Conservation Assessments
for 11 Species of Bryophytes

Bartramiopsis lescurii (James) Kindb.
Diplophyllum plicatum Lindb.
Encalypta brevicolla (Bruch & Schimp.) Bruch ex Ångstr. **var. *crumiana*** (Horton) Crum & Anderson
Herbertus aduncus (Dicks.) S.F. Gray
Herbertus sakuraii (Warnst.) Hattori
Kurzia makinoana (Steph.) Grolle
Marsupella emarginata (Ehrh.) Dum.**var. *aquatica*** (Lindbenb.) Dum.
Orthodontium gracile (Wils. in Sm.& Sowerby) Schwaegr. *ex* B.S.G.
Plagiochila semidecurrens **Lehm. & Lindbenb. var. *alaskana*** (Evans) H.Inoue
Radula brunnea Steph.
Tritomaria quinquedentata (Huds.) Buch

2005

Encalypta brevicolla var. *crumiana*
and *Orthodontium gracile* updated 2011

USDA Forest Service Region 6 and
USDI Bureau of Land Management, Oregon and Washington

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Preface

Converting Survey and Manage Management Recommendations into Conservation Assessments
Much of the content in this document was included in previously transmitted Management Recommendations developed for use with Survey and Manage Standards and Guidelines. With the removal of those Standards and Guidelines, the Management Recommendations have been reconfigured into Conservation Assessments to fit Special Status/Sensitive Species Program (SSSSP) objectives and language. Changes include: the removal of terminology specific to Survey and Manage Standards and Guidelines, addition of Oregon Natural Heritage Information Center, Washington Natural Heritage Program, and California Department of Fish and Game Natural Diversity Database ranks for the species, and the addition of USDA Forest Service and USDI Bureau of Land Management Special Status/Sensitive Species status and policy. Habitat, range, and taxonomic information have also been updated to be current with data gathered since the Management Recommendations were initially issued. The framework of the original documents is maintained in order to expedite getting this information to field units. For this reason these documents do not entirely conform to recently adopted standards for the Forest Service and BLM for Conservation Assessment development in Oregon and Washington.

Assumptions about site management
In the Final Supplemental Environmental Impact Statement (FSEIS) and Record of Decision (ROD) to Remove or Modify the Survey and Manage Standards and Guidelines, assumptions were made as to how former Survey and Manage species would be managed under Agency Special Status/Sensitive Species policies. Under the assumptions in the FSEIS, the ROD stated "The assumption used in the final SEIS for managing known sites under the Special Status Species Programs was that sites needed to prevent a listing under the Endangered Species Act would be managed. For species currently included in Survey and Manage Categories A, B and E (which require management of all known sites), it is anticipated that only in rare cases would a site not be needed to prevent a listing…. Authority to disturb special status species sites lies with the agency official who is responsible for authorizing the proposed habitat-disturbing activity" (USDA and USDI 2004). Six of the 11 species covered in these Conservation Assessments were listed as Category A, B, or E at the time of the signing of the ROD, and the above assumptions apply to these species' management under the agencies' SSSSP.

The remaining five species included in this document were removed from Survey and Manage prior to the ROD, when it was determined that their persistence was not dependent upon association with late-successional/old-growth stands. Known sites continued to be managed for these species while their inclusion within the SSSSP was being evaluated. Now that these five species have been added to one or more agency SSSSP, sites are to be managed consistent with SSSSP policies. The assumptions listed in the ROD regarding site management do not apply to these five species.

Management Considerations
Within each of the following Conservation Assessments, under the "Managing in Species Habitat Areas" section, there is a discussion on "Management Considerations" for each species. "Management Considerations" are actions and mitigations that the deciding official can utilize as a means of providing for the continued persistence of the species' site. These considerations are

not required and are intended as general information that field level personnel could utilize and apply to site-specific situations. Management of all of the species covered in these Conservation Assessments follows Forest Service 2670 Manual policy and BLM 6840 Manual direction. (Additional information, including species specific maps, is available on the Interagency Special Status Species website.)

Conservation Assessment

for

False apple moss

***Bartramiopsis lescurii* (James) Kindb.**

Originally issued
as Management Recommendations
October 24, 1996
Nancy Fredricks, Author

Reconfigured, January 2005
Judith A. Harpel

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SUMMARY

Preface: Since the transmittal of the Management Recommendations in 1996, new information has been collected regarding the habitat of *Bartramiopsis lescurii* and is presented herein.

Species: *Bartramiopsis lescurii* (James) Kindb.
Taxonomic Group: Bryophyte: Moss
Management Status: US Forest Service Region 6 Sensitive; no status with the BLM. *Bartramiopsis lescurii* is currently ranked as G3G5/S1 by the Washington Natural Heritage Program (WNHP), which indicates that this species is considered critically imperiled by WNHP in the state. It is also listed as endangered in Washington by WNHP. It was originally included as a Survey and Manage species but dropped in 2001 because of its apparent lack of association with old-growth stands.

Range: *Bartramiopsis lescurii* has a North Pacific distribution, extending from Washington, north through British Columbia to Alaska, and across Kamchatka to Japan. It is very rare south of the Canadian border with only one documented site in the contiguous United States, in the Big Four area, Mt. Baker Snoqualmie National Forest, Snohomish Co., Washington.

Specific Habitat: In Washington *Bartramiopsis lescurii* occurs on small soil pockets within a talus slope in full sun at the base of a large cliff complex.

Threats: Collection of material for scientific purposes could extirpate a population from the site. Trail construction, rock climbing, and other recreation activities could contribute to the loss of sites.

Management Considerations:

- Maintain microsite characteristics and avoid disturbance of substrate on which it lives and disturbance to the plants themselves.
- Route roads and trails away from scree slopes and cliff bases.
- Restrict collection of bryophytes at and near known sites.
- Take appropriate action if there are negative impacts from recreational or other activities.

Data Gaps and Information Needs:

- Identify and locate high-priority habitat.
- Inventory high-priority habitat.
- Determine rates of growth and colonization.
- Evaluate degree of genetic uniqueness relative to other populations

I. Natural History

A. Taxonomic/Nomenclatural History

Bartramiopsis lescurii (James) Kindberg was originally described in 1875 as *Atrichum lescurii* James. In 1894, Kindberg described the new genus *Bartramiopsis* based on this species. The genus remains monotypic, differing from *Bartramia* in the lack of peristome teeth and presence of a distinctive membrane (epiphragm), which is broken free from the capsule wall and projects on the columella like a parasol, slightly above the mouth of the capsule (Christy and Wagner 1996). It is placed in the family Polytrichaceae.

Synonymy:
Atrichum lescurii James
Oligotrichum lescurii (James) Mitt
Bartramiopsis sitkana Kindb.
Lyellia lescurii (James) Salm**.**

B. Species Description

1. Morphology

Lawton 1971:33, Schofield 1985: 58, Christy and Wagner 1996.
Bartramiopsis lescurii forms dark green to reddish-brown tufts up to 5 cm tall. Leaves are 4-6 mm long, lanceolate, from a sheathing base, with clear, unistratose, 0.4-0.7 mm long cilia on the upper margins of the sheath. Leaf margins are serrate in the upper part, and 4-9 lamellae, 3-9 cells tall, are on the ventral surface of the costa. The leaves are spreading when moist, crisped and contorted when dry.

2. Reproductive Biology

Bartramiopsis lescurii is dioicious, the capsule is erect, 1.5-2 mm, ovoid, wider at the mouth, on a short, thick 7-12 mm long seta. The epiphragm is often elevated on the columella above the mouth of the capsule, peristome teeth are lacking and the operculum is rostrate, about 1 mm long. Sporophytes appear to be infrequent.

3. Ecological Roles

Although the ecological roles of individual bryophyte species are often not well understood, in general bryophytes contribute to ecosystem function in a number of ways.
According to Schofield (1985) extensive mats of bryophytes can significantly influence the water balance of a forest by absorbing and releasing moisture, and recycling leached nutrients from the tree canopy into the ecosystem. Many micro-organisms such as protozoa, fungi, bacteria, and blue-green alga often are associated with bryophytes and some species have been found to have antibiotic properties in them (Richardson 1981).

Bryophytes also directly interact with other organisms by providing nesting material and food for birds, voles, and lemmings (Longton 1992, Slack 1988). Both aquatic and terrestrial bryophytes provide shelter and food for the larvae and adults of numerous species of invertebrates (Richardson 1981). Finally bryophytes are pioneer species that provide the first step in vascular plant succession and they contribute to soil formation through the acceleration of physical and chemical weathering of rock material.

C. Range and Known Sites

Bartramiopsis lescurii has a North Pacific distribution, extending from Washington, north through British Columbia to Alaska, and across Kamchatka to Japan. It is very rare south of the Canadian border with only one documented site in the contiguous United States, in the Big Four area, Snohomish Co., Washington. In British Columbia, it was reported to be widespread in humic portions of the Province from sea-level to subalpine elevations, extending inland to the flanks of Hudson Bay Mountain, near the town of Smithers (Schofield 1976).

References to populations on the west slopes of the Olympic Mountains in the Scientific Analysis Team Report (Thomas et al. 1993) have not been substantiated and are believed to be erroneous.

D. Habitat Characteristics and Species Abundance

In British Columbia, *Bartramiopsis lescurii* inhabits cool, often shady humid canyons and stream terraces at low elevations in moist, coniferous forest. It is generally found on vertical rather than horizontal surfaces, on mineral soil over cliffs or outcrops or on the soil of upturned roots systems (Schofield, pers. comm.). Talus slopes at the base of steep cliffs characterize the Big Four site and an "ice cave" with northern aspect affording unusual microclimate conditions at a relatively low elevation (640 m/2100 ft.). Five to six patches covering less than 1 square meter (three square ft) were located in June 1996. The site is located on a scree slope with embedded boulders below a rock cliff above perpetual ice, at approximately 70 percent slope. A revisit to the site in October 2002 failed to relocate the population however the snowfield was much larger that year and the site may have been covered by snow or ice. During another revisit to the site in October 2004, after an extensive search, only one small patch about the size of a half dollar was found on the talus slope. None of the former five to six patches that were present in 1996 were relocated. At the Big Four site, associated species in the vicinity include *Aruncus sylvester, Gaultheria ovatifolia, Spiraea densa, Carex spectabilis, Athyrium filix-femina, Saxifraga ferruginea, Heuchera micrantha, Cladothamnus pyroliflorus, Alnus sitchensis, Pseudotsuga menziesii,* and *Chamaecyparis nootkatensis.* Associated bryophytes include *Pogonatum urnigerum, Oligotrichum aligerum, Oligotrichum parallelum,* and *Polytrichum* spp.

II. Current Species Situation

A. Status History

Bartramiopsis lescurii was not rated by the bryophyte viability panels during the during the Forest Ecosystem Assessment Team process because of limited information (Thomas et. al 1993). It was originally included as a Survey and Manage species (USDA & USDI 1994) but dropped in 2001 because of its apparent lack of association with old-growth stands (USDA & USDI 2001).

Bartramiopsis lescurii is currently ranked as G3G5/S1 by the Washington Natural Heritage Program (WNHP), which indicates that this species is considered critically imperiled by WNHP in the state. It is also listed as endangered in Washington by WNHP. It is on the US Forest

Service Region 6 Sensitive Species list. Due to not being suspected or documented on BLM lands in Washington, it has no status with the BLM.

B. Major Habitat and Viability Considerations

The major viability considerations for *Bartramiopsis lescurii* are management activities that directly impact habitat or populations and lead to the loss of populations. The only documented site is within a recreational area. The greatest threats to this population would be loss due to scientific collection and recreational impacts. If no additional sites were discovered, the Big Four population would be vulnerable to stochastic events that could eliminate this species from the contiguous United States. Populations on the periphery of their range are often disproportionately important for protecting genetic diversity (Lesica and Allendorf 1992). These geographically marginal populations may contain genetically unique alleles better suited to potential climate change and other environmental variation.

As with other species at the edge of their range, the southern populations of *B. lescurii* may be vulnerable to climate change. Air quality is a concern for bryophytes in general. 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.

C. Threats to the Species

The primary threats to *Bartramiopsis lescurii* are activities that disrupt moisture and temperature regimes, habitat or populations. Collection of material for scientific purposes, rock climbing, or trail construction could extirpate the population from the only documented site within the contiguous United States.

D. Distribution Relative to Land Allocations

The only site of *Bartramiopsis lescurii* within the contiguous United States is located in a late-successional reserve on the Mt. Baker-Snoqulamie National Forest.

III. Management Goals and Objectives

Management for this species follows Forest Service Region 6 Sensitive Species (SS) policy (FSM 2670), and/or BLM Oregon and Washington Special Status Species (SSS) policy (6840).

For Oregon and Washington BLM administered lands, SSS policy details the need to manage for species conservation. Conservation is defined as the use of all methods and procedures which are necessary to improve the condition of SSS and their habitats to a point where their Special Status recognition is no longer warranted. Policy objectives also state that actions authorized or approved by the BLM do not contribute to the need to list species under the Endangered Species Act.

For Region 6 of the Forest Service, SS policy requires the agency to maintain viable populations of all native and desired non-native wildlife, fish, and plant species in habitats distributed throughout their geographic range on National Forest System lands. Management "must not

result in a loss of species viability or create significant trends toward federal listing" (FSM 2670.32) for any identified SS.

IV. Habitat Managment

A. Lessons from History

There is considerable literature on the declines of bryophytes in Europe. Rapid decreases and fragmentation of primeval forests have caused a serious threat to bryophytes (Laaka 1992). In addition, air pollution (particularly sulfur compounds in combination with low pH) and acid rain are implicated in declines of bryophytes (Hallingback 1992, Rao 1982). The extinction rate and rates of decline are high in areas where trends are documented (Greven 1992, Hallingback 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; and 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. As with other species at the edge of their range, the southern populations of *B. lescurii* may be vulnerable to climate change.

B. Identifying Species Habitat Areas

All known sites of *Bartramiopsis lescurii* on federal lands administered by the Forest Service and/or BLM in Oregon and Washington are identified as areas where the information presented in this Conservation Assessment could be applied. A species habitat area is defined as the suitable habitat occupied by a known population plus the surrounding habitat needed to support the species.

C. Managing in Species Habitat Areas

The objective of species habitat areas is to maintain habitat conditions such that species viability will be maintained at an appropriate scale, in accordance with agency policies. Specific management considerations include:

- Maintain microsite characteristics and avoid disturbance of substrate on which it lives and disturbance to the plants themselves.
- Route roads, trails, and recreation sites away from scree slopes and cliff bases at, and in the immediate vicinity, of known sites.
- Discourage recreation activities, such as rock climbing, which could impact known sites.
- Permit scientific collections for deposition only at a recognized herbarium and only then if the population is of adequate size and condition and with concurrence of the Forest or BLM District botanist.
- Special forest product permits for moss collection should specify that collection may not occur at or near (up to one mile depending upon the habitat suitability) known sites.

V. Research, Inventory, and Monitoring Opportunities

The objective of this section is to identify opportunities to acquire additional information which could contribute to more effective species management. The content of this section has not been prioritized or reviewed as to how important the particular items are for species management. The inventory, research, and monitoring identified below are not required. These recommendations should be addressed by a regional coordinating body.

A. Data Gaps and Information Needs

Initial efforts should focus on gathering additional information on associated species, habitat, and ecology.

- Identify and locate high-priority habitat (Contact bryologists and botanists familiar with *Bartramiopsis lescurii* in other parts of its range to assist in defining high probability habitat to search for additional populations).
- Inventory high-priority habitat (Talus slopes at cliff bases on toe slopes, mid-slopes, and other high probability habitat should be examined for new populations).
- Determine rates of growth and colonization.
- Evaluate degree of genetic uniqueness relative to other populations.

B. Research Questions

- What ecological factors characterize the habitat of *Bartramiopsis lescurii*?
- Assuming populations are located in the Big Four area or within the contiguous United States, how similar genetically are these populations to those farther north? What contribution do these populations make to the genetic diversity of the species?
- What factors limit *B. lescurii*? What is the growth rate of this species?

C. Monitoring Opportunities and Recommendations

Monitor recreational impacts at Big Four annually to determine the status of the site. A visit to the Big Four site in October of 2002 did not locate any of the populations. In October 2004 another site revisit located only one small population on the talus slope.

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Conservation Assessment

for

Giant folded leaf

***Diplophyllum plicatum* Lindb.**

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Nancy Fredricks, Author

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Jennifer Sperling

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SUMMARY

Preface: Since the transmittal of the Management Recommendations in 1996, new information has been collected regarding the range and habitat of *Diplophyllum plicatum*, and is presented herein.

Species: *Diplophyllum plicatum* Lindb.
Taxonomic Group: Bryophyte: Liverwort
Management Status: Bureau Assessment for the BLM in Oregon; no status with the US Forest Service. *Diplophyllum plicatum* is rated by the Oregon Natural Heritage Information Center (ORNHIC) as G4/S2 for Oregon and Washington and is on List 2 for Oregon which indicates that it is considered imperiled within the state of Oregon by ORNHIC, but more common or secure elsewhere. This species was formerly in Survey and Manage Category B.

Range: *Diplophyllum plicatum* has a North Pacific distribution which includes Japan, Alaska, Siberia, British Columbia, Washington, and Oregon. In the Pacific Northwest, the range extends from the coastal southern Oregon north to the Olympic Peninsula and the Washington Cascades. It is a common species in coastal British Columbia and Alaska, extending through the Aleutians.

Specific Habitat: *Diplophyllum plicatum* is found on both organic and inorganic substrates. These include decayed wood, down logs, trunks of *Thuja plicata* (Western red cedar), *Pseudotsuga menziesii* (Douglas-fir), *Taxus brevifolia* (Pacific Yew) and *Picea sitchensis* (Sitka spruce), mineral soil, and rock. It occurs on moist north-facing slopes, especially in shaded fairly steep crevices along river and streams, and on soil of upturned roots.

Threats: Any threats are those that would damage the population, their microhabitat, and the adjoining habitat surrounding the populations. Such examples include damaging or harvesting trees, recreational development and fire. Other threats to the species are collecting and unstable substrate.

Management Considerations:

- Maintain microsite characteristics while avoiding disturbance at known sites, including modification of existing substrate and canopy.
- Maintain coarse woody debris and avoid disturbance of stumps and humic soil.
- Restrict collection of bryophytes at and near known sites.

Data Gaps and Information Needs:

- Is there additional remaining habitat or known sites between Cape Perpetua and the Olympic Peninsula?
- What is the ecological amplitude of *Diplophyllum plicatum*, particularly in the southern portion of its range?
- How does *D. plicatum* respond to modification of the microclimate?
- Sites should be monitored to assess population size and evaluate project impacts.

I. Natural History

A. Taxonomic/Nomenclatural History

Diplophyllum plicatum Lindb. was described in 1872. A recent synonym is *Macrodiplophyllum plicatum* (Lindb.) Perss. It is currently classified in the division Hepatophyta, order Jungermanniales, family Scapaniceae (Stotler and Crandall-Stotler 1977).

Diplophyllum plicatum Lindb. Acta Soc. Sci. Fenn. 10:235. 1872.

B. Species Description

1. Morphology (Frye and Clark 1946:573)

Diplophyllum plicatum is a large, loosely tufted, dark green (to brownish or yellowish) leafy liverwort. Stems have an external layer of colored and thickened cells, 1-3 cells thick, and internal cells averaging about the same size. Two rows of bilobed, folded leaves closely clasp the stem at the base and are inserted transversely, with decurrent ventral lobes that are 2-4 times as long as wide. A well-developed band of elongated cells (vitta) in each lobe is evident with magnification. The leaf cells have pronounced rounded, bulging thickenings of the cell walls, referred to as nodose trigones**.** Leaves are keeled, sometimes with a wing of one row of cells, lobes are unequal, the lower lobe is distinctly larger than the upper. Lower lobes of leaves are 22.5 mm long, 0.8 mm wide, upper lobes are 1.2-1.7 mm long with margins varying from entire to finely serrate. Deeply plicate perianths**,** lobulate to lobed at the mouth may be present in the forks of branches.

Diplophyllum plicatum is the largest member of the genus, and is distinguished by its robustness and leaf-cells with thin walls and distinct bulged thickenings (trigones), with the exception of those near the edge.

This large *Diplophyllum* might be mistaken for a robust *Scapania*. *Diplophyllum* species have narrow lateral lobes, the lower lobes spread almost horizontally from the axis, the upper lobes are much smaller and spread obliquely, while *Scapania* species have lobes of the lateral leaves folded upon each other, with the upper and lower lobes not spreading at widely different angles. The common *D. albicans* lacks nodose trigones and also has a vitta in its leaf lobes. However, in *D. plicatum* the vitta is evident only under the microscope.

2. Reproductive Biology

Diplophyllum plicatum is dioicious and requires water for sexual reproduction. Sporophytes are not common (Schofield, pers. comm.). Rounded to cubic 3-4 celled gemmae may or may not be present on the leaf tips.

3. Ecological Roles

Although the ecological roles of individual bryophyte species are often not well understood, in general bryophytes contribute to ecosystem function in a number of ways.
According to Schofield (1985) extensive mats of bryophytes can significantly influence the water balance of a forest by absorbing and releasing moisture, and recycling leached nutrients from the tree canopy into the ecosystem. Many micro-organisms such as protozoa, fungi, bacteria and blue-green alga often are associated with bryophytes and some species have been found to have antibiotic properties in them (Richardson 1981).

Bryophytes also directly interact with other organisms by providing nesting material and food for birds, voles, and lemmings (Longton 1992, Slack 1988). Both aquatic and terrestrial bryophytes provide shelter and food for the larvae and adults of numerous species of invertebrates (Richardson 1981). Finally bryophytes are pioneer species that provide the first step in vascular plant succession and they contribute to soil formation through the acceleration of physical and chemical weathering of rock material.

C. Range and Known Sites

Diplophyllum plicatum has a North Pacific distribution which includes Japan, Alaska, Siberia, British Columbia, Washington, and Oregon. It is a common species in coastal British Columbia and Alaska, extending through the Aleutians (Schofield, pers. comm.). In the Pacific Northwest, the range extends from the coastal southern Oregon north to the Olympic Peninsula and the Washington Cascade. In Washington there are sites in the following areas: Olympic National Park, (Clallam, Jefferson, Mason Counties), Mt. Baker-Snoqulamie National Forest (Snohomish and Whatcom Counties), Mt. Rainer National Park (Pierce Co.) and near Aberdeen, Pacific Beach, Westport, and Quinalt Lake in Grays Harbor County. There is one historical collection from Skamania County but it is difficult to determine the exact location of this site because the information is very limited. In Oregon the majority of the sites occur on Federal land primarily on BLM administered land in Coos County. Other locations include, Saddle Mountain State Park, (Clatsop Co.), Siuslaw National Forest (Lincoln, Lane and Douglas Counties) and one site in Tillamook County.

D. Habitat Characteristics and Species Abundance

Throughout its range in the Pacific Northwest, *Diplophyllum plicatum* tends to occur in either Western hemlock/Douglas-fir stands with western cedar present or Sitka Spruce older forests stands. It occurs in areas that sustain year-round cool habitats with high humidity which are fairly common along the immediate coast and in the Coast Range, but it will also occur on the western slopes of the Cascades with frequent fog and where coastal vegetation extends into the Cascades. In the area of consideration, it is a low elevation species, generally in canyons and in cliffs; northward it extends to alpine areas and commonly grows on tree bases (Schofield, pers. com.).

Typically it is found on tree boles or stumps of western red cedar in riparian sites with high humidity and cool temperatures throughout the year. This species will also occur on the bark of hardwoods and conifers, thin soil over rock and decaying wood in cool, humid patches along the west side of the Cascades. Suspected range could include any areas along the west slope of the Cascades where cool, humid conditions are prevalent.

Diplophyllum plicatum is found on both organic and inorganic substrates. Substrate most commonly known is *Thuja plicata* (western red cedar) stump with the side facing the direction of nearby water source usually sustaining the highest number of individuals within the population. It is notable that those surface areas which have shed the outer bark on the stump have a higher tendency to be populated with individuals. Other known substrates have included decayed wood, down logs, trunks of western red cedar, *Pseudotsuga menziesii* (Douglas-fir), *Taxus brevifolia* (Pacific yew), *Picea sitchensis* (Sitka spruce), *Alnus rubra* (red alder) trees and mineral soil, and rock all within a relatively high humidity and high moisture area. It also occurs

on moist north-facing cliffs, especially in shaded cliff crevices along river and stream banks, and on soil of upturned roots. In one atypical location, one population has been documented to occur on the trunk of a *Tsuga heterophylla* (western hemlock) in lower moisture, nonriparian habitat. Key elements appear to be high moisture, older conifer stands, and high humidity. The epicenter of the population exists in small clusters in southern Oregon in the Burnt mountain area. This species usually forms fairly small patches and is rarely abundant within any stand.

II. Current Species Situation

A. Status History

Diplophyllum plicatum was rated as a rare, narrowly distributed species by the bryophyte viability panel (FEMAT 1993). This species was included in survey strategies 1 and 2 under the Northwest Forest Plan (USDA and USDI 1994) which required surveys prior to ground-disturbing activities and management of known sites. In 2001 this species moved to Category B which dropped the pre-project survey requirement (USDA and USDI 2001).

This species is rated by the Oregon Natural Heritage Information Center (ORNHIC) as G4/S2 for Oregon and Washington and is on List 2 for Oregon, which indicates that it is considered imperiled within the State of Oregon by ORNHIC but more common or secure elsewhere (ORNHIC 2004). *Diplophyllum plicatum* is a Bureau Assessment for the BLM in Oregon. It has no status with the US Forest Service.

B. Major Habitat and Viability Considerations

The major concern is the very limited amount of remaining suitable habitat for this species on federal land, particularly old-growth Sitka spruce forests along the northern coastal areas of Oregon.

C. Threats to the Species

Logging of old-growth Sitka spruce forest is the most serious threat to this species. In addition, road construction, campground construction, and collection of special forest products could impact local populations. The infrequency of sporophytes impedes its distributional spread (Schofield, pers. comm.).

D. Distribution Relative to Land Allocations

The majority of the *Diplophyllum plicatum* sites occur in Late-Successional Reserves on Coos Bay BLM District and the Siuslaw National Forest. The remainder occurs in Olympic National Park.

III. Management Goals and Objectives

Management for this species follows Forest Service Region 6 Sensitive Species (SS) policy (FSM 2670), and/or BLM Oregon and Washington Special Status Species (SSS) policy (6840).

For Oregon and Washington BLM administered lands, SSS policy details the need to manage for species conservation. Conservation is defined as the use of all methods and procedures which are necessary to improve the condition of SSS and their habitats to a point where their Special Status recognition is no longer warranted. Policy objectives also state that actions authorized or approved by the BLM do not contribute to the need to list species under the Endangered Species Act.

For Region 6 of the Forest Service, SS policy requires the agency to maintain viable populations of all native and desired non-native wildlife, fish, and plant species in habitats distributed throughout their geographic range on National Forest System lands. Management "must not result in a loss of species viability or create significant trends toward federal listing" (FSM 2670.32) for any identified SS.

IV. Habitat Management

A. Lessons from History

There is considerable literature on the declines of bryophytes in Europe. Rapid decreases and fragmentation of primeval forests have caused a serious threat to bryophytes that grow on decaying wood (Laaka 1992). In addition, air pollution (particularly sulfur 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; and 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. Identifying Species Habitat Areas

All known sites of *Diplophyllum plicatum* on federal lands administered by the BLM and/or Forest Service Region 6 in Washington and Oregon are identified as areas where the information in this Conservation Assessment could be applied. A species habitat area is defined as the suitable habitat occupied by a known population plus the surrounding habitat needed to support the species.

C. Managing in Species Habitat Areas

The objective of species habitat areas is to maintain habitat conditions such that species viability will be maintained at an appropriate scale in accordance with agency policies. Specific management considerations are to:

- Maintain habitat microsite conditions, retaining shade and moisture regimes, especially of old-growth Sitka spruce forest at sites near the coast. Avoid disturbance at known sites, including modification of canopy.
- Maintain adequate coarse woody debris substrates at the sites, and avoid disturbance of well-rotted wood and humic soil.
- Permit scientific collections for deposition only at a recognized herbarium and only then if the population is of adequate size and condition and with concurrence of the Forest or BLM District botanist.
- Special forest product permits for moss collection should specify that collection may not occur at or near (up to one mile depending upon the habitat suitability) known sites.

V. Research, Inventory, and Monitoring Opportunities

The objective of this section is to identify opportunities to acquire additional information which could contribute to more effective species management. The content of this section has not been prioritized or reviewed as to how important the particular items are for species management. The inventory, research, and monitoring identified below are not required. These recommendations should be addressed by a regional coordinating body.

A. Data Gaps and Information Needs

- Is there additional remaining habitat or known sites between Cape Perpetua and the Olympic Peninsula?

B. Research Questions

- How does *Diplophyllum plicatum* respond to modification of the microclimate?

C. Monitoring Opportunities and Recommendations

- Monitor sites to assess population size and evaluate project impacts. In particular, monitor and manage collection of special forest products to ensure that this activity is not affecting known sites or populations of this species.

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Conservation Assessment

for

Crum's extinguisher moss

***Encalypta brevicolla* (Bruch & Schimper in B.S.G.) Bruch *ex* Ångstr.**

var. *crumiana* (Horton) Crum & Anderson

Originally issued November 4, 1996
as Management Recommendations
Nancy Fredricks, Author

Reconfigured January 2005
Richard Helliwell

Section VII. Photos added February 2011
Candace Fallon

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SUMMARY

Preface: Since the transmittal of the Management Recommendations in 1996, new information has been collected regarding the habitat of *Encalypta brevicolla* var. *crumiana*. The new information is included in this Conservation Assessment.

Species: *Encalypta brevicolla* (Bruch & Schimper in B.S.G.) Bruch *ex* Ångstr. var. *crumiana* (Horton) Crum & Anderson
Taxonomic Group: Bryophyte: Moss
Management Status: US Forest Service Region 6 Sensitive in Oregon and Washington and BLM Bureau Sensitive in Oregon. *Encalypta brevicolla* var. *crumiana* is listed by the Oregon Natural Heritage Information Center (ORNHIC) and Washington Natural Heritage Program (WNHP) as G4T1/S1 for both Oregon and Washington, and List 1 by ORNHIC for Oregon. These rankings indicate that this taxon is considered critically imperiled in both states by the Heritage Programs, and that this particular variety is rare throughout its range. WNHP also rates this taxon as endangered in Washington. This species was dropped from Survey and Manage in 2002 because of the lack of association with old-growth forest.

Range: *Encalypta brevicolla* var. *crumiana* is endemic to the Pacific Northwest. It has been reported from two sites in the world: Mt. Rainier National Park and the Siskiyou National Forest.

Specific Habitat: The Oregon site is located in minor crevices and fractures on a large, igneous outcrop at 4400 feet elevation. The rock outcrop is located on a northwest-facing ridge that is exposed to wind and fog interception. The site is fully exposed although the lower portion of the outcrop extends into Douglas-fir and fir forest. The Washington site has never been relocated and there is no habitat information included with the collection.

Threats: The Mt. Rainier site may be located near Longmire Campground and might be vulnerable to trampling and activities associated with recreation. Other threats to this species are collecting, quarrying, and air pollution.

Management Considerations:

- Maintain microsite characteristics and avoid disturbance at known sites.
- Route roads, trails, and recreation sites away from known sites
- Restrict collection of bryophytes at and near known sites.

Data Gaps and Information Needs:

- Relocating the Mt. Rainer National Park site would greatly increase our understanding of the habitat needs of the species and validate that the site is still extant.
- Current habitat and range information suggests that there is a great deal of potential habitat and substrate for this species that has not been surveyed.

I. Natural History

A. Taxonomic/Nomenclatural History

Encalypta brevicolla (Bruch, Schimper et Gümbel) Bruch *ex* Ångstr. subsp. *crumiana* (Horton) Crum & Anderson was described as a subspecies of *Encalypta brevicolla* by Horton (1983), then changed by Crum and Anderson (1989) to a variety. There are no additional recent synonyms. This species is placed in the order Encalyptales, family Encalyptaceae.

B. Species Description

1. Morphology (Horton 1983, Christy and Wagner 1996)

Plants of *Encalypta brevicolla* var. *crumiana* are erect, to 25 mm tall, with leaves that are light green at the shoot tips and dark green to blackish below. Leaves are contorted when dry, keeled with a prominent, shiny green or brown costa that is plainly spiny-papillose on the back toward the tip of the leaf. Leaf blades are relatively broad, oblong or obovate, hooded when dry and have cells with straight walls and simple papillae. Most leaves bear awns to 2 mm. Capsules are smooth or wrinkled with a dark red seta ranging from 2.5 to 17 mm long. Peristome teeth are # 0.4 mm long, smooth, and white to peach-colored.

Members of this genus are quite similar to each other. This variety is separated from the typical variety *E. brevicolla* var. *brevicolla* by its smooth peristome and poor ornamentation of the spores. *E. brevipes* has a short beak on the calyptra and lacks a peristome.

2. Reproductive Biology

Although no specific information has been located on the reproductive biology of *Encalypta brevicolla* var. *crumiana*, some generalizations may apply to this moss. Asexual reproduction is common in most bryophytes (Wyatt and Anderson 1984) and dispersal distance may be limited even in those species which reproduce by means of spores (Stoneburner et al. 1992). While it was previously speculated that the small spores of bryophytes were widely dispersed, few spores may actually survive the atmospheric environment (van Zanten and Pocs 1981). Limited dispersal ability of bryophytes has important conservation implications. Populations may not recolonize areas readily and outcrossing opportunities may be limited. Even in continuously distributed bryophyte taxa, it appears that gene flow may be highly restricted (Wyatt 1992).

3. Ecological Roles

Although the ecological roles of individual bryophyte species are often not well understood, in general bryophytes contribute to ecosystem function in a number of ways.
According to Schofield (1985) extensive mats of bryophytes can significantly influence the water balance of a forest by absorbing and releasing moisture, and recycling leached nutrients from the tree canopy into the ecosystem. Many micro-organisms such as protozoa, fungi, bacteria, and blue-green alga often are associated with bryophytes and some species have been found to have antibiotic properties in them (Richardson 1981).

Bryophytes also directly interact with other organisms by providing nesting material and food for birds, voles, and lemmings (Longton 1992, Slack 1988). Both aquatic and terrestrial bryophytes provide shelter and food for the larvae and adults of numerous species of invertebrates (Richardson 1981). Finally bryophytes are pioneer species that provide the first step in vascular

plant succession and they contribute to soil formation through the acceleration of physical and chemical weathering of rock material.

C. Range and Known Sites

This species is reported from two sites in the world. These include one in Pierce County, Washington near Longmire, Mt. Rainier National Park at 850 m elevation (2800 ft.) and one in Curry County, Oregon near Squirrel Peak at 1340 m elevation (4400 ft.). The date from the Mt. Rainier collection was 1937. The Squirrel Peak site was discovered in 1978. The Mt. Rainier site has not been relocated. The Squirrel Peak site was relocated in 2002 but possibly burned over in the Biscuit Fire.

D. Habitat Characteristics and Species Abundance

The Washington site has never been relocated and there is no habitat information included with the collection. Horton (1983) describes habitat for the species overall "as relatively exposed, windswept, xeric sites with protected microhabitat that might be more mesic tha(n) the surrounding macrohabitat". The following bryophytes are listed as associates: *Amphidium lapponicum, Bartramia ithyphylla, Encalypta ciliata, Polytrichastrum alpinum, Polytrichum piliferum, Racomitrium canescens* and *R. heterostichum*. Distinct habitat differences between the two varieties are not provided.

The Oregon site was most recently revisited in 2002. It is on a large, igneous outcrop at 4400 feet elevation. The rock outcrop is located on a ridge that is exposed to wind and fog interception. *Encalypta brevicolla* var. *crumiana* is limited to minor crevices and fractures on the northwest face of the outcrop. Some occurrences have partial, local shade and the bryoflora on the north face is indicative of relatively humid conditions but there is no seep immediately associated with the specific locations of *E. brevicolla* var. *crumiana*. The site is fully exposed although the lower portion of the outcrops extends downward into the Douglas-fir and fir forest. Other bryophytes at the location include *Dryptodon patens, Grimmia montana*, and *Racomitrium* spp. Vascular plant cover was very sparse but included *Sedum* sp., *Selaginella wallacei*, and *Cheilanthes gracillima*. *Encalypta ciliata* was observed at other similar outcrops in the vicinity of the Squirrel Peak site along with all of the other bryophytes listed by Horton above (Christy 2002).

Christy (2002) postulated that three characteristics of the Oregon site may be significant: "it (1) is situated at the very top of an open, exposed ridge with northwest aspect, (2) is in a saddle at the head of a valley, flanked by High Ridge to the northeast and Burnt Ridge to the southwest that may funnel air into the saddle, and (3) has an unobstructed exposure to marine airflow and fog from the northwest."

In 2002 about "50-75 gametophytes with about 12 capsules in four patches" were observed at Squirrel Peak (Christy 2002). This appears to be a decline from the last revisit of the site in 1994 and is certainly a decline from the first visit to the site in 1978 when the type collections were made. The population does not appear to have ever recovered to the original patch sizes from which at least three collections were made in 1978. There is no available information on the affect of the Biscuit fire on the site.

II. Current Species Situation

A. Status History

Encalypta brevicolla var. *crumiana* was not rated by the panels during the Forest Ecosystem Assessment Team process because of limited information (FEMAT 1993). Because it is endemic to the Pacific Northwest and appears to be very rare, this species was included in Survey and Manage survey strategies 1 and 3 under the Northwest Forest Plan (USDA and USDI 1994). This required that known sites be managed and that broad-scale surveys would be undertaken. An amendment to the Northwest Forest Plan in 2001 moved this species to a new category that represented rare species for which surveys were not considered practical (USDA and USDI 1994). Surveys conducted for this species resulted in it being dropped from Survey and Manage in 2002 because of the lack of association with old-growth forest.

Encalypta brevicolla var. *crumiana* is listed by the Oregon Natural Heritage Information Center (ORNHIC) and Washington Natural Heritage Program (WNHP) as G4T1/S1 in Oregon and Washington, and List 1 by ORNHIC for Oregon. These rankings indicate that this taxon is considered critically imperiled in both states by the Heritage Programs, and that this particular variety is rare throughout its range. WNHP also rates this taxon as endangered. This species was dropped from Survey and Manage in 2002 because of the lack of association with old-growth forest. This species is listed as Forest Service Region 6 Sensitive in Oregon and Washington and BLM Bureau Sensitive in Oregon.

B. Major Habitat and Viability Considerations

The major viability considerations for *Encalypta brevicolla* var. *crumiana* are management activities that directly impact habitat or populations and lead to the loss of populations. The Squirrel Peak site has not been revisited since the Biscuit Fire in 2002 to determine what effect the fire had on the population.

Air quality is a concern for bryophytes in general, although the level of air pollution at the Siskiyou site may not be a concern at this time. If still extant, the Mt. Rainier site would likely be affected by pollution from the Seattle area. 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.

C. Threats to the Species

Although it has not been recently relocated, the Mt. Rainier site was initially identified as occurring near Longmire Campground and might be vulnerable to trampling and activities associated with recreation. Modification of the local microclimate would also threaten this species. Other threats to this species are collecting, quarrying, and air pollution. Although the sensitivity of this taxon to air pollution is unknown, bryophytes are particularly vulnerable on fog-drenched ridges because aerosols concentrate pollutants.

D. Distribution Relative to Land Allocations

Both known sites are located on federal land. The Washington site is in Mt. Rainier National Park and the Squirrel Peak site appears to fall within Matrix lands on Siskiyou National Forest.

III. Management Goals and Objectives

Management for this species follows Forest Service Region 6 Sensitive Species (SS) policy (FSM 2670), and/or BLM Oregon and Washington Special Status Species (SSS) policy (6840).

For Oregon and Washington BLM administered lands, SSS policy details the need to manage for species conservation. Conservation is defined as the use of all methods and procedures which are necessary to improve the condition of SSS and their habitats to a point where their Special Status recognition is no longer warranted. Policy objectives also state that actions authorized or approved by the BLM do not contribute to the need to list species under the Endangered Species Act.

For Region 6 of the Forest Service, SS policy requires the agency to maintain viable populations of all native and desired non-native wildlife, fish, and plant species in habitats distributed throughout their geographic range on National Forest System lands. Management "must not result in a loss of species viability or create significant trends toward federal listing" (FSM 2670.32) for any identified SS.

IV. Habitat Management

A. Lessons from History

No information regarding this species is available at this time.

B. Identifying Species Habitat Areas

All known sites of *Encalypta brevicolla* var. *crumiana* on federal lands administered by the BLM and Forest Service in Washington and Oregon are identified as areas where the information in this Conservation Assessment could be applied. A species habitat area is defined as the suitable habitat occupied by a known population plus the surrounding habitat needed to support the species.

C. Managing in Species Habitat Areas

The objective of species habitat areas is to maintain habitat conditions such that species viability will be maintained at an appropriate scale, in accordance with agency policies. Specific management considerations include:

- Protect known sites by maintaining microsite characteristics and avoiding disturbance to the plants or their substrate.
- Route roads, trails, and recreation sites away from known sites.

- Permit scientific collections for deposition only at a recognized herbarium and only then if the population is of adequate size and condition and with concurrence of the Forest or BLM District botanist.
- Special forest product permits for moss collection should specify that collection may not occur at or near (up to one mile depending upon the habitat suitability) known sites.

V. Research, Inventory, and Monitoring Opportunities

The objective of this section is to identify opportunities to acquire additional information which could contribute to more effective species management. The content of this section has not been prioritized or reviewed as to how important the particular items are for species management. The inventory, research, and monitoring identified below are not required. These recommendations should be addressed by a regional coordinating body.

A. Data Gaps and Information Needs

- Conduct further attempts to relocate the Mt. Rainer National Park site. This would greatly increase our understanding of the habitat needs of the species and validate that the site is still extant.
- Inventory high priority habitat (Current habitat and range information suggests that there is a great deal of potential habitat and substrate for this species that has not been surveyed).

B. Research Questions

- What ecological factors characterize the habitat of *Encalypta brevicolla* var. *crumiana*?
- What are factors limiting to *E. brevicolla* var. *crumiana*?
- How different genetically is *E. brevicolla* var. *crumiana* from the common variety?
- Assuming populations are relocated, how do populations at Squirrel Peak and Mt. Rainier differ genetically? What can we learn about dispersal from this information?

C. Monitoring Opportunities and Recommendations

- Baseline population size and reproductive effort should be established at the known sites in order to document population trend.

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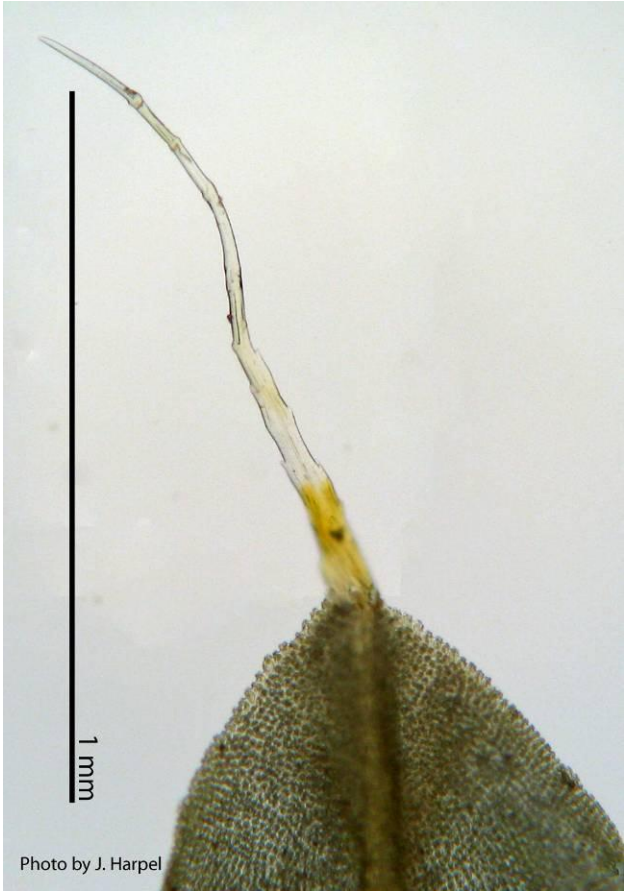
VII. Photos

All photos by Judy Harpel, under contract with the Oregon/Washington Bureau of Land Management.

Alar and basal cells

Upper medial cells

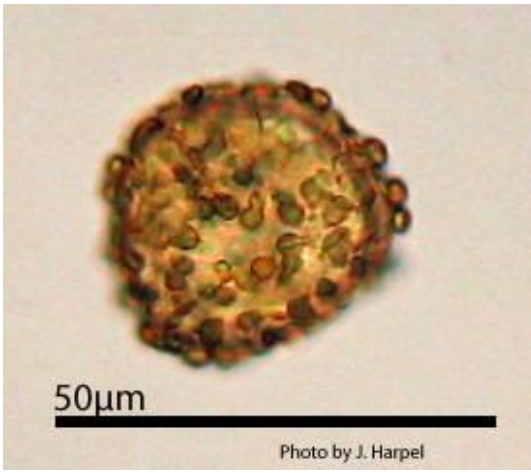
Leaf



Leaf apex

Calyptra

Whole mount wet



Spore

Conservation Assessment

for

Common scissorleaf

***Herbertus aduncus* (Dicks.) S.F. Gray)**

Originally issued November 1996
as Management Recommendations
Nancy Fredricks, Author

Reconfigured January 2005
John Davis

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SUMMARY

Preface: Since the transmittal of the Management Recommendations in 1996, new information has been collected regarding the range and habitat of *Herbertus aduncus.* The new information is included in this Conservation Assessment.

Species: *Herbertus aduncus* (Dicks.) S.F. Gray
Taxonomic Group: Bryophyte: Liverwort
Management Status: Bureau Assessment for the BLM in Oregon; no status with the US Forest Service. *Herbertus aduncus* is rated by the Oregon Natural Heritage Information Center (ORNHIC) as G5/S1 for Oregon and Washington and List 2 in Oregon, which indicates that it is considered critically imperiled within both states by ORNHIC, but more common or secure elsewhere. This species was formerly in Survey and Manage Category E.

Range: Within the Northwest Forest Plan area, *Herbertus aduncus* is known from localities in Northwest Washington, primarily on the Olympic Peninsula and in Oregon in the Columbia River Gorge and on two Coast Range peaks in Clatsop County. To the north, it is widespread and locally abundant in coastal southern Alaska and British Columbia.

Specific Habitat: *Herbertus aduncus* occurs in relatively exposed montane, windswept sites, in generally moist, protected microsites on rock outcrops, in crevices, and on ledges, wedged among stones or roots. It also festoons tree branches in some locations.

Threats: Primary threats to existing known sites include air pollution, and overcollecting. Additional threats include logging, road and trail construction, helicopter landings, campground construction, and collection of bryophytes as special forest products.

Management Considerations:

- Maintain habitat for this species at known sites by retaining shade, moist conditions, and protected microsites.
- Restrict collection of bryophytes at and near known sites.

Data Gaps and Information Needs:

- Conduct inventory in high probability coast range habitat to locate additional populations and collect ecological data including associated species, population size, and habitat characteristics.

I. Natural History

A. Taxonomic/Nomenclatural History

Herbertus has a rather convoluted taxonomic literature. The genus *Herbertus* is placed in the order Jungermanniales, family Herbertaceae (Stotler and Crandall-Stottler 1977).

Synonymy:
Herberta adunca (Dicks.) S. Gray
Herbertus aduncus (Dicks.) S.F. Gray, Nat. Arr. Brit. Pl. 1:705, 1821.
Jungermannia adunca Dicks., Plant. Crypt. Fasc. 3:12, pl. 8, fig. 8, 1793.
Schisma aduncum Dumort., Comm. Bot., p. 116, 1822.
Herberta adunca var. *b. Hutchinsiae* Schiffn., Lotos 60:54, 1912.
Schisma aduncum K. Mull., Rabenh. Krypt.-Fl. 6(2):324, 1914, in part (fig. 96).
Herberta hutchinsiae Evans, Bull. Torrey Bot. Club 44:214, pl. 8, 1917; K. Muller, Rabenh. Krypt.-Fl. 3rd ed., 6(1):560, fig. 159, 1954.

B. Species Description

1. Morphology: (Frye and Clark 1943: 177, Godfrey 1977:64, Pojar and MacKinnon 1994:438, Schuster 1966:712, Smith 1990:16, Hong et al. 1993:42)

Within the area of consideration, *Herbertus aduncus* is a rusty brown leafy liverwort which often forms extensive, loose, sometimes straggly mats, which may be pendulous from cliff-faces or bark. Stems are radially symmetric, almost thread-like or at least very slender, typically unbranched and rigid, the leafy ones erect or ascending to pendulous, 2-10 cm long (occasionally 15-20 cm). Stems are 150-250µm wide by 130-200µm high (9-12 cells high by 10-14 cells wide). Leaves are about 1 mm long, lance shaped, divided into two sharp lobes to halfway or more. Leaves are imbricate (overlapping), variable with different nutritional conditions, on slender stems only about 360-440µm wide (at and below level of sinus) x 900-1,040Φm long, with the lobes scarcely curved, on robust stems 480-650µm wide x 1250-1950Φm long with the lobes strongly falcate (curved like a sickle), postically secund (turned toward the substrate). Vittae (well developed band of elongated cells) of leaves distinct, extending to, or beyond the middle of the lobes, but not to the apices; cells of vittae elongated, near leaf base ca. (15)17-20(22) x 35-75Φm.
Underleaves are similar to leaves but slightly smaller, squarrose, the lobes subparallel to slightly divaricate. Male inflorescences are intercalary (somewhere below the apex). The bracts are mostly in 4-6 pairs, less deeply lobed than the leaves, with non-falcate lobes. The margins below the lobes are subentire to irregularly denticulate. Female inflorescence is terminal. Bracts (modified leaf associated with inflorescences) and bracteoles (modified underleaf of female inflorescences) are similar to each other, forming a compact "budlike" structure, especially before fertilization. Margins of bracts are closely denticulate to just above the level of the sinuses, with curved teeth. Perianth ovate, not strongly narrowed to the mouth, divided to the middle into six lanceolate, long-acuminate lobes. Capsule is ±ovoid.

The wiry stems, and upright leaves may superficially resemble a moss, but the two-lobed leaves help distinguish these species as members of the liverwort genus *Herbertus*. Hong et al. (1993) uses the following key characters to distinguish *H. aduncus* subsp. *aduncus* from *H. sakuraii*

subsp. *sakuraii*: *Herbertus aduncus* leaves more or less weakly imbricate, up to 3/4 to 4/5 bifid, bands of elongated cells (vitta) strongly developed, lobes narrow (less than 15 cells wide, with vitta consisting of 7-8 cells), linear-lanceolate, 4-6 times as long as wide, usually not glossy. *Herbertus sakuraii* subsp. *sakuraii* leaves are bifid to less than half with acuminate segments, strongly falcate, vitta well developed and extending entire portion of leaf lobes, margins of lobes weakly recurved; leaf disc suborbicular to broadly ovate, usually glossy.

Herbertus sakuraii differs in color and subtle leaf characters. *Herbertus sakuraii* is slightly larger on average than *H. aduncus*, with leaf bases that are broader and more rounded at the corners and underleaves that are more differentiated from the lateral leaves. It is typically golden-brown in color. Over the range of the species, there is considerable variation in color and habit (Schofield, pers. comm.). Pojar and MacKinnon (1994) describe *H. aduncus* as red to brown in color and Hong (1993) reports it as yellowish brown. Hong (1993) described *H. sakuraii* as strongly blackish brown to reddish brown, Schofield (pers. comm.) reports it as dark brown to rusty brown, while Christy and Wagner (1996) indicate it is typically golden-brown.

2. Reproductive Biology

Herbertus aduncus is diocious with both male and female reproductive structures produced on separate plants. Pojar and Mackinnon (1994*)* note that *H. aduncus* rarely produces sporophytes, however Schofield (1968) indicates that in suitable habitats (e.g., on *Alnus rubra*, *Chamaecyparis nootkatensis*, and *Pinus contorta*) it is often fertile, with both male and female tufts occurring on the same tree. However, on humid cliffs, over boulders, in bogs and fens reproductive structures have not been found. Like all bryophytes, a film or layer of water is required for sexual reproduction. Sporophytes have not been reported on *H. sakuraii* in North America (Schofield, pers. comm.).

3. Ecological Roles

Although the ecological roles of individual bryophyte species are often not well understood, in general bryophytes contribute to ecosystem function in a number of ways.
According to Schofield (1985) extensive mats of bryophytes can significantly influence the water balance of a forest by absorbing and releasing moisture, and recycling leached nutrients from the tree canopy into the ecosystem. Many micro-organisms such as protozoa, fungi, bacteria, and blue-green alga often are associated with bryophytes and some species have been found to have antibiotic properties in them (Richardson 1981).

Bryophytes also directly interact with other organisms by providing nesting material and food for birds, voles, and lemmings (Longton 1992, Slack 1988). Both aquatic and terrestrial bryophytes provide shelter and food for the larvae and adults of numerous species of invertebrates (Richardson 1981). Finally bryophytes are pioneer species that provide the first step in vascular plant succession and they contribute to soil formation through the acceleration of physical and chemical weathering of rock material.

C. Range and Known Sites

Within the Northwest Forest Plan area, *Herbertus aduncus* is known from at least ten localities. In Washington there are several locations in Olympic National Park in Clallam and Jefferson Counties. There is also at least one site on private land on the Olympic Peninsula. There are

reported sites on the Mt. Baker-Snoqualmie National Forest in and near the Town Wall in Snohomish County. In Oregon, there are sites on Onion Peak and Saddle Mountain in Clatsop County. There are also known sites at Oneonta and Wahkeena Creeks in the Columbia River Gorge on the Oregon side of the Columbia River. There is a third site in the Columbia Gorge near Latourell Falls that has never been relocated. To the north, it is widespread and locally abundant in coastal southern Alaska and British Columbia, becoming rare south of the Canadian border. Globally, it is also known from Europe, Japan, and Formosa.

D. Habitat Characteristics and Species Abundance

Herbertus aduncus occurs in generally moist, protected microsites on basaltic rock outcrops, in crevices, and on ledges, wedged among stones or roots and on trees in some areas where it can form large mats. On Saddle Mountain, it is shaded by trees near the cliff base. Schofield (1968) describes immense, red-brown hemispheres and masses of this species that entirely encircle the conifer or deciduous tree. Elevations range from 100 to 215 m (328 to 700 ft.) in Washington and from 750 to 945 m (2470 to 3090 ft.) at Saddle Mountain in Oregon.

II. Current Species Situation

A. Status History

Herbertus aduncus was not rated by the panels convened by the Forest Ecosystem Management Assessment Team because insufficient information was available. It was originally included in survey strategies 1 and 3 under the Northwest Forest Plan (USDA & USDI 1994). An amendment to the Northwest Forest Plan in 2001 moved this species to a new category that represented rare species for which surveys were not considered practical (USDA and USDI 2001). Subsequent strategic surveys resulted in the species moving to a different category the following year because of uncertainty regarding its association with old-growth.

Herbertus aduncus is rated by the Oregon Natural Heritage Information Center (ORNHIC) as G5/S1 in Oregon and Washington and List 2 in Oregon, which indicates that it is considered critically imperiled within both states by ORNHIC, but more common or secure elsewhere (ORNHIC 2004). This species was formerly in Survey and Manage Category E. *Herbertus aduncus* is a Bureau Assessment for the BLM in Oregon. It has no status with the US Forest Service.

B. Major Habitat and Viability Considerations

Herbertus aduncus is extremely rare within our range and the limited number of known sites makes it vulnerable to stochastic events. Disturbance of known sites poses the greatest threat to these species. The limited amount of habitat within the suspected range of the species may be a major habitat consideration.

C. Threats to the Species

Most known sites are not in areas scheduled for timber harvest or other management activities. Collecting may pose a threat to currently known sites. Other threats could include quarrying, timber harvest, road building, and recreational activities. In general, bryophytes are sensitive to air pollution.

D. Distribution Relative to Land Allocations

The majority of the *Herbertus aduncus* sites are located within the Columbia River Gorge National Scenic Area in Oregon. Two sites occur on non-federal lands in Washington and Oregon.

III. Management Goals and Objectives

Management for this species follows Forest Service Region 6 Sensitive Species (SS) policy (FSM 2670), and/or BLM Oregon and Washington Special Status Species (SSS) policy (6840).

For Oregon and Washington BLM administered lands, SSS policy details the need to manage for species conservation. Conservation is defined as the use of all methods and procedures which are necessary to improve the condition of SSS and their habitats to a point where their Special Status recognition is no longer warranted. Policy objectives also state that actions authorized or approved by the BLM do not contribute to the need to list species under the Endangered Species Act.

For Region 6 of the Forest Service, SS policy requires the agency to maintain viable populations of all native and desired non-native wildlife, fish, and plant species in habitats distributed throughout their geographic range on National Forest System lands. Management "must not result in a loss of species viability or create significant trends toward federal listing" (FSM 2670.32) for any identified SS.

IV. Habitat Management

A. Lessons from History

There is a considerable literature on the declines of bryophytes in Europe. Rapid decreases and fragmentation of primeval forests have caused a serious threat to bryophytes (Laaka 1992). In addition, air pollution (particularly sulfur 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; and 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. Identifying Species Habitat Areas

All known sites of *Herbertus aduncus* on federal lands administered by the Bureau of Land Management and/or Forest Service Region 6 in Washington and Oregon are identified as areas where the information in this Conservation Assessment could be applied. A species habitat area is defined as the suitable habitat occupied by a known population plus the surrounding habitat needed to support the species.

C. Managing in Species Habitat Areas

The objective of species habitat areas is to maintain habitat conditions such that species viability will be maintained at an appropriate scale, in accordance with agency policies. Specific management considerations include:

- Maintain habitat for these species at known sites by retaining shade, moist conditions, and protected microsites. Avoid disturbance of rock substrate associated with the plants.
- Route roads, trails, and recreation sites away from known sites.
- Avoid populations during trail maintenance or reconstruction activities.
- Discourage recreation activities that could impact known sites.
- Permit scientific collections for deposition only at a recognized herbarium and only then if the population is of adequate size and condition and with concurrence of the Forest or BLM District botanist.
- Special forest product permits for moss collection should specify that collection may not occur at or near (up to one mile depending upon the habitat suitability) known sites.

V. Research, Inventory, and Monitoring Opportunities

The objective of this section is to identify opportunities to acquire additional information which could contribute to more effective species management. The content of this section has not been prioritized or reviewed as to how important the particular items are for species management. The inventory, research, and monitoring identified below are not required. These recommendations should be addressed by a regional coordinating body.

A. Data Gaps and Information Needs

- Inventory high priority habitat: Potential suitable habitat occurs on the Olympic Peninsula, and in the coast ranges of Oregon. Other coast range peaks which may also provide suitable habitat include, Sugar Loaf (The Nature Conservancy) and Nicolai Mountain (Clatsop State Forest).
- It is unknown if there is suitable habitat for *Herbertus aduncus* in the Cascades south of the Index, Washington known site.

B. Research Questions

- How different genetically are *Herbertus aduncus* and *H. sakuraii*?
- What are the ecological requirements of these species?

C. Monitoring Opportunities and Recommendations

- Monitor the impacts of recreational activity on populations near hiking trails.

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Conservation Assessment

for

Pacific scissorleaf

***Herbertus sakuraii* (Warnst.) Hattori**

Originally issued November 1996
as Management Recommendations
Nancy Fredricks, Author

Reconfigured January 2005
John Davis

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SUMMARY

Preface: Since the transmittal of the Management Recommendations in 1996, there has been no new information collected regarding the range or habitat of *Herbertus sakuraii*.

Species: *Herbertus sakuraii* (Warnst.) Hattori
Taxonomic Group: Bryophyte: Liverwort
Management Status: Bureau Assessment for the BLM in Oregon; US Forest Service Region 6 Sensitive in Oregon. *Herbertus sakuraii* is rated by the Oregon Natural Heritage Information Center (ORNHIC) as G4/S1 and List 2 in Oregon, which indicates that it is considered critically imperiled within the state by ORNHIC but more common or secure elsewhere (ORNHIC 2004). The species in not on the Washington Natural Heritage Program list. This species was dropped from the Survey and Manage list in 2001 because of apparent lack of association with old-growth.

Range: *Herbertus sakuraii* has been reported only from Saddle Mountain State Park, Clatsop Co, Oregon.

Specific Habitat: *Herbertus sakuraii* occurs on both inorganic and organic substrates, typically found on moist, shady cliffs.

Threats: Primary threats to existing known sites include air pollution and overcollecting. Additional threats include logging, road and trail construction, helicopter landings, campground construction, and collection of bryophytes as special forest products.

Management Considerations:

- Maintain habitat for this species at known sites by retaining shade, moist conditions, and protected microsites.
- Restrict collection of bryophytes at and near known sites.

Data Gaps and Information Needs:

- Conduct inventory in high probability coast range habitat to locate additional populations and collect ecological data including associated species, population size, and habitat characteristics.

I. Natural History

A. Taxonomy and Nomenclature

Herbertus has a rather convoluted taxonomic literature and the synonymy of *H. aduncus* and *H. sakuraii* is extensive. The genus *Herbertus* is placed in the order Jungermanniales, family Herbertaceae (Stotler and Crandall-Stotler 1977). According to (Stotler and Crandall-Stottler 1977) and Schuster (1966) *H. sakuraii* Hatt. is combined into *H. aduncus* subsp. *aduncus*. Although currently, Schofield (2002) recognizes *H. sakuraii* as one of the four species found within Western North America. Therefore for the purpose of this reconfigured document, we have chosen to treat the two species as separate.

Synonymy:
Herbertus aduncus (Dicks.) S.F. Gray, Nat. Arr. Brit. Pl. 1:705, 1821.
Jungermannia adunca Dicks., Plant. Crypt. Fasc. 3:12, pl. 8, fig. 8, 1793.
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Jungermannia juniperina var. *b*. Hook., Brit. Jungerm., Pl. 4, 1816 (in part).
Herbertus aduncus Gray, Nat. Arr. Brit. Pl. 1:705, 1821; Underwood, Bot Gaz. 14:195, 1889 (not of Evans, 1917b; Macvicar, 1926; Schuster, 1957d, etc.).
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Herberta adunca var. *b. Hutchinsiae* Schiffn., Lotos 60:54, 1912.
Schisma aduncum K. Mull., Rabenh. Krypt.-Fl. 6(2):324, 1914, in part (fig. 96).
Herberta hutchinsiae Evans, Bull. Torrey Bot. Club 44:214, pl. 8, 1917; K. Muller, Rabenh. Krypt.-Fl. 3rd ed., 6(1):560, fig. 159, 1954.
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B. Species Description

1. Morphology: (Frye and Clark 1943: 177, Godfrey 1977:64, Pojar and MacKinnon 1994:438, Schuster 1966:712, Smith 1990:16, Hong et al. 1993:42).

The wiry stems and upright leaves may superficially resemble a moss, but the two-lobed leaves help distinguish this species as a member of the liverwort genus *Herbertus*. Hong et al. (1993) uses the following key characters to distinguish *H. aduncus* subsp. *aduncus* from *H. sakuraii* subsp. *sakuraii*: *Herbertus aduncus* leaves more or less weakly imbricate, up to 3/4 to 4/5 bifid,

bands of elongated cells (vitta) strongly developed, lobes narrow (less than 15 cells wide, with vitta consisting of 7-8 cells), linear-lanceolate, 4-6 times as long as wide, usually not glossy. *Herbertus sakuraii* subsp. *sakuraii* leaves are bifid to less than half with acuminate segments, strongly falcate, vitta well developed and extending entire portion of leaf lobes, margins of lobes weakly recurved; leaf disc suborbicular to broadly ovate, usually glossy.

Herbertus sakuraii differs in color and subtle leaf characters. *H. sakuraii* is slightly larger on average than *H. aduncus*, with leaf bases that are broader and more rounded at the corners and underleaves that are more differentiated from the lateral leaves. It is typically golden-brown in color. Over the range of the species, there is considerable variation in color and habit (Schofield, pers. comm.). Pojar and MacKinnon (1994) describe *H. aduncus* as red to brown in color and Hong (1993) reports it as yellowish brown. Hong (1993) described *H. sakuraii* as strongly blackish brown to reddish brown, Schofield (pers. comm.) reports it as dark brown to rusty brown, while Christy and Wagner (1996) indicate it is typically golden-brown.

2. Reproductive Biology

Sporophytes have not been reported on *H. sakuraii* in North America (Schofield, pers. comm.). Like all bryophytes, a film or layer of water is required for sexual reproduction. It may disperse by fragmentation.

3. Ecological Roles

Although the ecological roles of individual bryophyte species are often not well understood, in general bryophytes contribute to ecosystem function in a number of ways.
According to Schofield (1985) extensive mats of bryophytes can significantly influence the water balance of a forest by absorbing and releasing moisture, and recycling leached nutrients from the tree canopy into the ecosystem. Many micro-organisms such as protozoa, fungi, bacteria, and blue-green alga often are associated with bryophytes and some species have been found to have antibiotic properties in them (Richardson 1981).

Bryophytes also directly interact with other organisms by providing nesting material and food for birds, voles, and lemmings (Longton 1992, Slack 1988). Both aquatic and terrestrial bryophytes provide shelter and food for the larvae and adults of numerous species of invertebrates (Richardson 1981). Finally bryophytes are pioneer species that provide the first step in vascular plant succession and they contribute to soil formation through the acceleration of physical and chemical weathering of rock material.

C. Range and Known Sites

In the United States portion of the Pacific Northwest, *Herbertus sakuraii* subsp. *sakuraii* has been reported only from Saddle Mountain, Clatsop Co., Oregon. It also occurs in Alaska, British Columbia, Japan, Formosa, and Nepal.

D. Habitat Characteristics and Species Abundance

The known site of *Herbertus sakuraii* on Saddle Mountain is on relatively open cliff ledges within a mixed Douglas-fir, Sitka spruce, silver fir, and western hemlock forest. This occurs within the Sitka spruce zone of the Coast Range. It inhabits damp crevices of shaded humid

north-facing slope near the ridge top, from 750 to 945 m (2470 to 3090 ft.) in elevation. This species occurs on cliffs and the degree of association with late-successional and old-growth forest is not clear. This species is rare at this site.

II. Current Species Situation

A. Status History

Herbertus sakuraii was not rated by the panels convened by the Forest Ecosystem Management Assessment Team because insufficient information was available. It was originally included as a Survey and Manage species (USDA & USDI 1994) but dropped in 2001 because of its apparent lack of association with old-growth stands (USDA & USDI 2001).

Herbertus sakuraii is rated by the Oregon Natural Heritage Information Center (ORNHIC) as G4/S1 and List 2 in Oregon, which indicates that it is considered critically imperiled within the state by ORNHIC but more common or secure elsewhere (ORNHIC 2004). The species in not on the Washington Natural Heritage Program list. This species was dropped from the Survey and Manage list in 2001 because of apparent lack of association with old-growth. *Herbertus sakuraii* is a Bureau Assessment for the BLM in Oregon and Sensitive for the US Forest Service in Oregon.

B. Major Habitat and Viability Considerations

Herbertus sakuraii is extremely rare within Oregon and Washington and the limited number of known sites makes it vulnerable to stochastic events. Disturbance of known sites poses the greatest threat to these species. The limited amount of habitat within the suspected range of the species may be a major habitat consideration.

C. Threats to the Species

Most known sites are not in areas scheduled for timber harvest or other management activities. Collecting may pose a threat to the currently known site. Other threats in other potential habitat could include quarrying, timber harvest, road building, and recreational activities. In general, bryophytes are sensitive to air pollution.

D. Distribution Relative to Land Allocations

In the United States portion of the Pacific Northwest, only one known site exists for *Herbertus sakuraii.* It is known only from Saddle Mountain State Park in Clatsop Co., Oregon (on non-federal land).

III. Management Goals and Objectives

Management for this species follows Forest Service Region 6 Sensitive Species (SS) policy (FSM 2670), and/or BLM Oregon and Washington Special Status Species (SSS) policy (6840).

For Oregon and Washington BLM administered lands, SSS policy details the need to manage for species conservation. Conservation is defined as the use of all methods and procedures which are necessary to improve the condition of SSS and their habitats to a point where their Special Status recognition is no longer warranted. Policy objectives also state that actions authorized or approved by the BLM do not contribute to the need to list species under the Endangered Species Act.

For Region 6 of the Forest Service, SS policy requires the agency to maintain viable populations of all native and desired non-native wildlife, fish, and plant species in habitats distributed throughout their geographic range on National Forest System lands. Management "must not result in a loss of species viability or create significant trends toward federal listing" (FSM 2670.32) for any identified SS.

IV. Habitat Management

A. Lessons from History

There is a considerable literature on the declines of bryophytes in Europe. Rapid decreases and fragmentation of primeval forests have caused a serious threat to bryophytes (Laaka 1992). In addition, air pollution (particularly sulfur 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; and 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. Identifying Species Habitat Areas

All known sites of *Herbertus sakuraii* on federal lands administered by the Forest Service and the Bureau of Land Management in Washington and Oregon are identified as areas where the information in this Conservation Assessment could be applied. A species habitat area is defined as the suitable habitat occupied by a known population plus the surrounding habitat needed to support the species.

C. Managing in Species Habitat Areas

The objective of species habitat areas is to maintain habitat conditions such that species viability will be maintained at an appropriate scale, in accordance with agency policies. Specific management considerations include:

- Maintain habitat for this species at known sites by retaining shade, moist conditions, and protected microsites. Avoid disturbance of rock substrate associated with the plants.
- Route roads, trails, and recreation sites away from known sites.
- Avoid populations during trail maintenance or reconstruction activities.
- Discourage recreation activities that could impact known sites.
- Permit scientific collections for deposition only at a recognized herbarium and only then if the population is of adequate size and condition and with concurrence of the Forest or BLM District botanist.
- Special forest product permits for moss collection should specify that collection may not occur at or near (up to one mile depending upon the habitat suitability) known sites.

V. Research, Inventory, and Monitoring Opportunities

The objective of this section is to identify opportunities to acquire additional information which could contribute to more effective species management. The content of this section has not been prioritized or reviewed as to how important the particular items are for species management. The inventory, research, and monitoring identified below are not required. These recommendations should be addressed by a regional coordinating body.

A. Data Gaps and Information Needs

- Inventory high priority habitat: Potential habitat for additional sites occurs on the Olympic Peninsula, and in the coast ranges of Oregon. Other coast range peaks, which may also provide suitable habitat, include Sugar Loaf (The Nature Conservancy) and Nicolai Mountain (Clatsop State Forest).

B. Research Questions

- How different genetically are *Herbertus aduncus* and *H. sakuraii*?
- What are the ecological requirements of this species?

C. Monitoring Opportunities and Recommendations

- Monitor the impacts of recreational activity on populations near hiking trails.

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Conservation Assessment
for
slender clawleaf
***Kurzia makinoana* (Steph.) Grolle**

Originally issued November 4, 1996,
as Management Recommendations
Nancy Fredricks, Author

Reconfigured January 2005
Rick Dewey

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SUMMARY

Preface: Since the transmittal of the Management Recommendations in 1996, new information has been collected regarding the range, habitat and taxonomy of *Kurzia makinoana*. The new information is included within this document.

Species: *Kurzia makinoana* (Steph.) Grolle
Taxonomic Group: Bryophyte: Liverwort
Management Status: Bureau Assessment for the BLM in Oregon; no status with the US Forest Service. *Kurzia makinoana* is rated by the Oregon Natural Heritage Information Center (ORNHIC) as G2G3Q/S1 for Oregon and Washington and List 2 in Oregon which indicates that it is considered critically imperiled within both states by ORNHIC, but may be more common or secure elsewhere. This species was formerly in Survey and Manage Category B.

Range: In Oregon, Washington, and California, *Kurzia makinoana* is known from only a few coastal or near-coastal localities. It occurs on the Olympic Peninsula, including Olympic National Park, Clallam County, and Mt. Baker-Snoqualmie National Forest, Snohomish County, Washington. It also occurs on the Coos Bay BLM District, Coos County, Oregon, and in Mendocino, Humboldt, and Del Norte Counties, California.

Specific Habitat: *Kurzia makinoana* occurs on well-shaded, rotten wood and humic soil at low elevations, especially on stream terraces, floodplains and other cool, moist forest locations sometimes exceeding the width of Riparian Reserves. It is reported from wetlands in other portions of its range. In Washington, it is closely associated with old-growth forests, particularly near riparian areas.

Threats: Activities that alter the hydrology, coarse woody debris substrate, or microsite conditions would threaten this species. Liverworts are highly susceptible to desiccation and are often specific in their substrate requirements. Logging, road construction, campground construction, recreational trampling, scientific collection and collection of special forest products in the vicinity of known sites may impact this species.

Management Considerations:

- Maintain microsite conditions (i.e., shade, moist conditions) at known sites on stream terraces, floodplains, and riparian areas.
- Avoid disturbance of well-rotted wood and humic soil and modification of canopy.
- Restrict collection of bryophytes at and near known sites.

Data Gaps and Information Needs:

- Conduct inventory to locate additional populations.
- Revisit known sites to verify population status and document ecological conditions.

I. Natural History

A. Taxonomic/Nomenclatural History

Kurzia makinoana (Steph.) Grolle Rev. Bryol. et Lichén 32:171 1964
This tiny liverwort is placed in the division Hepatophyta, class Jungermanniopsida, order Jungermanniales, family Lepidoziaceae (Stotler and Crandall 1977). Inoue (1974) recognizes four species of *Kurzia* in the northern temperate-boreal zone. Schuster (1969) concurs, recognizing *K. sylvatica* and *K. setacea* (=*K. pauciflora*) within North America and noting that *K. trichoclados* appears confined to Europe while *K. makinoana* may be restricted to Japan. Smith (1990) and Paton (1999) recognize *K. sylvatica*, *K. pauciflora* (= *K. setacea*) and *K. trichoclados* in Europe. Hattori and Mizutani (1958) regard *K. sylvatica* and *K. trichoclados* as conspecific with *K. makinoana*, and hence, recognize *K. makinoana* and *K. setacea* as the only distinct *Kurzia* species within the northern temperate-boreal zone. Hong (1988) recognizes *K. sylvatica*, *K. setacea* and *K. trichoclados* in western North America, noting multiple sites of the former two taxa in British Columbia. Schofield (1968) notes numerous sites of *K. makinoana* from British Columbia, but in more recent discussions with John Christy (Schofield 2003), "Any records of *Kurzia makinoana* from N(orth) A(merica) should be treated with skepticism, but (*Kurzia*) *pauciflora* (= *Kurzia setacea*) and (*Kurzia*) *sylvatica*, at least are clearly on both coasts." Godfrey (1969) reports *K. makinoana* and *K. setacea* from southwestern British Columbia, with determination of the former species based on material examined by Inoue. Whittemore (1999) lists *K. sylvatica* for California but notes, that "Populations of this species from the Pacific Coast are often treated as a distinct species under the name *Kurzia makinoana* (Steph.) Grolle." There currently is not a consensus among experts as whether *K. makinoana* and *K. sylvatica* are separable species or, accepting that they are, whether one or both taxa are present in western North America. If *K. makinoana* and *K. sylvatica* are to be regarded as conspecific, then it appears appropriate that the latter be regarded as a synonym of the former. The concept of *K. makinoana* appears to have been first published in 1897 (as *Lepidozia makinoana* Steph.), while that of *K. sylvatica* appears to have been first published in 1904 (as *Lepidozia sylvatica* Evans). In this document, the name *K. makinoana* is applied in a broad sense, including the concepts of both *K. makinoana* (Steph.) Grolle and *K. sylvatica* (Evans) Grolle.

Synonymy (from Schuster 1980)
Lepidozia makinoana Steph., Bull. Herb. Boissier 5:94, 1897.
Lepidozia exigua Steph., Spec. Hep. 3:626, 1909.
Lepidozia tosana Steph., ibid. 629, 1909.
Microlepidozia makinoana Hatt., Jour. Hattori Bot. Lab. no. 7:42, 1952.
Kurzia makinoana Grolle, Rev. Bryol. et Lichén. 32(1-4):171, [1963] 1964.
Lepidozia sylvatica Evans, Rhodora 6: 186, 1904.
Microlepidozia sylvatica Joerg., Bergens Mus. Skrifter 16: 304, 1934; Schuster, Hep & Anth. N. Am. 2: 49, 1969.
Kurzia sylvatica Grolle, Herzogia 3: 77, 1973.

B. Species Description

1. Morphology (Hattori and Mizutani 1958, Hong 1988, Inuoe 1974, Schuster 1980, Christy and Wagner 1996)

Kurzia makinoana is a tiny leafy liverwort, dull or deep green to brownish-green in color, dense, aromatic, occurring in interwoven, tufts or patches (occasionally creeping as scattered stems among other bryophytes). Stems are 5-20 mm long, threadlike, creeping to ascending, irregularly to more or less regularly pinnately to bipinnately branched, occasionally terminating in slender, runnerlike branches with reduced leaves (flagella); leafy branches usually lateral; flagella usually behind, toward the substrate (postical). Rhizoids are sparsely developed, at the bases of the lower underleaves, more frequent on flagella. Leaves are barely contiguous to imbricate, transversely inserted, arising from segments (merophytes) 4 cells broad, the basal portion spreading but lobes usually more or less suberect to erect, or even slightly incurved, thus the leaves look typically hand-like, somewhat cupped. Leaves are 3-4 lobed; lobes entire, subulate
to narrowly lanceolate, usually somewhat incurved, dorsal lobes of stem leaves reduced and formed of 2 (3) strongly elongated cells, or of 2 (3) cells broad at base and 1-2 cells high, the lobe thus 2-4 (5) celled, or all lobes more or less equal. Branch leaves are similar to stem leaves but smaller and more often 2-3 lobed. Cuticle dull when dry; oil bodies absent, except in medullary (and less often in cortical) stem cells, occasionally few in leaf cells (small, subspherical, glistening, when present). Underleaves of stem are usually 3(4)-lobed, 1-2 lobes often much reduced. Male inflorescence are on short postical (more rarely lateral) branches; bracts in 4-5 pairs, strongly concave, divided 0.5-0.65 their length into two ovate to triangular, acuminate lobes, whose margins are sharply spinose-dentate. Female inflorescence are on a very short postical branch, usually with no leaves except for the closely sheathing bracts, ovate to 2 times as long as wide, 2(3) lobed, with few and short teeth, one margin usually without teeth, lobes 0.25-0.4 of leaf length. Perianth bears only 1-3-celled teeth at mouth.

Kurzia species may be confused with *Blepharostoma* (which has more filamentous leaf lobes that are narrow and uniseriate to the base) and *Cephaloziella* (which has bilobed leaves and small or obsolete underleaves). As noted above, in this document, the name *K. makinoana* is being applied in a broad sense, combining the narrower concepts of both *K. makinoana* and *K. sylvatica*. It may be useful to note in passing that, according to Inoue (1974) and Schuster (1980), vegetative *K. makinoana* can be distinguished from *K. sylvatica* by the reduced dorsal lobes of the leaves (composed of 4-5 cells vs. the typical 8+ cells of the other lobes; *K. sylvatica* leaf lobes are more or less equal, typically 8+ cells each), and the thicker walls of the stem cortical cells. It should be noted as well, that material recently collected on the Olympic Peninsula, Washington (2000) and on the Coos Bay BLM District, Oregon (1999, 2004), generally agrees with the vegetative description provided for *K. makinoana* (Steph.) Grolle by Schuster (1980).

2. Reproductive Biology

Kurzia makinoana is dioicious and requires water for sexual reproduction. Little information is available concerning asexual reproduction in this species.

3. Ecological Roles
Although the ecological roles of individual bryophyte species are often not well understood, in general bryophytes contribute to ecosystem function in a number of ways.
According to Schofield (1985) extensive mats of bryophytes can significantly influence the water balance of a forest by absorbing and releasing moisture, and recycling leached nutrients from the tree canopy into the ecosystem. Many micro-organisms such as protozoa, fungi, bacteria, and blue-green alga often are associated with bryophytes and some species have been found to have antibiotic properties in them (Richardson 1981).

Bryophytes also directly interact with other organisms by providing nesting material and food for birds, voles, and lemmings (Longton 1992, Slack 1988). Both aquatic and terrestrial bryophytes provide shelter and food for the larvae and adults of numerous species of invertebrates (Richardson 1981). Finally bryophytes are pioneer species that provide the first step in vascular plant succession and they contribute to soil formation through the acceleration of physical and chemical weathering of rock material.

C. Range and Known Sites
Kurzia makinoana is known from coastal sites in northern California, Oregon, Washington, and British Columbia, as well as Japan. In Oregon, Washington, and California, *K. makinoana* is known from a few coastal or near-coastal localities in Olympic National Park, Clallam County, and Mt. Baker-Snoqualmie National Forest, Snohomish Co., Washington, Coos Bay BLM District, Coos County, Oregon, and in Mendocino, Humboldt, and Del Norte Counties, California.

D. Habitat Characteristics and Species Abundance
Kurzia makinoana occurs on well-shaded, rotten wood and humic soil at low elevations, especially on stream terraces, floodplains, and other cool, moist forest locations. The two known sites in Washington occur in old-growth forests, near riparian areas, at low elevations 100 m (328 ft.) and 335 m (1,100 ft.), elevation, respectively. Each of these sites is within 40 km (25 miles) of the coast. At the Oregon site it occurs on humic material at the edge of a coastal lake where, depending on time of year, it is submerged, emergent, or merely moist. California populations are reported from mires or small bogs. According to the bryophyte viability panel convened by the Forest Ecosystem Management Assessment Team, *K. makinoana* is reported from Ft. Bragg (Del Norte County), where it is often associated with the pitcher plant *Darlingtonia* and from Redwood National Park (bryophyte panel notes, June 1993). Although most of the collections in British Columbia are from shaded humus banks in forests, the Queen Charlotte Islands collections are from damp humus in bogs (Hong 1988).

II. Current Species Situation

A. Status History
Kurzia makinoana was rated by the bryophyte panels convened by the Forest Ecosystem Management Analysis Team (1993). This species was included in survey strategies 1 and 2 under the Northwest Forest Plan (USDA and USDI 1994) which required surveys prior to

ground-disturbing activities and management of known sites. In 2001 this species moved to Category B which dropped the pre-project survey requirement (USDA and USDI 2001).

Kurzia makinoana is rated by the Oregon Natural Heritage Information Center (ORNHIC) as G2G3Q/S1 for Oregon and Washington and List 2 in Oregon which indicates that it is considered critically imperiled within both states by ORNHIC, but may be more common or secure elsewhere. The G2G3Q ranking reflects that taxonomic questions that are addressed earlier in this document. This species was formerly in Survey and Manage Category B. *Kurzia makinoana* is considered Bureau Assessment for the BLM in Oregon. It has no status with the US Forest Service.

B. Major Habitat and Viability Considerations

Very little is known about the abundance, distribution, and ecology of this species in the region. Historical locations of this species may have been extirpated from low-elevation forests on non-federal lands, due to logging and land clearing. Reduction of habitat or extirpation of populations on non-federal lands at low elevations increases the importance of populations on federal lands for the continued viability of this species. Riparian Reserves may be adequate to protect some occurrences of this species, but Norris (pers. com.) indicates that the species occurs on broad floodplains and stream terraces that may fall outside of the immediate riparian area. This should be considered if adjustments are made to interim Riparian Reserve widths during Watershed Analysis.

C. Threats to the Species

Threats to *Kurzia makinoana* include any alteration of hydrology or of habitat that results in desiccation or changes in microclimate. In addition, any activity that would remove or decrease availability of coarse woody debris may reduce potential habitat for this species. Liverworts are highly susceptible to desiccation, and availability of suitable substrate is limiting for bryophytes that inhabit rotten logs. Logging, road construction, campground construction, and collection of special forest products in the vicinity of known sites may threaten this species.

Acid precipitation may be a threat to this species, although plants buffered by forest canopy may be less vulnerable than epiphytic ones. Being located on the ground, *K. makinoana* would be removed from areas of highest deposition (e.g. twigs and branches in canopy).

D. Distribution Relative to Land Allocations

Known sites of *Kurzia makinoana* are documented within a Late-Successional Reserve, a BLM Area of Critical Environmental Concern, a Forest Service Research Natural Area and within Olympic National Park. The California site is located within in a State Park.

III. Management Goals and Objectives

Management for this species follows Forest Service Region 6 Sensitive Species (SS) policy (FSM 2670), and/or BLM Oregon and Washington Special Status Species (SSS) policy (6840).

For Oregon and Washington BLM administered lands, SSS policy details the need to manage for species conservation. Conservation is defined as the use of all methods and procedures which are necessary to improve the condition of SSS and their habitats to a point where their Special Status recognition is no longer warranted. Policy objectives also state that actions authorized or approved by the BLM do not contribute to the need to list species under the Endangered Species Act.

For Region 6 of the Forest Service, SS policy requires the agency to maintain viable populations of all native and desired non-native wildlife, fish, and plant species in habitats distributed throughout their geographic range on National Forest System lands. Management "must not result in a loss of species viability or create significant trends toward federal listing" (FSM 2670.32) for any identified SS.

IV. Habitat Management

A. Lessons from History

There is considerable literature on the declines of bryophytes in Europe. Rapid decreases and fragmentation of primeval forests have caused a serious threat to bryophytes (ecologically similar to *Kurzia makinoana*) that grow on decaying wood (Laaka 1992). In addition, air pollution (particularly sulfur 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; and 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. Identifying Species Habitat Areas

Known sites are documented from the immediate coast or no more than 25 miles inland. Unless additional populations are located farther inland, the range of the species in Oregon and Washington should be considered to extend from the coast to 60 miles inland on the Olympic, Mt. Baker-Snoqualmie, Siuslaw, and Siskiyou National Forests, as well as the Salem, Eugene, and Coos Bay BLM Districts.

All known sites on federal lands administered by the BLM and/or Forest Service Region 6 in Washington and Oregon are identified as areas where the information in this Conservation Assessment could be applied. A species habitat area is defined as the suitable habitat occupied by a known population plus the surrounding habitat needed to support the species.

C. Managing in Species Habitat Areas

The objective of species habitat areas is to maintain habitat conditions such that species viability will be maintained at an appropriate scale, in accordance with agency policies. Specific management considerations include:

- Maintain microsite conditions (i.e., shade, moist conditions) at known sites on stream terraces, floodplains, and riparian areas.
- Maintain adequate coarse woody debris substrates at the known sites.
- Avoid disturbance of well-rotted wood and humic soil and modification of canopy.
- During Watershed Analysis, consider designating appropriate widths of Riparian Reserves in order to maintain suitable habitat at known sites. Where the species occurs on broad floodplains or terraces, this may be greater than the ROD-prescribed Riparian Reserves.
- Permit scientific collections for deposition only at a recognized herbarium and only then if the population is of adequate size and condition and with concurrence of the Forest or BLM District botanist.
- Special forest product permits for moss collection should specify that collection may not occur at or near (up to one mile depending upon the habitat suitability) known sites.

V. Research, Inventory, and Monitoring Opportunities

The objective of this section is to identify opportunities to acquire additional information which could contribute to more effective species management. The content of this section has not been prioritized or reviewed as to how important the particular items are for species management. The inventory, research, and monitoring identified below are not required. These recommendations should be addressed by a regional coordinating body.

A. Data Gaps and Information Needs

- Inventories should be conducted by knowledgeable experts, particularly in low elevation areas along the coast to locate additional populations of this species, to better characterize its distribution, habitat, and provide ecological information.
- Revisit known sites to verify population status and document ecological conditions to assist in the location of additional populations.

B. Research Questions

Populations on the periphery of the species' range in western North America occur in considerably different habitat (bogs) than populations in the central portion of the range (well rotten logs in old-growth forest).

- What is the ecological amplitude of *Kurzia makinoana* in the central portion of its range?
- What role does vegetative reproduction play in the dispersal of this species?

Further taxonomic study of the holoarctic species of section Microlepidozia is needed. Particularly relevant questions include:

- Are *K. makinoana* (Steph.) Grolle and *K. sylvatica* (Evans) Grolle morphologically separable entities?
- If yes to the above, what is their geographic extent? Are both, or only one, present in the Pacific Northwest? How do their habitats compare?

C. Monitoring Opportunities and Recommendations

The principal objective of monitoring is to detect trends at local known sites that may bear on the larger issue of species viability at both local and regional scales. Recommendations include:

- Monitor a subset of known sites. Subset selection should include criteria such as site size (number of individuals), geographic location, local physical conditions (e.g., elevation, moisture regime), and type of local plant community (e.g., structure, composition).
- Monitor site size (number of individuals and/or area of occupancy).
- Monitor for physical changes/damage at site, due either to human actions or "natural" causes.
- Monitor for successional (e.g., structural and compositional) changes in surrounding plant community.

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Conservation Assessment

for

Stream Ladderwort

***Marsupella emarginata* (Ehrh.) Dum.** var. ***aquatica* (Lindenb.) Dumort.**

Originally issued November 1, 1996
as Management Recommendations
Nancy Fredricks, Author

Reconfigured January 2005
Rick Dewey

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SUMMARY

Preface: Since the transmittal of the Management Recommendations in 1996, new information has been collected regarding the range and habitat of *Marsupella emarginata* var. *aquatica*. The new information has been incorporated into this document.

Species: *Marsupella emarginata* var. *aquatica* (Lindenb.) Dumort.
Taxonomic Group: Bryophyte: Liverwort
Management Status: Bureau Assessment for the BLM in Oregon; no status with the US Forest Service. *Marsupella emarginata* var. *aquatica* is rated by the Oregon Natural Heritage Information Center (ORNHIC) as G5/T3/S1 and List 2 for Oregon which indicates that it is considered critically imperiled within the state by ORNHIC, but more common or secure elsewhere. This species is not on the Washington Natural Heritage Program list. This species was formerly in Survey and Manage Category B.

Range: Within the states of Washington and Oregon *Marsupella emarginata* var. *aquatica* is known from only two sites, one on Willamette National Forest, Lane Co., Oregon, and one on Mt. Baker-Snoqualmie National Forest, Snohomish Co., Washington. These are the only known locations in the western United States.

Specific Habitat: *Marsupella emarginata* var. *aquatica* grows attached to submerged rocks in fast flowing, cold, perennial streams.

Threats: Degradation of water quality is potentially an important threat to this taxon. Water pollution from sewage and motorboats at Waldo Lake could negatively impact the population in the lake's outlet stream. Release of zinc from galvanized culverts is known to be toxic to bryophytes. Grazing could have a significant impact on riparian habitats at other potential sites.

Management Considerations:

- Maintain water quality, including cold temperatures and stream flows, along with microclimate and rocky substrates at known sites.
- Follow riparian reserves standards and guidelines.
- To the extent possible, divert recreationists from the sites.
- Monitor impacts to population and take action to minimize recreation impacts.
- Restrict collection of bryophytes at and near known sites.
- If results of monitoring indicate declines in water quality, it may become necessary to restrict motorized boats.

Data Gaps and Information Needs:

- Evaluate impact of zinc from galvanized culverts and other contaminants on downstream aquatic ecosystems.
- Inventory potential suitable habitat (i.e., cold-water streams and upper elevation perennial streams) to locate additional populations.
- Determine taxonomic status of *Marsupella emarginata* var. *aquatica* and its relationship to the common variety.

I. Natural History

A. Taxonomic/Nomenclatural History

There is debate regarding the appropriate taxonomic rank of *Marsupella emarginata* var. *aquatica*. This taxon was elevated to *Marsupella aquatica* (Lindenb.) Schiffn. However, Schuster reports that transitional forms occur and some authors do not recognize this variety as distinct from the typical variety and consider it an ecotype. Wagner is inclined to recognize this taxon at the species level (Christy and Wagner 1996). Further work, perhaps including genetic studies, may be necessary to resolve these taxonomic questions. This species is placed in the order Jungermanniales, family Gymnomitriaceae (Stotler and Crandall-Stotler 1977).

Marsupella emarginata ssp. *emarginata* var. *aquatica* (Lindenb.) Dum.

B. Species Description

1. Morphology (Frye and Clark 1943:231, Hong 1982, Schuster 1974, Smith 1990:154)
Marsupella emarginata var. *aquatica* is a robust, dull or deep green to blackish leafy liverwort. It occurs in extensive, dense patches. Shoots are generally 1.6-2.5 mm wide by (3)5-8(10) cm long, erect, and usually simple and rigid. Leaves are transversely inserted and bilobed, usually with two oil-bodies per leaf cell.

Marsupella emarginata var. *aquatica* is macroscopically differentiated from the typical variety by the stiffer, more rigid, shallowly divided leaves which are pectinately oriented. Unlike the variety *M. emarginata* var. *emarginata*, plants of the aquatic variety are not typically brown or redbrown, although reddish patches may occasionally occur. Leaves are usually broader than in *M. emarginata* var. *emarginata*, with rotund or blunt-obtuse lobes. Leaf margins are prominently revolute or reflexed, more strongly so than in *M. emarginata* var. *emarginata*. The most distinctive difference is in habitat: *M. emarginata* var. *emarginata* grows on rocks in very wet places, but is never submerged throughout the year. No other aquatic bryophytes are similar to this species.

2. Reproductive Biology
Specialized asexual reproductive structures, such as gemmae, are unknown within the genus. The species is dioicous, with individual plants being either male or female. Paton (1999) describes the presence of sporophytes in this variety as “fairly frequent.” Water is required for sexual reproduction of all bryophytes and is probably the dispersal vector for the spores and any non-specialized asexual propagules produced by this aquatic taxon.

3. Ecological Roles
Although the ecological roles of individual bryophyte species are often not well understood, in general bryophytes contribute to ecosystem function in a number of ways.
According to Schofield (1985) extensive mats of bryophytes can significantly influence the water balance of a forest by absorbing and releasing moisture, and recycling leached nutrients from the tree canopy into the ecosystem. Many micro-organisms such as protozoa, fungi, bacteria, and blue-green alga often are associated with bryophytes and some species have been found to have antibiotic properties in them (Richardson 1981).

Bryophytes also directly interact with other organisms by providing nesting material and food for birds, voles, and lemmings (Longton 1992, Slack 1988). Both aquatic and terrestrial bryophytes provide shelter and food for the larvae and adults of numerous species of invertebrates (Richardson 1981). Finally bryophytes are pioneer species that provide the first step in vascular plant succession and they contribute to soil formation through the acceleration of physical and chemical weathering of rock material. Rock-dwelling, aquatic bryophytes, in general, can serve as sediment traps and cover, if not a food source as well, for a variety of aquatic invertebrates.

C. Range and Known Sites

Within the states of Washington and Oregon, *Marsupella emarginata* var. *aquatica* is know from only two sites, one on Willamette National Forest, Lane Co., Oregon, and one on the Mt. Baker-Snoqulamie National Forest, Snohomish Co., Washington. These are the only known locations in the western United States. It may occur in other cold perennial streams in the Oregon and Washington Cascades and may actually be widespread (Schofield, pers. comm.). The global distribution includes the British Isles (Wales and Yorkshire to Shetland Isles, Ireland), Greenland, Newfoundland and Nova Scotia, Scandinavia, central and western Europe, and the northeastern United States (Maine, New Hampshire, New York). It has also been reported in British Columbia and Alaska (Schofield, pers. comm.).

D. Habitat Characteristics and Species Abundance

In Oregon and Washington, *Marsupella emarginata* var. *aquatica* occurs in robust colonies attached to submerged rocks in cold, perennial streams. At the Waldo Lake site, the taxon occurs intermittently in the first two miles of the Lake's outlet stream. Within this reach, it typically is present in the steeper, faster flowing sections, and absent from the lower gradient, slower moving sections (Wagner 1999).

II. Current Species Situation

A. Status History

There was only a single known site of *Marsupella emarginata* var. *aquatica* at the time of its initial viability ratings resulting in a high level of concern for this species (Forest Ecosystem Management Assessment Team 1993). This species was included in survey strategies 1 and 2 under the Northwest Forest Plan (USDA and USDI 1994) which required surveys prior to ground-disturbing activities and management of known sites. In 2001 this species moved to Category B which dropped the pre-project survey requirement (USDA and USDI 2001).

Marsupella emarginata var. *aquatica* is rated by the Oregon Natural Heritage Information Center (ORNHIC) as G5/T3/S1 and List 2 for Oregon which indicates that it is considered critically imperiled within the state by ORNHIC, but more common or secure elsewhere. This species is not on the Washington Natural Heritage Program list. *Marsupella emarginata* var. *aquatica* is considered Bureau Assessment for the BLM in Oregon. It has no status with the US Forest Service. This species was formerly in Survey and Manage Category B.

B. Major Habitat and Viability Considerations
Water quality and recreation impacts are the primary considerations for maintaining viable populations of *Marsupella emarginata* var. *aquatica.*

C. Threats to the Species
The main threat to this species is recreational activity. Increasing hiker and mountain biker impacts around lakes and along streams may also threaten this species. Construction of a footbridge at trail crossings over the effluent streams may impact populations. Release of zinc from galvanized culverts is known to be toxic to bryophytes. Grazing may have a significant impact on riparian habitats at potential sites. Any rare species known only from a limited number of sites are vulnerable to collection pressures.

Water pollution from sewage and motorboats at Waldo Lake could negatively impact a population of *Marsupella emarginata* var. *aquatica*.

D. Distribution Relative to Land Allocations
The Waldo Lake site occurs on Willamette National Forest immediately south of Waldo Lake Wilderness Area, within a Tier 2 Watershed and in the Willamette National Forest Plan as Dispersed Recreation (semiprimitive non-motorized use, no timber harvest). The site on Mt. Baker-Snoqulamie National Forest is in a Late-Successional Reserve.

III. Management Goals and Objectives

Management for this species follows Forest Service Region 6 Sensitive Species (SS) policy (FSM 2670), and/or BLM Oregon and Washington Special Status Species (SSS) policy (6840).

For Oregon and Washington BLM administered lands, SSS policy details the need to manage for species conservation. Conservation is defined as the use of all methods and procedures which are necessary to improve the condition of SSS and their habitats to a point where their Special Status recognition is no longer warranted. Policy objectives also state that actions authorized or approved by the BLM do not contribute to the need to list species under the Endangered Species Act.

For Region 6 of the Forest Service, SS policy requires the agency to maintain viable populations of all native and desired non-native wildlife, fish, and plant species in habitats distributed throughout their geographic range on National Forest System lands. Management "must not result in a loss of species viability or create significant trends toward federal listing" (FSM 2670.32) for any identified SS.

IV. Habitat Management

A. Lessons from History
A significant decline has been observed in the aquatic lichen *Hydrotheria venosa* in the

Appalachian Mountains. Many lichens and liverworts are sensitive to small changes in their environment, and there are concerns that subtle changes in water chemistry from pollution and acid rain may result in similar declines in aquatic liverworts in the Pacific Northwest.

B. Identifying Species Habitat Areas

All known sites of *Marsupella emarginata* var. *aquatica* on federal lands administered by the BLM and/or Forest Service in Washington and Oregon are identified as areas where the information in this Conservation Assessment could be applied. A species habitat area is defined as the suitable habitat occupied by a known population plus the surrounding habitat needed to support the species.

C. Managing in Species Habitat Areas

The objective of species habitat areas is to maintain habitat conditions such that species viability will be maintained at an appropriate scale, and in accordance with agency policies. Specific management considerations include:

- Maintain water quality with special attention to avoiding dust abatement materials and other non-point sources of contaminants in the vicinity of known sites.
- Maintain cold temperatures and stream flows, microclimate, and rocky substrates at known sites.
- Implementation of Aquatic Conservation Strategy will be important to this species. Maintain riparian reserves and follow standards and guidelines restricting timber harvest, grazing, road construction, recreation, and other activities as prescribed in the Record of Decision (USDA and USDI 1994, page C-31 to C-38).
- To the extent possible, divert recreationists from sites.
- Monitor impacts to population and take action to minimize recreation impacts.
- Maintain habitat of this species by avoiding construction of trails, bridges, and other structures which may cause change in water quality or directly disturb populations.
- If results of monitoring indicate declines in water quality, it may become necessary to restrict motorized boats.
- Permit scientific collections for deposition only at a recognized herbarium and only then if the population is of adequate size and condition and with concurrence of the Forest or BLM District botanist.

V. Research, Inventory, and Monitoring Opportunities

The objective of this section is to identify opportunities to acquire additional information which could contribute to more effective species management. The content of this section has not been prioritized or reviewed as to how important the particular items are for species management. The inventory, research, and monitoring identified below are not required. These recommendations should be addressed by a regional coordinating body.

A. Data Gaps and Information Needs

- Inventory late-successional reserves, Research Natural Areas and other withdrawn areas to locate additional populations, specifically in cold-water streams and upper elevation

perennial streams in the Cascade Mountains. This would contribute valuable information concerning taxon range and habitat amplitude.

B. Research Questions

- Investigate the taxonomic status of *Marsupella emarginata* var. *aquatica* and its relationship to the typical variety. Some bryologists do not recognize this variety as sufficiently distinct from the terrestrial *M. emarginata* var. *emarginata* to justify varietal status.
- Because there is concern specifically about the impact of zinc from culverts on downstream aquatic bryophytes, laboratory studies to evaluate zinc tolerance limits may help determine thresholds of toxicity. Studies of other more common aquatic bryophytes (e.g., *Fontinalis*) would also be valuable in identifying ecological tolerances to heavy metals, silt, temperature, and organic chemicals from outboard motors).
- If this taxon is found to occur more widely, might it serve as a biological indicator of water quality?
- What are the dispersal mechanisms of this taxon? How does it reproduce?
- What is its tolerance to flood events and to seasonal desiccation?

C. Monitoring Opportunities and Recommendations

- Monitor recreation impacts and water quality (e.g., heavy metals, silt load, temperature) and track population trends using regionally developed protocol.

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Conservation Assessment

for

Slender thread moss

***Orthodontium gracile* (Wils. ex Sm.) Schwaegr. ex. B.S.G.**

Originally issued November 1, 1996
as Management Recommendations
Nancy Fredricks, Author

Reconfigured January 2005
Lisa D. Hoover

Section VII. Photos added February 2011
Candace Fallon

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SUMMARY

Preface: Since the transmittal of the Management Recommendations in 1996, new information has been collected regarding the range and habitat of *Orthodontium gracile.*
The new information is included within this document.

Species: *Orthodontium gracile* (Wils. ex Sm.) Schwaegr. ex. B.S.G.
Taxonomic Group: Bryophyte: Moss
Management Status: Bureau Sensitive for the BLM in California; no status for the BLM or Forest Service in Oregon and Washington. *Orthodontium gracile* is listed by the Oregon Natural Heritage Information Center (ORNHIC) in category G5/S1 and List 2 for Oregon, which indicates that this taxon is considered critically imperiled in the state by ORNHIC, but is considered secure at the Global scale. California Department of Fish and Game Natural Diversity Database preliminarily ranks this species S2S3. This species is not on the Washington Natural Heritage Program list. This species was formerly in Survey and Manage Category B.

Range: *Orthodontium gracile* is known in the Pacific Northwest from the Coast Ranges of northern California and southwestern Oregon. Sites on federally administered lands include Muir Woods National Monument, Redwood National Park and the Siskiyou National Forest.

Specific Habitat: *Orthodontium gracile* occurs in shady habitats in old-growth or mature second-growth coast redwood (*Sequoia sempervirens*) forest. It may be found on the lower bark of coast redwood trunks, sometimes below wounds on the tree, or on downed redwood logs. It typically occurs on redwood bark that may or may not have been burned or charred.

Threats: Logging of redwoods is the primary threat to this species. It is currently known from only three populations on federal land.

Management Considerations:

- Maintain substrate (i.e. bole, down log).
- Maintain micro-site conditions around occupied substrate (e.g. shade, humidity, moisture).
- Restrict collection of bryophytes at and near known sites.
- Maintain appropriate fire regime with prescribed burns if research results indicate it is beneficial.

Data Gaps and Information Needs: Current information needs include verification of the known sites on federal land, status of the populations at the known sites, the specific habitat characteristics provided by coast redwood, the role of fire in establishment of *Orthodontium gracile*.

I. Natural History

A. Taxonomic/Nomenclatural History

Orthodontium gracile was originally described in 1839 as *Bryum gracile* Wils. then placed in the genus *Orthodontium* by Schwaeger in 1844. There are no recent synonyms. The genus is placed in the order Eubryales, family Bryaceae.

B. Species Description

1. Morphology (Andrews 1935, Lawton 1971, Smith 1978, Christy and Wagner 1996)
Plants of *Orthodontium gracile* are erect, up to 1.2 cm tall, yellow-green above and brown below. Leaves are erect, 5-7 mm long, linear and very slender, curving in various directions to give mats a felty appearance. The leaf cells are long and narrow, with undifferentiated alar cells. Capsules are smooth, usually erect, 1-2 mm long, symmetric, brownish yellow, becoming whitish with age. The neck of the capsule is about as long as the urn.

Only one other species of *Orthodontium, O. pellucens* (Hook.) B.S.G. in C. Müll. occurs within the range of *O. gracile*. According to Christy and Wagner (1996), *Orthodontium* appears similar to a small *Dicranum* or *Dicranella*, which may grow in the same habitat. *Dicranum* is usually larger, has short leaf cells and differentiated, often brown alar cells, and its capsules are large and asymmetric, with short necks. *Dicranella* has short leaf cells and either ribbed or smooth asymmetric capsules.

The combination of characters that distinguish *O. gracile* include the linear leaves without differentiated alar cells, the erect, smooth yellow-brown capsules, and the habitat of rotting or charred wood or bark of coast redwood (*Sequoia sempervirens*).

2. Reproductive Biology
Although no specific information has been located on the reproductive biology of *Orthodontium gracile*, some generalizations may apply to this moss. Asexual reproduction is common in most bryophytes (Wyatt and Anderson 1984) and dispersal distance may be limited even in those species which reproduce by means of spores (Stoneburner et al. 1992). While it was previously speculated that the small spores of bryophytes were widely dispersed, few spores may actually survive the atmospheric environment (van Zanten and Pocs 1981). Limited dispersal ability of bryophytes has important conservation implications. Populations may not recolonize readily and outcrossing opportunities may be limited. Even in continuously distributed bryophyte taxa, it appears that gene flow may be highly restricted (Wyatt 1992).

3. Ecological Roles
Although the ecological roles of individual bryophyte species are often not well understood, in general bryophytes contribute to ecosystem function in a number of ways.
According to Schofield (1985) extensive mats of bryophytes can significantly influence the water balance of a forest by absorbing and releasing moisture, and recycling leached nutrients from the tree canopy into the ecosystem. Many micro-organisms such as protozoa, fungi, bacteria, and blue-green alga often are associated with bryophytes and some species have been found to have antibiotic properties in them (Richardson 1981).

Bryophytes also directly interact with other organisms by providing nesting material and food for birds, voles, and lemmings (Longton 1992, Slack 1988). Both aquatic and terrestrial bryophytes provide shelter and food for the larvae and adults of numerous species of invertebrates (Richardson 1981). Finally bryophytes are pioneer species that provide the first step in vascular plant succession and they contribute to soil formation through the acceleration of physical and chemical weathering of rock material.

C. Range and Known Sites

Orthodontium gracile is also known from Australia, Great Britain, and northwestern France. It was considered by Dixon (1924) to be a very rare and distinct species, hardly known outside Britain, except in two or three French localities. It is rare in Great Britain, but apparently increasing its range in Europe (Norris, pers. comm.). In the Pacific Northwest it is only known from the redwood area of northern California and southwestern Oregon (Koch 1951, 1952; Lawton 1971). Coast redwoods inhabit a discontinuous, narrow and irregular coastal strip approximately 500 km (310 miles) long and 5 to 10 km (3 to 6 miles) wide stretching from Brookings, Oregon south to the San Luis Obispo county line in central California. It occurs on alluvial slopes up to 1000 m (3280 ft.) in elevation within the coastal fog belt.

In California, the range of this species includes the counties of Del Norte, Humboldt, Mendocino, Sonoma, and Marin. The range extends south to San Mateo, Santa Clara, Santa Cruz, and Monterey counties south of the range of the northern spotted owl. Eighteen historical sites are reported for California; two occur on federal land (Muir Woods National Monument and Redwood National Park). There are two sites in Oregon, a historical collection from Loeb State Park in Curry County that has not been recently relocated, and a second site on the Siskiyou National Forest, also in Curry County. Although the collection from the Siskiyou National Forest did not have sporophytes, it is still considered a site for *O. gracile*.

D. Habitat Characteristics and Species Abundance

Orthodontium gracile occurs in shaded habitats on the lower trunks of old-growth or mature second growth coast redwood, sometimes below wounds on the tree, on down logs, or on charred stumps. Norris (1987) reports that it was more abundant in old-growth forest than in 100 year old second-growth. *Orthodontium gracile* is reported to be quite abundant where it is found (Norris, pers. comm.). An elevational range between 90 and 150 m (300 to 1,110 ft.) is reported from sites. Associated species of *O. gracile* include *Aulacomnium androgynum*, *Plagiothecium laetum*, and *Lepidozia reptans*.

II. Current Species Situation

A. Status History

Insufficient information was available to rate *Orthodontium gracile* at the time of the bryophyte viability panel during the Forest Ecosystem Management Analysis Team assessment (1993). This species was included in survey strategies 1 and 3 under the Northwest Forest Plan (USDA and USDI 1994). This required that known sites be managed and that broad-scale surveys would be undertaken. An amendment to the Northwest Forest Plan in 2001 moved this species to a new

category that represented rare species for which surveys were not considered practical (USDA and USDI 1994).

Orthodontium gracile is listed by the Oregon Natural Heritage Information Center (ORNHIC) in category G5/S1 and List 2 for Oregon, which indicates that this taxon is considered critically imperiled in the state by ORNHIC, but is considered secure at the Global scale (ORNHIC 2004). California Department of Fish and Game Natural Diversity Database preliminarily ranks this species S2S3. This species is not on the Washington Natural Heritage Program list. This species was formerly in Survey and Manage Category B.

Orthodontium gracile is considered Bureau Assessment for the BLM in California. It currently has no status with the Forest Service or BLM in Oregon and Washington.

B. Major Habitat and Viability Considerations

The major viability considerations for *Orthodontium gracile* are the loss of populations due to management activities, particularly the harvest of coast redwood. Timber harvest and road building may directly impact the habitat or populations of this species by altering the microclimate and removing the substrate. Of the original 1,971,000 acres of old-growth redwood, there are approximately 102,690 acres of old-growth (5 percent) remaining within state parks (Becking 1982). Because most of the coast redwood habitat occurs on state and private land generally managed on short rotations, the role of federal lands is key to maintaining the viability of this species in North America. The narrow elevational and geographical range of *Orthodontium gracile* could also make this species potentially vulnerable to climate change, which could result in a decline in vigor of this species. Fire may be required to maintain or increase habitat for this species.

C. Threats to the Species

Removal of redwood trees providing current and future habitat for *Orthodontium gracile* is the primary threat to this species. The two known sites on federal land in California occur in the Redwood National Park and Muir Woods National Monument. Because no timber harvest is permitted in these areas, these populations are unlikely to be at risk from harvest activities. This species is restricted to a very narrow elevational band along the coast and may be subject to changes in microclimate. If *O. gracile* requires specific conditions created by burning the fire resistant bark of the coast redwood, fire suppression could result in the decline of this species.

D. Distribution Relative to Land Allocations

The majority of *Orthodontium gracile* sites occur on State or National Park lands in California. The Siskiyou National Forest sites in southern Oregon are within Late-Successional Reserves. There is also an Oregon site in Loeb State Park.

III. Management Goals and Objectives

Management for this species follows Forest Service Region 6 Sensitive Species (SS) policy (FSM 2670), and/or BLM Oregon and Washington and/or California Special Status Species (SSS) policy (6840).

For Oregon and Washington BLM administered lands, SSS policy details the need to manage for species conservation. Conservation is defined as the use of all methods and procedures which are necessary to improve the condition of Special Status Species and their habitats to a point where their Special Status recognition is no longer warranted. Policy objectives also state that actions authorized or approved by the BLM do not contribute to the need to list species under the Endangered Species Act.

For Region 6 of the Forest Service, SS policy requires the agency to maintain viable populations of all native and desired non-native wildlife, fish, and plant species in habitats distributed throughout their geographic range on National Forest System lands. Management "must not result in a loss of species viability or create significant trends toward federal listing" (FSM 2670.32) for any identified SS.

IV. Habitat Management

A. Lessons from History

The northernmost population of this species in the Pacific Northwest was originally discovered in 1950, northeast of Brookings, Oregon. This site has been subsequently logged and the population apparently extirpated. In other cases, where original, undisturbed collecting sites have been revisited (in several cases over ten years later), populations have been relocated. Strong declines in three species of *Orthotrichum* have been noted in southern Sweden, with the role of air pollution implicated (Hallingbäck 1992). 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 concern for this coastal species is unknown, although it is unlikely that air quality is an immediate threat within the range of consideration.

B. Identifying Species Habitat Areas

All known sites of *Orthodontium gracile* on federal lands administered by the Forest Service and BLM in California and/or Washington and Oregon are identified as areas where the information in this Conservation Assessment could be applied. A species habitat area is defined as the suitable habitat occupied by a known population plus the surrounding habitat needed to support the species.

C. Managing in Species Habitat Areas

The objective of species habitat areas is to maintain habitat conditions such that species viability will be maintained at an appropriate scale, in accordance with agency policies. Specific management considerations include:

- Maintain substrate (i.e. bole, down log).
- Maintain micro-site conditions around occupied substrate (e.g. shade, humidity, moisture).
- Permit scientific collections for deposition only at a recognized herbarium and only then if the population is of adequate size and condition and with concurrence of the Forest or BLM District botanist.

- Special forest product permits for moss collection should specify that collection may not occur at or near (up to one mile depending upon the habitat suitability) known sites.
- Maintain appropriate fire regime with prescribed burns if research results indicate it is beneficial.

V. Research, Inventory, and Monitoring Opportunities

The objective of this section is to identify opportunities to acquire additional information which could contribute to more effective species management. The content of this section has not been prioritized or reviewed as to how important the particular items are for species management. The inventory, research, and monitoring identified below are not required. These recommendations should be addressed by a regional coordinating body.

A. Data Gaps and Information Needs

- Evaluate sites to verify which are currently included in existing reserves and state parks.
- Survey sites to verify population status.
- Once the habitat at sites is characterized, conduct surveys of suitable habitat within the range of coast redwood to determine the distribution of this species on federal lands.

B. Research Questions

- What is the role of fire in the establishment of *Orthodontium gracile*?
- Does *O. gracile* occur on substrates other than coast redwood?
- What specific habitat characteristics are provided by coast redwood?
- Are the *O. gracile* populations within the range of coastal redwood the same taxon that occurs in Australia and Europe? In Europe, its substrate includes sandstone, and in Australia it occurs on *Eucalyptus*, suggesting quite different ecological tolerances in other parts of the world. These collections were not available for study in the herbaria visited.
- What are the population growth rates at the known sites? Are populations stable?

C. Monitoring Opportunities and Recommendations

- Population monitoring at known sites to ensure viability and to identify any known site impacts.
- Establish macro-photo points to track change in the size of the moss mats over time.

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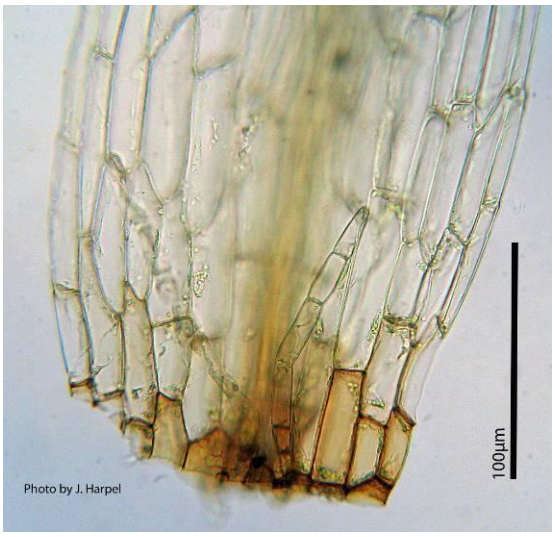
VII. Photos

All photos by Judy Harpel, under contract with the Oregon/Washington Bureau of Land Management.



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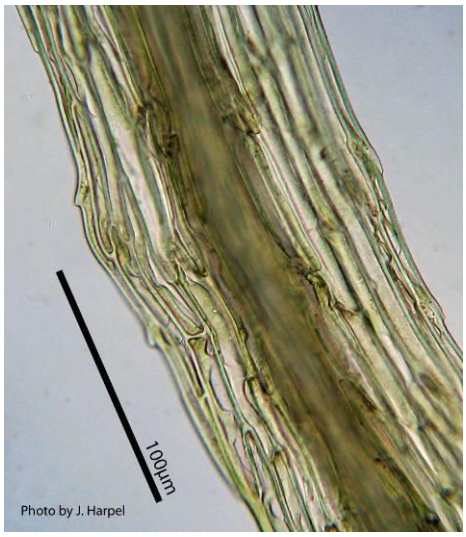
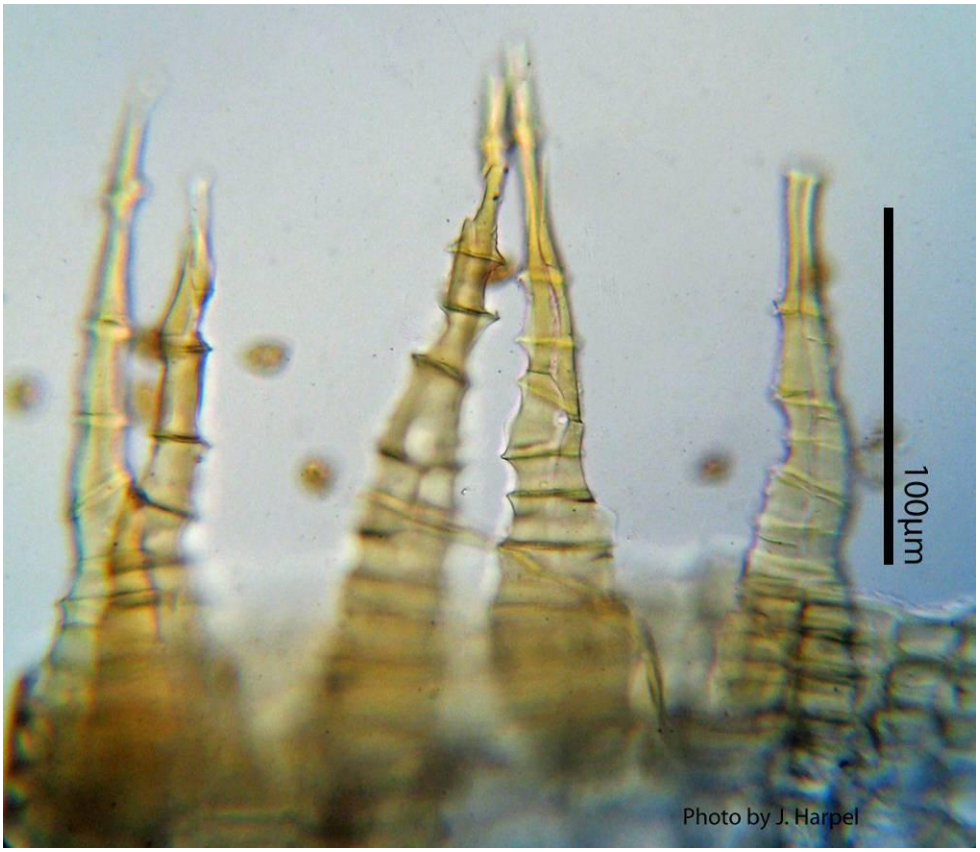


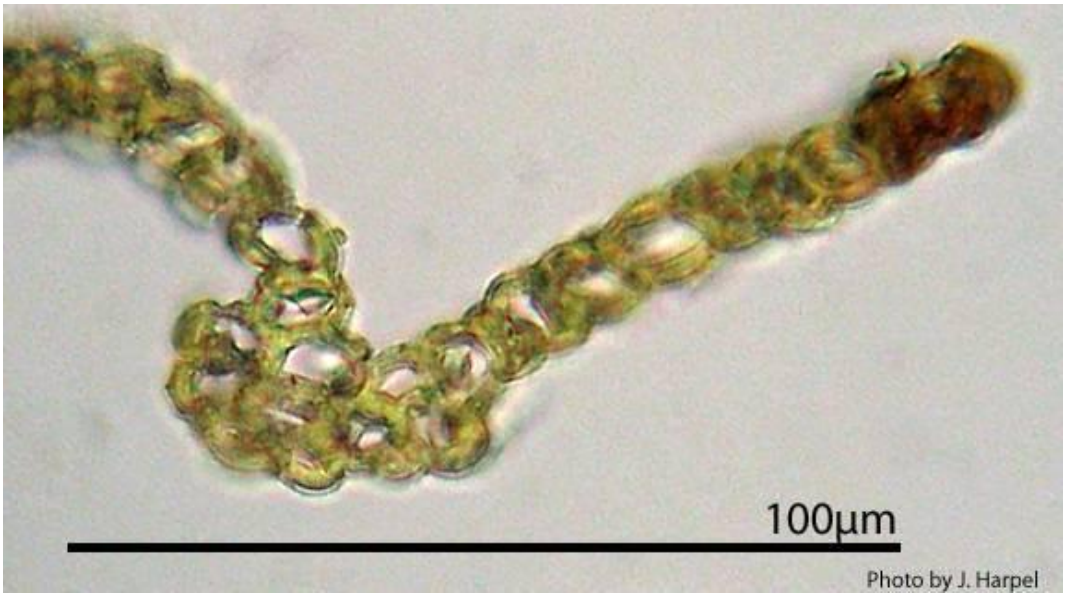
Upper medial cells



Peristome teeth

Leaf

Leaf apex



Leaf cross section

Dry sporophyte

Sporophyte

Whole mount dry

Conservation Assessment

for

Alaska cedarshake

Plagiochila semidecurrens Lehm. & Lindenb. **var. *alaskana***

(Evans) H.Inoue

Originally issued, December 1998
as Management Recommendations
Nancy Fredricks, Author

Reconfigured January 2005
Lance Holmberg

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SUMMARY

Preface: Since the transmittal of the Management Recommendations in 1996, new information has been collected regarding the habitat of *Plagiochila semidecurrens* var. *alaskana*. The new information has been incorporated into this Conservation Assessment.

Species: *Plagiochila semidecurrens* Lehm. & Lindenb. var. *alaskana* (Evans) Inoue.
Taxonomic Group: Bryophyte: Liverwort
Management Status: Bureau Assessment for the BLM in Oregon; US Forest Service Region 6 Sensitive. *Plagiochila semidecurrens* var. *alaskana* is rated by the Oregon Natural Heritage Information Center (ORNHIC) as G4/T3/S1 and List 2 for Oregon, which indicates that it is considered critically imperiled within the state by ORNHIC but more common or secure elsewhere (ORNHIC 2004). The variety is less common than the species generally. The species is not listed by Washington Natural Heritage Program (WNHP). This species was dropped from the Survey and Manage list in 2001 because of its apparent lack of association with old-growth.

Range: At present, *Plagiochila semidecurrens* var. *alaskana* and *P. semidecurrens* var. *semidecurrens* are both known from a single disjunct population in the Pacific Northwest, at Saddle Mountain State Park in the Coast Range of northwest Oregon.

Specific Habitat: *Plagiochila semidecurrens* var. *alaskana* and *P. semidecurrens* var. *semidecurrens* are found on rocks and conifers near creeks in shady moist areas. This species requires high levels of humidity.

Threats: Changes in microclimate (particularly humidity) within areas inhabited by this species could cause local extirpation. Logging activity or road construction pose the most serious threats. Trail construction, and collection of special forest products in the vicinity of known sites could also impact local populations.

Management Considerations:

- Maintain microsite conditions at known sites including high humidity levels required by this species. Retain canopy cover to provide shade. Avoid disturbance of substrates used by the species.
- Restrict collection of bryophytes at and near known sites.

Data Gaps and Information Needs:

- Conduct surveys of high probability habitat on other basaltic peaks in the Oregon Coast Range to locate additional populations.
- Basic information on associated species, population size, and ecological parameters is needed.

I. Natural History

A. Taxonomic/Nomenclatural History

Within the genus *Plagiochila* there has been a considerable amount of taxonomic confusion and species and variety concepts are often not clear. In 1992 Hong lists both *P. semidecurrens* var. *alaskana* and *P. semidecurrens* var. *semidecurrens* as new for Oregon based on three Schofield collections from Saddle Mountain in Clatsop Co. Oregon. This article has resulted in a conflict between the BLM and Forest Service Sensitive Species lists because the Oregon Natural Heritage Information Center (2004) uses *P. semidecurrens* var. *alaskana* and the Forest Service Sensitive Species list retained *P semidecurrens*, the former Survey and Manage name. Therefore some clarification is needed.

Inoue (1965) comments that "*P. semidecurrens* is a very polymorphous species … and many variants can be found. But these variants are considered to be caused largely by different habitat conditions". He also comments that the extreme forms of *P. semidecurrens* have been called *P. fryii*, *P. alaskana*, and *P. shimizuana*, and occur in the northern areas, such as Alaska, or at subalpine or alpine regions within the distributional range of *P. semidecurrens*. Although based on material from Alaska and Japan he recognized one variety, and combined *P. fryii*, *P. alaskana*, and *P. shimizuana* into *Plagiochila semidecurrens* var. *alaskana* (Evans) Inoue.

Schofield (1968) comments that "*P. semidecurrens* shows considerable variability as demonstrated by Evans' considering the western American material to represent two species, *P. alaskana* Evans and *P. fryei* Evans". In 1979 (Schofield & Godfrey) refer to "minor subspecies of Plagiochila semidecurrens" as occurring on Saddle Mountain.

Schuster (1980) states "The treatment of the *P. semidecurrens* complex (incl. *P. fryei* and *P. alaskana*) as a single plastic species has been modified by Inoue (1965), who would recognize a "var. *alaskana*" for the depauperate Alaskan material". Although Schuster previously recognized *P. semidecurrens* fo. *alaskana* (Evs.) Schust. he further comments that "With the lack of biological data, such a difference in treatment is taxonomically meaningless".

Although Christy and Wagner (1996) describes *Plagiochila semidecurrens* var. *alaskana* in their publication, they state, "For management purposes the varieties can be ignored and the species treated as a whole". Further correspondence with Dave Wagner (pers comm. 2004) supports the decision to combine the var. *alaskana* into *P. semidecurrens*.

Finally, because there is still some taxonomic confusion over the variety concept and both varieties are rare; and occur within the same range and habitat, this reconfigured document will provide information for both varieties.

Synonyms:
Plagiochila semidecurrens Lindenburg and Gottsche, Spec. Hep. 142, 1840-44. *Plagiochila robustissima* Horikawa, J. Sci. Hiroshima Univ. Ser. B. Div. 2, 1:78 *Plagiochila kamuesis* Tayl., J. Bot. 262, 1846.
Plagiochila shimizuana Hattori, J. Hattori Bot. Lab. 12:84 1954. (nomen nudum).

B. Species Description
1. Morphology (Hong 1992, Schofield 1968, Christy and Wagner 1996)
The following description is of *Plagiochila semidecurrens* subsp. *grossidens* (Herz.) Schuster. This taxon has since been lumped into *P. semidecurrens* (Lehm.& Lindenb.) Lehm. & Lindenb. var. *semidecurrens.* However, the description remains useful for plants in Oregon and Washington.

Plants in dense patches, slightly glossy, yellowish-brown to brownish-green. Shoots 2-3 cm long by 1.5-2 mm wide, ascending, rigid, simple or with occasional branches. Branches intercalary (somewhat below the apex), similar to main stem but spreading obliquely away from it. Leaves 1050-1400 µm long x 1000-1250 µm wide, suborbicular to broadly ovate, the widest point always a close to the base; erect spreading, the convex dorsal fold at 25-45 degrees to the stem, but leaves postically (behind, toward substrate) secund (turned to one side); line of insertion arched, strongly decurrent dorsally, shortly decurrent ventrally, slightly imbricate. Dorsal margin arched, strongly revolute to beyond the middle or to the apex, distal portion with 2-8 teeth. Apex broadly rounded with several course teeth. Postical margin arched, dilated near the base and bearing 9-15 teeth. Teeth 1-3 cells wide at the base to 3-8 cells high but up to 2-5 cells wide, sharp to narrow; average number per leaf is 18-25 with a minimum of 8-12 and maximum of 35; usually somewhat unequal at apex. Cells of leaves isodiametric and 13.5-1.5 gum at apex, 14-16 u x 18-25 µm near middle, 13-16,um by 40-65 µm near the base and forming a distinct vitta (well-developed band of elongated cells); cells more or less thickened especially those of the vitta and margins, trigones (three-angled thickenings at corners of cells) ill-defined and often coalescing. Oil bodies 2-4 per apical or median cell, 9-12 per vitta cell; from 3 x 5 to 2.5 x 7 µm up to 3.3 x 10 µm; appearing nearly homogenous but faintly granulose at high magnification. Underleaves of several uniseriate capillary segments, or occasionally several cells wide at the base and divided into uniseriate cilia distally.

Male plants unknown. Female plants with terminal gynoecia (female inflorescence), often with one or no subfloral innovations (new shoots usually formed at base of inflorescence); bracts similar to leaves and similarly spinose-dentate; 1.5 mm long x 1 mm wide. Perianth elongate, half emergent from bracts at maturity, 2.7 mm long x 0.9-1mm wide, strongly laterally compressed; keels subequal in length, 2-2.8 as long as the mouth is wide; the mouth squarely truncate, closely minutely spiny-ciliate to ciliate-toothed 17 µm; elaters 2-spiral, ca. 10 µm in diameter.

Plagiochila is a leafy liverwort distinguished by round obliquely inserted (succubous) leaves, absent or reduced underleaves, toothed leaf margins, and a laterally compressed, bilabiate perianth that has a mouth width to body length of 1:6 and is often winged on the margins.

Further characters of importance in distinguishing the species within the genus include leaf cell size shape and orientation, stem branching pattern, type of asexual reproduction, capsule wall anatomy, and oil body type. Recently chromosome number has been shown to be of use (Inoue 1974) but as yet little information for the species is available.

Plagiochila semidecurrens has evenly toothed leaf margins with cilia-like teeth, well developed vitta cells at the leaf base, and bulging or coalescing trigones. The shiny leaf surface distinguishes it from *P. satoii.*

Genera most easily mistaken for *Plagiochila* are *Jungermannia* and *Jamesoniella.* All three genera have round succubous leaves and reduced or absent underleaves. *Plagiochila* has toothed leaf margins that roll under upon drying, oil bodies in distinct globules, and a perianth that is strongly laterally compressed above, wide and obliquely truncate at the mouth. The perianth and female bracts of *Jamesoniella* have teeth or cilia, a conspicuous bracteole (modified underleaf of female inflorescence) is present and, with the exception of the rhizoids, the plant is often dull reddish brown. *Jungermannia* has a wide open perianth mouth that is entire or obscurely lobiate, entire female bracts, and lacks the bracteole.

All other species of *Plagiochila* expected in western Oregon are members of the Section *Asplenioides* and are separated from *P. semidecurrens* of the section *Zonatae* by their larger cell size (median averaging 22-25 µm wide), coarsely segmented oil-bodies, small merely acute teeth, dull surface, and deflexed rather than strongly reflexed leaves.

2. Reproductive Biology

Like all liverworts, *Plagiochila semidecurrens* var. *alaskana* requires water for sexual reproduction. Male plants are unknown and specimens are frequently sterile. Sporophytes are occasional (Schofield, pers. comm.).

3. Ecological Roles

Although the ecological roles of individual bryophyte species are often not well understood, in general bryophytes contribute to ecosystem function in a number of ways.
According to Schofield (1985) extensive mats of bryophytes can significantly influence the water balance of a forest by absorbing and releasing moisture, and recycling leached nutrients from the tree canopy into the ecosystem. Many micro-organisms such as protozoa, fungi, bacteria, and blue-green alga often are associated with bryophytes and some species have been found to have antibiotic properties in them (Richardson 1981).

Bryophytes also directly interact with other organisms by providing nesting material and food for birds, voles, and lemmings (Longton 1992, Slack 1988). Both aquatic and terrestrial bryophytes provide shelter and food for the larvae and adults of numerous species of invertebrates (Richardson 1981). Finally bryophytes are pioneer species that provide the first step in vascular plant succession and they contribute to soil formation through the acceleration of physical and chemical weathering of rock material.

C. Range and Known Sites

Within the area of consideration, at present this species is known from a single disjunct population in the Pacific Northwest, at Saddle Mountain State Park in the Coast Range of northwest Oregon. Globally, *Plagiochila semidecurrens* is known from the Philippines, Sri Lanka, northern India (Sikkim-Himalaya), Nepal, montane portions of China, Taiwan, and Japan. It extends eastward in an arc across the North Pacific through the Aleutian Islands to the southern coast of Alaska and to the central west coast of Vancouver Island. Inoue (1965) comments that both *P. semidecurrens* and *P. semidecurrens var. alaskana*, occur in the northern areas, such as Alaska, or at subalpine or alpine regions within the same distributional range.

D. Habitat Characteristics and Species Abundance

Plagiochila semidecurrens var. *alaskana* is found on rocks or epiphytic on conifers near creeks in shady moist areas. According to Schofield (1968) this species "shows a diverse ecology, occurring abundantly on cliffs and banks of humid canyons, particularly near waterfalls, on maritime exposed cliffs, on tundra cliffs and as an epiphyte." It has a wide elevational range in British Columbia and Alaska (Schofield, pers. comm.). At Saddle Mountain, it is occurs at 750 m (2470 ft.) elevation on a north-facing basalt outcrop.

II. Current Species Situation

A. Status History

Plagiochila semidecurrens var. *alaskana* was not rated by the panels convened by the Forest Ecosystem Management Assessment Team (1993) due to lack of information. It was originally included as a Survey and Manage species (USDA & USDI 1994) but dropped in 2001 because of its apparent lack of association with old-growth stands (USDA & USDI 2001).

Plagiochila semidecurrens var. *alaskana* is rated by the Oregon Natural Heritage Information Center (ORNHIC) as G4/T3/S1 and List 2 for Oregon, which indicates that it is considered critically imperiled within the state by ORNHIC but more common or secure elsewhere. The variety is less common than the species generally (ORNHIC 2004). This species was dropped from the Survey and Manage list in 2001 because of its apparent lack of association with old-growth. *Plagiochila semidecurrens* var. *alaskana* is a Bureau Assessment species for the BLM in Oregon and Forest Service Region 6 Sensitive. It is not listed by Washington Natural Heritage Program.

B. Major Habitat and Viability Considerations

The major viability consideration for *Plagiochila semidecurrens* var. *alaskana* is loss of populations due to management activities that directly impact the habitat or the populations. This species appears to be extremely rare within Oregon and Washington and the single known site makes it vulnerable to stochastic events. Disturbance at the known site poses the greatest threat to this species. A warming climate may stress populations at the limit of the species' range. Air quality may eventually be a consideration for the peaks in the Coast Range that may be inhabited by *P. semidecurrens* var. *alaskana*.

C. Threats to the Species

Due to the inconspicuous nature of this species and the relatively limited areas that have been intensively surveyed for liverworts, additional populations of this species may occur. Logging activities and road construction pose the most serious threats to undocumented populations. Changes in microclimate, particularly humidity, within areas inhabited by this species could cause local extirpation. Trail construction and collection of special forest products in the vicinity of known sites could impact local populations.

D. Distribution Relative to Land Allocations

The only site of *Plagiochila semidecurrens* var. *alaskana* within the contiguous United States occurs in Saddle Mountain State Park in Clatsop County, Oregon.

III. Management Goals and Objectives

Management for this species follows Forest Service Region 6 Sensitive Species (SS) policy (FSM 2670), and/or BLM Oregon and Washington Special Status Species (SSS) policy (6840).

For Oregon and Washington BLM administered lands, SSS policy details the need to manage for species conservation. Conservation is defined as the use of all methods and procedures which are necessary to improve the condition of SSS and their habitats to a point where their Special Status recognition is no longer warranted. Policy objectives also state that actions authorized or approved by the BLM do not contribute to the need to list species under the Endangered Species Act.

For Region 6 of the Forest Service, SS policy requires the agency to maintain viable populations of all native and desired non-native wildlife, fish, and plant species in habitats distributed throughout their geographic range on National Forest System lands. Management "must not result in a loss of species viability or create significant trends toward federal listing" (FSM 2670.32) for any identified SS.

IV. Habitat Management

A. Lessons from History

No information about this species is available at this time.

B. Identifying Species Habitat Areas

No sites have been documented on federal land. Any sites of *Plagiochila semidecurrens* var. *alaskana* discovered on federal lands administered by the Forest Service and BLM in Washington and Oregon could be identified as areas where the information in this Conservation Assessment could be applied. A species habitat area is defined as the suitable habitat occupied by a known population plus the surrounding habitat needed to support the species.

C. Managing in Species Habitat Areas

The objective of species habitat areas is to maintain habitat conditions such that species viability will be maintained at an appropriate scale, in accordance with agency policies. Specific management considerations include:

- Maintain microsite conditions at known sites including high humidity levels required by this species. Retain canopy cover to provide shade. Avoid disturbance of substrates used by the species.
- Route roads, trails, and recreation sites away from known sites.
- Avoid populations during trail maintenance or reconstruction activities.
- Discourage recreation activities that could impact known sites.
- Permit scientific collections for deposition only at a recognized herbarium and only then if the population is of adequate size and condition and with concurrence of the Forest or BLM District botanist.
- Special forest product permits for moss collection should specify that collection may not occur at or near (up to one mile depending upon the habitat suitability) known sites.

V. Research, Inventory, and Monitoring Opportunities

The objective of this section is to identify opportunities to acquire additional information which could contribute to more effective species management. The content of this section has not been prioritized or reviewed as to how important the particular items are for species management. The inventory, research, and monitoring identified below are not required. These recommendations should be addressed by a regional coordinating body.

A. Data Gaps and Information Needs

- Visit known site and collect basic information on associated species, population size, and ecological parameters.

B. Research Questions

- What is the ecological amplitude for *Plagiochila semidecurrens* var. *alaskana* and *P. semidecurrens* var. *semidecurrens*?
- How does this species reproduce, disseminate, and colonize new sites?

C. Monitoring Opportunities and Recommendations

- Nothing identified at this time.

VI. References

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Conservation Assessment
for
Brown Flatwort
***Radula brunnea* Steph.**

Original issued December 1996
as Management Recommendations
Nancy Fredricks, Robin Lesher, Judy Harpel, Authors

Reconfigured January 2005
Lance Holmberg

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SUMMARY

Preface: Since the transmittal of the Management Recommendations in 1996, new information has been collected regarding the habitat of *Radula brunnea*. The new information has been incorporated into this Conservation Assessment.

Species: *Radula brunnea* Steph.
Taxonomic Group: Bryophyte: Liverwort
Management Status: Bureau Assessment for the BLM in Oregon; US Forest Service Region 6 Sensitive. *Radula brunnea* is rated by the Oregon Natural Heritage Information Center (ORNHIC) as G3/S1 and List 2 for Oregon, which indicates that it is considered critically imperiled within the state by ORNHIC but not immediately imperiled elsewhere (ORNHIC 2004). This species is not on the Washington Natural Heritage Program list. This species was dropped from Survey and Manage in 2001 because of its apparent lack of association with old-growth.

Range: *Radula brunnea* has been found in North America only on the basalt breccia cliffs of Saddle Mountain, Clatsop County, Oregon. Global distribution includes Japan and the Russian Far East.

Specific Habitat: *Radula brunnea* grows on shaded north-facing cliffs below the ridge on Saddle Mountain in high-humidity habitat subject to fog interception. In Japan, it is found on the bark of trees in subalpine areas and occasionally on rock.

Threats: Both hiking trails and rock climbing could affect populations by physically removing or trampling the plants. Scientific collecting could also seriously damage the local populations.

Management Considerations.

- Maintain habitat for this species at sites by retaining occupied substrate and associated microsite conditions near the populations.
- Restrict activities that alter substrate or microsite, or remove individuals from the local populations.
- Restrict collection of bryophytes at and near known sites.

Data Gaps and Information Needs:

- Potentially suitable habitat on the Olympic Peninsula and in the Coast Range of Oregon should be surveyed to locate additional populations.
- What are the ecological requirements of this species?

I. Natural History

A. Taxonomy and Nomenclature

Radula brunnea Steph. was first described by Franz Stephani in 1910 from Mount Komagadake, Japan (Kitagawa 1973). The species is in the order Jungermanniales, family Radulaceae, section Amentulosae. Synonymy: none.

B. Species Description

1. Morphology

Radula brunnea forms medium-sized, compact, very pinnately branched dark brown to olive-green mats, which turn blackish to reddish brown when dry. The leafy shoots are 2.0-6.5 cm long and are composed of two types of branches: numerous tiny-leaved (microphyllus) side-branches grow at right angles to the stem under the larger-leaved (macrophyllus) branches. According to Yamada (1979), the leaf lobes are "densely to moderately imbricate, widely spreading, strongly concave, ovate more or less falcate, 1.0-1.1 mm long, 0.7-0.8 mm wide, apex rounded, usually narrowly incurved, dorsal base fully covering the stem." The leaf cells are slightly mammillose on the outer surface of the dorsal lobes and have bulging trigones (three angled thickenings at the corners of the cells). One large granular, bumpy oil-body is present in each cell. Rhizoids appear to be lacking. The most notable feature is the vast number of tiny branchlets with small leaves under almost every leaf along the stem (Christy and Wagner 1996). This species can be separated from other members of the section Amentulosae by the basal appendages of leaf-lobes and lobules with two or three teeth (Yamada 1979).

2. Reproductive Biology

In Japan, *Radula brunnea* is dioicous with the antheridia on short terminal branches in five and six bracts. The archegonia are terminal on the stems and branches, with one or two leaves subtending the archegonia below. Reproductive material of *R. brunnea* was not found on any of the Saddle Mountain collections.

3. Ecological Roles

Although the ecological roles of individual bryophyte species are often not well understood, in general bryophytes contribute to ecosystem function in a number of ways.
According to Schofield (1985) extensive mats of bryophytes can significantly influence the water balance of a forest by absorbing and releasing moisture, and recycling leached nutrients from the tree canopy into the ecosystem. Many micro-organisms such as protozoa, fungi, bacteria, and blue-green alga often are associated with bryophytes and some species have been found to have antibiotic properties in them (Richardson 1981).

Bryophytes also directly interact with other organisms by providing nesting material and food for birds, voles, and lemmings (Longton 1992, Slack 1988). Both aquatic and terrestrial bryophytes provide shelter and food for the larvae and adults of numerous species of invertebrates (Richardson 1981). Finally bryophytes are pioneer species that provide the first step in vascular plant succession and they contribute to soil formation through the acceleration of physical and chemical weathering of rock material.

C. Range and Known Sites

Radula brunnea is found in Japan and eastern Asia, with one disjunct population on Saddle Mountain in Clatsop County, Oregon. No federal sites are known, but the species may occur on other exposed fog-drenched peaks in the Olympic Mountains or the Coast Range, such as Onion Peak (under private ownership). Potential habitat was inventoried on Mary's Peak and Mount Hebo (Siuslaw National Forest), and Saddleback Mountain Area of Critical Environmental Concern (ACEC) on Salem District BLM, but the species was not found.

D. Habitat Characteristics and Species Abundance

On Saddle Mountain, *Radula brunnea* forms dark brown to nearly black patches on very steep, exposed, north-facing basalt breccia cliffs, in both sheltered and open sites just below the ridgetop (Schofield 1979). Associated liverwort species were *Apometzgeria pubescens, Herbertus sakuraii, Marsupella emarginata, Metzgeria conjugata, Radula obtusiloba* subsp. *polyclada,* and *Tritomaria quinquedentat*a. According to Alaback and Frenkel (1978), many rare vascular plants grow in these rocky, inaccessible habitats. Vascular plants that may be present in these rocky habitats occupied by *R. brunnea* include parsley-fern *(Cryptogramma crisp*a*),* Cardwell's penstemon *(Penstemon cardwell*ii*),*tufted saxifrage *(Saxifraga caespitos*a*),* and Oregon selaginella *(Selaginella oregan*a*).* For a complete discussion of the vascular plant flora, see Alaback and Frenkel (1978) and Chambers (1973). In Japan, *R. brunnea* grows on rocks, tree trunks, and rarely on humus (Yamada 1979). The species is not abundant where it occurs.

Although a few Pacific silver and noble fir trees *(Abies amabilis* and *A. procer*a) are scattered along the top of the ridge at the Saddle Mountain site, *R. brunnea* grows in full sun to partially shaded sites on the north-facing basalt breccia cliffs just below the ridge. It is not associated with late-successional or old-growth forests.

II. Current Species Situation

A. Status History

Radula brunnea was not rated by the panels convened by the Forest Ecosystem Management Assessment Team (1993) because information about it was lacking. It was originally included as a Survey and Manage species (USDA & USDI 1994) but dropped in 2001 because of its apparent lack of association with old-growth stands (USDA & USDI 2001).

Radula brunnea is rated by the Oregon Natural Heritage Information Center (ORNHIC) as G3/S1 and List 2 for Oregon, which indicates that it is considered critically imperiled within the state by ORNHIC but not immediately imperiled elsewhere (ORNHIC 2004). This species is not on the Washington Natural Heritage Program list. This species was dropped from Survey and Manage in 2001 because of its apparent lack of association with old-growth. *Radula brunnea* is a Bureau Assessment species for the BLM in Oregon. It is also on the US Forest Service Region 6 Sensitive Species list.

B. Major Habitat and Viability Considerations

The major viability consideration for *Radula brunnea* is loss of populations resulting from activities that could degrade the habitat or harm the populations. This species is extremely rare

in the area of the Northwest Forest Plan and the single occupied site makes it vulnerable to stochastic events. Disturbances at the site pose the greatest threat to this species.

C. Threats to the Species

Activities that alter the microsite or occupied substrate may threaten this species where it now grows; the viability of these populations could be lost or damaged by the physical removal or trampling of the plants. Scientific collecting, trail building, and recreation (such as hiking and rock climbing) may also harm the local populations.

D. Distribution Relative to Land Allocations

The only site of *Radula brunnea* in North America occurs in Saddle Mountain State Park in Clatsop County, Oregon.

III. Management Goals and Objectives

Management for this species follows Forest Service Region 6 Sensitive Species (SS) policy (FSM 2670), and/or BLM Oregon and Washington Special Status Species (SSS) policy (6840).

For Oregon and Washington BLM administered lands, SSS policy details the need to manage for species conservation. Conservation is defined as the use of all methods and procedures which are necessary to improve the condition of SSS and their habitats to a point where their Special Status recognition is no longer warranted. Policy objectives also state that actions authorized or approved by the BLM do not contribute to the need to list species under the Endangered Species Act.

For Region 6 of the Forest Service, SS policy requires the agency to maintain viable populations of all native and desired non-native wildlife, fish, and plant species in habitats distributed throughout their geographic range on National Forest System lands. Management "must not result in a loss of species viability or create significant trends toward federal listing" (FSM 2670.32) for any identified SS.

IV. Habitat Management

A. Lessons from History

No information on this species is available at this time.

B. Identifying Species Habitat Areas

No sites have been documented on federal land. Any sites of *Radula brunnea* discovered on federal lands administered by the BLM and Forest Service in Washington and Oregon could be identified as areas where the information in this Conservation Assessment could be applied. A species habitat area is defined as the suitable habitat occupied by a known population plus the surrounding habitat needed to support the species.

C. Managing in Species Habitat Areas

The objective of species habitat areas is to maintain habitat conditions such that species viability will be maintained at an appropriate scale, in accordance with agency policies. Specific management considerations include:

- Retain occupied substrate and associated microsite conditions, specifically avoiding disturbance to the rock substrate associated with the plants.
- Avoid direct damage to the plants.
- Route roads, trails, and recreation sites away from known sites.
- Avoid populations during trail maintenance or reconstruction activities.
- Discourage recreation activities that could impact known sites.
- Permit scientific collections for deposition only at a recognized herbarium and only then if the population is of adequate size and condition and with concurrence of the Forest or BLM District botanist.
- Special forest product permits for moss collection should specify that collection may not occur at or near (up to one mile depending upon the habitat suitability) known sites.

V. Research, Inventory, and Monitoring Opportunities

The objective of this section is to identify opportunities to acquire additional information which could contribute to more effective species management. The content of this section has not been prioritized or reviewed as to how important the particular items are for species management. The inventory, research, and monitoring identified below are not required. These recommendations should be addressed by a regional coordinating body.

A. Data Gaps and Information Needs

- Inventory potentially suitable habitat on the Olympic Peninsula and in the Coast Ranges of Oregon to locate additional populations on federal land. Other Coast Range peaks that may also provide suitable habitat include Nicolai Mountain (Clatsop State Forest), and Sugar Loaf (The Nature Conservancy). It might also occur on other exposed fog-drenched peaks in the Olympic Mountains or Coast Range.

B. Research Questions

- What are the ecological requirements of this species?

C. Monitoring Opportunities and Recommendations

- If any populations are discovered on federal land, monitor them to determine if they are being damaged by recreational activity or collecting.

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Conservation Assessment

for

Giant Brownwort

***Tritomaria quinquedentata* (Huds.) Buch**

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Nancy Fredricks, Author

Reconfigured January 2005
Rick Dewey

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SUMMARY

Preface: Since the transmittal of the Management Recommendations in 1996, new information has been collected regarding the range and habitat of *Tritomaria quinquedentata*. The new information has been incorporated into this Conservation Assessment.

Species: *Tritomaria quinquedentata* (Huds.) Buch
Taxonomic Group: Bryophyte, Liverwort
Management Status: Bureau Assessment for the BLM in Oregon; no status with the US Forest Service. *Tritomaria quinquedentata* is rated by the Oregon Natural Heritage Information Center (ORNHIC) as G5/S1 in Oregon and Washington and List 2 in Oregon, which indicates that it is considered critically imperiled within the states by ORNHIC, but more common or secure elsewhere. This species was formerly in Survey and Manage Category B.

Range: Within the states of Washington and Oregon, *Tritomaria quinquedentata* is known from several sites within northern Washington and at Saddle Mountain State Park in northwestern Oregon. The northern Washington sites are located in Olympic National Park, Mt. Baker-Snoqualmie National Forest, and Okanogan-Wenatchee National Forest.

Specific Habitat: In Oregon and Washington, *Tritomaria quinquedentata* occurs in arctic boreal-like environments in cool, moist sites generally associated with cold water streams. Known sites occur on sandy, mineral soil or humus along low gradient, low volume, perennial streams and seeps and on rock in a talus slope. It is reported to also occur on wet humus over boulders, shaded cliffs, on soil over exposed rock surfaces, on decaying branches at the fringes of spray zones, and among heather on slopes.

Threats: The main threat to this species is the loss of cool, moist, glacial refugia - sites that were presumably more abundant in the region during or immediately following glaciation. Disturbance of these rare sites by activities which modify microclimate may result in the local extirpation of this species.

Management Considerations:

- Maintain habitat (e.g., intact wet humus and soil, cool air, cold water) for this species at all known sites. Avoid disturbance, including modification of canopy and soil layer.
- Restrict collection of bryophytes at and near known sites.
- Minimize impacts from recreation associated actions, including trampling.

Data Gaps and Information Needs:

- Revisit known sites to document population status and determine ecological requirements.
- Conduct further inventory to better document geographic extent of range, particularly in central/southern Washington and northern Oregon.

I. Natural History

A. Taxonomic/Nomenclatural History

Tritomaria quinquedentata (Huds.) Buch was originally described as *Jungermannia quinquedentata* Huds. It has no recent synonyms. It is placed in the class Jungermanniales, family Jungermanniaceae.

B. Species Description

1. Morphology (Frye and Clark 1945:421, Hong 1994, Kitagawa 1965:117, Schuster 1969:678, Smith 1990:128, Christy and Wagner 1996)

Tritomaria quinquedentata is a large green to yellow-brown or pale brown leafy liverwort, often forming extensive, sprawling patches. It is usually intermingled with other bryophtyes. Stems are 1.5 to 5 cm long, typically prostrate with upturned tips, remotely branched, dorsal side green, ventral side brown. Rhizoids are long and form dense mats. Leaves are in two rows down the stem, contiguous to imbricate (overlapping), widely spreading, orbicular-ovate, strongly asymmetrical, leaves usually wider than long, strongly unequally trilobate (ventral lobe the largest), with cuspidate (ending abruptly in stout rigid point) lobed apices. Dorsal lobes are transversely inserted, apiculate to cuspidate. Ventral lobes are larger and obliquely inserted. Sometimes dorsal lobes are folded over ventral lobes, the leaf then loosely complicate-canaliculate (folded lengthwise-channeled). Trigones (thickened corners of cells) are usually small, not bulging. Three to seven oil bodies are present in each cell. Underleaves are absent. Gemmae are rare. Perianths are emergent.

The large size and asymmetric three-lobed leaf are useful field characters to help distinguish *T. quinquedentata*. It can be separated from similar appearing *Lophozia* subgen. Barbilophozia by the lack of both underleaves and cilia on the ventral base of the leaves. Other Tritomaria species produce abundant gemmae (small vegetative reproductive bodies consisting of a few cells).

2. Reproductive Biology

Tritomaria quinquedentata rarely produces asexual gemmae. The species is dioicous, with individual plants being either male or female. Godfrey (1969) reported sporophytes to be rare. Sporophytes and gametangia were lacking in material recently collected in northern Washington. Like all bryophytes, the species requires water for sexual reproduction.

3. Ecological Roles

Although the ecological roles of individual bryophyte species are often not well understood, in general bryophytes contribute to ecosystem function in a number of ways.

According to Schofield (1985) extensive mats of bryophytes can significantly influence the water balance of a forest by absorbing and releasing moisture, and recycling leached nutrients from the tree canopy into the ecosystem. Many micro-organisms such as protozoa, fungi, bacteria, and blue-green alga often are associated with bryophytes and some species have been found to have antibiotic properties in them (Richardson 1981).

Bryophytes also directly interact with other organisms by providing nesting material and food for birds, voles, and lemmings (Longton 1992, Slack 1988). Both aquatic and terrestrial bryophytes provide shelter and food for the larvae and adults of numerous species of invertebrates

(Richardson 1981). Finally bryophytes are pioneer species that provide the first step in vascular plant succession and they contribute to soil formation through the acceleration of physical and chemical weathering of rock material.

C. Range and Known Sites

Within the states of Washington and Oregon, *Tritomaria quinquedentata* is known from several sites within northern Washington and at Saddle Mountain State Park, Clatsop County, in northwestern Oregon. The northern Washington sites are located in Olympic National Forest, Mt. Baker-Snoqualmie National Forest, Whatcom, Snohomish and King Counties, and Okanogan-Wenatchee National Forest, Okanogan County. The Whatcom County sites in Washington are within a 6.5 km (4 mile) radius of the historic site of Shuksan on the Nooksack River. The sites in Olympic National Park, and King, Snohomish and Okanogan Counties were discovered as a result of field inventories during the period of 2000-2002. Hong (1994) mapped seven sites of *T. quinquedentata* in western Washington, however, only three collections have been located. Field inventories specifically targeting *T. quinquedentata* were conducted in the southern Washington Cascades during 2003. No occurrences were documented in searches of apparently suitable habitat within portions of the Goat Rocks, Mt. Adams, and Indian Heaven Wilderness Areas. Saddle Mountain, Oregon, is the site of many disjunct rarities, including the bryophytes *Diplophyllum albicans*, *D. plicatum*, *Herbertus aduncus*, *H. sakuraii*, *Iwatsukiella leucotricha*, *Plagiochila semidecurrens*, and *Racomitrium aquaticum*.

Globally, this species is circumboreal, found throughout most of the tundra and taiga regions of the northern hemisphere. In North America it is transcontinental. In western North America, its range extends from Alaska and the Yukon south throughout British Columbia and Alberta, south to northwestern Oregon, and east to Montana and Colorado.

D. Habitat Characteristics and Species Abundance

Tritomaria quinquedentata occurs in arctic boreal-like environments in cool, moist sites associated with cold water streams in the Oregon and Washington Cascades. At most of the recently discovered sites in Washington (2000-2002), it occurs on sandy, mineral soil or humus along low gradient, low volume, perennial streams, and seeps. It was found on rock in a talus slope with nearby *Acer macrophyllum* at its Snohomish County site. The species is said to also occur on wet humus over boulders, shaded cliffs, on soil over exposed rock surfaces, on decaying branches at the fringes of spray zones, and among heather on slopes (Hong 1994). Reported collection elevations in Washington range from 2300-5600 feet. It has been found on a seepy north-facing cliff at Saddle Mountain. This species may be more widespread than has been currently documented and is probably under-collected (Schofield, pers. com.). It was rare to uncommon at each of its several recent (2001) collection sites in King and Okanogan Counties, Washington.

II. Current Species Situation

A. Status History

Tritomaria quinquedentata was not rated during the bryophyte viability panels (Forest Ecosystem Management Assessment Team 1993) because of limited information. Due to its

apparent rarity in the Pacific Northwest, this species was included in Survey and Manage survey strategies 1 and 3 under the Northwest Forest Plan (USDA and USDI 1994). This required that known sites be managed and that broad-scale surveys would be undertaken. An amendment to the Northwest Forest Plan in 2001 moved this species to a new category that represented rare species for which surveys were not considered practical (USDA and USDI 2001).

Tritomaria quinquedentata is rated by the Oregon Natural Heritage Information Center (ORNHIC) as G5/S1 in Oregon and Washington and List 2 in Oregon, which indicates that it is considered critically imperiled within the states by ORNHIC, but more common or secure elsewhere (ORNHIC 2004). This species was formerly in Survey and Manage Category B. *Tritomaria quinquedentata* is a Bureau Assessment species for the BLM in Oregon. It has no status with the US Forest Service.

B. Major Habitat and Viability Considerations

Tritomaria quinquedentata is known from relatively few sites based on current knowledge. The major viability considerations are loss of habitat and inadvertent extirpation from sites that are not known, particularly in central and southern Washington, and northern Oregon. Climate change is an additional concern for *T. quinquedentata*, as warming climate may restrict suitable habitat.

C. Threats to the Species

This species may be a glacial relict in our area, now restricted to a limited number of sites and potential habitat may be limited. Disturbance of these sites from activities which modify microclimate, may result in the local extirpation of these species. Activities associated with recreation are the most likely threats to the known populations which occur in popular recreation areas. The apparently limited extent of suitable habitat, particularly in central and southern Washington and northern Oregon, and an apparent modest use, locally, of asexual and sexual reproduction, may have resulted in this species having a low capability of dispersal from existing sites.

D. Distribution Relative to Land Allocations

Among the Whatcom County sites, one is located within the Mt. Baker Snoqualmie Wilderness Area, one is located east of Silver Fir Campground, and one is located in a heavily used recreational area near Austin Pass. The Snohomish County site is located within the Perry Creek RNA. The King County site occurs within the Stevens Pass Ski Area. The Okanogan County sites are included within the Lake Chelan-Sawtooth Wilderness Area, the Pasayten Wilderness Area, and the North Cascades Scenic Highways Corridor. One site occurs within Olympic National Park. The Clatsop County site is located within Saddle Mountain State Park.

III. Management Goals and Objectives

Management for this species follows Forest Service Region 6 Sensitive Species (SS) policy (FSM 2670), and/or BLM Oregon and Washington Special Status Species (SSS) policy (6840).

For Oregon and Washington BLM administered lands, SSS policy details the need to manage for species conservation. Conservation is defined as the use of all methods and procedures which

are necessary to improve the condition of SSS and their habitats to a point where their Special Status recognition is no longer warranted. Policy objectives also state that actions authorized or approved by the BLM do not contribute to the need to list species under the Endangered Species Act.

For Region 6 of the Forest Service, SS policy requires the agency to maintain viable populations of all native and desired non-native wildlife, fish, and plant species in habitats distributed throughout their geographic range on National Forest System lands. Management "must not result in a loss of species viability or create significant trends toward federal listing" (FSM 2670.32) for any identified SS.

IV. Habitat Management

A. Lessons from History

No specific information on this species is available at this time.

B. Identifying Species Habitat Areas

All known sites of *Tritomaria quinquedentata* on federal lands administered by the Bureau of Land Management and/or Forest Service in Washington and Oregon are identified as areas where the information in this Conservation Assessment could be applied. A species habitat area is defined as the suitable habitat occupied by a known population plus the surrounding habitat needed to support the species.

C. Managing in Species Habitat Areas

The objective of species habitat areas is to maintain habitat conditions such that species viability will be maintained at an appropriate scale, in accordance with agency policies. Specific management considerations include:

- Maintain current arctic boreal-like habitat and microclimatic conditions (e.g. intact wet humus and soil, cool air, cold water).
- Prevent disruption to the soil layer and modification of the canopy.
- Restrict livestock use if damage to the species or its substrate is observed.
- Minimize impacts from recreation and associated actions including trampling.
- Permit scientific collections for deposition only at a recognized herbarium and only then if the population is of adequate size and condition and with concurrence of the Forest or BLM District botanist.
- Special forest product permits for moss collection should specify that collection may not occur at or near (up to one mile depending upon the habitat suitability) known sites.

V. Research, Inventory, and Monitoring Opportunities

The objective of this section is to identify opportunities to acquire additional information which could contribute to more effective species management. The content of this section has not been

prioritized or reviewed as to how important the particular items are for species management. The inventory, research, and monitoring identified below are not required. These recommendations should be addressed by a regional coordinating body.

A. Data Gaps and Information Needs

- Visit known sites to verify population status and document ecological conditions to assist in the location of additional populations.
- Survey potential suitable habitat, particularly in central and southern Washington and northern Oregon. This will allow further understanding of the local range of the species.
- Examine Oregon and Washington collections of this species for presence of asexual or sexual reproductive structures. Are these structures rarely present on local material?

B. Research Questions

- What is the ecological amplitude of *Tritomaria quinquedentata*?
- What factors limit its distribution?
- Is this species a glacial relict?

C. Monitoring Opportunities and Recommendations

The principal objective of monitoring is to detect trends at local known sites that may bear on the larger issue of species viability at both local and regional scales. Recommendations include:

- Monitor a subset of known sites. Subset selection should include criteria such as site size (number of individuals), geographic location, local physical conditions (e.g., elevation, moisture regime), and type of local plant community (e.g., structure, composition).
- Monitor site size (number of individuals and/or area of occupancy).
- Monitor for physical changes/damage at site, due either to human actions or "natural" causes.
- Monitor for successional (e.g., structural and compositional) changes in surrounding plant community.

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