

Final Report: “Surveying populations of *Umbilicaria phaea* var. *coccinea*, a rare lichen endemic to the western United States” (FRF 2022-2023 cycle)

Author: Heather Stewart-Ahn (hstewart4@ewu.edu)

Affiliations: Department of Biology, Eastern Washington University, Cheney, WA 99004

Introduction

The vast and varied landscape of the Cascade-Siskiyou National Monument (CSNM) is a renowned haven for biodiversity and rare species, the impetus for the region’s protected status. Among its many floristic treasures, the CSNM features numerous populations of *Umbilicaria phaea* var. *coccinea*, a rare lichen known to be endemic to the western United States. In 2022 *U. phaea* var. *coccinea* was categorized as Vulnerable by the International Union for Conservation of Nature (IUCN) Red List (McMillin et al. 2022), one tier below Endangered status. Morphologically identical yet effortlessly differentiated by color, the red hued *U. phaea* var. *coccinea* is distinguished easily by sight from another species variety, *Umbilicaria phaea* var. *phaea*, which is brown. These two species varieties are exclusively saxicolous (rock dwelling), and they have a foliose growth form (leaf-like and dorsiventral, meaning distinct upper and lower surfaces) with a centralized attachment appendage on their lower surface (umbilicate).

While *U. phaea* var. *phaea* is widespread and abundant, known to occur predominantly in western North America, including coastal locations, *U. phaea* var. *coccinea* has a distinct inland distribution. The vivid red variety typically occurs with the brown variety, yet known sites are concentrated near the Cascade Mountain range in southern Oregon and northern California, comprising an area ~75 miles long and ~55 miles wide. Additionally, there are documented disjunct occurrences— a few in central Oregon and two in central Washington (Allen et al. 2022, Villella et al. 2010). Current data on the distribution of *U. phaea* var. *coccinea* is limited strictly to known sites thereby constituting an insufficient representation of its overall abundance. Conducting an intensive census documenting site specific population abundances and surveying for new populations can provide unprecedented foundational data for long term monitoring and conservation assessments. Thus, concise data on the population sizes of *U. phaea* var. *coccinea* will enhance efforts to conserve it and the unique places that sustain its existence.

Furthermore, in August 2021 I observed *U. phaea* var. *coccinea*, for the first time at the Horseshoe Ranch Wildlife Area within the CSNM. During this introductory encounter I collected an anomalous specimen, it was all red with one brown lobe, hence two varieties appearing on a single thallus. A few months later, I collected two more chimeric specimens in Vantage, WA. Chimeric lichen specimens are a novel phenomenon; similar observations have been previously

reported among other lichen species in few instances, yet no further investigation has occurred since the 1970's (Laundon 1978). The *U. phaea* var. *coccinea* surveys will include trying to document and to collect more chimeric specimens. Additionally, at sites with populations >200 thalli, collections will be made for population genetics DNA data.

There are over 20 documented sites for *U. phaea* var. *coccinea* located throughout the CSNM, the most sizeable known populations are near Pilot Rock, Horseshoe Ranch, and Skookum Creek along the eastern border of the Soda Mountain Wilderness. As a federally protected area situated at the center of its concentrated distribution area, the CSNM poses a crucial mainstay for this captivating scarlet lichen. Additionally, educating the public about lichens and their conservation is important to me. As a component of this proposal I will participate in a guided lichen walk to discuss and to view *U. phaea* var. *coccinea* at the CSNM.



Figure 1. The rare and vivid red species variety *U. phaea* var. *coccinea* always occurs alongside *U. phaea* var. *phaea*, the brown and common variety; aside from color they are identical in appearance. (Photo by Heather Stewart-Ahn)



Figure 2. Typically, habitats for *U. phaea* var. *coccinea* are arid and exposed while also featuring an abundance of rock, most often basaltic andesite. (Photo by Zane Walker)

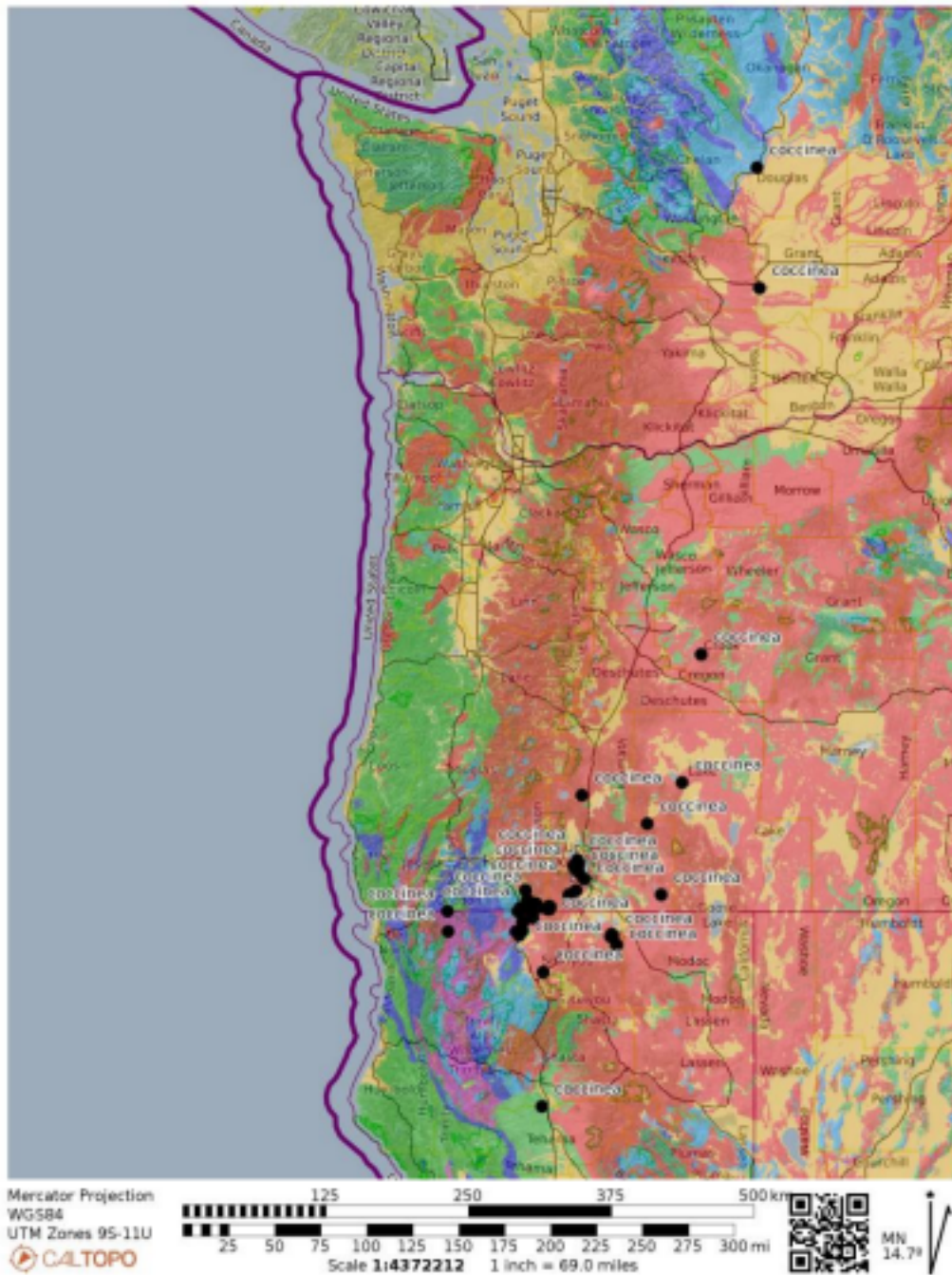


Figure 3. Map of *U. phaea* var. *coccinea* documented occurrences; each black dot indicates a known site, however there is no data regarding the size of each population.

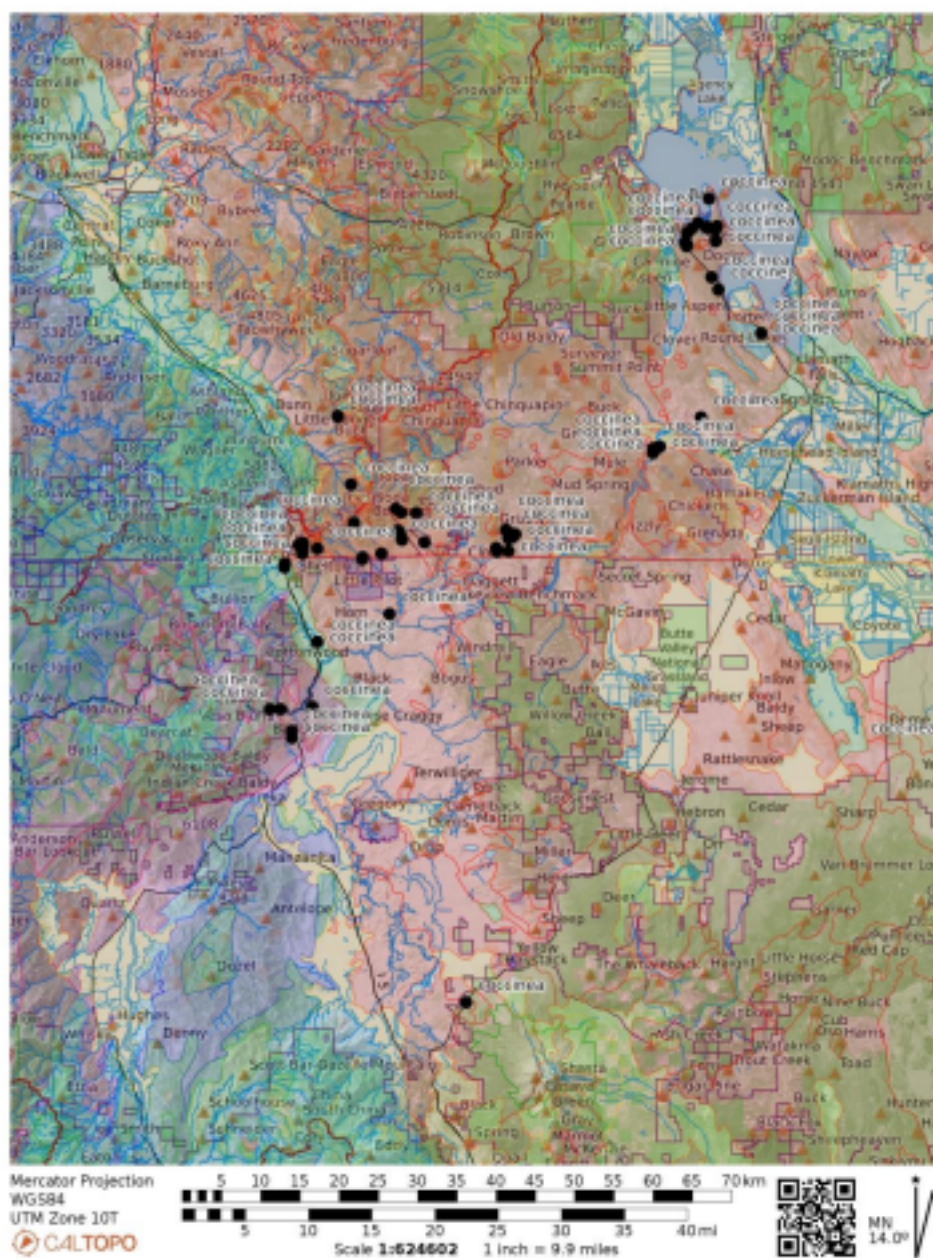


Figure 4.
Map of the core range of *U. phaea* var. *coccinea*, each black dot indicates a known site.



Figure 5. The first chimeric specimen of *U. phaea* var. *coccinea* observed and collected in August 2021 at the Horseshoe Ranch Wildlife Area. (Photo by Heather Stewart-Ahn)

Methods

Among the ~100 officially documented sites for *U. phaea* var. *coccinea*, my goal was to survey a minimum of 30 known sites encompassing the range of its distribution. In addition, I aimed to survey a minimum of 15 randomized GPS points generated within a 1-5 mile buffer zone of known sites to attempt to locate new sites as well as to record absence data. Each site was surveyed for ~1-5 hours, dependent upon the population size and the extent of rock substrate continuity. At each site multiple GPS coordinates (centrum, site parameters), ecological data (plant community, habitat), and an exact or estimated population size was recorded. Lastly, sterile DNA sampling collections of *U. phaea* var. *coccinea* and *U. phaea* var. *phaea* (n = 12-15

thalli of each variety) for population genetics was performed at sites with >200 thalli present; GPS coordinates, slope, and aspect for each collection were recorded. However, due to extenuating circumstances, the DNA analyses were not completed. The DNA sampling specimens are being kept in private freezer storage and they are available for any further research projects. Lastly, I participated in a Friends of CSNM Sunday Hike series at Horseshoe Ranch, to view and to teach the public about *U. phaea* var. *coccinea*, on June 25, 2023.

Results

I attempted to visit a total of 48 locations; surveys were completed at 44 locations. The two disjunct central Oregon sites in the Fremont-Winema and Ochoco National Forests were notably inaccessible due to road obstructions. Populations at three known sites were extirpated— two due to wildfire and one due to marmot activity. In some cases, occurrences previously documented as multiple sites were fused into a single site. For example, 7 different known sites along the Lone Pilot Trail in the CSNM were fused into a single site due to acute low abundances across the 7 sites. I surveyed 19 randomized points that resulted in 8 new sites, most of which had very low abundances. Excepting the disjunct population in Vantage, WA, all high abundance populations are near the Klamath River. Population genetics DNA sampling was performed at 7 sites. Two more chimeric specimens were documented and collected. Yet another chimera was found at Vantage, WA and an unusual chimera with a mottled appearance was found in northern California along the Shasta River.

Table 1. Census data inventory: 1) site name indicates general vicinity, * denotes collections were made for population genetics, ** denotes a known population extirpated by wildfire or wildlife activity; 2) latitude and longitude are centrum points, due to the IUCN Red List Vulnerable status this information should not be shared with the public; 3) # Thalli = total number of *U. phaea* var. *coccinea* individuals present at the site, when >100 thalli were present the number was estimated, N/A denotes site was inaccessible; 4) Abundance = # Thalli converted into an abundance rating metric wherein (a) 1-3 = 1, (b) 4-10 = 2, (c) 11-100 = 3, (d) 101-300 = 4, (e) 301-3k = 5, the rating scale was determined by the range of data; 5) Category = source of the location data wherein (a) “Known” = officially documented site, (b) “Other” = provided by private individuals, (c) “Random” = GPS points generated within a 1-5 miles buffer zone of known sites, (d) “New” = random point that resulted in a new site, (e) “iNat” = location data

sourced from iNaturalist observations (<https://www.inaturalist.org>).

Site #	Site Name	Latitude	Longitude	# Thalli	Abundance	Category
1	Lone Pilot Trail	42.02008	-122.5829	10	2	Known
2	Horseshoe Ranch*	41.97995	-122.4504	1784	5	Other
3	Topsey I	42.13444	-122.033	6	2	Known
4	Topsey II**	42.12676	-122.0438	0	0	Known
5	Clover	42.16727	-121.9703	13	3	Known
6	Eagle Point	42.4158	-121.9582	2	1	Known
7	Spence Mtn. North	42.38259	-121.9837	1	1	Known
8	Spence Mtn. Central	42.37765	-121.9909	1	1	Known
9	Doak Mountain	42.36297	-121.992	2	1	Known
10	Lower Hooligan Talus	42.32705	-121.9535	18	3	Known
11	Howard Bay Rest Area	42.31304	-121.9429	55	3	Known
12	Pioneer Bridge*	41.80949	-122.5912	2698	5	Other
13	Dry Gulch Bridge	41.8009	-122.5994	351	5	Known
14	Ash Creek*	41.83415	-122.6184	1491	5	Known
15	Happy Camp**	41.83333	-123.3833	0	0	Known
16	Tree of Heaven CG	41.83131	-122.6608	6	2	New
17	Vantage*	46.90967	-119.9459	888	5	Known

18	McBride CG	41.3539 7	-122.281 7	22	3	iNat
19	Hotlum HWY97**	41.4947 4	-122.330 3	0	0	Known
20	Big Springs Rd.	41.5235 8	-122.365 4	2	1	New
21	Shasta Valley	41.7134 9	-122.488 7	1	1	New
22	Island Spring CG	42.0895 2	-122.072 6	18	3	New
23	Big Bend*	42.0890 9	-122.056 3	2330	5	Other
24	Fall Creek*	41.9884 5	-122.365	3500	5	iNat
25	Old California	41.5525 1	-122.205	18	3	iNat
26	Cougar Rd.*	41.5133 7	-122.187 2	274	4	iNat
27	Yellow Butte	41.5358 7	-122.255	0	0	Random
28	Clover Butte	42.2176 9	-122.068 8	0	0	Random
29	West Branch Rd.	42.1093 9	-122.202	0	0	Random
30	Camp Four Creek	42.11308	-122.207 8	2	1	New

31	Odessa	42.4290 5	-122.061 6	0	0	Random
32	Walker Ranch I	41.8977 9	122.37552	200	4	New
33	Walker Ranch II	41.8755 3	-122.358 7	125	4	New
34	Walker Ranch III	41.8936	122.35577	250	4	New
35	Horseshoe Ranch II	41.9824 7	-122.453 9	450	5	Known

36	Horseshoe Ranch III	41.9890 7	-122.461 5	3	1	Known
37	Klamath Canyon I	42.04119	-122.082 4	0	0	Random
38	Klamath Canyon II	42.0576 7	-122.078	0	0	Random
39	Wanapum Dam I	46.8816 6	-119.953 4	0	0	Random
40	Wanapum Dam II	46.89115	-119.952	0	0	Random
41	Road 9 Vantage	46.9652 6	-119.898 1	0	0	Random
42	Hilt Rd.	41.9960 5	-122.610 8	250	4	Known
43	Roy Jones Rd. (Copco)	41.90119	-122.544 3	0	0	Random
44	Everitt Vista (Shasta)	41.3347 3	-122.252 9	0	0	Random
45	Hornbrook	41.91	-122.56	N/A	N/A	Known
46	Crater Lk	42.9433 8	-121.907 5	N/A	N/A	Known
47	Ochoco NF	44.0724	-120.589 4	N/A	N/A	Known
48	Black Butte	41.3704 7	-122.35	N/A	N/A	iNat

Table 2. Number of sites per location category.

Location Category	# of Sites
Known	17
iNat	4
Other	4
Random	11
New	8

Total	44
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Table 3. Summary of abundance ratings.

Abundan ce Rating	# of Sites	%
1 (1-3)	8	27%
2 (4-10)	3	10%
3 (11-100)	6	20%
4 (101-300)	5	16%
5 (301-3k)	8	27%

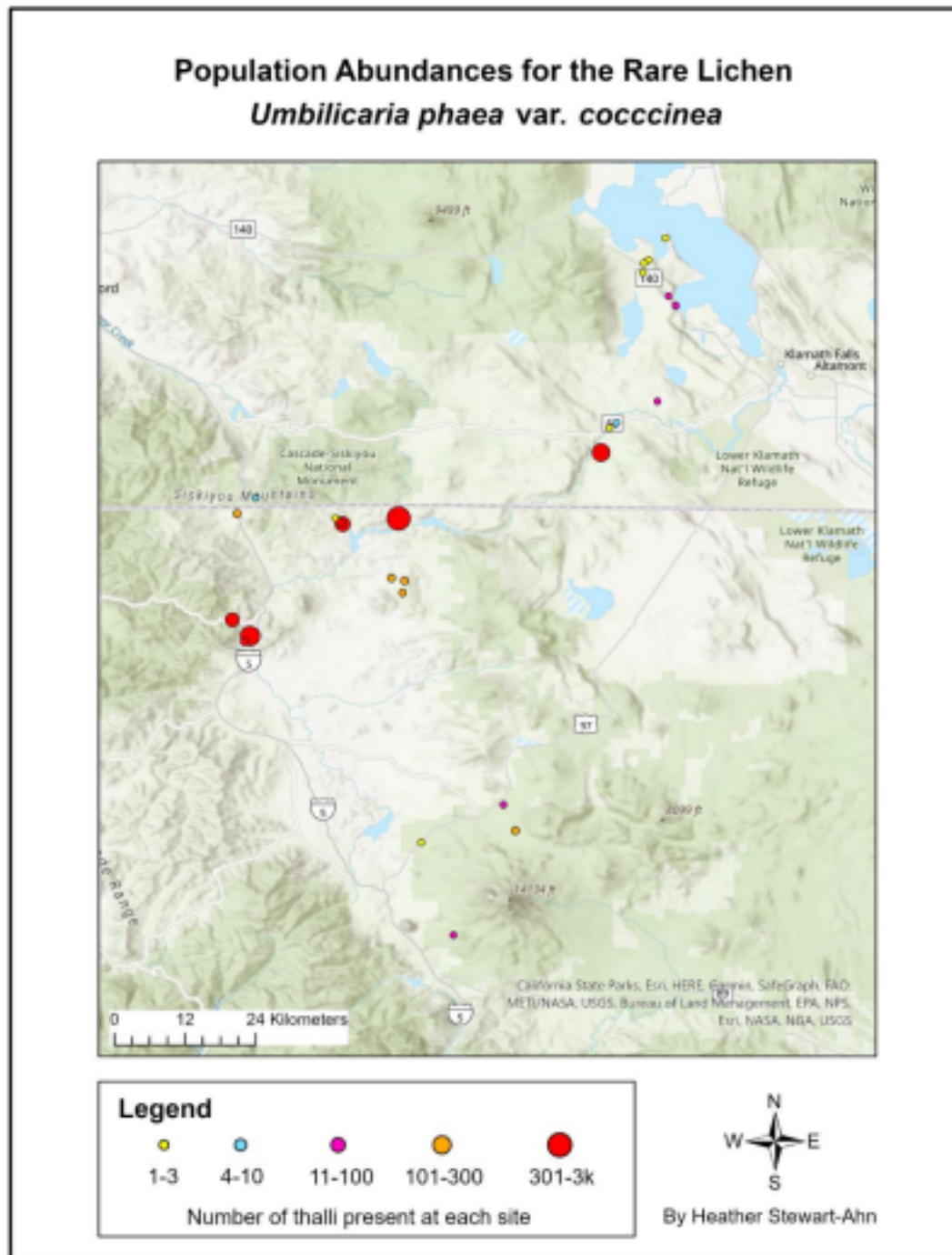


Figure 6. Updated map of *U. phaea* var. *coccinea* core range sites incorporating population abundance data and showing a distribution pattern wherein the most abundant sites are in proximity to the Klamath River.



Figure 7. A new chimera with a mottled appearance was collected in northern California near the Shasta River, this was the only site (Dry Gulch Bridge) featuring an amalgamation of basalt and serpentine substrate; in total 5 chimeric specimens were documented— 3 from Vantage, WA, 1 near Yreka, CA, and 1 near Copco, CA.



Figure 8. Scorched and irreversibly damaged: one of two *U. phaea* var. *coccinea* populations extirpated by high intensity wildfire, located on the north side of Mt. Shasta near Weed, CA.

Discussion

Overall, my survey results demonstrate *U. phaea* var. *coccinea* is more rare than previously documented. For example, over half the sites (57%) have less than 100 thalli and over a third (37%) have merely 10 thalli or less. Perhaps these findings will merit revising its IUCN Red List status from Vulnerable to Endangered. However, given that the 19 randomized locations resulted in the discovery of 8 new sites, albeit the majority of which had very low abundance, it is likely

many more populations exist, particularly in the core range. Considering the strong association with the Klamath River shown in these results, it is worth noting there are extensive Klamath dam removal projects currently underway, which might have an impact on populations. Extreme wildfire activity is an increasing threat, two sites have been extirpated, and one of the most abundant sites (Ash Creek) was only a few miles away from the catastrophic 2022 McKinney Fire. Since this study included collecting absence data, these results could be used to construct a species distribution model to determine which ecological factors beyond rock substrate availability influence occurrences. More crucially, follow up work on population genetics might yield insights into the disjunct distribution pattern, the phenomenon of chimeric specimens, and ultimately the causation of the red pigment.

Acknowledgements

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Item	Date	Location	Amount \$
Gasoline	6/18/2022	Spokane, WA	58.84
Gasoline	6/18/2022	Cle Elum, WA	61.72
Gasoline	6/19/2022	Ridgefield, WA	61.66
Gasoline	6/19/2022	Canyonville, OR	53.09
Gasoline	6/21/2022	Ashland, OR	46.35
Gasoline	6/23/2022	Ashland, OR	59.92
Gasoline	6/25/2022	Ashland, OR	66.39
Gasoline	6/27/2022	Canyonville, OR	62.00
Gasoline	6/27/2022	Ridgefield, WA	58.32
Gasoline	6/27/2022	Ellensburg, WA	54.90
Gasoline	7/4/2022	Spokane, WA	62.20
Gasoline	7/5/2022	Moses Lake, WA	56.25
Gasoline	8/10/2022	Spokane, WA	36.48
Gasoline	8/10/2022	Ellensburg, WA	40.24
Gasoline	8/11/2022	Napavine, WA	51.00
Gasoline	8/11/2022	Albany, OR	36.60
Gasoline	8/11/2022	Canyonville, OR	25.54
Gasoline	8/13/2022	Ashland, OR	28.01
Gasoline	8/15/2022	Ashland, OR	46.00
Gasoline	8/17/2022	Ashland, OR	49.37
Gasoline	8/20/2022	Ashland, OR	29.00
Gasoline	8/21/2022	Ashland, OR	41.34
Gasoline	8/21/2022	Bend, OR	42.60
Gasoline	8/22/2022	Prineville, OR	25.43
Gasoline	8/22/2022	Carson, WA	34.00
Gasoline	8/23/2022	Covington, WA	49.00
Gasoline	8/23/2022	Ritzville, WA	48.02
Gasoline	6/21/2023	Ellensburg, WA	56.00
Gasoline	6/24/2023	Napavine, WA	56.00
Gasoline	6/24/2023	Albany, OR	29.51
Gasoline	6/24/2023	Canyonville, OR	29.00
Gasoline	6/26/2023	Canyonville, OR	53.01
Gasoline	6/26/2023	Ridgefield, WA	52.00
Gasoline	6/27/2023	Maple Valley, WA	38.01
Gasoline	6/27/2023	Ritzville, WA	52.01
Grocery: Food	6/19/2022		

Ashland, OR 107.49 Grocery: Food 8/12/2022 Ashland, OR 105.46
Grocery: Food 8/20/2022 Ashland, OR 17.73 Grocery: Food
8/21/2022 Ashland, OR 56.92 Misc. Supplies 6/20/2022 Ashland, OR
11.35 Misc. Supplies 6/23/2022 Ashland, OR 8.99 Misc. Supplies
8/11/2022 Ashland, OR 26.99

GRAND TOTAL 2022-23 FIELD WORK EXPENSES = \$1,984.74