Added to California Rare Plant Rank 2.1 on October 31, 2011

Rare Plant Status Review: *Botrychium pedunculosum*
Proposed New Add to Rank 2.1 ~~1B.1~~, G2G3 / S1

Danny Slakey (CNPS), Aaron Sims (CNPS) and Roxanne Bittman (CNDDB)
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Changes made to the original document appear in blue text.

Background

The fern *Botrychium pedunculosum* is a perennial rhizomatous herb in the Ophioglossaceae family which is highly dependant on mycorrhizal associations for nutrition throughout its life cycle. It is broadly distributed across western North America, ranging from Alaska west to Saskatchewan (but with a highly disjunct occurrence in Quebec) to as far south as Tuolumne County, California (NatureServe 2011). It is included in *Flora of North America, Vol. 2* (available online at: http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=233500290), but was not included in *The Jepson Manual, Second Edition*, due to its very recent discovery in California. *Botrychium pedunculosum* is a polyploid species (n=90) derived from a hybridization event between *B. lanceolatum* and a possibly-extinct relative of *B. pallidum* (Clines et al. 2009). Many moonworts (*Botrychium* subg. *Botrychium*) are cryptic (Hauk and Haufler 1999), but *B. pedunculosum* has several unique morphological characters that set it apart from the majority of others. It is most similar in morphology to *B. hesperium* and *B. pinnatum* (NatureServe 2011), and has been known to form sterile hybrids with *B. pinnatum* (Wagner and Wagner 1986). It can be distinguished from other moonworts by its long-stalked trophophore: it is the "only western twice-dissected moonwort in which the length of the [trophophore] stalk equals or exceeds the distance between the first two pinna pairs" (Farrar 2005). Also, *B. pedunculosum* is a duller gray-green, compared to the bright green of *B. pinnatum* (NatureServe 2011). *Botrychium pedunculosum* produces a reddish- to pinkish-brown stripe leading down from the trophophore base, however, this trait is also shared to varying degrees with its close relatives *B. hesperium, B. pinnatum, B. michiganense* (not yet described), and the eastern *B. matricariifolium* (Farrar 2005, NatureServe 2011). Most *Botrychium* spp. produce a spore-bearing sporophore and a sterile trophophore, but occasionally produce a trophophore with supernumerary (extra) sporangia on the lowest pinnae pair. *Botrychium pedunculosum* and *Botrychium ascendens* are the only two species that regularly (but not always) produce supernumerary sporangia, especially on plants growing in high light conditions (Farrar 2005). This character can be used at the population-scale to differentiate it from similar-looking taxa with a brown stripe. *Botrychium pedunculosum* has been observed with sporangia in California in August.

Botrychium pedunculosum was found in a meadow within an upper montane coniferous forest. The meadow is at the contact zone between granitic and volcanic base rocks, forming an andesitic tuff breccia. *Botrychium minganense* was found growing in the meadow as well, and other associated species include C*alocedrus decurrens, Fragaria*

sp., *Listera convallarioides,* and *Adenocaulon bicolor* (J. Haas pers. comm. 2011). The leaf litter of *Calocedrus decurrens* may favorably alter soil properties for growth of *Botrychium* spp. (Clines et al. 2009). The California population of *B. pedunculosum* was found at about 1845 meters.
The only known California occurrence of *B. pedunculosum* was discovered in 2010 by Jennie Haas, botanist for the Stanislaus National Forest. This population has been verified through genetic testing by Dr. Don Farrar (Iowa State University) and a voucher has been deposited at the Ada Hayden Herbarium (D. Farrar pers. comm. 2011, J. Haas pers. comm. 2011). B*otrychium* spp. can be very difficult to spot in the field, so additional surveys should be conducted to search for more populations of *B. pedunculosum*, particularly in areas with *Calocedrus decurrens* or at moderate- to high-elevation contact zones of volcanic and granitic rock formations.

Although the species is broadly-distributed outside of California, it is never very common, with an estimated global aboveground population of 650-3000 individuals, in about 57 distinct occurrences (NatureServe 2011). The species is Critically Imperiled (S1; generally ≤5 occurrences) in 7 U.S. States and Canadian provinces (AK, ID, MT, OR, AB, QC, and SK; not counting California) and Imperiled (S2; generally 5-20 occurrences) in 2 U.S. States and Canadian provinces (WA and BC; NatureServe 2011).

Threats to the California occurrence of *B. pedunculosum* can be broken up into immediate threats from grazing, as well as long-term potential threats. Cattle graze on this portion of the forest, and have been reported to graze about 75% of *B. pedunculosum* plants in the population before they reach maturity and set spores (J. Haas pers. comm. 2011). Long- term grazing effects on *Botrychium* spp. populations, however, are not well-understood (Clines et al. 2009). Many *Botrychium* spp. perform well under a moderate disturbance regime, and can sometimes be found many years (15-50) after a major disturbance event, such as road-building (Clines et al. 2009). Though the moderate disturbance associated with grazing may indeed reduce spore count and thus limit reproduction in this plant, it may also reduce competition from grasses and sedges, opening up potential sites for colonization (J. Haas pers. comm. 2011). The Conservation Assessment for *Botrychium* in California National Forests (Clines et al. 2009) calls for a continuation of the management regimes that have allowed for *Botrychium* spp. to establish and persist in the past, since much of their ecology is still poorly understood. Despite this management recommendation, a wooden debris barrier was built in 2010 to keep cattle out of the site, but it was broken down over the 2010/2011 winter with the onset of heavy snows; it was not very effective at restricting cattle from the site. The barrier was rebuilt in the late summer of 2011 (J. Haas pers. comm. 2011). The site will continue to be surveyed, and management may be adapted based on the observed effects of grazing removal.

Some land management considerations and threats to *Botrychium pedunculosum* in California can be inferred from studies done on the species and genus as a whole. In most plant species, such small and disjunct populations of plants would be considered at risk for inbreeding depression, due to the potential for homozygosity of recessive

deleterious alleles (Clines et al. 2009). However, *Botrychium* spp. reproduce almost exclusively by intragametophytic self-fertilization, and therefore genetic drift and inbreeding depression should not be of concern to this species (Clines et al. 2009). Some individuals and populations of rare *Botrychium* spp. as a whole tend to be ephemeral. Three different *Botrychium* spp. studied over 6 years had relatively short life spans of individuals after sporophyte emergence, with half-lives ranging from 1-3 years (Lesica and Ahlenslager 1996). Also, many populations of *Botrychium* spp. undergo routine extirpations and colonization of new areas, which could be attributed to their affinity for a moderate degree of disturbance (Clines et al. 2009). While similar demographic data are not available for *B. pedunculosum*, the possibility of natural extirpation of the California occurrence over time should be considered. Because of these typical population dynamics, the California occurrence should be monitored frequently, and surrounding lands with potential habitat should be surveyed and managed for the potential colonization of spores to form new populations (Clines et al. 2009).

Based on the available information, CNPS and CNDDB recommend that *Botrychium pedunculosum* be added to California Rare Plant Rank 2.1 ~~1B.1~~ of the CNPS Inventory.

Recommended Actions
CNPS: Add to CNPS 2.1 ~~1B.1~~
CNDDB: Add to CNDDB G2G3 / S1

Please review the draft CNPS Inventory record below, respond Yes or No on the proposal to add this species to the Inventory and CNDDB, and provide any edits/comments. If responding No, please provide supporting information.

Draft CNPS Inventory Record
Botrychium pedunculosum W.H. Wagner
stalked moonwort
Ophioglossaceae
Rank 2.1 ~~1B.1~~
Tuolumne
Alaska, Idaho, Montana, Oregon, Washington
Cherry Lake North (473C) 3811918
Upper montane coniferous forest, Meadows and seeps / granitic, volcanic, andesitic; elevation 1845 meters.
Perennial rhizomatous herb. Fertile in August.
Discovered in CA by Jennie Haas in 2010; known in CA only from Stanislaus NF.
Threatened by overgrazing and excessive trampling. Similar to *B. ascendens* and *B. hesperium*. Hybridizes with *B. pinnatum*. Not in *The Jepson Manual* (1993) and *TJM 2*.
See *American Fern Journal* 76(2):33-47 (1986) for original description.