Summary of 2008-2013 Monitoring for Pumice Grapefern, *Botrychium pumicola* in the BPA Power Line Corridor

Deschutes National Forest
Crescent Ranger District

Photo courtesy of Keir Morse

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Abstract

Five annual censuses for the rare endemic pumice grapefern, *Botrychium pumicola*, were conducted between 2008 and 2013 at sites in the Bonneville Power Authority (BPA) power line corridor of the Crescent Ranger District, Deschutes National Forest. This population occurs in a montane frost pocket habitat whose open character is further maintained by periodic mowing in the corridor. Data collected with plant counts provided information to further characterize this population in terms of form, habitat and herbivory. Plant counts increased after relatively low numbers in 2008, ranging from 423 to 2820 total plants for eight sites surveyed over that time period, and a high of 2900 plants in 2013 when an additional site was included. The lowest count was in 2008 (423 plants) with counts for all other years above1850. Average proportion of plants with herbivory ranged from approximately 2-16%, with the lowest herbivory rate in 2013. Incidence of multi-stem clusters (i.e., multiple plants originating from the same hole) ranged from approximately 14-16% of plants counted, and was more consistent among sites than herbivory rates. Habitat data indicated that more than 90% of plants grew either in open conditions or mixed with other vegetation, with approximately 70% of all plants growing mixed with other species. Very few plants grew under shrub canopy. The numbers reported here indicate that the overall population of *B. pumicola* in the power line corridor is likely steady, if not increasing. This contrasts with observations of other frost pocket populations of *B. pumicola* on Deschutes National Forest, which appear to be declining. From a management perspective, these data suggest that the periodic mowing to maintain open habitat within the power line corridor appears beneficial to maintaining the resident grapefern population.

Introduction

Botrychium pumicola, the pumice grapefern, is a small but attractive fern easily overlooked by the casual observer. Its stout, fleshy, pinnately-compound leaves emerge to a height of 2-8cm from perennial roots that penetrate the substrate up to 10cm. The roots possess a mycorrhizal (i.e., fungal) association that is essential for plant survival (Johnson-Groh et al. 2002). Each plant is composed of a trophophore, or fern-like leaf blade, and may produce a sporophore, or spore-bearing leaf blade. Spore cases crowd the sporophore margins like clusters of grapes, inspiring this species common name. The grayish-green leaves typically emerge soon after snow melt and wither to yellowish brown as summer progresses and the spores mature. Individual plants may lay dormant up to 3 years before re-emerging, with some anecdotal observations of emergence correlated with heavy rainfall (Powers 2011). The *B. pumicola* life cycle from spore to mature, spore-bearing plant may encompass 5-8 years, with most of that occurring below ground. (Johnson-Groh et al. 2002).

Botrychium pumicola is an endemic species rare in its limited range. It occurs in fragmented distributions on pumice soils in the Cascade region of central and southern Oregon, as well as Mt. Shasta area in northern California. Approximately 2/3 of the known *B. pumicola* population exists on Deschutes National Forest, and other nearby populations include locations in the Winema National Forest, the Prineville District of the Bureau of Land Management, and Crater Lake National Park (Powers 2011). *B. pumicola* is listed as a Threatened by the State of Oregon and Sensitive on the U.S Forest Service Region 6 Sensitive Species List and Bureau of Land Management Special Status Plant List (ISSSSP, 2010). It is also on the Oregon Natural Heritage Program's (2004) List 1: "taxa which are endangered or threatened throughout their range or which are presumed extinct." Total population estimates for *B. pumicola* range conservatively from 26,880

(Powers 2011) to 27,560 plants (Raven 2008), with the population in Deschutes National Forest estimated at 16,360 plants (Powers 2011).

There are two main habitat types for *Botrychium pumicola*: rocky summit slopes of alpine ridges and open frost pockets within montane lodgepole pine (*Pinus contorta*) (Powers 2011). Both types are characterized by coarse, dry, sometimes rocky soils and sparse vegetation with that lacks trees and large shrubs. *B. pumicola* alpine habitats are open ridgelines or gentle, convex slopes above 7,200 feet elevation. Montane frost pocket sites are openings in lodgepole pine forests resulting from topographic variables that affect frequency and severity of freezing temperatures. These frost pockets are gently sloping basins or other low-lying areas that experience lower temperatures relative to surrounding areas, due to cold air drainage. The lower temperatures cause frequent frost-heaving of the loose pumice soils, which then suppresses the establishment of trees and large shrubs (Powers 2011).

The population that is the topic of this report occurs in a montane frost pocket habitat at 4400-4550 feet along the BPA (Bonneville Power Authority) power line corridor in the Crescent Ranger District of Deschutes National Forest. Annual censuses of this population have occurred since 2008. Although portions of the corridor are naturally-occurring frost pockets, its open nature is also maintained by periodic mowing, approximately every three years. No herbicides are used to remove tree and shrub canopy within the corridor. An OHV road borders the BPA power line corridor, and disturbance from off-road driving through habitat and at least one population has been observed intermittently since 2011 (Figure 1). While the disturbance ecology of *Botrychium pumicola* is poorly understood, one study found that the species tolerates clipping and shading well, does not tolerate plant burial, and can recover from mild soil scraping and compaction (Amsberry and Meinke 2003). From many anecdotal observations, Powers (2011) asserts that disturbance does not favor *B. pumicola,* but that populations can recover from mild site disturbance if it is not recurring and does not displace the soil horizons. In any case, frequent monitoring of populations in disturbed areas such as the BPA power line is of particular importance for informing management promptly of any decline. The purpose of this report is to summarize 2008-2013 monitoring data for the BPA power line *B. pumicola*, to better describe this population, any apparent population trends and possible relationships between population numbers and weather variables such as precipitation and temperature.

Figure 1. Tire tracks through *Botrychium pumicola* population in the BPA power line corridor. Photo taken in July, 2013.

Methods

Sites and Surveys

District botanist Christina Veverka selected *Botrychium pumicola* monitoring sites based on her knowledge of the species' location in the BPA (Bonneville Power Authority) power line corridor of the Crescent Ranger District. Numbered power poles roughly delineate each site, with the areas for focused searches more precisely located by GPS and hand-drawn maps. Search area varied among sites, based on the extent of area known to have *B. pumicola* plants (from initial searches in 1999), generally approximately 0.25 to 0.5 acre. Nine sites contain the known *B. pumicola* population in the BPA power line corridor, with each site given a three-digit ID number.

Field staff conducted population counts for emerged *Botrychium pumicola* plants annually from 2008-2013, except for 2009. Thus, data presented here represent five years of population censuses. The district botanist chose survey dates to maximize the chance of encountering fully-emerged plants, before their senescence (late June- early July, with the exception of 2008 data collected 3rd week of July). Field staff conducted thorough searches for *B. pumicola* at each site and marked individual plants with pin flags as they were located (Figure 2). Once all plants were flagged, staff counted each trophophore as an individual plant. Beginning in 2010, census data included a habitat descriptor for each plant ("Open," "Veg," or "Canopy"), how many plants had signs of herbivory (small nips removed from fronds) and how many incidents of "multi-plant clusters," with multiple trophophores emerging from one hole (Figure 2). For 2008 and 2010 surveys, staff also recorded the common vascular and non-vascular plants present at each

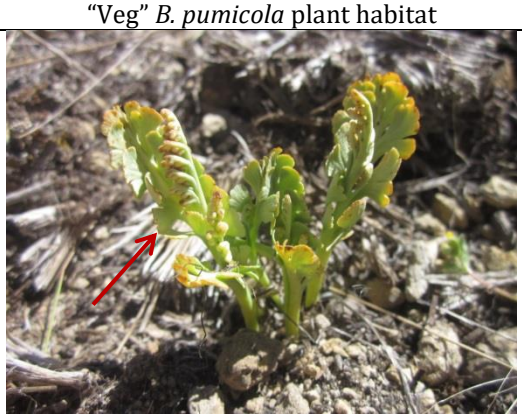
site, which could then be used as coarse frequency data to characterize the vegetation associations of the BPA power line *B. pumicola* population.

Botrychium pumicola plants marked by pin flags

"Open" *B. pumicola* plant habitat

"Veg" *B. pumicola* plant habitat

"Canopy" *B. pumicola* plant habitat.



B. pumicola with herbivory (marked by red arrow)

"Multi" *B. pumicola* (multiple-stems from one origin)

Figure 2. Illustrations of *Botrychium pumicola* census protocol for the BPA power line corridor.

Weather data

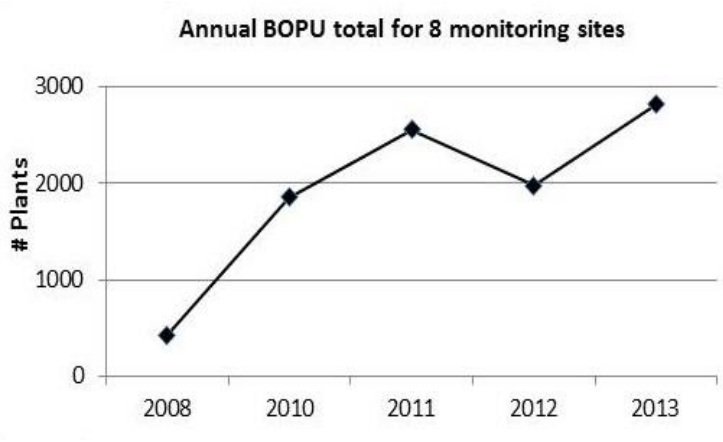
NOAA's climate data online search tool (http://www.ncdc.noaa.gov/cdo-web/search) provided weather data from the station located just north of Chemult, OR (latitude 43.2, longitude -121.8, elevation 4760 ft). Monthly averages for precipitation and max/min temperatures as well as monthly maximum snow depth were available for 2007-2013. These were compared with annual *Botrychium pumicola* population counts, to see if there might be any obvious relationships between these variables.

Results

Population data

Total counts for *Botrychium pumicola* (BOPU) plants from all sites monitored in 2008-2013 ranged from 423 to 2820 (Figure 3). Including an additional site (507), which had missing data for 2008, brings total population count for the BPA power line corridor to a height of 2900 in 2013. (See Appendix A for field data from all sites.) All sites had their lowest counts in 2008 and their highest in 2011 and 2013, with 2013 being slightly higher for most sites.

Populations between sites varied widely, but were generally consistent in their ranking (high to low). For instance, sites 510, 514 and 517 consistently had populations below 100 plants whereas 513 and 515 generally had populations above 500 plants (except in 2008, which had low populations for all sites).



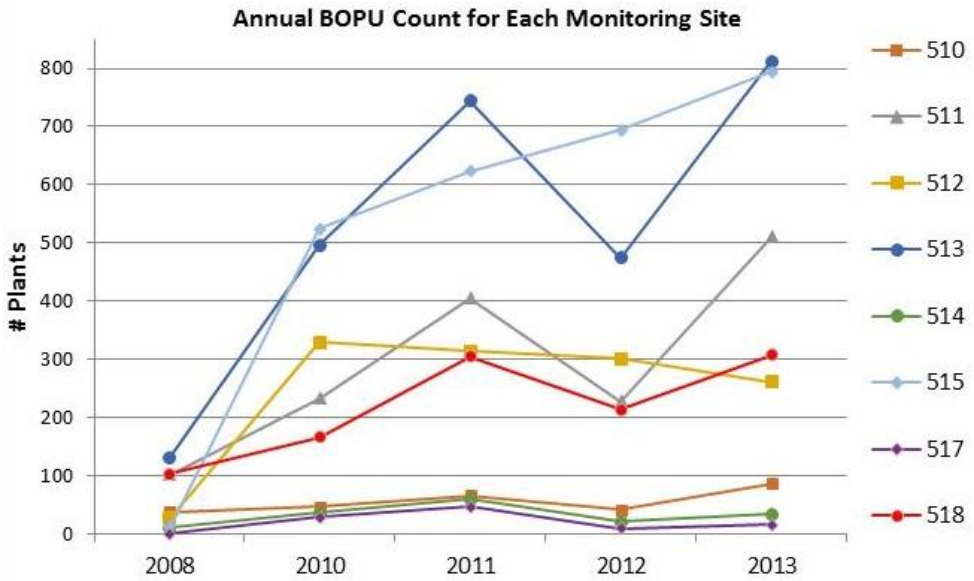


Figure 3.Total *Botrychium pumicola* plants counted each year (top graph) and for each site (bottom graph).

Percent of plants with herbivory ranged from approximately 2% to 16% among years of data collection, with lowest values observed in 2013 and highest values observed in 2010 (Table 1). Herbivory varied widely among sites, however, as indicated by standard deviation values approaching or exceeding the mean. A couple sites in 2012 and 2010 had herbivory ranging from 30-42% (see Appendix A), but most maximum site values were well below 20% herbivory frequency. Percent of plants growing in a multi-plant cluster was more consistent among years and among sites.

Table 1. Average percent of plants per site with signs of herbivory and average percent of multi-plant clusters per site (N=8).

Year	Plants with Herbivory Mean (StDev) %	"Multi" cluster observations* Mean (StDev) %
2008	Not available	Not available
2010	15.7% (10.7)	Not available
2011	7.8% (5.2)	13.5% (6.3)
2012	11.7% (13.6)	15.2% (8.4)
2013	2.2% (2.3)	15.8% (5.0)
*Calculated for each site by dividing number of "multi" observations by total number of plants.		

Habitat data show the vast majority of *Botrychium pumicola* plants (>90% for most sites) in the BPA power line population growing in either "open" conditions or closely associated with other plants ("veg"). Among

all sites, nearly twice the proportion of plants grew closely with other plants ("veg") compared to open conditions (Figure 4). Few *B. pumicola* plants occurred under shrub canopy.

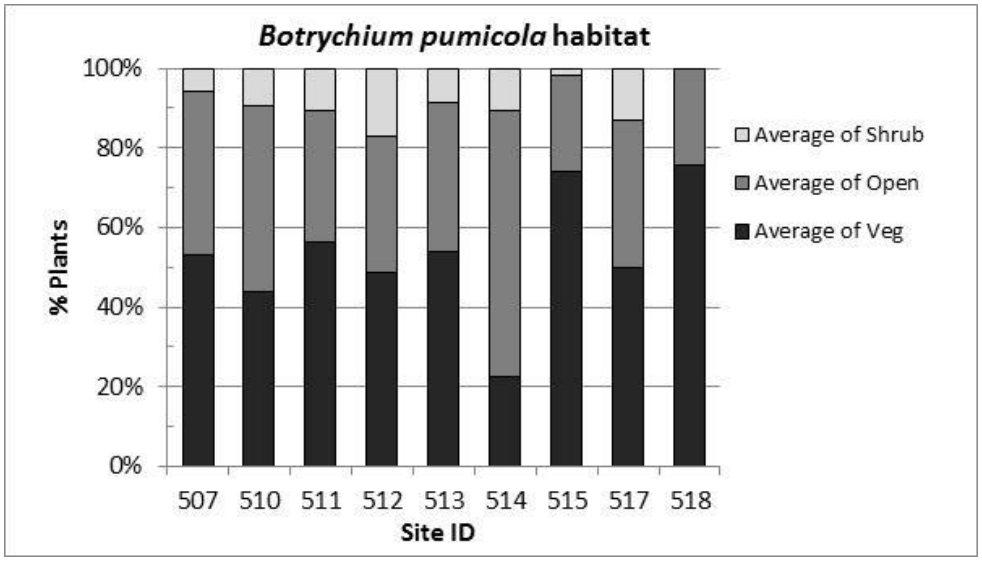


Figure 4. Proportion of plants at each site in three habitat categories. Each bar represents an average of 2010-2013 data for each site.

There was a high number of species consistently recorded at *Botrychium pumicola* sites, as evidenced by the fact that no species was had a total recording occurrence greater than 7% (Table 2). Most sites had at least 20 species recorded. The most consistently-recorded species were *Pinus contorta* (Lodgepole pine) and *Purshia tridentata* (Bitterbrush). Several graminoid (grass or sedge) species were also consistently-recorded among sites, including *Achnatherum occidentale* (Western needlegrass), *Carex rossii* (Ross's sedge), and *Elymus elymoides* (Bottlebrush squirreltail). Appendix B contains a complete list of the 37 species recorded among all sites and their relative occurrence on datasheet records.

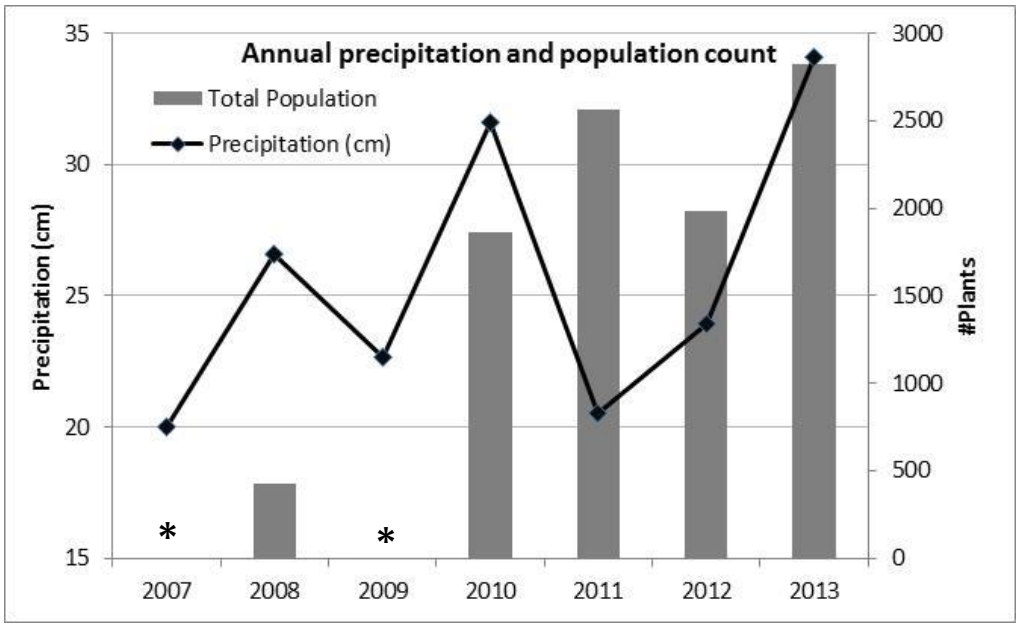
Table 2. Common plant species present among sites, from 2010 data. "%Recorded" is a coarse frequency approximation calculated as the number of times each species was recorded (for all sites) divided by the total number of species records.

Life form	Species	Common name	% Recorded
Tree	*Pinus contorta*	Lodgepole pine	6.7%
Shrub	*Purshia tridentata*	Bitterbrush	6.7%
Graminoid	*Achnatherum occidentale*	Western needlegrass	5.9%
Graminoid	*Carex rossii*	Ross's sedge	5.9%
Graminoid	*Elymus elymoides*	Bottlebrush squirreltail	5.2%
Moss	*Bryum sp.*	Bryum moss	4.4%
Forb	*Collinsia parviflora*	Blue-eyed Mary	4.4%
Moss	*Grimmia sp.*	Rock moss	4.4%
Forb	*Viola purpurea*	Goosefoot violet	4.4%
Forb	*Antennaria rosea*	Rosy pussytoes	3.7%
Forb	*Cirsium scariosum*	Elk thistle	3.7%

Forb	*Madia minima*	Small-head tarweed	3.7%
Forb	*Achillea millefolium*	Yarrow	3.0%
Forb	*Arabis holboellii*	Flatseed rockcress	3.0%
Forb	*Eriogonum nudum*	Barestem buckwheat	3.0%
Graminoid	*Festuca idahoensis*	Idaho Fescue	3.0%
Forb	*Phacelia hastata*	White-leaf phacelia	3.0%
		All other species	**25.9%**

Weather data

Examination of snow and temperature data did not reveal obvious differences among years, but precipitation data will be presented here for illustration and coarse interpretation. Annual precipitation (Jan-Dec) varied between approximately 20 cm and 34.1 cm for the years 2007-2013. For the months immediately preceding *Botrychium pumicola* emergence (May-June), 2009 had the highest precipitation values, although May of 2008 and 2013 were also high (Figure 5).



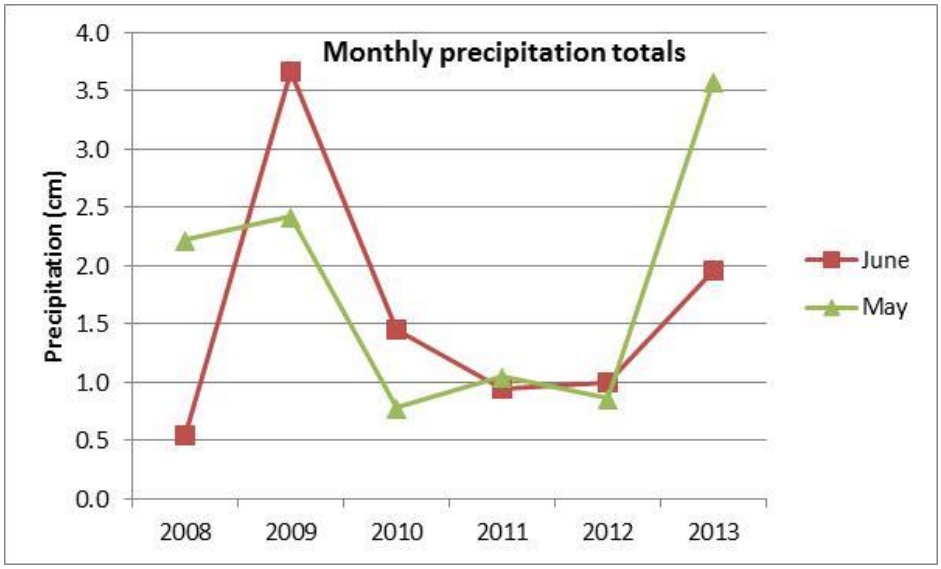


**Figure 5. Total precipitation by calendar year, vs. population (top graph) and precipitation for two months preceding *Botrychium pumicola* emergence (bottom graph). ***Note: Zero values for population in 2007 and 2009 are missing data; no surveys occurred during those years.

Discussion

Monitoring data collected 2008-2013 in the BPA power line corridor contributes valuable information to characterize and quantify this montane frost pocket population of *Botrychium pumicola*. Habitat data collected during population censuses show that approximately twice as many plants grow closely associated with other herbs as in the open, suggesting that competition with herbaceous species is not a detriment to *B. pumicola*. This further describes the unique frost pocket habitat of *B. pumicola* and contradicts one theory for the occurrence of pumice grapefern on alpine ridges—that competition from other plants is lower in these sparse communities and thus favors *B. pumicola* (C. Veverka, personal communication). Monitoring data found few grapeferns growing in the shade of shrub canopies, but this could be due in part to the relative lack of shrubs at each site. Periodic mowing of the BPA power line corridor prevents the establishment of large shrubs and conifers and helps maintain *B. pumicola* habitat, as well as appearing to favor the success of native bunchgrasses (C. Veverka, personal communication).

There was high variability among years and between plots for proportion of grapefern exhibiting herbivory. However, with the exception of a couple individual site values above 30%, most herbivory was well below 20% frequency of occurrence, and the severity of herbivory was usually only the removal of leaf tips, probably from small mammal activity (C. Veverka, personal communication). The clipping treatments in Amsberry and Menke (2003) show that such minor herbivory is not a likely stressor for *B. pumicola*.

Annual censuses of *Botrychium pumicola* for the nine sites in the BPA power line corridor suggest a population increase since monitoring began in 2008, since plant counts in 2010-2013 were 4 to 6 times higher than 2008 counts. Preliminary examination of weather data did not suggest obvious reasons for this dramatic increase, although 2010 precipitation was higher than other monitoring years, and the months immediately preceding plant emergence (May and June) were higher in 2009 and 2013 than other years. It is possible that higher precipitation had a lasting effect on plant emergence for 2010-2013 surveys, with a more dramatic effect depending on the timing of precipitation (i.e., in the two months prior to emergence). Drought is known to have a significant suppressive effect on emergence for other *Botrychium* species (Muller 1992), and Powers (2011) reports observations of increased *B. pumicola* emergence following heavy spring rainfall. However there are several factors related to the BPA power line censuses and the characteristics of *B. pumicola* that increase uncertainty in describing any real population trends and their possible causes from these data.

First, the data reported here are not exact population counts, since only emerged plants can be censused. Because *Botrychium pumicola* can lie dormant for several years, the number of plants emerging in any given year can vary widely and thus complicate assessment of actual population numbers (Raven 2008). Widely fluctuating *Botrychium* emergence from year to year is reported for *B. pumicola* (Amsberry and Meinke 2003) as well as other *Botrychium* species (Montgomery 1990, Muller 1992, 1993, Johnson-Groh and Farrar 1993, Lesica and Ahlenslager 1996). It may be that 2008 was not a "good" year for plant emergence at the BPA power line sites, so the low 2008 counts could simply reflect a higher dormancy rate that year.

Second, detection difficulty can have a serious effect on the accuracy of *Botrychium pumicola* counts. Staff conducted complete censuses at each site, which has the advantage of not needing statistical analyses to detect trend but disadvantages when survey area is large and plants are difficult to detect. *B. pumicola* plants are easily overlooked due to their size, and can easily blend in with other vegetation- a particular

problem at sites such as 515 and 518 where a high proportion of plants (i.e., >70%, from habitat data) grow closely with other species. *B. pumicola* becomes even harder to detect as it withers and yellows with the summer heat, so it is essential that surveys occur in the window between maximum plant emergence and senescence. This may have been an issue in the 2008 surveys that occurred 2-4 weeks later than other survey years. It is possible that low plant counts in 2008 resulted from plants going undetected after they had withered. It is also likely that staff developed a better search image for *B. pumicola* after the 2008 surveys, and this may have led to higher numbers of plants detected in 2010-2013 (C. Veverka, personal communication In any case, many more years of monitoring data are needed to accurately detect trends and investigate correlating variables to help identify influences on *B. pumicola* populations.

Despite uncertainties in obtaining precise plant counts for the BPA power line *Botrychium pumicola* population, it is encouraging that censuses for the past several years suggest at least steady, if not definitely increasing, numbers. Population size reported here underscore the importance of the BPA power line population in the context of other nearby populations, since it comprises as much as 17% of the known *B. pumicola* population for Deschutes National Forest. This proportion may be even higher now, since recent field checks of several formerly large *B. pumicola* populations in Katati Basin (Deschutes NF) found very few emerged plants (C. Powers, personal communication). Katati Basin populations were discovered and censused in 1990 prior to a salvage logging operation for beetle-killed lodgepole pine, with some sites having 600-1500 plants (Powers, personal communication). Censuses before and after a second Katati Basin operation in 2000 showed the populations had held steady or increased. The second operation was necessary to remove dead trees (from the 1990 no-logging buffer zone) that had fallen into the *B. pumicola* population, increasing fire danger and the chance for killing plants from superheated soil (Powers 2011). In the last 10 years however, lodgepole pine and large shrubs have grown into the Katati Basin sites, until most areas are now covered with bitterbrush and trees 15-ft tall (Powers, personal communication).

The apparent *Botrychium pumicola* decline in Katati Basin is likely the result of disappearing frost pocket habitat; historic aerial photos show a much greater extent to the natural frost pockets than now exists (C. Powers, personal communication). In contrast to Katati Basin frost pockets, the BPA power line corridor is kept open by periodic mowing, thus maintaining *B. pumicola* habitat. And in contrast to Katati populations, the BPA power line grapefern population appears to be steady or even increasing. The implications of these observations suggest that active management may be necessary to remove lodgepole pine and maintain the open habitat of frost pocket sites. Such management on US Forest Service lands could be achieved through stewardship projects, commercial timber sales or fuel reduction projects. In any case, Annual monitoring will continue for the BPA power line *B. pumicola* population, and monitoring of other known frost pocket populations in the Crescent Ranger District is needed. Continued monitoring is an essential step in determining population trends and informing the conservation management of this rare endemic species.

Monthly precipitation totals were examined for values that might obviously contribute to differences between the 2008 counts and other years. Total annual precipitation was highest in 2010, and pre-emergence precipitation (i.e., May-June totals) was much higher in 2009 than other years. Censuses did not occur in 2009 so it is not known whether these precipitation values may have caused a higher emergence rate in 2009 that lingered into subsequent years. Other factors that may contribute to differences in population counts are discussed, including the variable, ephemeral nature of *B. pumicola* emergence and difficulties in plant detection. Survey timing may have caused detection difficulties that contributed to lower numbers found in 2008, since the surveys occurred several weeks later than other years. Observer

bias may have caused higher numbers found in later years, since staff were experienced and likely had a better search image for the plant. Despite these factors, the numbers reported here indicate that the overall population of *B. pumicola* in the power line corridor is likely steady, if not increasing. This contrasts with observations of other frost pocket populations of *B. pumicola* on Deschutes National Forest, which appear to be declining. From a management perspective, these data suggest that the periodic mowing to maintain open habitat within the power line corridor appears beneficial to maintaining the resident grapefern population. Annual monitoring for this population of *B. pumicola* will continue, and is particularly important given the size of this population and the observed decline of other frost pocket populations and habitat.

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Appendices

Appendix A. Population field data for *Botrychium pumicola* monitoring sites.

Note: "NR"= Not recorded

		#Plants					
Site ID	Survey Date	Total	Veg	Open	Shrub	Herbivory	Multi
507	7/10/2013	84	56	25	3	0	9
510	6/20/2013	86	32	52	2	2	12
511	7/8/2013	510	351	148	11	7	77
512	7/8/2013	261	147	113	1	6	45
513	6/25/2013	812	475	288	49	45	113
514	6/20/2013	34	5	25	4	2	6
515	7/10/2013	794	621	168	5	3	189
517	7/10/2013	16	10	6	0	0	3
518	7/8/2013	307	260	47	0	0	19
507	6/28/2012	63	33	28	2	1	10
510	6/28/2012	41	30	11	0	7	4
511	7/9/2012	228	153	40	35	7	28
512	6/28/2012	301	218	79	4	10	42
513	7/3/2012	475	270	191	14	25	64
514	6/28/2012	21	3	18	0	9	7
515	7/9/2012	694	560	120	14	8	144
517	6/28/2012	9	5	3	1	1	1
518	6/28/2012	213	174	39	0	21	14
507	6/27/2011	77	37	40	0	3	7
510	6/27/2011	66	27	35	4	6	7
511	6/27/2011	405	209	152	44	17	56
512	6/29/2011	314	135	116	63	18	36
513	6/29/2011	744	410	273	61	46	89
514	6/29/2011	59	19	38	2	9	15
515	7/11/2011	623	442	175	6	24	124
517	6/29/2011	46	21	13	12	1	4
518	6/28/2011	305	215	87	3	49	19
507	6/9/2010	80	35	32	13	3	NR
510	6/9/2010	46	16	14	16	8	NR
511	6/9/2010	233	61	116	56	21	NR
512	6/10/2010	329	89	101	139	75	41
513	6/10/2010	496	206	192	98	89	57
514	6/14/2010	36	7	19	10	1	6
515	6/14/2010	525	328	172	25	44	99
517	6/15/2010	29	14	15	0	3	4
518	6/15/2010	166	100	66	0	61	8
510	7/24/2008	37	NR	NR	NR	NR	NR
511	7/24/2008	102	NR	NR	NR	NR	NR
512	7/24/2008	27	NR	NR	NR	NR	NR
513	7/22/2008	131	NR	NR	NR	NR	NR
514	7/22/2008	11	NR	NR	NR	NR	NR
515	7/22/2008	12	NR	NR	NR	NR	NR
517	7/22/2008	0	NR	NR	NR	NR	NR
518	7/22/2008	103	NR	NR	NR	NR	NR

Appendix B. Species Recorded at Monitoring Sites by Order of Frequency

"%Recorded" is a coarse frequency approximation calculated as the number of times each species was recorded (for all sites) divided by the total number of species occurrences in the records.

Life Form	Species	Common Name	% Recorded
Tree	*Pinus contorta*	Lodgepole pine	6.7%
Shrub	*Purshia tridentata*	Bitterbrush	6.7%
Graminoid	*Achnatherum occidentale*	Western needlegrass	5.9%
Graminoid	*Carex rossii*	Ross's sedge	5.9%
Graminoid	*Elymus elymoides*	Bottlebrush squirreltail	5.2%
Moss	*Bryum sp.*	Bryum moss	4.4%
Forb	*Collinsia parviflora*	Blue-eyed Mary	4.4%
Moss	*Grimmia sp.*	Rock moss	4.4%
Forb	*Viola purpurea*	Goosefoot violoet	4.4%
Forb	*Antennaria rosea*	Rosy pussytoes	3.7%
Forb	*Cirsium scariosum*	Elk thistle	3.7%
Forb	*Madia minima*	Small-head tarweed	3.7%
Forb	*Achillea millefolium*	Yarrow	3.0%
Forb	*Arabis holboellii*	Flatseed rockcress	3.0%
Forb	*Eriogonum nudum*	Barestem buckwheat	3.0%
Graminoid	*Festuca idahoensis*	Idaho Fescue	3.0%
Forb	*Phacelia hastata*	White-leaf phacelia	3.0%
Forb	*Antennaria sp.*	Pussytoes	2.2%
Forb	*Lupinus lepidus*	Prairie lupine	2.2%
Forb	*Penstemon cinicola*	Ash penstemon	2.2%
Tree	*Pinus ponderosa*	Ponderosa pine	2.2%
Shrub	*Ribes cereum*	Wax current	2.2%
Lichen	*Cladonia sp.*	Cup lichen	1.5%
Forb	*Fragaria virginiana*	Broadpetal strawberry	1.5%
Forb	*Horkelia fusca*	Horkelia	1.5%
Moss	*Polytrichum sp.*	Polytrichum moss	1.5%
Forb	*Verbascum thapsus*	Mullein	1.5%
Graminoid	*Agrostis sp.*	Bentgrass	0.7%
Shrub	*Arctostaphylos patula*	Greenleaf manzanita	0.7%
Graminoid	*Bromus cariniatus*	California brome	0.7%
Forb	*Collomia linearis*	Narrow-leaf collomia	0.7%
Forb	*Eriophyllum lanatum*	Oregon sunshine	0.7%
Forb	*Leucocrinum montanum*	Star lily	0.7%
Forb	*Microsteris gracilis*	Pink microsteris	0.7%
Lichen	*Peltigera sp.*	Felt lichen	0.7%
Graminoid	*Poa pratensis*	Kentucky bluegrass	0.7%
Moss	*Polytrichum juniperinum*	Juniper polytrichum	0.7%