Technical Memo to Metro

HISTORICAL AND EXISTING VASCULAR AND BRYOPHYTE FLORA, FORMER BLUE HERON PAPER MILL, WILLAMETTE FALLS, OREGON CITY, OREGON

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Background

Willamette Falls has long been a focus of botanical interest, but industrial development at the site has limited public access for over a century. The closure of the Blue Heron paper mill on the south bank of the river, and proposed redevelopment of the site, has given planners an opportunity to revisit this part of the falls and identify its current flora. As part of the pre-construction planning process for public access to the falls, Metro contracted John Christy to document the historical and existing vascular flora on the site, and Philip Gaddis joined us to document the bryophyte flora.

For millennia, the falls has been a magnet for fishing, settlement, and more recent industrial development. Photographs by Carleton Watkins show that the south bank of the river at Willamette Falls had been modified for industrial uses as early as 1867. Infrastructure included dams and spillways to create a boat basin, and millraces to power a sawmill, gristmill, and woolen mill. Later, paper mills and electrical generating stations were built on both sides of the falls. These activities concentrated at the falls have impacted all native habitat except vertical cliff faces on basalt outcrops along the river. Significant portions of the shoreline at the Blue Heron site have been modified by fill. Remaining habitat in natural or semi-natural condition includes areas hydrated by tidal action of the Willamette River, areas of seasonal or perennial seepage below spillways and the old grinders, and basalt outcrops with varying exposures. The basalt outcrops are a relic of the Bretz or Missoula Floods (Allen et al. 1986), and exposures along this part of the Willamette River provide outlier habitat for both mesic and xeric species more common in the Columbia River Gorge (Detling 1958). Willamette Falls has a similar history to that of Niagara Falls in terms of industrial development, presence of a rock substrate supporting disjunct populations of rare plants, and botanical exploration that occurred primarily between 1885 and 1915 (Eckel 2013).

Methods

The project area was limited to shoreline outcrops, wetland alcoves, and filled slopes between the Blue Heron mill buildings and the river. We also briefly examined the rail spur south of the mill, and the adjoining property at the falls owned by Portland General Electric. Information on the existing flora was compiled by John Christy, Philip Gaddis, and Brian Vaughn during visits to the site. Field work was done on April 17, May 8, May 11, and June 24, 2015. Access on May 11 was from the Willamette River using Metro's boat, the remaining days being done on foot. During the inventory, Christy focused primarily on vascular plants, and Gaddis focused primarily on bryophytes. Voucher specimens were collected as needed, and will be deposited in the Portland State University Herbarium.

Vascular plants. Information about the historical vascular flora at the falls was compiled from Nuttall (1841), Gorman (1916-1917), Maguire (1943), Christy et al. (2009), online herbarium databases [Academy of Natural Sciences of Drexel University (2010), Natural History Museum (2014), Consortium of Pacific Northwest Herbaria (2015)].

Bryophytes. Information about the historical bryoflora at the falls was compiled from Chapman and Sanborn (1941), Flowers (1952), online herbarium databases [Consortium of Pacific Northwest Herbaria (2015)], and historical bryophyte specimens housed at Portland State University and Oregon State University that have not yet been databased.

Precision of locality data. Unfortunately, early botanists often were not precise about where they collected specimens, so something from "Willamette Falls" could have been anywhere in the general vicinity, but possibly not from the immediate area of the falls. Because the historical record for vascular plants is fairly large, we chose to be conservative by including localities labeled specifically "Willamette Falls," but excluding records indicating that they were collected "near" the falls, or on "bluffs overlooking the falls." Conversely, because the historical record for bryophytes is more limited, we chose to include all localities relating to the falls, including those indicating that they were collected nearby or on the bluffs above the falls. Given the imprecise historical locality data, we can never be certain if all of these species really occurred at the falls.

Nomenclature follows the Oregon Flora Project (2014), Christy and Wagner (2014), and Wagner (2014).

Historical flora of Willamette Falls

Vascular plants. Primary sources about the historical vascular flora at the falls yielded 165 records, representing 65 species collected between 1834 and 1940 (Table 1). The table also includes names of collectors, collection dates, and sources of data. More information about the collectors and chronology can be found in Christy et al. (2009). Several of the region's earliest plant collectors, including David Douglas and Meredith Gairdner, are known to have visited Willamette Falls on their travels, but we could not find any plant collections made there earlier than those of Nuttall. Despite ongoing transit of the falls by various botanists in the decades following Nuttall's visit, there is no record of specimens collected there until Louis Henderson began his investigations in 1884. The most comprehensive collecting of vascular plants at the falls was done by Edmund Sheldon in 1902 and 1903. Bryophytes at the falls were collected primarily by Albert Foster between 1903 and 1910, and to a lesser extent by Michael Flinn between 1905 and 1920.

Willamette Falls is the type locality for *Arnica amplexicaulis*, collected by Thomas Nuttall in 1834 or 1835 (Nuttall 1841, Maguire 1943). *Sullivantia oregana* and *Bolandra oregana*, rare species with type localities at Milwaukie (Watson 1879, but per specimen label at Gray Herbarium, Harvard University) have never been reported from Willamette Falls.

Two species of the historical flora are exotic (3%), the rest native (97%). Because many exotic species already were well established in the metro area by 1885 (Christy et al. 2009), the high proportion of native species collected at the falls may reflect collectors' preferences more than what may have actually occurred there.

Bryophytes. Primary sources about the historical bryoflora at the falls and vicinity yielded 57 records, representing 31 species likely to have occurred within the project area, collected between 1895 and 1920 (Table 1). None of these are considered exotic.

Existing flora at Blue Heron site

Vascular plants. Table 1 lists 166 species that we observed at the Blue Heron site in 2015.

Native species seen at Blue Heron in 2015 that are rare to the Portland metro area include: *Agrostis pallens, Apocynum cannabinum, Carex vulpinoidea, Cystopteris fragilis, Eriogonum compositum, Erythranthe moschata, Festuca roemeri, Penstemon richardsonii, Poa secunda, Rubus leucodermis, Saxifraga mertensiana, Scutellaria lateriflora, Sedum spathulifolium, Sedum stenopetalum,* and *Selaginella wallacei* (Christy et al. 2009, Appendix D). However, work done in the Willamette Narrows by Philip Gaddis and John Christy between 2011 and 2015, and by Maze and Bushman (2015) at Elk Rock have confirmed that a number of these species still persist in the area and may not be quite as scarce as they were thought to be in 2009. Of the species listed above, *Cystopteris fragilis* and *Penstemon richardsonii* are the most significant finds at Blue Heron because few sightings are known from the metro area, particularly for the *Penstemon* that had not been seen since 1976, and otherwise is known locally only from Elk Rock (Figure 1; Maze and Bushman 2015). Specimens of *Alnus rhombifolia, Cyperus fuscus,* and *Cystopteris fragilis* seen at the Blue Heron site need verification.

In contrast to the historical flora, 86 species (52%) of the existing flora are exotic, and 80 (48%) are native. This proportion of native to exotic species reflects the long-term disturbance that has occurred at the site since the earliest times, and probably a more comprehensive documentation of the flora than was done by the early collectors. Most of the exotic taxa are well-known invasive upland species and do not need special mention here. Wetland invasives of particular concern include *Iris pseudacorus, Ludwigia hexapetala, Lythrum salicaria*, and *Phalaris arundinacea*. The *Lythrum* is quite abundant on cobble areas of river alcoves among the basalt bluffs, and can easily spread downstream by seed and fragmentation. *Carduus pycnocephalus* and *Verbena brasiliensis* may be weeds of emerging concern, the latter also on cobble and capable of dispersal downstream. *Verbena brasiliensis* needs verification, but seems distinct from *V. bonariensis* that has also been found in the metro area.

Bryophytes. 53 species of bryophytes were observed at the Blue Heron Mill site in 2015. This includes 13 (42%) of the 31 historically documented species. Conversely, 18 species (58%) of the historically documented bryophyte species were not detected. Two missing species, *Blindia acuta* and *Orthotrichum rupestre*, were the only known occurrences in the Portland metropolitan area. Two others, *Encalypta ciliata* and *Pseudobraunia californica*, were each known from only one other site in the metro area. All of these species are mosses primarily associated with rocky cliffs and outcrops. *Blindia acuta* is typically associated with permanently wet rock and splash zones of waterfalls, a habitat only marginally surveyed in the current study.

Barbula convoluta is new to the list of bryophytes known from the Portland metro area, but is a ruderal species. *Leptobryum pyriforme* is known from one other site in the metro area. *Fissidens*

fontanus is a List 2 species (Oregon Biodiversity Information Center (2013), but appears to be undercollected in the state and is probably more common than first thought.

Of the observed species, 2 are known to be exotic. *Lunularia cruciata* is a regionally abundant, thallose liverwort of moist riparian soil banks. *Campylopus introflexus* is an invasive moss on dry, exposed soil and sand.

Significant habitat at Blue Heron, and presence or absence of botanical components

Rock outcrops and alcove wetlands are the principal native habitats remaining in the project area. Many of the outcrops have been impacted by construction of mill facilities, and presumably by decades of poor air quality. However, significant remnants of undisturbed cliff faces remain (Figures 1 and 2). The top of the cliffs presently occupied by the clarifier structure are in good condition and subject to seasonal washover below the spillway. The wetland alcoves contain industrial structures and debris, some of which are of considerable cultural interest. However, sand and cobble substrates, as well as areas hydrated by leakage from spillways and the old grinders support a diverse array of native wetland plants, although they are subject to considerable disturbance during peak river flows.

Native vegetation on the cliffs and outcrops is better preserved at Blue Heron than elsewhere in the metro area, because of the absence of overhanging mats of English ivy. This greatly increases their conservation value. Based on what we see today in the project area, important vascular species for the outcrops include *Agrostis pallens, Eriogonum compositum, Eriophyllum lanatum, Festuca roemeri, Penstemon richardsonii, Philadelphus lewisii, Physocarpus capitatus, Poa secunda, Saxifraga mertensiana, Sedum spathulifolium, Sedum stenopetalum, Selaginella wallacei, Symphyotrichum subspicatum, Tolmiea menziesii, and Triteleia hyacinthina.* Five species of willows (*Salix exigua, S. hookeriana, S.lasiandra, S. scouleriana, S. sitchensis*) are also present on site, and probably were a component of original riparian vegetation, though some may have been aided by leakage from mill structures.

Although the bryophyte communities at the Blue Heron site are relatively diverse, they appear to be dominated inordinately by a few abundant species. Most other species appear to be comparatively sparsely distributed in the study area compared to more protected sites in the vicinity, such as Willamette Narrows, Canemah Bluffs, Camassia Preserve, and immediately above the Blue Heron site on the grounds of the Museum of the Oregon Territory. The river shoreline rocks are surprisingly devoid of bryophyte species. Above ordinary high water, moist and shaded rock habitats are overwhelmingly dominated by dense monocultures of *Scleropodium cespitans*, a common species in our area, but usually mixed with other bryophyte species. More horizontal rock surfaces on ledges and tops of bluffs are comparatively sparsely populated by colonies of *Racomitrium* and *Grimmia* species. At other, more protected sites outside the project area, these habitats are densely covered with these species as well as with *Dicranum howellii*, *Polytrichum juniperinum*, and *Homalothecium megaptilum*. Where well established, this community can be several inches deep and support habitat for many vascular plants of conservation concern such as *Comandra umbellata*, *Allium acuminatum*, *Allium amplectens*, *Brodiaea coronaria*, *Piperia transversa*, *Lomatium triternatum*, and *Lomatium utriculatum*.

Increasing the diversity of native historical species on basalt outcrops at Willamette Falls would be a desirable restoration target. Although portions of the rocks are subject to periodic scouring by high river flows, higher ledges and cliffs are free of scour and could support an array of species that probably once occurred there. In this habitat, bryophytes are critical keystone ecosystem builders because of their ability to create soils and trap sediments on these otherwise barren substrates. Establishment and spread of bryophyte mats is an essential first step in creating habitat for vascular plants. This could be accomplished by transplanting moss mats and excluding trampling from foot traffic. With proper management, the basalt bluffs at Blue Heron could become a showcase for all of these plants.

Records from Willamette Narrows and Elk Rock indicate that a number of vascular species are missing from today's Blue Heron site, but could be targets for restoration. These would include *Agrostis pallens, Allium amplectens, Allium acuminatum, Arctostaphylos uva-ursi, Arnica amplexicaulis, Bolandra oregana, Brodiaea coronaria, Castilleja hispida, Cascadia nuttallii, Ceanothus cuneatus, Delphinium leucophaeum, Grindelia integrifolia, Heuchera micrantha, Lithophragma parviflorum, Lomatium dissectum, Lomatium triternatum, Micranthes gormanii, Micranthes integrifolia, Micranthes fragosa, Micranthes marshallii, Micranthes rufidula, Penstemon serrulatus, Rupertia physodes, Silene antirrhina, Silene douglasii, Silene menziesii, Sullivantia oregana,* and *Viburnum ellipticum*. Because Willamette Falls is the type locality of *Arnica amplexicaulis*, special effort should be made to reestablish this species at the falls. Bryophyte species suitable for reintroduction at Blue Heron include *Racomitrium, Grimmia, Dicranum howellii*, *Polytrichum juniperinum*, and *Homalothecium megaptilum.*

Only 8 (12%) of the historical vascular plants were seen at Blue Heron in 2015, while 13 (42%) historical bryophytes persist at the site (Table 1). This difference may be attributable in part to the limited accuracy of historical locality data and collecting activity of early botanists. It also may illustrate the vulnerability of vascular plants in the face of habitat change, and the relatively greater resilience of some bryophyte species that are able to persist in protected microsites, or, like some of the wetland and aquatic species, are habitat generalists that are able to survive as long as water is present and of reasonably good quality.

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Table 1. Historical and existing vascular and bryophyte flora of Blue Heron mill site, Willamette Falls, 1834-2015. Herbarium acronyms: BM = Natural History Museum, London; HPSU = Portland State University; NY = New York Botanical Garden; OSC = Oregon State University; PH = Academy of Natural Sciences, Philadelphia; REED = Reed College; SOC = Southern Oregon University; SRP = Boise State University; UBC = University of British Columbia; WS = Washington State University.

Taxon	Family	Habitat	Native/ Exotic	Collector	Historical	Current	Source
Vascular plants							
Acer macrophyllum	Sapindaceae	fill banks, outcrops	N	–	–	2015	
Achillea millefolium	Asteraceae	outcrops	N	–	–	2015	–
Acmispon americanus var. *americanus*	Fabaceae	outcrops, cobbles	N	–	–	2015	–
Agrostis microphylla	Poaceae	?	N	L.F. Henderson	1885	–	OSC, REED
Agrostis pallens	Poaceae	outcrops	N	L.F. Henderson	1884	2015	OSC
Agrostis stolonifera	Poaceae	spillways, cobbles, outcrop seepage	E	–	–	2015	–
Aira caryophyllea var. caryophyllea	Poaceae	outcrops	E	–	–	2015	–
Aira praecox	Poaceae	outcrops	E	–	–	2015	–
Allium acuminatum	Amaryllidaceae	?	N	E.P. Sheldon	1903	–	OSC
Allium vineale	Amaryllidaceae	outcrops	E	–	–	2015	–
Alnus rhombifolia	Betulaceae	fill banks, riparian	N	–	–	2015	–
Alnus rubra	Betulaceae	fill banks	N	–	–	2015	–
Alopecurus pratensis	Poaceae	buildings	E	–	–	2015	–
Anisocarpus madioides	Asteraceae	?	N	?	?	–	Gorman 1916-17
Apocynum cannabinum var. *glaberrimum*	Apocynaceae	cobbles	N	–	–	2015	–
Arnica amplexicaulis	Asteraceae	?	N	T. Nuttall	1834-1835	–	Nuttall 1841; BM, PH
Artemisia douglasiana	Asteraceae	fill banks, outcrops	N	–	–	2015	–
Athyrium filix-femina var. *cyclosorum*	Athyriaceae	water, dam, spillways	N	–	–	2015	–
Azolla sp. (sterile)	Salviniaceae	grotto, dam, spillways	N	–	–	2015	–
Berberis aquifolium	Berberidaceae	outcrops	N	–	–	2015	–
Brodiaea coronaria	Asparagaceae	?	N	E.P. Sheldon, T. Howell	1902	–	OSC
Bromus racemosus	Poaceae	fill banks, outcrops	E	–	–	2015	–
Bromus sterilis	Poaceae	fill banks, outcrops	E	–	–	2015	–
Buddleja davidii	Scrophulariaceae	buildings	E	–	–	2015	–
Calystegia sepium ssp. *angulata*	Convolvulaceae	fill banks, cobbles	E	–	–	2015	–
Carduus pycnocephalus	Asteraceae	buildings	E	–	–	2015	–
Carex unilateralis	Cyperaceae	?	N	E.P. Sheldon	1902	–	OSC
Carex vulpinoidea	Cyperaceae	spillways	N	–	–	2015	–
Centaurium erythraea	Gentianaceae	outcrop seepage	E	–	–	2015	–
Cerastium arvense ssp. *strictum*	Caryophyllaceae	fill banks	N	–	–	2015	–

Cerastium glomeratum	Caryophyllaceae	buildings	E	–	–	2015	–
Chamaesyce maculata	Euphorbiaceae	cobbles	E	–	–	2015	–
Cicuta douglasii	Apiaceae	water, dam, spillways	N	–	–	2015	–
Cirsium arvense	Asteraceae	fill banks	E	–	–	2015	–
Clarkia gracilis ssp. *gracilis*	Onagraceae	?	N	E.P. Sheldon	1903	–	OSC
Claytonia perfoliata ssp. *perfoliata*	Montiaceae	outcrops	N	–	–	2015	–
Clematis vitalba	Ranunculaceae	fill banks, buildings	E	–	–	2015	–
Collinsia grandiflora	Plantaginaceae	?	N	E.P. Sheldon	1903	–	OSC
Conium maculatum	Apiaceae	fill banks, cobbles	E	–	–	2015	–
Convolvulus arvensis	Convolvulaceae	fill banks, cobbles, outcrops	E	–	–	2015	–
Cornus nuttallii	Cornaceae	?	N	unknown	1899	–	OSC
Cornus sericea	Cornaceae	cobbles, riparian	N	–	–	2015	–
Crataegus monogyna	Rosaceae	fill banks, outcrops, cobbles	E	–	–	2015	–
Cuscuta sp. (sterile)	Convolvulaceae	water, spillways	?	–	–	2015	–
Cyperus fuscus	Cyperaceae	cobbles	E	–	–	2015	–
Cyperus strigosus	Cyperaceae	?	N	E.P. Sheldon	1903	–	OSC
Cystopteris fragilis	Cystopteridaceae	?; buildings (grotto)	N	E.P. Sheldon	1903	2015	OSC
Cytisus scoparius	Fabaceae	fill banks, cobbles	E	–	–	2015	–
Danthonia californica	Poaceae	?	N	E. P. Sheldon	1903	–	OSC, SRP
Daucus carota	Apiaceae	fill banks, cobbles	E	–	–	2015	–
Daucus pusillus	Apiaceae	?	N	E.P. Sheldon	1903	–	OSC, SOC, UBC
Dichanthelium acuminatum ssp. *acuminatum*	Poaceae	?	N	W.N. Suksdorf	1895	–	WS
Dichanthelium oligosanthes ssp. *scribnerianum*	Poaceae	?	N	W.N. Suksdorf, E.P. Sheldon	1896, 1903	–	OSC, WS
Dichelostemma capitatum ssp. *capitatum*	Asparagaceae	?	N	E.P. Sheldon	1903	–	OSC
Draba verna	Brassicaceae	outcrops	E	–	–	2015	–
Drymocallis glandulosa	Rosaceae	?	N	E.P. Sheldon	1903	–	OSC
Dysphania ambrosioides	Amaranthaceae	seepage on fill banks, cobbles	E	–	–	2015	–
Eleocharis ovata	Cyperaceae	water, dam, spillways	N	–	–	2015	–
Eleocharis palustris	Cyperaceae	water, spillways, outcrop seepage	N	–	–	2015	–
Epilobium brachycarpum	Onagraceae	fill banks, cobbles, outcrops, buildings	N	–	–	2015	–
Epilobium ciliatum ssp. *ciliatum*	Onagraceae	fill banks, water, dam, spillways, cobbles, outcrop seepage, buildings	N	–	–	2015	–
Epilobium densiflorum	Onagraceae	outcrops	N	–	–	2015	–
Equisetum arvense	Equisetaceae	fill banks, water, spillways, cobbles	N	–	–	2015	–
Erigeron annuus	Asteraceae	buildings, outcrops	E	–	–	2015	–

Erigeron philadelphicus	Asteraceae	?	N	?	?	–	Gorman 1916-17
Erigeron strigosus	Asteraceae	?	E	?	?	–	Gorman 1916-17
Eriogonum compositum var. *compositum*	Polygonaceae	outcrops	N	–	–	2015	–
Eriophyllum lanatum var. *integrifolium*	Asteraceae	outcrops	N	–	–	2015	–
Erythranthe alsinoides	Phrymaceae	outcrop seepage, buildings	N	–	–	2015	–
Erythranthe guttata	Phrymaceae	water, dam, spillways, buildings	N	–	–	2015	–
Erythranthe microphylla	Phrymaceae	?	N	E.P. Sheldon	1903	–	OSC
Erythranthe moschata	Phrymaceae	?; water, spillways	N	T. Howell	1902	2015	OSC
Euphorbia crenulata	Euphorbiaceae	?	N	?	?	–	Gorman 1916-17
Festuca roemeri var. *roemeri*	Poaceae	outcrops	N	–	–	2015	–
Fraxinus latifolia	Oleaceae	fill banks, outcrop seepage	N	–	–	2015	–
Galium aparine	Rubiaceae	?; fill banks, outcrops	N	E.P. Sheldon	1904	2015	OSC
Geranium dissectum	Geraniaceae	fill banks	E	–	–	2015	–
Geranium lucidum	Geraniaceae	fill banks, buildings, outcrops	E	–	–	2015	–
Geranium robertianum	Geraniaceae	fill banks, outcrops, buildings	E	–	–	2015	–
Gnaphalium palustre	Asteraceae	cobbles	N	–	–	2015	–
Gnaphalium stramineum	Asteraceae	buildings	N	–	–	2015	–
Hedera helix ssp. *helix*	Araliaceae	fill banks, buildings	E	–	–	2015	–
Helianthus tuberosus	Asteraceae	?	N	W.N. Suksdorf	1896	–	WS
Holcus lanatus	Poaceae	fill banks, cobbles, outcrops	E	–	–	2015	–
Holodiscus discolor var. *discolor*	Rosaceae	outcrops	N	–	–	2015	–
Hordeum brachyantherum	Poaceae	outcrops	N	–	–	2015	–
Hydrocotyle ranunculoides	Araliaceae	water, dam, spillways	N	–	–	2015	–
Hypericum perforatum	Hypericaceae	fill banks, cobbles, outcrops	E	–	–	2015	–
Hypochaeris radicata	Asteraceae	fill banks, outcrops, cobbles	E	–	–	2015	–
Impatiens capensis	Balsaminaceae	water, dam, spillways	E	–	–	2015	–
Iris pseudacorus	Iridaceae	water, dam, spillways	E	–	–	2015	–
Juncus covillei	Juncaceae	?	N	E.P. Sheldon	1902	–	OSC
Juncus effusus ssp. *effusus*	Juncaceae	fill banks, water, riparian	E	–	–	2015	–
Kickxia elatine	Plantaginaceae	fill banks, cobbles	E	–	–	2015	–
Lapsana communis	Asteraceae	fill banks	E	–	–	2015	–
Lathyrus latifolius	Fabaceae	fill banks, cobbles, outcrops	E	–	–	2015	–

Leersia oryzoides	Poaceae	water, spillways	N	–	–	2015	–
Lemna minor	Araceae	water, dam, spillways	N	–	–	2015	–
Leptosiphon bicolor	Polemoniaceae	?	N	?	?	–	Gorman 1916-17
Leucanthemum vulgare	Asteraceae	fill banks, cobbles, outcrops	E	–	–	2015	–
Ligusticum apiifolium	Apiaceae	?	N	E.P. Sheldon	1903	–	OSC
Lomatium utriculatum	Apiaceae	?	N	E.P. Sheldon	1903	–	OSC
Lotus corniculatus	Fabaceae	fill banks, water, dam, spillways, outcrop seepage	E	–	–	2015	–
Ludwigia hexapetala	Onagraceae	water, dam, spillways	E	–	–	2015	–
Lycopus americanus	Lamiaceae	water, dam, spillways, outcrop seepage	N	–	–	2015	–
Lysimachia nummularia	Primulaceae	water, spillways	E	–	–	2015	–
Lythrum portula	Lythraceae	water, spillways, cobbles	E	–	–	2015	–
Lythrum salicaria	Lythraceae	fill banks, water, dam, cobbles, riparian, outcrop seepage	E	–	–	2015	–
Madia elegans	Asteraceae	?	N	E. P. Sheldon	1902, 1903	–	HPSU, OSC
Madia gracilis	Asteraceae	?	N	E. P. Sheldon	1903, 1904	–	HPSU, OSC
Medicago lupulina	Fabaceae	fill banks, outcrops	E	–	–	2015	–
Melilotus officinalis	Fabaceae	fill banks	E	–	–	2015	–
Mentha × piperita ssp. *piperita*	Lamiaceae	water, dam, spillways, cobbles	E	–	–	2015	–
Mentha pulegium	Lamiaceae	water, dam, spillways, cobbles, outcrop seepage	E	–	–	2015	–
Microseris laciniata ssp. *leptosepala*	Asteraceae	?	N	E.P. Sheldon	1903	–	OSC, SOC, UBC
Mollugo verticillata	Molluginaceae	cobbles	E	–	–	2015	–
Montia parvifolia	Montiaceae	?	N	E.P. Sheldon	1902	–	OSC
Mycelis muralis	Asteraceae	fill banks, buildings	E	–	–	2015	–
Myosotis laxa	Boraginaceae	water, spillways	N	–	–	2015	–
Myosotis micrantha	Boraginaceae	?	E	E.P. Sheldon	1903	–	UBC
Myriophyllum aquaticum	Haloragaceae	water, dam, spillways	E	–	–	2015	–
Nasturtium officinale	Brassicaceae	dam, spillways	E	–	–	2015	–
Navarretia intertexta ssp. *intertexta*	Polemoniaceae	?	N	E.P. Sheldon, T. Howell	1902	–	OSC
Navarretia squarrosa	Polemoniaceae	cobbles	N	–	–	2015	–
Nemophila parviflora var. *parviflora*	Hydrophyllaceae	?	N	E.P. Sheldon	1903	–	OSC
Oemleria cerasiformis	Rosaceae	?	N	E.P. Sheldon	1903	–	OSC
Oenanthe sarmentosa	Apiaceae	water, dam, spillways	N	–	–	2015	–
Osmorhiza berteroi	Apiaceae	?	N	E.P. Sheldon	1903	–	OSC

Penstemon richardsonii var. *richardsonii*	Plantaginaceae	outcrops, cobbles	N	E.P. Sheldon, T. Howell	1903	2015	OSC
Pentagramma triangularis ssp. *triangularis*	Pteridaceae	?	N	J.W. Thompson	1928	–	OSC
Persicaria hydropiper	Polygonaceae	water, dam, spillways, cobbles	E	–	–	2015	–
Phalaris arundinacea	Poaceae	fill banks, riparian, cobbles	E	–	–	2015	–
Philadelphus lewisii	Hydrangeaceae	outcrops	N	–	–	2015	–
Physocarpus capitatus	Rosaceae	?; outcrops	N	E.P. Sheldon	1903, 1904	2015	HPSU, OSC
Plagiobothrys figuratus var. *figuratus*	Boraginaceae	?	N	L.F. Henderson	1885	–	OSC
Plagiobothrys nothofulvus	Boraginaceae	?	N	E.P. Sheldon	1902	–	OSC
Plantago lanceolata	Plantaginaceae	fill banks, outcrops	E	–	–	2015	–
Plantago major	Plantaginaceae	buildings	E	–	–	2015	–
Plectritis congesta	Valerianaceae	?	N	E.P. Sheldon	1903	–	OSC
Poa compressa	Poaceae	outcrops	E	–	–	2015	–
Poa secunda ssp. *secunda*	Poaceae	?; outcrops	N	L.F. Henderson	1885, 1886	2015	OSC
Polygonum spergulariiforme	Polygonaceae	?	N	E.P. Sheldon	1903	–	OSC
Polypodium glycyrrhiza	Polypodiaceae	fill banks, outcrops, maple	N	–	–	2015	–
Polystichum munitum	Dryopteridaceae	fill banks	N	–	–	2015	–
Populus trichocarpa	Salicaceae	fill banks, riparian, outcrop seepage	N	–	–	2015	–
Portulaca oleracea	Portulacaceae	cobbles	E	–	–	2015	–
Potentilla anserina ssp. *anserina*	Rosaceae	water, dam, spillways, cobbles	N	–	–	2015	–
Potentilla gracilis var. *gracilis*	Rosaceae	?	N	E.P. Sheldon	1903	–	HPSU, OSC
Poteridium occidentale	Rosaceae	?	N	E.P. Sheldon	1903	–	OSC
Prunella vulgaris var. *vulgaris*	Lamiaceae	cobbles	E	–	–	2015	–
Pyrus sp. (sterile ornamental)	Rosaceae		E	–	–	2015	–
Quercus garryana var. *garryana*	Fagaceae	outcrops	N	–	–	2015	–
Ranunculus flammula	Ranunculaceae	?	N	T. Howell	1898		OSC
Ranunculus repens	Ranunculaceae	fill banks, water, riparian	E	–	–	2015	–
Robinia pseudoacacia	Fabaceae	fill banks	E	–	–	2015	–
Rorippa curvisiliqua	Brassicaceae	water, spillways	N	–	–	2015	–
Rorippa palustris ssp. *palustris*	Brassicaceae	seepage on fill banks, cobbles	N	–	–	2015	–
Rosa pisocarpa ssp. *pisocarpa*	Rosaceae	?	N	E.P. Sheldon	1902	–	OSC
Rosa sp. (ornamental)	Rosaceae	fill banks	E	–	–	2015	–
Rubus bifrons	Rosaceae	fill banks, outcrops, cobbles	E	–	–	2015	–
Rubus laciniatus	Rosaceae	fill banks, outcrops, cobbles	E	–	–	2015	–

Rubus leucodermis	Rosaceae	outcrops	N	–	–	2015	–
Rubus ursinus	Rosaceae	fill banks, outcrops	N	–	–	2015	–
Rumex acetosella	Polygonaceae	fill banks, spillways, outcrops	E	–	–	2015	–
Rumex crispus	Polygonaceae	cobbles	E	–	–	2015	–
Rumex salicifolius var. *salicifolius*	Polygonaceae	cobbles	N	–	–	2015	–
Sagina procumbens	Caryophyllaceae	fill banks, outcrop seepage	E	–	–	2015	–
Salix exigua var. *columbiana*	Salicaceae	riparian, outcrop seepage, spillways	N	–	–	2015	–
Salix hookeriana	Salicaceae	fill banks, riparian, outcrop seepage	N	–	–	2015	–
Salix lasiandra var. *lasiandra*	Salicaceae	fill banks, riparian	N	–	–	2015	–
Salix scouleriana	Salicaceae	outcrops	N	–	–	2015	–
Salix sitchensis var. *sitchensis*	Salicaceae	spillways	N	–	–	2015	–
Sanicula bipinnatifida	Apiaceae	?	N	E.P. Sheldon	1903	–	OSC
Sanicula crassicaulis var. *crassicaulis*	Apiaceae	?	N	E.P. Sheldon	1903	–	OSC, SOC, UBC
Saponaria officinalis	Caryophyllaceae	fill banks	E	–	–	2015	–
Saxifraga mertensiana	Saxifragaceae	outcrops	N	–	–	2015	–
Schedonorus arundinaceus	Poaceae	buildings	E	–	–	2015	–
Scirpus microcarpus	Cyperaceae	fill banks, riparian	N	–	–	2015	–
Scutellaria antirrhinoides	Lamiaceae	?	N	E.P. Sheldon	1903	–	OSC
Scutellaria lateriflora	Lamiaceae	water, dam, spillways	N	–	–	2015	–
Sedum spathulifolium ssp. *spathulifolium*	Crassulaceae	outcrops	N	E.P. Sheldon	1903	2015	OSC
Sedum stenopetalum ssp. *stenopetalum*	Crassulaceae	outcrops	N	L.F. Henderson	1885	2015	OSC
Selaginella wallacei	Selaginellaceae	outcrops	N	–	–	2015	–
Senecio jacobaea	Asteraceae	fill banks	E	–	–	2015	–
Senecio sylvaticus	Asteraceae	outcrops	E	–	–	2015	–
Senecio vulgaris	Asteraceae	fill banks, cobbles	E	–	–	2015	–
Sherardia arvensis	Rubiaceae	fill banks, outcrops	E	–	–	2015	–
Sinapis arvensis	Brassicaceae	fill banks	E	–	–	2015	–
Solanum dulcamara	Solanaceae	fill banks, water, cobbles	E	–	–	2015	–
Solidago elongata	Asteraceae	outcrops, cobbles	N	–	–	2015	–
Sonchus asper	Asteraceae	buildings	E	–	–	2015	–
Spiraea douglasii var. *douglasii*	Rosaceae	water, dam, spillways	N	–	–	2015	–
Stellaria media	Caryophyllaceae	fill banks	E	–	–	2015	–
Stellaria nitens	Caryophyllaceae	outcrops	N	–	–	2015	–
Symphyotrichum subspicatum	Asteraceae	fill banks, outcrops	N	–	–	2015	–
Tanacetum vulgare	Asteraceae	fill banks, cobbles	E	–	–	2015	–
Taraxacum officinale	Asteraceae	fill banks	E	–	–	2015	–
Tolmiea menziesii	Saxifragaceae	outcrop seepage	N	–	–	2015	–

Toxicodendron diversilobum	Anacardiaceae	fill banks, outcrops	N	–	–	2015	–
Toxicoscordion venenosum	Melanthiaceae	?	N	E.P. Sheldon	1903	–	OSC
Trichostema oblongum	Lamiaceae	?	N	E.P. Sheldon, T. Howell	1902	–	OSC
Trifolium arvense	Fabaceae	fill banks	E	–	–	2015	–
Trifolium ciliolatum	Fabaceae	?	N	?	?	–	Gorman 1916-17
Trifolium variegatum	Fabaceae	?	N	E.P. Sheldon	1903	–	OSC
Triteleia hyacinthina	Asparagaceae	outcrops	N	E.P. Sheldon	1903, 1904	2015	OSC
Turritis glabra	Brassicaceae	?	N	E.P. Sheldon	1903	–	OSC
Typha latifolia	Typhaceae	water, dam, spillways	N	–	–	2015	–
Urtica dioica ssp. *dioica*	Urticaceae	water, spillways, cobbles	E	–	–	2015	–
Vaccinium cespitosum	Ericaceae	?	N	L.F. Henderson	1885	–	OSC, SRP
Verbascum blattaria	Scrophulariaceae	fill banks, outcrops, cobbles	E	–	–	2015	–
Verbascum thapsus	Scrophulariaceae	fill banks, outcrops, buildings	E	–	–	2015	–
Verbena brasiliensis	Verbenaceae	cobbles	E	–	–	2015	–
Veronica americana	Plantaginaceae	water, dam, spillways	N	–	–	2015	–
Veronica peregrina var. *peregrina*	Plantaginaceae	buildings	N	–	–	2015	–
Viburnum ellipticum	Adoxaceae	?	N	E.P. Sheldon	1903	–	OSC
Vicia americana var. *americana*	Fabaceae	?	N	L.F. Henderson	1887	–	OSC
Vicia hirsuta	Fabaceae	fill banks, cobbles, outcrops	E	–	–	2015	–
Vicia sativa var. *sativa*	Fabaceae	fill banks, outcrops	E	–	–	2015	–
Vulpia bromoides	Poaceae	buildings, outcrops	N	–	–	2015	–
Woodsia scopulina	Woodsiaceae	?	N	E.P. Sheldon	1903	–	OSC
Xanthium strumarium var. *canadense*	Asteraceae	cobbles	N	–	–	2015	–
Liverworts							
Lunularia cruciata	Lunulariaceae	shaded soil	N	–	–	2015	–
Porella cordaeana	Porellaceae	shaded wet rocks	N	–	–	2015	–
Porella navicularis	Porellaceae	maple trunk	N	–	–	2015	–
Mosses							
Amblystegium serpens	Amblystegiaceae	outcrops	N	–	–	2015	–
Amphidium californicum	Rhabdoweissiaceae	outcrops	N	A.S. Foster	1910	–	HPSU
Anacolia menziesii	Bartramiaceae	outcrops	N	A.S. Foster, M.A. Flinn	1905, 1907	–	Flowers 1952; HPSU, NY, WTU
Antitrichia californica	Leucodontaceae	maple trunk	N	–	–	2015	–
Barbula convoluta	Pottiaceae	moist shaded outcrops, buildings	N	–	–	2015	–
Bartramia pomiformis	Bartramiaceae	outcrops	N	M.A. Flinn	1906	–	HPSU

Blindia acuta	Seligeriaceae	outcrops	N	M.A. Flinn	1912	–	HPSU
Bryolawtonia vancouveriensis	Neckeraceae	moist rock	N	M.A. Flinn	1905	–	HPSU
Bryum argenteum	Bryaceae	cracks in concrete pavement	N	–	–	2015	–
Campylopus introflexus	Dicranaceae	outcrops	E	–	–	2015	–
Ceratodon purpureus	Ditrichaceae	outcrops	N	A.S. Foster	1903	2015	HPSU
Claopodium bolanderi	Leskeaceae	outcrops	N	–	–	2015	–
Claopodium crispifolium	Leskeaceae	soil over rock, tree bases	N	A.S. Foster	1905	–	HPSU
Climacium dendroides	Climaciaceae	moist soil	N	–	–	2015	–
Dichodontium pellucidum	Rhabdoweissiaceae	wet shaded rocks	N	–	–	2015	–
Dicranum fuscescens	Dicranaceae	outcrops	N	M.A. Flinn	1906	–	HPSU
Dicranum scoparium	Dicranaceae	soil, soil over rock	N	A.S. Foster	1906	–	HPSU, WS, WTU
Dicranum tauricum	Dicranaceae	base of spruce	N	A.S. Foster	1906	–	HPSU
Didymodon vinealis	Pottiaceae	outcrops	N	–	–	2015	–
Encalypta ciliata	Encalyptaceae	outcrops	N	A.S. Foster	1905	–	HPSU
Fissidens bryoides	Fissidentaceae	moist, shaded soil	N	–	–	2015	–
Fissidens fontanus	Fissidentaceae	wet rocks	N	–	–	2015	–
Fissidens ventricosus	Fissidentaceae	wet rocks	N	A.S. Foster	1905	2015	HPSU, WTU
Funaria hygrometrica	Funariaceae	outcrops	N	M.A. Flinn	1905	2015	HPSU
Grimmia pulvinata	Grimmiaceae	rocks, buildings	N	A.S. Foster	1906	2015	HPSU
Grimmia trichophylla	Grimmiaceae	outcrops	N	A.S. Foster	1895, 1905	2015	HPSU, NY, WS, WTU
Hedwigia stellata	Hedwigiaceae	rocks	N	A.S. Foster	1906	–	HPSU
Homalothecium aureum	Brachytheciacee	rocks	N	A.S. Foster	1906	2015	HPSU
Homalothecium fulgescens	Brachytheciaceae	maple trunk	N	–	–	2015	–
Homalothecium megaptilum	Brachytheciacee	outcrops	N	M.A. Flinn	1906	–	HPSU
Homalothecium nevadense	Brachytheciaceae	rocks	N	–	–	2015	–
Homalothecium nuttallii	Brachytheciaceae	maple trunk	N	–	–	2015	–
Hygroamblystegium varium var. *humile*	Amblystegiaceae	moist shaded rocks	N	–	–	2015	–
Hygrohypnum bestii	Amblystegiaceae	spillway seepage	N	–	–	2015	–
Hygrohypnum ochraceum	Amblystegiaceae	boom logs	N	A.S. Foster	1910	–	HPSU
Hypnum subimponens	Hypnaceae	rock	N	–	–	2015	–
Imbribryum miniatum	Bryaceae	outcrop seepage	N	A.S. Foster	1905, 1910	–	Chapman & Sanborn 1941; HPSU, UBC
Isothecium stoloniferum	Lembophyllaceae	maple trunk	N	–	–	2015	–
Kindbergia praelonga	Brachytheciaceae	outcrop seepage	N	M.A. Flinn	1920	2015	HPSU
Leptobryum pyriforme	Meesiaceae	moist shaded rock and soil	N	–	–	2015	–
Leptodictyum riparium	Amblystegiaceae	aquatic	N	–	–	2015	–
Leucolepis acanthoneura	Mniaceae	shaded outcrops and soil	N	–	–	2015	–
Orthotrichum consimile	Orthotrichaceae	maple trunk	N	–	–	2015	–

Orthotrichum lyellii	Orthotrichaceae	maple trunk	N	–	–	2015	–
Orthotrichum rupestre	Orthotrichaceae	outcrops	N	A.S. Foster	1906	–	OSC
Philonotis fontana var. *fontana*	Bartramiaceae	wet soil over rock	N	–	–	2015	–
Plagiomnium venustum	Mniaceae	base of maple	N	M.A. Flinn	1905	2015	HPSU
Pohlia wahlenbergii	Mielichhoferiaceae	wet soil over rock	N	–	–	2015	–
Polytrichum juniperinum	Polytrichaceae	outcrops	N	–	–	2015	–
Porotrichum bigelovii	Neckeraceae	moist to wet rocks	N	–	–	2015	–
Pseudobraunia californica	Hedwigiaceae	outcrops	N	A.S. Foster	1906	–	HPSU
Ptychomitrium gardneri	Ptychomitriaceae	outcrops	N	A.S. Foster	1905	–	HPSU, NY
Racomitrium elongatum	Grimmiaceae	outcrops	N	A.S. Foster	1906	2015	HPSU
Racomitrium heterostichum	Grimmiaceae	outcrops	N	A.S. Foster	1906	2015	HPSU
Racomitrium aciculare	Grimmiaceae	outcrops	N	–	–	2015	–
Racomitrium affine	Grimmiaceae	outcrops	N	–	–	2015	–
Racomitrium ericoides	Grimmiaceae	outcrops	N		1905	–	HPSU
Racomitrium varium	Grimmiaceae	outcrops	N	–	–	2015	–
Rhynchostegium aquaticum	Amblystegiaceae	wet rocks	N	–	–	2015	–
Rosulabryum capillare	Bryaceae	outcrops	N	A.S. Foster	1906	2015	WTU
Rosulabryum gemmascens	Bryaceae	outcrops	N	–	–	2015	–
Schistidium rivulare	Grimmiaceae	seasonally wet rocks	N	–	–	2015	–
Scleropodium cespitans	Brachytheciaceae	outcrops	N	A.S. Foster	1905	2015	HPSU
Scouleria aquatica	Scouleriaceae	seasonally wet rocks	N	M.A. Flinn	1915	2015	NY
Syntrichia princeps	Pottiaceae	outcrops	N	A.S. Foster	1906	2015	HPSU
Syntrichia latifolia	Pottiaceae	rocks and alder trunk	N	–	–	2015	–
Tortula hoppeana	Pottiaceae	wet shaded rocks	N	–	–	2015	–
Tortula muralis	Pottiaceae	rocks, buildings	N	–	–	2015	–

Figure 1. Top: *Penstemon richardsonii* on basalt outcrops below mill clarifier. Bottom: outcrops and clarifier.

Figure 2. Basalt outcrops at Blue Heron mill site with relictual native vegetation. White flower on right is *Eriogonum compositum*. Note mats of moss in crevices and on rock faces.