Plant Species Evaluation Form

Tortella alpicola Dixon

ALPINE CRISP-MOSS

Family: Pottiaceae (CNPS 2018) | **PLANTS Symbol:** TOTO3 (USDA 2018) | **Calif. Endemic:** No (CNPS 2018)

Synonyms/Other Names: *Tortella alpicola* has had several incarnations enroute to its current circumscription, and has thus acquired several synonyms (Tropicos 2017; The Plant List 2013). The name *T. alpicola* was first published for material collected in the Indian Himalayas in 1928 (Dixon 1930). Forty years later, Greene (1970) described several Antarctic collections as a distinct species, *Sarconeuron tortelloides* S.W. Greene, but this name was soon transferred to *Tortella* (Robinson 1972) as *Tortella tortelloides* (S.W. Greene) H. Rob (this remains the accepted name on ITIS, 2017). Robinson's taxon was reduced to the variety *Tortella fragilis* var. *tortelloides* (S.W. Greene) Zander & Hoe when new collections from Hawaii were described by Zander and Hoe (1979). Subsequently, Zander (1993) elevated this taxon back to species rank, while simultaneously recognizing it as conspecific with the Himalayan species *T. alpicola*, whose name had priority. Eckel (1997, 1998, 2007) expanded the range of *T. alpicola* with finds in North America and further refined the concept for this species. Recent discoveries (Otnyukova et al. 2006; Rams et al. 2006; Dirkse and Losada-Lima 2011) follow and expand on Eckel's work.

Identification Issues: *Tortella alpicola* plants are distinguished by their small size, dense tufting or turf-forming, an absence of tomentum on typical (sterile) stems, broken tips on most of the leaves, and vividly shining white leaf bases on the stem in contrast with the deep or bright green of the limb (Eckel 2007). In addition, this species has distinctive leaf tips that are cylindrical, with a warty surface and scalloped in outline, but which are usually missing from all but the youngest leaves at stem tips, due to their function as vegetative propagules (Otnyukova et al 2006).

In western North America, *Tortella alpicola* is most commonly confused with its sympatric congeners *T. tortuosa* and *T. fragilis*, both of which are widely distributed across similar habitats in North America, including California (Eckel 2007; Wilson 2017). The following set of field characters was compiled from Rams et al. (2004), Otnyukova et al. (2006), and Eckel (2007) to distinguish these three species:

1) Plants of *T. alpicola* are usually much smaller (0.5-1.5 cm) than those of *T. tortuosa* and *T. fragilis* (1-5 cm).

2) A central strand is present on each stem in *T. alpicola* (vs. absent in *T. tortuosa* and *T. fragilis*.

3) The rhizoid (reddish) tomentum is absent from (rarely sparse on) the stems of *T. alpicola* (vs. well developed in *T. tortuosa* and *T. fragilis*).

4) Leaf bases are colorless in all three species, with an abrupt transition along an oblique line to the distal chlorophyllose cells. *Tortella alpicola* leaf bases have a distinctive "snow-white" appearance, (vs. pale-yellowish to almost colorless but without a specifically bright-white aspect in *T. tortuosa* and *T. fragilis*).

5) Colorless leaf base cells in *T. alpicola* and *T. tortuosa* extend about halfway up the leaf lamina, whereas *T. fragilis* the colorless cells reach almost fragile leaf tip.

6) Leaf tips are very easily broken off (caducous) in both *T. fragilis* and *T. alpicola*, and typically plants retain their leaf tips only on the youngest leaves. In contrast, the leaf tips of *T. tortuosa* are long-acuminate, and, although fragile, are not as universally broken off.

7) In *T. alpicola*, the caduceus portion of the leaf tips are cylindrical, regularly segmented (creating a scalloped appearance) and bear papillose cells on all sides. These tips fall in multiple segments. The caduceus portion of the leaf tips of *T. fragilis* have no regular constrictions, and also their lateral faces are formed by non-papillose cells. The leaf tips of *T. fragilis* fall as a single, rigid unit. In the instances where leaf tips are broken off in *T. tortuosa*, the separating fragments are flat, wide and have developed lamina.

Taxonomy:

The following description is taken from the *Flora of North America, North of Mexico* (Eckel 2007).

Species In Genus: 53 nearly worldwide (7 in North America). Etymology: Latin tortus, twisted, and -ella, diminutive, alluding to the nature of the peristome teeth. The specific epithet *alpicola* refers to its preference, at low latitudes, for high elevations.

Genus Description: Plants small to medium-sized, in loose or dense tufts, mats or compact sods, fragile, dull green, yellowish to dark green distally, black, brown or tan proximally with prominent shining costae. Stems erect, often branched, in transverse section with hyalodermis, somewhat weak sclerodermis, central strand absent or present, rhizoids dense or few at the base, occasionally tomentose; axillary hairs long, 1-seriate, of 10-20 cells, hyaline. Stem leaves cirrhate-crispate to incurved when dry, spreading to recurved when moist, elongate-oblong to linear-lanceolate or linear-subulate, widest at or near the base; base hyaline, oblong, erect; margins plane to incurved distally, generally entire and minutely crenulate by projecting papillae, but often slightly or irregularly scalloped by indentations at points of laminal weakness, occasionally somewhat to strongly undulate, rarely with a border of elongate, clear, smooth cells in one series beyond midleaf, gradually tapering distally or more or less abruptly narrowed; apex acute or obtuse, cucullate or concave, with an apiculus, mucro or short subula; costa strong, percurrent to short-excurrent, adaxial and abaxial epidermal cells often present, often interrupted, adaxial and abaxial stereid bands and 1 layer of median guide cells present, hydroid strand occasionally present; proximal cells enlarged, laxly long-rectangular, thin-walled, hyaline, occasionally brown and rather thick-walled, smooth, abruptly differentiated from the green cells distally or gradual in transition, limit of the proximal region usually appears as a V, sometimes a U, often extending distally up each leaf margin as a short or elongated border; distal laminal cells medially and distally rounded-hexagonal, chlorophyllose, frequently obscured by numerous, dense, C-shaped papillae on both surfaces. Specialized asexual reproduction at the stem apex occasional, by deciduous or fragile propaguloid leaf tips, or by deterioration of fragile leaves

along zones of laminal weakness. Sexual condition dioicous, occasionally autoicous; perigonia terminal, short-foliose to gemmate or as stalked buds in leaf axils of perichaetiate plants; perichaetia terminal, leaves not or little differentiated, or distinct and long-setaceous. Seta 1(-2) per perichaetium, yellow or reddish proximally with age, to 3 cm, erect, smooth. Capsule erect and symmetric or slightly inclined, yellow to reddish brown, darker red or brown at mouth, elliptic to cylindric, more or less wrinkled-plicate when dry and empty; annulus sometimes present, of 1-4 rows of vesiculose cells, persistent; operculum conic or long-rostrate, half as long as the urn or longer, straight or inclined; peristome orange-red, single, with a low basal membrane, of 32 filiform rami joined at the base into 16 pairs, twisted counterclockwise or merely obliquely inclined, branched-spiculose, rarely nearly smooth. Calyptra cucullate, smooth. Spores 8-12(-20) µm, yellowish brown, moderately coarsely to finely papillose to nearly smooth.

Species Description: Plants light or dark and vivid or clear green distally, pale buff-brown proximally with glistening white leaf bases, elongate, not rosulate. Stems thin, slender, 0.5-1(-1.5) cm, branches few to several, central strand present and conspicuous, not tomentose except in perichaetiate plants. Stem leaves fragile, closely to loosely aggregated, uniform in size, apices in sterile plants (except the youngest) usually fallen, incurved-circinate and weakly contorted when dry, erect-spreading, occasionally patent when moist, gradually long-lanceolate, 1.5-2 mm; base undifferentiated or somewhat broader than the limb, elliptical; margins of some leaves weakly undulate, constricted, lobed in scallop-shapes in several places distally, erect to incurved; apex narrowly acuminate, occasionally sharply contracted into a subula in the apical 1/3, this a papillose cylinder about the size of the costa, composed of a series of barrel-shaped segments disarticulating at constrictions, intact subula and tip of propaguloid apex with an apiculus of several cells, this usually dentate and tipped by one or two, elongate, sharply pointed clear cells, in sterile plants leaf apices caducous along zones of weakness; costa short-excurrent, in leaves of fertile plants adaxial surface covered distally by an epidermis of quadrate, papillose laminal cells, back of the costa smooth throughout—in leaves of fragile sterile plants abaxial costa surface smooth only proximally apical subula, densely papillose on both adaxial and abaxial surfaces in the distal subulate region, in cross section cells weakly differentiated and frequently rather chaotic, adaxial epidermis always present, adaxial stereid cells often disappearing in the distal region of the leaf, proximal laminal cells abruptly differentiated from distal cells, pale white-hyaline and transparent; distal laminal cells relatively large, 10-14 µm wide, lamina 1-stratose but apparently 2-stratose at juncture of lamina and costa, especially along the distal costa in propaguloid leaves of sterile plants; marginal cells undifferentiated, papillose-crenulate throughout. Specialized asexual reproduction in two modes, a general fragility of the leaf lamina as well as smaller, soft, multistratose, propaguloid deciduous leaf apices articulated by regular constrictions, falling early in units of approximately uniform length. Sexual condition apparently dioicous; perigonia not seen; perichaetiate stems tomentose, perichaetia terminal on successive perichaetial innovations; outer perichaetial leaves differentiated, especially evident when dry, longer than the cauline leaves, long-lanceolate to linear-lanceolate, fragile, tipped with long, rigid, subulate, smooth awns; rising beyond the contorted stem leaves when dry, not propaguloid, unbordered. Sporophytes unknown.

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).

State Listing	G-rank	S-rank	CRPR	R5 FSS	NFP SM	CA BLM
CA: Not listed NV: Not listed OR: Not listed	G5?	CA: S1 NV: Not listed OR: Not listed	2B.3	Not listed	Not listed	Not listed

SWAP:	NNHP:	NNPS:	ORBIC:	OCS:	IUCN:
Not listed	Not listed	Not listed	Not listed	Not listed	Not listed

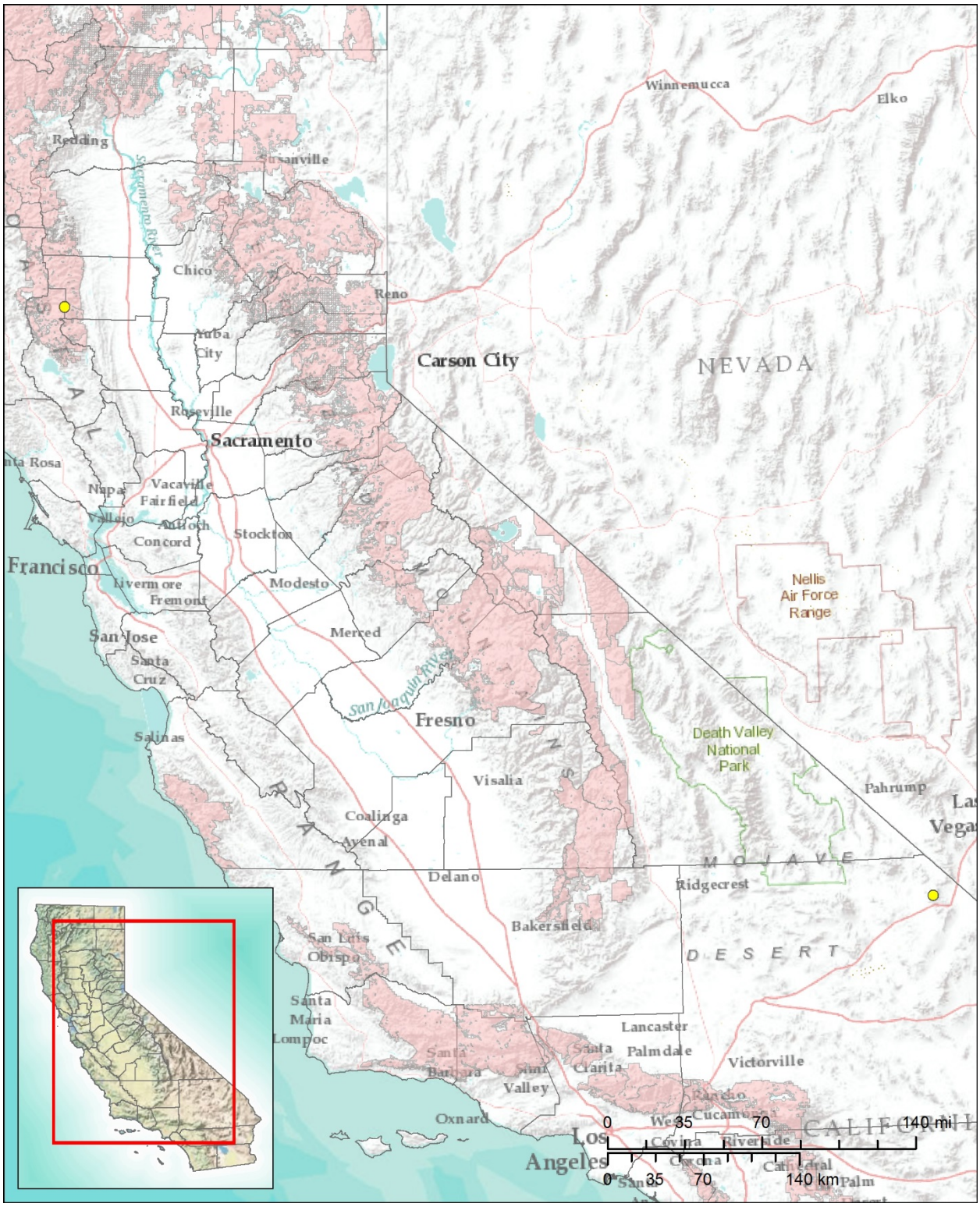
Expanded abbreviations and citations: State Listing=California Endangered Species Act Listing (CDFW 2018b), Nevada Division of Forestry Fully Protected Plant Species (NAC 527) (NDF 2012), Oregon Department of Agriculture Listed Plants (ODA 2014); G-rank=Global Conservation Status (CDFW 2018a; NatureServe 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: *Tortella alpicola* is now known to occur nearly worldwide, with confirmed collections in USA, Canada, Colombia, Uzbekistan, Kyrgyzstan, Mongolia, India, Hawaii, and Antarctica (Dixon 1930; Greene et al. 1970; Zander and Hoe 1979; Eckel 1997; Otnyukova et al., 2004), as well as unverified collections in CNABH (2018), e.g. Venezuela, China. Recent published reports have added the Canary Islands and southern Spain (Rams et al. 2006; Dirkse and Losada-Lima 2011), and the authors confirm the distribution of this species to fit an arctic-montane-alpine pattern. This distribution is not uncommon for cryptogams, whose propagules have enormous long-distance dispersal capability, and is characterized by ranges that include both Arctic and Antarctic, where they occur near sea level, and high elevations in temperate and even tropical mountain ranges. There remain, however, large gaps in both the world and North American ranges, and that it is clearly not yet adequately documented in these floras. Otnyukova et al. (2004) assert that regional occurrences of *Tortella alpicola* may have remained unrecognized due to the previous taxonomic difficulties, which will correct itself, now that it is widely understood to be distinct from the common and widespread *Tortella fragilis* and *T. tortuosa*.

In North America, it was once considered rare as only a few isolated stations had been recorded, but Eckel's work (1997, 1998, 2007) have brought it to the attention of North American bryologists. It is now confirmed from Alaska, Washington, California, Idaho, Montana, Colorado Wyoming, Nebraska, and Arizona. In Canada it is confirmed from Alberta, Northwest Territories, Yukon, and Quebec (Eckel 2007).

Within California, *T. alpicola* is known from the vicinity of Low Gap, Mendocino National Forest, Lake County, and on the north side of Mt. Clark, Mojave National Preserve, San Bernardino County (CNPS 2018; CNDDB 2018). This widely disjunct distribution in California suggests this species may well occur at additional locations, although the lack of specimens to date suggest that it is at least uncommon within the state. The substrate for this species is reported as many different rock types, all basic to neutral (Otnyukova et al. 2004). It appears to

be on calcareous outcrops in its two California locations. If this edaphic preference is real in our region, this species should be expected to be rare in California, as montane land with basic rock substrate has a small area in this state.



California Statewide Distribution. Sources: *Distribution*: CNDDB 2017. *Layers*: USDA Forest Service, Pacific Southwest National Forests: CPAD 2016. California counties: CDF 2009. *Basemaps*: California inset map: © 2013 National Geographic Society, i-cubed (Esri 2017a). Main map: Esri, DeLorme, USGS, NPS (Esri 2012) and Esri, USGS, NOAA (Esri 2017b).

Northern California Distribution. Sources: *Distribution*: CNDDB 2017. *Layers*: USDA Forest Service, Pacific Southwest National Forests: CPAD 2016. California counties: CDF 2009. *Basemaps*: California inset map: © 2013 National Geographic Society, i-cubed (Esri 2017a). Main map: Esri, DeLorme, USGS, NPS (Esri 2012) and Esri, USGS, NOAA (Esri 2017b).

Locations within California:

Note: 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) definition of Element Occurrences in California). Official Element Occurrence (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 in meters from source were 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 verbatim from the original Reference (Source) unless additional citation is given.

Rec. #	Locality	County	Quad	Reference (Source)	Date Last Observed	Population Info	Threats	Land Manager	Elev. (ft.)
1	ALONG FOREST ROAD M3 AT LOW GAP, S OF SHEETIRON MOUNTAIN, MENDOCINO NATIONAL FOREST.	Lake	St. John Mtn. (3912246)	CNDDB, May 2017 (EO 1)	7/3/1997	OBSERVED BY SHEVOCK IN 1997.		Mendocino NF	5100
2	DRAINAGE ABOUT 1 MILE N OF CLARK MOUNTAIN SUMMIT, CLARK MOUNTAIN WILDERNESS.	San Bernardino	Clark Mtn. (3511555)	CNDDB, May 2017 (EO 2)	5/17/2005	ONLY SOURCE OF INFORMATION FOR THIS SITE IS A 2005 LAEGER COLLECTION. COLLECTION DETERMINED AS TORTELLA ALPICOLA BY DAVID TOREN IN 2012.		NPS-EAST MOJAVE NSA	6000

Distribution on National Forest System (NFS) Lands:

(Please see Reference column of Locations table above for references pertaining to Record Numbers indicated on NFS lands.)

National Forest System (NFS) lands	Record #s (from Locations table above)	CNDDB EOs	Non-CNDDB Records	Recent (seen in past 20 yrs.)	Historic (not seen in past 20 yrs.)	Most Recent Obs.	EOs/ Recs. (5 mile buffer)	Total Records on NFS lands
Angeles:	-	-	-	-	-	-	-	0
Cleveland:	-	-	-	-	-	-	-	0
Eldorado:	-	-	-	-	-	-	-	0
Inyo:	-	-	-	-	-	-	-	0
Klamath:	-	-	-	-	-	-	-	0
Lake Tahoe Basin MU:	-	-	-	-	-	-	-	0
Lassen:	-	-	-	-	-	-	-	0
Los Padres:	-	-	-	-	-	-	-	0
Mendocino:	1	1	-	-	1	3-Jul-1997	-	1
Modoc:	-	-	-	-	-	-	-	0
Plumas:	-	-	-	-	-	-	-	0
San Bernardino:	-	-	-	-	-	-	-	0
Sequoia:	-	-	-	-	-	-	-	0
Shasta-Trinity:	-	-	-	-	-	-	-	0
Sierra:	-	-	-	-	-	-	-	0
Six Rivers:	-	-	-	-	-	-	-	0
Stanislaus:	-	-	-	-	-	-	-	0
Tahoe:	-	-	-	-	-	-	-	0
Totals:	N/A	1	0	0	1	N/A	0	1

Demographic and Population Trends: No targeted surveys are known to have been done on this species in California or worldwide, although those doing floristic work for bryophytes in Eurasia and Antarctica have encountered it regularly, suggesting that has been overlooked in those regions (Otnyukova et al 2004; Greene et al. 1970). Thus this species is likely to be found in additional mountain ranges and polar areas world-wide (Rams et al. 2006). The literature has been silent on abundance and trends where it has been found.

The only trend information available must be inferred from collection label information. This species was collected in 1997 (*Shevock 15866*, CAS547676), 2000 (*Toren 7714*, CAS547675),

and 2006 (*Sargent 1708*, ILL00033827) in the Low Gap area of Mendocino National Forest by three different collectors in what appear from the site descriptions to be three different sites or habitats (CNABH 2018). Although abundance or extent of population was not noted by the collectors, the serial nature of the collections suggests that *T. alpicola* may be locally common in this particular area, and that it is persisting.

Life History: *Tortella alpicola* is perennial, possibly persisting for many years, forming small clumps or turf in their preferred, relatively stable habitat such as rock crevices (Greene et al 1970; Eckel 2007). This species is noted to be diminuitive, the smallest of this genus in North America (Eckel 1998), and it tends to occupy extreme habitats of drought and cold (Zander and Eckel 1993). It is possible that its habitat preference is wider, but it does not compete well with other moss species.

Tortella alpicola is thought to propagate largely via vegetative reproduction as no sporophytes have ever been observed, and very few collections are perichaetiate (with specialized reproductive leaves indicating potential presence of archegonia or both archegonia and antheridia) (Eckel 1998). The vegetative reproduction is effected by the breaking off of specialized segments of leaf tips from young leaves, which will disperse and grow into new plants if they end up in suitable habitat (Eckel 1997, 1998; Otnyukova et al. 2004). This reproductive mode is presumably continuous throughout the portion of the year during which the plants are producing new leaves.

Diversity: To date, *Tortella alpicola* has not been included in phylogenetic analyses of Pottiaceae. Although it is not unusual for a moss to have a cosmopolitan, arctic-montane distribution, as does *T. alpicola*, the diversity of substrates reported for this species (granite, sandstone, obsidian, schist, limestone, bark) is suggestive of some degree of local adaptation.

The lack of sporophytes observed in any material to date also removes some information from debate about the cohesiveness of this species. Eckel (1998) speculates that reproductive plants may occur in particular habitats of this species' range, such as short-grass plains (where two perichaetiate specimens were found) with sterile forms only occurring in the harsher montane or polar habitats. Eckel (1998) further asserts that more fertile material will need to be found to understand any such patterns. For instance, it is not known if the plants with perichaetae contain only female or both male and female structures, as Eckel (2007) reports in the most recent description of the species only that perigonia are not known and that the species is apparently dioicus (the typical condition of the genus), in which case the lack of sporophytes could be due to only a single sex being present.

Zander and Hoe (1979) report on an informal test of leaf plasticity on Hawaiian material that they grew indoors in a humid chamber (a styrofoam box) and found that the new leaves produced in this environment lacked the characteristic vegetative propagules at their leaf tips, and thereby resembled leaves of *Tortella tortuosa*. They speculated that this is an indication of environmental plasticity, that the formation of the vegetative propagules may be triggered by cold or drought stress.

Habitat: In the Western USA, *Tortella alpicola* has been reported to inhabit cracks, crevices, or ledges of cliffs or outcrops of various rock types, especially basic to neutral in pH (CNABH 2018). One would expect the aspect of the site at California's latitude to be north-facing and montane in elevation, as this moss is thought to prefer cold sites, especially those with frequent frosts (Zander and Hoe 1979). One would also expect the site to be either seasonally dry or to dry out between rains, although a continuously moist site would be rare but not out of the question as "damp soil, fellfield", and "among *Kobresia*" have also been reported as microhabitats (CNABH 2018). Collections to date have not reported moss associates.

Worldwide, the habitat reported for *T. alpicola* is rather wide, and tends to be in environments of "considerable stress" (Zander and Hoe 1979). In tropical areas, the elevations reported are high, and shade plays a key role in habitat. In the Canary Islands, Dirkse and Losada-lima (2011) report it occurring in crevices and irregular small holes in N-facing obsidian rocks, in dry volcanic landscape with little vegetation at 2,400 m elevation. In Hawaii, Zander and Hoe (1979) report it from shaded volcanic ash and rocks at 2,620 m and 2,955 m elevation on the upper NW slope of Haleakala Volcano. In temperate to polar regions, the elevations decrease with increasing latitude, but protected microsites (typically provided by rocks) remain an almost universally reported habitat trait. Otnyukova et al. (2004) report the most common habitat of *T. alpicola* in northern regions of eastern Europe to be rock crevices, usually in rather sheltered faces. Rocks are usually calcareous to about neutral, including limestones, as well as schists. Habitats are similar to those North America, both montane and valley, on wet tundras or on shaded or exposed, wet or dry rocks, granites, schists, sandstones, calcareous rock outcrops, occasionally from tree trunks (*Populus*). In Antarctica, Greene et al. (1970) report it in moist rock crevices and between boulders at 120-330 m on several points of the coast of Alexandra Island.

Habitat Status or Trend: *Tortella alpicola* is reported from two sites in California, both on public land, and both in relatively remote areas with few local threats. No assessments of habitat status or trend have come to light in the research for this document.

The first site is on rock outcrops within the Mendocino National Forest. The area is managed primarily for logging and recreation, with gravel access roads in the vicinity. The nearby Snow Mountain Wilderness is currently proposed for de-protection.

The second site is on the north slope of Clark Mountain, on NPS-managed lands within the Mojave National Preserve, portions of which are currently under consideration for de-protection. The area around Clark Mountain remains largely intact wilderness, formerly with nearby mining industry, currently as primitive development for recreation, with a few gravel roads accessing it.

Capacity for the Species to Disperse: Mosses are well known for their enormous dispersal capacity conferred by their numerous, microscopic and hardy sexual spores (Frahm 2008). As a result, they typically have much larger ranges, with many more significant disjunctions, than do seed plants. There are many species of mosses that disperse via vegetative means primarily or exclusively, but which are also known to have large, even cosmopolitan ranges. It is therefore

thought that a vegetative reproduction, which occurs via many different means in mosses, does not relatively limit dispersal capacity in this group (Frahm 2008).

Tortella alpicola is among the moss species not known to possess sporophytes (Eckel 1987, 1988, 2007), so the sexual mode of reproduction is rare, if it occurs at all, in this species. However, this species has evolved specialized leaf apices that, by breaking apart, produce copious quantities of pieces small enough (ca. 100 μm, about the size of a large sexual spore) to qualify as the presumptive mode of dispersal (Eckel 1998; illustration in Otnyukova et al. 2004).

Species that have both a large range but that are also rare throughout that range are thought to be limited by their narrow ecological niche rather than dispersal capacity (Frahm 2008). This may be the case for *T. alpicola*, as it appears to have an affinity for dry, cold, protected (cracks) sites on basic to neutral rock.

Threats: *Tortella alpicola* inhabits crevices in rocky areas in polar and montane regions, which are relatively protected from fire and tend to be low priority for human use. *Tortella alpicola* clearly requires periodically moist, cool habitat, and possibly even nightly frost, according to Zander and Hoe (1979), so it may be adversely affected by global warming in mountain regions, such as the two occurrence locations in California. On the other hand, there is potential for increase in the area of its habitat in polar regions as ice cover over land melts. No threats are listed in CNDDB (2018) database, because entries are based on specimen collections without relevant information included.

Literature Cited

[BLM] Bureau of Land Management. 2010. Special Status Plants in California, Including BLM Designated Sensitive Species. February 8, 2010. Available at: https://www.blm.gov/ca/dir/pdfs/2010/im/CAIM2010-008ATT2B.pdf [accessed 25 May 2017].

[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.

[CDFW] California Department of Fish and Wildlife. 2015. California State Wildlife Action Plan, 2015 Update: A Conservation Legacy for Californians; Volume II, Appendix C: Species of Greatest Conservation Need. Gonzales, A. G. and J. Hoshi (eds.). Prepared with assistance from Ascent Environmental, Inc., Sacramento, CA. Available at: https://www.wildlife.ca.gov/swap/final [accessed 11 May 2017].

[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].

[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].

[CDFW] California Department of Fish and Wildlife, Natural Diversity Database. 2018a. Special Vascular Plants, Bryophytes, and Lichens List. Quarterly publication, January 2018. 127 pp.

Available at https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=109383 [accessed 22 January 2018].

____. 2018b. State and Federally Listed Endangered, Threatened, and Rare Plants of California. Last updated January 2018. 6 pp. Available at: https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=109390&inline [accessed 22 January 2018].

[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].

[CNPS] California Native Plant Society, Rare Plant Program. 2018. *Inventory of Rare and Endangered Plants of California* (online edition, v8-03 0.39). Website http://www.rareplants.cnps.org [accessed 22 January 2018].

[CPAD] California Protected Areas Database. 2016. Version 2016b1. GreenInfo Network. Available at: http://www.calands.org/.

[CNABH] Consortium of North American Bryophyte Herbaria. 2018. Website http//:bryophyteportal.org/portal/index.php [accessed 28 February 2018].

Dirkse, G. M. and A. Losada-Lima. 2011. Additions and amendments to the moss flora of the Canary Islands. *Cryptogamie, Bryologie* 32(1): 37-41.

Dixon, H. N. 1930. Additions to the moss flora of the north-western Himalayas. *Annales Bryologici* 3: 51-70.

Eckel, P. M. 1997. The moss *Tortella alpicola* Dix new to Alberta and the Yukon Territory with a discussion of its range and comments on related species. *The Canadian Field-Naturalist* 111: 320–322.

____. 1998. Re-evaluation of *Tortella* (Musci, Pottiaceae) in conterminous U.S.A. and Canada with a treatment of the European species *Tortella nitida. Bulletin of the Buffalo Society of Natural Sciences* 36: 117–191.

____. 2007. *Tortella*. Pp. 378, 502 *in*: Flora of North America Editorial Committee (eds.), *Flora of North America North of Mexico, Vol. 27*. New York and Oxford.

Esri. 2012. World Reference Overlay [basemap overlay]. Scale Range: 1:591,657,528 down to 1:72,224. Esri, DeLorme, USGS, NPS. Updated 2 September 2017. Available at: http://www.arcgis.com/home/item.html?id=9763d83ba63048da8a2e0a71ccea4416 [8 December 2017].

____. 2017a. USA Topo Maps [basemap]. Scale Range: 1:591,657,528 down to 1:18,056. National Geographic Society, i-cubed, 2013. Updated 5 October 2017. Available at: http://www.arcgis.com/home/item.html?id=99cd5fbd98934028802b4f797c4b1732 [8 December 2017].

____. 2017b. World Terrain Base [basemap]. Scale Range: 1:591,657,528 down to 1:72,224. Esri, USGS, NOAA. Updated 9 February 2017. Available at:

http://www.arcgis.com/home/item.html?id=c61ad8ab017d49e1a82f580ee1298931 [8 December 2017].

Frahm, J. P. 2008. Diversity, dispersal and biogeography of bryophytes (mosses). *Biodiversity and Conservation* 17(2): 277-284. https://doi-org.jpllnet.sfsu.edu/10.1007/s10531-007-9251-x.

Greene, S. W., D. M. Greene, P. D. Brown, and J. M. Pacey. 1970. Antarctic moss flora. 1. The genera *Andraea, Pohlia, Polytrichum, Psilopilum* and *Sarconeurum*. *British Antarctic Survey Science Report* 64: 1-118.

[ITIS] Integrated Taxonomic Information System. 2017. Website http://www.itis.gov/ [accessed June 2017].

[IUCN] International Union for Conservation of Nature. 2017. The IUCN Red List of Threatened Species. Website http://www.iucnredlist.org/ [accessed 26 May 2017].

NatureServe. 2018. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Website http://explorer.natureserve.org [accessed 22 January 2018].

[NDF] Nevada Division of Forestry. 2012. NAC 527.010 List of fully protected species of native flora. April 2012. Available at: https://www.leg.state.nv.us/NAC/NAC-527.html#NAC527Sec010 [accessed 12 May 2017].

[NNHP] Nevada Natural Heritage Program. 2017. Species Lists. Department of Conservation and Natural Resources. Available at: http://heritage.nv.gov/species/lists.php [accessed 25 May 2017].

[ODA] Oregon Department of Agriculture. 2014. Oregon listed and candidate plants - complete list. Native Plant Conservation Program. August 13, 2014. Available at: https://data.oregon.gov/Natural-Resources/Oregon-listed-and-candidate-plants-complete-list/8s3k-ygh2 [accessed 25 May 2017].

[ODFW] Oregon Department of Fish and Wildlife. 2016. Oregon Conservation Strategy, Chapter 6: Strategy Species. Oregon Department of Fish and Wildlife, Salem, Oregon. PDF content last updated December 30, 2016. Available at: http://oregonconservationstrategy.org/ [accessed 25 May 2017].

[ORBIC] Oregon Biodiversity Information Center. 2016. Rare, Threatened and Endangered Species of Oregon. Institute for Natural Resources, Portland State University, Portland, OR. 130 pp. Available at: http://inr.oregonstate.edu/sites/inr.oregonstate.edu/files/2016-rte-book.pdf [accessed 25 May 2017].

Otnyukova, T. N., E. A. Ignatova, M. S. Ignatov, and V. E. Fedosov. 2004. New records of *Tortella alpicola* Dix. in Eurasia. *Arctoa* 13: 197–201.

Rams, S., R. M. Ros, and O. Werner. 2006. *Tortella alpicola* (Pottiaceae) from Spain, new to western Europe. *The Bryologist* 109(3): 404-407.

Robinson, H. E. 1972. Observations on the origin and taxonomy of the Antarctic moss flora. Pp. 163-177 *in*: Llano, G. A. (ed.), *Antarctic Terrestrial Biology*. Antarctic Research Series 20, American Geophysical Union, Washington, DC.

The Plant List. 2013. Version 1.1. Published on the Internet; http://www.theplantlist.org/ [accessed 6 September 2017].

Tropicos. 2017. Missouri Botanical Garden. Website http://www.tropicos.org [accessed 2 November 2017].

[USDA] U.S. Department of Agriculture Forest Service, Pacific Southwest Region. 2013. Regional Forester Sensitive Species List. Available at: http://www.fs.usda.gov/main/r5/plants-animals/plants [accessed 9 May 2017].

[USDA] U.S. Department of Agriculture Forest Service and U.S. Department of Interior Bureau of Land Management. 2001. List of Survey and Manage Species in Record of Decision and Standards and Guidelines for Amendments to the Survey and Manage, Protection Buffer, and other Mitigation Measures; as amended by Annual Species Reviews 2001-2003. Available at: https://www.blm.gov/or/plans/surveyandmanage/files/sm-fs-enc3-table1-1-dec2003wrtv.pdf [accessed 12 September 2017].

[USDA] U.S. Department of Agriculture, Natural Resources Conservation Service. 2018. PLANTS Database. Website http://plants.usda.gov/ [accessed 22 January 2018].

Wilson, P. 2017. *California Moss eFlora*. The University and Jepson Herbaria, Regents of the University of California. Website http://ucjeps.berkeley.edu/CA_moss_eflora/ [accessed 16 May 2017].

Zander, R. H. and P. M. Eckel. 1993. Genera of the Pottiaceae: mosses of harsh environments. *Bulletin of the Buffalo Society of Natural Sciences* 32.

Zander, R. H. and W. J. Hoe. 1979. Geographic disjunction and heterophylly in *Tortella fragilis* var. *tortelloides* (=*Sarconeurum tortelloides*). *Bryologist* 82(1): 84-87.

Persons Contacted:

Carlberg, T. 2017. USDA Forest Service, Six-Rivers National Forest; President, California Lichen Society. Information submitted at Mendocino/Six Rivers FS-SCC and IPA Workshop, Loleta, CA. Contacted 16-18 November 2017.

Goldsworthy, E. 2017. Botanist, Green Diamond Resource Company, Arcata, CA. Information submitted at Mendocino/Six Rivers FS-SCC and IPA Workshop, Eureka, CA. Contacted 16-18 November 2017.

Hoover, L., J. McRae, and S. Carothers. 2017. Hoover and McRae: Forest Botanists, Six Rivers NF, Eureka, CA; Carothers: Botanical Contractor, Arcata, CA. Information submitted at Mendocino/Six Rivers FS-SCC and IPA Workshop, Loleta, CA. Contacted 16-18 November 2017.

O'Connell, G., G. Lester, D. York, B. Clare, G. Laural, P. Clint. 2017. California North Coast botanists. Information submitted at Mendocino/Six Rivers FS-SCC and IPA Workshop, Loleta, CA. Contacted 16-18 November 2017.

Shevock, J. R. 2018. Research Associate, California Academy of Sciences. Electronic correspondence regarding new records of *Tortella alpicola* for California. Personal communication 28 January 2018.

Taylor, D. Wm. 2017. Environmental contractor, Aptos, CA. Information submitted at Mendocino/Six Rivers FS-SCC and IPA Workshop, Eureka, CA. Contacted 16-18 November 2017.

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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.