed Increase Notes
Some species produced seed while they were in pots. *Pyrrocoma racemosa* plants were overwintered from 2006 and flowered profusely in 2007. Seeds were collected by hand as they matured. *Gratiola ebracteata* and *Eleocharis obtusa* flowered in their cone-tainers. They were too small in the spring to be transplanted out and were cared for through the summer in cone-tainers. Small battery-powered grass clippers were used to cut *G. ebracteata,* and *E. obtusa* like a mini- swather. Seeds were dried in small bags in an open greenhouse.

Mature *Cicendia quadrangularis* capsules were cut and placed in seed collection envelopes to dry. Seeds are tiny enough to slip out of paper bags. Capsules can be separated from the seed using handscreens.

The *Balsamorhiza deltoidea*, *Lotus formosissimus*, *Ranunculus alismaefolius,* and *Eleocharis palustris* did not produce seed in 2007**.** These plants are being over-wintered at the PMC and will be planted into seed increase plots in 2008. *L. formosissimus* plants from the previous year did not over winter. Freezing temperatures killed the plants in the cone-tainers.

The *Ludwigia palustris* did flower this year! As seed was maturing, the plants senesced or died, and filled seed was not produced. *Castilleja tenuis* and *Orthocarpus bracteosa* seedlings experienced severe damping off. Very few seedlings survived. These plants were potted up into gallon pots with an *Eriophyllum lanatum* plant as a host. Seed was collected by hand as the capsules matured. It was very time consuming and inefficient. Next year, seedlings will be monitored more carefully and will be transplanted into a field covered with weed fabric.

VI. Plant Materials Delivery

Seed was requested for delivery in late August in order to be available for fall sowing on restoration sites. Some plantings were still producing seed at this time. Seeds from plantings that had completed seed production for the season were picked up by BLM staff on September 7, 2007. Some of the later ripening seed and some dormant plants were picked up by BLM staff on October 2 and 11, 2007. 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 2007.

Species	**Amount of seed produced**	**Date delivered**	**Notes**
Carex feta	131 g	7-Sep	Produced in 2006
Carex feta	490 g	2-Oct	
Carex tumulicola	58 g	11-Oct	
Castilleja tenuis	4 g	2-Oct	
Carex vesicaria	26 g	11-Oct	
Downingia elegans	2.9 lbs	7-Sep	
Downingia yina	2.6 lbs	7-Sep	
Eleocharis obtusa	35 g	7-Sep	
Eryngium petiolatum	3 lbs	11-Oct	
Galium trifidum	1.9 lbs	2-Oct	
Gentiana sceptrum	99 g	2-Oct	
Gratiola ebracteata	77 g	7-Sep	
Lasthenia glaberrima	1.7 lbs	7-Sep	
Lupinus bicolor	6.5 lbs	7-Sep	
Madia glomerata	16 lbs	7-Sep	Produced in 2006
Montia linearis	114 g	7-Sep	
Myosotis laxa	100 g	7-Sep	
Navarettia intertexta	2 lbs	7-Sep	
Nemophila menziesii	1 lb	7-Sep	
Dichanthelium acuminatum	62 g	2-Oct	
Orthocarpus bracteosus	12 g	2-Oct	
Perideridia oregana	42 g	7-Sep	Produced in 2006
Phlox gracilis	2 lbs	7-Sep	
Rorippa curvisiliqua	2 lbs	2-Oct	
Saxifraga oregana	16 g	7-Sep	
Sidalcea virgata	1.35 g	7-Sep	
Veronica peregrina	1.6 lbs	7-Sep	

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

February 22, 2006

THE 2005 BUREAU OF LAND MANAGEMENT ANNUAL REPORT:
Medford District

I. Brief Background of Project

The Corvallis Plant Materials Center (PMC) entered into a new 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 amended in 2005, it was agreed that the PMC would establish and maintain seed increase fields of three grasses and three legumes, establish two seed increase plots of rushes, perform germination trials and containerized production of one legume and seven forbs. A minimum of 1550 plants are to be delivered to the BLM at a time and place agreed upon by PMC and BLM staff.

II. Accessions Involved

Accessions included for the Medford District BLM in 2005 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 2005.

Scientific name	Common Name	Symbol	Accession	Activities in 2005[1]
Cimicifuga elata	tall bugbane	**CIEL**	9079390	trl, pxn
Cordylanthus tenuis	slender bird's beak	**COTE3**	9079392	trl, pxn
Darlingtonia californica	California pitcherplant	**DACA5**	9079391	trl, pxn
Festuca californica	California fescue	**FECA**	9079327	sfp
Festuca romerii	Roemer's fescue	**FERO**	9079326	sfp
Frasera umpquaensis	Umpqua green gentian	**FRUM**	9079387	trl, pxn
Juncus tenuis	poverty rush	**JUTE**	9079388	trl, pxn
Lomatium macrocarpum	big-seeded lomatium	**LOMA3**	9079325	pxn
Lupinus albifrons	silverleaf lupine	**LUAL4**	9079322	sfp
Lupinus sulphureus[2]	yellow lupine	**LUSU5**	9079321	sfp
Melica harfordii	Hartford's melic	**MEHA2**	9079328	sfp
Rupertia physoides	forest scurf peas	**RUPH3**	9079323	sfp
Scirpus microcarpus	panicled bulrush	**SCMI2**	9079386	trl, pxn
Wyithia angustifolia	California compassplant	**WYAN**	9079389	trl, pxn
Xerophyllum tenax	common beargrass	**XETE**	9079385	trl, pxn

1- sfp = seed increase, trl= germination research trials, pxn=plant production, dlv=plant materials delivery

2-this species was later identified as *Lupinus luteolus*.

III. Experimental Propagation

Informal germination trials were set up for production of the seven new forbs in this agreement. Cold-moist stratification trials were set up in the spring of 2005. These trials were set up as production trials rather than a formal laboratory germination evaluation since the intent is to produce vigorous seedlings under normal greenhouse propagation conditions. Seeds of each species were sown into Ray Leach stubby cone-tainers filled with moistened media (Sunshine #1 a special peat-based soil-less mix). Seeds were lightly covered with fine vermiculite, and the flats were placed in polyethylene bags and moved into the walk-in cooler (36-38^{o} F). Flats were removed after 45 or 90 days and placed outside in a lathhouse. Most seedlings emerged within two weeks and grew vigorously. FRUM seedlings experience sudden damping off in all conetainers within a week after emerging. DACA seedlings were slow to emerge (four weeks) and seedlings disappeared two weeks after emergence. It is not known whether damping off or predation was the cause. No germination was observed in any of the XETE conetainers. Trials were begun again with these three species to better understand their germination needs.

Table 2. Treatments That Produced the Highest Germination per Species at the Corvallis Plant Material Center in 2005.

Species	Code	Treatment	Germ	Notes
Scirpus microcarpus	**SCMI2**	45days c/m stratification	70%	Surface sow, needs light
Wyithia angustifolia	**WYAN**	90days c/m stratification	65%	
Xerophyllum tenax	**XETE**	120 days c/m stratification	0%	May need light, alternating temps
Frasera umpquaensis	**FRUM**	90days c/m stratification	40%	seedlings damped off
Juncus tenuis	**JUTE**	45days c/m stratification	76%	Surface sow, needs light
Cimicifuga elata	**CIEL**	2-wks warm followed by 90days c/m stratification	73%	
Cordylanthus tenuis	**COTE3**	90days c/m stratification	87%	
Darlingtonia californica	**DACA5**	90days c/m stratification		planted into peat moss, needs light

IV. Field Seed Increase

Containerized plants of *Lupinus albifrons* and *Rupertia physiodes* produced in 2004 were transplanted into existing seed increase plots to fill in rows. Transplanting occurred on March 14, 2005.

Weed control in the grass and legume seed increase fields was performed mainly by hand weeding and rogueing. Borders were sprayed with glyphosate. Most fields were spot-sprayed with glyphosate using a shielded backpack sprayer to control exotic bentgrasses and other rhizomatous weeds.

Hartford's melic field was sprayed with 2,4-D in late February to control broadleaf weeds that were smothering the grass seedlings. Some of the less-developed seedlings were damaged by the spraying. Areas in between the rows were sprayed with glyphosate using a shielded backpack sprayer to control large broadleaf weeds before they flowered and produced seed.

Seed increase fields of California fescue and Roemers fescue fields flowered early due to a very warm February. As a result, the fields could not be sprayed with 2,4-D to control spring-germinating broadleaf weeds. The California fescue field became very weedy. It was hand weeded many times as well as spot-sprayed sprayed with glyphosate using a shielded backpack sprayer. Constant rain during anthesis is believed to have caused poor seed fill in both of these fields. Florets of California fescue were spotted with black mold although plants and seedheads appeared to be very vigorous.

Legume plots also experienced constant rain during pollination and seed maturation. Pods sometimes rotted off the stems, aborting all seeds. Pods were hand collected in May and June, and placed in an open greenhouse to dry. Higher *Rupertia* yields may be reached by installing weed fabric in between the rows of plants. This will catch the ripe seed as it falls from the plant. Maturity was extremely variable within the plants and on each individual plant making efficient, high yielding harvest impossible. Seeds were hand-stripped from plants when sepals became very dry and papery and as seed began to dry and shrink. The yellow lupine was grown in 1-gallon pots this year to control fungus and rot issues that were a problem in 2004. Overall survival in 2005 was higher than field grown plants in 2004, but plants were smaller, and death from fusarium was still present (but greatly reduced). Seed yield was higher than in 2004.

Table 3. Harvest data on fields at the PMC for the for Medford District BLM cooperative agreement with Corvallis Plant Materials Center in 2005.

Species	Acc #	Acres	Date	Method	Yield	Comments
FECA	9079327	0.56	June 18	Hand	8lbs	Fair stand, good vigor
FERO	9079326	0.14	July 10	combine	2lbs	Fair stand, good vigor
LUAL4	9079322	0.01	June 10	Hand	7 g	Good stand, excellent vigor
LUSU5	9079321	0.01	July 15	Hand	33g	Fair stand, fair vigor
MEHA2	9079328	0.34	August 6	Hand	6lbs	Poor stand, poor vigor
RUPH3	9079323	0.01	July 21	Hand	64g	Good stand, good vigor

After harvest, all fields were mowed with a Brady flail chopper to remove residue. California fescue field was mowed at three different heights: 3”, 6” and 9”. As of late November the rows of plants that were mowed at 6” exhibited the greatest vigor and foliage re-growth. Plants mowed at 3” had some crown damage and ones mowed at 9” still had a lot of old material present and less re-growth than those mowed at 6”. Plants will be evaluated in late spring 2006 for variation in tiller presence based on mowing heights.

V. Container Plant Production.

On March 13, 2005, seeds of each species were sown into Ray Leach stubby cone-tainers filled with moistened media (Sunshine #1 a special peat-based soil-less mix) and lightly covered with fine vermiculite. Seeded flats that required cold-moist stratification to break seed dormancy were placed in polyethylene bags and moved into the walk-in cooler (36-38^{o} F). Flats that did not require cold-moist stratification were placed in a shadehouse. Plants were watered overhead daily and monitored for diseases and pests.

Yellow lupine plants were transplanted into 1-gallon ribbed pots on May 15, 2005. They were placed in a shadehouse for the growing season while seeds were harvested.

Table 4. Container Plant Production at the Corvallis PMC in 2005 for the BLM Medford District.

Species	Code	Amt seed used (g)	# Produced
Scirpus microcarpus	**SCMI2**	2	450
Wyithia angustifolia	**WYAN**	13	330
Xerophyllum tenax	**XETE**	7	0
Frasera umpquaensis	**FRUM**	5	0
Juncus tenuis	**JUTE**	1	250
Cimicifuga elata	**CIEL**	3	160
Cordylanthus tenuis	**COTE3**	4	180
Darlingtonia californica	**DACA5**	1	0

VI. Delivery of Plant Materials.

No materials were delivered in 2005.

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

December 22, 2006

THE 2006 BUREAU OF LAND MANAGEMENT ANNUAL REPORT:
Medford District

I. Brief Background of Project

The Corvallis Plant Materials Center (PMC) entered into a new 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 amended in 2006. It was agreed that the PMC would maintain seed increase fields of three grasses, three legumes, and two rushes; perform germination trials and containerized production of one legume and eight forbs; and establish seed increase fields of eight new grass accessions as well as eight new forb species. A minimum of 400 plants are to be delivered to the BLM at a time and place agreed upon by PMC and BLM staff.

II. Accessions Involved

Accessions included for the Medford District BLM in 2006 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 2006.

Scientific Name	Common name	Code	Accession #	Activity in 2006
Iris douglasiana	Douglas Iris	**IRDO**	9079417	trl, pxn
Juncus ensifolius	sword leaf rush	**JUEN**	9079418	trl,pxn
Penstemon roezlii	Roezl's penstemon	**PERO12**	9079419	trl, pxn, sfp
Sisyrincium bellum	western blue-eyed grass	**SIBE**	9079420	trl, pxn
Tritilia hyacinthina	white hyacinth	**TRHY3**	9079421	trl, pxn
Festuca elmeri	coast fescue	**FEEL2**	9079422	pxn, sfp
Polemonium carneum	royal Jaccob's ladder	**POCA4**	9079424	trl, pxn
Eriogonum umbellatum	sulfur-flowered buckwheat	**ERUM**	9079425	trl,pxn
Lupinus adsurgens	Drew's silky lupine	**LUAD**	9079426	pxn, sfp
Potentilla glandulosa	sticky cinquefoil	**POGL9**	9079427	trl,pxn
Bromus lavipes	woodland brome	**BRLA3**	9079393	sfp
Poa secunda	Sandberg blue grass	**POSE**	9079394	sfp
Festuca roemerii	Roemer's fescue	**FERO**	9079395	sfp
Bromus lavipes	woodland brome	**BRLA3**	9079396	sfp

Table 1(con't). Accessions involved for Medford District BLM cooperative agreement with Corvallis Plant Materials Center in 2006.

Scientific Name	Common name	Code	Accession #	Activity in 2006
Bromus carinatus	California brome	**BRCA5**	9079397	sfp
Achnatherum lemmonii	Lemmon's needlegrass	**ACLE8**	9079398	pxn
Festuca californica	California fescue	**FECA**	9079399	sfp
Cimicifuga elata	tall bugbane	**CIEL**	9079390	dlv
Darlingtonia californica	California pitcherplant	**DACA5**	9079391	trl, pxn
Festuca californica	California fescue	**FECA**	9079327	sfp
Festuca romeri	Roemer's fescue	**FERO**	9079326	sfp
Frasera umpquaensis	Umpqua green gentian	**FRUM**	9079387	trl, pxn
Juncus tenuis	poverty rush	**JUTE**	9079388	pxn
Lomatium macrocarpum	big-seeded lomatium	**LOMA3**	9079325	pxn
Lupinus albifrons	silverleaf lupine	**LUAL4**	9079322	sfp, dlv
Melica harfordii	Harford's melic	**MEHA2**	9079328	sfp
Rupertia physoides	forest scurf peas	**RUPH3**	9079323	sfp
Scirpus microcarpus	panicled bulrush	**SCMI2**	9079386	pxn
Wyithia angustifolia	California compassplant	**WYAN**	9079389	pxn
Xerophyllum tenax	common beargrass	**XETE**	9079385	trl, pxn

1- sfp= seed increase, trl= germination research trials, pxn=plant production, dlv=plant materials delivery

III. Experimental Propagation

Informal germination trials were set up for production of the eight new forbs in this agreement. Cold-moist stratification trials were set up in the spring of 2006. These trials were set up as production trials rather than a formal laboratory germination evaluation since the intent is to produce vigorous seedlings under normal greenhouse propagation conditions. Seeds of each species were sown into Ray Leach stubby cone-tainers filled with moistened media (Sunshine #1 a special peat-based soil-less mix) amended with micronutrients and slow release fertilizer. Seeds were lightly covered with fine vermiculite, and the flats were placed in polyethylene bags and moved into the walk-in cooler (36-38^{o} F). Flats were removed after 45 or 90 days and placed outside in a lath house. Most seedlings emerged within two weeks and grew vigorously.

Table 2. Treatments That Produced the Highest Germination per Species at the Corvallis Plant Materials Center in 2006.

Species	Code	Optimum treatment	Germ	Notes
Scirpus microcarpus	**SCMI2**	45 days c/m stratification	70%	Surface sow, needs light
Xerophyllum tenax	**XETE**	120 days c/m stratification	67%	Needs light, alternating temps
Frasera umpquaensis	**FRUM**	90 days c/m stratification	40%	seedlings damped off
Species	**Code**	**Optimum treatment**	**Germ**	**Notes**
Juncus ensifolius	**JUEF**	45 days c/m stratification	42%	Surface sow, needs light
Darlingtonia californica	**DACA5**	90 days c/m stratification	88%	planted into peat moss, needs light
Iris douglasiana	**IRDO**	80 days c/m stratification	25%	may need to be frozen during stratification
Penstemon roezlii	**PERO12**	80 days c/m stratification	85%	Needs light, alternating temps
Sisyrincium bellum	**SIBE**	none found	0%	Needs light, alternating temps
Tritilia hyacinthina	**TRHY3**	90 days c/m stratification	93%	Needs light, alternating temps
Festuca elmeri	**FEEL2**	14 days c/m stratification	99%	
Polemonium carneum	**POCA4**	80 days c/m stratification	65%	Needs light, alternating temps
Eriogonum umbellatum	**ERUM**	80 days c/m stratification	92%	Needs light, alternating temps
Lupinus adsurgens	**LUAD**	scarification	78%	inoculate with rhizobium
Potentilla glandulosa	**POGL9**	80 days c/m stratification	45%	Needs light, alternating temps

IV. Field Seed Increase

Most of the seed provided by the BLM needed a finer cleaning to blow out chaff and weed seeds. Informal germination tests were performed on most of the seed lots prior to planting. All new grass fields, except *Achnatherum lemmonii*, were seeded into fields on October 11, 2005 using a six-row Planet Jr. seeder equipped with a carbon banding unit. *Achnatherum lemmonii*, *Eriogonum umbellatum*, *Potentilla glandulosa*, *Polemonium carneum*, and *Penstemon roezlii* were seeded using a single-row belt seeder. Rows were then sprayed with a thin strip of carbon slurry using a backpack sprayer. All fields were sprayed with Diuron (a non-selective, pre-emergent herbicide) after sowing. Fall rains began the day after seeding and spraying were completed so no fall irrigation was needed. However, the rain was heavy, lasting for 30 days and caused severe damping off in the *Festuca elmeri* field and damaged some plants in the *Bromus lavipes*-(Sprignette) and *Festuca roemerii*- (RoundTop) fields.

Table 3. Seeding rates and field sizes sown on October 11, 2005, at the Corvallis Plant Materials Center for the Medford BLM district.

Festuca elmeri **0.08 acres** or 18 184' rows 12" btwn rows	480g	94%	13 lbs/acre (bulk) 12 lbs/acre (PLS) 66 PSL/ft-row	216,000
Bromus lavipes **0.5 acres** or 120 180' rows 12" btwn rows	2000g	4%	9 lbs/acre (bulk) 0.36 lbs/acre (PLS) < 1PLS/ft-row	94,400
Poa secunda **0.5 acres** or 120 181' rows 12" btwn rows	200g	70%	1 lbs/acre (bulk) 0.7 lbs/acre (PLS) 12 PLS/ft-row	1,006,700
Festuca roemerii **0.25 acres** or 84 130' rows 12" btwn rows	339g	87%	4 lbs/acre (bulk) 3.5 lbs/acre (PLS) 16 PLS/ft-row	271,300
Bromus lavipes **0.25 acres** or 60 184' rows 12" btwn rows	1165g	92%	10 lbs/acre (bulk) 9 lbs/acre (PLS) 20 PLS/ft-row	92,800
Bromus carinatus **0.4 acres** or 96 180' rows 12" btwn rows	1957g	74%	11 lbs/acre (bulk) 8 lbs/acre (PLS) 9 PLS/ft-row	50,000
Festuca californica **0.2 acres** or 72 130' rows 12" btwn rows	294g	94%	3.5 lbs/acre (bulk) 3.3 lbs/acre (PLS) 7 PLS/ft-row	110,000
Penstemon roezlii **0.02 acres** or 4 181' rows 16" btwn rows	16g	85%	2 lbs/acre (bulk) 1.7 lbs/acre (PLS) 42 PLS/ft-row	873,000
Polemonium carneum **0.015 acres** or 3 181' rows 16" btwn rows	32g	65%	5 lbs/acre (bulk) 3.3 lbs/acre (PLS) 28 PLS/ft-row	216,000
Eriogonum umbellatum **0.015 acres** or 3 181' rows 16" btwn rows	87g	92%	12 lbs/acre (bulk) 11 lbs/acre (PLS) 46 PLS/ft-row	110,600
Achnatherum lemmonii **0.02 acres** or 6 130’ rows 16’ btwn rows	12g	69%	14 lbs/acre (bulk) 9 lbs/acre (PLS) 46 PLS/ft-row	127,000
Potentilla glandulosa **0.08 acres** or 18 181' rows 16" btwn rows	39g	45%	1 lbs/acre (bulk) .45 lbs/acre (PLS) 60 PLS/ft-row	2,268,000

Achnatherum lemmonii seedlings began to emerge in January. The fields were inundated with water and the seedlings were sometimes completely under standing water. Survival was moderate, but after the water receded in February more seedlings emerged. The field was rated as good. Transplants were also grown in cone-tainers to fill in gaps in the field. *Eriogonum umbellatum*, *Potentilla glandulosa*, *Penstemon roezlii*, and *Polemonium carneum* seedlings did not emerge until March and continued to emerge through May. All fields looked very good, considering they were under water for weeks at a time in December and January, except *P. glandulosa*. Rows of *P. glandulosa* were only about 10% full, but individual plants were very vigorous.

Containerized plants of *Scirpus microcarpus* and *Juncus tenuis* that were produced in 2005 were transplanted into a constructed wetland pond for seed increase. Transplanting occurred on January 14, 2006. After planting, four days of freezing temperatures occurred, followed by a month of rain. The level of water in the pond was over three feet deep. The water control system could not pump out all the water due to flooding and high water tables. Most of the transplants did not survive. More plants were grown in the summer and will be transplanted in the spring of 2007. Transplants of *Lupinus adsurgens*, *Rupertia physoides*, and *Festuca elmeri* were grown in the fall of 2005 and transplanted into seed increase fields on March 13, 2006. Mulch was applied to *L. adsurgens* and *F. elmeri* plots to retain moisture in summer and suppress weeds.

In the spring, *Bromus carinatus* field appeared to have herbicide damage. Plants were stunted and twisted. This damage was also noticed in an *Elymus glaucus* field on a different area of the PMC farm. It was discovered that both of these fields had a cover crop of winter wheat the previous year. Allelopathy from the wheat is the suspected cause of the stunting and twisting of the plants. The *Bromus carinatus* field also had a horrible infestation of smut. It was not machine harvested. Plants that were smut-free were harvested individually by hand.

Field notes 2006:

Weed control in the forb and legume seed increase fields was performed mainly by hand weeding and rouging. Borders were cultivated or sprayed with glyphosate. Most fields were spot-sprayed with glyphosate using a shielded backpack sprayer to control exotic bentgrasses and other rhizomatous weeds. All grass fields were sprayed with Banvel in the spring to control broadleaf weeds.

All grass fields (only the portions that were over 1 year old) were fertilized in October 2006 with 25 lbs/ac nitrogen (N) and in February with 50 lbs/ac N plus 15 lbs/ac sulfur (S). Grass fields were burned using drip torches following harvest. In mid October, a new pre-emergent herbicide, Outlook, was applied to all fields that had been harvested in 2006. It will be evaluated in the winter and spring for effectiveness.

Weed fabric was installed between existing rows of *Rupertia physoides*. About 2” of soil was removed between the rows before weed fabric was stapled down; this created a trough to catch the seed as it falls from the plant. It was quite successful; the small field yielded almost a pound of seed. A passive seed collection method, like this, is also good for maximizing genetic diversity among the harvest. 90-100% of all seeds that the plant produced were harvested, which is almost impossible to achieve with machine harvest on crops that have very indeterminate ripening and seed that shatters easily.

Two new harvesters were used this year. One, informally named the "moon rover", is a hand-built, self propelled swather. It has a conveyer belt that moves all material after it is cut and loads it into bags. Two people operate the machine with one person driving and the other helping to feed the material into bags. The machine has all the benefits of hand harvesting without the labor. Once material was bagged it was laid out on to tarps to dry and cure. It was then fed though a plot thresher, and cleaned as usual. The other harvester is a Woodward flail-vac seed stripper. It uses a high speed brush to strip seed off the heads of grasses and dry flower stalks of forbs. It is mounted like the bucket on a front end loader. The unit has proven to be effective for harvesting several species. It was moderately effective for the *Melica harfordii*. It didn't remove all of the seed, so multiple passes were needed.

Table 3. Seed harvested from seed increase fields at the Corvallis Plant Materials Center in 2005.

Species	Accession #	acres	Method	Yield	Comments
FEEL	9079422	0.08	hand	24 g	good stand, fair vigor
BRLA	9079396	0.25	moon rover	22 lbs	good stand, good vigor
FERO	9079326	0.1	hand	2 lbs	poor stand, low vigor
FECA	9079327	0.2	moon rover	34 lbs	fair stand, fair vigor
MEHA	9079328	0.2	seed stripper	6 lbs	poor stand, fair vigor
LUAL	9079322	0.1	hand	22 g	good stand, low vigor
BRCA	9079397	0.4	hand	8 lbs	excellent stand, **SMUT!!**
PERO	9079419	0.1	hand	194g	excellent stand, high vigor
RUPH	9079323	0.1	leaf blower	312 g	good stand, high vigor

V. Container Plant Production.

On December 13, 2005, seeds of each species were sown into Ray Leach stubby cone-tainers filled with moistened media (Sunshine #1 a special peat-based soil-less mix) amended with micronutrients and slow-release fertilizer and lightly covered with fine vermiculite. Seeded flats that required cold-moist stratification to break seed dormancy were placed in polyethylene bags and moved into the walk-in cooler (36-38^{o} F). Flats that did not require cold-moist stratification were placed in a shadehouse. Plants were watered overhead daily and monitored for diseases and pests. All plants produced (except *Tritilia hyacinthina*, *Xerophyllum tenax*, and *Darlingtonia californica*) will be used to expand or establish seed increase plots.

Table 4. Containerized Plant Production at the Corvallis PMC in 2006 for the BLM Medford District.

Code	Treatment	Amt seed used	Germ	Number produced
SCMI2	45days c/m stratification	2 g	70%	400
XETE	120 days c/m	2 g	67%	120
FRUM	90days c/m stratification	3 g	40%	0
JUEF	45days c/m stratification	1 g	42%	70
DACA5	90days c/m stratification	1 g	88%	0
IRDO	80 days c/m stratification	40 g	25%	70
PERO12	80 days c/m stratification	2 g	85%	120
SIBE	90 days c/m stratification	3 g	0%	0
TRHY3	90days c/m stratification	2 g	93%	395
FEEL2	2 weeks c/m stratification	2 g	99%	400
POCA4	80 days c/m stratification	2 g	65%	80
ERUM	80 days c/m stratification	4 g	92%	450
LUAD	Scarification	7g	78%	130
JUTE	5 weeks c/m stratification	1 g	45%	200
POGL	80 days c/m stratification	1 g	45%	135

VI. Delivery of Plant Materials.

No materials were delivered in 2006. See Appendix 1 for current seed in storage at the Corvallis Plant Materials Center.

Appendix 1

Table 5. Current seed in storage at Corvallis Plant Materials Center, January 11, 2007.

Scientific Name	Code	Accession #	Seed in storage Produced by PMC	Provided by BLM
Achnatherum lemmonii	**ACLE8**	9079398		
Bromus carinatus	**BRCA5**	9079397	621 g	2340 g
Bromus lavipes	**BRLA3**	9079393		
Bromus lavipes	**BRLA3**	9079396	22 lbs	64 g
Cimicifuga elata	**CIEL**	9079390		14 g
Darlingtonia californica	**DACA5**	9079391		6 g
Eriogonum umbellatum	**ERUM**	9079425		5 g
Festuca californica	**FECA**	9079399		836 g
Festuca californica	**FECA**	9079327	42 lbs	
Festuca elmeri	**FEEL2**	9079422	24 g	21 g
Festuca roemerii	**FERO**	9079395		803 g
Festuca romerii	**FERO**	9079326	339 g	
Frasera umpquaensis	**FRUM**	9079387		
Iris douglasiana	**IRDO**	9079417		72 g
Juncus ensifolius	**JUEN**	9079418		2 g
Juncus tenuis	**JUTE**	9079388		13 g
Lomatium macrocarpum	**LOMA3**	9079325		129 g
Lupinus adsurgens	**LUAD**	9079426	3 g	
Lupinus albifrons	**LUAL4**	9079322	29 g	
Melica harfordii	**MEHA2**	9079328	6 lbs	
Penstemon roezlii	**PERO12**	9079419	194 g	1 g
Poa secunda	**POSE**	9079394		2372 g
Polemonium carneum	**POCA4**	9079424		1 g
Potentilla glandulosa	**POGL9**	9079427		1 g
Rupertia physoides	**RUPH3**	9079323	352 g	
Scirpus microcarpus	**SCMI2**	9079386		33 g
Sisyrincium bellum	**SIBE**	9079420		8 g
Tritilia hyacinthina	**TRHY3**	9079421		8 g
Wyithia angustifolia	**WYAN**	9079389		
Xerophyllum tenax	**XETE**	9079385		226 g

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

December 30, 2007

THE 2007 BUREAU OF LAND MANAGEMENT ANNUAL REPORT:
Medford District

I. Brief Background of Project

The Corvallis Plant Materials Center (PMC) entered into a new 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 amended in 2007. It was agreed that the PMC would maintain seed increase fields of five grasses, two legumes, and four forbs; continue germination trials and containerized production of two forbs; and establish seed increase fields of three species of rushes. Some plants that were produced in 2006 were maintained at the PMC until the spring of 2007.

II. Accessions Involved

Accessions included for the Medford District BLM in 2007 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 2007.

Species	Common name	Code	Accession #	Activity in 2007[1]
Achnatherum lemmonii	Lemmon's needlegrass	ACLE8	9079398	pxn
Bromus lavipes	woodland brome	BRLA3	9079393	sfp
Bromus lavipes	woodland brome	BRLA3	9079396	sfp
Eriogonum umbellatum	sulfur-flowered buckwheat	ERUM	9079425	pxn, sfp
Festuca californica	California Fescue	FECA	9079399	sfp
Festuca roemeri	Roemer's fescue	FERO	9079395	sfp
Iris douglasiana	Douglas Iris	IRDO	9079417	trl, pxn
Juncus ensifolius	sword leaf rush	JUEN	9079418	trl,pxn
Juncus tenuis	poverty rush	JUTE	9079388	pxn
Lomatium macrocarpum	big-seeded lomatium	LOMA3	9079325	pxn, dlv
Lupinus adsurgens	Drew's silky lupine	LUAD	9079426	sfp
Penstemon roezlii	Roezl's penstemon	PERO12	9079419	pxn, sfp
Poa secunda	Sandberg blue grass	POSE	9079394	sfp
Polemonium carneum	royal Jaccob's ladder	POCA4	9079424	pxn
Potentilla glandulosa	sticky cinquefoil	POGL9	9079427	pxn, sfp

Table 1 (con't). Accessions involved for Medford District BLM cooperative agreement with Corvallis Plant Materials Center in 2007.

Species	Common name	Code	Accession #	Activity in 2007[1]
Rupertia physoides	forest scurf peas	RUPH3	9079323	sfp
Scirpus microcarpus	panicled bulrush	SCMI2	9079386	pxn
Sisyrinchium bellum	western blue-eyed grass	SIBE	9079420	trl, pxn
Triteleia hyacinthina	white hyacinth brodiaea	TRHY3	9079421	pxn
Wyethia angustifolia	California compassplant	WYAN	9079389	pxn, dlv
Xerophyllum tenax	common beargrass	XETE	9079385	pxn, dlv

1- sfp = seed increase, trl= germination research trials, pxn=plant production, dlv=plant materials delivery

III. Experimental Propagation

There was no experimental propagation in 2007.

IV. Field Seed Increase

The PMC did not establish any new fields from seed in 2007. Fields that were established in 2004 finally were discontinued due to poor spring emergence. *Festuca californica*, *Festuca roemeri*, and *Melica harfordii* fields were plowed under. All newer fields were looking fair except the *Polemonium carneum* and *Festuca elmeri* fields. *P. careneum* plants looked extremely stressed and many did not survive the winter. The remaining plants were dug up and put into pots that were placed in the shadehouse. The plants did very well in the shadehouse. The *F. elmeri* plants struggle with the heavy saturated soils in the winter and the late summer drought at the PMC. The field was mulched and summer moisture did not seem terribly limiting.

The *Bromus lavipes* field had a vigorous spring emergence and the field looked full and green. During a few days in March, however, the PMC experienced freezing temperatures following heavy rains. After this, the *B. lavipes* field turned a red hue and many plants did not survive. The field was still worth harvesting but was removed after harvest.
Eriogonum umbellatum and *Penstemon roezlii* fields were expanded using container plants that were grown in 2006. The *E. umbellatum* transplants did not flower this year, but the established plants flowered heartily. *P. roezlii* transplants flowered and set seed this year, but were less vigorous than the established plants. The spring freezes caused many new transplants to frost heave. PMC employees returned to the fields and replanted all the transplants and no plants were lost.

The *Potentilla glandulosa* field was very spotty in 2006 and in the fall/winter of 2006/2007 the plants were dug up and transplanted to form full rows. These plants grew and flowered. Transplanting seemed to decrease the vigor of the plants, but they are expected to make a full recovery.

At least half of the *Rupertia physiodes* field did not emerge this spring. This might have been a delayed response to being accidentally tilled the previous spring. Transplants are being grown to replace the lost rows of plants.

Lupinus adsurgens plants flowered this year. Plants were very healthy and produced a lot of good seed. No seed or plant predation was noticed on any of the plants. This species is thriving at the PMC.

Table 2. Yields from seed increase fields at the Corvallis Plant Materials Center in 2007.

Species	Field Size (ac)	Method	harvest dates	Yield	Comments
Achnatherum lemmonii	0.03	hand	26-Jun	48 g	fair stand, low vigor
Bromus lavipes	0.25	seed stripper	11-Jul	11 lbs	poor stand, good vigor
Eriogonum umbellatum	0.015	hand	28-Jun	2.7 lbs	excellent stand, high vigor
Festuca roemeri	0.25	seed stripper	2-Jul	9.5 lbs	good stand, medium vigor
Lupinus adsurgens	0.01	hand	Jul 9-Aug 20	2 lbs	good stand, high vigor
Penstemon roezlii	0.02	hand	6-Aug	8.5 lbs	excellent stand, high vigor
Poa secunda	0.5	seed stripper	22-Jun	16 lbs	excellent stand, high vigor
Potentilla glandulosa	0.01	hand	4-Jul	25 g	small stand, medium vigor
Rupertia physoides	0.01	leaf blower	6-Aug	192 g	good stand, high vigor

Field notes 2006:

Weed control in the forb and legume seed increase fields was performed mainly by hand weeding and rouging. Borders were cultivated. Most fields were spot-sprayed with glyphosate using a shielded backpack sprayer to control exotic bentgrasses and other rhizomatous weeds. All grass fields were sprayed with Banvel in the spring to control broadleaf weeds, except the *B. lavipes* field. It was looking stressed so it was not sprayed. All grass fields (only the portions that were over 1 year old) were fertilized in October 2006 with 25 lbs/ac nitrogen (N) and in February 2007 with 50 lbs/ac N plus 15 lbs/ac sulfur (S). Grass fields were burned using drip torches following harvest. In mid October, Outlook (a non-selective pre-emergent herbicide) was applied to some fields that had been harvested in 2007 (*Poa secunda, Achnatherum lemmoni*). Outlook was used for the first time at the PMC in 2006. No plant damage was observed and weed control was very good. It may not need to be applied to fields every year. This fall, Outlook was only applied to fields that had not received the Outlook treatment in the fall of 2006.

V. Container Plant Production.

Containers of *Triteleia hyacinthina, Scirpus microcarpus, Sisyrinchium bellum, Juncus ensifolius, Juncus tenuis,* and *Iris douglasiana* were cared for throughout the summer in an outdoor shadehouse. The plants were too small to be transplanted out in early spring; they will be transplanted out into fields in the spring of 2008.

Table 3. Containerized plant production at the Corvallis PMC in 2007 for the BLM Medford District.

Species	Accession #	Amt.	Treatment	Purpose
Achnatherum lemmonii	9079398	500	70 days cold stratification	field expansion
Iris douglasiana	9079417	120	90 days cold stratification	field establishment
Juncus ensifolius	9079418	70	45 days cold stratification	field establishment
Juncus tenuis	9079388	125	45 days cold stratification	field establishment
Penstemon roezlii	9079419	200	outside overwinter	field expansion
Polemonium carneum	9079424	100	outside overwinter	shadehouse production
Potentilla glandulosa	9079427	200	outside overwinter	field expansion
Rupertia physoides	9079323	200	scarfication	field expansion
Sisyrinchium bellum	9079420	200	90 days cold stratification	field establishment

VI. Delivery of Plant Materials

Doug Kendig visited the PMC on April 20, 2007 and picked up plants that were grown for the 2006 agreement.

Table 4. Plants picked up by BLM staff on April 20, 2007

Species	Accession #	Amount
Lomatium macrocarpum	9079325	80 cones
Wyethia angustifolia	9079389	175 cones
Xerophyllum tenax	9079385	150 cones

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

February 22, 2006

THE 2005 BUREAU OF LAND MANAGEMENT ANNUAL REPORT:
Roseburg District

I. Brief Background of Project

The Corvallis Plant Materials Center (PMC) entered into a new agreement with the Roseburg District of the Bureau of Land Management (BLM) in 2005 to provide native plant materials for ecological restoration. It was agreed that the PMC would establish and maintain seed increase fields of three grasses (four accessions) and one legume in the fall of 2005. These fields will be expanded in the fall of 2006.

II. Accessions Involved

Accessions included for the Roseburg District BLM in 2005 are listed in Table 1. This table also displays activities performed by PMC staff.

Table 1. Accessions involved for Roseburg District BLM cooperative agreement with Corvallis Plant Materials Center in 2005.

Species	Common name	Symbol	Accession	Activity in 2005
Danthonia californica	California oatgrass	DACA	9079415 Culvert yard	pxn
Danthonia californica	California oatgrass	DACA	9079428 Yampah Flat	pxn
Elymus elymoides	bottle-brush squirreltail	ELEL5	9079416	sfp
Lupinus rivularis	river lupine	LURI	9079430	sfp
Achnathrum lemmonii	Lemmon's needlegrass	ACLE8	9079429	sfp

1- sfp = seed increase, trl= germination research trials, pxn=plant production, dlv=plant materials delivery

III. Field Seed Increase

Seed received from the BLM was cleaned and weighed. Both lots of Danthonia had many empty hulls present, consequently these lots were too small to be sown into fields with any machine. Fields will be established using container-grown transplants.

Table 2. Weight of seed lots after cleaning for the Roseburg District BLM cooperative agreement with Corvallis Plant Materials Center in 2005.

Species	Accession	Seed wt post-cleaning
Danthonia california	9079415 Culvert yard	20g
Danthonia california	9079428 Yampah Flat	6g
Elymus elymoides	9079416	160g
Lupinus rivularis	9079430	1640g
Achnathrum lemmonii	9079429	177g

Informal germination tests were preformed on some of the lots prior to sowing. The germination tests helped determine seeding rates for species that were being sown directly into fields. On October 21, 2005 LURI was sown using a six-row Planet-Jr planter equipped with a carbon banding unit. ACLE and ELEL were also sown on this date, using a single-row belt seeder. Rows were covered with a thin band of carbon with a backpack sprayer. All fields were sprayed with Diuron (a non selective pre-emergent) following carbon application.

Table 3. Seed increase field establishment on October 21 for the Roseburg District BLM cooperative agreement with Corvallis Plant Materials Center in 2005.

Species/Ac	Amt seeded	Germ	Approximate seeding rate	Seeds/lb
ELEL **0.04 acres** or 9 181' rows 12" btwn rows	152g	76%	8 lbs/acre (bulk) 6 lbs/acre (PLS)	92,400
LURI **0.17 acres** or 42 181' rows 12" btwn rows	1630g	90%	21 lbs/ac (bulk) 18 lbs/ac (PLS)	35,000
ACLE **0.02 acres** or 6 130' rows 12" btwn rows	170g	N/A	18 lbs/ac (bulk)	92,000

ELEL and LURI seeds emerged within two weeks and stands looked great. Although, the heavy rain and standing water throughout January stressed the LURI stand. It was seeded heavily and many plants survived the flooded conditions. The belt seeder was an effective way to plant a field with very limited seed. Seeds need to be completely de-awned to keep them from bridging inside the seeder. ACLE seedlings will not emerge until late winter. The field will be evaluated in spring of 2006.

V. Container Plant Production.

On November 13, 2005, seeds DACA were sown into Ray Leach stubby cone-tainers filled with moistened media (Sunshine #1 a special peat-based soil-less mix) and lightly covered with fine vermiculite. Seeded flats of DACA require cold-moist stratification to break seed dormancy so they were placed in polyethylene bags and moved into the walk-in cooler (36-38^{o} F). Flats were removed from the cooler on January 28, 2006 and placed in a greenhouse set at moderate temperatures (65^{o} day/ 50° night). Six grams of seed lot SNC-05-RB428 produced 181 plants. 17 grams of seed lot SNC-05RB415 produced 851 plants. These will be transplanted into fields in late spring and irrigated if needed. Field sizes are estimated at 200 ft^{2} for the Yampah Flat accession and 0.02 acres for the Culvert Yard accession.

VI. Delivery of Plant Materials.

No materials were delivered in 2005.

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

December 20, 2006

THE 2006 BUREAU OF LAND MANAGEMENT ANNUAL REPORT:
Roseburg District

I. Brief Background of Project

The Corvallis Plant Materials Center (PMC) entered into a new agreement with the Roseburg District of the Bureau of Land Management (BLM) in 2005 to provide native plant materials for ecological restoration. It was agreed that the PMC would establish and maintain seed increase fields of three grasses (four accessions) and one legume. A small amount of hand collected seed was used to establish fields in 2005. These fields were harvested in 2006 and the resulting seed is being used to expand the seed increase fields. The fields (and seed that will be harvested from these fields in 2007) will now be labeled as “G2”, since the G1 and G2 sections can interbreed. The lupine field was not expanded this year due to it being (typically) a biennial. The seed produced this year from the field was not enough to create a large field. The existing field will be destroyed during harvest next year and the seed produced in 2006 and 2007 can be combined to create a new G2 field.

II. Accessions Involved

Accessions included for the Roseburg District BLM in 2006 are listed in Table 1. This table also displays activities performed by PMC staff.

Table 1. Accessions involved for Roseburg District BLM cooperative agreement with Corvallis Plant Materials Center in 2006.

Species	**Common name**	**Symbol**	**Accession**	**Activity in 2006**[1]
Danthonia californica	California oatgrass	DACA	9079415 Culvert Yard	sfp, pxn
Danthonia californica	California oatgrass	DACA	9079428 Yampah Flat	sfp, pxn
Elymus elymoides	bottle-brush squirreltail	ELEL5	9079416	sfp
Lupinus rivularis	river lupine	LURI	9079430	sfp
Achnatherum lemmonii	Lemmon's needlegrass	ACLE8	9079429	pxn, sfp

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

III. Field Seed Increase Activities

The winter of 2005/06 was very wet and cold. Fields often had standing water and seedlings were completely submerged for weeks at a time. The *Elymus elymoides* field survived the winter with no damage. The *Lupinus rivularis* seedlings were very stressed throughout the winter and many seedlings died. The field had been seeded at a very high rate; consequently the low seedling survival did not affect the quality of the stand. The *Achnatherum lemmonii* seedlings were emerging when the fields were covered with water. Some mortality occurred, but by spring the rows were mostly filled in and plants grew vigorously through summer. *Danthonia californica* fields and two rows of *Achnatherum lemmonii* were established using container-grown transplants. The plants were transplanted into fields in early March.

Weed control was performed mainly by hand. The ELEL5 field was also sprayed with Bronate® in late spring to removed broadleaf weeds. Roundup® was used around the field borders.

Most fields were hand harvested multiple times throughout the growing season. The *Elymus elymoides* field was harvested by a hand-crafted machine nick-named the "moon rover." It is a self-propelled swather. The machine uses a conveyer belt to move all material after it is cut and loads it into bags. Two people operate it. One person drives and the other helps feed the material into bags. The moon rover has all the benefits of hand harvesting without the labor. Once material was bagged, it was placed onto tarps to dry and cure. It was then fed through a plot thresher and cleaned as usual.

Table 2. Seed yields for the Roseburg District BLM cooperative agreement with Corvallis Plant Materials Center in 2006.

Symbol	Accession	Field size	Harvest method	Yield
Danthonia californica	9079415 Culvert Yard	0.02 ac	hand	12 g
Danthonia californica	9079428 Yampah Flat	200 ft^2	hand	7 g
Elymus elymoides	9079416	0.04 ac	moon rover	11 lbs
Lupinus rivularis	9079430	0.17 ac	hand	460 g
Achnatherum lemmonii	9079429	0.02 ac	hand	10 g

Following harvest, *Elymus elymoides* field was burned and *Achnatherum lemmonii* field was mowed to remove residue. All established grass fields were sprayed in late October with Outlook®, a non-selective pre-emergent herbicide. Initial results are very promising. Little to no weeds or volunteer seedlings have germinated and established plants do not appear damaged.

Informal germination tests were performed on some of the seed lots prior to sowing. The germination tests helped determine seeding rates for species that were being sown directly into fields. On October 12, 2006, *Elymus elymoides* was sown using a six-row Planet-Jr® planter equipped with a carbon banding unit. The field was sprayed with Karmex® (a non selective pre-emergent herbicide) following carbon application. *Elymus elymoides* seedlings emerged within two weeks and stands looked great. It is very difficult to harvest *Elymus elymoides* efficiently. A larger field was established so that a combine can be used to harvest the field in 2007.

Table 3. Seed increase field establishment on October 16, 2006 for the Roseburg District BLM cooperative agreement with Corvallis Plant Materials Center in 2006.

Species/Ac	**Amt seeded**	**Germ**	**Approximate seeding rate**	**Seeds/lb**
Elymus elymoides **0.37 acres** or 90 181' rows 12" btwn rows	2400 g	64%	9 lbs/acre (bulk) 7 lbs/acre (PLS[1])	135,571

1. Pure live seed

V. Container Plant Production.

On September 25, 2006, seeds of both *Danthonia californica* accessions and *Achnatherum lemmonii*, were sown into Ray Leach stubby cone-tainers filled with moistened media (Sunshine #1: a special peat-based soil-less mix) and lightly covered with fine vermiculite. Seeded flats of *Danthonia californica* require cold-moist stratification to break seed dormancy so they were placed in polyethylene bags and moved into the walk-in cooler (36-38^{o} F). Flats will be removed from the cooler on December 21, 2006 and placed in a greenhouse set at moderate temperatures (65^{o} day/ 50^{o} night). Plants will be transplanted out into fields in early spring.

Table 4. Plant Production for the Roseburg District BLM cooperative agreement with Corvallis Plant Materials Center in 2006.

Symbol	**Accession**	**Amt seed used**	**Number produced**	**Total field size after transplanting**
Danthonia californica	9079415 Culvert yard	12 g	588	0.037 ac
Danthonia californica	9079428 Yampah Flat	7 g	396	0.001 ac
Achnatherum lemmonii	9079429	10 g	676	0.04 ac

VI. Delivery of Plant Materials.

No materials were delivered in 2006. Remaining seed of *Elymus elymoides* (6 lbs) and *Lupinus rivularis* (460 g) will be kept in a cooled/dehumidified seed storage facility at the PMC until requested by BLM staff.

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

October 20, 2007

THE 2007 BUREAU OF LAND MANAGEMENT ANNUAL REPORT:
Roseburg District

I. Brief Background of Project

The Corvallis Plant Materials Center (PMC) entered into a new agreement with the Roseburg District of the Bureau of Land Management (BLM) in 2005 to provide native plant materials for ecological restoration. It was agreed that the PMC would establish and maintain seed increase fields of three grasses (four accessions) and one legume. In the fall of 2006, new species were added to this agreement including one grass, two legumes, and three forbs. No new species were added in 2007. Seed increase fields were expanded using seed that was produced in 2007.

II. Accessions Involved

Accessions included for the Roseburg District BLM in 2007 are listed in Table 1. This table also displays activities performed by PMC staff.

Table 1. Accessions involved for Roseburg District BLM cooperative agreement with Corvallis Plant Materials Center in 2007.

Species	Common name	Symbol	Accession	Activity in 2007[1]
Eriogonum nudum	barestem buckwheat	ERNU3	9079489	sfp
Eriophyllum lanatum* var. *achillaeoides	wooly sunflower	ERLAA	9079490	sfp
Sisyrinchium bellum	blue-eyed grass	SIBE	9079491	pxn
Lupinus albifrons	silver lupine	LUAL4	9079492	sfp
Lotus micranthus	small-flowered deervetch	LOMI	9079493	sfp
Festuca californica	California fescue	FECA	9079494	sfp
Silene hookeri* ssp. *hookeri	Hooker's silene	SIHO	9079495	pxn, sfp
Danthonia californica	California oatgrass	DACA	9079415	sfp
Danthonia californica	California oatgrass	DACA	9079428	sfp
Elymus elymoides	bottle-brush squirreltail	ELEL5	9079416	sfp
Lupinus rivularis	river lupine	LURI	9079430	sfp
Achnatherum lemmonii	Lemmon's needlegrass	ACLE8	9079429	sfp

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

III. Field Seed Increase Activities

Forb fields that were sown in 2006 emerged in the spring of 2007. All three forb fields were patchy, but the stands are worth maintaining and plants will grow to fill in the gaps. Containerized plants of *Danthonia californica*, *Achnatherum lemmonii*, *Festuca californica*, *Silene hookeri*, *Lupinus albifrons*, and *Sisyrinchium bellum* that were grown in the fall of 2006 were used to establish small seed increase plots in the spring of 2007. The plants of all species except the *S. bellum* and *S. hookeri*, were transplanted into fields in early March.

Weed control in seed increase fields was performed mainly by hand. The squirreltail field was also sprayed with Bronate® in late spring to removed broadleaf weeds. Fields borders were tilled. Medusahead rye was discovered in the *E. elymoides* field once it began to bloom. This invasive weed was rogued from the field as much as possible. Since it is an annual species, a pre-emergent such as Outlook will be applied to the field this fall. This should prevent any remaining medusahead seed from germinating and becoming established. The field should be medusahead free in the 2008 harvest. It is believed that the weed was in the collection provided to the PMC. The two grasses look very similar and medusahead was most likely collected by mistake.

Most fields were hand harvested multiple times throughout the growing season. The *D. californica* and *A. lemmonii* fields were harvested by hand using rice knives. The *E. elymoides* field was swathed and then harvested with a small plot combine. The medusahead rye plants that were missed during the many walks through the field came out of the back of the combine. The seed heads were not threshed by the action of the combine. The squirreltail seeds disarticulate very easily from the rachis, making this species easier to combine. This reduced the amount of medusahead seeds that made it into the harvest. At this time it is not clear how much, if any medusahead seeds are in the seed lot harvested this year.

The *Lupinus rivularis* field was swathed and then pitchforked onto tarps to shatter. Tarps were moved into an open shed to protect it from any summer rain. Once dry, the material was beaten with pitchforks. Most pods shattered while drying. Material was pitchforked off the tarps and the seeds and pods left on the tarp were run through a brush machine to break up any unopened pods. Seed was then cleaned using an air-screen machine.

The *S. hookeri* plants grew in their containers in the greenhouse until early summer. They began to flower and were moved outside where they had access to pollinators. When seed capsules were ripe they were picked from the plants and put in paper bags in an open greenhouse to dry.

Due to the very uneven ripening and easy seed shatter, the *L. micranthus* field was checked twice weekly for ripe pods. Pods were hand picked when mature but before they shattered. This was quite time consuming and inefficient. Next year the field will be grown using weed fabric so the seeds can shatter onto the fabric, where they will be swept up.

The *F. californica*, *L. albifrons*, and *E. lanatum* plots did not flower in their first year. This is typical for these species. They are expected to produce seed in 2008. The *E. nudum* field did flower very late in the season and produced a very minimal amount of seed.

Table 2. Seed yields for the Roseburg District BLM cooperative agreement with Corvallis Plant Materials Center in 2007.

Species	Accession	Field size (ac)	Date harvested	Method	Yield
Lotus micranthus	9079493	0.04 acres	June 18-August 15	hand	25 g
Silene hookeri* ssp. *hookeri	9079495	n/a	June 26, August 29	hand	84 g
Danthonia californica	9079415 CY	0.05	June 25, July 5	hand	6 lbs
Danthonia californica	9079428 YF	0.02	June 26, July 2	hand	585 g
Elymus elymoides	9079416	0.35	July 31	swath/ combine	12 lbs
Lupinus rivularis	9079430	0.17	June 18	swath	75 lbs
Achnatherum lemmonii	9079429	0.04	June 19, June 26	hand	4.23 lbs

Following harvest, *E. elymoides* field was burned and *A. lemmonii* field was mowed to remove residue. All established grass fields were sprayed in late October with Outlook®, a non-selective pre-emergent herbicide.

Table 3. Seed increase field establishment for the Roseburg District BLM cooperative agreement with Corvallis Plant Materials Center in 2007.

Species	Accession number	Date	Method	Field size (ac)	Seeding rate (bulk)
Lupinus rivularis	9079430	27-Sep	cone-seeder	0.48	12.5 lbs/ac
Danthonia californica	9079428	4-Nov	cone-seeder	0.13	9.3 lbs/ac
Danthonia californica	9079415	12-Oct	cone-seeder	0.45	13 lbs/ac
Acnatherum lemmonii	9079429	4-Nov	cone-seeder	0.3	12.6 lbs/ac

IV. Container Plant Production

On August 15, 2007, seeds of *D. californica* and *S. hookeri*, were sown into Ray Leach stubby cone-tainers filled with moistened media (Sunshine #1: a special peat-based soil-less mix) and lightly covered with fine vermiculite. Seeds of both species require cold-moist stratification to break dormancy so they were placed in polyethylene bags and moved into the walk-in cooler (36-38^o F). Flats were removed from the cooler on November 14, 2007 and placed in a greenhouse set at moderate temperatures (65^o day/ 50^o night). Plants will be transplanted out into fields in early spring.

Table 4. Plant Production for the Roseburg District BLM cooperative agreement with Corvallis Plant Materials Center in 2007.

Species	**Accession**	**Amount seed used**	**Number produced**
Silene hookeri ssp hookeri	9079495	10g	980
Danthonia californica	9079428	11g	980

V. Delivery of Plant Materials
No materials were delivered in 2007. Remaining seed will be kept in a cooled/dehumidified seed storage facility at the PMC until requested by BLM staff.

Table 5. Seeds in storage at the Corvallis Plant Materials Center for the Roseburg District BLM cooperative agreement with Corvallis Plant Materials Center in 2007.

Species	**Lot number**	**Weight**
Eriogonum nudum	SWC-06-RB489	99 g
Eriophyllum lanatum* var. *achillaeoides	SWC-06-RB490	234 g
Sisyrinchium bellum	SWC-06-RB491	75 g
Lotus micranthus	SWC-06-RB493	11 g
Festuca californica	SWC-06-RB494	4 g
Silene hookeri* ssp. *hookeri	SG1-07-RB495	72 g
Silene hookeri* ssp. *hookeri	SWC-06-RB495	23 g
Danthonia california	SG2-07-RB415	100g
Danthonia california	SG2-07-RB428	39 g
Elymus elymoides	SG1-06-RB416	5 lbs
Elymus elymoides	SG1-07-RB416	12 lbs
Lupinus rivularis	SG1-07-RB430	69 lbs
Lupinus rivularis	SG1-06-RB430	475 g
Achnatherum lemmonii	SG2-07-RB429	213 g

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

January 24, 2007

THE 2006 LASSEN VOLCANIC NATIONAL PARK ANNUAL REPORT:
Kings Creek Revegetation Project

I. **Brief Background of Project**

The Corvallis Plant Materials Center (PMC) entered into a new agreement with Lassen Volcanic National Park in 2006 to provide native plant materials for revegetation in the King's Creak area. It was agreed that the PMC would produce a minimum of 3700 container plants including 700 legume plugs, 2500 sedge and rush plugs, 500 grass plugs and 1800 containers of one shrub. Activities in 2006 included collection of manzanita cuttings and seed of one grass and one legume.

II. Accessions Involved

Table 1. Accessions involved in the Kings Creek Revegetation Project.

Species	Common name	Code	Accession	Activity in 2006
Juncus balticus	Baltic rush	JUBA	9079507	trl
Carex abrupta	abruptbeak sedge	CAAB2	9079503	trl
Carex staminiformis	Shasta sedge	CAST7	9079506	trl
Lupinus obtusilobus	satin lupine	LUOB	9079501	col, trl
Deschampsia cespitosa	tufted hairgrass	DECE	9079500	col, trl
Arctostaphylos nevadensis	pinemat manzanita	ARNE	9079498	col, trl
Carex nigricans	black alpine sedge	CANI2	9079499	col, trl
Carex breweri	Brewer's sedge	CABR12	9079505	trl
Juncus parryi	Parry's rush	JUPA	9079504	trl

III. Seed and Plant Collections

PMC staff traveled to the Park on October 12, 2006 to collect manzanita cuttings and seed of any species on the collection list that were ripe. Over 500 cuttings were collected as well as a small amount of seed of tufted hairgrass and satin lupine. PMC staff traveled to the park again to collect manzanita cuttings on October 26, 2006. Approximately 100 cuttings were taken from about 7000 ft elevation, just ahead of snowfall. Target cuttings were of mature, 1-year-old (current season's growth) cuttings of good vigor and caliper. Cuttings were packed into moist vermiculite in polyethylene bags and shipped to the PMC at Corvallis packed in ice. These were then stored in a walk-in cooler at 38 F for 12 weeks. They will be propagated in the spring of 2007.

III. Experimental Propagation

Most species involved in this project are ones that have never been propagated at the Corvallis PMC. Informal germination tests were set up on all of the species. Three set of 100 seeds were counted, weighed and placed in plastic germination boxes on moistened germination paper and stored in a growth chamber set at 8°(C) days and 4°(C) nights with 8 hours of light. Juncus sp. will undergo two stratification treatments: 45 days and 90 days. Carex sp. will be removed at 90 days and 120 days. The grass and legume will be removed after two weeks and four weeks. Results will be included in the 2007 annual report.

V. Delivery of Plant Materials.

There were no deliveries in 2006.

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

November 29, 2007

THE 2007 LASSEN VOLCANIC NATIONAL PARK ANNUAL REPORT:
Kings Creek Revegetation Project

I. Brief Background of Project

The Corvallis Plant Materials Center (PMC) entered into a new agreement with Lassen Volcanic National Park in 2006 to provide native plant materials for revegetation in the King's Creek area. It was agreed that the PMC would produce a minimum of 3700 container plants including 700 legume plugs, 2500 sedge and rush plugs, 500 grass plugs and 1800 containers of one shrub species. Activities in 2007 included propagation and delivery of manzanita plants plus germination trials on one grass, two rushes, four sedges and one legume. PMC staff also traveled to the Park to collect more manzanita cuttings.

II. Accessions Involved

Table 1. Accessions involved in the Kings Creek Revegetation Project.

Species	Common name	Code	Accession	Activity in 2007 [1]
Juncus balticus	Baltic rush	JUBA	9079507	trl
Carex abrupta	abruptbeak sedge	CAAB2	9079503	trl
Carex staminiformis	Shasta sedge	CAST7	9079506	trl
Lupinus obtusilobus	satin lupine	LUOB	9079501	trl
Deschampsia cespitosa	tufted hairgrass	DECE	9079500	trl
Arctostaphylos nevadensis	pinemat manzanita	ARNE	9079498	pxn, trl, dlv, col
Carex nigricans	black alpine sedge	CANI2	9079499	trl
Carex breweri	Brewer's sedge	CABR12	9079505	trl
Juncus parryi	Parry's rush	JUPA	9079504	trl

1- trl = germination trials, pxn= plant production, dlv= delivered plant materials, col= collected plant materials

III. Experimental Propagation

Most species involved in this project are ones that have never been propagated before at the Corvallis PMC. Informal germination tests were set up on all of the species. For each species, nine sets of 100 seeds were counted, weighed and placed in plastic germination boxes on moistened germination paper and stored in a growth chamber set at 8°(C) days and 4°(C) nights with 8 hours of light. *Juncus* sp. underwent two stratification treatments: 45 days and 90 days. *Carex* sp. were removed from stratification after 90 days and 120 days. The grass and legume were removed from stratification after two weeks and four weeks. Each treatment had three replications per species. Three boxes of each species were also set out at room temperature as a "control" treatment. When germination boxes were removed from stratification they were placed with the control treatments at room temperature. Germination was recorded weekly.

Table 2. Results of germination trials conducted at the PMC for the King's Creek Revegetation Project.

Species	Germination
Juncus balticus	
45 days cold (JUBA1)	31%
90 days cold (JUBA2)	11%
90 days cold (JUBA3)	17%
Carex abrupta	
90 days cold (CAAB1)	43%
120 days cold (CAAB2)	33%
120 days cold (CAAB3)	44%
No strat (CAAB4)	0%
Carex staminiformis	
90 days cold (CAST1)	46%
120 days cold (CAST2)	40%
120 days cold (CAST3)	58%
No strat (CAST4)	8%
Lupinus obtusilobus	
2 weeks cold+scarfiy (LUOB1)	81%
4 weeks cold+scarfiy (LUOB2)	81%
4 weeks cold+scarfiy (LUOB3)	81%

Species	Germination
Deschampsia cespitosa	
2 weeks cold (DECE1)	23%
4 weeks cold (DECE1)	18%
4 weeks cold (DECE1)	15%
Carex nigricans	
90 days cold (CANI1)	49%
120 days cold (CANI2)	43%
120 days cold (CANI3)	39%
No strat (CANI4)	7%
Carex breweri	
90 days cold (CABR1)	1%
120 days cold (CABR2)	12%
120 days cold (CABR3)	11%
No strat (CABR4)	0%

Two weeks after the 90-day stratification treatment boxes were removed from the cooler; all the boxes were moved into a greenhouse where daytime temperatures were around 80 degrees. Many of the boxes displayed rapid germination once they were in the hot greenhouse. "Control" germination boxes were again made and placed in the hot greenhouse. These boxes exhibited no germination. It is concluded that a long stratification is needed to break dormancy on most of these species and hot temperatures are needed for germination. This information is important for propagation of this species and also to understand the importance of fall sowing, if seeds of these species are ever used in restoration projects.

IV. Plant Propagation

Arctostaphylos nevadensis cuttings that were collected in the fall of 2006 were kept in a cooler until the end of January. On January 28, 2007, cuttings were removed from the coolers. Stems were stripped of lower leaves, re-cut, dipped in a 0.8% IBA powder, and stuck into 6” deep propagation flats filled with perlite. Flats were placed on heat mats set at 70° (F) in an unheated greenhouse. Flats were watered lightly and kept barely moist. Rooting occurred rapidly. Within 4 weeks, 65% of cuttings were ready to be potted up. Weak or non-rooted cuttings were left in the flats. Rooted cuttings were placed in “D40” cones (40cc containers) with Sunshine #4 (a soil-less, peat based media) amended with a slow release fertilizer and micronutrients. Potted cuttings were left in the unheated greenhouse and were overhead watered weekly. Pots were carefully monitored for overwatering.

Four weeks later, cuttings that were remaining in the propagation flats were checked for root abundance and ones that were ready were transplanted into D40 cones. All pots were moved to an outdoor shadehouse on May 25, 2007, and remained there until delivery to the park on September 11, 2007. Overall, rooting success was rated at 82% (1630 cuttings out of 1980 formed roots). Of the 1630 cuttings that were potted up, 1340 survived (82% survival rate).

The PMC is to deliver 1800 *A. nevadenis* plants for the park by fall of 2009. The majority of the plants were delivered this year. Another 460 plants will be delivered in 2008. PMC staff traveled to the park on October 23, 2007 to collect more cuttings. Staff collected 800 cuttings and brought them back to the PMC for cold storage until they will be rooted in tewhe late winter.

VI. Delivery of Plant Materials.

Park staff came to the PMC to pick up the manzanita plants that had been propagated this year. 1340 plants were delivered to the park on September 11, 2007. Early snows in the park created delays in the road construction and not all areas were ready to plant. About 260 plants would not be able to be planted at the park in the fall of 2007. PMC and Park staff agreed that it would be best for the plants to be returned to the PMC, cared for throughout 2008, and delivered to the Park in the fall of 2008 when the road construction will be finished.

Returned manzanitas will be overwintered in a walk-in cooler. The cool, wet winters at the PMC cause many high elevation plants to rot or become disease ridden if left outside. Through previous experience with high elevation plants, the PMC has found that the most successful way to overwinter these plants is by keeping them slightly dry and as close to freezing temperatures as possible. Plants will be removed from the cooler when the spring rains have lightened (May-June 2008).

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

December 29, 2007

THE 2007 LASSEN VOLCANIC NATIONAL PARK ANNUAL REPORT:
Visitors' Center Landscape Project

I. Brief Background of Project

The Corvallis Plant Materials Center (PMC) entered into a new agreement with Lassen Volcanic National Park in 2007 to provide native plant materials for planting around the new visitors' center. It was agreed that the PMC would produce a minimum of 6200 container plants including: 2000 grass plugs, 1000 sedge and rush plugs, and 3200 containers of shrubs. If tree and shrub seed cannot be provided (in case of a bad seed year), alternative forb species will be added to the agreement in lieu of the shrub plants. Trees and shrubs maybe added later when seed is available. Activities in 2007 included collection and propagation of two shrubs.

II. Accessions Involved

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

Species	Common name	Code	Accession Number	Activity in 2007[1]
Elymus glaucus	blue wildrye	ELGL	9079530	-
Bromus carinatus	California brome	BRCA5	9079531	-
Abies magnifica	California red fir	AMBA		-
Tsuga mertensiana	mountain hemlock	TSME		-
Chrysolepsis sempervirens	bush chinquapin	CHSE11		-
Holodiscus microphyllus	oceanspray	HOMI3	9079548	trl
Ceanothus cordulatus	whitethorn ceanothus	CECO	9079553	col, trl
Arctostaphylos nevadensis	pine mat manzanita	ARNE	9079554	col
Senecio triangularis	arrowleaf ragwort	SETR	9079545	trl
Anaphalis margaritacea	pearly everlasting	ANMA	9079547	-
Carex jonesii	Jones's sedge	CAJO	9079541	trl
Carex microptera	smallwing sedge	CAMI7	9079543	trl
Juncus balticus	baltic rush	JUBA	9079555	trl
Juncus ensifolius	swordleaf rush	JUEN	9079549	trl
Wyethia mollis	woolly mules-ears	WYMO	9079546	trl
Lupinus arbustus	longspur lupine	LUAR6	9079551	trl

1- trl = germination trials, col= collected plant materials

III. Experimental Propagation

Informal germination tests were set up on *Juncus* and *Carex* species that have never been propagated at the Corvallis PMC. For each species, nine sets of 100 seeds were counted, weighed and placed in plastic germination boxes on moistened germination paper and stored in a growth chamber set at 8°(C) days and 4°(C) nights with 8 hours of light. Treatments include 45 or 90 days cold-moist stratification or no cold-moist stratification. Each treatment has three replications per species. Results are pending and will be reported in the 2008 report.

The PMC is to provide 100 containers of *Ceanothus cordulatus*. This species has not been propagated previously at the PMC. Seeds were collected by park staff and delivered to the PMC. Seed was cleaned and placed in hot water (180°F) and left to cool/soak for 24 hours. Seeds were then mixed with moistened peat-based media in a plastic zip-lock bag and placed in a walk-in cooler. Seeds will be monitored weekly for germination. Stem cuttings were also collected at the park by PMC staff on October 23-24, 2007. Target materials were stems that were at least six inches long, current season's growth, and free of diseases. Cuttings were packed with moistened vermiculite and stored in a walk-in cooler (38°F). Only 100 cuttings were taken, and will be propagated in February 2008 after cold storage through the winter.

IV. Plant Propagation

Arctostaphylos nevadensis cuttings were collected at the Park by PMC staff on October 23-24, 2007. Collection area was defined by the Park as the south entrance sign north to the visitors' center. Staff collected 4000 cuttings from this area. Target material were stems that were at least six inches long, non-branching, this season's growth, free of diseases. Cuttings were packed with moistened vermiculite and stored in a walk-in cooler (38°F) until December 20, 2007. Half of the cuttings (approximately 2000) were prepared for rooting by stripping the leaves from the lower 4 inches, making a fresh basal cut, dipping them in an 0.8% IBA rooting powder, and sticking them into moist perlite in 4" deep propagation flats. Flats were placed on heat mats set at 70° F in an unheated greenhouse and lightly watered weekly or as needed. Due to space limitations on the heat mats, cuttings will be propagated in two rounds.

V. Delivery of Plant Materials

No plant materials were delivered in 2007.

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

December 20, 2006

THE 2006 FEDERAL HIGHWAY ADMINISTRATION ANNUAL REPORT:
Rock Creek Bridge Replacement

I. Brief Background of Project

The Corvallis Plant Materials Center (PMC) entered into a new agreement with the Federal Highway Administration in 2006 to provide native plant materials for ecological restoration after the Rock Creek Bridge is reconstructed. This area lies within the critical habitat of the endangered Oregon silverspot butterfly (*Speyeria zerene hippolyta*). The butterfly has become threatened due to the degradation and loss of its coastal meadow habitat. The early blue violet is the obligate host to the silverspots' caterpillars and has also been negatively impacted in its coastal meadow ranges by the encroachment of tall, spreading exotic plants. The butterfly also needs access to nectar sources such as Pacific aster (*Aster chilensis*), goldenrod (*Solidago canadensis*), yarrow (*Achillea millefolium*), *and* pearly everlasting (*Anaphalis margaritacea*). It was agreed that the PMC would establish and maintain seed increase fields of one grass and two forbs, as well as produce a total of 9500 plugs of four forbs and one grass. Prior to planting, the restoration site will have six inches of soils removed to reduce the presence of exotic vegetation and seed. Soils on the site are classified as fertile fluvial deposits and range between 4 and 6 feet deep. In 2007, plugs grown by the PMC will be transplanted into the
site. Red fescue and early blue violet will be planted in patches surrounded by nectar plants.

II. Accessions Involved

Accessions included in the Rock Creek Bridge Replacement project are listed below. These accessions are also being used for the USFW Oregon Silverspot Butterfly Seed Increase Project.

Table 1. Accessions involved for the Rock Creek Bridge Replacement Project at the Corvallis Plant Materials Center in 2006.

Species	Common name	Symbol	Accession	Activity in 2006
Achillea millefolium	common yarrow	ACMI2	9079448	sfp
Anaphalis margaritacea	pearly everlasting	ANMA	9079451	col
Aster chiliensis	pacific aster	ASCH2	9079449	col
Soildago canadensis	goldenrod	SOCA6	9079497	col
Festuca rubra	red fescue	FERU	9079450	col, sfp
Viola adunca	early blue violet	VIAD	9079406	sfp

1- sfp= seed increase, col = collection of seed from wild

III. Field Seed Increase Activities

Informal germination tests were performed on some of the lots prior to sowing. The germination tests helped determine seeding rates for species that were being sown directly into fields. Only ACMI was chosen for direct seeding. On May 4, 2006, ACMI was sown using a six-row Planet-Jr planter. Seedlings emerged within two weeks and the field looked great.

A small seed increase plot of *Viola adunca* was established using plants that were collected from the Rock Creek area in 2004. A sheet of weed fabric was stapled down over the field, then holes were cut in the fabric and plants were transplanted in 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 seeds were then vacuumed up using battery-powered, handheld vacuums. Pods were also collected by hand when feasible. Violet pods turn upright when they are mature, which makes determining seed ripeness much easier. This plot will be expanded in 2007 using plants grown from the seed that was harvested from the plants in 2006. A total of 55g of clean seed was harvested this year.

IV. Container Plant Production.

On July 25, 2006, seeds *Festuca rubra* and *Aster chiliensis* were sown into Ray Leach stubby cone-tainers filled with moistened media (Sunshine #1 a special peat-based soil-less mix) and lightly covered with fine vermiculite. Seeded flats of *F. rubra* were placed in polyethylene bags and moved into a walk-in cooler (36-38^{o} F) for two weeks. They were then moved outside to a shadehouse. Plants will be transplanted out into fields in late fall of 2006 to establish seed increase fields.

V. Native Seed Collection.

Table 2. Seed collections in 2006 for the Rock Creek Bridge replacement.

				cleaned seed	
Species	**Common name**	**Symbol**	**Accession**	**2005**	**2006**
Achillea millefolium	common yarrow	ACMI2	9079448	104 g	0
Anaphalis margaritacea	pearly everlasting	ANMA	9079451	10 g	1 g
Aster chilensis	pacific aster	ASCH2	9079449	9 g	7 g
Solidago canadensis	goldenrod	SOCA6	9079497	0	2 g
Festuca rubra	red fescue	FERU	9079450	7 g	29 g
Viola adunca	early blue violet	VIAD	9079406	0	0

Staff members from the PMC, USFW and ODOT were able to collect more seed in late September, 2006. Collections were made from the Rock Creek Bridge north to Cape Perpetua. This seed will be used to grow plugs for transplanting on the restoration site in 2007. Any remaining seed will be used to establish seed increase fields for future restoration projects by NRCS, USFW, or ODOT in the Critical Habitat area.

VI. Delivery of Plant Materials.
No materials were delivered in 2006.

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

December 20, 2007

THE 2007 FEDERAL HIGHWAY ADMINISTRATION ANNUAL REPORT:
Rock Creek Bridge Replacement

I. Brief Background of Project

The Corvallis Plant Materials Center (PMC) entered into a new agreement with the Federal Highway Administration in 2006 to provide native plant materials for ecological restoration after the Rock Creek Bridge is reconstructed. This area lies within the critical habitat of the endangered Oregon silverspot butterfly (*Speyeria zerene hippolyta*). The butterfly has become threatened due to the degradation and loss of its coastal meadow habitat. The early blue violet is the obligate host to the silverspots' caterpillars and has also been negatively impacted in its coastal meadow ranges by the encroachment of tall, spreading exotic plants. The butterfly also needs access to nectar sources such as Pacific aster (*Aster chilensis*), goldenrod (*Solidago canadensis*), yarrow (*Achillea millefolium*), and pearly everlasting (*Anaphalis margaritacea*). It was agreed that the PMC would establish and maintain seed increase fields of one grass and two forbs, as well as produce a total of 9500 plugs of four forbs and one grass. Prior to planting, the restoration site will have six inches of soil removed to reduce the presence of exotic vegetation and seed. Soils on the site are classified as fertile fluvial deposits and range between 4 and 6 feet deep. Activities in 2007 included maintenance and harvest of three seed increase plots and production and delivery of 9800 plants.

II. Accessions Involved

Accessions included in the Rock Creek Bridge Replacement project are listed below. These accessions are also being used for the USFW Oregon Silverspot Butterfly Seed Increase Project.

Table 1. Accessions involved for the Rock Creek Bridge Replacement Project at the Corvallis Plant Materials Center in 2007.

Species	Common name	Symbol	Accession	Activity in 2007
Achillea millefolium	common yarrow	ACMI2	9079448	sfp, dlv
Anaphalis margaritacea	pearly everlasting	ANMA	9079451	pxn, dlv
Aster chiliensis	Pacific aster	ASCH2	9079449	pxn, dlv
Soildago canadensis	goldenrod	SOCA6	9079497	pxn, dlv
Festuca rubra	red fescue	FERU	9079450	pxn, sfp, dlv
Viola adunca	early blue violet	VIAD	9079406	pxn, sfp, dlv

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

III. Field Seed Increase Activities

The *Achillea millefolium* seed increase field grew vigorously throughout the growing season. Weed control was primarily performed by hand weeding; borders were sprayed with glyphosate. The plot was harvested with the “moon rover”, a self-propelled swather. The harvester cuts the plant material and feeds it up on a conveyor belt where it can be pushed into large poly bags. Material in the bags was dumped out onto tarps inside an open shed to dry. Material was threshed by hand and seed was cleaned using an air-screen machine and an air-density separator.

A small seed increase plot of *Viola adunca* was established using plants that were collected from the Rock Creek area in 2004. The plot was expanded in 2007 using extra plants that were produced in 2006. 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 seeds were then vacuumed up using battery-powered, handheld vacuums. Pods were also collected by hand when feasible. Violet pods turn upright when they are mature, which makes determining seed ripeness simple.

Using container plants that were grown in 2006, a small plot of *Festuca rubra* was established. About 700 plants were transplanted into a field on February 18, 2007, on 1 ft spacing. The field was hand weeded twice during the growing season. The plants experienced an outbreak of rust and were treated with sulfur dust. The rust occurred when the plants were flowering so other rust treatments such as Propiconazole /Chlorothalonil (Tilt/Bravo™) or Azoxystrobin and Propiconazole(Quilt™) were not used. Seeds were harvested by hand as they matured. After harvest, plants were treated with Quilt™ to control rust.

Table 2. Seed yields for the Rock Creek Bridge Replacement Project at the Corvallis Plant Materials Center in 2007.

Species	Method	Dates	Yield
Achillea millefolium	moon rover	August 10	n/a
Festuca rubra	hand	July 5-17	1.5 lbs
Viola adunca	hand	March 15-June 28	454 g

IV. Container Plant Production.

On January 30, 2007, seeds of *V. adunca* were sown into Ray Leach stubby cone-tainers filled with moistened media (Sunshine #1 a special peat-based soil-less mix) and lightly covered with fine vermiculite. Racks of cone-tainers were placed in polyethylene bags and moved into a walk-in cooler (36-38^{o} F) for 120 days. They were then moved outside to a shadehouse.

Table 3. Containerized plant production for the Rock Creek Bridge Replacement Project at the Corvallis Plant Materials Center in 2007.

Species	**Accession Number**	**Number of conetainers planted**	**Amount of seed used**	**Number of conetainers produced**
Anaphalis margaritacea	9079451	1200	1g	1086
Aster chiliensis	9079449	1700	6g	1629
Solidago canadensis	9079497	1700	2g	1614
Festuca rubra	9079450	2800	17g	2788
Viola adunca	9079406	2100	4g	2058

The seeds of *F. rubra, Solidago canadensis, Aster chiliensis,* and *Anaphalis margaritacea* were sown on May 30, 2007, into Ray Leach stubby cone-tainers filled with moistened media (Sunshine #1 a special peat-based soil-less mix) and lightly covered with fine vermiculite (except for the *A. margaritacea*, which was not covered with vermiculite). Racks of cone-tainers were placed into a shadehouse.

All plants were watered overhead daily. *V. adunca* plants were fertilized with a light rate of water-soluble 20-20-20 mix twice during the later part of the growing season. Plants were sprayed with a soap and neem oil mix to prevent insect pests at 2-week intervals during June and July. The *A. margaritacea*. *S. canadenis*, and *A. chiliensis* plants became so large that they could not be effectively watered by overhead means. Shallow water troughs were built and racks were placed in the troughs for bottom watering once or twice a week to supplement overhead watering.

Plants were hardened off in early October to prepare them for outplanting. All nectar plants (*A. margaritacea, A. chiliensis, S. canadensis*) were cut back to 1" before outplanting. These plants typically die back in the winter and it was much easier to transport and transplant the trimmed plants.

V. Delivery of Plant Materials.

A total of 9831 plants and 5 lbs of seed were picked up by ODOT staff on October 15, 2007. Remaining *A. millefolium* will be held at the PMC seed storage facilities until needed by ODOT.

Table 4. Seed and plants delivered to ODOT staff on October 15, 2007 for the Rock Creek Bridge Replacement Project at the Corvallis Plant Materials Center in 2007.

Species	**Common Name**	**Code**	**Accession number**	**Number of cone-tainers**	**Amount of seed**
Achillea millefolium	common yarrow	ACMI2	9079448	0	1.5 lbs
Anaphalis margaritacea	Pearly everlasting	ANMA	9079451	1086	0
Aster chiliensis	Pacific aster	ASCH2	9079449	1629	0
Solidago canadensis	Goldenrod	SOCA6	9079497	1614	0
Festuca rubra	red fescue	FERU	9079450	2788	1.5 lbs
Viola adunca	early blue violet	VIAD	9079406	2058	1 lb

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

September 20, 2007

THE 2007 FEDERAL HIGHWAY ADMINISTRATION ANNUAL REPORT:
Fort Hill Nelson's Checkermallow *(Sidalcea nelsoniana)* Seed Increase

I. Brief Background of Project

The Corvallis Plant Materials Center (PMC) entered into a new agreement with the Federal Highway Administration in 2007 to provide temporary refuge for endangered Nelson's checkermallow plants that will be impacted by road construction. Plants will be housed at the PMC until a mitigation site is established in 2010. While the plants are at the PMC, seeds will be collected from them. The seed will be used to grow containerized plants. At the conclusion of this project, the impacted plants, the seed they produced, and container plants (grown from the seed) will all be planted in the mitigation site.

II. Accessions Involved

Accession included in the Fort Hill Nelson's checkermallow project is presented below.

Table 1. Accessions involved for the Fort Hill Nelson's checkermallow project at the Corvallis Plant Materials Center in 2007.

Species	Common name	Symbol	Accession	Activity in 2007[1]
Sidalcea nelsoniana	Nelson's checkermallow	SINE	9079516	sfp

1- sfp = seed increase

III. Field Seed Increase Activities

Plants were dug up and transported to the PMC on March 13 and 14. Plants were stripped of soil and weeds using water hoses with sprayer nozzles. The root masses were chopped into 3-4in pieces using a machete. The pieces were planted into a field covered with weed fabric. Holes were cut in the fabric just big enough to put the plants through. 831 plant pieces were planted in the field. Rows are 3ft apart and plants within the rows are 2 ft apart. Field size is 15 ft by 190 ft (0.06 acres). Rain watered in the plants the day they were planted. Supplemental water (via sprinkler irrigation) was added twice in late May. No fertilizers or other inputs were added to the field. Plants grew very vigorously and flowered in late June. No seed weevils were detected. Plants were checked often to make sure that the expanding plants were not impeded by the weed fabric. Seed maturity was quite variable across the field. On August 15, 2007, mature seed was hand-stripped from the plants and placed in an open greenhouse to dry. Seed was also swept up from the weed fabric. On September 13, the remaining seed was hand-stripped from the plants and the weed fabric was swept again. A few seeds that were collected in the later harvest appeared to be weevil damaged. This will be monitored closely in 2008.

Seed was cleaned using a large brush machine and an air screen machine. The field produced nine pounds of seed. Plants were cut back in September and the weed fabric was trimmed away from the base on larger plants. Survival was also recorded at this time. Out of 831 plants that had been transplanted in March, only 80 had died (91% survival).

III. Plant Production

The *S. nelsoniana* production field has space to be expanded; therefore seed that was harvested from the plot in 2007 was used to grow plugs that will be used to expand the seed increase field. On September 14, seeds were sown into 200 Ray-Leach "stubby" cone-tainers filled with moistened media (sunshine #1, a special peat-based soil-less mix) and lightly covered with fine vermiculite. Seeded flats were placed in polyethylene bags and moved into a walk-in cooler (36-38°F) for three months. After stratification, they were placed in a greenhouse set at moderate temperatures. These plants will be transplanted into the field in early spring of 2008.

IV. Delivery of Plant Materials

There were no deliveries in 2007. Seed produced for this project will be stored at the PMC seed storage facilities until requested.

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

December 20, 2007

THE 2007 MOUNT RAINIER NATIONAL PARK ANNUAL REPORT:
Steven's Canyon Road Revegetation Project

I. Brief Background of Project

The Corvallis Plant Materials Center (PMC) entered into a new agreement with the National Park Service (NPS) in 2007 to provide native plant materials for ecological restoration along Steven's Canyon Road following road construction. It was agreed that the PMC would establish and maintain seed increase fields of three grasses (five accessions). The PMC will deliver 195 lbs (PLS) of upper elevation grasses and 135 lbs (PLS) of lower elevation grasses. This project is expected to be complete in 2009. All seed is planned to be delivered in the fall of 2009. Activities in 2007 included wild seed collection and seed increase field establishment of high and low elevation ecotypes of three grasses.

II. Accessions Involved

Accessions included for the Steven's Canyon Road revegetation project in 2007 are listed in Table 1. This table also displays activities performed by PMC staff.

Table 1. Accessions involved for the Steven's Canyon Road revegetation project in 2007.

Species	Common Name	Code	Accession Number	Activity in 2007[1]
Upper Elevation				
Elymus glaucus	blue wildrye	ELGL	9079518	col, sfp
Festuca rubra	red fescue	FERU	9079519	col, sfp
Bromus carinatus	California brome	BRCA5	9079531	col, pxn
Lower Elevation				
Elymus glaucus	blue wildrye	ELGL	9079520	col, sfp
Festuca rubra	red fescue	FERU	9079521	col, sfp

1- sfp = seed increase, pxn=plant production, col= collected plant materials

III. Wild Seed Collection

PMC staff was responsible for collecting seed from the park to establish the seed increase fields. Collection boundaries were determined by park staff. The upper collection zone was the intersection of Steven's Canyon Rd. and Paradise Rd. down to the intersection of Steven's Creek and Steven's Canyon Rd. The lower collection zone was defined as the intersection of Backbone Ridge and Steven's Canyon Rd. down to the entrance station near the intersection of Steven's Canyon Rd. and SR 123. The dominant *Bromus* species along the upper section of the road was determined to be *Bromus inermis* (a non-native plant). This species was not collected by PMC staff. A few plants of *Bromus carinatus* were found along the upper roadsides, but it was very limited.

Table 2. Wild collections for the Steven's Canyon Road revegetation project in 2007.

Species	**Accession Number**	**Collection dates**	**Amount Collected**
Upper Elevation			
Elymus glaucus	9079518	Aug 22- Sept 7	590 g
Festuca rubra	9079519	Aug 22- Sept 7	488 g
Bromus carinatus	9079531	Aug 22- Sept 7	85 g
Lower Elevation			
Elymus glaucus	9079520	Aug 22-24	985 g
Festuca rubra	9079521	Aug 22-24	920g

Seeds were brought back to the PMC greenhouses to dry. Seed was cleaned and then informal germination tests were performed on both high and low ecotypes of *Elymus glaucus* and *Festuca rubra.*

IV. Field Seed Increase Activities

In September and October, fields were sown using the PMC's new precision cone-seeder. This type of seeder is calibrated to drill a programmed amount of seed over a programmed area. The PMC staff set the seeder for intervals of 24ft. Pre-weighed packets were fed into the seed drill at 24ft intervals. It is very precise and is a good choice for drilling limited amounts of wild-collected seed. This new seeder is a huge improvement over the old Plantet Jr seeder.

Table 3. Seed increase field establishment in the fall of 2007 for the Steven's Canyon Road revegetation project in 2007.

Species	**Accession Number**	**Date**	**Seeding method**	**Bulk Seeding rate**	**Field size**
Upper Elevation					
Elymus glaucus	9079518	29-Oct	cone-seeder	8.5 lbs/ac	0.14 ac
Festuca rubra	9079519	4-Nov	cone-seeder	3.7 lb/ac	0.26 ac
Lower Elevation					
Elymus glaucus	9079520	27-Sep	cone-seeder	10 lbs/ac	0.20 ac
Festuca rubra	9079521	6-Nov	cone-seeder	5.4 lbs/ac	0.37 ac

V. Container Plant Production.

On September 15, 2007, seeds of *B. carinatus* were sown into Ray Leach stubby cone-tainers filled with moistened media (Sunshine #1: a special peat-based soil-less mix) and lightly covered with fine vermiculite and placed in a greenhouse set at moderate temperatures (65 ^{o}F day/ 50^{o} F night). Plants will be transplanted out into fields in early spring. This method of field establishment was chosen over direct seeding due to the limited amount of wild collected seed.

VI. Delivery of Plant Materials.

No materials were delivered in 2007.

CORVALLIS PLANT MATERIALS CENTER
NATURAL RESOURCES CONSERVATION SERVICE
CORVALLIS, OREGON
Sonja Johnson

February 10, 2006

THE 2005 US FISH AND WILDLIFE ANNUAL REPORT:
***Viola adunca* Seed Increase Project**

I. Brief Background of Project

The Corvallis Plant Materials Center (PMC) entered into a new agreement with US Fish and Wildlife in 2005 to increase seed of early blue violet (*Viola adunca*) for use in recovery efforts for the Oregon silverspot butterfly (*Speyeria zerene hippolyta*). The butterfly has become threatened due to the degradation and loss of its coastal meadow habitat. The early blue violet is the obligate host to the silverspots' caterpillars and has also been negatively impacted in its coastal meadow ranges by the encroachment of tall, spreading exotic plants. Seed increase on the violets will provide a source for future seedling grow-outs which can then be transplanted back into areas of Oregon silverspot butterfly habitat enhancement and restoration.

Activities in 2005 included salvaging violet plants from a construction site, potting up and maintaining plants, and harvesting and cleaning seed. Germination trials were performed to determine optimum seed propagation methods.

II. Accessions Involved

SCIENTIFIC NAME	COMMON NAME	SYMBOL	ACCESSION #	# PLANTS	SEEDS PRODUCED
Viola adunca	early blue violet	VIAD	9079406	189	535 grams

III. Containerized Seed Increase

In April 14th, 2005, staff from the PMC and US Fish and Wildlife salvaged violet plants from a private lot on the Oregon coast. The collection location was recently cleared, allowing the violets to grow with minimal competition, and was in close proximity to many of the sites being considered for butterfly habitat restoration. Plants were dug out and placed in plastic bags or coolers for transportation back to the PMC. There, they were potted into 5-inch square pots filled with Sunshine #1 (a peat-based soil-less media) amended with micronutrients (MicroMax) and a slow-release fertilizer (Osmocote 14-14-14). A total of 189 plants were planted, 108 of which were placed in an outdoor shadehouse with the remaining 81 being placed in a greenhouse to determine whether or not the warmer temperatures of the greenhouse would encourage increased plant growth or earlier flowering.

Plants were watered as necessary and growth was monitored. The violets in the greenhouse were slightly more rapid in development and seed harvest began on the 4th of May. As temperatures began to rise the plants were consolidated into the cool of the shadehouse and put onto an automatic drip irrigation system. Seed harvest continued daily throughout the summer and into early October. On September 21st, US Fish and Wildlife staff picked up approximately 100 violet plants to deliver to four recovery sites on the coast. Seeds were determined ready to harvest when the capsule they were in turned to point upward. Observation led to the belief that this stage immediately precedes the seed pod splitting open, at which time seeds can be lost. Ripe pods were pinched from their stems and put in a cloth bag in the greenhouse to dry. As they dried, most of the harvested capsules split and the seeds were easily separated from the majority of their pods by shaking the bag to settle the seeds at the bottom. Final cleaning was performed using an air screen machine, yielding 535 grams of seed.

IV. Experimental Propagation

Germination trials were performed on the early blue violet seed produced in 2005 to determine how many days of cold moist stratification is optimum for seed propagation. Trials were conducted by counting out 100 seeds onto moistened germination paper set in plastic boxes and placing three sets of three boxes each into a walk-in cooler set at fluctuating temperatures (16 hours 50ºF, 8 hours 40ºF) and 8 hours of light. Each set was then removed after either 60, 90, or 120 days and seeds were counted as they germinated. Results of the germination trials suggest that *Viola adunca* seeds respond most favorably in both mean germination and consistency between repetitions to 120 days of cold moist stratification.

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

December 28, 2007

THE 2007 US FISH AND WILDLIFE ANNUAL REPORT:
Oregon Silverspot Butterfly Seed Increase Project

I. Brief Background of Project

The Corvallis Plant Materials Center (PMC) entered into a new agreement with US Fish and Wildlife (USFW) 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 USFW. The butterfly has become threatened due to the degradation and loss of its coastal meadow habitat. The early blue violet is the obligate host to the silverspot caterpillars and has also been negatively impacted in its coastal meadow ranges by the encroachment of tall, spreading exotic plants. Coastal red fescue, (recently renamed sand fescue, *Festuca ammobia*) is included in this agreement as a matrix species in the coastal meadows. All other forbs included in this project are nectar sources for the adult butterflies.

Activities in 2007 included expanding, maintaining, and harvesting three seed increase plots, wild seed collection of nectar species, and cleaning wild collected seed.

II. Accessions Involved

The following table lists the accessions involved in this project. These accessions are also being used in the Rock Creek Bridge Replacement project with Oregon Department of Transportation/Federal Highways Administration.

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

Species	**Common name**	**Symbol**	**Accession**	**Activity in 2007**[1]
Achillea millefolium	common yarrow	ACMI2	9079448	sfp
Anaphalis margaritacea	pearly everlasting	ANMA	9079451	col
Aster chiliensis	Pacific aster	ASCH2	9079449	col
Solidago canadensis	goldenrod	SOCA6	9079497	col
Festuca ammobia	sand fescue	FEAM	9079450	col, sfp
Viola adunca	early blue violet	VIAD	9079406	sfp, pxn, dlv
Tanacetum camphoratum	camphore tansy	TACA2	9079559	Col
Artemisia suksdorfii	coastal wormwood	ARSU4	9079560	Col
Solidago simplex ssp. *simplex* var. *spathulata*	dune goldenrod	SOSIS4	9079561	Col

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

III. Seed Increase

A small seed increase plot of *V. adunca* was established using plants that were collected from the Rock Creek area in 2004. 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 seeds were then vacuumed up using battery-powered, handheld vacuums. Pods were collected also, by hand when feasible. Violet pods turn upright when they are mature, which makes determining seed ripeness simple. This plot was expanded in 2007 using plants grown from the seed that was harvested in 2006.

Table 2. Yields in 2007 for the USFW Oregon Silverspot seed increase project

Species	Harvest dates	Method	Field size	Yield
Achillea millefolium	August 14, August 20	moon rover	0.010 ac	15 lbs
Viola adunca	May 5- July 8	hand, and vacuuming on weed fabric	0.001 ac	454 g

The *Achillea millefolium* field was hand weeded many times throughout the winter and spring of 2007. The field flowered profusely but ripening was somewhat uneven across the field. To maximize yields, the field was hand harvested on August 14, 2007. About 10% of the flower heads were mature and harvested at that time. The rest of the field was harvested using the "moon rover" on August 20, 2007. This technique was very efficient. The moon rover cuts all the plant material which lands on a conveyor belt that feeds the material into large bags. The bags were emptied onto tarps in a shed to dry.

F. ammobia seed collected by USFS in the summer of 2007 was used to sow a large seed increase field. Heavy rain in September and October limited the amount of land that the PMC could prepare for fall sowing. Not all of the seed was sown. The rest of the seed will be used to expand the field in the spring. This will also provide a comparison between fall and spring planting.

Table 3. Establishment of seed increase fields at the Corvallis Plant Materials Center for the USFW Oregon Silverspot seed increase project.

Species	Code	Date sown	Seeding rate (bulk)	Germination	Field size
Festuca ammobia	FEAM	27-Sep	4 lbs/ac	90%	0.36 ac

IV. Container Plant Production.

On January 15, 2007 16g of *V. adunca* seed were sown into 4410 Ray Leach "stubby" cone-tainers filled with moistened media (Sunshine #1, a special peat-based soil-less mix) and lightly covered with fine vermiculite. Seeded flats of violets were placed in polyethylene bags and moved into a walk-in cooler (36-38^{o} F) for four months. After stratification, they were moved outside to a lathhouse. In early August, all plants were moved to a shadehouse to harden them off and prepare them for fall delivery.

V. Native Seed Collection

Staff members from the PMC, USFW and USFS were able to collect seed in fall of 2007. Collections were made from the southern edge of the Tillamook National Forest south to Florence. This seed will be used to establish seed increase fields in the spring of 2008 for future restoration projects by NRCS, USFW, or USFS in the Critical Habitat area.

Table 2. Seed collected in 2007 for the USFW Oregon Silverspot seed increase project.

Species	**Accession**	**Amount of cleaned seed**	**Seeds/lb**
Festuca ammobia	9079450	2 lbs	380,000
Achillea millefolium	9079448	Not available	6,000,000
Anaphalis margaritacea	9079451	50g	14,000,000
Aster chiliensis	9079449	111g	1,300,000
Soildago canadensis	9079497	98g	4,600,000
Tanacetum camphoratum	9079559	10 g	850,000
Artemisia suksdorfii	9079560	14g	2,300,000
Solidago spathulata	9079561	3g	2,000,000

VI. Delivery of Materials

PMC staff delivered 2100 plants to USFW on October 3, 2007. The remaining 2000 plants were picked up by USFW on October 5, 2007. All seed will remain in PMC seed storage facilities until requested.

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

December 30, 2005

THE 2005 OLYMPIC NATIONAL PARK ANNUAL REPORT:
Elwha River Ecosystem and Fisheries Restoration

I. Brief Background of Project

The Corvallis Plant Materials Center (PMC) entered into a new agreement with Olympic National Park in 2004 to provide native plant materials for the ecological restoration of Lake Mills and Lake Aldwell following dam removal on the Elwha River. It was agreed that the PMC would propagate a minimum of 300 lbs (PLS) and 60,000 containers of shrubs; 900 lbs (PLS) and 46,000 containers of herbs and forbs; and 2,020 lbs of grasses, sedges, and rushes. A more detailed production list will be determined by PMC and NPS staff as restoration plans are finalized.

Activities in 2005 included collecting seed of 16 species; establishment and maintenance of seed production fields including five grasses, seven forbs, and two sedges; containerized stock production of eight species; maintenance of cutting blocks of nine shrubs and one forb. Details are provided below.

II. Accessions Involved

Table1. Accessions involved and activities performed in 2005 for Elwha River Ecosystem and Fisheries Restoration Cooperative Agreement at the Corvallis Plant Materials Center.

Species	Common name	Symbol	Accession number	2005 Activity[1]
Achillea millefolium	common yarrow	ACMI2	9079349	Sfp
Agrostis exarata	spiked bentgrass	AGEX	9079401	Sfp Col
Anaphalis margaritacea	pearly everlasting	ANMA	9079350	Sfp Col
Artemisia suksdorfii	coastal wormwood	ARSU4	9079400	Sfp Col
Aruncus dioicus	goatsbeard	ARDI8	9079370	Pxn
Bromus complex	Brome complex	BR sp	9079332	Sfp Col
Bromus vulgaris	Columbia brome	BRVU	9079333	Sfp Col
Carex deweyana	dewey sedge	CADE9	9079330	Sfp Pxn Col
Carex hendersonii	Henderson's sedge	CAHE7	9079331	Pxn Col
Carex pachystachya	thick-headed sedge	CAPA14	9079329	Sfp Pxn Col
Ceanothus sanguineus	redstem ceanothus	CESA	9079342	Trl
Deschampsia elongata	slender hairgrass	DEEL	9079335	Sfp Col
Elymus glaucus	blue wildrye	ELGL	9079334	Sfp Col

Table1 (Con't). Accessions involved and activities performed in 2005 for Elwha River Ecosystem and Fisheries Restoration Cooperative Agreement at the Corvallis Plant Materials Center.

Species	**Common name**	**Symbol**	**Accession number**	**2005 Activity**[1]
Epilobium angustifolium	tall fireweed	EPAN	9079345	Sfp Col
Epilobium ciliatum	fringed willowherb	EPCI	9079346	Sfp
Eriophyllum lanatum	wooly sunflower	ERLA	9079441	Pxn Col
Fragaria virginiana	woodland strawberry	FRVI	9079354	Pxn
Gaultheria shallon	salal	GASH	9079340	Pxn
Juncus bolanderi	Bolander's rush	JUBO	9079371	Pxn Col
Juncus effusus	common rush	JUEF	9079348	Pxn
Lonicera ciliosa	orange honeysuckle	LOCI3	9079364	Cb
Lonicera involucrata	honeysuckle	LOIN	9079363	Cb
Lupinus latifolius var. latifolius	broadleaf lupine	LULA4	9079336	Pxn Col
Luzula comosa	Pacific woodrush	LUCO	9079444	Pxn, Col
Luzula parviflora	smallflowered woodrush	LUPA4	9079337	Pxn Col
Petasites frigidus var.palmatus	Arctic sweet coltsfoot	PEFRP	9079344	Pxn Col
Populus balsamifera ssp. trichocarpa	black cottowood	POBAT	9079369	Cb
Ribes divaricatum	spreading gooseberry	RIDI	9079365	Cb
Ribes lacustre	prickly currant	RILA	9079366	Cb
Rosa nutkana	nutka rose	RONU	9079338	Cb Trl
Rubus spectabilis	salmonberry	RUSPS	9079362	Cb
Salix lucida var. lasiandra	Pacific willow	SALUL	9079368	Cb
Salix sitchensis	Sitka willow	SASI2	9079361	Cb
Sambucus racemosa	red elderberry	SARA2	9079367	Cb
Stachys chamissonis var. colleyae	Mexican hedgenettle	STME	9079343	Pxn
Symphoricarpos albus	common snowberry	SYAL	9079339	Cb
Vicia americana	American vetch	VIAM	9079341	Pxn Col

1- sfp = seed increase, trl= production research trial, pxn= plant production, col= collected plant materials from park, cb= cutting block

III. Native Seed and Plant Collections

Four separate trips were conducted in July and August 2005; approximately 246 person hours were recorded as actual collection time. Seed collections were performed all over the Elwha watershed (below 1000ft elevation) throughout the growing season. A total of 19 lbs of clean seed of sixteen species were collected in 2005.

Optimum collection times for sedge seeds were late June through early August depending on sun exposure. Grasses displayed a wide collection window, also mainly depending on sun exposure, peak collection occurred in late July through mid August. Forbs were mostly collected in August. Lupines were an exception; they were collected in mid to late July.

Table 2. Native Seed and Plant Collection in the Elwha Watershed in 2005 for Elwha River Ecosystem and Fisheries Restoration Cooperative Agreement at the Corvallis Plant Materials Center.

Species	**Symbol**	**Accession number**	**Collection dates**	**Amt collected**
Forbs				
Anaphalis margaritacea	ANMA	9079350	8/22/05- 8/31/05	25g
Epilobium angustifolium	EPAN	9079345	8/22/04- 8/30/05	65g
Lupinus latifolius var. latifolius	LULA4	9079336	7/18/05- 8/04/05	30g
Petasites frigidus var.palmatus	PEFRP	9079344	6/20/05- 7/10/05	10g
Vicia americana	VIAM	9079341	8/1/05- 8/10/05	23g
Eriophyllum lanatum	ERLA	9079441	8/30/05-9/15/05	2g
Grasses, sedge, and rushes				
Agrostis exerata	AGEX	9079401	7/18/05-8/4/05	167g
Bromus complex	BR sp	9079332	7/18/05-8/4/05	1099g
Bromus vulgaris	BRVU	9079333	7/18/05- 8/11/05	2831g
Carex deweyana	CADE9	9079330	7/18/05-8/4/05	135g
Carex hendersonii	CAHE7	9079331	7/18/04- 7/21/04	3g
Carex pachystachya	CAPA14	9079329	7/18/05-8/4/05	358g
Deschampsia elongata	DEEL	9079335	7/18/05-8/4/05	336g
Elymus glaucus	ELGL	9079334	7/18/05- 8/11/05	3310
Juncus bolanderi	JUBO	9079371	8/10/05-9/13/05	12g
Luzula parviflora	LUPA4	9079337	7/18/05-8/4/05	3g

IV. Experimental Propagation

Most species involved in this project have been propagated successfully at the PMC for previous park service agreements or other projects. A handful of species were new in 2004 and informal propagation trials were performed. Seeds of ARDI8, LUPA, CAHE, CADE, CESA, JUEF, JUBO were placed in plastic germination boxes on moistened germination paper and stored in a walk-in cooler for 45 and 90 days each. One “control” box of seeds was left in a greenhouse set at fall temperatures (60 degree days, 50 degree nights). Not all results were available for the 2004 report. Final data is reported below.

Table 3. Results of Experimental Propagation Trials Performed at the Corvallis PMC in 2004/2005 for the Elwha River Ecosystem and Fisheries Restoration Cooperative Agreement.

	Germination after treatment		
Species	**Control**	**45 days**	**90 days**
ARDI8	0	0	85%
CADE	0	77%	75%
CAHE	0	0	63%
JUBO	0	72%	73%
JUEF	0	88%	79%
LUPA	0	0%	81%

Cuttings of RIDI, RILA, RONU, were also taken experimentally in the fall of 2004. They were cut into 12" sections containing at least two nodes (one above the soil and one below) and stuck into long conetainers filled with moistened media (Sunshine #1, a peat-based soil-less media) amended with micronutrients (MicroMax) and a balanced slow-release fertilizer. Conetainers were left outdoors in a lathhouse to overwinter. In February of 2005, conetainers were brought into a greenhouse set at moderate temperatures (65° days/50° nights). Both *Ribes sp* exhibited excellent rooting and filled the conetainers within 6 weeks. At planting time, the RONU cuttings were divided into four treatments: no treatment, dipped in rooting hormone, scarred, and scarred and dipped in rooting hormone. No differences were observed in cuttings that were dipped in rooting hormone vs no hormones. There was however, a noteable difference in cuttings that were scarred vs unscarred. Cuttings that had received scarring before planting were 50% more likely to root and exhibited much higher vigor.

V. Cutting Block Establishment.

Cuttings that were planted into conetainers in fall of 2004 were overwintered outdoors in a lathhouse. In February 2005, they were moved to a greenhouse set at moderate spring temperatures (65° days/50° nights). They were watered overhead daily and monitored for pests and diseases. SYAL shoots were infested with aphids in March. They were sprayed twice weekly with a soap & oil solution for three weeks. Roots filled the conetainers by early May and plants were transplanted out into fields on May 10, 2005. LOIN, LOCI, RILA, and RIDI were transplanted into 3'wide strips of weed fabric. SYAL, RONU, and RUSP were transplanted into existing sod. Blocks were watered with sprinklers for 4-hour sets at 2-week intervals throughout the growing season. All species except RUSP had high survival. RUSP transplants were sensitive to sun exposure and experience high levels of die-back. Plants will be re-evaluated in spring to assess survival.
Salix lucida var. lasiandra, *Salix sitchensis, Sambucus racemosa,* and *Populus balsamifera ssp. Trichocarpa* that were planted in fall of 2004 exhibited very high survival rates and vigor throughout the growing season of 2005. All species had 95-100% survival except SARA (55%). Mice were a considerable pest in the cutting blocks covered with weed fabric and as a result, many trees were girdled. Aluminum foil was

wrapped around the bases of the trees in early October. Willows experienced the heaviest damage from girdling, possibly losing 20% of trees. Any losses will be replaced with cuttings from existing trees within the blocks. Lower survival rates of SARA were expected and 100 cuttings from 2004 were planted into tall treepots and cared for throughout 2005 in a lathhouse. These cuttings had a survival rate of 85%.

VI. Field Production Activities

Containerize plants that were produced in the fall of 2004 were transplanted into fields in January 2005. When possible, they were planted next to rows of seedlings that had been sown in the fall. This provided a comparison between fields produced from transplants versus direct seeding. Transplants performed better in both sedge fields and ANMA. All other species showed no difference in establishment methods.

Plants of CAHA, LUPA, LULA and ARDI were not vigorous enough in early spring to be transplanted out into fields. It was decided to keep these plants in containers throughout the 2005 growing season and transplant them out into fields in the fall. VICA was transplanted into rows of weed fabric in early spring. Plants slowly went dormant but re-emerged in late June. Plants looked weak and survival will be assessed in spring of 2006.

Spring seeding:

Table 4. Establishment information for new seed increase fields for the Elwha River Ecosystem and Fisheries Restoration Cooperative Agreement at the Corvallis PMC in February 2005.

Species/Ac		**Amt seeded**	**Germ**	**Approximate seeding rate**	**Seeds/lb**
EPCI acres or 176' rows btwn rows	0.05 12 24"	94g	78%	4.1lbs/acre (bulk) 1.7lbs/acre (PLS) 428 PLS/ft-row	8,440,000
EPAN acres or 176' rows btwn rows	0.05 11 24"	237g	60%	10 lbs/acre (bulk) 1.9lbs/acre (PLS) 412 PLS/ft-row	10,869,000
ANMA acres or 176' rows btwn rows	0.02 4 24"	97g	30%	10lbs/acre (bulk) 0.6lbs/acre (PLS) 231 PLS/ft-row	12,954,000
ACMI acres or 180' rows btwn rows	0.5 121 12"	493g	58%	2.8lbs/acre (bulk) 1.6lbs/acre (PLS) 116 PLS/ft-row	3,117,200

Forb seed that was collected in the summer of 2004 was sown using a single-row Planet Jr walk-behind planter in early February 2005. Seed was thinned using horticulture grade vermiculite. Settings on the planter were adjusted to surface sow the seed. 2ft wide strips of weed fabric were tacked down between the rows to control weeds and to act as a passive seed collector. ACMI was sown using a six-row Planet Jr. seeder towed behind a tractor. Most seedlings emerged within 2-3 weeks after planting, and stand establishment and vigor was rated high for all species, except ANMA. ANMA seedlings were slow to establish and rows were spotty.

Field Production Notes for 2005:

Weed control in grass fields was primarily performed by hand (mainly to remove exotic perennial grasses) and spraying borders and spot-spraying with glyphosate. Broadleaf herbicides (2,4-D and Banvel) were applied to grass fields in February and May. *Poa annua* plants in the BRVU field were smothering the crop, consequently the field was sprayed with glyphosate in between the rows using a shielded back-pack sprayer.

EPCI, EPAN, and ANMA fields were hand weeded monthly through May. ACMI field was sprayed with glyphosate in between the rows using a shielded back-pack sprayer. All forb fields grew vigorously and flowered in the summer. Fields were rouged before harvest to remove any seed-bearing weeds.

Both Carex fields were sprayed with glyphosate in late February before Carex seedlings had emerged. CAPA field was hand hoed in late May. CADE field had <1% emergence and was sprayed out. A new CADE field will be established from transplants in spring of 2006.

Harvest Notes for 2005:

Seed was harvested from established stands of *Carex deweyana*, *Carex pachystachya*, *Deschampsia elongata*, *Elymus glaucus*, *Bromus* complex, and *Bromus vulgaris*. Fields were harvested by hand with rice knives or swathing and combining. Experimental harvesting was investigated for *Deschampsia elongata*. The field was swathed and one quarter of the field was pitch-forked onto tarps and moved to a drying shed. After two weeks of drying, material was pitch-forked into a stationary combine. Swaths that were left to dry on the field were combined two weeks after swathing. Seed loss was considerable with both harvest methods. The extra labor required to remove swathed material off the field makes it a very inefficient method, yet seed yields are higher. Further trials will be conducted using Palisade (a growth regulator that blocks ethylene action to slow abscission layer development and keep the seed attached to the plant) to prevent high losses from shattering during swathing and drying time before combining.

Harvesting forb fields were all experimental in 2005. EPCI field grew and flowered profusely. Weed fabric had been placed in between the rows to prevent weed growth, but it also became a very effective tool for harvesting. Seeds fell onto the fabric and collected in large, fluffy piles. A leaf-blower, used in reverse as a vacuum, was maneuvered down the rows of weed fabric. It removed and compacted the material into sac attached to the leaf-blower. The sac was emptied into large poly bags and placed in an open greenhouse to dry. This method was extremely effective and efficient. It also made cleaning the seed very simple. Most harvest methods collect a large amount of plant material along with the seed. Vacuuming left the plants fully intact on the field and the harvested seed was relatively free of plant material. Vacuumed material was emptied into a brush machine to rub the hairs off the seed. An air screen machine was used to sift the seed and blow out any remaining hairs.

Table 5. Seed harvest in 2005 for the Elwha River Ecosystem and Fisheries Restoration Cooperative Agreement at the Corvallis PMC.

Species	Acres	Date(s)	Method	Yield	Lbs/ac	Comments
ACMI	0.5	9/13	Swathed	70lbs	140	Excellent stand, high vigor
ANMA	0.02	8/15-9/18	Hand	61g	N/A	Good stand, fair vigor, transplants look excellent
BR sp.	0.1	6/28	Hand	38lbs	380	Excellent stand, high vigor
BRVU	0.1	7/15	Hand	6lbs	60	Good stand, fair vigor
CADE	0.02	7/07	Hand	35g	N/A	poor stand, low vigor, transplants look excellent
CAPA	0.085	6/30	Hand	376g	80	poor stand, low vigor, transplants look excellent
DEEL	0.25	6/30	Swathed	82lbs	328	Excellent stand, high vigor
ELGL	0.05	7/17	Hand	10.5lbs	200	Excellent stand, high vigor
EPAN	0.05	8/12	Hand	2g	N/A	Invested with EPCI
EPCI	0.05	8/5-9/13	Vacuum	26lbs	260	Excellent stand, high vigor
JUBO	800 plants	8/23	Hand	5g	N/A	Plants flowered in containers
LULA	75 plants	6/15	Hand	12g	N/A	Plants flowered in containers

EPAN field was heavily contaminated with EPCI (staff is assuming that seed collection bags were mislabeled or mixed?). Racemes of EPAN plants were cut off individually as they matured and placed in poly bags to dry in an open greenhouse. The rest of the field was treated as an EPCI field and vacuumed with a leaf blower. EPAN plants will be dug out and used to establish a new field. The existing EPAN field will then be treated as another EPCI field. After harvest, fields were mowed with a sickle-bar mower and residue was raked and pitch-forked from the field.

Plants in the ACMI field did not go dormant as seed was maturing. This eliminated direct combining as a harvest option. The decision was made to swath the field, let it dry, then combine. ACMI shatters very easily and much of the seed fell out of the plants as they were swathed. Seed was retained more than expected while the swathed material was drying. However, more seed was again lost in the combining process. In spite of losing at least 60% of the seed in the harvest process, nine 30-gallon barrels of seed and chaff were recovered off the combine. Flail-vac harvesters and swathing material onto rolls of paper will be attempted next year. Swathing and combining yarrow was successful, but a large percent of seed was lost. Also, many low-growing weeds were present in the field at harvest time and combining cannot select out these weeds. Flail-vac harvesters are very adjustable in height and can be set to harvest seed off the plants at 1ft off the ground, preventing low-growing weeds from being harvested. After harvest, plants continued to flower. Field was mowed in early November to cease flowering.

LULA and JUBO plants flowered in containers and seed was hand harvested from these plants as they matured. Only CADE and CAPA transplants flowered and produced seed in 2005, the fall-seeded plants did not.

Fall 2005 Establishment of Seed Increase Fields:

All seed collected in 2005 was cleaned and informal germination tests were performed on most of the seed lots prior to planting. Only grasses, one sedge, and one forb were selected for fall seeding, other forbs will be seeded in the spring of 2006 after spring germinating weeds have been sprayed out of the fields. The other sedge fields will be established using transplants. Fields were sown on October 2 and 11, 2005 using a six-row Planet Jr. seeder equipped with a carbon banding unit. Fields were sprayed with Diuron after seeding. Most seedlings emerged within 2-3 weeks after planting, and stand establishment and vigor was rated high for all species, except ARSU. The ARSU planting had no emergence two months after planting. It may have been sown too deeply. Diuron provided fair weed control. Banvel was applied in November to grass fields to control broadleaves. Glyphosate was applied over sedge field in November to control all weeds (sedges will not emerge until late winter).

ARDI plants that were produced in the spring of 2005 were transplanted out into a field on December 21, 2005. Weed fabric was stapled over the ground next to a willow planting. The willows will create a shadier site for the Aruncus.

Table 6. Establishment information for new seed increase fields for the Elwha River Ecosystem and Fisheries Restoration Cooperative Agreement at the Corvallis PMC in 2005.

Species/Ac	**amt seeded**	**germ**	**approximate seeding rate**	**seeds/lb**
ELGL 0.51 acres or 120 184' rows 12" btwn rows	2280g	80%	10lbs/acre(bulk) 8lbs/acre (PLS) 22 PSL/ft-row	120,000
BRVU 0.56 acres or 132 180' rows 12" btwn rows	2756g	86%	11lbs/ac (bulk) 9lbs/acre (PLS) 20PLS/ft-row	88,250

Table 6 (con't). Establishment information for new seed increase fields for the Elwha River Ecosystem and Fisheries Restoration Cooperative Agreement at the Corvallis PMC in 2005.

Species/Ac	**amt seeded**	**germ**	**approximate seeding rate**	**seeds/lb**
DEEL 0.18 acres or 42 181' rows 12" btwn rows	325g	83%	4 lbs/acre (bulk) lbs/acre (PLS) PLS/ft-row	2,670,000
CAPA 0.13 acres or 30 176' rows 12" btwn rows	210g	65%	4 lbs/acre (bulk) lbs/acre (PLS) PLS/ft-row	790,000
BR sp. 0.31 acres or 72 184' rows 12"btwn rows	959g	94%	7lbs/acre (bulk) 6.4lbs/acre(PLS) 9PLS/ft-row	56,000
ARSU 0.25 acres or 60 180' rows 12" btwn rows	79g	45%	0.7lbs/acre(bulk)	4,623,000
AGEX 0.45 acres or 108 180' rows 12" btwn rows	148g	75%	0.7lbs/acre(bulk) 0.5lbs/acre(PLS) 90 PLS/ft-row	7,153,000

Field Production for 2006:

Most fields that were planted in the fall of 2004 will produce seed in 2006. *Deschampsia elongata* and *Bromus vulgaris* fields look less vigorous in fall of 2005 than they did in fall of 2004. These fields may have decreased production on year two and may need to be treated as annuals. Most other fields will have higher yields in 2006 than in 2005. Sedge, rush, and legume fields did not produce seed the first year (except sedge transplants), these fields should flower and set seed in 2006.

VII. Container Plant Production

Some of the seed lots collected from the Elwha watershed were too small or valuable to be seeded with machines. These seeds were planted into containers filled with moistened media (Sunshine #1, a peat-based soil-less media) amended with micronutrients (MicroMax) and a balanced slow-release fertilizer and will be transplanted into a field when appropriate.

Table 7. Container Plant Production in 2005 at the Corvallis PMC for the Elwha River Ecosystem and Fisheries Restoration Cooperative Agreement.

Species	**Code**	**amt seeded**	**number produced**	**treatment**
Anaphalis margaritacea	ANMA	1 g	500	none
Eriophyllum lanatum	ERLA	2 g	500	10 weeks cold-moist stratification
Epilobium angustifolium	EPAN	3 g	200	none
Carex deweyana	CADE9	15g	2000	5 weeks cold-moist stratification
Carex hendersonii	CAHE7	3g	45	12 weeks cold-moist stratification
Luzula comosa	LUCO	3g	200	4-weeks cold-moist stratification
Luzula parviflora	LUPA4	2g	500	5-weeks cold-moist stratification
Lupinus latifolius var. latifolius	LULA4	7g	800	scarification
Vicia americana	VIAM	5g	350	soaked in hot water 24 hours

VIII. Seed Test Results/Delivery of Plant Materials

All lots of seed that were produced at the Corvallis PMC were sent to the Oregon State University seed lab for germination and purity tests. Tests were conducted in December of 2005. Results are listed below.

Table 8. Seed test results for seed lots produced at the PMC for the Elwha River Ecosystem and Fisheries Restoration Cooperative Agreement.

Species	**Bulk Amt**	**Purity**	**Germination**	**PLS Amt**
ACMI	70lbs	82.56%	93%	54lbs
BR sp.	38lbs	99.70%	93%	35lbs
BRVU	6lbs	99.69%	80%	5lbs
DEEL	82lbs	95.02%	83%	65lbs
ELGL	10.5lbs	99.19%	91%	9.5lbs
EPCI	26lbs	93.50%	71%	17lbs
			total	185.5lbs

No deliveries were made in 2005. All seed is being held at the PMC in cold storage until requested.

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

December 30, 2006

THE 2006 OLYMPIC NATIONAL PARK ANNUAL REPORT:
Elwha River Ecosystem and Fisheries Restoration

I. Brief Background of Project
The Corvallis Plant Materials Center (PMC) entered into a new agreement with Olympic National Park in 2004 to provide native plant materials for the ecological restoration of Lake Mills and Lake Aldwell following the removal of two high head dams on the Elwha River. It was agreed that the PMC would propagate a minimum of 4000 lbs of grass and forb seed. A more detailed production list will be determined by PMC and NPS staff as restoration plans are finalized.

Activities in 2006 included collecting seed of 18 species; establishment and maintenance of seed production fields including five grasses, seven forbs, four rushes, two legumes, and two sedges; containerized stock production of eight species; maintenance of cutting blocks of nine shrubs and one forb. Details are provided below.

II. Accessions Involved

Table1. Accessions involved and activities performed in 2006 for Elwha River Ecosystem and Fisheries Restoration Cooperative Agreement at the Corvallis Plant Materials Center.

Species	Common name	Symbol	Accession number	2006 Activity[1]
Achillea millefolium	common yarrow	ACMI2	9079349	Sfp, Col
Agrostis exarata	spiked bentgrass	AGEX	9079401	Sfp, Col
Anaphalis margaritacea	pearly everlasting	ANMA	9079350	Sfp, Col
Artemisia suksdorfii	coastal wormwood	ARSU4	9079400	Sfp
Aruncus dioicus	goatsbeard	ARDI8	9079370	Sfp
Bromus complex	Brome complex	BR sp	9079332	Sfp, Col
Bromus vulgaris	Columbia brome	BRVU	9079333	Sfp, Col
Carex deweyana	dewey sedge	CADE9	9079330	Sfp Pxn
Carex hendersonii	Henderson's sedge	CAHE7	9079331	Sfp,Pxn
Carex pachystachya	thick-headed sedge	CAPA14	9079329	Sfp Pxn Col
Collomia grandifloria	Grand collomia	COGR	9079355	Pxn, Col
Deschampsia elongata	slender hairgrass	DEEL	9079335	Sfp Col
Elymus glaucus	blue wildrye	ELGL	9079334	Sfp Col
Epilobium angustifolium	tall fireweed	EPAN	9079345	Sfp Col
Epilobium ciliatum	fringed willowherb	EPCI	9079346	Col
Eriophyllum lanatum	wooly sunflower	ERLA	9079441	Pxn Col

Table1(con't). Accessions involved and activities performed in 2006 for Elwha River Ecosystem and Fisheries Restoration Cooperative Agreement at the Corvallis Plant Materials Center.

Species	Common name	Symbol	Accession number	2006 Activity[1]
Gaultheria shallon	salal	GASH	9079340	Pxn
Juncus bolanderi	Bolander's rush	JUBO	9079371	Pxn Col
Juncus effusus	common rush	JUEF	9079348	Pxn, Col
Lonicera ciliosa	orange honeysuckle	LOCI3	9079364	Cb
Lonicera involucrata	honeysuckle	LOIN	9079363	Cb
Lupinus latifolius var. latifolius	broadleaf lupine	LULA4	9079336	Pxn, Sfp, Col
Luzula comosa	Pacific woodrush	LUCO	9079444	Pxn, Sfp Col
Luzula parviflora	smallflowered woodrush	LUPA4	9079337	Pxn, Sfp Col
Populus balsamifera ssp. trichocarpa	black cottowood	POBAT	9079369	Cb
Prunella vulgaris ssp. Lanceolata	lance selfheal	PRVUL2	9079483	Sfp, Col
Ribes divaricatum	spreading gooseberry	RIDI	9079365	Cb
Ribes lacustre	prickly currant	RILA	9079366	Cb
Rosa nutkana	nutka rose	RONU	9079338	Cb
Rubus spectabilis	salmonberry	RUSPS	9079362	Cb
Salix lucida var. lasiandra	Pacific willow	SALUL	9079368	Cb
Salix sitchensis	Sitka willow	SASI2	9079361	Cb
Sambucus racemosa	red elderberry	SARA2	9079367	Cb
Symphoricarpos albus	common snowberry	SYAL	9079339	Cb
Vicia americana	American vetch	VIAM	9079341	Pxn Col

1- sfp = seed increase, trl= production research trial, pxn= plant production, col= collected plant materials from park, cb= cutting block

III. Native Seed and Plant Collections

Five separate trips were conducted in July and August 2006; approximately 368 hours were spent performing collections. Seed collections were made all over the Elwha watershed (below 1000ft elevation) throughout the growing season. A total of 20 lbs of clean seed of 18 species were collected in 2006.

Table 2. Native Seed and Plant Collection in the Elwha Watershed in 2006 for Elwha River Ecosystem and Fisheries Restoration Cooperative Agreement at the Corvallis Plant Materials Center.

Species		Amt collected	Dates
Achillea millefolium	ACMI2	108 g	8/7-8/22
Agrostis exarata	AGEX	242 g	7/10-7/25
Anaphalis margaritacea	ANMA	61 g	8/20-8/24
Bromus complex	BR sp	2158 g	7/10-7/25
Bromus vulgaris	BRVU	1316 g	7/20-8/10
Collomia grandiflora	COGR	21 g	8/7-8/20
Deschampsia elongata	DEEL	230 g	7/10-7/25
Elymus glaucus	ELGL	10 lbs	7/20-8/24
Epilobium angustifolium	EPAN	70 g	8/20-8/24
Epilobium ciliatum	EPCI	50 g	8/20-8/24
Eriophyllum lanatum	ERLA	35 g	8/20-8/24
Juncus bolanderi	JUBO	49 g	8/20-8/24
Juncus effusus	JUEF	61 g	8/20-8/24
Lupinus latifolius var. latifolius	LULA4	70 g	7/20-8/24
Luzula comosa	LUCO	6 g	7/10-7/25
Luzula parviflora	LUPA4	16 g	7/10-7/25
Prunella vulgaris ssp. Lanceolata	PRVUL2	283 g	7/25-8-10
Vicia americana	VIAM	16 g	8/7-8/24

IV. Experimental Propagation

Most species involved in this project have been propagated successfully at the PMC. Two new species were added in 2006 (*Collomia grandiflora* and *Prunella vulgaris spp lanceolata*) and informal propagation trials were performed. Seeds of COGR and PRVU were placed in plastic germination boxes on moistened germination paper and stored in a walk-in cooler both species exhibited germinated within two weeks while remaining in the cooler and both had germination rates between 84-89%. It is inferred that these species will germinate best if fall sown or sown in early spring while temperatures are still cool.

V. Cutting Block Maintenance.

The base of all willows and elderberry shrubs were wrapped with aluminum foil to prevent damage from rodents. Individuals that had died the previous fall were replaced with healthy cuttings from other plants within the cutting blocks. All cutting blocks were fertilized with a slow release fertilizer in March.

VI. Field Production Activities

Containerize plants that were produced in the fall of 2005 were transplanted into fields in January 2006. Fields of LUCA, CAHE, LULA, ARDI, were established using transplants. LULA and ARDI plugs were transplanted into weed fabric that had been stapled down over the field. The ANMA field was augmented using transplants in to fill in empty places within the rows. JUBO and JUEF were planted into simulated ponds in January 2006. After planting, the ponds were flooded by heavy rain; plants were under

four feet of water. Almost all of the JUEF and about ¾ of the JUBO died. New plants were grown in the fall of 2006 and will be transplanted into the ponds in early spring of 2007.
Plants of ERLA and LUPA were not vigorous enough in early spring to be transplanted out into fields. It was decided to keep these plants in containers throughout the 2006 growing season and transplant them out into fields in the fall.

Plants grown in the summer of 2006 were used to expand and fill in the CAPA and CADE fields.

Spring seeding:

The ACMI field that was sown in the spring of 2005 was planted with rows that were 1 ft apart. The plants grew so vigorously that it wasn't feasible to use a cultivator between the rows without severely damaging every other row in the field. A new field was sown in May 4, 2006. Using seed that was collected in the summer of 2004, ACMI was sown using a six-row Planet Jr. equipped with a carbon banding unit. The planter was set up to only plant every other row, creating three rows that were 2 ft apart, instead of six rows that were 1 ft apart (as with the previous field). The field was sprayed with Karmex (a non-selective pre-emergent herbicide) prior to planting. Spotty rain came within two days and no irrigation was set up for the plot. Most seedlings emerged within 2-3 weeks after planting, and stand establishment and vigor was rated high for all species.
AGEX field that had been sown in fall of 2006 had very low emergence and seedlings looked very weak. There was a high amount annual bluegrass (*Poa annua*) within the rows which heavily competed with the AGEX the field was sprayed out and re-sown in the spring. Using a precision cone-seeder, a new field was established on April 24, 2006. The field was not irrigated. Seedlings germinated and remained small throughout the growing season.

Table 3. Spring seeding at the Corvallis Plant Materials Center in 2006 for the Elwha River Ecosystem and Fisheries Restoration Cooperative Agreement.

Species/Ac	**amt seeded**	**germ**	**approximate seeding rate**	**seeds/lb**
ACMI 0.2 acres or 24 180' rows 24" btwn rows	400 g	58%	4 lbs/acre (bulk) 2lbs/acre (PLS) 372 PLS/ft-row	3,117,200
AGEX 0.1 acres or 12 160' rows 12" btwn rows	20 g	75%	0.5 lbs/acre (bulk) 0.4 lbs/acre (PLS) 20 PLS/ft-row	7,153,000

Field Production Notes for 2006:

Weed control in grass fields was primarily performed by hand (mainly to remove exotic perennial grasses) and spraying borders and spot-spraying with glyphosate. Broadleaf herbicides (Bison and Banvel) were applied to grass fields in February and May.

EPAN, ARLU, CAPA, and ANMA fields were hand weeded monthly through May. All forb fields grew vigorously and flowered in the summer. Fields were rouged before harvest to remove any seed-bearing weeds.CAPA and ARLU fields were sprayed with glyphosate in late February before Carex seedlings had emerged.

BRVU and AGEX (fall-sown) fields had very low emergence rates and were severely damaged by freezing or submerged conditions in the winter and spring. Both fields were sprayed out. BRVU is not performing well under dry, sunny conditions. The plants seem to act as annuals in the Corvallis climate and produce little seed. It will be more productive to collect seed from the park and use the wild seed to be used in the restoration. Production fields will not be continued with this species.

EPCI field became crowded with volunteers and was sprayed out. It will be re-established in the spring of 2007 and will be treated as an annual crop in the following years.

Harvest Notes for 2005:

Fields were harvested by hand with rice knives, swathing and combining, seed stripper or the new “moon rover”. DEEL field was swathed and combined again this year. It was swathed at a greener stage than last year. It seems that this species does not after-ripen. Germination, seed size, and overall yields were much lower in the 2006 harvest. Next year, the seed stripper and moon rover will be experimented with.

ACMI field was harvested this year using a Woodward Flail-vac seed stripper. It uses a high speed brush to strip seed off the heads of grasses and dry flower stalks of forbs. It is mounted like the bucket on a front end loader. The unit has proven to be effective for harvesting several species. It was moderately effective for the yarrow. It didn’t remove all of the seed, so multiple passes were needed Also, many low-growing weeds were present in the field at harvest time. Flail-vac harvesters are adjustable in height and can be set to harvest seed off the plants at 1ft off the ground, preventing low-growing weeds and seeds from being harvested.

ELGL and BRsp were both harvested using a “moon rover.” It is a hand-built, self-propelled swather. It has a conveyor belt that moves all material that has been cut and loads it into bags. Two people operate it; one person drives and the other helps feed the material into bags. The moon rover has all the benefits of hand harvesting but greatly reduces the labor involved. Once material was bagged, it was placed onto tarps to dry and cure. It was then fed through a plot thresher and cleaned as usual. The moon rover produced higher yields than swathing/combining and less weeds were present in the seed tests of seed lots that had been harvested with moon rover. It is a great harvest tool for fields that are less than half acre. Larger fields would require a lot of drying space.

Table 4. Seed harvest in 2006 for the Elwha River Ecosystem and Fisheries Restoration Cooperative Agreement at the Corvallis PMC.

Species	Ac.	Date(s)	Method	Yield	Comments
ACMI	0.25	18-Aug	seed stripper	50 lbs	Excellent stand, high vigor
ANMA	0.1	Aug 10- Sept 4	Hand	255 g	Good stand, high vigor
BR sp.	0.42	15-Jun	moon rover	195 lbs	Excellent stand, high vigor
BRVU	0.1	5-Jul	Hand	124 g	very poor stand, low vigor
CADE	0.02	20-Jun	Hand	216 g	small stand, high vigor
CAPA	0.22		Hand	6.4 lbs	good stand, medium vigor
DEEL	0.43	June 16/ June 23	swathed/ combined	90 lbs	Excellent stand, medium vigor
ELGL	0.56	26-Jul	moon rover	52 lbs	Excellent stand, medium vigor
EPAN	0.1	July 5- Aug 15	Hand	252g	fair stand, high vigor
LULA	0.1	12-Jun	Hand	2 g	good stand, high vigor
LUCO	0.01	May 15- June 30	Hand	65 g	small stand, high vigor

Following harvest, BRsp, ELGL, CAPA, DEEL, fields were all burned using drip torches. ACMI would not burn, so it was mowed and raked. EPAN and EPCI fields were cut using a sickle bar mower. Residue was left on the field to hold down the weed fabric over winter, the fields will be cleaned up in spring before plants begin to emerge. ARSU, ANMA, and LULA plants were cut back by hand in late winter to remove previous season's growth.

Days before the rain began in the fall, a new pre-emergent herbicide Outlook was applied to burned fields to control volunteer seedlings and weedy annuals. Results look very promising. Fields are very clean and established plants do not appear damaged.

Fall 2006 Establishment of Seed Increase Fields:

All seed collected in 2005 was cleaned and informal germination tests were performed on most of the seed lots prior to planting. Only two grasses, one rush, and two forbs were selected for fall seeding, other forbs will be seeded in the spring of 2006 after spring germinating weeds have been sprayed out of the fields. After planting, Corvallis experienced heavy rain for 31 consecutive days totaling 15”. Seedlings of the grass species emerged and grew very slowly. Diuron provided fair weed control. Seedlings were still too small to receive an application of broadleaf herbicide in mid-winter. It will be applied when the seedlings are large enough in the spring. ERLA and LUPA are expected to emerge in February of 2007 and hopefully were not damaged by the winter weather. They will be evaluated in the spring.

Table 5. Establishment information for new seed increase fields for the Elwha River Ecosystem and Fisheries Restoration Cooperative Agreement at the Corvallis PMC in 2006.

Species/Ac	Amt seeded	Germ	Approximate seeding rate	Seeds/lb
DEEL				
0.35 acres or			4 lbs/acre (bulk)	
84 181' rows			lbs/acre (PLS)	
12" btwn rows	176 g	81%	PLS/ft-row	1,200,000
PRVU				
0.11 acres or			lbs/acre (bulk)	
36 135' rows			lbs/acre (PLS)	
12" btwn rows	75 g	87%	PLS/ft-row	906,000
AGEX				
0.20 acres or			3 lbs/acre (bulk)	
48 180' rows			3 lbs/acre (PLS)	
12" btwn rows	234 g	98%	PLS/ft-row	2,700,000
ERLA				
0.025 acres or			2 lbs/acre (bulk)	
5 185' rows			1.8 lbs/acre (PLS)	
18" btwn rows	23 g	88%	PLS/ft-row	
LUPA				
0.017 acres or			2 lbs/acre (bulk)	
3 185' rows			1.6 lbs/acre (PLS)	
18" btwn rows	16 g	75%	PLS/ft-row	

Even though a large amount of seed was collected of ELGL and BRsp in 2006, it was not planted into fields. Dam removal has been delayed again; therefore major production will be delayed until two years before planting is expected to occur. The Corvallis PMC will create large fields in the fall of 2007 using the seed that was collected in 2006 and 2007.

VII. Container Plant Production

Some of the seed lots collected from the Elwha watershed were too small or valuable to be seeded with machines. These seeds were planted into containers filled with moistened media (Sunshine #1, a peat-based soil-less media) amended with micronutrients (MicroMax) and a balanced slow-release fertilizer and will be transplanted into a field when appropriate. Trays of CAPA, CADE, JUBO, JUEF, LUCO and ERLA were placed in polyethylene bags and moved into a walk-in cooler after sowing. LUCO trays were removed after three weeks, and all others were removed after five weeks. Upon removal from the cooler, trays were placed in a greenhouse or an outdoor lathhouse to germinate.

Table 6. Container Plant Production in 2006 at the Corvallis PMC for the Elwha River Ecosystem and Fisheries Restoration Cooperative Agreement.

Species	Code	Amt of seed used	date planted	Number of plants produced
Carex deweyana	CAPA14	7g	5/14/2006	1500
Carex pachystachya	CADE	9g	5/14/2006	1300
Eriophyllum lanatum	ERLA	2g	9/16/2006	1500
Juncus bolanderi	JUBO	1 g	10/15/2006	400
Lupinus latifolius var. latifolius	LULA4	70g	9/16/2006	700
Luzula comosa	LUCO	6 g	7/20/2006	400
Vicia americana	VIAM	16 g	9/16/2006	400

Field Production for 2006:

Most fields that were planted in the fall of 2006 will produce seed in 2007. *Deschampsia elongata* and *Bromus vulgaris* fields look less vigorous in fall of 2005 than they did in fall of 2004. These fields may have decreased production on year two and may need to be treated as annuals. Most other fields will have higher yields in 2006 than in 2005. Sedge, rush, and legume fields did not produce seed the first year (except sedge transplants), these fields should flower and set seed in 2006. After planting in the fall of 2006, there are almost four acres of seed increase fields at the PMC for this project.

VIII. Seed Test Results/Delivery of Plant Materials

No deliveries were made in 2006. All seed is being held at the PMC in cold storage until requested.All lots of seed that were produced at the Corvallis PMC were sent to the Oregon State University seed lab for germination and purity tests. Tests were conducted in December of 2005. Results are listed below.

Table 7. Germination and purity test results conducted on seed lots produced at the Corvallis Plant Materials Center.

Species	Yield	Germ	Purity	PLS amt
ACMI[1]	50 lbs	n/a	n/a	n/a
BR sp.	195 lbs	95%	96.08%	178 lbs
CAPA	6.4 lbs			
DEEL (old field)	16 lbs	66%	83.92%	9 lbs
DEEL (new field)	74 lbs	79%	98.41%	57 lbs
ELGL	52 lbs	88%	96.25%	44 lbs

1- test results were not available at reporting time

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

December 30, 2007

THE 2007 OLYMPIC NATIONAL PARK ANNUAL REPORT:
Elwha River Ecosystem and Fisheries Restoration

I. Brief Background of Project

The Corvallis Plant Materials Center (PMC) entered into a new agreement with Olympic National Park in 2004 to provide native plant materials for the ecological restoration of Lake Mills and Lake Aldwell following the removal of two high head dams on the Elwha River. It was agreed that the PMC would propagate a minimum of 4000 lbs of grass and forb seed. A more detailed production list will be determined by PMC and NPS staffs as restoration plans are finalized. Dam removal was again delayed in 2007. Plans now estimate that the dams might be removed in 2012. Most of the fields that are now in production will not survive until 2012 and the seed that is produced from the existing fields (and from previous years) will not be viable in 2012. Possible exceptions are the sedges and legumes. These plants and seeds are long-lived. Seed production on these species will continue in 2008 and future years. Production on all other species will be halted until dam removal plans have been finalized and demolition has begun.

Activities in 2007 included collecting seed of *Lupinus latifolius*; establishment and maintenance of seed production fields including four grasses, two forbs, three rushes, one legume, and three sedges; containerized stock production of eight species; and maintenance of cutting blocks of nine shrubs. Some species were discontinued this year due to change in restoration plans or overproduction in previous years. Details are provided below.

II. Accessions Involved

Table1. Accessions involved and activities performed in 2007 for Elwha River Ecosystem and Fisheries Restoration Cooperative Agreement at the Corvallis Plant Materials Center.

Species	**Common name**	**Symbol**	**Accession number**	**2007 Activity**[1]
Achillea millefolium	common yarrow	ACMI2	9079349	sfp
Agrostis exarata	spiked bentgrass	AGEX	9079401	sfp
Artemisia suksdorfii	coastal wormwood	ARSU4	9079400	sfp
Aruncus dioicus	goatsbeard	ARDI8	9079370	sfp
Bromus complex	Brome complex	BR sp	9079332	sfp
Carex deweyana	Dewey sedge	CADE9	9079330	sfp, pxn
Carex hendersonii	Henderson's sedge	CAHE7	9079331	sfp, pxn
Carex pachystachya	thick-headed sedge	CAPA14	9079329	sfp, pxn
Deschampsia elongata	slender hairgrass	DEEL	9079335	sfp

Table1 (con't). Accessions involved and activities performed in 2007 for Elwha River Ecosystem and Fisheries Restoration Cooperative Agreement at the Corvallis Plant Materials Center.

Species	Common name	Symbol	Accession number	2007 Activity[1]
Elymus glaucus	blue wildrye	ELGL	9079334	sfp
Eriophyllum lanatum	wooly sunflower	ERLA	9079441	sxn
Juncus bolanderi	Bolander's rush	JUBO	9079371	pxn, sfp
Lonicera ciliosa	orange honeysuckle	LOCI3	9079364	cb
Lonicera involucrata	honeysuckle	LOIN	9079363	cb
Lupinus latifolius var. latifolius	broadleaf lupine	LULA4	9079336	pxn, sfp, col
Luzula comosa	Pacific woodrush	LUCO	9079444	pxn, sfp
Luzula parviflora	smallflowered woodrush	LUPA4	9079337	pxn, sfp
Populus balsamifera ssp. trichocarpa	black cottowood	POBAT	9079369	cb
Ribes divaricatum	spreading gooseberry	RIDI	9079365	cb
Ribes lacustre	prickly currant	RILA	9079366	cb
Rosa nutkana	nutka rose	RONU	9079338	cb
Rubus spectabilis	salmonberry	RUSPS	9079362	cb
Salix lucida var. lasiandra	Pacific willow	SALUL	9079368	cb
Salix sitchensis	Sitka willow	SASI2	9079361	cb
Sambucus racemosa	red elderberry	SARA2	9079367	cb
Symphoricarpos albus	common snowberry	SYAL	9079339	cb

1- sfp = seed increase, trl= production research trial, pxn= plant production, col= collected plant materials from park, cb= cutting block

III. Native Seed and Plant Collections

Only one trip occurred this year, due to project delays. Only *L. latifolius* seed was collected this year. It was a bad seed year for Lupines (many seed predators, not much flowering) and 15g of seed was collected.

IV. Experimental Propagation

NPS staff collected seeds of *Lathyrus polyphyllus* this year. Germination trials are being conducted and results will be included in the 2008 report.

V. Cutting Block Maintenance

The base of all willows and elderberry shrubs were wrapped with aluminum foil to prevent damage from rodents. Individuals that had died the previous fall were replaced with healthy cuttings from other plants within the cutting blocks. All cutting blocks were fertilized with a slow release fertilizer in March. Many willows were infested with stem borers this year; stems were cut very low to the ground and hopefully will survive. Cutting blocks will be maintained during project delays.

VI. Field Production Activities

Containerized plants that were produced in the fall of 2006 were transplanted into fields in January 2007. Fields of *Luzula campestris, L. parviflora*, and *L. latifolius*, were established or expanded using transplants. *Juncus bolanderi* plants were transplanted into artificial ponds in January 2007.

Field Production Notes for 2006:

Weed control in grass fields was primarily performed by hand (mainly to remove exotic perennial grasses) and spraying borders and spot-spraying with glyphosate. Broadleaf herbicides (Bison and Banvel) were applied to grass fields in February and May.

Artemisia suksdorfii, *Carex hendersonii*, *Carex pachystacha*, *Carex deweyana*, *L. campestris*, and *L. parviflor*a fields were hand weeded monthly through May. Fields were rouged before harvest to remove any seed-bearing weeds.

Fall sown *Deschampsia elongata* and *Agrostis exerata* fields were fairly weak throughout the winter. These fields were much less vigorous than previous year's fields. They flowered and produced a poor amount of seed. These species might be best produced as spring sown fields. They would not flower on the first year, but they would be healthy established plants during their first winter and would flower the following spring. This adds a half year of maintenance onto the fields, but would probably increase yields.

Harvest Notes for 2007:

Fields were harvested by hand with rice knives, swathing and combining, seed stripper or the new "moon rover". *D. elongata* field was seed-stripped this year. This seems to be the most effective harvest method that the PMC has tried with this species. Seeds were easily stripped from the plants and there was no shatter. Almost all the seed was recovered. Timing is critical with this species. Hot temperatures or winds can turn this species from green seed to shattering in a couple of hours. Fields need to be checked multiple times each day when they are close to being mature.

The seed stripper was also used on the *A. exerata* field. This is the most promising harvest method that the PMC has used on this species. The seed is very tiny and shatters easily. Most harvest methods, such as swathing and combining, are too rough and shatter or blow the seed out the back of the combine. The seed stripper removed all the seed off of the plants and seemed to catch it all. The brush had to be slowed down so it did not spit the seed back out onto the ground. Using a slower brush speed and a faster driving speed than usual, harvest was very efficient. Seed was also very clean. The seed stripper only removed seeds and a bit of chaff from the plant. Minimal cleaning is needed after this form of harvest.

The “moon rover” was used this year on the *C. pachystachya* field. Only the older section of the field was harvested (the younger side barely flowered and was very weedy). The moon rover was an okay harvester for this species. Some seed heads bent over and were not cut. It was possible to drive one way across the field and then turn around and drive the other way across the field to get all the seed heads, but it wasn’t very efficient. This species tends not to shatter too easily. It might be possible to swath and combine this sedge if fields are very large. The PMC fields are still small (under 0.25 acres), but this technique should be tried as fields are expanded.

The *Bromus* complex field experienced some mortality in the older section of the field in the spring of 2007. The PMC had many weeks of severely wet and cold weather in March. There was standing water in the field for days at a time, in the same area that experienced mortality. The newer section of the field looked undamaged.

C. deweyana plants flowered this year, but these plants are still young and have not reached full maturity. Seeds were hand harvested, which was very labor intensive. The moon rover would be a good choice for this field as the plants get larger. If the field size reaches over 0.25 acres, swathing and combining could be an efficient harvest method. This field will be retained and expanded until dam removal.

The *E. glaucus* field reached peak production this year, despite this being a bad year for the grasses. The PMC experienced rain during the flowering periods of many of the grass species in this project. Many other grass growers in the Willamette Valley had lower yields from their grass fields in 2007.

The *L. latifolius* field is growing quite well. Plants are getting larger and flowering more, and the field has been expanded too. This field is doing well considering how limited the wild collections are. It is still inefficient to keep this species as a part of this project because the increase fields are so small, and it will take many years to make them a decent size. But the seeds are very long lived and any seed produced now will be viable when it is needed for the restoration site.

The *Carex hendersonii* plants are performing well at the PMC. This plant is tolerating full sun and moderately heavy clay soils. Plants go dormant soon after flowering, but seem to be getting larger every year and producing a fair amount of seed. The primary constraint in working with this species is the limited amount of seed in the wild.

The *L. parviflora* field flowered for the first time in 2007. Harvest was performed by hand and was very inefficient. This species seems to be really struggling in the PMC fields. The full sun and summer drought have caused a lot of mortality in the seed increase field.

Early fall rains seemed to ruin the flowering and seed maturation of the *A. suksdorfii* field. The plants are large and healthy and this year they were covered with blooms. Unfortunately, the PMC experienced three weeks of rain in September. The rain coincided with the end of the flowering period. The plants were checked multiple times, but no seed was ever found. The field was not harvested.

The *L. comosa* plants are performing well at the PMC. This plant is tolerating full sun and moderately heavy clay soils. Plants go dormant soon after flowering, but seem to be getting larger every year and producing a good amount of seed. The main limitation in working with this species is the limited amount of seed in the wild.

Juncus bolanderi plants flowered this year. Stems were cut by hand using rice knives. This plant will always have to be hand harvested due to the size and shape of the ponds. These plants are growing well in the ponds and are expanding.

Table 2. Seed harvest in 2007 for the Elwha River Ecosystem and Fisheries Restoration Cooperative Agreement at the Corvallis PMC.

Species	**Field size (ac)**	**Date(s)**	**Method**	**Yield**	**Comments**
***Bromus* complex**	0.42	June 13/ June 20	seed stripper	70 lbs	older stand fairly spotty, high/med vigor
Carex deweyana	0.02	June 21	hand	1 lb	small stand, high vigor
Carex pachystachya	0.22	June 19	moon rover	12 lbs	good stand, medium vigor
Deschampsia elongata	0.35	June 27	seed stripper	16 lbs	fair stand, low vigor
Elymus glaucus	0.56	July2, July 12	swath/ combine	142 lbs	Excellent stand, high vigor
Lupinus latifiolius	0.01	May 22- June 20	hand	1 lb	good stand, high vigor
Luzula comosa	0.001	May 29- June 18	hand	0.7 lbs	small stand, high vigor
Agrostis exerata	0.3	July 6	seed stripper	18 lbs	fair stand, med vigor
Carex hendersonii	0.001	June 14	hand	0.1 lbs	small stand, high vigor
Luzula parviflora	0.01	June 14	hand	29 g	fair stand, low vigor

Following harvest, most fields were removed due to delays in the project. Legume and sedge fields were left in and seed production on these species will continue. *E. glaucus* field was left in as a trial plot for herbicide testing. Any seed produced from the field will be used for research purposes and then destroyed.

VII. Container Plant Production

A very small amount of *L. latifolius* seed was collected in 2007 and sown into containers filled with moistened media (Sunshine #1, a peat-based soil-less media) amended with micronutrients (MicroMax) and a balanced slow-release fertilizer. Plants will be transplanted into a field when appropriate.

VIII. Seed Test Results/Delivery of Plant Materials

No deliveries were made in 2007. All seed is being held at the PMC in cold storage until requested. Samples from lots of seed that were produced at the Corvallis PMC were sent to the Oregon State University seed lab for germination and purity tests. Tests were conducted in September of 2007. Results are listed below.

Table 3. Germination and purity test results, and quantities for seed lots produced at the Corvallis Plant Materials Center.

Species	%Purity	Germination	Bulk lbs	PLS lbs
Elymus glaucus	99.16	96	142	135
Deschampsia elongata	85.79	89	16	12
Agrostis exarata	99.48	95	18	17
***Bromus* complex**	99.07	96	70	67
Achillea millefolium[1]	96.77	95	50	46

1-seed lot produced in 2006.

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

December 30, 2005

THE 2005 OLYMPIC NATIONAL PARK ANNUAL REPORT:
Hurricane Ridge Road Revegation Project

I. Brief Background of Project

The Corvallis Plant Materials Center (PMC) entered into a new agreement with Olympic National Park in 2004 to provide native plant materials for revegetation of Hurricane Ridge Road. It was agreed that the PMC would produce a minimum of 255 lbs (PLS) of two lower elevation grasses, 100lbs (PLS) of two upper elevation grasses, and 45lbs of three upper elevation forbs. The PMC is also responsible for collecting a minimum of 3.5 lbs of seed of four native forbs. Delivery is expected in 2007.

Activities in 2005 included collecting seed of ten species (16 accessions), cleaning of native seed collected by PMC staff; expansion, maintenance, and harvest of seed production fields including three grasses, and three forbs; and containerized stock production. Details are provided below.

II. Accessions Involved

Low elevation collection area was defined by the park as the roadsides of Hurricane Ridge Rd from the intersection of Race Rd north to the “double parking area”. High elevation collection area included roadsides from the “Switchbacks” trailhead north to the Visitor’s center parking lot.

Table 1. Accessions involved for Hurricane Ridge Cooperative Agreement at the Corvallis Plant Materials Center.

Species	Common Name	Symbol	Accession Number	2005 Activities[1]
Low elevation				
Elymus glaucus	blue wildrye	ELGL	9079352	sfp, col
Bromus vulgaris	Columbia bromegrass	BRVU	9079353	sfp, col
Eriophyllum lanatum	common woolly sunflower	ERLA6	9079405	col
Achillea millefolium	common yarrow	ACMI2	9079407	col
Anaphalis margaritacea	pearly everlasting	ANMA	9079408	col
Heracleum maximum	common cow parsnip	HEMA80	9079414	col
Chamerion angustifolium	fireweed	CHAN9	9079409	col

Table 1(con't). Accessions involved for Hurricane Ridge Cooperative Agreement at the Corvallis Plant Materials Center.

Species	Common Name	Symbol	Accession Number	2005 Activities[1]
Elymus glaucus	blue wildrye	ELGL	9079356	sfp, col
Bromus sitchensis	Alaska Brome	BRSI	9079357	sfp, col
Eriophyllum lanatum	common woolly sunflower	ERLA6	9079358	sfp, col
Lupinus latifolius	broadleaf lupine	LULA4	9079351	sfp, col
Artemisia ludoviciana	Louisiana sage (white sagebrush)	ARLU	9079359	sfp, col
Achillea millefolium	common yarrow	ACMI2	9079402	col
Anaphalis margaritacea	pearly everlasting	ANMA	9079403	col
Heracleum maximum	common cow parsnip	HEMA80	9079413	col
Chamerion angustifolium	fireweed	CHAN9	9079404	col

[1] Activity codes: col= collected at Park (by PMC staff); sfp= seed produced at PMC.

III. Native Seed and Plant Collections

Table 2. Native Seed and Plant Collection for the Hurricane Ridge Road Cooperative Agreement in 2005 for at the Corvallis Plant Materials Center.

Species	Symbol	Accession Number	Collection dates	Amt
High elevation				
Elymus glaucus	ELGL	9079356	8/22-8/25	550 g
Bromus sitchensis	BRSI	9079357	8/12-8/22	1016 g
Eriophyllum lanatum	ERLA6	9079358	8/22-9/6	324 g
Lupinus latifolius	LULA4	9079351	8/1-8/22	3500 g
Artemisia ludoviciana	ARLU	9079359	9/6-9/8	481g
Achillea millefolium	ACMI2	9079402	9/6-9/8	107 g
Anaphalis margaritacea	ANMA	9079403	9/6-9/8	248 g
Heracleum maximum	HEMA80	9079413	8/22-9/6	1700 g
Chamerion angustifolium	CHAN9	9079404	9/6-9/8	85 g
Low elevation				
Elymus glaucus	ELGL	9079352	8/10-8/25	937g
Bromus vulgaris	BRVU	9079353	8/10-8/25	1423g
Eriophyllum lanatum	ERLA6	9079405	9/6-9/8	15 g
Achillea millefolium	ACMI2	9079407	9/6-9/8	100 g
Anaphalis margaritacea	ANMA	9079408	9/6-9/8	150 g
Heracleum maximum	HEMA80	9079414	8/10-8/25	1450 g
Chamerion angustifolium	CHAN9	9079409	9/6-9/8	125 g

PMC staff was responsible for native seed collections. They were performed primarily along the roadsides of Hurricane Ridge Road. Approximately 184 hours were recorded as actual collection time. A total of 27 lbs of clean seed of ten species was collected in 2005.

III. Field Seed Increase

ARLU field was created using containers grown from fall of 2004. Plants were transplanted into fields in the spring on 1'X1' spacing. Five 130ft rows were planted. Plants grew vigorously and suppressed any possible weed growth. No flowering occurred in 2005.

Table 3. Establishment information for new seed increase fields for the Hurricane Ridge Cooperative Agreement at the Corvallis PMC in 2004.

Species	Amount seeded	Germ	Approximate seeding rate	Seeds/lb
ELGL (LO) 0.18 acres or 60 130' rows 12" btwn rows	846g	94%	10.4lbs/acre(bulk) 9.8lbs/acre (PLS) 28PLS/ft-row	122,000
BRVU 0.25 acres or 84 130' rows 12" btwn rows	1073g	82%	9.5lbs/acre (bulk) 7.8 lbs/acre (PLS) 19 PLS/ft-row	106,000
BRSI 0.20 acres or 66 130' rows 12" btwn rows	945g	55%	10.4lbs/acre(bulk) 5.7lbs/acre (PLS) 9 PLS/ft-row	65,000
ELGL (HI) 0.10 acres or 18 240' rows 12" btwn rows	283g	82%	6lbs/acre (bulk) 5lbs/acre (PLS) 12 PLS/ft-row	99,000
ARLU 0.08 acres or 24 137' rows 24" btwn rows	50g	25%	1.4lbs/acre (bulk) .35lbs/acre (PLS) 20 PLS/ft-row	2,470,000
ERLA 0.10 acres or 30 133' rows 12" btwn rows	261g	35%	6lbs/acre (bulk) 2.1lbs/acre (PLS) 36 PLS/ft-row	720,000

In March of 2005, LULA transplants were used to fill in gaps in the rows that were seeded in the fall. Fall seeding was moderately successful. Slugs, snails, and cucumber beetles were all pests in the LULA planting. These pests reduced the number of surviving seedlings. "Slug-go" was sprinkled over the plot to control slugs and snails, "Bio-neem" oil & soap was applied as a foliar spray on plants to prevent predation from cucumber beetles. Sulfur dust was applied to plants that exhibited powdery mildew. Weed control in the fields was performed by hand.

All seed collected in 2005 was cleaned and informal germination tests were performed on most of the seed lots prior to planting. Grasses, ERLA and ARLU were seeded into fields on October 21, 2005 using a six-row Planet Jr. seeder. All fields were carbon banded while sowing, then sprayed with Diuron. Fall rains began the day after both seeding and spraying were completed so no fall irrigation was needed. Most seedlings emerged within 2-3 weeks after planting, and stand establishment and vigor was rated high for all species, except ARLU, no plants emerged. BRSI and ERLA will be evaluated in the spring, these seed exhibit a physiological dormancy and will not germinate until February. Diuron provided fair weed control. Banvel was applied in November to grass fields to control broadleaves. Glyphosate was applied over ERLA fields in November to control all weeds.

IV. Field Production Activities

Weed control was primarily performed by hand (mainly to remove exotic perennial grasses) and spraying borders and spot-spraying with glyphosate. Broadleaf herbicides (Bison and Banvel) were applied to grass fields in February and May.

Seed was harvested from established stands of *Bromus vulgaris*, *Bromus sitchensis*, both high and low ecotypes of *Elymus glaucus* and *Eriophyllum lanatum*. The *Lupinus latifolia* and *Artemisia ludoviciana* fields did not flower in 2005.

Table 4. Field Production at Corvallis Plant Material Center in 2005 for the Hurricane Ridge Rd project.

Species	**Area Harvested**	**Date(s)**	**Method**	**Yield**	**Comments**
ELGL (LO)	0.11 acres	July 11	swath/ combine	10.5lbs	Excellent stand, high vigor
BRVU	0.13 acres	July 11	swath/ combine	7lbs	Good stand, fair vigor
BRSI	0.033 acres	7/15-30	hand	333g	Poor stand, good vigor
ELGL (HI)	0.06 acres	8/12	hand	363g	Poor stand, low vigor
ERLA	0.046 acres	9/15	hand	107g	Fair stand, good vigor

After harvest, residue was removed from grass fields using a Brady flail chopper. It mows and vacuums, spitting all material up into a large tow-behind trailer. Cutting height was set at three inches.

Lots larger than five pounds were sampled and sent to the Oregon State University Seed Laboratory for germination and purity testing. Excess seed was returned by the lab and is being stored at the Corvallis PMC until delivery is requested. Seed lots that are less than five pounds will be bulked with 2006 production and sent in for testing in the fall of 2006.

Table 5. Test Results for Seed Lots Produced in 2005 by the Corvallis Plant Materials Center for the Hurricane Ridge Rd project.

Species	% Germination	% Purity	Bulk Amt	PLS Amt
ELGL (LO)	91	97.97	10.5lbs	9.36lbs
BRVU	71	88.49	7	4.4lbs
BRSI[1]	59	N/A	333g	N/A
ELGL (HI)[1]	98	N/A	363g	N/A
ERLA[1]	N/A	N/A	107g	N/A

1-seed lot is less than five pound and was not tested at OSU seed lab germ tests were informal ones performed at PMC.

VII. Delivery of Plant Materials

No deliveries were made in 2004.

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

December 30, 2006

THE 2006 OLYMPIC NATIONAL PARK ANNUAL REPORT:
Hurricane Ridge Road Revegetation Project

I. Brief Background of Project

The Corvallis Plant Materials Center (PMC) entered into a new agreement with Olympic National Park in 2004 to provide native plant materials for revegetation of Hurricane Ridge Road. It was agreed that the PMC would produce a minimum of 255 lbs (PLS) of two lower elevation grasses, 100 lbs (PLS) of two upper elevation grasses, and 45 lbs of three upper elevation forbs. The PMC is also responsible for collecting a minimum of 3.5 lbs of seed of four native forbs. Delivery is planned to occur in fall of 2007. Activities in 2006 included collecting seed of seven species, cleaning of native seed collected by PMC staff; expansion, maintenance, and harvest of seed production fields including three grasses and three forbs; and containerized stock production. Details are provided below.

II. Accessions Involved

NPS staff defined the low elevation collection area to be the roadsides of Hurricane Ridge Rd. from the intersection of Race Rd. north to the “double parking area”. High elevation collection area included roadsides from the “Switchbacks” trailhead north to the Visitor’s Center parking lot.

Table 1. Accessions involved for Hurricane Ridge Road Cooperative Agreement at the Corvallis Plant Materials Center.

Species	Common Name	Symbol	Accession Number	2005 Activities[1]
Low elevation				
Elymus glaucus	blue wildrye	**ELGL**	9079352	sfp,
Bromus vulgaris	Columbia bromegrass	**BRVU**	9079353	sfp, col
Eriophyllum lanatum	common woolly sunflower	**ERLA6**	9079405	-
Achillea millefolium	common yarrow	**ACMI2**	9079407	-
Anaphalis margaritacea	pearly everlasting	**ANMA**	9079408	-
Heracleum maximum	common cow parsnip	**HEMA80**	9079414	col
Chamerion angustifolium	fireweed	**CHAN9**	9079409	-
High elevation				
Elymus glaucus	blue wildrye	**ELGL**	9079356	sfp
Bromus sitchensis	Alaska Brome	**BRSI**	9079357	sfp, col

Table 1 (con't). Accessions involved for Hurricane Ridge Road Cooperative Agreement at the Corvallis Plant Materials Center.

Species	Common Name	Symbol	Accession Number	2005 Activities[1]
Eriophyllum lanatum	common woolly sunflower	**ERLA6**	9079358	sfp
Lupinus latifolius	broadleaf lupine	**LULA4**	9079351	sfp, col
Artemisia ludoviciana	Louisiana sage (white sagebrush)	**ARLU**	9079359	sfp, col
Achillea millefolium	common yarrow	**ACMI2**	9079402	col
Anaphalis margaritacea	pearly everlasting	**ANMA**	9079403	col
Heracleum maximum	common cow parsnip	**HEMA80**	9079413	-
Chamerion angustifolium	fireweed	**CHAN9**	9079404	col

[1] Activity codes: col= collected at Park (by PMC staff); sfp= seed produced at PMC.

III. Native Seed and Plant Collections

PMC staff was responsible for native seed collections. They were performed primarily along the roadsides of Hurricane Ridge Road. Approximately 96 hours were recorded as actual collection time. A total of 27 lbs of clean seed of seven species was collected in 2006.

Table 2. Native seed and plant collection for the Hurricane Ridge Road Cooperative Agreement in 2006 at the Corvallis Plant Materials Center.

Species	Symbol	Accession Number	Collection dates	Amt
High elevation				
Elymus glaucus	ELGL	9079356	8/22-8/25	100 g
Eriophyllum lanatum	ERLA6	9079358	8/22-9/6	0.5 lbs
Lupinus latifolius	LULA4	9079351	8/1-8/22	2 lbs
Artemisia ludoviciana	ARLU	9079359	9/6-9/8	100 g
Achillea millefolium	ACMI2	9079402	9/6-9/8	100 g
Anaphalis margaritacea	ANMA	9079403	9/6-9/8	150 g
Heracleum maximum	HEMA80	9079413	8/22-9/6	1 lb
Chamerion angustifolium	CHAN9	9079404	9/6-9/8	240 g
Low elevation				
Bromus vulgaris	BRVU	9079353	8/10-8/25	4 lbs

III. Field Seed Increase

The winter of 2005 was very wet and cold. Fields often had standing water. *Lupinus latifolius*, *Eriophyllum lanatum*, and *Artemesia ludoviciana* fields were inundated with water for two weeks continuously in December. Even though the plants and seeds were covered with water for at least 30 days during the winter, existing plants survived, and seedlings emerged in the spring with very minimal damage.

As soon as the water receded in the spring, slugs, snails, and cucumber beetles were pests in the *L. latifolius*, and *A. ludoviciana* plantings. “Slug-go” was sprinkled over the plot to control slugs and snails, “Bio-neem” oil & soap was applied as a foliar spray on plants to prevent predation from cucumber beetles. Sulfur dust was applied to plants that exhibited powdery mildew. Weed control in the fields was performed by hand.

All of the grass fields, except the *Bromus vulgaris*, survived the winter. The *B. vulgaris* field was severely damaged. Few plants survived, and those that did were very weak and flowered late.

IV. Field Production Activities

Weed control was primarily performed by hand (mainly to remove exotic perennial grasses) and spraying borders and spot-spraying with glyphosate. Broadleaf herbicides (Bison and Banvel) were applied to grass fields in February and May. Forb fields were weeded entirely by hand multiple times throughout the growing season.

Seed was harvested from new and established stands of *B. vulgaris*, *Bromus sitchensis*, and the low ecotype of *Elymus glaucus*. Only the established section of the high elevation of *E. glaucus* flowered in 2006; the new section did not. The *L. latifolius, E. lanatum* and *A. ludoviciana* fields that were over one year old (established in the fall of 2004) flowered in 2006. The newer sections of the fields (ones that were seeded the in the fall of 2005) did not flower. Harvest areas presented in Table 4 (below), include only areas that flowered and do not represent total field sizes.

Table 4. Field production at Corvallis Plant Material Center in 2006 for the Hurricane Ridge Rd. Project.

Species	**Area (ac)**	**Date(s)**	**Method**	**Yield**	**Comments**
ELGL (LO)	0.25	July 3/ July 17	swath/ combine	106 lbs	Excellent stand, high vigor
BRVU	0.25	10-Jul	hand	152 g	Poor stand, low vigor
BRSI	0.2	26-Jun	moon rover	3 lbs	Good stand, good vigor
ELGL (HI)	0.06	7-Jul	moon rover	9 lbs	Good stand, good vigor
ARLU	0.02	5-Jul	hand	160 g	Fair stand, high vigor
LULA4	0.04	July5 - Aug 3	hand	1 lb	Good stand, good vigor
ERLA	0.046	18-Jul	moon rover	8 lbs	Excellent stand, high vigor

A new harvester, informally named the “moon rover”, was used this year. It is a hand-built, self propelled swather. It has a conveyer belt that moves all material after it is cut and loads it into bags. Two people operate the machine with one person driving and the other helping feed the material into bags. The machine has all the benefits of hand harvesting without the labor. Once material was bagged it was emptied out on to tarps to dry and cure. It was then fed through a plot thresher, and cleaned as usual. After harvest, all grass fields were mowed with a Brady flail-chopper to remove post-harvest residue. Forb fields were not mowed. The flail chopper was able to remove most of the residue on the grass fields. Because the fields were quite clean, a new pre-emergent herbicide, Outlook®, was applied to the grass fields. Initial results look very promising. Volunteer seedlings and weed seedlings are very sparse and the crops do not appear any less vigorous.

Seed lots larger than five pounds were sampled and sent to the Oregon State University Seed Laboratory for germination and purity testing. Excess seed was returned by the lab and is being stored at the Corvallis PMC until delivery is requested. Lots that are less than five pounds will be bulked with 2007 production and sent in for testing in the fall of 2007.

Table 5. Test results for seed lots produced in 2006 by the Corvallis Plant Materials Center for the Hurricane Ridge Rd. Project.

Species	% Germination	% Purity	Bulk Amt	PLS Amt
ELGL (LO)	97	99.41	106 lbs	102 lbs
BRVU[1]	N/A	N/A		N/A
BRSI[1]	N/A	N/A		N/A
ELGL (HI)	91	98.49	9 lbs	8 lbs
ERLA	91 (TZ)	96.31	8 lb	7 lbs

1-seed lot is less than five pounds and was not tested at OSU seed lab.

VII. Delivery of Plant Materials

No deliveries were made in 2006.

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

December 30, 2007

THE 2007 OLYMPIC NATIONAL PARK ANNUAL REPORT:
Hurricane Ridge Road Revegetation Project

I. Brief Background of Project

The Corvallis Plant Materials Center (PMC) entered into a new agreement with Olympic National Park in 2004 to provide native plant materials for revegetation of Hurricane Ridge Road. It was agreed that the PMC would produce a minimum of 255 lbs (PLS) of two lower elevation grasses, 100 lbs (PLS) of two upper elevation grasses, and 45 lbs of three upper elevation forbs. The PMC is also responsible for collecting a minimum of 3.5 lbs of seed of four native forbs. Delivery was planned to occur in fall of 2007. Due to funding constraints, the construction has not begun and is scheduled to be complete in the fall of 2009. Seed will be held at the PMC until it is needed by the Park.

Activities in 2007 included collecting seed of four species, cleaning of native seed collected by PMC staff and maintenance and harvest of seed production fields including three grasses and three forbs. Details are provided below.

II. Accessions Involved

NPS staff defined the low elevation collection area to be the roadsides of Hurricane Ridge Rd. from the intersection of Race St. south to the “double parking area”. High elevation collection area included roadsides from the “Switchbacks” trailhead west to the Visitor’s Center parking lot.

Table 1. Accessions involved for Hurricane Ridge Road Cooperative Agreement at the Corvallis Plant Materials Center.

Species	Common Name	Symbol	Accession Number	2007 Activities[1]
Low elevation				
Elymus glaucus	blue wildrye	**ELGL**	9079352	sfp
Bromus vulgaris	Columbia bromegrass	**BRVU**	9079353	sfp, col
Eriophyllum lanatum	common woolly sunflower	**ERLA6**	9079405	-
Achillea millefolium	common yarrow	**ACMI2**	9079407	-
Anaphalis margaritacea	pearly everlasting	**ANMA**	9079408	-
Heracleum maximum	common cow parsnip	**HEMA80**	9079414	
Chamerion angustifolium	fireweed	**CHAN9**	9079409	-

High elevation				
Elymus glaucus	blue wildrye	**ELGL**	9079356	sfp, col
Bromus sitchensis	Alaska Brome	**BRSI**	9079357	sfp, col
Eriophyllum lanatum	common woolly sunflower	**ERLA6**	9079358	sfp
Lupinus latifolius	broadleaf lupine	**LULA4**	9079351	sfp, col
Artemisia ludoviciana	Louisiana sage (white sagebrush)	**ARLU**	9079359	sfp
Achillea millefolium	common yarrow	**ACMI2**	9079402	-
Anaphalis margaritacea	pearly everlasting	**ANMA**	9079403	-
Heracleum maximum	common cow parsnip	**HEMA80**	9079413	-
Chamerion angustifolium	fireweed	**CHAN9**	9079404	-

[1] Activity codes: col= collected at Park (by PMC staff); sfp= seed produced at PMC.

III. Native Seed and Plant Collections

PMC staff was responsible for native seed collections. They were performed primarily along the roadsides of Hurricane Ridge Road. Approximately 30 hours were recorded as actual collection time. A total of 9 lbs of clean seed of four species was collected in 2007.

Table 2. Native seed collection for the Hurricane Ridge Road Cooperative Agreement in 2007 at the Corvallis Plant Materials Center.

Species	Symbol	Accession number	Collection dates	Amt
High elevation				
Elymus glaucus	ELGL	9079356	8/22-8/25	1 lb
Bromus sitchensis	BRSI	9079357	8/12-8/22	2 lbs
Lupinus latifolius	LULA4	9079351	8/1-8/22	15 g
Low elevation				
Bromus vulgaris	BRVU	9079353	8/10-8/25	1 lb

IV. Field Seed Increase

In the spring, slugs, snails, and cucumber beetles were pests in the *Lupinus latifolius*, and *Artemisia ludoviciana* plantings. “Slug-go” was sprinkled over the plot to control slugs and snails, “Bio-neem” oil & soap was applied as a foliar spray on plants to prevent predation from cucumber beetles. Sulfur dust was applied to plants that exhibited powdery mildew. Broadleaf herbicides (Bison and Banvel) were applied to grass fields (except *Bromus sitchensis* field) in February and May. Forb fields were weeded entirely by hand multiple times throughout the growing season.

Mortality in the *L. latifolius* plot was higher this winter. Plot remains about 50% full. Existing plants are vigorous and flowered well. Seeds were collected by hand as they matured.

A. ludoviciana plants did not flower as much in 2007 as they did in 2006. Plants that had been established by transplants in the spring of 2005 barely flowered, although plants were still vigorous. Seeds were collected by hand in two harvests.

Eriophyllum lanatum field was very vigorous and the stand is full. It is a very nice field and is the best performing forb in this agreement. Field was harvested using the "moon rover" (a self-propelled swather). Material was spread out on tarps to dry. Four weeks after harvest, it was run through a small Wintersteiger plot combine. It had to be run through twice to remove all the seeds from the heads.

The *B. sitchensis* field struggled through the winter and spring. Plants were slow growing in the spring and appeared stressed. Therefore, this field was not sprayed with spring broadleaf herbicides. Flowering was spotty and maturity was incredibly uneven. To maximize the small yield, the field was harvested multiple times by hand. This field was removed in the fall of 2007.

The low ecotype of *Elymus glaucus* has always performed well at the PMC, this year, filled seed was hard to find. The plants were vigorous and the stand was excellent. The field was swathed and combined. While combining, it was noticed that many seeds were empty. The high elevation ecotype of *E. glaucus* looked even worse this year. The section of the field that was planted in the fall of 2005 barely flowered this year, and the older section didn't perform much better. The stand is thin and the existing plants are struggling. Field was harvested using the "moon rover" and seeds were threshed using a plot thresher. Plot was removed in the fall of 2007.

Table 4. Field production at Corvallis Plant Materials Center in 2007 for the Hurricane Ridge Rd. Project.

Species	Area (ac)	Date(s)	Method	Yield	Comments
ELGL (LO)	0.25	July 6- July 13	swath/ combine	65 lbs	Excellent stand, high vigor
BRSI	0.2	June19- July 3	hand	8 lbs	poor stand, good vigor
ELGL (HI)	0.06	July 25	moon rover	10 lbs	poor stand, low vigor
ARLU	0.1	July 5	hand	2 lbs	Fair stand, high vigor
LULA4	0.1	May30- June30	hand	1 lb	Poor stand, good vigor
ERLA	0.15	August 1	moon rover	13 lbs	Excellent stand, high vigor

After harvest, all grass fields were mowed with a Brady flail-chopper to remove post-harvest residue. Forb fields were not mowed.

Samples from seed lots larger than five pounds were sent to the Oregon State University Seed Laboratory for germination and purity testing. Excess seed was returned by the lab and is also being stored at the Corvallis PMC until delivery is requested. Seed lots that are less than five pounds will bulked with 2006 production and sent in for testing in the fall of 2008.

Table 5. Test results for seed lots produced in 2007 by the Corvallis Plant Materials Center for the Hurricane Ridge Rd. Project.

Species	Purity	Germ	Bulk lbs produced in 2007	PLS lbs produced in 2007
Elymus glaucus (high)	94.74	91	10.25	8.83
Elymus glaucus (low)	98.59	96	65	61
Eriophyllum lanatum	97.85	64	13	8

VII. Delivery of Plant Materials

No deliveries were made in 2007.

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

December 30, 2005

THE 2005 MOUNT RAINIER NATIONAL PARK ANNUAL REPORT:
State Road 123 Revegetation Project

I. Brief Background of Project

The Corvallis Plant Materials Center (PMC) entered into a new agreement with Mount Rainier National Park in 2004 to provide native plant materials for the ecological restoration of the State Road 123 construction area. It was agreed that the PMC would produce a minimum of 25 lbs (PLS) of *Elymus glaucus*, 50 lbs (PLS) of *Bromus carinatus*, and 25 lbs (PLS) of *Festuca rubra*.

Activities in 2005 included cleaning of native seed collected by NPS staff, establishment, maintenance, harvest and seed cleaning of three grass seed increase fields.

II. Accessions Involved

Accessions included for State Road 123 are listed in Table 1. This table also displays activities performed by PMC staff in 2005.

Table 1. Accessions involved for State Road 123 cooperative agreement with Corvallis Plant Materials Center in 2005.

Scientific Name	Common Name	Symbol	Accession #	2005 Activity[1]
Bromus carinatus	California brome	BRCA5	9079309	Sfp
Elymus glaucus	blue wildrye	ELGL	9079310	Sfp
Festuca rubra	Red fescue	FERU	9079308	Sfp

1- sfp= seed field production.

III. Experimental Propagation

There was no experimental propagation in 2005.

IV. Field Seed Increase

Park staff provided the PMC with seed for fall planting. On October 21, 2005 fields of FERU and BRCA5 were expanded using a six-row Plantet-jr seeder with a carbon-banding unit. Fields were sprayed with Diuron after planting. Seedlings emerged within 2-3 weeks. Soon after planting, many days of hard rain pelted the seedlings, but did not seem to cause any significant damage. Fields were sprayed with Banvel in late November to control broadleaf weeds.

Table 2. Seed Increase Field Establishment October, 2005.

Species/ Ac	Seeding Rate	Method	Weed Control
BRCA .05 acre 12 150' rows	10 (bulk)lbs/acre	Seeded with six-row Planet Jr. seeder	none
FERU .08 acres 24 150'rows	4 (bulk)lbs/acre	Seeded with six-row Planet Jr. equipped with a carbon-banding unit	Diuron application following carbon banding

2005 Field Seed Production Notes:

All three fields were fertilized in October 2004 with 25 lbs/ac nitrogen (N), and in February with 50 lbs/ac N plus 15 lbs/ac sulfur (S). Weed control within the plots was mainly performed by hand-hoeing and rouging. Glyphosate was used on the field borders. Grass fields were mowed using a Brady flail chopper to remove residue.

Table 3. Seed Harvested for State Road 123 Revegetation Project at Corvallis Plant Materials Center in 2005.

Species	Area Harvested	Date(s)	Method	Yield	Comments
BRCA5	.045 acre	June 25	Hand	35lbs	Good stand, high vigor
FERU	.04	July 20	Swath/ combine	934g	Excellent stand, high vigor
ELGL	.58 acre	July 12	Swath/ combine	221lbs	Excellent stand, high vigor

After harvest, FERU field was burned using drip torches. Three one-meter plots were sprayed with water prior to burning to act as control plots. These plots remained unburned as the fire passed, and will be evaluated for seed yields in 2006.

V. Delivery of Plant Materials.

A portion of the seed produced was requested for delivery on September 10, 2005. It was mailed to the park and the remaining seed will be stored at the PMC until requested. The FERU produced at the PMC in 2005 was contaminated with many weeds that could not be removed. Park staff collected 100g of wild FERU seed in 2005, it was combined with the field produced FERU and used to expand the existing field.

Table 4. Seed Delivered on September 10, 2005 to Mount Rainier National Park.

Species	Bulk Amt delivered	% Germination	% Purity	PLS amt delivered	Amount Remaining
BRCA5	55lbs	88	98.71	47.8lbs	0
ELGL	68lbs	95	99.3	64.1lbs	144lbs

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

November 30, 2006

THE 2006 MOUNT RAINIER NATIONAL PARK ANNUAL REPORT:
State Road 123 Revegetation Project

I. Brief Background of Project

The Corvallis Plant Materials Center (PMC) entered into a new agreement with Mount Rainier National Park in 2004 to provide native plant materials for the ecological restoration of the State Road 123 construction area. It was agreed that the PMC would produce a minimum of 25 lbs (PLS) of *Elymus glaucus*, 50 lbs (PLS) of *Bromus carinatus*, and 25 lbs (PLS) of *Festuca rubra*. A delivery of seed was scheduled to occur in fall of 2006 and the project should be completed in the fall of 2007.

Activities in 2006 included cleaning of native seed collected by NPS staff, establishment, maintenance, harvest and seed cleaning of three grass seed increase fields.

II. Accessions Involved

Accessions included for State Road 123 are listed in Table 1. This table also displays activities performed by PMC staff in 2006.

Table 1. Accessions involved for State Road 123 Revegetation Project with Corvallis Plant Materials Center in 2006.

Scientific Name	Common Name	Symbol	Accession #	2005 Activity[1]
Bromus carinatus	California brome	BRCA5	9079309	sfp
Elymus glaucus	blue wildrye	ELGL	9079310	sfp
Festuca rubra	red fescue	FERU	9079348	sfp

1- sfp = seed field production.

III. Experimental Propagation

There was no experimental propagation in 2006.

IV. Seed Increase

Park staff provided the PMC with seed for fall planting. On October 21, 2006 fields of FERU and BRCA5 were expanded using a six-row Plantet-jr® seeder with a carbon-banding unit. Fields were sprayed with Diuron (a non-selective pre-emergent herbicide) after planting. Fall rains began within a week of planting, therefore no irrigation was needed. Seedlings emerged within 2-3 weeks. The ELGL field did not need to be expanded this year.

Table 2. Seed increase field establishment October, 2006.

Species/ Ac	Seeding Rate	Method	Weed Control
Bromus carinatus 0.17 acre 48 150' rows	13 (bulk)lbs/acre	Seeded with six-row Planet Jr. seeder equipped with a carbon-banding unit	Diuron application following carbon banding
Festuca rubra 0.07 acres 18 150'rows	3 (bulk)lbs/acre	Seeded with six-row Planet Jr. equipped with a carbon-banding unit	Diuron application following carbon banding

2005 Field Seed Production Notes:

All three fields (only the portions that were over 1 year old) were fertilized in October 2005 with 25 lbs/ac nitrogen (N), and in February 2006 with 50 lbs/ac N plus 15 lbs/ac sulfur (S). Weed control within the plots was mainly performed by hand-hoeing and rouging. Glyphosate was used on the field borders. Grass fields were burned using drip torches following harvest. In mid October, a new pre-emergent herbicide, Outlook®, was applied to all fields that had been harvested in 2006. It will be evaluated in the winter and spring for effectiveness.

The *Festuca rubra* field was harvested by a hand-crafted machine nick-named the "moon rover." It is a self-propelled swather. The machine uses a conveyer belt to move all material after it is cut and loads it into bags. Two people operate it. One person drives and the other helps feed the material into bags. The moon rover has all the benefits of hand harvesting without the labor. Once material was bagged, it was placed onto tarps to dry and cure. It was then fed through a plot thresher and cleaned as usual.

Table 3. Seed Harvested for State Road 123 Revegetation Project at Corvallis Plant Materials Center in 2006.

Species	Area Harvested	Date(s)	Method	Yield	Comments
Bromus carinatus	.045 acre	June 26	Seed stripper	20 lbs	Fair stand, high vigor
Festuca rubra	0.12 acre	June 23	Moon rover	26 lbs	Excellent stand, high vigor
Elymus glaucus	0.58 acre	June 29	Swath/ combine	270 lbs	Excellent stand, high vigor

After harvest in 2005, *Festuca rubra* field was burned using drip torches. Three one-meter plots were sprayed with water prior to burning to act as control plots. These plots remained unburned as the fire passed, and were evaluated for seed yields in 2006. Vegetation and seed was harvested from six plants in unburned plots and six plants in the burned area of the field. Plants in the unburned plants had more vegetation than the burned plants. Burned plants produced, on average, 10g more seed per plant than unburned plants. Burning also reduces thatch on the fields which makes pre-emergent herbicides more effective.

V. Delivery of Plant Materials.

A portion of the seed produced was requested for delivery on September 12, 2006. It was mailed to the park and the remaining seed will be stored at the PMC until requested.

Table 4. Seed delivered on September 12, 2006 to Mount Rainier National Park.

Species	Bulk Amt delivered	% Germination	% Purity	PLS amt delivered	Amount Remaining
Bromus carinatus	20 lbs	90	99.44	17.9	0
Festuca rubra	26 lbs	91	91.28	23.5	0
Elymus glaucus	88 lbs	96	98.89	21.6	181 lbs of 2006 seed 144 lbs of 2005 seed

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

October 29, 2007

THE 2007 MOUNT RAINIER NATIONAL PARK ANNUAL REPORT:
State Road 123 Revegetation Project

I. Brief Background of Project

The Corvallis Plant Materials Center (PMC) entered into a new agreement with Mount Rainier National Park in 2004 to provide native plant materials for the ecological restoration of the State Road 123 construction area. It was agreed that the PMC would produce a minimum of 25 lbs (PLS) of *Elymus glaucus*, 50 lbs (PLS) of *Bromus carinatus*, and 25 lbs (PLS) of *Festuca rubra*. A final seed delivery was scheduled for the fall of 2007 when the project was completed. These fields may be continued to produce seeds for use in restoring flood-damaged areas.

Activities in 2007 included maintenance, harvest and seed cleaning of three grass seed increase fields.

II. Accessions Involved

Accessions included for State Road 123 are listed in Table 1. This table also displays activities performed by PMC staff in 2007.

Table 1. Accessions involved for State Road 123 Revegetation Project with Corvallis Plant Materials Center in 2007.

Scientific Name	Common Name	Symbol	Accession #	2007 Activity[1]
Bromus carinatus	California brome	BRCA5	9079309	sfp
Elymus glaucus	blue wildrye	ELGL	9079310	sfp, dlv
Festuca rubra	red fescue	FERU	9079348	sfp

1- sfp= seed field production, dlv= delivery.

III. Experimental Propagation

There was no experimental propagation in 2007.

IV. Seed Increase

The older sections of the *Bromus carinatus*, *Festuca rubra*, and *Elymus glaucus* fields looked fair after winter. The PMC experienced many hard frosts in March. The fields were still slightly dormant and didn't seem affected by the freezing temperatures. The new sections of the *B. carinatus* and *F. rubra* fields were growing quite slowly during the spring, but once air temperatures reached 65° (F) the plants grew vigorously. The new *F. rubra* section did not flower in 2007, although the *B. carinatus* flowered and produced a good amount of seed. The *E.*

glaucus field looked vigorous, but when it flowered the stand seemed thin. After it was swathed, the PMC received a two inches of summer rain. This caused a lot of seed to shatter on the ground before it was dry enough to be combined. This field is very old (for a blue wildrye field) and it is not surprising to see the drop in production, which was worsened by the summer rains that interfered with harvesting.

Table 2. Seed Harvested for State Road 123 Revegetation Project at Corvallis Plant Materials Center in 2007.

Species	**Area Harvested**	**Date(s)**	**Method**	**Yield**	**Comments**
Bromus carinatus	0.18 acres	July 2	"Moon rover"	55 lbs	Good stand, high vigor
Festuca rubra	0.12 acres	June 27	Seed stripper	53 lbs	Excellent stand, high vigor
Elymus glaucus	0.58 acres	July 6/ July 23	Swath/ combine	38 lbs	Excellent stand, medium vigor

2007 Field Seed Production Notes:

All three fields (only the portions that were over 1 year old) were fertilized in October 2006 with 25 lbs/ac nitrogen (N), and in February 2007 with 50 lbs/ac N plus 15 lbs/ac sulfur (S). Weed control within the plots was mainly performed by hand-hoeing and rouging, and broadleaf herbicides. Field borders were cultivated periodically throughout the year. After harvest, fields were burned using drip torches. In mid October of 2006, a new pre-emergent herbicide, Outlook®, was applied to all fields that had been harvested in 2006. The herbicide didn't seem to cause any injury to the established plants and fields were very clean. The PMC will continue to use this herbicide as a weed control method on second year fields. It may not be necessary to use it every year on the fields. More research on timing of applications will be performed on other grass seed increase fields at the PMC.

V. Delivery of Plant Materials

Only 50 lbs of *E. glaucus* was requested for delivery in the fall of 2007. It was mailed to the park and the remaining seed will be stored at the PMC until requested.

Table 4. Seed delivered on September 20, 2007 to Mount Rainier National Park.

Species	**Bulk amount delivered**	**Germi-nation %**	**Purity %**	**PLS amount delivered**	**(PLS)Amount remaining**
Bromus carinatus	0	91	99.75	0	50 lbs of 2007 seed
Festuca rubra	0	86	98.40	0	45 lbs of 2007 seed
Elymus glaucus	72 lbs	95	99.30	67.92 lbs	36 lbs of 2007 seed 181 lbs of 2006 seed 76 lbs of 2005 seed

CORVALLIS PLANT MATERIALS CENTER
NATURAL RESOURCES CONSERVATION SERVICE
CORVALLIS, OREGON
Amy Bartow
December 30, 2007

THE 2007 US ARMY/OREGON MILITARY DEPARTMENT ANNUAL REPORT:
Camp Rilea Seed Increase Project

I. Brief Background of Project

The Corvallis Plant Materials Center (PMC) entered into a new agreement with the US Army (specifically with the Oregon Military Department (OMD) in 2007 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 now extirpated from Camp Rilea due to the loss of disturbance in its coastal meadow habitat. The early blue violet is the obligate host to the silverspot caterpillars and has also been negatively impacted in its coastal meadow ranges by the encroachment of tall, spreading exotic plants. Seed increase on the violets will provide a source for future seedling grow-outs which can then be transplanted back into areas of Oregon silverspot butterfly habitat enhancement and restoration. Production of nectar plants or other matrix species will be added to this agreement if seeds and funds become available.

II. Accessions Involved

The table below lists the accessions involved in this project. Activities in 2007 included seed collection and cleaning of three species, production of violets, and germination trials.

Table 1. Accessions in the Camp Rilea seed increase project.

Species	Common name	Symbol	Accession	Activity in 2007[1]
Viola adunca	early blue violet	VIAD	9079558	col, pxn
Carex pansa	dune sedge	CAPA16	9079563	trl
Solidago simplex ssp. *simplex* var. *spathulata*	dune goldenrod	SOSIS4	9079532	trl

1- trl= germination trials, col= wild seed collection, pxn=plant production

III. Seed Collections

On June 4th, 2007 PMC staff and OMD staff traveled to Camp Rilea to collect violet seeds. *V. adunca* seeds were collected from many areas across the base. OMD staff returned to collect more seeds on June 20th, 2007. Collections from each Area (defined by OMD maps) and each date were kept separately in paper envelopes in an open greenhouse (used as a drying shed).

Table 2. Native seed collections in 2007 for the Camp Rilea seed increase project.

Species	Accession	Collection dates	Amount collected	Seeds/lb
Viola adunca	9079558	June 6, June 20	15 g	470,000
Carex pansa	9079563	Sept 20- Oct 4	2356 g	540,000
Solidago simplex ssp. *simplex* var. *spathulata*	9079532	Sept 9- Dec 18	105 g	2,000,000

Carex pansa seeds were collected by OMC staff on September 20 and October 4th, 2007. Seeds do not shatter easily and can be harvested successfully for months after seeds are mature. Germination trials began in late September and the seed will be sown into a seed increase field in the spring. The goldenrod was collected many times during the late summer and early fall. OMD staff collected early, mid, and late blooming plants. Seed was cleaned at the PMC and will be used to grow containerized plants in 2008.

IV. Germination Trials

C. pansa has never been propagated at the PMC, therefore informal germination trials were performed. Replications of 100 seeds were counted and placed under different stratification periods. Seeds in the warm treatment (80° F days/ 65°F nights) showed some germination after 4 weeks, but germination was less than 10% for each of the three replications after 10 weeks. The 45 or 90-day cold stratification treatment did not improve germination. It was then inferred that the seeds may have a physical dormancy rather than a physiological dormancy.

Table 3. Stratification trials on *Carex pansa* for the Camp Rilea seed increase project.

Treatment	Rep	% Germination	Notes
Warm, no scarification	1	9	Germination occurred between 35-60 days after sowing
	2	11	
	3	12	
45 day cold stratification, no scarification	1	10	Germination occurred 10-20 days after removal from the cooler
	2	12	
	3	11	
90 day cold stratification, no scarification	1	12	Germination occurred between 10-20 days after removal from the cooler
	2	9	
	3	10	

A Forsburg seed scarifier was used to de-hull the seeds. The hulls of *C. pansa* are extremely hard to remove. The seeds were placed in the scarifier for varying amounts of time and then placed in a warm growth chamber (80° F days/ 65°F nights). Three minutes in the scarifier seemed to de-hull a high percentage (approximately 75%) of the seed. In this treatment, the de-hulled seeds were selected for the germination trial. There were no broken or chipped seeds using this time interval.

Table 4. Scarification trials on *Carex pansa* for the Camp Rilea seed increase project.

Treatment	Rep	Germination %	Notes
Warm, scarify for 30 seconds	1	3	Germination occurred 10-20 days after sowing
	2	6	
	3	4	
Warm, scarify for 1 minute	1	6	Germination occurred 10-20 days after sowing
	2	9	
	3	5	
Warm, scarify for 2 minutes	1	6	Germination occurred 17-20 days after sowing
	2	8	
	3	7	
Warm, completely deulled	1	56	Germination occurred 5-12 days after sowing
	2	62	

Seeds that received scarification but were not completely de-hulled did not show an improvement in germination. These tests were concluded after 21 days; the stratification trials were observed for 2 months. This explains the slightly higher germination in the warm treatment without scarification versus the warm treatments with scarification. The de-hulled seeds readily germinated (within five days). It is concluded that seeds must be completely de-hulled before sowing into a seed increase field and will germinate in warm temperatures. De-hulled seed will be sown into the seed increase field in late spring. There are approximately 540,000 hulled *C. pansa* seeds per pound. De-hulled seed weighs considerably less and there are approximately 1,540,000 de-hulled seeds per pound. This needs to be considered when determining seeding rates.

Solidago simplex ssp. *simplex* var. *spathulata* seeds were germinated in a warm (75-80° F) growth chamber. The seeds germinated within two weeks and germination was 65% for the wild collected seed lot.

V. Container Plant Production

After drying, *V. adunca* seeds were cleaned using small hand screens and placed in germination boxes on moistened germination paper. Boxes were left in a walk-in cooler (40° F) for 120 days for cold-moist stratification to break seed dormancy. Boxes were removed on October 15, 2007.

APPENDIX

Plant Fact Sheets and Plant Guides

United States Department of Agriculture
Natural Resources Conservation Service

Plant Fact Sheet

LEMMON'S NEEDLEGRASS
Achnatherum lemmonii (Vasey) Barkworth
Plant Symbol = ACLE8

Contributed by: *USDA NRCS Plant Materials Center, Corvallis, Oregon*

Dale Darris
USDA NRCS Corvallis PMC

Alternate Names: Also known as Lemmon's stipa, *Stipa lemmonii* (Vasey) Scribner. Other scientific names are *Achnatherum lemmonii* subsp. *pubescens* and *Achnatherum lemmonii* var. *jonesii*.

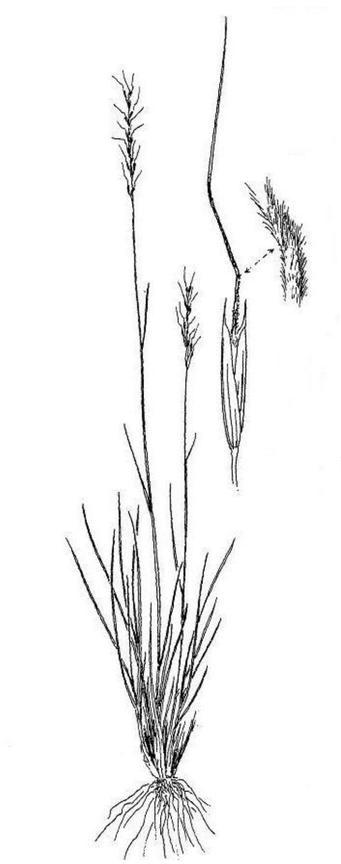
Uses: Lemmon's needlegrass is a desirable cool season bunchgrass for restoration of upland prairies and oak savannas, including sites representing extremes in both drought and soil infertility. In western Oregon and western Washington its best use may be revegetation of hot, sunny, dry, south facing slopes and rocky outcrops with impoverished or weakly developed soils. In drier and nearly semi-arid regions of the western US, the species can be used for rangeland plantings as a component of seed mixtures.

Lemmon's needlegrass is a valuable forage plant and has good palatability for deer, sheep, and cattle. It produces large seeds that are important food for birds and small mammals. The species may have potential in low maintenance lawns or xeric landscaping.

Description: Lemmon's needlegrass is a medium to long lived, relatively short, densely tufted perennial grass with culms (stems) that are 20-80 cm tall and hairy below the nodes (joints). Leaf blades are 10-20 cm long, 1-2 mm wide, flat or rolled inward, and often blue-green in color. The form is spreading to upright and the inflorescence (seed head or panicle) is spike-like, narrow, and pale or purplish in color. Spikelets are one flowered. The subspecies *pubescens* has pubescent or tomentose culms. Lemmon's needlegrass flowers in May and seeds mature by mid June in the foothills of western Oregon.

Key to Identification: Lemmon's needlegrass has a distinct spike-like seed head and long awns (linear appendages that are 15-50 mm but typically 20-35 mm) on the seed that are bent twice and twisted at maturity. The species can easily be confused with other grasses in the genus *Stipa* or *Achnatherum.* However, other needlegrasses are less likely to occur at low elevations west of the Cascades from the Willamette Valley northward. Western needlegrass (*Stipa occidentalis*) can co-exist at mid-elevations but its seed is much smaller than Lemmon's needlegrass. Without seed heads the fine textured bluish foliage of Lemmon's needlegrass may be confused with Roemer's fescue (*Festuca roemeri*) which has a broader, branching panicle.

Adaptation: Lemmon's needlegrass is found naturally in northern and western California, including the Sierra Nevada Mountains, north to southern British Columbia and east to Montana, Utah, and Arizona. The species has deep fibrous roots and is very drought tolerant. Stands typically occur on dry sunny slopes, grasslands, savannas, openings within pine woodlands, and upland prairies from sea-level to 7500 ft. elevation. It is adapted to low fertility and moderately acid to slightly alkaline (pH 5.0-7.5), shallow soils derived from basalts. Soil texture ranges from gravelly to medium fine loams and silts. The subspecies *pubescens* is restricted to serpentine soils (soils high in silicates of magnesium and iron as well as other minerals and therefore toxic to many plants).



Line drawing reprinted by permission,
University of Washington Press

Commercial availability of seed: Seed is periodically available in California from vendors. In addition, the Bureau of Land Management and the US Forest Service contract with private growers to produce Lemmon's needlegrass for their restoration work and growers sometimes sell extra seed. Most of this seed originates from east of the Cascades or southern Oregon. Willamette Valley and western Washington sources may be limited to wild collections.

Relative abundance in the wild: This species is infrequent in the Willamette Valley and Puget lowlands where it is often confined to foothills and south slopes. It is more common east of the Cascades as well as in southern Oregon and California.

Limitations or environmental concerns:
Lemmon's needlegrass has high seed dormancy and delayed germination which can allow weedy species to establish first. After seedling emergence, establishment is still relatively slow. Plants are shade intolerant. It can be disease prone on winter wet to summer moist sites where it is maladapted or a weak competitor. Like other needlegrasses, the long awned seed can cause injury to the mouth and other facial tissues of livestock.

Establishment: The awns on the seed should be removed by a debearder or other device in order to plant using standard seeding equipment. Germination for most seed lots improves substantially with 60-90 days of cold, moist chilling (stratification). Therefore, direct seeding should be in the fall to overcome dormancy. In some cases, light scarification of the seed coat has improved germination as well. There are approximately 95,000 seeds/lb (+/- 15%) with awns removed but hulls intact. One pound of live seed sown per acre is equivalent to about 2.2 live seeds per square foot. For best results and easier management, sow alone at 4-8 lbs/ac or at lower rates in mixes with other species that have similar seed dormancy. Where winters are relatively mild and snow free, seed may germinate outdoors as early as January. Control of fall and winter weeds is essential for initial stand establishment, otherwise results can be poor. Good results can be achieved with the use of a nonselective foliar applied herbicide after sowing but prior to emergence of Lemmon's needlegrass. The species tolerates light to moderate grazing and fire as natural components of prairie ecosystems.

Prepared By:
Dale Darris, Sonja Johnson, and Amy Bartow. USDA NRCS Plant Materials Center, Corvallis, Oregon.

Species Coordinator:
Dale Darris, USDA NRCS Plant Materials Center, Corvallis, Oregon.

Edited 7/31/07 D. Darris; 070802 jsp

For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

Plant Fact Sheet

SPIKE BENTGRASS

Agrostis exarata Trin.

Plant symbol = AGEX

Contributed by: USDA NRCS Plant Materials Center, Corvallis, Oregon

Dale Darris
USDA NRCS Corvallis PMC

Alternate names: Other common names include spike redtop and western bentgrass. There are three recognized varieties: *A. exarata.* var. *exarata, A. exarata.* var. *pacifica* Vasey, and *A. exarata*. var. *monolepis* (Torrey) Hitchc. Spike bentgrass apparently hybridizes with *A. scabra* and *A. stolonifera.*

Uses: As a pioneer species, spike bentgrass has good potential for restoration of prairie wetlands, riparian areas, and other seasonally wet or intermittently flooded habitats. It is also useful for revegetation of ditches, logged or burned over timberland, and other disturbances within brush and open woodland communities.

Where locally abundant, this species is an important source of forage for livestock. Foliage remains green and palatable throughout the summer. Its palatability is rated good for cattle, horses, and elk, and fair to good for sheep and deer. Spike bentgrass is also planted as a soil stabilizer in degraded areas and has been suggested for use in excluding reed canarygrass (*Phalaris arundinacea*). Value for wildlife habitat is ranked high for numerous birds and mammals. Compared to many bentgrasses, spike bentgrass is considered by some as more compatible with other native grasses, forbs, and trees.

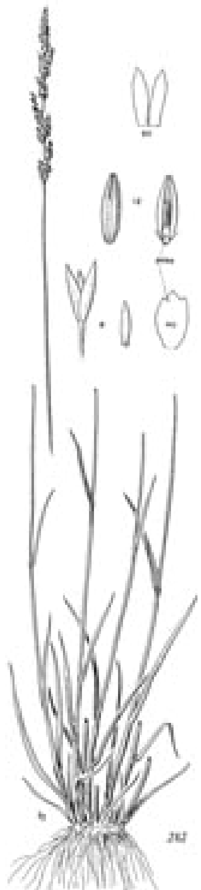
Description: Spike bentgrass is a medium textured, cool season, perennial bunchgrass with a dense, spike-like flower head (panicle). The stems (culms) are slender and erect, usually 50 to 100 (150) cm tall. The leaf blades are 2 to 20 mm wide, 5 to 20 cm long, and harsh to the touch. This species contains considerable variability, from dwarf alpine forms to taller, more robust specimens along the seacoast. Some texts indicate the occasional presence of short rhizomes and root development or growing points at lower nodes, but rhizomes appear to be lacking on plants in our area. This species is found mostly in the western United States and Canada.

Key to identification: Compared to most other bentgrasses, the panicle is particularly narrow and more spike-like. It is 10 to 25 cm long. The individual flower groups (spikelets) are very tiny and 1-flowered. A botanical grass key may be required to accurately distinguish it from other bentgrasses.

Relative abundance in the wild: Spike bentgrass is relatively common is western Oregon, western Washington, and California. It can be locally abundant on moist sites throughout the western states. The species produces large quantities of tiny seeds with good retention that are easy to harvest or collect. It is usually not found in large pure stands, but occurs as scattered individuals or small colonies across a landscape.

Adaptation: Spike bentgrass has broad adaptation to a wide variety of habitats. Despite the tiny seed size, it is easy to establish and a high seed producer with good commercial potential. Spike bentgrass occurs in a wide variety of habitats including forest openings, grasslands, shrub lands, wet meadows, freshwater and high tidal marshes, as well as along streams, rocky beaches, and lake margins. It is most commonly found in moist open places, but occasionally grows in dry habitats such as semi-arid grasslands. Relatively shade intolerant, this species performs well on moderately acidic, mineral soils.

While most prevalent on disturbed sites such as ditches, harvested forestland, and roadsides, it may also be found in established meadow and riparian plant communities. Habitats range from sea level to alpine zones**.** This species occurs mostly in the western United States and Canada.



Line drawing reprinted by permission, University of Washington Press

Establishment: Some recommend a light debearding to remove the seed appendage (awn) in order to facilitate further seed cleaning and sowing with a drill. The seed has no dormancy and germinates readily. There are approximately 5,600,000 seeds/lb (+/- 20%). A seeding rate of 1 lb/acre of pure live seed would result in 125 live seeds per square foot. Given the small seed size, the single species seeding rate is generally 1-3 lbs/acre, but some literature recommends a rate of 3-5 or up to 8 lbs/acre to attain a full stand. The species establishes easily on moist, mineral soil in spring or fall. However, the seed readily migrates in flood prone areas so a thin mulch layer coupled with a late summer or early fall plantings may be preferred.

Management: Information on this species is limited. Moderate amounts of forage are produced and utilized by livestock, large game, and other wildlife well into summer. The ability of spike bentgrass to easily volunteer on moist, disturbed ground and readily produce seed makes it a candidate for moist soil management of wetland habitat for waterfowl, shorebirds, and other wildlife.

Limitations or environmental concerns:
Due to its abundant seed production and broad adaptability, it may be considered weedy in certain environments. Please consult with your local NRCS Field Office, Cooperative Extension Service office, or state natural resource or agriculture department regarding its status and use.

Commercial availability of seed: Several seed sources are available for California and at least one for the Willamette Valley of Oregon. Ecotypes may be harder to locate for other western states.

Prepared By:
Dale Darris and Amy Bartow, USDA NRCS Plant Materials Center, Corvallis, Oregon.

Species Coordinator:
Dale Darris, USDA NRCS Plant Materials Center, Corvallis, Oregon.

Edited: 16mar2006 jsp, 16sept2008 dcd.

For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

AMERICAN SLOUGHGRASS
Beckmannia syzigachne (Steud.) Fern.
Plant symbol = BESY

Contributed by: USDA NRCS Plant Materials Center, Corvallis, Oregon

Dale Darris
USDA NRCS Corvallis PMC

Alternate Names
Other common names include western sloughgrass, caterpillar grass.

Uses
American sloughgrass is native cool season grass important for wetland restoration as well as erosion control along ditches, streams, waterways, and the shorelines of lakes or ponds. It is valuable as a wetland forage species and is hayed or grazed in some regions. The seeds provide important food for waterfowl, seed-eating birds, and small mammals. The species has been commonly sown for wetland wildlife habitat. Palatability is rated high for all classes of livestock. It provides relatively quick and reliable cover under appropriate growing conditions.

Status
Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g. threatened or endangered species, state noxious status, and wetland indicator values).

Description and Adaptation
American sloughgrass is an annual or short-lived perennial bunchgrass with stout, leafy stems (culms) that are 60 to 100 cm tall. The flower head (inflorescence) is a very narrow, upright spike, 20 to 30 cm long. It has a double row of densely compacted, 1-flowered spikelets on one side of the panicle branches. The seed with hull attached is nearly flat and disk-like in shape. This species occurs in the cooler parts of North America, particularly the north central and northwestern United States, as well as southern Canada, Alaska, and a portion of eastern Europe and Asia. However, it is not found at mid or high elevations and has not been collected in western Washington**.** Seedling vigor and establishment are moderately rapid. The plant flowers in June and goes to seed in July or August in western Oregon.

Adaptation: American sloughgrass is best adapted to poorly drained, irrigated, and somewhat acidic to alkaline soils with shallow water tables. It performs best on clay soils covered with a thin layer of organic matter, but grows on coarser substrates as well. Habitats include marshes, vernal pools and depressions within wetland prairies, pond shores, shallow water, and other flooded or seasonally wet sites. American sloughgrass thrives where the soils are saturated at or near the surface year round. It will also maintain itself under continuous, year round flooding up to 10 cm deep. Studies have shown that survival rapidly declines beginning at depths of 15 cm and beyond. It is intolerant of summer dry soils and shade.

Relative abundance in the wild: High in western Oregon. This species may be scarce or rare in other parts of its natural range. Individual plants usually contain many seed heads, which produce abundant seed. The seed does not shatter readily which creates a large window of time for easy collection.

Establishment
American sloughgrass lacks complex seed dormancy characteristics and rapidly colonizes mudflats or

other recently exposed moist soil. Reports of percent seed germination vary, but it may be improved by rubbing or hulling the seed (and in turn possible light abrasion of the seed coat), and by providing alternating temperature regimes. The best time to plant is in the fall, or as a dormant seeding, which will promote early spring establishment. Surface sown seed readily floats and migrates with flowing water, so insure adequate but shallow soil or mulch coverage. Generally, stands decline after three to five years on adapted sites. There are 240,000 seeds/lb (+/- 20%) with hulls intact. Recommended single species seeding rates can vary widely, depending on the site and purpose of the planting. Range is 5-18 lbs/ac. One lb of live seed per acre is equivalent to 5 to 6 live seeds per square foot.

Line drawing reprinted with permission, University of Washington Press

Management

In the Northern Plains, forage production is considered moderate to high. As a short-lived species, a pattern of deferred, rotational grazing may be needed every two or three years to allow for seed production and natural regeneration of the stand. It will require a high water table or regular irrigation during the dry season. Sloughgrass has the ability to readily volunteer on exposed mudflats or other moist, disturbed ground and produce abundant seed crops. This makes it a good candidate for moist soil management (slow de-watering, disking, etc.) of certain wetlands and shallow water impoundments for waterfowl, shorebird, and other wildlife habitat.

Environmental Concerns

Relatively narrow ecological adaptation. While sloughgrass is usually replaced by more competitive grasses over time, it is sometimes considered weedy in low lying seed production field of introduced grasses in western Oregon. It can volunteer readily after tillage.

Cultivars, Improved, and Selected Materials (and area of origin)

'Egan' American sloughgrass was released as a cultivar by the Alaska Plant Materials Center in Palmer, Alaska in 1986 for wetland reclamation. Seed sources are relatively common for western Oregon, Alaska, and the north central US, but less so elsewhere.

Contact your local Natural Resources Conservation Service (formerly Soil Conservation Service) office for more information. Look in the phone book under "United States Government". The Natural Resources Conservation Service will be listed under the subheading "Department of Agriculture."

Prepared By:

Dale Darris and Amy Bartow, USDA NRCS Plant Materials Center, Corvallis, Oregon.

Species Coordinator:

Dale Darris, USDA NRCS Plant Materials Center, Corvallis, Oregon.

Edited: 16mar2006 jsp,, 4sept2008 dcd.

For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

Plant Fact Sheet

CALIFORNIA BROME

Bromus carinatus **Hook. & Arn.**

plant symbol = BRCA5

Contributed by: USDA NRCS Plant Materials Center, Corvallis, Oregon

Dale Darris
USDA NRCS Corvallis PMC

Alternate names: Some taxonomic treatments include mountain brome (*Bromus marginatus*), (*Bromus carinatus* var. *marginatus*) and others. Consult the Flora of North America, Volume 24 (2007) and Intermountain Flora, Volume 6 (1977).

Uses: California brome is a medium-tall, competitive, native bunchgrass valued for its rapid and easy establishment in revegetation and erosion control. It is also widely used for rehabilitation after wildfires and mining, rangeland improvement, and restoration of upland plant communities. This species is considered to be a moderately to highly productive, nutritious, and palatable forage relished by all classes of livestock prior to maturity. In some ranges it is important summer forage for elk, but considered less palatable to deer. Bear, geese, and various rodents also consume the foliage. The deep fibrous root system makes the plant fairly resistant to grazing and drought. While a good range grass, used alone it may not be suitable for permanent pasture because of its short longevity. One of the better uses of California brome may be as a native competitor to aid in the reduction of exotic weeds a year or two in advance of planting other native grasses. California brome provides good cover for wildlife and the seed is consumed by small mammals and game birds. It is sometimes recommended as a cover crop for vineyards and orchards in California.

Description: California brome is a native, cool-season, annual, biennial, or short-lived perennial bunchgrass. It is a highly variable species. The base of this robust plant is very open with coarse, erect to spreading stems (culms) that grow 45-120 cm tall. Leaf blades are 1-12 mm wide, lax and spread out along stems. The inflorescence (seed head , panicle) is 10-30 cm long, large, open, and erect to somewhat drooping. The root system is deep and widespread.

Key to identification: California brome intergrades with mountain brome and some authors classify both as the same species. For additional information on *Bromus marginatus* refer to the species Plant Guide available from the PLANTS Web site. Other species are also very difficult to distinguish from California brome so a current taxonomic key should be consulted. Sitka brome (*Bromus sitchensis*) is a good example and their natural habitats overlap considerably. Both occur in full sun, but Sitka brome can also be found in somewhat shadier environments. According to some taxonomists, Sitka brome is taller with broader, more drooping panicles and spikelets (subunits of the seedhead) that occur more toward the tip of the branchlets compared to California brome. Pacific brome (*Bromus pacificus*) can also be confused with both bromes, but its leaves are soft hairy (on at least one side) and it has other distinguishing features. Pacific brome occurs mainly along the Pacific Coast in moist habitats but extends inland to the Puget trough of Washington at low elevations.

Adaptation: California brome is widely distributed in western North America from British Columbia and Alberta south to California and Mexico and eastward to Montana, Wyoming, Colorado, and New Mexico. It occurs in open areas including meadows, coastal prairies, montane slopes, and waste places as well as open woodlands, oak savanna, sagebrush, and chaparral from sea level to 11,000 ft in elevation. The species is adapted to moderately moist to dry soils with a pH of 5.5 to 8.0. While tolerant of somewhat poor drainage and fine textured silty clays, best growth is attained on medium-textured or loamy soils with good drainage. It is found in environments with full sun to slight shade. The species withstands fall fires and controlled burns and will sprout from surviving crowns. In other cases, stands may top kill but full stand recovery occurs after a few years.

Commercial availability: Seed of selections derived from local, natural sources as well as cultivated releases are available for use in parts of the West. When selecting a seed source, consideration should be given to ecological sensitivity of the site as well as the origin of the seed stock. Wild seed is common in open areas, meadows, and waste places.

Cultivars, Improved, and Selected Materials (and area of origin): NRCS selected class germplasm releases include Southern Cal 1000 (Orange Co., CA), Coastal 500 (San Luis Obispo Co., CA), Central Coast 2600 (Santa Barbara Co., CA), Central Sierra 3200 (Yuba Co., CA), and Northern Cal 40 (Point Contra Costa Co., CA). NRCS also released the cultivar 'Cucamonga' (Rancho Cucamonga, CA). Additional information and detailed descriptions for many releases are given in the Bromus carinatus Plant Guide available from the PLANTS Web site and your local State NRCS office.

<Line drawing used with permission, Univ. of Washington Press

Limitations or environmental concerns: California brome spreads easily by seed and can quickly become a moderate to serious weed pest in certain agricultural crops. Its use should generally be avoided in certain areas of intensive agriculture such as fields of introduced grasses grown for seed. Seed may remain viable in the soil for several years. High seeding rates in mixes with other less competitive native grasses should be avoided. California brome is susceptible to a disease called head smut. Wild stands or fields to be harvested for seed should be inspected carefully for the disease and infected plants avoided or removed. Smut can be controlled by treating the seed with an approved fungicide prior to sowing. Leaf and stem rusts are other potential pests.

Establishment: Seed dormancy is usually absent in natural populations from low elevation so California brome can be fall or spring sown. Germination occurs in 10-14 days and seedling growth and plant development are rapid. However, seed obtained from higher elevation populations may have dormancy requiring 30-90 days of cold moist stratification (moist pre-chilling) or fall sowing for best germination. Physical conditioning of the seed to remove the awns (narrow appendage at the tip of the seed) is an option to improve flow through seeding equipment. There are 60, 000-82,000 seeds/lb with the upper range associated with de-awned seed. Therefore, each pound of seed planted per acre will result in about 1.5-2.0 seeds/sq. ft. When sown alone, the suggested rate is 8-10 lbs of pure live seed (PLS) per acre. Lower rates (1-3 lbs/ac) should be used in seed mixes with less competitive grasses.

Stand management depends on your project objectives (prairie restoration, cover crop, rotational livestock grazing, etc.). As a cover crop, the species has intermediate tolerance to mowing. Fire is an effective tool for post harvest residue management in seed production. The species decreases under heavy grazing but increases with light to moderate use.

Prepared By:
Dale Darris, USDA NRCS Plant Materials Center, Corvallis, Oregon. July 2007.

Species Coordinator:
Dale Darris, USDA NRCS Plant Materials Center, Corvallis, Oregon.

Edited: 070723 jsp, 080904 cs and dcd

For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

Plant Fact Sheet

COLUMBIA BROME
Bromus vulgaris (Hook.) Shear

plant symbol = BRVU

Contributed by: USDA NRCS Plant Materials Center, Corvallis, Oregon

Dale Darris
USDA NRCS Corvallis PMC

Alternate names: Narrow-flowered brome is another common name.

Uses: Columbia brome is a native upland grass useful for erosion control and revegetation along shady streambanks, ravines, and roadsides. The species is also important for the restoration of moist to relatively dry understory woodland plant communities. The fibrous root system aids in soil retention especially on steeper, rocky, north facing slopes. Ranked high as palatable livestock forage, Columbia brome is valuable for grazing at mid to higher elevations in certain western ranges. It's affinity for shade lends application to silvopastural systems (combined tree and forage production). Elk utilize it in spring and other ungulates presumably graze it as well. The seed and plants serve as food and cover for small mammals and birds.

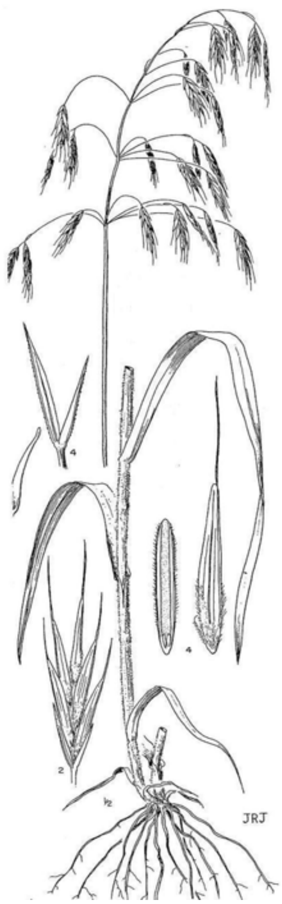
Description: Columbia brome is a cool season perennial bunchgrass that is short to medium lived depending on growing conditions. The base is loosely clumped and non-rhizomatous although rooting may (rarely) occur from lower nodes along the stems (culms). The culms are 45-120 cm tall and erect to spreading, often with hairy nodes (joints). Inflorescences (seedheads or panicles) are 8-22 cm long, spreading to drooping, typically with the slender, compressed spikelets (subunits of the seedhead) all hanging in the same direction. Leaves are course textured (5-12 mm wide), often hairy on at least one side, basal to part way up the stems, lax, and flat.

Key to identification: Despite the typical hairy nodes and uniform orientation of the drooping seedheads, Columbia brome is difficult to distinguish from three other native bromes that occur in the western US, often in similar habitats: fringed brome (*Bromus ciliatus*), Orcutt's brome (*Bromus orcuttianus*), and woodland or Chinook brome (*Bromus laevipes*). Refer to a botanical key for detailed descriptions of traits and proper identification. It should not be confused with false brome (*Brachypodium sylvaticum*), a weedy and invasive introduced grass that also grows in woodland situations. The spikelets of both species noticeably droop, but on Columbia brome they are clearly stalked (i.e. on short branchlets) and on false brome they are not.

Adaptation: Columbia brome is widely distributed in the western US and Canada from sea level to an elevation of 6500 ft. In the US it occurs from Washington south to California and west to Montana, Wyoming, and Utah. It strongly prefers shaded habitats including woodland edges and the floor of hardwood and coniferous forest types. Survival in open areas appears more limited to ravines, north facing slopes, seepage areas, and montane meadows.

Soil adaptation varies from volcanic ash to deep, moderately well and well drained sandy loams, loams, silts, and clays that are moderately acid to slightly alkaline (pH 5.4 to 7.9) with generally rich nutrient regimes. The species is found in disturbed environments such as along streams and in clearcuts, as well as in mature undisturbed forests. In natural settings, response to fire varies with litter dryness and intensity of burn, but is generally considered neutral in terms of regeneration. Prolonged smoldering can destroy plants. Tolerances to saline, flooded or saturated soil conditions are low.

Commercial availability: A few seed sources from Oregon and California are periodically for sale.



Line drawing reprinted with permission,
University of Washington Press

Relative abundance in the wild: Columbia brome is very common in both disturbed and undisturbed forest environments. Seed is relatively easy to hand collect but shatters (separates from the seedhead) readily at maturity.

Limitations or environmental concerns: This species can be initially slow to germinate and sometimes difficult to establish, especially on open, dry, sunny sites where it is maladapted. It is often difficult to grow for seed on open farmland where plants may appear stressed and die after one growing season. There are no known environmental concerns.

Establishment: Seed dormancy has not been reported for Columbia brome, but germination can be staggered or delayed for several weeks, especially if spring sown. Fall seeding in cool soils is recommended. No special physical conditioning of the seed is required for use in a drill or broadcast seeder, but removal of the awn (linear appendage) and minute hair from the seed improves seed flow in some equipment.

Establishment rate from seed is moderately fast after germination. There are approximately 95,000 (+/-20%) seeds per pound with seed hulls intact and 108,000 seeds per pound with hulls removed (naked seed). Therefore, each 1 pound of live seed sown per acre is equivalent to approximately 2 to 2.5 live seeds per square foot. Sown alone, a suggested minimum seeding rate is 15-20 lbs of pure live seed (PLS) per acre for general revegetation.

When grown for seed, fields should be situated on the north side of tall windbreaks or in other wooded settings to receive partial shade. Good soil fertility and drainage are needed. Burning for post harvest residue management is not recommended at this time. Hulls often separate from the seed and seed may be damaged during mechanical harvest with a combine. Stands are typically variable and frequently short lived. Management requirements for livestock utilization are not well reported but may approach those of other native bromes provided there is partial shade.

Prepared By:
Dale Darris, USDA NRCS Plant Materials Center, Corvallis, Oregon. June 2007.

Species Coordinator:
Dale Darris, USDA NRCS Plant Materials Center, Corvallis, Oregon.

For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

Plant Fact Sheet

BLUEJOINT

Calamagrostis canadensis (Michx.) Beauv.

Plant symbol = CACA4

Contributed by: USDA NRCS Plant Materials Center, Corvallis, Oregon

Dale Darris
USDA NRCS Corvallis PMC

Alternate Names: Other common names include bluejoint reedgrass, Canada bluejoint, Canadian reedgrass, meadow pinegrass, marsh reedgrass, and marsh pinegrass. There are four botanical varieties.

Uses: Bluejoint is a mid-sized to tall native grass useful for wetland restoration and enhancement as well as shoreline and streambank stabilization. Creeping underground shoots (rhizomes) improve the plants ability to bind soil, especially along higher gradient streams and waterways. It is included in hydroseeding mixtures for drainage ditches designed to filter stormwater. This species provides forage for bison, elk, and deer, as well as food and habitat for small mammals, waterfowl, birds, and bears. It furnishes substantial amounts of herbage and stands have been hayed in the Midwestern states. Forage value varies widely by region with ratings from poor to good for all classes of livestock. Palatability is considered fair at best regardless of livestock type. It is highest in the spring prior to maturity.

Status: Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g. threatened or endangered species, state noxious status, and wetland indicator values).

Description and Adaptation: Bluejoint is a long lived, perennial cool season grass with stout stems that grows 60 to 180 cm tall. There are 3 to 8 prominent joints (nodes) along the stems. This species spreads slowly (5 to 15 cm/year) by rhizomes forming a sod. Leaves are ribbed, lax, rough to the touch, and 3 to 8 mm wide. The flower head (panicle) is rather narrow to open and loosely branched, upright to drooping when mature, and 10 to 20 (30) cm long. Flowering occurs in late June or July and the seed matures in August. The tiny seeds have fine hairs attached at one end of their hull and are easily windborne. They remain viable in the soil for up to 5 (7) years. Bluejoint occurs from low to mid-elevation across most of Canada and the United States, except for the Southeast.

Adaptation: Bluejoint can be found in a wide variety of environments including meadows, open woods, wet thickets or swamps, marshes, bogs, ditches, and the margins of streams and lakes. It can readily colonize disturbed areas especially in colder northern forests following logging or fire. This species thrives in more nutrient rich, saturated soils, peat, or deep, fine textured substrates that are moist all summer. Reportedly, bluejoint only withstands seasonal inundation and temporary spring flooding up to 15 cm deep. However, stands have maintained themselves for several years in permanent standing water at similar depths. This species is adapted to very acid to slightly alkaline soils (pH 3.5 to 8).

Key to identification: This species resembles reed canarygrass (*Phalaris arundinacea*) but the latter is coarser textured, has much larger, smooth seed, and produces reddish rhizomes near the soil surface. Consult a botanical key to distinguish bluejoint from other *Calamagrostis* species.

Relative abundance in the wild: Common in many areas of the northern boreal and temperate forests, it is scarce to nonexistent in the Willamette Valley of Oregon, but more common along the Pacific Coast near lakes, in the Puget lowlands of Washington, and at mid-elevations in the Mountains. Seed ripens in late summer. Collection can be difficult due to poor or erratic seed production.

Line drawing reprinted with permission, University of Washington Press

Establishment: Bluejoint seed has no dormancy and germinates when fall or spring sown. The basal hairs on the seed should be removed with a debearder to improve seed flow. Hulls may be removed in the process, resulting in approximately 4 million seeds/lb (+/- 20%). A seeding rate of 1/lb per acre will result in about 92 seeds per square foot. Because seed is expensive, it typically comprises 1 to 20 percent of a wetland mix. Rates as low as 0.03 to 0.06 lbs/ac are suggested. Rhizomes and plugs are more successful. One source recommends a spacing of 6, 12 or 18 inches for uniform aerial coverage in 1, 2 or 3 years. The planting density is 3500 to 7000 plants/ac.

Management: This species is sensitive to overgrazing in some regions and multiple cuttings can reduce forage yields. Foliage is most palatable when young, prior to seed head maturation. Coincidently, moist soil conditions may restrict spring grazing. Therefore, livestock utilization should be timed according to how dry the soils are and the stage of plant maturity.

Weediness and control: This plant may become weedy or invasive in some regions or habitats and may exclude desirable vegetation if not properly managed. Methods of control for reforestation include using herbicide applications, biological control with diseases, minimal or specialized mechanical site preparation methods, and deep burning, hot fires. If bluejoint is a problem in your area, please consult your local NRCS, Extension Service, state forestry or agriculture department offices regarding the plants use and control measures.

Environmental Concerns: Poor seed fill can occur in many populations. In contrast, regeneration and spread from seed and rhizomes can be highly prolific on moist sites in the northern boreal forests of Canada. As a result, bluejoint is a serious competitor to white spruce seedlings and other conifer reforestation efforts in that region. After logging, light fires, or other disturbances, it can increase quickly, forming a complete stand with a thick layer of thatch that restricts establishment of other species. Bluejoint is a minor weed in cranberry bogs. When used for forage or hay, its value is limited by high silica content and a rapid loss of nutritional quality following seed head formation. Some strains are apparently susceptible to a fungal or bacterial disease of the stems called white top.

Cultivars, Improved, and Selected Materials (and area of origin): Seed is expensive and sources specific to Oregon, Washington, and California are lacking. Nursery stock and seed are more readily available in other parts of the West, Midwest, and Northeast United States.

Prepared By:
Dale Darris, USDA NRCS Plant Materials Center, Corvallis, Oregon.

Species Coordinator:
Dale Darris, USDA NRCS Plant Materials Center, Corvallis, Oregon.

Edited: 23mar2006 jsp, 16sept2008 dcd.

For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

Plant Fact Sheet

CALIFORNIA OATGRASS

Danthonia californica Bolander

Plant Symbol = DACA3

Contributed by: NRCS Plant Materials Center, Corvallis, Oregon

Photo by Dale Darris

Alternate Names: Another common name is California danthonia. Synonyms include *Danthonia americana* and four botanical varieties: *americana*, *californica*, *palousensis*, and *piperi*.

Uses: California oatgrass is recommended for revegetation, wildlife plantings, and restoration of oak savannas, transitional wetlands, and upland prairies, especially in the Pacific Coast states. The species is valuable for enhancing biodiversity by exhibiting a spatial distribution compatible with forbs and improving habitat for feeding, nesting, and hiding by songbirds. It is a definitive component of certain prairies that form critical habitat for other endemic organisms including sensitive butterflies and beetles. The foliage is eaten by certain caterpillars and the grains are consumed by birds and mammals.

As a rangeland plant, California oatgrass is well utilized by livestock. Prior to maturity, it is rated as good to very good forage for cattle and horses in the Pacific Coast states, but less palatable for sheep and goats. Ratings are lower for eastern, drier portions of its natural range. Plants withstand heavy grazing but can be overgrazed leading to their depletion. Protein analysis is high and stands have formed that are dense enough for haying. Other potential uses include cover and erosion control in vineyards, young orchards, and parks, as well as along trails. As a candidate for native lawn, this species can be mowed to maintain a turf-like stand. It takes heavy foot traffic, trampling, and moderate summer moisture stress and can act as a stay-green firebreak.

Description: California oatgrass is a long lived perennial bunchgrass with stems (culms) that grow 30-100 cm tall and separate at the lower nodes (joints) upon maturity. The leaf sheaths are smooth to densely hairy. Leaves are both basal and attached to the stem. The upper blades are flat to in-rolled and spreading to abruptly bent with distinct spreading hairs where they meet the stem. The panicle (seed head) flowers between May and early July and is 3-8 cm long, loose, and open with 1-6 broadly spreading spikelets. Awns (linear appendages) on the seed are abruptly bent and 4-12 mm long. Seed is produced both in the terminal panicle and at the lower nodes enclosed (hidden) within the leaf sheaths of the stem. California oatgrass can be confused with timber oatgrass (*Danthonia intermedia*), poverty oatgrass (*D. spicata*), and one-spiked oatgrass (*D. unispicata*) but all three have more erect, compact panicles with the latter having a single spikelet in the seed head.

Adaptation: California oatgrass occurs naturally from British Columbia to southern California and eastward through the Rocky Mountain States and Provinces. Broadly adapted, it is a minor to dominant constituent of numerous woodland, shrubland, grassland, and transitional wetland habitats. The species is found on a wide array of soils types from excessively drained sandy loams to less permeable silts and clays and from relatively infertile sites to rich, moist bottomland. While it inhabits summer dry sites such as steep, sunny south and west slopes, shallow rocky outcrops, and serpentine soils (soils high in magnesium, iron, and

Reprinted with permission,
Univ. of Washington Press

certain heavy metals and deficient in other nutrients), as well as seasonally flooded wetlands, arid sites do not support it. The species occurs within the following ranges: elevation 0-7200 ft, annual precipitation 17 to 79 inches, and soil pH 5.5 to 8. Ratings are relatively low for fertility requirement, salinity tolerance, deer resistance, and shade tolerance, variable for drought resistance, and high for fire resistance and wildlife value. It has special adaptations for disturbance prone ecosystems.

Environmental concerns: California oatgrass is not considered to be weedy within its natural range. However, because of seed dormancy and latent seed in the soil, individuals may continue to sporadically emerge several years after stand removal. No toxic properties for domestic livestock, wildlife, or humans have been reported. The species has few significant pests but is one of many hosts for blind seed disease (*Gloeotinia temulenta*), a potentially serious pest in ryegrass (*Lolium* spp.) fields grown for seed.

Establishment: Growing California oatgrass from seed can be problematic as the result of delayed or sporadic germination and moderately slow seedling development combined with early competition from other species. The variable germination rates are the result of either a seed coat imposed dormancy, physiological (embryo) dormancy, no dormancy, or a combination of all three. To determine the amount of dormancy in a seed lot, both a TZ (tetrazolium) test for viability and germination test should be run. The difference between the two indicates the amount of dormancy. To overcome high dormancy, good germination will require fall sowing to cold moist stratify the seed outdoors over winter (alternatively, moist stratify in a cooler for 30-120 days at 1-4°F), scarification of the seed coat to weaken it, or both. Proven methods of scarification (sulfuric acid treatment, abrasion with sandpaper, use of a huller-scarifier or brush machine) each have their limitations. Hull removal (dehulling) and awn removal are coincidental to the process. Mechanical methods must be gentle enough to prevent damage to the seed embryo. An oat huller may be an option.

Keys to establishment for revegetation and other purposes are preplant weed control and proper seedbed preparation such as 1-3 years of fallow. Besides tillage and herbicides, site preparation methods and weed and stand management options include prescribed fire, grazing, mowing, or combinations thereof. The most successful stands are often achieved by sowing the seed alone rather than in a mix, succeeded by the use of a nonselective herbicide such as glyphosate to kill new weeds before the California oatgrass seedlings emerge following delayed germination. Very shallow soil coverage (1/4 inch or less) is critical because of the seed's light requirement. There are 90,000-165,000 seeds/lb depending on the degree of processing and natural variation. Each 1 lb of pure live seed (PLS) sown per acre results in 2-4 live seeds/ft^2. Sown alone, the suggested seeding rate for drilling is 9-15 PLS lbs/ac. The rate is doubled for broadcast seeding. A starter fertilizer is usually not recommended as it encourages excessive weed competition but a thin covering of mulch or jute netting is particularly useful on steeper banks. California oatgrass propagates readily by division. Plugs grown in standard potting media have worked better than direct seeding in many situations.

Prepared By:
Dale C. Darris and Peter Gonzalves, USDA, NRCS, Plant Materials Center, Corvallis, Oregon.

Species Coordinator:
Dale C. Darris, Conservation Agronomist, USDA, NRCS, Plant Materials Center, Corvallis, Oregon

For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

Plant Fact Sheet

ANNUAL HAIRGRASS
Deschampsia danthonioides (Trin.) Munro
Plant symbol = DEDA

Contributed by: USDA NRCS Plant Materials Center, Corvallis, Oregon

Dale Darris
USDA NRCS Corvallis PMC

Alternate Names
Other scientific names include *Aira danthonioides* Trin., *Deschampsia calycina* J. Presl, and *Deschampsia danthonioides* (Trin.) Munro var. *gracilis* (Vasey) Munz

Uses
Annual hairgrass is useful for wetland restoration, erosion control, and revegetation of other moist, disturbed areas where quick, low growing ground cover is desired. Given its apparent lack of competitiveness, this species may prove valuable as a temporary nurse crop for establishing perennial native species in both wetland and upland seed mixes. Waterfowl and birds eat the seeds. However, the foliage may be of less merit for wildlife herbage and cover compared to other grasses because of its short stature, lifespan, and limited productivity. The palatability and nutritional value of annual hairgrass for livestock and game is not documented. The vernal pools which it occupies are important reservoirs for aquatic invertebrates and amphibians.

Status
Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g. threatened or endangered species, state noxious status, and wetland indicator values).

Description and Adaptation
Annual hairgrass is a fine textured, native, cool season grass with smooth, slender stems (culms) that are 10 to 60 cm tall. The form is upright to spreading, short, and somewhat tufted. The narrow leaf blades are hairless, rough on the edges, slightly inrolled, 0.5 to 1.5 (2) mm wide, and 1 to 10 cm long. Flower heads (panicles) are open, 7 to 25 cm long, with ascending lower branches. Annual hairgrass occurs from near sea level at the coast to 8000 feet in the Rocky Mountains. It is primarily found from Alaska south to Baja California and east to Montana and New Mexico; also the Northeast US and Chile.

Key to identification: Annual hairgrass can be distinguished from slender hairgrass (*Deschampsia elongata*) and tufted hairgrass (*Deschampsia caespitosa*) by its weaker root development, fewer leaves, and smaller stature. Without close inspection it may be confused with other annual grasses, such as annual fescues (*Vulpia* spp.). Both may occur in waste areas. Consult botanical keys for proper identification.

Relative abundance in wild: While most common in the Pacific Coast states, the species can still be hard to locate. However, it can occur in large stands, especially in vernal pools dominated by annuals. Seed retention is fair and fill is good. The period for wild collection can extend several weeks as maturation progresses along a soil moisture gradient within depressions.

Adaptation: Annual hairgrass reaches its preeminence in vernal pools, mudflats and other shallow depressions that are ponded in winter and desiccated in summer. In California, habitat also includes alkali and coastal grasslands, the edges of alkali playas, and seasonally or periodically inundated wetlands dominated by annuals. Other habitats can include streambanks, roadsides, drier banks, vernal seepage areas, waste areas, and mountain meadows. Typical substrates appear to be acidic (pH 5) to moderately alkaline fine textured clay soils and silt loams above a shallow, impervious layer. However, it also grows on coarse textured substrates that stay moist through seed development. Annual hairgrass apparently tolerates some salinity and prefers full sun. Fall germinants actively grow all winter, tolerating several days to several weeks of continual submergence.

Line drawing reprinted with permission, University of Washington Press

Establishment
Annual hairgrass germinates readily and is easy to establish on open, moist ground. There is no seed dormancy and therefore no requirement for physiological conditioning or over wintering outdoors. However, as a winter annual in milder growing climes of the West Coast, it is best suited to early fall sowing. The seed should be run through a debearder or brush machine to remove pubescence (hairs). This will accentuate further seed cleaning and improve flow through a drill and other planting device. There are approximately 900,000 seeds per pound (+/- 30%). A seeding rate of 1 lb/acre pure live seed (PLS) would result in 20 live seeds per square foot. Seeding rates will vary widely depending on planting purpose, site conditions, and method used.

Management
As an annual, this species requires regular disturbance or moist to wet open ground in fall and winter in order to proliferate. It is not competitive and is easily replaced by other species. Annual hairgrass should be well suited to moist soil management techniques (slow de-watering, disking, etc.) in shallow water impoundments and other controlled wetlands. Such methods are used to improve habitat for waterfowl, shorebirds and other wildlife by maximizing seed production of annuals.

Environmental Concerns
Shallow roots and low herbage production may limit this species usefulness for soil stabilization on highly erosive soils or unconsolidated substrates. While annual hairgrass is a weak competitor with weeds, it may be less likely to become a weed itself. Although this species can increase in open waste areas, reports of this species becoming invasive are lacking.

Cultivars, Improved, and Selected Materials (and area of origin)
Plants and seeds are sometimes available in California. This species is generally not available elsewhere within its range, requiring wild harvests or contract seed growing to provide material.

Prepared By:
Dale Darris and Amy Bartow, USDA NRCS Plant Materials Center, Corvallis, Oregon.

Species Coordinator:
Dale Darris, USDA NRCS Plant Materials Center, Corvallis, Oregon.

Edited: 16mar2006 jsp, 16sept2008 dcd.

For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

Plant Fact Sheet

SLENDER HAIRGRASS

Deschampsia elongata (Hook.) Munro

Plant symbol = DEEL

Contributed by: USDA NRCS Plant Materials Center, Corvallis, Oregon

Dale Darris
USDA NRCS Corvallis PMC

Alternate Names

Another scientific name is *Aira elongata.*

Uses

Slender hairgrass is a moderate to fast growing native bunchgrass useful for erosion control along waterways, ditches, and streambanks, as well as on other seasonally wet or recently disturbed sites. It can also be sown as cover after logging in ravines and other moist forest areas. This species has potential as a nurse crop for slower establishing, longer lived species like California oatgrass (*Danthonia californica*) or other native prairie and woodland grasses and herbs. Forage value is fair to good prior to maturity. This is a versatile and underutilized native grass. It is also regarded as an attractive ornamental grass because of its fine texture, wispy seed heads, and golden color in summer.

Status

Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g. threatened or endangered species, state noxious status, and wetland indicator values).

Description and Adaptation

Slender hairgrass is a moderate sized, fine textured, cool season grass. It is generally a biennial or short-lived perennial under most conditions. Stems (culms) are 40 to 80 (100) cm tall. Leaves are hair-like, less than 1.5 mm wide, and form a basal tuft. The open sheaths are smooth and auricles are absent. The panicle (flowerhead) is 5 to 25 (30) cm long, narrow with slender upward-pointing branches, and a pale green to purple color. This species occurs primarily from Alaska to California and east to Montana and New Mexico.

Key to identification: The slender, upright to arching seed head and fine leaves are indicative of its common name. It should not be confused with tufted hairgrass (*Deschampsia caespitosa*) which is taller, coarser, and more robust. In addition, the panicles of tufted hairgrass are more open and branching, and the leaves are broader and flatter than slender hairgrass. Annual hairgrass (*Deschampsia danthonioides*) is smaller and the panicle is also much broader and open compared to slender hairgrass. Because of the fine texture and small florets, it may loosely resemble a bentgrass (*Agrostis* sp.) without closer inspection.

Relative abundance in the wild: Scattered to relatively common but rarely in large numbers. Slender hairgrass is occasionally found in drainage ways, seep areas, ditches, and damp open woods, as well as adjacent to moist pathways or other disturbed areas.

Adaptation: Slender hairgrass can be found in wet meadows and along the margins of streams, ponds, and lakes. Habitat also includes moist slopes and the understory of open forests from lowland to alpine zones. It is also a component of coastal prairies. As a species of secondary plant succession, slender hairgrass re-establishes after logging in associated forest communities. It is found on fine sandy or gravelly soils as well as heavier soil types. This species tolerates full sun to partial shade.

Establishment
There is no seed dormancy and slender hairgrass establishes readily by sowing in the fall or early spring. Removal of surface hairs (pubescence) on the seed aids in further seed cleaning as well as sowing with a drill. There are approximately 2,300,000 seeds/lb (+/- 20%). Each pound of live seed sown per acre applies about 54 seeds per square foot. Based on seed size and seedling vigor, suggested seeding rates are 2-4 lbs/ac when sown alone. Higher rates may be required when broadcasting to achieve full stands under more difficult conditions.

Line drawing reprinted with permission, University of Washington Press

Management
Information on the management of this species is lacking. Given its short-lived nature, grazing must be deferred during flowering and seed set every other year for stand regeneration. Its ability to easily volunteer on moist, disturbed ground and readily produce seed makes it a candidate for moist soil management of wetland habitat for waterfowl, shorebirds, and other wildlife.

Environmental Concerns
Short-lived and may not compete well with weedy herbaceous species. There are no major concerns described for this species.

Cultivars, Improved, and Selected Materials (and area of origin)
Multiple sources of seed are readily available in California. One or more populations originating from western Oregon are on the market as well. Seed sources from other regions for use in the same area may be lacking.

Prepared By:
Dale Darris and Robert Tracey, USDA NRCS Plant Materials Center, Corvallis, Oregon.

Species Coordinator:
Dale Darris, USDA NRCS Plant Materials Center, Corvallis, Oregon.

Edited: 20mar2006 jsp

For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service

Plant Fact Sheet

CALIFORNIA FESCUE

Festuca californica Vasey

Plant Symbol = FECA

Contributed by: USDA NRCS Plant Materials Center, Corvallis, Oregon

Alternate names: A close relative is Parish's California fescue, *Festuca parishii* or *Festuca californica* var. *parishii*.

Uses: California fescue is a native grass useful for the restoration of upland plant communities, especially oak savanna, open woodlands, and prairies in Oregon and California. Its deep roots make it a good candidate for erosion control on slopes. The species often persists throughout the year with evergreen foliage in milder environments. Tightly clumped bases and non-aggressive growth habit suggest compatibility with forbs. Other possible uses are revegetation of disturbed areas and wildlife food and cover. Palatability is medium for all classes of ungulates. The species attracts certain butterflies and many native birds eat the seeds. As a tall grass with thick chalky blue to green foliage, California fescue is increasingly appreciated for its ornamental and environmental landscape value.

Description: California fescue is a native, cool season perennial bunchgrass that is intermediate to long lived. The base is tightly clumped and the culms (stems) are tall and erect, growing to a height of 60-140 cm. Inflorescences (flowers or panicles) are 10-30 cm long, open and sparsely branched. Branches usually occur in pairs. Leaves are medium textured (2-4 mm wide), primarily basal, stiff, sometimes purple tinged, flat or rolled, firm, and rough to the touch. Plants are typically grayish blue to green and lack horizontal rooting systems. This species flowers anytime between March and July, depending on elevation, population, or locale.

Key to identification: California fescue is coarser textured and usually taller than other native fescues, but might be confused with tall fescue (*Schedonorus phoenix*, synonym *Festuca arundinacea*), which is widely introduced in the region. However, compared to California fescue, the leaves of tall fescue are wider (4-10 mm vs. 2-4 mm) and have prominent or clasping auricles (lobes at the base of the leaf blades). Parish's fescue is smaller, but otherwise very similar to California fescue.

Adaptation: California fescue is found in large parts of Oregon and California; its range includes the Coast Ranges, foothills, and valleys from Clackamas County, Oregon, to San Luis Obispo County, California. The species also occurs in the Cascade Range from Clackamas County south into California and in the north and central Sierra Nevada. Elevation range is from sea level to 6500 ft. in the mountains. Its relative, Parish's California fescue, is confined to the San Bernardino Mountains of California.

California fescue plants become hardy at a young age and, once established, are tough survivors. Adapted to a variety of conditions, the species tolerates sun to intermediate shade and semi-drought, as well as moist soil along stream banks. However, it is most frequent in the dappled shade, along the borders of woods, and on north facing slopes. Other habitats include oak savanna, the understory of mixed conifer-hardwood forests, chaparral, and serpentine soils (soils toxic to many plants due to high levels magnesium and iron silicates and other minerals). Preferred soils are medium to fine textured with a pH of 5.7 to 7.5. In one study, the species was rated tolerant to salt spray and moderately tolerant to soil salinity, similar to many other grasses including introduced tall fescue.

Commercial availability: A few seed sources are sometimes for sale in Oregon and California. Several cultivars with exceptional foliage are found in the horticultural trade, but they are vegetatively propagated or have a narrow gene base and are not recommended for restoration.

Line drawing reprinted with permission, University of Washington Press

Relative abundance in the wild: California fescue has become rare in the Willamette Valley. Often hard to find, it is an excellent candidate for species reintroduction. This grass is relatively common in Southwest Oregon and parts of California.

Limitations or environmental concerns: This species is initially slow to germinate and sometimes difficult to establish, especially with competition. Seed set is low in some years which may be the result interference in pollination from rains during early spring flowering. There are no known environmental concerns.

Establishment: California fescue appears to have minor seed dormancy, at least in some populations. Others report no dormancy, but two weeks of cold moist chilling (stratification treatment) can result in more uniform and quicker germination. Spring sowing of untreated seed can have staggered germination; seedlings may emerge over a period of two to eight weeks. Therefore, fall planting when soil temperatures are cooler is highly recommended. No special physical conditioning of the seed is required for using a drill or broadcast seeder. While slow to establish, seedlings become hardy plants. . There are approximately 224,000 (+/- 20%) seeds per pound with hulls intact. Each 1 pound of seed sown per acre is equivalent to approximately 5 seeds per square foot. Sown alone, a suggested minimum seeding rate is 10 lbs of pure live seed (PLS) per acre for general revegetation. In seed mixes, fast germinating and quick establishing grasses should be kept to a low percentage.

Some practitioners prefer container plants of California fescue because of spotty or variable establishment from seed. It is easily propagated vegetatively by division of the crown. California fescue is presumed to have some tolerance to fire as a natural component of grassland ecosystems. Suggested frequency for prescribed fire is once every three to five years. However, summer burning can be fatal if plants are green and active. Specific guidelines for stand management and grazing are not well reported.

Prepared By:
Dale Darris and Sonja Johnson. USDA NRCS Plant Materials Center, Corvallis, Oregon.

Species Coordinator:
Dale Darris, USDA NRCS Plant Materials Center, Corvallis, Oregon.

Edited 7/31/07 D. Darris; 070802 jsp

For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service

Plant Fact Sheet

ROEMER'S FESCUE
Festuca roemeri (Pavlick) Alexeev

Plant Symbol = FERO

Contributed by: USDA NRCS Plant Materials Center, Corvallis, Oregon

Dale Darris
USDA NRCS Corvallis PMC

Alternate names: Also known as *Festuca idahoensis* Elmer ssp. *roemeri* (Pavlic) S. Aiken. Other names include *Festuca idahoensis* var. *roemeri*, *Festuca roemeri* var. *roemeri* or northern Roemer's fescue, and *Festuca roemeri* var. *klamathensis* or southern Roemer's fescue.

Uses: Roemer's fescue is an important native grass for restoration of upland prairie and oak savanna within its natural range of western Oregon, western Washington, and northwest California. While uncommon or even rare due to habitat loss, it is still dominant in some remnant prairies. Typically found on steep, shallow, or highly mineral soils, it may also be useful for revegetation and erosion control where a slower establishing, fine textured native grass is desired. Although Roemer's fescue does not compete well with introduced grasses, it is drought tolerant and its non-aggressive growth habit suggests compatibility with forbs. Other possible uses are low maintenance lawns or as a cover crop in vineyards and young orchards, although further evaluation is needed. Some populations and specimens have ornamental value, including those with fine textured, purple and red tinged stems or bluish foliage. Forage value and palatability for wildlife and livestock are unknown, but may be similar to Idaho fescue (*F. idahoensis*). As a range grass, Idaho fescue is rated as fair to good forage.

Description: Roemer's fescue is a native cool season perennial bunchgrass with variable longevity and mostly basal foliage. It is short, fine textured, and densely tufted, and has stiff culms that grow 35-100 cm tall. The panicle (seed head) is open and 5-20 cm long. Leaves are often glaucous (covered with a whitish waxy coating) and color varies throughout a wide spectrum of greens and blues. Stem color ranges from light green to dark purple or red.

Key to identification: Proper identification takes experience. Refer to "Fescues and Allies of Western Oregon" by B. Wilson (Institute for Applied Ecology, Corvallis, OR, 2002) for details with an excerpt as follows: "The less blue individuals are easily confused with chewings red fescue (*Festuca rubra* var. *commutata*), which is widely naturalized. When the two grow together, Roemer's fescue lives in drier or less disturbed microhabitats. It is very easily confused with sheep and hard fescues. Sterile individuals are indistinguishable or identifiable only by leaf anatomy. However, fertile *F. roemeri* has a much more open inflorescence and longer lemmas than any sheep or hard fescue. Occasionally confused with sterile *Stipa lemmonii* (Lemmon's needlegrass), but Roemer's fescue does not live on the xeric soils preferred by *S. lemmonii*."

Adaptation: Roemer's fescue is a mid to late succession species in its natural habitat. It prefers moderately acid to slightly alkaline, fine to medium textured mineral soils. The species generally grows in full sun but will tolerate partial shade near forest edges and oaks. While drought tolerant with extensive roots, it is found on somewhat more mesic (moist) sites such as the edges of grassy balds. As an upland grass it requires good soil drainage and does not tolerate winter soil saturation or flooding.

Roemer's fescue is only found west of the Cascade and northern Sierra Nevada Mountain Ranges. Variety *roemeri* occurs from Douglas County and northeast Jackson County, Oregon, north to British Columbia and south along the Pacific coast to San Francisco. The species occurs on moderately dry to moist prairies, savannas, meadows, and grassy openings within woods. Variety *klamathensis* occurs in similar habitats, but also on serpentine substrates (soils toxic to many plants due to high levels of magnesium and iron silicates and other minerals). It is not found along the coast. The species intergrades with Idaho fescue (*Festuca idahoensis*) in southwest Oregon.

Reprinted with permission, University of Washington Press

Commercial availability: One or more populations are available for western Oregon.

Relative abundance in the wild: Roemer's fescue is scarce from the Willamette Valley of Oregon north to British Columbia. It is scattered to uncommon from Eugene, Oregon south to San Francisco.

Limitations or environmental concerns: There is potential for poor seed fill in some populations, possibly from inbreeding depression or other factors. It is susceptible to stem and leaf rust which can severely weaken plants in some years. Misidentification between Roemer's fescue and introduced red fescue (*Festuca* rubra) may lead to contamination of seed fields and restoration sites.

Establishment: Seeds germinate without treatment. However, germination is quicker and more uniform after 14 days of cold, moist stratification (chilling). There are approximately 500,000 seeds/lb with hulls intact. A seeding rate of 1 lb/ac results in about 12 seeds/sq. ft. Sown alone, recommended rates vary from 4 to 20 pure live seed (PLS) lbs/ac depending on goals. Fall seeding is generally preferred but not required. Rate of establishment from seed is moderately slow. Spring sown plants do not flower until the second full growing season. This species is presumed to be well adapted to fire as a natural feature of prairie ecosystems. It may possess management requirements similar to Idaho fescue such as deferred grazing every few years, but verification is needed.

Prepared By:
Dale Darris, Sonja Johnson, and Amy Bartow. USDA NRCS Plant Materials Center, Corvallis, Oregon.

Species Coordinator:
Dale Darris, USDA NRCS Plant Materials Center, Corvallis, Oregon.

Edited 7/31/07 D. Darris; 070801 jsp

For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

Plant Fact Sheet

TALL MANNAGRASS

Glyceria elata (Nash ex Rydb.) M.E. Jones

Plant symbol = GLEL

Contributed by: USDA NRCS Plant Materials Center, Corvallis, Oregon

Dale Darris
USDA NRCS Corvallis PMC

Alternate Names
Another common name is fowl mannagrass. It is now classified as the same species as the more widely distributed *Glyceria striata* which has similar common names.

Uses
Tall mannagrass is a rapidly establishing native species suitable for restoration of swamps, the edges of marshes, ponds, and streams, and other wetland plant communities where an herbaceous understory is desired. It has versatility for use along creeks and ditch bottoms where exposure may vary from full sun to dense shade, thereby improving soil stability beyond the use of woody plants alone. Where this species dominates, herbage production is high. Palatability of *G. striata* is rated good to very good for cattle and horses which consume both flower stems and leaves. It is rated fair to good for sheep which tend to use only the leaves. The seed is food for waterfowl and birds while the foliage and tall stems provide good wildlife cover. Foliage is seasonally grazed at a light to heavy rate by deer, muskrat, and bears. Elk can make minor use of it as well. Tall mannagrass may be applicable to seeding mixtures targeted to improve species richness and exclude reed canarygrass (*Phalaris arundinacea*) prior to its invasion. It is occasionally planted as an ornamental in and around backyard ponds.

Status
Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g. threatened or endangered species, state noxious status, and wetland indicator values).

Description and Adaptation
In the Pacific Northwest, tall mannagrass is a long lived, cool season perennial bunchgrass with somewhat succulent stems (culms) that reach a height of 100 to 180 cm. The form is erect, robust, and clumpy despite the production of slow growing rhizomes or underground stems. Rate of spread may vary among populations. Leaf blades are soft, ribbon-like, 6 to 12 mm wide and 15 to 25 cm long. The flowerhead (panicle) is loose, broad, pyramid-like, and 8 to 27 cm long with spreading and drooping branches. Populations previously described for *G. striata* include plants that are shorter and tougher with smaller leaves (2 to 5 mm wide) and flower heads that are more closed. *G. elata* was primarily confined to the western states, but as *G. striata*, it occurs across most of North America.

Key to identification: Physical differences described between tall mannagrass and *G. striata* are inconsequential because they are now listed as the same species. Tall mannagrass can be easily confused with reed mannagrass (*Glyceria grandis*) which has smoother leaves and lack its slightly rough texture. Others mannagrasses are easier to distinguish, but a botanical key should be consulted.

Relative abundance in the wild: Seed ripens in July or August and retention within the flower head is fair to good. Collections can be readily made along wet forest road ditches, but access can be difficult along streams or in denser, swampy brush where this species is commonly found.

Adaptation: Tall mannagrass widely occurs in bogs**,** seeps, wet woods, thickets or swampy areas, shaded ditches, and along or in streams. It may occasionally be found growing in full sun on summer damp soils as well as in standing water. Reportedly, this species is best adapted to freshwater, semi-aquatic habitats (*G. elata*) or those that are irregularly to seasonally flooded and saturated for up to 25 percent of the growing season (*G. striata*). However, local plants have thrived and flowered under continuous inundation (1-10 cm) for several years. Tall mannagrass tolerates open areas but prefers shady habitats. It may occur as single plants, small colonies, or larger stands that dominate the understory of ash swales as well as willow, aspen, and other wetland forest or shrub communities. Soils range from organic to mineral with a pH of 4 (acidic) to 8 (slightly alkaline). This species does not tolerate salinity and needs moderately good fertility. This species is very shade tolerant, similar to reed mannagrass, yet it can be grown in full sun to produce substantial seed.

Establishment
The presence of seed dormancy, if any, may vary among populations. Seeds can germinate within 2 to 3 weeks without treatment but 14 to 30 days of cold moist stratification (moist pre-chilling) has resulted in faster but not necessarily higher germination rates. Others report the need for 150 days of stratification in cold water. Fall sowing is preferred if dormancy is known or uncertain. Seed hulls readily detach but removal is unnecessary. There are approximately 1,600,000 seeds per pound with hulls intact. A seeding rate of 1lb pure live seed per acre will result is about 37 live seeds per square foot. Seeding rates depend on methods used, objectives, and site conditions.

Line drawing reprinted with permission, University of Washington Press

Management
Management considerations for utilization of *G. striata* by livestock may predictably apply to tall mannagrass. Sites where it occurs are typically too wet for grazing when the herbage is most succulent. Therefore, access must be deferred until late in the season when soils are drier and quality has declined somewhat. Tolerance to fire and heavy grazing is not well documented. Tall mannagrass can be grown for seed on upland sites with medium to fine textured soils if regular irrigation is applied in summer and fall.

Environmental Concerns
Some strains or populations of *G. striata* may contain cynogenetic compounds. Cyanide poisoning from it as well as reed mannagrass has been reported in cattle. Because tall mannagrass is now the same species or closely related, caution is advised for livestock utilization. Likewise, plant diseases that infect *G. striata* may apply to tall mannagrass. This includes the fungal pathogens *Epichloe glyceriae* which causes floral castration and *Ustilago striiformis*, better known as stripe smut. Fungicides may be needed for control. Consult with your local Extension Service agent, plant disease control handbook, or other experts for advice. Other species of mannagrass are described as weedy in certain crops or wet areas, but concerns for tall mannagrass are not widely known.

Cultivars, Improved, and Selected Materials (and area of origin)
Seed sources and plants are regularly available throughout much of the species natural range within the United States.

Prepared By:
Dale Darris, USDA NRCS Plant Materials Center, Corvallis, Oregon.

Species Coordinator:
Dale Darris, USDA NRCS Plant Materials Center, Corvallis, Oregon.

Edited: 21mar2006 jsp, 17sept2008 dcd.

For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

Plant Fact Sheet

SLENDER-SPIKED MANNAGRASS
Glyceria leptostachya Buckl.
Plant symbol = GLLE2

Contributed by: USDA NRCS Plant Materials Center, Corvallis, Oregon

Alternate Names
Other common names include davy mannagrass, slimheaded mannagrass, and soft mannagrass.

Uses
Slender-spiked mannagrass is a lesser known, mid-sized native grass suitable for wetland restoration and enhancement. It may also be used for seeding the edges of streams and lakes, as well as the bottom of low gradient drainage ditches and other watercourses. This species exhibits a low-lying growth form and vegetative spread that helps reduce erosion. The prostrate floating leaves and stems may further aid in control erosion by lining the banks of streams, waterways, and channels during high flows. The seed and leaves are a likely source of food for waterfowl, shore birds, songbirds, and small mammals, similar to other mannagrasses.

Forage value and palatability for livestock are unknown. However, the tender, green foliage is probably utilized by deer and other ungulates.

Status
Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g. threatened or endangered species, state noxious status, and wetland indicator values).

Description and Adaptation
Slender-spiked mannagrass is a short-lived, perennial, cool season grass with succulent foliage and erect to low lying stems that are 60 to 110 cm tall. Reportedly, this grass also produces rhizomes (underground stems), but individuals often retain a more bunchgrass appearance. Plants may spread vegetatively from lower stems that root at nodes (joints) in contact with the soil. The leaf blades are flat to rolled slightly inward, 3 to 7 (10) mm wide, and rough on both sides. On land, they develop mostly at the base of the plant but floating leaves can form when plants are submerged. The flowerhead (panicle) is open, 20 to 40 cm long, with a few branches pressed close to the main axis. Slender-spiked mannagrass occurs from Alaska south to California but not further inland.

Key to identification: In the Pacific Northwest USA, this species resembles a smaller version of western mannagrass (*Glyceria occidentalis*), which is coarser, more open, and has much larger seeds. It can also be confused with northern mannagrass (*Glyceria borealis*) but the latter has a smooth leaf blade while the upper blades of slender-spiked mannagrass are rough in texture. Consult a botanical key to distinguish these species.

Relative abundance in the wild: Generally uncommon throughout its natural range compared to other mannagrasses. Scattered plants are occasionally found along small streams and in riparian wetlands or marshy areas, especially in the Willamette Valley of Oregon and along the Pacific Coast. Seed ripens in July or August. Retention within the panicle is poor to fair at best. Wild collections rarely yield much seed because populations are usually small and plants are widely scattered.

Adaptation: This species is well adapted to wet meadows, the margins of streams, lakeshores, freshwater marshy areas, and other depressions that stay moist in summer. It easily withstands year round inundation by developing a floating leaf growth form. However, longevity may be reduced. This species is found on acidic soils that are coarse to fine textured. Tolerance to salinity, alkalinity, or high soil acidity is unknown. Slender-spiked mannagrass typically grows in full sun.

Establishment
Slender-spiked mannagrass seed has no strong dormancy and germinates at a moderate rate in fall or spring. Establishment rate is intermediate. Hulls are loosely attached and may be readily removed during seed processing. There are approximately 1,300,000 seeds/lb (+/- 30%). A sowing rate of 1 lb per/ac of pure live seed will result in about 30 live seeds per square foot. The potential high cost of seed may limit its use to mixtures with other native grasses. Based on seed size and seedling vigor alone, a seedling rate of 2 to 5 lbs/ac may be adequate for a single species stand.

Management
There is a lack of information about the management of slender spiked mannagrass for livestock or other purposes. Succulent growth should favor palatability, but grazing would be inappropriate or restricted under the wet environments where this species grows. Seed production requires extensive irrigation, poorly drained soils, seasonal wetlands, or shallow water impoundments. Regeneration is favored by disturbance and the presence of open mud or prolonged moist soil that is sparsely vegetated. This species may be suited to moist soil management (slow de-watering, disking, etc.) of impounded wetlands for improving waterfowl, shorebird, and other wildlife habitat.

Line drawings reprinted with permission, University of Washington Press

Limitations and Environmental Concerns
It is difficult to obtain seed of any volume from the wild. In western Oregon, other mannagrasses, especially western mannagrass, are considered weeds in low lying fields of Italian ryegrass (*Lolium* spp.) grown for seed. Apparently, slender-spiked mannagrass is of infrequent or lesser concern. It is not reported to be a competitive, weedy or invasive plant species.

Cultivars, Improved, and Selected Materials (and area of origin)
This species is rarely sold as seed or plants. Availability depends on wild collections or contract growing with producers who specialize in native herbaceous plant seed.

Prepared By:
Dale Darris, USDA NRCS Plant Materials Center, Corvallis, Oregon.

Species Coordinator:
Dale Darris, USDA NRCS Plant Materials Center, Corvallis, Oregon.

Edited: 21mar2006 jsp, 17sept2008 dcd.

For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

Plant Fact Sheet

WESTERN MANNAGRASS

Glyceria occidentalis (Piper) J.C. Nels.

Plant symbol = GLOC

Contributed by: USDA NRCS Plant Materials Center, Corvallis, Oregon

Dale Darris
USDA NRCS Corvallis PMC

Alternate Names
Other names are Northwestern mannagrass, tall mannagrass, and waxy mannagrass.

Uses
Western mannagrass is a native species important for restoration of freshwater marshes, vernal pools, and depressions within wetland prairies. The species rapid growth, underground stems, and floating leaves aid in reducing erosion along the edges of streams and lakes where it naturally occurs. In the Pacific Northwest, this grass is recommended for use in stormwater management, including detention ponds and biofiltration swales that are wet year round. The foliage and seeds provide food and cover for waterfowl, small seed-eating birds, muskrats, and other small mammals. Western mannagrass may be useful in seed mixtures aimed at increasing plant diversity while helping deter the invasion of reed canarygrass (*Phalaris arundinacea*). The seed can be dried and ground into flour and was apparently eaten by Native Americans.

Status
Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g. threatened or endangered species, state noxious status, and wetland indicator values).

Description and Adaptation
Western mannagrass is a short-lived, cool season perennial grass with flaccid stems (culms) that reach a height of 70 to 150 cm. The form is moderately coarse textured, clumpy, and upright to nearly flat: spreading from rhizomes or decumbent (low lying) stems that root at the nodes (joints). When submerged in spring, this species produces floating stems and leaves, but flowering is reduced. Leaf blades are ribbon-like, 4 to 13 mm wide, and 15 to 30 cm long. Flowerheads (panicles) are narrow and 15 to 40 cm long, with appressed branches and long cylindrical spikelets (the groupings of individual florets or flowers). The flowering period is long, from May to September. Western mannagrass occurs from British Columbia south to California and east to Idaho and Nevada at elevations below 4000 feet.

Key to identification: Western mannagrass is easily confused with northern mannagrass (*Glyceria borealis*) and slender spiked mannagrass (*Glyceria leptostachya*) which are found in similar aquatic habitats. Western mannagrass has larger florets (individual flowers) and the seed is three times larger compared to the other two. A botanical key, scale, and hand lens are needed for proper identification.

Relative abundance in the wild: This species is widely occurring and common in the Pacific Northwest at low elevations, especially along streams and in wet meadow depressions. Despite the long flowering period, seed collection is laborious because retention is poor: the seed drops (shatters) very easily when green and not fully mature. However, additional seed may be held within the lower leaf sheath and can be removed by threshing.

Adaptation: This species is easy to establish and grow on adapted sites. It can volunteer readily.

Western mannagrass grows naturally in vernal pools, wet depressions, marshes, and ditch bottoms, as well as along the shores of lakes, streams, and ponds. While found in full sun, it occasionally occurs in partial shade as well. Soils include poorly drained sands, loams, and clays with acid, neutral or slightly alkaline pH. This species can grow in permanent standing or slow moving water at least 30 cm deep. It is intolerant of drought and is not found on saline sites. Soil fertility requirements are moderate.

Establishment

The seed has no physiological dormancy and germinates readily without treatment in less than three weeks. The species can be broadcast on the surface of mud or muck in the fall or spring. Moist soil is adequate for germination, but if the site is inundated prior to germination, the seed must be secured in place with a thin mulch or mat to prevent it from floating or washing away. The hull detaches readily but can be left intact. There are approximately 215,000 to 360,000 seeds/lb (+/- 20%) with and without hulls, respectively. A seeding rate of 1 lb pure live seed per acre will result in about 5 to 8 live seeds per square foot. Actual seeding rates will depend on methods, objectives, and site conditions. Western mannagrass is easily propagated by division or as container stock sown from seed and maintained in shallow standing water.

Line drawing reprinted with permission, University of Washington Press

Dale Darris
USDA NRCS Corvallis PMC

Management

There is a lack of information about the management of western mannagrass. It can be grown and maintained under continuously moist, saturated, or seasonally to permanently flooded conditions. Regeneration and spread is favored by wet open areas and disturbance. Water impoundments or other controlled wetlands should not be allowed to dry out, especially if viable seed has not yet formed.

Environmental Concerns

Seed is difficult to collect in the wild. Western mannagrass is a serious weed in low lying, poorly drained fields of introduced grasses grown for seed in Oregon. Some strains may be herbicide resistant. Riparian wetland and stream restoration projects should consider substituting other native grasses if ryegrass (*Lolium* spp.) seed fields are downstream. Consult with your local Extension Service agent, weed control handbook, or other experts for advice.

Cultivars, Improved, and Selected Materials (and area of origin)

Seeds, plugs, or containers are usually available, but seed is often expensive.

Prepared By:
Dale Darris, USDA NRCS Plant Materials Center, Corvallis, Oregon.

Species Coordinator:
Dale Darris, USDA NRCS Plant Materials Center, Corvallis, Oregon.

Edited: 21mar2006 jsp, 17sept2008 dcd.

For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

Plant Fact Sheet

MEADOW BARLEY

***Hordeum brachyantherum* Nevski**

Plant symbol = HOBR2

Contributed by: USDA NRCS Plant Materials Center, Corvallis, Oregon

Dale Darris
USDA NRCS Corvallis PMC

Alternate Names

There are two subspecies: *H. brachyantherum* ssp. *brachyantherum* and ssp. *californicum*, the latter referred to as California barley. Another name is little barley. This species can hybridize with certain *Hordeum* and *Elymus* (wildrye) species.

Uses

Because of its high seedling vigor, wide soil tolerances, and rapid development, meadow barley is often used as a quick cover for soil stabilization on wet, dry, and saline sites. It is sometimes used for forage where locally abundant, but resource value may be rated low to moderate for livestock. The value for deer is considered high in spring. Palatability for ungulates is moderately good early on but poor at maturity. Sown at lower rates to allow other species to establish, meadow barley is an important component of freshwater wetland, tidal marsh, meadow, and riparian seed mixtures for restoration and revegetation. In certain trials, meadow barley has shown higher potential to impede the progress of reed canarygrass compared to several other native wetland grasses. It is regarded useful as a temporary nurse crop for longer lived species on dry, infertile sites. The species is occasionally used as a vineyard cover crop in California. Plants provide wildlife cover and the leaves and large seed may be of some value to small mammals and waterfowl.

Status

Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g. threatened or endangered species, state noxious status, and wetland indicator values).

Description and Adaptation

Meadow barley is a native, short to medium lived, cool season, perennial bunchgrass. This species occurs primarily from Alaska to California and east to the Rocky Mountains. It can also be found sporadically in other states. Growth habit is an open tuft with erect to slightly spreading, smooth stalks (culms) that are 40 to 105 cm tall. The flower head (panicle) is a narrow, flattened spike, 5 to 10 cm long with bristle-like awns and a brittle central axis (rachis) that breaks off in pieces from the top down at maturity. Leaves are green to bluish green, 2 to 9 mm wide. They may be primarily basal or extend up and down the stem.

Key to identification: The flower heads are bristly and often purplish in color, becoming stubby at maturity which distinguishes it from timothy (*Phleum pretense*), meadow foxtail (*Alopecuris pratensis*), or other grasses with narrow spikes. It resembles common barley (*Hordeum vulgare*) which is an annual usually confined to cultivated areas. Meadow barley is upright, while its closest relative, California barley, is shorter and more spreading.

Relative abundance in the wild: Meadow barley is common to sporadic in moist meadows and clearings. It is most abundant in maritime environments. Seed shatters (drops) readily requiring careful monitoring of maturity and multiple collections.

Adaptation: Meadow barley is moderately drought tolerant but best adapted to moist soils, including bottom lands, depressions, meadows, the edges of streams and salt marshes, forest clearings, and ocean beaches from sea level to subalpine elevations. It is tolerant to moderately alkaline and saline conditions, as well as low fertility, seasonally saturated soils, and intermittent flooding. Soil texture can vary from coarse sand to clay. This species prefers full sun. This species can produce a seed crop the first year if sown in late fall or early spring. This is among the more broadly adapted and easier to establish of all native grasses in the western US.

Establishment

There is usually no seed dormancy and meadow barley is easy to establish by sowing in the fall or early spring. The awns and nonviable florets (flower structures) attached to each spikelet should be removed to reduce bulk and allow for seed to flow through planting equipment. The number of seeds per pound can vary widely, depending on the degree of seed conditioning. Bulky seed can range from 30,000 to 100,000 seeds/lb, while highly processed seed will have approximately 150,000 seeds/lb (+/- 30%). The latter will result in 3 to 4 seeds per square foot for each lb applied per acre. Suggested seeding rates vary from 8 to 40 lbs/ac when sown alone, depending on seed size, methods, site conditions, and purpose of planting.


Line drawing reprinted with permission, University of Washington Press

Management

Meadow barley can be an increaser or decreaser under heavy grazing, depending on the palatability of other plants present. Forage value is moderately good early on but poor at maturity. Livestock are likely to cause soil compaction on moist sites with fine textured soils where this species often thrives. Short-lived especially under drier conditions, regeneration may rely on a period of deferred grazing during flowering and seed set every few years. The species is easily eliminated by close mowing early in the growing season. It stays green all summer if moisture is present and is capable of producing a second flush of seed heads later in summer. Tolerance to prescribed burning is high. Specific management practices apply to cover crop use, particularly in vineyards. Under cultivation for seed, several harvests may be required to capture seed that matures unevenly and shatters easily.

Environmental Concerns

Awns on the spikelets readily attach to hair and skin. Apparently they can harm certain animals by working into noses, mouths, or intestines. Others indicate little injury to livestock or deer that graze the foliage. Certain meadow barley populations are susceptible to fungal diseases, particularly head smut and leaf or stem rust. Fungicides may be needed for control. Consult with your local Extension Service agent, plant disease control handbook, or other experts for advice. The species has potential to be weedy under certain conditions and is listed as a weed in cotton.

Cultivars, Improved, and Selected Materials (and area of origin)

Multiple sources of seed are readily available in California, as are several in Oregon. A limited number of seed sources from other regions are also available for use in certain western states.

Prepared By:

Dale Darris, USDA NRCS Plant Materials Center, Corvallis, Oregon.

Species Coordinator:

Dale Darris, USDA NRCS Plant Materials Center, Corvallis, Oregon.

Edited: 21mar2006 jsp, 16sept2008 dcd.

For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

Plant Fact Sheet

OCEANSPRAY

Holodiscus discolor (Pursh) Maxim.

Plant Symbol = HODI

Contributed by: USDA NRCS Plant Materials Center, Corvallis, Oregon

Alternate Names: Also known as *Holodiscus boursieri* (Carr.) Rehd., *Holodiscus microphyllus* Rydb., *Spiraea discolor* Pursh, *Sericotheca discolor* Rydb., and *Schizonotus discolor* Raf. Additional common names include creambush, arrowwood, ironwood, hardhack, rock spiraea and mountain spray.

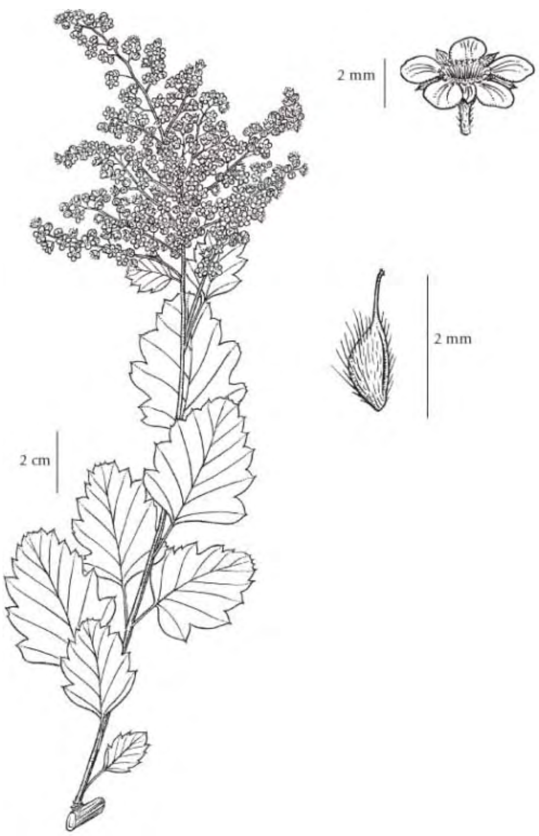
Uses: This hardy species, tolerant of wide moisture regimes, soil types, and both sun and shade, is useful for low maintenance riparian plantings, reclamation of droughty and rocky or disturbed sites, and windbreaks. This broad adaptation and abundant mid-summer flower clusters at the tips of arching branches make oceanspray a popular ornamental for highway and landscape plantings and an important host for beneficial insects. Palatability for livestock and wildlife is generally considered to be low but varies with climate and incidence of fire. It is browsed by cattle, deer, elk, snowshoe hares and dusky-footed wood rats but not moose. As a common understory species, oceanspray provides cover for numerous birds and small mammals and also treefrogs. Seeds were eaten by Native Americans who also used the hard straight stems for arrow, spear and harpoon shafts, halibut hooks, digging sticks and sewing and knitting needles. Pioneers used the wood as pegs in place of nails. Medicinally, an infusion of dried seed was used to treat diarrhea and prevent contagious diseases. A poultice of oceanspray bark and leaves was applied to burns or sores.

Legal Status: Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g. threatened or endangered species, state noxious status, and wetland indicator values).

Description: Oceanspray is a moderately long-lived, moderately fast growing perennial shrub of the Rose family. It is native to western North America from British Columbia to southern California including areas of Montana, Colorado and Arizona. Multiple arching stems achieve 6 to 20 feet with the taller specimens found in shade or nearer the coast. The deciduous, alternate leaves are oval to triangular with deep veins and shallow lobes plus very fine teeth. They are green above and dull green beneath due to fine hairs and turn reddish in fall. Drooping, 4 to 7+ in. clusters of very small creamy white, sometimes pinkish flowers turn to beige then brown and often persist through winter. Fruit develops in mid to late summer and consists of five tiny, hairy, light yellow achenes (dry, one-seeded fruit) per flower. The bark is red-grey and peels from older stems.

Adaptation and Distribution: Oceanspray performs well in shade or full sun and is adapted to course, medium and fine textured soils with pH 5.0 to 7.5. Ranging from sea level to 7000 ft., this species has moderate drought tolerance and low fertility requirements. Oceanspray is abundant near the coast and common west of the Cascades where it often dominates the forest shrub layer. Remnant stands occur among higher peaks of Great Basin mountain ranges. Oceanspray habitat varies considerably and includes streambanks, the understory of moist woods, cutover timberland and dry rocky soils and talus slopes. For a current distribution map, please consult the Plant Profile page for this species on the PLANTS Web site.

Pests and Potential Problems: The genus is largely free of insect pests and diseases although susceptibilities to fireblight (*Erwinia amylovora*), a fungal leaf spot (*Septogloeum sp*.) and aphids have been reported. It is also a host of the root parasite, pine broomrape (*Orobanche pinorum*).



Holodiscus discolor
© PROVINCE OF BRITISH COLUMBIA

Establishment: Oceanspray is typically propagated by seed requiring 15 to 18 weeks of cold moist storage (stratification) to overcome dormancy. There are more than 5,000,000 seeds per pound. Seed viability is reported as less than 10%. Seedlings develop slowly. Oceanspray can also be propagated from softwood or hardwood cuttings or by layering. Success in rooting varies widely depending on clone and technique. Softwood cuttings taken in spring may be treated with a rooting hormone and grown under mist with bottom heat. Better results may be expected with fall or winter collected hardwood cuttings, also treated with rooting hormone. Autumn is the best time to transplant container stock.

Management: As a poor competitor, oceanspray benefits from weed control when young. The fibrous root system requires well drained soil at least 12 in. deep. Consider supplemental irrigation during establishment year or years with low rainfall. Cutting back mature stems will encourage vigorous growth suitable for cutting wood.

Environmental Concerns: Oceanspray spreads slowly either by seed or by root sprouting although it will recolonize rapidly following fire or other disturbance. It is non-toxic to humans and wildlife.

Cultivars, Improved, and Selected Materials (and area of origin): Oceanspray is available as seed, container stock or bare-root from west coast native plant nurseries. It is a popular ornamental in parts of Europe where the cultivar 'carneus' may be available. A more compact growing related species, *Holodiscus dumosus*, native to the east side of the Cascades and Sierra Nevada mountains is sometimes marketed as a dwarf oceanspray. The Corvallis Plant Materials Center has two selected class germplasms pending release for use in western Washington and western Oregon.

Prepared By: *Pete Gonzalves* and *Dale Darris*. USDA NRCS Plant Materials Center, Corvallis, Oregon. October 2007.

Species Coordinator: *Pete Gonzalves*. USDA NRCS Plant Materials Center, Corvallis, Oregon.

Line Drawing Source Document: Douglas, G.W., D.V. Meidinger, and J. Pojar (editors). 1999. Illustrated Flora of British Columbia. Volume 4: Dicotyledons (Orobanchaceae Through Rubiaceae). B.C. Ministry of Environment, Lands & Parks and B.C. Ministry of Forests. Victoria, British Columbia.

Edited: 26Oct2007 PG

United States Department of Agriculture
Natural Resources Conservation Service

Plant Fact Sheet

PRAIRIE JUNEGRASS

***Koeleria macrantha* (Ledeb.) J.A. Schultes**

Plant Symbol = KOMA

Contributed by: USDA NRCS Corvallis Plant Materials Center

Dale Darris, USDA NRCS Oregon PMC

Alternate Names

Other scientific names include *Aira cristata* L., *Aira macrantha* Ledeb., *Koeleria mukdenensis* Domin, *Koeleria cristata* (L.) Pers., *Koeleria gracilis* Pers., *Koeleria mukdenensis* Domin, *Koeleria nitida Nutt.*, *Koeleria yukonensis* and *Koeleria pyrmidata* (Lam.) Beauv. Common names include Junegrass, mountain Junegrass, and crested hairgrass.

Uses

Prairie Junegrass is useful in seed mixes for restoration of native prairie, savanna, coastal scrub, chaparral and open forest habitats across much of North America. Good drought tolerance and fibrous roots make it useful for revegetation and erosion control on mined lands, over septic systems, and on construction sites, burns and other disturbed areas. Active growth begins early in spring providing good forage for livestock, deer, antelope and elk. Declining palatability during seed formation rebounds in late summer where there is adequate moisture. Bighorn sheep and mountain goats graze this species from rocky soils at high elevation. It provides feed for upland game birds, small mammals, and numerous grasshoppers and leafhoppers. Prairie Junegrass may also be cultivated for forage or fodder and is used as a low input turfgrass (e.g. golf courses) and as an ornamental grass. Native Americans used the seeds to make flour for bread and mush. They also fashioned paint brushes and brooms from the leaves.

Status

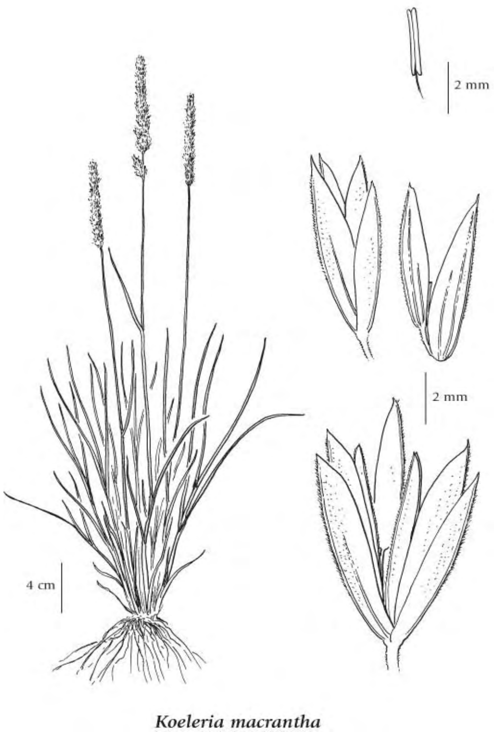
Prairie Junegrass is considered endangered in Ohio and Kentucky and critically impaired in Louisiana. Consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g. threatened or endangered species, state noxious status, and wetland indicator values).

Description

Prairie Junegrass is a highly variable, moderately long-lived, cool season perennial bunchgrass that grows 0.5 to 2 ft. tall. Clusters of narrow, markedly veined, light green to bluish green leaves grow to about 7 in. tall. The leaves are flat to in-rolled with slightly rough edges and boat-shaped, pointed tips. Erect seedheads appear as dense, pale green to purplish spikes, tapered at both ends, and 2 to 5 in. long, that are often held well above the foliage. They fluff open somewhat during flowering. There are 2 to 4 flowers per spikelet.

Adaptation

Prairie Junegrass is adapted to a wide variety of climates, soils and native plant communities. The North American distribution of this circumpolar species ranges from eastern Alaska, down through California into Mexico, and east to Alabama, Delaware, and Ontario. For additional information on distribution, consult the Plant Profile page for this species on the PLANTS Web site. Prairie Junegrass is most commonly found on rocky to sandy loam soils of low fertility but also occurs on clay bearing soils with adequate drainage. This plant prefers a soil pH of 6.0 to 8.0. A frequent component of both seral and climax plant communities from 4,000 to 12,000 ft., prairie Junegrass occasionally dominates northern plains mixed prairie. Depending upon seed source, it tolerates cold, heat, drought, fire and serpentine soils. It does not tolerate high soil salinity.



Line drawing courtesy of University of Washington Press

Establishment

Prairie Junegrass seed has little dormancy following cold storage through winter and is generally planted in spring. There are about 1.8 million seeds per pound (+/- 20%) although viability is often below 50 percent. For seed production, 0.75 to 2 lb. PLS (pure live seed) per acre is drilled shallowly (for light exposure) in rows 24 to 36 in. apart, depending on available irrigation or rainfall. Narrower (12 in.) rows may be used where cultivation between rows is not required. At least 1 lb. per acre is used to seed pasture which may require 2 to 3 years for establishment prior to grazing. Application of fertilizer to wild ecotypes is usually not recommended. Selective herbicides are available for seed production fields or to aid in pasture or native habitat establishment.

Management

Prairie Junegrass flowers in April to June and seed matures in July or August depending upon location and climate. Once established, it will tolerate moderate grazing to 3 or 4 in., even during the fall months as long as moisture is available to stimulate re-growth. In park settings, this grass tolerates foot traffic better than many other native grasses. At least partially due to its small stature, prairie Junegrass is very resistant to fire and will often increase in percent cover after a fire or other disturbance. In turf settings, this species tolerates repeated low mowing.

Pests and Potential Problems

Prairie Junegrass is often free of significant insect and disease problems but is occasionally the target of striped flea beetles, rusts, leaf spots or blights.

Environmental Concerns

Prairie Junegrass usually spreads slowly if at all, and only by seed. However, it played an important role in prairie revegetation following severe drought and dust storms in the 1930s. It generally provides 5% or less of the herbaceous cover in natural settings.

Cultivars, Improved, and Selected Materials

'Barkoel' prairie Junegrass is an improved cool-season turfgrass cultivar developed from plants native to northern Europe. 'Barkoel' seed is available from Barenbrug USA, Tangent, OR. Two native germplasms selected for roadside planting, prairie restoration, and landscaping have been released from the Elsberry Plant Materials Center in Elsberry, IA.

Prepared By

Pete Gonzalves and *Dale Darris*, USDA NRCS, Plant Materials Center, Corvallis, Oregon

Species Coordinator

Daniel G. Ogle, USDA NRCS Idaho State Office, Boise, Idaho

Edited: 23apr08pjg; 080915jsp

For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

Plant Fact Sheet

RICE CUTGRASS

Leersia oryzoides **(L.) Sw.**

Plant symbol = LEOR

Contributed by: USDA NRCS Plant Materials Center, Corvallis, Oregon

Dale Darris
USDA NRCS Corvallis PMC

Alternate Names
Plant synonyms include *Homalocenchrus oryzoides* (L.) Pollich, and *Phalaris oryzoides* L. Another common name is sickle grass.

Uses
Rice cutgrass is valuable for wildlife habitat improvement, wetland restoration, and erosion control in ditches and other watercourses. The seeds are an important food source for waterfowl, small mammals, and shorebirds. Ducks pull up and consume underground stems (rhizomes). Dense colonies provide cover and habitat for fish, reptiles, and amphibians. The forage produced is highly palatable. This plant's creeping rhizomes and spreading habit are good for sediment stabilization along the immediate shorelines of streams and lakes. Tolerant of highly acidic conditions (pH=3), the species is being studied for use in constructed wetlands and the treatment of acid mine drainage. It may have potential for vegetated drainage ditches that mitigate agricultural runoff, including pesticides.

Status
Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g. threatened or endangered species, state noxious status, and wetland indicator values).

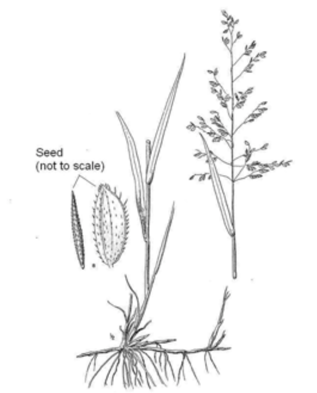
Description and Adaptation
Rice cutgrass is a native cool season grass that grows and flowers comparatively late in summer. The seed ripens in late August to early October, more typical of a warm season species. This short to medium lived perennial spreads by scaly, underground rhizomes and often forms dense colonies. The stalks (stems) are upright to sprawling, velvety at the nodes (joints), and 90 to 125 (150) cm tall. Leaf blades are 7 to 30 cm long, 6 to 15 (20) mm wide, and yellow-green in color. They have a coarse or rough upper surface and are lined with tiny teeth along the margins. The flowerhead (panicle) is open, often drooping, and 10 to 20 cm long. Some panicles remain enclosed within the lower leaf sheaths and release seeds upon decay of the stem. The seed hull is covered with minute bristles that readily cling to clothing or fur for dispersal. Rice cutgrass is widespread across southern Canada and most of the United States. It is also found in the warmer parts of Europe.

Key to identification: This grass is quickly identified by running a hand through it. The sharp leaves can cut flesh and tear weaker clothing. They are abrasive and sandpapery to the touch. Seeds resemble rice and are not easily confused with other native grasses. The spikelets hang in a single row creating a 1-sided appearance to each panicle branch. Rice cutgrass can easily be confused with two other species of *Leersia* commonly found in North America. Consult botanical keys for proper ID.

Relative abundance in the wild: Rice cutgrass is occasional to very abundant. Once stands are located, seed is easily stripped by hand. Retention of seed is fair at best. Seed shatters (drops) readily at maturity.

Adaptation: Rice cutgrass can be found in a variety of wet, sunny, and partially shaded sites. However, it is most common near streams, ponds, or beaver areas, and in ditches, canals, or freshwater marshes. This species thrives best in nutrient rich mud and slow moving or stagnant water. Seedlings may not survive submergence for more than 2 to 3 days, while mature plants easily tolerate seasonal to permanent flooding. Reportedly, this grass can grow in standing water up to 0.5 (15 cm), 1 ft (30 cm) or 3 ft (1 meter) deep. It can be found in other habitats where soils are saturated at or near the surface year round or continuously moist in summer. It occasionally co-exists with reed canarygrass (*Phalaris arundinacea*) on wetter sites, but is much less broadly adapted. Soils may range from acid to alkaline [pH (3) 5.1 to 8.8] sands, silts, loams, or clays. For natural regeneration, rice cutgrass needs bare mud and an open vegetative structure created by seasonal inundation and regular disturbance.

Establishment
Rice cutgrass seed possesses physiological dormancy requiring a 180 to 270 day period of cool, moist stratification (moist chilling). Gentle scarification (abrasion of the seed coat after hull removal) may improve germination as well. Late summer or early fall seeding is recommended. Seeds will germinate the following spring. There are approximately 360,000 seeds/lb (+/- 20%). A seeding rate of 1 lb/acre of pure live seeds will result in 8 live seeds per square foot. Rarely sown alone due to cost, it typically comprises 1 to 20% of a seed mix. Rhizomes, rootstock, and container plants are also used for establishment. A spacing of 1 to 3 feet (30-90 cm) will achieve uniform ground coverage in 1 to 3 years respectively. Rhizomes should be planted 2 to 5 inches (5-12 cm) deep.



Line drawing reprinted with permission, Univ. of Wash. Press

Management
Plants develop relatively slowly in spring, becoming most productive during the summer. The seed matures in late August or September and the plants go dormant soon after (October-November). Stand maintenance or proliferation requires adequate soil fertility, regular flooding, and soil disturbance every two to three years to create open areas. For wildlife enhancement, this species is well suited to moist soil management techniques (slow summer de-watering, soil disking, etc.) applied to certain wetlands and shallow water impoundments. In some cases, disturbance and regeneration have been promoted by grazing cattle.

Environmental Concerns
Rice cutgrass has a narrow ecological adaptation and may not persist well. However, it is also a weed in some situations, including commercial cranberry beds (bogs) in the Pacific Northwest and Northeast. It is sometimes considered a weed in the Southeast as well. This species can form dense colonies to the potential exclusion of other native marsh grasses and herbs. However, under undisturbed conditions it is regularly replaced by other species. The abrasive leaves may cause skin injury.

Cultivars, Improved, and Selected Materials (and area of origin)
Seed sources can be hard to locate for Oregon, Washington, and California. Container plants and rootstock are somewhat more common. It is readily available in the Midwestern states from seed producers and nurseries.

Prepared By:
Dale Darris and Amy Bartow, USDA NRCS Plant Materials Center, Corvallis, Oregon.

Species Coordinator:
Dale Darris, USDA NRCS Plant Materials Center, Corvallis, Oregon.

Edited: 21mar2006 jsp, 16sept2008 dcd.

For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

Plant Fact Sheet

PACIFIC NINEBARK

Physocarpus capitatus (Pursh) Kuntze

Plant Symbol = PHCA11

Contributed by: USDA NRCS Plant Materials Center, Corvallis, Oregon

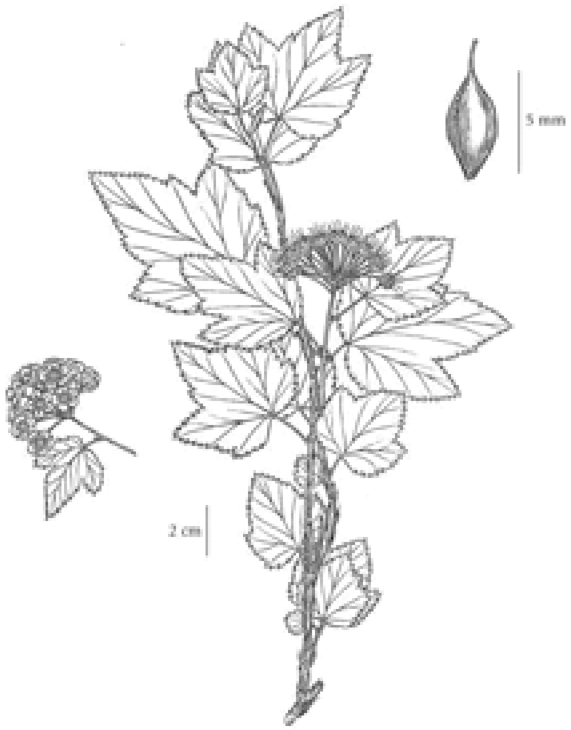
Alternate Names: Also known as *Physocarpus opulifolius* (L.) Maxim. var. *tomentellus* (Ser.) Boivin and *Spiraea capitatus* Kursh.

Uses: Pacific ninebark's fibrous roots and capacity to root from un-rooted cuttings make it suitable for soil bioengineering techniques including live stakes, fascines and brush mats. It is particularly valuable for streambank and lakeshore stabilization applications. Pacific ninebark provides good cover and nesting sites for birds and small mammals but has low palatability when browsed by deer, elk and bear. It has ornamental value for the wild garden or open woodland. Although considered toxic by some, Pacific ninebark was used as an emetic, purgative and laxative by Native Americans.

Legal Status: Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g. threatened or endangered species, state noxious status, and wetland indicator values).

Description: Pacific ninebark is a long-lived perennial shrub of the Rose family native to the Pacific Northwest. It grows rapidly with multiple stems achieving 2 to 4 meters in an erect to arching form with angled branches. The reddish papery bark peels off in long thin layers giving rise to the common name. Deciduous leaves that appear alternately along the stem are 3-10 cm long, 3-5 lobed and doubly toothed at the margin. They are deeply veined, shiny dark green above and lighter beneath with fine star-shaped hairs. Fall color is described as rose-brown. Small (4 mm wide), 5-petaled creamy white flowers with pink stamens form dense rounded clusters at the branch terminals. Flowers appear between late April and July. One to four hard shiny pear-shaped yellow seeds form within small fruits that are individually surrounded by dark reddish brown, bell-shaped bracts. These bracts often persist during winter. For a current distribution map, please consult the Plant Profile page for this species on the PLANTS Web site.

Adaptation and Distribution: Pacific ninebark prefers partial shade but tolerates full sun and is adapted to course, medium and fine textured slightly acidic soils. Occupying low to middle elevations in areas with annual precipitation of 50 to 200 cm, this species has low fertility requirements and low drought tolerance. Pacific ninebark is scattered to common west of the Cascades and often abundant in wet areas and on steep north slopes of the coastal mountains. Habitats include streambanks, lake margins, and swampy areas or openings in moist woods. Occasionally, Pacific ninebark is found in coastal marsh lands and meadows or at drier shrubby sites. Pacific ninebark occurs primarily west of the British Columbia Coast, Cascade, and Sierra Nevada Mountain Ranges from extreme southeast Alaska to central California. It is less prevalent east of the Cascades where its range extends along the Columbia, Snake and Clearwater Rivers into Idaho and overlaps with that of mallow ninebark (*Physocarpus malvaceus*).



Physocarpus capitatus
© Province of British Columbia

Pests and Potential Problems: The genus is relatively free of insect pests and diseases although susceptibility to aphids and powdery mildew has been reported. Flower and seed eating specialist insects are known to occur on common ninebark (*Physocarpus opulifolius*), a native of the eastern United States.

Establishment: Pacific ninebark is typically propagated by seed (requiring 2 to 4 months cold stratification) or is rooted from softwood or hardwood cuttings. There are 43750 seeds per ounce with viability ranging from below 50% to nearly 100%. Softwood cuttings taken in spring may be grown under mist, whereas dormant hardwood cuttings may be planted directly in the field as live stakes or fascines. Autumn is the best time to transplant cuttings or rooted stock. Mulching improves establishment.

Management: Nursery plantings of Pacific ninebark can be as dense as 1200 plants per acre in soil at least 20 in. deep. Consider supplemental irrigation during establishment year or years with low rainfall.

Environmental Concerns: Pacific ninebark spreads slowly either by seed or by root sprouting. Concerns are minimal, except for possible toxicity.

Cultivars, Improved, and Selected Materials (and area of origin): Pacific ninebark is routinely available in containers or bare-root from west coast native plant nurseries. There is a prostrate ornamental cultivar named 'Tilden Park' that grows to a height of 4-5 feet.

Prepared By: *Pete Gonzalves* and *Dale Darris*. USDA NRCS Plant Materials Center, Corvallis, Oregon.

Species Coordinator: *Pete Gonzalves*. USDA NRCS Plant Materials Center, Corvallis, Oregon.

Line Drawing Source Document: Douglas, GW, GB Straley, D Meidinger, and J. Pojar. 1999. *Illustrated Flora of British Columbia* vol.3. Ministry of Environment, Lands and Parks, Victoria, British Columbia.

Edited: 28Jun2007 PG; 070716 jsp

Plant Fact Sheet

PINE BLUEGRASS

Poa scabrella (Thurb.) Benth. ex Vasey

Plant Symbol = POSC

Contributed by: USDA NRCS Plant Materials Center, Corvallis, Oregon

Dale Darris
USDA NRCS Corvallis PMC

Alternate names: Another common name is Sandberg bluegrass. *Poa scabrella* or pine bluegrass was formerly recognized as a separate species. It has since been combined with up to 44 other bluegrasses into a large complex known as *Poa secunda* or Sandberg bluegrass.

Caution: The *Poa secunda* complex represents a highly variable array of ecological forms occurring over a large area of the United States in diverse habitats. Information pertinent to certain forms may not apply well to the entire species across all regions. Therefore, this fact sheet applies best only to *Poa secunda* (formerly *Poa scabrella*) as it occurs west of the Cascades in the Pacific Northwest.

Uses: Pine bluegrass is a native cool season bunchgrass of small to moderate stature useful for restoration of upland meadows, wet prairies, and pine or oak savanna, depending on region. While slow to establish, it is drought tolerant and useful for dry, rocky outcrops as well as moist, slower draining sites. Other uses include revegetation, rehabilitation after wildfire, erosion control in mixes with other grasses, upland bird habitat (nesting cover, source of seed), and natural area landscaping. Specific information on livestock and wildlife utilization of pine bluegrass west of the Cascades is lacking. However, on drier western rangelands, ecotypes within the *Poa secunda* complex have value for livestock grazing and big game forage, especially in early spring. Palatability prior to dormancy and again in fall is rated fair to good for most ungulates, small mammals, and certain birds. Productivity can be low, especially in dry years. Potential uses that need further testing west of the Cascades are low input lawns and cover crops in vineyards or other horticultural crops where its early summer dormancy may be beneficial.

Description: Pine bluegrass is a fine textured, short to medium lived, strongly tufted perennial grass with erect culms (stems) 40-100 cm tall. Mature clumps are typically 10-16 cm wide and the foliage is light to medium green or slightly bluish, and mostly basal. Leaf blades are numerous, 1-2 mm wide, 5-22 cm long, flat to folded or rolled inward, and lax. The panicle (inflorescence or seed head) is upright and narrow. Dormancy occurs in summer when soils dry while new growth initiates during fall, winter and spring. Seed matures in June-July in the western interior valleys of Oregon and Washington and in August at higher elevations.

Key to identification: Pine bluegrass has narrower panicles, narrower leaf blades (1-2 mm vs. 2-5 mm), and does not spread by stolons (or rhizomes) in comparison to two common, weedy introduced relatives: roughstalk bluegrass (*Poa trivialis*) and Kentucky bluegrass (*Poa pratensis*). It does not have cobwebby hair along the veins or at the base of the floret (individual flower unit) like Kentucky bluegrass. Pine bluegrass is no longer distinguished from Sandberg bluegrass, Canby's bluegrass (*Poa canbyi*), and other bluegrasses in the same complex.

Commercial availability: Populations originating from Oregon, California, Washington, and other western states are available and marketed as *Poa scabrella* or *Poa secunda.* Selected germplasm and cultivated varieties have also been released within the complex and some are better forage producers. However, given the limited testing and potential site or use specificity of different forms, utilization of any population should be confined within the same ecoregion and elevation zone, or a reasonable geographic distance from the original collection site.

Relative abundance in the wild: Pine bluegrass is somewhat infrequent west of the Cascades in Oregon and Washington. However, it is more common in other regions of the West.

Limitations or environmental concerns: The species is susceptible to stem and leaf rust in some years, especially under seed production. This can increase mortality and may necessitate the use of approved fungicides. It is slow to establish during the first year and may be out competed by weeds. There are no substantial environmental concerns.

Line drawing reprinted with permission, University of Washington Press

Adaptation: Pine bluegrass inhabits open woodlands and sagebrush steppe as well as on dry, rocky slopes, exposed slopes, or shallow soils with good drainage. However, populations are also found in higher precipitation zones under moister soil or slower draining conditions including seasonally wet prairies of western Oregon and Washington. The *Poa secunda* complex has a wide range, occurring from near sea level along the Pacific Coast eastward to higher elevations in the mountain west as well as Great Plains. Soil types vary from moderately acid sands to loams and clay loams with a pH from 6.0 to 8.0. The species occurs in full sun as well as in partial shade of open timber or savanna. It is well adapted to fire as a component of prairie ecosystems.

Establishment: Seed of *Poa secunda* is classified as nondormant and typically germinates without treatment. However some populations of pine bluegrass germinate more uniformly or at a higher percent with 14, 30 or 60 days of cold, moist chilling (stratification). Therefore, fall seeding is advised. No special physical conditioning of the seed is needed. Seed weight varies from 900,000-1,500,000 seeds/lb. Each pound of pure live seed (PLS) sown per acre results in 20-34 live seeds/sq. ft. Seeding depth must be shallow, preferably less than ¼ in. on heavier soils and ½ in. on lighter soils. Pine bluegrass is rarely sown alone (2-3 lbs/ac) but rather in mixes with other grasses (0.5-2 lbs/ac). Higher rates (4-8+ lbs/ac) are applied to higher precipitation zones (30+ inches/yr) and experimental uses such as low input cover. Rate of establishment from seed is slow. If fall sown, flowering can occur the following spring in milder climates.

Prepared by:
Dale Darris, USDA NRCS Plant Materials Center, Corvallis, Oregon. July 2007.

Species coordinator:
Dale Darris, USDA NRCS, Plant Materials Center, Corvallis, Oregon.

For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

Plant Fact Sheet

RED-FLOWERING CURRANT

Ribes sanguineum Pursh

Plant Symbol = RISA

Contributed by: USDA NRCS Plant Materials Center, Corvallis, Oregon

Pete Gonzalves

Alternate Names: Also known as *Ribes sanguineum* Pursh forma *atrorubens* (Loudon) Rehder, *R. glutinosum* Benth, *Coreosma sanguinea* (Pursh) Spach and *Calobotrya sanguinea* (Pursh) Spach. Common names include redflower currant, blood currant, winter currant, and pink-flowering currant.

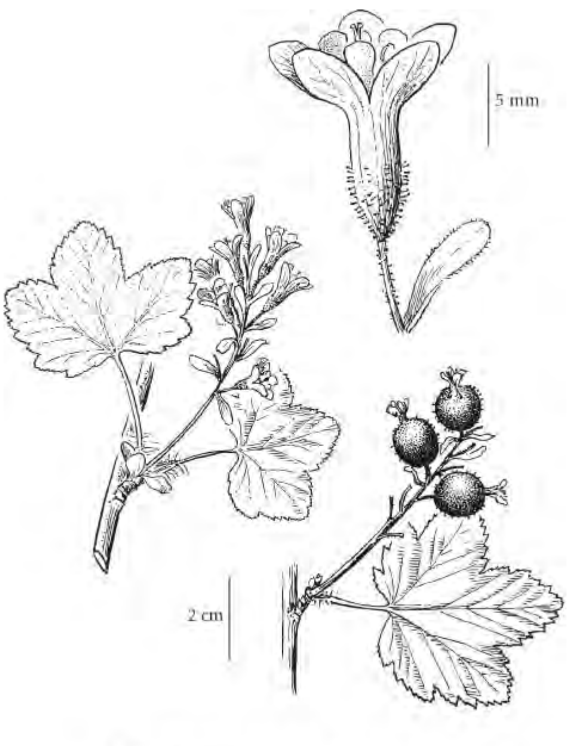
Uses: Red-flowering currant is a drought tolerant deciduous shrub that may be useful in restoration plantings. It provides early spring nectar for hummingbirds and butterflies, forage for the larvae of more than two dozen species of moths and butterflies, and nesting sites or cover for songbirds and small mammals. Numerous birds including grouse, quail, robins, finches, towhees, and woodpeckers, and small mammals consume the berries. Red-flowering currant provides occasional browse for game animals and modest forage value for sheep and cattle. Abundant showy flowers make this plant attractive as a landscape specimen or informal hedge and more than a dozen selections and hybrids are featured in the ornamental trade. Berries, although very tart, are considered suitable by some for jam, jelly, pie, juice or syrup. Native Americans ate the berries fresh or dried. This species has been investigated for medicinal anti bacterial and anti viral properties and is used in currant fruit breeding programs to confer resistance to anthracnose, powdery mildew and currant stem borer.

Status: This plant is critically imperiled within Idaho and planting of currants is restricted in Michigan. Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g. threatened or endangered species, state noxious status, and wetland indicator values).

Description: Red-flowering currant (family: Grossulariaceae) produces numerous small flowering spurs on multiple thornless stems. It grows at a moderate rate up to 10 ft. and develops an upright to spreading form. Deciduous, alternate leaves are 1-3 in. and rounded with 3-5 shallow lobes and deep veins lending a wrinkled appearance. They are green above and dull green beneath due to fine hairs and turn yellow to reddish in mid to late summer. Leaves of some plants are pungent when crushed. Numerous 2-6 in. long, nodding clusters of 5-25 flowers appear in March to June. The flowers are composed of pink to deep red (rarely white) tubular fused sepals and small protruding red or white flower petals. Blue-black berries smaller than 0.5 in. have a thin white waxy coating, hold about 20 seeds each, and mature in early to mid summer. Thin orange or red tinted bark turns gray-brown and peels from older stems.

Adaptation: Red flowering currant is a moderately long-lived woody perennial hardy to -4°F. It prefers sun or partial shade and well-drained, moderately fertile soil of near neutral or slightly acidic pH. Plants are commonly found from southwest British Columbia through western Washington and Oregon (mostly west of the Cascade Mountains crest) and the California Coast Ranges to Santa Barbara County. There are also small relict populations in northern Idaho. Red-flowering currant habitat includes open woods, forest gaps, dry rocky slopes and disturbed sites from sea level up to 6,000 ft. For a current distribution map, please consult the Plant Profile page for this species on the PLANTS Web site.

Establishment: Red-flowering currant is a pioneer species sprouting from seed or root crowns following fire. It is propagated by seed, cuttings or layering. Heavy seed crops occur every second or third year and 100 lbs. of berries will yield about 4 lbs. of seed. There are approximately 284,000 seeds per pound. Seed is naturally distributed by birds and small mammals and may remain viable in soil for several years. Fall sowing or cold moist storage (stratification) near 32°F for 30-140 days may aid germination. Propagation with cuttings has been successful with soft wood in spring, semi-hard wood in summer and hard wood collected during the dormant season. Rooting may improve by including a 'heel' of older wood and using bottom heat, mist, or rooting hormone. Red-flowering currant generally does not establish well using soil bioengineering practices such as live stakes or fascines but may be successful on particularly favorable sites with supplemental irrigation or with mulch.



Ribes sanguineum var. *sanguineum*

Management: Provide supplemental water during the first and perhaps second season but allow soil to dry 3-4 in. down between irrigations and do not provide water after mid to late summer when leaves naturally begin to fall. Prune immediately after flowering to encourage vigorous growth suitable for future flower bearing.

Pests and Potential Problems: Red-flowering currant is fairly resistant to most insect and disease pests of this genus including aphids and currant fruit fly (*Euphranta canadensis*). It is susceptible to currant borer (*Synanthedon tipuliformis*), oak root fungus (*Armillaria mellea*) and seedlings may be susceptible to damping off disease.

Environmental Concerns: Red-flowering currant spreads slowly by seed, root sprouting and layering. As an alternate host of white pine blister rust (*Cronartium ribicola*), red-flowering currant has been considered a weed in several timber states and, along with other *Ribes* sp., was the subject of extensive eradication efforts in the past. It is non-toxic to humans and wildlife.

Cultivars, Improved, and Selected Materials (and area of origin): There are four geographical botanical varieties of *Ribes sanguineum*. More than a dozen named cultivars and hybrids are routinely available as container stock from retail nurseries. Popular choices include 'White Icicle' (early white flowers) 'Pinky Pig' (pink flowers) and 'King Edward VII' (compact with deep red flowers).

Prepared By and Species Coordinators: *Pete Gonzalves* and *Dale Darris*, USDA NRCS Plant Materials Center, Corvallis, Oregon.

Line Drawing Source Document: Douglas, GW, GB Straley, D Meidinger, and J. Pojar. 1999. Illustrated Flora of British Columbia vol.3. Ministry of Environment, Lands and Parks, Victoria, BC.

Edited: 10Apr2008 pjg; 080917 jsp

For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

RED ELDERBERRY

Sambucus racemosa L. var. *racemosa*

Plant symbol = SARAR3

Contributed by: USDA NRCS Plant Materials Center, Corvallis, Oregon

©William S. Justice. Courtesy of Smithsonian Institution, Dept. of Systematic Biology, Botany.

Alternate Names: Other scientific names include *Sambucus callicarpa*, *Sambucus microbotrys*, *Sambucus pubens*, *Sambucus pubens*. var. *arborescens*, *Sambucus racemosa* ssp. *pubens* and Sambucus *racemosa* var. *pubens*. Alternate common names include scarlet elder, stinking elderberry, stinking elder, red-berried elder, bunchberry elder, and red elder.

Warning: Red elderberry fruit may be toxic when taken internally, without sufficient preparation.

Uses: The dense roots and rhizomes of red elderberry make it useful for soil stabilization and erosion control on moist sites including streambanks. It provides fair to good food and cover for birds plus small and large mammals. Hummingbirds collect nectar from the flowers. With fair energy and low protein values, this variety is rated fair to good as browse for livestock and game animals. The fruit is high in ascorbic acid. Stems, bark, leaves and roots contain cyanide-producing toxins but berries may be consumed as jelly or wine after cooking. This versatile plant can also be used to make dye, insecticide, medicine, and musical instruments. The colorful fruit attracts birds and several cultivars have been developed for ornamental applications.

Legal Status: Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g. threatened or endangered species, state noxious status, and wetland indicator values).

Description: Red elderberry is a large deciduous shrub or small tree of the Honeysuckle family that grows 10-20 ft tall with a broad arching form. Older specimens have large, multiple trunks with coarse bark. Red elderberry begins growth early in spring and produces abundant, small, creamy white flowers in large, conical or pyramidal shaped clusters between April and July. Large clusters of small, bright red, fleshy berries appear in summer bearing 2-5 seeds per fruit. Opposite leaves are divided into 5-7 pointed, oval to oblong or lance shaped 5-10 cm long leaflets with finely toothed margins. The foliage has a strong, distinctive odor. Twigs are pithy and light weight, dark red or purple to reddish-brown in color, and covered with numerous small bumps (raised pores). Dead terminal twigs are common.

Adaptation and Distribution: Red elderberry is an early to mid seral species in the west and a component of climax deciduous forests in the eastern U. S. It inhabits streambanks, ravines, swamps, moist forest clearings and higher ground near wetlands from sea level to 9500 ft in elevation. It is shade tolerant but prefers a sunny exposure. Red elderberry is found on a wide variety of soils but favors deeper, loamy sands and silts and nutrient rich sites with good drainage, ample moisture and a pH of 5.0 to 8.0. This species is circumpolar in northern temperate zones extending south in cooler areas along the California coast and at higher elevations in the Rocky and Appalachian Mountains. Red elderberry is widespread throughout its range and is occasionally dominant or co-dominant in moist areas. It is still common but less dense on upland sites.

Britton, N.L., and A. Brown. 1913. *Illustrated flora of the northern states and Canada*. Vol. 3: 268.

Establishment: Red elderberry may be propagated vegetatively by dormant hardwood cuttings taken in late fall or winter, by softwood cuttings taken in the spring or summer, and by root or rhizome cuttings. Stem cuttings require at least 2 nodes (joints) with the basal cut just below the lower node. Stem cuttings may benefit from the use of a rooting hormone solution like IBA or IBA-talc. Layering is another means of propagation. Sturdy, unrooted dormant cuttings taken in late fall or winter can be planted directly on moist streambanks as “live stakes”.

Due to seed coat and embryo dormancy, dry or fresh seed requires 30-60 days warm, moist (20-30°C) stratification followed by at least 90-150 days cold stratification (5°C) [cold, moist chilling], or 5-15 min sulfuric acid plus 2 months cold, moist chilling at 1-4°C for good germination. Others suggest that after pulp removal, fresh seed can be sown immediately in late summer to provide both warm (fall) and cold (winter) periods for conditioning. There are about 200,000 – 300,000 clean seeds per pound. Red elderberry consistently produces abundant fruit and seed. Container and bare root nursery stock may be planted using standard practices. Fall planting is recommended over winter and spring if material is available at this time.

Management: Nursery plantings of red elderberry can be as dense as 700 plants per acre in soil at least 24 in. deep. Consider supplemental irrigation during establishment year or years with low rainfall. Red elderberry will re-sprout from both roots and the seed bank following fire. Severe pruning will prevent a spindly growth habit in ornamental applications.

Pests and Potential Problems: Viral cankers can girdle and kill the stems. Bacterial and fungal leaf spots, powdery mildew and cane borers are usually not serious.

Environmental Concerns: Red elderberry spreads slowly either by seed or by root sprouting. In moist forests of the Pacific Northwest this species (var. *racemosa*) can inhibit tree regeneration following fire, but it is not considered a primary competitor. Although little effect has been discerned in the field, plants may have some allelopathic potential as they inhibited germination and growth of Douglas-fir (*Pseudotsuga menziesii*) and other species under experimental conditions.

Cultivars, Improved, and Selected Materials (and area of origin): Red elderberry is routinely available in containers or bare-root from west coast native plant nurseries. ‘Plumosa Aurea’ is an ornamental cultivar with cut leaves and yellow foliage.

Prepared by: Pete Gonzalves and Dale Darris. USDA NRCS Plant Materials Center, Corvallis, Oregon. June 2007.

Species coordinator: Pete Gonzalves. USDA NRCS Plant Materials Center, Corvallis, Oregon.

For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

Plant Fact Sheet

PALE FALSE MANNAGRASS

Torreyochloa pallida (Torr.) Church var. *pauciflora* (J. Presl) J.I. Davis

Plant symbol = TOPAP3

Contributed by: USDA NRCS Plant Materials Center, Corvallis, Oregon

Dale Darris
USDA NRCS Corvallis PMC

Alternate Names

Other common names include weak alkaligrass, weak mannagrass, and weak false manna. Synonyms include *Glyceria pauciflora*, *Glyceria otisii*, *Pucinellia pauciflora*, and *Torreyochloa pauciflora*.

Uses

Pale false mannagrass has potential for restoration and enhancement of forested, prairie, and riparian wetlands, as well as other non tidal wetland plant communities. Its underground creeping stems (rhizomes) improve the plants ability to stabilize soils along faster moving streams and watercourses. The seeds are probably eaten by waterfowl and other birds, while the foliage provides cover for wildlife. The value of false mannagrass as forage for livestock, large game, and small mammals is not widely known. It may have potential for use in ditches or swales designed to filter agricultural or stormwater runoff. Strong rhizome production coupled with low lying, curved stems that root from the joints, makes this species a good candidate for streambank, channel, and shoreline stabilization.

Status

Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g. threatened or endangered species, state noxious status, and wetland indicator values).

Description and Adaptation

Pale false mannagrass is a native, perennial cool season grass that grows 30 to 150 cm tall. The stems are erect to decumbent (low lying and bent upward) and may root where the nodes (joints) touch the ground. It actively spreads by rhizomes (underground shoots). Leaf blades are rolled when young, flat when mature, 3-15 mm wide, and slightly rough to the touch on one or both sides. The flower head (panicle) is loose and open, 7 to 20 cm long, with ascending or drooping branches. Pale false mannagrass occurs from Alaska to California and east to South Dakota and New Mexico. It can found from near sea-level to timberline in the Mountains.

Key to identification: Pale false mannagrass is easily confused with true mannagrasses (*Glyceria* spp.), which it was once classified as. However, its leaf sheaths (lower part of the leaf surrounding the stem) are open rather than closed and have cross- markings. The species is also similar to true alkaligrasses (*Pucinellia* spp.). Consult with a botanical key for distinguishing traits.

Relative abundance in the wild: Scattered in Oregon and Washington in marshy areas and roadside ditches where reed canarygrass (*Phalaris arundinacea*) does not dominate. Its abundance elsewhere is unknown. Seed retention is fair to good, production is high and seed fill is excellent. False mannagrass also ripens over several weeks in late summer wherever soil moisture is non-uniform. These features make wild collection easy.

Adaptation: Pale false mannagrass is found in freshwater marshes, swamps, wet forest openings, wet meadows, ditches and other depressions. It grows in acid soils comprised of loamy, organic, or sandy substrates. The species tolerance to salinity, alkalinity, and high acidity is not well reported. It typically occurs on continuously moist, saturated, and shallow flooded areas. At moderate elevations in Oregon, false mannagrass can form its own plant association where it comprises 30 to 80 percent of the total cover. Most of the surface area between plants is mud or open water. This species is found in full sun to intermediate shade but may prefer the latter.

Dale Darris
USDA NRCS Corvallis PMC

Establishment
The seed has no dormancy and germinates when fall or spring sown. It has a weak hull and requires no special conditioning. Establishment rate is moderate as is rhizome spread. There are approximately 1,955,000 seeds per pound (+/- 30%). A seeding rate of 1 lb/ac of pure lives seeds will result in about 45 live seeds per square foot. Suggested rates are 1 to 4 lbs/ac when sown as a single species. Rhizomes and plugs may also be used. Recommended spacing is 8 to 16 inches (20 to 40 cm) for uniform aerial coverage within one and two years respectively.

Management
There is a lack of information about the management of this species for livestock or other uses. When cultivated for seed, poorly drained soils or summer irrigation is required along with moderate soil fertility levels. Tolerance to wildfire or prescribed burning is not well documented.

Environmental Concerns
In some situations false mannagrass can form dense stands that may limit diversity, but it is not known to be weedy.

Cultivars, Improved, and Selected Materials (and area of origin)
This species is rarely sold as seed or plants. Availability depends on wild harvests, hand collections, or contract growing with producers who specialize in native herbaceous seed.

Prepared By:
Dale Darris, USDA NRCS Plant Materials Center, Corvallis, Oregon.

Species Coordinator:
Dale Darris, USDA NRCS Plant Materials Center, Corvallis, Oregon.

Edited: 23mar2006 jsp, 17sept2008 dcd.

For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

Plant Guide

CALIFORNIA OATGRASS
Danthonia californica Bolander

Plant Symbol = DACA3

Contributed by: USDA NRCS Plant Materials Center, Corvallis, Oregon

Dale Darris, USDA NRCS Oregon PMC

Alternate Names

Another common name is California danthonia. Synonyms include *Danthonia americana* and four botanical varieties of *Danthonia californica:* var. *americana*, var. *californica*, var. *palousensis*, and var. *piperi*.

Uses

Restoration and wildlife habitat: California oatgrass is an important native constituent of drier upland and moist lowland prairies as well as open woodlands. Therefore, it is commonly recommended for revegetation, wildlife plantings, and restoration of oak savannas, transitional wetlands, and grasslands, especially in the Pacific Coast states where it is most common.

Native bunchgrasses like California oatgrass are valuable for enhancing biodiversity. Healthy stands can reduce invasion by exotic species yet exhibit a spatial distribution compatible with forbs (Maslovat 2001). Combined with other native grasses and forbs, California oatgrass improves habitat diversity for feeding, nesting, and hiding by songbirds (Oregon Department of Fish and Wildlife 2000), as well as other animals. The grains are eaten by small birds and mammals (Mohlenbrock 1992). Prairies with California oatgrass as a definitive species are also unique refuges for other endemic organisms. For example, the Ohlone tiger beetle (*Cicindela ohlone*) is an endangered (federally listed) predatory insect known only to five remnant stands of California native grassland in Santa Cruz County (Santa Cruz Public Libraries 2003). These rare grasslands, including the coastal terrace prairies, remain biodiversity “hotspots” and are considered in need of protection (Stromberg et al. 2001).

Forage: As a rangeland plant, California oatgrass is well utilized by livestock and certain wildlife. Prior to maturity, the species is rated as good to very good forage for cattle and horses in the Pacific Coast states, but less palatable for sheep and goats. Ratings are lower for eastern, drier portions of its natural range (USDA Forest Service 1988). Others claim it is palatable to all classes of livestock and a mainstay grass for range grazing in places like Humboldt County, California (Cooper 1960). California oatgrass withstands heavy grazing (USDA Forest Service 1988, Cooper 1960). However, it is also reported that animals seek out and overgraze individual plants sometimes leading to rapid stand depletion (Crampton 1974). This species can provide green forage year round in some areas. Under moderate grazing it stools readily, forms a “sod” (ie. the bunches coalesce), and can produce a substantial volume of high quality forage. Less desirable species diminish as the sod forms. Higher nutritional content and grazing preference make California oatgrass desirable in a management system over soft chess (*Bromus mollis*) (Heady et al. 1963). Protein analysis is high at 8 to 26 percent; the low point coming in January after the herbage has been leached by precipitation (Cooper 1960). This species has formed stands dense enough for haying in California (USDA Forest Service 1988).

Pollinators: California oatgrass is used as food by the caterpillar larva of certain butterflies including two skippers (*Hesperia lindseyi* and *Hesperia columbia)* (Robinson et al. 2007). It is an important component of native grasslands that form critical habitat for other butterflies including the vulnerable Vancouver ringlet (*Choenonymphya tullia insulana*), Taylor's checkerspot (*Euphydryas editha taylori*) (Chappell 2006), and the endangered Fender's blue butterfly (*Icaricia icarioides fenderi*) (Collins 2006).

Cover and turf: Other potential uses include cover and erosion control in vineyards, young orchards (Edminster 2003), grassy lanes, and parks, as well as along trails. As a candidate for native lawn, this species can be planted and mowed to maintain a turf-like stand in landscape settings or elsewhere (Wrysinski 2004, Daniels 2007, Amme 2003). California oatgrass persists along compacted hiking trails and takes heavy foot traffic, trampling, and moderate summer moisture stress. It also has potential as a stay-green firebreak (Edminster 2003, Fire Safe Council 2007).

Status
Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g. threatened or endangered species, state noxious status, and wetland indicator values).

Description
California oatgrass (family: Poaceae) is a slow establishing yet long lived, cool season (C_3) perennial bunchgrass of intermediate texture. Its stems (culms) grow 30-100 (10-130) cm tall and disarticulate (separate) at the lower nodes (joints). The leaf sheaths are smooth to densely hairy. Leaves are both basal and attached to the stem with the upper blades being 8-25 (10-30) cm long, flat to in-rolled, and spreading to abruptly bent. The ligule (at the throat of the leaf blade) is less than 1 mm and fringed with small straight hairs. Additionally, 1-3 mm long, soft spreading hairs appear at the leaf collar and throat (photo). Flowering occurs in May or June depending on location. The panicle (inflorescence) is 2-6 cm long, loose, and open with 1-5 (3-6) broadly spreading spikelets. Glumes are 14-18 mm long. There are 3-8 (5-10) florets (flowers) per spikelet (see photo). Lemmas are 5-10 (8-15) mm long, hairy along the margins with stiff awned teeth and an abruptly bent awn that is (4) 8-12 mm long (Darbyshire 2003, Hickman 1993, Hitchcock et al. 1969, Klinkenberg 2007).

California oatgrass
Reprinted with permission, University of Washington Press


Leaf blades often bend at a broad angle from the stem and hairs fringe or replace the ligule (var. *californica*). .Additional tufts of hairs appear at the leaf collar. Photo by Steve Matson used with permission.

Flowering and seed formation: California oatgrass produces seed from both open flowers that allow for cross-pollination and closed flowers that have obligate self-pollination. Its open pollinated flowers are referred to as chasmogamous and the seed they produce are chasmogenes (chasmogamic seed). Closed pollinated flowers are cleistogamous and the seed they produce are cleistogenes (cleistogamic seed). The chasmogamous seed is produced in the exposed panicle and is sometimes referred to as terminal seed. In contrast, the cleistogamous seed is primarily found at the lower nodes of the flowering culm and typically remains enclosed in the leaf sheaths (Dobrenz and Beetle 1966, Campbell et al. 1983).


Spikelets are flattened with 5-10 flowers (florets) each. Photo by Steve Matson used with permission.

There are differences between chasmogamic and cleistogamic seed production. Sometimes referred to as hidden seed, cleistogenes are typically shorter or longer (narrower) and larger than seed from the inflorescence and some lack a developed lemma and palea (Dobrenz and Beetle1966). Most commonly, there are 3-4 spikelets per flowering culm and 5-6 florets per spikelet. However, a single lower node can bear 6-7 cleistogenes and there can be 5-6 such nodes per culm. Therefore, more hidden seed can be produced than terminal seed. Production of cleistogenes increases under grazing pressure (Dobrenz and Beetle 1966).

Seed coat characteristics may also differ between the two seed types as evidenced by contrasting germination responses to acid scarification reported by Laude (1949). Bruns (2005) found that seed set was lower in chasmogamous spikelets compared to cleistogamous spikelets and more maternal reproductive effort was put into cleistogamous seed production. However, chasmogamous seed had higher and quicker germination rates, as well as a higher rate of early seedling growth compared to cleistogamous progeny. In contrast, Weatherwax (1928) states there are no consistent differences in the two types of caryopses (naked seeds) and that both types germinate alike and seedling plants are alike in appearance and vigor through flowering.

By July or August after the panicle has matured and some of the terminal seed has shattered (fallen from the plant), the remaining culm will disarticulate (separate) at the basal node (Darris pers. obs.). Dispersal of remaining cleistogenes is probably aided by this process (Dobrenz and Beetle 1966). The dry stems with enclosed seed may wrap around the feet or limbs of passing animals (Darris pers. obs.).

Similar species: California oatgrass can be confused with timber oatgrass (*Danthonia intermedia*) which has a shorter stature, more erect, compact panicle branches, glumes that are longer than the flowers which are rarely visible, and hairless leaf sheaths. The panicles of poverty oatgrass (*Danthonia spicata*) and one-spike oatgrass (*Danthonia unispicata*) are also much narrower and therefore more spike-like, the latter having a single spikelet in the inflorescence (Stewart and Hebda 2000). The lemmas of California oatgrass are smooth along the back with hairs only at the margins while the lemmas of poverty oatgrass have hairs at both positions (Kozloff 2005).

Distribution: California oatgrass occurs naturally from British Columbia to southern California, east to Montana and Saskatchewan and south through the Rocky Mountains to New Mexico and Arizona. A form is also found in Chile (Hitchcock et al. 1969). For current distribution, please consult the Plant Profile page for this species on the PLANTS Web site.

Adaptation

General: California oatgrass has relatively broad adaptation and is considered a stress-tolerator. It occurs on a wide array of soil types from excessively drained sandy loams to less permeable silts and clays and from relatively infertile sites to rich bottomland. While the species occurs on more xeric sites such as sunny south and west slopes, adequate subsurface moisture or winter rains in milder climates are common themes. In California, arid sites do not support it; including the inner foothills of the Coast Range and Sierra Nevada foothills (Crampton 1974). Elevation range for the species is 0-2200 m (7200 ft) (Hickman 1993). Annual precipitation varies from 43 to 200 cm (17 to 79 in) in its natural range of habitats for the West Coast states.

California oatgrass is also found on serpentine soils of Oregon and California, suggesting that at least some populations or races are especially tolerant to drought, calcium and other key nutrient deficiencies, high magnesium, and high levels of certain heavy metals such as nickel. Serpentine soils are often shallow and rocky with low levels of silts and clays (Brady et al. 2005). Based on soil types and site descriptions, California oatgrass appears to be adapted to moderately acid to alkaline soils (estimated pH 5.5-8).

Depending on region, the species is classified as a facultative upland, facultative, and facultative wetland plant. Fertility requirement is considered low as is salinity tolerance (USDA NRCS 2007). However, its common occurrence on coastal prairies and bluffs suggests some local resistance to salt spray. California oatgrass is rated low for drought resistance (8 on a scale of 1-10), relatively high for fire resistance (3), low for shade tolerance (8), high for wildlife value (2), and relatively low for deer resistance (7) (Fire Safe Council 2007). In contrast, others rate drought tolerance as medium or moderate (USDA NRCS 2007, Wrysinski 2004) and the species is known to inhabit sites that are very dry in summer. Klinkenberg (2007) reports a soil moisture regime of 2.1 [0=xeric, 4=mesic, 8=hydric]. Maslovat (2002) describes California oatgrass as having high tolerance to fire along with other characteristics making it a good candidate for disturbance prone ecosystems.

Habitat and plant communities: California oatgrass is a minor to dominant constituent of numerous woodland, shrubland, grassland, and transitional wetland habitats, particularly in the Pacific Coast States. Included among the woodland sites are several Garry oak (*Quercus garryana*) communities in California, Oregon, Washington, and southwestern British Columbia (Franklin and Dyrness 1973). This species is also an understory grass in certain lodgepole pine (*Pinus contorta*) communities in the interior Northwest as well as Jeffrey pine (*Pinus jeffreyi*) grass woodlands on serpentine soils of the Siskiyou Mountains region (Northwest Habitat Institute 2008, Franklin and Dyrness 1973).

California oatgrass is prominent within a number of primarily graminoid communities. Significant populations occur west of the Cascades in Oregon and Washington on prairie and oak savanna habitat. Most of the annual precipitation is from 43-140 cm (17-55 in) (Wildlife Habitat Institute 2008). In the eastern foothills of the Oregon Coast Range where winters are cool and relatively moist but summers hot and droughty, the *Danthonia californica* Valley association occupies xeric, rocky, south and west facing slopes. The species represents up to 70 percent of the cover on these sites (NatureServe 2008). California oatgrass is also a dominant, co-dominant, or frequent component in grassy bald associations such as *Danthonia californica-Eriophyllum lanatum* and *Festuca roemeri-Plectritis congesta*. One or both of these associations occur in patches from the Georgia Basin of Southwest British Columbia south through the San Juan Islands, Puget Sound, western Columbia Gorge, and the Willamette Valley of Oregon. These sites are seasonally moist to very dry with shallow soils, rock outcrops, and moderate to steep slopes with southern to western exposures and an annual precipitation range of 74 to 185 cm (29 to73 in). California oatgrass is part of the sole remaining native-dominated prairie community of the south Puget Sound: the *Festuca roemeri-Sericocarpus rigidus* association. The habitat is moderately dry with relatively rich, deep, excessively drained, gravelly sandy loam soils (Chappell 2006).

In maritime regions along the northern California Coast and into Oregon, winters are mild and wet and summers cool and dry. Here California oatgrass is a dominant, often signature plant of the coastal grasslands including three associations: *Danthonia californica-Festuca rubra, Danthonia californica-Aira caryophyllea,* and *Deschampsia caespitosa-Danthonia californica* (coastal). The extent of all these West Coast herbaceous communities was probably much greater prior to fire suppression, land use conversions, exotic weed invasion, and brush encroachment (NatureServe 2008). In this same area are California coastal scrub communities containing California oatgrass including the *Baccharis pilularis-Danthonia californica* association (NatureServe 2008). The species is also found in Ceonothus-Manzanita (*Arctostaphylos spp.)* shrublands or chaparral that extend from southwest Oregon throughout much of California. In this region the climate is typically very warm and relatively dry with about 43 to 76 cm (17 to 30 in) of annual precipitation. Soils are generally shallow over bedrock or are formed from coarse alluvial deposits and some are serpentine (Wildlife Habitat Institute 2008).

California oatgrass also occupies transitional wetlands in western Oregon and western Washington. The *Deschampsia caespitosa-Danthonia californica* association is found in nutrient rich wetlands and flat bottomlands that are temporarily to seasonally flooded. Dry, hot summers and mild, wet winters are the norm. This and similar communities were historically maintained by frequent burning. Soils are usually fine textured silts and clays, moderately permeable to impermeable, with a high winter and spring water table (NatureServe 2008). An example of this community is French Flat in Josephine County, Oregon, where tufted hairgrass (*Deschampsia caespitosa*) dominates the seasonally hydric soils while California oatgrass dominates the mesic sites (Mousseaux 2004).

Establishment

Establishment of California oatgrass from seed can be problematic as the result of delayed germination and variable seed dormancy, as well as moderately slow seedling development combined with early competition from other species. Difficulties with reseeding *Danthonia* species were reported in the early to mid 1900's when interest grew in reintroducing native perennial grasses on depleted or weedy grazing lands in California (Laude 1949).

Seed dormancy and germination: Evidence suggests the variable seed dormancy in California oatgrass is the result of either single or double (combined) dormancy. The dormancy may be variants of seed coat imposed dormancy, physiological (embryo) or both. Moreover, the amount and possibly the type of dormancy can vary among populations of California oatgrass (Trask and Pyke 1998). It may also depend on crop year or seed lot (Laude 1949) within the same population because climatic conditions during seed development can influence the expression of seed dormancy. Furthermore, the length of time and conditions during storage may affect seed dormancy of grasses like California oatgrass by influencing after ripening (Simpson 1990). Amme (2008) reports that fresh seed or seed that is sown and watered immediately after collection can germinate readily at a high percentage. In contrast, germination is delayed after a period storage, suggesting that dormancy can deepen over time.

Field observations indicate dormancy will also vary among seeds within the same seed lot of California oatgrass. In some years at Corvallis, Oregon, both fall seeding of fields and fall sowing of containers resulted in a portion of seedlings emerging within three weeks, while additional seedlings emerged as early as March in each of the following two springs (Darris per. obs.). Others report more continuous but prolonged germination and emergence periods. Some variability in the dormancy and germination in mechanically harvested lots may be due in part to aggressive seed combining and conditioning/cleaning processes. In these instances some dehulling (ie. hulling or separating the caryopsis or kernel from the lemma and palea), may occur and the seed coat (pericarp) is inadvertently scarified or nicked on some seeds and not others.

Given the variable dormancy in California oatgrass seed, many methods have been used for improving germination with varying success. No treatment may be needed (Emery 1988, Dyer 2001) and direct sowing with untreated dry seed resulted in 60% germination in 21 days for Young (2001). Mechanical abrasion or "injury" with coarse sand paper or brush machines in the process of dehulling, acid scarification, or puncturing of the seed coat alone have improved germination by reducing seed coat imposed dormancy. However, mechanical scarification can be difficult to achieve without unwanted damage to the seed. In a study done by the Corvallis Plant Materials Center (PMC) (unpublished data) germination was greatly reduced by using a huller-scarifier (brush machine) to dehull and simultaneously scarify seed alone or in combination with prechilling (cold moist stratification) treatments. The mechanical procedure was far too aggressive and caused excessive damage to the seed and therefore significantly lower germination. This supports Laude (1949) who indicated mechanical scarification to weaken the seed coat did not appear feasible due to the protruding embryo being in an exposed position resulting in embryo injury.

An alternative physical means of scarification may be the use of an oat huller to condition the seed. It appears to dehull more gently and reduce breakage to the ends of the seed compared to a huller-scarifier (Darris pers. obs.). Further testing is needed to confirm if this machine can simultaneously dehull and effectively scarify the seed coat to get good germination without resorting to acid treatment.

In one greenhouse study, inflorescence (terminal) seed treated for 15 minutes with concentrated sulfuric acid (sp. gr. 1.84) as a means of scarification resulted in faster and higher seedling emergence for all 16 populations after 4 weeks, and for all but 4 populations after 16 weeks (Laude 1949). The acid both dehulled the seed and etched the seed coat. However, 15 minutes seemed too severe for cleistogenes. For terminal seed, 15 minutes of acid treatment gave the best results in the field (8-20% seedling emergence), 30 to 45 minutes gave the best results in a germinator (81% germination), and 20 minutes resulted in the highest emergence (19-27%) in a greenhouse. In contrast, 5 to 10 minutes gave the best results for cleistogenes in the field (4% emergence) and greenhouse (10% emergence), while 10 to 15 minute treatments were best in the germinator (71-81% germination). In all cases, performance declined for acid treatments beyond these time frames. This work underscores the fact that different results can occur between controlled environments and field conditions and between the two seed types of California oatgrass. It also demonstrates the importance of recommending the best treatments found in field tests for field use (Laude 1949).

It would appear dormancy reduction in these trials was primarily the result of injury to or weakening of the seed coat and not dehulling (Laude 1949). Glumes or the seed covering formed by lemma and palea (the seed "hull") can create seed dormancy in grasses (Simpson 1990) apart from the coat itself. However, whether in a germinator, greenhouse, or field and regardless of seed type, both untreated seed with lemma and palea intact and dehulled seed barely germinated while dehulled seed nicked with a scalpel showed a substantial improvement in percent germination and emergence. The author considers nicking the seed and acid treatment to be akin for the necessary purpose of weakening the seed coat.

The seed coat imposed dormancy in California oatgrass may or may not be a form of physical dormancy (seed coat constraint on moisture imbibition). Laude (1949) found that dehulled but unscarified seed and acid scarified seed both adsorbed moisture similarly. As a result, the author suggests the dormancy is caused by restricted gas exchange or mechanical constraints and not the prevention of moisture uptake. However, based on structural characteristics of grass seed coats, Simpson (1990) argues that rate or specific location of moisture uptake by the seed rather than gas exchange can be explanations. This suggests the possibility of California oatgrass seed possessing a variant of "physical" dormancy but further investigation is needed.

For reducing physiological dormancy, a solution of potassium nitrate (KNO_3) or moist prechilling (cold moist stratification) alone have improved germination, as has giberellic acid (GA_3) in combination with seed scarification, KNO_3 plus scarification, or prechilling. Improvement with a combination of chemical and physical treatments supports the notion that California oatgrass can have complex or combined dormancy. Dobrenz and Beetle (1966) found that for both chasmogamic and cleistogamic seed, germination was similar and did not occur without blotters being soaked with KNO_3. Results were 0% germination for controls and 10% germination using a solution of 0.2 % KNO_3. In a study with four populations having 0 to 91% initial dormancy, a combination of seed scarification (by dehulling and rubbing seeds/caryopses between course sandpaper) and GA_3 (300 ppm or 0.03%) improved cumulative germination to over 80% in all but one seed lot, while breaking over 90% of the dormancy. KNO_3 only enhanced germination in combination with scarification and GA_3 (Task and Pyke 1998). In a pilot study to enhance germination Trask (1996) found GA_3 (400 ppm) alone to be the most successful treatment regardless of whether the seed was scarified or not. A combination of light, a 20/25°C (68/77°F) night/day temperature regime, and seven week prechill is suggested by Chirco and Turner (1986-2007). Unpublished work by the Corvallis PMC on two populations of California oatgrass demonstrated that moist prechilling of both inflorescence seed and cleistogenes at 5°C (39°F) for 45 to 90 days was effective in significantly improving germination as recorded for the first 28 days in a germinator.

Other practitioners indicate improved germination with 30 days of moist prechilling at 3-4°C (37-39°F) in combination with manual removal of the hull (Keeley 2000), 12 to 13 weeks of cold moist stratification alone, or simple fall sowing (Boyer 2007a). From personal communication with Jebb (1995), Rose et al. (1998) report California oatgrass does better with a one to three day soak in running water followed by three months of cold moist stratification at 1-5°C (34-41°F). Guerrant and Raven (1995) achieved good germination with cold stratification at 5°C (41°F) for six weeks followed by warm stratification for six weeks using 16 hour days at 20°C (68°F) and 8 hour nights at 10°C (50°F). Knapp and Rice (1994) found seed viability and germination varied among populations. They had "high" germination rates by squeezing the caryopsis out from the glumes and lemmas, pre-treating with 400 ppm GA_3, and cold moist stratifying for 2-3 weeks at 4°C (39°F). In successful field applications using fall sown seed, it may not be clear whether germination was enhanced by cold moist stratification over winter, or weakening of the seed coat by soil influences, or both.

Finally, Maslovat (2001) reported that California oatgrass required light to germinate and associates this trait with natural regeneration after disturbance. However, for the Corvallis PMC some seed germinated in the dark, suggesting light may not always be necessary.

Summary: California oatgrass seed can be nondormant, for example when "fresh", or commonly possess one or more types of dormancy that need to be overcome for germination to occur. The kind or amount of treatment(s) required, if any, may be specific to population, crop year, seed lot, seed type, storage conditions, or age of seed. The Association of Official Seed Analysts (AOSA) has not set official rules for testing the germination of California oatgrass. Nevertheless, for many seed lots the most practical method to improve germination without resorting to chemical enhancements is cold moist stratification. This can be done by fall seeding or moist prechilling in a controlled environment for 21-120 days. For other seed lots, dehulling/scarification of the seed will greatly improve germination if the seed coat can be scratched, nicked, or eroded without undue injury to the embryo. Manual methods to remove the caryopsis from the hull (squeezing out the caryopsis, rolling seed between rubber mats) along with the use of sandpaper or scalpels to weaken the surface are not practical on a large scale. A mechanical means is needed for large seed lots but a brush machine appears to be too aggressive. Gentler mechanical means of dehulling and scarifying, such as the use of an oat huller, needs further evaluation. Acid scarification requires special safety precautions but merits consideration. Finally, in some cases a combination of both stratification and scarification may prove to be the most effective way of reducing dormancy.

Natural establishment: Maslovat (2001) examined and described factors influencing natural and assisted establishment of California oatgrass in Garry oak ecosystems of Southwest British Columbia. Characteristics of this grass suggest it is an important colonizer following disturbances such as fire. While a modest seed producer, its seed dormancy and need for light to germinate help create a persistent seed bank (Maslovat 2001). The seed often remains viable in the ground for years. Stands can be resurrected from this latent seed by mowing or other disturbances (Amme 2003).

Seedling recruitment appears aided by retention of shallow litter or moss and variable microtopography, especially minor depressions and grooves that favor higher moisture storage. Deeper litter, often exacerbated by long term fire suppression, may act as an impediment to root penetration and seedling emergence. However, raking of the soil to completely remove litter and clippings can reduce seed germination and establishment on some sites (Maslovat 2001).

The awns found on unprocessed seeds of California oatgrass presumably improve dispersal by attaching to passing animals. In addition, the same awns are hygroscopic (bend and straighten with wetting and drying), a trait implicated in natural seed burial. They may also assist in seed migration and selection of more favorable microsites (Maslovat 2001).

Site preparation: Keys to establishing California oatgrass for revegetation and other goals are preplant weed control and proper seedbed preparation. Starting situations can vary greatly, calling for site specific strategies. Among the most difficult cases are abandoned fields and other areas dominated by exotic weeds that have an extensive weed seed bank built up in the soil. One option for site preparation is to fallow the area for one to three years with repeated tillage operations following each flush of new weeds in order to reduce the weed seed bank prior to sowing. A nonselective herbicide (usually glyphosate) can be used in combination with the tillage (Darris 2003, Campbell 2004, Stromberg et al. 2002, Stromberg and Kephart 2003). Others suggest the weed seeds are usually too numerous and better addressed with minimal soil disturbance and two years of herbicide application followed by planting with a no-till drill (Boyer 2007b).

In restoring oak savanna or other grassland habitats, plowing or other major tillage operations are not recommended next to existing desirable native trees and shrubs, on sites that already have some native plant diversity or rare plants, or before ground nesting birds have completed their nesting cycle (Campbell 2004). In order to preserve native perennial grasses already on site, herbicides are a poor choice where weedy annual grasses are a problem because (except for fine fescues) the chemicals used to control one group also control the other (McClaran 1981). Such sites or inclusions are better candidates for interseeding, no-till drilling, or transplanting.

Besides tillage and herbicides, other site preparation methods include burning, grazing, mowing, soil solarization or combinations thereof (Campbell 2004, Rodgers 1981, Kephart and Amme 1992). Where permitted, burning can be a good choice for site preparation depending on existing conditions (Campbell 2004, Rogers 1981).

Seed testing: Given the potential for highly variable seed dormancy, it is strongly recommended that all seed lots of California oatgrass be given a TZ (tetrazolium chloride) test to determine total viability along with a germination test before purchasing and planting. The difference between the two tests will give an estimate of the percent dormant seed. If dormancy is low, special stratification or scarification treatments are unnecessary. If dormancy is high, pure live seeding rate calculations need to be based on total seed viability and not percent germination.

Direct seeding: Direct sowing of California oatgrass in the Pacific Northwest USA is usually best in late summer or fall (August-October) to naturally stratify the seed over winter (Maslovat 2001), assuming high dormancy in the seed lot. However, seeding date may be extended into the early winter (November) if site conditions have low risk of disturbance after seeding and the time outdoors remains long enough for natural stratification to occur (cool moist conditions may be required for up to 4 months). Emergence in milder winter growing climes typically occurs in late February and March (Boyer 2007b). Late winter or spring sowing with dormant seed can also result in germination the following March (Maslovat 2001), but seed losses from predation, erosion, weed competition, natural mortality, or other factors are potentially greater due to the lengthier period of inactivity. Spring planting may work equally well in some regions if seed is primarily nondormant or cold moist stratified or scarified in advance.

On occasion, de-awing of California oatgrass seed may be needed to facilitate movement through certain seeding machinery. However, Maslovat (2001) describes the ecological importance of the awn and states "restoration of this species will only be successful if the disaspores [seeds] remain awned". Despite this pronouncement, germination of some seed lots benefit from dehulling/scarifying and substantial awn removal cannot be prevented during mechanical or acid conditioning.

The most successful stands of California oatgrass are usually achieved by drilling, no-till drilling, or broadcasting the seed alone rather than in a mix. As with natural establishment, very shallow soil coverage (0.6 cm or 0.25 in or less) is critical because of the light requirement. Broadcast seeding may additionally benefit from irregular surfaces. Mixing the species with nondormant seed of fast establishing grasses or forbs, native or otherwise, can lead to poor establishment because quicker germinating species will occupy the space first. To achieve a more natural appearance in prairie restoration, California oatgrass can be sown alone in irregular patches within more favorable soil inclusions then surrounded by a variety of higher diversity plantings. This is similar to the mosaic seeding approach described by Campbell (2004). Plant diversity can also be achieved afterwards by over seeding new stands the following spring or fall with forbs and/or other native grasses that have nondormant seed.

Some restoration practitioners suggest seeding forbs a year before the grasses for improved species richness, as native forbs are more able to establish without grass competition (Clark and Wilson 2005). However, California oatgrass may be an exception and could be sown with forbs because of its seed dormancy.

For California oatgrass to be sown in a mixture, the most viable options may be (1) combining it with species that have similar seed dormancy, (2) using it with low rates of a less competitive, more diminutive species or short-lived plants useful for winter cover, or (3) both. Species for the first option could include Columbia needlegrass (*Achnatherum nelsonii*) or Lemmon's needlegrass (*Achnatherum lemmonii*). Choices for the second option include slender hairgrass (*Deschampsia elongata*) (Boyer 2007b, Darris 2003) which only lives 1 to 3 years, or better yet, annual hairgrass *(Deschampsia danthonioides*). However, both native hairgrasses establish readily when fall sown and should be limited to 0.5 kg/ha (~1/2 lb/ac) in a mix with California oatgrass. They are also prolific re-seeders.

It is reported that California oatgrass has anywhere from 198,000 to 363,000 seeds/kg (90,000-165,000 seeds/lb) (Wrysinski 2004, Heritage Seedlings 2007, Darris and Lambert 2000, Guerrant and Raven 1995). The number probably depends on the degree of physical seed conditioning, genetics, and growing conditions at the time of seed formation. Dehulled and de-awned seed lots will be in the high end of the range. Each 1 kg of pure live seed (PLS) sown per ha will result in 20-37 live seeds/m2 (1 lb PLS/ac results in about 2-4 live seeds/ft^2). Sown alone, suggested seeding rates for drilling are 10-16 PLS kg/ha (9-15 PLS lbs/ac), depending on goals and site conditions. Rates are high because of unpredictability and should be doubled for broadcast seeding.

Amendments: A starter fertilizer is usually not recommended for slow establishing native grasses like California oatgrass as it encourages excessive weed competition. A covering of mulch such as a thin layer of native straw, hydromulch, or erosion blanket is particularly useful on steeper banks. For improved stability, the straw can be crimped into the soil or covered with a netting (Kephart and Amme 1992) such as jute.

Weed control: Guidelines for the use of a number of herbicides for controlling weeds in native grass plantings in California are outlined by Drewitz and Anderson (2003). Pesticide labels vary by state and change over time, so the most current, local information must be reviewed and followed. Seed dormancy in California oatgrass can be put to good use. Sowing monotypic stands allows for fall and early winter germinating weeds to be controlled with glyphosate or other nonselective herbicide before the oatgrass seedlings emerge (Boyer 2007b, Darris 2003). After emergence and early growth of the California oatgrass, broadleaf weeds can further be controlled with a selective broadleaf herbicide applied at the right stage (Peachy et al. 2007). Mowing over the top of the oatgrass seedlings is a good alternative to control taller weeds, as is wicking with an herbicide, especially before the weeds go to seed. Timely, controlled grazing may also be beneficial for weed control in newer stands.

Transplanting: Some practitioners have had more establishment success using transplanted seedlings instead of seed (Suttle and Thornsen 2007, Buisson et al. 2004, Angelo 2005, McClaran 1981). Reasons can include low germination rates and slow seedling and plant development the first year limiting the species ability to compete with weeds and other plants. Container grown seedlings are well suited to smaller projects. Initial costs are higher per acre, but site preparation requirements can be less and establishment risks lower compared to direct seeding. If a "sod" appearance is desired, a grid spacing of 12-15 cm (5-6 in) may be needed. Amme (2003) suggests a good "turf" of California oatgrass can be established with a spacing of 20-25 cm (8-10 in).

Management

As with all species, best management practices for California oatgrass can vary widely depending on the purpose of the planting or field (erosion control, turf, range, wildlife, or habitat restoration), available resources, site conditions, climate, stand composition, and other factors. Swards of native perennial grasses or grass-forb meadows containing California oatgrass can be improved and maintained with properly timed mowing, grazing, burning, herbicide applications, or combinations thereof. In California, the Pacific Northwest, and possibly other regions, doing nothing is often not an option in the long run because of ongoing and sometimes increasing competition from weedy annuals or invasive perennials, and the spread of shrubs or trees previously controlled or excluded by fire (Stromberg and Kephart 2003)
.

Mowing: Mowing is a viable option for controlling certain annual and perennial weeds as well as undesirable woody plants. For example, invasive perennial grasses such as tall oatgrass (*Arrhenatherum elatius*) are replacing native species on grasslands targeted for habitat conservation. From experimental work in western Oregon, Wilson and Clark (2001) report that after several years of late spring mowing at a 15 cm (6 in) height, both flowering and abundance of California oatgrass increased as a result of release from suppression by tall oatgrass. The annual mowing was timed to the flowering of tall oatgrass and its maximum above ground allocation.

For annual weed control, mowing two to three times, especially the first year after establishment can be beneficial and may be required. In California, close mowing in the early spring (March) generally favors perennial grass establishment and enhances vigor. At the same time it reduces direct competition from weedy annuals and the production of annual grass seed along with their buildup in the soil bank (Kephart and Amme 1992). Annuals should be mowed to about 10 cm (4 in) in height after food reserves have been moved into their seedheads but before the large seeds are viable (Stromberg and Kephart 2003). A fall mowing also improves perennial grass growth while providing space and light for new seedlings (Kephart and Amme 1992)

When used in a home garden, grass alley, trail side, or turf setting, California oatgrass can be mowed as low as 6-8 cm (2.5-3 in) in height (Darris pers. obs.). Daniels (2007) suggests mowing only once a year in early spring. The species will maintain itself as a tough, persistent "sod" of intermediate texture if plants are spaced tightly enough (Darris pers. obs.). It can be kept green year round if occasionally irrigated and cut back (Amme 2003).

Grazing: Adaptive and flexible grazing techniques are an option for improving abundance of native grasses like California oatgrass and other desirable herbaceous plants in grassland communities (Stromberg and Kephart 2003, Menke 1992, Bartolome et al. 2004). However, universal prescriptions cannot be made due to variable site, timing, climatic, stand composition, and other factors. The amount of cover for this species can increase, decrease or remain unchanged under grazing.

In California's Coast Range grasslands, Bartolome and others (2004) report that California oatgrass had little response over time to seasonal grazing but increased when grazing was removed. In contrast, its foliar cover increased under continuous grazing and decreased when grazing ceased on California coastal grassland (Hatch et. al. 1999). Similarly, others observed higher cover (Hayes and Holl 2003) and increased vegetative growth and fewer competing annuals under moderate or even heavy grazing (Heady et. al 1963). California oatgrass and other native perennial grasses increased, range condition and health of the herd improved, and annuals decreased when heavy grazing was replaced by moderate stocking rates and deferred-rotation grazing (Cooper 1960). The species will develop a shorter more spreading form in response to clipping that can make it less noticeable to grazers (Edwards 1992). However, grazing (and burning) practices favorable to one native grass species may damage others (Hatch et. al. 1999).

According to Menke (1992), grazing can be the primary step in a perennial native grass restoration project as well as ongoing maintenance. For restoring California native grasslands, he prescribes several days of high intensity, short-duration sheep or cattle grazing in order to remove the inflorescences of alien annual grasses before they set seed. The grazing event must be planned so that it still allows enough time for native perennial grasses (like California oatgrass) to flower and produce seed before spring soil moisture is exhausted. This action promotes increased vigor and crown cover of the natives. Secondarily, an intense period of heavy livestock grazing during midsummer dormancy of the perennial bunchgrasses reduces dead stems, litter buildup, and self-shading while hoof action enhances nutrient cycling by putting dead material in contact with the soil.

Prescribed fire: Controlled burning is widely recognized as an important tool to control invasion of native and exotic woody plants in order to maintain prairies, ranges or other natural systems containing California oatgrass. As a species which evolved in western prairie ecosystems where fire is a natural process, it is generally tolerant to late summer burning. In a study by Hatch and others (1999) the species was unaffected by fire. However, it is less tolerant to fire than *Nassella pulchra* in California grasslands (Bainbridge and D'Antonio 2003). In these areas, fire is used to decrease the abundance of non-native species and increase or restore native vegetation but results are inconsistent (Bainbridge and D'Antonio 2003). Menke (1992) considers late spring-early summer burning to reduce alien weed seed production a viable enhancement tool for California grasslands with significant native bunchgrass populations. Burning is timed to the period when most weed seeds are still within the flower heads (panicles) so they can be destroyed. If litter levels are excessive, high mortality may result unless this fuel load is reduced in advance by mowing or grazing. Once stands are improved, burning is recommended only once every three to four years. Three years is about the time for alien annuals to recover to pre-fire levels (Menke 1992).

Herbicides: Certain invasive non-native species that pose a continuing threat to native plant communities and other systems with California oatgrass can be effectively managed with herbicides. Whenever possible, they should be integrated with other management measures. Weed control for natural areas is described in depth by Tu and others (2001). References such as the Pacific Northwest Weed Management Handbook (Peachy et al. 2007) cover herbicide recommendations for cropping systems, non-crop areas, and other situations that can apply to California oatgrass.

Pests and Potential Problems

Few pest problems for California oatgrass have been recorded. However, it is one of many native grass hosts for the fungus (*Gloeotinia temulenta*) which causes blind seed disease, a potentially serious pest in ryegrass (*Lolium* spp.) seed production fields (Fischer 1944, Alderman 2001). Field burning is among several effective controls. The species can be infected by a nematode (*Cynipanguina danthoniae*) that causes leaf galls (Maggenti et al. 1974).

Amme (1986) indicated that California oatgrass, along with other native grasses tested, appeared disease resistant during germination, transplanting, and growth in liners. No losses were attributed to damping-off. Rust (*Puccinia* sp.) and other stem or leaf diseases have not been regularly observed or have been of little consequence for seed producers (Kanegy 2007) and the Plant Materials Center, Corvallis, Oregon (Darris pers. obs.).

Environmental Concerns

California oatgrass is not considered to be weedy within its natural range and is easy to control by mechanical or chemical means. However, because of seed dormancy, a resilient seed coat, and latent seed in the soil, individuals may continue to sporadically emerge several years after a stand is removed. The species is not reported to have toxic properties for domestic livestock, wildlife, or humans.

Seed and Plant Production

As with sowing California oatgrass for revegetation and other uses, planting new fields for agronomic seed increase and producing container nursery stock from seed may be confounded by poor or delayed germination due to seed dormancy. If dormancy is known or suspected, seed should have a TZ test to determine viability and then fall (Sept-Oct) sown or cold, moist stratified for 30-120 days. Dehulling or scarification may also be needed as described earlier.

Seed production: Suggested seeding rates are high (11-20 PLS kg/ha or 10-18 PLS lbs/ac) to insure adequate stands since not all seed dormancy may be overcome. Clean, firm, weed free seedbeds and a seeding depth of 0.3 to 0.6 cm (0.13 to 0.25 in) are ideal. The suggested row spacing is 30-45 cm (12-18 in) but wider rows may be needed for cultivators or shielded row sprayers used for applying herbicides. To fit their irrigation systems and equipment, some growers produce the seed in nursery beds usually comprised of four narrow rows with wider (91-107 cm or 36-42 in) rows between the beds (Anderson 2008). Given issues of seed dormancy and slow establishment, a more reliable alternative is to start fields in the fall or spring from greenhouse grown plugs set 15-25 cm (6-10 in) apart within row.

Fertilization and irrigation: Typically, no fertilizer is applied until May after new fall plantings when 27-44 kg of nitrogen/ha (25-40 lbs N/ac) is used. For established seed fields of California oatgrass in western Oregon, annual applications of nitrogen are made in late February or March at rates of 55-110 kg N/ha (50-100 lbs N/ac). Suggested rates may change as more information is learned. Other fertilizers containing potassium, phosphorus, sulfur, or micronutrients may be needed according to soil tests.

In western Oregon, no irrigation is required for new stands as long as the planting of seedlings or seeding is done in fall as recommended. Spring plantings will require irrigation the first year only. However, on droughty soils or in the Central Valley of California and other summer dry, low precipitation areas, summer irrigation may be needed every year.

Weed and pest control: Weeds are controlled in new and existing stands by tillage, mowing, hand hoeing, spot or shielded spray treatments between rows with glyphosate herbicide, and applications of broadleaf herbicides with general labels for grass seed production (Peachy et al. 2007). Mowing off taller weeds and their flower heads that overtop the California oatgrass the first year provides some control. A better option is to use a flail forage harvester that both mows off and removes weed seed stalks, including annual bluegrass (*Poa annua*). While a number of herbicides are labeled for control of this and other annual weedy grasses in established fields of perennial grasses grown for seed, only one of these products (dimethenamid-P) can be legally applied to native California oatgrass in Oregon (BASF Corporation 2007). Supplemental labeling expires December 31, 2009 unless renewed. Significant disease pests such as rust (*Puccinia* spp.), ergot (*Claviceps purpurea*), or smut (*Ustilago* spp.) and insect problems have not been reported. Always read and follow label directions completely when applying any herbicide or other pesticide.

Harvesting: Harvesting California oatgrass is usually done by swathing (windrowing) followed by combining a week or two later after the seed and stalks have adequately dried. It is important to harvest the hidden seed (cleistogenes) in the stems since their numbers are often greater than the amount of seed produced in the exposed inflorescence. To extract both types of seed in a single operation, some growers (Kenagy 2007, Anderson 2008) use a combine equipped with an aggressive four row, spike toothed cylinder and concave set at narrow clearance. Other options include double harvesting using a combine with a rasp cylinder or stripping and vacuuming the seed with a flail-vac seed stripper. The stripper, mounted like a front end loader on a tractor, has a fast spinning brush which rips, pulls, or vacuums the seed from the seed heads and throws it into a hopper. Newer forms of seed strippers may work as well. However, stripping wastes hidden seed unless stems are harvested separately. This can be done later in summer when they readily break off near the base of the plant. The additional seed is then extracted with an aggressive stationary seed thresher or hammer mill that breaks apart the stems.

Flowering and seed formation is commonly absent or meager the first year. This may be due to the plant’s slow development, vernalization requirement, or both. Yields increase in subsequent years and often will not peak until the third growing season. They can average 110-330 kg/ha (100-300 lbs/ac). Properly managed, fields can remain productive for a decade or more.

Crop residues: Post harvest residue management usually involves simple mowing to remove decadent foliage and improve exposure of grass crowns and growing points to light and cool temperatures, or flail chopping to break up the stems and leaf matter into finer material. Excessive plant litter left on the soil surface can reduce the effectiveness of certain herbicides in grass seed production, so baling heavier residues, if present, may also be a good option. A flail forage harvester will both cut and remove the crop aftermath in one operation. Given the general tolerance of California oatgrass to fire, summer burning during plant dormancy may be an alternative but no information on its application or benefit for seed production of this species has been reported.

Seed cleaning and conditioning: Threshed seed is usually first run through a scalping machine or screen to remove stems and other course materials. As described earlier, dehulling/scarification of some seed lots can improve germination if excessive seed damage can be avoided in the process. Options include using a huller/scarifier (brush machine) equipped with gentler brushes or run at slower speeds, or possibly an oat dehuller. Seed is often de-awned in the same process which may be a goal in itself to improve flow through certain seeding equipment and reduce storage volume. Final cleaning is done with an air-screen machine but care is needed to prevent the wasteful disposal of longer cleistogenes or smaller dehulled seed (groats or kernals). In Oregon, seed certification standards for California oatgrass require a minimum purity of 90% and allow a maximum of 0.15% other crops, 10% inert matter, 0.15% common weed seeds, and four restricted weed seeds/lb (Oregon Seed Certification Service 2008).

Plant production: Containers or flats of California oatgrass can be sown in winter or early spring with untreated, dry seed presumably low in dormancy (Young 2001, Dyer 2001) or fresh seed sown immediately after harvest before dormancy develops (Amme 2008). Standard, well drained potting media amended with micronutrients and optional starter or slow release fertilizers works well. Others suggest a medium of 1:1 peat and vermiculite and a light application of nitrogen fertilizer weekly (Rose et al. 1998) or every six weeks with 10-10-5 NPK soluble fertilizer (Amme 1986). Sometimes the seed is dehulled/scarified then sown in plastic flats lined with newspaper and kept at temperatures from 15-25°C (59-75°F) (Keeley 2000). Several shapes and sizes of plug type containers are used for production of seedling transplants.

The seed should be covered with 0.6 cm (0.25 in) or less of potting media or vermiculite and kept moist. Germination and sprouting commences in 10-21 days, but can continue for months (Amme 1986). Plants are maintained with irrigation under controlled greenhouse conditions at 18-25°C (65-75°F). Fertilization is typically discontinued during the summer months. Compared to fall and winter sown and potted seedlings (liners), those similarly handled in late spring and early summer had few or no flowering culms by fall (Amme 1986). Cutting the plants back once or twice helps prevent containers from drying out and encourages new growth of culms. If held over, a single clipping maintained good vigor for California oatgrass through the second year (Amme 1986).

For seed lots where physiological dormancy is initially high, flats or containers are fall sown at the Corvallis PMC with untreated or partially dehulled seed and left outdoors over winter to naturally stratify. Alternatively, flats or trays of plugs are sown, well watered, placed in plastic bags, and moved into a walk-in cooler for cold moist stratification at 1-4°C (34-40°F) for 90-120 days. If the principal dormancy is seed-coat imposed, it is suggested that seed be carefully acid scarified or dehulled in advance and then sown soon after at any time of the year. Once in the warm greenhouse and seedlings emerge, it can take 9-12 weeks for plants to become well established in 7-10 cubic inch, cone shaped containers. Plants should be acclimated for several weeks or more in a lath house or shadehouse prior to spring outplanting or maintained there until fall. For seed with physiological dormancy, remaining “empty” containers may be held over until next spring as they often contain viable seed that will germinate after a second winter period.

California oatgrass propagates readily by division. One method is to collect plants during the dormant season or maintain them in a lath house until dormant. Bring the clumps into a greenhouse in January, and divide them up into segments with a single root. Plantlets are then potted in plug or cone shaped containers, kept moist in the greenhouse at 18-21°C (65-70°F), and later moved back to a lath house (Dyer 2001, Rose et al. 1998). One gallon pots can be split into 3-5 plugs (Las Pilitas Nursery 2007).

Cultivars, Improved, and Selected Materials (and area of origin)

In 2000, the NRCS Plant Materials Center at Corvallis, Oregon, the US Fish and Wildlife Service, and the Oregon Agricultural Experiment Station released Baskett Slough Germplasm California oatgrass, a selected class pre-variety (Darris and Lambert, 2000). The origin of this “natural” germplasm is the Baskett Slough National Wildlife Refuge in Polk County, Oregon. It was not bred or hybridized and particular attention was given to include genetic diversity indicative of the population. Primarily for restoration and erosion control, its intended area of use is US EPA Level III Ecoregion 3 or the southern portion of USDA Major Land Resource Area (MLRA) 2 which includes the Willamette Valley of Oregon and a part of southwest Washington below 1500 ft. elevation. Seed is commercially available. Several other source identified populations of California oatgrass are periodically grown and sold as seed in Oregon and California. Native plant nurseries regularly produce plants of known origin in plugs and pots.

Population genetics and seed transfer: Understanding patterns of genetic variation in California oatgrass across the landscape provides insight into adaptation and can help guide seed movement of populations within and among regions. In an analysis of data from a common garden study containing 66 populations (accessions) primarily from western Oregon and southwest Washington, plant vigor and seed abundance significantly correlated with winter precipitation, winter minimum temperature, and summer maximum temperature. However, for the subset of 33 Willamette Valley accessions, there were no significant correlations suggesting this region could be treated as a single seed zone for the species (Johnson undated).

In an evaluation of isozyme (protein enzyme) systems in 22 populations of California oatgrass from Oregon and California, Knapp and Rice (1994) found higher levels of among-population variation than within. Such a pattern is more typical of self-pollinating species unlike open–pollinated conifers which tend to exhibit the opposite. This makes it more likely for California oatgrass to have genetically distinct populations resulting in the need for smaller seed transfer zones compared to tree species. In addition, variety c*alifornica* and variety *americana* were found to have distinct genetic compositions. As a result, for purposes of restoration, they advise against mixing the two varieties and are in favor of matching each variety to the variety growing in the vicinity. However, most taxonomic authorities do not recognize the two varieties as separate entities. Knapp and Rice also noted seedlings from one population with narrower leaves came from a unique vernal pool location suggesting that restorationists should consider localized selection pressures when considering seed sources for a planting.

References

Alderman, S.C. 2001. Blind seed disease. Miscellaneous Publication No. 1567. United States Department of Agriculture, Agricultural Research Service. URL: http://arsserv0.tamu.edu/is/np/blindseed/contents.htm

Amme, D. 1986. Nursery production of western native perennial grasses. In: Proceedings of Conference XVI International Erosion Control Association 1985. San Francisco, CA.

Amme, D. 2003. Creating a native California meadow. Grasslands 13(3):1, 9-11.

Amme (2008). Personal communication. California Native Grasslands Association and East Bay Parks.

Anderson, J. 2008. Personal communication. Hedgerow Farms. Winters, CA.

Angelo, C. 2005. Restoration of *Danthonia californica*, *Elymus glaucus*, and *Nassella pulchra* at Elkhorn Slough National Estuarine Reserve. University of California Santa Cruz. Santa Cruz, California.

Bainbridge, S. & C. D'Antonio. 2003. Prescribed fire for controlling exotics in the California grassland: factors influencing success. Workshop: Use of fire to control invasive plants. 7th International Conference on the Ecology and Management of Invasive Species. Ft. Lauderdale, Florida.

Bartolome, J.W., J.S. Fehmi, R.D. Jackson, & B. Allen-Diaz. 2004. Response of a native perennial grass stand to disturbance in California's Coast Range grassland. Restoration Ecology. 12(2): 279-289,

BASF Corporation. 2007. Outlook herbicide for use in perennial grasses grown for seed. Supplemental label. BASF Corporation. Research Triangle Park, NC.

Boyer, L. 2007a. Personal communication. Heritage Seedlings. Salem, OR.

Boyer, L. 2007b. Native Willamette Valley prairie and oak habitat restoration site preparation and seeding information. Heritage Seedlings. Salem, OR. URL: http://www.heritageseedlings.com/PDF/prairieandoakrestorationmethods.pdf

Brady, K.U., A.R. Kruckeberg, and H.D. Bradshaw Jr. 2005. Evolutionary ecology of plant adaptation to serpentine soils. Annual Review of Ecology. Evolution and Systematics 36:243–66.

Bruns, E. 2005. Maternal investment in and fitness of chasmogamous and cleistogamous progeny of the native perennial grass *Danthonia californica*. Undergraduate thesis. University of California Santa Cruz.

Buisson, E., E. Corcket, T. Dutoit, S. Anderson, & K. Holl. 2004. Restoring old fields by seeding and transplanting keystone species in the grasslands of

California central coast. ESA Annual Meeting, Portland, OR. Ecological Society of America.

Campbell. B.H. 2004. Restoring rare native habitats in the Willamette Valley. Defenders of Wildlife, West Linn, Oregon and Washington D.C.

Campbell, C.S., J.A. Quinn, G.P. Cheplick, & T. J. Bell. 1983. Cleistogamy in grasses. Annual Review of Ecology and Systematics 14: 411-441.

Clark, D.L. & M.V. Wilson. 2005. Restoration of native upland prairies for Fender's blue butterfly (*Icaricia icarioides fenderi*). Report for Oregon Fish and Wildlife Service and U.S. Fish and Wildlife Service, Portland, Oregon.

Chappell, C.B. 2006. Upland plant associations of the Puget Trough ecoregion, Washington. Natural Heritage Rep. 2006-01. Washington Department of Natural Resources, Natural Heritage Program, Olympia , WA URL: http://www.dnr.wa.gov/nhp/refdesk/communities/pdf/intro.pdf

Chirco, E & T. Turner. 1986 (updated 2007). Species without AOSA testing procedures. The Newsletter of the Association of Official Seed Analysts. Vol. 60, 2:2-66

Collins, M. 2006. Designation of critical habitat for the Fender's blue butterfly (*Icaricia icarioides fenderi*), *Lupinus sulphureus* ssp. *kincaidii* (Kincaid's lupine), and *Erigeron decumbens* var. d*ecumbens* (Willamette daisy); Final Rule. U.S. Fish and Wildlife Service. Federal Register: October 31, 2006.71(210): 63861-63977.

Cooper, D.W. 1960. Fort Baker ranges return to champagne grasses. Journal of Range Management 13:203-205.

Crampton, B. 1974. Grasses in California. California Natural History Guides 33. University of California Press. Berkeley, California.

Daniels, S. 2007. Native grasses suitable for lawn substitutes. Wild Lawns Inc. URL: http://ww2.lafayette.edu/~danielss/grasses.html

Darbyshire. S.J. 2003. *Danthonia*. In: Flora of North America Editorial Committee, eds. Flora of North America North of Mexico. 12+ vols. New York and Oxford. Vol. 25. 301-306.

Darris, D.C. 2003. Considerations for establishing native grasses from seed for restoration, revegetation and erosion control in western Washington and western Oregon. Plant Materials Technical Note No. 35. USDA Natural Resources Conservation Service. Portland, Oregon.

Darris D. and S. Lambert. 2000. Baskett Slough Selection of California oatgrass. Fact Sheet. USDA Natural Resources Conservation Service. Plant Materials Center, Corvallis, OR.

Dobrenz, A.K., & A.A. Beetle. 1966. Cleistogenes in *Danthonia*. Journal of Range Management. 19:292-296.

Drewitz, J. & J. Anderson. 2003. Using herbicides to control weeds in native grass plantings. Section 15 IN: Using native grasses and graminoids in restoration and revegetation. Workshop proceedings. California Native Grasslands Association. Davis CA.

Dyer, D.A. 2001. Propagation protocol for production of container *Danthonia californica*; USDA NRCS Lockeford Plant Materials Center, Lockeford, CA. In: Native Plant Network. URL: http://www.nativeplantnetwork.org (accessed 10 December 2007). Moscow (ID): University of Idaho, College of Natural Resources, Forest Research Nursery.

Edminster, C. 2003. California oatgrass *Danthonia californica*. Pacific Northwest Natives. Albany, Oregon. URL: http://www.pacificnwnatives.com/California_Oatgrass.pdf

Edwards, S.W. 1992. Observations on the prehistory and ecology of grazing in California. Fremontia 20:3-11.

Emery, D.E. 1988. Seed propagation of native California plants. Santa Barbara Botanic Garden. Santa Barbara, CA.

Fire Safe Council. 2007. Fire safe vegetation. El Dorado County, California. URL: http://www.edcfiresafe.org/fire_safe_vegetation.htm#nativeVines (accessed 12/18/2007).

Fischer, G.W. 1944. The blind-seed disease of ryegrass *(Lolium* sp.) in Oregon. Phytopathology 34:934-935.

Franklin J.F. and C.T. Dyrness. 1973. Natural Vegetation of Oregon and Washington. General Technical Report PNW-8. USDA Forest Service. Portland, Oregon.

Guerrant, E.O. Jr. and A. Raven. 1995. Seed germination and storability studies of 69 plant taxa native to the Willamette Valley wet prairie. The Berry Botanic Garden. Portland, Oregon.

Hatch, D.A., J.W. Bartolome, J.S. Fehmi, & D.S. Hillyard. 1999. Effects of burning and grazing on coastal California grassland. Restoration Ecology 7(4): 376-381.

Hayes, G.F. & K.D. Holl. 2003. Cattle grazing impacts on annual forbs and vegetation composition on mesic grasslands in California. Conservation Biology 17(6): 1694-1702.

Heady, H.F., D.W. Cooper, J.M. Rible, & J.F. Hooper. 1963. Comparative forage values of California oatgrass and soft chess. Journal of Range Management 16:51-54.

Heritage Seedlings. 2007. Native Willamette Valley seed. Salem, Oregon. URL: http://www.heritageseedlings.com/PDF/SeedPriceList.pdf

Hickman, J.C. (editor) 1993. The Jepson Manual: Higher Plants of California. University of California, Berkeley and Los Angeles, California.

Hitchcock, C.L., A. Cronquist, M. Ownbey, & J.W. Thompson. 1969. Vascular plants of the Pacific Northwest. University of Washington Press, Seattle and London.

Jebb, T. 1995. Personal communication. USDA Bureau of Land Management. Sprague Seed Orchard, Merlin, OR. Cited in: Rose, R., C.E.C. Chachulski & D.L. Haase. 1998. Propagation of Pacific Northwest Native Plants. Oregon State University Press. Corvallis, OR.

Johnson, R. (undated) Summary of common garden studies: what do we know about genetic variation in the Willamette Valley? Pacific Northwest Research Station. USDA Forest Service. URL: http://www.nativeseednetwork.org/site_files/SummaryOfCommonGardenStudies_-_RandyJohnson.pdf

Kanegy, P. 2007. Personal communication. Kanegy Seed Farm, Albany, OR.

Keeley, M.A. 2000. A study in urban revegetation: germination and establishment of South Puget Sound prairie plants on a capped landfill. MS Thesis. University of Washington. Seattle, WA.

Kephart, P. & D. Amme. 1992. Native perennial grass establishment and management. Grasslands. California Native Grass Association. Feb. 1992.

Klinkenberg. B. (editor) 2007. E-Flora BC: electronic atlas of the plants of British Columbia [www.eflorea.bc.ca]. Lab for Advanced Spatial Analysis, Department of Geography, University of British Columbia, Vancouver (accessed 12/10/2007).

Knapp, E. & K. Rice. 1994. Isozyme variation within and among populations of *Danthonia californica*: final report. Department of Agronomy and Range Science, University of California Davis. Davis, California.

Kozloff, E.N. 2005. Plants of Western Oregon, Washington, and British Columbia. Timber Press. Portland, Oregon.

Las Pilitas Nursery. 2007. *Danthonia californica*. URL: http://laspilitas.com/plants/459.htm (accessed 12/5/2007).

Laude, H.M. 1949. Delayed germination of California oatgrass, *Danthonia californica*. Agron. J. 41:404-408.

Maggenti, A.R., W.H. Hart & G.A. Paxman. 1974. A new genus and species of gall forming nematode from *Danthonia californica*, with a discussion of life history. Nematologica 19 (1973): 491-497.

Maslovat, C.Y. 2001. Germination ecology of native grass species, *Danthonia californica* and *Elymus glaucus*, in Garry oak ecosystems and the implications for restoration. Master of Science Thesis. University of Victoria, Victoria, British Columbia, Canada.

Maslovat, C.Y. 2002. Historical jigsaw puzzles: piecing together the understory of Garry oak (*Quercus garryana*) ecosystems and the implications for restoration. In: General Technical Report PSW-GTR-184. USDA Forest Service.

McClaran, M.P. 1981. Propagating native perennial grasses. Fremontia. 9(1): 21-23.

Menke, J.W. 1992. Grazing and fire management for native perennial grass restoration in California grasslands. Fremontia. 20(2):22-25.

Mohlenbrock, R.H. 1992. Western wetland flora: field office guide to plant species. USDA Natural Resources Conservation Service. West Region, Sacramento, California.

Mousseaux, M. 2004. French Flat. Kalmiopsis 11:46-53.

NatureServe. 2008. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.0. NatureServe, Arlington, Virginia. URL: http://www.natureserve.org/explorer. (Accessed: April 7, 2008).

Northwest Habitat Institute. 2008. Habitat descriptions. Interactive Biodiversity Information System. Corvallis, Oregon. URL: http://www.nwhi.org/index/ibis

Oregon Department of Fish and Wildlife. 2000. Landowner's guide to creating grassland habitat for the Western Meadowlark and Oregon's other grassland birds. Salem, OR.

Oregon Seed Certification Service. 2008. Pre-variety germplasm seed standards. Oregon State University. Corvallis, Oregon. URL: http://www.oscs.orst.edu/standards/pvg-seed.standards.doc

Peachey, E., et al. 2007. (compilers) Pacific Northwest weed management handbook. Extension Services of Oregon State University, Washington State University, and University of Idaho.

Robinson, G.S., P.R. Ackery, I.J. Kitching, G.W. Beccaloni & L.M. Hernández. 2007. HOSTS-a database of the world's Lepidopteran hostplants. The Natural History Museum, London, England. URL: http://www.nhm.ac.uk/research-curation/projects/hostplants/#9

Rodgers, D. 1981. Notes on planting and maintenance of bunchgrasses. Fremontia. 9(1):24-28.

Rose, R., C.E.C. Chachulski, & D.L. Haase. 1998. Propagation of Pacific Northwest natives. Oregon State University Press. Corvallis, OR.

Santa Cruz Public Libraries (compiler). 2003. Ohlone tiger beetle. Endangered species in Santa Cruz County. URL: http://scplweb.santacruzpl.org/ref/endang/endang.shtml

Simpson, G.M. 1990. Seed dormancy in grasses. Cambridge University Press. Cambridge and other cities.

Stewart, H. & R.J. Hebda. 2000. Grasses of the Columbia Basin of British Columbia. Working Paper 45. Royal British Columbia Museum, Natural History Section. Victoria, BC, Canada.

Stromberg, M.R. & P.H. Kephart. 2003. Landowners guide to native grass enhancement and restoration. Hastings Natural History Reservation, University of California, Carmel Valley, California. URL: http://www.hastingsreserve.org/NativeGrass/GrassManageIntro.html

Stromberg, M. R., P. H. Kephart, & M. Sicular-Mertens. 2002. Restoration of native grasses in California old fields II: cheap tills. Unpublished Manuscript.

Stromberg, M.R., P.H. Kephart, & V. Yadon. 2001. Composition, invasibility, and diversity in coastal California grasslands. Madrono. 48(4): 236-252.

Suttle, K.B. & M.A. Thornsen. 2007. Climate change and grassland restoration in California: lessons from six years of rainfall manipulation in a north coast grassland. Madrono. 54 (3):225-233.

Trask, M. 1996. Germination enhancement trials pilot project. Grasslands. VI(1):1-3.

Trask, M.M. & D.A. Pyke. 1998. Variability in seed dormancy of three Pacific Northwestern grasses. Seed Science Technology. 26:179-191.

Tu, M., C. Hurd, & J.M. Randall. 2001. Weed control methods handbook: tools and techniques for natural areas. The Nature Conservancy. URL: http://tncweeds.ucdavis.edu/handbook.html

USDA Forest Service. 1988 (reprint). Range Plant Handbook. Dover Publications, Inc. New York.

USDA, NRCS. 2007. The PLANTS Database (http://plants.usda.gov, 10 December 2007). National Plant Data Center, Baton Rouge, LA 70874-4490 USA.

Weatherwax, P. 1928. Cleistogamy in two species of *Danthonia*. Botanical Gazette. 86: 104-109.

Wilson, M.V. & D.L. Clark. 2001. Controlling invasive *Arrhenatherum elatius* and promoting native prairie grasses through mowing. Applied Vegetation Science 4.1:129-138.

Wrysinski, J. 2004. Know your natives. A pictorial guide to California native plants. Yolo County Resource Conservation District. Woodlands, California.

Young, B. 2001. Propagation protocol for production of container *Danthonia californica* Boland plants; USDI NPS – Golden Gate National Park, San Francisco, CA. In: Native Plant Network. URL: http://nativeplantnetwork.org (accessed 10 December 2007). Moscow (ID): University of Idaho, College of Natural Resources, Forest Research Nursery.

Prepared By
Dale C. Darris and Peter Gonzalves, USDA, NRCS, Plant Materials Center, Corvallis, Oregon.

Species Coordinator
Dale C. Darris, Conservation Agronomist, USDA, NRCS, Plant Materials Center, Corvallis, Oregon

Edited: 6/18/08, 7/21/08 DCD.

For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>