

# ISSSSP Final Report – *Botrychium pumicola* Population Monitoring on the Deschutes National Forest, Oregon

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This final report represents the second year of two years of *Botrychium pumicola* (BOPU2) historic site visits funded by the ISSSSP program to assess population and habitat conditions, in light of the observed decline in montane site population numbers of this species on the Deschutes and Fremont-Winema National Forests. An interim report was submitted in November 2017 documenting the first year of findings. For this final report, the Deschutes and Fremont-Winema are submitting their results separately.

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## SUMMARY

In both years we found a mixed set of results from our visits in terms of population counts. Overall, counts are mostly lower in non-powerline sites than they were in the 1990's, but not in all cases (Table 1). It appears that overall the BOPU2 occurring in the Newberry Pumice Plume area is faring better than those sites within the Mazama Airfall area (Figure 1). Whether this is a consequential observation is unclear.

What was very clear, however, was the lodgepole pine incursion into virtually every site we visited, excluding the powerlines which are maintained in a tree-free state (Figure 10), and Newberry Caldera rim (Figures 3-4).

Moving forward, we are establishing a small set of "sentinel" sites wherein the open habitat that BOPU2 prefers will be maintained by removing the younger, encroaching lodgepole pines, possibly on a 5-year schedule. In 2019 or 2020 we will be starting that maintenance.

Concurrent with this project, the author has been working with soil scientists to try to understand the role the soil profile may be playing in the decline. Four soil pits were dug, two in the Newberry Pumice, two in the Mazama ash. Findings are inconclusive but tantalizing: unlike the Mazama pits, the Newberry Pumice excavations show a definite and abrupt textural change within the rooting zone which is allowing the profile to retain water deep into the summer. We speculate that this extra moisture helps retain BOPU2 as it competes with the invading lodgepoles, but further work is needed and is planned in 2019.

## Recommendations

To continue building on the work already occurring, these items seem appropriate for the populations found on the Deschutes National Forest:

- Move forward with maintenance of BOPU2 habitat in "sentinel" sites.
- Create and keep maintained a spreadsheet with all known BOPU2 populations listed across all ownerships, tracking population trends through time. This is a FY19 funded ISSSSP project.

- An annual or biennial meeting of BOPU2 managers, to compare notes on monitoring and projects involving BOPU2 habitat improvement.
  - Continue existing demographic monitoring of paired cut/control plots.
  - Continue soil pit examinations of BOPU2 sites within Newberry Pumice Airfall and Mazama Airfall deposits, and in areas where BOPU2 individuals are especially large such as at Bend/Ft. Rock site 145 and the Crescent and/or BLM powerline sites.
  - Continue revisits to historic sites not yet visited in recent years.
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## Methods

Sites were chosen because they contained enough plants in previous visits over a large enough area to offer the best chance of finding plants during these revisits. For example, sites were not chosen that only had recorded, say, 10 plants or less.

Site visits occurred during June and July of 2017-18 on the Bend/Ft. Rock Ranger District (BFR). The Crescent district on the Deschutes visited sites in 2018 using the district botanist and volunteers. On BFR, sites were typically visited by 2-5 Forest Service employees at a time, in addition to having the help of volunteers and high school and university groups (Figure 8). This was a substantial outlay of capacity but it was well worth it, and necessary to get the number of sites checked that we did.

The BFR sites were visited using the polygons as they were drawn in our GIS layer, augmented by information contained in Region Six site record paper forms kept from the original findings. Unlike in 2017, although our approach to searching the recorded polygons was thorough, in 2018 we did not do a complete search of the whole polygon in all cases. In 2017 the full-polygon approach significantly impacted our ability to visit more sites; thus in the name of expediency we were able to visit many more sites in 2018 but at times without the entire site being censused for BOPU2. In all cases, however, we were able to get a very good idea of current habitat conditions and a good understanding of the level of BOPU2 occupancy.

## Results

Thirteen BOPU2 sites were visited in 2018 on BFR. We were able to accomplish this higher number (compared to 2017, when we visited six) by taking a different approach – if time ran short, we stopped the count and didn't return if enough of the site was seen to give us a good sense of the habitat there. With one exception, all sites were located in the Newberry Pumice Airfall region.

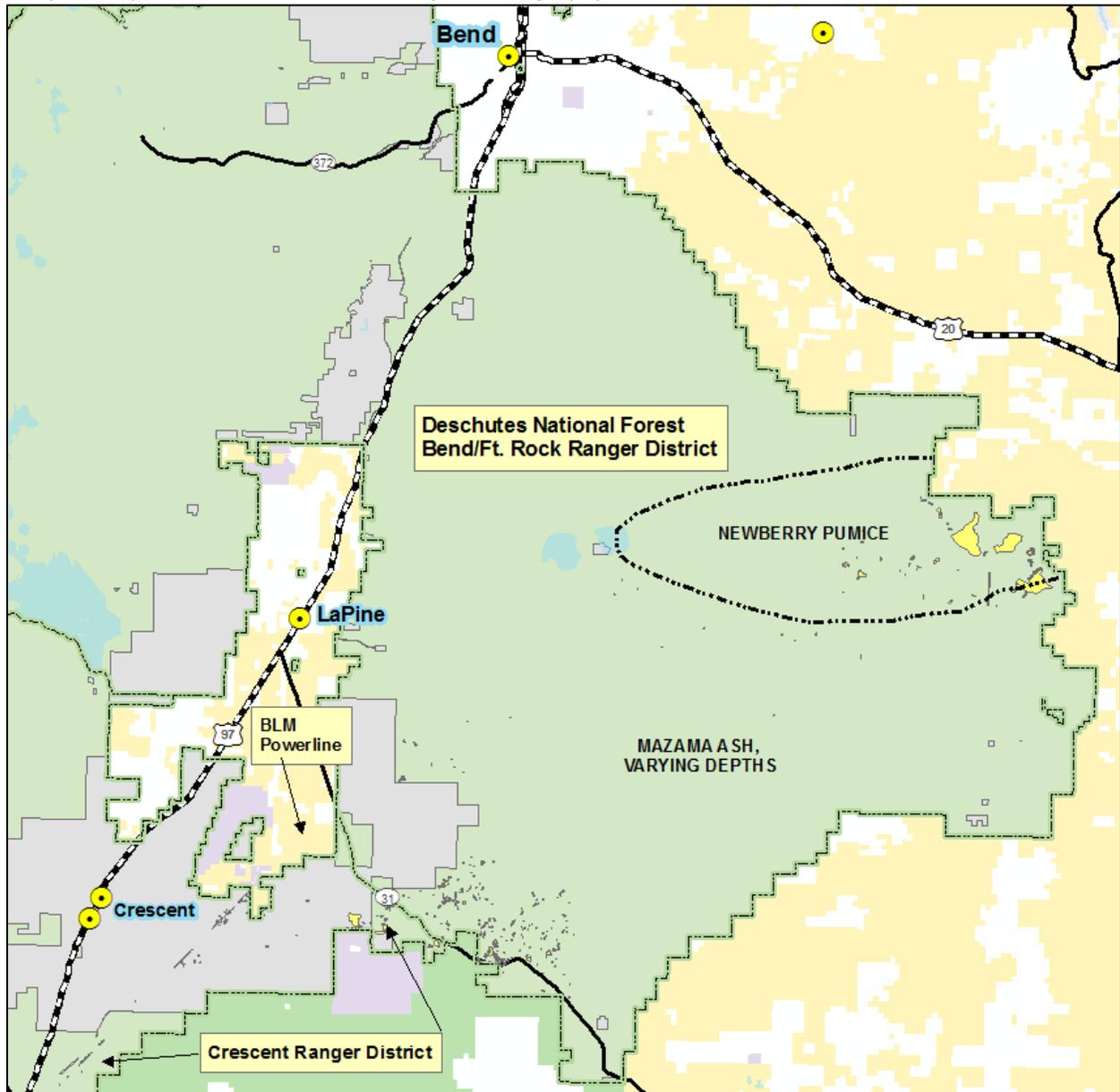
Seventeen BOPU2 sites were visited on the Crescent Ranger District in 2018, all on Mazama deposits, and followed the same pattern – lodgepole incursion into non-maintained sites.

The two sites associated with the higher-elevation Newberry Caldera rim (#78 and 310) were still tree-free, and the number of BOPU2 present were similar to or more than was found in the past. One of two sagebrush-dominated sites abundantly eclipsed the numbers seen in the 1990's; either of those would make a good candidate for a sentinel site (Figure 6). At other sites, the numbers were weaker than previously, but still healthy enough, while at still other sites, the habitat had completely grown in with 20-year old lodgepole and had shaded the site enough such that no BOPU2 were seen, or close to none. See Table 1 for a full accounting of sites visited in 2018. Table 2 is a repeat of what was presented for 2017 results.

Plants found at most sites were of small stature – approximately 3-5 centimeters (cm). Most had sporophores. The exceptions are the Crescent and BLM powerlines and at BFR site 145. There are many

whoppers in these populations – one measured ~11.5 cm in site 145 (measured at top of sporophore; Figure 9). It is not clear what this size difference is related to – age, more beneficial site conditions, a combination of the two, or something else? In 2018 a soil pit was dug in site 145, and in 2019 we hope to dig one at one of the powerline sites to continue asking what the soil can tell us.

**Figure 1.** General locations of Mazama Ashfall and Newberry Pumice Plume deposits overlain with *Botrychium pumicola* locations (seen as yellow or gray spots).



### Discussion

As with the 2017 visits, if the powerline sites – sites actively maintained in a tree-free condition – and the Newberry Caldera rim sites are taken out of consideration, all sites visited in 2018 contained varying levels of young, 15-20 year old lodgepole pine encroachment into what had previously been shrub-dominated pumice openings within a forested matrix.

The sites associated with Newberry Caldera rim are sparsely forb- and graminoid-dominated and occur at higher elevations; that may be one explanation why no trees have encroached into them at this point.

During the course of our visits in 2018 on BFR it became apparent that there were BOPU2-occupied sites that had some - but fewer - encroaching lodgepoles, and thus still relatively close to their historic open condition and could be maintained in that state with relatively little effort. The term “sentinel” site has been floated in this context. We know we do not have the capacity to do a full census of our populations every year; the idea here is that a relatively inexpensive youth crew could cut the small lodgepoles out, with Forest Service employees returning every five years or so to do a population count at those sites and also remove young seedlings at that time. There are five that have been selected from 2018’s site visits on BFR; see Figures 5-7 for three of them. These sites would be in addition to the three paired treatment/control plots that were cut in 2016 and have been monitored for signs of BOPU2 annually since; in the treatment plots any new lodgepole seedlings are being removed when visited.

The Newberry Meadow site with its densely-packed lodgepoles received this lodgepole-removal treatment in 2017-18 (Figure 7), where two species of *Botrychium* and one related species (*Sceptridium multifidum*) occur including BOPU2.

Although not part of this ISSSSP proposal, an important piece of the puzzle is to try to understand the soil component at sites where BOPU still exists and in the places where it is declining. The author has been working with Sarah Hash, soil scientist on BFR, and Susie Roe, soils technician at BFR (who also has a Master’s degree related to the ecology of BOPU2), to help get a better picture of this.

To that end Hash and Roe have dug four soil pits to date, two in the Newberry pumice and two in the Mazama deposits, to try to understand the subterranean nature of these young volcanic soils that might shed some light.

What follows is a subset of their summary:

“The Mazama ash and pumice profiles on the Bend-Ft. Rock tend to be thick (four feet or more) before contacting a buried soil, have gradual textural changes with depth, and lack a significant textural contrast at the buried soil interface (sand textures in the Mazama material overlie gravelly loamy sand or sandy loam textures in the buried soil). The Newberry pumice profiles described are shallower to a buried soil and have sharp textural contrasts within their profiles (coarse pumice gravel over sandy loams or loamy sands). When sampled, both Newberry profiles (one overlying a thin residual soil on a basaltic lava flow, and one overlying a Mazama ash soil atop waterlain basin deposits) had significant moisture present somewhere in the profile, despite being late in the growing season during a dry year on low precipitation sites.”

“This is a big leap, and pure conjecture, but it is possible that these hydrologic properties have affected the ability of certain sites to maintain robust populations of BOPU with shifting seasonal precipitation patterns. Maybe the sites with a more dependable reservoir of water within the profile are better-buffered against climatic fluctuations and the water demands of encroaching vegetation (PICO), and are more likely to have water available at times the developing BOPU need it. The presence of water and/or high humidity may also be beneficial to the mycorrhizal fungal partners of BOPU, upon which it is obligately dependent. The fungal hyphae are likely extending more broadly and deeply into the soil than the visible rooting structure of the plant itself.”

This finding would help explain why BOPU2 populations remain at the two sites in the Newberry soils, but would not explain why the BOPU2 at site 249 remains at 1990's levels, since it occurs on Mazama soils. More soil excavations to continue addressing the soil's role in BOPU2 population declines are planned by Hash and Roe in 2019.

**Figure 2.** Roe and Hash (in pit) excavating a pit at BOPU2 site 249 in Mazama ash, 24 August 2018.



**Figure 3.** The Dome, site 78 on Newberry Caldera rim, 9 July 2018. Pin flags denote BOPU2 locations.



**Figure 4.** Forest Service employees at site 310 on Newberry Caldera rim, 9 July 2018.



**Figure 5.** Example of a sentinel site: site #98 near Weasel Butte with a variety of smaller trees that could be hand-removed, 15 June 2018.



**Figure 6.** Example of sagebrush sentinel site, site 302, 22 June 2018.



**Figure 7.** Youth Conservation Corps crews cutting dense young lodgepoles in Newberry Meadow, site 79. 28 June 2018.



**Figure 8.** Students and teachers from White Swan High School and Heritage University in Toppenish, Washington assisted Forest Service botanists in counting BOPU2 at site 145, 12 July 2018.



**Figure 9.** Robust, sporulating *Botrychium pumicola* individual (~11.5 cm) at Site 145, an unusually large size for any of our revisited montane sites except this one and the powerline sites on Crescent RD and nearby BLM.



**Figure 10.** Powerline site at Crescent Ranger District, 22 June 2016. Pin flags denote BOPU2 locations.



**Table 1.** BOPU2 Population Counts, Bend/Ft. Rock & Crescent RD's plus one BLM site, 2018 vs. historic. Site numbers and their locations are in the NRIS database and accompanying GIS layer (for simplicity, only the final digits in the site number are displayed here.) It is presumed the BLM site is present in the GeoBob database.

Site #	Year First Located	# Plants historically	# Plants Found 2018	Comments	Ashfall Region	Sentinel Site?
BEND/FT. ROCK:						
78	Pre-1990; records are sketchy	?	466	The Dome, assoc. with Newberry Caldera rim; a healthy population; habitat intact with no tree encroachment.	Newberry Pumice	
79	1988	5-9	20	Newberry Meadow	Newberry Pumice	X
81	1990	50 in 1990; 140 in 1999	>220	Did not finish; a vibrant population.	Newberry Pumice	X
98	1991	50-100	10	By Weasel Butte	Newberry Pumice	X
133	1993	50-60	0	Far gone with lodgepoles.	Newberry Pumice	
145	1996	~500	>243	Very healthy BOPU2 site but with some LP's coming in; only ~1/3 of poly was surveyed.	Newberry Pumice	X
193	1996	500+ in two polys	75 in larger poly, 13 in smaller one (88 total)	Formerly known as "BOPU Park". Site has LP encroachment.	Mazama	
232	1996	45, scattered in multiple polys	0	Far gone with lodgepoles.	Newberry Pumice	
255	1993	55-60	0	"Zero habitat"	Newberry Pumice	

**Table 1** (continued). BOPU2 Population Counts, Bend/Ft. Rock & Crescent RD's plus one BLM site, 2018 vs. historic.

Site #	Year First Located	# Plants historically	# Plants Found 2018	Comments	Ashfall Region	Sentinel Site?
302	1999	21	12 but unfinished	Open sagebrush habitat with a few small LP's	Newberry Pumice	X
310	1999	~80	106	Still very open habitat, on Newberry Caldera Rim	Newberry Pumice	
331	2000	~70	14 but unfinished	Site was ~2/3 surveyed	Newberry Pumice	
353	2001	300	11	Far gone with lodgepoles.	Newberry Pumice	
CRESCENT:						
35	1990's	125	18		Mazama	
36	1990's	175	3		Mazama	
39	1990's	350	0		Mazama	
43	1990's	364	15		Mazama	
45	1990's	751	15	Survey not complete	Mazama	
117	1990's	75	0		Mazama	
126	1990's	8	0		Mazama	
507	2008	80	32	Powerline	Mazama	
510	2008	37	13	Powerline	Mazama	
511	2008	102	445	Powerline	Mazama	
512	2008	27	361	Powerline	Mazama	
513	2008	131	885	Powerline	Mazama	
514	2008	11	57	Powerline	Mazama	
515	2008	12	994	Powerline	Mazama	
517	2008	0	29	Powerline	Mazama	
518	2008	103	346	Powerline	Mazama	
BLM: BPA Powerline	2003	724	1068	Powerline	Mazama	

**Table 2.** BOPU2 Population Counts, Bend/Ft. Rock Ranger District, 2017 vs. historic

Site #	Year First Located	# Plants historically	# Plants Found 2017	Ashfall Region	Comments
99	1992	100 in biggest poly in 2000 visit	40	Mazama	
138	1993	400+	0	Mazama	Large mats of Antennaria.
140	1993	49+	0	Mazama	Pocket gopher activity.
165	1995	30 in biggest poly	2	Mazama	Reforestation in occupied habitat found.
249	1993	100+ in biggest poly	~200	Mazama	This one had LP encroachment yet there were many BOPU2. <b>Would make a good "sentinel" site.</b>
383	2005	~300	46 (incomplete-plants senescing)	Newberry Pumice Plume	Powerline site on BFR.