

## Bryophytes of Fort Clatsop National Memorial, Oregon

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**Abstract.** Seventy-two taxa of bryophytes (21 liverworts, 51 mosses, 0 hornworts) are currently known from Fort Clatsop National Memorial. The bryoflora of Fort Clatsop is typical of second-growth low-elevation forests and wetlands along the coast of northern Oregon and southwestern Washington. Soil and duff support the greatest number of taxa, followed in decreasing order by decaying wood, epiphytes, and rock. Restoration of native vegetation and old-growth forest at the Memorial will provide scarce low-elevation habitat with long-term stability for bryophytes.

**Background.** The years 2004-2006 will mark the bicentennial of the Lewis and Clark Expedition, sent by the U.S. government to explore northwestern North America. The 33 members of the expedition traveled 12,800 km by boat, horseback, and foot from the Mississippi River to the mouth of the Columbia River and back again. They spent the winter of 1805-1806 at Fort Clatsop in what is now Fort Clatsop National Memorial (Clatsop County, Oregon; Township 08N, Range 10W, Sections 35 and 36; 46° 123'N, 123° 52'W), about 3.2 km south of the Columbia River and 9.6 km inland from the Pacific Ocean. The park encompasses 51 ha surrounding a replica of the log stockade built by the expedition, and a small site in nearby Seaside where expedition members boiled seawater to obtain salt.

Habitats in the park include second-growth Sitka spruce - western hemlock (*Picea sitchensis* - *Tsuga heterophylla*) forest, Sitka spruce swamp, Hooker willow - Pacific willow (*Salix hookeriana* - *Salix lucida* ssp. *lasiandra*) swamp, Hooker willow - crabapple (*Salix hookeriana* - *Malus fusca*) swamp, red alder (*Alnus rubra*) floodplain forest and red alder swamp, freshwater tidal marsh, permanent and intermittent springs and streams, and weedy habitats around buildings, in lawns, and along trails and abandoned roadbeds. Elevation ranges from 0-18 m above sea level. Total annual precipitation averages 1625 mm, most of which occurs in winter and is followed by summer drought. The average winter temperature in nearby Astoria is 6° C, the average summer temperature 15° C, with extremes ranging from -14 to 38° C.

Of 232 authentic plant specimens known to have been collected by the Lewis and Clark Expedition, two were bryophytes and one was a marine alga (Reveal et al. 1999). One of the bryophytes, the moss *Eurhynchium oregonum*, was collected

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by Meriwether Lewis at Fort Clatsop on 20 January 1806 (Moulton 1999). This specimen, housed at the Academy of Natural Sciences in Philadelphia (PH), is the earliest known scientific collection of a bryophyte to have been made in what is now the state of Oregon, and is also the earliest known collection of this species. Had it fallen into the right hands, Lewis' collection would most certainly have been the type specimen for this species, but unfortunately it was either overlooked or ignored by botanists naming Lewis' specimens of vascular plants. *Eurhynchium* ["*Hypnum*"] *oreganum* was not described until 43 years later by Sullivant (1849), based on a specimen collected in 1841 by William Brackenridge or Charles Pickering of the U.S. Exploring Expedition ["Wilkes Expedition"] from somewhere in western Washington [then also called "Oregon"] between Puget Sound and the Columbia River.

**Recent collecting.** No reports of bryophytes from Fort Clatsop are known other than those referring to Lewis' collection of *Eurhynchium oreganum* in 1806 (Meehan 1898, Coues 1898, Cutright 1969, Reveal et al. 1999, Moulton 1999). After Lewis' departure from Fort Clatsop, no bryophytes were collected from the site for another 180 years, when National Park Service employees, Judith Harpel, and the author began to document the park's bryoflora. Collecting for this report was restricted to the area within the current 125-acre boundary of the park and the adjacent willow swamp owned by the Fort Clatsop Historical Association. Small areas of park ownership east of the Lewis and Clark River and at the Salt Works site in Seaside were not sampled. Voucher specimens were deposited at Fort Clatsop National Memorial and Oregon State University (OSC).

**Current bryoflora and habitat.** Seventy-two taxa of bryophytes are currently known from Fort Clatsop National Memorial, including 21 liverworts and 51 mosses (Table 1). These taxa are represented by at least 123 specimens collected at the site since 1806. Most of the species are very common in the Sitka spruce - western hemlock zone along the coast of northern Oregon and southwestern Washington. No currently-listed rare bryophytes were found, although *Bazzania denudata*, *Polytrichum formosum*, *Sphagnum pacificum*, and *Sphagnum girgensohnii* are uncommon in Oregon.

Soil and duff supported the greatest number of taxa, followed in decreasing order by decaying wood, epiphytes, and rock (Table 2). Epiphytic bryophytes were most abundant on Sitka spruce, western hemlock, bigleaf maple (*Acer macrophyllum*), red alder, salmonberry (*Rubus spectabilis*), and elderberry (*Sambucus racemosa*). Four moss species (*Bryum capillare*, *Didymodon vinealis* var. *vinealis*, *Tortula muralis*, *Zygodon viridissimus* var. *rupestris*) were found only on stones and mortar of a drinking fountain, and are not considered representative of natural habitat in the park. Three species of sphagnum moss (*S. girgensohnii*, *S. pacificum*, *S. palustre*) occurred in a small Sitka spruce/ skunk



cabbage - slough sedge (*Picea sitchensis* / *Lysichiton americanum* - *Carex obnupta*) swamp. *Sphagnum* is unknown from other Sitka spruce swamps in Oregon but becomes more common in this habitat in Washington and British Columbia. It may have established relatively recently in the Memorial because it occupies a relatively small portion of suitable habitat present.

Species richness of bryophytes at Fort Clatsop is similar to other low-elevation sites along the coast of Oregon. Hasselbach (1995) reported 91 taxa from Cascade Head Experimental Forest, a site larger than Fort Clatsop and with more diverse forest and rocky habitat, including undisturbed old-growth forest. Christy et al. (1998) estimated that 75 species of bryophytes occur in the Oregon Dunes National Recreation Area, an area many times larger than Fort Clatsop but similarly lacking extensive mature forest or rocky substrates. Saddle Mountain State Park contains at least 92 species of bryophytes but a number of these are restricted to higher elevations not present at Fort Clatsop. Of the three sites, Cascade Head Experimental Forest is most similar to Fort Clatsop in elevation, climate, and history of disturbance. Despite the variety of human disturbances that have occurred at Fort Clatsop since the 1850's, including logging, homesteading, clay mining, and construction of roads, trails, buildings, lawns, and landscaped areas, substrate preferences of bryophytes are very similar to those at Cascade Head (Table 2).

The National Park Service plans to restore native vegetation and old-growth forest at Fort Clatsop to approximate conditions as they were in 1805-1806 when the fort was occupied by Lewis and Clark (National Park Service 1995). Maintenance of existing mid-seral forest stands and their gradual conversion to late seral status will improve the diversity of bryophytes in the park by providing a greater variety of microhabitats, particularly large-diameter decaying logs. An anticipated enlargement of the Memorial from 51 to 607 ha, including additional wetlands and sand dune habitat, will no doubt include new bryophyte habitat and increase the number of taxa presently known from the park. Almost all low-elevation sites along this part of the coast have been disturbed extensively by logging or settlement, and very few tracts in the area owned by federal, state, or local governments are managed as natural areas. This makes Fort Clatsop National Memorial an important site where management will provide long-term habitat stability for bryophytes.

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Table 1. Bryophytes of Fort Clatsop National Memorial, Oregon. Collection numbers are those of the author. Voucher specimens were deposited at Fort Clatsop National Memorial and Oregon State University (OSC). Habitat is Sitka spruce - western hemlock forest unless noted otherwise.

### Liverworts

- Bazzania denudata* (Torrey) Trevisan: soil and duff (9087).  
*Calypogeia azurea* R. Stotler & Crotz: rotten decorticated logs. (9104, 9107)  
*Calypogeia fissa* (Linnaeus) Raddi: soil bank (9028, 9080).  
*Cephalozia bicuspidata* (Linnaeus) Dumortier: soil, duff, and rotten logs, and in landscaped beds (9026, 9038, 9106).  
*Cephalozia lunulifolia* (Dumortier) Dumortier: rotten logs (9105).  
*Cephaloziella turneri* (Hooker) K. Müller: soil bank (9027).  
*Chiloscyphus pallescens* (Ehrhart) Dumortier: tree roots (9110).  
*Conocephalum conicum* (Linnaeus) Underwood: seepy soil in red alder / skunk cabbage swamp (9084).  
*Diplophyllum albicans* (Linnaeus) Dumortier: soil bank (9029).  
*Frullania nisquallensis* Sullivant: bark of red alder and Pacific willow (9024, 9045).  
*Gyrothya underwoodiana* M.A. Howe: soil under red alder and salmonberry (9088).  
*Lepidozia reptans* (Linnaeus) Dumortier: rotten logs (9108).  
*Pellia neesiana* (Gottsche) Limpricht: stream banks (9070).  
*Porella cordaeana* (Huebener) Moore: bark of elderberry in red alder forest (9081).  
*Porella navicularis* (Lehmann & Lindenberg) Pfeiffer: bark of red alder and Pacific willow (9046).  
*Radula bolanderi* Gottsche: bark of Sitka spruce in freshwater marsh (9023).  
*Riccardia latifrons* (Lindberg) Lindberg: root ball of fallen tree in Sitka spruce swamp, and in landscaped bed (9025, 9036).  
*Riccardia multifida* (Linnaeus) S. F. Gray: old bark chips in landscaped bed (9037).  
*Riccia fluitans* Linnaeus: root ball of fallen Sitka spruce in freshwater marsh (9022).  
*Scapania bolanderi* Austin: rotten logs (9109).  
*Scapania undulata* (Linnaeus) Dumortier: rocks in spring and stream in Sitka spruce swamp (9042, 9069).

### Mosses

- Antitrichia curtipendula* (Hedwig) Bridel: rotten logs and bark of red alder (9082).  
*Atrichum selwynii* Austin: soil under red alder and salmonberry (9066).  
*Aulacomnium androgynum* (Hedwig) Schwägrichen: stump in Sitka spruce / Hooker willow - crabapple swamp (9019).  
*Brachythecium albicans* (Hedwig) Schimper: decaying log on mud flat of tidal river (9039).  
*Bryum capillare* Hedwig: mortar between basalt blocks of drinking fountain (9015).  
*Calliergonella cuspidata* (Hedwig) Loeske: rotten log in tidal marsh, and among grass in lawn (9016, 9064).  
*Ceratodon purpureus* (Hedwig) Bridel: rotten log in tidal marsh (9017).  
*Claopodium crispifolium* (Hooker) Renauld & Cardot: red alder stump (9096).  
*Dicranum fuscescens* Turner: bark of western hemlock (9092).



- Dicranum scoparium* Hedwig: rotten logs and bases of trees, also in landscaped beds (9035, 9099).
- Didymodon vinealis* (Bridel) R.H. Zander: mortar between basalt blocks of drinking fountain (9015-2).
- Ditrichum pusillum* (Hedwig) Hampe: soil under red alder and salmonberry (9065).
- Epipterygium tozeri* (Greville) Lindberg: root ball of fallen red alder and Pacific willow in Sitka spruce - red alder swamp (9050, 9078).
- Eurhynchium oreganum* (Sullivant) A. Jaeger: decaying logs, duff, and stems of elderberry (9089).
- Eurhynchium praelongum* (Hedwig) Schimper: stems of salmonberry and on mud in slough sedge swamp (9071, 9101).
- Fontinalis howellii* Renauld & Cardot: bark of Pacific willow, and forming submerged beds in seasonally-flooded ponds (9048, 9093).
- Heterocladium macounii* Best: over rocks in streambed (9058).
- Hookeria lucens* (Hedwig) Smith: mud in slough sedge swamp (9095).
- Hygrohypnum ochraceum* (Turner) Loeske: on rock in streambed (9057).
- Hylocomium splendens* (Hedwig) Schimper: on duff and soil in skunk cabbage swamp (9056).
- Hypnum circinale* Hooker: rotten logs (9103).
- Isoetecium myosuroides* Bridel: lower trunks and branches of Sitka spruce (9100).
- Leucolepis acanthoneuron* (Schwägrichen) Lindberg: on duff and along streambeds (9090).
- Neckera douglasii* Hooker: bark of Hooker willow and red alder (9074, 9074-1).
- Oligotrichum aligerum* Mitten: soil at edge of landscaped bed (9033).
- Orthotrichum consimile* Mitten: twigs of crabapple and red alder in Sitka spruce / Hooker willow - crabapple swamp (9021).
- Orthotrichum lyellii* Hooker & Taylor: bark of red alder and Pacific willow (9073).
- Plagiomnium insigne* (Mitten) T.J. Koponen: duff and soil (9112).
- Plagiothecium undulatum* (Hedwig) Schimper: duff and rotten logs (9094).
- Pogonatum contortum* (Bridel) Lesquereux: duff and rotten logs (9111).
- Pohlia cruda* (Hedwig) Lindberg: soil on root ball (9059).
- Pohlia prolifera* (Kindberg) Lindberg: old bark chips in landscaped bed (9032).
- Polytrichastum alpinum* (Hedwig) G.L. Smith: soil in red alder - bigleaf maple - western hemlock forest (9075).
- Polytrichum commune* Hedwig: old bark chips in landscaped bed (9034).
- Polytrichum formosum* Hedwig: soil (9062).
- Polytrichum juniperinum* Hedwig: soil along sidewalk in landscaped area (9031).
- Porotrichum bigelovii* (Sullivant) Kindberg: over bedrock in small seasonal waterfall (9061).
- Pseudotaxiphyllum elegans* (Bridel) Z. Iwatsuki: rotten wood and soil of root balls and cutbanks (9040, 9068, 9083, 9097, 9102).
- Rhizomnium glabrescens* (Kindberg) T.J. Koponen: rotten logs (9113).
- Rhytidiadelphus loreus* (Hedwig) Warnstorf: duff (9091).
- Rhytidiadelphus squarrosus* (Hedwig) Warnstorf: soil among grass in lawn (9043, 9063).
- Rhytidiadelphus triquetrus* (Hedwig) Warnstorf: soil at edge of Sitka spruce - western hemlock - bigleaf maple forest (9079).



*Sanionia uncinata* var. *symmetrica* (Renauld & Cardot) H.A. Crum & L.E. Anderson: bark of Hooker willow and crabapple in Sitka spruce / Hooker willow - crabapple swamp (9018, 9049).

*Sphagnum girgensohnii* Russow: mucky soil in Sitka spruce / slough sedge - skunk cabbage swamp (9055, 9060).

*Sphagnum pacificum* Flatberg: mucky soil in Sitka spruce / slough sedge - skunk cabbage swamp (9052, 9053).

*Sphagnum palustre* Linnaeus: mucky soil in Sitka spruce / slough sedge - skunk cabbage swamp (9054).

*Tetraphis pellucida* Hedwig: rotten logs and stumps in forest and skunk cabbage swamp (9044, 9076, 9085).

*Tortula muralis* Hedwig: mortar between basalt blocks of drinking fountain (9015-1).

*Ulota obtusiuscula* J.K.A. Müller & Kindberg: bark of red alder along stream (9072).

*Ulota phyllantha* Bridel: twigs of crabapple in Sitka spruce / Hooker willow - crabapple swamp (9020).

*Zygodon viridissimus* var. *rupestris* Lindberg: mortar between basalt blocks of drinking fountain (9015-3).

Table 2. Substrate preferences for bryophytes at Fort Clatsop National Memorial and Cascade Head Experimental Forest, Oregon (Hasselbach 1995). The total for Fort Clatsop exceeds the 72 taxa known from the site because some occur on more than one substrate. Comparable data for Cascade Head are unavailable.

| Site         | Substrate     | Liverworts | Mosses | Total |
|--------------|---------------|------------|--------|-------|
|              |               |            |        |       |
|              |               |            |        |       |
| Fort Clatsop | Soil and duff | 10         | 29     | 39    |
|              | Decayed wood  | 8          | 14     | 22    |
|              | Epiphytic     | 5          | 14     | 19    |
|              | Rock          | 1          | 8      | 9     |
|              | total         |            |        | 89    |
|              |               |            |        |       |
| Cascade Head | Soil and duff | 6          | 30     | 36    |
|              | Decayed wood  | 12         | 9      | 21    |
|              | Epiphytic     | 6          | 12     | 18    |
|              | Rock          | 2          | 14     | 16    |
|              | total         |            |        | 91    |



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