Plant Species Evaluation Form

*Asplenium trichomanes* L. subsp. *trichomanes*

**MAIDENHAIR SPLEENWORT**

**Family:** Aspleniaceae  
**PLANTS Symbol:** ASTRT  
**Calif. Endemic:** No

**Synonyms/Other Names:** *Asplenium trichomanes* L. was published by Linnaeus in 1753. The following names were reported as applied to this entity in the past: *Asplenium melanocaulon* Willd. and *Chamaefilix trichomanes* (L.) Farw. (Tropicos 2018). Some sources report *Asplenium trichomanes* L. subsp. *trichmanes* as a synonym of *Asplenium trichomanes* L. (The Plant List 2013; Tropicos 2018), although this appears to be an error because the reference cited (R. Moran 1992, FNA) does not exist. The *Flora of North America North of Mexico* treatment (Wagner et al. 1993) and *Jepson Manual* (Smith 2012) both recognize this subspecies.

**Identification Issues:** *Asplenium trichomanes* can easily be distinguished from other ferns. It grows as a tuft of fronds from a short rhizome. The fronds are all similar in appearance, usually glabrous, notably long and narrow, gradually tapering towards the tip. Fronds can reach 40 cm in length but are more commonly 8–20 cm. The fronds are simply divided into small, yellow-green to dark-green pinnae more or less oval in shape, with entire to shallowly crenate margins. The stipe and rachis of the frond are dark all along their length (Smith 2012). The shiny red-brown rachis persists after the pinnae have been shed and may be more numerous than the living fronds (Lorain 1989). The pinnae bear two rows of elongate sori (organs containing the spores) on their undersides, arranged on either side of the midrib in a zipper-like pattern. This in contrast to sori of *Pellaea*, which are marginal (Lorain 1989). The sori are covered by persistent indusia when young, which later reflex (Smith 2012).

There are five species of *Asplenium* in California, but none overlap in range with *A. trichomanes* (CCH 2018). The most common species in California, *A. vespertinum*, is the only other species with a uniformly dark red-to purple-brown rachis (midrib) and stipe (petiole), and is the most similar. It has in the past been considered a subspecies of *A. trichomanes*. It is distinguished from *A. trichomanes* subsp. *trichomanes*, by its larger, toothed or lobed pinnae (pinnae are entire to faintly crenate in subsp. *trichomanes*). *Asplenium vespertinum* has been found only in southern California. *Asplenium viride*, a second species with toothed pinnae (also known as *A. trichomanes-ramosum* L.), but with a distally green stipe and rachis, is known in California only from the east side of Sierra Buttes (Sierra County). *Asplenium bulbiferum* is a New Zealand horticultural escape with highly dissected fronds, established in a few urban areas. *Asplenium septentrionale*, a native, is extremely distinctive, with filiform, often forked blades and is known from a few sites in montane Shasta and Tehama counties.

**Taxonomy:**
Asplenium trichomanes L. subsp. trichomanes

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Genera In Family: 1 or 2 genera (most segregates now subsumed in Asplenium). Popular in horticulture. Habit: Rhizome-scale cells with lateral walls dark brown to +- black, surficial walls clear. Leaf: stipe ×-section with 1 X-shaped or 2 back-to-back C-shaped vascular strands; segment veins generally free. Sporangia: in linear [to oblong] sori along veins; indusia linear, opening away from veins; stalk cells in 1 row; spores elliptic, winged.


Habit: Plant in soil or on rocks; rhizome generally short-creeping to erect. Leaf: often tufted, generally glabrous; rachis often +- winged; blade simple or 1[many]-pinnate or forked; pinnae often more developed acroscopically, often without obvious midrib. Sporangia: indusia persistent, covering sori when young, later reflexed.

Species Description: Leaf: 1-pinnate, many, clustered, 8--25 cm; stipe 1--3(5+) cm, 0.4--0.6 mm wide, narrowly winged adaxially, dark purple-brown, shiny; blade generally 0.5--1.5 cm wide, linear; pinnae 15--30(37) pairs, 3--6(7) mm, 2--3 mm wide, oblong, generally shallowly crenate on acroscopic and distal margins. Sporangia: sori generally 1--1.5 mm, generally 2--4 pairs per pinna. Chromosomes: 2n=72.

Status:
Note: Federally recognized Endangered, Threatened, Proposed, or Candidate species under the Endangered Species Act are omitted as they do not meet the definition of a Species of Conservation Concern (FSH 1909.12 § 12.52).

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Expanded abbreviations and citations: State Listing=California Endangered Species Act Listing (CDFW 2018b), Nevada Division of Forestry Fully Protected Plant Species (NAC 527) (NDF 2012), Oregon Department of Agriculture Listed Plants (ODA 2014); G-rank=Global Conservation Status (CDFW 2018a; NatureServe 2018); S-rank=Subnational (state or province-level) Conservation Status (CDFW 2018a; NatureServe 2018; NNHP 2017; ORBIC 2016); CRPR=California Rare Plant Rank (CNPS 2018); R5 FSS=USDA Forest Service Region 5 Regional Forester Sensitive Plant Species List (USDA 2013); NFP SM=Forest Service and Bureau of Land Management Northwest Forest Plan Survey and Manage Species (USDA 2001); CA BLM=California Bureau of Land Management Designated Sensitive Species (BLM 2010); SWAP=California State Wildlife Action Plan Status (CDFW 2015); NNHP=Nevada Natural Heritage Program Status (NNHP 2017); NNPS=Nevada Native Plant Society Status (NNHP 2017); ORBIC=Oregon Biological Information Center Status (ORBIC 2016); OCS=Oregon Conservation Strategy Species (ODFW 2016); IUCN=International Union for Conservation of Nature Red List Status (IUCN 2017).

Distribution: Asplenium trichomanes is almost worldwide in distribution, being widespread in temperate and subarctic areas of both hemispheres, and in montane regions in the tropics. It has been shown to have multiple ploidy levels, and the diploid form is recognized as A. trichomanes subspecies trichomanes (Smith 2012). Asplenium trichomanes subsp. trichomanes occurs worldwide, although it is significantly less frequent than the polyploid lineages that are highly
Asplenium trichomanes L. subsp. trichomanes

successful colonizers of new habitat, such as post-glacial landscapes and man-made walls (Vogel et al. 1999).

Subspecies trichomanes is widely distributed in North America, occurring in 46 states and the District of Columbia, including Hawaii and Alaska, and much of Canada and Greenland. It is frequent in the rainforests of the Pacific Northwest, its occurrences become sparse in drier climates, such as southern and eastern Oregon and eastern Washington (CPNWH 2018). Its occurrences are markedly few and widely scattered in the arid portions of the southern U.S. It has never been reported in Nevada, and the single known site in Idaho has been reported as extirpated (CNPS 2018; Lorain 1989).

In California, A. trichomanes subsp. trichomanes was first collected in Del Norte County, California, in the Middle Fork of the Smith River near Hiouchi in 1980 (Lang and Stansell 1982), extending its known range 300 kilometers southwards, from McKenzie Pass, Oregon. This single site remains the only known location in California (CNDDB 2017; CNPS 2018).
Asplenium trichomanes L. subsp. trichomanes

Locations within California:

Record numbers indicate sites that contain an individual, population, or groups of populations located within ¼ mile of each other, per the California Natural Diversity Database (CNDDB 2017) definition of Element Occurrences (EOs) in California. Official EO numbers for plants in California are determined solely by the CNDDB and are included within the Reference (Source) column for CNDDB data. Duplicate records from the same site are given the same record number and included in red. The Population Info column includes total number of individuals and total number and size of populations/sub-populations when provided. Elevations provided in meters from source have been converted to feet. If not provided in original source, Land Manager information was obtained using the California Protected Areas Database (CPAD 2016) and Quad information was obtained using 24K Quads, SDE Feature Class (CDFG 2013). All other information is directly from the Reference (Source) unless additional citation is given.

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<td>Del Norte</td>
<td>Hiouchi (4112471)</td>
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<td>21-Sep-2012</td>
<td>FEWER THAN 10 INDIVIDUALS OBSERVED BY YORK IN 2012. A 1980 COLLECTION BY LANG FROM &quot;MYRTLE CREEK, 3.5 KM NNE OF HIOUCHI, SECTION 33&quot; IS ALSO ATTRIBUTED TO THIS SITE.</td>
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(Please see Reference column of Locations table above for references pertaining to Record Numbers indicated on NFS lands.)

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**Demographic and Population Trends:** *Asplenium trichomanes* is only known from a single occurrence in California (CNDDB 2017). Three CCH (2017) specimens are also attributed to this site (see accompanying locations table submitted with this document). This occurrence is on the Six Rivers NF and is verified as extant by Dana York in 2012, but with fewer than 10 individuals observed at that time. Its occurrence rank is listed as unknown. It should be noted that this plant is a long-lived perennial, so its population numbers are not expected to fluctuate, although the fronds may get ratty and thus difficult to detect in summer and fall, as is shown in Dana York’s photos of some individuals in 2012 (CalPhotos 2018). There are no repeat census data reported from which to estimate trends.
**Asplenium trichomanes** L. subsp. *trichomanes*

**Life History:** Like most ferns, *A. trichomanes* subsp. *trichomanes* has a diploid sporophyte generation alternating with a haploid gametophyte generation. The sporophyte is the recognizable generation, being a long-lived perennial herb with tufts of fronds arising from short rhizomes (Smith 2012). The gametophyte is a small green thallus that lives less than 2 years (Dyer 1994; Smith 2012).

The sporophyte produces thousands of haploid spores via meiosis, presented on the underside of the frond pinnae. These are released from May through July in California (CNPS 2018), and are dispersed by wind (Suter et al. 2000). The role of spore banks in fern life history is not yet well understood (Dyer 1994), but studies that include *Asplenium* species have established that spores can persist in the soil at least a year, have some tolerance of dessication, and require light and certain temperature-moisture regimes to germinate (Dyer and Lindsey 1992; Aragon and Pangua 2004).

Members of the genus *Asplenium* are homosporous, meaning the haploid spores dispersed from the sporophyte have the potential to develop into bisexual gametophytes bearing both antheridia and archegonia, although gametophyte populations typically are a mix of male, female, and bisexual. Sperm swim across wet surfaces from the antheridia to fertilize an egg within an archegonium (this must occur within a few millimeters or at most a few centimeters) and a diploid sporophyte subsequently develops from the surface of the gametophyte (Vogel et al. 1999).

**Diversity:** In their *Flora of North America North of Mexico* treatment, Wagner et al. (1993) presented Aspleniaceae as comprised of a single, extremely diverse genus, *Asplenium*, of circa 700 species worldwide. Their reasoning for this taxonomic arrangement was that a satisfactory taxonomic division into subgenera or satellite genera was not possible because of the absence of any significant morphological gaps. Although various generic segregates had previously been proposed, these authors assert that the existence of numerous "intergeneric" hybrids negated their validity. This pattern of variation in ploidy level and reticulation between variants is repeated within *Asplenium trichomanes*, where are several subspecies and nothosubspecies (hybrids between subspecies) recognized worldwide. Chromosome counts of 2n = 72 (diploid), 144 (tetraploid), and in two cases 288 (hexaploid) have been reported for this subspecies (Tropicos 2018).

There are two recognized subspecies of *A. trichomanes* in North America: subsp. *trichomanes* and subsp. *quadrivalens* (Wagner et al. 1993). *Asplenium trichomanes* subsp. *trichomanes* is a diploid with 2n = 72 chromosomes. *Asplenium trichomanes* subsp. *quadrivalens* is a tetraploid with 2n = 144 chromosomes. Both subspecies have worldwide ranges, and triploid hybrids are known between them (Smith 2012). In North America, subsp. *quadrivalens* is known to occur in the northeastern U.S. and in the Puget Sound region of Washington and British Columbia. It is distinguished from subsp. *trichomanes* in morphology by its significantly larger spores (37-43 μm), and in behavior by its preference for calcareous rocks such as limestone and dolomite. *Asplenium trichomanes* subsp. *trichomanes* has spores 27-32 μm in diameter and prefers acidic rocks (sandstone, basalt, and granite). The chromosome count for the California occurrence of *A.
Asplenium trichomanes L. subsp. trichomanes

trichomanes subsp. trichomanes is 2n = 72, consistent with other counts in subsp. trichomanes (Smith 2012).

Habitat: Linnaeus (1753) described the habitat of the type specimen of A. trichomanes as “habitat in Europae fissuris ripuum” or fissures in rocks. Asplenium species, both diploid and tetraploid, are “rock ferns”, but with strong substrate specificity for different types of rocks (Vogel et al. 1999). The tetraploid subspecies are predominantly calcicoles, notably common on man-made walls in Europe (Suter et al. 2000). In contrast, the diploid forms, including subsp. trichomanes, are predominantly calcifuges.

The habitat reported for the western U.S. is moist crevices and talus slopes with multiple species of mosses and Polypodium hesperium reported as associates, with the mesic forest species Asarum caudatum, Athyrium filix-femina, Disporum hookeri, and Oplopanax horridum frequently found nearby (Lorain 1989).

In California, the habitat of the single known location of this plant is in lower montane coniferous forest, at an elevation of 600 feet (183 meters) (CNPS 2018). The microhabitat is a rocky slope of non-calcareous rocks in a gorge across from a waterfall, within the splash zone of the waterfall on Myrtle Creek (Hoover et al. 2017; CNDDB 2018).

Asplenium trichomanes is on the search list for Green Diamond Resource Company survey crews, and they have been looking for it, but the company owns mainly forest floor habitat and this one is very much associated with wet, rocky, higher elevation habitat (Goldsworthy pers. comm. 2018).

Habitat Status or Trend: The diploid species of Asplenium are considered to be indicator species for glacial refugia in Europe. They are thought to have persisted in these sites over many millennia, as long as those refugia remain “safe zones” of the preferred mesic rock substrates (Vogel et al. 1999). Sudden or large climate shifts or climate warming-driven catastrophic weather may extirpate relict populations, as might local human activities if relict populations are not located and protected (Olson et al. 2012). In North America, subspecies trichomanes is most densely distributed in the most mesic portions of the continent, such as the maritime northeastern provinces of Canada and New England, and the Puget Sound region (CNH 2018; CPNWH 2018), and its widely scattered populations in drier regions would similarly be either relics of former mesic climates or the result of extremely rare successful colonization events. Because of the lack of proximal spore sources, the isolated populations are at higher risk of extirpation from any factor (Olson et al. 2012).

Local extirpation due to human activity is also a possibility. In Idaho, habitat-altering activities such as timber harvest, rock quarrying, and road building are cited as the most significant threats to the rocky, moist sites in that region, and site impacts from timber harvest is thought to have caused extirpation of the single known Idaho location (Lorain 1989).

Capacity for the Species to Disperse: The primary method of colonization and gene-flow in ferns is via haploid spores (Suter et al. 2000). The large number of spores produced annually by each sporophyte raises the potential for colonization events, although a strong leptokurtic
distribution of spore rain means nearly all spores land within a few meters of their source and successful long-distance dispersal events are rare (Peck et al. 1990; Wolf et al. 2001).

*Asplenium trichomanes* subsp. *trichomanes* produces copious spores on the underside of its frond pinnae. They are elliptic, winged, and 27-32 μm in diameter (Smith 2012), and thus suited to wind dispersal. It has short rhizomes, producing a clump individual and no other vegetative reproductive structures are reported (Smith 2012). Hoover et al. (2017) state that *A. trichomanes* subsp. *trichomanes* has a low capacity to disperse, presumably because, despite awareness of its presence and rarity, no additional populations have been located in California over several decades.

Because *Asplenium* ferns are homosporous, a single spore can, in theory, find a new population through intragametophytic selfing, and this does indeed occur in *Asplenium*, as high levels of inbreeding are reported from tetraploid *Asplenium* species (Suter et al. 2000). The ability of the gametophytes to self-fertilize and the opportunity for long-distance dispersal conferred by production of numerous spores are thought to be the key adaptations that allow tetraploid species of *Asplenium* to widespread in much of the world, especially in post-glacial and man-made environments (Vogel et al. 1999).

Vogel et al. (1999) report on genetic studies of *A. trichomanes* subspecies *trichomanes* in Europe: despite the large range of this subspecies, the populations of this subspecies studied exhibited very little genetic variation within or between populations, and had a high fixation rate of alleles. Similarly, Howard et al. (1994) report a deficiency of heterozygotes in eastern North American populations. Vogel et al. (1999) consider these two pieces of evidence indicative of *A. trichomanes* subsp. *trichomanes* being functionally an inbreeding taxon throughout most of its range (whether this is a result of a high proportion of self-fertilizing gametophytes or of the extreme rarity of a second successful spore dispersal event into an established population, they do not speculate). For example, if a spore lands in a safe site at a new location, the solitary gametophyte developing from that spore is capable of sporophyte formation via self-fertilization, but subsequent production of spores from the resulting sporophyte will result in a population of genetically identical individuals (Suter et al. 2000). Wolf et al. (2001) offer an alternative explanation for widespread but intermittent occurrence of diploid *Asplenium*, which is long term survival of populations in glacial refugia. Notably, the single known population in California occurs within the Klamath-Siskiyou glacial refugium (Coleman and Kruckeberg 1999). Genetic and distributional patterns in Europe of diploid *Asplenium* taxa suggest that some are indeed pre-glacial relics (Vogel et al. 1999), but insufficient DNA evidence exists for parsing these alternative explanations for North American *A. trichomanes* subsp. *trichomanes*.

**Threats:** Asplenium trichomanes subsp. trichomanes exists in California in a single, small, localized population in a highly specialized mesic habitat, a waterfall spray zone (CNDDB 2018) and is thus vulnerable to extirpation by random local events, such as stream flow variation or channel shifts. CNDDB (2018) reports EO 1 as “located next to a popular trail”, so trampling or collecting could also be potential threats at this site.
Literature Cited


[CDFG] California Department of Fish and Game. 2013. 24K Quads, SDE Feature Class. Index for 1:24,000-scale (24K), 7.5-minute by 7.5-minute, paper U.S. Geological Survey maps in California.


[CNDDB] California Department of Fish and Wildlife, Natural Diversity Database. 2017. RareFind 5 [Internet application] and CNDDB Maps and Data. Available at: https://www.wildlife.ca.gov/Data/CNDDB/Maps-and-Data [Government Version, May 2017].

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[CDF] California Department of Forestry and Fire Protection. 2009. 1:24,000 County Boundaries (cnty24k09_1_poly) [shapefile]. California Department of Forestry and Fire Protection, California Department of Fish and Game. Berkeley Library Geodata. Available at: https://geodata.lib.berkeley.edu/catalog/ark28722-s73w23 [10 December 2017].


Asplenium trichomanes L. subsp. trichomanes


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Persons Contacted:


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Author(s) and Date:
Alison Colwell, Assistant Rare Plant Botanist, California Native Plant Society, (916) 447-2677 x219, acolwell@cnps.org;
Aaron E. Sims, Rare Plant Botanist, California Native Plant Society, (916) 324-3816, asims@cnps.org. July 11, 2018.

Reviewer(s) and Date:
David Magney, Rare Plant Program Manager, California Native Plant Society, (916) 447-2677 ext. 205, dmagney@cnps.org. July 11, 2018.

Formatting: Form is set up as 508 compliant. Please use the “styles” if further formatting is necessary.

Purpose: This is to maintain the best available science on a species that could be used by the Forest Service in a variety of functions. Specifically, there would be additional steps and evaluations to determine whether or not this species would be considered a Species of Conservation Concern under the 2012 Planning Rule or a Sensitive Species under the 1982 Planning Rule.

Additional Considerations at the Forest Level: Habitat amount and juxtaposition of both the species and habitat locations.