Climate Change Vulnerability Assessment for West Eugene Wetland Species

2013

Report to the Bureau of Land Management, Eugene District

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PREFACE

IAE is a non-profit organization whose mission is conservation of native ecosystems through restoration, research and education. IAE provides services to public and private agencies and individuals through development and communication of information on ecosystems, species, and effective management strategies. Restoration of habitats, with a concentration on rare and invasive species, is a primary focus. IAE conducts its work through partnerships with a diverse group of agencies, organizations and the private sector. IAE aims to link its community with native habitats through education and outreach.

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Dana Ross of Dana Ross Consulting provided valuable expert knowledge for assessment of the butterfly species reviewed in this report. Diane Steeck of the City of Eugene provided extensive technical assistance with the CCVI rankings and with reviewing this report.

Cover photographs: White-top aster, Willamette daisy, Taylor's checkerspot, Kincaid's lupine and Fender's blue, Shaggy horkelia, Hitchcock's blue-eyed grass, Bradshaw's desert-parsley, golden paintbrush, and Western Pond Turtle. *Most photos by TN Kaye and M. Blakeley-Smith, IAE; western pond turtle by Lauri Holts, City of Eugene.*

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TABLE OF CONTENTS

Climate Change Vulnerability Assessment for West Eugene Wetland Species

REPORT TO THE BUREAU OF LAND MANAGEMENT, EUGENE DISTRICT

1. INTRODUCTION

Local climate is one important factor that controls species distributions. To preserve rare grassland species, manage and restore grassland habitat, and maintain communities that are resilient to climate change in the Pacific Northwest (PNW), land managers and restoration practitioners in the Willamette Valley (WV) need to proactively incorporate climate change considerations into both short- and long-term planning and management actions. Climate change scenarios (IPCC 2000) predict direct effects on average annual temperature and precipitation in the next 50-100 years for the PNW, with implications for a host of possible indirect effects such as micro-climate changes or barriers to dispersal linked to site-specific factors (GCRP 2009). Climate forces acting upon native grasslands may affect plant species' distribution, range, phenology, and ability to compete with non-native species, among many effects.

With large-scale experiments just beginning to provide data, little species-specific information is currently available. This project is one of the first to assess climate vulnerability of individual grassland plant and animal species in the WV (but see Steel et al. 2011), and will directly support development of a Resource Management Plan for the West Eugene Wetlands (WEW) on Bureau of Land Management (BLM) lands.

For this assessment of species' vulnerabilities to climate change, we utilized NatureServe's Climate Change Vulnerability Index (CCVI). Developed by Young et al. (2011), the CCVI is an evaluation tool that combines downscaled local and regional physical climate change data with species biological information to generate two principal outputs: 1) a categorical rank assigning relative risk to each species that climate change will cause a species to decline or increase and 2) identification of the factors causing risk. Along with past and future projected climate, the index is determined through expert opinion and documented studies on a species' range, life history, and adaptive capacity. The index also considers documented and modeled responses to climate change, when available. Recent examples of the use of the CCVI include West Virginia's assessment of climate vulnerability of 185 species of concern (Byers and Norris 2011), a Nevada task force's application of the tool for adding climate change considerations into a state wildlife action plan (Young et al. 2009), and an Oregon application to species included in the Oregon Conservation Strategy (Steel et al. 2011).

Knowledge gained from this assessment will have short-term outcomes of informing management of rare plant populations and providing insight into the climate resiliency of native plant species currently being propagated for restoration of prairies and savannas. A long-term outcome will be the overall improved understanding of potential climate change effects on native WV grassland species and communities.

2. GOALS AND OBJECTIVES

The goal of this project is to investigate the climate change vulnerabilities of native grassland species, of which six are federally listed, four are species of conservation concern (USFWS 2010) and one is semi-aquatic; as well as key invasive species that pose a significant threat to native species of grasslands. We model vulnerabilities at multiple geographic scales and under three increasing climate change scenarios to understand the full range of potential future effects of climate change for each species.

This project has three primary objectives:

1) Assess the relative climate change vulnerabilities of 31 Willamette Valley native species and 5 invasive species;

2) Determine the extent of climate change vulnerability at local (WEW) and ecoregional (WV) scales for all species, and range-wide within the United States for all listed/conservation concern species; and

3) Assess climate change vulnerabilities across a range of climate change scenarios predicting little change to significant change.

3. FORECASTED CLIMATE CHANGE IN THE WILLAMETTE VALLEY

Climate change is expected to have substantial effects on the Willamette Valley over the next 50-100 years, but these effects vary depending on the particular climate model predictions. The CMIP3 (Coupled Intermodel Comparison Project 3) global climate models (Randall et al. 2007) generally agree that the Pacific Northwest will experience increased average annual and seasonal temperatures compared to 20th Century averages (Mote & Salathe 2010). In the southern Willamette Valley, average annual temperatures are expected to increase 2-4 °F (1.1-2.2 °C) or more by 2050, with greater increases in summer temperatures (4-6°F [2.2-3.3 °C] on average) (Doppelt et al. 2009). Models are less consistent regarding precipitation, with some projecting increases in annual rainfall and others decreases by 2050, but generally less precipitation is expected during summer, while a small increase is possible in winter months (Mote & Salathe 2010). A notable change is that winter snowpack is expected to decrease by 60% or greater by 2050, resulting in earlier peaks for snowmelt runoff at lower levels than current conditions. With regard to disturbance, little change is expected in wildfire frequency, but the region may experience more frequent flooding due to increased storm events (Doppelt et al. 2009). In grassland habitats of the WV, depending on site-specific factors, these changes may result in higher winter and spring water levels in wet prairies, increase spring flooding events, and prolong a noticeably warmer summer drought period.

4. METHODS

4.1. Climate Change Vulnerability Index

Exposure and Sensitivity

The CCVI combines downscaled climate data, landscape setting, and abiotic factors for an assessment area with a suite of factors pertaining to species' biology to derive a climate change vulnerability ranking. To accomplish this, the index combines information on climate (direct exposure), landscape setting (indirect exposure), and species sensitivity (Figure 1). It is designed to incorporate effects attributable only to climate change and is meant to be used in conjunction with other information (species' rarity, habitat availability, etc.) for broader conservation assessments. Research data and expert opinion can both be used to inform the index, and it also allows for incorporation of uncertainty (Young et al. 2011).

Direct climate exposure predictions for a given assessment area were calculated using a Geographic Information System (GIS) and a standard set of climate maps provided by ClimateWizard (Girvetz et al. 2009). The CCVI accounts for indirect climate exposure and species sensitivity by considering a set of 20 factors (Table 1). Factors assessed by the CCVI were selected for inclusion in the model based on published research associating the factor with vulnerability to climate change (Young et al. 2011). Each factor is considered independently in the index, and we assigned a category indicating the direction and degree to which the factor influences the species' vulnerability to climate change. Categories included: *Greatly Increase*, *Increase*, *Somewhat Increase*, *Neutral*, *Somewhat Decrease*, or *Decrease*; based upon their nature some factors were only eligible for a subset of these categories. All information on expected climate change and species sensitivity was entered into a spreadsheet (CCVI release 2.1) that calculated a final ranking for each of our species, climate and region combinations. We followed the CCVI Guidelines (Young et al. 2011) for each factor, which provided a description of the categorical ranking methods along with examples. When we were uncertain about a species' sensitivity to climate change, we selected more than one categorical ranking to span our sense of uncertainty. For example, many species were ranked "*somewhat increase-neutral*" for dependence on a range from few to many pollinators. While the CCVI was designed to incorporate data from research documenting species' actual response to climate change effects, this information was lacking for the species examined here and therefore left "unknown" in our assessments.

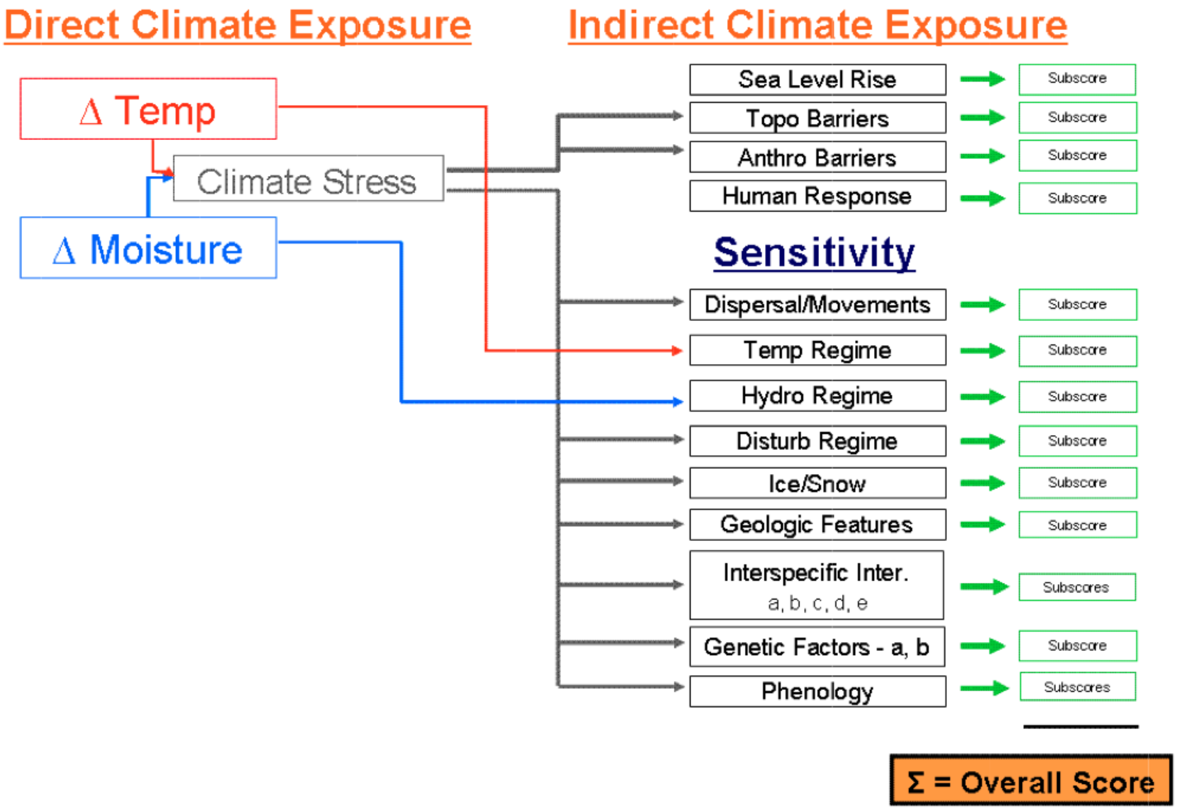


Figure 1. Relationship between climate exposure and species sensitivity factors to calculate the CCVI (Young et al. 2011).

Index scores and measures of confidence

The CCVI returned a categorical vulnerability rating (Table 2) calculated as the sum of the climate exposure and sensitivity factors (Young et al. 2011). Uncertainty in the ratings was determined through a Monte Carlo simulation which recalculated the index when more than one option was selected per assessment factor. This simulation was run 1,000 times, with equal likelihood for each option, producing a "low" to "very high" confidence rating.

Table 1. Indirect climate exposure and species' sensitivity factors employed in the CCVI.

Factor	Description
Indirect Exposure (Landscape setting)	
Sea level rise	Effects of a 0.5-1m sea level rise and associated storm surges
Natural barriers	Degree to which natural barriers (e.g. mountain ranges, waterbodies) limit a species' ability to shift its range in response to climate change
Anthropogenic barriers	Degree to which anthropogenic barriers (e.g. large areas of urban/agricultural development) limit a species' ability to shift its range in response to climate change
Climate Change mitigation	Effects of climate change-related mitigation (e.g. solar panel arrays, wind farms)
Sensitivity (Species biology)	
Dispersal and movements	Known dispersal capacities and ability to shift location through unsuitable habitat as needed due to climate change
Historical thermal niche	Exposure to recent past temperature variations (last 50 yrs.)
Physiological thermal niche	Association with cool or cold environments likely to be decreased by climate change
Historical hydrological niche[1]	Exposure to recent past hydrological variations (last 50 yrs.)
Physiological hydrological niche	Dependence on a narrow precipitation/hydrologic regime
Disturbance	Dependence on a specific disturbance regime likely to be impacted by climate change
Ice/Snow dependency	Dependence upon ice, ice-edge, or snow cover habitats
Restriction to uncommon geological features	Requirements for a particular soil, substrate, geology, water chemistry, or physical feature (e.g caves, cliffs)
Interspecific interactions:	
Habitat creation	Dependence on other species to create any habitat necessary for life cycle completion. For plants, includes seedling establishment.
Dietary versatility	Animals only. Diversity of food types; dietary specialists/generalists.
Pollinator versatility	Plants only. Number of pollinator species.
Propagule dispersal	Dependence on other species for dispersal.
Interspecific interactions	Mutualism, parasitism, commensalism, predator-prey relationship, unrelated to habitat, seedling establishment, diet, pollination, or dispersal.
Genetic variation	Measured genetic variation
Genetic bottlenecks	Occurrence of bottlenecks in recent evolutionary history (past 500 years). Applied only if measured genetic variation is unknown.
Phenological response	Measured change in phenology as compared to other species in similar habitats or taxonomic groups.

Documented response to climate change:	
Recent response	Range contraction or phenology mismatch with critical resources
Modeled future change (2050)	Distribution or population models demonstrating change in range or population size
Overlap of modeled future range with current range	Percent of the current range that intersects with predicted future range
Occurrence of protected areas	Percent of modeled future distribution that intersects with protected areas

[1] We developed customized criteria for this category. See Methods section and Appendix A for details.
Descriptions in table sourced from CCVI model guidelines (Young et al. 2011).

Table 2. CCVI vulnerability rankings returned for each assessed species.

Rankings		**Definition**
Extremely Vulnerable	EV	Abundance and/or range extent within geographical area assessed extremely likely to substantially decrease or disappear by 2050.
Highly Vulnerable	HV	Abundance and/or range extent within geographical area assessed likely to decrease significantly by 2050.
Moderately Vulnerable	MV	Abundance and/or range extent within geographical area assessed likely to decrease by 2050.
Not Vulnerable/ Presumed Stable	PS	Available evidence does not suggest that abundance and/or range extent within the geographical area assessed will change (increase/decrease) substantially by 2050. Actual range boundaries may change.
Not Vulnerable/ Increase Likely	IL	Available evidence suggests that abundance and/or range extent within geographical area assessed is likely to increase by 2050.
Insufficient Evidence	IE	Available information about a species' vulnerability is inadequate to calculate an Index score.

4.2. Species

We selected five groups of WV grassland species for evaluation: listed/conservation concern species, butterfly species of conservation and management interest, nectar plants significant to butterfly conservation, core native plants used in habitat restoration, and key invasive plant species that greatly threaten prairie and savanna systems in this region.

Listed/Conservation Concern Species

Ten listed and conservation concern species (two insect invertebrates, one reptile, and seven vascular plants) were chosen for this study (Table 3). These species are Oregon native prairie inhabitants and addressed in the USFWS Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington (USFWS 2010). With the exception of golden paintbrush and Taylor's checkerspot, all of these species are found on BLM-managed lands in the WEW.

Butterfly Species

A few notable butterfly species were included in our study due to the importance of their WEW or southern Willamette Valley populations. While not formally listed, these species are very uncommon and are closely associated with grassland habitats; they are all considered generalist feeders but in larval stages each species requires one or very few host plants. The great copper (*Lycaena xanthoides*), thought to be extirpated from the WV, was rediscovered in the WEW in 2005 (Severns et al. 2006) and subsequent surveys have located it on additional protected sites, including restored prairies (NABA 2010). In the WEW great copper oviposits solely on willow dock, despite using numerous species of dock elsewhere throughout its range (Severns et al. 2006). In addition, the great copper anecdotally appears to be closely associated with gumweed as an adult nectar source in the Eugene area. Sonoran skipper (*Polites sonora siris*) have fewer than 20 known populations in the Willamette Valley (WDNR 2011). The larvae feed on grasses, particularly *Poa* and *Festuca* spp. (Pyle 2002). The field crescent (*Phycoides pulchella* nr. *pulchella*) is functionally a unique subspecies in the southern Willamette Valley (D. Ross, pers. comm.) and uses *Aster* spp. as larval host plants.

Table 3. Federal and state listed status for the ten listed/conservation concern species assessed in this report.

Species Name	Common Name	Federal Status[1]	Oregon Status[2]
Euphydryas editha taylori	Taylor's checkerspot	Candidate	N/A (Invertebrate)
Icaricia icarioides fenderi	Fender's blue butterfly	Endangered	N/A (Invertebrate)
Actinemys marmorata	Western pond turtle	Species of Concern	Sensitive Critical
Castilleja levisecta	Golden paintbrush	Threatened	Endangered
Erigeron decumbens* var. *decumbens	Willamette daisy	Endangered	Endangered
Horkelia congesta* ssp. *congesta	Shaggy horkelia	Species of Concern	Candidate
Lomatium bradshawii	Bradshaw's desert parsley	Endangered	Endangered
Lupinus oreganus	Kincaid's lupine	Threatened	Threatened
Sericocarpus rigidus	Whitetop aster	Species of Concern	Threatened
Sisyrinchium hitchcockii	Hitchcock's blue-eyed grass	Species of Concern	NR

1. USFWS Recovery Plan (2010).
2. Rare, Threatened, and Endagnered Species of Oregon (ORBIC 2010). NR = Not ranked.

Nectar Species

Native species known to provide nectar resources for the endangered Fender's blue butterfly (Schultz and Dlugosch 1999, Thomas and Schultz 2010) were assigned to this category (Table 4). Fender's blue is distributed throughout the WV with several populations significant to its range-wide recovery found in the WEW, making this species a focal conservation target at both scales. Fender's blue prefers native nectar sources (Schultz and Dlugosch 1999), and current restoration efforts for sites occupied by

Fender's blue prioritize increasing abundance of native nectar-producing species. Investigating this specific functional group enables a more comprehensive evaluation of potential climate change effects to Fender's blue by incorporating the potential vulnerability of its adult food resources.

Core Species

The common native prairie species we selected represent hardier, mostly perennial species that persist in both high-quality and degraded prairie remnants, and which are typically used as matrix "core" species in restoration and enhancement of Willamette Valley prairie plant communities (Table 4). Practitioners, land managers, and ecologists have invested significant resources advancing successful methods for restoring native prairie plant communities, developing sufficient seed sources of these species, and maintaining restored and enhanced sites. Understanding the climate vulnerability of these core prairie species will inform continued and future prairie restoration and species preservation efforts. While not a typical core species, willow dock was included in this group because it is the primary host plant for the great copper butterfly.

Invasive Species

After habitat loss and fragmentation, invasive plant species pose the greatest threat to native Willamette Valley prairie and savanna species (USFWS 2010). Invasive plant species inherently possess competitive characteristics that enable them to establish widely and become dominant, making them unlikely candidates for vulnerability to climate change. Our purpose in including them in this assessment was to determine whether climate change may improve conditions for them, enabling them to become an even greater threat to native prairies. We evaluated a five species (Table 4) that alter prairie habitat structure either by converting prairies to shrub lands or by excluding nearly all forbs, most of which are very difficult to control once they have become established.

Table 4. Nectar, core, and invasive status of 23 plant species selected for assessment.

Species Group	Species Name	Common name
Nectar	*Eriophyllum lanatum var. leucophyllum*	Woolly sunflower
	Sidalcea malviflora ssp. virgata	Rose checkermallow
	Calochortus tolmiei	Tolmie's mariposa lily
	Iris tenax var. tenax	Oregon iris
	Allium amplectens	Slim-leaf onion
	Camassia quamash var. maxima	Common camas
	Grindelia integrifolia [1]	Gumweed
Core Prairie	*Deschampsia caespitosa var. caespitosa*	Tufted hairgrass
	Festuca roemeri var. roemeri	Roemer's fescue
	Danthonia californica var. americana	California oatgrass
	Agrostis exarata var. exarata	Spike bentgrass
	Rumex salicifolius var. salicifolius	Willow dock
	Ranunculus occidentalis var. occidentalis	Western buttercup
	Plectritis congesta var. congesta	Rosy plectritis

	Achillea millefolium	Yarrow
	Prunella vulgaris var. lanceolata	Self-heal
	Potentilla gracilis var. gracilis	Slender cinquefoil
	Madia elegans var. elegans	Showy tarweed
Invasive	*Rubus discolor*	Himalayan blackberry
	Centaruea x pratensis	Meadow knapweed
	Agrostis stolonifera	Creeping bentgrass
	Leucanthemum vulgare	Ox-eye daisy
	Arrhenatherum elatius	Tall oatgrass

1. Grindelia integrifolia *for WV scale; WEW populations are almost exclusively the hybrid* Grindelia integrifolia x nana *(Ken Chambers pers. comm. cited in Severns 2005, and D. Steeck pers. comm.). We use* Grindelia integrifolia *and the common name gumweed throughout this report but are implicitly referring to the hybrid when discussing the WEW.*

4.2. Assessment areas

Our second project objective was to assess climate change vulnerability at three geographic scales; local, ecoregional, and for the listed/conservation concern species, range-wide. To meet this objective, we evaluated the following spatial scales: the WEW, the WV, and species' range extents in the United States.

West Eugene Wetlands

The WEW are an approximately 3,000-acre network of conserved lands in the southern WV, comprised largely of wet and upland prairie, oak savanna, and oak woodland. The Rivers to Ridges Partnership, a group of 14 agencies and non-governmental organizations, works collaboratively toward conservation and restoration of native habitats and species in the WEW and adjoining protected areas. The localized area of the WEW within the Willamette Valley is of particular interest from a climate vulnerability standpoint due to its importance to the recovery of several listed species and species of conservation concern and because of the significant resources invested in habitat restoration in this area. For the purposes of this assessment, we delineated a WEW boundary encompassing sites that have been managed to conserve native species for nearly two decades. As land managers and ecologists who have worked extensively on rare plant conservation and prairie restoration on these sites, we have specific knowledge of the WEW distribution of all of the assessed species and therefore are confident in applying the entire geographic area within the WEW to the CCVI assessment model.

Willamette Valley

The Willamette Valley was the second scale at which all species were assessed, to investigate regional climate vulnerability and inform conservation and restoration work occurring in the mid- and north valley. WV borders were defined using the level three ecoregion boundary of The Nature Conservancy's terrestrial ecoregions of the world (TNC 1995). Occurrence maps are not readily available at the WV scale except for listed/conservation concern species; therefore we assumed that nectar, core prairie, and invasive species were distributed throughout the entire WV. For the ten listed/conservation concern species, we delineated geographic distributions by watershed boundaries at the fourth level hydrologic unit (USGS 2012) according to NatureServe Explorer (NatureServe 2012) natural heritage records, except for Willamette daisy, Bradshaw's lomatium, Kincaid's lupine, and Fender's blue, which were delineated to the sixth level hydrologic unit (finer scale) based on availability of point occurrence data (USFWS 2010). Golden paintbrush was modeled according to its historical distribution. For those watersheds whose boundaries crossed the WV ecoregion boundary, only the portion of the watershed within the WV was analyzed.

Species ranges

For listed/conservation concern species, we also assessed their range-wide climate vulnerability in the United States to put in context the vulnerability of WEW/WV populations and also to understand overall species' vulnerability. Range maps (Appendix B) were created for each species based on their occurrence in the US watersheds as above (and for the northern portion of the range of Western pond turtle). The only difference in species range assessment areas from WV assessment areas is that species ranges were not limited to the WV ecoregion, but instead geographic extents were determined by natural heritage records (NatureServe 2012). Based on natural heritage records, listed/conservation concern species geographic ranges are within Oregon and Washington except for Hitchcock's blue-eyed grass, golden paintbrush, whitetop aster, and Taylor's checkerspot butterfly. Hitchcock's blue-eyed grass was documented in one watershed in California (Mattole), which was included in its range assessment. Golden paintbrush, whitetop aster, and Taylor's checkerspot occur in BC, Canada (Parks Canada Agency 2005a, 2005b), but climate predictions outside the US have lower grid cell resolutions from our projections in this study, and watershed data for Canada are not listed in NatureServe Explorer. Taylor's checkerspot butterfly also occurs in Washington (Washington Department of Fish and Wildlife 2005), but watershed occurrence data were not available for some animals in Washington's natural heritage records (NatureServe 2012). For our purposes, ranges were defined as the fourth or sixth level hydrologic units that currently or historically contained that species. While this is an overestimate of the actual species distribution, we considered it appropriate for this study.

GIS analysis was conducted with QGIS 1.8.0 (Quantum GIS Development Team 2012) and R 2.15.1 (R Core Team 2012) with spatial analysis packages raster (Hijmans and van Etten 2012) and maptools (Lewin-Koh et al. 2012).

Climate predictions

To address the third project objective of assessing species' vulnerabilities across a range of projected climate change, we employed the "Special Report on Emissions Scenarios" (SRES) (IPCC 2000). Each scenario has different predictions on the future state of greenhouse gas emissions due to trade-offs among economic and environmental focus as well as either regional or global interactions among nations, although these scenarios do not encompass the complete range of possible future climates. The "B1" or best-case scenario generally assumes a politically and economically integrated world with an emphasis on use of clean, non-fossil fuels, and thus the lowest overall climate change. Under SRES B1 by 2050, average temperatures across the Willamette Valley are projected to increase by 1.2 – 2.8° C from the 1961-1990 average. The "A1B" scenario also assumes a politically and economically integrated world, but with a balanced emphasis on the use of fossil and non-fossil fuels, representing a moderate level of climate change. Under SRES A1B by 2050, average temperatures across the

Willamette Valley are projected to increase by 1.2 – 3.8° C from the 1961-1990 average. The "A2" or worst-case scenario assumes a politically and economically fragmented world with emphasis on continued heavy fossil fuel usage, and therefore the most severe climate repercussions. Under SRES A2 by 2050, average temperatures across the Willamette Valley are projected to increase by 1.4 – 3.9° C from the 1961-1990 average. These three scenarios are ordered by their predicted increase in global average surface warming, although the A2 scenario does not project temperature increases higher than A1B until around 2100 (Figure 2).

We used maps of predicted climate constructed from a suite of 16 CMIP3 general circulation models (GCM) utilized in the IPCC AR4 report (IPCC 2007) under each of the three emissions scenario projections to generate the Oregon and Washington climate predictions used in this assessment. This approach addresses two levels of variability in climate predictions. First, by using all 16 GCMs instead of only a single GCM, we accounted for variability among the models. Second, we incorporated the full range of predictions across GCMs and emissions scenarios by using projections calculated from GCM ensembles of the lowest, median, and highest changes in climate of the B1, A1B, and A2 scenarios, respectively (Girvetz et al. 2009).

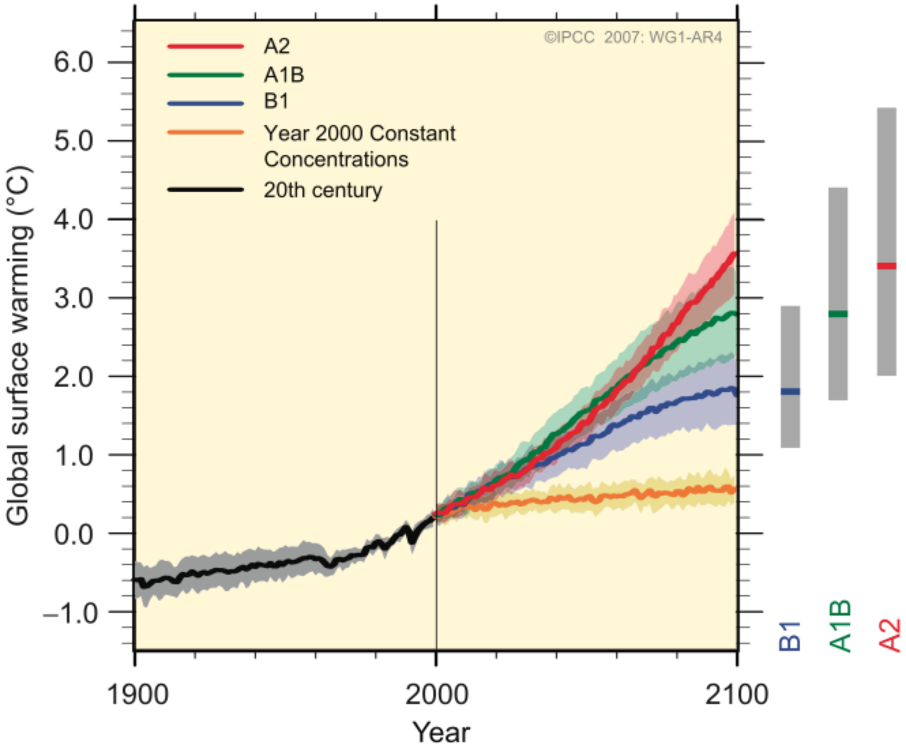


Figure 2. Schematic of SRES greenhouse gas emission scenarios (from IPCC 2007).

Ensembles are created by selecting a particular value (i.e., lowest, median, and highest changes) for every mapped grid cell in each GCM. The process then combines each of the selected values, one grid cell at a time, to create a final 'ensemble' model for each emissions scenario. The final ensemble model may contain predictions from more than one GCM (e.g., the ensemble median projection of one grid cell comes from any GCM under the A1B emissions scenario that had the median value for that cell across all GCMs). Our ensemble model for the best-case (B1) scenario, "ensemble lowest", represents the 'lowest of the low' climate change from all of the GCMs, our middle-ground (A1B) scenario, "ensemble median", predicts the median climate change, and the values generated for the highest (A2) emissions scenario, "ensemble highest", truly represent the 'worst of the worst' predictions. This approach bookends the full range of predicted climate changes, while also providing an indication of the average projected change. A drawback of this ensemble approach is that all models are considered equally weighted, when in fact not all models are constructed equally (e.g., horizontal and vertical resolutions differ among GCMs), and only a few simulate geophysical phenomena relevant to the PNW, such as the Pacific Decadal Oscillation. However, studies have found no significant difference in long-term model forecasts between the top ten GCMs for the PNW and ten randomly selected GCMs (Mote et al. 2011).

Climate variables

We utilized the online mapping tool ClimateWizard (Girvetz et al. 2009) to produce historical (1951-2006 averages) and predicted (2040-2069 averages) climate maps for Oregon and Washington. The historical maps contained estimates of annual variation in precipitation (mm) and temperature (°C) at a 4km grid size (Daly et al. 1994) (Figure 3). The predicted maps contained 12km grid size estimates (Maurer et al. 2007) of the difference in annual mean temperature (°C) (Figure 4) and the difference in annual moisture (Figure 5) measured as the Hamon AET:PET ratio (Hamon 1961). This moisture metric is a ratio of the actual evapotranspiration to the potential evapotranspiration (PET is usually calculated without vegetation and soil moisture data) found in the assessment area. The ensemble lowest (B1) and highest (A2) projections for the AET:PET ratio represented the least and most negative change in the ratio, respectively.

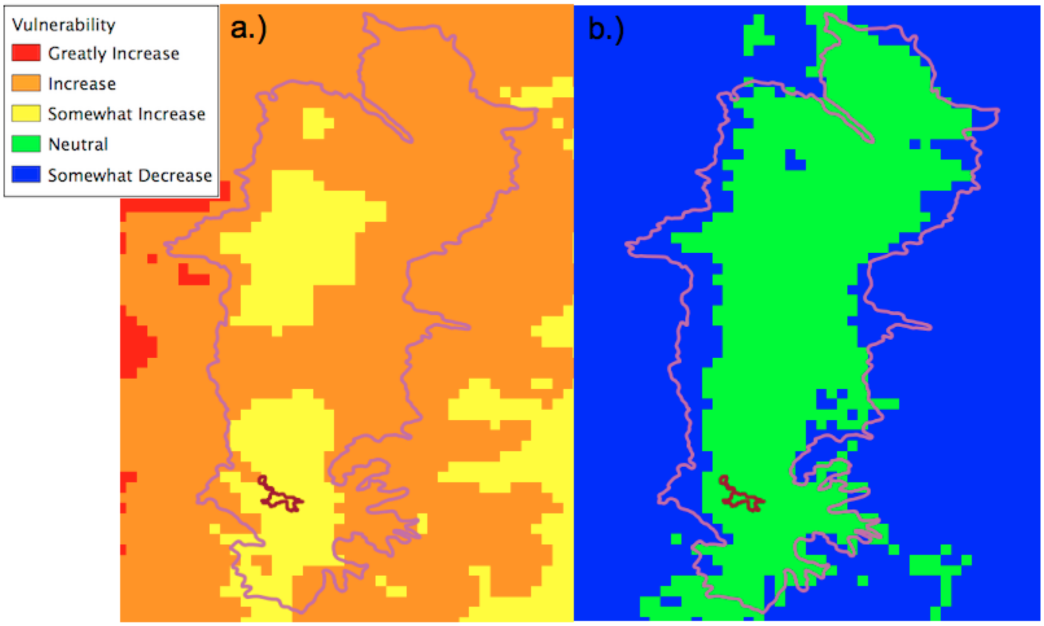


Figure 3. Historical thermal (a.) and hydrological (b.) variation for the WV (light purple border) and WEW (dark red border) based on annual temperature (°C) and precipitation (mm) variation from 1961-2006. Map colors indicate the categories assigned for each grid cell from the sensitivity factors C2ai and C2bi in the CCVI Guidelines (Young et al. 2011) and the custom temporal variation in total annual precipitation (see Appendix A).

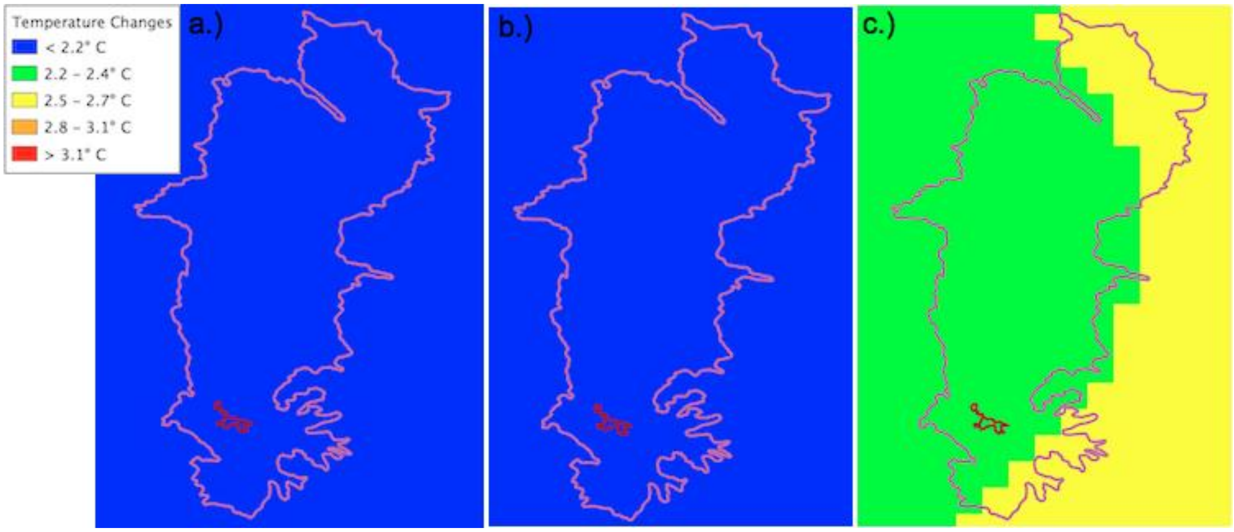


Figure 4. Projected temperature changes in the B1 ensemble lowest (a.), A1B ensemble median (b.), and A2 ensemble highest (c.) GCM projections to year 2050 (2040-2069 average) for the WV (light purple border) and WEW (dark red border) based on changes in annual temperature (°C) from 1961-1990 averages. Map colors indicate CCVI direct climate exposure categories.

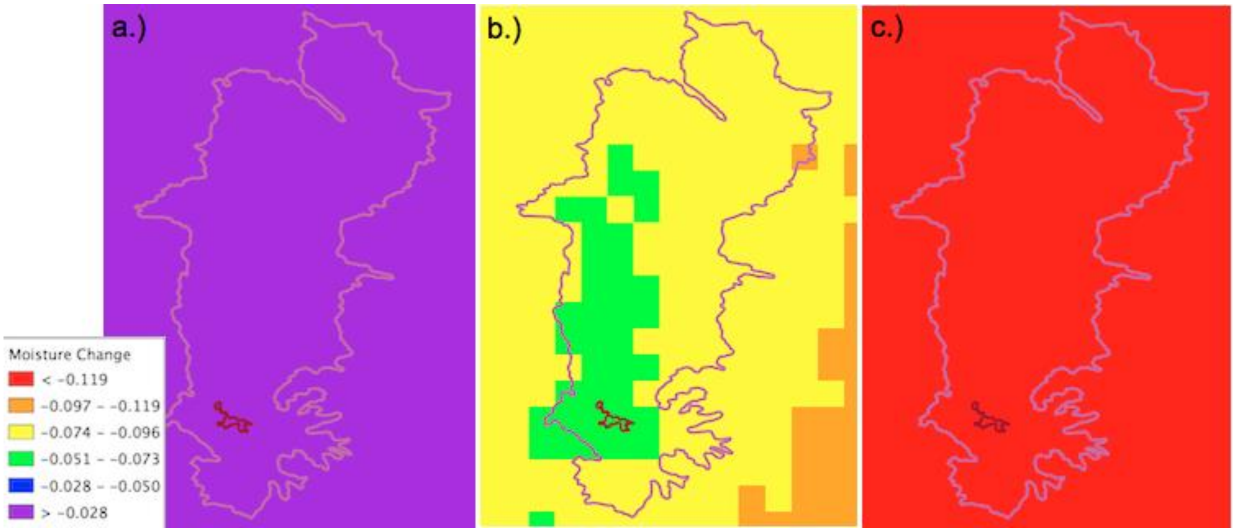


Figure 5. Projected moisture changes in the B1 ensemble lowest (a.), A1B ensemble median (b.), and A2 ensemble highest (c.) GCM projections to year 2050 (2040-2069 average) for the WV (light purple border) and WEW (dark red border) based on changes in the Hamon AET:PET moisture ratio from 1961-1990 averages. Map colors indicate CCVI direct climate exposure categories.

4.3. Applying the CCVI

Each application of the CCVI is somewhat unique (aside from species and geographic areas assessed) in that the vulnerability categories for each factor are interpreted to a certain extent by the particular group of experts using the index. Below, we summarize briefly the reasoning we used for this assessment.

Direct exposure to climate change

Direct exposure to climate change was measured as the predicted climate for each assessment area, classified into five categories of increasing vulnerability. Each mapped climate grid cell provided one value. We simply calculated the total number of cells overlapping the assessment area and proportioned those values by the temperature and moisture categories set by the NatureServe CCVI Guidelines (Young et al. 2011).

Indirect exposure to climate change

Indirect exposure to climate change was measured as increased vulnerability from sea level change (which did not affect our areas), natural and anthropogenic barriers, and land use changes resulting from human responses to climate change (e.g., solar arrays or wind farms). Natural barriers to range shift were considered to be large river systems, forestlands, and for wet prairie species, upland habitat.

Specifically, in the Willamette Valley the Willamette River and its major tributaries as well as forested foothills were considered barriers. In the WEW the water bodies are predominantly streams or small creeks, and forests and woodlots areas are highly fragmented, creating few actual natural barriers for the species assessed. Upland prairie was considered a greater natural barrier at the WEW scale due to the limited extent of the assessment area. Overall we gave a more conservative ranking in this category for the WV scale than the WEW, and for wet prairie species (as compared to upland or generalist species) in the WEW.

We assumed anthropogenic barriers would increase vulnerability more than natural barriers due to an increase in land use by humans. Additionally, we considered land use alteration or degradation due to current (e.g., cropland, grass fields, vineyards) or past agricultural use in this category. In particular, we noted that many remaining prairies are severely degraded in terms of vegetative composition due to historic grazing or agricultural use, and that present-day dense grass cover and thatch are barriers to dispersal for several of the species we assessed. In particular the urban setting of the WEW greatly increased vulnerability for all native species. Despite the fact that human population increase is projected in the WEW and WV due to addition of ‘climate refugees,’ (PNWERC 2002) we determined that the specific wording in the model was more conservative and did not warrant inclusion of this particular climate-related pressure on habitat availability and quality.

Sensitivity to climate change

Species-specific sensitivity to climate change was determined by 20 factors in six main categories: 1) dispersal, 2) predicted sensitivity to temperature and moisture changes, 3) restriction to uncommon geological features, 4) reliance on interspecific interactions, 5) genetic factors, and 6) phenological response to changing seasonal temperature and precipitation dynamics. We relied on our expert opinion of species' life history for ranking sensitivity factors in categories 1, 3, and 4, and one factor in category 2, and published research was available to support our rankings in the remainder of the categories. The rationale we applied is presented below for each ranked factor, and species-specific data are included in Appendix B.

Dispersal varied by species, with the butterfly and turtle species judged to be the least vulnerable due to long migration distances (Schultz 1998, D. Ross, pers. comm., Rosenberg et al. 2009). Plants fell along the entire spectrum of *decreased* vulnerability to *greatly increased* vulnerability. Wet prairie plant species with the potential to disperse via water were determined to be slightly less vulnerable than gravity-dispersed species (which received a ranking of *greatly increased* vulnerability). However, even species that could be water dispersed were still limited due to an average dispersal distance of less than 10 m for the great majority of propagules. Invasive species were variable; animal dispersal of ox-eye daisy and Himalayan blackberry caused these species to be ranked as *neutral* and *decreasing* in vulnerability, respectively.

Species' predicted sensitivity to temperature and moisture changes are important factors for the CCVI in general and for the suite of species we assessed. There are four factors which taken together address a species' climate niche: a) exposure to historical temperature variation (last 50 years) in the assessment area, b) whether a species is dependent on ice/snow habitats (does not apply in this assessment), c) exposure to historical precipitation variation (last 50 years) in the assessment area and d) species' dependence on specific seasonal or permanent hydrologic conditions. To evaluate the historical temperature variation as instructed by the CCVI guidelines, we used GIS to calculate the 1951-2006 mean annual climate variation for the WV and WEW from ClimateWizard maps and then determined the proportion of each assessment area with the most temporal variation. Climate vulnerability was judged to increase if past climate variation was relatively low (Figure 3). NatureServe's CCVI assessment protocol for the historical hydrologic regime only provided for spatial variation, which is inappropriate for the very localized geographic scale of the WEW. Therefore, we developed a customized method to determine temporal variation in total annual precipitation, which we then applied to both the WEW and the WV (see Appendix A for detailed description). We consulted with the CCVI's primary author on our methodology to ensure the results we generated would appropriately fit the calculations used in the CCVI (B. Young, pers. comm.).

A species' physiological thermal niche was assessed by how restricted a species is to cold environments, while a species' physiological hydrological niche was assessed by a species' dependence on a moisture regime and the likelihood of that regime to change. These physiological climate niches were determined through estimation of a species' habitat preferences, regardless of the size or location of the assessment area, and on the climate change of the habitat itself. Species generally restricted to wet prairie habitat were neutral and did not experience any change in vulnerability because the magnitude of projected changes to hydrology and temperature at the 2050 horizon were not determined to significantly change wet prairie conditions within the assessment areas. Species which occur in upland prairie or in both wet and upland prairie spanned the range from neutral to *somewhat decreasing* in vulnerability because warmer temperatures and decreasing moisture availability were determined to have no effect on or to possibly benefit upland prairie and savanna habitats. For butterfly species, ranks in this factor varied according to relative association with upland or wet prairie host species. While butterfly species are expected to increase in vulnerability due to increased harm to eggs and larva from greater winter/spring precipitation, they are also expected to benefit from decreased adult nectar shortage as nectar plant growth benefits from spring/summer precipitation. None of our species were assumed to increase in vulnerability due to a dependence on a disturbance regime or snow cover. Climate change is not expected to change the frequency of fire disturbance in grasslands, and snow cover is minimal for these species in our assessment area and is not expected to change.

Vulnerability due to restriction to uncommon geological features ranged from *neutral* to *decreasing*. Despite the name of this factor, it addresses a species' need for a specific substrate or soil, including those dominant within the assessment area. We assumed that clay-textured soils which swell seasonally creating perched wetland conditions to be a key feature required by wet prairie species and those which occur at the hydrologic fringe between wet and upland prairie. Wetland species thus received a *neutral* rank, while upland species and habitat generalists *somewhat decreased* or *decreased* in vulnerability, respectively. Butterfly species were assigned a *neutral* ranking to reflect the importance of puddling habitat.

Species' reliance on interspecific interactions contained five factors (habitat, diet, pollination, dispersal, and mutualism/parasitism/etc.) for which rankings were generally consistent across taxonomic groups. Butterfly species were ranked with an *increase* in vulnerability due to their dependence on other species, specifically plants, for their diet, habitat, and dispersal; and in particular due to each species' dependence on one to very few egg and larval host plants. Fender's blue larvae may possess specialized glands that secrete a sweet solution that cause some ant species to protect the larvae from predators and parasites (Endangered and Threatened Wildlife and Plants 2000). The listed/conservation concern plant species ranked only a *somewhat increase* in vulnerability due to specific pollinator requirements, with the exception of golden paintbrush, a generalist-pollinated hemi-parasite, which was the only species we expected to face an increase in vulnerability due to its specialized parasitic interaction with neighboring plant roots. The nectar, core, and invasive species all ranked the same for these five factors, receiving *neutral* rankings in each category.

Genetic factors were unknown for five of the nine listed/conservation concern species; genetic variation and bottlenecks were undocumented. Golden paintbrush and Kincaid's lupine have relatively high genetic variation (Godt et al. 2005, Liston et al. 1995, Severns 2009), and Bradshaw's lomatium and Hitchcock's blue-eyed grass have enough genetic variation to not change their vulnerabilities (Gitzendanner and Soltis 2001, Groberg et al. 2010). Several of the common prairie species have also been studied in the Willamette Valley, some in more detail than others. Roemer's fescue has been demonstrated to have high variation across its range (Wilson et al. 2008), as has rose checkermallow. Oregon sunshine, western buttercup, yarrow, self-heal, slender cinque-foil and California oatgrass have all been demonstrated to have genetic variability (Miller et al. 2008); although the degree of the variation (greater or less than "average") is not known, we ranked these species as *neutral*.

Phenological response to changing seasonal temperature and precipitation dynamics was assumed to have the most uncertainty across species of all the sensitivity factors. We justified a *slightly increasing* to *slightly decreasing* vulnerability ranking for all species because of unexpected adaptive capabilities dependent on other factors, such as genetic variation and distributional barriers, previously addressed in the assessment.

5. RESULTS AND DISCUSSION

5.1. Species Findings

The vulnerability assessment for 31 native grassland species and five invasive species at multiple geographic scales and under three greenhouse gas scenarios resulted in a wide range of predicted susceptibilities to climate change (Tables 5 and 6). Worsening climate change scenarios were most responsible for increasing vulnerability as compared to geographic scale or species guild. All native species were found to be vulnerable to climate change. Butterflies were the most affected group generally followed by wet prairie plants (listed, nectar, and core species).

The index projects greater vulnerability in the WV and range-wide for listed/conservation concern species than in the relatively small region of the WEW. This outcome is primarily due to the direct effects of climate change. Current models show the WV will experience a greater degree of warming and decrease in moisture availability than the WEW. The WV has more/greater natural barriers to climate change shifts than the WEW, although the WEW has more/greater anthropogenic barriers. Complete model outputs are included in Appendix C.

Listed/Conservation Concern Species

The rare species all increased in vulnerability as predicted climate change effects worsened, some more than others. All rare species were *presumed stable* under the most optimistic (B1) emissions scenario, where temperatures are projected to increase by less than 2.2°C by 2050 (Figure 4), and the Hamon moisture ratio actually increases slightly. Under the moderate (A1B) scenario, most species remained *presumed stable* except for the butterflies and Bradshaw's lomatium, a wet prairie species, which increased to *moderately vulnerable* at the WV and range-wide scale. Only Western pond turtle remained *presumed stable*, due to its broad habitat use, diet, and ability to disperse over large distances, even in somewhat urban settings. Fender's blue and Bradshaw's lomatium became *highly vulnerable* at the WEW and WV scales. The vulnerability of Fender's blue is primarily tied to it's limited range (endemic to the WV) and potential decrease or loss of nectar and host plants. Bradshaw's lomatium increased in vulnerability due to loss of available wetland hydrology and soil moisture.

The factors likely driving the final index rankings for the listed/conservation concern species are the direct climate exposures (predicted temperature and moisture changes), natural and anthropogenic barriers, dispersal/movement, historical thermal regime, physiological hydrological regime, and geologic requirements. Ranking of butterflies was also affected by dependence on one to few host plants for life cycle completion. Of those factors, only physiological hydrological regime and geologic requirements are expected to *(somewhat)* decrease vulnerabilities, as the suite of species assessed are found across a range of conditions from wet prairie fringe to uplands. Factors contributing to an increase in climate change vulnerability in rare plant species were natural and anthropogenic barriers, limited dispersal, limited historical temperature ranges, and uncertainty in the ability of these species to adjust their phenology to the rate of climate change.

Table 5. Vulnerability rankings for federally listed and conservation concern species at WEW, WV, and range-wide scales. Current trends in greenhouse gas emissions have surpassed those projected in the A2 "worst-case" scenario.

Scale	**WEW**			**WV**			**OR/WA Range**		
Climate Scenario	**B1**	**A1B**	**A2**	**B1**	**A1B**	**A2**	**B1**	**A1B**	**A2**
Extremely Vulnerable[1]									
Highly Vulnerable			**Fender's blue** Bradshaw's lomatium			**Fender's blue** Bradshaw's lomatium			**Fender's blue** Bradshaw's lomatium
Moderately Vulnerable		**Fender's blue** **Taylor's checkerspot**	**Taylor's checkerspot** Willamette daisy Kincaid's lupine Golden paintbrush Shaggy horkelia White-top aster Hitchcock's blue-eyed grass		**Fender's blue** Bradshaw's lomatium	**Taylor's checkerspot** Willamette daisy Kincaid's lupine Golden paintbrush Shaggy horkelia White-top aster Hitchcock's blue-eyed grass		**Fender's blue** Bradshaw's lomatium	**Taylor's checkerspot** Willamette daisy Kincaid's lupine Shaggy horkelia White-top aster Hitchcock's blue-eyed grass
Presumed Stable	**ALL**	**Western pond turtle** Bradshaw's lomatium Willamette daisy Kincaid's lupine Golden paintbrush Shaggy horkelia White-top aster Hitchcock's blue-eyed grass	**Western pond turtle**	**ALL**	**Taylor's checkerspot** **Western pond turtle** Willamette daisy Kincaid's lupine Golden paintbrush Shaggy horkelia White-top aster Hitchcock's blue-eyed grass	**Western pond turtle**	**ALL**	**Taylor's checkerspot** **Western pond turtle** Willamette daisy Kincaid's lupine Golden paintbrush Shaggy horkelia White-top aster Hitchcock's blue-eyed grass	**Western pond turtle** Golden paintbrush
Increase Likely									

Bold type indicates animals, regular font indicates plants.

[1] Vulnerability ranks. EV=Abundance/range extent extremely likely to substantially decrease or disappear by 2050. HV=A/RE likely to decrease significantly by 2050. MV=A/RE likely to decrease by 2050. PS=A/RE not likely to increase/decrease substantially by 2050 (range may shift somewhat). IL=A/RE likely to increase by 2050.

Table 6. Vulnerability rankings for butterfly, nectar, core, and invasive species at WEW and WV scale. Current trends in GHG emissions have surpassed those projected in the A2 "worst-case" scenario.

Scale	**WEW**			**WV**		
Climate Scenario	**B1**	**A1B**	**A2**	**B1**	**A1B**	**A2**
Extremely Vulnerable[1]			**Great copper**			
Highly Vulnerable			**Sonoran skipper** **Field crescent** Slim-leaf onion Common camas Tufted hairgrass Spike bentgrass Western buttercup			**Great copper** **Sonoran skipper** **Field crescent** Tolmie's mariposa lily Oregon iris Slim-leaf onion Common camas Tufted hairgrass Spike bentgrass Western buttercup Rosy plectritis Self-heal
Moderately Vulnerable		**Great copper** **Sonoran skipper** **Field crescent** Common camas	Woolly sunflower Rose checkermallow Tolmie's mariposa lily Oregon iris Roemer's fescue California oatgrass Rosy plectritis Self-heal Slender cinquefoil Gumweed Willow dock		**Great copper** **Sonoran skipper** **Field crescent** Tolmie's mariposa lily Oregon iris Slim-leaf onion Common camas Tufted hairgrass Spike bentgrass Western buttercup Rosy plectritis Self-heal	Woolly sunflower Rose checkermallow Roemer's fescue California oatgrass Slender cinquefoil Gumweed Willow dock Yarrow Showy tarweed *Tall oatgrass*
Presumed Stable	**ALL**	**ALL** (except above/ below)	Yarrow Showy tarweed *Ox-eye daisy* *Creeping bentgrass* *Tall oatgrass*	**ALL**	Woolly sunflower Rose checkermallow Roemer's fescue California oatgrass Slender cinquefoil Gumweed Willow dock Yarrow Showy tarweed	*Ox-eye daisy* *Creeping bentgrass*
Increase Likely		*Himalayan blackberry*	*Himalayan blackberry* *Meadow knapweed*		*Himalayan blackberry* *Meadow knapweed*	*Himalayan blackberry* *Meadow knapweed*

Bold type indicates animals, regular font indicates plants, *italics* indicates invasive species.

1. Vulnerability Ranks. EV=Abundance/range extent extremely likely to substantially decrease or disappear by 2050. HV=A/RE likely to decrease significantly by 2050. MV=A/RE likely to decrease by 2050. PS=A/RE not likely to increase/decrease substantially by 2050 (range may shift somewhat). IL=A/RE likely to increase by 2050.

Some aspects of the rare species' biology were expected to contribute to climate change vulnerability but ultimately appeared not to have an effect. Golden paintbrush is hemiparasitic on other plants through root-root contact, but that relationship did not increase its vulnerability despite an expected decrease in interactions with host plants. White-top aster was expected to increase in vulnerability due to flower morphology limiting effective pollination, however the species received a similar rating as nearly all other rare plants. The fact that most of the species evaluated are upland species or somewhat associated with uplands decreased their vulnerability. Additionally, golden paintbrush and Kincaid's lupine have sufficient genetic variation to decrease their vulnerability.

A subset of the listed/conservation concern species are Oregon Conservation Strategy species (ODFW 2005) and their climate vulnerabilities were also recently assessed with the CCVI at the Willamette Valley scale by a separate study (Steel et al. 2011). That study employed somewhat different methodologies in modeling climate and assigning sensitivity scores than we used. Interestingly, Steel et al. (2011) assigned different sensitivity scores than we did for several factors, sometimes differing by more than one level (i.e., *somewhat decrease* to *somewhat increase*). Most of these differences are attributable either to the factors considered barriers to dispersal or those where sensitivity scores were determined by GIS (e.g., historical and physiological thermal and hydrological niches). Our study assessed both natural and anthropogenic barriers more conservatively than Steel et al. (2011) by one sensitivity factor each. Our GIS analysis was conducted using the same general approach as theirs with two key differences. The occurrence information we used to map species distribution incorporated data from NatureServe and the US Fish and Wildlife Service, but also included detailed records that we collected over several years of surveying and monitoring rare species (see methods for details). Secondly, the custom analysis we developed for investigating the variation of species' historical hydrological niche resulted in a different ranking between our study and theirs. For the remaining sensitivity factors, several were scored the same while some differed, but not in a consistent way. Our assessment employed a more recent version of the CCVI model (v. 2.1) while Steel et al. (2011) used a previous version (v1.2), which could also explain some differences in scores.

Despite these differences, our results agree with those of Steel et al. (2011) by ranking as *presumed stable* under the median (A1B) scenario for Kincaid's lupine, Willamette daisy, golden paintbrush, white-topped aster, and Western pond turtle. Western pond turtle also remained *presumed stable* even under worsening climate conditions. However, Steel et al. (2011) found that golden paintbrush and Kincaid's lupine became *highly vulnerable* under the worst-case (A2) scenario, while our assessment ranked them as *moderately vulnerable*. It is not surprising that these species were ranked more vulnerable by Steel et al. (2011) under the A2 scenario, as the two studies used slightly different methods to determine this category. Our study employed all 16 GCMs to derive ensemble values, while Steel et al. selected one GCM predicting extreme increases in temperature and precipitation and thus the *moderately vulnerable* rankings returned by our assessment incorporate more uncertainty in the climate predictions. Steel et al. accepted the uncertainty of the single GCM they selected for the benefit of informing an extreme worst-case scenario. Bradshaw's lomatium ranked differently under both emissions scenarios, *presumed stable* (A1B) and *moderately vulnerable* (A2) by Steel et al., but *moderately vulnerable* (A1B) and *highly vulnerable* (A2) in our assessment.

Most of the differences between our results and those of Steel et al. (2011) appear to be due to differences in our assessments of direct climate exposure rather than interpretations of species sensitivities. Although different groups of experts returned dissimilar individual sensitivity scores, these differences were both more and less conservative between studies and across sensitivity factors, which tended to cancel-out the effects of differing professional opinions. In the end, both approaches returned ranks that fit with our basic understanding of these species and potential climate change effects, and in practice a ranking of *moderately* to *highly vulnerable* for these species should be considered by agencies and land managers.

Butterflies

All butterfly species assessed were more vulnerable than plant species to climate change and all increased in vulnerability as climate change scenarios worsened. The great copper, Sonoran skipper, and field crescent ranked very similarly in climate vulnerability to Fender's blue and Taylor's checkerspot. Generally, butterfly species were *presumed stable* under the lowest emissions (B1) scenario, became *moderately vulnerable* in the middle-emissions scenario and *highly vulnerable* under the worst-case (A2) scenario. Two notable exceptions are that great copper ranked as *extremely vulnerable* at the WEW scale (likely due to the severity of anthropogenic barriers in the WEW), and that Taylor's checkerspot remained *moderately vulnerable* even under the worst-case scenario (due to its use of upland habitats).

Numerous factors contributed to the severe vulnerabilities of the butterfly species. Each species we assessed is closely tied to just one or a few host plants that affect multiple life stages and dispersal success. The index does not evaluate the direction of climate change effects on host plants, but our evaluation of these plants showed that under the worst-case scenario, Kincaid's lupine (host plant for Fender's blue), willow dock and gumweed (great copper), and Roemer's fescue (Sonoran skipper) also increased in vulnerability. In addition, anthropogenic barriers to dispersal were an issue for the three non-listed/conservation concern butterfly species because they do not prefer to travel through pastures, over tree lines, or through otherwise dense tall vegetation (D. Ross, pers. comm.). Combined with urbanized areas, the WEW and WV landscapes thus pose major barriers to dispersal for these species. Additionally because they are tied so closely to a few hosts, vulnerability of wet prairie habitats increases vulnerability for butterflies whose host species are dependent on the wetter end of the hydrologic gradient. The *highly vulnerable* and *extremely vulnerable* rankings due to climate change for butterflies underscores the importance of restoring suitable habitat for these species and developing climate change-specific management strategies.

Of the butterfly species we investigated, Fender's blue and Taylor's checkerspot are OCS species (ODFW 2005) and were also assessed by Steel et al. (2011) for the Willamette Valley scale. Results between the two studies were similar for Fender's blue, ranking as *moderately vulnerable* under the moderate emissions scenario (A1B) for both studies and under severe climate change as *highly vulnerable* (this study) and *extremely vulnerable* under the OCS study (Steel et al. 2011). Taylor's checkerspot had greater disparity among the two studies, ranking less vulnerable in this assessment (*presumed stable* (A1B), *moderately vulnerable* (A2)) than in the OCS assessment (*moderately vulnerable* (A1B), *highly vulnerable* (A2)). As with the native plants, we assessed several sensitivity scores differently than Steel et al. (2011)

for Taylor's checkerspot. We gave more conservative to anthropogenic barriers (*increase* vs. *neutral*, respectively), dispersal (*neutral* vs. *decrease*), dependence on another species for habitat creation (*increase* vs. *neutral*), and diet specificity (*increase* vs. *somewhat increase*). As with the native plants, we also scored more conservatively factors derived from GIS that evaluate historical and physiological temperature and hydrology. Again, this was likely due to the (presumably) more detailed data set we employed. Conversely the OCS study was more conservative in ranking the effects of disturbance and dependence on specific geological/soils habitat. We attribute the ranking differences to a) our familiarity with these two species, having worked directly with them through research and monitoring and managing their populations for over a decade, b) potential model version differences, and c) more detailed occurrence mapping which informed our GIS analysis. Interestingly, although we generally gave more conservative scores on the species sensitivity factors, Taylor's checkerspot ranked as less vulnerable overall by us than in the OCS study, possibly because direct climate exposure data imported into the CCVI from ClimateWizard GIS analysis plays a significant role in a species' final ranking.

Nectar Species

Nectar species were all *presumed stable* under the best-case (B1) scenario. Some species, including common camas, Tolmie's lily, Oregon iris, and slim-leaf onion, increased to *moderately vulnerable* under moderate climate change (A1B) at the WV scale, and those same species or a subset of them became *moderately vulnerable* at the WEW scale and *highly vulnerable* at the WV scale under the worst case (A2) scenario. The factors most responsible for these rankings included natural and anthropogenic barriers, very limited dispersal capacity, exposure to minimal historical variation in temperature, unknown genetic variability, and for common camas, location of the assessment areas at the southern edge of its range. Of these, direct climate exposure was the most influential as demonstrated by the fact that all factors other than climate remained constant across worsening scenarios.

Habitat preferences largely drove the determination of these species as *moderately* or *highly vulnerable* at the WEW scale. Climate effects anticipated for the WEW and WV include an earlier, wetter spring and a longer, warmer summer drought period (Doppelt et al. 2009). These particular conditions most affect wet prairie habitats, and the ecotone between wet and upland prairie. Dispersal ability also contributed to vulnerability. Many species we assessed are gravity-dispersed, or if they could be water-dispersed, have heavy seeds that are unlikely to be dispersed very far under typical seasonal hydrological conditions (minimal additional flooding effects are anticipated in wet prairies due to climate change). Combined with the natural and anthropogenic barriers, these species have extremely limited movement potential in response to climate change. Broader habitat tolerance and availability of information on genetic diversity moderated the climate change vulnerability for species such as woolly sunflower and rose checkermallow, but these species still ranked as *moderately vulnerable* under the worst-case scenario.

Core Prairie Species

There was no substantial vulnerability difference between nectar species and core prairie species. Instead, the habitat preferences of each plant species were more likely to affect their vulnerability ranking; prairie species were more vulnerable than habitat generalists or upland species. The worst-case emissions scenario increased vulnerability for all native species. Wet prairie species were substantially affected, generally switching from *presumed stable* under the most optimistic scenario (B1) to *highly vulnerable* under the greatest projected climate change. Surprisingly, even tufted hairgrass, a species tolerant to a range of early-season hydrology (near inundation to somewhat dry) with a global distribution, became *highly vulnerable* due to the importance of its habitat relationship.

Upland species and species with broader habitat tolerance were *moderately vulnerable* under worsening conditions. Yarrow, a species with very broad tolerances, and showy tarweed, a late-flowering upland species that may be animal dispersed were unaffected at the WEW scale, while their vulnerability increased to *moderately vulnerable* in the WV reflecting the greater predicted thermal and moisture changes at the ecoregional scale.

Invasive Species

Invasive species were not vulnerable to climate change, mostly ranking as *presumed stable*. Himalayan blackberry ranked as *increase likely* in all but the lowest-emissions (B1) scenario, and meadow knapweed also ranked as *increase likely* in the mid- (WV only) and worst-case emissions scenarios. Tall oatgrass increased in vulnerability at the WV scale, becoming *moderately vulnerable* under the worst-case emissions scenario due to its seed being gravity-dispersed.

5.2. Study Areas

Historically, the WV has very mild temperature variations and a high range of precipitation, with dry summers and wet winters. Relative to other areas of the US, it also has lower climate anomalies predicted from climate change models. Thus, we expected a pairwise increase in both climate factors by 2050 in the worst-case scenario for our assessment areas. However, the direct climate exposure categories returned unexpected results from the downscaled ClimateWizard data for both the WEW and WV assessment areas. While the direction of climate change met our expectations, temperature and available moisture did not change to the same degree. Temperatures under the “highest change” model (A2) mostly increased by less than 2.5°C in the WV and WEW, which was only one category higher than the lowest temperature increase offered in the CCVI. In contrast, the moisture ratio of actual to potential evapotranspiration decreased below -0.119, which was the highest vulnerability category for that factor The historical thermal regime across the two assessment areas was lower than average (31.8 - 43.0 °C) in annual temperature variation, with higher spatial variation in the Willamette Valley than in the West Eugene Wetlands. These predicted changes *increased* and *somewhat increased* the respective thermal vulnerabilities for the two geographic scales.

Despite worsening emissions, federally listed and conservation concern species ranks generally did not differ across the three geographic study areas, and were one category more severe only for the Fender’s blue at the WV and range-wide scales. For butterflies, results were nearly identical for the two scales, with the primary difference that at the WV scale Fender’s blue was *extremely vulnerable*, while at the WEW scale the great copper was *extremely vulnerable*. The decrease in Fender’s blue rank to moderately vulnerable at the WEW scale is due to fewer natural barriers and a smaller historical temperature variation, despite greater anthropogenic barriers. The great copper is more vulnerable at the WEW scale as it is limited to only one larval host plant.

As described above, within the model vulnerability among nectar and core prairie species is more strongly affected by habitat preference and known genetic variation than the guild we assigned. Generally, species found only in wet prairies or on wet prairie fringes ranked most conservatively. However, effects occurred in the middle-ground scenario (A1B) at the Willamette Valley scale, while the same effects didn't occur until the worst-case (A2) scenario for the WEW. Lastly, invasive species were similar in rankings across the scales, with meadow knapweed projected to fare even better at the WEW scale than the WV. Most species are *presumed stable* under most scenarios at most scales. Himalayan blackberry, as a habitat generalist with seed dispersal via birds and mammals, is most likely to increase.

Despite a sessile life history, of the listed/conservation concern species we studied, grassland plants appear to be more resilient to climate change than butterflies in the Willamette Valley according to the CCVI. Bradshaw's lomatium was the only plant species with a vulnerability index ranking equal to that of animals under the A1B and A2 scenarios (Table 6). Butterflies can escape worsening conditions, yet their interspecific interactions require host and nectar plants, increasing their vulnerabilities through effects from climate change on plants. These interactions are split among three sensitivity factors (other species for habitat, diet, and propagule dispersal) that led to a *somewhat increased* vulnerability ranking for our butterfly species despite a *neutral* ranking for dispersal distance and natural barriers.

5.3. Climate change scenarios

Most of our study species are expected to have higher vulnerabilities in the assessment areas due to changes in climate from rises in greenhouse gas emissions, while two non-native plant species, Himalayan blackberry and Meadow knapweed, are expected to benefit (Table 5 & 6). Such a drastic impact is troubling given the mild changes to temperature and precipitation in the PNW by 2050 relative to other areas of North America, such as the Southwestern US and Canada (IPCC 2007). Even more troubling is that while we considered the A2 scenario the "worst-case" scenario in our study, recent trends in climate for the last decade (2000-2009) show global CO_2 concentrations have exceed those projected for the same time period under the A2 scenario (Allison et al. 2009). Thus, projections used in the AR4 IPCC (2007) report are now considered conservative estimates of future climate and sea level change. The range in greenhouse gas emissions from the B1, A1B, and A2 scenarios contributes a great deal to our uncertainty in species' vulnerabilities to climate change, yet the A2 scenario is more representative of current climate trends. Therefore, vulnerabilities from the A2 scenario should be considered over the other two scenarios.

As one final note of caution on climate forecasts, variability among output from the 16 CMIP3 global climate models is higher than ensemble-averaged model output among the three SRES scenarios (Figure 2). For instance, the emission scenarios are indistinguishable until around 2025 due to the high variability among model projections. For this reason we chose maximum, median, and minimum projection ensembles to include all model uncertainty, but future assessments may benefit from choosing GCMs that best represent the PNW.

5.4. Limitations of CCVI

While the CCVI presents a methodology that considers many aspects of a species' climate vulnerability, it does not account for climate-induced changes in complex biotic interactions such as competition, predation, and pollination that could increase vulnerabilities of some of our assessed species. With many of our non-native plant species *presumed stable* and Himalayan blackberry ranked as *increase likely* with climate change, we expect competition among native and non-native prairie plants to increase. Competition may also limit establishment of species outside their current extents. Herbivory from insects and mammals may increase through loss of predators due to human population growth (Woodroffe 2000), and through changes which benefit predator populations or diseases (e.g. pine bark beetle). The current CCVI includes ranking plant vulnerabilities by number of current pollinators, but it lacks a pollinator loss assessment. We expect climate change to cause a reduction in many native pollinator populations (Memmott et al. 2007, Potts et al. 2010), which would increase the risk to plants with currently low pollinator counts.

At the time of this study, other than the numerical factor rankings, the details of the CCVI algorithm (ver. 2.1) were not publicly released, and Young et al. (In press) was not yet published. Therefore we can only speculate on the direct effects of our climate scenarios on sensitivity factors and the final index score. The lack of understanding of this component of the CCVI precludes the ability to consider the weight of specific factors, especially when making management decisions for at-risk species.

6. CONCLUSIONS

The vulnerability to climate change of a diverse group of species found in the West Eugene Wetlands assessment area varied substantially among species, regions, and climate change scenarios. Below are several general conclusions that can be drawn from this project:

- Butterflies may be especially vulnerable to moderate or severe climate change at all spatial scales we examined.
- Native Willamette Valley rare, nectar, and core prairie plant species are moderately to highly vulnerable to moderate and severe climate change.
- The Western pond turtle does not appear to be vulnerable to climate change using this assessment tool, but the species is currently suffering from low reproductive success and juvenile survival. If predation pressure increases under future climates and if that process were included in the assessment, this species' ranking could worsen.
- Most invasive plant species we examined are likely to be unaffected by climate change or will increase in abundance.
- The CCVI method incorporates many factors that potentially affect species' vulnerability, but for

plants in particular negative effects to pollinators, competitive exclusion, and changes to the frequency or intensity of disturbance regimes also driven by climate change were not considered and will likely have mostly negative effects.

- CCVI is just one approach to assessing species vulnerability to climate change. Other methods are available, including bioclimatic envelope mapping and sophisticated demographic modeling approaches, and these are being applied to some of the rare species in our region. However, these methods require use of large amounts of data and intensive analysis. CCVI makes many assumptions but it is relatively fast and efficient for a large number of taxa, with broad applicability for land managers.

7. LITERATURE CITED

Allison, I., Bindoff, N. L., Bindschadler, R. A., Cox, P. M., de Noblet, N., England, M. H., Francis, J. E., Gruber, N., Haywood, A. M., Karoly, D. J., Kaser, G., Le Quéré, C., Lenton, T. M., Mann, M. E., McNeil, B. I., Pitman, A. J., Rahmstorf, S., Rignot, E., Schellnhuber, H. J., Schneider, S. H., Sherwood, S. C., Somerville, R. C. J., Steffen, K., Steig, E. J., Visbeck, M., and Weaver, A. J. 2009. The Copenhagen Diagnosis: Updating the world on the latest climate science. The University of New South Wales Climate Change Research Centre (CCRC), Sydney, Australia, 60pp.

Daly, C., Neilson, R. P., and Phillips, D. L. 1994. A Statistical Topographic Model for Mapping Climatological Precipitation over Mountainous Terrain. Journal of Applied Meteorology 33:140–158.

Doppelt, B., Hamilton, R., Williams, C., Koopman, M., Vynne, S. 2009. Preparing for Climate Change in the Upper Willamette River Basin of Western Oregon, Co-Beneficial Planning for Communities and Ecosystems. Climate Leadership Initiative, University of Oregon, Eugene, OR.

Endangered and Threatened Wildlife and Plants; Endangered Status for *Erigeron decumbens* var. *decumbens* (Willamette Daisy) and Fender's Blue Butterfly (*Icaricia icarioides fenderi*) and Threatened Status for *Lupinus sulphureus* ssp. *kincaidii* (Kincaid's Lupine), Final Rule, *Federal Register* 65:16 (25 January 2000) p. 3875.

Floberg, J., Goering, M., Wilhere, G., MacDonald, C., Chappell, C., Rumsey, C., Ferdana, Z., Holt, A., Skidmore, P., Horsman, T., Alverson, E., Tanner, C., Bryer, M., Iachetti, P., Harcombe, A., McDonald, B., Cook, T., Summers, M., and Rolph, D. 2004. Willamette Valley-Puget Trough-Georgia Basin Ecoregional Assessment. Volume one: Report. Prepared by The Nature Conservancy with support from The Nature Conservancy of Canada, Washington Department of Fish and Wildlife, Washington Department of Natural Resources (Natural Heritage and Nearshore Habitat programs), Oregon State Natural Heritage Information Center and the British Columbia Conservation Data Centre. 150 pp.

Girvetz, E. H., Zganjar, C., Raber, G. T., Maurer, E. P., Kareiva, P., and Lawler, J. J. 2009. Applied Climate-Change Analysis: The Climate Wizard Tool. PLoS ONE 4(12): e8320.

Gitzendanner, M. A. and Soltis, P. S., 2001. Genetic variation in rare and widespread *Lomatium* species (Apiaceae): a comparison of AFLP and SSCP data. Edinburgh Journal of Botany 58 (2), 347–356.

Godt, M. J. W., Caplow, F., and Hamrick, J. L. 2005. Allozyme diversity in the federally threatened golden paintbrush, *Castilleja levisecta* (Scrophulariaceae). Conservation Genetics 6:87–99.

Groberg, M., Meyers, S., Amsberry, K., and Meinke, R. 2010. Taxonomic and status evaluation of *Sisyrinchium hitchcockii*. Oregon Department of Agriculture, Salem, Oregon.

Hagen, L. and Hagen, D. 2010. A 2010 Survey of Butterflies at two West Eugene Wetlands Sites. North American Butterfly Association, Eugene Chapter, Eugene, OR. http://www.naba.org/chapters/nabaes/outreach.html

Hamon, W. R. 1961. Estimating potential evapotranspiration: Journal of the Hydraulics Division, Proceedings of the American Society of Civil Engineers 87:107–120.

Hijmans, R. J. and van Etten, J. 2012. raster: Geographic analysis and modeling with raster data. R package version 2.0-12. http://CRAN.R-project.org/package=raster

Intergovernmental Panel on Climate Change (IPCC). 2000. Emission Scenarios. Intergovernmental panel on climate change, Geneva, Switzerland.

Intergovernmental Panel on Climate Change (IPCC). 2007. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Parry, M. L., Canziani, O. F., Palutikof, J. P., van der Linden, P. J., and Hanson, C. E., eds., Cambridge University Press, Cambridge, UK, 976pp. Available: http://www.ipcc.ch/ipccreports/ar4-wg2.htm.

Lewin-Koh, N. J. and Bivand, R., contributions by Pebesma, E. J., Archer, E., Baddeley, A., Bibiko, H., Callahan, J., Carrillo, G., Dray, S., Forrest, D., Friendly, M., Giraudoux P., Golicher, D., Rubio, V. G., Hausmann, P., Hufthammer, K. O., Jagger, T., Luque, S. P., MacQueen, D., Niccolai, A., Short, T., Snow, G., Stabler, B., and Turner, R. 2012. maptools: Tools for reading and handling spatial objects. R package version 0.8-16. http://CRAN.R-project.org/package=maptools

Liston, A., St. Hilaire, K., and Wilson, M. V. 1995. Genetic diversity in populations of Kincaid's lupine, host plant of fender's blue butterfly. Madroño 42:309-322.

Maurer, E. P., Brekke, L., Pruitt, T., and Duffy, P. B. 2007. Fine-resolution climate projections enhance regional climate change impact studies, Eos Trans. AGU, 88(47), 504.

Memmott, J., Craze, P. G., Waser, N. M., and Price, M. V. 2007. Global warming and the disruption of plant–pollinator interactions. Ecology Letters, 10(8), 710-717

Miller, S., Carlson, M., Fiegener, R., Gisler, M., Kaye, T., Ward, K., Weiss, L., Young, A., and Bartow, A. 2008. Using Common Garden Studies to Inform Seed Transfer Zones for Willamette Valley plant species. Final Report to the Bureau of Land Management, Eugene District, December 30, 2008.

Mote, P. W., and Salathe Jr, E. P. 2010. Future climate in the Pacific Northwest. Climatic Change, 102(1-2), 29-50.

Mote, P., Brekke, L., Duffy, P. B., and Maurer, E. 2011. Guidelines for constructing climate scenarios. Eos, Transactions American Geophysical Union, 92(31), 257-258.

NatureServe. 2012. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: October 10, 2012).

Noss, R., LaRoe III, E., and Scott., J. 1995. Endangered Ecosystems of the United States: A Preliminary Assessment of Loss and Degradation. U.S. Geological Service, Biological Resources Division. http://el.erdc.usace.army.mil/emrrp/emris/EMRIS_PDF/ec.pdf

Oregon Biodiversity Information Center. 2010. Rare, Threatened, and Endangered Species of Oregon. Institute for Natural Resources, Portland State University, Portland, Oregon. 105 pp.

Pacific Northwest Ecosystem Research Consortium. 2002. Willamette River Basin Planning Atlas, Trajectories of Environmental and Ecological Change. D. Hulse, S. Gregory, and J. Baker, eds. Oregon State University Press, Corvallis, OR.

Parks Canada Agency. 2005a. Recovery Strategy for Multi-Species at Risk in Garry Oak Woodlands in Canada (proposed). In Species at Risk Act Recovery Strategy Series. Ottawa: Parks Canada Agency. 61 pps.

Parks Canada Agency. 2005b. Recovery Strategy for Multi-species at Risk in Maritime Meadows Associated with Garry Oak Ecosystems in Canada (proposed). In Species at Risk Act Recovery Strategy Series. Ottawa: Parks Canada Agency. 98 pps.

Potts, S. G., Biesmeijer, J. C., Kremen, C., Neumann, P., Schweiger, O., and Kunin, W. E. 2010. Global pollinator declines: trends, impacts and drivers. Trends in ecology & evolution, 25(6), 345-353.

Quantum GIS Development Team. 2012. Quantum GIS Geographic Information System. Open Source Geospatial Foundation Project. http://qgis.osgeo.org

R Core Team. 2012. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, URL http://www.R-project.org/.

Randall, D. A., Wood, R. A., Bony, S., Colman, R., Fichefet, T., Fyfe, J., Kattsov, V., Pitman, A., Shukla, J., Srinivasan, J., Stouffer, R. J., Sumi, A., and Taylor, K. E. 2007. Climate models and their evaluation. In: Solomon S et al (eds) Climate change 2007: the physical science basis. Contribution of working group I to the fourth assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK

Rosenberg, D., Gervais, J., Vesely, D., Barnes, S., Holts, L., Horn, R., Swift, R., Todd, L., and Yee, C. 2009. Conservation Assessment of the Western Pond Turtle in Oregon (Actinemys marmorata). USDI Bureau of Land Management and Fish and Wildlife Service, USDA Forest Service Region 6, Oregon Department of Fish and Wildlife, City of Portland, Portland Metro Parks, Portland, OR.

Schultz, C. 1998. Dispersal Behavior and Its Implications for Reserve Design in a Rare Oregon Butterfly. Conservation Biology 12:284-292.

Schultz, C. and Dlugosch, K. 1999. Nectar and hostplant scarcity limit populations of an endangered Oregon butterfly. Oecologia 119:231-238.

Severns, P. 2009. Conservation Genetics of Kincaid's Lupine: A Threatened Plant of Western Oregon and Southwest Washington Grasslands. PhD dissertation, Oregon State University (http://scholarsarchive.library.oregonstate.edu/xmlui/bitstream/handle/1957/12711/SevernsPaulM09. pdf).

Severns, P. and Villegas, S. 2005.Butterflies Hanging on to Existence in the Willamette Valley: A Relict Population of the Great Copper (*Lycaena xanthoides* Boisduval). Northwest Science Notes 79:77-80.

Severns, P., Boldt, L., and Villegas, S. 2006. Conserving a wetland butterfly: quantifying early lifestage survival through seasonal flooding, adult nectar, and habitat preference. Journal of Insect Conservation 10:361–370.

Steel, Z., Wilkerson, M., Grof-Tisza, P., and Sulzner, K. 2011. Assessing species and area vulnerability to climate change for the Oregon Conservation Strategy: Willamette Valley Ecoregion. Conservation Mangement Program, University of California-Davis, Davis, CA.

Thomas, R. and Schultz, C. 2010. Response of Fender's blue butterfly to large scale habitat restoration in critical habitat: Distribution of Fender's blue butterfly eggs in The Nature Conservancy's Hayfield site, 2008 and 2009 and Assessing nectar resource phenology for the Fender's blue butterfly, 2009. Report to the Bureau of Land Management, Eugene District.

The Nature Conservancy, USDA Forest Service and U.S. Geological Survey, based on Bailey, Robert G. 1995. Description of the ecoregions of the United States (2nd ed.). Misc. Pub. No. 1391, Map scale 1:7,500,000. USDA Forest Service. 108pp.

USDA, NRCS. 2012. The PLANTS Database (http://plants.usda.gov, 29 June 2012). National Plant Data Team, Greensboro, NC 27401-4901 USA.

U.S. Geological Survey and U.S. Department of Agriculture, Natural Resources Conservation Service. 2012. Federal Standards and Procedures for the National Watershed Boundary Dataset (WBD) (3d ed.): U.S. Geological Survey Techniques and Methods 11–A3, 63 p., available only at http://pubs.usgs.gov/tm/tm11a3/.

U.S. Fish and Wildlife Service. 2010. Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington. U.S. Fish and Wildlife Service, Portland, Oregon. xi + 241 pp.

USFWS Species Reports. Listings and occurrences for Oregon. 29 June 2012. Environmental Conservation Online System. Retrieved from http://ecos.fws.gov/tess_public/pub/stateListingAndOccurrenceIndividual.jsp?state=OR.

Van der Putten, W. H., Macel, M., Visser, M. E., 2010. Predicting species distribution and abundance responses to climate change: why it is essential to include biotic interactions across trophic levels. Philosophical Transactions of the Royal Society B: Biological Sciences, 365(1549), 2025-2034.

Wilson, B., Darris, D. C., Fiegener, R., Johnson, R., Horning, M. E., and Kuykendall, K. 2008. Seed transfer zones for a native grass (Festuca roemeri): genecological evidence. Native Plants Journal 9:287-302.

Woodroffe, R. 2000. Predators and people: using human densities to interpret declines of large carnivores. Animal Conservation 3:165-173.

Young, B., Byers, E., Gravuer, K., Hall, K., Hammerson, G., and Redder, A. 2011. Guidelines for Using the NatureServe Climate Change Vulnerability Index: Release 2.1. NatureServe.

APPENDIX A, TEMPORAL AND SPATIAL VARIATION IN TOTAL ANNUAL PRECIPITATION (HISTORICAL HYDROLOGICAL REGIME)

Temporal and spatial variation in total annual precipitation (Factor C2bi: Historical hydrological regime)

The original categories for the historical hydrological regime factor are based on the total range of mean annual precipitation (PPT) in an assessment area. This method is an incomplete assessment of precipitation variation as it only measures spatial variation, while temporal variation is lost in the averaging across years, and small areas are inappropriately ranked based on low spatial PPT variation. To measure temporal and spatial variation in total annual PPT for the historical hydrological regime factor, we calculated standard deviations (SDs) across the historical period (1951-2006) for 16 grid cells from areas of high to low mean annual PPT in Oregon. Annual PPT means and SDs are highly correlated ($\rho = 0.98$), and a linear regression model predicting SDs from means explained 96% of the variation in SDs (p-value < 0.0001) (Figure A1).

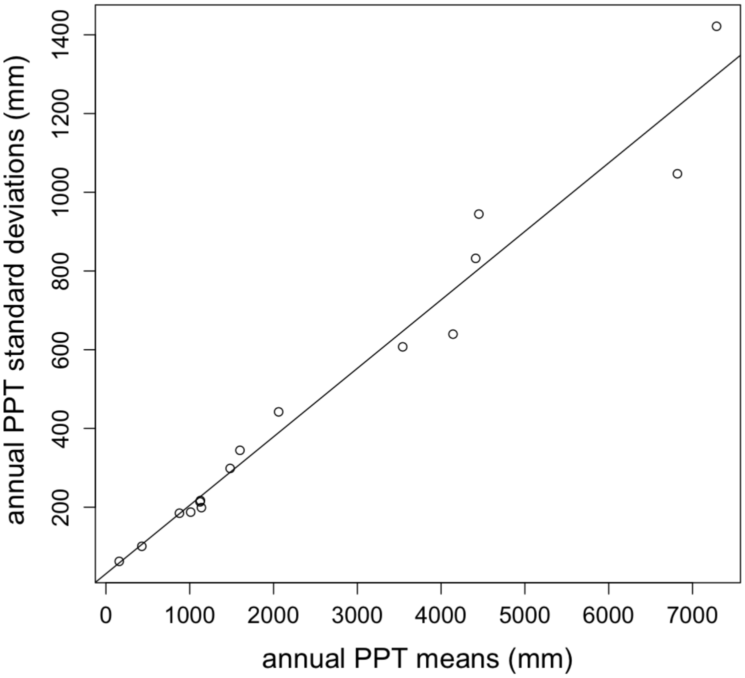


Figure A1. Linear regression of total annual precipitation (PPT) means on total annual precipitation standard deviations.

Based on the linear model of PPT SDs from PPT means, we estimated the annual PPT variation of the entire conterminous US from the original historical (1951-2006) mean annual PPT data. We used the PPT

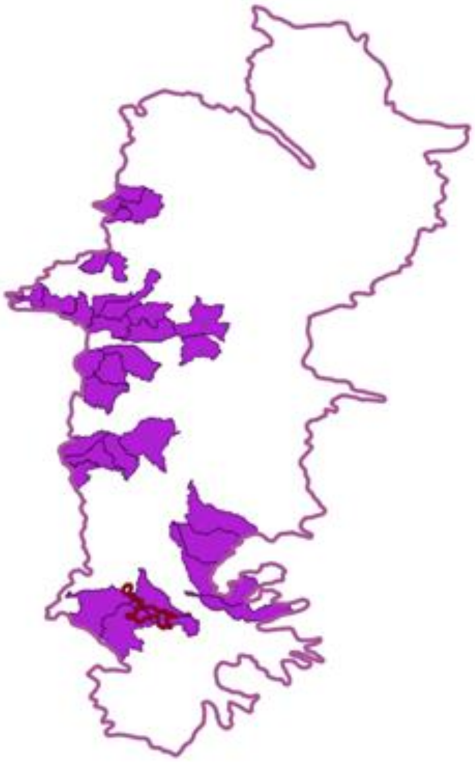
SD estimates to develop new vulnerability category cutoffs for the historical hydrological regime factor that scaled appropriately to the original category cutoffs for this factor based on quantiles of the US PPT mean and SD distributions.

To scale the old categorical cutoffs by the new cutoffs, we simulated a distribution of spatial variation in annual PPT for the conterminous US by iterating random selections of two grid cells from historical (1951-2006) mean annual PPT values across the conterminous US and calculating their difference after each random draw. We iterated this 10,000 times to estimate the spatial variation distribution that pertains to the original categories for the historical hydrological regime, and we used the distribution to find quantiles equaling the category cutoffs (100, 254, 508, and 1016 mm), which were about 13%, 34%, 57%, and 91%. We could then find cutoff values (Table A1) in our distribution of annual PPT SDs from the four quantiles. We used these new cutoffs to count the proportion of grid cells from the Willamette Valley and West Eugene Wetlands PPT SDs that fell into the five categories and then choose the category ranking with the highest proportion of cells, similar to the assessment for the historical thermal regime factor.

Table A1. Categorical rankings for the historical hydrological regime factor based on spatial and temporal variation in total annual precipitation of the conterminous US from 1961-2006.

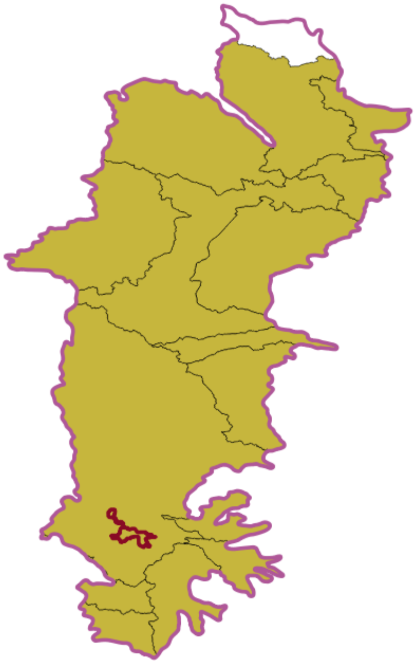
Vulnerability	***Variation***
Greatly Increase	< 82 mm
Increase	82 - 110 mm
Somewhat Increase	110 - 170 mm
Neutral	170 - 260 mm
Somewhat Decrease	> 260 mm

APPENDIX B, RANGE MAPS FOR LISTED/CONSERVATION CONCERN SPECIES

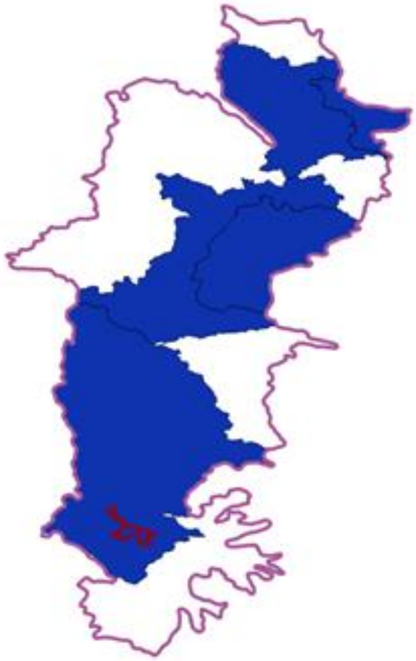


Fender's blue butterfly
Icaricia icarioides fenderi

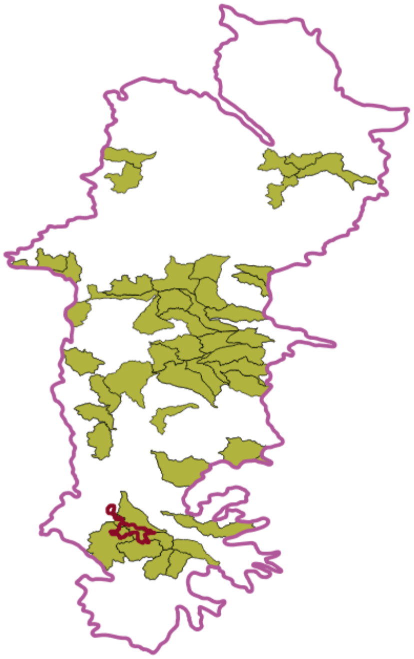
Taylor's checkerspot
Euphydryas editha taylori



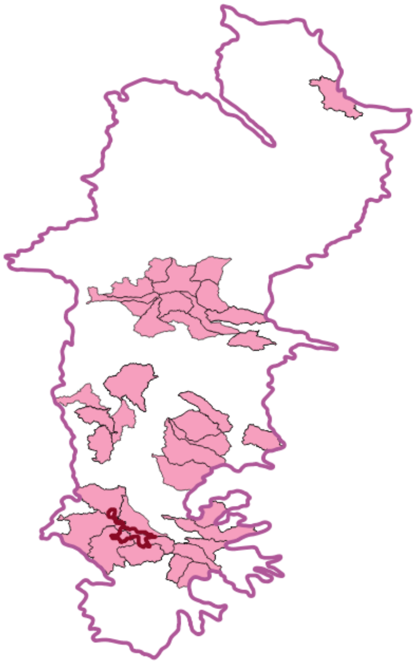
Western pond turtle
Actinemys marmorata



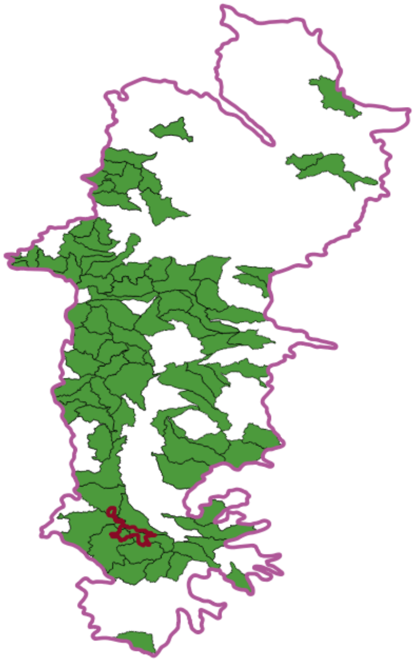
Golden paintbrush
Castilleja levisecta
**historical distribution*



Willamette daisy
Erigeron decumbens var. decumbens



Bradshaw's lomatium
Lomatium bradshawii



Kincaid's lupine
Lupinus oreganus

Shaggy horkelia
Horkelia congesta

Sericocarpus rigidus
Whitetop aster

Hitchcock's blue-eyed grass
Sisyrinchium hitchcockii

APPENDIX C, SPECIES EXPOSURE AND SENSITIVITY SCORES WITH FINAL RANKINGS

Listed and Conservation Concern Species

							Temperature Scope					Hamon AET:PET Moisture Metric Scope						Sea level	Natl barriers	Anth barriers	CC mitigation	Dispersal/Movement	historical thermal niche	physiological thermal niche	historical hydrological niche	physiological hydrological niche	Disturbance	Ice/snow	Physical habitat	Other spp for hab	Diet	Pollinators	Other spp disp	Other spp interaction	Genetic var	Gen bottleneck	Phenol response	Doc response	Modeled change	Modeled overlap	Protected Areas			
Taxonomic Group	Species	English Name	Geographic Area	Range Rel.	GRank	SRank	A >5.5F	A 5.1F	A 4.5F	A 3.9F	A <3.9F	< -0.119	-0.12	-0.1	-0.07	-0.05	>-0.028	B1	B2a	B2b	B3	C1	C2ai	C2aii	C2bi	C2bii	C2c	C2d	C3	C4a	C4b	C4c	C4d	C4e	C5a	C5b	C6	D1	D2	D3	D4	Index	Confidence	Climate Scenario
Invert-Insect	*Euphydryas editha taylori*	Taylor's checkerspot	Range	Entire range	5	1	0	0	38.61	61.39	0	100	0	0	0	0	0	N	N	Inc	N	N	Inc	N	SD	N-SD	N	N	SD	Inc	Inc	N/A	N	N	U	N	SI-N-SD	U	U	U	U	MV	Mod	A2 (high)
Invert-Insect	*Icaricia icarioides fenderi*	Fender's blue	Range	Entire range	5	1	0	0	2.11	97.89	0	100	0	0	0	0	0	N	N	Inc	N	N	Inc	N	N	N-SD	N	N	SD	Inc	Inc	N/A	N	SI-N	U	N	SI-N-SD	U	U	U	U	HV	Low	A2 (high)
Reptile	*Actinemys marmorata*	Western pond turtle	N. range	Northern edge of range	G3G4	S2	8.47	21.16	44.56	25.81	0	84.42	10.2	5	0.38	0	0	N	N	Inc	N	N-SD	N	N	SD	N	N	N	Dec	N	N	N/A	N	N	SI	N/A	SI-N-SD	U	U	U	U	PS	Low	A2 (high)
Vascular Plant	*Castilleja levisecta*	Golden paintbrush	Range	Entire range	1	1	0	0	29.25	70.75	0	99.44	0.56	0	0	0	0	N	SI	Inc	N	GI	Inc	N	SD	N-SD	N	N	SD	N	N/A	N	N	SI-N	SD	N/A	SI-N-SD	U	U	U	U	PS	Low	A2 (high)
Vascular Plant	*Erigeron decumbens*	Williamette daisy	Range	Entire range	4	1	0	0	6.52	93.48	0	100	0	0	0	0	0	N	SI	Inc	N	Inc	Inc	N	N	N-SD	N	N	SD	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	MV	Mod	A2 (high)
Vascular Plant	*Horkelia congesta congesta*	Shaggy horkelia	Range	Entire range	4	2	0	0.69	56.35	42.96	0	100	0	0	0	0	0	N	SI	Inc	N	Inc	Inc	N	SD	N-SD	N	N	SD	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	MV	Mod	A2 (high)
Vascular Plant	*Lomatium bradshawii*	Bradshaw's desert parsley	Range	Entire range	2	2	0	0	12.09	87.91	0	100	0	0	0	0	0	N	SI	Inc	N	Inc	Inc	N	N	N	N	N	N	N	N/A	N	N	N	N	N/A	SI-N-SD	U	U	U	U	HV	Mod	A2 (high)
Vascular Plant	*Lupinus oreganus*	Kincaid's lupine	Range	Entire range	5	2	0	0	19.03	80.97	0	100	0	0	0	0	0	N	SI	Inc	N	GI	Inc	N	N	N-SD	N	N	SD	N	N/A	N	N	N	SD	N/A	SI-N-SD	U	U	U	U	MV	Mod	A2 (high)
Vascular Plant	*Sericocarpus rigidus*	White-topped aster	Range	Entire range	3	2	0	4.9	41.72	53.38	0	94.87	2.1	3	0	0	0	N	SI	Inc	N	Inc	Inc	N	SD	N-SD	N	N	SD	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	MV	Low	A2 (high)
Vascular Plant	*Sisyrinchium hitchcockii*	Hitchcock's blue-eyed grass	Range	Entire range	2	1	0	1.38	64.22	34.4	0	94.95	5.05	0	0	0	0	N	SI	Inc	N	Inc	SI	N	SD	N-SD	N	N	SD	N	N/A	N	N	N	N	N/A	SI-N-SD	U	U	U	U	MV	Low	A2 (high)
Invert-Insect	*Euphydryas editha taylori*	Taylor's checkerspot	WV	Southern edge of range	5	1	0	0	3.92	96.08	0	100	0	0	0	0	0	N	N	Inc	N	N	Inc	N	N	N-SD	N	N	SD	Inc	Inc	N/A	N	N	U	N	SI-N-SD	U	U	U	U	MV	Mod	A2 (high)
Invert-Insect	*Icaricia icarioides fenderi*	Fender's blue	WV	Entire range	5	1	0	0	1.23	98.77	0	100	0	0	0	0	0	N	N	Inc	N	N	Inc	N	N	N-SD	N	N	SD	Inc	Inc	N/A	N	SI-N	U	N	SI-N-SD	U	U	U	U	HV	Low	A2 (high)
Reptile	*Actinemys marmorata*	Western pond turtle	WV	Northern edge of range	G3G4	S2	0	0	25.68	74.32	0	100	0	0	0	0	0	N	N	Inc	N	N-SD	Inc	N	N	N	N	N	Dec	N	N	N/A	N	N	SI	N/A	SI-N-SD	U	U	U	U	PS	VH	A2 (high)
Vascular Plant	*Castilleja levisecta*	Golden paintbrush	WV	Southern edge of range	1	1	0	0	20	80	0	100	0	0	0	0	0	N	SI	Inc	N	GI	Inc	N	N	N-SD	N	N	SD	N	N/A	N	N	SI-N	SD	N/A	SI-N-SD	U	U	U	U	MV	Mod	A2 (high)
Vascular Plant	*Erigeron decumbens*	Williamette daisy	WV	Entire range	4	1	0	0	5.7	94.3	0	100	0	0	0	0	0	N	SI	Inc	N	Inc	Inc	N	N	N-SD	N	N	SD	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	MV	Mod	A2 (high)
Vascular Plant	*Horkelia congesta congesta*	Shaggy horkelia	WV	Northern edge of range	4	2	0	0	12.1	87.9	0	100	0	0	0	0	0	N	SI	Inc	N	Inc	Inc	N	N	N-SD	N	N	SD	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	MV	Mod	A2 (high)
Vascular Plant	*Lomatium bradshawii*	Bradshaw's desert parsley	WV	Entire range	2	2	0	0	10.17	89.83	0	100	0	0	0	0	0	N	SI	Inc	N	Inc	Inc	N	N	N	N	N	N	N	N/A	N	N	N	N	N/A	SI-N-SD	U	U	U	U	HV	Mod	A2 (high)
Vascular Plant	*Lupinus oreganus*	Kincaid's lupine	WV	Center of range	5	2	0	0	5.2	94.8	0	100	0	0	0	0	0	N	SI	Inc	N	GI	Inc	N	N	N-SD	N	N	SD	N	N/A	N	N	N	SD	N/A	SI-N-SD	U	U	U	U	MV	Mod	A2 (high)
Vascular Plant	*Sericocarpus rigidus*	White-topped aster	WV	Center of range	3	2	0	0	10.71	89.29	0	100	0	0	0	0	0	N	SI	Inc	N	Inc	Inc	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	MV	Mod	A2 (high)
Vascular Plant	*Sisyrinchium hitchcockii*	Hitchcock's blue-eyed grass	WV	Northern edge of range	2	1	0	0	9.8	90.2	0	100	0	0	0	0	0	N	SI	Inc	N	Inc	Inc	N	N	N-SD	N	N	SD	N	N/A	N	N	N	N	N/A	SI-N-SD	U	U	U	U	MV	Mod	A2 (high)
Invert-Insect	*Euphydryas editha taylori*	Taylor's checkerspot	WEW	Southern edge of range	5	1	0	0	0	100	0	100	0	0	0	0	0	N	N	GI	N	N	SI	N	N	N-SD	N	N	SD	Inc	Inc	N/A	N	N	U	N	SI-N-SD	U	U	U	U	MV	Low	A2 (high)
Invert-Insect	*Icaricia icarioides fenderi*	Fender's blue	WEW	Entire range	5	1	0	0	0	100	0	100	0	0	0	0	0	N	N	GI	N	N	SI	N	N	N-SD	N	N	SD	Inc	Inc	N/A	N	SI-N	U	N	SI-N-SD	U	U	U	U	HV	Low	A2 (high)
Reptile	*Actinemys marmorata*	Western pond turtle	WEW	Northern edge of range	G3G4	S2	0	0	0	100	0	100	0	0	0	0	0	N	N	GI	N	N-SD	SI	N	N	N	N	N	Dec	N	N	N/A	N	N	SI	N/A	SI-N-SD	U	U	U	U	PS	High	A2 (high)
Vascular Plant	*Castilleja levisecta*	Golden paintbrush	WEW	Southern edge of range	1	1	0	0	0	100	0	100	0	0	0	0	0	N	N	GI	N	GI	SI	N	N	N-SD	N	N	SD	N	N/A	N	N	SI-N	SD	N/A	SI-N-SD	U	U	U	U	MV	Mod	A2 (high)
Vascular Plant	*Erigeron decumbens*	Williamette daisy	WEW	Entire range	4	1	0	0	0	100	0	100	0	0	0	0	0	N	N	GI	N	Inc	SI	N	N	N-SD	N	N	SD	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	MV	Mod	A2 (high)
Vascular Plant	*Horkelia congesta congesta*	Shaggy horkelia	WEW	Northern edge of range	4	2	0	0	0	100	0	100	0	0	0	0	0	N	N	GI	N	Inc	SI	N	N	N-SD	N	N	SD	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	MV	Mod	A2 (high)
Vascular Plant	*Lomatium bradshawii*	Bradshaw's desert parsley	WEW	Entire range	2	2	0	0	0	100	0	100	0	0	0	0	0	N	SI	GI	N	Inc	SI	N	N	N	N	N	N	N	N/A	N	N	N	N	N/A	SI-N-SD	U	U	U	U	HV	Mod	A2 (high)
Vascular Plant	*Lupinus oreganus*	Kincaid's lupine	WEW	Center of range	5	2	0	0	0	100	0	100	0	0	0	0	0	N	N	GI	N	GI	SI	N	N	N-SD	N	N	SD	N	N/A	N	N	N	SD	N/A	SI-N-SD	U	U	U	U	MV	Mod	A2 (high)
Vascular Plant	*Sericocarpus rigidus*	White-topped aster	WEW	Center of range	3	2	0	0	0	100	0	100	0	0	0	0	0	N	N	GI	N	Inc	SI	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	MV	Mod	A2 (high)
Vascular Plant	*Sisyrinchium hitchcockii*	Hitchcock's blue-eyed grass	WEW	Northern edge of range	2	1	0	0	0	100	0	100	0	0	0	0	0	N	N	GI	N	Inc	SI	N	N	N-SD	N	N	SD	N	N/A	N	N	N	N	N/A	SI-N-SD	U	U	U	U	MV	Mod	A2 (high)
Invert-Insect	*Euphydryas editha taylori*	Taylor's checkerspot	Range	Entire range	5	1	0	0	0	0	100	0	22.8	49	28.7	0	0	N	N	Inc	N	N	Inc	N	SD	N-SD	N	N	SD	Inc	Inc	N/A	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	A1B (med)
Invert-Insect	*Icaricia icarioides fenderi*	Fender's blue	Range	Entire range	5	1	0	0	0	0	100	0	0	47	52.6	0	0	N	N	Inc	N	N	Inc	N	N	N-SD	N	N	SD	Inc	Inc	N/A	N	SI-N	U	N	SI-N-SD	U	U	U	U	PS	Mod	A1B (med)
Reptile	*Actinemys marmorata*	Western pond turtle	N. range	Northern edge of range	G3G4	S2	0	0.47	10.77	20.07	68.69	0	10.4	53	27.6	8.94	0	N	N	Inc	N	N-SD	N	N	SD	N	N	N	Dec	N	N	N/A	N	N	SI	N/A	SI-N-SD	U	U	U	U	PS	High	A1B (med)
Vascular Plant	*Castilleja levisecta*	Golden paintbrush	Range	Entire range	1	1	0	0	0	0	100	0	2.79	87	10.6	0	0	N	SI	Inc	N	GI	Inc	N	SD	N-SD	N	N	SD	N	N/A	N	N	SI-N	SD	N/A	SI-N-SD	U	U	U	U	PS	VH	A1B (med)
Vascular Plant	*Erigeron decumbens*	Williamette daisy	Range	Entire range	4	1	0	0	0	0	100	0	0.72	62	37.3	0	0	N	SI	Inc	N	Inc	Inc	N	N	N-SD	N	N	SD	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	PS	High	A1B (med)
Vascular Plant	*Horkelia congesta congesta*	Shaggy horkelia	Range	Entire range	4	2	0	0	0	0	100	0	22.6	66	11.3	0	0	N	SI	Inc	N	Inc	Inc	N	SD	N-SD	N	N	SD	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	A1B (med)
Vascular Plant	*Lomatium bradshawii*	Bradshaw's desert parsley	Range	Entire range	2	2	0	0	0	0	100	0	0	50	50	0	0	N	SI	Inc	N	Inc	Inc	N	N	N	N	N	N	N	N/A	N	N	N	N	N/A	SI-N-SD	U	U	U	U	MV	Mod	A1B (med)
Vascular Plant	*Lupinus oreganus*	Kincaid's lupine	Range	Entire range	5	2	0	0	0	0	100	0	0.18	61	39	0	0	N	SI	Inc	N	GI	Inc	N	N	N-SD	N	N	SD	N	N/A	N	N	N	SD	N/A	SI-N-SD	U	U	U	U	PS	High	A1B (med)
Vascular Plant	*Sericocarpus rigidus*	White-topped aster	Range	Entire range	3	2	0	0	0	14.69	85.31	0	5.83	79	11.9	3.49	0	N	SI	Inc	N	Inc	Inc	N	SD	N-SD	N	N	SD	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	A1B (med)
Vascular Plant	*Sisyrinchium hitchcockii*	Hitchcock's blue-eyed grass	Range	Entire range	2	1	0	0	0	0	100	0	26.2	49	25.2	0	0	N	SI	Inc	N	Inc	SI	N	SD	N-SD	N	N	SD	N	N/A	N	N	N	N	N/A	SI-N-SD	U	U	U	U	PS	VH	A1B (med)
Invert-Insect	*Euphydryas editha taylori*	Taylor's checkerspot	WV	Southern edge of range	5	1	0	0	0	0	100	0	0	43	56.9	0	0	N	N	Inc	N	N	Inc	N	N	N-SD	N	N	SD	Inc	Inc	N/A	N	N	U	N	SI-N-SD	U	U	U	U	PS	High	A1B (med)
Invert-Insect	*Icaricia icarioides fenderi*	Fender's blue	WV	Entire range	5	1	0	0	0	0	100	0	0	39	61.4	0	0	N	N	Inc	N	N	Inc	N	N	N-SD	N	N	SD	Inc	Inc	N/A	N	SI-N	U	N	SI-N-SD	U	U	U	U	PS	Mod	A1B (med)
Reptile	*Actinemys marmorata*	Western pond turtle	WV	Northern edge of range	G3G4	S2	0	0	0	0	100	0	0.68	76	23.6	0	0	N	N	Inc	N	N-SD	Inc	N	N	N	N	N	Dec	N	N	N/A	N	N	SI	N/A	SI-N-SD	U	U	U	U	PS	VH	A1B (med)
Vascular Plant	*Castilleja levisecta*	Golden paintbrush	WV	Southern edge of range	1	1	0	0	0	0	100	0	0	70	29.6	0	0	N	SI	Inc	N	Inc	Inc	N	N	N-SD	N	N	SD	N	N/A	N	N	SI-N	SD	N/A	SI-N-SD	U	U	U	U	PS	Mod	A1B (med)
Vascular Plant	*Erigeron decumbens*	Williamette daisy	WV	Entire range	4	1	0	0	0	0	100	0	0.76	60	39.2	0	0	N	SI	Inc	N	Inc	Inc	N	N	N-SD	N	N	SD	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	PS	High	A1B (med)
Vascular Plant	*Horkelia congesta congesta*	Shaggy horkelia	WV	Northern edge of range	4	2	0	0	0	0	100	0	0	75	25.5	0	0	N	SI	Inc	N	Inc	Inc	N	N	N-SD	N	N	SD	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	PS	High	A1B (med)
Vascular Plant	*Lomatium bradshawii*	Bradshaw's desert parsley	WV	Entire range	2	2	0	0	0	0	100	0	0	48	51.9	0	0	N	SI	Inc	N	Inc	Inc	N	N	N	N	N	N	N	N/A	N	N	N	N	N/A	SI-N-SD	U	U	U	U	MV	Mod	A1B (med)
Vascular Plant	*Lupinus oreganus*	Kincaid's lupine	WV	Center of range	5	2	0	0	0	0	100	0	0.25	49	51	0	0	N	SI	Inc	N	Inc	Inc	N	N	N-SD	N	N	SD	N	N/A	N	N	N	SD	N/A	SI-N-SD	U	U	U	U	PS	VH	A1B (med)
Vascular Plant	*Sericocarpus rigidus*	White-topped aster	WV	Center of range	3	2	0	0	0	0	100	0	0	66	33.9	0	0	N	SI	Inc	N	Inc	Inc	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	PS	Mod	A1B (med)
Vascular Plant	*Sisyrinchium hitchcockii*	Hitchcock's blue-eyed grass	WV	Northern edge of range	2	1	0	0	0	0	100	0	0	45	54.9	0	0	N	SI	Inc	N	Inc	Inc	N	N	N-SD	N	N	SD	N	N/A	N	N	N	N	N/A	SI-N-SD	U	U	U	U	PS	VH	A1B (med)
Invert-Insect	*Euphydryas editha taylori*	Taylor's checkerspot	WEW	Southern edge of range	5	1	0	0	0	0	100	0	0	0	100	0	0	N	N	GI	N	N	SI	N	N	N-SD	N	N	SD	Inc	Inc	N/A	N	N	U	N	SI-N-SD	U	U	U	U	PS	High	A1B (med)
Invert-Insect	*Icaricia icarioides fenderi*	Fender's blue	WEW	Entire range	5	1	0	0	0	0	100	0	0	0	100	0	0	N	N	GI	N	N	SI	N	N	N-SD	N	N	SD	Inc	Inc	N/A	N	SI-N	U	N	SI-N-SD	U	U	U	U	PS	Mod	A1B (med)
Reptile	*Actinemys marmorata*	Western pond turtle	WEW	Northern edge of range	G3G4	S2	0	0	0	0	100	0	0	0	100	0	0	N	N	GI	N	N-SD	SI	N	N	N	N	N	Dec	N	N	N/A	N	N	SI	N/A	SI-N-SD	U	U	U	U	PS	VH	A1B (med)
Vascular Plant	*Castilleja levisecta*	Golden paintbrush	WEW	Southern edge of range	1	1	0	0	0	0	100	0	0	0	100	0	0	N	N	GI	N	Inc	SI	N	N	N-SD	N	N	SD	N	N/A	N	N	SI-N	SD	N/A	SI-N-SD	U	U	U	U	PS	VH	A1B (med)
Vascular Plant	*Erigeron decumbens*	Williamette daisy	WEW	Entire range	4	1	0	0	0	0	100	0	0	0	100	0	0	N	N	GI	N	Inc	SI	N	N	N-SD	N	N	SD	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	A1B (med)
Vascular Plant	*Horkelia congesta congesta*	Shaggy horkelia	WEW	Northern edge of range	4	2	0	0	0	0	100	0	0	0	100	0	0	N	N	GI	N	Inc	SI	N	N	N-SD	N	N	SD	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	A1B (med)
Vascular Plant	*Lomatium bradshawii*	Bradshaw's desert parsley	WEW	Entire range	2	2	0	0	0	0	100	0	0	0	100	0	0	N	SI	GI	N	Inc	SI	N	N	N	N	N	N	N	N/A	N	N	N	N	N/A	SI-N-SD	U	U	U	U	PS	Mod	A1B (med)
Vascular Plant	*Lupinus oreganus*	Kincaid's lupine	WEW	Center of range	5	2	0	0	0	0	100	0	0	0	100	0	0	N	N	GI	N	Inc	SI	N	N	N-SD	N	N	SD	N	N/A	N	N	N	SD	N/A	SI-N-SD	U	U	U	U	PS	VH	A1B (med)
Vascular Plant	*Sericocarpus rigidus*	White-topped aster	WEW	Center of range	3	2	0	0	0	0	100	0	0	0	100	0	0	N	N	GI	N	Inc	SI	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	A1B (med)
Vascular Plant	*Sisyrinchium hitchcockii*	Hitchcock's blue-eyed grass	WEW	Northern edge of range	2	1	0	0	0	0	100	0	0	0	100	0	0	N	N	GI	N	Inc	SI	N	N	N-SD	N	N	SD	N	N/A	N	N	N	N	N/A	SI-N-SD	U	U	U	U	PS	VH	A1B (med)
Invert-Insect	*Euphydryas editha taylori*	Taylor's checkerspot	Range	Entire range	5	1	0	0	0	0	100	0	0	0	0	0	100	N	N	Inc	N	N	Inc	N	SD	N-SD	N	N	SD	Inc	Inc	N/A	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Invert-Insect	*Icaricia icarioides fenderi*	Fender's blue	Range	Entire range	5	1	0	0	0	0	100	0	0	0	0	0	100	N	N	Inc	N	N	Inc	N	N	N-SD	N	N	SD	Inc	Inc	N/A	N	SI-N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Reptile	*Actinemys marmorata*	Western pond turtle	N. range	Northern edge of range	G3G4	S2	0	0	0	0	100	0	0	0	0	0	100	N	N	Inc	N	N-SD	N	N	SD	N	N	N	Dec	N	N	N/A	N	N	SI	N/A	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Castilleja levisecta*	Golden paintbrush	Range	Entire range	1	1	0	0	0	0	100	0	0	0	0	0	100	N	SI	Inc	N	GI	Inc	N	SD	N-SD	N	N	SD	N	N/A	N	N	SI-N	SD	N/A	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Erigeron decumbens*	Williamette daisy	Range	Entire range	4	1	0	0	0	0	100	0	0	0	0	0	100	N	SI	Inc	N	Inc	Inc	N	N	N-SD	N	N	SD	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Horkelia congesta congesta*	Shaggy horkelia	Range	Entire range	4	2	0	0	0	0	100	0	0	0	0	0	100	N	SI	Inc	N	Inc	Inc	N	SD	N-SD	N	N	SD	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Lomatium bradshawii*	Bradshaw's desert parsley	Range	Entire range	2	2	0	0	0	0	100	0	0	0	0	0	100	N	SI	Inc	N	Inc	Inc	N	N	N	N	N	N	N	N/A	N	N	N	N	N/A	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Lupinus oreganus*	Kincaid's lupine	Range	Entire range	5	2	0	0	0	0	100	0	0	0	0	0	100	N	SI	Inc	N	GI	Inc	N	N	N-SD	N	N	SD	N	N/A	N	N	N	SD	N/A	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Sericocarpus rigidus*	White-topped aster	Range	Entire range	3	2	0	0	0	0	100	0	0	0	0	0	100	N	SI	Inc	N	Inc	Inc	N	SD	N-SD	N	N	SD	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Sisyrinchium hitchcockii*	Hitchcock's blue-eyed grass	Range	Entire range	2	1	0	0	0	0	100	0	0	0	0	0	100	N	SI	Inc	N	Inc	SI	N	SD	N-SD	N	N	SD	N	N/A	N	N	N	N	N/A	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Invert-Insect	*Euphydryas editha taylori*	Taylor's checkerspot	WV	Southern edge of range	5	1	0	0	0	0	100	0	0	0	0	0	100	N	N	Inc	N	N	Inc	N	N	N-SD	N	N	SD	Inc	Inc	N/A	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Invert-Insect	*Icaricia icarioides fenderi*	Fender's blue	WV	Entire range	5	1	0	0	0	0	100	0	0	0	0	0	100	N	N	Inc	N	N	Inc	N	N	N-SD	N	N	SD	Inc	Inc	N/A	N	SI-N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Reptile	*Actinemys marmorata*	Western pond turtle	WV	Northern edge of range	G3G4	S2	0	0	0	0	100	0	0	0	0	0	100	N	N	Inc	N	N-SD	Inc	N	N	N	N	N	Dec	N	N	N/A	N	N	SI	N/A	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Castilleja levisecta*	Golden paintbrush	WV	Southern edge of range	1	1	0	0	0	0	100	0	0	0	0	0	100	N	SI	Inc	N	GI	Inc	N	N	N-SD	N	N	SD	N	N/A	N	N	SI-N	SD	N/A	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Erigeron decumbens*	Williamette daisy	WV	Entire range	4	1	0	0	0	0	100	0	0	0	0	0	100	N	SI	Inc	N	Inc	Inc	N	N	N-SD	N	N	SD	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Horkelia congesta congesta*	Shaggy horkelia	WV	Northern edge of range	4	2	0	0	0	0	100	0	0	0	0	0	100	N	SI	Inc	N	Inc	Inc	N	N	N-SD	N	N	SD	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Lomatium bradshawii*	Bradshaw's desert parsley	WV	Entire range	2	2	0	0	0	0	100	0	0	0	0	0	100	N	SI	Inc	N	Inc	Inc	N	N	N	N	N	N	N	N/A	N	N	N	N	N/A	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Lupinus oreganus*	Kincaid's lupine	WV	Center of range	5	2	0	0	0	0	100	0	0	0	0	0	100	N	SI	Inc	N	GI	Inc	N	N	N-SD	N	N	SD	N	N/A	N	N	N	SD	N/A	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Sericocarpus rigidus*	White-topped aster	WV	Center of range	3	2	0	0	0	0	100	0	0	0	0	0	100	N	SI	Inc	N	Inc	Inc	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Sisyrinchium hitchcockii*	Hitchcock's blue-eyed grass	WV	Northern edge of range	2	1	0	0	0	0	100	0	0	0	0	0	100	N	SI	Inc	N	Inc	Inc	N	N	N-SD	N	N	SD	N	N/A	N	N	N	N	N/A	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Invert-Insect	*Euphydryas editha taylori*	Taylor's checkerspot	WEW	Southern edge of range	5	1	0	0	0	0	100	0	0	0	0	0	100	N	N	GI	N	N	SI	N	N	N-SD	N	N	SD	Inc	Inc	N/A	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Invert-Insect	*Icaricia icarioides fenderi*	Fender's blue	WEW	Entire range	5	1	0	0	0	0	100	0	0	0	0	0	100	N	N	GI	N	N	SI	N	N	N-SD	N	N	SD	Inc	Inc	N/A	N	SI-N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Reptile	*Actinemys marmorata*	Western pond turtle	WEW	Northern edge of range	G3G4	S2	0	0	0	0	100	0	0	0	0	0	100	N	N	GI	N	N-SD	SI	N	N	N	N	N	Dec	N	N	N/A	N	N	SI	N/A	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Castilleja levisecta*	Golden paintbrush	WEW	Southern edge of range	1	1	0	0	0	0	100	0	0	0	0	0	100	N	N	GI	N	GI	SI	N	N	N-SD	N	N	SD	N	N/A	N	N	SI-N	SD	N/A	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Erigeron decumbens*	Williamette daisy	WEW	Entire range	4	1	0	0	0	0	100	0	0	0	0	0	100	N	N	GI	N	Inc	SI	N	N	N-SD	N	N	SD	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Horkelia congesta congesta*	Shaggy horkelia	WEW	Northern edge of range	4	2	0	0	0	0	100	0	0	0	0	0	100	N	N	GI	N	Inc	SI	N	N	N-SD	N	N	SD	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Lomatium bradshawii*	Bradshaw's desert parsley	WEW	Entire range	2	2	0	0	0	0	100	0	0	0	0	0	100	N	SI	GI	N	Inc	SI	N	N	N	N	N	N	N	N/A	N	N	N	N	N/A	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Lupinus oreganus*	Kincaid's lupine	WEW	Center of range	5	2	0	0	0	0	100	0	0	0	0	0	100	N	N	GI	N	GI	SI	N	N	N-SD	N	N	SD	N	N/A	N	N	N	SD	N/A	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Sericocarpus rigidus*	White-topped aster	WEW	Center of range	3	2	0	0	0	0	100	0	0	0	0	0	100	N	N	GI	N	Inc	SI	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Sisyrinchium hitchcockii*	Hitchcock's blue-eyed grass	WEW	Northern edge of range	2	1	0	0	0	0	100	0	0	0	0	0	100	N	N	GI	N	Inc	SI	N	N	N-SD	N	N	SD	N	N/A	N	N	N	N	N/A	SI-N-SD	U	U	U	U	PS	VH	B1 (low)

Nectar Species and Butterflies (non-listed)

							Temperature Scope					Hamon AET:PET Moisture Metric Scope						Sea level	Natl barriers	Anth barriers	CC mitigation	Dispersal/Movement	historical thermal niche	physiological thermal niche	historical hydrological niche	physiological hydrological niche	Disturbance	Ice/snow	Phys habitat	Other spp for hab	Diet	Pollinators	Other spp disp	Other spp interaction	Genetic var	Gen bottleneck	Phenol response	Doc response	Modeled change	Modeled overlap	Protected Areas			
Taxonomic Grou	Species	English Name	Geographic Area	Range Rel.	GRank	SRank	A >5.5F	A 5.1F	A 4.5F	A 3.9F	A <3.9F	< -0.119	-0.119	-0.096	-0.073	-0.05	>-0.028	B1	B2a	B2b	B3	C1	C2ai	C2aii	C2bi	C2bii	C2c	C2d	C3	C4a	C4b	C4c	C4d	C4e	C5a	C5b	C6	D1	D2	D3	D4	Index	Confidenc	Climate Scenario
Vascular Plant	*Eriophyllum lanatum var. leucophyllum*	Woolly sunflower	Willamette Valley	Center of range	G5T5		0	0	25.68	74.32	0	100	0	0	0	0	0	N	SI	Inc	N	GI	Inc	N	N	N-SD	N	N	Dec	N	N/A	SI-N	N	N	N	N/A	SI-N-SD	U	U	U	U	MV	Mod	A2 (high)
Vascular Plant	*Sidalcea malviflora ssp. virgata*	Rose checkermallow	Willamette Valley	Center of range	G5TNR		0	0	25.68	74.32	0	100	0	0	0	0	0	N	SI	Inc	N	GI	Inc	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	SD	N/A	SI-N-SD	U	U	U	U	MV	Mod	A2 (high)
Vascular Plant	*Calochortus tolmiei*	Tolmie's lily	Willamette Valley	Center of range	G4		0	0	25.68	74.32	0	100	0	0	0	0	0	N	SI	Inc	N	GI	Inc	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	HV	Low	A2 (high)
Vascular Plant	*Iris tenax var. tenax*	Oregon iris	Willamette Valley	Center of range	G4G5TNR		0	0	25.68	74.32	0	100	0	0	0	0	0	N	SI	Inc	N	GI	Inc	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	HV	Low	A2 (high)
Vascular Plant	*Allium amplectens*	Slim-leaf onion	Willamette Valley	Center of range	G4		0	0	25.68	74.32	0	100	0	0	0	0	0	N	SI	Inc	N	GI	Inc	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	HV	Low	A2 (high)
Vascular Plant	*Camassia quamash var. maxima*	Common camas	Willamette Valley	Southern edge of range	G5T3T5		0	0	25.68	74.32	0	100	0	0	0	0	0	N	SI	Inc	N	Inc	Inc	N	N	N	N	N	N	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	HV	High	A2 (high)
Vascular Plant	*Eriophyllum lanatum var. leucophyllum*	Woolly sunflower	Willamette Valley	Center of range	G5T5		0	0	0	0	100	0	0.675	75.676	23.649	0	0	N	SI	Inc	N	GI	Inc	N	N	N-SD	N	N	Dec	N	N/A	SI-N	N	N	N	N/A	SI-N-SD	U	U	U	U	PS	Mod	A1B (med)
Vascular Plant	*Sidalcea malviflora ssp. virgata*	Rose checkermallow	Willamette Valley	Center of range	G5TNR		0	0	0	0	100	0	0.675	75.676	23.649	0	0	N	SI	Inc	N	GI	Inc	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	SD	N/A	SI-N-SD	U	U	U	U	PS	Mod	A1B (med)
Vascular Plant	*Calochortus tolmiei*	Tolmie's lily	Willamette Valley	Center of range	G4		0	0	0	0	100	0	0.675	75.676	23.649	0	0	N	SI	Inc	N	GI	Inc	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	MV	Low	A1B (med)
Vascular Plant	*Iris tenax var. tenax*	Oregon iris	Willamette Valley	Center of range	G4G5TNR		0	0	0	0	100	0	0.675	75.676	23.649	0	0	N	SI	Inc	N	GI	Inc	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	MV	Low	A1B (med)
Vascular Plant	*Allium amplectens*	Slim-leaf onion	Willamette Valley	Center of range	G4		0	0	0	0	100	0	0.675	75.676	23.649	0	0	N	SI	Inc	N	GI	Inc	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	MV	Low	A1B (med)
Vascular Plant	*Camassia quamash var. maxima*	Common camas	Willamette Valley	Southern edge of range	G5T3T5		0	0	0	0	100	0	0.675	75.676	23.649	0	0	N	SI	Inc	N	Inc	Inc	N	N	N	N	N	N	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	MV	High	A1B (med)
Vascular Plant	*Eriophyllum lanatum var. leucophyllum*	Woolly sunflower	Willamette Valley	Center of range	G5T5		0	0	0	0	100	0	0	0	0	0	100	N	SI	Inc	N	GI	Inc	N	N	N-SD	N	N	Dec	N	N/A	SI-N	N	N	N	N/A	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Sidalcea malviflora ssp. virgata*	Rose checkermallow	Willamette Valley	Center of range	G5TNR		0	0	0	0	100	0	0	0	0	0	100	N	SI	Inc	N	GI	Inc	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	SD	N/A	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Calochortus tolmiei*	Tolmie's lily	Willamette Valley	Center of range	G4		0	0	0	0	100	0	0	0	0	0	100	N	SI	Inc	N	GI	Inc	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Iris tenax var. tenax*	Oregon iris	Willamette Valley	Center of range	G4G5TNR		0	0	0	0	100	0	0	0	0	0	100	N	SI	Inc	N	GI	Inc	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Allium amplectens*	Slim-leaf onion	Willamette Valley	Center of range	G4		0	0	0	0	100	0	0	0	0	0	100	N	SI	Inc	N	GI	Inc	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Camassia quamash var. maxima*	Common camas	Willamette Valley	Southern edge of range	G5T3T5		0	0	0	0	100	0	0	0	0	0	100	N	SI	Inc	N	Inc	Inc	N	N	N	N	N	N	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Eriophyllum lanatum var. leucophyllum*	Woolly sunflower	WEW	Center of range	G5T5		0	0	0	100	0	100	0	0	0	0	0	N	N	GI	N	GI	SI	N	N	N-SD	N	N	Dec	N	N/A	SI-N	N	N	N	N/A	SI-N-SD	U	U	U	U	MV	Mod	A2 (high)
Vascular Plant	*Sidalcea malviflora ssp. virgata*	Rose checkermallow	WEW	Center of range	G5TNR		0	0	0	100	0	100	0	0	0	0	0	N	N	GI	N	GI	SI	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	SD	N/A	SI-N-SD	U	U	U	U	MV	Mod	A2 (high)
Vascular Plant	*Calochortus tolmiei*	Tolmie's lily	WEW	Center of range	G4		0	0	0	100	0	100	0	0	0	0	0	N	N	GI	N	GI	SI	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	MV	Low	A2 (high)
Vascular Plant	*Iris tenax var. tenax*	Oregon iris	WEW	Center of range	G4G5TNR		0	0	0	100	0	100	0	0	0	0	0	N	N	GI	N	GI	SI	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	MV	Low	A2 (high)
Vascular Plant	*Allium amplectens*	Slim-leaf onion	WEW	Center of range	G4		0	0	0	100	0	100	0	0	0	0	0	N	SI	GI	N	GI	SI	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	HV	Mod	A2 (high)
Vascular Plant	*Camassia quamash var. maxima*	Common camas	WEW	Southern edge of range	G5T3T5		0	0	0	100	0	100	0	0	0	0	0	N	SI	GI	N	Inc	SI	N	N	N	N	N	N	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	HV	Mod	A2 (high)
Vascular Plant	*Eriophyllum lanatum var. leucophyllum*	Woolly sunflower	WEW	Center of range	G5T5		0	0	0	0	100	0	0	0	100	0	0	N	N	GI	N	GI	SI	N	N	N-SD	N	N	Dec	N	N/A	SI-N	N	N	N	N/A	SI-N-SD	U	U	U	U	PS	VH	A1B (med)
Vascular Plant	*Sidalcea malviflora ssp. virgata*	Rose checkermallow	WEW	Center of range	G5TNR		0	0	0	0	100	0	0	0	100	0	0	N	N	GI	N	GI	SI	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	SD	N/A	SI-N-SD	U	U	U	U	PS	VH	A1B (med)
Vascular Plant	*Calochortus tolmiei*	Tolmie's lily	WEW	Center of range	G4		0	0	0	0	100	0	0	0	100	0	0	N	N	GI	N	GI	SI	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	A1B (med)
Vascular Plant	*Iris tenax var. tenax*	Oregon iris	WEW	Center of range	G4G5TNR		0	0	0	0	100	0	0	0	100	0	0	N	N	GI	N	GI	SI	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	A1B (med)
Vascular Plant	*Allium amplectens*	Slim-leaf onion	WEW	Center of range	G4		0	0	0	0	100	0	0	0	100	0	0	N	SI	GI	N	GI	SI	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	PS	Mod	A1B (med)
Vascular Plant	*Camassia quamash var. maxima*	Common camas	WEW	Southern edge of range	G5T3T5		0	0	0	0	100	0	0	0	100	0	0	N	SI	GI	N	Inc	SI	N	N	N	N	N	N	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	MV	Low	A1B (med)
Vascular Plant	*Eriophyllum lanatum var. leucophyllum*	Woolly sunflower	WEW	Center of range	G5T5		0	0	0	0	100	0	0	0	0	0	100	N	N	GI	N	GI	SI	N	N	N-SD	N	N	Dec	N	N/A	SI-N	N	N	N	N/A	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Sidalcea malviflora ssp. virgata*	Rose checkermallow	WEW	Center of range	G5TNR		0	0	0	0	100	0	0	0	0	0	100	N	N	GI	N	GI	SI	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	SD	N/A	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Calochortus tolmiei*	Tolmie's lily	WEW	Center of range	G4		0	0	0	0	100	0	0	0	0	0	100	N	N	GI	N	GI	SI	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Iris tenax var. tenax*	Oregon iris	WEW	Center of range	G4G5TNR		0	0	0	0	100	0	0	0	0	0	100	N	N	GI	N	GI	SI	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Allium amplectens*	Slim-leaf onion	WEW	Center of range	G4		0	0	0	0	100	0	0	0	0	0	100	N	SI	GI	N	GI	SI	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Camassia quamash var. maxima*	Common camas	WEW	Southern edge of range	G5T3T5		0	0	0	0	100	0	0	0	0	0	100	N	SI	GI	N	Inc	SI	N	N	N	N	N	N	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Invert-Insect	*Polites sonora siris*	Sonoran skipper	Willamette Valley	Center of range			0	0	25.68	74.32	0	0	100	0	0	0	0	N	N	Inc	N	N	SI	N	N	N	N	N	N	Inc	Inc	N/A	N	N	U	N	SI-N-SD	U	U	U	U	HV	Mod	A2 (high)
Invert-Insect	*Lycaena xanthoides*	Great copper	Willamette Valley	Northern edge of range	G4	SNR	0	0	25.68	74.32	0	0	100	0	0	0	0	N	N	Inc	N	N	SI	N	N	N	N	N	N	Inc	Inc	N/A	N	N	U	N	SI-N-SD	U	U	U	U	HV	Mod	A2 (high)
Invert-Insect	*Phycoides pulchella nr pulchella*	Field crescent	Willamette Valley	Center of range	G5TNR		0	0	25.68	74.32	0	0	100	0	0	0	0	N	N	Inc	N	N	SI	N	N	N	N	N	N	Inc	Inc	N/A	N	N	U	N	SI-N-SD	U	U	U	U	HV	Mod	A2 (high)
Invert-Insect	*Polites sonora siris*	Sonoran skipper	WEW	Southern edge of range			0	0	0	100	0	100	0	0	0	0	0	N	N	GI	N	N	SI	N	N	N	N	N	N	Inc	Inc	N/A	N	N	U	N	SI-N-SD	U	U	U	U	HV	Mod	A2 (high)
Invert-Insect	*Lycaena xanthoides*	Great copper	WEW	Northern edge of range	G4	SNR	0	0	0	100	0	100	0	0	0	0	0	N	N	GI	N	N	SI	N	N	N	N	N	N	GI	Inc	N/A	N	N	U	N	SI-N-SD	U	U	U	U	EV	Mod	A2 (high)
Invert-Insect	*Phycoides pulchella nr pulchella*	Field crescent	WEW	Center of range	G5TNR		0	0	0	100	0	100	0	0	0	0	0	N	N	GI	N	N	SI	N	N	N	N	N	N	Inc	Inc	N/A	N	N	U	N	SI-N-SD	U	U	U	U	HV	Mod	A2 (high)
Invert-Insect	*Polites sonora siris*	Sonoran skipper	Willamette Valley	Center of range			0	0	0	0	100	0	0.675	75.676	23.649	0	0	N	N	Inc	N	N	SI	N	N	N	N	N	N	Inc	Inc	N/A	N	N	U	N	SI-N-SD	U	U	U	U	MV	Mod	A1B (med)
Invert-Insect	*Lycaena xanthoides*	Great copper	Willamette Valley	Northern edge of range	G4	SNR	0	0	0	0	100	0	0.675	75.676	23.649	0	0	N	N	Inc	N	N	SI	N	N	N	N	N	N	Inc	Inc	N/A	N	N	U	N	SI-N-SD	U	U	U	U	MV	Mod	A1B (med)
Invert-Insect	*Phycoides pulchella nr pulchella*	Field crescent	Willamette Valley	Center of range	G5TNR		0	0	0	0	100	0	0.675	75.676	23.649	0	0	N	N	Inc	N	N	SI	N	N	N	N	N	N	Inc	Inc	N/A	N	N	U	N	SI-N-SD	U	U	U	U	MV	Mod	A1B (med)
Invert-Insect	*Polites sonora siris*	Sonoran skipper	WEW	Southern edge of range			0	0	0	0	100	0	0	0	100	0	0	N	N	GI	N	N	SI	N	N	N	N	N	N	Inc	Inc	N/A	N	N	U	N	SI-N-SD	U	U	U	U	MV	Mod	A1B (med)
Invert-Insect	*Lycaena xanthoides*	Great copper	WEW	Northern edge of range	G4	SNR	0	0	0	0	100	0	0	0	100	0	0	N	N	GI	N	N	SI	N	N	N	N	N	N	GI	Inc	N/A	N	N	U	N	SI-N-SD	U	U	U	U	MV	VH	A1B (med)
Invert-Insect	*Phycoides pulchella nr pulchella*	Field crescent	WEW	Center of range	G5TNR		0	0	0	0	100	0	0	0	100	0	0	N	N	GI	N	N	SI	N	N	N	N	N	N	Inc	Inc	N/A	N	N	U	N	SI-N-SD	U	U	U	U	MV	Mod	A1B (med)
Invert-Insect	*Polites sonora siris*	Sonoran skipper	Willamette Valley	Center of range			0	0	0	0	100	0	0	0	0	0	100	N	N	Inc	N	N	SI	N	N	N	N	N	N	Inc	Inc	N/A	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Invert-Insect	*Lycaena xanthoides*	Great copper	Willamette Valley	Northern edge of range	G4	SNR	0	0	0	0	100	0	0	0	0	0	100	N	N	Inc	N	N	SI	N	N	N	N	N	N	Inc	Inc	N/A	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Invert-Insect	*Phycoides pulchella nr pulchella*	Field crescent	Willamette Valley	Center of range	G5TNR		0	0	0	0	100	0	0	0	0	0	100	N	N	Inc	N	N	SI	N	N	N	N	N	N	Inc	Inc	N/A	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Invert-Insect	*Polites sonora siris*	Sonoran skipper	WEW	Southern edge of range			0	0	0	0	100	0	0	0	0	0	100	N	N	GI	N	N	SI	N	N	N	N	N	N	Inc	Inc	N/A	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Invert-Insect	*Lycaena xanthoides*	Great copper	WEW	Northern edge of range	G4	SNR	0	0	0	0	100	0	0	0	0	0	100	N	N	GI	N	N	SI	N	N	N	N	N	N	GI	Inc	N/A	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Invert-Insect	*Phycoides pulchella nr pulchella*	Field crescent	WEW	Center of range	G5TNR		0	0	0	0	100	0	0	0	0	0	100	N	N	GI	N	N	SI	N	N	N	N	N	N	Inc	Inc	N/A	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)

Core Prairie (blue) and Invasive Species (yellow)

							Temperature Scope					Hamon AET:PET Moisture Metric Scope						Sea level	Natl barriers	Anth barriers	CC mitigation	Dispersal/Movement	historical thermal niche	physiological thermal niche	historical hydrological niche	physiological hydrological niche	Disturbance	Ice/snow	Phys habitat	Other spp for hab	Diet	Pollinators	Other spp disp	Other spp interaction	Genetic var	Gen bottleneck	Phenol response	Doc response	Modeled change	Modeled overlap	Protected Areas			
Taxonomic Grou	Species	English Name	Geographic Area	Range Rel.	GRank	SRank	A >5.5F	A 5.1F	A 4.5F	A 3.9F	A <3.9F	< -0.119	-0.119	-0.096	-0.073	-0.05	>-0.028	B1	B2a	B2b	B3	C1	C2ai	C2aii	C2bi	C2bii	C2c	C2d	C3	C4a	C4b	C4c	C4d	C4e	C5a	C5b	C6	D1	D2	D3	D4	Index	Confidenc	Climate Scenario
Vascular Plant	*Deschampsia caespitosa var. caespitosa*	Tufted hairgrass	Willamette Valley	Center of range	G5		0	0	25.68	74.32	0	100	0	0	0	0	0	N	SI	Inc	N	Inc	Inc	N	N	N	N	N	N	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	HV	Mod	A2 (high)
Vascular Plant	*Festuca roemeri var. roemeri*	Roemer's fescue	Willamette Valley	Center of range	G4G5TNR		0	0	25.68	74.32	0	100	0	0	0	0	0	N	SI	Inc	N	GI	Inc	N	N	N-SD	N	N	N	N	N/A	N	N	N	SD	N/A	SI-N-SD	U	U	U	U	MV	Mod	A2 (high)
Vascular Plant	*Danthonia californica var. americana*	California oatgrass	Willamette Valley	East/west edge of range	G5		0	0	25.68	74.32	0	100	0	0	0	0	0	N	SI	Inc	N	GI	Inc	N	N	N-SD	N	N	SD	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	MV	Mod	A2 (high)
Vascular Plant	*Agrostis exarata var. exarata*	Spike bentgrass	Willamette Valley	Center of range	G5		0	0	25.68	74.32	0	100	0	0	0	0	0	N	SI	Inc	N	Inc	Inc	N	N	N	N	N	N	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	HV	Mod	A2 (high)
Vascular Plant	*Rumex salicifolius var. salicifolius*	Willow dock	Willamette Valley	Northern edge of range	G5TU		0	0	25.68	74.32	0	100	0	0	0	0	0	N	SI	Inc	N	Inc	Inc	N	N	N-SD	N	N	SD	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	MV	Mod	A2 (high)
Vascular Plant	*Ranunculus occidentalis var. occidentalis*	Western buttercup	Willamette Valley	Center of range	G5T5		0	0	25.68	74.32	0	100	0	0	0	0	0	N	SI	Inc	N	GI	Inc	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	N	N/A	SI-N-SD	U	U	U	U	HV	Low	A2 (high)
Vascular Plant	*Plectritis congesta ssp. congesta*	Rosy plectritis	Willamette Valley	Center of range	G5T5?		0	0	25.68	74.32	0	100	0	0	0	0	0	N	SI	Inc	N	GI	Inc	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	HV	Low	A2 (high)
Vascular Plant	*Achillea millefolium*	Yarrow	Willamette Valley	Center of range	G5		0	0	25.68	74.32	0	100	0	0	0	0	0	N	SI	Inc	N	Inc	Inc	N	N	N-SD	N	N	Dec	N	N/A	SI-N	N	N	N	N/A	SI-N-SD	U	U	U	U	MV	Low	A2 (high)
Vascular Plant	*Prunella vulgaris var. lanceolata*	Self-heal	Willamette Valley	Center of range	G5T5		0	0	25.68	74.32	0	100	0	0	0	0	0	N	SI	Inc	N	GI	Inc	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	N	N/A	SI-N-SD	U	U	U	U	HV	Low	A2 (high)
Vascular Plant	*Potentilla gracilis var. gracilis*	Slender cinquefoil	Willamette Valley	Southern edge of range	G5T5		0	0	25.68	74.32	0	100	0	0	0	0	0	N	SI	Inc	N	GI	Inc	N	N	N-SD	N	N	Dec	N	N/A	SI-N	N	N	N	N/A	SI-N-SD	U	U	U	U	MV	Mod	A2 (high)
Vascular Plant	*Madia elegans var. elegans*	Showy tarweed	Willamette Valley	Northern edge of range	GNRTNR		0	0	25.68	74.32	0	100	0	0	0	0	0	N	SI	Inc	N	SI	Inc	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	MV	Mod	A2 (high)
Vascular Plant	*Grindelia integrifolia*	Gumweed	Willamette Valley	Southern edge of range	G5SNR		0	0	25.68	74.32	0	100	0	0	0	0	0	N	SI	Inc	N	Inc	Inc	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	MV	Mod	A2 (high)
Vascular Plant	*Rubus discolor*	Himalayan blackberry	Willamette Valley	Center of range	GNR		0	0	25.68	74.32	0	100	0	0	0	0	0	N	N	N	N	Dec	Inc	N	N	N-SD	N	N	Dec	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	IL	VH	A2 (high)
Vascular Plant	*Centaurea x pratensis*	Meadow knapweed	Willamette Valley	Center of range	GNR		0	0	25.68	74.32	0	100	0	0	0	0	0	N	N	N	N	N	Inc	N	N	N-SD	N	N	Dec	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	PS	Mod	A2 (high)
Vascular Plant	*Agrostis stolonifera*	Creeping bentgrass	Willamette Valley	Center of range	G5		0	0	25.68	74.32	0	100	0	0	0	0	0	N	N	N	N	Inc	Inc	N	N	N-SD	N	N	Dec	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	A2 (high)
Vascular Plant	*Leucanthemum vulgare*	Ox-eye daisy	Willamette Valley	Center of range	GNR		0	0	25.68	74.32	0	100	0	0	0	0	0	N	N	N	N	SI	Inc	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	A2 (high)
Vascular Plant	*Arrhenatherum elatius*	Tall oatgrass	Willamette Valley	Center of range	GNR		0	0	25.68	74.32	0	100	0	0	0	0	0	N	N	N	N	GI	Inc	N	N	N-SD	N	N	N	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	MV	Low	A2 (high)
Vascular Plant	*Deschampsia caespitosa var. caespitosa*	Tufted hairgrass	Willamette Valley	Center of range	G5		0	0	0	0	100	0	0.675	75.676	23.649	0	0	N	SI	Inc	N	Inc	Inc	N	N	N	N	N	N	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	MV	Mod	A1B (med)
Vascular Plant	*Festuca roemeri var. roemeri*	Roemer's fescue	Willamette Valley	Center of range	G4G5TNR		0	0	0	0	100	0	0.675	75.676	23.649	0	0	N	SI	Inc	N	GI	Inc	N	N	N-SD	N	N	N	N	N/A	N	N	N	SD	N/A	SI-N-SD	U	U	U	U	PS	Mod	A1B (med)
Vascular Plant	*Danthonia californica var. americana*	California oatgrass	Willamette Valley	East/west edge of range	G5		0	0	0	0	100	0	0.675	75.676	23.649	0	0	N	SI	Inc	N	GI	Inc	N	N	N-SD	N	N	SD	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	PS	Mod	A1B (med)
Vascular Plant	*Agrostis exarata var. exarata*	Spike bentgrass	Willamette Valley	Center of range	G5		0	0	0	0	100	0	0.675	75.676	23.649	0	0	N	SI	Inc	N	Inc	Inc	N	N	N	N	N	N	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	MV	Mod	A1B (med)
Vascular Plant	*Rumex salicifolius var. salicifolius*	Willow dock	Willamette Valley	Northern edge of range	G5TU		0	0	0	0	100	0	0.675	75.676	23.649	0	0	N	SI	Inc	N	Inc	Inc	N	N	N-SD	N	N	SD	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	MV	Mod	A1B (med)
Vascular Plant	*Ranunculus occidentalis var. occidentalis*	Western buttercup	Willamette Valley	Center of range	G5T5		0	0	0	0	100	0	0.675	75.676	23.649	0	0	N	SI	Inc	N	GI	Inc	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	N	N/A	SI-N-SD	U	U	U	U	MV	Low	A1B (med)
Vascular Plant	*Plectritis congesta ssp. congesta*	Rosy plectritis	Willamette Valley	Center of range	G5T5?		0	0	0	0	100	0	0.675	75.676	23.649	0	0	N	SI	Inc	N	GI	Inc	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	MV	Low	A1B (med)
Vascular Plant	*Achillea millefolium*	Yarrow	Willamette Valley	Center of range	G5		0	0	0	0	100	0	0.675	75.676	23.649	0	0	N	SI	Inc	N	Inc	Inc	N	N	N-SD	N	N	Dec	N	N/A	SI-N	N	N	N	N/A	SI-N-SD	U	U	U	U	PS	VH	A1B (med)
Vascular Plant	*Prunella vulgaris var. lanceolata*	Self-heal	Willamette Valley	Center of range	G5T5		0	0	0	0	100	0	0.675	75.676	23.649	0	0	N	SI	Inc	N	GI	Inc	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	N	N/A	SI-N-SD	U	U	U	U	MV	Low	A1B (med)
Vascular Plant	*Potentilla gracilis var. gracilis*	Slender cinquefoil	Willamette Valley	Southern edge of range	G5T5		0	0	0	0	100	0	0.675	75.676	23.649	0	0	N	SI	Inc	N	GI	Inc	N	N	N-SD	N	N	Dec	N	N/A	SI-N	N	N	N	N/A	SI-N-SD	U	U	U	U	PS	Mod	A1B (med)
Vascular Plant	*Madia elegans var. elegans*	Showy tarweed	Willamette Valley	Northern edge of range	GNRTNR		0	0	0	0	100	0	0.675	75.676	23.649	0	0	N	SI	Inc	N	SI	Inc	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	A1B (med)
Vascular Plant	*Grindelia integrifolia*	Gumweed	Willamette Valley	Southern edge of range	G5TNR		0	0	0	0	100	0	0.675	75.676	23.649	0	0	N	SI	Inc	N	Inc	Inc	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	PS	Mod	A1B (med)
Vascular Plant	*Rubus discolor*	Himalayan blackberry	Willamette Valley	Center of range	GNR		0	0	0	0	100	0	0.675	75.676	23.649	0	0	N	N	N	N	Dec	Inc	N	N	N-SD	N	N	Dec	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	IL	Mod	A1B (med)
Vascular Plant	*Centaurea x pratensis*	Meadow knapweed	Willamette Valley	Center of range	GNR		0	0	0	0	100	0	0.675	75.676	23.649	0	0	N	N	N	N	N	Inc	N	N	N-SD	N	N	Dec	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	A1B (med)
Vascular Plant	*Agrostis stolonifera*	Creeping bentgrass	Willamette Valley	Center of range	G5		0	0	0	0	100	0	0.675	75.676	23.649	0	0	N	N	N	N	Inc	Inc	N	N	N-SD	N	N	Dec	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	A1B (med)
Vascular Plant	*Leucanthemum vulgare*	Ox-eye daisy	Willamette Valley	Center of range	GNR		0	0	0	0	100	0	0.675	75.676	23.649	0	0	N	N	N	N	SI	Inc	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	A1B (med)
Vascular Plant	*Arrhenatherum elatius*	Tall oatgrass	Willamette Valley	Center of range	GNR		0	0	0	0	100	0	0.675	75.676	23.649	0	0	N	N	N	N	GI	Inc	N	N	N-SD	N	N	N	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	A1B (med)
Vascular Plant	*Deschampsia caespitosa var. caespitosa*	Tufted hairgrass	Willamette Valley	Center of range	G5		0	0	0	0	100	0	0	0	0	0	100	N	SI	Inc	N	Inc	Inc	N	N	N	N	N	N	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Festuca roemeri var. roemeri*	Roemer's fescue	Willamette Valley	Center of range	G4G5TNR		0	0	0	0	100	0	0	0	0	0	100	N	SI	Inc	N	GI	Inc	N	N	N-SD	N	N	N	N	N/A	N	N	N	SD	N/A	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Danthonia californica var. americana*	California oatgrass	Willamette Valley	East/west edge of range	G5		0	0	0	0	100	0	0	0	0	0	100	N	SI	Inc	N	GI	Inc	N	N	N-SD	N	N	SD	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Agrostis exarata var. exarata*	Spike bentgrass	Willamette Valley	Center of range	G5		0	0	0	0	100	0	0	0	0	0	100	N	SI	Inc	N	Inc	Inc	N	N	N	N	N	N	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Rumex salicifolius var. salicifolius*	Willow dock	Willamette Valley	Northern edge of range	G5TU		0	0	0	0	100	0	0	0	0	0	100	N	SI	Inc	N	Inc	Inc	N	N	N-SD	N	N	SD	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Ranunculus occidentalis var. occidentalis*	Western buttercup	Willamette Valley	Center of range	G5T5		0	0	0	0	100	0	0	0	0	0	100	N	SI	Inc	N	GI	Inc	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	N	N/A	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Plectritis congesta ssp. congesta*	Rosy plectritis	Willamette Valley	Center of range	G5T5?		0	0	0	0	100	0	0	0	0	0	100	N	SI	Inc	N	GI	Inc	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Achillea millefolium*	Yarrow	Willamette Valley	Center of range	G5		0	0	0	0	100	0	0	0	0	0	100	N	SI	Inc	N	Inc	Inc	N	N	N-SD	N	N	Dec	N	N/A	SI-N	N	N	N	N/A	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Prunella vulgaris var. lanceolata*	Self-heal	Willamette Valley	Center of range	G5T5		0	0	0	0	100	0	0	0	0	0	100	N	SI	Inc	N	GI	Inc	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	N	N/A	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Potentilla gracilis var. gracilis*	Slender cinquefoil	Willamette Valley	Southern edge of range	G5T5		0	0	0	0	100	0	0	0	0	0	100	N	SI	Inc	N	GI	Inc	N	N	N-SD	N	N	Dec	N	N/A	SI-N	N	N	N	N/A	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Madia elegans var. elegans*	Showy tarweed	Willamette Valley	Northern edge of range	GNRTNR		0	0	0	0	100	0	0	0	0	0	100	N	SI	Inc	N	SI	Inc	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Grindelia integrifolia*	Gumweed	Willamette Valley	Southern edge of range	G5TNR		0	0	0	0	100	0	0	0	0	0	100	N	SI	Inc	N	Inc	Inc	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Rubus discolor*	Himalayan blackberry	Willamette Valley	Center of range	GNR		0	0	0	0	100	0	0	0	0	0	100	N	N	N	N	Dec	Inc	N	N	N-SD	N	N	Dec	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Centaurea x pratensis*	Meadow knapweed	Willamette Valley	Center of range	GNR		0	0	0	0	100	0	0	0	0	0	100	N	N	N	N	N	Inc	N	N	N-SD	N	N	Dec	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Agrostis stolonifera*	Creeping bentgrass	Willamette Valley	Center of range	G5		0	0	0	0	100	0	0	0	0	0	100	N	N	N	N	Inc	Inc	N	N	N-SD	N	N	Dec	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Leucanthemum vulgare*	Ox-eye daisy	Willamette Valley	Center of range	GNR		0	0	0	0	100	0	0	0	0	0	100	N	N	N	N	SI	Inc	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Arrhenatherum elatius*	Tall oatgrass	Willamette Valley	Center of range	GNR		0	0	0	0	100	0	0	0	0	0	100	N	N	N	N	GI	Inc	N	N	N-SD	N	N	N	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Deschampsia caespitosa var. caespitosa*	Tufted hairgrass	WEW	Center of range	G5		0	0	0	100	0	100	0	0	0	0	0	N	SI	GI	N	Inc	SI	N	N	N	N	N	N	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	HV	Mod	A2 (high)
Vascular Plant	*Festuca roemeri var. roemeri*	Roemer's fescue	WEW	Center of range	G4G5TNR		0	0	0	100	0	100	0	0	0	0	0	N	N	GI	N	GI	SI	N	N	N-SD	N	N	N	N	N/A	N	N	N	SD	N/A	SI-N-SD	U	U	U	U	MV	Mod	A2 (high)
Vascular Plant	*Danthonia californica var. americana*	California oatgrass	WEW	East/west edge of range	G5		0	0	0	100	0	100	0	0	0	0	0	N	N	GI	N	GI	SI	N	N	N-SD	N	N	SD	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	MV	Mod	A2 (high)
Vascular Plant	*Agrostis exarata var. exarata*	Spike bentgrass	WEW	Center of range	G5		0	0	0	100	0	100	0	0	0	0	0	N	SI	GI	N	Inc	SI	N	N	N	N	N	N	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	HV	Mod	A2 (high)
Vascular Plant	*Rumex salicifolius var. salicifolius*	Willow dock	WEW	Northern edge of range	G5TU		0	0	0	100	0	100	0	0	0	0	0	N	SI	GI	N	Inc	SI	N	N	N-SD	N	N	SD	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	MV	Mod	A2 (high)
Vascular Plant	*Ranunculus occidentalis var. occidentalis*	Western buttercup	WEW	Center of range	G5T5		0	0	0	100	0	100	0	0	0	0	0	N	N	GI	N	GI	SI	N	N	N	N	N	SD	N	N/A	SI-N	N	N	N	N/A	SI-N-SD	U	U	U	U	HV	Low	A2 (high)
Vascular Plant	*Plectritis congesta ssp. congesta*	Rosy plectritis	WEW	Center of range	G5T5?		0	0	0	100	0	100	0	0	0	0	0	N	N	GI	N	GI	SI	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	MV	Low	A2 (high)
Vascular Plant	*Achillea millefolium*	Yarrow	WEW	Center of range	G5		0	0	0	100	0	100	0	0	0	0	0	N	N	GI	N	Inc	SI	N	N	N-SD	N	N	Dec	N	N/A	SI-N	N	N	N	N/A	SI-N-SD	U	U	U	U	PS	Low	A2 (high)
Vascular Plant	*Prunella vulgaris var. lanceolata*	Self-heal	WEW	Center of range	G5T5		0	0	0	100	0	100	0	0	0	0	0	N	N	GI	N	GI	SI	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	N	N/A	SI-N-SD	U	U	U	U	MV	Mod	A2 (high)
Vascular Plant	*Potentilla gracilis var. gracilis*	Slender cinquefoil	WEW	Southern edge of range	G5T5		0	0	0	100	0	100	0	0	0	0	0	N	N	GI	N	GI	SI	N	N	N-SD	N	N	Dec	N	N/A	SI-N	N	N	N	N/A	SI-N-SD	U	U	U	U	MV	Mod	A2 (high)
Vascular Plant	*Madia elegans var. elegans*	Showy tarweed	WEW	Northern edge of range	GNRTNR		0	0	0	100	0	100	0	0	0	0	0	N	N	GI	N	SI	SI	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	PS	Low	A2 (high)
Vascular Plant	*Grindelia integrifolia*	Gumweed	WEW	Southern edge of range	G5TNR		0	0	0	100	0	100	0	0	0	0	0	N	N	GI	N	Inc	SI	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	MV	Mod	A2 (high)
Vascular Plant	*Rubus discolor*	Himalayan blackberry	WEW	Center of range	GNR		0	0	0	100	0	100	0	0	0	0	0	N	N	N	N	Dec	SI	N	N	N-SD	N	N	Dec	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	IL	VH	A2 (high)
Vascular Plant	*Centaurea x pratensis*	Meadow knapweed	WEW	Center of range	GNR		0	0	0	100	0	100	0	0	0	0	0	N	N	N	N	N	SI	N	N	N-SD	N	N	Dec	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	IL	Low	A2 (high)
Vascular Plant	*Agrostis stolonifera*	Creeping bentgrass	WEW	Center of range	G5		0	0	0	100	0	100	0	0	0	0	0	N	N	N	N	Inc	SI	N	N	N-SD	N	N	Dec	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	PS	High	A2 (high)
Vascular Plant	*Leucanthemum vulgare*	Ox-eye daisy	WEW	Center of range	GNR		0	0	0	100	0	100	0	0	0	0	0	N	N	N	N	SI	SI	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	A2 (high)
Vascular Plant	*Arrhenatherum elatius*	Tall oatgrass	WEW	Center of range	GNR		0	0	0	100	0	100	0	0	0	0	0	N	N	N	N	GI	SI	N	N	N-SD	N	N	N	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	PS	Mod	A2 (high)
Vascular Plant	*Deschampsia caespitosa var. caespitosa*	Tufted hairgrass	WEW	Center of range	G5		0	0	0	0	100	0	0	0	100	0	0	N	SI	GI	N	Inc	SI	N	N	N	N	N	N	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	PS	Mod	A1B (med)
Vascular Plant	*Festuca roemeri var. roemeri*	Roemer's fescue	WEW	Center of range	G4G5TNR		0	0	0	0	100	0	0	0	100	0	0	N	N	GI	N	GI	SI	N	N	N-SD	N	N	N	N	N/A	N	N	N	SD	N/A	SI-N-SD	U	U	U	U	PS	VH	A1B (med)
Vascular Plant	*Danthonia californica var. americana*	California oatgrass	WEW	East/west edge of range	G5		0	0	0	0	100	0	0	0	100	0	0	N	N	GI	N	GI	SI	N	N	N-SD	N	N	SD	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	A1B (med)
Vascular Plant	*Agrostis exarata var. exarata*	Spike bentgrass	WEW	Center of range	G5		0	0	0	0	100	0	0	0	100	0	0	N	SI	GI	N	Inc	SI	N	N	N	N	N	N	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	PS	Mod	A1B (med)
Vascular Plant	*Rumex salicifolius var. salicifolius*	Willow dock	WEW	Northern edge of range	G5TU		0	0	0	0	100	0	0	0	100	0	0	N	SI	GI	N	Inc	SI	N	N	N-SD	N	N	SD	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	PS	Mod	A1B (med)
Vascular Plant	*Ranunculus occidentalis var. occidentalis*	Western buttercup	WEW	Center of range	G5T5		0	0	0	0	100	0	0	0	100	0	0	N	N	GI	N	GI	SI	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	N	N/A	SI-N-SD	U	U	U	U	PS	VH	A1B (med)
Vascular Plant	*Plectritis congesta ssp. congesta*	Rosy plectritis	WEW	Center of range	G5T5?		0	0	0	0	100	0	0	0	100	0	0	N	N	GI	N	GI	SI	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	A1B (med)
Vascular Plant	*Achillea millefolium*	Yarrow	WEW	Center of range	G5		0	0	0	0	100	0	0	0	100	0	0	N	N	GI	N	Inc	SI	N	N	N-SD	N	N	Dec	N	N/A	SI-N	N	N	N	N/A	SI-N-SD	U	U	U	U	PS	VH	A1B (med)
Vascular Plant	*Prunella vulgaris var. lanceolata*	Self-heal	WEW	Center of range	G5T5		0	0	0	0	100	0	0	0	100	0	0	N	N	GI	N	GI	SI	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	N	N/A	SI-N-SD	U	U	U	U	PS	VH	A1B (med)
Vascular Plant	*Potentilla gracilis var. gracilis*	Slender cinquefoil	WEW	Southern edge of range	G5T5		0	0	0	0	100	0	0	0	100	0	0	N	N	GI	N	GI	SI	N	N	N-SD	N	N	Dec	N	N/A	SI-N	N	N	N	N/A	SI-N-SD	U	U	U	U	PS	VH	A1B (med)
Vascular Plant	*Madia elegans var. elegans*	Showy tarweed	WEW	Northern edge of range	GNRTNR		0	0	0	0	100	0	0	0	100	0	0	N	N	GI	N	SI	SI	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	A1B (med)
Vascular Plant	*Grindelia integrifolia*	Gumweed	WEW	Southern edge of range	GNRTNR		0	0	0	0	100	0	0	0	100	0	0	N	N	GI	N	Inc	SI	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	A1B (med)
Vascular Plant	*Rubus discolor*	Himalayan blackberry	WEW	Center of range	GNR		0	0	0	0	100	0	0	0	100	0	0	N	N	N	N	Dec	SI	N	N	N-SD	N	N	Dec	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	IL	Mod	A1B (med)
Vascular Plant	*Centaurea x pratensis*	Meadow knapweed	WEW	Center of range	GNR		0	0	0	0	100	0	0	0	100	0	0	N	N	N	N	N	SI	N	N	N-SD	N	N	Dec	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	A1B (med)
Vascular Plant	*Agrostis stolonifera*	Creeping bentgrass	WEW	Center of range	G5		0	0	0	0	100	0	0	0	100	0	0	N	N	N	N	Inc	SI	N	N	N-SD	N	N	Dec	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	A1B (med)
Vascular Plant	*Leucanthemum vulgare*	Ox-eye daisy	WEW	Center of range	GNR		0	0	0	0	100	0	0	0	100	0	0	N	N	N	N	SI	SI	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	A1B (med)
Vascular Plant	*Arrhenatherum elatius*	Tall oatgrass	WEW	Center of range	GNR		0	0	0	0	100	0	0	0	100	0	0	N	N	N	N	GI	SI	N	N	N-SD	N	N	N	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	A1B (med)
Vascular Plant	*Deschampsia caespitosa var. caespitosa*	Tufted hairgrass	WEW	Center of range	G5		0	0	0	0	100	0	0	0	0	0	100	N	SI	GI	N	Inc	SI	N	N	N	N	N	N	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Festuca roemeri var. roemeri*	Roemer's fescue	WEW	Center of range	G4G5TNR		0	0	0	0	100	0	0	0	0	0	100	N	N	GI	N	GI	SI	N	N	N-SD	N	N	N	N	N/A	N	N	N	SD	N/A	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Danthonia californica var. americana*	California oatgrass	WEW	East/west edge of range	G5		0	0	0	0	100	0	0	0	0	0	100	N	N	GI	N	GI	SI	N	N	N-SD	N	N	SD	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Agrostis exarata var. exarata*	Spike bentgrass	WEW	Center of range	G5		0	0	0	0	100	0	0	0	0	0	100	N	SI	GI	N	Inc	SI	N	N	N	N	N	N	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Rumex salicifolius var. salicifolius*	Willow dock	WEW	Northern edge of range	G5TU		0	0	0	0	100	0	0	0	0	0	100	N	SI	GI	N	Inc	SI	N	N	N-SD	N	N	SD	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Ranunculus occidentalis var. occidentalis*	Western buttercup	WEW	Center of range	G5T5		0	0	0	0	100	0	0	0	0	0	100	N	N	GI	N	GI	SI	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	N	N/A	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Plectritis congesta ssp. congesta*	Rosy plectritis	WEW	Center of range	G5T5?		0	0	0	0	100	0	0	0	0	0	100	N	N	GI	N	GI	SI	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Achillea millefolium*	Yarrow	WEW	Center of range	G5		0	0	0	0	100	0	0	0	0	0	100	N	N	GI	N	Inc	SI	N	N	N-SD	N	N	Dec	N	N/A	SI-N	N	N	N	N/A	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Prunella vulgaris var. lanceolata*	Self-heal	WEW	Center of range	G5T5		0	0	0	0	100	0	0	0	0	0	100	N	N	GI	N	GI	SI	N	N	N-SD	N	N	SD	N	N/A	N	N	N	N	N/A	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Potentilla gracilis var. gracilis*	Slender cinquefoil	WEW	Southern edge of range	G5T5		0	0	0	0	100	0	0	0	0	0	100	N	N	GI	N	GI	SI	N	N	N-SD	N	N	Dec	N	N/A	SI-N	N	N	N	N/A	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Madia elegans var. elegans*	Showy tarweed	WEW	Northern edge of range	GNRTNR		0	0	0	0	100	0	0	0	0	0	100	N	N	GI	N	SI	SI	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Grindelia integrifolia*	Gumweed	WEW	Southern edge of range	G5TNR		0	0	0	0	100	0	0	0	0	0	100	N	N	GI	N	Inc	SI	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Rubus discolor*	Himalayan blackberry	WEW	Center of range	GNR		0	0	0	0	100	0	0	0	0	0	100	N	N	N	N	Dec	SI	N	N	N-SD	N	N	Dec	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Centaurea x pratensis*	Meadow knapweed	WEW	Center of range	GNR		0	0	0	0	100	0	0	0	0	0	100	N	N	N	N	N	SI	N	N	N-SD	N	N	Dec	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Agrostis stolonifera*	Creeping bentgrass	WEW	Center of range	G5		0	0	0	0	100	0	0	0	0	0	100	N	N	N	N	Inc	SI	N	N	N-SD	N	N	Dec	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Leucanthemum vulgare*	Ox-eye daisy	WEW	Center of range	GNR		0	0	0	0	100	0	0	0	0	0	100	N	N	N	N	SI	SI	N	N	N-SD	N	N	SD	N	N/A	SI-N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)
Vascular Plant	*Arrhenatherum elatius*	Tall oatgrass	WEW	Center of range	GNR		0	0	0	0	100	0	0	0	0	0	100	N	N	N	N	GI	SI	N	N	N-SD	N	N	N	N	N/A	N	N	N	U	N	SI-N-SD	U	U	U	U	PS	VH	B1 (low)