WASHINGTON NATURAL HERITAGE PROGRAM

Recovery Actions for *Sidalcea nelsoniana* (Nelson's checkermallow) and *Lomatium bradshawii* (Bradshaw's lomatium) at Ridgefield National Wildlife Refuge

Prepared for
U.S. Fish and Wildlife Service
Region 1

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Natural Resources

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Sidalcea nelsoniana (Nelson's checkermallow)
and
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USFWS COOPERATIVE AGREEMENT 13410-6-J035

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The U.S. Fish and Wildlife Service
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Introduction

The work reported here was conducted under U.S. Fish and Wildlife Service (USFWS) Cooperative Agreement 13410-6-J035, supporting recovery actions for *Sidalcea nelsoniana* (Nelson's checkermallow) and *Lomatium bradshawii* (Bradshaw's lomatium) on the Ridgefield National Wildlife Refuge (Refuge) in Clark County, Washington (see Figure 1). The objectives of the agreement were to provide evaluation of the Refuge for potential introduction sites for these species and to participate in planting and monitoring *Sidalcea nelsoniana* outplantings. In the course of time spent at the Refuge we also compiled a vascular plant species list and vegetation map of the area.

Figure 1. Location of Ridgefield National Wildlife Refuge. The Columbia River, running diagonally across the map, is the border between Washington on the north and Oregon on the south.

The Washington Natural Heritage Program (WNHP), with federal support under Section 6 of the Endangered Species Act, is working under several grants on recovery of *Lomatium bradshawii* and *Sidalcea nelsoniana* in southern Washington. The recovery plan for the prairie species of Western Washington and southwestern Washington (USFWS 2010) establishes criteria for downlisting or delisting these species.

Lomatium bradshawii, federally listed as endangered, will require a permanently protected, stable population of at least 5,000 individuals in southern Washington (as well as requirements in Oregon), to be downlisted to threatened status; two protected populations totaling 10,000 individuals will be required before the species can be delisted, or removed entirely from threatened or endangered status under the Endangered Species Act. At the present time, a single population of the species is known in the state, in Clark County. This population is large, far larger than the requirements of the recovery plan, but it occurs on private land and has no legal protection at the present time. Consequently, meeting the downlisting criteria for *Lomatium bradshawii* will require that the extant population be brought into some form of permanent conservation status, prioritizing protection of the species; delisting will require establishment of at least one additional protected population of this species within Washington. It may require establishment of two new populations if protection cannot be assured for the extant Clark County population.

Likewise, *Sidalcea nelsoniana*, federally listed as threatened, will require two stable populations totaling 10,000 individuals or 5,000 square meters of foliar coverage in southern Washington (again, in addition to requirements in Oregon) to be delisted, or removed from listing under the Endangered Species Act. At the present time, two small populations of the species are known in the state, one in Clark County and one in Lewis County. Both are on private land and neither currently have any legal protection. It is possible that the Lewis County population could be legally protected and managed to increase the population size to meet recovery criteria, but no progress has been made in this direction. Consequently, meeting the delisting criteria for *Sidalcea nelsoniana* will likely require establishment of both recovery populations of this species within Washington.

Based on the criteria described above, meeting recovery for both *Lomatium bradshawii* and *Sidalcea nelsoniana* will likely require the establishment of new populations of these species within their historical ranges. Potential pitfalls of reintroduction efforts are described and discussed below; with appropriate planning these risks should be avoided or minimized.

1. **The increase of planted populations may contribute to reducing the perception of the value of wild populations.** However, continuing the emphasis on existing populations should prevent the perception that existing populations need not be protected, following the logic that new ones can be simply be developed in more convenient places. In practice, the difficulty and failure that may be encountered in efforts to establish new populations emphasizes the value of existing populations and the complexity and specificity of habitat requirements.

2. **A population that is planted but that is unable to reproduce, or that will ultimately decline because of other factors, may give the false impression of recovery.** Long term monitoring will help our understanding of the viability of outplantings, as will keeping aware that reproduction is essential for viability of a population.

3. **Bringing plant material onto an isolated site presents the risk of inadvertently introducing weeds or other pathogens from off-site.** There are ample examples where propagating material off-site and bringing plants and soil, or even just seed, back to the site of origin have also brought weeds and other unwanted organisms. It does not appear that there are absolute safeguards against this form of contamination. However, keeping the risk in mind, conducting careful inspections of material brought onto a site, and monitoring specifically for new weed introductions would greatly reduce the potential risk. To reduce the potential for long distance dispersal of pathogens or weeds, one general guideline would be to choose propagation facilities as near as possible to the eventual plantings.

4. **Outplantings may be misinterpreted as naturally occurring populations.** A population planted deliberately has significantly different conservation value than a naturally occurring one. This danger should be avoided entirely by including all outplantings in the databases of the respective state natural heritage programs.

5. **Cross-pollination may occur between a natural population and an outplanted one, if they happen to grow in proximity, resulting in genetic contamination of the wild population.** Genetic contamination should not be a danger in augmentation plantings, where seed is collected from a population, grown into seedlings off site, and then returned for augmentation planting of the same population. In establishing new populations, care should be taken to review occurrence records and survey suitable adjacent habitat.

6. **Establishing a new population with limited genetic material may result in a genetically depauperate population**. Establishing a new population from a small number of individuals does present the potential for a population with narrow genetic diversity and may create a genetic bottleneck. In work with other species, researchers are considering the benefits of using multiple seed sources for new populations to increase genetic potential. In some cases mixed seed sources are being used for introduction plantings.

7. **Competing needs may exist for the same resources, or conservation of one species may occasionally be in competition with another.** This risk can be mitigated by promoting communication between researchers in different disciplines and making decisions cooperatively on different uses of the same resources.

8. **Introducing a species, even a rare one, into any of the few remaining high quality sites, where the species may not have historically occurred, has the potential to disturb the existing ecology** (Adolf Ceska, formerly of the Ministry of Environment, Lands and Parks Conservation Data Centre, personal communication). Two aspects of this topic suggest that this risk is minimal. Most new populations area being established in areas that have already been profoundly altered by invasive non-native species, and while attempting to introduce rare species may fail, it seems unlikely to contribute to the loss of an established native community. In addition, the rare species that are being considered for introductions are typically minor components of native communities and appear unlikely to become invasive themselves.

Newly established populations, in order to meet recovery criteria, must also be in a permanently protected status. Because of ownership and management by the USFWS, populations of either of these species, if successfully established on the Refuge, could receive permanent protection and management that prioritizes conservation of the species.

Evaluation of the suitability of potential introduction sites for rare species in Washington has been based primarily on similarity to existing reference sites. Vegetation, soils, slope, aspect, elevation, and hydrology of a potential site have been compared with those of reference sites (Caplow and Chappell 2004). In these evaluations, vegetation has been relied upon most heavily, because vegetation characteristics are more readily apparent and require less intensive data collection than hydrology and soils. Most importantly, plant growth may express complex soil, biological, and hydrological interactions that cannot otherwise be easily characterized, but that determine the suitability of a site.

Evaluation of existing characteristics continues to be the first step in site selection, and vegetation, especially, suggests which sites appear suitable for further examination. However, there are two main limitations to the usefulness of using existing vegetation as the primary indicator. First, the alteration of the historical disturbance regime and invasion by non-native species may mask suitable soils and hydrology. This is especially pronounced on the Refuge, where most land has been intensively managed for agriculture and, since the establishment of the Refuge, for wildlife habitat. Secondly, habitat requirements of rare species may be difficult to evaluate or to replicate, and some species appear to thrive in a variety of sites. Although examination of Willamette Valley occurrences has offered additional information on site characteristics, selection for *Lomatium bradshawii* in Washington is limited by the single reference site in the state, and references for *Sidalcea nelsoniana* are limited to the two occurrences here. One of these has been highly fragmented and otherwise modified by development, and the other has also been altered, to a lesser extent, by ditching and vegetation clearing.

In extensive outplanting experimentation with *Castilleja levisecta* (golden paintbrush), extremely variable and patchy survival of out-planted seedlings has suggested micro-site characteristics that have not been evident in site evaluations (Pearson and Dunwiddie

2006, Arnett and Dunwiddie 2010). As a second step in site selection, experimental plantings have been proposed to use the response of out-plantings of the rare species itself as an indicator of the site suitability (Tom Kaye, Institute for Applied Ecology, and Peter Dunwiddie, formerly of The Nature Conservancy, personal communications). Experimental planting allows a variety of sites to be tested prior to the larger effort of full-scale introduction.

Methods and Results

Lomatium bradshawii experimental planting

Methods

As part of the work under this cooperative agreement between the USFWS and the Washington Natural Heritage Program (WNHP), a small experimental planting of *Lomatium bradshawii* was conducted to evaluate the suitability of three sites for outplanting this species. In addition to evaluating sites, two propagation methods were tested in this experiment.

The first propagation method was to sow seed directly into the field at potential reintroduction sites. Research with *Lomatium bradshawii* in Oregon indicated a high success rate with direct seeding (Kaye et al. 2003). The second propagation method was to plant seed in containers off-site and then transplant seedlings into the field during the following winter.

Seed was collected on August 4, 2006 from the extant Washington population of *Lomatium bradshawii* in Clark County. A portion of this seed was propagated off-site at The Nature Conservancy's Shotwell's Landing native plant nursery in Thurston County to produce plants ready for out-planting in the winter of 2007-2008. Another portion of the seed was set aside for the direct seeding experimentation.

Site Selection

Several potential introduction sites were identified on the Refuge in a site visit on September 26, 2006, with input from Refuge staff Joe Engler and from Western Washington Fish and Wildlife Office staff Ted Thomas and Judy Lantor. Three sites for outplanting were selected (see Figure 2) adjacent to the main road through the refuge or in other suitable locations that could be easily accessed and relocated. Plots and transect marking stakes were located so that they would not interfere with refuge mowing. Refuge staff were not expected to participate in maintenance of the *Lomatium* plants, but they were informed of the plot locations so they could be avoided or mowed at times least likely to impact the *Lomatium*.

Observations were made at each transect site to develop a profile of vegetation, soils, and hydrology. The presence and relative abundance of vascular plants at each transect

Figure 2. Location of *Lomatium bradshawii* planting sites at Ridgefield National Wildlife Refuge

location were recorded. Observations were also made of soil saturation and the development of competing vegetation. Soils were collected from a subset of the plots for laboratory analysis.

Decisions on Experiment Continuation or Termination

It was decided at the beginning of this experiment that the USFWS would determine how long the experimental plants should remain on the site. While approval of this experiment on the Refuge did not assume approval for introduction, an obvious benefit of the experiment in protected areas would be that the USFWS has the opportunity to allow successful plantings to remain. Full-scale introductions would require additional planning and a FWS management decision to adopt long-term protection of *Lomatium bradshawii* on the Refuge.

Direct Seeding

On March 15, 2007, the WNHP established three 100-meter transects at the Refuge (see Figure 2). A total of 25 square meter plots were randomly selected along these transects (8, 8, and 9 plots on transect 1, 2, and 3, respectively) and each plot was raked to remove duff and dense plant growth. Twenty *Lomatium bradshawii* seeds were planted in each plot, scattered and pressed into contact with the bare soil exposed by raking. The locations of these transects and plots are described below.

Transect 1, Kiwa Trailhead

Origin: Along the edge of the trail between the Kiwa trailhead sign and the fence to the north, 7 meters from the sign post, marked with a buried spike and tag #1.
UTM NAD 83, 18' accuracy, 518947E, 5071770N

Heading: 255 degrees, aimed at the large tree closest to the road at the west edge of this field.

West end of transect: 518855, 5071734, with 15' accuracy.

8 plots, at 18, 19, 22, 28, 34, 76, 87, and 92 meters. Plots are on the south side of the transect, starting at the meter mark indicated.

The vegetation is dominated by non-native rhizomatous grasses, especially *Holcus lanatus*, with *Phalaris arundinacea* prominent at the more moist western end of the transect. *Dipsaucus fullonum* is also present at the moist west end, where moss cover is approximately 30 percent. All species present are recorded in Appendix C.

Most of the transect crosses upland vegetation, and while the soils were moist or saturated early in the spring, they had dried entirely early on in the summer. The west end was wetter, with willows and *Phalaris arundinacea*, and while it also dried completely in the summer, it retained moisture longer.
Soils here were silty clay loam and clay loam, not apparently very different in texture from those at the exant *Lomatium bradshawii* population. Potassium, magnesium, and, especially, copper were higher than at the extant site. Other soil characteristics did not seem to differ significantly.

Transect 2, Midlands Meadow/Canvasback Lake

Origin: At the base of the post for the sign saying "Area beyond this sign is closed." marked with a buried spike and tag #2.

UTM NAD 83, 13' accuracy, 519099E, 5071693N

Heading: 210 degrees, aimed at the northern-most tree in a distant row (not the trees at the edge of the dike on which this access road runs).

Southwest end of transect, where it enters the water: 519065, 5071624N, accuracy 14'.

8 plots, at 5, 8, 38, 39, 50, 56, 68, and 73 meters, on the northwest side of the transect, starting at the meter mark indicated.

This site is in general more moist than at Transect 1, with *Dipsaucus fullonum* and *Phalaris arundinacea* especially prominent. Coverages of *Lotus corniculatus* and *Juncus effusus* are also high. The transect was laid out to cross different hydrological conditions, from fairly dry at the northern end and where the transect crossed a vegetated gravel roadbed. At the south end the transect extended until it reached standing water. In late spring and early summer the upland portions of this transect were completely dry; where the transect dropped fairly steeply into water the soils were saturated late into the season.

Soils at Transect 2 appeared fairly similar to those at the extant site, at least where the sample was collected near the moist end. The texture was clay loam, and nutrient levels were close to the range of those at the extant site.

Transect 3, Ruddy Lake, just south of the Ducks Unlimited plaque
Origin: At the base of the post for a sign saying "Area beyond this sign is closed", just south of the large rock with the bronze plaque identifying this site as the Bachelor Island Wetlands, marked with a buried spike and tag #3.

UTM NAD 83, 14' accuracy, 519212E, 5072000N

Heading: 180 degrees, aimed at lone large tree.

South end of transect, at the tree: 519223, 5071903N, 15' accuracy

9 plots, at 22, 24, 41, 47, 50, 78, 82, 85, and 93 meters, on the northwest side of the transect, starting at the meter mark indicated.

Holcus lanatus is dominant, *Phalaris arundinacea, Cirsium vulgare* and *Cirsium arvense* also present, along with *Dactylis glomerata, Lotus corniculatus,* and *Galium aparine.* All species present are listed in Appendix C.
At the time of planting the soil along Transect 3 appeared quite moist, with standing water tangential to the transect. However, this area became surprisingly dry soon in the season, perhaps because of manipulation of water levels at the Refuge.

The soils at Transect 3, silty clay loam, were slightly more coarse in texture than those at the extant *Lomatium bradshawii* site, and they seemed to differ in several other ways. The level of organic matter, potassium, manganese, and sulfur were lower, while copper, zinc, and saturation of calcium were considerably higher.

Seedling Outplanting
Propagation of the seed collected at Lacamas Creek on August 4, 2006 was planted and grown into seedlings at The Nature Conservancy's Shotwell's Landing plant nursery. The seedlings were all transplanted out into plots on Transect 1, at the Kiwa trailhead.

A portion of the seed was sown at the nursery on September 6, 2007, and produced 31 plugs. A second portion of the seed was stratified on March 27, 2007 and sown at the nursery on May 15, 2007, yielding 37 plugs.

On March 20, 2008 the total of 68 plugs was planted out in 13 random plots along Transect 1, at the Kiwa trailhead. Five plugs were planted in each plot, one in the center and one in the center of each quarter of the plot. The plots that were randomly selected along Transect 1 were 11, 13, 27, 30, 33, 40, 43, 45, 56, 60, 82, 86, and 95.

Soils Analysis

Soil samples were collected for laboratory analysis from randomly selected plots on each transect used for the experimental planting of *Lomatium bradshawii*, and from other sites selected from off the Refuge as reference sites, particularly the location of the natural population of *Lomatium nelsoniana* near Lacamas Creek. Within each randomly selected square meter plot, five small trowel holes were dug, one at each corner and in the middle. One half-trowel measure of soil was collected from each hole, at a depth of approximately 15 cm. The five samples from each plot were mixed to produce a sample of approximately 500 cm^3. The soil samples were sent to A&L Western Agricultural Laboratories in Modesto, California for analysis. Table 1 gives the location of each soil sample. The laboratory results are presented in Appendix F.

Table 1. Locations of soil samples collected at Ridgefield NWR and other reference sites. Results of laboratory analysis are presented in Appendix F.

***Lomatium bradshawii* sites**		
date	**sample #**	**location**
18-Apr-07	LOBR-1	Camas Meadow golf course #1
18-Apr-07	LOBR-2	Camas Meadow golf course #2
18-Apr-07	LOBR-3	Camas Meadow golf course #3
18-Jun-07	LOBR-4	*Carex densa* site, along I-5 in Clark County
3-Jul-07	LOBR-5	Ridgefield Transect 1, near Kiwa trailhead
3-Jul-07	LOBR-6	Ridgefield Transect 1, near Kiwa trailhead
3-Jul-07	LOBR-7	Ridgefield Transect 2, near Canvasback Lake
3-Jul-07	LOBR-8	Ridgefield Transect 3, near Ruddy Lake
3-Jul-07	LOBR-9	Ridgefield Transect 3, near Ruddy Lake

Results

Documentation of Plant Survival
On July 3, 2007, a search was made for seedlings from the March 15 sowing, but no *Lomatium bradshawii* plants were found on any transect. On June 12, 2008, another search was made of the planting transects, and no seedlings or plants were found. The growth of weeds far exceeded expectations, and dense head-high grass was the usual vegetation cover. The soils in the planting areas were still moist, but beyond the period of saturation.

The planting transects were monitoring on numerous subsequent occasions, and no surviving plants were observed at any of the sites. It appears that neither direct seeding nor transplanting seedlings resulted in any *Lomatium bradshawii* survival on the site. We have concluded that these outplanting efforts were both entirely unsuccessful.

Sidalcea nelsoniana outplanting

Methods

Early field evaluation had identified several potential planting areas, prior to involvement by WNHP and the establishment of the cooperative agreement.

In late 2007, a large number of *Sidalcea nelsoniana* seedings that had been grown from seed collected in Oregon became available for planting, and the FWS staff decided to mobilize a team to plant them at Ridgefield in the areas that had been previously identified as having potential. The method of outplanting is described in detail in Appendix A (Dillon 2008).

Plantings were made in rows parallel to the adjacent water bodies; during monitoring a count was made of the plants surviving and flowering in each row. Collecting data in this manner allowed us to measure the plants vigor or survival relative to level above the water.

2009: May 12, 2009 Survival monitoring: Jeff Dillon, Judy Lantor, and Joe Arnett. The planting sites had been mowed in the previous fall, after the *Sidalcea* seed had scattered.

At the Texas Island site some goods activity was evident, and voles. *Cirsium arvense* is present at the site, *Festuca arundinaea* is abundant, *Plantageo lanceolata* is present

At the 100 Acre South site, survival was estimated at 78%, with approximately 60% flowering. The *Sidalcea* plants growing among the *Phalaris arundinacea* are generally larger and more vigorous, though they face severe competition from the *Phalaris*, the moisture must be more optimum.

At the 100 Acre North site, there has been significant goose activity, pulling plugs out of the ground, and FWS and replanted them several times. This is a drier site, with smaller plants, but high survival.

At the Smith Lake site there was high survival. *Equisetum* is abundant, Cirsium arvense and Rubus armeniacus are evident in places,

June 10, 2009 Flowering monitoring: Jeff Dillon, Kate Norman, and Joe Arnett

2010: Smith Lake and 100 acre field monitoring June 1, 2010 by Judy Lantor, Alex Chmeilewski, and Joe Arnett. Texas Island monitoring June 14, 2010 by Rex Crawford and Joe Arnett

Smith Lake: Counts are by row, starting along the water to the south. Bold number indicates two plants at one planting point. Estimated total planting of 1,846 plugs, 36 rows of 46 and 10 rows of 19

One Hundred Acre North: Counts are by row, starting along the side closest to the water. Total planting of 160 plugs, 6' x 6' spacing.

One Hundred Acre South, hacking tower site: Counts are by row, starting on the uphill edge, parallel to the water. Total planting of 400 plugs, 6' x 6' spacing.

Texas Island: Counts are by row, starting on the downhill edge, parallel to the water. Total planting of 100 plugs planted 9Dec2007, 10' x 10' spacing. 5 or 6 flowering plants seen July 2008

Results

A summary of survival of *Sidalcea nelsoniana* at the four outplanting sites is presented below in Table 1. The data at these sites, collected by row, is presented in Appendix B.

Floristic inventory of Ridgefield National Wildlife Refuge

Field visits were made to several portions of the Refuge to evaluate their potential as reintroduction sites for *Sidalcea nelsoniana* and *Lomatium bradshawii*. The focus of these site evaluation was to areas that included the most natural, least modified native vegetation, especially the area in and around the Blackwater Island Research Natural Area. A floristic record was made of species observed, which is recorded in Appendix C. Known rare plant occurrences there were monitoring in the course of the visits, and two new populations of rare plants, *Trillium parviflorum* and *Howellia aquatilis*, were recorded. Other references that included references to the Refuge were also reviewed, including Christy and Putera (1993), Wiberg and Greene (1981), and a species list compiled during Washington Native Plant Society field trips (Washington Native Plant Society 1987). Species recorded in these references are also included in Appendix C, annotated with a reference to their source. These references also included records of *Salix sessilifolius* and *Collinsia sparsiflora* var. *bruceae;* these will be added to the WNHP Biotics database.

Vegetation Mapping of Ridgefield National Wildlife Refuge

WNHP ecologists prepared a map of existing vegetation of the Refuge; maps and description of the process used are presented in Appendix E.

Table 2. Summary of *Sidalcea nelsoniana* survival at four outplanting sites at Ridgefield NWR. Planting occurred in December 2007.

Smith Lake, 1,801 plants				
	2009		**2010**	
	survival	flowering	survival	flowering
Total	1,710	1,575	1554	1464
Percent	92.6	85.3	84	79
One Hundred Acre North, 180 plants				
	survival	flowering	survival	flowering
Total	104	65	97	84
Percent	65	40.6	61	53
One Hundred Acre South, hacking tower site, 400 plants				
	survival	flowering	survival	flowering
Total	195	163	211	188
Percent survival	48.8	40.8	53	47
Texas Island, 100 plants				
	survival	flowering	survival	flowering
Total	53	36	34	22
Percent survival	53	36	34	22
Kiwa Trailhead, 49 plants				
	survival	flowering	survival	flowering
Total	0	0	0	0
Percent survival	0	0	0	0

Conclusions and Recommendations

Lomatium bradshawii

The small scale experimental planting conducted by the WNHP suggests that those sites we examined at the Refuge do not include suitable habitat for the introduction of *Lomatium bradshawii*. However, the Refuge is large and diverse (see Appendix E) and we have only been able to look closely at a portion of it. Furthermore, land management at the Refuge includes extensive efforts at weed removal and manipulation of hydrology. It may be that efforts at other sites within the refuge, especially where the soil saturation extends later into the season, would be more successful.

The large and vigorous *L. bradshawii* occurrence near Lacamas Creek and review of habitat characteristics of other occurrences in Oregon suggest that this species has very specific requirements for soil and hydrology, including fine clay soils that are inundated in the winter, saturated late into the spring and early summer. Competing vegetation is generally native shrubs that are controlled by fire or mowing. Blue camas is a common associate, in extensive wet meadow communities. Oaks occur nearby, but Oregon ash is more common in close proximity to the *Lomatium*.

The Refuge, in contrast, occurring within the flood plain of the Columbia River, appears to have had a more dynamic history. Soils on the Refuge and at Lacamas Creek, where the extant *Lomatium bradshawii* population occurs, do not appear markedly different (see Appendix F). The average clay content at the Refuge and the Lacamas Creek site is comparable, as is the percentage of organic matter.

It appears that the differences in hydrology between the sites are most significant, as the profound differences in associated vegetation indicate. The intensive invasion by non-native herbaceous plants at the Refuge appears to reflect the differences in site characteristics, and to compound the difficulty of establishing *Lomatium bradshawii*. Camas is generally in low densities, except in small patches of organic soils on rocky balds associated with oaks.

Observations of the differences in habitat preferences were consistent with the results of the experimental outplantings, which were completely unsuccessful. Competition from non-native weeds at the sites on the Refuge appeared overwhelming. Late spring hydrology of the Refuge sites also appeared significantly different from the extant occurrence; the areas of all three transects dried earlier in the season than the Lacamas Creek site, and water levels changed relatively rapidly; at the Lacamas Creek site the site gradually dried up through the spring and early summer.

It is possible that additional efforts at planting *Lomatium bradshawii* at the Refuge would have better success, and that the failure of this planting effort was at least partially the timing of the planting, the skill of the planters, or the importance of better site preparation and maintenance. It is our impression that the Lacamas Creek site has a combination of hydrology and vegetation that is not found at the Refuge, and that is significantly different from the experimental planting sites. However, although the Lacamas Creek site is extremely robust, it is only one reference point, and the Refuge may include other areas that would also be favorable for *L. bradshawii*.

We recommend that further attempts not be made to establish *Lomatium bradshawii* in the sites where we attempted plantings. The competition from invasive non-native weeds was overwhelming, and the sites overall appeared too dry later in the spring. Our inventory has not revealed other sites at the Refuge that appear suitable for establishing *Lomatium bradshawii,* though it may be that the vegetation and hydrology of some areas could be manipulated to recreate suitable conditions. Weed control would be required, as would finding, or establishing, the appropriate inundation, saturation, and gradual complete drying that occurs at Lacamas Creek.

If additional work with this species was planned at the Refuge, we would recommend the following four step process:

- Characterize more precisely the extant populations of *Lomatium bradshawii* in both Oregon and Washington, relative to hydrology and associated vegetation. This would require recording the duration of inundation and saturation at several sites and developing a profile of associated species based on quantitative data.

- Review seasonally flooded portions of the refuge where the hydrology may more closely approximate, or be altered to more closely approximate, the extant populations.

- Continue with small scale experimental plantings to test site suitability

- Consider larger scale plantings if initial success at specific sites and if USFWS management decides that long term protection of a planting site fits with management plans for the Refuge.

Sidalcea nelsoniana

The *Sidalcea nelsoniana* outplanting at the Refuge has been extremely successful, with a high percentage of the transplants surviving and flowering. The long-term viability of the population will depend on its ability to maintain its vigor with the increase in non-native species, and the ability of seeds to establish new individuals. It is encouraging that *Sidalcea nelsoniana* can so easily be propagated, and that it has responded so well at the Refuge. It appears highly probable that a population contributing to recovery and eventual delisting of the species could be established here.

We recommend the following actions at the Refuge in support of recovery of *Sidalcea nelsoniana*:

- Monitor the outplantings annually, and, as far as practical, record plants that have been planted separately from those that establish naturally from the seed that is released. Because of the regular spacing of the outplants, it should be possible in most cases to record these two groups of plants separately.

- Make efforts to establish a native prairie community at the outplanting sites, particularly at the Smith Lake site. Some efforts, though largely unsuccessful so far, have already been made at this site. A species list of recommended associated species could be developed from extant populations of *S. nelsoniana*, especially those in Oregon that are in better ecological condition than the small Washington occurrences.

- Control invasive non-native species. *Rubus armeniacus* is one species that is becoming established at the Smith Lake and 100 Acre North sites, that could more easily be controlled in these early stages of invasion.

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Appendix A

Introduction of *Sidalcea nelsoniana* on the Ridgefield National Wildlife Refuge

December 2007

Jeff Dillon, U.S. Fish and Wildlife Service

Report Date September 18, 2008

Introduction of *Sidalcea nelsoniana* on the Ridgefield National Wildlife Refuge, Clark County, Washington
December 2007

Sidalcea nelsoniana

The *Sidalcea nelsoniana*, Nelson's checkermallow, (listed as threatened in February 1993) occurs from southern Linn County and Benton County, Oregon, to Lewis County, Washington. The bulk of the population occurs in the Willamette Valley with only two known populations occurring in Washington. Four other native *Sidalcea* species (*Sidalcea malviflora* ssp. *virgata*, *Sidalcea campestris*, *Sidalcea cusickii,* and *Sidalcea hirtipes*) are found within the geographic range of *Sidalcea nelsoniana*. However, no known species of *Sidalcea* naturally occurs on the Ridgefield National Wildlife Refuge (RNWR).

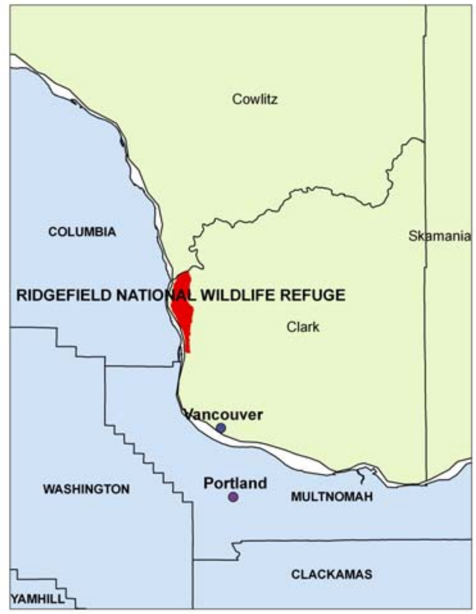
Sidalcea nelsoniana is an herbaceous perennial plant in the mallow family (Malvaceae). It produces numerous elongate, branched **i**nflorescences 50 to 150 cm (20 to 60 inches) tall, consisting of a vertical stem with 30 to 100 lavender to deep pink flowers clustered in spike-like racemes. In the Willamette Valley, *Sidalcea nelsoniana* begins flowering as early as mid-May, and continues through August to early September, depending upon the moisture and climatic conditions of each site. Above-ground portions of the plant die back in the fall, usually followed by some degree of regrowth at the base, with the emergence of small, new leaves that persist through the winter directly above the root crown.

Sidalcea nelsoniana is known from wet prairies and stream sides and, although occasionally occurring in the understory woodlands, populations usually occupy open habitats supporting early seral plant species. These native prairie remnants are frequently found at the margins of sloughs, ditches, and streams, roadsides, fence rows, drainage swales and fallow fields.

Ridgefield National Wildlife Refuge

The RNWR is located in Clark County on the outskirts of Ridgefield, Washington, along the Columbia River. The RNWR was established to provide wintering habitat for waterfowl, especially dusky Canada geese. The RNWR has acquired approximately 5,300 acres. The RNWR contains a mosaic of seasonal wetlands, permanent wetlands, grasslands, upland forests, riparian corridors, oak woodlands, and cropland. Management emphasis is to provide habitat for wintering waterfowl.

The RNWR currently manages water levels on about 1,000 acres of wetlands on the River S, Bachelor Island, and Ridgeport Dairy Units. Water control structures can provide management of water levels within the wetlands. The water delivery system provides water to wetlands during the winter for a variety of water birds, and is used to hold water in some units for vegetation management, rearing of ducks, and to support native amphibians/reptiles.



Introduction of *Sidalcea nelsoniana*

In December 2007, five *Sidalcea nelsoniana* plots were established on the RNWR. In total, 2,530 plugs were planted in five plots ─ 1) Hundred Acre South (400 plants), 2) Hundred Acre North (180 plants), 3) Smith Lake (1,801 plants), 4) Texas Island (100 plants), and 5) the Kiwa Trailhead (49 plants) (see Figure 1). The first three plots are located on Bachelor Island Unit and the last two units are located on the River "S" Unit. Site preparation was only implemented on the Smith Lake plot. The remaining four plots were mowed in the fall of 2007.

After planting, plots were visited approximately every two to three weeks until February to check on the plants. As plots 1 through 4 are in high use areas for geese, it was necessary to visit each site to replant plugs pulled from the ground by wintering geese. The geese definitely keyed in on the high nutrient content in the leaves and root collar of the greenhouse grown plugs. Hundred Acre South was the hardest hit by geese but, with perseverance, a majority of the plugs survived into the summer. Once the plugs started putting out new root growth into the surrounding soil in February, it became impossible for the geese to pull the plugs out of the ground. The wintering geese left for the breeding grounds in April.

A site visit to all five introduction sites for *Sidalcea nelsoniana* was conducted in early July 2008. All sites had blooming plants and varying levels of competitive vegetative growth.

<u>Hundred Acre South</u> (Site 1)

Hundred Acre South is split diagonally nearly in the middle by pasture mix in the southwest half and reed canary grass in the northeast half (Figure 2). This site had numerous plugs (up to 200) pulled from the ground repeatedly during December, January and February by wintering Canada and Cackling geese. Several visits and continual replanting of the plugs accomplished a 70 to 80 percent survival of the 400 plugs first planted.

The *Sidalcea nelsoniana* planted in the pasture mix area was on a drier site and the pasture mix growth reached only about 12 to16 inches tall. The *Sidalcea nelsoniana* responded by matching its flowering stalk to the surrounding vegetation (12 to16 inches tall) (Figure 3). Over 60 percent of the plants in this pasture mix were found to be flowering. Due to the short vegetation, it was comparatively easier to locate non-flowering *Sidalcea nelsoniana* (Figure 4).

The *Sidalcea nelsoniana* planted in the reed canary grass area was on a wetter site and the reed canary grass was 14 to 54 inches tall. The *Sidalcea nelsoniana* again responded by matching its flowering stalk to the surrounding vegetation (Figure 5). There were several *Sidalcea nelsoniana* plants in the tallest reed canary grass that were over four feet tall and greater than a quarter inch in diameter at the base (Figures 6 and 7). These plants were found to be very robust in size (often comprising 2 to 4 stems). It was interesting to observe *Sidalcea nelsoniana* plants to be matching the surrounding vegetation inch for inch in growth. There seemed to be fewer *Sidalcea nelsoniana* per area along the line between the two plant communities.

<u>Hundred Acre North</u> (Site 2)

Hundred Acre North is primarily a pasture mix plant community (Figure 8). It is located on the west side of a slough and approximately 6 to 8 feet above summer water level. This site also sustained multiple heavy predation by grazing geese but also predation by nutria from the nearby slough. Although 160 plants were planted at this site, only three individuals were found in July and these were very small in size (Figure 9). Site was very dry in early July and when plants did not flower, locating them was pretty difficult. Therefore, more plants may be still alive but merely small in size. A site visit next early June will better inform us of the success of the introduction.

<u>Smith Lake</u> (Site 3)

The Smith Lake site is located on the other side of the slough from Hundred Acre North and 1,801 *Sidalcea nelsoniana* were planted here. This was the only site that was disked and planted with native grass seed (Roemer's fescue *Festuca roemerii*, Columbia brome Bromus *vulgaris*, California oat grass *Danthonia californica*, meadow barley *Hordeum brachyantherum*, blue wild rye *Elymus glaucus*, and tufted hairgrass *Deschampsia cespitosa* [last species was old seed; germination rate may not have been good]) (Figure 10).

Over 90 percent of the *Sidalcea nelsoniana* are still present on the site and over 80 percent produce at least one flowering stalk. Due to the prepared field, it was pretty easy to look down each row of *Sidalcea nelsoniana* and see all of the plants in the row (and the spots where the plants are missing) (Figure 11). As with the previous fields, the flowering stalks matched the surrounding vegetation height. The vegetated growth of the native grass was fairly short, with most of the area reaching only 8 to 14 inches, and not very dense (Figure 12). *Sidalcea nelsoniana* seemed to do quite well on the site often producing multiple blooming stems (Figure 13) and producing seed in the first growing season (Figure 14). A low spot in the northeast corner has some fairly substantial surface cracks in early July but the plants that survived the inundation seemed to be surviving quite well (Figure 15).

The geese did not seem to use this field much which was probably due to the small amount of growth of the native grasses last winter. Nutria did some small damage but not like in Hundred Acre North. The nutria may have felt too exposed in the field or there was not enough vegetation to attract them.

Texas Island (Site 4)

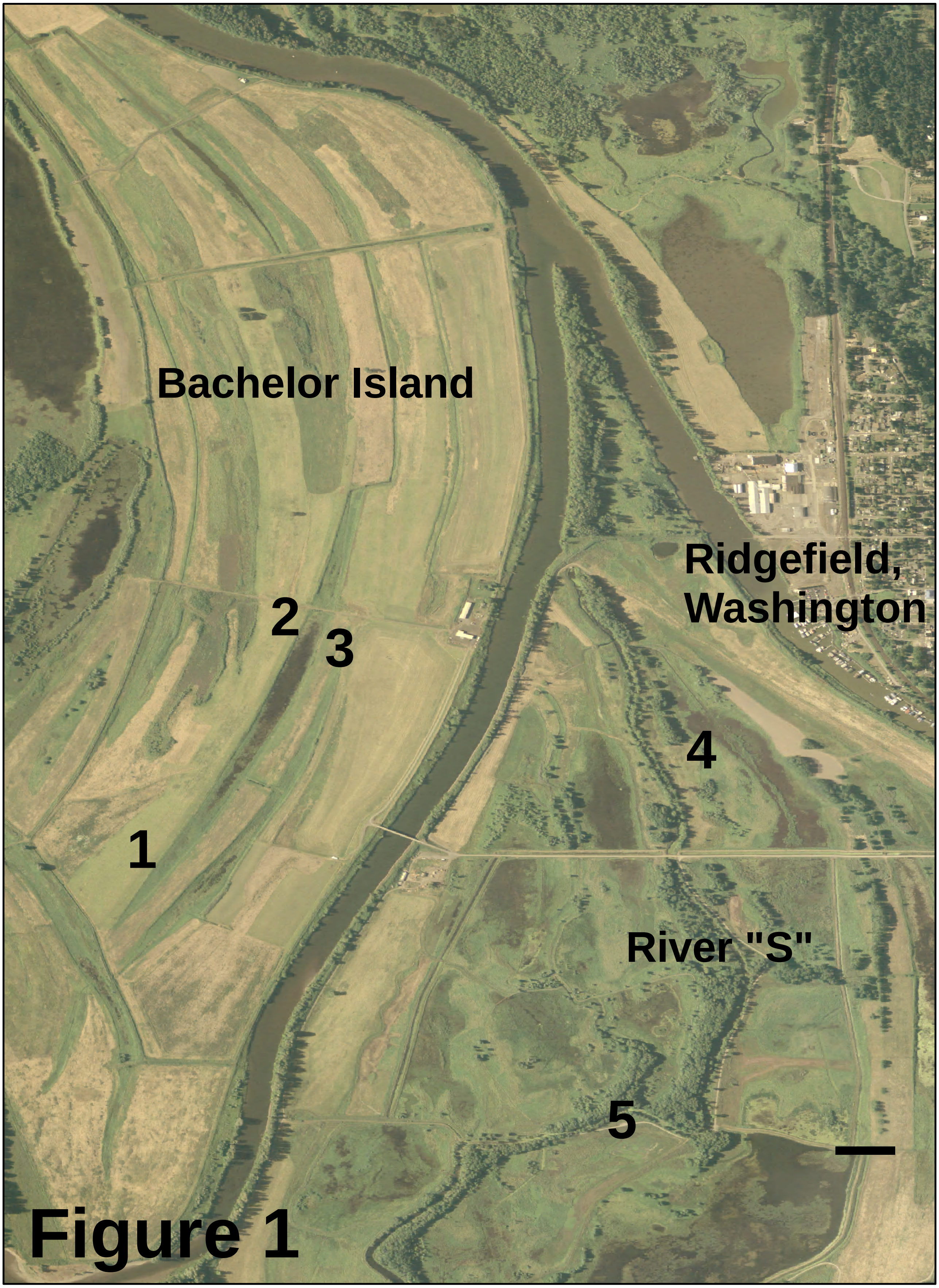
Texas Island was the first field planted with 100 *Sidalcea nelsoniana* on a 10 ft by 10 ft spacing (Figure 16). The site was mowed in early fall of 2007 before planting with *Sidalcea nelsoniana*. There was a fair amount of vole activity in evidence during planting. Most of the plants were producing new leaves in late February. In early July, the surrounding vegetation was thick and nearly 36 inches tall (Figure 17). Only five to six plants were evident and these were all producing flowering stalks (Figure 18). Other *Sidalcea nelsoniana* most likely occurs at this site but are hidden in the dense vegetation. The corners of the plot had been marked with wooden stakes. Although four stakes marked the corners of the plot, no stakes could be located in the dense vegetation (perhaps they have been pulled). Vegetation may need to be thinned on this site if we want to continue with this plot.

Kiwa Trailhead (Site 5)

The Kiwa plot had the heaviest density of vegetation of all the plots (Figure 19). Vegetation was five to six feet tall and very thick. I was only able to locate three plants and that was due to the visibility of the flowering heads in the upper portion of the surrounding vegetation. Vole damage was noted in late winter. Voles seemed to create a burrow entrance at the location of several *Sidalcea nelsoniana* plugs. But by late winter, a majority of the plants were still in place. So it is probable that more than three *Sidalcea nelsoniana* still exist at this site.

Figures

Introduction Sites for Nelson's checkermallow



No warranty is made by the U.S. Fish and Wildlife Service as to the accuracy, reliability, or completeness of these data for individual or aggregate use with other data. Original data were compiled from various sources. Spatial information may not meet National Map Accuracy Standards. This information may be updated without notification.

0 0.2 0.4 0.8 Miles

December 2007

Figure 2. Hundred Acre South – Plot is located between hack tower in foreground and planted field in background. Denser growth of reed canary grass can be seen on the center right of the picture.

Figure 3. Hundred Acre South – *Sidalcea nelsoniana* located in the pasture mix portion of the plot.

Figure 4. Hundred Acre South – *Sidalcea nelsoniana* without a flowering stem located in the pasture mix portion of the plot.

Figure 5. Hundred Acre South – *Sidalcea nelsoniana* (purple circles) located in the reed canary grass portion of the plot.

Figure 6. Hundred Acre South – *Sidalcea nelsoniana* in 4.5 foot tall reed canary grass.

Figure 7. Hundred Acre South – Same single *Sidalcea nelsoniana* as Figure 6 but reed canary grass pulled back to reveal nearly entire plant. Note robust stems and leaves.

Figure 8. Hundred Acre North – Plot is located in center of picture (bordered by tall vegetation along the slough and out to the tall shrub along the slough).

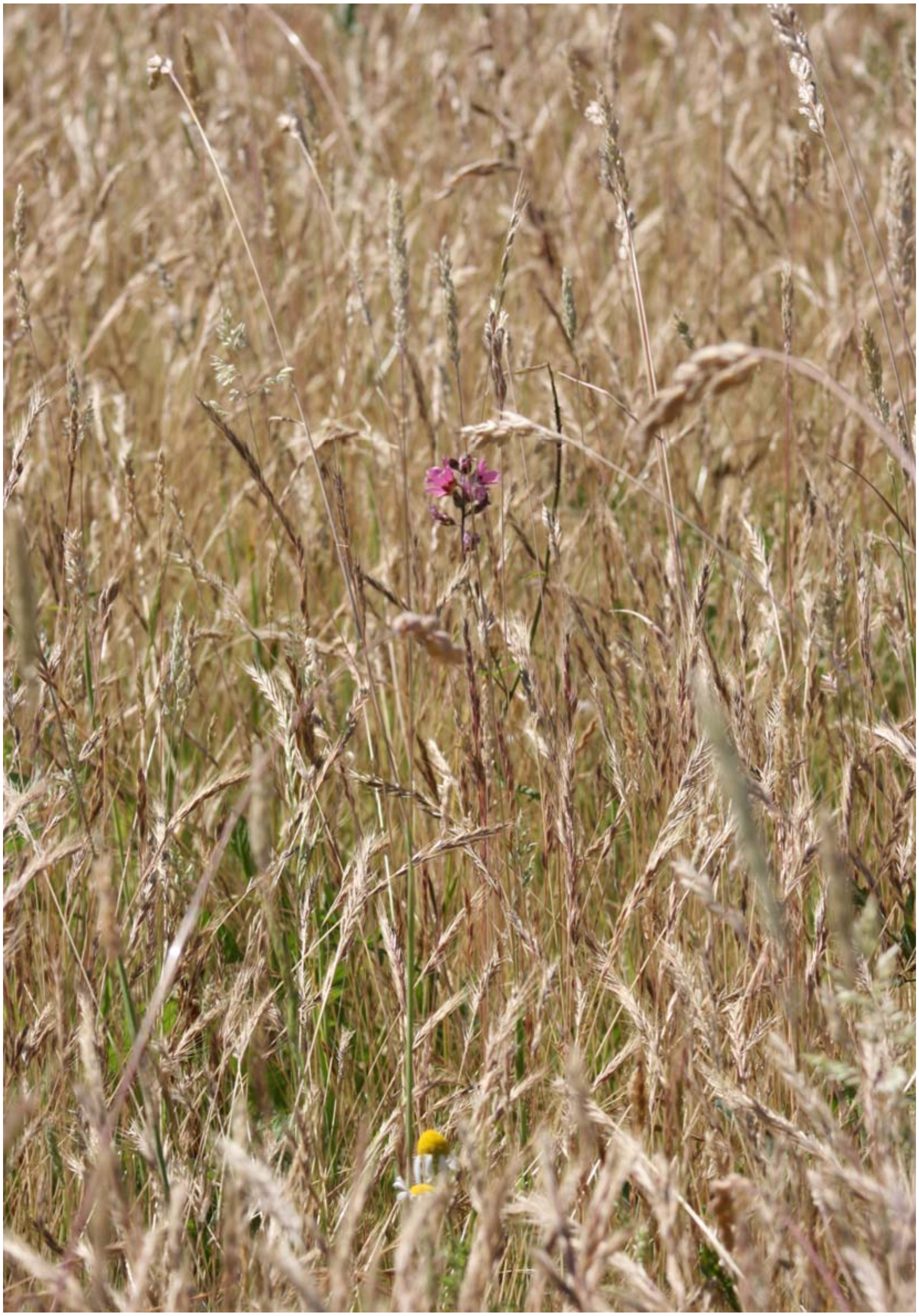


Figure 9. Hundred Acre North – One of three *Sidalcea nelsoniana* plants found blooming. Surrounding vegetation is a pasture mix.

Figure 10. Smith Lake plot in December 2007. Pin flags mark planting locations. Ground cover is native grass seed planted earlier in the Fall.

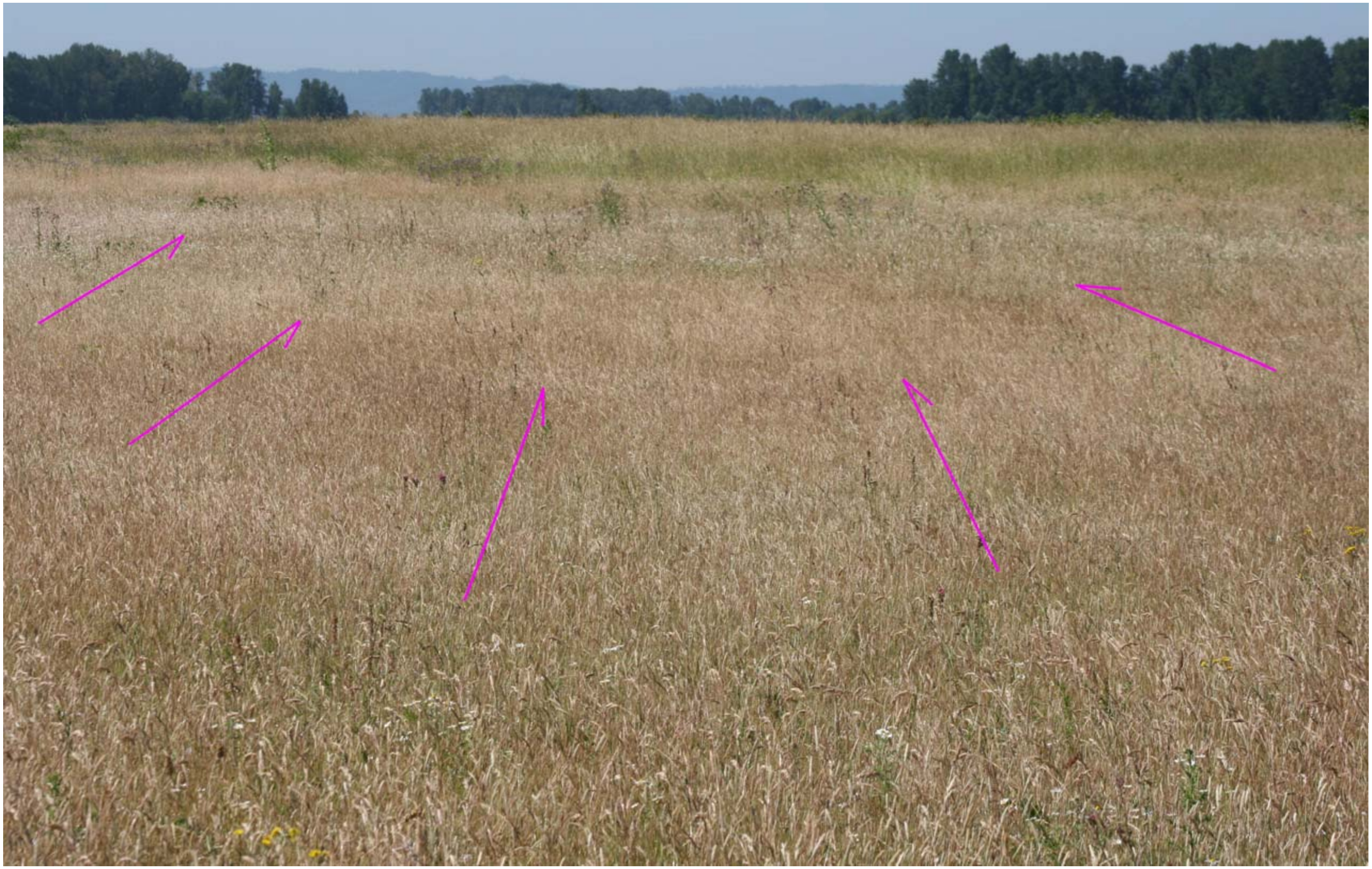


Figure 11. Smith Lake – Smith Lake plot in July 2008. On the left of each arrow is a row of *Sidalcea nelsoniana* most of which are blooming.

Figure 12. Smith Lake – Typical *Sidalcea nelsoniana* on this plot.

Figure 13. Smith Lake – Fairly robust plant for the site.

Figure 14. Smith Lake – *Sidalcea nelsoniana* flowers with developing seeds.

Figure 15. Smith Lake – *Sidalcea nelsoniana* in low area in this plot where ground cracking was quite evident.

Figure 16. Texas Island – Volunteer planting crew (17 people of all ages) came out on a rainy Sunday afternoon to plant *Sidalcea nelsoniana* (early December 2007).

Figure 17. Texas Island – There are *Sidalcea nelsoniana* in there somewhere (early July 2008).

Figure 18. Texas Island – Found one.

Figure 19. Kiwa Trailhead – It's a jungle out there. Vegetation is four to six feet tall and very dense. For reference, trail starts between the large post at the top center of the picture and the vehicle is a Hybrid Ford Escape.

Appendix B Monitoring survival of *Sidalcea nelsoniana* plantings at Ridgefield National Wildlife Refuge, 2009 and 2010.

2009: May 12, 2009 Survival monitoring by Jeff Dillon, Judy Lantor, and Joe Arnett. June 10, 2009 flowering monitoring by Jeff Dillon, Kate Norman, and Joe Arnett.

2010: Smith Lake and 100 acre field monitoring June 1, 2010 by Judy Lantor, Alex Chmeilewski, and Joe Arnett. Texas Island monitoring June 14, 2010 by Rex Crawford and Joe Arnett

Smith Lake

Counts are by row, starting along the water to the south. Bold number indicates two plants at one planting point. Estimated total planting of 1,846 plugs, 36 rows of 46 and 10 rows of 19

	2009		2010	
	survival	flowering	survival	flowering
	30	29	26	25
	39	37	37	35
	38	38	38	37
	39	39	38	37
	44	39	40	40
	40	41	43	42
	43	41	42	40
	43	40	40	36
	40	36	29	26
	43	38	43	42
	41	40	37	37
	45	44	39	39
	43	42	42	42
	45	43	39	33
	43	42	33	27
	42	36	38	37
	44	37	43	39
	45	42	38	36
	46	44	43	42
	45	45	43	42
	46	40	44	44
	46	42	46	45
	45	42	45	45
	44	44	44	44
	44	44	43	42
	41	43	43	43
	44	43	41	41
	44	41	43	43
	42	42	41	40
	44	45	45	45
	45	43	44	43
	42	37	40	38
	43	38	38	35
	46	47	42	39
	43	38	30	29

	43	34	38	37
	17	7	4	7
	19	16	16	5
	15	15	5	3
	18	9	13	8
	17	15	11	6
	17	11	5	5
	18	12	9	9
	19	15	21	13
	19	14	25	15
	11	5	7	6
Total	**1,710**	**1,575**	**1554**	**1464**
Percent	**92.6**	**85.3**	**84**	**79**
One Hundred Acre North				
Counts are by row, starting along the side closest to the water. Total planting of 160 plugs, 6' x 6' spacing				
	survival	flowering	survival	flowering
	12	2	3	3
	15	9	19	15
	25	17	23	19
	25	20	26	26
	20	14	21	18
	7	3	5	3
Total	**104**	**65**	97	84
Percent	**65**	**40.6**	61	53
One Hundred Acre South, hacking tower site				
Counts are by row, starting on the uphill edge, parallel to the water. Total planting of 400 plugs, 6' x 6' spacing				
	survival	flowering	survival	flowering
	34	8	22	15
	30	12	32	29
	31	14	26	23
	25	18	30	26
	20	17	27	25
	20	21	21	20
	14	27	19	19
	12	20	16	15
	9	26	12	12
		15	6	4
Total	**195**	**163**	**211**	**188**
Percent survival	**48.8**	**40.8**	**53**	**47**

Texas Island				
Counts are by row, starting on the downhill edge, parallel to the water. Total planting of 100 plugs planted 9Dec2007, 10' x 10' spacing. 5 or 6 flowering plants seen July 2008				
	survival	flowering	survival	flowering
			1	1
	5	2	2	2
	3	3	1	1
	6	1	3	2
	3	3	2	1
	3	4	1	1
	4	3	3	2
	8	5	4	4
	7	3	4	1
	6	5	7	4
	8	7	6	3
Total	**53**	**36**	**34**	**22**
Percent survival	**53**	**36**	**34**	**22**

Appendix C: Vascular plant species recorded at Ridgefield NWR

Sources : X=Arnett site visits 2007-2010; including Carty Unit visit with Melissa Kirkland, Wes Messinger, Alexis Casey, Shannon Archuleta, and others on May 1, 2008; and Kiwa Trail with Nathan Reynolds June 12, 2008; W=WNPS list, July 1986; CP=Christy and Putera 1992; WG= Wiberg and Greene 1981.

Species	common name	origin	River S Unit, Kiwa trail area and trailhead; Transect 1	River S Unit, Midlands Meadow, Canvasback Lake, Transect 2	River S Unit, Ruddy Lake area, Transect 3	Carty Unit, Blackwater Lakes RNA	Complete Ridgefield NWR
Acer circinatum	vine maple	native				WG	WG
Acer macrophyllum	bigleaf maple	native				WG	WG
Achillea millefolium	yarrow	native and introduced				WG	WG
Actaea rubra	baneberry	native				X	X
Agrostis capillaris (A. tenuis)	colonial bentgrass	introduced	X				X
Aira caryophyllea	silver hairgrass	introduced	X				X
Alisma plantago-aquatica	water plantain	native		X		WG	WG, X
Alnus rubra	red alder	native				WG	WG
Alopecurus geniculatus	water foxtail	native		X			X
Alopecurus pratensis	meadow foxtail	introduced				X	X
Amelanchier alnifolia	serviceberry	native				WG, X	WG, X
Amorpha fruticosa	false indigo	introduced	X				X
Anaphalis margaritacea	pearly everlasting	native				WG	WG
Anthemis cotula	dog fennel	introduced				WG	WG
Anthoxanthum odoratum	sweet vernalgrass	introduced	X	X		X	X
Anthriscus caucalis (=A. scandicina)	burr chervil	introduced	X			X	X
Aphanes occidentalis (Alchemilla)	parsley piert	native				X	X
Aquilegia formosa	columbine	native				WG	WG
Arctium minus	common burdock	introduced				X	WG, X
Arnica amplexicaulis	clasping arnica	native				WG	WG
Asplenium trichomanes	maidenhair spleenwort	native				X	X
Aster species	aster					WG	WG
Athyrium filix-femina	lady fern	native				WG, X	WG, X

Barbarea verna	early wintercress	introduced				X	X
Barbarea vulgaris	bitter wintercress	introduced				X	X
Barberea orthoceras	American wintercress	native				WG	WG
Bellis perennis	English daisy	introduced				WG	WG
Berberis aquifolium	hollyleaved Oregon-grape	native				WG, X	WG, X
Berberis nervosa	Cascade oregon-grape	native				WG	WG
Bidens vulgata	tall beggerticks	introduced		X		WG	WG
Brassica rapa ssp. *campestris*	common mustard	introduced				X	X
Bromus diandrus (B. rigidus)	ripgut brome	introduced				X	X
Bromus species	brome	introduced				WG	WG
Bromus sterillis	barren brome	introduced				WG, X	WG, X
Callitriche sp.	water-starwort	native				X	X
Camassia quamash	blue camas	native				WG, X	X, W, WG
Campanula scouleri	Scouler's bluebells	native				WG	WG
Capsella bursa-pastoris	shepherd's-purse	introduced				WG	WG
Cardamine hirsuta	hairy bittercress	introduced	X			X	X
Cardamine nuttalii (C. pulcherrima)	slender toothwort	native				WG	WG
Cardamine oligosperma	little western bittercress	native				X	X
Cardamine pennsylvanica	Pennsylvania bittercress	native				X	X
Carduus pycnocephalus	Italian thistle	introduced	x				x
Carex aquatilis	water sedge	native				X	X
Carex interrupta	green-fruited sedge	native					CP
Carex spp.	sedge	native				X	X
Centaurium erythraea	European centaury	introduced	X				X
Cerastium dubium	doubtful chickweed	introduced				WG	WG
Cerastium glomeratum (=C. viscosum)	sticky chickweed	introduced				WG, X	WG, X
Cirsium arvense	Canada thistle	introduced	X		X	WG	X, WG
Cirsium vulgare	bull thistle	introduced			X	x	X
Claytonia perfoliata ssp. *perfoliata (=Montia perfoliata)*	miner's-lettuce	native				W, X	W, WG, X
Collinsia parviflora	small-flowered blue-eyed Mary	native				WG, x	x, WG

Collinsia sparsiflora var. bruciae	few-flowered blue-eyed Mary	native				WG, W	W, WG
Collomia grandiflora	large-flowered collomia	native				WG	WG
Convolvulus arvensis	bindweed	introduced	X		X		X
Coreopsis tinctoria (C. atkinsoniana)	golden tickseed	native				WG	WG
Cornus sericea (=C. stolonifera)	red-osior dogweed	native	X			WG, X	WG, X
Corylus cornuta	beaked hazelnut	native				WG	WG
Crataegus douglasii	black hawthorn	native					WG
Crataegus douglasii var. suksdorfii	black hawthorn	native				X	X
Crataegus monogyna	English hawthorn	introduced	X				X
Crepis capillaris	smooth hawksbeard	introduced	X				X
Crocidium multicaule	spring gold	native				WG	WG
Cystopteris fragilis	fragile fern	native				X	X
Dactylis glomerata	orchardgrass	introduced	X			WG, X	WG, X
Daucus carota	Queen Anne's lace	introduced	X			WG	WG, X
Delphinium nuttallii	Nuttall's larkspur	native				WG, X	WG, X
Dipsaucus fullonum (D. sylvestris)	teasel	introduced	X	X		X	X
Dryopteris arguta	marginal wood fern	native				WG, X	WG, X
Echinochloa crus-galli	barnyard grass	introduced	X				X
Eleocharis palustris	common spikerush	native			X		X, CP
Elymus glaucus	blue wildrye	native			X		X
Elymus repens (=Agropyron repens, Elytrigia repens)	quackgrass	introduced	X				X
Elymus trachycaulis var. trachycaulis (Agropyron caninum)	bearded wheatgrass	native				WG	WG
Epilobium angustifolium	fireweed	native				WG	X, WG
Epilobium ciliatum ssp. watsonii	willowherb	introduced			X	X	X
Epilobium minutum	dwarf willowherb	native				WG	WG
Equisetum arvense	common horsetail	native	X				X
Eriophyllum lanatum	woolly sunflower	native				X	X
Erodium cicutarium	crane's-bill	introduced				W, WG	W, WG
Erythronium oreganum	fawn lily	native				W, WG, X	W, WG, X
Fragaria vesca	woods strawberry	native				WG, X	WG, X
Fragaria virginiana ssp. platypetala	broadpetal strawberry	native				W	W

Fraxinus latifolia	Oregon ash	native	X			WG, X	X, CP, WG
Fritillaria affinis	checker lily	native				W, WG, X	W, WG, X
Galium aparine	bedstraw, cleavers	native				X	X
Galium trifidum	small bedstraw	native				WG	WG
Galium triflorum	fragrant bedstraw	native				WG	WG
Gaultheria shallon	salal	native				WG	WG
Geranium dissectum	cut-leaf geranium	introduced	x				x
Geranium molle	dovefoot geranium	introduced				W, WG, X	W, WG, X
Geranium pusillum	small-flowered crane's-bill	introduced				WG	WG
Geum macrophyllum	Oregon avens	native				X	WG, X
Geum trifllorum	prairie smoke	native				X	X
Glecoma hederacea	creeping charlie	introduced				WG, W, X	W, WG, X
Gnaphalium uliginosum	marsh cudweed	introduced				WG	WG
Helenium autumnale	sneezeweed	native				WG	WG
Holcus lanatus	velvetgrass	introduced	X		X	WG, X	WG, X
Holodiscus discolor	oceanspray	native				WG, X	WG, X
Hordeum brachyantherum	meadow barley	native				WG	WG
Howellia aquatilis	water howellia	native				X	X
Hypericum perforatum	Klamathweed, St. John's-wort	introduced			X	X	X
Hypochaeris radicata	hairy cat's-ear	introduced	X			WG, X	WG, X
Impatiens capensis	spotted jewelweed	introduced				WG, X	WG, X
Iris pseudacorus	yellow iris	introduced	X				X
Juncus acuminatus	sharp-fruited rush	native			X		X
Juncus effusus	smooth rush	native and introduced		X	X		X
Lamium purpureum	red deadnettle, red henbit	introduced				X	X
Lathyrus latifolius	everlasting peavine	introduced				WG	WG
Lathyrus polyphyllus	leafy pea	native				W	W
Lemna minor	duckweed	native				WG	CP, WG
Lepidium virginicum	tall peppergrass	native				X	X
Leucanthemum vulgare (=Chrysanthemum leucanthemum)	oxeye daisy	introduced				WG	WG
Lilium columbianum	tiger lily	native				WG	WG

Lindernia dubia	lindernia, false-pimpernel	native					CP
Lithophragma parviflorum	small-flowered prairie star	native				W, WG, X	W, WG, X
Lolium multiflorum	Australian ryegrass	introduced				WG	WG
Lonicera ciliosa	orange honeysuckle	native				WG	WG
Lotus corniculatus	birdfoot trefoil	introduced	X	X	X		X
Lotus micranthus	small-flowered deervetch	introduced	X				X
Ludwigia palustris	marsh primrose-willow	native					CP
Lysichiton americanum	skunk cabbage	native				WG	WG
Lysimachia nummularia	creeping jenny	introduced				WG, X	WG, X
Maianthemum dilatatum	lily-of-the-valley	native				X	X
Maianthemum racemosum (=Smilacina racemosa)	plumed solomonseal	native				X	X
Maianthemum stellatum (=Smilacina stellata)	star-fower solomonseal	native				W, X	W, X
Malus fusca	western crabapple	native				X	X
Matricaria discoidea (=M. matricarioides)	pineapple weed	introduced			X		X
Matricaria matricariodes	pineapple plant	introduced			X		X
Mentha arvensis	corn mint	native				WG	WG
Mentha pulegium	pennyroyal	introduced			X		X
Micranthes gormanii (Saxifraga occidentalis var. *dentata*	Gorman's saxifrage	native				X	X
Micranthes integrifolia (Saxifraga integrifolia)	whole-leaf saxifrage	native				X	X
Micranthes occidentalis (Saxifraga occidentalis)	western saxifrage	native				WG, X	WG, X
Mimulus alsinoides	chickweed monkeyflower	naitve				X	X
Mimulus guttatus	yellow monkeyflower	native				WG, X	WG, X
Moehringia macrophylla (Arenaria macrophylla)	large-leav sandwort	native				WG	WG
Montia howellia	Howell's montia					X	X
Montia linearis	narrow-leaved montia	native				X	X
Mycelis muralis (Lactuca muralis)	wall lettuce	introduced				X	X
Myosotis discolor	yellow and blue forget-me-not	introduced				W, WG, X	W, WG, X
Myosotis laxa	small forget-me-not	native				WG	WG

Myosotis sylvatica	wood forget-me-not	introduced				X	X
Myosurus minimus	tiny mousetail	native				X	X
Navarrettia squarrosa	skunkweed	native				WG	WG
Nemophila parviflora	small-flowered nemophila	native				W, X	W, X
Nepeta cataria	cat-nip	introduced				WG	WG
Nuphar polysepalum	yellow water-lily	native				WG	WG
Oemleria cerasiformis	Indian plum	native	X			WG, X	WG, X
Oenanthe sarmentosa	water-parsley	native				WG	WG
Orobanche uniflora	naked broom-rape	native				WG	WG
Osmorhiza chilensis	mountain sweet-cicely	native				WG, x	WG, x
Parentucellia viscosa	yellow parentucellia	native	X		X	WG, x	WG, x
Paspalum distichum	knotgrass	native					CP
Persicaria hydropiperoides (Polygonum hydropiperoides)	swamp smartweed	native					CP
Persicaria punctata (Polygonum punctatum)	dotted smartweed	native				WG	WG
Phacelia heterophylla	varileaf phacelia	native				X	X
Phacelia nemoralis	woodland phacelia	native				W	W
Phalaris arundinacea	reed canarygrass	introduced	X	X	X	X	X
Philadelphus lewisii	mock-orange	native				WG	WG
Physostegia parviflora	physostegia	native				WG	WG
Pityrogramma triangularis	goldback fern	native				X	X
Plagiobothrys scouleri var. scouleri	Scouler's popcorn-flower	native				X	X
Plantago lanceolata	English plantain	introduced	X		X	WG, X	WG, X
Plantago major	common plantain	introduced	X		X	WG, X	WG, X
Plectritis congesta	seablush	native				WG, W, X	X, W, WG
Poa compressa	flat-stem bluegrass	introduced				WG	WG
Poa palustris	fowl bluegrass	introduced				WG	WG
Polygonum aviculare	common knotweed	introduced			X		X
Polypodium glycyrrhiza	licorice fern	native				WG, X	WG, X
Polysticum munitum	sword fern	native				WG	WG
Populus balsamifera ssp. *trichocarpa*	cottonwood	native	X		X	WG	WG, X

Potentilla glandulosa	gland cinquefoil	native				WG	WG
Prunella vulgaris	self-heal	native and introduced				WG, X	WG, X
Prunus virginiana var. demissa	chokecherry	introduced				X	X
Pseudotsuga menziesii	Douglas-fir	native				WG, X	WG, X
Pyrus fusca	Western crabapple	native				WG	WG
Quercus garryana	Oregon white oak	native				WG, W, X	WG, W, X
Ranunculus aquatilis	water buttercup	native				X	X
Ranunculus occidentalis var. occidentalis	western buttercup	native				W, X	W, X
Ranunculus orthorhynchus	straight-beak buttercup	native				WG, X	WG, X
Ranunculus repens	creeping buttercup	introduced			X	WG	WG, X
Ranunculus sardos	hairy buttercup	introduced				WG	WG
Ranunculus sceleratus var. *multifidus*	celeryleaved buttercup	native	X				X
Ranunculus uncinatus	little buttercup	native				WG, X	WG, X
Rhamnus purshiana	cascara	native				WG, X	WG, X
Ribes sanguineum	red-flowering currant	native				WG	WG
Rorippa palustris (R. Islandica)	marsh yellowcress	native				WG	WG
Rosa eglanteria	sweetbriar	introduced				WG	WG
Rosa gymnocarpa	baldhip rose	native				WG	WG
Rosa nutkana	Nootka rose	native				WG	WG
Rosa pisocarpa	clustered rose	native				WG	WG
Rubus armeniacus (R. discolor)	Himalayan blackberry	introduced	X		X	WG, W, X	WG, W, X
Rubus laciniatus	evergreen huckleberry	native	x			WG	WG, X
Rubus leucodermis	blackcap	native				WG	WG
Rubus macrophyllus	large-leaved blackberry	introduced				WG	WG
Rubus parviflorus	thimbleberry	native				WG, X	WG, X
Rubus spectabilis	salmonberry	native				WG	WG
Rubus ursinus ssp. *macropetalus*	trailing blackberry	native				WG, X	WG, X
Rumex acetosella	sheep sorrel	introduced				X	X
Rumex conglomeratus	clustered dock	introduced				WG	WG
Rumex crispus	curly dock	introduced	X			WG	WG, x
Sagittaria latifolia	wapato	native					X, CP

Salix lucida (=S. lasiandra)	Pacific willow	native	X			WG, X	WG, X, CP
Salix sessilifolia	soft-leaved willow	native					CP
Sambucus racemosa var. racemosa (=Sambucus racemosa var. *arborescens)*	red elderberry	native				WG	WG
Sanicula crassicaulis	Pacific blacksnakeroot	native				X	X
Schedonorus arundinaceus (Festuca arundinacea)	tall fescue	introduced	X				X
Schoenoplectus mucronatus	ricefield bulrush	introduced	X		X		X
Schoenoplectus tabernaemontani (Scirpus validus)	soft-stem bulrush	native	X				X
Sedum lanceolatum	lanceleaved stonecrop	native				X	X
Sedum leibergii	Leiberg's sedum	native				WG	WG
Selaginella wallacei	Wallace's spikemoss	native				X	X
Senecio jacobaea	tansy ragwort	introduced	X			WG, X	WG, X
Solanum dulcamara	bittersweed nightshade	introduced			X	WG, X	WG, X
Solidago lepida var. lepida (S. canadensis)	Canada goldenrod	native				WG	WG
Sonchus asper	prickly sowthistle	introduced	X				X
Sparganium sp.	bur-reed	native			X		X
Spiraea douglasii	hardhack	native				WG, X	WG, X
Stellaria media	common chickweed	introduced				WG, X	WG, X
Symphoricarpos albus var. *laevigatus*	snowberry	native				WG, X	WG, X
Taraxacum officinale	dandilion	introduced	X			WG, W, X	WG, W, X
Tellima grandiflora	fringecup	native				WG, W, X	WG, W, X
Thallictrum sp.	meadow-rue	native				WG	WG
Thuja plicata	western redcedar	native				WG	WG
Tillaea aquatica	pygmy-weed	native					CP
Tolmiea menziesii	youth-on-age	native				WG, W	WG, W
Tonella tenella	small-flowered tenella	native				W	W
Toxicodendron diversilobum	poison-oak	native				WG, X	WG, X
Trientalis borealis ssp. *latifolia (=T. latifolia)*	western starflower	native				WG, W	WG, W
Trifolium arvense	rabbit-foot clover	introduced	X				X
Trifolium dubium	least hop-clover	introduced				X	X
Trifolium hybridum	Alsike clover	introduced	X			WG	WG, X

Trifolium oliganthum	few-flowered clover	native				X	X
Trifolium pratense	red clover	introduced	X				X
Trifolium procumbens	hop clover	introduced	X			WG	WG, X
Trifolium repens	white clover	introduced	X				X
Trifolium subterraneum	subterranean clover	introduced				W	W
Trillium ovatum	common trillium	native				WG	WG
Trillium parviflorum	small-flowered trillium	native				X	X
Triphysaria pusilla (=Orthocarpus pusillis)	dwarf owl-cover	native				W	W
Tripleurosperm cf. inodorum (Matricaria inodorum)	scentless camomile	introduced	X				X
Triteleia hyacinthina (=Brodiaea hyacinthina)	hyacinth brodiaea	native					WG
Typha latifolia	cattail	native	X			WG	WG, X
Urtica dioica ssp. *gracillis*	stinging nettle	native	X			WG, W, X	WG, W, CP, X
Valerianella locusta	European corn-salad	introduced				WG	WG
Valerianella sp.	valerianella	introduced				X	X
Verbascum blattaria	moth mullein	introduced	X			WG	WG, X
Verbascum thapsus	flannel mullein	introduced	X			WG, X	WG, X
Veronica americana	American brooklime	native				WG	WG
Veronica filiformis	thread-stalk speedwell	introduced				WG	WG
Veronica scutellata	marsh speedwell	native				X	X
Veronica serpyllifolia var. serpyllifolia	thyme-leaved speedwell	introduced				X	X
Viburnum ellipticum	oval-leaved viburnum	native				WG, X	WG, X
Vicia americana	American vetch	native				WG	WG
Vicia cracca	bird vetch	introduced	X				X
Vicia hirsuta	tiny or hairy vetch	introduced			X	WG, X	WG, X
Vicia sativa	common tare	introduced				X	X
Vinca major	periwinkle	introduced				X	X
Viola glabella	wood violet	native				WG, W	WG, W
Viola langsdorfii	Aleutian violet	native				WG	WG
Viola septentrionalis	northern violet	native				WG	WG
Vulpia bromoides	barren or six-weeks fescue	introduced	X				X
Vulpia myuros	rat-tail six-weeks grass	introduced	X				X
Xanthium strumarium	cocklebur	native				WG	WG

Appendix D

Report on rare plants and ecosystems at Ridgefield NWR
from the Washington Natural Heritage Program Biotics database

October 8, 2010

***Quercus garryana / Viburnum ellipticum - Toxicodendron diversilobum Woodland* - 001 -** Oregon White Oak / Oval-leaf Viburnum - Poison-oak

Confirmed: Y **ElCode**: CEGL003354 **EO ID**: 222 **Data Sensitive**: N
St. Status: **Fed. Status**: **St. Rank**: S1 **Global Rank**: G1
Survey Site: BLACKWATER ISLANDS RNA
Quads: 4512277 - Saint Helens | 4512276 - Ridgefield
Directions:
TRS: 004N001W S11 S2 | 004N001W S12 S2 | 004N001W S44 NEOFNE | 004N001W S57 SE | 004N001W S37
County: Clark **Latitude:** 455024N **Longitude:** 1224532W
Est. Rep. Acc.: **Precision_BCD**: S **Confidence Extent**: **Additional Inventory** : N
GIS EO Rep & Sources: 15952: 15948 | 15949 | 15950 | 15951
Surveyors: Chappell, C. 1995 | WIBERG C & S GREENE 1983
Last Observed: 1995-06-15 **Survey Date**: 1995-06-15 **First Observed**: 1981
EO Data: 06-95 CBC - Surveyed portion of EO located outside of RNA to east. Forest dominated by QUGA with few to no other trees. Tall shrub understory dominated by Viburnum ellipticum, Holodiscus discolor, Oemleria cerasiformis, Amelanchier alnifolia, Toxicodendron diversiloba, and Symphoricarpos albus. Southern end has some Rubus discolor. Dryopteris arguata is common along with several other herbs. No sign of logging. Open areas between oak forest dominated by non-native grasses.
Basic EO Rank: B **EO Rank Date**: 1998-12-16 **Size (acres)**: 33.00
EO Rank Comment: Large size for type; few exotics.
General Description: Restricted to basalt knolls above 6 meters in elevation, largest trees 76 CM DBH, most 40-60 CM DBH, forming closed stands interspersed with open grasslands.| 06-95 CBC - Broken basalt parent material. Small ridges and knolls. Mosaic with exotic grasslands. Part of large refuge landscape with agricultural past.
Min. Elevation (ft.): 20 **Max. Elevation**: 50 **Aspect**: **Slope**:
Protection Comments:
Management Comments:
Owner Code: USAFWSPVT **Special Status**: RNANWR **Managed Areas**: Blackwater Island RNA | Ridgefield NWR
General Comments:
Plant Association:
Associated Species: Bromus sterilis, Dactylis glomerata, Agropyron caninum, AMAL, SYAL

***Salix lucida ssp. lasiandra / Salix fluviatilis Woodland* - 001 -** Pacific Willow / Columbia River Willow

Confirmed: Y **ElCode**: CEGL000949 **EO ID**: 2504 **Data Sensitive**: N
St. Status: **Fed. Status**: **St. Rank**: S2 **Global Rank**: G3Q
Survey Site: BLACKWATER ISLANDS RNA
Quads: 4512277 - Saint Helens | 4512276 - Ridgefield
Directions:
TRS: 004N001W S12 | 004N001W S37
County: Clark **Latitude:** 455024N **Longitude:** 1224547W
Est. Rep. Acc.: **Precision_BCD**: M **Confidence Extent**: **Additional Inventory** : N
GIS EO Rep & Sources: 5826: 5825
Surveyors: FED COM ON ECOL RESERVES 1977
Last Observed: 1977 **Survey Date**: 1977 **First Observed**: 1977
EO Data:
Basic EO Rank: C **EO Rank Date**: **Size (acres)**:
EO Rank Comment:
General Description:
Min. Elevation (ft.): **Max. Elevation**: **Aspect**: **Slope**:
Protection Comments:
Management Comments:
Owner Code: USAFWS **Special Status**: RNA **Managed Areas**: Blackwater Island RNA
General Comments:
Plant Association:
Associated Species: POTR 2-SALIX.

***Collinsia sparsiflora var. bruceae* - 010 -** few-flowered collinsia

Confirmed: Y **ElCode**: PDSCR0H0F2 **EO ID**: 8165 **Data Sensitive**: N
St. Status: S **Fed. Status**: **St. Rank**: S1S2 **Global Rank**: G4T4
Survey Site: Ridgefield NWR
Quads: 4512277 - Saint Helens | 4512276 - Ridgefield
Directions: Ridgefield NWR.
TRS: 004N001W S44 | 003N001W S40 | 004N001E S07 | 004N001W S12 | 004N001E S18 | 004N001W S15 | 004N001W S13 | 004N001E S40 | 004N001W S41 | 004N001W S40 | 004N001W S36 | 003N001W S47 | 004N001W S39 | 004N001W S23 | 004N001E S17 | 004N001W S27 | 004N001W S43 | 004N001W S26 | 004N001W S47 | 004N001W S25 | 004N001W S24 | 004N001W S45 | 004N001E S31 | 003N001W S01 | 004N001W S42 | 003N001E S49 | 004N001E S37 | 004N001W S22 | 003N001E S45 | 003N001E S06 | 004N001W S38 | 004N001E S39 | 004N001E S30 | 004N001W S11 | 004N001E S32 | 004N001W S14 | 004N001E S19 | 004N001E S38 | 003N001W S02 | 004N001W S37 | 004N001W S48 | 004N001E S29 | 004N001W S46 | 004N001E S20
County: Clark **Latitude:** 454831N **Longitude:** 1224525W
Est. Rep. Acc.: **Precision_BCD**: G **Confidence Extent**: N **Additional Inventory** : N
GIS EO Rep & Sources: 33067: 33066

Surveyors: Wiberg, C. & S. Greene, 1981
Last Observed: 1981 **Survey Date**: 1981 **First Observed**: 1981
EO Data: Plants obs.
Basic EO Rank: E **EO Rank Date**: 1981 **Size (acres)**:
EO Rank Comment:
General Description:
Min. Elevation (ft.): **Max. Elevation**: **Aspect**: **Slope**:
Protection Comments:
Management Comments:
Owner Code: USAFWS **Special Status**: NWR **Managed Areas**: Ridgefield NWR
General Comments: Reported in Wiberg & Greene 1981 and Washington Native Plant Society species list from 1986.
Plant Association:
Associated Species:

Howellia aquatilis - 002 - howellia

Confirmed: Y **ElCode**: PDCAM0A010 **EO ID**: 6701 **Data Sensitive**: N
St. Status: T **Fed. Status**: LT **St. Rank**: S2S3 **Global Rank**: G3
Survey Site: Blackwater Island RNA, Ridgefield NWR
Quads: 4512277 - Saint Helens
Directions: From center of Ridgefield, go N ~1 mi. to refuge office on the W side of the road. From the lower parking lot, a path crosses the RR on a bridge, continue W to a dirt road that goes NW parallel to Columbia River side channel. After ~0.5 mi. a trail goes NE, through woods, to a field. Cross field, climb a fence. Plants found in three small ponds. From here, go N to small pond near Gee Creek, between two grassy basalt knobs. Plants found on E side of pond.
TRS: 004N001W S37
County: Clark **Latitude:** 455027N **Longitude:** 1224601W
Est. Rep. Acc.: **Precision_BCD**: S **Confidence Extent**: N **Additional Inventory** : N
GIS EO_Rep & Sources: 1740: 1739 | 33070 | 33071 | 33072
Surveyors: Kemp, L.M., 1980 | Arnett, Joe (WNHP), 2009, 2008 | Unknown, 1992
Last Observed: 2009-05-13 **Survey Date**: 2009-05-13 **First Observed**: 1980-05-15
EO Data: 2009: New (fourth) location. Plants obs. in 18" of water. Probably more plants in the area. | 2008: Plants obs. from three locations (two new sites). | 1992: Plants obs. | 1980: Plants abundant in a vernal pool that is ~30 X 30 ft. in size.
Basic EO Rank: B **EO Rank Date**: 1992-03 **Size (acres)**:
EO Rank Comment: Note: This rank is for the orignal location; three additional sites have been added since.
General Description: Vernal pool/small ponds.
Min. Elevation (ft.): 10 **Max. Elevation**: 20 **Aspect**: 0 **Slope**: 0
Protection Comments:
Management Comments: 1980: Heavily grazed by cattle, would recommend fencing.
Owner Code: USAFWS **Special Status**: NWRRNAPRS **Managed Areas**: Blackwater Island RNA | Ridgefield NWR
General Comments: 1980: Would make an excellent study area to determine if plant is actually a fugitive.
Plant Association:
Associated Species: See individual source feature tabs for information.

Poa nervosa - 006 - Wheeler's bluegrass

Confirmed: Y **ElCode**: PMPOA4Z1T0 **EO ID**: 900 **Data Sensitive**: N
St. Status: S **Fed. Status**: **St. Rank**: S2 **Global Rank**: G3?
Survey Site: Carty Unit | Ridgefield NWR
Quads: 4512277 - Saint Helens
Directions: From I-5, exit 14, go W 3.0 mi. to "light." Then go N 1.1 mi. to Ridgefield NWR entrance parking. Cross footbridge over railroad, and walk 0.5 mi. N on interpretive trail. Keep right at all T's, to trail signed "private property, access seasonal." Pass the 1st trail and take the 2nd down into a broad swale. Leave the trail and go W to the water's edge, then follow the shore north to the site, which is just before the N end of the peninsula. Plants are on the rocky slope 1-2 meters above water level. On returning, just N of boundary, take open side trail W to obvious grassy knoll. Cross over top and find another group of plants on NW side, about 1 meter above water level.
TRS: 004N001W S12 NEOFSW
County: Clark **Latitude:** 455031N **Longitude:** 1224507W
Est. Rep. Acc.: **Precision_BCD**: S **Confidence Extent**: ? **Additional Inventory** : N
GIS EO_Rep & Sources: 3642: 3641 | 27962
Surveyors: Barrett, J., 1981 | Beggs, Pam, 2003 | Stark, Fred, 2005
Last Observed: 2005-06-12 **Survey Date**: 2005-06-12 **First Observed**: 1981-06-24
EO Data: 2005: 105 stems obs. in two areas totaling 7 sq. meters. Clumpy distribution. 50% vegetative only, 50% flowering. | 2003: Plants not found. | 1981: 46 plants, in 1/2 ac. area, all brown at time of survey. Plants found adjacent to the water on basalt outcrop.
Basic EO Rank: C **EO Rank Date**: 1981-06-24 **Size (acres)**:
EO Rank Comment: Rank based on 1981 visit by Barrett.
General Description: Terrain hilly, drowned partially w/ water (fresh-water marsh). Outcrop fairly well vegetated and surrounded by forest of mostly QUGA. Very thin humus soil; weather and broken basalt substrate. Wetter areas have FRLA2 and Salix.
Min. Elevation (ft.): 10 **Max. Elevation**: **Aspect**: NW **Slope**: 25 DEG, >35 DEG
Protection Comments:
Management Comments: 2005: Site furthest east is flanked by rampant growth of Himalayan blackberry, which might spread over it in time. Both sites are invaded by annual Bromus commutatus and may soon receive Bromus tectorum, which is present on the shore to the south. | 1981: Little direct human impact. There is a trail that goes onto the outcrop, but the plants hadn't been trampled. Area is not grazed by livestock.
Owner Code: USAFWSPVT **Special Status**: NWRUUU **Managed Areas**: Ridgefield NWR
General Comments: 2005 survey was early and optimum flower development would be 2 weeks later.

Plant Association:
Associated Species: Sedum spathulifolium, S. lanceolatum, Bromus mollis, B. commutatus, B. diandrus (rigidus), Festuca megalura, Crepis capillaris, Aira praecox, A. caryophyllea, Trifolium oliganthum, T. variegatum, Brodiaea hyacinthina (Triteleia hyacinthina), B. coronaria, Camassia quamash, Elymus glaucus, Rhytidiadelphus triquetrus, Anthoxanthum oderatum, Lotus micrantha, Rubus armeniacus (discolor).

Salix sessilifolia - 008 - soft-leaved willow

Confirmed: Y **ElCode**: PDSAL022Q0 **EO ID**: 8164 **Data Sensitive**: N
St. Status: S **Fed. Status**: **St. Rank**: S2 **Global Rank**: G4
Survey Site: Ridgefield NWR
Quads: 4512277 - Saint Helens | 4512276 - Ridgefield
Directions: Ridgefield NWR.
TRS: 003N001W S01 | 004N001E S30 | 004N001W S11 | 004N001E S32 | 004N001W S14 | 004N001E S19 | 004N001E S38 | 003N001W S02 | 004N001W S37 | 004N001W S48 | 004N001E S29 | 004N001W S46 | 004N001E S20 | 004N001W S44 | 003N001W S40 | 004N001E S07 | 004N001W S12 | 004N001E S18 | 004N001W S15 | 004N001W S13 | 004N001E S40 | 004N001W S41 | 004N001W S40 | 004N001W S36 | 003N001W S47 | 004N001W S39 | 004N001W S23 | 004N001E S17 | 004N001W S27 | 004N001W S43 | 004N001W S26 | 004N001W S47 | 004N001W S25 | 004N001W S24 | 004N001W S45 | 004N001E S31 | 004N001W S42 | 003N001E S49 | 004N001E S37 | 004N001W S22 | 003N001E S45 | 003N001E S06 | 004N001W S38 | 004N001E S39
County: Clark **Latitude:** 454831N **Longitude:** 1224525W
Est. Rep. Acc.: **Precision_BCD**: G **Confidence Extent**: N **Additional Inventory** : N
GIS EO_Rep & Sources: 33065: 33064
Surveyors: Christy, John & Judy Putera, 1992
Last Observed: 1992 **Survey Date**: 1992 **First Observed**: 1992
EO Data: Plants obs.
Basic EO Rank: E **EO Rank Date**: 1992 **Size (acres)**:
EO Rank Comment:
General Description:
Min. Elevation (ft.): **Max. Elevation**: **Aspect**: **Slope**:
Protection Comments:
Management Comments:
Owner Code: USAFWS **Special Status**: NWR **Managed Areas**: Ridgefield NWR
General Comments: Reported in Christy and Putera 1992. Precise location not given.
Plant Association:
Associated Species:

Trillium parviflorum - 009 - small-flowered trillium

Confirmed: Y **ElCode**: PMLIL20150 **EO ID**: 4905 **Data Sensitive**: N
St. Status: S **Fed. Status**: **St. Rank**: S2S3 **Global Rank**: G2G3
Survey Site: Ridgefield NWR
Quads: 4512277 - Saint Helens | 4512276 - Ridgefield
Directions: Ridgefield National Wildlife Refuge, Carty Unit. From I-5, take Exit 14 and proceed ~3 mi. W to light in Ridgefield. Turn N onto Main Ave and proceed to Ridgefield NWR entrance and parking area. Take footbridge over railroad and proceed N for 0.45 mi, passing longhouse replica and bearing right at all forks. Plants are located 10 meters W of trail, 10 meters before footbridge and "red elderberry" sign.
TRS: 004N001W S12 SEOFSW | 004N001W S37
County: Clark **Latitude:** 455019N **Longitude:** 1224500W
Est. Rep. Acc.: **Precision_BCD**: S **Confidence Extent**: ? **Additional Inventory** : N
GIS EO_Rep & Sources: 1738: 1737 | 33068
Surveyors: Kemp, Lois, 1982 | Beggs, Pam (RareCare), 2002 | Stark, Fred (RareCare), 2005 | Arnett, Joe (WNHP), 2010, 2009
Last Observed: 2010-04-20 **Survey Date**: 2010-04-20 **First Observed**: 1982-04-13
EO Data: 2010: Plants seemed abundant, healthy. | 2009: 3 plants obs. at new location. | 2005: 94 individuals obs. in a 25 x 50 ft. area. Clumpy distribution. 15% vegetative, 85% in flower. | 2002: Plants not found. Colonies could be under extensive thickets of Rubus discolor. | 1982: Two colonies, 150 ft. apart. First colony, 85 plants in a 40 X 80 ft. area. Second colony, 200+ plants in a 30 X 50 ft. area. Plants all ages w/ numerous seedlings.
Basic EO Rank: AB **EO Rank Date**: 1992-12-07 **Size (acres)**:
EO Rank Comment: The occurrence is within a NWR. In 1982, it was a healthy population in terms of size (ca. 300 plants) and structure. No threats were discernable at the time. The site has not been revisited since 1982. Ranked by DLS
General Description: Level to near-level, moist, shady woodland adjacent to river floodplain. Areas of standing water and hillocks nearby and adjoining the two colonies. 1982: This portion of the unit is lightly grazed by cattle.Thin silt loam; broken basaltic cobbles. Gee Creek site: Level area, densely vegetated, near shallow pond between two basalt knobs, with oaks and grassland.
Min. Elevation (ft.): 20 **Max. Elevation**: 25 **Aspect**: SW, flat **Slope**: flat
Protection Comments: Site is within a NWR. A management plan for the taxon at this site should be developed. 1992-12-08 DLS
Management Comments: 2005: Moist, flat areas similar to population site have been invaded by Lysimachia nummularia, which has displaced all native groundcover herbs. | 2002: Widespread amounts of Rubus discolor on entire trail, creating extensive thickets which continue upward on Quercus garryana. | 1982: No evidence of cattle having been where the Trillium occur, probably too brushy. Colonies are away from and out of site of trails and not likely to be visited by the average recreationalist.
Owner Code: USAFWS **Special Status**: NWR **Managed Areas**: Ridgefield NWR
General Comments:
Plant Association:
Associated Species: See individual source feature tabs for information.

Wolffia columbiana - 001 - Columbia water-meal

Confirmed: Y **ElCode**: PMLEM03030 **EO ID**: 2832 **Data Sensitive**: N
St. Status: R1 **Fed. Status**: **St. Rank**: SNR **Global Rank**: G5

Survey Site: RIDGEFIELD NWR - BOWER SLOUGH
Quads: 4512277 - Saint Helens | 4512276 - Ridgefield
Directions: Ditch at north end of Loop Road
TRS: 004N001W S38 | 004N001W S24
County: Clark **Latitude:** 454858N **Longitude:** 1224518W
Est. Rep. Acc.: **Precision_BCD**: M **Confidence Extent**: N **Additional Inventory** : N
GIS EO_Rep & Sources: 24726: 24725
Surveyors: Zika, Peter & F Weinmann, 2000
Last Observed: 2000-07-24 **Survey Date**: 2000-07-24 **First Observed**: 2000-07-24
EO Data: common
Basic EO Rank: **EO Rank Date**: **Size (acres)**:
EO Rank Comment:
General Description: Ditch
Min. Elevation (ft.): 10 **Max. Elevation**: **Aspect**: **Slope**:
Protection Comments:
Management Comments:
Owner Code: USAFWS **Special Status**: NWR **Managed Areas**: Ridgefield NWR
General Comments:
Plant Association:
Associated Species: Wolffia borealis, Lemna minor, Spriodella polyrhiza, Azolla

Appendix E

Current vegetation of U.S.F.W.S. Ridgefield National Wildlife Refuge in Clark County using the National Vegetation Classification hierarchy

R. C. Crawford and F. J. Rocchio
Washington Natural Heritage Program

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Introduction

This appendix provides a map of the current vegetation of Ridgefield National Wildlife Refuge (Refuge) in Clark County, Washington. The primary purpose of this map is to help identify areas with conservation potential, specifically sites that might be appropriate for introductions of two federally listed plant species, *Sidalcea nelsoniana* (Nelson's checkermallow) and *Lomatium bradshawii* (Bradshaw's lomatium).

In addition, a protocol for developing a range of possible conservation, management or restoration targets is provided. This protocol, referred to as Ecological Integrity Assessments (EIAs), was developed by NatureServe (Faber-Langendoen et al. 2006) and fine-tuned by the Washington Natural Heritage Program (Rocchio and Crawford 2009) as a method for assessing ecological integrity, setting management or restoration goals, and documenting attainment of those goals. The EIA method is briefly described and two EIAs specific to southwestern Washington prairies (e.g., upland and wet prairies) are provided.

Project Area and Methods

The location of the Refuge is shown in Figure 1. A vegetation map of this area was developed based on interpretation of the apparent land-use/land cover of most recent aerial photographs (2009), field reconnaissance (2010), and land use changes apparent on older imagery (1990s, 2006 and 2008). Polygons were typically digitized at the 1:10,000 scale or at finer resolution when habitat differences were not fully apparent or inconclusive at the 1:10,000 scale. The resulting 297 polygons vary between 0.23 acre and 196 acres with an average of 17.3 acres. **Because a systematic and quantitative accuracy assessment was out of the scope of this project, errors associated with misclassification and/or inaccurate delineation of polygons have not in all cases been determined. Appropriate caution should be used in interpretation of data and conclusions from this report.**

Image Interpretation and Cover types

Sixteen land-use/land Cover types are mapped with twenty modifiers yielding forty-eight unique Cover types. Cover type definitions were derived in somewhat of an *ad hoc* manner reflecting what was confidently discernable, the scale of image evaluation, and what met the objective of the project. Each primary Cover type definition includes modifying descriptors (species, additional life forms, and hydrologic indicators) and the prairie areas (in parenthesis) where the class appears. Cover type reflects the likelihood of supporting habitat for species associated with southwest Washington prairies and with a site's potential for restoration.

Figure 1. Location of Ridgefield National Wildlife Refuge

Cover Type definitions

Bareground shoreline – Areas with sparse or herbaceous vegetation in upland non-cultivated landscapes along the Columbia River. *Modifiers*: none.

Canal and verge - Artificial channel and adjacent vegetation. *Modifiers*: ash.

Closed Forest- area with over approximately 60% cover of trees. *Modifiers*: ash, ash-willow, conifer, conifer-hardwood, cottonwood, cottonwood-ash, hardwood, oak, oak-conifer, riparian, second growth and willow.

Developed - concentrations of buildings, impervious surfaces, landscaping and associated ruderal vegetation. *Modifiers*: air field grassland, ball field grassland, oak.

Emergent Wetland - Herbaceous-dominated areas associated with wetland on NWI map or interpreted to be wetland area not associated with a stream or channel and apparently not grazed or hayed herbaceous often dominated by reed canarygrass (*Phalaris arundinacea*). *Modifiers*: *Amorpha*, ash, trees, and willow.

Flooded – Areas that appear to be naturally or artificially flooded long enough to support some vegetation on at least one image since 1999. (semi-permanent to seasonally flood regimes). *Modifiers*: reed canarygrass and trees.

Grasslands – Upland areas dominated by native, perennial graminoids and herbaceous plants. *Modifiers*: none.

Hedge row – Prominent shrub-dominated strips along roads or cultivated areas. *Modifiers*: none.

Open forest- area with less than approximately 60% cover of trees. *Modifiers*: ash, conifer, conifer-hardwood, cottonwood, hardwood, logged, oak, oak-ash, oak-conifer, and willow.

Pasture – Herbaceous-dominated areas that do not appear to be annually cropped fields, do not have apparent haying lines/stacks and are likely to be grazed by livestock and moderate to high likelihood to support native plants. *Modifiers*: riparian, shrubs, trees, wetland, wetland/reedcanarygrass, wetlands/trees.

Pasture/Hayfield - Herbaceous-dominated areas that do not appear to be annually cropped fields do have some apparent haying/mowing lines and are likely to be grazed by livestock and moderate likelihood to support native plants. *Modifiers*: trees, wetland.

Riparian – Areas associated exclusively with a natural channel at Ridgefield and/or ditch or other artificial channel (Lewis) withtypically woody-dominated stream side vegetation. *Modifiers*: ash, ash-oak, cottonwood, shrubs, and stream.

Road and verge – Areas with a road surface and all or portion of adjacent roadside vegetation. It may include roadside ditches. *Modifiers*: none.

Shrubfield – Areas dominated by non-coniferous shrubs. *Modifiers*: forest, old field, planted and wetland old field.

Stream – Un-vegetated natural channel. *Modifiers*: none.

Water – Permanently flooded areas without emergent or woody vegetation. *Modifiers*: pond.

Modifiers

Amorpha – areas with high cover of *Amorpha fruiticosa*

ash – forested area dominated by *Fraxinus latifolia*.

ash-willow - forested area co-dominated by *Fraxinus latifolia* and *Salix (*presumably *lucida)* cottonwood - forested area dominated by *Populus balsamifera* ssp. *trichocarpa*

cottonwood-ash forested area co-dominated by *Populus balsamifera* ssp. t*richocarpa* and *Fraxinus latifolia*

hardwood - forested area dominated by unknown hardwood trees

oak - forested area dominated by *Quercus garryana* trees.

oak-ash - forested area co-dominated by *Quercus garryana* and *Fraxinus latifolia* trees.

oak-conifer - forested area co-dominated by *Quercus garryana* and unknown conifer trees.

planted – woody plants in rows.

pond - open water covering less than 20 acres and less than 2 meters at deepest

reed canarygrass - area dominated by *Phalaris arundinacea*.

shoreline – areas directly adjacent to the Columbia River.

shrubs – short woody plants with multi stems.

trees – tall woody plants assumed to be single stem.

wetland - areas associated with wetland on NWI or interpreted to be wetland area not associated with a stream or channel.

willow - area dominated or with by *Salix (*presumably *lucida)*.

These Cover types have been cross-referenced with the National Vegetation Classification (NVC), as the described below (see Table 2 below).

National Vegetation Classification

The International Vegetation Classification (IVC) covers all vegetation from around the world. In the United States, its national application is the U.S. National Vegetation Classification (NVC), supported by the Federal Geographic Data Committee (FGDC 2008), NatureServe (Faber-Langendoen et al. 2009), and the Ecological Society of America (Jennings et al. 2009), with other partners. The IVC and NVC were developed to classify natural, semi-natural and cultural vegetation, wetlands and uplands, and identify types based on vegetation composition and structure and associated ecological factors. The NVC meets several important needs for conservation and resource management. It provides:

- An 8-level, ecologically based framework that allows users to address conservation and management concerns at scales relevant to their work.

- A characterization of ecosystem patterns across the entire landscape or watershed, both upland and wetland.
- Information on the relative rarity of types. Each association has been assessed for conservation status (extinction risk).
- Relationships to other classification systems that are explicitly linked to the NVC types.
- A federal standard for all federal agencies, facilitating sharing of information on ecosystem types (FGDC 2008).

Polygon Cover type and modifier combinations were placed within the NVC in hierarchical levels Class through Group, within a review version of the 2010 Revised USNVC, version 1.0 (Table 1). The hierarchical nature of the NVC provides map labels at different scales to match different objectives. Table 2 lists all Cover types and modifier labels and their relationship to NVC Group. The NVC classification levels are used to display general distribution of mapped areas in this report. All classification levels and Cover types are available digitally as a spreadsheet and GIS layer.

Table 1. National Vegetation Classification hierarchy of vegetation mapped at project sites (from the Revised USNVC version 1.0 , NatureServe 2010). Figures 3 through 6 illustrate the distribution of NVC Class level polygons.

Class	Subclass	Formation	Division	Macrogroup	Group
1 Forest & Woodland	1.C Temperate Forest	1.C.2 Cool Temperate Forest	1.C.2.b Western North American Cool Temperate Forest	Californian-Vancouverian Foothill & Valley Forest & Woodland	Californian-Vancouverian Deciduous Oak Woodland Group;
				Vancouverian Lowland & Montane Rainforest	North Pacific Maritime Douglas-fir - Western Hemlock Forest Group; North Pacific Red Alder - Bigleaf Maple - Douglas-fir Forest Group
				Western North American Ruderal Forest & Plantation	Western North American Conifer & Hardwood Plantation Group [Placeholder]
		1.C.3 Temperate Flooded & Swamp Forest	1.C.3.c Western North American Flooded & Swamp Forest	Western North American Cool Temperate Ruderal Flooded & Swamp Forest (Provisional)	Northwest North American Ruderal Riparian Group [Placeholder]
				Vancouverian Flooded & Swamp Forest	North Pacific Lowland Riparian Forest & Woodland Group; North Pacific Maritime Lowland Hardwood-Conifer Swamp Group
2 Shrubland & Grassland	2.C Temperate & Boreal Shrubland & Grassland	2.C.1 Temperate Grassland, Meadow & Shrubland	2.C.1.a Vancouverian & Rocky Mountain Grassland & Shrubland	Southern Vancouverian Lowland Grassland & Shrubland	Southern Vancouverian Shrub & Herbaceous Bald, Bluff & Prairie Group
				Southern Vancouverian Lowland Ruderal Grassland & Shrubland	Northwest Ruderal Meadow & Shrubland [Placeholder]

		2.C.5 Temperate & Boreal Freshwater Wet Meadow & Marsh	2.C.5.b Western North American Freshwater Wet Meadow & Marsh	Western North American Lowland Freshwater Wet Meadow, Marsh & Shrubland	Western North American Temperate Interior Freshwater Marsh Group
				Western North American Ruderal Wet Meadow & Marsh	Western North American Ruderal Wet Meadow & Marsh Group
7 Agricultural Vegetation	7.1 Woody Agricultural Vegetation	7.1.B. Other Woody Agricultural / Rural Vegetation	7.1.B.1 Other Woody Farmland/Rural Vegetation	Temperate and Tropical Other Woody Farmland/Rural Vegetation	Other land in farms (not associated with farmsteads)
	7.2 Herbaceous Agricultural Vegetation	7.2.A. Herbaceous Cultivated Crop	7.2.A.2. Close Grown Crop	Temperate and Tropical Close Grown Crop	Wheat
			7.2.A.3. Cultivated Pasture and Hayland	Temperate and Tropical Cultivated Hayland and Pasture	Grass and Legumes
		7.2.C. Other Herbaceous Agricultural and Rural Vegetation	7.2.C.2. Other Rural, Crop or Farmland	Temperate and Tropical Rural Vegetation	Other cropland not planted (180) [conversion of forest to unimproved pasture]
8 Developed Vegetation	8.1. Herbaceous & Woody Developed Vegetation	8.1.A. Developed (Close cropped)	8.1.A.1 Lawn	Temperate and Tropical Lawn	Cool season Lawn
			8.1.A.x provisional Verges	Temperate and Tropical verges [Placeholder]	Cool season Verges [placeholder]
		8.1.B. Other Developed Urban / Built Up Vegetation	Urban / Build Up Vegetation	Other Urban / Built Up Vegetation	Vacant Lot Vegetation (abandoned log yard)
				Other Urban / Built Up Vegetation Other Urban / Built Up Wetland Vegetation	Urban / Built Up Vegetation; Vacant Lot Wetland Vegetation;(abandoned log yard)

Table 2. USNVC Group and map Cover type – modifier relationships.

Class	Group	Cover Type and Modifier
1 Forest & Woodland	Californian-Vancouverian Deciduous Oak Woodland Group	Closed Forest oak
		Closed Forest oak mixed hardwoods
		Open Forest oak
		Open Forest oak conifer
	North Pacific Lowland Riparian Forest & Woodland Group	Bareground shoreline
		Closed Forest ash
		Closed Forest ash - willow
		Closed Forest cottonwood
		Closed Forest cottonwood - ash
		Closed Forest willow
		Open Forest ash
		Open Forest cottonwood
		Open forest oak ash
		Open Forest willow
		Riparian
		Riparian ash
		Riparian cottonwood
		Riparian shrubs
		Closed Forest conifer - hardwood

	North Pacific Red Alder - Bigleaf Maple - Douglas-fir Forest Group	Closed Forest hardwood Open Forest hardwood
	Northwest North American Ruderal Riparian Group [Placeholder]	Canal and verge ash Emergent Wetland amorpha Emergent Wetland ash Emergent Wetland trees Emergent Wetland willow
2 Shrubland & Grassland	Northwest Ruderal Meadow & Shrubland [Placeholder]	Pasture Pasture shrubs Pasture trees
	Southern Vancouverian Shrub & Herbaceous Bald, Bluff & Prairie Group	Grassland
	Western North American Ruderal Wet Meadow & Marsh Group	Emergent Wetland Flooded Flooded reed canarygrass Flooded trees Pasture wetland Pasture wetland reed canarygrass Pasture wetland trees Pasture/Hayfield wetland Pasture/Hayfield Pasture/Hayfield trees Hedge row Shrubfield planted
	Cool season Verges [Placeholder] Other Urban / Built Up Vegetation	Road and verge Developed Developed oak
Lacustrine		Water Water pond
Riverine		Canal and verge Stream

Results and Discussion

Image interpretation resulted in delineation of 297 polygons representing 5,152 acres with polygon sizes between 0.23 and 196 acres, and an average of 17.3 acres and a median value of 8.3 acres. The most mapped NVC Classes were the Forest and Woodland and the Shrubland and Grassland Classes, 1,808 and 1,594 acres, respectively. Most of the Ridgefield National Wildlife Refuge is cultivated or ruderal/semi-natural vegetation, that is, vegetation in which human activities (past or present) significantly influence its composition or structure, but does not eliminate or dominate spontaneous ecological processes (FGDC 2008). Significant natural, native oak and associated communities occur at northern end of the Refuge.

Most (72%) of the Shrubland and Grassland Class is sub-divided into a lower hierarchical unit, the Western North American Freshwater Wet Meadow & Marsh Division and the remaining 36% is the upland Vancouverian & Rocky Mountain Grassland & Shrubland Division (Table 4). Most (89%) of the Shrubland and Grassland Class appears in a ruderal or semi-natural vegetation Macrogroup. The majority is mapped as the Ruderal Wet Meadow & Marsh Macrogroup (Table 4). This suggests that wet prairies may constitute the majority, albeit semi-natural, of southwestern Washington prairie sites remaining in the project area.

Table 3. Acres of USNVC Class and Division at Ridgefield National Wildlife Refuge. Divisions are abbreviated names; see Table 1 for complete names.

	Ridgefield	
Forest and Woodland Class	**1808**	
wetland forest		240
upland forest		1568
Shrub/Grassland Class	**1594**	
wetland		1431
upland shrub and grass		163
Agricultural Class	**1332**	
cultivated		1332
non-cultivated		0
un-improved		0
Developed Class	**130**	
Water	**288**	
Total acres	**5152**	

Table 4. Acres of USNVC Division and Macrogroup of the Shrub and Grassland Class at Ridgefield National Wildlife Refuge.

Prairie	Ridgefield
Vancouverian and Rocky Mountain Grassland and Shrubland Division	**163**
Southern Vancouverian Lowland Grassland & Shrubland	6
Southern Vancouverian Lowland Ruderal Grassland & Shrubland	157
Western North American Freshwater Wet Meadow and Marsh Division	**1431**
Western North American Lowland Freshwater Wet Meadow, Marsh & Shrubland	0
Western North American Ruderal Wet Meadow & Marsh	1431
Total acres	**1594**

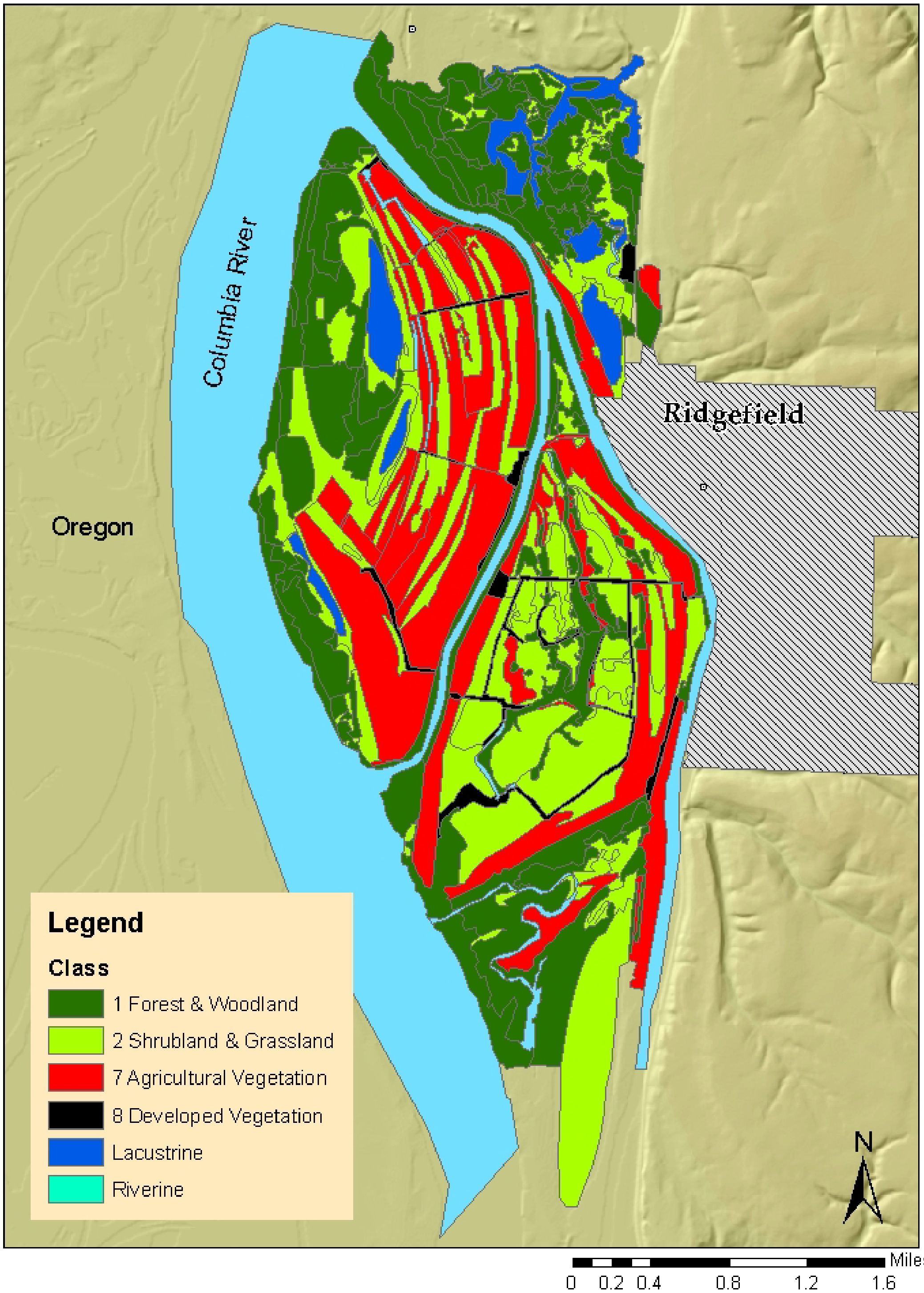

Figure 2. Distribution of NVC Classes mapped at Ridgefield National Wildlife Refuge

Imprecison of knowledge of pre-settlement prairie locations does not allow for an exact accounting of prairie loss or conversion but our mapping does indicate the relative proportion of area converted to agricultural or urban development land uses. Land uses are assumed to represent deviation from a natural condition and differing probabilities of the presence of native prairie species. Presumably the NVC Class with the highest probability of supporting **native prairie species** is the Shrubland and Grassland Class followed by Forest and Woodland, Agriculture and finally Developed Classes, although as stated by Caplow and Miller (2004) fencerows and other transitions often support native species. A finer level of classification (Macrogroup or Group in the NVC) may be a more appropriate level of landscape evaluation for focusing conservation planning efforts. Our probability estimates of native prairie species presence associated with mapped NVC Macrogroups are summarized in Table 5.

Table 5. List of US NVC Macrogroups and the probability of the presence of **native prairie species** within each. Upland and wet prairies defined in U.S. Fish and Wildlife Service (2010); H= a high likelihood of encountering species restricted to native prairies; M= Moderate or an equal likelihood of the presence or absence of species restricted to native prairies; L= Low or unlikely presence of species restricted to native prairies.

Macrogroup	UPLAND Prairie Species	WET PRAIRIE Species
Californian-Vancouverian Foothill & Valley Forest & Woodland	H	
Southern Vancouverian Lowland Grassland & Shrubland	H	
Southern Vancouverian Lowland Ruderal Grassland & Shrubland	M	
Temperate and Tropical Rural Vegetation (unimproved pasture)	M	
Temperate and Tropical Permanent Pasture & Hayland	M	M
Western North American Lowland Freshwater Wet Meadow, Marsh & Shrubland	M	H
Western North American Ruderal Wet Meadow & Marsh	L	M
Western North American Cool Temperate Ruderal Flooded & Swamp Forest [provisional]	L	L
Vancouverian Flooded & Swamp Forest	L	L
Other Urban / Built Up Wetland Vegetation	L	L
Vancouverian Lowland & Montane Rainforest	L	
Western North American Ruderal Forest & Plantation	L	
Other Urban / Built Up Vegetation	L	
Temperate and Tropical Close Grown Crop	L	
Temperate and Tropical Cultivated Hayland and Pasture	L	
Temperate and Tropical Lawn	L	
Temperate and Tropical Other Woody Farmland/Rural Vegetation	L	
Temperate and Tropical Verges [Placeholder]	L	

High probability polygons for the presence of upland prairie species include oak stands, native prairie and rocky balds and bluffs that occupy 170 acres at Ridgefield National Wildlife Refuge in the Research Natural Area (RNA). Moderate probability polygons for upland prairie species included mostly ruderal vegetation types and total 157 acres at Ridgefield. Non-cultivated pastures are moderate probability polygons for upland and for wet prairie species. Moderate probability wet prairie species polygons total 1430 acres at Ridgefield. These are considered overestimates because it is highly probable that we conservatively mapped many agricultural areas as non-cultivated pasture or hayfields and likely included cultivated hayfields. Most of the Ridgefield National Wildlife Refuge outside the RNA was intensively farmed in the past. The probability of native species based on these putative relationships appears in Figure 3.

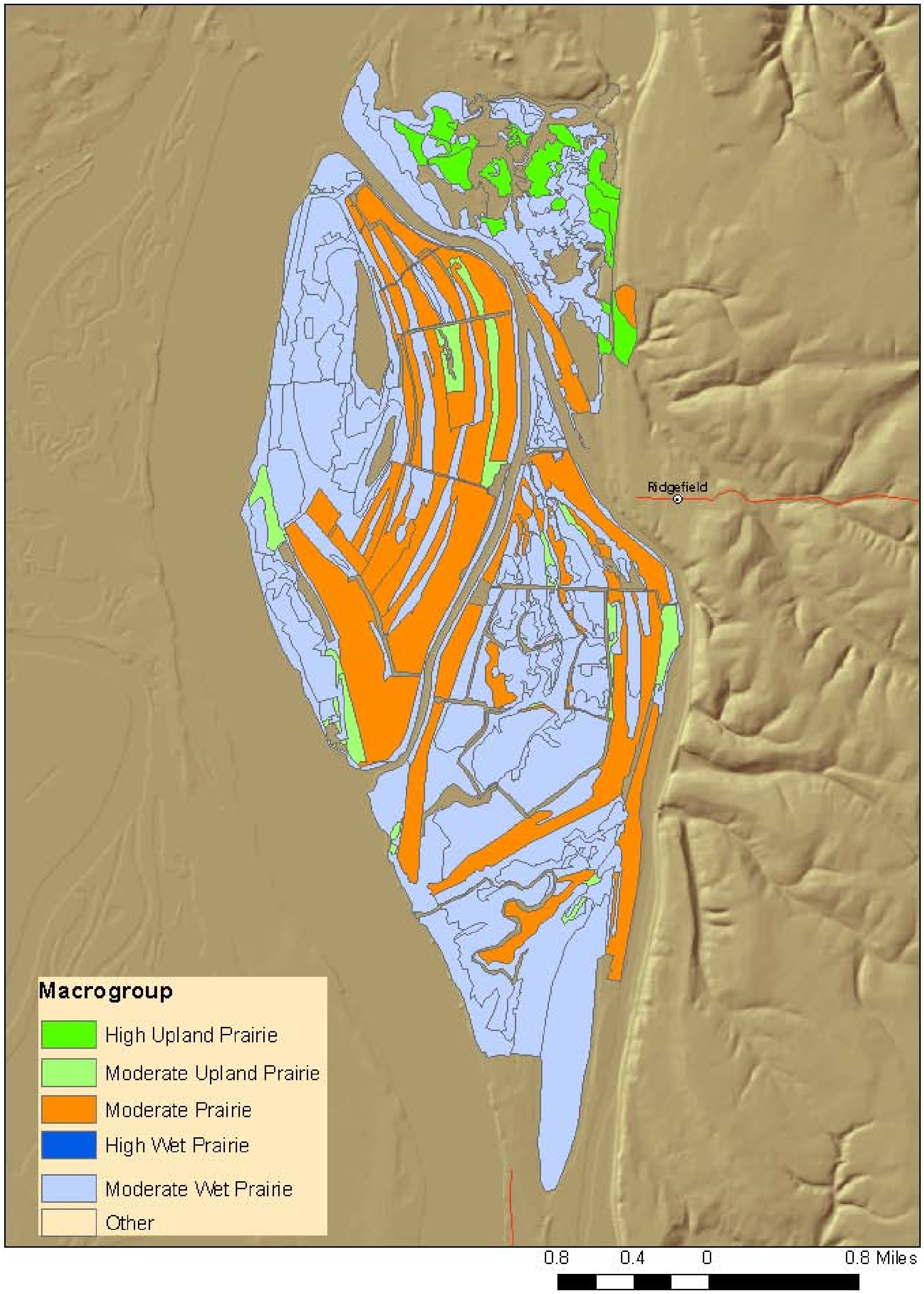

Figure 3. Distribution of polygons with estimated likelihood of containing southwest Washington prairie species based on NVC Macrogroup (see Table 3) at Ridgefield National Wildlife Refuge.

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Attachment: Ecological Integrity Assessments

NatureServe and the Natural Heritage Network have developed an approach for assessing ecological condition that is scaled both in terms of the scale of ecosystem type that is being assessed and the level of information required to conduct the assessment. This method is called the Ecological Integrity Assessment (EIA) (Faber-Langendoen et al. 2006) and is now being implemented for a variety of small- and large-scale projects (Rocchio and Crawford 2009, Tierney et al. 2009). The EIA aims to measure the current ecological integrity of a site through a standardized and repeatable assessment of current ecological conditions associated with the structure, composition, and ecological processes of a particular ecological system. These conditions are then compared or ranked according to conditions expected in those sites operating within the bounds of their natural range of variation for that particular ecological system. The purpose of assigning an index of ecological integrity is to provide a succinct assessment of the current status of the composition, structure and function of occurrences of a particular ecosystem type and to give a general sense of conservation value, management effects, restoration success, etc. The EIA can be applied at a variety of spatial scales ranging from a remote-sensing, GIS-based approach to an on the ground, quantitative analysis these are referred to as Level 1 – remote assessments (GIS), Level 2 – rapid assessments (site) and Level 3 – intensive assessments (plot). A generalized Level 1 EIA is provided in Rocchio and Crawford (2009).

EIAs have been developed to assess units of Ecological Systems, a related but different classification than the NVC. Ecological systems provide a spatial-ecologic perspective on the relation of associations and alliances (fine-scale NVC types), integrating vegetation with natural dynamics, soils, hydrology, landscape setting, and other ecological processes. They can also provide a mapping application of the NVC, much as soil associations help portray the spatial-ecologic relations among soil series in a soil taxonomic hierarchy. Ecological systems types facilitate mapping at meso-scales (1:24,000 – 1:100,000; Comer and Schulz 2007) and a comprehensive ecological systems map exists for Washington State (www.landscope.org). Ecological systems meet several important needs for conservation, management and restoration, because they provide:

- an integrated biotic and abiotic approach that is effective at constraining both biotic and abiotic variability within one classification unit.
- comprehensive maps of all ecological system types are becoming available.
- explicit links to the USNVC, facilitating crosswalks of both mapping and classifications.

Ecological systems are somewhat comparable to the Group level of the NVC hierarchy, thus can be linked to other levels of the NVC hierarchy. For example, the Willamette Valley Upland Prairie Ecological System is equivalent to the Southern Vancouverian Shrub and Herbaceous Bald, Bluff & Prairie Group and Willamette Valley Wet Prairie Ecological System is equivalent to NVC's Western North American Temperate Wet Meadow & Seep Herbaceous Group. Level 2 EIAs have been developed for these ecological systems and, since they support the southwest Washington prairie species of concern, are included here as a guide for developing a range of possible conservation, management or restoration targets. Both the NVC and Ecological Systems classifications can be used to define the ecological variability that may affect the ecological integrity of an area.

Willamette Valley Upland Prairie and Savanna

Ecological Summary

This is a grassland and savanna system endemic to the Puget Trough and Willamette Valley. Historically, this system occurred as large and small patches from portions of the Georgia Basin, Puget Trough, and Willamette Valley. In Washington, it is most expansive in the South Puget Sound region (e.g., Pierce and Thurston counties) but is also found in the San Juan Islands and in southwestern Washington. Most sites are topo-edaphically dry and experience extreme soil drought in the summer. In the South Puget Sound, this system occurs as large patches within more forested landscapes, usually associated with deep, gravelly/sandy glacial outwash that is excessively well drained. Historically, it also occurred as large patches on glacially associated soils of variable texture in localized portions of the Georgia Basin in both Washington and British Columbia, especially within the Olympic Mountain rainshadow. Landforms are usually flat, rolling, or gently sloping, and often part of extensive plains.

These upland prairies and savannas are thought to have developed during the relatively hot and dry Hypsithermal period about 10,000 to 7,000 b.p. (Whitlock 1992). Thereafter, a cooler and moister climate has prevailed creating suitable conditions for encroachment of woody vegetation into many prairies. Historically, frequent fires or extreme environmental conditions (e.g., drier climate and/or excessively drained soils) prevented the establishment of shrubs and trees. The high frequency of fires (< 10 years) was a result of occasional lightning strikes but more often from intentional ignition by indigenous inhabitants who set fires to encourage to the growth of food plants such as *Camassia quamash* and *Pteridium aquilinum* and to control the encroachment of woody vegetation. Fires are thought to have occurred every few years (Chappell and Kagan 2001). Annual soil drought during the summer made it difficult for woody species (especially trees) to establish in these grasslands. However, occasionally *Quercus garryana* and *Pseudotsuga menziesii* would establish and survive long enough to be resistant to frequent fires thereby creating savanna conditions (Chappell and Kagan 2001). Following European settlement of the region, anthropogenic fire became less frequent resulting in widespread encroachment of the prairies and savannas by woody vegetation, especially conifers.

Historically, these prairies and savannas are dominated by a native bunchgrass, *Festuca idahoensis* ssp. *roemeri* and, to a lesser degree, *Danthonia californica* and *Carex inops* ssp. *inops*, along with abundant and diverse perennial forbs such as *Achillea millefolium*, *Apocynum androsaemifolium*, *Brodiaea coronaria* ssp. *coronaria*, *Camassia quamash* ssp. *azurea* or ssp. *maxima*, *Campanula rotundifolia*, *Eriophyllum lanatum* var. *leucophyllum*, *Fragaria virginiana*, *Fritillaria affinis* var. *affinis*, *Hieracium cynoglossoides*, *Lomatium utriculatum*, *Lotus micranthus*, *Microseris laciniata*, *Prunella vulgaris* ssp. *lanceolata*, *Ranunculus occidentalis* var. *occidentalis*, *Sericocarpus rigidus*, *Viola adunca*, and *Zigadenus venenosus* var. *venenosus* (Dunwiddie et al. 2006). *Elymus trachycaulus*, *E. glaucus*, *Koeleria macrantha*, and *Stipa lemmonii* can be locally important. Savannas with scattered deciduous (*Quercus garryana*) and/or coniferous (*Pseudotsuga menziesii, Pinus ponderosa*) trees are rarely found now, but such savannas historically covered about one-third of the total acreage. Shrubs such as *Symphoricarpos albus*, *Rosa nutkana*, *Toxicodendron diversilobum*, *Amelanchier alnifolia*, and *Arctostaphylos uva-ursi* are common shrubs. Dunwiddie et al. (2006) recorded 278 plant taxa within the South Puget Sound prairies. Of these, 164 (59%) were native species, while 111 (40%) were non-native and four (~1%) were of uncertain origin. Forbs comprised a majority of the species (74%) while graminoids (17%), shrubs (8%), and trees (2%) were of less importance (Dunwiddie et al. 2006). Most of the native forbs were perennial (70%) while most of the nonnative forbs were annuals and biennials. The majority of graminoids were perennial, whether native (94%) or nonnative (67%) (Dunwiddie et al. 2006). In many extant prairies, moss (e.g., *Racomitrium canescens*) and lichen (*Cladina mitis*)cover is high between bunchgrasses, however some researchers postulate that more frequent fires would have resulted in less moss and lichen cover and a higher cover and diversity of native annual species (Dunwiddie et al. 2006).

Stressors

The stressors described below are those primarily associated with the loss of extent and degradation of the ecological integrity of existing occurrences. The stressors are the cause of the system shifting away from its natural range of variability. In other words, type, intensity, and duration of these stressors is what moves a system's ecological integrity rank away from the expected, natural condition (e.g. A rank) toward degraded integrity ranks (i.e. B, C, or D).

The exclusion of fire from most of this system over the last 100+ years has resulted in profound changes. Oak savanna has, for all practical purposes, disappeared from the landscape. *Pseudotsuga menziesii* encroachment, in the absence of fire, is a "natural" process that occurs eventually on the vast majority of upland prairie, except perhaps on the very driest sites. This encroachment leads to the conversion of prairies and savannas to forests. Fire exclusion has also resulted in increases in shrub cover and the conversion of some prairies to shrublands. Nonnative species such as *Cytisus scoparium*, *Hypericum perforatum*, *Hypochaeris radicata*, *Holcus lanatus*, *Chrysanthemum leucanthemum*, *Agrostis capillaris*, *Anthoxanthum odoratum*, *Poa pratensis*, *Arrhenatherum elatius*, *Taeniatherum caput-medusae*, *Festuca arundinacea*, *Hieracium pilosella*, *Potentilla recta*, *Centaurea* spp., and *Bromus mollis* are prominent in this habitat and generally increase after ground-disturbing activities like grazing or off-road vehicle use. The dominant native grass, *Festuca roemeri*, can be eliminated with heavy grazing. Prescribed fire and other management tools have been used recently to control *Cytisus scoparium*, *Pseudotsuga menziesii* encroachment, and to attempt to mimic historical conditions in some areas.

Conceptual Ecological Model

The general relationships among the key ecological attributes associated with natural range of variability of the Willamette Valley Upland Prairie and Savanna system are presented in Figure 1.

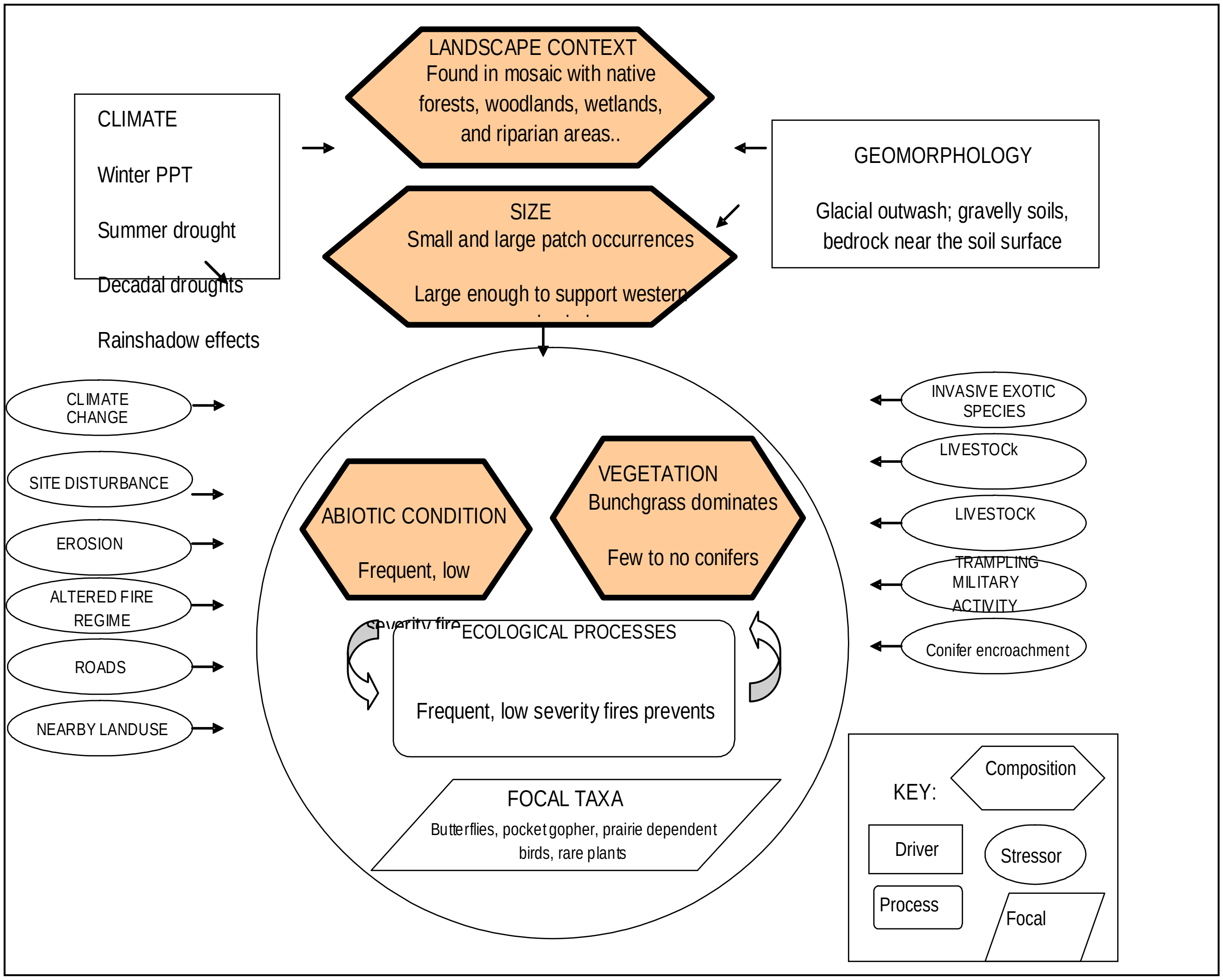

Figure 1. Generalized Conceptual Ecological Model for Willamette Valley Upland Prairie and Savanna Ecological System.

Ecological Integrity Assessments

The assessment of ecological integrity can be done at three levels of intensity depending on the purpose and design of the data collection effort. The three-level approach is intended to provide increasing accuracy of ecological integrity assessment, recognizing that not all conservation and management decisions need equal levels of accuracy. The three-level approach also allows users to choose their assessment based in part on the level of classification that is available or targeted. If classification is limited to the level of forests vs. wetlands vs. grasslands, the use of remote sensing metrics may be sufficient. If very specific, fine-scale forest, wetland, and grassland types are the classification target then one has the flexibility to decide to use any of the three levels, depending on the need of the assessment. In other words, there is no presumption that a fine-level of classification requires a fine-level of ecological integrity assessment.

Because the purpose is the same for all three levels of assessment (to measure the status of ecological integrity of a site) it is important that the Level 1 assessment use the same kinds of metrics and major attributes as used at Levels 2 and 3. Level 1 assessments rely almost entirely on Geographic Information Systems (GIS) and remote sensing data to obtain information about landscape integrity and the distribution and abundance of ecological types in the landscape or watershed. Level 2 assessments use relatively rapid field-based metrics that are a combination of qualitative and narrative-based rating with quantitative or semi-quantitative ratings. Field observations are required for many metrics, and observations will typically require professional expertise and judgment. Level 3 assessments require more rigorous, intensive field-based methods and metrics that provide higher-resolution information on the integrity of occurrences. They often use quantitative, plot-based protocols coupled with a sampling design to provide data for detailed metrics.

Although the three levels can be integrated into a monitoring framework, each level is developed as a stand-alone method for assessing ecological integrity. **When conducting an ecological integrity assessment, one need only complete a single level that is appropriate to the study at hand.** Typically only one level may be needed, desirable, or cost effective. But for this reason it is very important that each level provide a comparable approach to assessing integrity, else the ratings and ranks will not achieve comparable information if multiple levels are used.

Level 1 EIA

A generalized Level 1 EIA is provided in Rocchio and Crawford (2009). Please refer to that document for the list of metrics applicable to this ecological system. For the Level 1 Fire Condition Class metric, please use the metric ratings for that same metric found below in the Level 2 EIA.

Level 2 EIA

The following table displays the metrics chosen to measure most of the key ecological attributes in the conceptual ecological model above. The EIA is used to assess the ecological condition of an assessment area, which may be the same as the element occurrence or a subset of that occurrence based on abrupt changes in condition or on artificial boundaries such as management areas. **Unless otherwise noted, metric ratings apply to both Level 2 and Level 3 EIAs. The difference between the two is that a Level 3 EIA will use more intensive and precise methods to determine metric ratings.** To calculate ranks, each metric is ranked in the field according the ranking categories listed below. Then, the rank and point total for each metric is entered into the EIA Scorecard and multiplied by the weight factor associated with each metric resulting in a metric 'score'. Metric scores within a key ecological attribute are then summed to arrive at a score (or rank). These are then tallied in the same way to arrive at an overall ecological integrity score.

Table 1. Willamette Valley Upland Prairie and Savanna Ecological Integrity Assessment Scorecard

Metric	Justification	Rank			
		A (5 pts.)	**B (4 pts.)**	**C (3 pts.)**	**D (1 pts.)**
Rank Factor: LANDSCAPE CONTEXT					
Key Ecological Attribute: *Edge Effects*					
Edge Length	The intactness of the edge can be important to biotic and abiotic aspects of the site.	75 – 100% of edge is bordered by natural communities	50 – 74% of edge is bordered by natural communities	25 – 49% of edge is bordered by natural communities	< 25% of edge is bordered by natural communities
Edge Width		Average width of edge is at least 100 m.	Average width of edge is at least 75-100 m.	Average width of edge is at least 25-75 m.	Average width of edge is at least <25 m.
Edge Condition		>95% cover native vegetation, <5% cover of non-native plants, intact soils	75–95% cover of native vegetation, 5–25% cover of non-native plants, intact or moderately disrupted soils	25–50% cover of non-native plants, moderate or extensive soil disruption	>50% cover of non-native plants, barren ground, highly compacted or otherwise disrupted soils

Key Ecological Attribute: *Landscape Structure*					
Connectivity	Intact areas have a continuous corridor of natural or semi-natural vegetation between shrub steppe areas	Intact: Embedded in 90-100% natural habitat; connectivity is expected to be high.	Variegated: Embedded in 60-90% natural or semi-habitat; habitat connectivity is generally high, but lower for species sensitive to habitat modification;	Fragmented: Embedded in 20-60% natural or semi-natural habitat; connectivity is generally low, but varies with mobility of species and arrangement on landscape.	Relictual: Embedded in < 20% natural or semi-natural habitat; connectivity is essentially absent
Landscape Condition Model Index	The intensity and types of land uses in the surrounding landscape can affect ecological integrity.	Landscape Condition Model Index >.8		Landscape Condition Model Index 0.75 – 0.5	Landscape Condition Model Index < 0.5
Rank Factor: CONDITION					
Key Ecological Attribute: *Vegetation Composition*					
Cover Native Plant Species	Native species in shrub and herbaceous layers; non-natives increase with human impacts.	Native species total cover >95% and dominate all physiognomic layers;	Native species total cover > 90	Native species total cover 40 to 90%.	Native species total cover < 40%; nonnative species dominate.
Douglas-fir encroachment (Chappell 2000; Chappell 2004)	The amount of encroachment by *Pseudotsuga menziesii* is an indication of the integrity of the fire regime.	*Pseudotsuga menziesii,* if present, consists of widely scattered large, old trees.	Douglas-fir at densities of <4 individuals/acre regardless of size.	Douglas-fir numerous as seedlings/saplings/small trees.	Douglas-fir numerous as seedlings/saplings/small trees and >25% cover.

Cover of Ground Mosses and Lichens	Without frequent fire, moss (e.g., *Racomitrium canescens*) and especially lichen (e.g., *Cladina mitis*) increase and crowd out native species. *These are BPJ estimates*	Total cover <25%	Total cover 25-40%		Total cover >40-%
Cover of Native Increasers	Some stressors such as grazing can shift or homogenize native composition toward species tolerant of stressors. (i.e., *Carex inops*, *Lupinus* spp.,	<10% cover	10-20% cover	20-50%	>50% cover
Shrub Cover (DW-SPS CAP) Measured in area being managed for prairie	Shrub cover outside of NRV can indicate past disturbance such as grazing or fire suppression. *Symphoricarpos albus, Toxicodendron diversiloba, Rosa nutkana*	None or minimal cover (<1%).	Present and <10% cover.	<10-25%	>25%
Cover of Scotch broom (*Cytisus scoparius*)	This invasive shrub displaces native species and is very aggressive. Early detection is critical	None or minimal (<1%) present.	Present, but sporadic (<5% cover).	Prevalent (5–25% cover).	Abundant > 25% cover
Cover of Invasive Herbaceous Species	Invasive species can inflict a wide range of ecological impacts. Early detection is critical. Examples include *Arrhenatherum elatius*, *Holcus lanatus*, *Agrostis capillaris*, *Chrysanthemum leucanthemum.*	None or minimal (<1%) present.	Invasive species present, but sporadic (<5% cover).	Invasive species prevalent (5–30% absolute cover).	Invasive species abundant (>30% absolute cover).

Richness of Prairie Associated Plant Species (Alverson 2009a; Chappell 2000)	The overall composition of native species can shift when exposed to stressors. This metric measures the presence of those species with strong fidelity to prairies. Refer to fidelity list below.	>15 species with high fidelity of prairies	10-15 species with high fidelity of prairies	5-10 species with high fidelity of prairies	<5 species with high fidelity of prairies
Key Ecological Attribute: *Physicochemical*					
Soil Surface Condition	Soil disturbance can result in erosion thereby negatively affecting many ecological processes	Bare soil areas are limited to naturally caused disturbances such as flood deposition or game trails	Some bare soil due to human causes but the extent and impact is minimal. The depth of disturbance is limited to only a few inches and does not show evidence of ponding or channeling water.	Bare soil areas due to human causes are common. There may be pugging due to livestock resulting in several inches of soil disturbance. ORVs or other machinery may have left some shallow ruts.	Bare soil areas substantially & contribute to altered hydrology or other long-lasting impacts. Deep ruts from ORVs or machinery may be present, or livestock pugging and/or trails are widespread. Water will be channeled or ponded.
Rank Factor: SIZE					
Key Ecological Attribute: *Size*					
Relative Size	Indicates the proportion lost due to stressors such as complete fire suppression (conversion to a new system), development, roads, etc.	Site is at or minimally reduced from natural extent (>95% remains)	Occurrence is only modestly reduced from its original natural extent (80-95% remains)	Occurrence is substantially reduced from its original natural extent (50-80% remains)	Occurrence is severely reduced from its original natural extent (<50% remains)

Absolute Size	Absolute size may be important for buffering impacts originating in the surrounding landscape.	Very large (>500 ac/200 ha) Large enough to support a population of western meadowlarks (Chappell 2000)	Large (100-500 ac/40-200 ha)	Moderate (20-100 ac/8-40 ha) Large enough to manage with a prescribed fire rotation. Size still large enough for many species (Chappell 2000)	Small (<20 ac/8 ha)

Level 3 EIA

Level 3 metrics would include more quantitative measures of the metrics listed above. In addition, further consideration might be given to:

- presence/absence of wildlife species of concern such as Western Meadowlarks, Streaked Horned Larks, pocket gophers, and prairie-associated invertebrates (e.g., Mardon Skipper, Puget Blue, Taylor's Checkerspot, Zerene fritillary, Obscure elfin, Oregon branded skipper, Puget Sound fritillary, Valley silverspot, Propertius duskywing)
- species composition of lichens and bryophytes.
- Alverson (2009a) has suggested metrics for 1 m^2 quadrats.

Triggers or Management Assessment Points

Ecological triggers or conditions under which management activities need to be reassessed are show in the table below. Since the Ecological Integrity rankings are based on hypothesized thresholds, they are used to indicate where triggers might occur. Specific details about how these triggers translate for each metric can be found by referencing the values or descriptions for the appropriate rank provided in the Tables above.

Table 2. Triggers for Level 2 & 3 EIA

Key Ecological Attribute or Metric	Trigger	Action
Any metric (except Connectivity or LCM)	▪ C rank ▪ Shift from A to B rank ▪ negative trend within the B rating (Level 3)	Level 2 triggers: conduct Level 3 assessment; make appropriate short-term management changes to ensure no further degradation Level 3 triggers: make appropriate management adjustments to ensure no additional degradation occurs. Continue monitoring using Level 3.
Any Key Ecological Attribute	▪ any metric has a C rank ▪ > than ½ of all metrics are ranked B ▪ negative trend within the B rating (Level 3)	Level 2 triggers: conduct Level 3 assessment; make appropriate short-term management changes to ensure no further degradation

		Level 3 triggers: make appropriate management adjustments to ensure no additional degradation occurs. Continue monitoring using Level 3.

Protocol for Integrating Metric Ranks

If desired, the user may wish to integrate the ratings of the individual metrics and produce an overall score for the three rank factor categories: (1) Landscape Context; (2) Condition; and (3) Size. These rank factor rankings can then be combined into an Overall Ecological Integrity Rank. This enables one to report scores or ranks from the various hierarchical scales of the assessment depending on which best meets the user's objectives. Please see Table 5 in Rocchio and Crawford (2009) for specifics about the protocol for integrating or 'rolling-up' metric ratings.

List of Native Species with High Fidelity to Willamette Valley Upland Prairie and Savanna (from Chappell et al. 2004 and Alverson 2009b)

SPECIES	FAMILY	COMMON NAME	Present in Georgia Basin	Present in Puget Trough	Present in Lower Columbia River	Present in Willamette Valley
Achnatherum lemmonii (Vasey) Barkworth ssp. lemmonii	Poaceae	Lemmon's needlegrass	1	1		1
Agoseris elata (Nuttall) Greene	Asteraceae	Tall Agoseris	1	1	1	1
Agoseris grandiflora (Nuttall) Greene	Asteraceae	large flowered agoseris	1	1	1	1
Agoseris heterophylla (Nuttall) Greene ssp. heterophylla	Asteraceae	annual agoseris	1	1	1	1
Agrostis diegoensis Vasey	Poaceae		1	1	1	1
Agrostis microphylla Steud.	Poaceae	awned spike bentgrass	1	1	1	1
Allium acuminatum Hook.	Liliaceae	tapertip onion	1	1	1	1
Allium amplectens Torr.	Liliaceae	narrowleaf wild onion	1	1	1	1
Allium cernuum Roth var. obtusum Cockerell	Liliaceae		1	1	1	1
Amsinckia menziesii (Lehm.) A. Nels. & J.F. Macbr.	Boraginaceae	rancher's fiddleneck	1	1	1	?
Arabis hirsuta (L.) Scop. var. eschscholtziana (Andrz.) Rollins	Brassicaceae	hairy rockcress	1	1	1	1
Athysanus pusillus (Hook.) Greene	Brassicaceae	sandweed	1	1	1	1
Balsamorhiza deltoidea Nuttall	Asteraceae	deltoid balsamroot	1	1	1	1
Brodiaea coronaria (Salisb.) Engl. ssp. coronaria	Liliaceae	harvest brodiaea	1	1	1	1
Bromus carinatus Hook. & Arn.	Poaceae	California brome	1	1	1	1
Calochortus tolmiei Hook. & Arn.	Liliaceae	Tolmie's cat's ear	1	?	1	1

SPECIES	FAMILY	COMMON NAME	Present in Georgia Basin	Present in Puget Trough	Present in Lower Columbia River	Present in Willamette Valley
Camassia leichtlinii (Baker) S. Watson ssp. suksdorfii (Greenm.) Gould	Liliaceae	large camas	1	1	1	1
Camassia quamash (Pursh) Greene ssp. maxima Gould	Liliaceae	small camas	1	1	1	1
Campanula rotundifolia L.	Campanulaceae	Scots harebell	1	1	1	1
Carex aurea Nuttall	Cyperaceae	golden fruited sedge	1	1		1
Carex densa (L.H. Bailey) L.H. Bailey	Cyperaceae	dense sedge	1	?	1	1
Carex inops L.H. Bailey ssp. inops	Cyperaceae	long stolon sedge	1	1	1	1
Carex rossii W. Boott	Cyperaceae	Ross' sedge	1	1	1	1
Carex tumulicola Mack.	Cyperaceae	foothill sedge	1	1	1	1
Castilleja attenuata (A. Gray) T.I. Chuang & Heckard	Scrophulariaceae	narrow leaved paintbrush	1	1	1	1
Castilleja hispida Benth. ssp. hispida	Scrophulariaceae	harsh paintbrush	1	1	1	1
Castilleja levisecta Greenm.	Scrophulariaceae	Golden Paintbrush	1	1	1	1
Centaurium muehlenbergii (Griseb.) W. Wight ex Piper	Gentianaceae	Muehlenberg's centaury	1	1	1	1
Cerastium arvense L. ssp. strictum (L.) Ugborogho	Caryophyllaceae	field chickweed	1	1	1	1
Cirsium remotifolium (Hook.) DC.	Asteraceae		1	?	1	1
Clarkia amoena (Lehm.) A. Nelson & J.F. Macbr. var. caurina (Abrams) C.L. Hitchc.	Onagraceae	farewell to spring	1	1		1
Clarkia amoena (Lehm.) A. Nelson & J.F. Macbr. var. lindleyi	Onagraceae	farewell to spring	1	1	1	1

SPECIES	FAMILY	COMMON NAME	Present in Georgia Basin	Present in Puget Trough	Present in Lower Columbia River	Present in Willamette Valley
(Dougl.) C.L. Hitchc.						
Clarkia gracilis (Piper) A. Nelson & J.F. Macbr. ssp. gracilis	Onagraceae	slender godetia	1	?	1	1
Clarkia purpurea (Curtis) A. Nelson & J.F. Macbr. ssp. quadrivulnera (Douglas ex Hook.) F.H. Lewis & M.R. Lewis	Onagraceae	purple godetia	1	1	1	1
Clarkia viminea (Douglas ex Hook.) A. Nelson & J.F. Macbr.	Onagraceae	large godetia	1	1		1
Claytonia rubra (Howell) Tidestr. ssp. rubra	Portulacaceae	redstem miner's lettuce	1	1	1	1
Collinsia grandiflora Lindl.	Scrophulariaceae	large flowered blue-eyed Mary	1	1	1	1
Collinsia parviflora Lindl.	Scrophulariaceae	small flowered blue-eyed Mary	1	1	1	1
Comandra umbellata (L.) Nuttall var. californica (Eastw.) C.L. Hitchc.	Santalaceae	bastard toadflax	1	1	?	1
Crocidium multicaule Hook.	Asteraceae	spring gold	1	1	1	1
Cryptantha intermedia (A. Gray) Greene var. grandiflora (Rydb.) Cronq.	Boraginaceae	common cryptantha	1	1	1	1
Danthonia californica Bolander var. americana (Scribner) A.S. Hitchc.	Poaceae	Umbrella Plant	1	1	1	1
Danthonia spicata (L.) Beauv. var. pinetorum Piper	Poaceae	common wild oatgrass	1	1	1	1
Daucus pusillus Michaux	Apiaceae	rattlesnake weed	1	1	1	1
Delphinium menziesii DC.	Ranunculaceae	Menzies' larkspur	1	1	1	1

SPECIES	FAMILY	COMMON NAME	Present in Georgia Basin	Present in Puget Trough	Present in Lower Columbia River	Present in Willamette Valley
Deschampsia danthonioides (Trin.) Munro	Poaceae	annual hairgrass	1	1	1	1
Dichelostemma congestum (Sm.) Kunth	Liliaceae	ookow	1	1	1	1
Dodecatheon hendersonii A. Gray ssp. hendersonii	Primulaceae	Henderson's shooting star	1	1	1	1
Dodecatheon pulchellum (Raf.) Merr. ssp. macrocarpum (A. Gray) Roy Taylor & MacBryde	Primulaceae		1	1	1	1
Downingia elegans (Douglas ex Lindl.) Torr. var. elegans	Campanulaceae	elegant downingia	1	?	1	1
Downingia yina Applegate	Campanulaceae	Willamette downingia	1	?	1	1
Dryopteris arguta (Kaulf.) Maxon	Dryopteridaceae	coastal shield fern	1	1	1	1
Elymus trachycaulus (Link) Gould ex Shinners ssp. trachycaulus	Poaceae	bearded wheatgrass	1	1	1	1
Epilobium densiflorum (Lindl.) P.C. Hoch & P.H. Raven	Onagraceae	close flowered boisduvalia	1	1	1	1
Epilobium torreyi (S. Watson) P.C. Hoch & P.H. Raven	Onagraceae	Torrey's willowherb	1	1	1	1
Erigeron speciosus (Lindl.) DC. var. speciosus	Asteraceae	showy daisy	1	1	1	1
Eriophyllum lanatum (Pursh) J. Forbes var. leucophyllum (DC) W.R. Carter)	Asteraceae	Oregon sunshine	1	1	1	1
Festuca roemeri Y.V. Alexeev	Poaceae	Roemer's fescue	1	1	1	1
Fragaria virginiana Duchesne var. platypetala (Rydb.) H.M. Hall	Rosaceae	prairie strawberry	1	1	1	1
Fritillaria affinis (Schult.) Sealy var. affinis	Liliaceae	chocolate lily	1	1	1	1
Gaillardia aristata Pursh	Asteraceae	Great Blanket-flower	1	1	1	1

SPECIES	FAMILY	COMMON NAME	Present in Georgia Basin	Present in Puget Trough	Present in Lower Columbia River	Present in Willamette Valley
Galium boreale L.	Rubiaceae		1	1	1	1
Githopsis specularioides Nuttall	Campanulaceae	bluecup	1	1	1	1
Grindelia integrifolia DC var. integrifolia	Asteraceae	Willamette Valley gumweed	1	1		1
Heterocodon rariflorum Nuttall	Campanulaceae	western pearlflower	1	1	1	1
Hieracium cynoglossoides Arv.-Touv.	Asteraceae		1	1	1	
Hieracium scouleri Hook. var. scouleri	Asteraceae	Scouler's hawkweed	1	1	1	1
Idahoa scapigera (Hook.) A. Nels. & J.F. Macbr.	Brassicaceae	flatpod	1	1		1
Isoetes nuttallii A. Br.	Isoetaceae	Nuttall's quillwort	1	1	1	1
Koeleria macrantha (Ledeb.) Schult.	Poaceae	junegrass	1	1	1	1
Lasthenia glaberrima DC.	Asteraceae	smooth goldfields	1	1		1
Ligusticum apiifolium (Nuttall) A. Gray	Apiaceae	celery leaved lovage	1	?	1	1
Linanthus bicolor (Nuttall) Greene ssp. bicolor	Polemoniaceae	bicolored linanthus	1	?	1	1
Lithophragma parviflorum (Hook.) Nuttall var. parviflorum	Saxifragaceae	small flowered woodland star	1	1	1	1
Lomatium dissectum (Nuttall) Mathias & Constance var. dissectum	Apiaceae	fern leaved lomatium	1	1	1	1
Lomatium nudicaule (Pursh) J.M. Coult. & Rose	Apiaceae	barestem lomatium	1	1	1	1
Lomatium triternatum (Pursh) J.M. Coult. & Rose var. triternatum	Apiaceae	nineleaf lomatium	1	1	1	1

SPECIES	FAMILY	COMMON NAME	Present in Georgia Basin	Present in Puget Trough	Present in Lower Columbia River	Present in Willamette Valley
Lomatium utriculatum (Nuttall) J.M. Coult. & Rose	Apiaceae	spring gold	1	1	1	1
Lotus formosissimus Greene	Fabaceae	bicolored lotus	1	1	?	1
Lotus pinnatus Hook.	Fabaceae	bog lotus	1	1	1	1
Lupinus arbustus Douglas ex Lindl. var. arbustus	Fabaceae	spurred lupine	1		1	1
Lupinus lepidus Douglas ex Lindl. var. lepidus	Fabaceae	prairie lupine	1	1	1	1
Lupinus sulphureus Douglas ex Hook. ssp. kincaidii (C.P. Sm.) C.L. Hitchc.	Fabaceae	Kincaid's lupine	1	1		1
Madia exigua (Sm.) A. Gray	Asteraceae	threadstem tarweed	1	1	1	1
Madia glomerata Hook.	Asteraceae	mountain tarweed	1	1	?	1
Madia gracilis (Sm.) D.D. Keck	Asteraceae	slender tarweed	1	1	1	1
Madia minima (A. Gray) D.D. Keck	Asteraceae		1	1	1	
Meconella oregana Nuttall	Papaveraceae	White Meconella	1	1	1	1
Microseris laciniata (Hook.) Sch. Bip. ssp. laciniata	Asteraceae	cutleaf microseris	1	1	1	1
Minuartia tenella (Nuttall) Mattf.	Caryophyllaceae	slender sandwort	1	1	1	1
Montia dichotoma (Nuttall) Howell	Portulacaceae	dwarf montia	1	1	1	1
Navarretia intertexta (Benth.) Hook. ssp. intertexta	Polemoniaceae	needle leaved navarretia	1	1	1	1
Nuttallanthus texanus (Scheele) D.A. Sutton	Scrophulariaceae	blue toadflax	1	1	1	1
Orobanche fasciculata Nuttall	Orobanchaceae	clustered broomrape	1	1	1	1

SPECIES	FAMILY	COMMON NAME	Present in Georgia Basin	Present in Puget Trough	Present in Lower Columbia River	Present in Willamette Valley
Orobanche uniflora L. var. occidentalis (Greene) Taylor & MacBryde	Orobanchaceae	small flowered naked broomrape	1	1	1	1
Orthocarpus bracteosus Benth.	Scrophulariaceae	rosy owlclover	1	1	1	1
Panicum acuminatum Sw. ssp. fasciculatum (Torr.) Freckman & Lelong	Poaceae	western witchgrass	1	?	1	1
Panicum oligosanthes Schult. var. scribnerianum (Nash) Fern.	Poaceae	Scribner's rosette grass	1	1	1	1
Pentagramma triangularis (Kaulf.) Yatsk., Windham, E. Wollenw. ssp. triangularis	Pteridaceae	gold back fern	1	1	1	1
Perideridia montana (Blank.) Dorn	Apiaceae	mountain yampah	1	1	1	1
Phacelia linearis (Pursh) Holz.	Hydrophyllaceae	narrow leaved phacelia	1	1	1	1
Phlox gracilis (Hook.) Greene ssp. gracilis	Polemoniaceae	pink annual phlox	1	1	1	1
Pinus ponderosa Douglas ex C. Lawson var. ponderosa	Pinaceae	ponderosa pine	1	?	1	1
Piperia transversa Suksdorf	Orchidaceae	Suksdorf's rein orchid	1	1	1	
Plagiobothrys figuratus (Piper) I.M. Johnst. ssp. figuratus	Boraginaceae	fragrant popcorn flower	1	1	1	1
Plectritis congesta (Lindl.) DC. var. congesta	Valerianaceae	rosy plectritis	1	1	1	1
Poa scabrella (Thurb.) Benth	Poaceae	pine bluegrass	1	1	1	1
Polygonum bistortoides Pursh	Polygonaceae	western bistort	1	?	1	1
Polygonum douglasii Greene var. douglasii	Polygonaceae	Douglas' knotweed	1	1	1	1

SPECIES	FAMILY	COMMON NAME	Present in Georgia Basin	Present in Puget Trough	Present in Lower Columbia River	Present in Willamette Valley
Polygonum spergulariaeforme Meisn.	Polygonaceae	fall knotweed	1	1	1	1
Potentilla glandulosa Lindl. var. glandulosa	Rosaceae	sticky cinquefoil	1	1	1	1

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Willamette Valley Wet Prairie

Ecological Summary

This is a small patch, wet meadow system largely restricted to the Willamette Valley of Oregon and parts of western Washington. In Washington, this system was historically mostly found in the South Puget Sound area where it occurred in areas with seasonally high water tables (e.g., local depressions, swales and low gradient riparian areas) within the matrix of a fire-maintained prairie landscape. Given their location within a fire-maintained, open grassland landscape, these wet prairies experienced periodic fire, which is what distinguishes them from similar wetland types found elsewhere in western Washington and Oregon.

Within Washington, these wet prairies are found in two geographic areas: South Puget Sound and southwest Washington (i.e., Clark and Lewis County). The wet prairies of southwest Washington and the Willamette Valley of Oregon (hereafter referred to as 'Willamette Valley wet prairies') are often perched on clay-rich soils and historically covered large areas. The South Puget Sound wet prairies differ in that they are associated with permeable glacial outwash and thus are restricted to swales and riparian areas where surface topography intersects local groundwater tables and in other areas with local aquitards. The aquitards are likely the result of overflow deposition or temporary impoundment of glacial melt-water (Easterly et al. 2005). Aquitards may have also formed from lahars or volcanic ash (Easterly et al. 2005). In addition to having different soil characteristics, the South Puget Sound wet prairies were much more localized than Willamette Valley wet prairies.

The wet prairies in the South Puget Sound have been drastically reduced in extent and remaining wet prairies are so disturbed that the original composition, diversity and structure of the vegetation are largely unknown (Easterly et al. 2005). However, the South Puget Sound wet prairies are thought to be floristically similar to the Willamette Valley, of which more natural remnants remain. Based on the composition of the Willamette Valley wet prairies, it is thought that the South Puget Sound Prairie wet prairies were dominated primarily by graminoids, especially *Deschampsia caespitosa, Camassia quamash, Carex densa*, and *Carex unilateralis*, and to a lesser degree by forbs (e.g., *Isoetes nuttallii*) or shrubs (e.g., *Rosa nutkana*). Chappell et al. (2004) compiled a list of species known from prairies in the Willamette Valley, Puget Trough and Georgia Basin ecoregion. This list has been maintained an updated by Alverson (2009b) and indicates which prairie-associated habitat type each species occurred in, including oak woodland and savanna, herbaceous balds and rock outcrops, upland prairies, seasonal wet prairies, and vernal pools and seepages.

This system was productive and likely dynamic due to frequency of fire. Vegetation composition may have changed rapidly between fires. Without frequent fires, woody species associated with riparian areas would likely have encroached into and dominated narrow wet prairie swales along riparian corridors (Easterly et al. 2005). Areas supporting larger and wider wet prairies, such as in outwash channels and depressions, would have been more isolated from woody encroachment and would likely have persisted longer than narrow strips along wooded riparian areas (Easterly et al. 2005). The composition of woody species would likely have included many that are present today, but likely in different proportions. Relatively fire-tolerant trees like *Quercus garryana*, *Populus tremuloides* and probably *P. balsamifera* ssp. *trichocarpa,* would have likely been more abundant than the fire intolerant *Fraxinus latifolia*, which is presumed to have increased since European settlement (Easterly et al. 2005). Shrubby species likely included *Symphoricarpos albus*, *Crataegus douglasii*, *Rosa nutkana*, *R. pisocarpa*, *Oemleria cerasiformis*, *Amelanchier alnifolia*, *Spiraea douglasii* and *Salix* spp. In addition, until recently *Alnus sinuata* was apparently common around wetland edges in the Tacoma area, and may have been a component of these systems and *Pteridium aquilinum* may have been aggressive and had significant cover in some sites (Easterly et al. 2005).

Stressors

The stressors described below are those primarily associated with the loss of extent and degradation of the ecological integrity of existing occurrences. The stressors are the cause of the system shifting away from its natural range of variability. In other words, type, intensity, and duration of these stressors is what moves a system's ecological integrity rank away from the expected, natural condition (e.g. A rank) toward degraded integrity ranks (i.e. B, C, or D).

Wet prairies have been lost and/or degraded due to numerous anthropogenic land uses and activities. Due to their productive nature, many wet prairies were converted to agriculture use, others were overgrazed, and others experienced invasion of woody vegetation due to fire suppression. Many other sites have been altered by draining, roads, and groundwater withdrawal. Due to these impacts, wet prairies have been nearly extirpated in the South Puget Sound region. The hydrologic regime of remaining wet prairie sites has likely been altered by draining and/or recession of the water table (Easterly et al. 2005). Fire suppression, attenuation of salmon runs, and altered hydrology of the current landscape has likely had a profound influence on the ecological processes and dynamics, such as nutrient cycling and successional status, of remaining wet prairie sites (Easterly et al. 2005).

Conceptual Ecological Model

The general relationships among the key ecological attributes associated with natural range of variability of the Willamette Valley Wet Prairie system are presented in Figure 1.

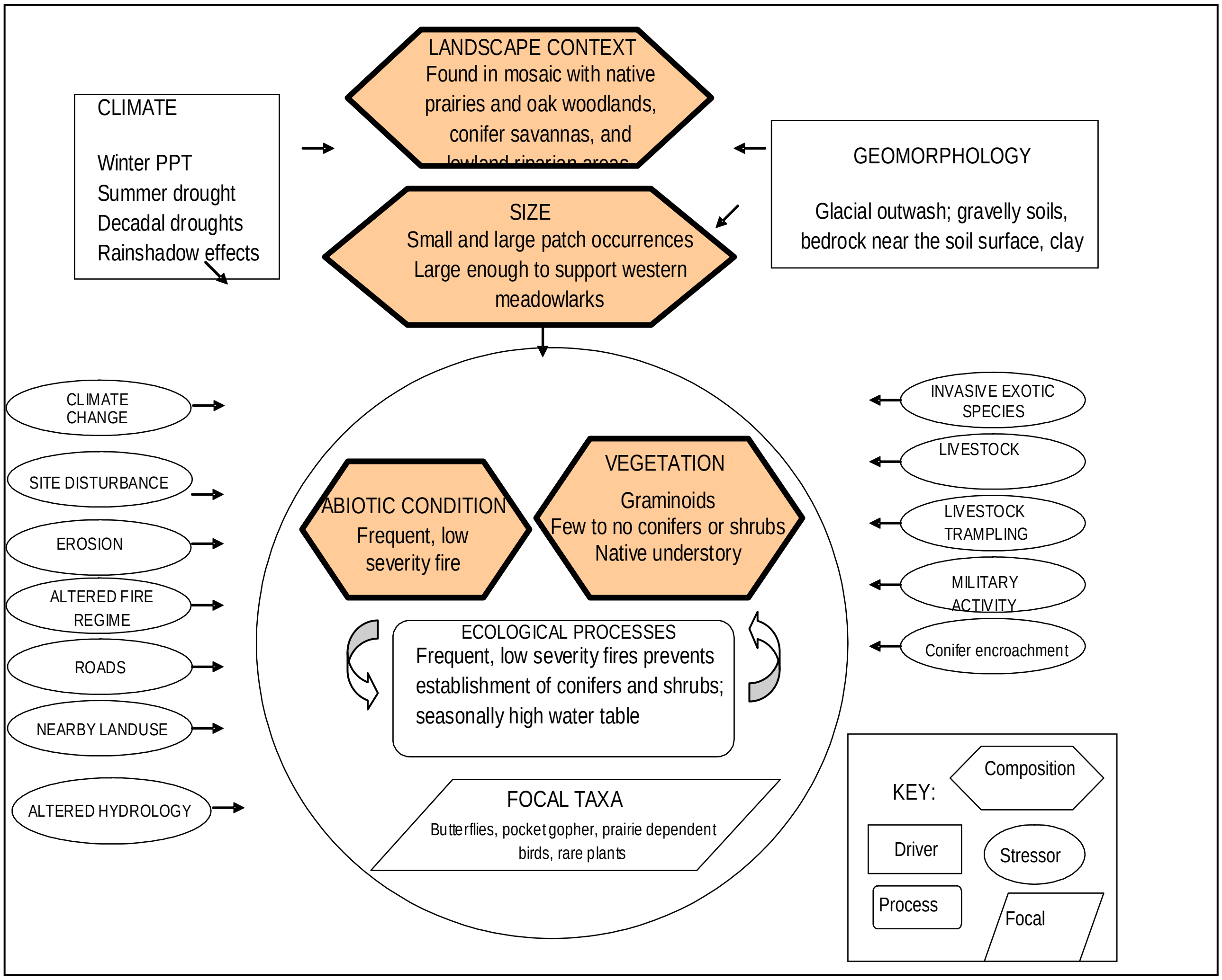

Figure 2. Generalized Conceptual Ecological Model for Willamette Valley Wet Prairie Ecological System.

Ecological Integrity Assessments

The assessment of ecological integrity can be done at three levels of intensity depending on the purpose and design of the data collection effort. The three-level approach is intended to provide increasing accuracy of ecological integrity assessment, recognizing that not all conservation and management decisions need equal levels of accuracy. The three-level approach also allows users to choose their assessment based in part on the level of classification that is available or targeted. If classification is limited to the level of forests vs. wetlands vs. grasslands, the use of remote sensing metrics may be sufficient. If very specific, fine-scale forest, wetland, and grassland types are the classification target then one has the flexibility to decide to use any of the three levels, depending on the need of the assessment. In other words, there is no presumption that a fine-level of classification requires a fine-level of ecological integrity assessment.

Because the purpose is the same for all three levels of assessment (to measure the status of ecological integrity of a site) it is important that the Level 1 assessment use the same kinds of metrics and major attributes as used at Levels 2 and 3. Level 1 assessments rely almost entirely on Geographic Information Systems (GIS) and remote sensing data to obtain information about landscape integrity and the distribution and abundance of ecological types in the landscape or watershed. Level 2 assessments use relatively rapid field-based metrics that are a combination of qualitative and narrative-based rating with quantitative or semi-quantitative ratings. Field observations are required for many metrics, and observations will typically require professional expertise and judgment. Level 3 assessments require more rigorous, intensive field-based methods and metrics that provide higher-resolution information on the integrity of occurrences. They often use quantitative, plot-based protocols coupled with a sampling design to provide data for detailed metrics.

Although the three levels can be integrated into a monitoring framework, each level is developed as a stand-alone method for assessing ecological integrity. **When conducting an ecological integrity assessment, one need only complete a single level that is appropriate to the study at hand.** Typically only one level may be needed, desirable, or cost effective. But for this reason it is very important that each level provide a comparable approach to assessing integrity, else the ratings and ranks will not achieve comparable information if multiple levels are used.

Level 1 EIA

A generalized Level 1 EIA is provided in Rocchio and Crawford (2009). Please refer to that document for the list of metrics applicable to this ecological system. For the Level 1 Fire Condition Class metric, please use the metric ratings for that same metric found below in the Level 2 EIA.

Level 2 EIA

The following table displays the metrics chosen to measure most of the key ecological attributes in the conceptual ecological model above. The EIA is used to assess the ecological condition of an assessment area, which may be the same as the element occurrence or a subset of that occurrence based on abrupt changes in condition or on artificial boundaries such as management areas. **Unless otherwise noted, metric ratings apply to both Level 2 and Level 3 EIAs. The difference between the two is that a Level 3 EIA will use more intensive and precise methods to determine metric ratings.** To calculate ranks, each metric is ranked in the field according the ranking categories listed below. Then, the rank and point total for each metric is entered into the EIA Scorecard and multiplied by the weight factor associated with each metric resulting in a metric 'score'. Metric scores within a key ecological attribute are then summed to arrive at a score (or rank). These are then tallied in the same way to arrive at an overall ecological integrity score.

Table 3. Willamette Valley Wet Prairie Ecological Integrity Assessment Scorecard

Metric	Justification	Rank			
		A (5 pts.)	**B (4 pts.)**	**C (3 pts.)**	**D (1 pts.)**
Rank Factor: LANDSCAPE CONTEXT					
Key Ecological Attribute: *Buffer Effects*					
Buffer Length	The buffer can be important to biotic and abiotic aspects	Buffer is > 75 – 100% of occurrence perimeter.	Buffer is > 50 – 74% of occurrence perimeter.	Buffer is 25 – 49% of occurrence perimeter	Buffer is < 25% of occurrence perimeter.

Buffer Width	of the wetland as it provides connectivity and provides a 'filter' from exogenous threats.	Average buffer width of occurrence is > 200 m, adjusted for slope.	Average buffer width is 100 – 199 m, after adjusting for slope.	Average buffer width is 50 – 99 m, after adjusting for slope.	Average buffer width is < 49 m, after adjusting for slope.
Buffer Condition		Abundant (>95%) cover native vegetation, little or no (<5%) cover of non-native plants, intact soils, AND little or no trash or refuse.	Substantial (75–95%) cover of native vegetation, low (5–25%) cover of non-native plants, intact or moderately disrupted soils; minor intensity of human visitation or recreation.	Moderate (25–50%) cover of non-native plants, moderate or extensive soil disruption; moderate intensity of human visitation or recreation.	Dominant (>50%) cover of non-native plants, barren ground, highly compacted or otherwise disrupted soils, moderate or greater intensity of human visitation or recreation, no buffer at all.
Key Ecological Attribute: *Landscape Structure*					
Connectivity	Intact areas have a continuous corridor of natural or semi-natural vegetation between shrub steppe areas	Intact: Embedded in 90-100% natural habitat; connectivity is expected to be high.	Variegated: Embedded in 60-90% natural or semi-habitat; habitat connectivity is generally high, but lower for species sensitive to habitat modification;	Fragmented: Embedded in 20-60% natural or semi-natural habitat; connectivity is generally low, but varies with mobility of species and arrangement on landscape.	Relictual: Embedded in < 20% natural or semi-natural habitat; connectivity is essentially absent
Landscape Condition Model Index	The intensity and types of land uses in the surrounding landscape can affect ecological integrity.	Landscape Condition Model Index >0.8		Landscape Condition Model Index 0.75 – 0.5	Landscape Condition Model Index < 0.5
Rank Factor: CONDITION					
Key Ecological Attribute: *Vegetation Composition*					
Cover Native Plant Species	Native species in shrub and herbaceous layers; non-natives increase with human impacts.	Native species total cover >95% and dominate all physiognomic layers;	Native species total cover > 90	Native species total cover 40 to 90%.	Native species total cover < 40%; nonnative species dominate.

Douglas-fir encroachment (Chappell 2000; Chappell 2004)	The amount of encroachment by *Pseudotsuga menziesii* is an indication of the integrity of the fire regime.	*Pseudotsuga menziesii,* if present, consists of widely scattered large, old trees.	Douglas-fir at densities of <4 individuals/acre regardless of size.	Douglas-fir numerous as seedlings/saplings/small trees.	Douglas-fir numerous as seedlings/saplings/small trees and >25% cover.
Cover of Native Increasers	Some stressors such as grazing can shift or homogenize native composition toward species tolerant of stressors. (i.e., Carex inops)	<10% cover	10-20% cover	20-50%	>50% cover
Shrub Cover	Shrub cover outside of NRV can indicate past disturbance such as grazing or fire suppression. *Symphoricarpos albus*, *Crataegus douglasii*, *Rosa nutkana*, *R. pisocarpa*, *Oemleria cerasiformis*, *Amelanchier alnifolia*, *Spiraea douglasii* and *Salix*	None or minimal cover (<1%).	Present and <10% cover.	<10-25%	>25%
Cover of Invasive Herbaceous Species	Invasive species can inflict a wide range of ecological impacts. Early detection is critical. Examples include *Phalaris arundinacea, Poa pratensis, Elymus repens*.	None or minimal (<1%) present.	Invasive species present, but sporadic (<5% cover).	Invasive species prevalent (5–30% absolute cover).	Invasive species abundant (>30% absolute cover).

Richness of Wet Prairie Associated Plant Species (Alverson 2009a; Chappell 2000)	The overall composition of native species can shift when exposed to stressors. This metric measures the presence of those species with strong fidelity to prairies. Refer to fidelity list below.	>15 species with moderate or high fidelity toward wet prairies	10-15 species with moderate or high fidelity toward wet prairies	5-10 species with moderate or high fidelity toward wet prairies	<5 species with moderate or high fidelity toward wet prairies
Key Ecological Attribute: *Hydrology*					
Water Source	Anthropogenic sources of water can have detrimental effects on the hydrological regime	Source is natural or naturally lacks water in the growing season. No indication of direct artificial water sources	Source is mostly natural, but site directly receives occasional or small amounts of inflow from anthropogenic sources	Source is primarily urban runoff, direct irrigation, pumped water, artificially impounded water, or other artificial hydrology	Water flow has been substantially diminished by human activity
Hydroperiod **(partially from Alverson 2009a)**	Alteration in hydrology or sediment loads or some onsite stressors can degrade channel stability	Hydroperiod of the site is characterized by natural patterns of filling or inundation and drying or drawdown. Soils are generally saturated to the surface during the rainy season.	The filling or inundation patterns in the site are of greater magnitude (and greater or lesser duration than would be expected under natural conditions, but thereafter, the site is subject to natural drawdown or drying.	The filling or inundation patterns in the site are characterized by natural conditions, but thereafter are subject to more rapid or extreme drawdown or drying, as compared to more natural wetlands. OR filling or inundation patterns are of substantially lower magnitude or duration than expected under natural conditions, but thereafter, the site is subject to natural drawdown or drying.	Both the filling/inundation and drawdown/drying of the site deviate from natural conditions (either increased or decreased in magnitude and/or duration). Soils are either never saturated to the surface during the rainy season, or are completely inundated for more than 120 continuous hours (5 days) at least once in a five year period.

Hydrological Connectivity (non-riverine)	Floodwater should have access to the floodplain. Stressors resulting in entrenchment affect hydrological connectivity	Rising water in the site has unrestricted access to adjacent upland, without levees, excessively high banks, artificial barriers, or other obstructions to the lateral movement of flood flows.	Lateral excursion of rising waters is partially restricted by unnatural features, such as levees or excessively high banks, but < than 50% of the site is restricted by barriers to drainage. Restrictions may be intermittent along the site, or the restrictions may occur only along one bank or shore. Flood flows may exceed the obstructions, but drainage back to the wetland is incomplete due to impoundment.	Lateral excursion of rising waters is partially restricted by unnatural features, such as levees or excessively high banks, and 50-90% of the site is restricted by barriers to drainage. Flood flows may exceed the obstructions, but drainage back to the wetland is incomplete due to impoundment.	All water stages in the site are contained within artificial banks, levees, sea walls, or comparable features, or greater than 90% of wetland is restricted by barriers to drainage. There is essentially no hydrologic connection to adjacent uplands.
Key Ecological Attribute: *Physicochemical*					
Soil Surface Condition	Soil disturbance can result in erosion thereby negatively affecting many ecological processes	Bare soil areas are limited to naturally caused disturbances such as flood deposition or game trails	Some bare soil due to human causes but the extent and impact is minimal. The depth of disturbance is limited to only a few inches and does not show evidence of ponding or channeling water.	Bare soil areas due to human causes are common. There may be pugging due to livestock resulting in several inches of soil disturbance. ORVs or other machinery may have left some shallow ruts.	Bare soil areas substantially & contribute to altered hydrology or other long-lasting impacts. Deep ruts from ORVs or machinery may be present, or livestock pugging and/or trails are widespread. Water will be channeled or ponded.
Water Quality	Excess nutrients, sediments, or other pollutant have an adverse affect on natural water quality	No evidence of degraded water quality. Water is clear; no strong green tint or sheen.	Some negative water quality indicators are present, but limited to small and localized areas. Water may have a minimal greenish tint or cloudiness, or sheen.	Negative indicators or wetland species that respond to high nutrient levels are common. Water may have a moderate greenish tint, sheen or other turbidity with common algae.	Widespread evidence of negative indicators. Algae mats may be extensive. Water may have a strong greenish tint, sheen or turbidity. Bottom difficult to see during due to surface algal mats and other vegetation blocking light to the bottom.
Rank Factor: SIZE					

Key Ecological Attribute: *Size*					
Relative Size	Indicates the proportion lost due to stressors such as complete fire suppression (conversion to a new system), development, roads, etc.	Site is at or minimally reduced from natural extent (>95% remains)	Occurrence is only modestly reduced from its original natural extent (80-95% remains)	Occurrence is substantially reduced from its original natural extent (50-80% remains)	Occurrence is severely reduced from its original natural extent (<50% remains)
Absolute Size	Absolute size may be important for buffering impacts originating in the surrounding landscape.	Very large (>300 ac/120 ha)	Large (100-300 ac/40-120 ha)	Moderate (10-100 ac/4-40 ha)	Small (<10 ac/4 ha)

Level 3 EIA

Level 3 metrics would include more quantitative measures of the metrics listed above. In addition, further consideration might be given to:

- Alverson (2009a) has suggested metrics for 1 m^2 quadrats.
- Nitrogen Enrichment (C:N)
- Phosphorous Enrichment (C:P)
- Soil Organic Carbon
- Soil Bulk Density
- Water Table Depth

Triggers or Management Assessment Points

Ecological triggers or conditions under which management activities need to be reassessed are show in the table below. Since the Ecological Integrity rankings are based on hypothesized thresholds, they are used to indicate where triggers might occur. Specific details about how these triggers translate for each metric can be found by referencing the values or descriptions for the appropriate rank provided in the Tables above.

Table 4. Triggers for Level 2 & 3 EIA

Key Ecological Attribute or Metric	Trigger	Action
Any metric (except Connectivity or LCM)	▪ C rank ▪ Shift from A to B rank ▪ negative trend within the B rating (Level 3)	Level 2 triggers: conduct Level 3 assessment; make appropriate short-term management changes to ensure no further degradation Level 3 triggers: make appropriate management adjustments to ensure no additional degradation occurs. Continue monitoring using Level 3.
Any Key Ecological Attribute	▪ any metric has a C rank ▪ > than ½ of all metrics are ranked B ▪ negative trend within the B rating (Level 3)	Level 2 triggers: conduct Level 3 assessment; make appropriate short-term management changes to ensure no further degradation

		Level 3 triggers: make appropriate management adjustments to ensure no additional degradation occurs. Continue monitoring using Level 3.

Protocol for Integrating Metric Ranks

If desired, the user may wish to integrate the ratings of the individual metrics and produce an overall score for the three rank factor categories: (1) Landscape Context; (2) Condition; and (3) Size. These rank factor rankings can then be combined into an Overall Ecological Integrity Rank. This enables one to report scores or ranks from the various hierarchical scales of the assessment depending on which best meets the user's objectives. Please see Table 5 in Rocchio and Crawford (2009) for specifics about the protocol for integrating or 'rolling-up' metric ratings.

List of Native Species with Moderate and High Fidelity to Willamette Valley Wet Prairies (from Chappell et al. 2004 and Alverson 2009b)

SPECIES	FAMILY	COMMON NAME	Degree of fidelity to prairie habitats	Present in Georgia Basin	Present in Puget Trough	Present in Lower Columbia River	Present in Willamette Valley	Occurs in Wet Prairie	Occurs in Vernal Pools or Seeps
Agrostis exarata Trin. var. exarata	Poaceae	spike bentgrass	M	Y	?	Y	Y	Y	Y
Agrostis microphylla Steud.	Poaceae	awned spike bentgrass	H	Y	Y	Y	Y	Y	Y
Alopecurus carolinianus Walt.	Poaceae	Tufted Foxtail	H	Y	Y		Y		Y
Alopecurus geniculatus L. var. geniculatus	Poaceae	water foxtail	M	Y	Y	Y	Y	Y	Y
Alopecurus saccatus Vasey	Poaceae	Pacific foxtail	H	?	Y		Y		Y
Androsace filiformis Retz.	Primulaceae	slender rock-jasmine	H			Y	Y	Y	
Aristida oligantha Michaux	Poaceae	prairie threeawn	H				Y		Y
Asclepias fascicularis Duchesne	Asclepiadaceae	narrowleaf milkweed	H				Y	Y	Y
Beckmannia syzigachne (Steud.) Fernald	Poaceae	sloughgrass	H			Y	Y	Y	Y
Callitriche heterophylla Pursh ssp. bolanderi (Hegelm.) Calder & Taylor	Callitrichaceae	Bolander's water starwort	M	Y		Y	Y		Y
Callitriche marginata Torr.	Callitrichaceae	Winged Water-starwort	M	Y			Y		Y
Calochortus uniflorus Hook. & Arn.	Liliaceae	large flowered startulip	H				Y	Y	
Cardamine penduliflora O.E. Schulz	Brassicaceae	Willamette Valley bittercress	M			?	Y	Y	

SPECIES	FAMILY	COMMON NAME	Degree of fidelity to prairie habitats	Present in Georgia Basin	Present in Puget Trough	Present in Lower Columbia River	Present in Willamette Valley	Occurs in Wet Prairie	Occurs in Vernal Pools or Seeps
Carex athrostachya Olney	Cyperaceae	slenderbeak sedge	M	Y	Y	Y	Y	Y	
Carex aurea Nuttall	Cyperaceae	golden fruited sedge	H	Y		Y	Y	Y	
Carex cusickii Mack. ex Piper & Beattie	Cyperaceae	Cusick's sedge	M	?	?	?	Y	Y	
Carex densa (L.H. Bailey) L.H. Bailey	Cyperaceae	dense sedge	H	?	Y	Y	Y	Y	Y
Carex feta L.H. Bailey	Cyperaceae	green sheathed sedge	M	Y	?	Y	Y	Y	
Carex scoparia Schkuhr ex Willd. var. scoparia	Cyperaceae	pointed broom sedge	M	Y		Y	Y	Y	
Carex unilateralis Mack.	Cyperaceae	one sided sedge	M	Y	Y	Y	Y	Y	Y
Centunculus minimus L.	Primulaceae	chaffweed	M	Y		Y	Y	Y	Y
Cicendia quadrangularis (Lam.) Griseb.	Gentianaceae	timwort	H				Y	Y	Y
Crassula aquatica (L.) P. Schoenl.	Crassulaceae	water pygmy weed	M	Y	Y	Y	Y		Y
Crassula connata (Ruiz & Pavón) Berger var. connata	Crassulaceae	Sand Pygmyweed	H	Y					Y
Cuscuta pentagona Engelm. var. pentagona	Cuscutaceae	field dodder	M	Y		?	Y	Y	Y
Deschampsia cespitosa (L.) P. Beauv. s.l.	Poaceae	tufted hairgrass	M	Y	Y	Y	Y	Y	Y
Deschampsia danthonioides (Trin.) Munro	Poaceae	annual hairgrass	H	Y	Y	Y	Y	Y	Y
Downingia elegans (Douglas ex Lindl.) Torr. var. elegans	Campanulaceae	elegant downingia	H	?	Y	Y	Y	Y	Y
Downingia yina Applegate	Campanulaceae	Willamette	H	?	Y	Y	Y	Y	Y

SPECIES	FAMILY	COMMON NAME	Degree of fidelity to prairie habitats	Present in Georgia Basin	Present in Puget Trough	Present in Lower Columbia River	Present in Willamette Valley	Occurs in Wet Prairie	Occurs in Vernal Pools or Seeps
		downingia							
Eleocharis acicularis (L.) Roem. & Schult. var. acicularis	Cyperaceae	needle spikerush	M	?	Y	Y	Y	Y	Y
Eleocharis palustris (L.) Roem. & Schult. var. palustris	Cyperaceae	creeping spikerush	M	?	Y	Y	Y	Y	Y
Epilobium densiflorum (Lindl.) P.C. Hoch & P.H. Raven	Onagraceae	close flowered boisduvalia	H	Y	Y	Y	Y	Y	Y
Epilobium pygmaeum (Speg.) P.C. Hoch & P.H. Raven	Onagraceae	smooth willowherb	H			Y	Y		Y
Equisetum palustre L.	Equisetaceae	marsh horsetail	M				Y	Y	
Eryngium petiolatum Hook.	Apiaceae	coyotethistle	H			Y	Y	Y	Y
Gentiana sceptrum Griseb.	Gentianaceae	king's gentian	M	?		Y	Y	Y	
Glyceria occidentalis (Piper) J.C. Nelson	Poaceae	western mannagrass	M			Y	Y	Y	Y
Gnaphalium palustre Nuttall	Asteraceae	lowland cudweed	M	Y	Y	Y	Y	Y	Y
Gratiola ebracteata Benth.	Scrophulariaceae	bractless hedge hyssop	M	Y	Y	Y	Y	Y	Y
Helenium autumnale L. var. grandiflorum (Nutt). T.&G.	Asteraceae	autumn sneezeweed	M	Y	Y	Y	?	Y	
Juncus confusus Coville	Juncaceae	Colorado rush	H	?	?	?	Y	Y	
Juncus dudleyi Wieg.	Juncaceae	Dudley's rush	M				Y	Y	
Juncus hemiendytus F.J. Herm. var. hemiendytus	Juncaceae	dwarf rush	H			Y	Y		Y

SPECIES	FAMILY	COMMON NAME	Degree of fidelity to prairie habitats	Present in Georgia Basin	Present in Puget Trough	Present in Lower Columbia River	Present in Willamette Valley	Occurs in Wet Prairie	Occurs in Vernal Pools or Seeps
Juncus nevadensis S. Watson var. nevadensis	Juncaceae	Sierra rush	H			Y	Y	Y	Y
Juncus occidentalis Wieg.	Juncaceae	prairie rush	M	Y	Y	Y	Y	Y	
Lepidium oxycarpum Torr. & Gray	Brassicaceae	Sharp-pod Pepper-grass	H	Y					Y
Limnanthes macounii Trel.	Limnanthaceae	Macoun's meadowfoam	H	Y					Y
Lotus formosissimus Greene	Fabaceae	bicolored lotus	H	Y	?	Y	Y	Y	Y
Lotus pinnatus Hook.	Fabaceae	bog lotus	H	Y	Y	Y	Y	Y	Y
Mentha canadensis L.	Lamiaceae	field mint	M	Y	?	Y	Y	Y	
Mimulus douglasii (Benth.) A. Gray	Scrophulariaceae	Dougla's Monkeyflower	H				Y	Y	Y
Mimulus tricolor Hartw.	Scrophulariaceae	Tricolor Monkeyflower	H				Y		Y
Montia fontana L. var. tenerrima (Gray) Fern. & Wieg.	Portulacaceae	water chickweed	M	Y	Y	Y	Y	Y	Y
Montia linearis (Douglas ex Hook.) Greene	Portulacaceae	narrowleaf montia	M	Y	Y	Y	Y	Y	Y
Myosurus minimus L.	Ranunculaceae	least mousetail	H	Y	Y	Y	Y		Y
Navarretia leucocephala Benth. ssp. leucocephala	Polemoniaceae	white flowered navarretia	H				Y		Y
Navarretia squarrosa (Eschsch.) Hook. & Arn.	Polemoniaceae	skunkweed	M	Y	Y	Y	Y		Y

SPECIES	FAMILY	COMMON NAME	Degree of fidelity to prairie habitats	Present in Georgia Basin	Present in Puget Trough	Present in Lower Columbia River	Present in Willamette Valley	<u>Occurs in Wet Prairie</u>	Occurs in Vernal Pools or Seeps
Navarretia willamettensis S.C. Spencer	Polemoniaceae	Willamette navarretia	H				Y		Y
Penstemon hesperius Peck	Scrophulariaceae	western penstemon	H			Y		Y	
Physostegia parviflora	Lamiaceae	western false dragonhead	M			Y		Y	
Plagiobothrys figuratus (Piper) I.M. Johnst. ssp. figuratus	Boraginaceae	fragrant popcorn flower	H	Y	Y	Y	Y	Y	Y
Plagiobothrys scouleri (Hook. & Arn.) I.M. Johnst. var. hispidulus (Greene) Dorn	Boraginaceae	sleeping popcornflower	M	?		Y	Y	Y	
Plagiobothrys scouleri (Hook. & Arn.) I.M. Johnst. var. scouleri	Boraginaceae	Scouler's popcorn flower	M	Y	Y	Y	Y	Y	Y
Plantago bigelovii Gray ssp. bigelovii	Plantaginaceae	coastal plantain	H	Y		Y		Y	Y
Polygonum bistortoides Pursh	Polygonaceae	western bistort	H	?	Y	Y	Y	Y	
Polygonum polygaloides ssp. confertiflorum	Polygonaceae	close flowered knotweed	H			Y	Y		Y
Potentilla rivalis Nuttall	Rosaceae	Brook Cinquefoil	H	Y	Y	Y		Y	
Psilocarphus elatior (A. Gray) A. Gray	Asteraceae	tall woollyheads	M	Y	Y	Y	Y	Y	Y
Psilocarphus oregonus Nuttall	Asteraceae	Oregon Woollyheads	M			Y	Y	Y	Y
Pyrrocoma racemosa (Nuttall) Torr. & A. Gray var. racemosa	Asteraceae	racemed goldenweed	H				Y	Y	

SPECIES	FAMILY	COMMON NAME	Degree of fidelity to prairie habitats	Present in Georgia Basin	Present in Puget Trough	Present in Lower Columbia River	Present in Willamette Valley	Occurs in Wet Prairie	Occurs in Vernal Pools or Seeps
Ranunculus alismifolius Geyer ex Bentham var. alismifolius	Ranunculaceae	plantain leaved buttercup	H	Y	Y	Y	Y	Y	Y
Ranunculus lobbii (Hiern) A. Gray	Ranunculaceae	Lobb's water buttercup	H	Y	?		Y		Y
Ranunculus orthorhynchus Hook. var. orthorhynchus	Ranunculaceae	straightbeak buttercup	H	Y	Y	Y	Y	Y	
Ranunculus orthorhynchus Hook. var. platyphyllus A. Gray	Ranunculaceae	broadleaved buttercup	H	Y		Y	Y	Y	
Rorippa curvisiliqua (Hook.) Bessey ex Britton	Brassicaceae	western yellowcress	M	Y	Y	Y	Y		Y
Rotala ramosior (L.) Koehne	Lythraceae	Toothcup	M		?	Y	Y		Y
Salix piperi Bebb	Salicaceae	Piper's willow	M	?	Y	Y	Y	Y	
Saxifraga oregana Howell var. oregana	Saxifragaceae	Oregon saxifrage	H	?	Y	Y	Y	Y	
Sclerolinon digynum (A. Gray) C.M. Rogers	Linaceae	northwestern yellowflax	H				Y	Y	Y
Sidalcea cusickii Piper	Malvaceae	Cusick's checkermallow	H				Y	Y	
Sidalcea nelsoniana Piper	Malvaceae	Nelson's Sidalcea	H			Y	Y	Y	
Stellaria longipes Goldie ssp. longipes	Caryophyllaceae	longstalk starwort	M	Y	Y	?		Y	
Thalictrum polycarpum (Torr.) S. Watson	Ranunculaceae	tall western meadowrue	M		?	?	Y	Y	

SPECIES	FAMILY	COMMON NAME	Degree of fidelity to prairie habitats	Present in Georgia Basin	Present in Puget Trough	Present in Lower Columbia River	Present in Willamette Valley	Occurs in Wet Prairie	Occurs in Vernal Pools or Seeps
Trichostema oblongum Benth.	Lamiaceae	downy blue curls	H			Y	Y	Y	Y
Veronica peregrina L. var. xalapensis (Kunth) H. St. John & F.A. Warren	Scrophulariaceae	hairy purslane speedwell	M	Y	Y	?	Y	Y	Y
Veronica scutellata L.	Scrophulariaceae	marsh speedwell	M	?	Y	Y	Y	Y	Y
Viola langsdorfii (Regel.) Fisch.	Violaceae	Alaska violet	M	Y				Y	
Viola nephrophylla Greene	Violaceae	northern bog violet	M	Y				Y	

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Appendix F

Laboratory Analysis of Soils at the Ridgefield NWR

And comparison sites

December 7, 2009

A&L Western Agricultural Laboratories

Modesto, California

A & L WESTERN AGRICULTURAL LABORATORIES

1311 WOODLAND AVE #1 | MODESTO, CALIFORNIA 95351 | (209) 529-4080 | FAX (209) 529-4736

REPORT NUMBER: 09-334-030

CLIENT NO: 9999-D

SEND TO: WSD NATURAL RESOURCES/HERITAGE PROG
1111 WASHINGTON ST SE
OLYMPIA, WA 98504-7014

SUBMITTED BY: JOE ARNETT

GROWER: LOBR 1-9

DATE OF REPORT: 12/07/09

SOIL ANALYSIS REPORT

SAMPLE ID	LAB NUMBER	Organic Matter * % Rating	Organic Matter ** ENR lbs/A	Phosphorus P1 (Weak Bray) **** * ppm	Phosphorus $NaHCO_3$-P (OlsenMethod) **** * ppm	Potassium K ***** * ppm	Magnesium Mg *** * ppm	Calcium Ca *** * ppm	Sodium Na *** * ppm	pH Soil pH	pH Buffer Index	Hydrogen H meq/100g	Cation Exchange Capacity C.E.C. meq/100g	PERCENT CATION SATURATION (COMPUTED) K %	Mg %	Ca %	H %	Na %
1	54243	7.6VH	182	13L	24**	149L	492M	1956L	38VL	4.8	5.3	12.7	27.1	1.4	14.9	36.0	47.0	0.6
2	54244	14.2VH	315	1VL	16**	172L	495M	1916L	30VL	5.1	5.4	8.7	22.9	1.9	17.8	41.7	38.0	0.6
3	54245	5.6VH	142	3VL	16**	190M	425M	1697L	29VL	4.9	5.4	9.9	22.5	2.2	15.6	37.7	44.0	0.6
4	54246	6.7VH	163	22M	22**	79L	350M	1860L	35VL	5.2	6.2	6.6	19.1	1.1	15.1	48.6	34.5	0.8
5	54247	3.2M	93	25M	28**	253M	706H	2687L	40VL	5.4	6.3	8.0	28.0	2.3	20.7	47.8	28.5	0.6

** NaHCO3-P unreliable at this soil pH

SAMPLE NUMBER	Nitrogen NO_3-N ppm	Sulfur SO_4-S ppm	Zinc Zn ppm	Manganese Mn ppm	Iron Fe ppm	Copper Cu ppm	Boron B ppm	Excess Lime Rating	Soluble Salts mmhos/cm	Chloride Cl ppm		PARTICLE SIZE ANALYSIS SAND %	SILT %	CLAY %	SOIL TEXTURE
1		40VH	0.2VL	23H	46VH	0.6L	0.2VL					31	30	39	CLAY LOAM
2		32H	0.2VL	22H	50VH	0.5L	0.2VL					33	38	29	CLAY LOAM
3		39VH	0.2VL	20H	58VH	0.5L	0.2VL					37	36	27	CLAY LOAM
4		15M	1.6M	13H	91VH	0.7L	0.5L					29	52	19	SILT LOAM
5		10L	1.4M	23H	76VH	3.3VH	0.2VL					17	48	35	SILTY CLAY LOAM

* CODE TO RATING: VERY LOW (VL), LOW (L), MEDIUM (M), HIGH (H), AND VERY HIGH (VH).
** ENR - ESTIMATED NITROGEN RELEASE
*** MULTIPLY THE RESULTS IN ppm BY 2 TO CONVERT TO LBS. PER ACRE OF THE ELEMENTAL FORM
**** MULTIPLY THE RESULTS IN ppm BY 4.6 TO CONVERT TO LBS. PER ACRE P_2O_5
***** MULTIPLY THE RESULTS IN ppm BY 2.4 TO CONVERT TO LBS. PER ACRE K_2O
MOST SOILS WEIGH TWO (2) MILLION POUNDS (DRY WEIGHT) FOR AN ACRE OF SOIL 6-2/3 INCHES DEEP

This report applies only to the sample(s) tested. Samples are retained a maximum of thirty days after testing.

Mike Buttress, CPAg
A & L WESTERN LABORATORIES, INC.

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SOIL ANALYSIS REPORT

SAMPLE ID	LAB NUMBER	Organic Matter		Phosphorus		Potassium	Magnesium	Calcium	Sodium	pH		Hydrogen	Cation Exchange Capacity	PERCENT CATION SATURATION (COMPUTED)				
		* % Rating	** ENR lbs/A	P1 (Weak Bray) **** * ppm	$NaHCO_3$-P (OlsenMethod) **** * ppm	K ***** * ppm	Mg *** * ppm	Ca *** * ppm	Na *** * ppm	Soil pH	Buffer Index	H meq/100g	C.E.C. meq/100g	K %	Mg %	Ca %	H %	Na %
6	54248	4.5H	120	7VL	21**	177L	797M	3235L	68VL	5.0	6.2	16.3	39.7	1.1	16.5	40.6	41.0	0.7
7	54249	5.2H	134	9L	28**	135L	538M	2233VL	47VL	4.5	6.1	22.3	38.4	0.9	11.5	29.0	58.0	0.5
8	54250	3.3M	96	6VL	20**	53VL	521M	2188L	59L	5.2	6.5	8.2	23.8	0.6	18.0	45.9	34.5	1.1
9	54251	3.5M	100	4VL	29**	132L	466M	1922L	35VL	5.4	6.3	5.5	19.5	1.7	19.7	49.3	28.5	0.8

** NaHCO3-P unreliable at this soil pH

SAMPLE NUMBER	Nitrogen NO_3-N ppm	Sulfur SO_4-S ppm	Zinc Zn ppm	Manganese Mn ppm	Iron Fe ppm	Copper Cu ppm	Boron B ppm	Excess Lime Rating	Soluble Salts mmhos/cm	Chloride Cl ppm		PARTICLE SIZE ANALYSIS: SAND %	SILT %	CLAY %	SOIL TEXTURE
6		16M	4.4H	7M	82VH	4.1VH	0.2VL					21	50	29	CLAY LOAM
7		14M	3.5H	5M	83VH	2.6VH	0.2VL					25	46	29	CLAY LOAM
8		7L	2.2M	4M	83VH	3.7VH	0.2VL					17	46	37	SILTY CLAY LOAM
9		4L	1.3M	9M	76VH	3.3VH	0.2VL					15	48	37	SILTY CLAY LOAM

* CODE TO RATING: VERY LOW (VL), LOW (L), MEDIUM (M), HIGH (H), AND VERY HIGH (VH).
** ENR - ESTIMATED NITROGEN RELEASE
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