Center for Natural Lands Management
South Sound Prairies Conservation Nursery
2017 Annual Report

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Summary and Highlights

The Center for Natural Lands Management's Conservation Nursery Program is a cooperative conservation infrastructure project, which provides native grassland seed services primarily in Western Washington. Our core mission is the regional production of native seed for a coordinated set of land managers to recover listed species and enhance the habitat they depend on (Figure 1).

In additional to cooperative regional seed production, we provide custom seed increase services, greenhouse propagation of restoration plugs, wildland seed collection, seed cleaning and storing, and seed mix development for specific projects. In 2017 direct seed sales became a significant portion of our operations, allowing land managers to purchase locally adapted native seed "off the shelf", significantly increasing the flexibility and responsiveness of regional habitat enhancement efforts.

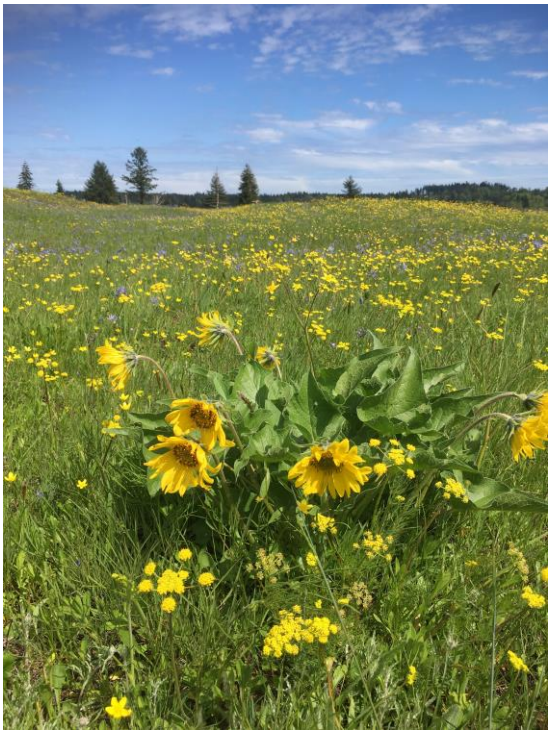

Figure 1. Glacial Heritage Preserve in spring bloom

This year we grew 950 pounds of seed from over 100 native ecotypes (species-region combinations). We expanded seed production to include coastal Oregon ecotypes to support the recovery efforts of the Oregon silverspot butterfly. Fields established under our previous expansion into the North Puget Sound are maturing and provided the first significant harvests of seed for San Juan Islands and Olympic Rain Shadow ecoregions. These harvests combined with coordination and partnerships with local nurseries have made seed from over 75 North Sound ecotypes available to restoration practitioners.

Background

The Conservation Nursery was started as a volunteer effort to fill an unmet need for seeds and transplants of native species with local genetics. Originally, the program was envisioned to provide the plant resources for the South Sound Prairies cooperative which included The Nature Conservancy, Washington Department of Fish and Wildlife, Washington Department of Natural Resources and US Fish and Wildlife Service.

Since the early days in the mid 2000's, the program has grown in scope and partners, and the parent organization has changed to the Center for Natural Lands Management. Today we operate multiple seed farms, cleaning facilities and nurseries; we partner with a diversity of private producers; and we serve dozens of agencies, municipalities and non-profits.

Cooperative Conservation

Regionally significant conservation gains are best accomplished by a concerted and cooperative effort. CNLM applies this approach to all aspects of its habitat enhancement programs and the seed farms are no exception. The Nursery works closely with land managers to identify the species and quantities of seed that will be needed to meet restoration targets in the near term; local experts are engaged to collect germplasm (Figure 2); joint funding is sought to initiate seed production at the appropriate scale; and working group meetings are held to further communication and collaboration. This strategy reduces the need for custom contracts, increases the diversity of seed available to a wider range of land managers; and reduces the cost of locally adapted native seed.

Figure 2. Seed collection on Joint Base Lewis McChord

CNLM is coordinating regional production so that seed is available when needed and partner's nursery production is complementary, supplying extensive quantities of seed for species recovery and habitat enhancement, developing production methods to increase the diversity of seed available, and communicating important research into seeding methodology to the greater grassland conservation community. Coordination of production efforts across partners results in better utilization of limited resources, avoids duplication of efforts, and encourages appropriately scaled production across the range of nursery facilities available to the region.

First employed in the South Sound Prairies, the Conservation Nursery now coordinates seed production for several ecoregions. These can be coarsely lumped into the South Sound, North Sound and Oregon Coast.

South Sound

The primary species of concern in the South Sound include the Taylor's checkerspot butterfly (*Euphydryas editha taylori*), golden paintbrush(*Castilleja levisecta*), streaked horned lark (*Eremophila alpestris strigata*) and Mazama pocket gopher (*Thomomys mazama pugetensis; T.m. glacialis; T.m. tumuli and T.m. yelmensis*). The Conservation Nursery has worked with land managers and recovery experts to identify the plant species required to build habitat and facilitate recovery for these listed species. The Nursery has developed a tiered production strategy that incorporates the diversity of landscapes, restoration targets and biological opinions in the South Sound while maximizing production efficiencies.

North Sound

Thought extinct for 80 years the island marble butterfly has re-emerged on the southern tip of San Juan Island. Habitat research and release plots at American Camp (San Juan Island National Historic Park) have been successful at establishing abundant host plants for the butterfly. The next phase of research focuses on balancing a diverse prairie matrix with appropriate densities of host plants for the island marble butterfly. Nursery production for the San Juan Islands focuses on the grasses and forbs necessary for this prairie matrix.

In the Olympic Rain Shadow ecoregion the species focus is golden paintbrush. Establishing a low stature and diverse matrix for the paintbrush requires many of the same species grown for the San Juan Islands, but with genetics local to Whidbey Island and the Olympic Peninsula.

In the Olympics our seed production builds habitat for populations of Taylor's checkerspot that occur on ridges and forest openings.

Figure 3. Early blue violet

Coastal Oregon

The Oregon silverspot butterfly once occupied coastal meadows and coast range grasslands from Northern California through Southern Washington. Populations have been imperiled and declining largely due to the loss of suitable habitat. Critical to this habitat is an abundance of the larval food plant, early blue violet (*Viola adunca,* Figure 3). The Corvallis Plant Materials Center pioneered large scale seed production of this plant but can no longer produce native seeds under contract. CNLM is establishing replacement fields and working with regional partners to provide seed of this and other important nectar and habitat plants.

Community Impact

The Conservation Nursery is dedicated to being a positive force in our community. We believe that a connection to the land and access to native seed can empower the community to make meaningful contributions to the environmental restoration of their landscape. We are working hard to increase the local recognition and understanding of prairie lands through educational and interpretive events while making regionally and genetically appropriate native seed available to an expanding segment of the public. This includes creatively partnering with those interested in using native seeds and supporting the growth of the native seed industry, public and private, through technical assistance and coordinated contracting.

Beyond providing quality native seed, the Nursery is committed to offering living-wage, career employment. We invest in our staff and work with a variety of training programs to introduce members of our community to the fields of conservation and sustainable agriculture. We offer site placement for interns from the Veterans Conservation Corps, Americorps, WorkSource Washington and the Doris Duke Conservation Scholars program among others.

Expanding Access to Native Seed

State and federal conservation lands are important habitat but represent only a small fraction of the historic extent of prairie habitat in our area. Without providing access to native seeds for private lands and local jurisdictions we will not make a meaningful change to the downward trajectory that native plant populations in our area are experiencing.

The infrastructure and expertise that has been built to support federal restoration projects can be leveraged to produce native seed for a broad range of habitat enhancement activities and reduce dependence on federal grants. Cities and parks are increasingly interested in displaying truly native vegetation in natural settings or in demonstration gardens. Agricultural assistance programs such as the Natural Resource Conservation Service's Environmental Quality Incentive Program are supporting the purchase and use of native seed and plants. Weed boards, transportation departments and ports are also incorporating native seed into their vegetation management plans.

The Conservation Nursery is committed to creatively exploring how to build upon listed species recovery efforts to more broadly return native plant communities to our landscape.

Outreach

Nursery program outreach focuses on introducing local community members to the beauty and diversity of native prairie plants. We offer tours, field trips and workshops at the nursery and farms that introduce the basic activities involved in cultivating native plants.

In 2017, CNLM offered a community open house at Violet Prairie Seed Farm and Shotwell's Landing Nursery on Prairie Appreciation Day. This informal event afforded visitors the opportunity to walk the seed production fields and interact with nursery staff. Additionally, several tours were conducted at the farm sites for various partners and community members throughout the year to share knowledge related to seed production throughout the region.

Figure 4. Middle schoolers help pull rocks from seed fields

On March 16th we hosted 60 Komachin Middle School students at Violet Prairie Seed Farm. The students dug in (literally) and energetically accomplished large-scale weeding and field improvement projects (Figure 4). This event was so successful that it cemented a partnership with Komachin; they will be returning this coming year.

The prairie demonstration garden continues to be a powerful outreach tool. This volunteer-

maintained garden provides the backdrop to seed collection and cleaning workshops. 2017 improvements to the garden include the addition of a seating area to accommodate the workshop attendees. The garden has also inspired the creation and expansion of similar projects. Avanti High School augmented their pollinator garden after a visit to CNLM's prairie demonstration garden with seed and culled plants. The Native Plant Society, Olympia Regional Learning Academy, local restoration enthusiasts, and community members also salvaged plants from Shotwell's Landing Nursery and Violet Prairie Seed Farm.

All told, school groups, college students, and community members gave 1717 hours to the nursery program through field production, seed harvesting, wild collection, demonstration garden maintenance, and the advancement of a new seed lot tracking database for the program.

Industry Support

The Conservation Nursery was created to fill an unmet need in the native seed industry, namely medium-scale seed production of a diversity of prairie plants with South Sound genetics. To accomplish this goal, we've needed to give and receive assistance from industry, government and non-profit growers. As our role has expanded we have continued our collaborative, non-competitive integration with the seed industry maintaining the overarching goal of increasing access to locally adapted native seed. To this end we contract with large growers when we can consolidate a large enough customer base; and we provide protocols and technical assistance to smaller growers to help expand their native seed production. We also rely on many other specialized entities for various aspects of the native seed production process.

In 2017, the Nursery worked with growers in the North Sound to establish golden paintbrush seed production on San Juan Island and a native buttercup seed field at the Pacific Rim Institute on Whidbey Island. Specialized seed cleaning equipment is still limited in the North Sound and CNLM has made their seed shop available for cleaning, tracking and sometimes storing of wild and nursery produced seed. The Nursery has requested the Institute for Applied Ecology to produce a bed of Oregon coast yarrow (*Achillea millefollium*) at their new seed farms outside of Corvallis, Oregon.

Figure 5. Inmate tech sows plugs

Our largest seed contracts are with BFI Native Seed in Moses Lake, Washington. They have produced the South Sound ecotype of *Festuca roemeri* for several years now. In 2017 the Nursery purchased and distributed 2900 pounds of fescue. BFI Native Seeds is also contracted to produce *Lomatium utriculatum* seed

for the South Sound partnership. Excessive vole predation at Violet Prairie Seed Farm has limited the ability to produce this seed in-house. BFI's *Lomatium* fields were established in 2017 and are expected to produce their first crop in 2018.

The Sustainability in Prisons Project (SPP) has been a long-term part and partner of the Conservation Nursery, producing hundreds of thousands of native plant plugs for the South Sound Prairies community (Figure 5). While plug production for the farm is becoming more integrated into the CNLM, SPP continued to provide over 100,000 plugs for the seed farm in 2017 and nearly as many for on-the-ground restoration actions. SPP has also begun producing seed of some of the more labor-intensive species such as violets and catch-flies.

Triangle Farms in Salem, Oregon provided seed cleaning services for large lots of asters that the CNLM seed processing facility was not able to efficiently clean in the winter of 2016-2017. However, new methods were implemented in fall of 2017 that allowed for this cleaning to now be done in-house.

The Seed Lab at Oregon State University has conducted seed purity and viability testing of the CNLM harvest for several years now. This information is critical not only to the end users of the seed but also feeds back into the farm refining and improving production and storage practices.

This Year in Production

Seed Production

The 2017 growing season was challenging, but ultimately successful. Strange weather crippled some crops and grant funding roller coasters delayed the hiring of the farm crew until well into the spring rush, but a long dry fall allowed for a good harvest and some catch up. Altogether the Nursery harvested 948 pounds of A-grade seed from just over 100 ecotypes. An additional 200 pounds of lower grade seed was grown, and two dozen new ecotypes were establishing and did not produce seed. Appendix 1 details all regional, contract and wild seed production by ecotype.

Figure 6: Severe hailstorm damage to early flowering species at Violet Prairie.

Figure 7. Bird exclusion net installation over Balsamroot field

2017 Low and Highlights

Weather Challenges: Toward the end of a very wet and cold winter and spring, Violet Prairie Seed Farm was hit with a severe hail storm in May 2017 during peak flowering for many early season species (Figure 6). The damage appeared devastating at first, shredding flowers and foliage alike. This event resulted in significantly lower yields of many crops, especially annual species. Fortunately, some perennial species that were in flower at the time of the hail storm produced another flush of flowers and managed a reasonable harvest.

Farm Upgrades:

With expanding demand, increasingly diverse crops and a lot of old, repurposed farm equipment; infrastructure improvements are a major component of the program. This year we focused on our raised bed nursery, harvesting equipment and major upgrades to the irrigation systems.

Our raised bed nursery at Shotwell's Landing is a decade old and the 60 wooden beds are beginning to crumble. We have initiated a several-year project to repair the rotting wood, replace the depleted soil and line the beds with vole-deterring hardware cloth. Nearly one third of the beds were completed in 2017.

Our old plot combine had some major hydraulic repairs done over the winter and was running smoothly in time for the first harvest of the spring. Two additional (and even older) small

combines were acquired for use at satellite farms. These old Wintersteigers from the 1970's are small enough to trailer between farm sites and should greatly increase our harvest efficiency at the smaller farms. An antique sickle bar mower was acquired to experiment with the larger-scale harvest of grasses. Repairs and upgrades to an ancient seed de-bearder proved key to cleaning our large quantities of grass and aster seed and may have eliminated the need for a very expensive sizing up of our brush machine.

Balsamroot under wraps: In 2016 we installed 25,000 square feet of bird netting over the *Balsamorhiza deltoidea* field (Figure 7), but we were too late in the season to protect the crop. However, in 2017 the birds were effectively kept out of the production beds and we increased our harvest six-fold. This harvest was accomplished despite the shredding the plants endured by the May hail storm. Luckily, balsamroot proved to be one of the most resilient early flowering species.

Regional Seed Production Reports

South Sound

Seed production for the Southern Puget Prairies ecoregion continues to dominate the fields. During the 2017 growing season CNLM maintained and established 86 South Sound species with approximately 162,700 linear row feet and 30 raised beds. CNLM's seed production facilities produced 796 pounds of South Sound seed and contracts delivered another 2900 pounds of fescue seed.

North Sound

The Center for Natural Lands Management has been expanding the quantity and diversity of North Sound ecoregional seed production to support the expanding grassland restoration efforts in that area. The Conservation Nursery produced seed for several distinct ecoregions within the North Sound including San Juan Islands, Olympic Rain Shadow, Low Olympics and High Olympics. This has been a very collaborative effort working with several local nurseries, and while CNLM has only 21 North Sound ecotypes in production, fully 78 ecotypes are in production or have seed on hand within the network of North Sound partner nurseries.

Plantings from the Olympic Rain Shadow (ORS) region are the most expansive and more established because of the extensive collection of wild seed on hand at the Pacific Rim Institute. In general, San Juan Island ecotypes had to be newly wild-collected and propagated during 2016 and were just being planted in the fall of 2017. Low Olympic ecotypes are very limited and are produced to support Taylor's checkerspot populations on forest balds above Port Angeles. High Olympic ecotypes were contracted by the Forest Service to support Taylor's checkerspot populations in the Olympic National Forest.

Coastal Lowlands (CLO) Seed Production

The Conservation Nursery first began discussion on seed production for the Oregon silverspot butterfly and the coastal prairie habitat enhancement in 2016. Nine species were identified for a very limited initial grow-out. Plugs were sown in December 2016 and January 2017 with available seed and, with the exception of *Viola adunca*, all species were planted at CNLM's three South Sound

seed farms in the spring and fall of 2017. With consideration to genetic isolation, crops were sited to avoid cross pollination with similar WA species. Four beds of *Viola adunca* were established at the Washington Correction Center for Women (WCCW), where inmate technicians are trained to monitor and harvest seed pods daily. An additional four beds of violets with differing coastal genetics will be added in 2018, as will experimental field plantings at CNLM seed farms. The first harvest of Oregon coastal seed is expected in 2018.

Wild Collection

The Conservation Nursery strives to maintain local adaptations and broad genetic diversity in its seed crops by appropriately sourcing foundation seed and minimizing agricultural selection. Our policy is to use wild-collected seed to establish perennial seed beds and minimize the number of generations that annuals spend in cultivation. This requires that CNLM maintains a wild-seed collection program.

Wild-seed collection is a time-consuming venture which leads to relatively small quantities of seed. Thanks to the dedication of CNLM's volunteer-powered wild-collection team the nursery was largely able to meet its demand for wild foundation seed. Several partner agencies also contributed to the seed collection effort, especially in regions that are distant from the South Sound.

Figure 8: Americorps and volunteer identify a wild population of *Dodecatheon hendersonii*

In 2017, a CNLM staff member was assisted throughout the season by a dedicated AmeriCorps member (Figure 8). This year's focus was on improved volunteer training, project organization, and targeted collection of fewer species. With this increased leadership in the field, it was possible to ensure proper species identification, GPS mapping, data collection, and efficient use of volunteer time. Over the season, foundation seed was collected from 15 total sites, including 6 sites on Joint Base Lewis-McChord. Overall, for the volunteer-powered South Sound program, 28 different species were collected. These collections add up to approximately 18 pounds of clean wild collected seed.

Seed Processing

Every lot of seed, whether farm produced or wild collected requires careful curing and processing to be ready for storage, use on the prairie, or in container production. Cleaning protocols are unique to the species, the harvest method and the contaminants to be removed. While conventional agricultural crops have machines and techniques developed specifically for them, our native species require experimentation, alteration of equipment and sometimes invention to achieve desirable results. The cleaning process can be extremely challenging for some of our native species and can

represent a significant portion of the cost associated with production. In total, the Conservation Nursery processed 485 seed lots totaling 1400 pounds of native seed.

Innovations in our seed cleaning processes have been driven by necessity. Huge increases in both grass and aster seed production in 2017 required changes to our cleaning protocols. The seed cleaners refined the use of a previously under-utilized piece of equipment, the 1950's A.T. Ferrell debearder. After new bearings, belts, and substantial experimentation we can now clean hundred-pound lots of grasses and asters in-house.

Seed cleaning facilities, especially those that can process native seed, are rare in Western Washington and this has led CNLM to offer seed cleaning services to other organizations. While seed cleaning contracts are just a small part of the nursery program they are another way that investments in the South Sound Prairies program can be leveraged to further conservation region-wide.

The chaff produced from the cleaning of native species can be a valuable restoration material. The Nursery separates the genetically appropriate chaff for Joint Base Lewis McChord Fish and this is transported regularly to the Base to act as a seed filled mulch on burn scars and other disturbed lands.

Figure 9. Climate controlled seed storage at Violet Prairie Seed Farm

Seed Storage

A new, long-term seed storage container was built in 2016 and was fully operational throughout 2017 (Figure 9). The 2,500 ft^3 storage facility is a modified shipping container that can be maintained at 40^0 F and 40% humidity, which we consider optimal for native seed storage. Once seed is harvested, cleaned, and inventoried, it is transported to the storage facility until it is needed for restoration seeding or plug production.

This storage provides much needed flexibility for appropriately timing restoration seedings. Research into the timing of effective restoration seeding has pushed the seeding target earlier and earlier in the fall, compressing the window between seed harvest and use. With increasing quantity and diversity of seed it is impossible to process all of the seed prior to the early-September seeding date.

With the advent of climate-controlled seed storage, partners can hold back later-season species for seeding in the following year. This establishes a stockpile for each agency and increases the

likelihood of appropriately timed seeding. The prudence of this inventory management was highlighted over the summer of 2017 when the Scatter Creek wildfire opened vast acreage needing immediate and effective seeding. Fortunately, WDFW had previously stockpiled seed in inventory and had a reserve from which to seed that site post-fire.

Greenhouse Production

Native plant plugs are used directly in restoration projects when species are challenging to establish from seed or when rapid establishment is desired over a limited landscape. Plugs are also used extensively on the seed farm. Because the Nursery strives to produce seed that is genetically representative of wild populations we try to have all perennial beds established with wild collected seed. Direct sowing wild seed on the farm often results in sporadic and incomplete germination with significant increases in maintenance cost and reduction in yield. Instead we germinate wild seed in the greenhouse where low germination rates are more easily mitigated, and transplant established plugs into the seed fields (Figure 10).

Figure 10. Transplanting plugs to establish a seed field

Native plug production can be a challenging endeavor. Producing native prairie forbs from wild collected seed is highly resource intensive, requiring over-sowing an average of 70% more tubes than will be delivered. The sowing season commences in the fall for seeds that over-winter and break dormancy in late winter. Another significant sowing begins in mid-spring. In some cases, an artificial cold-stratification (in a refrigerator) is necessary for seeds and germination commences in the summer. This necessary and intensive project is highly collaborative with several regional partners.

Plug production for South Sound prairie restoration and seed fields is largely conducted by the Sustainability in Prisons Project (SPP). In 2017, SPP delivered 186,000 plant plugs of 69 species. SPP utilizes an innovative and socially beneficial approach to nursery production which builds greenhouse facilities inside prisons and trains inmate technicians in conservation and horticulture.

SPP training includes weekly workshops on the ecology and propagation techniques of each species led by graduate students from The Evergreen State College and supervised by dedicated Department of Corrections staff. SPP has produced a Conservation Nursery Manual, a living document providing production protocols for over 60 prairie species, which is the foundation for training their inmate nursery technicians.

The expansion of the Conservation Nursery beyond the South Sound has increased the number of growers providing high quality plugs for the seed farms. The Salish Seeds project of the San Juan County Land Bank, wild-collected native seed and grew the plugs to establish CNLM's San Juan Island ecotype seed fields. The Pacific Rim Institute on Whidbey Island was the source of foundation seed and plugs for the Olympic Rain Shadow ecotypes. Supporting small, local growers is fundamental to the Conservation Nursery's goals of growing and sustaining a robust cooperative of native plant producers and expanding access to native seed.

2017 marked the first year in a decade that CNLM's nursery team integrated bulb and plug production directly into the program. This production included a small order for the US Forest Service, a small plug order for the establishment of Central Oregon coastal species, and the production of grasses and bulbs for island marble butterfly recovery. This will expand in 2018 to include most of the plugs used on the seed farms.

Research and Development

One of the most challenging and rewarding aspects of growing native seed is that there are rarely established production protocols for these species. With up to 100 species in production at a time, there are always unique challenges needing experimentation. Continual review of current protocols and cost tracking informs alterations to crop maintenance and harvest methods.

Figure 11: Koelaria macrantha combine harvest

Grass Production Scaled

2017 included the largest production of grass seed to date by the program. As grass crops have matured, significant increases in seed production necessitated the development of protocols for each of the eight species we produce.

Integrating Oregon State University research and NRCS resources, we arrived at a protocol to monitor seed moisture and shatter, informing harvest timings. This new monitoring method revealed harvests could hold and ripen in the field later than previously supposed.

Equipment customization was key to successful mid-scale grass production. *Danthonia californica* was a species with which we had particular success. Its yields were maximized this year by harvesting panicle seeds with a tractor-mounted flail vac, which strips mature seed from the stems.

This harvest was done twice: once when seeds began to shatter; and again a week later. Stems were left to cure on the plants and then harvested with a combine which threshed the stems, extracting the stem seed. *Koeleria macrantha*, which had been a challenging species in the past, proved to be a perfect candidate for direct combining (Figure 11).

Elymus glaucus was cut with the sickle bar mower and left to cure in field (Figure 12). Unfortunately, the stalks were too long and slick for our combine to thresh, so it was necessary to thresh by hand. Future harvests will address this challenge as we continue to refine our protocols.

Figure 12: Swathed grass field curing at Violet Prairie

Thatch and Weed Management Methods

Native perennial farming necessitates the retention of crops for several years. Some species with spreading forms and rhizomatous growth can limit the use of mechanical equipment to suppress weeds and support regrowth. The inability to cultivate combined with the plant habit can result in a build-up of thatch (dead and decaying plant material) that can be thick and may impede regrowth and attract pests.

Cerastium arvense had excessive thatch left after harvest in previous years, which seemed to restrict the following year's growth and subsequent seed yield. In the summer of 2016, experimental methods were used to try to stimulate new growth in this species: some beds received a mechanical treatment in which residual plant material was chopped up using a disking tractor implement, others were burned with a propane torch, and others received no treatment. In 2017, re-growth in the burned beds suggested that treatment was the most effective in promoting new growth as well as suppressing weeds (Figure 13). However, the control beds also had healthy regrowth, suggesting that other factors are also at work.

Figure 13. Left: Summer 2016 Cerastium beds post treatments

Right: May 2017 in bloom the day before the hailstorm

Harvest Impacts on Seed Processing

Anaphalis margaritacea (Figure 14) is a species that leaves many seed growers at a loss for how to efficiently harvest and process the seed. CNLM's nursery program trialed a combination of seed harvesting and seed cleaning techniques. We compared hand-cutting the indeterminate seed heads as they matured against a single tractor flail-vac harvest at peak maturity. The original intention was to perform multiple tractor harvests, but the brush stripped the plants making a second harvest impossible. While more labor intensive it seems that hand harvest is necessary to capture a significant quantity of seed.

Additional complication is encountered at the cleaning stage. This plant is easy to grow and sets abundant flowers, but the miniscule seed is encased in an impenetrable fluff. In 2016 hundreds of hours across several machines were necessary to extract the seed. In 2017 we attempted to streamline this untenable input of labor, but the result was a ten-fold reduction in yield. While this plant would be a valuable component to native seed mixes, we have not yet discovered how to produce it affordably.

Figure 14. Anaphalis margaritacea

Establishment of Challenging Lupine Species

Lupinus lepidus requires ongoing trials to determine appropriate production methods to establish and maintain healthy stands. Germination is spotty and extends for nearly 12 months from sowing. Adult plants that enter the winter die prior to re-flowering in the spring (figure 15). This requires a complete renewal of beds every year.

Figure 15: All living *Lupinus lepidus* plants in this October 2016 picture had perished by May of 2017

Several years of field trials on this species have compared scarification methods, sowing times, and protective agricultural fabric to promote germination and survivorship. While some improvements have been made, 2017-2018 trials will be focused on additional production treatments which include increasing sowing rates, using first generation farm seed instead of wild seed, spring nitrogen application, and co-planting with *Luzula comosa*.

Lupinus albicaulis beds were originally established in 2014 and since then, it has been difficult to get more plants established through direct sowing. In the fall of 2017, some beds were planted with plugs and others were direct sown at much heavier rates (~0.5g per row foot, up from ~0.15g per row foot), in accordance with NRCS Plant Materials Center rates. Unfortunately, plugs had suffered from rabbit herbivory before spring

delivery and were too small to plant. Plugs were held until fall, but were stressed, and are not expected to survive the winter. Cotyledons from the direct sowing (and presumed volunteer seedlings from prior years' crops) germinate well in the fall but disappear quickly. As 2018 production proceeds, the effectiveness of these methods should be more apparent. However, before concluding best establishment methods, it may be necessary to attempt more appropriately timed plug plantings.

Looking Forward

Plug Production Changes

In 2018, the majority of transplants used on the farm will be produced at the CNLM nursery rather than at SPP facilities. This increases efficiencies by allowing the farm managers to respond more rapidly to plug failures and to time plantings based on plug maturity rather than delivery schedules.

SPP will continue to produce the largest orders of plugs for the farm as well as all the plugs necessary for restoration actions and butterfly rearing. This should also increase efficiencies within the SPP program by increasing the size of plug lots and limiting the number of species and seed lots that need to be tracked.

New Seed Delivery Dates

With the considerable expansion of CNLM's seed production in the past few years, seed cleaning now extends from the first harvests in May through February. Each year there is a rush to clean as many species as possible prior to the September sowing window and there is uncertainty as

Table 1: Species for each seed delivery date

SEED DELIVERY DATE	
September 15	March 1
Aquilegia formosa	Achillea millefolium
Armeria maritima	Agoseris grandiflora
Balsamorhiza deltoidea	Allium amplectens
Bromus carinatus var. carinatus	Amsinckia menziesii
Bromus carinatus var. marginatus	Anaphalis margaritacea
Bromus pacificus	Apocynum androsaemifolium
Camassia leichtlinii	Arabis hirsuta
Camassia quamash	Brodiaea congesta
Carex inops ssp. inops	Brodiaea coronaria
Cerastium arvense ssp. strictum	Calandrinia ciliata
Collinsia grandiflora	Campanula rotundifolia
Collinsia parviflora	Cardamine nuttallii
Danthonia californica	Castilleja ambigua
Danthonia spicata	Castilleja hispida
Delphinium nuttallii	Castilleja levisecta
Dodecatheon hendersonii	Cirsium brevistylum
Dodecatheon pulchellum	Cirsium remotifolium
Drymocallis glandulosa var. glandulosa	Clarkia amoena ssp. lindleyi
Erigeron philadelphicus	Clarkia amoena var. caurina
Erigeron speciosus	Collomia grandiflora
Erigeron strigosus	Deschampsia cespitosa
Heuchera chlorantha	Dichanthelium acuminatum
Iris tenax	Dichanthelium oligosanthes
Koeleria macrantha	Dichelostemma congestum
Leptosiphon bicolor	Elymus glaucus
Lithophragma parviflorum	Elymus trachycaulus
Lupinus bicolor	Eriophyllum lanatum
Luzula comosa	Festuca roemeri
Micranthes integrifolia	Festuca rubra
Microseris laciniata	Festuca rubra ssp. arenicola
Microsteris gracilis	Fritillaria affinis
Nuttallanthus te1anus	Gaillardia aristata
Plagiobothrys figuratus	Geranium bicknellii
Plagiobothrys scouleri	Gilia capitata
Plantago lanceolata	Hieracium scouleri
Plectritis congesta ssp. brachystemon	Ligusticum apiifolium
Plectritis congesta ssp. congesta	Lomatium nudicaule
Potentilla gracilis	Lomatium triternatum
Prunella vulgaris var. lanceolata	Lomatium utriculatum
Ranunculus occidentalis	Lupinus albicaulis
Sidalcea nelsoniana	Lupinus lepidus
Sisyrinchium idahoense	Montia linearis
Toxicoscordion venenosus	Navarretia interte1ta
Trifolium willdenovii	Navarretia squarrosa
Trillium parviflorum	Packera macounii
Triodanis perfoliata	Perideridia gairdneri
Turitis glabra	Polemonium carneum
Viola praemorsa var. praemorsa	Quercus garryana
	Ranunculus orthorhynchus
	Rhinanthus minor ssp. minor
	Rupertia physodes
	Sanicula crassicaulis var. crassicaulis
	Sanicula graveolens
	Sericocarpus rigidus
	Silene douglasii var. douglasii
	Silene scouleri ssp. scouleri
	Solidago missouriensis
	Solidago missouriensis var. tolmieana
	Solidago simplex
	Symphyotrichum eatonii
	Symphyotrichum hallii
	Triteleia grandiflora
	Triteleia hyacinthina
	Vicia americana
	Viola adunca
	Wyethia angustifolia

to what seed partners will receive by that date.

To increase partners ability to plan and to reduce the pressure on the seed cleaners, the Nursery is setting two discreet seed delivery dates and providing a list of species that will be cleaned by each date. The first date is September 15 and will include most of the annual species and early bloomers. The remainder of species will be cleaned by March 1 to be ready for a spring sowing or held until fall. This may mean that some species will not be available for sowing in the fall of 2018 but going forward, late species will be held over and available at the earliest sowing date with known quantities. We believe this should greatly improve restoration planning and success. Table 1 lists the species for each delivery date.

Acknowledgments

The Conservation Nursery is truly a collaborative effort. The vision, generosity and hard work of our staff and all our partners has made the program successful. A great diversity of genetically appropriate native seed is now available in abundance in the South Sound. As we move forward together, our goal is to continue to lower the barriers to native seed use and to expand the regions where native seed is available.

Appendix 1. Total 2017 Seed Production

Species	Region	Pounds
Achillea millefolium	Southern Puget Prairies	9.684
Agoseris grandiflora	Southern Puget Prairies	0.282
Allium amplectens	Southern Puget Prairies	0.061
Anaphalis margaritacea	Southern Puget Prairies	0.138
Apocynum androsaemifolium	Southern Puget Prairies	1.372
Aquilegia formosa	Southern Puget Prairies	1.450
Armeria maritima	Southern Puget Prairies	13.151
Balsamorhiza deltoidea	Southern Puget Prairies	33.466
Brodiaea coronaria	Southern Puget Prairies	2.581
Camassia leichtlinii	Southern Puget Prairies	16.518
Camassia quamash	Southern Puget Prairies	13.414
Campanula rotundifolia	Southern Puget Prairies	0.190
Carex comosa	Southern Puget Prairies	0.010
Carex inops ssp. inops	Southern Puget Prairies	0.489
Carex utriculata	Southern Puget Prairies	0.002
Castilleja hispida	Southern Puget Prairies	0.198
Castilleja levisecta	Southern Puget Prairies	3.588
Cerastium arvense ssp. strictum	Southern Puget Prairies	4.129
Cirsium brevistylum	Southern Puget Prairies	0.214
Cirsium remotifolium	Southern Puget Prairies	0.134
Clarkia amoena ssp. lindleyi	Southern Puget Prairies	0.961
Collinsia grandiflora	Southern Puget Prairies	44.387
Collinsia parviflora	Southern Puget Prairies	21.896
Collomia grandiflora	Southern Puget Prairies	13.087
Danthonia californica	Southern Puget Prairies	37.172
Danthonia spicata	Southern Puget Prairies	0.795
Delphinium nuttallii	Southern Puget Prairies	4.947
Dichanthelium acuminatum	Southern Puget Prairies	16.369
Dichanthelium oligosanthes	Southern Puget Prairies	64.871
Dodecatheon hendersonii	Southern Puget Prairies	0.042
Dodecatheon pulchellum	Southern Puget Prairies	0.556
Elymus glaucus	Southern Puget Prairies	37.834
Elymus trachycaulus	Southern Puget Prairies	2.499
Erigeron philadelphicus	Southern Puget Prairies	0.542
Erigeron speciosus	Southern Puget Prairies	8.672
Eriophyllum lanatum	Southern Puget Prairies	17.294
Festuca roemeri	Southern Puget Prairies	2928.817
Fritillaria affinis	Southern Puget Prairies	0.092
Gaillardia aristata	Southern Puget Prairies	2.981
Geranium bicknellii	Southern Puget Prairies	0.054
Gilia capitata	Southern Puget Prairies	6.635
Heuchera chlorantha	Southern Puget Prairies	9.560

Appendix 1 cont'd. Total 2017 Seed Production

Species	Region	Pounds
Hieracium scouleri	Southern Puget Prairies	0.029
Iris tenax	Southern Puget Prairies	18.897
Juncus supiniformis	Southern Puget Prairies	0.524
Koeleria macrantha	Southern Puget Prairies	36.329
Leptosiphon bicolor	Southern Puget Prairies	4.717
Ligusticum apiifolium	Southern Puget Prairies	0.489
Lithophragma parviflorum	Southern Puget Prairies	0.544
Lomatium triternatum	Southern Puget Prairies	93.104
Lomatium utriculatum	Southern Puget Prairies	2.593
Lupinus albicaulis	Southern Puget Prairies	49.774
Lupinus bicolor	Southern Puget Prairies	5.479
Lupinus lepidus	Southern Puget Prairies	1.368
Luzula comosa	Southern Puget Prairies	4.812
Marah oregana	Southern Puget Prairies	0.530
Micranthes integrifolia	Southern Puget Prairies	1.119
Microseris laciniata	Southern Puget Prairies	27.598
Microsteris gracilis	Southern Puget Prairies	2.896
Navarretia intertexta	Southern Puget Prairies	6.653
Perideridia gairdneri	Southern Puget Prairies	0.625
Plagiobothrys figuratus	Southern Puget Prairies	17.366
Plectritis congesta ssp. congesta	Southern Puget Prairies	44.025
Polemonium carneum	Southern Puget Prairies	0.657
Potentilla gracilis	Southern Puget Prairies	27.734
Prunella vulgaris var. lanceolata	Southern Puget Prairies	1.143
Ranunculus orthorhynchus	Southern Puget Prairies	0.557
Rupertia physodes	Southern Puget Prairies	0.211
Sanicula crassicaulis var. crassicaulis	Southern Puget Prairies	0.028
Sericocarpus rigidus	Southern Puget Prairies	0.486
Sidalcea nelsoniana	Southern Puget Prairies	3.744
Sisyrinchium idahoense	Southern Puget Prairies	15.347
Solidago missouriensis	Southern Puget Prairies	8.153
Solidago missouriensis var. tolmieana	Southern Puget Prairies	3.090
Solidago simplex	Southern Puget Prairies	3.066
Symphyotrichum hallii	Southern Puget Prairies	0.062
Toxicoscordion venenosus	Southern Puget Prairies	0.607
Trifolium willdenovii	Southern Puget Prairies	2.587
Triteleia hyacinthina	Southern Puget Prairies	3.831
Viola adunca	Southern Puget Prairies	7.221
Viola howellii	Southern Puget Prairies	0.906
Viola praemorsa var. praemorsa	Southern Puget Prairies	0.043
Wyethia angustifolia	Southern Puget Prairies	0.003
TOTALS	**Southern Puget Prairies**	**3321.14**

Appendix 1 cont'd. Total 2017 Seed Production

Species	Region	Pounds
Achillea millefolium	Coastal Lowlands	0.243
Allium cernuum	Coastal Lowlands	0.001
Anaphalis margaritacea	Coastal Lowlands	0.006
Angelica lucida	Coastal Lowlands	3.301
Armeria maritima	Coastal Lowlands	0.076
Camassia quamash	Coastal Lowlands	0.079
Carex pansa	Coastal Lowlands	0.688
Cirsium edule	Coastal Lowlands	0.013
Clarkia amoena var. caurina	Coastal Lowlands	21.496
Daucus pusillus	Coastal Lowlands	20.342
Festuca rubra	Coastal Lowlands	0.221
Hosackia crassifolia	Coastal Lowlands	0.058
Lilium cernuum	Coastal Lowlands	0.622
Lupinus latifolius	Coastal Lowlands	0.002
Lupinus littoralis	Coastal Lowlands	0.009
Lupinus rivularis	Coastal Lowlands	0.155
Polygonum paronychia	Coastal Lowlands	0.026
Ranunculus occidentalis	Coastal Lowlands	0.130
Sisyrinchium idahoense	Coastal Lowlands	0.130
Solidago canadensis	Coastal Lowlands	0.274
Solidago spathulata	Coastal Lowlands	0.340
Symphyotrichum chilense	Coastal Lowlands	0.001
Symphyotrichum subspicatum	Coastal Lowlands	0.011
Tanacetum bipinnatum	Coastal Lowlands	0.129
Trifolium wormskioldii	Coastal Lowlands	0.048
Viola adunca	Coastal Lowlands	0.015
TOTALS	**Coastal Lowlands**	**48.42**
Lupinus oreganus var. kincaidii	Cowlitz/Newaaukum Prairie Floodplains	0.742
Sidalcea nelsoniana	Cowlitz/Newaaukum Prairie Floodplains	0.132
TOTALS	**Cowlitz/Newaaukum Prairie Floodplains**	**0.87**
Castilleja hispida	High Olympics	2.829
Lomatium utriculatum	High Olympics	2.780
Lupinus rivularis	High Olympics	0.461
Plectritis congesta ssp. congesta	High Olympics	4.239
TOTALS	**High Olympics**	**10.31**
Castilleja hispida	Low Olympics	0.477
Eriophyllum lanatum	Low Olympics	0.000
Fragaria virginiana	Low Olympics	0.001
Microsteris gracilis	Low Olympics	0.015
Plectritis congesta ssp. congesta	Low Olympics	0.027
TOTALS	**Low Olympics**	**0.52**

Appendix 1 cont'd. Total 2017 Seed Production

Species	Region	Pounds
Achillea millefolium	Olympic Rain Shadow	0.719
Castilleja levisecta	Olympic Rain Shadow	0.120
Cerastium arvense ssp. strictum	Olympic Rain Shadow	2.885
Erigeron speciosus	Olympic Rain Shadow	7.106
Eriophyllum lanatum	Olympic Rain Shadow	3.072
Festuca roemeri	Olympic Rain Shadow	16.278
Festuca rubra	Olympic Rain Shadow	45.856
Lomatium nudicaule	Olympic Rain Shadow	15.879
Lomatium utriculatum	Olympic Rain Shadow	20.264
Lupinus densiflorus	Olympic Rain Shadow	0.022
Luzula comosa	Olympic Rain Shadow	1.056
Prunella vulgaris var. lanceolata	Olympic Rain Shadow	0.803
TOTALS	**Olympic Rain Shadow**	**114.06**
Achillea millefolium	San Juan Islands	0.492
Allium acuminatum	San Juan Islands	0.015
Anaphalis margaritacea	San Juan Islands	0.275
Brodiaea coronaria	San Juan Islands	0.023
Cerastium arvense ssp. strictum	San Juan Islands	0.842
Collinsia parviflora	San Juan Islands	0.052
Dodecatheon hendersonii	San Juan Islands	0.017
Elymus glaucus	San Juan Islands	15.966
Eriophyllum lanatum	San Juan Islands	0.896
Leptosiphon bicolor	San Juan Islands	0.264
Luzula comosa	San Juan Islands	0.007
Plectritis congesta ssp. congesta	San Juan Islands	8.382
Solidago lepida var. salebrosa	San Juan Islands	0.041
Triteleia hyacinthina	San Juan Islands	0.003
Turitis glabra	San Juan Islands	1.979
TOTALS	**San Juan Islands**	**29.25**
Balsamorhiza deltoidea	Western Cascasde Lowlands and Valleys	0.036
Castilleja hispida	Western Cascasde Lowlands and Valleys	0.021
Collinsia parviflora	Western Cascasde Lowlands and Valleys	0.180
Collomia grandiflora	Western Cascasde Lowlands and Valleys	0.004
Eriophyllum lanatum	Western Cascasde Lowlands and Valleys	0.015
Festuca roemeri	Western Cascasde Lowlands and Valleys	0.214
Lupinus albicaulis	Western Cascasde Lowlands and Valleys	0.021
Plectritis congesta ssp. congesta	Western Cascasde Lowlands and Valleys	0.315
TOTALS	**Western Cascasde Lowlands and Valleys**	**0.81**
GRAND TOTAL	**All Regions**	**3924.33**