An inventory of bryophytes on the summit of Pink Mountain (Peace River District, British Columbia, Canada)

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ABSTRACT.—The bryophyte diversity in northern British Columbia is insufficiently studied. We conducted a bryophyte survey in a 2.2-km² proposed ecological reserve at the summit of Pink Mountain in the Peace River District of northern British Columbia. Pink Mountain is at the southern periphery of the ranges of several arctic flora species as well as the northernmost reaches of other temperate flora species. The south summit of Pink Mountain has a high floristic diversity coincident with its limestone geology, which provides a more alkaline condition for plant growth than the north summit does. We documented 65 species, including 2 new provincial records for British Columbia (*Polytrichum hyperboreum* and *Tayloria hornschurchii*), one red-listed (threatened) species (*Tortula systylia*), and one blue-listed (at-risk) species (*Mnium arizonicum*). *Polytrichum hyperboreum* and *T. hornschurchii* have affinities to habitats more typical of polar regions. The presence of *P. hyperboreum* at Pink Mountain represents a southward range extension from 61°33' N in western North America. Because isolated populations at species distribution limits are likely to be vulnerable to climate change, the establishment of an ecological reserve on the south end of the summit of Pink Mountain is important for the preservation of bryophyte habitat.

RESUMEN.—La diversidad de briófitas en el norte de British Columbia ha sido poco estudiada. Nosotros realizamos un muestreo de briófitas en 2.2 km² de la reserva ecológica que se encuentra en la cima de Pink Mountain en el distrito Peace River al norte de British Columbia. Pink Mountain se encuentra en la periferia sur del rasgo de distribución de varias especies de flora ártica, así como, en el rango de distribución más norteña de algunas especies de flora templada. La cima sur de Pink Mountain posee alta diversidad florística coincidente con la roca calcárea que forma el suelo, la cual proporciona condiciones más alcalinas para el crecimiento de las plantas que la cima norte. Documentamos 65 especies, incluyendo dos nuevos registros para la provincia de British Columbia *Polytrichum hyperboreum* y *Tayloria hornschurchii*, una de ellas se encuentra en la lista roja de especies amenazadas (*Tortula systylia*) y la otra en la lista azul de especies en riesgo (*Mnium arizonicum*). *Polytrichum hyperboreum* y *T. hornschurchii* tienen afinidad a los hábitats de las regiones polares. La presencia de *P. hyperboreum* en Pink Mountain representa una extensión hacia el sur en su rango de distribución de 61°33' N al oeste de Norteamérica. Debido a que, es probable que las poblaciones aisladas en los límites de distribución de las especies sean vulnerables al cambio climático, el establecimiento de una reserva ecológica en el extremo sur de la cima de Pink Mountain es de vital importancia para preservar el hábitat.

The Rocky Mountains of northern British Columbia are characterized by a mosaic of landscapes typical of montane regions of western North America. The bryophyte diversity of this region is poorly studied, even though it is distinctly different from that in the southern portions of the province or the near coastal mountains (Schofield 1988). For example, limited vouchers from the region have been deposited at the University of British Columbia Bryophyte Herbarium. Out of the 68,468

bryophyte vouchers with GPS data points deposited at the herbarium from different regions of British Columbia, only 7611 vouchers are from north of 54° N, and only 2092 (2% of the total) are from north of 54° N and east of 125° W, which includes the Peace River region, an area of over 119,200 km². This region represents 13% of the area of the province. Pink Mountain (57°04.277' N, 122°52.484' W; Fig. 1) is an example of the Muskwa foothills ecosection located within the Peace River

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Fig. 1. Location map of Pink Mountain. Inset shows the location of Pink Mountain within the province of British Columbia.

region on the easternmost edge of the Northern Rocky Mountains. A comprehensive account of the bryophytes on Pink Mountain is lacking.

Pink Mountain is located within the SWBmk (Moist Cool Spruce–Willow–Birch) biogeoclimatic subzone with its valley bottoms dominated by white spruce (*Picea glauca*) and aspen (*Populus tremuloides*) (Pojar and Stewart 1991). These trees are replaced by subalpine fir (*Abies lasiocarpa*) and white spruce at higher elevations. The summit of the mountain, at 1770 m, has a highly diverse arctic flora and fauna and is known for butterfly viewing. Its vegetation consists of a scrub subzone above the associated forest variant, with dwarf willows, grasses, sedges, forbs, and lichens. Pink Mountain Provincial Park, on the slopes west of the summit, was established to protect local fossil beds (Ackerman and Wilkin 2006). The climate of Pink Mountain is cool. According to Climate BC extrapolations based on 1961–1990 Climate Normals (Wang et al. 2016), the summit of Pink Mountain has

a mean annual temperature of -2.2°C with 111 frost-free days, a mean warmest-month temperature of 9.5°C , a mean coldest-month temperature of -13.2°C , a mean annual precipitation of 749 mm (428 mm of the precipitation falls as snow), and an annual average relative humidity of 63%.

Pink Mountain is of ecological interest because of its geological history, climatology, and location. Pink Mountain is at the southern periphery of the ranges of several arctic flora species, as well as the northernmost reaches of other temperate flora species. The south summit of Pink Mountain has an unusually high floristic diversity compared to the northern summit, and other peaks within the area, due to its limestone geology, which provides a more alkaline condition for plant growth. Pink Mountain hosts a plethora of microhabitats with different soil moisture and nutrient regimes to support a wide diversity of calcareous-associated species.

Pink Mountain took form as one of the asymmetrical folds parallel to the Rocky

Mountain thrust belt. Due to the thrusting of the Rockies from west to east, “rippling” occurred at the front, thus forming the foothills, also known as the Laramide Orogeny, during the late Cretaceous (approximately 60 to 70 million years ago; Hinds and Spratt 2005). During the time of rippling, rocks from the Upper Cretaceous were the last rocks to be deposited and are most often exposed. As a result, almost all of the foothills in the area, including the northern summit of Pink Mountain, are covered by Middle or Lower Cretaceous rocks, which mainly consist of sandstone and shale. However, in some instances, where the ripple is sufficiently large and high, erosion has removed all the Cretaceous as well as some of the underlying Jurassic and Triassic rocks (Hinds and Spratt 2005). This is the case at the southern summit of Pink Mountain, where erosion has cut through into the Lower Triassic Montney Formation, which is now exposed at the summit. Triassic rocks in the area have considerable amounts of dolomite, limestone, phosphate (at the base of the Halfway River), halite (salts), and even shell beds (coquina) mixed in them (Hinds and Spratt 2005). Soil samples from the southern end of the summit have a high pH, which indicates a parent rock of limestone and high plant nutrient levels (Long 2016). Bryophyte species assemblages on limestone formations are often very dissimilar from assemblages on other parent substrates (Hinds and Spratt 2005). Limestone-inhabiting bryophyte species tend to have higher calcium requirements and contents than bryophytes on nonbasic rock substrate.

Our objective was to survey and inventory the bryophyte flora in a proposed ecological reserve on the summit of Pink Mountain. Because limestone formations are known to have distinctive bryophyte species assemblages, we hypothesised that the southern summit of Pink Mountain may provide habitat for rare and disjunct calciphilic bryophytes that are unrepresented or underrepresented within British Columbia. This survey provides baseline information on the biodiversity of Pink Mountain for long-term conservation planning and resource management and improves knowledge of the bryophyte flora in arctic and alpine areas of the Peace River Region of British Columbia.

METHODS

A bryophyte inventory of the proposed Pink Mountain Ecological Reserve was conducted over 4 days, 19–22 July 2014, at 19 collection sites within an area of approximately 2.2 km² (Fig. 2). Specimens were collected using standard field collection techniques as described by Schofield and Drukker-Brammall (1992). The collection sites were identified based on geological features and chosen to encompass the variety of microhabitats on the mountain summit, with each site being a different side of a slope, a vale bottom, or a hilltop. All substrates within each of the collection sites (i.e., hummocks, ruts, rock faces, and crevices) were targeted for sampling, and field notes including the locality, microhabitat, substrate, and other environmental characteristics were recorded for all vouchers (refer to Table 1). Given the fragile ecosystem of the alpine meadows (see Supplementary Material 1 for photo), special care was taken to remove the smallest amount of material possible for each voucher. Care was also taken to avoid collecting the same species repeatedly to avoid overcollection. Additionally, the specimens were ranked on a qualitative abundance scale with 3 levels: scarce (observed only 1 time), occasional (observed 2–5 times), and common (observed >5 times).

The specimens were vouchered and deposited at the University of British Columbia (UBC) Herbarium (refer to Supplementary Material 2 for collection numbers). Occasionally voucher specimens consisted of more than one species mixed together. Moss identification, nomenclature, typical substrate associations, and arctic/alpine affinity were based on information in volumes 27 and 28 of *Flora of North America* (Flora of North America Bryophyte Editorial Committee 2015), supplemented by reference to Lawton (1971) and LaFarge-England and Vitt (1985). Liverwort identification and nomenclature were based on Söderström et al. (2016).

RESULTS

The survey yielded a total of 65 species, 53 of which were collected (Table 2). Twenty-two of the collected species were scarce, 16 were occasional, and 15 were common on Pink Mountain. Eleven of the collected species

Fig. 2. Collection sites of the bryophyte inventory within the proposed ecological reserve on the summit of Pink Mountain, British Columbia.

TABLE 1. Collection sites of the bryophyte inventory within the proposed ecological reserve on the summit of Pink Mountain, British Columbia.

Site number	Location	Latitude	Longitude	Elevation (m)	Habitat
1	Last switchback before summit	57.0486	-122.8580	1564	Exposed rocky slopes facing east, in transition region between boreal and subalpine ecosystems
2	On rocky slope above treeline	57.0472	-122.8579	1579	Roadside seepage at the bottom of a rock face facing east, 45% grade
3	On southern face of mountain	57.0428	-122.8623	1593	Dry, southwest-facing subalpine slope with moist areas facing the bowl of mountain
4	On southern face of mountain	57.0448	-122.8685	1640	Rocky, southwest-facing subalpine slope into bowl of Pink Mountain, 25% grade
5	On the cliff face of hill near summit of mountain	57.0539	-122.8697	1719	North-facing shale slope, mossy areas forming hummocks, alpine meadow habitat
6	Summit of mountain	57.0724	-122.8918	1793	In flat alpine meadow on a southwest face of rock with abundant <i>Xanthoria parietina</i>
9	Summit of mountain	57.0731	-122.8767	1775	In alpine meadow habitat, on the side of slope facing west near alpine foxtail (<i>Alopecurus alpinus</i>) habitat
10	Summit of mountain	57.0744	-122.8786	1767	Alpine flat terrain with minor slopes of 20° and small rock crevices
11	Summit of mountain	57.0754	-122.8806	1749	Open alpine meadow, on southwest-facing hummocks along hillside
12	Summit of mountain	57.0780	-122.8836	1737	In alpine meadow in west-facing grassy area between 2 hills and rock crevices
13	Summit of mountain, east side of road	57.0739	-122.8771	1737	In rocky caves and crevices between gigantic boulders
14	On the cliff face of hill near summit of mountain	57.0545	-122.8684	1707	In crevices, wet area mixed in with grasses at the bottom of a dry stream, slope 30%, facing west
15	Summit of mountain, on western slopes of summit	57.0712	-122.8758	1773	Along a northwest-facing hillside slope, 30% grade, with hummocks in alpine meadow
16	North of summit of mountain, between first and second gas well	57.0877	-122.8937	1659	In dry swell next to a dried-up pond along the road next to some bushes in an alpine meadow
17	North of summit of mountain, between first and second gas well	57.0921	-122.8981	1632	In alpine meadow valley between 2 slopes with abundant grasses
18	Summit of mountain	57.0765	-122.8818	1744	Along swells with grass and rocks in open alpine meadow
19	Summit of mountain	57.0751	-122.8799	1753	In seeps of rocks against a west-facing slope, in ruts mixed up with grasses

TABLE 2. Bryophyte species at Pink Mountain, British Columbia. Occurrences refer to site numbers where specimens were collected. Taxon abundance was measured on a scale of 3 rankings: scarce, occasional, and common (see methods for details). Notes specific to a taxon report, including reasons for uncertainty, are given below the table in footnotes. (See page 23 for continuation of Table 2.)

Taxon	Occurrence	Abundance	Notes
<i>Abietinella abietina</i> (Hedw.) M. Fleischer	12, 14, 15, 19	occasional	
<i>Aulacomnium palustre</i> (Hedw.) Schwägr.	2, 3, 9, 12, 16, 18, 19	common	
<i>Aulacomnium turgidum</i> (Wahlenb.) Schwägr.	2, 5, 11, 15, 19	common	!
<i>Barbilophozia hatcheri</i> (A. Evans) Loeske	1, 9, 10, 13, 14, 18, 19	common	
<i>Brachythecium coruscum</i> I. Hagen	16	scarce	!
<i>Brachythecium turgidum</i> (Hartm.) Kinb.	19	scarce	
<i>Brachythecium creberrimum</i> Taylor	19	scarce	
<i>Bryum pallens</i> Sw.	19	scarce	*
<i>Cephalozia bicuspidata</i> ssp. <i>ambigua</i> (C. Massal.) R.M. Schust.	5	scarce	
<i>Ceratodon purpureus</i> (Hedw.) Brid.	3, 14	occasional	*
<i>Cynodontium strumiferum</i> (Hedw.) Lindb.	5, 18	scarce	
<i>Dicranum acutifolium</i> (Lindb. & Arnell) C.E.O. Jensen	10, 12, 13, 17, 19	common	*
<i>Dicranum</i> cf. <i>elongatum</i> Schleich. ex Schwägr.	9, 11, 12, 13	common	A!
<i>Dicranum groenlandicum</i> Brid.	5, 12, 13, 14, 15	common	!
<i>Dicranum spadiceum</i> J.E. Zetterstedt	1, 9, 12, 15, 16	common	
<i>Distichium capillaceum</i> (Hedw.) Bruch & Schimp.	12, 15	occasional	
<i>Drepanocladus aduncus</i> (Hedw.) Warnst.	16, 19	occasional	
<i>Grimmia longirostris</i> (Hook.) Ochyra & arnowiec	9, 11	occasional	
<i>Hylacomium splendens</i> (Hedw.) Schimp.	1, 2, 3, 5, 14, 15, 18, 19	common	
<i>Hypnum</i> cf. <i>holmenii</i> Ando	15	scarce	B*
<i>Hypnum plicatulum</i> (Lindb.) A. Jaeger	5	scarce	!
<i>Hypnum revolutum</i> (Mitt.) Lindb.	9, 11, 12, 13, 14, 16, 19	common	*
<i>Hypnum vaucheri</i> Lesq.	12	scarce	*
<i>Lophozia ventricosa</i> (Dicks.) Dumort.	2	scarce	
<i>Mnium arizonicum</i> J.J. Amann	9	scarce	1
<i>Orthotrichum anomalum</i> Hedw.	6, 12	occasional	*
<i>Paraleucobryum enerve</i> (Thed.) Loeske	3, 14	occasional	
<i>Plagiomnium ellipticum</i> (Brid.) T.J. Kop.	19	scarce	!
<i>Pleurozium schreberi</i> (Brid.) Mitt.	1, 18	occasional	
<i>Pogonatum dentatum</i> (Menzies ex Brid.) Brid.	5	scarce	
<i>Pohlia annotina</i> (Hedw.) Lindb.	14	scarce	
<i>Pohlia bolanderi</i> (Lesq.) Broth.	14	scarce	!

were associated with calcareous substrate and 12 were associated with arctic or alpine habitats. The sites with the highest diversity appeared to be sites 19 (24 species), 12 (21 species), and 14 (16 species). Forty-one of the species collected were in the class Bryopsida, 7 in the class Polytrichopsida, and 5 in the class Jungermanniopsida. The bryophyte species composition of the summit ridge of Pink Mountain (sites 9, 10, 11, 12, 13, 15, 18, and 19) is different from the lower alpine slopes of Pink Mountain (sites 1, 2, 3, 4, 5, and 14), and only about one-third of the species tallied occurred in both environments; the Bray–Curtis dissimilarity index (Bray and Curtis 1957) was 0.64. The collection yielded one provincial blue-listed (at-risk) species, *Mnium arizonicum*, and one provincial red-listed (threatened) species, *Tortula systylia*, as determined by the Conservation Data Center of British Columbia (B.C.

Conservation Data Centre 2017). Furthermore, there were 2 species new to British Columbia (*Tayloria hornschurchii* and *Polytrichum hyperboreum*), and both can be recommended for addition to the provincial red list. We found no other specimens of these 2 species from British Columbia in herbaria at UBC, the Royal British Columbia Museum, or the University of Alberta.

DISCUSSION

This study documents the bryophyte flora on limestone formations in British Columbia. The south end of the summit of Pink Mountain provides a more alkaline substrate for calcareous species than the north end of the summit. In a comparison of soil attributes across different mountain peaks in the Muskwa Foothills ecosection (Long 2016), soil samples taken from the southern end of the summit

TABLE 2. Continued.

Taxon	Occurrence	Abundance	Notes
<i>Pohlia nutans</i> (Hedw.) Lindb.	5, 12	occasional	
<i>Polytrichastrum alpinum</i> (Hedw.) G.L. Sm.	14	scarce	
<i>Polytrichum commune</i> Hedw.	2, 17	occasional	
<i>Polytrichum hyperboreum</i> R. Br.	12, 16	occasional	2!
<i>Polytrichum juniperinum</i> Hedw.	9, 12, 15, 18	common	
<i>Polytrichum piliferum</i> Hedw.	9, 12	occasional	!
<i>Polytrichum strictum</i> Menzies ex Brid.	17, 19	occasional	!
<i>Ptilidium ciliare</i> (L.) Hampe	1, 10, 12, 13, 18, 19	common	
<i>Ptychostomum</i> subg. <i>Claodium</i> (Brid.) J.R. Spence	1, 12, 16, 19	occasional	
<i>Ptychostomum cryophilum</i> (Mårtensson) J.R. Spence	14	scarce	
<i>Ptychostomum pseudotriquetrum</i> (Hedw.) J.R. Spence & H.P. Ramsay	11, 12, 16, 19	common	
<i>Racomitrium canescens</i> (Hedw.) Brid.	4, 5, 14	common	*
<i>Rhytidium rugosum</i> (Hedw.) Kindb.	10, 11, 12, 15, 19	common	*
<i>Sanionia uncinata</i> (Hedw.) Loeske	2, 3, 5, 9, 12, 14, 15, 18, 19	common	
<i>Solenostoma</i> cf. <i>confertissimum</i> (Ness) Schljakov	2	scarce	C
<i>Syntrichia norvegica</i> F. Weber	9, 11, 16, 18	occasional	
<i>Syntrichia ruralis</i> (Hedw.) F. Weber & D. Mohr.	12, 14, 15, 19	occasional	
<i>Tayloria hornschurchii</i> (Grev. & Arn.) Broth.	15	scarce	3!
<i>Tomentypnum nitens</i> (Hedw.) Loeske	19	scarce	*
<i>Tortula systylia</i> (Schimp.) Lindb.	11	scarce	4!*
<i>Warnstorfia fluitans</i> (Hedw.) Loeske	19	scarce	
Taxa observed but not vouchered			
<i>Anthelia juratzkana</i> , <i>Barbilophozia barbata</i> , <i>Brachythecium</i> cf. <i>erythrorrhizon</i> , <i>Didymodon</i> sp., <i>Encalypta</i> sp. (sterile), <i>Grimmia ovalis</i> , <i>Lophozia longidens</i> , <i>Orthotrichum speciosum</i> , <i>Pseudoleskea atricha</i> , <i>Ptilium crista-castrensis</i> , <i>Tortula hoppeana</i> , <i>Desmatodon latifolius</i>			

1 Blue-listed species.

2 This record represents the first confirmed report of this species for British Columbia; it is also the southernmost and highest elevation record for this species.

3 This record represents the first confirmed report of this species for British Columbia.

4 Red-listed species.

A Specimen had unusual growth form in dense tufts.

B Variable alar cells.

C Poor material; leaf border differentiated but marginal cells not enlarged.

! Bryophytes associated with alpine or arctic habitats.

* Bryophytes associated with calcareous substrate.

indicated a limestone parent material with a pH of 6.20 and consisted mostly of coarse sand with moderate amounts of organic matter. In contrast, a soil sample from the north end of the summit had a pH of 5.23 and consisted mostly of fine sand with minimal amounts of organic matter.

The bryophyte composition of Pink Mountain is distinctive, in accordance with its substrate diversity and location at a crossover zone between the southernmost distribution of arctic bryophyte species and the northernmost extent of other temperate species. The occurrence of *Polytrichum hyperboreum* at Pink Mountain represents a new species record for British Columbia and extends the known southern range limit of the species. We have not found any published records of *P. hyperboreum* south of 61°33'N in western North America. We propose changes to the key to *Polytrichum* species of British Columbia in order to add *P. hyperboreum* (Supplementary

Material 3). With the discovery of *Tayloria hornschurchii* in British Columbia, all 6 known *Tayloria* species in North America occur in the province (Flora of North America Bryophyte Editorial Committee 2015).

In the Northern Hemisphere, bryophyte populations at their southernmost species distribution limits are the most vulnerable to climate change, and their habitats should be conserved (Désamoré et al. 2012). The projection of expected species distributions into the future depends on the assumption that species preserve identical niche preferences and migrate to locations that remain suitable. The specific ecophysiological features of bryophytes make them especially good indicators of climate change (Désamoré et al. 2012). Particularly relevant features of mosses relative to climate change include poikilohydry and reliance on atmospheric precipitation for water as well as nutrient uptake, resulting in no net photosynthesis over prolonged periods of

desiccation in patches (Bates et al. 2005); extreme sensitivity to moderate temperature increases in the temperate flora (Furness and Grime 1982); and effective dispersal ability. Consequently, changes in bryophyte communities are expected to result from major climatic shifts. For example, the extent of the changes in climate during the Holocene was enough to force bryophyte species to migrate in much the same manner as temperate tree species did (Svenning et al. 2008). Similar changes might be expected over the Anthropocene. Given the locally significant contribution of the expansive carpets of terrestrial bryophytes to the biomass of Pink Mountain, these changes can potentially pose severe functional consequences to the water storage, nutrient cycling, and microhabitat availability for other organisms in the alpine ecosystem.

Since the summit of Pink Mountain could be both the southernmost and highest elevation limit of certain arctic bryophyte species, it may be difficult for these populations to migrate if the climate of Pink Mountain becomes uninhabitable due to climate change. Rarity and lack of access to suitable habitat could limit dispersal of rarely fruiting dioicous species, such as *Tayloria hornschurchii* (LaFarge-England and Vitt 1985). Its known distribution within North America is primarily eastern Beringia, plus scattered locations in Alberta, Wyoming, and Colorado, and on Ellesmere Island (LaFarge-England and Vitt 1985). The preferred substrate of *Tayloria hornschurchii* is humus or humic soil (LaFarge-England and Vitt 1985). Populations typically occur on exposed soil at the sides of erosional mini-mounds in tundra or polar semideserts. Such environments are common elsewhere within the northern Rocky Mountains; hence the absence of the species at other sites within the area would either indicate that the species has dispersal limitations preventing its establishment, or that the species is largely undercollected and more documentation is necessary. The same case can be made for other rare species found on Pink Mountain, such as *Tortula systylia*, which is a red-listed species with only one other known occurrence in British Columbia. *Tortula systylia* inhabits soils in rock crevices in high-elevation alpine tundra (Flora of North America Bryophyte Editorial Committee 2015).

Dispersal limitations and increased mortality at receding margins can result in extirpation of

receding-edge populations and latitudinal displacement of the species range (Hampe and Petit 2005). In many bryophyte species, rear-edge populations are typically smaller and more isolated and cannot easily compensate for local extinction events, so consequently the colonization front of long-distance dispersal events from larger lower-latitude populations becomes the dominating population dynamic (Hampe and Petit 2005). This dynamic also results in the observed poleward decrease in genetic diversity both within as well as among populations (Hewitt 2000). However, locally abundant moss species with large rear populations will likely have better long-term persistence and mitigating effects on range shifts and extinction. Stable rear-edge populations, because of their age, contain the bulk of the genetic diversity of species, and new adaptations are more likely to emerge from these regions (Hampe and Petit 2005). Although *Polytrichum hyperboreum* is at its southernmost and highest elevation extent at Pink Mountain, it is much more locally abundant than the other intrinsically rare bryophytes on Pink Mountain such as *Tayloria hornschurchii*, and could act as an important source population for dispersal to the north. *Polytrichum hyperboreum* normally occupies open stony or sandy ground, ridges, ravines, and tundra, and occurs in deep masses along lake margins and stream banks (Flora of North America Bryophyte Editorial Committee 2015). Retention of the population of *P. hyperboreum*, as well as other species with rear-edge populations on Pink Mountain, could potentially serve as a buffer to climate change.

Conservation of Pink Mountain

Pink Mountain provides habitat for many rare plants, including the bryophytes outlined in this study. Further study of this unique ecosystem including additional systematic survey of the bryophytes would likely contribute more species to the provincial checklist. In addition to the effects of climate change, Pink Mountain is at risk of several major environmental threats that could result in extensive habitat loss. Recreational visitors accessing the mountaintop by road for 4 × 4 off-roading can cause extensive damage to the mountain and disrupt the fragile alpine area. The reactivation of 2 existing gas wells that were established in the 1960s would result in increased industrial

traffic and the bulldozing of large areas of tundra. The biggest threat is a proposal to install up to 40 wind turbines on the summit, whereby the concrete bases and expanded road network required to support these structures would severely impact the summit flora and fauna. The proposal to establish a 2.2-km² ecological reserve on the south end of the summit of Pink Mountain is important for the preservation of species habitat against such industrial development and for the mitigation of the loss of rare species because of climatic change.

SUPPLEMENTARY MATERIAL

Three online-only supplementary files accompany this article (scholarsarchive.byu.edu/wnan/vol78/iss1/3).

SUPPLEMENTARY MATERIAL 1. Photograph of alpine tundra of the summit of Pink Mountain (21 July 2014).

SUPPLEMENTARY MATERIAL 2. Collection numbers for bryophyte voucher specimens deposited at the University of British Columbia (UBC) Herbarium.

SUPPLEMENTARY MATERIAL 3. Proposed key to *Polytrichum* of British Columbia (based on Flora of North America Bryophyte Editorial Committee 2007).

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