



# Department of Defense Legacy Resource Management Program

PROJECT NUMBER 09-326

## **Guidelines for Establishing Nursery and Nursery Beds: A Management Plan**

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# South Puget Sound Regional Seed Production Management Plan

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## 1. Introduction

The south Puget Sound (SPS) is a region rich in natural resources, yet it hosts one the most threatened ecosystems in the United States. Over 92% of the short grass prairies and oak woodlands of western Washington have been converted to other land uses and only 3% is now considered to be historic prairie. These ecosystems support a wide array of endemic flora with their associated native pollinators, which are now at risk from encroachment by native trees and shrubs and a host of non-native invasive species. Many species have already been extirpated from the SPS prairies and several more species that are listed by Washington State as endangered, threatened or sensitive, are perilously close. Many prairie species, both flora and fauna, have experienced precipitous population declines in recent years and are in danger of regional extirpation without active management.

The open prairie landscape on Joint Base Lewis McChord (JBLM) is used extensively for most military training, including artillery practice, large arms fire, Stryker vehicle training, firebase construction, parachute drop zones and foot training. Approximately two thirds of the remaining SPS prairie habitat now occurs on JBLM. Military training and invasive plants continue to negatively impact prairie quality, which reduces native plant biodiversity, and in turn negatively impacts fauna that rely upon it to survive. Habitat restoration and enhancement efforts allow military trainers greater flexibility in using existing Department of Defense (DoD) lands and support JBLM's commitment to recover federal candidate species. Successful prairie restoration will allow for the reintroduction or translocation of candidate species that will benefit regional recovery efforts and could significantly reduce the potential for listing any of the candidate species. That will benefit regional recovery efforts and will likely reduce the potential for federal listings. If one of the candidate species were federally listed, it could cause serious disruption to training, impacting the type, location, duration and/or timing, and would prove costly, both financially and in terms of maintaining essential military training.

The ultimate goal of this project is to improve prairie quality at the landscape level by implementing prairie management and restoration actions that have a primary emphasis on recovering the Federal Candidates and other rare species throughout the SPS, and restoring native plant biodiversity on Fort Lewis' prairies. The Nature Conservancy's (TNC) Shotwell's Landing Nursery, which was largely established with Legacy funds is now fully developed and running at full capacity for both seed and plug production. This project is also to serve as a demonstration that other installations can follow and duplicate for themselves. With initial infrastructure for seed bed production established at Shotwell's Landing, actions turn towards establishing larger scale seed bed production sites and the associated harvesting and processing equipment necessary to deal with upwards of 1,200 pound of seed annually. Protocols for field establishment, harvesting and processing must be developed. A transition plan will be produced with DoD, FY10 funding after the 2011 field season, encompassing protocol development and infrastructure established for transfer to other military installations.

Funding has been primarily through DoD but increasingly state and other federal funding is becoming available for development of regional seed production facilities. In addition to funding support from the DoD Legacy Program, The Nature Conservancy has invested approximately \$150,000 and Washington Dept. of Fish and Wildlife (WDFW) will be investing \$125,000 in 2009. Additionally, a partnership with Washington Department of Natural Resources (WDNR) at Webster's Nursery has allowed for the establishment of long term seed production beds. Webster's Nursery is outfitted with irrigation and agricultural equipment necessary for production. WDNR has also allowed temporary use of seed cleaning equipment.

The primary objectives of regional seed production under this proposal are to ensure sufficient local sourced seed is available for large scale restoration efforts. This seed is necessary for the creation of habitat suitable for candidate and other rare species. This production will reduce pressures on wild populations, maximize efficiency and ensure seed available for land managers. This management plan is intended to serve as a five year guide for seed production actions to serve not only JBLM but the restoration of the conservation region.

## **2. Seed Production**

The next five years of development of seed production for the south Sound prairies will revolve around infrastructure evolution to meet the needs of an entire region. Regional needs roughly approximate the ability to produce 1,500 lbs. of forb and grass seed per year; or up to 20 acres in production at various sites and projects including Shotwell's Nursery (small scale), trial areas at Webster's Nursery (middle scale), and a larger on-base seedbed installation.

### **Regional Seed Production Strategy**

As restoration of western Washington's grasslands evolves, land management strategies have matured to include complex actions that foster the creation of habitat suitable for target prairie species. Sowing prairie grasses and forbs directly onto treated units within protected prairie has emerged as an effective step towards habitat creation. Consequentially, the South Sound prairie restoration community is formulating a collaborative strategy for the development of ecoregional seeding infrastructure. This strategy strives to address the availability, sourcing, and planting protocols for seeds used in habitat enhancements and will outline the development of necessary regional seed production infrastructure. The next five years of development of seed production for the south Sound prairies will revolve around determining infrastructure evolution to meet the needs of an entire region.

The Nature Conservancy has led these efforts, initiating and facilitating strategy development conversations; including local, state, federal and private partners. Regional partners including JBLM began by evaluating the benefits and risks of commercial, public and partner-based efforts for any appropriate phases of seed production. The majority of planning action have centered on

determining species needed in production. This is a fluid list that will be re-examined on a semi-annual basis as dictated by conservation partners.

Ecosystems perform numerous functions and provide a wide variety of services via floral communities whose members fill important functional roles; effective restoration often requires that we restore as many of these functions and services as possible. Through ecological degradation a reduced set of plant species (commonly including invasive species) may fill available functional role space, thereby reducing ecological integrity and limiting the community's ability to respond to environmental change. Production and application of native South Sound regional prairie seed can restore missing floral ecological roles. Strategic development of a foundational regional forb mix will depend on which functional traits are important to our particular South Sound prairies.

Currently, a foundational forb seed mix will first include a common species assemblage based on the composition of extant prairie plant communities. The mix will also be composed of species that fill basic functional roles necessary for particular candidate species applicable on JBLM prairies and are practical to grow and harvest during initial stages of seed production. This mix will be created to be applied after disturbance such as controlled burns and invasive species control. Forb species that fill multiple functional roles will be a higher priority for seed production. Initially this mix may cover the bare minimum of ecological needs; however as regional seed production proficiency, sophistication, and capacity continue to expand additional ecological niches will be filled. Various restoration projects may require different components of species grown for this mix, however all species included in this initial mix are of high restoration value and are a priority to be developed for seed production immediately. As questions and challenges arise, this mix will evolve accordingly.

Selection parameters considered a variety of appropriate factors for JBLM production including: use to butterflies, resistance to invasives, historical extent, current distribution, structure, soil and moisture needs, and ease of seed production (Appendix 1).

#### *Resistance to Invasives*

By selecting species most likely to exclude invasive species (trait overlap) or to completely use available resources (functional diversity) native communities can be assembled to resist invasion. Studies in Californian grasslands have

Fig. 1. *Lupinus albicaulis* seed pod



shown invasion was reduced when a high proportion of early season species was sown, possibly because this community was best able to preempt resources from exotic species (which were generally early-active). Invasive species on JBLM prairies may be out-competed by mainly fall germinating annuals as well as quick to establish early spring perennials.

### *Butterfly/Prairie Matrix Focused*

Butterflies of the South Puget Sound prairies are in decline, and are potentially limited by plant resources, including nectar and host plants as well as microhabitat-creating plant structures. Forb seed production will prioritize butterfly plant needs such as those of candidate species the Mardon Skipper and Taylor's Checkerspot. For JBLM prairies this would be primarily focused on Taylor's checkerspot and potentially Mardon skipper as the primary candidate species. Additionally for on-base sites as well as other regional locations, focusing on species that contribute to the overall prairie matrix or the plant resources deemed beneficial for enhancing prairie composition, structure and or function. These plant species benefit potential candidate species such as the Mazama Pocket Gopher and Streaked Horned Lark, which are also target species for recovery actions on JBLM.

The scale of restoration and enhancement efforts on South Sound Prairies has increased dramatically over the last few years. This increase has been fueled by the continuing success in invasive species control due to the controlled burn program. These advances in restoration and management increased the number of acres with annual seed needs. Determining the quantity of seed needed is the most difficult aspect of the strategy. Multiple factors affect the seed production need for each species. These factors include the amount of acreage to be restored, ecological target for the restoration, establishment rate, seed production rate and others. These factors vary annually based on weather, previous restoration actions and even changing conservation priorities.

Through the strategy, regional needs were estimated at 1,500 lbs. of forb and grass seed per year; production beginning at Shotwell's Nursery (small scale), trial areas at Webster's Nursery (middle scale), and a five acre larger-scale production area at Webster's Nursery.

Additionally, this strategy provides a flexible platform over time and throughout potentially changing seed production priorities. New priority species can be rapidly expanded through seed bed production to sufficient levels to initiate field production. Or if possible, a large wild collection effort could lead directly to field production the next year. This flexibility also allows production amounts and techniques to be fine-tuned over time as information on desired target communities and the habitat needs becomes available.

### **Shotwell's Landing**

Shotwell's Landing is a 40-acre property owned by the Nature Conservancy, adjacent to the Black River, and transected by Rainbow Creek. The majority of the property, formerly known as

Rainbow Valley, is a riparian wetland characterized by seasonal flooding. Roughly ten acres of road frontage are above the seasonal flood zone and host to three workbuildings including a new 1700 sq. ft. seed processing facility, a newly updated irrigation system, three 2000 sq. ft. hoophouses for plug production and 60 seed production beds.

Currently Shotwell's serves as hub for plant production actions and is currently building infrastructure to meet the regional plant production needs of over 1,500 lbs. of native seed annually. Shotwell's strives to research and produce rare and needed restoration species that are not available commercially.

Production of perennials in plugs began at Shotwell's Landing in January 2005 due to need of perennial forbs for enhancement plantings both regionally and at JBLM. Prior to that date, enhancement planting needs were met by plugs produced at various different sites, including the homes of volunteers, and the homes of various TNC employees around Olympia. The transfer of all related nursery materials to Shotwell's Landing was the result of an effort by the South Sound Program to increase efficiency and standardize all plug production activities. Currently Shotwell's can produce up to 100,000 native prairie plugs for restoration or seedbed development. Seed beds established with plugs are generally more successful at out-competing weed species. This capacity increase was completed in part with Legacy funding for both production of plugs for out-planting and for seedbed establishment and to assist with protocol development.

In 2007-2008 40, 128 sq. ft. seed production beds were established at Shotwell's Landing to serve as permanent seed beds for annual and perennial forbs for restoration on JBLM. As larger seedbeds are established these seed beds will transition to a mixture of rare or specialty species that are naturally rare or occur in swales and other sub-habitats on the prairie that favor more water tolerant species. Production of large lots of these species is currently not needed. Small lots may be all that is needed to meet restoration needs over several years.

Other species are needed in much larger amounts to meet the needs of the region. This increased production of native seed is the primary goal of the seed production program. With increased availability of core native seed, then larger amounts of lands can be restored and new lands can be included in restoration efforts. The actual amount of seed needed varies with species, due to establishment rates in the restoration and production rates by the plants.

Fig 2. *Lomatium utriculatum* production bed at Shotwells Landing.





Seed production at Shotwell's Landing begins with wild collection on prairie preserves by The Friends of Puget Prairies, a volunteer group coordinated through The Nature Conservancy. The group has a dedicated team that has been collecting prairie seed for multiple years. These experienced volunteers have the advantage of on-the-ground knowledge of key plant populations and have gone through training on wild collection techniques. The volunteer group also specializes in cleaning the small amounts of wild collected seed.

A seed collection handbook (Appendix 2) is currently being established to guide volunteers in the collection process. The most up to date copy will be available as part of the transfer Plan. In the future training will be held to keep wild seed collection standardized. These guidelines include basics such as: species identification, collection considerations including phenology and genetics, appropriate sites for collection, and handling prior to cleaning.

Once seed is collected and cleaned propagation protocols are established on species through grow-out in hoopouses. Species generally undergo outdoor stratification by being sown outdoors and exposed to winter rains and temperatures. In the spring flats are brought inside hoopouses and checked for germination. Seeds are also manually cold stratified by soaking seed

in water for 24 hours and refrigerating, checking for germination weekly. Some seed need scarification or actually breaking the seedcoast which is achieved by rubbing seed with sandpaper.

Fig. 3. *Microseris lacinata* seedling.



Seed after cleaning or plugs from the greenhouse are used to establish small seed production beds or foundation beds. These beds are small enough that most maintenance and collection actions are conducted by hand. The smaller size of seed beds lends them to staff, intern or volunteer actions.

Even untrained volunteers are used effectively to weed small beds. The controlled environment of the seed bed, with chosen soil type, water regime and fertilization schedule can help species flourish and increase seed production. Seed beds are also a good testing ground to determine optimal plant densities, plant cultural needs and seed collection

requirements in production conditions before a species is planted into larger fields.

The small controlled setting of the seed bed easily adapts to species that may have significant seed predation problems in the wild. Transfer to the controlled conditions of a nursery may be sufficient to minimize seed predation, or plants can be sprayed with appropriate pesticide to directly target the seed predators.

## Webster’s Nursery

Seed production expanded in 2008 to the use of the Department of Natural Resources Webster’s Tree nursery. One “block” (production unit) at Webster’s Nursery is six acres. In 2008 The Nature Conservancy, outplanted roughly 15,000 plugs and directed seed roughly 10 pounds of native seed of 10 species within 22,000 sq. ft. of Block 24. Species include: *Balsamorhiza deltoidea*, *Camassia quamash*, *Castilleja hispida*, *Erigeron speciosus*, *Eriophyllum lanatum*, *Lomatium utriculatum*, *Lupinus albicaulis*, *Plectritis congesta*, *Potentilla gracilis*, and *Solidago missouriensis*.

## 2. Basic Five Year Plan

### Shotwell’s Nursery

Over the next five years Shotwell’s will continue to facilitate intensive cultivation on a custom scale, replacing priority crops as needed when rare plant needs or core seed mixes shift. The diversity of rare and problematic-for-production species will increase and regional crops such as *Erigeron speciosus* will be phased out at Shotwell’s. Shotwell’s Nursery will host rare plants, smaller lots, and custom scale production for overall high diversity and low volume seed production projects.

Volunteers, interns, TNC, and WCC will continue to staff Shotwell’s, which will gain leverage as the regional seed processing and storage facility. Through Shotwell’s, The Nature Conservancy will organize and coordinate regional plant materials and influence population genetic decisions. Quality control on seed processing will be increased for projects supporting custom plug production and partner-contracted plug production.

Table 1. Shotwell’s Production

Year	Pounds produced Annually	# Species in Production	% Rare Species	% Restoration Species	Actions
2008	35	40	5%	95%	
2009	50	50	15%	85%	
2010	53	56	30%	70%	Restoration species sown at Webster’s
2011	45	60	40%	60%	Shift bulk producing species to Webster’s
2012	40	65	50%	50%	Acquire additional funding for rare species

## **Webster's Area I**

At roughly one acre Area I will be the site of pilot research of middle scale production. Cropping methodologies, irrigation options, yield potentials and labor costs will be examined in this section of production, which will maintain service options including irrigation and fertilization.

The first use of Webster's Area I over the next five years will be to quantify production costs (\$/lb) at different methodologies to show the benefits or disadvantages of irrigation and crop establishment from seeds or plugs. Other specific inquiries to be examined include:

**Seed Collection** - The use of tarped beds, vacuums, and costs associated with various machinery will be examined.

**Labor Costs** - Weeding contracts and the workability of large scale intensive hand-weeding will be investigated.

**Irrigation** - Survivorship and economy of winter annuals sown out of season with and without irrigation will be examined; as will those sown in season with and without irrigation.

**Crop establishment** – Sowing techniques including needed equipment and techniques will be innovated and tested. Soil nutrient and water-holding capacity will be monitored to produce protocols on site needs for natives.

**Pollination** - The presence and diversity of pollinators can be monitored in the easily accessible site.

Another top priority over the next five years at Webster's Area I will be to help meet the most pressing goals of the regional core mix. This involves planting all available plugs in proportion to current crop establishment deficits based on the core mix in 2009. Annuals will be revised in 2010, and 2011 will herald the earnest beginning of core mix seed collection.

<b>Year</b>	<b>Pounds produced Annually</b>	<b># Species in Production</b>
2009	50	6 in addition to current 8 established
2010	120	16 species sown in Area II
2011	120	12 species sown or replaced
2012	500	22 species established
2013	750	30 species established

Table 2. Webster’s Timeline

## **Webster’s Area II**

The next five years in Webster’s Area II will springboard from pointed inquiries at Area I and will depend on the compilation of a compatible suite of equipment assembled under a specific cropping plan (such as that of Heritage Nurseries in Oregon.) Also, soil moisture-holding capacity tests on the entire Block 24 will be conducted to establish if five acres of non-irrigated production is feasible. (Results will be compared with baseline production needs established by Heritage Nurseries.) If there are no red flags from these tests then we will negotiate a price range for work on increased acreage at Webster's based on a non-irrigated production model that utilizes our own equipment.

Work at Area II will begin with 12-18 months of weed control and site prep; designs including “green swards” will need to be worked out. After fall, winter and summer weeds have been killed crops will be established from seed in the fall of 2010. If site prep takes 18 months seeds will not be sown until the fall of 2011. Production should near 500 pounds in 2012 (Table 2) and by 2013-2014, production should near 1000 pounds. Yield estimates can be roughly based on those of Heritage Nursery.

This project will begin with and aim to maintain a low level of labor, especially as the shift is made from site prep to weed maintenance. Site prep will specifically include an 8-10 ft. boom on winter weeds and perimeter control. This will be followed by a site wide fumigation. Maintenance will be done using a variety of methods. Large areas will be sprayed using a hooded sprayer to isolate in between rows and around irrigation lines. Isolated weeds within rows will be done using hand tools and backpack sprayers with cones attached to wands to focus spray on target weeds.

Seed beds will be established with a variety of methods focusing on a per species approach. A seed drill will be used for most initial establishment or species will be plugged for quicker production based on the availability of plugs. Other establishment techniques will be explored.

Harvest will be conducted with a swather/hopper combo and a trailer for species that produce one isolated crop of seed. Other harvested techniques will also be explored based on recommendations from other producers. Seed strippers and combines are two harvest equipment pieces that could be explored. The use of weed tarp for weed control and for harvesting of species that ripen over long periods of time will also be explored.

## Other Production Sites

A number of other production sites may be future options for regional seed production. In respect to this project the role of The Nature Conservancy is to coordinate and produce restoration species plugs through the Evergreen State College's Sustainable Prisons Project (SPS) at Stafford Creek Correctional Center (SCCC). Through this project, correctional centers are able to produce 400,000 plugs annually. Plugs from this facility will be used to establish seed production beds at Shotwell's Landing, Webster's Nursery and at JBLM for increased on-base seed production.

JBLM on-base production sites are currently still under the site preparation stage. They will continue to focus on finding a site appropriate for production that is available and not affected by training activities. The site will need minimal site prep for weed control and some leveling. The establishment will be done entirely from plugs produced by SCCC and placed into tarped areas. Weed control will mostly be done manually within the rows and a general perimeter area will be boom-sprayed.

Other possibilities for seed production at cost effective scale may rise to prominence. These include the development of larger scale areas through a contract with a private for-profit or small farm. These possibilities may present a better economy of scale and offer the ability to expand past Webster's-scale production. Production at a small farm would most likely involve non-

irrigated crop establishment from seed, good soil and leasing acreage

Fig. 3. Clipper Eclipse air screen separator donated by WDNR.



## 4. Seed Processing

### Facilities

Current infrastructure building has occurred at Shotwell's Landing Restoration Nursery. A 1,700 square foot seed processing facility and work-building is almost complete. This building will host

all the processing equipment needed for regional production.

The facility includes an office for data collection and record keeping of seedlots. Seed lot tracking is an important aspect of regional coordination. A database is currently being developed for seed tracking. The database contains an inventory of all seedlots and tracks additions and withdrawals of seed. In addition a database can be helpful in tracking germination rates and plug propagation information. Successful record keeping of seedlot information such as seed sourcing through allocation is necessary when dealing with rare species as well as core species.

A seed lab is also being established for scientific inquiry into seed germination, viability, physical identification, etc. This lab will be equipped with microscopes, scales, specialized small seed equipment and a germination chamber for examining viability of seeds.

## **Equipment**

The main workbuilding area will be comprised of a suite of seed processing equipment. A drying shed will be established outside in the form of enclosed hoop house. After drying plant material will move into workbuilding and be processed using specialized agricultural equipment adjusted for native needs. Currently an air screen separator has been donated by Washington Department of Natural Resources (WDNR) and a hammermill has been purchased.

Additional equipment to be purchased includes a large scale air screen separator for increased processing ability. A debearder for removal of pappus on aster species and awns on grasses is also necessary to effectively clean seed. The final piece of equipment will be an air column separator for the removal of non-viable seeds and small chaff material.

## **Allocation and Storage**

Regional allocation meetings will be held to determine the distribution of seed annually. The distribution of seed will be proportional to funding source and restoration need. For JBLM, seed produced from on-base seedbeds will remain for use on-base while production beds at Shotwell's Landing will provide seed primarily for on-base use. If the seed is not needed at that time, there is an option for seed to be used off-base or stored until needed. After FY10 funding ends seed and access to facilities will remain available to JBLM as long as a cooperative agreement exists between TNC and JBLM and funding is available. In order to ensure seed and access JBLM will need to provide annual funding for maintenance, collection and processing of seed and facility maintenance.

A long-term seed storage area will also be established. This area will be adjusted with cooler storage materials to keep a constant temperature of 40% and will reduce humidity to a constant 40%. This has been determined as a standard for seed storage. Individual species information is currently unavailable as to the longevity of seeds in storage so seed should be tested on an annual basis to determine loss of viability over time. This information is necessary so material not needed in a year can be held over and used in subsequent years.

## **5. Conclusion**

The South Sound prairie restoration community has formulated a collaborative strategy for the development of eco-regional native prairie seed production, beginning with infrastructure considerations and broadening to address the availability, sourcing, and planting protocols for seeds used in habitat enhancements. The next five years of development of seed production for the South Sound prairies will revolve around infrastructure evolution to meet the needs of an entire region and will move through consensually prioritized waves of species' production. Current and future progress is made possible through the generous support and coordinated efforts of partnering private, local, state and federal agencies.

# Appendix 1. Regional South Sound Prairie Forb Seed Mix Options According to Functional Roles

Species*	Perennial Annual	Common to Extant Prairie*	Resist Invasives	Butterfly Food	Structure	Other ecological needs	Soil Comp.	Wet Prairie	Currently Building Stock?	Ease of Seed Pro	Seed or Plug Pro?	Priority	Status
Danthonia californica	P	High	M-Both	MS Host		Collateral Host Plant		x	x	High		5	2009 core
Eriophyllum lanatum var lanatum	P	High	H-Exclusion						x	High		4	2009 core
Plectritis congesta	A		H-Exclusion?	TC Host, Nectar					x	High		4	2009 core
Lupinus albicaulis	P	Medium	H-Persistence	PB Nectar, Host	x		N fixer N fixer		x	High	Seed	4	2009 core
Lupinus lepidus	P	High	H-Exclusion						x	High	Seed	4	2009 core
Lomatium utriculatum	P	High	M-Persistence	MS, TC Nectar					x	High	Seed	3	2009 core
Collinsia parviflora	A		H-Exclusion?	TC Host					x	Low		3	2009 core
Achillea millefolium var occidentalis	P	High	H-Both			Late summer bloom				High		3	2009 core
Ranunculus occidentalis var occidentalis	P	High	H-Both	MS Nectar					x	High		3	2009 core
Microseris laciniata ssp laciniata	P	High							x	High	Seed	3	2009 core
Sericocarpus rigidus	P	High	M-Both	VS Nectar		Late summer bloom			x	High		2	2009 core
Viola adunca var adunca	P	High		MS Nectar GSF, VS Host					x	Low		2	2009 core
Balsamorhiza deltoidea	P	Medium		TC Nectar	x				x	Low	Seed	2	2009 core
Lomatium triternatum	P			MS, TC Nectar	x				x	Low	Seed	2	2009 core
Potentilla gracilis var gracilis	P	High							x	High		2	2009 core b
Castilleja hispida	P	Low	M-Persistence	TC Host					x	High		2	2009 core b
Solidago missouriensis	P	Medium	M-Both		x	Late summer bloom			x	High		2	2009 core b
Erigeron speciosus	P	Medium	M-Both	VS Nectar	x	Late summer bloom			x	High		2	2009 core b
Hieracium cynoglossoides	P	High	M-Exclusion			Late summer bloom			x	Medium		1	2009 core b
Carex inops	P	High	H-Both						x	Medium		2	2010 core
Lupinus bicolor	A		Exclusion?				N fixer		x	Medium	Seed	2	
Koeleria macrantha	P					Collateral			x	High		2	
Zigadenus venenosus var venenosus	P	High	M-Persistence						x	Low	Seed	2	
Camassia quamash vars. (azurea, maxill...	P	High	H-Persistence	TC Nectar					x	Medium	Seed	2	
Apocynum androsaemifolium	P			VS Nectar	x	Late summer bloom						1	
Delphinium nuttallii	P								x	Low	Seed	1	
Viola praemorsa	P	Low		GSF Host					x	Low		1	
Prunella vulgaris ssp lanceolata	P	High	M-Persistence	Sonora S Nectar								1	
Fritillaria affinis var affinis	P	Medium	M-Persistence						x	Low	Seed	1	
Campanula rotundifolia	P	High	H-Persistence			Late summer bloom			x	Medium		1	2009 collect
Brodiaea coronaria ssp. Coronaria	P	Medium							x	Low	Seed	1	
Cerastium arvense	P	High	M-Persistence	VS Nectar?					x	Medium		1	
Cirsium undulatum	Biannual			TC Nectar		Late summer bloom						0	
Deschampsia (elongata)	P		H-Both					x					Establish
Aster hallii	P	Low						x					Establish
Wyethia augustifolia	P							x					Establish
Sidalcea	P		Fall germinant					x					Establish
Plagiobothrys	A							x					Establish
Sedges	P							x					Establish

\*List, Commonality based on Dunw iddie et al Occurrence paper

## Additional Annuals

Lotus micranthis	A		H-Exclusion								seed	3	2010 core
Trifolium tridentatum	A		H-Exclusion							Low	seed	3	2010 core
Linaria canadensis v. texana	A		H-Exclusion						x	Low	seed	3	2010 core
Clarkia amoena v. lindleyi	A		H-Exclusion						x	High		3	
Microsteris gracilis	A		H-Exclusion		0						seed	3	2010 core
Colinsia grandiflora	A		H-Exclusion									2	
Calandrinia ciliata	A		H-Exclusion						x	Medium		2	

2009 Core: 19 ssp

2010 Core: 24 ssp



## Appendix 2: Example of Production Cropping Information

Species	Seed Yield Estimate (lbs)	Earliest Seed Yield	Currently Estb Crop Area (sq ft)	Currently Estb Crop Area Notes	Years to Yield
<i>Eriophyllum lanatum</i> var <i>lanatum</i>	2.00	2009	2200	1.3 SL bed, (2) 0.5 WB bed	1
<i>Camassia quamash</i> vars. ( <i>azurea</i> , <i>maxima</i> )	0.75	2011	2000	1 WB bed	4
<i>Sericocarpus rigidus</i>	0.50	2009	128	1 SL bed	2
<i>Danthonia californica</i>	2.00	2009	256	2 SL bed	1
<i>Potentilla gracilis</i> var <i>gracilis</i>	0.50	2009	64	0.5 SL bed	1
<i>Lomatium utriculatum</i>	4.00	2009	2128	1 SL bed, 1 WB bed	2
<i>Viola adunca</i> var <i>adunca</i>	0.40	2009	384	3 SL	2
<i>Apocynum androsaemifolium</i>	Not established	2011			2
<i>Plectritis congesta</i>	8.00	2009	4128	1 SL bed, 2 WB bed	1
<i>Collinsia parviflora</i>	2.00	2009	2000	1 WB bed	1
<i>Lupinus albicaulis</i>	6.00	2009	2128	1 SL bed, 1 WB bed	1
<i>Balsamorhiza deltoidea</i>	0.25	2009	128	1 SL bed	3
	5.00	2011	2000	1 WB bed	3
<i>Castilleja hispida</i>	1.00	2009	1256	2 SL bed, 0.5 WB companion	2
<i>Solidago missouriensis</i>	2.00	2009	928	1 SL bed, 0.3 WB bed	1
<i>Lomatium triternatum</i>	0.30	2009	128	1 SL bed	3
<i>Hieracium cynoglossoides</i>	Not established	2011			2
<i>Achillea millefolium</i> var <i>occidentalis</i>	Not established	2010			1
<i>Ranunculus occidentalis</i> var <i>occidentalis</i>	0.25	2009	128	1 SL bed	1
<i>Lupinus lepidus</i>	Not established	2010			1
<i>Lupinus bicolor</i>	0.10	2009	64	0.5 SL bed	1
<i>Erigeron speciosus</i>	1.50	2009	128	1 SL bed	1
<i>Koeleria macrantha</i>	2.00	2009	128	1 SL bed	1
<i>Microseris laciniata</i> ssp <i>laciniata</i>	0.50	2009	192	1.5 SL bed	2
<i>Prunella vulgaris</i> ssp <i>lanceolata</i>	Not established				1
<i>Zigadenus venenosus</i> var <i>venenosus</i>	0.25	2009	128	1 SL bed	3
<i>Fritillaria affinis</i> var <i>affinis</i>	Not established				4
<i>Campanula rotundifolia</i>	0.05	2009	20	1 SL bed	1
<i>Brodiaea coronaria</i> ssp. <i>Coronaria</i>	Not established	2011	30	2 SL bed	4
<i>Cirsium undulatum</i>	Not established	2010			1
<i>Cerastium arvense</i>	0.05	2009	128	1 SL bed	1
<i>Deschampsia</i> ( <i>elongata</i> )	Not established	2010			1
<i>Aster howellii</i>	Not established				
<i>Wyethia augustifolia</i>	Not established	2013			4 or 5
<i>Sidalcea</i>	Not established				
<i>Plagiobothrys</i>	Not established				
Sedges	Not established				

\*SL=Shotwell's Landing; WB=Websters

## Appendix 3: Key Plants for Butterfly Species of Concern on Prairies in South Puget Sound, Washington

Ann Potter, March 12, 2009

Common Name	Scientific Name	Conservation Status <sup>1</sup>	Key Larval Food Plants <sup>2</sup>	Key Nectar Sources <sup>2</sup>
Propertius Duskywing	<i>Erynnis propertius</i>	SM; SGCN	<i>Quercus garryana</i>	Unknown
Oregon Common Branded Skipper	<i>Hesperia colorado oregonia</i>	SM; SGCN	Unknown grass or sedge	<i>Aster curtus</i> , <i>Solidago</i> , <i>Erigeron speciosus</i> (Late-season nectar)
Mardon Skipper	<i>Polites mardon</i>	SE; SGCN; FC	<i>Festuca roemeri</i> , <i>Danthonia californica</i>	<i>Viola adunca</i> , <i>Vicia sativa</i>
Sonora Skipper	<i>Polites sonora siris</i>	SM; SGCN	Unknown grass or sedge	<i>Prunella</i> Mostly Unknown (Mid-season nectar)
Hoary Elfin	<i>Incisalia polia</i>	SM; SGCN	<i>Arctostaphylos uva-ursi</i>	<i>Arctostaphylos uva-ursi</i>
Puget Blue	<i>Plebejus icarioides blackmorei</i>	SC; SGCN	<i>Lupinus albicaulis</i>	<i>Lupinus albicaulis</i> , <i>Marah oreganus</i>
Great Spangled Fritillary	<i>Speyeria cybele pugetensis</i>	SM; SGCN	<i>Viola praemorsa</i> and possibly other <i>Viola</i>	<i>Cirsium vulgare</i> (Late-season nectar)
Valley Silverspot	<i>Speyeria zerene bremnerii</i>	SC; SGCN	<i>Viola adunca</i> and possibly other <i>Viola</i>	<i>Cirsium arvense</i> , <i>Erigeron speciosus</i> , <i>Aster curtus</i> (Late-season nectar)
Taylor's Checkerspot	<i>Euphydryas editha taylori</i>	SE; SGCN; FC	<i>Plantago lanceolata</i> , and likely <i>Plectritis congesta</i> , <i>Collinsia</i> , <i>Castilleja</i>	<i>Balsamorhiza deltoidea</i> , <i>Lomatium triternatum</i> & <i>utriculatum</i> , <i>Camassia quamash</i> , <i>Plectritis congesta</i> , <i>Fragaria</i>

<sup>1</sup>SC= State Candidate; SE= State Endangered; SM= State Monitor; FC= Federal Candidate  
SGCN= Species of Greatest Conservation Need (CWCS)

## Appendix 4: Outline of Wild Seed Collection Training

### South Sound Program Annual Seed Collection Training

1. Importance Collaborative Seed Collection
  - a. Cooperative Conservation
  - b. Maintaining Quality Control
2. Partners Involved
  - a. Agencies
  - b. Property Managers
  - c. Project Managers and Staff
  - d. Volunteers
3. Where to Collect
  - a. Location of the Prairies
  - b. Access
4. When and What to Collect
  - a. Seed Collection Needs
5. How to Collect
6. Species for Collection
  - a. Aster / Composite (Asteraceae)
  - b. Pea (Fabaceae)
  - c. Lily (Liliaceae)
  - d. Figwort (Scrophulariaceae)
  - e. Grasses (Poaceae)
  - f. Buttercup (Ranunculaceae)

- g. Carrot (Apiaceae)
- h. Violet (Violaceae)
- i. Primrose (Primulaceae)
- j. Iris (Iridaceae)
- k. Plumbago (Plumbaginaceae)
- l. Campanula (Campanulaceae)
- m. Rose (Rosaceae)
- n. Valerian (Valerianaceae)
- o. Dogbane (Apocynaceae)
- p. Sedge (Cyperaceae)
- q. Gourds (Cucurbitaceae)
- r. Saxifrage (Saxifragaceae)
- s. Borage (Boraginaceae)
- t. Mustard (Brassicaceae)
- u. Evening Primrose (Onagraceae)
- v. Phlox (Polemoniaceae)
- w. Pink (Caryophyllaceae)
- x. Purslane (Portulacaceae)

## APPENDIX OF SEED COLLECTION DOCUMENTS

1. Seed Collection Overview
2. Field Crib Sheet
3. 2010 Master Plant List
4. Grasses
  - a. Prairie Grasses Spreadsheets by Dunwiddie
  - b. Fescue Taxonomy by Dunwiddie
5. Natural Selection for a Fruit Dimorphism in *Plectritis Congesta* by Ganders, Carey, & Griffiths
6. Driving Directions & Maps
7. List of Seed Collection Leaders Kit of Goodies
8. Sample of Range Control Authorization
9. CDs
  - a. Photos--Blooming, Senesced , Seed
  - b. Label format -- 14 per sheet
  - c. Master List of Plants
  - d. Prairie Species Information