



**South Puget Sound Site
Evaluations for Reintroduction
of Golden Paintbrush**

Prepared for
Region 1 of the USFWS

Prepared by
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South Puget Sound Prairie Site Evaluations for
Reintroduction of Golden Paintbrush
(*Castilleja levisecta*)

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Executive summary

Golden paintbrush (*Castilleja levisecta*) is listed as threatened under the U.S. Endangered Species Act. The conservation and recovery of rare plants is a process that requires many strategies. Among these strategies are various forms of reintroduction.

The Reintroduction Plan for golden paintbrush described a process for identifying sites for potential reintroduction of this species, based on the success and/or failure of other published plant reintroduction efforts. As a general rule, reintroduction efforts for other plant species have been more successful if new sites match existing sites for a species as closely as possible.

This document provides a summary of a site evaluation process in the South Puget Sound prairie region of the range of golden paintbrush. The existing site that was used as a match for all possible reintroduction sites was Rocky Prairie, the only population of golden paintbrush known from the South Puget Sound area.

Sixteen sites were evaluated and ranked. The ranking was based on similarity of sixteen soil, topography/hydrology, and vegetation characters to those of Rocky Prairie. The management issues for each site are evaluated and discussed in the text.

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1.0 Introduction

Golden paintbrush (*Castilleja levisecta*) is listed as threatened under the U.S. Endangered Species Act (ESA). The conservation and recovery of rare plants is a process that requires many strategies. Among these strategies are various forms of reintroduction. These include *reintroduction* to sites that were known to support populations in the past but from which the species has been extirpated, *introduction* to sites within the known range which were not known to support populations in the past, and *augmentation or enhancement* of existing populations. The ESA allows for reintroduction as a component of species recovery plans. The primary purpose of reintroduction efforts is to lessen the probability of extinction and encourage the recovery of a rare plant through the creation of new, self-sustaining populations (Pavlik 1996b).

Despite current interest in reintroduction of rare plants, the biological understanding of the reintroduction of species and populations is poorly developed (Falk et al. 1996). Successful large-scale reintroductions are relatively rare. There are guidelines for a rare plant reintroduction plan in Falk et al. (1996), and a number of reports on reintroduction attempts (Guerrant 1996a, Cully 1996, McDonald 1996, Gordon 1996, Pavlik 1988-1996a, Pavlik and Espeland 1991, and DeMauro 1994). This document is based primarily on the guidelines in Falk et al. (1996).

The Recovery Plan for *Castilleja levisecta* (USFWS 2000) identified reintroduction as an important component in the recovery of this species. The authors state that the following conditions, among others, must be met before delisting can be considered:

- 1. There are at least 20 stable populations distributed throughout the historic range of the species. To be deemed stable, a population must maintain a five year running average population size of at least 1,000 individuals**
- 2. At least 15 of these populations are located on protected sites. In order for a site to be deemed protected, it must be either owned and/or managed by a government agency or private conservation organization that identifies maintenance of the species as the primary management objective for the site, or the site must be protected by a permanent conservation easement or covenant that commits present and future landowners to the conservation of the species.**

The Reintroduction Plan for *Castilleja levisecta* (Caplow 2004) described a process for identifying sites for potential reintroduction of this species, based on the success and/or failure of other published plant reintroduction efforts. As a general rule, reintroduction efforts for other plant species have been more successful if new sites match existing sites for a species as closely as possible. Characteristics of soils, hydrology, geology, degree of disturbance, and vegetation have been used to compare and evaluate potential reintroduction sites (Heunneke et al. 1986). In 2004, all of the existing sites for *Castilleja levisecta* were visited and characterized. The site characteristics of populations of *C. levisecta* across its range that were considered were geology, soils, topography, aspect, hydrology, associated species, and plant community type (Chappell and Caplow 2004).

This document provides a summary of a site evaluation process in the South Puget Sound prairie region of the range of *Castilleja levisecta*. The existing site that was used as a match for all possible reintroduction sites was Rocky Prairie, the only population of *Castilleja levisecta* known from the South Puget Sound area. This system could also be used to evaluate other sites in the South Puget Sound Prairie region.

2.0 Background on *Castilleja levisecta*

From the Reintroduction Plan for *Castilleja levisecta* (Caplow 2004)

2.1 Listing history and known threats

The U.S. Fish and Wildlife Service (USFWS) published a final rule listing *Castilleja levisecta* as a threatened species on June 11, 1997 (62 FR 31740). A recovery plan was written in 2000 (USFWS 2000) and at that time an informal technical team was established. The intention of a technical team is to provide biological advice to the USFWS. The Regional Director of the USFWS, not the technical team, exercises the Service's authority and responsibility (USFWS 1990). Personnel on a technical team are chosen for their knowledge of the species' biology, recovery planning, or other issues relevant to the recovery of the species. The current technical team is made up of staff from the USFWS; the Washington Natural Heritage Program (WNHP); the Washington Natural Areas Program and the Washington Office of The Nature Conservancy (TNC) (both of which manage populations of *Castilleja levisecta* and have participated in reintroduction research); the Berry Botanic Garden in Portland, Oregon; and the Institute for Applied Ecology in Corvallis, Oregon. The technical team is active in coordinating efforts for recovery of *Castilleja levisecta*.

Threats to *Castilleja levisecta* include: invasion of habitat by woody trees and shrubs (as a result of fire suppression); invasion of habitat by nonnative plants; herbivory by mammals and invertebrates; roadside development for residential or commercial use; thatch, moss and lichen development (as a result of fire suppression); and trampling, picking, and collection at public sites (USFWS 2000).

2.2 Distribution

Historically, *Castilleja levisecta* was reported from more than 30 sites in the Puget Trough of Washington and British Columbia, and as far south as the Willamette Valley of Oregon (Hitchcock et al. 1959, Sheehan and Sprague 1984, Gamon 1995). A 1984 assessment found that the plant had been extirpated from more than 20 historic sites, including all Oregon sites (Sheehan and Sprague 1984, Gamon 1995).

Two extant populations of *Castilleja levisecta* occur in British Columbia, Canada, on small islands near Victoria. Historically, *C. levisecta* was documented from nine sites on southeastern

Vancouver Island, and on two adjacent islands. All but the two populations found on islands are extirpated or are of unknown status but are likely to have been extirpated (Ryan and Douglas 1994).

Nine extant populations of *Castilleja levisecta* occur in Thurston, Island, and San Juan Counties in Washington. At least fourteen additional historic sites were in Island, San Juan, Clark, Pierce, King, Jefferson, and Skagit Counties (Gamon 1995). Table 1 lists all historic and extant sites within the South Puget Sound area (Thurston and Pierce Counties).

Table 1. Summary of historic and extant sites for *Castilleja levisecta* in the South Puget Sound area (Gamon 1995).

Site Name	County	Last observation date	Current status/notes
Rocky Prairie	Thurston	2005	Extant
Roy	Pierce	1889	Presumed extirpated
Tenino Prairie	Thurston	1937	Could be Rocky Prairie
Near West Rocky Prairie	Thurston	1999?	Private land- status not known

2.3 Life history and ecology

Castilleja levisecta is a short-lived perennial herb. Individual plants generally do not survive longer than 5 to 6 years. (Dunwiddie et al. 2001). Biologists think this species reproduces exclusively by seed; vegetative spread has never been observed or reported.

Members of the genus *Castilleja*, like many others in the figwort family, may be parasitic or hemi-parasitic. *Castilleja levisecta* has also been shown to have the ability to germinate and develop in a greenhouse setting with and without a host plant (Wentworth 1994). Recent propagation experiments have tracked the effects of host plants. Sarah Reichard of the Center for Urban Horticulture (pers. comm. 2003) and Lawrence (2005) found that plants that were established with a *Festuca roemerii* host were more successful after outplanting than those not established with any host or with an *Eriophyllum lanatum* host. Preliminary results from outplanting experiments at Mima NAP and Glacial Heritage found that the most successful host over a one year period was *Eriophyllum lanatum* (Peason pers. comm. 2005). A study of the effect of various hosts on another generalist hemi-parasitic *Castilleja* (Adler 2003) found that legume hosts increased seed production and pollinator visitation in comparison to other hosts.

The pollinators of *Castilleja levisecta* have not been thoroughly documented. Evans et al. (1984) reported that a species of bumblebee, *Bombus californicus*, was observed visiting *C. levisecta*. Pollen could be observed on the bee's head as it exited the inflorescence. Wentworth (pers. comm. 1995) also observed that *Bombus* sp. were the most frequent visitors to *C. levisecta* inflorescences. Tepedino (pers. comm. 2001) suggested that large species of *Megachile*, leaf

cutter bees, can be mistaken for bumblebees, and two *Castilleja* species in the west (*C. aquariensis* and *C. christii*) were visited by large species of *Megachile*.

In a pollinator exclusion experiment, Wentworth (1994) found that fruits can be produced in the absence of pollinator visitation, but fruit set was almost five times greater in un-bagged inflorescences compared to inflorescences bagged to prevent visitation to the flowers by pollinators.

Although seed dispersal has not been directly observed, the seeds are probably shaken from the seed capsules and fall a short distance from the parent plant. Most individuals familiar with the species suspect that seedling establishment is inhibited by an increase in grass and forb cover. Rhizomatous grasses may be a serious threat to seedlings. Pearson and Dunwiddie (2003) found, in their seedling experiments, that those plots with dense thatch, moss, and lichen cover had lower numbers of seedlings. Lawrence (2005) also found greater vigor of transplants in sites with lower competing vegetation cover.

2.4 Population genetics

A study of the genetic structure of the existing populations of *Castilleja levisecta* was completed in 2003 (Godt et al. 2005). Material was gathered at all existing populations and allozymes were used to describe genetic diversity and structure in these eleven populations. The most significant results are summarized below.

- 1) Despite its relatively narrow range, exceptionally high levels of genetic diversity are maintained in *Castilleja levisecta*.
- 2) Smaller populations tended to have fewer alleles and less genetic diversity.
- 3) There is a significant negative correlation between genetic identity and geographic distance, indicating reduced gene flow between populations, although this correlation was less strong when Rocky Prairie was removed from the analysis.
- 4) Rocky Prairie is one of the most genetically diverse and genetically divergent populations.

2.5 Reintroduction-related issues

The Reintroduction Plan for *Castilleja levisecta* (Caplow 2004) discusses many of the issues surrounding reintroduction of this species, but some of the major issues relating to site selection (some unresolved) are summarized here:

Habitat restoration

If major restoration of a site needs to take place (weed control, replanting of natives, etc.), it is best to complete or at least do the major restoration activities prior to attempting a full reintroduction of *Castilleja levisecta*. This is because major plant community restoration activities can be difficult to implement without negative effects to the reintroduced species. This means that sites with restoration needs may be appropriate for a reintroduction, but only after major restoration activities have taken place. Lawrence (2005) found that there was a statistically significant inverse relationship between the success of out-planted *C. levisecta* at common garden sites (in the Willamette Valley and Jefferson County, Washington) and the cover of non-native species on the site, and recommended against reintroductions to sites dominated by non-native species.

Degree of protection

The Recovery Plan for *Castilleja levisecta* (USFWS 2000) is explicit that sites must be, “either owned and/or managed by a government agency or private conservation organization that identifies maintenance of the species as the primary management objective for the site, or the site must be protected by a permanent conservation easement or covenant that commits present and future landowners to the conservation of the species.” *Castilleja levisecta* populations on sites that do not meet these criteria do not contribute to the 20 populations on protected land needed for recovery of the species. Therefore, reintroductions on sites that do not meet these criteria are not contributing to recovery, as defined in the plan. In general, sites that are not protected should not be high priorities for reintroduction efforts, unless future protection is probable.

Use of fire as a management tool

Work by Dunwiddie et al. (2001) has shown that prescribed fire is an important management tool in maintaining the viability of *Castilleja levisecta* populations. Potential reintroduction sites where fire can be used are preferred, since this tool is so valuable in population management.

Taylor’s checkerspot (*Euphydryas edithe taylori*)

Taylor’s checkerspot is a grassland butterfly taxon that is a candidate for federal listing. This butterfly was once found on the prairies of Thurston, Mason, Pierce, and Lewis Counties, north to British Columbia, and south to the Willamette Valley. It is now known from only 10 Washington sites (Stinson 2005), and there is considerable interest in reintroduction of this butterfly to South Puget Sound prairie habitat. *Castilleja* species are known to be larval host plants for Taylor’s checkerspot, and *Castilleja hispida* has been planted at several sites that may be used as Taylor’s checkerspot reintroduction sites. See below for possible issues with *C. hispida*. More directly, it is possible that Taylor’s checkerspot may be able to use *Castilleja levisecta* as a host plant, and in fact Taylor’s checkerspot was once known from Rocky Prairie. This may or may not have a deleterious effect on newly established populations of *Castilleja levisecta*, but it should be considered when identifying possible sites for reintroduction of *Castilleja levisecta*.

Castilleja hispida

Castilleja hispida is a widespread western *Castilleja* whose range overlaps with *Castilleja levisecta* in the South Puget Sound prairie area, and less frequently elsewhere. *Castilleja hispida* has also been planted on several prairies where it was not previously known, as a larval host plant for Taylor's checkerspot. There is a population of *C. hispida* on Ft. Lewis that appears to have at least some intermediate characters between *C. hispida* and *C. levisecta*. Although *C. hispida* can be yellow to red in color, this population has smaller flowers than most *C. hispida*, and includes a mix of yellow, orange, and red plants. The existence of this population has raised some concern about potential hybridization between the two species. *Castilleja levisecta* is diploid throughout its range (Godt et al. 2005). *Castilleja hispida*, on the other hand, is known to have multiple ploidy levels throughout its range (M. Egger, pers. comm. 2005). Two species must nearly always have the same ploidy level to cross, so it is possible that some populations of *C. hispida* could cross with *C. levisecta*, while others could not. It is known that a small population of *C. hispida* was once present at Rocky Prairie, with no sign of introgression between the two species.

To resolve this question, we are beginning a study to examine ploidy levels in *C. hispida* and to attempt crosses between *C. hispida* and *C. levisecta*. Meanwhile, until the question is resolved, sites with either planted or native *C. hispida* would not be appropriate as large-scale reintroduction sites for *Castilleja levisecta*.

3.0 Study Area

The study area consisted of the extant prairies remaining in the South Puget Sound Prairie Landscape as defined by Dunn and Ewing (1997). This includes prairies on Fort Lewis and vicinity, Pierce County, prairies in Thurston County, and prairies in the Chehalis River valley of eastern Grays Harbor County (Figure 1). Prairies in Mason County were not considered, in part because of the distance from historic populations of *Castilleja levisecta* and in part because of the lack of prairies in fair or better condition. Grassy balds in the vicinity of Bald Hill in southeastern Thurston County were not considered part of the study area because the habitat is different than that of the historic populations of *Castilleja levisecta* in this geographic area.

The extant prairies within the study area are found primarily on gravelly, coarse-textured, excessively well-drained soils derived from recessional glacial outwash of the Vashon Glaciation. Soil series described from these extant prairies include Spanaway, Nisqually, and Spanaway-Nisqually complex (Pringle 1990). The latter is characterized by a mounded topography of Mima Mounds, with the mounds considered similar in character to Nisqually soils, and the intermounds similar to Spanaway. The vast majority of extant prairie area is located on Spanaway or Spanaway-Nisqually complex soils. Prairies found on Nisqually series were more extensive in the past and now occupy a very small proportion of extant prairies, due to conversion to agriculture. Nisqually soils differ from Spanaway soils in lacking substantial gravel, having deeper A horizons, and having higher water holding capacity (moderate as

opposed to low). Nisqually soils are more suited to agriculture than Spanaway or Spanaway-Nisqually complex soils and therefore a much higher proportional area of Nisqually soil prairies have been converted to agriculture. Due to higher water holding capacity, it appears that Nisqually soils may have also been more likely to be invaded by trees with the cessation of regular burning.

Prairie-like vegetation developed in the area during the warm, dry, Hypsithermal Period, which ended about 4,000 years ago. The prairie vegetation has been maintained since then by periodic Native American burning, which served to maintain important food plants and hunting grounds. About 120-150 years ago, regular burning ceased and prairies began succeeding to forest vegetation. The rate of succession appears to have varied dramatically on a site-by-site basis, with the still extant prairies being the last to succumb to the pressures of tree invasion in the absence of fire. Threats to the existing prairies include tree invasion, non-native plant species and their effects, and conversion to residential and other types of development.

4.0 Methods

4.1 General

The intention of this study was to apply the site selection methods that were described in the reintroduction plan for *Castilleja levisecta* (Caplow 2004) to the South Puget Sound portion of the range of the species. These methods were based on the work of Pavlik and Heisler (1988). A summary of this process is below:

1. Develop habitat factors for the natural populations (site characterization).
2. Establish geographic boundaries that reflect the known historic range of the species
3. Eliminate areas that don't conform to the most important habitat factors
4. Identify potential reintroduction sites
5. Visit and evaluate potential reintroduction sites for similarity to sites supporting natural populations
6. Further evaluate potential reintroduction sites for management and logistical appropriateness for reintroduction

In general, the following characteristics have been considered when matching sites with known populations of rare plants to potential reintroduction sites: geology, soils, topography (including aspect and slope), level of disturbance, and vegetation differences (Heunneke et al. 1986, Demauro 1994, Pavlick and Heisler 1988). We chose the specific factors that we did for reasons related to both the ecology of *Castilleja levisecta* and the particular expression of environment and vegetation present in the South Puget Sound Prairies.

The initial site characterization of all *Castilleja levisecta* populations was completed in 2004 (Chappell and Caplow 2004). Due to the strong geographic, genetic, and habitat differentiation between Rocky Prairie and all other populations, only the habitat factors for Rocky Prairie were used for this study. The habitat factors that were used to describe Rocky Prairie and then to rank

the potential reintroduction sites are listed in Table 2. We thought that these factors would provide a good indicator of degree of ecological similarity to Rocky Prairie. The rationale for choosing each of the factors is discussed below.

Table 2. Habitat factors used to rank the potential reintroduction sites

<p>Soils % coarse fragments at 6" % coarse fragments at 12" probable soil type</p> <p>Topography Degree of mounded prairie Presence of swales</p> <p>Vegetation % <i>Festuca</i> Total native forb cover Total cover exotics Total cover moss/lichen Total cover bare ground <i>Dicranum scoparium</i> cover <i>Rhacomitrium canescens</i> cover <i>Lupinus albicaulis</i> cover <i>Carex inops</i> cover # native species in common w/ Rocky Prairie</p>

Soils/geology

The geologic parent materials of all sites considered are similar (glacial outwash). We did observe considerable variation in percent coarse fragments at two different soil depths, and these are probably correlated with differences in water holding capacity of the soils. For this reason we included these variables. Soil textures ranged from sandy loams to loamy sands and differences were not readily apparent using hand texturing field methods, so we did not include soil texture (other than percent coarse fragments). We also included the soil series as a categorical variable based on our field observations of small soil pits with descriptions of the series in Pringle (1990). All soil profiles examined were very dark brown to blackish and substantial A horizons, so we did not use soil color as a variable. We did not do any lab work on soils, so any variables that might have been considered from that source were not used.

Topography

All the sites are flat or mounded, so aspect and slope are not significant factors. Rocky Prairie has some mounding, and so this variable was included. The highest density of *Castilleja levisecta* on Rocky Prairie is found in a broad swale that runs through the prairie. Therefore, we considered the presence of swale-like habitat as a positive factor for the species. Although hydrology was not measured specifically, we assumed that in these environments (with similar soils and subsurface geology), topography would be the primary driver for the hydrology of the sites.

Vegetation

The vegetation characteristics that we compared include some broad descriptors of the plant community, including percent cover of the following: *Festuca roemeri* (the dominant native grass in these prairies), native forbs collectively, non-native species collectively, moss and lichens, and bare ground. As mentioned previously, moss, lichen, and bare ground cover may have effects on *Castilleja levisecta* reproduction. In addition, we included cover estimates of *Carex inops* and *Lupinus albicaulis* because they are prominent subdominant species at Rocky Prairie, especially where *Castilleja* density is high, and are often absent or much less common on other prairies. We also chose to look at the cover of two species of moss because of the apparent correlations between them and *Castilleja levisecta* occurrence range-wide (Chappell and Caplow 2004). *Dicranum scoparium* was found to be common at many of the sites with *Castilleja levisecta* throughout its range (Chappell and Caplow 2004) and is an indicator of higher moisture availability; its most common habitat is forested environments (Klinka et al. 1989). *Rhacomitrium canescens* was absent from all plots taken at sites with *Castilleja levisecta*, and is an indicator of dry conditions (Klinka et al. 1989). It is common in many prairies and other habitats otherwise superficially similar to *Castilleja levisecta* habitat. We also compared the overall similarity in the native species within plots at each site with the species present at Rocky Prairie. Site land use history changes vegetation, so one reason for using many vegetation characteristics was to take into consideration and hopefully lessen the effects of land use history on the overall vegetation similarity rank.

4.2 Site choice

Sites to evaluate within the South Puget Sound area, shown in Table 3, were chosen based on the following criteria: 1) presence of native-dominated prairie, 2) permission to access site, and 3) probable similarity to Rocky Prairie or existing experimental reintroduction site.

Chappell et al. (2003) developed an oak/prairie layer for the South Puget Sound prairies, which was used to identify areas with native dominated or partially native dominated prairie (Figure 1). Experts (Chris Chappell of WNHP and Peter Dunwiddie, Pat Dunn, and Eric Devlin of TNC) were also consulted to identify potential sites. Sites were then further evaluated by staff from WNHP and/or TNC and rejected if the vegetation was known to be in poor condition or if conservation was unlikely for the site. Permission was requested to visit the remaining sites, and where granted, sites were visited. Table 3 lists all sites considered for this study. “Evaluated sites” are those that were visited and that have information presented in Appendix A. “Sites considered but rejected” are those that were rejected during the expert review process. “Sites where permission was not received” are those that may have appropriate habitat but for which permission to visit could not be secured.

Table 3. All South Puget Sound prairie sites considered for *Castilleja levisecta* site evaluation study

Site	Ownership	Permission granted	Latitude of plot	Longitude of plot
Evaluated sites				
Rocky Prairie	WA NAP	Yes	46° 55' 12.39" N	122° 51' 33.11" W
Scatter Creek - north	WDFW	Yes	46° 50' 37.59" N	122° 59' 18.88" W
Scatter Creek - south	WDFW	Yes	46° 49' 22.08" N	123° 0' 24.85" W
West Rocky Prairie	Private	Yes	46° 53' 45.17" N	122° 52' 5.14" W
Wolf-Haven	Private	Yes	46° 54' 11.61" N	122° 50' 47.55" W
Morgan	Private/TNC	Yes	46° 53' 55.43" N	122° 44' 4.85" W
Johnson Prairie	Army	Yes	46° 55' 38.44" N	122° 43' 58.28" W
South Wier	Army	Yes	46° 54' 14.77" N	122° 44' 11.55" W
Upper Wier - SW corner	Army	Yes	46° 54' 39.64" N	122° 42' 35.54" W
13th Division RNA	Army	Yes	47° 0' 38.19" N	122° 25' 29.64" W
91st Division Prairie - east of berm	Army	Yes	47° 0' 8.25" N	122° 37' 44.14" W
91 st Division Prairie - butterfly area	Army	Yes	47° 0' 0.43" N	122° 37' 23.11" W
Mima - northeast near CALE planting	WA NAP	Yes	46° 54' 19.07" N	123° 2' 55.79" W
Mima - west	WA NAP	Yes	46° 53' 40.10" N	123° 3' 36.14" W
Glacial - outplanting NW of oak grove	Thurston/TNC	Yes	46° 52' 11.22" N	123° 2' 55.60" W
Glacial – west of oak	Thurston/TNC	Yes	46° 52' 10.05" N	123° 2' 59.26" W
Sites considered but rejected				
Violet prairie – B. Morgan (visited)	Private	Yes	N/A	N/A
Cavness	Private	Yes	N/A	N/A
Bordeax Ranch	Private	No	N/A	N/A
Rock Prairie	Private	No	N/A	N/A
East Scatter Creek	Private	No	N/A	N/A
Township Road	Private	No	N/A	N/A
Roy Prairies, east side	Private	No	N/A	N/A
Tenino private grasslands	Private	No	N/A	N/A
Artillery Impact	Private	Yes	N/A	N/A
Sites where permission not received				
Chehalis Reservation	Chehalis	No	N/A	N/A
Unsurveyed Chehalis Reservation	Chehalis	No	N/A	N/A

4.3 Fieldwork

Site visits took place in 2005 on June 14th through June 17th, and on August 3rd (West Rocky Prairie). Florence Caplow visited all sites. Chris Chappell visited all sites except West Rocky Prairie and did most of the cover estimates. Other field evaluators included technical team members Ted Thomas of the USFWS and Peter Dunwiddie of TNC. Rod Gilbert of Ft. Lewis Fish and Wildlife escorted evaluators to the Ft. Lewis Sites, Kelly McCallister of WDFW escorted evaluators to West Rocky Prairie, Eric Delvin of TNC escorted evaluators to Morgan, Wolf-haven, and Violet Prairie, and Roberta Davenport of the Washington Department of Natural Resources (WDNR) escorted evaluators to Rocky Prairie. At each site, one or more plot areas were chosen, based on appearing most similar to Rocky Prairie or having mapped Nisqually soils, predictive of hydrology and vegetation similar to those of Rocky Prairie.

At each site we, the field evaluators, performed the following tasks:

1. Dug a soil pit and described soil texture and coarse fragments at 6” and 12” below the duff layer
2. Identified an area (generally 10 X 10 m) in which we recorded all vascular plant species (and moss species, if known); the estimated total cover of exotic species, moss/lichen species, and bare ground; and the estimated absolute cover of *Festuca roemerii*, *Dicranum scoparium*, *Rhacomitrium canescens*, *Lupinus albicaulis*, *Carex inops*, and *Aster curtus*.
3. Recorded other information on the site: size of prairie, size of plot, presence of mounds and/or swales, ownership, commitment of protection (current and future), size and nature of buffer, presence of *Castilleja hispida* on site or nearby, and likelihood of Taylor’s checkerspot introduction on site or nearby.

Data sheets with this information for each site are included in Appendix A. Full vascular plant lists for each plot are available from WNHP.

These issues of Taylor’s checkerspot and *Castilleja hispida* are complex, and it is not yet clear whether there would be conflict between recovery of *Castilleja levisecta* and recovery of Taylor’s checkerspot. Taylor’s checkerspot larvae are known to feed on *Castilleja* species, and *C. hispida* is a known host plant. *Castilleja hispida* may or may not hybridize with *C. levisecta*. *Castilleja hispida* is known to have several ploidy levels throughout its range. Polyploid *C. hispida* would not be able to cross with *C. levisecta*, but diploid *C. hispida* might. We are planning to research this question over the next two years, but until this question is resolved, the presence of *C. hispida* near or within a reintroduction site and the possibility of Taylor’s checkerspot introductions are both considered possible management issues conflicting with reintroduction of *C. levisecta*.

4.4 Analysis and ranking of characteristics

Each physical and vegetation-related characteristic was given a rank of 0-3, depending on the similarity to Rocky Prairie. For instance, *Festuca* cover was ranked as follows: 0-1% cover was given a rank of 0, 2-14% cover was given a rank of 1, 15-24% cover or >60% cover was given a rank of 2, and 25-60% cover was given a rank of 3. This was because the 25-60% cover was closest to the range of *Festuca* cover seen at Rocky Prairie.

The characteristics were then weighted to reflect our sense of the relative importance of the each characters to *Castilleja levisecta*. For instance, total native forb cover had a weighting of 1 (the highest possible) because high native forb cover is uncommon in the region and characteristic of Rocky Prairie, while total cover of various single species was given a weighting of 0.5, since it is less clear that the presence of any single species may be predictive of a successful site for *Castilleja levisecta*.

Finally, the summed rankings for each major category (Soils, Topography/Hydrology, and Vegetation) were equalized so that each category is of equal importance in terms of similarity. We then summed the equalized ranks to give a total “similarity index” to the portions of Rocky Prairie with the highest cover of *Castilleja levisecta*.

To minimize bias, all ranking was done “blind”. The sites were each given a code, and the ranker did not know which site was being ranked.

Appendix B contains the ranking for each characteristic and the rationale for the ranking and weighting.

The management portions of the data sheet were not ranked, but the information on each site is in Appendix A. Particular site issues are discussed in the Results section of this document.

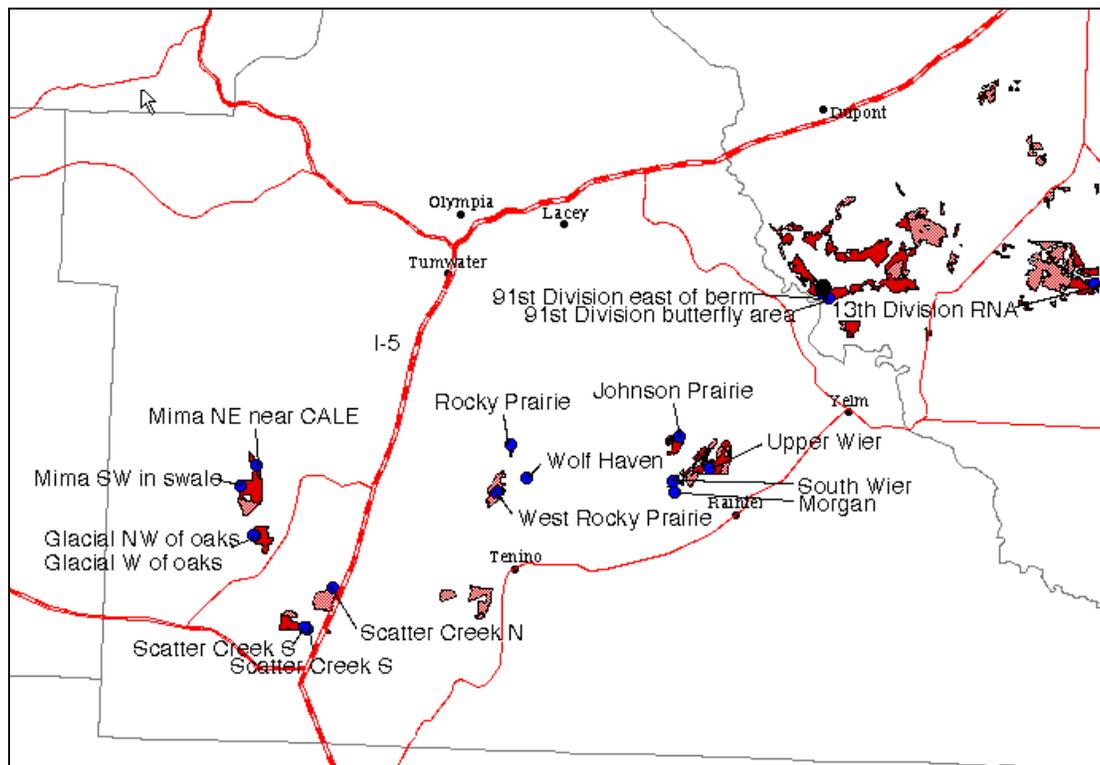


Figure 1. All evaluated sites. Red areas were identified as native or semi-native grasslands (Chappell et al. 2003).

5.0 Results

The similarity index of each site to Rocky Prairie is shown in Table 4. Each site is discussed in more detail below, in order from most similar to Rocky Prairie to least similar to Rocky Prairie.

Table 4. Similarity of all sites to Rocky Prairie, ranked in order of similarity

Rank of Similarity to Rocky Prairie	Site	Similarity Index
1	Rocky Prairie	8.25
2	Scatter Creek – south	6.61
3	South Wier	6.02
4	West Rocky Prairie	5.45
5	Johnson Prairie	4.92
6	Wolf-Haven	4.80
7	13th Division RNA	4.70
8	91st Division Prairie, east of berm	4.52
9	Glacial - outplanting NW of oak grove	4.00
10	Glacial - west of oak	3.93
11	Upper Wier - SW corner	3.73
12	Mima - west	3.50
13	Scatter Creek – north	3.43
14	91st Division Prairie, butterfly area	3.40
15	Mima - northeast near CALE planting	2.97
16	Morgan	2.51

5.1 Rocky Prairie

Rocky Prairie supports the second largest known population of *Castilleja levisecta* (ca. 7,000 plants) and the only population in the South Puget Sound prairies. It is also only one of two sites in the South Puget Sound prairies with historic collections of *Castilleja levisecta*. The plot was located near the center of the *Castilleja levisecta* population at Rocky Prairie, where population density on the site appears to be highest.

Topography

Rocky Prairie has both irregularly mounded prairie and a prominent flat-bottomed swale. The densest portion of the *Castilleja levisecta* population occurs in the swale.

Soils

Although Rocky Prairie is mapped as a Spanaway-Nisqually soil complex (Spanaway intermounds, Nisqually mounds), the areas on Rocky Prairie that support dense aggregations of *Castilleja levisecta* have a very low percent gravel in both the upper 6” and in the 6-12” layer, much lower than a Spanaway soil and similar to a Nisqually soil. No soil pit (three were dig on the site in the area of dense plants) exceeded 15% gravel, and the gravel percentage decreased with depth, which is a characteristic of Nisqually soils.

Vegetation

Rocky Prairie also has several unique vegetation characteristics in comparison with other South Puget Sound prairies, especially the areas with high density of *C. levisecta*. The forb diversity and cover are both unusually high. *Dicranum scoparium* is a dominant moss species. *Lupinus albicaulis* is present and has an unusually high cover. These characteristics all suggest a moister

prairie site and soils with a higher water-holding capacity than most extant South Puget Sound prairies (Chappell and Caplow 2004).

Management Issues

Rocky Prairie is a 33-acre site managed by the WDNR as an NAP. Weed control, prescribed fire, tree removal, and other techniques are all used to increase the value of the habitat for *Castilleja levisecta*. Both the population and the degree of protection and management meet the standards of the Recovery Plan for the species (USFWS 2000). It is a small site, with highly degraded prairie areas and successional forest adjacent to it, but seems to be large enough to support a viable population of *Castilleja levisecta*.

5.2 Scatter Creek- South

Scatter Creek- South is part of a 500-acre prairie, mostly managed by Washington Department of Fish and Wildlife (WDFW). Two plots were placed in a small part of the prairie that was mapped as Nisqually soil (Pringle 1990).

Topography

Scatter Creek - South is a flat prairie. There were no swales in the area where the plots were placed. A small population of *Castilleja hispida* occurs to the west of the plots in a swale, but that portion of the site does not have either high-quality prairie or appropriate soils.

Soils

Most of Scatter Creek is mapped as Spanaway or Spanaway-Nisqually complex. Approximately 5 acres in the southeast portion of the site are mapped as Nisqually, and soil pits showed a relatively low percentage of gravel (5-10%) that decreased with depth, as expected for Nisqually soils. Even within the mapped area of Nisqually soil, however, there were areas with a higher percentage of gravel. In general, the soils within the mapped area were a very good match for the soils within the *Castilleja levisecta* areas of Rocky Prairie.

Vegetation

The primary plot at Scatter Creek-South had 17 of the 25 species found in the Rocky Prairie plot, a high native forb cover, and a high cover of *Dicranum scoparium*. Although *Lupinus albicaulis* was not present in the plot, it was growing nearby. In general, it had a higher cover of fescue and lower forb covers than Rocky Prairie. However, the vegetation was more similar to Rocky Prairie than at any other site in the study.

Management Issues

Scatter Creek Wildlife Area is managed by WDFW as a Wildlife Recreation Area, and was purchased with recreation funds. The primary management issue for this site is the presence of *Arrhenatherum elatius*, which has aggressively increased on Scatter Creek over the past decade and has become dominant on some portions of the Wildlife Area. Over the past two years managers have begun using selective herbicides to control *Arrhenatherum elatius*, but it is too

soon to measure the effectiveness of these methods. This site is also likely to be a reintroduction site for Taylor's checkerspot, since it once occurred here, and *Castilleja hispida* is known from another part of Scatter Creek, within 1 mile of the appropriate habitat for *Castilleja levisecta*.

Due to its excellent ecological match with Rocky Prairie, this site would be appropriate for a large-scale reintroduction if a) at least a portion of the site could be formally dedicated to conservation of *Castilleja levisecta*, b) there is a long term commitment to aggressively controlling *Arrhenatherum elatius*, and c) it is known that either *C. hispida* and *C. levisecta* cannot cross, or that any *Castilleja hispida* on the site or planted nearby is not diploid. Ideally there would also be a way to use prescribed burning at the site. If these conditions could be met, this site would be an excellent choice for a reintroduction attempt.

5.3 South Wier

South Wier is part of a very large prairie complex of more than 2,500 acres, mostly managed by the Department of Defense (DOD) but also extending onto private land. The plot was placed in a small microsite (less than ½ acre) in a swale.

Topography

South Wier is an undulating prairie with some irregular depressions and swales, and the plot was placed in a shallow swale at the edge of where it connected with a much deeper semi-circular depression.

Soils

South Wier is mapped as a Spanaway soil (R. Gilbert pers. comm. 2005). The plot was intentionally placed in a small area (less than ½ acre) of high forb diversity and less gravelly soils. The soil pit had 20%-50% gravel, but gravel did decrease with depth, which is not generally a characteristic of Spanaway soils.

Vegetation

The plot at South Wier had 18 of the 25 species found in the Rocky Prairie plot, a high native forb cover, and *Lupinus albicaulis*. It did not have *Dicranum scoparium*, and the moss layer was mostly dominated by *Polytrichum* sp.. However, this vegetation composition similar to Rocky Prairie was only present in a small microsite within the larger prairie.

Management Issues

South Wier is managed by the DOD, and although it does not have formal protection, it is currently set aside as an area that does not have any track or wheeled training (although apparently training of this type does occur occasionally). The area is also used for dog training and other public uses. The primary management issue for this site is the lack of permanent protection from DOD activities and public use. Another issue is the small area of suitable habitat at this site. This site would not be appropriate for a large-scale reintroduction unless a) larger

areas of suitable habitat could be found, and b) the DOD was willing to provide permanent protection and conservation-oriented management for the reintroduction area.

5.4 West Rocky Prairie

West Rocky Prairie is an area of approximately 300 acres of remnant prairie, approximately one mile south of the Rocky Prairie population (and probably once contiguous with Rocky Prairie). *Castilleja levisecta* has also been known from a private parcel adjacent to West Rocky Prairie. West Rocky Prairie is currently in private ownership but is slated for purchase by WDFW. The plot was placed in an undulating intermound area that seemed typical of the site.

Topography

West Rocky Prairie is a mounded prairie with several large swales.

Soils

West Rocky Prairie is mapped as a Spanaway-Nisqually complex soil (Pringle 1990). The soil pit had <10% coarse fragments in the first 6", which increased to 25%-30% coarse fragments at 12". There were also larger rocks in the soil pit. We considered this soil to be a Spanaway soil, due to the increase of coarse fragments with depth, but it is less gravelly than most soils in this study.

Vegetation

West Rocky Prairie has a low species diversity of prairie forbs, probably due to a past history of heavy grazing. The plot at West Rocky Prairie had only 7 of the 25 species found in the Rocky Prairie plot, a low native forb cover, and a high cover of exotics. It had a high cover of *Dicranum scoparium*, which suggests a soil moisture regime similar to Rocky Prairie.

Management Issues

West Rocky Prairie has a number of management issues: it is currently privately owned, it is a probable site for Taylor's checkerspot reintroduction, it is in need of prairie restoration and weed control work, and it may not be an area where fire can be used, due to the proximity to residential areas. The site has both tall oat grass (not yet dominant) and other exotic species. This site would be appropriate for a large-scale reintroduction if a) it is acquired by WDFW as a conservation area, b) it is not used for reintroduction of *Castilleja hispida* as a larval host plant for Taylor's checkerspot, or the *C. hispida* that is used is known to be polyploid, and c) preliminary prairie restoration and weed control has already taken place and plans are in place for ongoing restoration. Ideally there would also be a way to use prescribed burning at the site. If these conditions could be met, this site would be an excellent choice for a reintroduction attempt.

5.5 Johnson Prairie

Johnson Prairie is an area of approximately 300 acres on Ft. Lewis, managed by the DOD. The plot was placed in an area that superficially resembled Rocky Prairie in vegetation composition. This site happened to be on the slope of a large swale.

Topography

Johnson Prairie is an undulating prairie with at least one swale.

Soils

Johnson Prairie is mapped as a Nisqually soil (R. Gilbert pers. comm. 2005). The soil pit had <40% coarse fragments in the first 6", which increased to 70% coarse fragments at 12". We considered this soil to be a Spanaway soil, despite the mapping as Nisqually. Other portions of the prairie may be Nisqually soil.

Vegetation

The plot at Johnson Prairie had 14 of the 25 species found in the Rocky Prairie plot, a high native forb cover, and a high cover of *Lupinus albicaulis*. It had no *Dicranum scoparium*, and *Polytrichum* sp. was the dominant moss in the plot. Vegetation composition in much of Johnson Prairie has lower native cover and higher exotic cover than the plot area.

Management Issues

Johnson Prairie has some formal protection from training, but despite this, training in wheeled and/or tracked vehicles does take place on the prairie. It is also used by the public. *Castilleja hispida* is on the site – both native and planted. The site is also a possible reintroduction site for Taylor's checkerspot. This site would not be appropriate for a large-scale reintroduction unless a) the DOD was willing to provide permanent protection and conservation-oriented management for the reintroduction area, b) it is known that either *C. hispida* and *C. levisecta* cannot cross, or that any *Castilleja hispida* on the site or planted nearby is not diploid.

5.6 Wolf Haven

Wolf Haven is an area of approximately 20 acres of prairie, within one mile of Rocky Prairie (and probably once contiguous with both Rocky Prairie and West Rocky Prairie). It is a privately owned site managed to provide a sanctuary for captive wolves and to provide education to the public about wolf conservation. The owners of Wolf Haven have been working with TNC to restore the remnant prairie on their land. The plot was placed in an inter-mound area that seemed typical of the site.

Topography

Wolf Haven is a regularly mounded prairie, without swales.

Soils

Wolf Haven is mapped as a Spanaway-Nisqually complex soil (Pringle 1990). The soil pit had 25% coarse fragments in the first 6", and 25% coarse fragments at 12". We considered this soil to be a Spanaway soil, although with fewer coarse fragments than some of the Spanaway soils.

Vegetation

The plot at Wolf Haven had 13 of the 25 species found in the Rocky Prairie plot, a relatively low cover of *Festuca roemerii*, a high native forb cover, a high cover of exotics species, and a very high cover of *Dicranum scoparium*. The vegetation seemed to be a degraded version of the vegetation at Rocky Prairie. *Festuca rubra* var. *commutata*, a non-native bunchgrass, is the dominant grass and much more common than *Festuca roemerii* at this site.

Management Issues

This site is currently privately owned, with no formal conservation easement in place. The site is also a possible reintroduction site for Taylor's checkerspot, and *Castilleja hispida* has been planted on the site. The use of fire as a management tool is unlikely. This site may be appropriate for a large-scale reintroduction if a) the owners agreed to a conservation easement and management for *Castilleja levisecta*, b) further restoration of the site could take place, and c) it is known that either *C. hispida* and *C. levisecta* cannot cross, or that any *Castilleja hispida* on the site or planted nearby is not diploid. Although *Festuca rubra* var. *commutata* may be relatively ecological equivalent in terms of functional role to *Festuca roemerii*, we do not know for certain if *Festuca rubra* var. *commutata* is a good host for *C. levisecta*.

5.7 13th Division RNA

13th Division RNA (Research Natural Area) is a 30 acre area within 13th Division Prairie, which is a very large prairie area (more than 1,000 acres) on Ft. Lewis and managed by the DOD. The plot was placed in an area that seemed typical of the site.

Topography

13th Division RNA is flat, with some shallow swales.

Soils

13th Division RNA is mapped as a Spanaway soil (R. Gilbert pers. comm. 2005). The soil pit had 50% coarse fragments in the first 6", which increased to 70% coarse fragments at 12".

Vegetation

The plot at 13th Division RNA had 14 of the 25 species found in the Rocky Prairie plot, a high native forb cover, and a high cover of *Lupinus albicaulis*. It had no *Dicranum scoparium*, and *Polytrichum* sp. was the dominant moss in the plot. *Festuca rubra* var. *commutata* was about equally common as *Festuca roemerii* on the portions of the prairie that we visited, with each species locally more or less dominant than the other. Collectively, these two bunchgrasses dominated the graminoid vegetation.

Management Issues

13th Johnson RNA is protected from training and from public use. *Castilleja hispida* grows nearby, and the site is also a possible reintroduction site for Taylor's checkerspot. Fire may not be possible as a management tool due to nearby residences. This site may be appropriate for a large-scale reintroduction if a) the DOD was willing to provide permanent protection and conservation-oriented management for the reintroduction area, b) it is known that either *C. hispida* and *C. levisecta* cannot cross, or that any *Castilleja hispida* on the site or planted nearby is not diploid. One possible issue for reintroduction is the relatively high coarse fragment content in the soil, which could affect the success of the reintroduced plants during drought years.

5.8 91st Division Prairie – east of berm

91st Division Prairie is the largest prairie on Ft. Lewis (more than 7,000 acres). It is within the Artillery Impact Area, which is used for training with live ordinance. It burns very frequently. The area of the plot had burned within the last year. The plot was placed in an area that seemed typical of the site.

Topography

91st Division Prairie is flat.

Soils

91st Division Prairie is mapped as a Spanaway soil (R. Gilbert pers. comm. 2005). We could not put in a soil pit due to possible presence of live ordinance. Nearby gopher mounds had approximately 15% coarse fragments.

Vegetation

The plot at 91st Division Prairie had 12 of the 25 species found in the Rocky Prairie plot, a high native forb cover, a high cover of exotic species (mostly annuals), and *Lupinus albicaulis* present. It had no *Dicranum scoparium*, and moss and lichen cover was low, due to frequent burning.

Management Issues

91st Division Prairie is an important training area and is regularly used. Live ordinance is used in this area. It might be possible to clear an area for planting, but the continued presence of live ordinance would greatly complicate any efforts here, and this area would not be set aside for conservation. For these reasons this area does not seem appropriate for a large-scale reintroduction of *Castilleja levisecta*.

5.9 Glacial – NW of oak grove

Glacial Heritage Preserve is owned by Thurston County Parks and managed by TNC. This 700 acre prairie is being intensively managed and restored by TNC and is also the site of an experimental reintroduction of *Castilleja levisecta*. This plot was placed in an undulating mound and intermound area that seemed typical of the site.

Topography

Glacial Heritage Preserve is a mounded prairie. There are ill-defined swales near this plot.

Soils

Glacial Heritage Preserve is mapped as a Spanaway-Nisqually complex soil (Pringle 1990). The soil pit had 50% coarse fragments in the first 6”, which decreased to 35% coarse fragments at 12”. Both the mound and intermound had high gravel content, in contrast to the description of a Spanaway-Nisqually complex profile by Pringle (1990).

Vegetation

This plot at Glacial Heritage Preserve had 14 of the 25 species found in the Rocky Prairie plot. It had almost no *Festuca roemeri*, a moderate native forb cover, a high cover of exotics and a 10% cover of *Dicranum scoparium* on the north side of the mounds. It did not have *Lupinus albicaulis*.

Management Issues

Glacial Heritage Preserve is being restored and is closed to public use. Fire is being used as a management tool on the site. There is currently no conservation easement on the site. It is a possible site for Taylor’s checkerspot reintroduction, *Castilleja hispida* has been planted on the site, and there is tall oatgrass in the area. It has a low “similarity rating” (9th out of 16 sites) as an ecological match for Rocky Prairie. The experimental reintroduction of *Castilleja levisecta* is a valuable use of the site, but it may not be appropriate for large-scale reintroduction, due to the poor ecological match with Rocky Prairie. If it is chosen for large scale reintroduction, the following issues should be addressed prior to reintroduction: a) permanent protection of at least a portion of the site through conservation easement or other protection, b) continued restoration of the site, particularly weed control, c) *C. hispida* removed, known to be polyploid, or known not to cross with *C. levisecta*.

5.10 Glacial- west of oak

Glacial Heritage Preserve is owned by Thurston County Parks and managed by TNC. This 700-acre prairie is being intensively managed and restored by TNC, and is also the site of an experimental reintroduction of *Castilleja levisecta*. This plot was placed in an undulating mound and intermound area that seemed typical of the site.

Topography

Glacial Heritage Preserve is a mounded prairie without swales.

Soils

Glacial Heritage Preserve is mapped as a Spanaway-Nisqually complex soil (Pringle 1990). The soil pit had 40% coarse fragments in the first 6”, which increased to 50% coarse fragments at 12”.

Vegetation

This plot at Glacial Heritage Preserve had 10 of the 25 species found in the Rocky Prairie plot, a moderate native forb cover, and a high cover of exotics. It also had *Dicranum scoparium*, mostly on the north side of mounds.

Management Issues

Glacial Heritage Preserve is being restored and is closed to public use. Fire is being used as a management tool on the site. There is currently no conservation easement on the site. It is a possible site for Taylor’s checkerspot reintroduction, *Castilleja hispida* has been planted on the site, and there is tall oatgrass in the area. It has a low “similarity rating” (10th out of 16 sites) as an ecological match for Rocky Prairie. The experimental reintroduction of *Castilleja levisecta* is a valuable use of the site, but it may not be appropriate for large-scale reintroduction, due to the poor ecological match with Rocky Prairie. If it is chosen for large scale reintroduction, the following issues should be addressed prior to reintroduction: a) permanent protection of at least a portion of the site through conservation easement or other protection, b) continued restoration of the site, particularly weed control, c) *C. hispida* removed, known to be polyploid, or known not to cross with *C. levisecta*.

5.11 Upper Wier – SW corner

Upper Wier is part of a very large prairie complex of more than 1,000 acres on Ft. Lewis, managed by the DOD. The plot was placed in what appeared to be typical good-condition prairie habitat on Upper Wier.

Topography

Upper Wier is a flat to undulating prairie with no swales. The plot area is flat.

Soils

Upper Wier is mapped as a Spanaway soil (R. Gilbert pers. comm. 2005). The soil pit had 40% coarse fragments in the first 6”, which increased to 60-70% coarse fragments at 12”.

Vegetation

The plot at Upper Wier had 10 of the 25 species found in the Rocky Prairie plot, moderate native forb cover, and *Lupinus albicaulis*. It did not have *Dicranum scoparium*, and the moss layer was mostly dominated by *Polytrichum* sp.

Management Issues

Upper Wier is managed by the DOD, and although it does not have formal protection, it is currently set aside as an area that does not have any track or wheeled training. The area is also used by the public. The primary issue for this site is the poor ecological match with Rocky Prairie. Secondary issues are the lack of permanent protection from DOD activities and public use.

5.12 Mima – west

Mima Mounds Natural Area is managed by the Natural Areas Program of the WDNR. It is a 500-acre prairie which has been managed for conservation for several decades. There are also two experimental *Castilleja levisecta* outplantings on the NAP. The plot was placed in an area typical of much of the site, on a small ridge between two mounds.

Topography

Mima is a regularly mounded prairie. There are no obvious swales on this site.

Soils

Mima is mapped as a Spanaway-Nisqually complex soil (Pringle 1990). This plot was placed in an area that seemed typical of the site. The soil pit had 40% coarse fragments in the first 6”, which increased to 70% coarse fragments at 12”. Although Pringle (1990) and others have characterized Mima mounds (the mounds themselves) as having low percent of coarse fragments, when we dug into a few mounds, we found high gravel content, contrary to the typical Spanaway-Nisqually complex description.

Vegetation

This plot at Mima had 6 of the 25 species found in the Rocky Prairie plot, a high native forb cover, no *Lupinus albicaulis*, and no *Dicranum scoparium*.

Management Issues

Mima is an NAP that is open to public use. Fire has been used as a management tool on the site. There is currently no conservation easement on the site. It is one of the few potential sites that is not a possible site for Taylor’s checkerspot reintroduction. *Castilleja hispida* is not known from the site. It has a low “similarity rating” (11th out of 16 sites) as an ecological match for Rocky Prairie. The experimental reintroduction of *Castilleja levisecta* is a valuable use of the site, but it may not be appropriate for large-scale reintroduction, due to the poor ecological match with Rocky Prairie.

5.13 Scatter Creek – north

Scatter Creek- North is in the North Unit of the Scatter Creek Wildlife Area, managed by WDFW. It is part of a 500-acre prairie. The plots were placed in a small part of the prairie that was mapped as Nisqually soil (Pringle 1990). The area may have been plowed at one time. The plots were placed in a portion on the Scatter Creek Wildlife Area that included no swales, though swales are present nearby.

Topography

Scatter Creek - north is an area of flat prairie. There were no swales in the area where the plots were placed. There are swales and mounds elsewhere within the North Unit of the Scatter Creek Wildlife Area.

Soils

Most of the soils of the Scatter Creek Wildlife Area are mapped as Spanaway or Spanaway-Nisqually complex. A few acres along the northern boundary of the North Unit are mapped as Nisqually, and soil pits showed a relatively low percentage of gravel (5%) that decreased with depth, as expected for Nisqually soils.

Vegetation

The plot at Scatter Creek-North had 8 of the 25 species found in the Rocky Prairie plot, a low native forb cover, a high cover of exotics, and no *Dicranum scoparium*.

Management Issues

Scatter Creek Wildlife Area is managed by WDFW as a Wildlife Recreation Area and was purchased with recreation funds. The primary issue for this site on the Northern Unit of Scatter Creek is the poor condition of the vegetation. Another issue is the presence of *Arrhenatherum elatius*, which has aggressively increased on Scatter Creek Wildlife area over the past decade and has become dominant on some portions. Over the past two years managers have begun using selective herbicides to control *Arrhenatherum elatius*, but it is too soon to measure the effectiveness of these methods. Unless this area becomes the focus of intensive restoration efforts and is placed in some conservation status, it would not be appropriate as a reintroduction site for *Castilleja levisecta*.

5.14 91st Division – butterfly area

91st Division Prairie is the largest prairie on Ft. Lewis (more than 7,000 acres). It is within the Central Impact Area, which is used for training with live ordinance. It burns very frequently. This plot is within an area that until recently supported a population of Taylor's checkerspots.

Topography

91st Division Prairie is flat.

Soils

91st Division Prairie is mapped as a Spanaway soil (R. Gilbert pers. comm. 2005). The plot was placed in an area that seemed typical of the site. We could not put in a soil pit due to possible presence of live ordinance. Nearby gopher mounds had approximately 35% coarse gravel.

Vegetation

The plot at 91st Division Prairie had 9 of the 25 species found in the Rocky Prairie plot, a high native forb cover, a high cover of exotic species (mostly annuals), and *Lupinus albicaulis* present. It had no *Dicranum scoparium*, and moss and lichen cover was low, due to frequent burning.

Management Issues

91st Division Prairie is an important training area and is regularly used. Live ordinance is used in this area. It might be possible to clear an area for planting, but the continued presence of live ordinance would greatly complicate any efforts here, and this area would not be set aside for conservation. For these reasons this area does not seem appropriate for a large-scale reintroduction of *Castilleja levisecta*.

5.15 Mima – northeast of CALE planting

Mima Mounds NAP is managed by the Natural Areas Program of the WDNR. It is a 500-acre prairie which has been managed for conservation for several decades. There are also two experimental *Castilleja levisecta* outplanting on the NAP. The plot was placed on an elevated inter-mound area in an area near the northernmost *Castilleja levisecta* outplanting site.

Topography

Mima is a mounded prairie. There are no obvious swales on this site.

Soils

Mima is mapped as a Spanaway-Nisqually soil (Pringle 1990). The soil pit had both cobbles and gravel at 6”, and it was not possible to dig to 12”, due to the high percentage of coarse fragments.

Vegetation

This plot at Mima Mounds NAP had 6 of the 25 species found in the Rocky Prairie plot, a low native forb cover, a high cover of *Festuca roemerii*, and no *Lupinus albicaulis*. It did have a relatively high cover of *Dicranum scoparium*, mostly on small north facing slopes.

Management Issues

Mima is an NAP that is open to public use. Fire has been used as a management tool on the site. There is currently no conservation easement on the site. It is one of the few potential sites that is not a possible site for Taylor’s checkerspot reintroduction. *Castilleja hispida* is not known from the site. It has a very low “similarity rating” (16th out of 16 sites) as an ecological match for Rocky Prairie. The experimental reintroduction of *Castilleja levisecta* is a valuable use of the

site, but it may not be appropriate for large-scale reintroduction, due to the poor ecological match with Rocky Prairie.

5.16 Morgan

Morgan is a privately owned portion of South Wier prairie, adjacent to Ft. Lewis. It will soon be acquired by TNC as a prairie conservation area. The South Wier prairie is approximately 2,500 acres. The plot was placed in an area that seemed most like Rocky Prairie on the site.

Topography

Morgan is a gently rolling to flat prairie, without swales. The plot was placed in a flat area.

Soils

Morgan is mapped as a Spanaway soil (Pringle 1990). The soil pit had 40% coarse fragments in the first 6", which increased to 60% coarse fragments at 12".

Vegetation

This plot at Morgan had 14 of the 25 species found in the Rocky Prairie plot, a low native forb cover, a low cover of *Festuca roemerii*, no *Lupinus albicaulis*, and a trace of *Dicranum scoparium*. The site was notable for its high cover of *Leucanthemum vulgare*.

Management Issues

Morgan, once it is in TNC ownership, will have a high degree of conservation protection and restoration activity. *Castilleja hispida* has been planted on the site, and it is a potential site for Taylor's checkerspot reintroduction. Prescribed burning may be possible on the site. However, the low "similarity rating" (15th out of 16 sites) to Rocky Prairie suggests that it would not be appropriate for introduction of *Castilleja levisecta*. If it is chosen as a reintroduction site for *Castilleja levisecta*, the following issues should be addressed before a reintroduction is attempted: a) control of exotic weeds, particularly *Arrhenatherum elatius* and *Leucanthemum vulgare*, and b) removal of *C. hispida*, unless the plants on the site are known to be polyploid, or known not to cross with *C. levisecta*.

6.0 Summary

This study was intended to identify and rank potential reintroduction sites for *Castilleja levisecta* in the Sound Puget Sound prairies. We hope that most of the potential sites were identified in this process, but the same methods could be applied to other sites in the future. The study is based on a number of assumptions. The strongest assumption is that matching the soils, topography, and characteristics of an existing site is a predictor for the success of reintroductions. The long-term persistence of the outplanting experiments at Mima Mounds and Glacial Heritage, especially during one or more years of drought, will be a test of that assumption, since those sites ranked very low in their similarity to Rocky Prairie.

We did identify a number of sites that were good ecological matches for Rocky Prairie, and, with some shift in management focus, could be reintroduction sites for *Castilleja levisecta* in the South Puget Sound area. The next steps would be to choose a small subset of sites as possible sites for reintroduction, begin appropriate management at those sites, and perhaps further study the microhabitats of each site, including mapping the soils with the lowest coarse fragment content, chemical soils analyses, and identifying areas with a high proportion of native vegetation and/or high *Dicranum scoparium* cover.

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Appendix A

Data from all evaluated sites

South Puget Sound Site Evaluations for Reintroduction of Golden Paintbrush – Appendix A

	Similarity to Rocky	Similarity Weight	DESCRIPTION	RANK	weighted rank	average
CHARACTERISTICS						
Rocky Prairie						
SIZE						
Size of prairie			30 acres high quality, several hundred acres degraded			
Size of microsite			3-4 acres			
SOILS						
		1				
% coarse fragments @ 6"	X	1	sandy loam, coarse fragments 15%,	3	3	
% coarse fragments @12"	X	1	sandy loam 5%-15% coarse fragments	3	3	
Ave. rock size			1-5 cm.			
Probable soil type	X	1	Nisqually	3	3	
Mapped soil type			Spanaway-Nisqually			
Comments			still same fragment level at 30"			
Similarity to RP		3		9	9	3
TOPO						
		0.75				
Mounded topography	X	0.5	yes- irregular and undulating	3	1.5	
Swales	X	1	yes	3	3	
Similarity to RP		1.5			4.5	2.25
VEGETATION						
		1				
% fescue	X	0.5	25%-60%	3	1.5	
Total native forb cover	X	1	35-60%	3	3	
Total cover exotics	X	0.5	20-60%	3	1.5	
Total cover moss/lichen	X	0.25	60-90%	3	0.75	
Total cover bare ground	X	0.25	0-10% (burrowing)	3	0.75	
Dicranum scoparium present/cover	X	0.5	20-45%	3	1.5	
Rhacomitrium present/cover	X	0.5	not in this microsite	3	1.5	
Lupinus albicaulis present/cover	X	0.5	3-50%	3	1.5	
Carex inops present/cover	X	0.5	1-20%	3	1.5	
# subdom native species in common w/ RP	X	1	All	3	3	
Bad weeds/which			CYTSCO, HIPI, ARRELA, present but cover low (3)			
Similarity to Rocky Prairie - total score		5.5		45	16.5	3
OWNERSHIP/MANAGEMENT						
Ownership			DNR - NAP			
Commitment to protection			yes			
Future protection possible			yes			
Size and nature of buffer			30 acre preserve, several hundred acres undeveloped			
Able to use fire every five years			yes			
OTHER ISSUES						
Castilleja hispida on site or nearby			Previously at south end of RP, and within pop. Not seen recently.			
Near or potential Taylor's intro site						
Potential Taylor's intro site			yes - used to be present			
Other issues						
Comments			does not include native forb cover or species list - used species list from Rocky plots 2004			
Final score- similarity						8.25

South Puget Sound Site Evaluations for Reintroduction of Golden Paintbrush – Appendix A

	Similarity to Rocky	Similarity Weight	DESCRIPTION	RANK	weighted rank	average
CHARACTERISTICS			Scatter Creek South			
SIZE						
Size of prairie			500 acres			
Size of microsite			5 X15			
SOILS		1				
% coarse fragments @ 6"	X	1	<10% coarse fragments, loamy sand	3	3	
% coarse fragments @12"	X	1	5% coarse fragments	3	3	
Ave. rock size			0.5-4 cm, ave. 1 cm		0	
Probable soil type	X	1	Nisqually	3	3	
Mapped soil type			Nisqually			
Comments			Site near CAHI 15-20% coarse fragments at 6", lots of BALDEL, ERISPE, LUPALB. Site N of horse trail 15% at 6", 20% at 12", lots of ERISPE			
Similarity to RP		3			9	3.000
TOPO		0.75				
Mounded topography	X	0.5	No	1	0.5	
Swales	X	1	No, but mesic	2	2	
Similarity to RP		1.5			2.5	1
VEGETATION		1				
% fescue	X	0.5	70%	2	1	
Total native forb cover	X	1	35%	2	2	
Total cover exotics	X	0.5	30%	3	1.5	
Total cover moss/lichen	X	0.25	60%	3	0.75	
Total cover bare ground	X	0.25	5%	3	0.75	
Dicranum scoparium present/cover	X	0.5	30%?	3	1.5	
Rhacomitrium present/cover	X	0.5	no	3	1.5	
Lupinus albicaulis present/cover	X	0.5	on site- not in plot	2	1	
Carex inops present/cover	X	0.5	yes	2	1	
# subdom native species in common w/ RP	X	1	17/25	2	2	
Bad weeds/which			AREELA serious, CYTSCO, SENJAC			
Similarity to Rocky Prairie - total score		5.5		37	13	2.364
OWNERSHIP/MANAGEMENT						
Ownership			WDFW			
Commitment to protection			high, though some public use			
Future protection possible			yes-WDFW trying to turn to 100% conservation			
Size and nature of buffer			large, though this site near road			
Able to use fire every five years			Unlikely- too close to freeway			
OTHER ISSUES						
Castilleja hispida on site or nearby			yes, nearby			
Near or potential Taylor's intro site			yes			
Potential Taylor's intro site			yes			
Other issues			WDFW actively engaged in weed management			
Comments						
Final score- similarity						6.614

South Puget Sound Site Evaluations for Reintroduction of Golden Paintbrush – Appendix A

	Similarity to Rocky	Similarity Weight	DESCRIPTION	RANK	weighted rank	average
CHARACTERISTICS			South Wier			
SIZE						
Size of prairie			>1000 acres			
Size of microsite			10x10			
SOILS						
		1				
% coarse fragments @ 6"	X	1	50% coarse fragments black sandy loam	1	1	
% coarse fragments @12"	X	1	20% coarse fragments	3	3	
Ave. rock size			0.5-5cm, 2cm average		0	
Probable soil type	X	1	Spanaway but decrease gravel w/depth	2	2	
Mapped soil type						
Comments						
Similarity to RP		3			6	2.000
TOPO						
		0.75				
Mounded topography	X	0.5	no, undulating	3	1.5	
Swales	X	1	yes, though swales are weedier, more CYSC	2	2	
Similarity to RP		1.5			3.5	1.750
VEGETATION						
		1				
% fescue	X	0.5	50%	3	1.5	
Total native forb cover	X	1	35%	2	2	
Total cover exotics	X	0.5	50%	3	1.5	
Total cover moss/lichen	X	0.25	50%, moss	3	0.75	
Total cover bare ground	X	0.25	2%	3	0.75	
Dicranum scoparium present/cover	X	0.5	no	0	0	
Rhacomitrium present/cover	X	0.5	no	3	1.5	
Lupinus albus present/cover	X	0.5	20%	3	1.5	
Carex inops present/cover	X	0.5	trace	2	1	
# subdom native species in common w/ RP	X	1	18/25	2	2	
Bad weeds/which			CYTSCO (1)			
Similarity to Rocky Prairie - total score				35	12.5	2.273
OWNERSHIP/MANAGEMENT						
Ownership			Ft. Lewis			
Commitment to protection			set aside (on paper) for no track of wheeled training, occasional			
Future protection possible			potential, not since training occurs, also public use (dog training)			
Size and nature of buffer			great			
Able to use fire every five years			yes			
OTHER ISSUES						
Castilleja hispida on site or nearby			nearest on Johnson			
Near or potential Taylor's intro site			Johnson			
Potential Taylor's intro site			probably not			
Other issues			very small area in otherwise less forb-rich prairie			
Comments						
Final score- similarity						6.023

South Puget Sound Site Evaluations for Reintroduction of Golden Paintbrush – Appendix A

	Similarity to Rocky	Similarity Weight	DESCRIPTION	RANK	weighted rank	average
CHARACTERISTICS			West Rocky Prairie			
SIZE						
Size of prairie			300			
Size of microsite			10 X 10m, much of site similar			
SOILS		1				
% coarse fragments @ 6"	X	1	<10% coarse fragments, sandy loam	3	3	
% coarse fragments @12"	X	1	25-30% coarse fragments	2	2	
Ave. rock size			ave. 2.5 cm but also large rock (10+ cm)		0	
Probable soil type	X	1	Spanaway	1	1	
Mapped soil type						
Comments						
Similarity to RP		3			6	2.000
TOPO		0.75				
Mounded topography	X	0.5	Yes	2	1	
Swales	X	1	Yes	3	3	
Similarity to RP		1.5			4	2.000
VEGETATION		1				
% fescue	X	0.5	20%	2	1	
Total native forb cover	X	1	15-20%	2	2	
Total cover exotics	X	0.5	85%	0	0	
Total cover moss/lichen	X	0.25	90%	3	0.75	
Total cover bare ground	X	0.25	trace	3	0.75	
Dicranum scoparium present/cover	X	0.5	80%	2	1	
Rhacomitrium present/cover	X	0.5	10%	2	1	
Lupinus albus present/cover	X	0.5	no	0	0	
Carex inops present/cover	X	0.5	5%	3	1.5	
# subdom native species in common w/ RP	X	1	7/25	0	0	
Bad weeds/which			CYSC, CHRLEU, HYPPER, HYPRAD, ERRELA nearby (2)			
Similarity to Rocky Prairie - total score		5.5		28	8	1.455
OWNERSHIP/MANAGEMENT						
Ownership			private - possibly WDFW			
Commitment to protection			High if goes to WDFW			
Future protection possible			trying			
Size and nature of buffer			large, though prairie is along east side, near houses			
Able to use fire every five years			Contingent on permission from nearby landowners			
OTHER ISSUES						
Castilleja hispida on site or nearby			hasn't been seen			
Near or potential Taylor's intro site			Was found here in past			
Potential Taylor's intro site			Yes			
Other issues			coarse fragments mine. Also CALE once known from within a mile			
Comments			Also CALE once known from within a mile - hasn't been seen on site- but should be searched for			
Final score- similarity						5.455

South Puget Sound Site Evaluations for Reintroduction of Golden Paintbrush – Appendix A

	Similarity to Rocky	Similarity Weight	DESCRIPTION	RANK	weighted rank	average
CHARACTERISTICS			Johnson Prairie			
SIZE						
Size of prairie			~300 acres			
Size of microsite			10x10, larger area mapped			
SOILS		1				
% coarse fragments @ 6"	X	1	40% coarse fragments, black, sandy loam	1	1	
% coarse fragments @12"	X	1	70% coarse fragments	0	0	
Ave. rock size			0.2-5 cm, average 2cm		0	
Probable soil type	X	1	Spanaway	1	1	
Mapped soil type						
Comments						
Similarity to RP		3			2	0.667
TOPO		0.75				
Mounded topography	X	0.5	not mound and swale, gently undulating	3	1.5	
Swales	X	1	yes, nice swale nearby	3	3	
Similarity to RP		1.5			4.5	2.250
VEGETATION		1				
% fescue	X	0.5	70%	2	1	
Total native forb cover	X	1	35%	2	2	
Total cover exotics	X	0.5	25%	3	1.5	
Total cover moss/lichen	X	0.25	60% moss, lots of Polytrichum	3	0.75	
Total cover bare ground	X	0.25	5%	3	0.75	
Dicranum scoparium present/cover	X	0.5	no	0	0	
Rhacomitrium present/cover	X	0.5	no	3	1.5	
Lupinus albicaulis present/cover	X	0.5	15%	3	1.5	
Carex inops present/cover	X	0.5	no	0	0	
# subdom native species in common w/ RP	X	1	14/25	2	2	
Bad weeds/which			CYTSCO (not bad here), HYPPER, AREELE in area (not in plot) (2)	1		
Similarity to Rocky Prairie - total score		5.5		29	11	2.000
OWNERSHIP/MANAGEMENT						
Ownership			Ft. Lewis			
Commitment to protection			on paper pretty good, will be both civilian and military use			
Future protection possible			potentially, but not strong			
Size and nature of buffer			very good			
Able to use fire every five years			yes			
OTHER ISSUES						
Castilleja hispida on site or nearby			on site, both native and planted			
Near or potential Taylor's intro site			Puget Blue site			
Potential Taylor's intro site			yes possible, historically here			
Other issues			recent Stryker traffic right through plot			
Comments			chose are with greatest forb cover, swale has more Erigeron			
Final score- similarity						4.917

South Puget Sound Site Evaluations for Reintroduction of Golden Paintbrush – Appendix A

	Similarity to Rocky	Similarity Weight	DESCRIPTION	RANK	weighted rank	average
CHARACTERISTICS			Wolf Haven			
SIZE						
Size of prairie			30 acres			
Size of microsite			10x10 (fairly typical of much of prairie, quality drops to NE)			
SOILS						
		1				
% coarse fragments @ 6"	X	1	25% coarse fragments, sandy loam	2	2	
% coarse fragments @12"	X	1	~25%	2	2	
Ave. rock size			1-3 cm., ave 1.5 cm		0	
Probable soil type	X	1	Spanaway	1	1	
Mapped soil type						
Comments			another hole in swale - 35% at 6", sandy loam, about the same at 12"			
Similarity to RP		3			5	1.667
TOPO						
		0.75				
Mounded topography	X	0.5	yes	2	1	
Swales	X	1	not well defined swales	2	2	
Similarity to RP		1.5			3	1.500
VEGETATION						
		1				
% fescue	X	0.5	10% (Roemer's)	1	0.5	
Total native forb cover	X	1	30-35%	2	2	
Total cover exotics	X	0.5	80%	0	0	
Total cover moss/lichen	X	0.25	70%	3	0.75	
Total cover bare ground	X	0.25	<5%	3	0.75	
Dicranum scoparium present/cover	X	0.5	60%	2	1	
Rhacomitrium present/cover	X	0.5	yes	2	1	
Lupinus albicaulis present/cover	X	0.5	no	0	0	
Carex inops present/cover	X	0.5	trace	2	1	
# subdom native species in common w/ RP	X	1	13/25	2	2	
Bad weeds/which			CYTSCO, TRADUB, SENJAC, tall oatgrass on site, knapweed on road (3)			
Similarity to Rocky Prairie - total score		5.5		26	9	1.636
OWNERSHIP/MANAGEMENT						
Ownership			Wolf Haven			
Commitment to protection			fairly high, TNC as partner			
Future protection possible			possible			
Size and nature of buffer			poor, N a railroad, decent to W, E forest and housing, S housing			
Able to use fire every five years			possible			
OTHER ISSUES						
Castilleja hispida on site or nearby			just where it's planted (3 plants)			
Near or potential Taylor's intro site			possible			
Potential Taylor's intro site			possible			
Other issues						
Comments			high cover of red fescue and LOMUTR			
Final score- similarity						4.803

South Puget Sound Site Evaluations for Reintroduction of Golden Paintbrush – Appendix A

	Similarity to Rocky	Similarity Weight	DESCRIPTION	RANK	weighted rank	average
CHARACTERISTICS			13th Division RNA			
SIZE						
Size of prairie			>1000 acres			
Size of microsite			10x10 (but with large area of similar habitat ~10-20 acres)			
SOILS		1				
% coarse fragments @ 6"	X	1	50% coarse fragments, black, loamy sand	1	1	
% coarse fragments @12"	X	1	70% coarse fragments	0	0	
Ave. rock size			0.5-4cm, ave 2cm		0	
Probable soil type	X	1	Spanaway	1	1	
Mapped soil type						
Comments						
Similarity to RP		3			2	0.667
TOPO		0.75				
Mounded topography	X	0.5	no	1	0.5	
Swales	X	1	yes, near creeks	3	3	
Similarity to RP		1.5			3.5	1.750
VEGETATION		1				
% fescue	X	0.5	70%	2	1	
Total native forb cover	X	1	30%	2	2	
Total cover exotics	X	0.5	30%	3	1.5	
Total cover moss/lichen	X	0.25	80%, mostly Polytrichum	3	0.75	
Total cover bare ground	X	0.25	<1%	3	0.75	
Dicranum scoparium present/cover	X	0.5	no	0	0	
Rhacomitrium present/cover	X	0.5	no	3	1.5	
Lupinus albicaulis present/cover	X	0.5	20%	3	1.5	
Carex inops present/cover	X	0.5	5%	3	1.5	
# subdom native species in common w/ RP	X	1	14/25	2	2	
Bad weeds/which			FESRUB, CRECAP, TRADUB (0)	3		
Similarity to Rocky Prairie - total score		5.5		30	12.5	2.273
OWNERSHIP/MANAGEMENT						
Ownership			Ft. Lewis			
Commitment to protection			RNA, not used for training			
Future protection possible						
Size and nature of buffer			very large			
Able to use fire every five years			maybe some issue because of nearby houses			
OTHER ISSUES						
Castilleja hispida on site or nearby			a little south of south creek			
Near or potential Taylor's intro site			could be, past Taylor site that had thousands			
Potential Taylor's intro site			5-6 years ago			
Other issues						
Comments			most places on this prairie have more red fescue than Roemer's			
Final score- similarity						4.689

South Puget Sound Site Evaluations for Reintroduction of Golden Paintbrush – Appendix A

	Similarity to Rocky	Similarity Weight	DESCRIPTION	RANK	weighted rank	average
CHARACTERISTICS			91st Division, east of berm			
SIZE						
Size of prairie			7000 acres			
Size of microsite			unknown, veg cover continues for a long ways			
SOILS		1				
% coarse fragments @ 6"	X	1	15% (gopher mounds- can't dig)	3	3	
% coarse fragments @12"	X	1			0	
Ave. rock size			2cm		0	
Probable soil type	X	1	Nisqually	3	3	
Mapped soil type						
Comments						
Similarity to RP		3			6	2.000
TOPO		0.75				
Mounded topography	X	0.5	flat, natural undulation	1	0.5	
Swales	X	1	no	1	1	
Similarity to RP		1.5			1.5	0.750
VEGETATION		1				
% fescue	X	0.5	80%	2	1	
Total native forb cover	X	1	30%	2	2	
Total cover exotics	X	0.5	50% (mostly annuals, but not as extreme as other site)	3	1.5	
Total cover moss/lichen	X	0.25	30%	1	0.25	
Total cover bare ground	X	0.25	20%	2	0.5	
Dicranum scoparium present/cover	X	0.5	no	0	0	
Rhacomitrium present/cover	X	0.5	no	3	1.5	
Lupinus albicaulis present/cover	X	0.5	1%	2	1	
Carex inops present/cover	X	0.5	trace	2	1	
# subdom native species in common w/ RP	X	1	12/25	1	1	
Bad weeds/which			HYRA, HYPE (0)			
Similarity to Rocky Prairie - total score		5.5		26	9.75	1.773
OWNERSHIP/MANAGEMENT						
Ownership			DOD			
Commitment to protection			impact area, no area, could be training area in future			
Future protection possible			no never			
Size and nature of buffer			huge			
Able to use fire every five years			most			
OTHER ISSUES						
Castilleja hispida on site or nearby			yes			
Near or potential Taylor's intro site			yes (near major Taylor site)			
Potential Taylor's intro site						
Other issues			burns very often, fire freq. Every 2-3 years			
Comments						
Final score- similarity						4.523

South Puget Sound Site Evaluations for Reintroduction of Golden Paintbrush – Appendix A

	Similarity to Rocky	Similarity Weight	DESCRIPTION	RANK	weighted rank	average
CHARACTERISTICS			Glacial outplanting NW of oak grove			
SIZE						
Size of prairie			800 acres			
Size of microsite			10 X 10			
SOILS		1				
% coarse fragments @ 6"	X	1	50% coarse fragmentsl, sandy loam	1	1	
% coarse fragments @12"	X	1	35% coarse fragments	1	1	
Ave. rock size			0.5-4 cm., ave 1.5cm.		0	
Probable soil type	X	1	Spanaway	1	1	
Mapped soil type						
Comments						
Similarity to RP		3			3	1
TOPO		0.75				
Mounded topography	X	0.5	yes	2	1	
Swales	X	1	yes, but not as deep as at RP	2	2	
Similarity to RP		1.5			3	1.5
VEGETATION		1				
% fescue	X	0.5	very low, trace, <0.01% cover	0	0	
Total native forb cover	X	1	30%?	2	2	
Total cover exotics	X	0.5	70%	2	1	
Total cover moss/lichen	X	0.25	70-80%	3	0.75	
Total cover bare ground	X	0.25	0	3	0.75	
Dicranum scoparium present/cover	X	0.5	10-15%	1	0.5	
Rhacomitrium present/cover	X	0.5	10%	2	1	
Lupinus albicaulis present/cover	X	0.5	no	0	0	
Carex inops present/cover	X	0.5	trace	2	1	
# subdom native species in common w/ RP	X	1	14/25	1	1	
Bad weeds/which			CHRLEU, HYPRAD, Agrostis, ARRELA (serious) (2)			
Similarity to Rocky Prairie - total score		5.5		23	8	1.454
OWNERSHIP/MANAGEMENT						
Ownership			county - TNC			
Commitment to protection			high but not as high as NAP			
Future protection possible			possible			
Size and nature of buffer			very large			
Able to use fire every five years			yes			
OTHER ISSUES						
Castilleja hispida on site or nearby			yes, planted			
Near or potential Taylor's intro site						
Potential Taylor's intro site			yes			
Other issues						
Comments			no native forb cover or species list			
Final score- similarity						3.955

South Puget Sound Site Evaluations for Reintroduction of Golden Paintbrush – Appendix A

	Similarity to Rocky	Similarity Weight	DESCRIPTION	RANK	weighted rank	average
CHARACTERISTICS			Glacial oak west			
SIZE						
Size of prairie			700 acres			
Size of microsite			10x10 m			
SOILS		1				
% coarse fragments @ 6"	X	1	brown, 40% coarse fragments, sandy loam	1	1	
% coarse fragments @12"	X	1	lighter color, 50% coarse fragments	1	1	
Ave. rock size			0.5-3cm, ave 1cm		0	
Probable soil type	X	1	Spanaway	1	1	
Mapped soil type						
Comments						
Similarity to RP		3			3	1.000
TOPO		0.75				
Mounded topography	X	0.5	yes, area of low ill defined mounds	3	1.5	
Swales	X	1	no	1	1	
Similarity to RP		1.5			2.5	1.250
VEGETATION		1				
% fescue	X	0.5	60%	3	1.5	
Total native forb cover	X	1	30%	2	2	
Total cover exotics	X	0.5	50-60%	3	1.5	
Total cover moss/lichen	X	0.25	70%	3	0.75	
Total cover bare ground	X	0.25			0	
Dicranum scoparium present/cover	X	0.5	30% (mostly on N side)	3	1.5	
Rhacomitrium present/cover	X	0.5	trace	2	1	
Lupinus albicaulis present/cover	X	0.5	no	0	0	
Carex inops present/cover	X	0.5	<1%	2	1	
# subdom native species in common w/ RP	X	1	10/25	0	0	
Bad weeds/which			CYTSCO, HYPRAD, CHRLEU, ARRELA (nearby- serious) (3)			
Similarity to Rocky Prairie - total score		5.5		25	9.25	1.682
OWNERSHIP/MANAGEMENT						
Ownership			county - TNC			
Commitment to protection			high but not as high as NAP			
Future protection possible			possible			
Size and nature of buffer			very large			
Able to use fire every five years			yes			
OTHER ISSUES						
Castilleja hispida on site or nearby			yes, planted			
Near or potential Taylor's intro site						
Potential Taylor's intro site			yes			
Other issues						
Comments			area has burned. No native species list			
Final score- similarity						3.932

South Puget Sound Site Evaluations for Reintroduction of Golden Paintbrush – Appendix A

	Similarity to Rocky	Similarity Weight	DESCRIPTION	RANK	weighted rank	average
CHARACTERISTICS			Upper Wier, SW corner			
SIZE						
Size of prairie			700 acres (maybe >1000)			
Size of microsite			10x10, but indicative of many acres			
SOILS		1				
% coarse fragments @ 6"	X	1	40% coarse fragments, black	1	1	
% coarse fragments @12"	X	1	60-70% coarse fragments	0	0	
Ave. rock size			0.2-5, 2 average		0	
Probable soil type	X	1	Spanaway	1	1	
Mapped soil type						
Comments						
Similarity to RP		3			2	0.667
TOPO		0.75				
Mounded topography	X	0.5	gently undulating mounds	3	1.5	
Swales	X	1	no	1	1	
Similarity to RP		1.5			2.5	1.250
VEGETATION		1				
% fescue	X	0.5	70%	2	1	
Total native forb cover	X	1	25%	2	2	
Total cover exotics	X	0.5	30%	3	1.5	
Total cover moss/lichen	X	0.25	80%, mostly Polytrichum	3	0.75	
Total cover bare ground	X	0.25	trace	3	0.75	
Dicranum scoparium present/cover	X	0.5	no	0	0	
Rhacomitrium present/cover	X	0.5	no	3	1.5	
Lupinus albicaulis present/cover	X	0.5	20%	3	1.5	
Carex inops present/cover	X	0.5	trace	2	1	
# subdom native species in common w/ RP	X	1	10/25	0	0	
Bad weeds/which			CYTSCO (1)			
Similarity to Rocky Prairie - total score		5.5		27	10	1.818
OWNERSHIP/MANAGEMENT						
Ownership			Ft. Lewis			
Commitment to protection			same as others, more protected than other sites, horse and dog activity			
Future protection possible						
Size and nature of buffer			excellent			
Able to use fire every five years			yes?			
OTHER ISSUES						
Castilleja hispida on site or nearby			no			
Near or potential Taylor's intro site			no			
Potential Taylor's intro site			no			
Other issues						
Comments						
Final score- similarity						3.735

South Puget Sound Site Evaluations for Reintroduction of Golden Paintbrush – Appendix A

	Similarity to Rocky	Similarity Weight	DESCRIPTION	RANK	weighted rank	average
CHARACTERISTICS			Mima West			
SIZE						
Size of prairie			500+ acres			
Size of microsite			5x8 m, similar to much of site			
SOILS		1				
% coarse fragments @ 6"	X	1	sandy loam, 40% coarse fragments	1	1	
% coarse fragments @12"	X	1	70% coarse fragments	0	0	
Ave. rock size			1-3 cm.		0	
Probable soil type	X	1	Spanaway	1	1	
Mapped soil type						
Comments			amount of coarse fragments increasing with depth			
Similarity to RP		3			2	0.667
TOPO		0.75				
Mounded topography	X	0.5	yes	2	1	
Swales	X	1	no	1	1	
Similarity to RP		1.5			2	1.000
VEGETATION		1				
% fescue	X	0.5	50%	3	1.5	
Total native forb cover	X	1	70%	3	3	
Total cover exotics	X	0.5	50%	3	1.5	
Total cover moss/lichen	X	0.25	70% (many fruticose lichen)	3	0.75	
Total cover bare ground	X	0.25	0	3	0.75	
Dicranum scoparium present/cover	X	0.5	no, mostly Polytrichum	0	0	
Rhacomitrium present/cover	X	0.5	no, mostly in intermount areas	3	1.5	
Lupinus albicaulis present/cover	X	0.5	no	0	0	
Carex inops present/cover	X	0.5	trace	2	1	
# subdom native species in common w/ RP	X	1	6/25	0	0	
Bad weeds/which			HYPRAD, CHRLEU, CYTSCO in area, ARRELA in area (2)			
Similarity to Rocky Prairie - total score		5.5		25	10	1.818
OWNERSHIP/MANAGEMENT						
Ownership			DNR - NAP			
Commitment to protection			total			
Future protection possible			yes			
Size and nature of buffer			large			
Able to use fire every five years			yes			
OTHER ISSUES						
Castilleja hispida on site or nearby			no			
Near or potential Taylor's intro site			no			
Potential Taylor's intro site			no			
Other issues						
Comments			miniature ridge between 2 mounds, no species list			
Final score- similarity						3.485

South Puget Sound Site Evaluations for Reintroduction of Golden Paintbrush – Appendix A

	Similarity to Rocky	Similarity Weight	DESCRIPTION	RANK	weighted rank	average
CHARACTERISTICS			Scatter Creek north			
SIZE						
Size of prairie			500 acres			
Size of microsite						
SOILS		1				
% coarse fragments @ 6"	X	1	5% coarse fragments	3	3	
% coarse fragments @12"	X	1			0	
Ave. rock size					0	
Probable soil type	X	1	Nisqually	3	3	
Mapped soil type			Nisqually			
Comments						
Similarity to RP		3			6	2.000
TOPO		0.75				
Mounded topography	X	0.5	No, not in this area	1	0.5	
Swales	X	1	Nearby- not here	1	1	
Similarity to RP		1.5			1.5	0.750
VEGETATION		1				
% fescue	X	0.5	trace	0	0	
Total native forb cover	X	1	low	0	0	
Total cover exotics	X	0.5	80%	0	0	
Total cover moss/lichen	X	0.25	<20%	1	0.25	
Total cover bare ground	X	0.25	20%	2	0.5	
Dicranum scoparium present/cover	X	0.5	yes	1	0.5	
Rhacomitrium present/cover	X	0.5	no	3	1.5	
Lupinus albicaulis present/cover	X	0.5	trace	2	1	
Carex inops present/cover	X	0.5	no	0	0	
# subdom native species in common w/ RP	X	1	8/25	0	0	
Bad weeds/which			CYTSCO, ARRELA, SENJAC (2)			
Similarity to Rocky Prairie - total score		5.5		17	3.75	0.682
OWNERSHIP/MANAGEMENT						
Ownership			WDFW			
Commitment to protection			some recreational use			
Future protection possible			greater possibility			
Size and nature of buffer			large			
Able to use fire every five years			perhaps			
OTHER ISSUES						
Castilleja hispida on site or nearby			not known from W end?			
Near or potential Taylor's intro site			yes			
Potential Taylor's intro site			no			
Other issues			maybe old field			
Comments			need to come back and look for site in better condition			
Final score- similarity						3.432

South Puget Sound Site Evaluations for Reintroduction of Golden Paintbrush – Appendix A

	Similarity to Rocky	Similarity Weight	DESCRIPTION	RANK	weighted rank	average
CHARACTERISTICS			91st Division, butterfly area			
SIZE						
Size of prairie			7000 acres (between the treeline and berm)			
Size of microsite			several hundred (plot is 10x10)			
SOILS						
		1				
% coarse fragments @ 6"	X	1	35% rock, sandy loam (gopher mounds - can't dig)	2	2	
% coarse fragments @12"	X	1			0	
Ave. rock size			3cm		0	
Probable soil type	X	1	Spanaway	1	1	
Mapped soil type						
Comments						
Similarity to RP		3			3	1.000
TOPO						
		0.75				
Mounded topography	X	0.5	no	1	0.5	
Swales	X	1	no	1	1	
Similarity to RP		1.5			1.5	0.750
VEGETATION						
		1				
% fescue	X	0.5	80%	2	1	
Total native forb cover	X	1	40%	3	3	
Total cover exotics	X	0.5	60% (mostly annuals)	3	1.5	
Total cover moss/lichen	X	0.25	30%	1	0.25	
Total cover bare ground	X	0.25	tr	3	0.75	
Dicranum scoparium present/cover	X	0.5	no, think its Polytrichum, immature, dried out	0	0	
Rhacomitrium present/cover	X	0.5	no	3	1.5	
Lupinus albicaulis present/cover	X	0.5	5%	2	1	
Carex inops present/cover	X	0.5	no, not in whole area	0	0	
# subdom native species in common w/ RP	X	1	9/25	0	0	
Bad weeds/which			HYPPER, Crepis sp., PARVIS (1)			
Similarity to Rocky Prairie - total score		5.5		22	9	1.636
OWNERSHIP/MANAGEMENT						
Ownership			DOD			
Commitment to protection			impact area, no area, could be training area in future			
Future protection possible			no never			
Size and nature of buffer			huge			
Able to use fire every five years			most			
OTHER ISSUES						
Castilleja hispida on site or nearby			yes			
Near or potential Taylor's intro site			yes (major Taylor site)			
Potential Taylor's intro site						
Other issues			burns very often, fire freq. Every 2-3 years			
Comments						
Final score- similarity						3.386

South Puget Sound Site Evaluations for Reintroduction of Golden Paintbrush – Appendix A

	Similarity to Rocky	Similarity Weight	DESCRIPTION	RANK	weighted rank	average
CHARACTERISTICS			Mima Northeast			
SIZE						
Size of prairie			450 acres			
Size of microsite			10x10 m, similar to much of site			
SOILS		1				
% coarse fragments @ 6"	X	1	6" cobbly sandy loam with some coarse fragments	0	0	
% coarse fragments @12"	X	1	cant get to 12" - too gravelly	0	0	
Ave. rock size			8-10 cm.		0	
Probable soil type	X	1	Spanaway	1	1	
Mapped soil type					0	
Comments					0	
Similarity to RP		3			1	0.333
TOPO		0.75				
Mounded topography	X	0.5	yes	2	1	
Swales	X	1	intermound areas but not swales, elevated	1	1	
Similarity to RP		1.5			2	1
VEGETATION		1				
% fescue	X	0.5	70%	2	1	
Total native forb cover	X	1	15%	1	1	
Total cover exotics	X	0.5	20%	3	1.5	
Total cover moss/lichen	X	0.25	80%	3	0.75	
Total cover bare ground	X	0.25	0	3	0.75	
Dicranum scoparium present/cover	X	0.5	40-60%	2	1	
Rhacomitrium present/cover	X	0.5	no	3	1.5	
Lupinus albicaulis present/cover	X	0.5	no	0	0	
Carex inops present/cover	X	0.5	10%	3	1.5	
# subdom native species in common w/ RP	X	1	6/25	0	0	
Bad weeds/which			HYPRAD, HYPPER (0)			
Similarity to Rocky Prairie - total score		5.5		24	9	1.636
OWNERSHIP/MANAGEMENT						
Ownership			DNR - NAP			
Commitment to protection			NAP			
Future protection possible			yes			
Size and nature of buffer			large			
Able to use fire every five years			yes			
OTHER ISSUES						
Castilleja hispida on site or nearby			no			
Near or potential Taylor's intro site			no			
Potential Taylor's intro site			no			
Other issues						
Comments						
Final score- similarity						2.970

South Puget Sound Site Evaluations for Reintroduction of Golden Paintbrush – Appendix A

	Similarity to Rocky	Similarity Weight	DESCRIPTION	RANK	weighted rank	average
CHARACTERISTICS			Morgan			
SIZE						
Size of prairie			2500 acres			
Size of microsite			10 X10 (10 acres about the same)			
SOILS		1				
% coarse fragments @ 6"	X	1	40% coarse fragments, black sandy loam	1	1	
% coarse fragments @12"	X	1	60% coarse fragments	0	0	
Ave. rock size			0.5-3cm, ave 1 cm at 6", 1-6 cm, average 4 cm at 12"		0	
Probable soil type	X	1	Spanaway	1	1	
Mapped soil type						
Comments						
Similarity to RP		3			2	0.667
TOPO		0.75				
Mounded topography	X	0.5	no-gently rolling	1	0.5	
Swales	X	1	not really	1	1	
Similarity to RP		1.5			1.5	0.750
VEGETATION		1				
% fescue	X	0.5	10%	1	0.5	
Total native forb cover	X	1	5-10%	1	1	
Total cover exotics	X	0.5	80%	0	0	
Total cover moss/lichen	X	0.25	90%	3	0.75	
Total cover bare ground	X	0.25	5%	3	0.75	
Dicranum scoparium present/cover	X	0.5	trace	0	0	
Rhacomitrium present/cover	X	0.5	70-80%	0	0	
Lupinus albicaulis present/cover	X	0.5	no	0	0	
Carex inops present/cover	X	0.5	trace	2	1	
# subdom native species in common w/ RP	X	1	14/25	2	2	
Bad weeds/which			HYPPER, dense CHRLEU throughout, low other weeds (0)			
Similarity to Rocky Prairie - total score		5.5		16	6	1.091
OWNERSHIP/MANAGEMENT						
Ownership			private- going to TNC			
Commitment to protection			High			
Future protection possible			yes			
Size and nature of buffer			Very good- adjacent to Ft/ Lewis			
Able to use fire every five years			yes			
OTHER ISSUES						
Castilleja hispida on site or nearby			some planted on site			
Near or potential Taylor's intro site			Johnson prairie- unsuitable habitat between			
Potential Taylor's intro site			Not specifically, but possible			
Other issues			Currently grazed - horses leaving soon			
Comments						
Final score- similarity						2.508

Appendix B

Ranking and weighting of ecological characteristics of all evaluated sites

CHARACTERISTICS	Site specific information			
	Similarity Weight	RANK range	weighted rank	average
SOILS	1			
% coarse fragments @ 6"	1	0-3	Rank * weight	
% coarse fragments @ 12"	1	0-3	Rank * weight	
Probable soil type	1	0-3	Rank * weight	
Soils similarity to Rocky Prairie	Sum of similarity weight		Sum of weighted ranks	Sum of weighted ranks divided by sum of similarity weight
TOPO	0.75			
Mounded topography	0.5	0-3	Rank * weight	
Swales	1	0-3	Rank * weight	
Topo similarity to Rocky Prairie	Sum of similarity weight		Sum of weighted ranks	Sum of weighted ranks divided by sum of similarity weight and multiplied by 0.75
VEGETATION	1			
% fescue	0.5	0-3	Rank * weight	
Total native forb cover	1	0-3	Rank * weight	
Total cover exotics	0.5	0-3	Rank * weight	
Total cover moss/lichen	0.25	0-3	Rank * weight	
Total cover bare ground	0.25	0-3	Rank * weight	
Dicranum scoparium present/cover	0.5	0-3	Rank * weight	
Rhacomitrium present/cover	0.5	0-3	Rank * weight	
Lupinus albicaulis present/cover	0.5	0-3	Rank * weight	
Carex inops present/cover	0.5	0-3	Rank * weight	
# subdom native species in common w/ RP	1	0-3	Rank * weight	
Vegetation Similarity to Rocky Prairie	Sum of similarity weight		Sum of weighted ranks	Sum of weighted ranks divided by sum of similarity weight
FINAL SIMILARITY SCORE				Sum of all averages (0-8.25)

Soils – Overall weighting of 1

- % coarse fragments @ 6" **weight = 1**
- 55% coarse fragments = 0
 - 35-55% coarse fragments = 1
 - 20-35% coarse fragments = 2
 - 0-20% coarse fragments = 3
- % coarse fragments @ 12" **weight = 1**
- 55% coarse fragments = 0
 - 35-55% coarse fragments = 1
 - 20-35% coarse fragments = 2
 - 0-20% coarse fragments = 3
- Probable soil type **weight = 1**
- Spanaway = 1
 - Spanaway with decreasing gravel or <25% = 2
 - Nisqually = 3

Topography - Overall weighting of 0.75

Mounded topography	weight = 0.5
➤ None	= 1
➤ Present	= 2
➤ Ill defined/irregular	= 3
Swales	weight = 1
➤ None	= 1
➤ Poorly defined	= 2
➤ Present	= 3

Vegetation – Overall weighting of 1

% fescue	weight = 0.5
➤ 0-1%	= 0
➤ 2-14%	= 1
➤ 14-24% or >60%	= 2
➤ 25-60%	= 3
Total native forb cover	weight = 1
➤ <5%	= 0
➤ 5-15%	= 1
➤ 16-35%	= 2
➤ >35%	= 3
Total cover exotics	weight = 0.5
➤ >80%	= 0
➤ 70-79%	= 1
➤ 60-70%	= 2
➤ 0-60%	= 3
Total cover moss/lichen	weight = 0.25
➤ <20%	= 0
➤ 20-39%	= 1
➤ 40-60% or >75%	= 2
➤ 60-75%	= 3
Total cover bare ground	weight = 0.25
➤ >10%	= 2
➤ 0-10%	= 3
Dicranum scoparium cover	weight = 0.5
➤ <1%/absent	= 0
➤ 1-20%	= 1
➤ >50%	= 2
➤ 20-50%	= 3
Rhacomitrium cover	weight = 0.5
➤ >25%	= 0
➤ 10-25%	= 1
➤ trace-10%	= 2
➤ 0/absent	= 3

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Lupinus albicaulis cover	weight = 0.5
➤ 0/absent	= 0
➤ trace-5%	= 2
➤ >5%	= 3

Carex inops cover	weight = 0.5
➤ 0/absent	= 0
➤ 0-3%	= 2
➤ >3%	= 3

# subdom native species in common w/ Rocky Prairie	weight = 1
➤ 6-10	= 0
➤ 11-15	= 1
➤ 16-19	= 2
➤ >19	= 3

Appendix C Maps of Sites





