

Surveys for the Rare Moss, *Bartramiopsis lescurii*, Mt Baker-Snoqualmie N.F., Darrington R.D., Snohomish Co., WA.

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SUMMARY

The moss, *Bartramiopsis lescurii*, is known from only a single historical (\pm 1941) site in the contiguous United States in Washington State. Since the previous search 15 years ago, *B. lescurii* was relocated in the same general area, Big Four Ice Cave. A detailed description of its current location, habitat, and population size is given. Additional searches in the greater Mt. Loop Rd. area of Mt. Baker-Snoqualmie N.F. were unsuccessful. Site selection was based on the following criteria similar to those at Big Four: at the bases of north facing cliffs, in shading features, in protective niches on gravel of rocky slopes, with proximity to persistent snow or ice, and associated with *Athyrium filix-femina* and *Oligotrichum hercynicum*. These sites were Lake Twentytwo, North Lake, Glacier Basin, Lake Kelcema, Perry Creek, and Bear Lake. Recommended sites for future surveys are Hall Peak and Mt. Pugh.

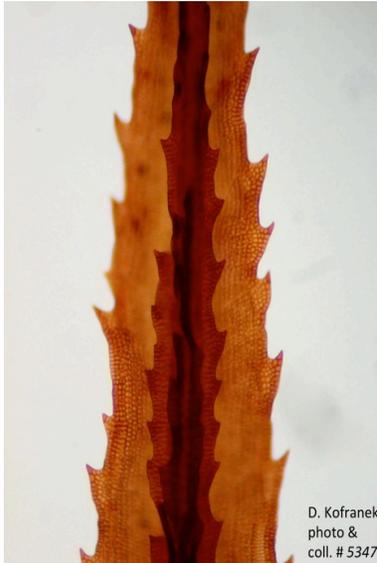
SPECIES ACCOUNT

Bartramiopsis lescurii (G3G5, NNR, S1, WA-SEN), Polytrichaceae, in North America, it ranges from Alaska, British Columbia and south barely to Washington. Across its range it grows on embankments of soil or soil over rock and uplifted root masses (BFNA 2007).

It is unique appearing because its leaves are very ornamented. In particular are the cilia at the shoulder of the clasping leaf base and lower leaf limb. This salient feature is observable with a hand lens making identification in the field possible. For full species descriptions and illustrations see FNA (2007) and Lawton (1971). For detailed information pertaining to the Washington population and more images of *B. lescurii* see Kofranek (2017).



Above left: dry shoots of *B. lescurii*. Above right: leaf.



D. Kofranek photo & coll. # 5347



D. Kofranek photo & coll. # 5347

Above left: upper leaf with lamellae. Above right: leaf lamina with sheathing leaf base. Light patches are areas of unistratose cells within bistratose regions.



D. Kofranek photo & coll. # 5347



D. Kofranek photo & coll. # 5347

Above left: marginal cilia. Above right: leaf transverse cross sections, showing mammilose cells.



Worley & Hamilton coll. #8264 at OSC.
Photo by D. Kofranek.

Above: capsules, showing disc-shaped columellae elevated above mouths of capsules.

HISTORY & SITE DESCRIPTION

B. lescurii has been known from only a single site in Washington State since about 1941, where it represents the only known population in the contiguous United States. Its persistence there is attributed to a unique microclimate at Big Four Mt. in Mt. Baker-Snoqualmie N.F.

A cold sink sits at the base of the mountain created by the 4,000 ft. north-facing wall. Snow accumulates throughout the winter and lingers throughout summer due to lack of direct sunlight. Consequently, the plant community around the cold sink resembles those at subalpine elevations and has species such as *Tsuga mertensiana* and *Cladothamnus pyroliflorus* occurring at 2,000 ft. Additionally, the accumulation of snow at its base melts annually forming a tunnel(s). This is referred to as the Ice Cave and is popular with tourists but dangerous because of collapsing ice.



Above left: Ice Cave. Above right: demonstration of cold sink at Ice Cave with visible cold air as pale haze across ground.

Relocation efforts of *B. lescurii* started in 1996 and were successful. In 2002 it was not found, presumably because it was still under snow. In 2004 it was relocated again on the same gravel slope. The span of 15 years without relocation efforts or further searches outside of the historical site was the impetus for this study.

Big Four Mountain Survey

August 30, 31, September 10, 11, 2019

Bartramiopsis lescurii was quickly found (waypoint 493) less than 20m south (upslope) from the coordinates of the 2004 site.

Deposits from avalanches and erosion from Big Four Mt. have accumulated at the base of the mountain as a broad 80 ft. tall rocky slope. This is unstable terrain and fragile habitat. There is a subtle lateral gradient across the slope in terms of established vegetation. Areas of the slope away from persistent or long lasting snowfields are well vegetated with forbs and shrubs, while slopes closer to snow are much less vegetated or bare. *B. lescurii* is in an area of early to intermediate colonization with well established bryophytes, scattered forbs, and woody plants small to lacking.

Various boulders are scattered across and embedded in the slope. *B. lescurii* is occupying a small protected niche: 2m x 1m x 0.5m. It is a 70% slope at 10° aspect, 1,974 ft. elevation, in open conditions but shaded most of time by the 4,000 ft. wall and at the time of survey,

about 20m from edge of snowfield. This is an area of late snowmelt that *B. lescurii* apparently receives as run off from the slab-shaped boulder.

The microsite is in the form of a small trench, something that a single scrape of a trowel could make, along the downhill face of the boulder. As it turns out, this is one of the limiting features that was seldom seen throughout the remainder of the surveys. The interface of gravel and boulders are often solidly filled in a planar to convex micro-topography. In cases where it was not filled in, other bryophytes were present that had long been established and are now dominant.

B. lescurii is on gravel soil in a shallow trench occupying a 4" x 9" area at $\leq 32\%$ coverage occurring in seven small tufts of plants: 1½" x 3", 1" x 1", 0.5" x 0.5", 1" x 1", 0.5" x 0.5", 2" x 2". The plants were hydrated, sometimes moist with dew and usually not dry and crisped (curled, contorted).



Above: *B. lescurii* circled in red. The similar species *Oligotrichum aligerum*, is circled in blue.



Above: total extent of known *B. lescurii* population in the contiguous United States.

Associated species include *Aruncus sylvester*, *Amelanchier alnifolia*, *Alnus viridis* ssp. *sinuata*, *Mimulus lewisii*, *Festuca occidentalis*, *Saxifragaceae* spp., *Oligotrichum aligerum*, *Bucklandiella sudetica*, *Diplophyllum* sp. Other bryophytes around the boulder are *Pohlia drummondii*, *Blindia acuta*, *Codriophorus acicularis*, *Dicranum howellii*, *Pogonatum urnigerum*, *Polytrichastrum alpinum*, *Scapania americana*, *Plagiothecium piliferum*, *Philonotis capillaris*, *Pellia* sp., and *Marsupella emarginata*.

B. lescurii is a relatively early colonizer and apparently does not compete well with other bryophytes at least not at this latitude. In this vicinity, just to the east where conditions are slightly more vegetated, similar micro-niches were crowded with many other species of bryophytes.

While searching with coordinates and comparing with old photos, it appears that the exact rock that *B. lescurii* was growing at in 2004 washed away. There is a channel there now created by snowmelt. There are some recognizable boulders in the 2004 photo that are still there now including the one with the 2019 *B. lescurii*. Further comparison of photos 15 years separated illustrates what hasn't changed, what has, and how.

Next the east slope was searched (waypoints 502, 503). It is generally a mirror image of the west slope, but with a slightly different aspect, and could receive different air currents. Areas of the slope were focused on that were slightly vegetated, embedded with boulders, and had protected microsites. As similar as this side appears to its counterpart, *B. lescurii* and its associated species were absent.



Above: surveyed habitat east of Ice Cave (waypoints 502, 503).

The open, rocky, late snowmelt habitat on the east side extends much farther than it does west of the Ice Cave. This was searched beyond the residual slabs of snow not part of the Ice Cave. The rock outcrops and bedrock of the area (waypoints 504, 581, 584) had crevices, but they were not protected enough. The habitat was followed for half a mile to its extent at a stream emerging from a high narrow near vertical slot canyon in the cliff face abutting a forest (waypoint 583). The only bryophytes at this habitat were strictly aquatic species that can remain attached during periods when melt water comes gushing out scouring everything in its path. In the greater area, the associated vascular plants were also the wrong species including *Artemisia douglasiana*.



Above: surveyed habitat farther east of Ice Cave to stream and forest (waypoint 583).

Finally, a boulder field with talus (waypoints 586-593) was explored 250m northeast of *B. lescurii* and the Ice Cave. The rock type includes granite, conglomerate, limestone, etc. and varies in size from car-size boulders to about 1m³. The rock substrate is 80% covered with bryophytes and lichens.



Above: boulder field with talus (waypoints 586-593).

Among the boulders there are many interspaces for *B. lescurii* to be protected in and even a cold sink (waypoint 592) at the slope bottom of the rocky field but perhaps being farther away from the cliff base it would receive too much light and overall warmth.

There are a couple of slot canyons above the talus. Both looked like interesting habitat but only western one was searched.



Above: slot canyons above boulder field. Canyon on right (east) was surveyed; the one on the left was not.

Interestingly, there are 11 species of the Polytrichaceae in the greater Ice Cave area, more than half for the state.

CRITERIA FOR SITE SELECTION & POTENTIAL HABITATS, SEARCH IMAGES

A great deal was learned through observation while searching for and relocating *B. lescurii* at Big Four Mt. These observations are compiled as criteria in order from large-scale physical features that can be seen on a topographical map or aerial to associated species observable from hundreds of meters distant to micro-site description. These criteria, together with search images, can save future surveyors time and effort. Since *B. lescurii* was never found at another location other than at the historical site, the guidelines below could be considered only perceived requirements, although there is confidence in their accuracy. In parts of its range where *B. lescurii* is common, it grows in a wide array of situations. Locally however, being at the edge of its range, presumably it is restricted to a narrow set of conditions. Therefore, the conditions at Big Four Mt. were applied in the site selection process.

1. North aspect.
2. Extreme physical/topographical feature such as a tall headwall.
3. Shade; the more the better.
4. Substrate: talus, cobble, scree, gravel, with embedded boulders. Unknown whether these need to be on a slope or not.
5. Persistent snowfields, glaciers, or very late-to-melt snowy areas present at the above setting.
6. Associated species: *Athyrium filix-femina* and *Oligotrichum hercynicum* NOT *Oxyria digyna* nor *Niphotrichum* spp.
7. Crevice in gravel at base of boulder downhill side.
8. Move aside *A. filix-femina* fronds if necessary.
9. Look for delicate, very narrow leaved, wispy moss species not rigid as in *O. aligerum*.

During searches one should bare in mind the three most look-a-like species to *B. lescurii*. They happen to be Washington's three sympatric species of *Oligotrichum*. All three are present at Big Four Mt. and other similar habitats, but are distinguishable in the field.

O. hercynicum is the closest look-alike and is considered an indicator species of the potential presence of *B. lescurii*. It is an arctic-alpine pioneer species in late snow melt areas (FNA 2007). The leaves are not as contorted when dry being more catenulate (incurved) and the leaf margins are not as strongly toothed as in *B. lescurii*. *O. hercynicum* lacks cilia.



Above: *Oligotrichum hercynicum*. Moist plants left, dry plants on right.

O. aligerum is mixed with *B. lescurii* at the Big Four Mt. site. This is ironic because it a rainforest species of low to mid elevations elevations (FNA 2007). It is slightly larger and stouter than *B. lescurii* but when dry its leaves curl and contort similarly to *B. lescurii*. It further differs from *B. lescurii* by having lamellae (longitudinal flaps) on both the top and bottom surfaces of the leaves, not just the top as in *B. lescurii*. The bottom surface of *B. lescurii* appears smooth.



Above: *Oligotrichum aligerum*.

O. parallelum is not necessarily very similar in having broad leaves and appearing more like *Atrichum* when well developed. However it is still mentioned as a representative form in the range of Polytrichaceae species that will be encountered during surveys.

B. lescurii is the only species in the Pacific Northwest that has cilia. With a hand lens the cilia low down on the leaf are thread-like and could be mistaken for something unrelated as sparse hyphal growth or rhizoids, which are brown and felt-like.



Above: *B. lescurii*.

FINAL THOUGHTS ABOUT *B. LESCURII*:

- Monitoring the population at Big Four Ice Cave is recommended every one to five years. This is more important now than ever because of climate change.
- Creating more micro-niches for *B. lescurii* at the Big Four site should be considered. This could be done by digging crevices with a trowel at the downhill side of embedded boulders.
- Wearing a helmet is strongly recommended for those doing future surveys. The habitat of *B. lescurii* inherently has falling rock all times of year.

SITE DESCRIPTIONS

By the completion of the surveys, habitats with the following physical features were searched: lakes, tarns, snowfields, shaded and exposed cliff bases, talus fields, gravel/scree slopes, slot canyons, and cirques. Below are the sites surveyed other than Big Four Mt. in order from best to least likely.

Lake Twentytwo RNA Survey

September 6 & 9, 2019

With its tall headwall, rubble at its base, late snow patches and ice cave, this site resembles a smaller version of Big Four Ice Caves. Lake Twentytwo, 2,500 ft., is also known for its cool microclimate, the reason for its RNA designation. There is more gravel, talus, and boulder habitat here than at Big Four Mt.



Above: Lake Twentytwo.

Both adjacent talus slopes of the lingering snowfield are very good, likely habitats for *B. lescurii*. One is north facing, the best aspect, and the other has the right associated species, *Athyrium filix-femina* and *Oligotrichum hercynicum*. There is much more fine woody debris here than at the Big Four Ice Cave. However, it does not appear to be smothering bryophytes because *O. hercynicum* is still frequent. Continuing west to a boulder field *Niphotrichum* spp., a good anti-indicator species, started to increase. There is a lot of area to

survey here with many micro-niches, therefore further searches would still be warranted. Additionally, the top of the talus slopes at the cliff base, out of direct sunlight.



Above: surveyed habitat at Lake Twentytwo.



Above: surveyed habitat at Lake Twentytwo.



Above: surveyed habitat at Lake Twentytwo.

Even though the first impression of Lake Twentytwo was very promising perhaps this basin loses its edge of coldness due to the lake's moderating effects on ambient temperatures.

As they are at Big Four, people are drawn to the Lake Twentytwo's ice cave. This includes scrambling around on the talus and gravel slopes, which is a sensitive and fragile habitat. People rolling boulders downslope were witnessed.

North Lake Survey

September 1 & 2, 2019

There is a tall, dramatic north to northwest facing ridge above North Lake. At 4,850 ft., it casts shade onto the rocky slopes at its base where there was still some snow (waypoints 511-524). There is a wide range of sizes of boulders, but closer to the cliff base the rocks are smaller and the interspaces are filled with gravel. These conditions matched those at Big Four Ice Cave. Furthermore, the slope undulates with the better microhabitats being in the concave portions. Although some of the vascular plants were species that grow in warmer conditions they dropped out past a certain point closer to the lake where it was suddenly breezier and colder.



Above: North Lake.



Above: surveyed talus slope habitat above North Lake.



Above: closer view of surveyed talus slope habitat above North Lake.

The North Lake survey was completed with thoughts that the lake could be moderating the cold temperatures of the area and that perhaps searching should be done at higher elevations. Finally, could the chemistry here be wrong for *B. lescurii*? Is the pH too high?

Glacier Basin Survey

September 7, 2019

Glacier Basin was accessed by hiking through the historic mining town of Monte Cristo into the Henry M. Jackson Wilderness and terminated below Wilmans Peaks.



Above: Glacier Basin. Surveyed area out of view to the right.

At Glacier Basin, 4,850 ft., the slope facing north northeast, looks perfect. After hiking up the cobble-sized talus and gravel on the east side (waypoint 565) of the snowfield, it soon became apparent it was too dry because it receives too much sunlight. The lower slopes of that area were still in sun on that late day of the year. *Oxyria digyna* and *Niphotrichum ericoides* were the dominant species with little else. Otherwise everything else was right for *B. lescurii*, i.e. large boulders embedded in gravel. Reaching and searching the base of the cliff was not necessary, as the habitat did not look right.



Above: surveyed talus habitat below Wilmans Peaks (waypoints 565, 566).



Above left: good close habitat (waypoint 565). Above right: better habitat but without *B. lescurii* (waypoint 566).

Skirting around the snowfield to its west (waypoint 566) conditions improved. The cliff base and the boulders in the vicinity were searched. I did not have time to search farther to the west where there are still more boulders and the associated species *Athyrium filix-femina*. It probably would not have produced anything though since it gets farther from the cooling effects of the snowfield.

Lake Kelcema Survey

September 5, 2019

This 25-30 ac. tarn is in the Boulder River Wilderness at 3,200 ft. in elevation. The surrounding forest has a distinctly boreal character with old growth *Tsuga mertensiana*, *Callitropsis nootkatensis*, *Abies amabilis*, *Picea*. The basin is situated on relatively thin soil over rock as seen by the old trail that is worn down to sloping granite bedrock. This impenetrable subsurface explains why there are boggy species along the way to the lake such as *Shagnum girensohnii* and *Pleurozium schreberii*. The *Picea* is stunted and chlorotic.

Some trees have tipped over because their root systems have peeled up from the bedrock. Shed-sized boulders are scattered and clustered along the north forested slopes.



Above: Lake Kelcema.

The lake is situated between two opposing rocky slopes with an inlet to the west and outlet to the east. The north facing slope has the most extreme relief as a cliff that sits atop a broad partially vegetated talus slope that extends down to the toe-slope and lakeshore. This area has the highest potential for *B. lescurii*. The talus is granite, mostly $\leq 1\text{m}^3$ in size with some as large as 3m^3 . These are variously vegetated due to age and irrigation. The scrub community here is composed of *Aruncus sylvester*, *Rubus spectabilis*, *Alnus viridis* ssp. *sinuata*, *Cladothamnus pyroliflorus*, *Oplopanax horridum*, *Spiraea douglasii*, *Vaccinium membranaceum*, *Salix* sp.

Searching focused on the talus and boulder fields (waypoints 546-541). The biggest boulders with interspaces spacious enough for a person to drop down into “exhaled” a constant cold draft which I thought perfect for *B. lescurii*. This situation is rich with bryophytes, especially at the points of contact between the boulders where they were covered with them. However, it appears that the bryophytes are in advanced enough succession that it is probably too late for *B. lescurii* to get established. Associated species, *Oligotrichum hercynicum* and *O. aligerum*, were found here (waypoint 547).



Above: Lake Kelcema, two different views of the same surveyed area (waypoints 546-541).

Part of the upper north facing area is gravelly but was not searched entirely because nothing was showing up.

Lake Kelcema fits many of the criteria for *B. lescurii* but it's suspected that the headwall is not high or steep enough to cast enough shade and prolong snowmelt. Additionally, the lake may be moderating temperatures that would be colder if it were not there.

Perry Creek RNA Survey

September 3, 2019

The main draw to Perry Crk. RNA was a north facing slot canyon (waypoints 534-536). It is 200 ft. at its deepest and only 12m wide at the bottom. The bottom is filled with boulders up to car-size, almost all of which are bare of bryophytes and other vegetation demonstrating how regularly disturbed it is. Large tumbled boulders and logs speak to the violent flooding that scours this place each year.



Above: surveyed slot canyon (waypoints 534-536).

This unique habitat shares many of the traits at the Big Four Ice Cave, such as depth, aspect, shade, with regular cool breezes rushing through the canyon. It seemed too warm without any persistent ice or lingering snowfield though. Additionally, gravel slopes are present with embedded boulders like that at the Ice Cave, but it has less bryophyte coverage and, other than *Athyrium filix-femina*, the wrong vascular and non-vascular associated species: *Adiantum pedatum*, *Tolmiea menziesii*, *Mycelis muralis*, *Blindia acuta*.



Above: gravel slope with embedded boulders near mouth of slot canyon (waypoint 534).

Farther downslope, closer to the rocky creek bottom (dry at time of survey), the rock and soil are too regularly scoured to support anything. The upper reaches of the slot canyon are not deemed worthwhile to search since the opposing walls are shorter and therefore more sunlight and warmth expose the slot canyon bottom and walls.

A talus slope (waypoint 537) was searched uphill to the base of a shaded seeping cliff where several strictly calcareous species were growing (waypoint 538).



Above: talus slope (waypoint 537) leading to hot spot at cliff base.



Above: hot spot at cliff base, lower center (waypoint 538).

Bear Lake Survey

September 8, 2019

A tall, steep north facing headwall backs this 25 ac. lake at 2,800 ft. The surrounding forest is old growth *Thuja plicata* with *Abies amabilis*, *Alnus rubra*, and *Vaccinium membranaceum*. *Sphagnum girgensohnii* is patchy across the forest floor and *Lobaria linita* on a tree base (waypoint 571).



Above: Bear Lake (waypoints 569-571).

Bear Lake is poor, unlikely habitat for *B. lescurii* since the limited amount of rocky habitat is mostly vegetated.

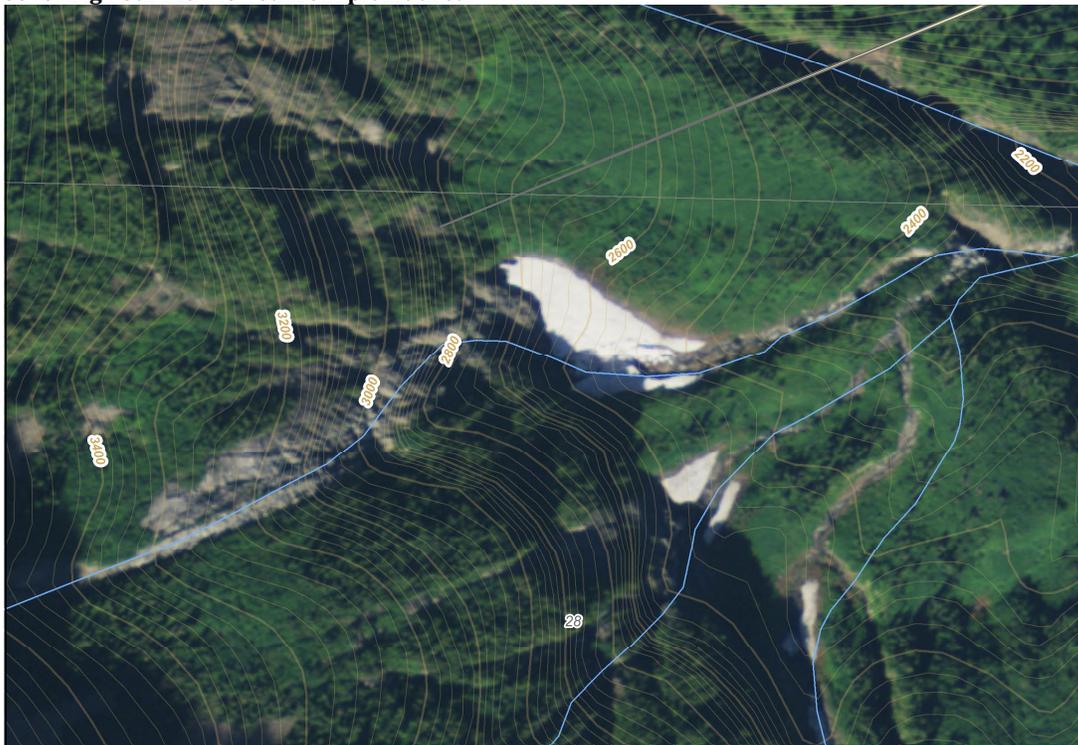
RECOMMENDATIONS FOR FUTURE SURVEYS

Hall Peak

This snowfield below this peak is the most suspected location to have *B. lescurii* being in such close proximity to the historical site and possessing nearly duplicate conditions of the population at the Ice Cave. It is partially up Big Four Mt. and was not surveyed because it was too hazardous at the time.



Above: Big Four Mt. viewed from picnic area.



Above: snowfield below Hall Pk. on Big Four Mt.

Mt Pugh

B. lescurii is known from “usually low to moderate elevations” [0-6,000 ft.] (FNA 2007) but at this low of latitude it may inhabit higher than expected elevations to compensate for cold. Glacier Basin and North Lake were the two highest sites surveyed, 4,850 ft. Conditions there appeared right for *B. lescurii* although it was absent. Perhaps future surveys should extend to 6,000 – 8,000+ ft. Mt. Pugh would be a good candidate by having rocky conditions, a north-facing glacier at 6,300 ft. and it has a trail that can be hiked out and back in one day.

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Above: north facing view from Ice Cave.