DRAFT, Version 1.1

Draft Management Recommendations for *Tetraphis geniculata* Girgh. *ex* Milde

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EXECUTIVE SUMMARY

Species: *Tetraphis geniculata* Girgh. *ex* Milde

Taxonomic Group: Bryophyte: Moss

ROD Components: 1,3, Managed Late-successional Area Protection Buffer Species (ROD, p. C-27)

Other Management Status: None in 1996. Included on preliminary list of rare mosses submitted to the Washington Natural Heritage Program (Harpel and Gamon, pers. comm.) with suggested category S2 (imperiled in the state because of rarity or because it is vulnerable to extinction or extirpation).

Range: *Tetraphis geniculata* is known from scattered localities from northern California to Alaska. *Tetraphis geniculata* has been documented from six collections in Jefferson, Grays Harbor, King, and Pierce counties in Washington. Five of these sites occur on federal land in the Gifford Pinchot National Forest and the Mt. Rainier and Olympic National Parks. It has been reported in the literature as occurring in Oregon although site information and specimens could not be located.

Specific Habitat: This species inhabits rotten stumps and logs, in shaded, humid locations at low to middle elevations. A closed canopy provides the best microclimate for optimal development of bryophyte species favoring decaying wood.

Threats: Removal of canopy and subsequent insolation and desiccation of the understory habitats and rotting wood substrate may reduce the abundance of this species.

Management Recommendations:

- Maintain microsite characteristics at the site, including high moisture levels, cool temperatures and shade. Provide appropriate canopy structure to maintain microclimate of known sites. Specifically, maintain greater than 70 percent closed-canopy forest habitats to provide shade (ROD, p. C-27)
- Provide for input and maintenance of a continuous supply of large woody debris in various decay classes and diameters over time and avoid disturbance of coarse woody debris substrate. Specifically, maintain decay class 3, 4, and 5 logs (ROD, p. C-27).
- Avoid direct and indirect impacts to the population associated with recreation-related activities.

Information Needs:

- Visit known localities to verify population status and collect site specific information.
- Conduct surveys to locate additional populations in suitable habitat.

I. Natural History

A. Taxonomic/Nomenclatural History

Tetraphis geniculata Girgh. *ex* Milde was described in 1863 and was previously called *Georgia trachypoda* Kindberg. *Tetraphis trachypoda* has straight, somewhat papillose setae and it may actually be synonymous with *T. pellucida* rather than *T. geniculata* (Schofield, pers. comm.). *Tetraphi*s is placed in the order Tetraphidales, family Tetraphidaceae.

B. Species Description

1. Morphology (Grout 1936:6, Lawton 1971:27, Crum and Anderson 1981:1243, Christy and Wagner 1996)

Plants of *Tetraphis geniculata* are erect, 7-15 mm high. Leaves are 1-2 mm long, ovate, brownish green or yellowish-brown, erect and stiff-looking to slightly contorted when dry, with a **prominent midrib**. Sterile leafy plants often produce tiny plates of cells, which are vegetative propagules, within splash cups formed at the tips of the shoots. On sporophyte- bearing plants, the setae are 0.7-1.7 cm long, yellow or brown, some typically kinked about halfway up, the distal end bending at a 45° angle. Above the bend, the seta is usually roughened. Capsules are abundant, yellow-brown and cylindrical. The peristome consists of **four large erect teeth**, which is a distinctive character for the genus. The abruptly bent **seta roughened above the bend** distinguishes this species from *T. pellucida*, which consistently has straight or flexuose, smooth setae.

Figure 1. Line drawing of *Tetraphis geniculata* from Grout (1936), Lawton (1971), Flowers in Grout (1973) and Crum and Anderson (1981) (to be added). (AWAITING COPYRIGHT APPROVAL)

2. Reproductive Biology

Tetraphis geniculata reproduces vegetatively by means of propagules (gemmae) within splash cups. These tiny plates of cells are disseminated by raindrops during the rainy season. The gemmae consist of 35-40 cells and are roughly heart-shaped and develop a slender stalk prior to dispersal (Watson 1971).

Capsules are usually abundant and more prominent during the dry season. The occurrence of both sexual and vegetative means of reproduction in mosses such as *Tetraphis* may be important for success (Slack 1982).

The reproductive mode and population structure of related *T. pellucida* vary with shoot density (Kimmerer 1991). Increased density is correlated with increased sporophyte production. Low density colonies of *Tetraphis pellucida* tend to reproduce asexually.

3. Ecology

Although the ecology of closely related *T. pellucida* is relatively well known, less is known about *Tetraphis geniculata*. Both grow in the same habitat and may co-occur. *Tetraphis geniculata* is most frequent on decaying logs and stumps of coniferous trees. It is possible that these species have a mycorrhizal association with decomposer fungi in the rotting wood (Christy and Wagner 1996).

All known sites have been reported from high precipitation areas, on rotten logs, indicating that high moisture may be required. In addition, the splash cups require rain to disperse vegetative propagules.

C. Range, Known Sites

Tetraphis geniculata is known from scattered localities from northern California to Alaska. Within the area of consideration, *Tetraphis geniculata* has been documented from five localities in Washington (Jefferson, Grays Harbor, King, and Pierce counties). Two collections were made from the same area; it is unclear whether they represent separate sites. It has been reported in the literature as occurring in Oregon (Grout 1936, Forman 1962, and Crum and Anderson 1981), but specimens and site information could not be located. It is also known from Japan, New England and the Canadian maritime provinces.

In British Columbia, it is most frequent in humid coniferous forests of coastal areas near sea level, especially in the north. It is scattered in the humid interior forests of the province and extends to subalpine forest (Schofield 1976).

Figure 2. Known sites of *Tetraphis geniculata* (to be added).

D. Habitat Characteristics and Species Abundance

Tetraphis geniculata inhabits well-rotted stumps and logs in shaded, humid locations at low to middle elevations. The decaying wood is generally friable and dark brown in color and maintains moisture for extended periods (Schofield, pers. comm.) It is almost always associated with the common *Tetraphis pellucida*. Other typical associates include *Lepidozia reptans, Buxbaumia piperi,* and *Aulocomnium palustre*. According to Christy and Wagner (1996), *Tetraphis geniculata* probably should be included on the Washington Natural Heritage program list of rare plants, as it seems to be rare south of the Canadian border.

All historical collections have been made between the years of 1952 and 1962 and have not been recently verified. Elevations were reported on two of the collections: 175 m (578 ft.) and 365 m (1200 ft.). Only one new population has been recently documented.

II. Current Species Situation

A. Why Species is Listed under Survey and Manage Standards and Guidelines

Tetraphis geniculata was not rated because of limited information during the bryophyte viability panel during the Forest Ecosystem Management Assessment Team (FEMAT) process. Because it appears to be rare in the Pacific Northwest, this species was included under Survey and Manage Strategy 1 and 3 in the Record of Decision (USDA and USDI 1994). The basis for its inclusion was to maintain viability at the known sites and to conduct inventories to learn more about the actual extent of its range, abundance, and associations.

In addition to being identified in the Record of Decision as Survey and Manage species, *Tetraphis geniculata* is included as a Managed Late-successional Area Protection Buffer Species. It was included in the list of species covered by Mitigation Step 5 of the Scientific Analysis Team Report (1993). Mitigation activities prescribed in this document included surveying to determine presence and distribution, and where located, maintaining decay class 3, 4, and 5 logs and greater than 70 percent closed-canopy forest habitats for shade. Shelterwood and thinning prescriptions for timber harvest may increase desiccation of coarse woody debris habitat and may result in population decline.

As part of this mitigation, it was recommended that Regional ecologists or botanists 1) maintain a spatially explicit database of all known sites and 2) develop species or area management plans.

B. Major Habitat and Viability Considerations

The major viability considerations for *Tetraphis geniculata* is loss of populations due to management activities which directly impact the habitat or the populations.

C. Threats to the Species

Activities associated with recreation, such as removal of the moss or disturbance of the coarse woody debris substrate, are the most likely threats to the known populations. One of the population is reported near a campground and the other is along a trail, both within National Parks. In addition, removal of canopy and subsequent exposure and desiccation of the understory habitat may reduce the abundance of this species.

D. Distribution Relative to Land Allocations

Four of the five known sites for this species are located within National Parks in Washington: one is within Mt. Rainier National Park (Pierce County) and three are within Olympic National Park (Jefferson County). One population occurs in T.T. Munger Research Natural Area on the Gifford Pinchot National Forest. The other population, in King County, is likely to occur on private land,

although State Land is located in the vicinity.

III. Management Goals and Objectives

A. Management Goals for the Taxon

The goal for the management of *Tetraphis geniculata* is to assist in maintaining species viability.

B. Specific Objectives

- Maintain microsite characteristics at the site, including high moisture levels, cool temperatures and shade.
- Maintain large, well-rotten coarse woody debris as current substrate and manage to maintain future substrate in a range of decay classes.

IV. Habitat Management

A. Lessons from History

There is a considerable literature on the decline of bryophytes in Europe. Rapid decreases and fragmentation of primeval forests have caused a serious threat to bryophytes (ecologically similar to *Tetraphis geniculata*) that grow on decaying wood (Laaka 1992). In addition, air pollution (particularly sulphur compounds in combination with low pH) and acid rain are implicated in declines of bryophytes (Hallingbäck 1992, Rao 1982). The extinction rate and rates of decline are high in areas where trends are documented (Greven 1992, Hallingbäck 1992). Factors associated with logging that cause declines in bryophytes include the temperature extremes and the drying effect of increased wind, the lowering of surface water, and drying of logs, reduction in amount of coarse woody debris substrate, increased dispersal distance between fragments of primeval forest (Laaka 1992). Lack of suitable substrate is the main reason for rarity of threatened epixylic (decaying wood inhabiting) species in managed forests.

B. Identification of Habitat Areas for Management

The small size of bryophytes allows many individuals to exist within a small area (Wyatt 1992). As long as the microsite conditions are maintained, it may be preferable to maintain numerous smaller reserves rather than a few larger ones, to better capture their genetic diversity.

All known sites are identified for management. If additional populations of *Tetraphis geniculata* are located, they should receive similar management, with the objective of

maintaining viable populations at all sites, until populations at a minimum of sites representing the genetic diversity within the species are determined to be stable.

C. Management within Habitat Areas

- Maintain microsite characteristics at the site, including high moisture levels, cool temperatures and shade. Provide appropriate canopy structure to maintain microclimate of known sites. Specifically, maintain greater than 70 percent closed-canopy forest habitats to provide shade (ROD, p. C-27)
- Provide for input and maintenance of a continuous supply of large woody debris in various decay classes and diameters over time and avoid disturbance of coarse woody debris substrate. Specifically, maintain decay class 3, 4, and 5 logs (ROD, p. C-27).
- Trail and campground construction in the vicinity of known sites of this species should avoid direct and indirect impacts to known populations.
- Collection of bryophytes for scientific purposes should be permitted at the known sites only by specific approval due to its rarity.
- The known sites should not be impacted by special forest product harvest. However, if additional known sites are located, harvest of special forest products in the vicinity of presently known sites should follow the professional recommendations of the botanist/ecologist.

D. Other Management Issues and Considerations

Air pollutants (both in precipitation and as dry particles) have negative effects on reproduction and growth of bryophytes (Rao 1982). The degree to which this issue is a consideration for this species is unknown.

V. Research, Inventory and Monitoring Needs

A. Data Gaps and Information Needs

Initial efforts should focus on gathering additional information on habitat, associated species, and ecology of this species. This information will aid in determining characteristics of high probability habitat and in determining the ecological requirements for *Tetraphis geniculata*.

The five known sites on federal land should be surveyed to locate and verify populations of *Tetraphis geniculata*; once the habitat is characterized, conduct surveys to locate additional populations, under Survey and Manage Strategy 3. Locating populations within Late-Successional Reserves, Research Natural Areas and other withdrawn areas would be a high priority. Surveys in areas designated for management in the vicinity of known sites in potentially suitable habitat are also recommended.

B. Research Questions

- How distinctive is *Tetraphis geniculata* from *T. pellucida* genetically?
- What ecological factors characterize the habitat of *Tetraphis geniculata*?
- Does *Tetraphis geniculata* have a mycorrhizal association with fungi? If so, what ecological role do these species play in nutrient cycling in the forest?

C. Monitoring Needs and Recommendations

No monitoring recommendation are identified at this time. Once populations are located, a regional monitoring strategy may be developed to document population trends over time.

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