Bryophyte and Lichen Species Richness in the Cedar River Municipal Watershed

Sampling and Analysis by
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INTRODUCTION, BACKGROUND AND PROJECT OBJECTIVES

Lichens and bryophytes (collectively often referred to as cryptogams) are an important component of biological diversity (biodiversity) in Pacific Northwest forest ecosystems. However, information on cryptogam species diversity, distribution, and abundance is often lacking due to their relative obscurity compared to higher plants and because there are relatively few botanists adequately trained in the taxonomy of lichens and bryophytes.

In the Cedar River Municipal Watershed (CRMW), an understanding of cryptogam diversity and distribution is important for informing the forest restoration program of the watershed's Habitat Conservation Plan (HCP), as it is likely that diversity of lichens and bryophytes has diminished as a result of large scale timber harvest and loss of most of the old growth forest prior to the HCP. For example, some lichens are known to live only in higher portions of the canopy in old growth trees. In order to evaluate the need and appropriateness of reintroducing cryptogam species that may have been extirpated from watershed or portions of the, it is necessary to know the current diversity and distribution of lichens and bryophytes.

As part of an initiative to document the diversity of species in the CRMW, staff in the Ecosystems Section, Watershed Services Division of Seattle Public Utilities began inventories of lichens and bryophytes in 2001. The initial inventory effort, conducted by intern Tammy Stout, provided a species list of lichens and bryophytes collected and some information on their distribution (Stout 2001). In addition, David Wagner conducted a bryophyte inventory of the 700 Road Ecological Thinning Project in 2006 (Wagner 2006). To build on these efforts, SPU contracted with two professional botanists, Martin Hutten and Katherine Glew, with expertise in the taxonomy and ecology of lichens and bryophytes to conduct a more extensive and targeted inventory of cryptogam species in the CRMW. Mr. Hutten focused on bryophytes and Ms. Glew focused on lichens for the surveys, which occurred in 2006 and 2007. This report documents the combined results of the surveys conducted by Hutton and Glew.

The 2006-2007 cryptogam inventory project addressed three specific questions about lichen and bryophyte diversity in the CRMW:

- What is the overall diversity of lichens and bryophytes in the CRMW?
- How does lichen and bryophyte diversity differ in relation to stand age? and
- Has past thinning had an effect on lichen and bryophyte diversity?

Methods

Sampling Protocol

An initial set of cryptogam sampling plots were selected from a larger set of Permanent Sampling Plots (PSPs) established in forested habitat in the Cedar River Municipal Watershed (Munro et al., 2003). The suite of PSP locations was determined on the basis of a systematic sampling grid with a random location of origin. The spacing of the samples was established such that total number of plots could be varied while maintaining a random distribution across the watershed. Cryptogam sampling plots were selected from the PSPs to represent 3-4 plots from 3 different age classes in the watershed (20-30 yr, 65-85 yr and old forest [> 190 yr]). Four additional plots in the 65-85 yr age class where commercial thinning had occurred in the past were also selected. Table 1 shows which PSPs were in each age class. Figure 1 is a map showing where the plots are located in the watershed and which life forms were sampled at each plot. Plots from each age class were selected to sample across the watershed as much as possible, however, the youngest and oldest forests are both at higher elevations. As a result there was not an even distribution of plots by stand age across elevations (Figure 2).

Additional sampling locations were selected to explore habitats not represented by the PSP plots. Locations of these diversity plots were subjectively selected by Hutten and Glew. Some were used for both lichens and bryophytes; others were only used for one life form (Table 1). The main factors in the selection process of the diversity plots were:

1. *Presence of cryptogam communities not represented in the PSP sampling effort.* The CRMW includes a wide variety of habitats, and only the most common forest types are represented by PSPs. The hydrophytic bryoflora of seeps, springs, wetlands, creeks and rivers is composed of a different set of species, and were generally not included in the PSP plots. Similarly, rock dwelling lichen and bryophyte communities have few members in common with forest communities, and these communities were also not represented in the PSPs.
2. *Absence of human disturbance.* Because human-disturbed sites tend to have lower cryptogam diversity than undisturbed sites, site selection focused on less-disturbed areas. The sites at the Walsh Lake outlet, and the riparian forest of upper Webster Creek were selected for bryophytes in the lower CRMW because they are among the few relatively undisturbed low elevation old forest fragments remaining in the CRMW, and we aimed to pick up some bryophytes typical of undisturbed, low elevation forest.
3. *Logistics.* Several potentially interesting high elevation habitats were initially selected but later rejected because of constraints by Seattle Public Utilities on access within the watershed.

4 *Rejected PSP's.* Several PSP's initially selected for use in the stand age or thinning treatment comparisons were later rejected because the plot conditions were considered unsuited for those comparisons. The data of these plots were incorporated as diversity plots.

Table 1. Cryptogam sampling locations in the CRMW.

Site Series	Forest Age (yr)	Site Name	Species Groups Sampled
	22	PSP 2110134128	
20-30 years	27	PSP 2109061128	Both
	28	PSP 2109032128	
	74	PSP 2208173128	
65-85 years	76	PSP 2207162128	Both
thinned	77	PSP 2208291128	
	81	PSP 2208194146	
	67	PSP 2207221128	
	69	PSP 2208074128	
65-85 years	71	PSP 2208063128	Both
unthinned	82	PSP 2208194109	
	83	PSP 2208334128	
	250	PSP 2109054192	
	280	PSP 2110102128	Both
old-growth	501	PSP 2111183128	
	700	PSP 2109142222	
	58	PSP 2209332128	Both
		Walsh Lake	Bryophytes only
	79	PSP 2208301128	Both
	80	PSP 2210311128	Both
	---	Findley Lake	Both
diversity	---	Myrica Wetland	Both
plots	---	Felsenmere	Both
	---	Webster	Bryophytes only
	502	PSP 2109142128	Both
	---	Washout on 720 Rd	Lichens only
	---	Rock wall/Road cut on 200 Rd	Lichens only
additional	---	Law's Ledge	Lichens only
diversity	---	Findley Lake Trailhead	Lichens only
areas	---	Fourteen Lakes	Lichens only

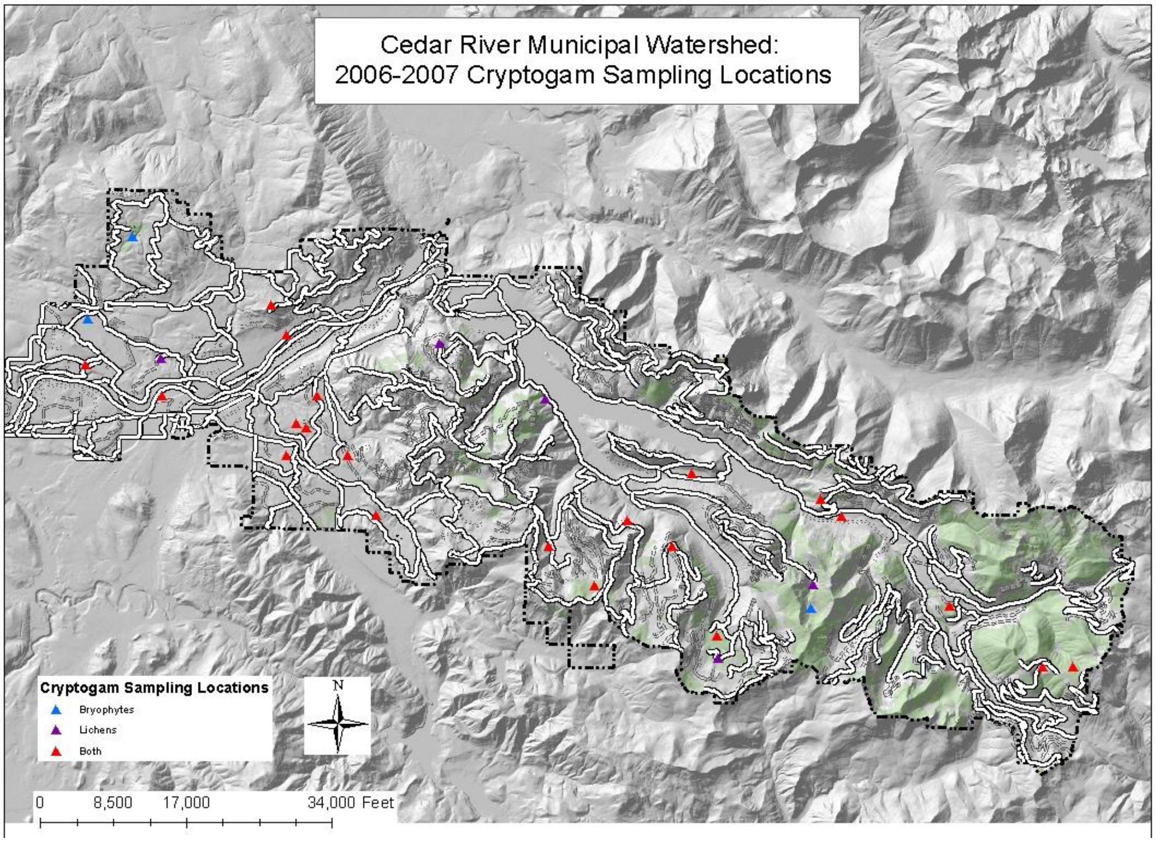
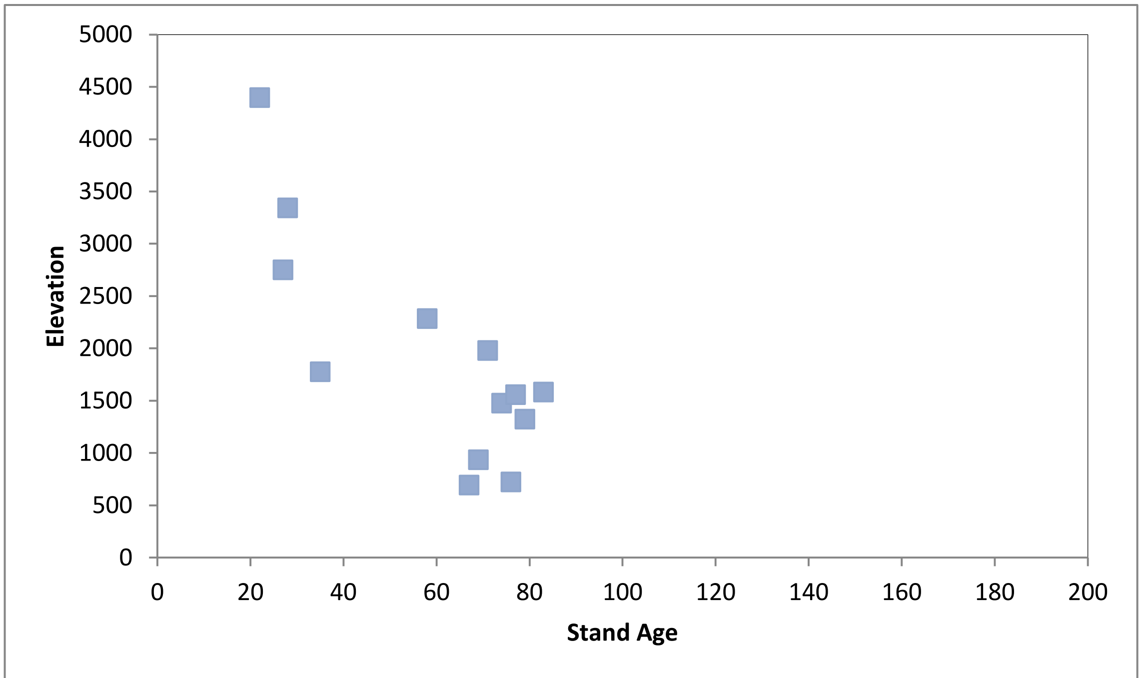


Figure 1. Map of bryophyte and lichen sampling locations in the CRMW, 2006-2007. Light green shaded areas are old-growth forest.



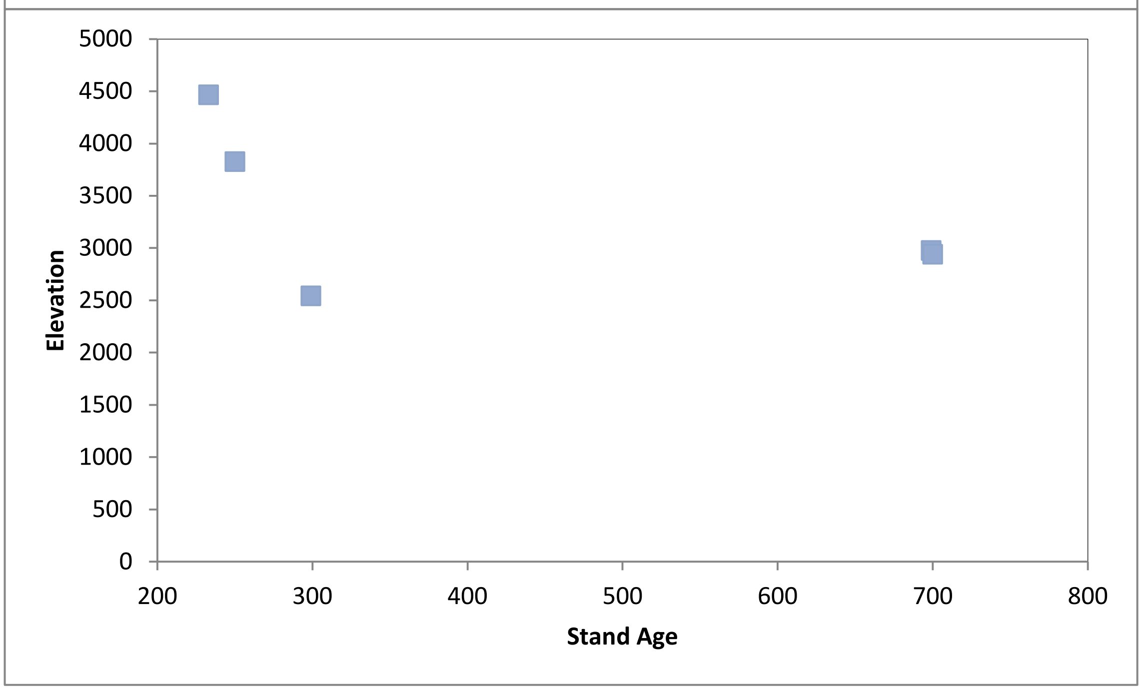


Figure 2: Stand age vs. elevation of PSPs sampled in 2006-2007 CRMW cryptogam surveys. Top graph shows PSPs in second growth and lower graph shows PSPs in old growth.

Field Data Collection

For PSPs, Hutten and Glew navigated to the permanently marked plot center using maps and GPS. For diversity plots, they subjectively selected a plot center to represent the habitat type of interest. Cryptogams were sampled following an adapted version of the lichen portion of the US Forest Service Forest Health Monitoring (FHM) protocol (McCune and Dey 1994). The cryptoflora within 15 m radius of plot center was documented from all substrates and microhabitats that were easily accessible. Tree boles were sampled only up to approximately 2 m above the ground, but litter fall branches from higher in the canopy were included where available. Each species/morpho-species[1] of moss, liverwort and lichen was collected, unless the taxon could be verified with certainty to species level in the field, in which case only observational data was recorded. As prescribed by the FHM protocol, survey duration was limited to two hours per plot. The most important departures from the FHM protocol were:

- the smaller size of the CRMW plots (15 m radius compared to 34.7 m),
- the inclusion of terrestrial species , and
- the focus on bryophytes in addition to lichens.

The substrates on which each cryptogam was found were recorded and abundance estimates for each taxon (using FHM abundance ratings) were also assigned, but abundance data are not reported here.

Three additional diversity areas were sampled for lichens but not formally set up as diversity plots. Two of these areas, Law's Ledge and trailhead to Findley Lake, are rocky sites with many crustose species. At these two sites, surveys focused on macrolichens. The third additional diversity area at Fourteen Lakes had a few trees with many lichens (specifically high *Usnea* diversity), which the surveys were focused on.

All specimen vouchers were collected, processed and deposited in the University of Washington Herbarium.

Results and Discussion

Species Richness: Bryophytes and Lichens

Table 2 shows the richness for each plot by taxonomic group. Numbers varied by age class. Results are discussed separately for lichens and bryophytes (mosses and liverworts combined) in the following sections.

[1] A morpho-species is an organism separated solely on the basis of morphology. Since many cryptogams require microscopic or chemical analyses to definitively distinguish between species, this is the highest level of identification possible in the field.

Table 2. Bryophyte and lichen species richness by plot.

Site Series	Forest Age (yr)	Site Name	Number of species		
			Liverworts	Mosses	Lichens
20-30 years	22	PSP 2110134128	4	25	8
	27	PSP 2109061128	15	17	18
	28	PSP 2109032128	13	36	12
65-85 years thinned	74	PSP 2208173128	10	11	32
	76	PSP 2207162128	13	14	29
	77	PSP 2208291128	13	17	24
	81	PSP 2208194146	13	20	26
65-85 years un-thinned	67	PSP 2207221128	11	19	23
	69	PSP 2208074128	10	16	34
	71	PSP 2208063128	14	19	19
	82	PSP 2208194109	13	14	29
	83	PSP 2208334128	13	17	29
old-growth	250	PSP 2109054192	16	15	26
	299	PSP 2110102128	11	12	27
	233	PSP 2111183128	14	19	27
	700	PSP 2109142222	16	7	45
diversity plots	58	PSP 2209332128	14	13	19
		Walsh Lake	13	27	not sampled
	79	PSP 2208301128	14	22	42
	35	PSP 2210311128	14	45	40
	---	Findley Lake	17	33	13
	---	Myrica Bog	26	31	48
	---	Felsenmere Diversity Plot	11	30	61
	---	Webster Creek	30	33	not sampled
	699	PSP 2109142128	22	24	37
	---	Washout on 720 Rd	not sampled	not sampled	32
	---	Rock wall/road cut -200 Rd	not sampled	not sampled	38
additional diversity areas	---	Law's Ledge	not sampled	not sampled	41
	---	Fourteen Lakes	not sampled	not sampled	23

Bryophyte Diversity

Over the duration of the project, 1,599 observations were made of 208 different species of mosses and liverworts. No hornworts were documented, but suitable habitat in the CRMW for hornworts was not sampled. The PSP plots yielded 133 bryophyte species, and the diversity plots yielded 175 species. The diversity plots included 84 species that were not detected in the PSP plots.

Effects of Stand Age

When moss and liverwort richness were plotted against stand age for plots from all stand ages, there was a very weak downward trend in moss richness, while liverworts showed a slight increase in richness with age (Figure 3). When plot less than 100 years were considered separately, there was a clear downward trend in moss, but not liverwort, richness with age. The expected general increase in moss richness with age was not apparent, instead there was a combination of a high documented richness in 20-40 year old stands and relatively low diversity in old forest.

The unexpectedly high moss diversity found in stands between 20-30 years may have been due to the particular characteristics of the sampled plots. The three young plots that were sampled each had unique microsite characteristics that may have led to higher diversity then expected for this age class:

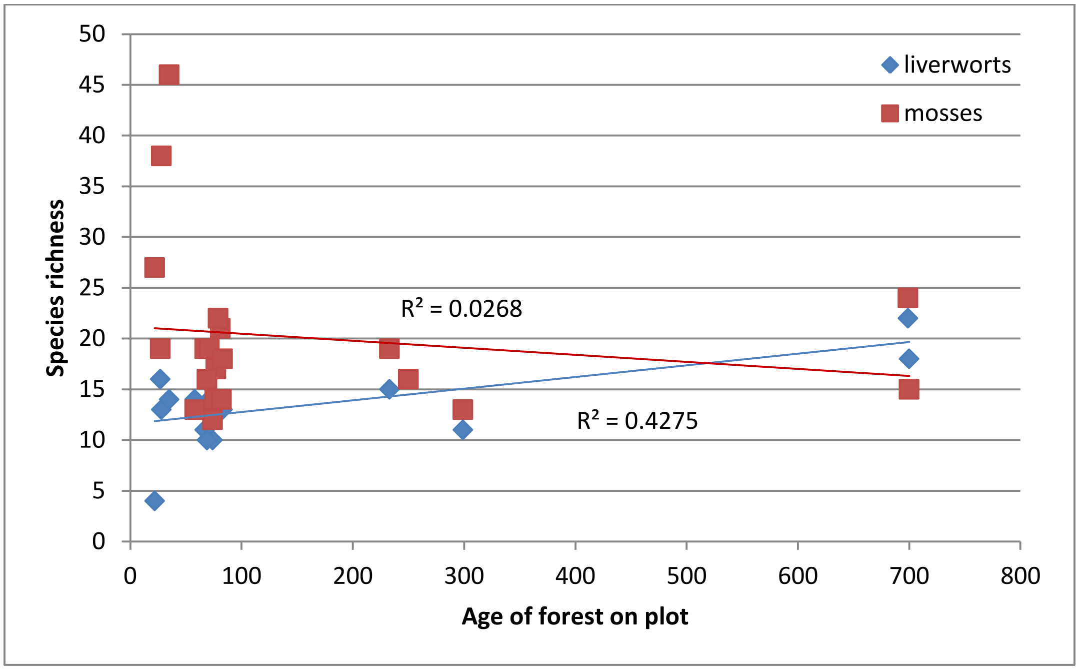
- PSP 2110134128 was the youngest stand sampled. This plot was at the second highest elevation in the study and may have been reforested with *Abies procera*. After 20 years, the stand was still open and yarding pathways were still visible (and channeling snowmelt and runoff). As a result the plot was probably rather atypical for this stand age, even at this elevation.

- PSP 2109032128 was a 28 years old, unthinned, closed-canopy, (average 60% canopy cover) second-growth stand dominated by western hemlock (70% of the trees, ≤ 11 in DBH [diameter at breast height]), with moderate a amount of Douglas-fir (25%, ≤ 13 in DBH), and some silver fir/noble fir (5%, ≤ 9 in DBH). The understory of the plot was poorly developed. About 40 % of the plot was non-forest, as it included the perimeter of a gravel pit with a few small red alder (≤ 1 in DBH). The extremely high diversity was due to the inclusion of a suite of species that are mineral soil obligates and not normally represented in stands of this age class. This plot was clearly an outlier that should be removed from our stand-age comparison.

- PSP 2109061128 contained a rather atypical open forest on steeper and locally seeping soils. The area was regularly used by elk, which results in open mineral soil habitats. As a result, the young forest had a higher terrestrial diversity than would be typical for this age class.

From these descriptions, it is apparent that the young plots were rather dissimilar from each other; each one adding a new set of species to the overall richness total for the group. While they may not be representative of all young stands, Hutten felt that the very high diversity in the ≤40 yr plots sampled was remarkable and unlikely to occur in such small and young plots.

Because bryophyte diversity is influenced by elevation, this bias in elevation distribution confounded the age related research questions. Most of the young stands and old-growth stands sampled in this study were in the Silver Fir Zone (2,500 to 4,000 ft elevation), but the intermediate-aged stands that were sampled were in the Western Hemlock Zone (≤ 2,500 ft). Epiphytes are less diverse at high elevations (although lithophytes tend to be more common at high elevations); consequently, the lower than expected diversity of old-growth plots have been at least partly a result of their location at higher elevations. Conversely, the higher than expected diversity of young forest plots may have been influenced by their having more open, mineral soil than is typical in forested habitats. In addition, the 15m radius plots may have been too small to adequately sample litter fall and to capture the full range of stand conditions in multi-layered forests with gaps and blowdown that typically occur in old growth. The higher variability in species richness in old-growth plots may be a result of the plot size sampling only a portion of the heterogeneity in old-growth habitat.



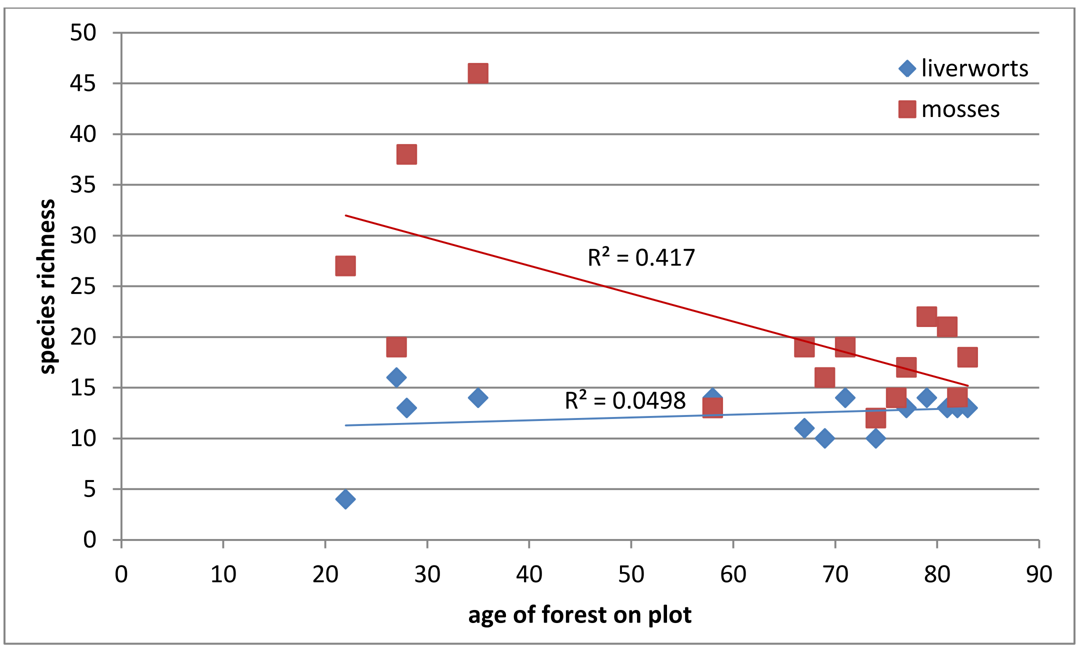


Figure 3: Bryophyte species richness by stand age in PSP plots. Lower graph is the same data as the upper graph but restricted to plots less than 100 years to better show the relationship of richness and age in second growth stands. Because stand age data was not available for the diversity plots, only PSP plots were included in the age-specific data summaries.

Effects of Thinning

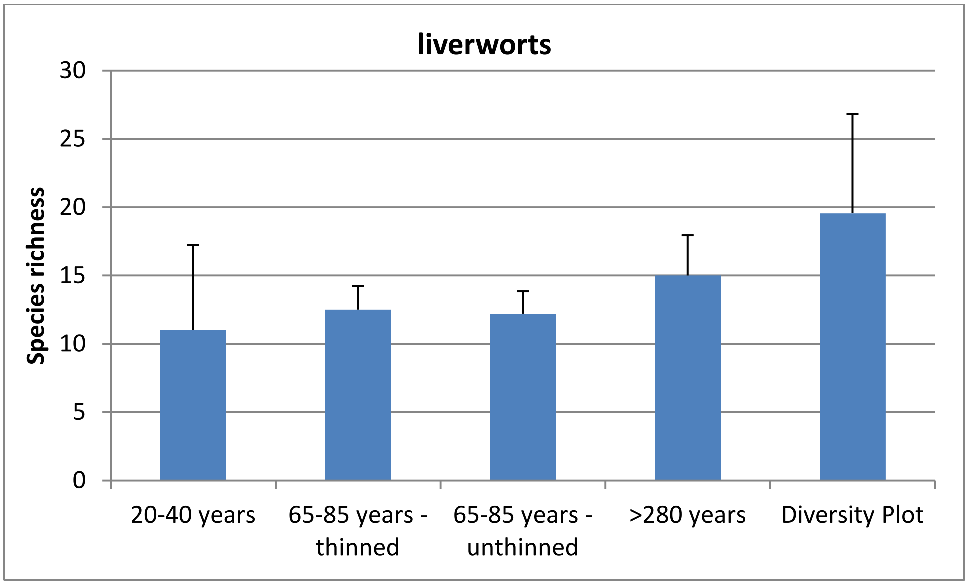
There was very little difference in the total number of taxa recorded in thinned versus unthinned plots (stand age of 65-85 years): 41 taxa from four thinned plots, 44 from five unthinned plots (Figure 4) . The number of species per plot varied from 21 to 33. The among-plot variability was slightly higher for mosses in unthinned than in thinned plots, but very similar for liverworts between the two plot types. It is possible that thinning negatively affects some species, but promotes others, resulting in species with an affinity for one or the other. Since most species unique to either thinned or unthinned forest appeared in only one or two plots, it is more likely that the association of most of these species is related to their rarity rather than to treatment type (Table 3).

There were two mosses (*Claopodium crispifolium, Heterocladium macouni*) and the thallose liverwort *Metzgeria conjugate*, however, that were found in three of the five unthinned plots, which suggests a preference for unthinned stands. *Claopodium crispifolium* requires more open conditions and hence its presence in unthinned- but absence in thinned plots is surprising. Since *Heterocladium macounii* and *Metzgeria conjugata* are shade tolerant, it is not surprising that those two species would be found in unthinned plots.

The bryoflora typically found on hardwood substrates was slightly higher in unthinned stands (14 taxa, 5 plots) than in thinned stands (9 taxa, 4 plots), which suggests that thinning may have some negative affect on this guild[2] of bryophyte taxa; but other than this hardwood effect , there was no evident effect of thinning on the relative diversity among guilds (see Appendix A).

In stands that are entirely closed before treatment, it is conceivable that thinning would have a positive effect on bryophyte diversity in the first few years after treatment. The plots in thinned young forest in this study were all thinned more than 25 years ago, and the effects of thinning may have diminished with time. Stands would need to be examined before and shortly after treatment to detect ephermal changes resulting from thinning.

[2] Bryophyte taxa with affinities toward a specific substrate are termed a "guild."



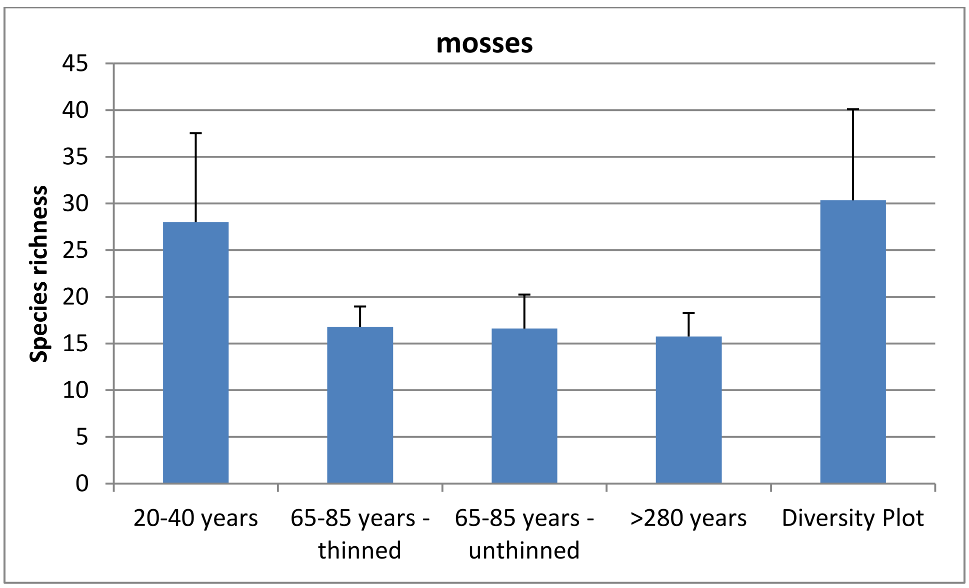


Figure 4: Bryophyte richness by stand age. Upper graph shows liverwort and lower graph shows moss richness. Error bars are one standard deviation.

Table 3: Bryophyte species unique to treatment type. Numbers in parentheses indicate in how many plots each species was found.

Taxa found only in unthinned plots	Taxa found only in thinned plots
Atrichum selwynii (1)	Bazzania ambigua (1)
Bryum capillare (1)	Brachythecium asperrimum (1)
Claopodium crispifolium (3)	Ditrichum ambiguum (1)
Heterocladium macounii (3)	Leucolepis acanthoneuron (1)
Metzgeria conjugata (3)	Lophocolea heterophylla (1)

Metzgeria temperata (1)	Pohlia cruda (1)
Plagiomnium insigne (2)	Rhytidiadelphus triquetrus (1)
Polytrichastrum alpinum (2)	Rhytidiopsis robusta (1)
Polytrichum formosum (1)	Rhytidiadelphus triquetrus (1)
Porella cordaeana (1)	
Ulota megalospora (1)	

Diversity Plots

High bryophyte species richness was documented in the CRMW diversity plots. More than 50 species per plot were recorded in several plots; the Webster Creek plot was the most diverse with 63 species. This is remarkable for the relatively small size of the CRMW plots. Using similar sampling methods, but not using a subjective plot selection protocol, 60 FHM style plots were established in pristine forested habitats throughout Olympic National Park (ONP). Only three ONP plots had more than 50 different bryophyte species, and the ONP plots were five times larger than those used in CRMW. The higher species richness of the CRMW diversity plots compared to ONP plots is likely influenced by the subjective plot selection protocol, which suggests that diversity 'hotspots' can be identified by experienced bryophyte biologists. The high diversity in these plots also indicates that relatively small sites with the right conditions can harbor a high bryophyte diversity and that such diversity hotspots still exist in CRMW, despite extensive impacts from timber harvest.

Some highlights of the bryophyte surveys in diversity plots were:

- *Buxbaumia virides*, or 'bug-on-stick moss', is an unusual leafless moss that prefers moist decayed logs. The taxon is listed in the Washington Natural Heritage Program (WNHP) database, but as SU (status unknown). The *B. viridis* population at CRMW was the only one M. Hutten has observed in northern Washington. The elevation recorded 4,458 ft is also the highest recorded elevation in northern Washington in M. Hutten's database. This moss was found only once in the CRMW, in the highest elevation old-growth PSP sampled for bryophytes. There was a relatively large population of it on a well-decayed moist log.

- Long-beaked water feather moss (*Platyhypnidium riparioides*) is listed in the WNHP database as S1 (Critically Imperiled - at very high risk of extirpation in the state). It was identified from a CRMW collection by Tami Stout (#99 originally submitted as *Scleropodium obtusifolium*, but reidentified by Hutten; see Appendix A). It has been collected infrequently by M. Hutten in northern Washington. As an obligate streamside moss, it is probably under-collected in the state.

- In Oregon, Washington, and California, whiskered veilwort (*Metzgeria temperata*) has been restricted to near-coast riparian areas and floodplains. The collections in CRMW were apparently the first in the Cascade Range. It is frequent on the Olympic Peninsula, but considered as rare farther south. However, the correct identification of this specimen may be *M. violacea*. CRMW and OP collections have been sent to Jon Shaw for genetic analysis, who should be able to resolve the identity of the CRMW material.

- In Oregon, and Washington, there have been few collections of the alpine leafy liverwort, *Schofieldia montana*. This species prefers exposed, but moist humic soils, such as those found in areas below late snowmelt patches. The status of this liverwort in Washington is not well understood, but as it is near the southern extent of its range, it is likely to become more rare with global warming and reductions in snowpack.

The diversity plots indicate that the bryophyte richness can be locally very high in the CRMW. The bryophyte surveys in diversity plots added 84 species not detected in the PSP plots. A high number of species were documented in a number of diversity hotspots in residual old-growth, riparian areas, and wetlands. For the diversity plots, hydrophytic bryophytes were one of the main targets, and the number of hydrophytic bryophytes was much higher in the diversity plots than in the PSPs (Figure A1 of Appendix A). Nonetheless, many expected species of hydrophytes were not found in the CRMW inventory. Stream headwaters with rocky substrates, seepage areas, and rocky outcrops in partially shaded, north facing settings typically contain many bryophytes not found in the CRMW inventory, but proposed collection sites representing these habitats were not included in this project due to logistical constraints.

The second-growth forests of the CRMW are relatively species poor, but compositionally similar to other managed forests in the region. As these forests increase in age, their complexity will increase. Existing pockets of young hardwoods will mature and should result in increased bryophyte and lichen diversity, although this may be temporary until the hardwoods eventually senesce and remove an important bryophyte substrate. Large snags and down wood will provide habitat to a suite of species that are presently uncommon. From refugia in residual old-growth, species should gradually recolonize forests previously managed for timber production when their structural complexity redevelops, although how fast this occurs will depend on dispersal rate.

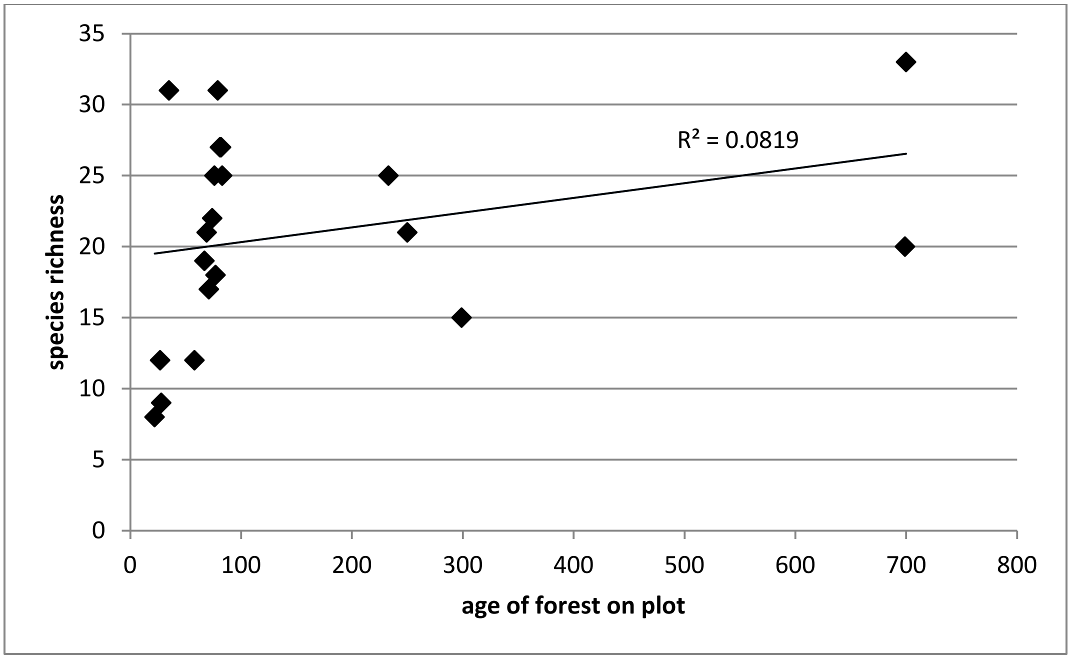
Lichen Diversity

In total, 185 lichen taxa were recorded in this study, though not all were identified to species. About 40% of these taxa were found in both PSP and diversity plots, 15% in PSP plots only, and 45% in diversity plots only.

Effects of Forest Age

Over the entire range of forest age represented in the PSP plots, there is a slight trend (r^2 = 0.08) toward higher lichen diversity with greater forest age(Figure 5). However, the trend is much stronger (r^2 = 0.39)within the subset of plots less than 100 years old, which are all second growth stands. There was no substantial difference in species richness in plots greater than 65 years old (Figure 6). However, some lichen species seem to be common in older stands, including those within the genera *Hypogymnia, Platismatia, Peltigera, Usnea, Tuckemannopsis*. Several species are naturally limited by elevation. For example, as elevation increases *Usnea* is replaced by *Alectoria.* Elevation effects on lichen distribution could have confounded the effects of forest age on lichen diversity, since forest harvest in the CRMW progressed from lower to higher elevations through time, resulting in the youngest second growth stands and most of the remaining old growth occurring at higher elevations. Consequently, the lower species richness in stands less than 65 years old and the lack of a difference between 65 - 85 yr old stands and old- growth plots may be due at least partly to elevation effects.

The young stands, 20 – 25 year old, were dominated by the genus *Cladonia*. Members of this genus are often characteristic of early successional forest following a disturbance, such as clear-cutting. The 35 year old plot PSP 2210311128, designated as a diversity plot, demonstrates that a young stand can have high diversity where there are varied substrates, which in this case, included ecotone habitat along a stream.



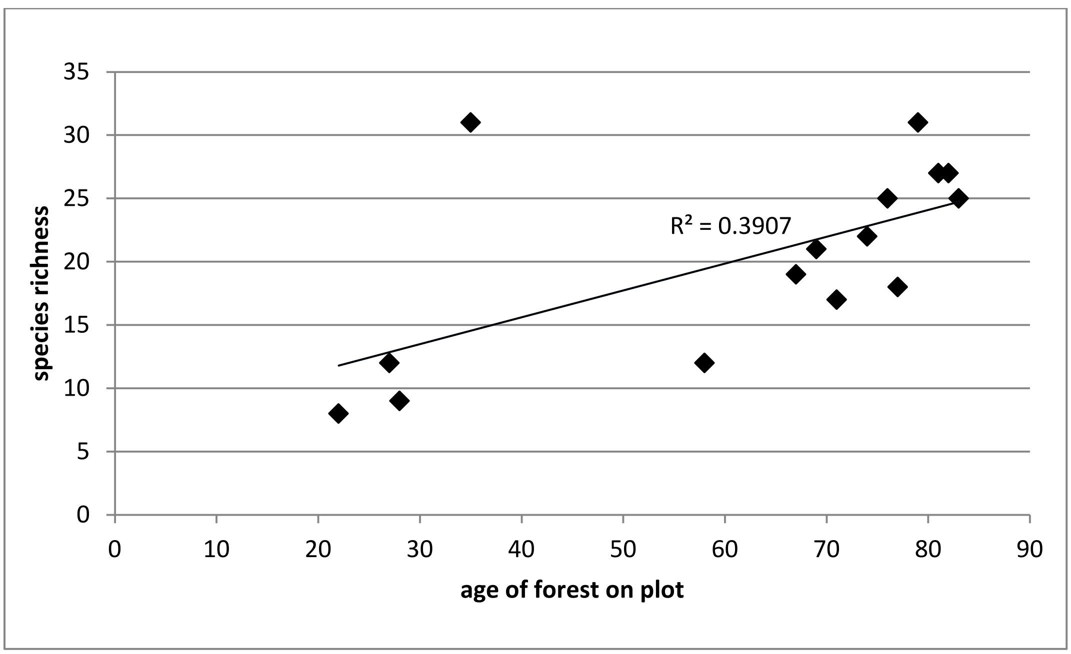


Figure 5: Lichen species richness by stand age in PSP plots. Lower graph is the same data as the upper graph but restricted to plots less than 100 years to better show the relationship of richness and age in second growth stands. Because stand age data was not available for the diversity plots, only PSP plots were included in the age-specific data summaries.

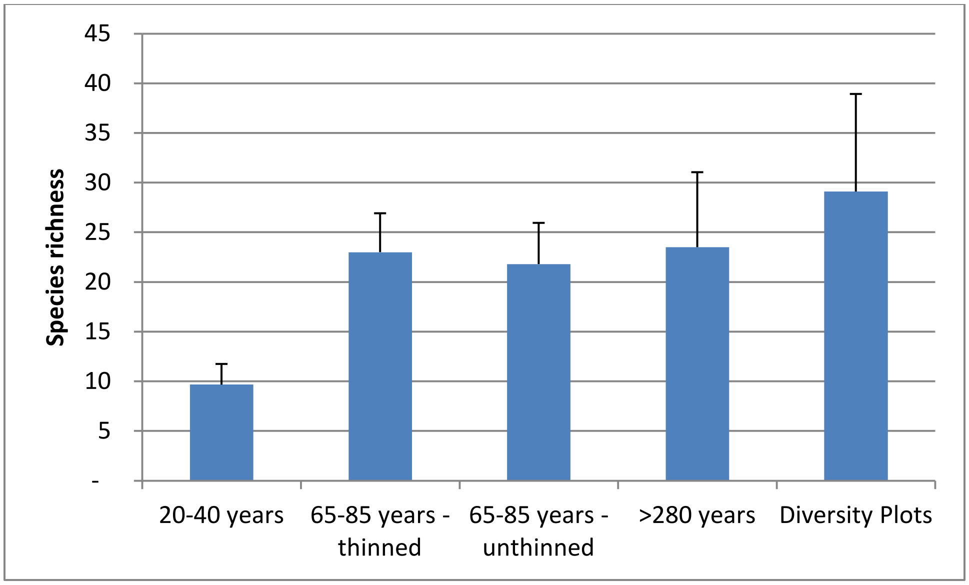


Figure 6. Lichen richness by age class. Error bars are one standard deviation.

Effects of Thinning

There were no apparent differences in lichen diversity between thinned and unthinned plots (Figure 6). Although no lichen biomass measurements were made in this study, there did appear to be lower biomass in thinned plots. There were a few species unique to thinned or unthinned areas (Table 4), but as with bryophytes most of these species occurred in only plot, suggesting that they are rare species in the CRMW and their occurrence is not related to thinning or no thinning .

Table 4: Lichen species unique to treatment type. Numbers indicate in how many plots each species was found.

Taxa found only in unthinned plots	Taxa found only in thinned plots
Cladonia bellidiflora (2)	Cetrelia cetrariodes (1)
Cladonia ecmocyna (2)	Parmelia hygrophila (1)
Cladonia fimbriata (1)	Parmeliopsis ambigua (1)
Cladonia norvegica (1)	Ramalina farinacea (1)
Hypogymnia duplicata (1)	Unsea (1)
Melanelia (1)	Usnea (fragile) (1)
Pertusaria amara (1)	Usnea subfloridana (1)
Plastimatia herrei (1)	
Platismatia stenophylla (2)	

Diversity Plots

Diversity plots had much higher species richness than PSPs, with abou 45% of the species recorded in the study occurring in diversity plots only. Within the diversity plots, the presence of rocks and alders tended to increase lichen diversity, particularly of crustose species and a number of the more cryptic macrolichens. Some of the best "hot spots" were areas that were disturbed, either naturally or unnaturally (e.g. road cuts) or were mixed conifer-hardwood. The occurrence of higher lichen diversity in riparian zones and rock outcrops has been well established (Peterson and McCune 2003, Neitlich and McCune 1997). However, for lichen diversity to be high in gaps created by disturbances, they needed to be close to older forests or to lakes or streams. In this study, stands with low tree diversity tended to have low lichen diversity.

Plots that had both hardwoods and conifers had higher lichen diversity than those stands that were dominated by conifers. Cyanolichens, those with cyanobacteria capable of fixing atmospheric nitrogen, were not well represented in the PSP plots, possibly because many of these lichens prefer hardwood trees and shrubs to conifers, which were not abundant in PSP plots. Alternatively, air pollution may be reducing the diversity and abundance of cyanolichens.

The felsenmere (a stable, broken rock field) diversity plot, estimated at 50 years old, had varied substrates and also a high diversity of lichens.

Two diversity plots with mixed alder and conifer had high lichen species richness (Plots 2210311128, 2208301128). Both of these plots had creeks running through them, which promoted the growth of hardwoods, especially alder.

Since lichen diversity was expected to be positively correlated with stand age, the lack of difference in lichen richness between 65-85 yr old stands and old-growth stands was surprising. Glew expected that a 700 year old stand would have significantly more lichen species than intermediate-aged stands. However, the confounding effects of elevation on lichen diversity make it difficult to interpret this data set with respect to the relationship between lichen diversity and stand age.

As expected, stands having higher substrate diversity had high lichen diversity, especially if there were rocks or alders. Both of these substrates support a wide variety of lichens, especially crustose forms.

The diversity of canopy lichens was difficult to assess without a recent wind storm or access to the canopy. Some genera, such as the genus *Bryoria*, do not blow out of the trees easily and may be absent from forest floor litter. In contrast, lichen species in the genus *Hypogymnia* were in the canopy and seemed to fall down easily with the branches. Typical species of this genus were *H. apinnata, H. imshaugii, H. inactiva*, and *H. physodes*. A lower canopy lichen, *Platismatia glauca,* was abundant within most of the stands.

Some unexpected findings were the abundance of certain genera. The genus *Nephroma* was found in huge colonies in the two old growth (700 year old) stands on road 720. *Cladonias* were in extensive abundance on the forest floor and fallen logs, especially in the older forests. Several species of *Cladonia* were uncommon – *C. albonigra, C. asahinae, C. bacillaris,* and *C. digitata*. *Fuscopannaria cyanolepra* was found on a road cut on the 100 Road. This is a typical habitat for the lichen, but this species is not often seen. A fertile *Bryoria friabilis* was found, which is not common on this side of the Cascade Mountains.

Other lichen species worth noting for their occurrence are:

Alectoria vancouverensis
Cladonia arbuscula
Cladonia cariosa
Cladonia crispata
Cladonia cyanipes
Cladonia norvegica
Diploschistes scruposus
Fuscopannaria cyanolepra
Fuscopannaria pacifica
Nephroma bellum
Nodobryoria oregana
Peltigera digenii
Peltigera neckeri
Peltigera retifoveata
Platismatia lacunosa
Pseudocyphellaria rainierensis
Usnea diplotypus
Usnea longissima

Recommendations for Further Studies

Under-documented Habitats

In Hutton's opinion, approximately half of the bryophyte diversity expected to occur in the CRMW have been recorded to date. Hutten believes that somewhere between 100 and 200 bryophyte species are still likely undocumented in the CRMW. This is based on the fact that there are many interesting habitats that remain unexplored for bryophytes in the CRMP including:

- Felsenmere fields, particularly on north-facing aspects. These unusually stable, coarse rock fields have well developed bryophyte communities. The single visit was constrained by protocol, and was south facing, adjacent to a forest, and hence likely has burned in the past.
- Snowmelt-fed habitats. These have barely been sampled and contain regionally rare taxa that are declining because of reductions in snowpack.
- Steep and rocky stream-headwaters. This habitat type should yield many undocumented taxa for the CRMW.

- Calcium-rich substrates. These typically have a unique flora but have not been explored in the CRMW (including concrete dams, bridge footings, etc.)
- Low elevation riparian areas.
- Alpine habitats.
- Biological soil crust.
- Rock outcrops and other non forest types.

For future lichen surveys, it would be valuable to spend more time at Law's Ledge, Fourteen Lakes, and the Findley Lake Trailhead to better survey lichen diversity. Another thing to consider in future lichen studies in the watershed is to conduct ordinations of lichen presence and abundance versus variables such as age, forest structure, substrate, thinning, elevation, and vegetation associations. It would be interesting to spend more time comparing lichen richness and species composition across gradients, such as elevation.

For both bryophytes and lichens, it would be of interest to examine how diversity changes with the influence of lakes, ponds, creeks, and rivers being in close proximity to the forest stands. Lichens gain much of their moisture and nutrient needs from the atmosphere. Thus stands that gain high humidity from water sources or are able to retain moisture might have higher diversity. Higher humidity levels should also favor bryophytes.

Air Quality

The general paucity of epiphytic cyanolichens, even in old-growth Pacific silver fir stands where cyanolichens are normally common, could indicate that that air quality in the CRMW may be affected by urban air pollution, either currently or in the past. Bryophytes are also sensitive to air pollution, but this is not yet well documented in the Pacific Northwest. Epiphytes in the genera *Ulota* and *Orthotrichum* are known to be sensitive to air quality in Europe. The area with the highest abundance of *Ulota megalospora* coincided with the area with luxuriant growth of pollution sensitive *Lobaria linata* and *Pseudocyphellaria rainierensis,* but this association could also be humidity related. The leafy liverwort *Lophozia inciza* is common throughout northwest Washington, but was uncommon or rare in the CRMW, which may also be related to air quality. Relevant questions related to the association of air quality and cryptogam richness and abundance in the CRMW include: What are the most sensitive groups of taxa? How would we best monitor these effects? Where would we look, and what floristic elements should we focus on?

Diversity in Relation to Forest Development

More field work is needed to determine how bryophyte diversity develops with forest succession, particularly in the first two decades following clear-cutting. The role of legacy substrates in the maintenance of diversity in young stands also should be assessed. In closed young stands the focal points of bryophyte diversity are legacy substrates. Hutten was uncertain whether this has been documented in the literature. Since there is no commercial timber harvest allowed over the 50-year Cedar River Watershed HCP, studies of bryophyte diversity in relation to clear-cutting would need to be conducted elsewhere.

Comments Regarding Methodology

Plot Selection

Most bryophytes are very micro-habitat specific. When bryophytes are used as indicators of macro-habitat, we have to consider to what degree their distribution and abundance is more strongly tied to substrate and micro-habitat than to macro-habitat. The presence of boulders on the forest floor may not affect the vascular plant flora, but will substantially influence the bryoflora. Similarly, the presence of any kind of surface water, even when present only seasonally, will influence bryophyte communities. These conditions are hydrological and geomorphological properties of the landscape, and independent of forest age and thinning treatments. In future studies examining the effects of forest age or thinning, it would be helpful to make comparisons among plots with relatively similar substrate conditions. In this study, variability among plots due to substrate differences may have confounded questions concerning bryophyte diversity in relation to stand age or elevation.

For future cryptogam studies, it would be very useful for the bryophyte and lichen surveyors to be working together on the same plots in the field. Observations and discussions would occur at the time of the survey that would be helpful for analyses. It would also ensure that field methodology would be consistent with each plot.

Explanatory Variables

Examining forest structure and species composition and physical variables might also help to explain patterns of cryptogam diversity. Such variables include canopy cover, mineral soil abundance, availability of rock, CWD, etc. Analysis of additional explanatory variables was beyond the scope of the present study.

Plot Size

We reduced the sampling radius from the 34.7 m in the FHM protocol to 15 m radius which more closely paralleled the PSP plot size. These plots were sufficiently large to document bryophyte diversity in homogeneous closed canopy 65-85 year old stands. In multi-layered forests, stands with gaps and blowdown, or even older homogenous forests having very sparse litterfall, 15 m radius plots may be too small to capture the full range of stand conditions. Should this study be continued, the size of forest plots should be large enough to capture the full heterogeneity of the more complex stands.

Conclusions

As stated in the Introduction, this study addressed three questions:

- What is the overall diversity of lichens and bryophytes in the CRMW?

- How does lichen and bryophyte diversity differ in relation to stand age? and
- Has past thinning had an effect on lichen and bryophyte diversity?

In regard to the first question, the project as completed recorded in 208 bryophyte and 185 lichen species. The subjectively selected diversity plots had much higher diversity for both bryophytes and lichens. There were 40 and 45% of the total bryophyte and lichen species, respectively, found in the diversity plots alone, indicating that "hot spots" are highly important to overall cryptogam diversity It is unknown what fraction of the total bryophyte and lichen flora is represented in this inventory, but Hutten felt that it was about half of what might be expected for bryophytes.

The results of this study were unclear regarding the relationship of bryophyte and lichen diversity to stand age. Because both young forest and old-growth forest plots were at higher elevation and intermediate age forest plots at lower elevations, differences among age classes might be confounded by elevation. Other factors that may have obscured differences in diversity in relation to forest age were the size of plots not being large enough to encompass the horizontal heterogeneity in old-growth and the selection of young forest plots in areas with relatively high substrate heterogeneity. Interestingly, in plots less than 100 years old, moss (but not liverwort) diversity decreased with age, while lichen diversity increased.

There were no apparent differences in either bryophyte or lichen diversity in relation to thinning. Since the thinned plots were treated more than 25 years ago, it is possible that regrowth since thinning has eliminated any ephemeral differences in cryptogam flora that occur immediately after thinning.

While this study greatly increased our knowledge of bryophyte diversity in the CRMW, it was not extensive enough to adequately sample all habitats in the watershed. Habitats that were undersampled in this study include felsenmere fields, areas of late snowmelt, stream headwaters, low elevation riparian areas, and rock outcrops. Other questions that might be addressed in future studies are the role of air pollution in controlling lichen diversity and the role of forest structural development in relation to bryophyte diversity.

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Appendix A: Guild Membership of Species Observed in CRMW Bryophyte Inventory

To gain better insight into how the bryophyte community composition differed among the various plot types, all documented species were assigned to guilds defined by substrate. Substrate preferences are usually specific enough that taxa can easily be assigned to the following broadly defined guilds:

- Lithophytes (species that grow on rock),
- Hydrophytes (species that grow in seasonally or perennially wet habitats),
- Mineral soil taxa,
- Terrestrial taxa,
- Forest floor taxa,
- Epiphytes, and
- Coarse woody debris (CWD) taxa.

Forest floor taxa are a subset of terrestrial taxa and were separated out from those terrestrial taxa not typically found on the forest floor. Figure 1A shows number of species by guild for each plot sampled for bryophytes, and Table A1 for details on guild membership.

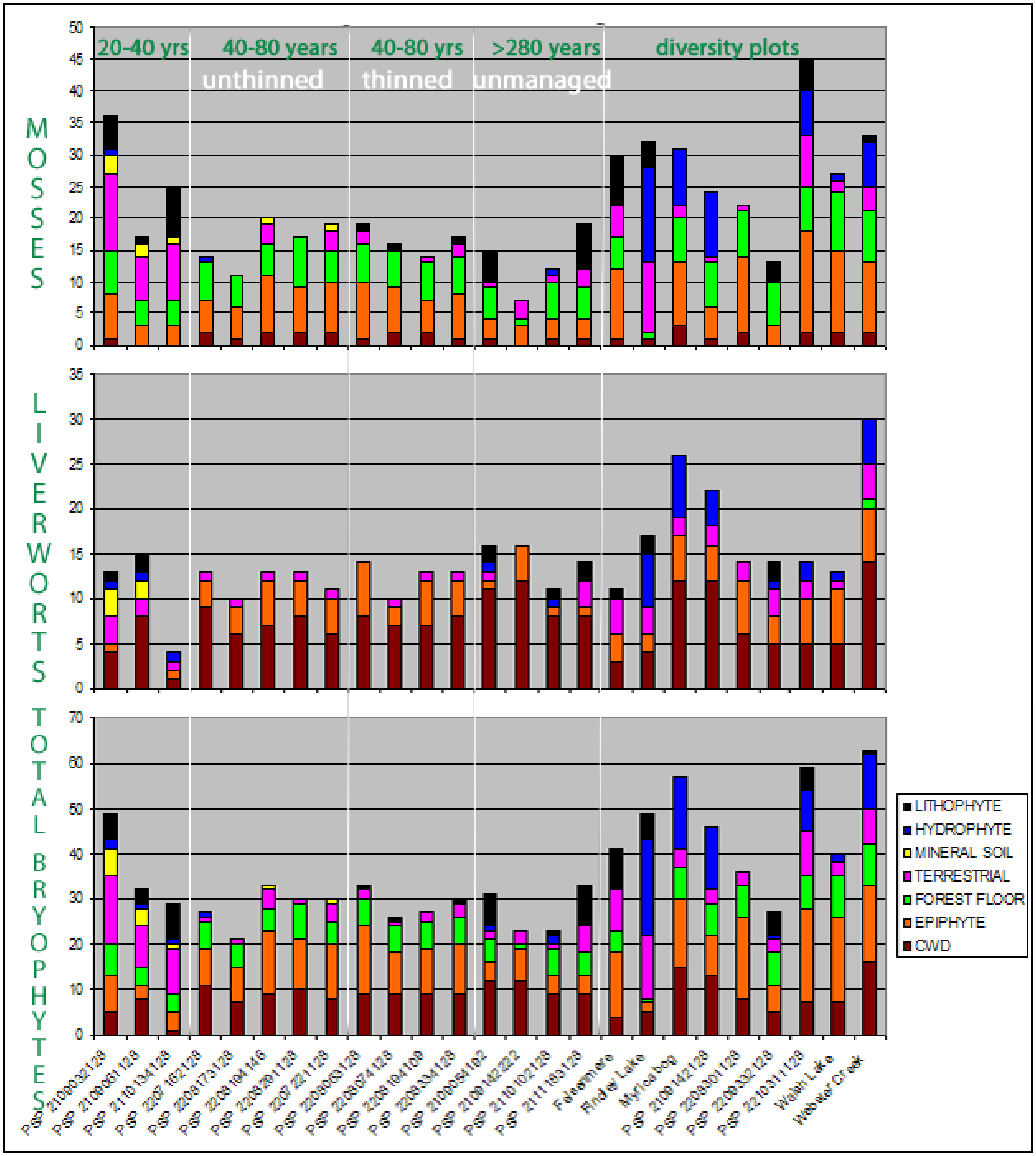

Figure A1: Bryophyte species richness by plot and substrate type.

Analysis of plot composition by guild (Figure A1), revealed the following observations:

Young Stands

- The abundance of epiphytes in stands younger than 40 years is generally lower than in stands 40 to 80 years old. Two of the epiphytic mosses in PSP 2109032128 were on hardwoods in forest edge habitat at the perimeter of the gravel pit (*Pseudoleskea stenophyllum* and *Brachythecium albicans*).

- There is a lower diversity of CWD inhabiting taxa. PSP 2109061128 had large accumulations of wood debris (possibly the remnants of an abandoned log deck), but nevertheless had a low diversity.

- There is a higher diversity of terrestrial taxa in younger versus older forest plots. The greater availability of terrestrial habitat in 20-40 year old plots is being utilized by a greater variety of taxa (mostly mosses).

- There is a higher diversity of mineral soil-inhabiting taxa in plots 20-40 years old. PSP 2109032128 includes a steeply sloping section of an exposed gravel pit (Figure A2).

- There is a clear pattern of rock dwelling taxa in each of the three plots 20-40 years old. In each case, the rocks were very small, no more than a couple of feet wide or tall, and typically much smaller. A lot of these smaller rock become buried in litterfall, which leads to abundant terrestrial bryophytes later on.

Old Growth Stands

1: The overall diversity of bryophytes occurring on CWD appears to be similar among 65-85 year old thinned and unthinned stands and old growth stands. This is surprising and could be due to an abundance of legacy CWD remaining in the second-growth stands. There does appear to be higher liverwort diversity on CWD in old-growth stands than in younger plots, but not higher moss diversity.

2: The overall epiphyte diversity in old-growth plots is lower than in either the thinned or unthinned plots between 65-85 years. This may be due to an elevation effect, as the old growth plots tend to be at higher elevation where epiphytic bryophytes are much less diverse.

3: In old growth plots a higher proportion of the community is composed of lithophytes. This is also likely the result of an elevation effect. These plots tended to be on steeper slopes at higher elevations, where rock is more common.

Table A1: Species observed in CRMW bryophyte inventory and their guild membership.

Cedar River Municipal Watershed Bryophytes							
Scientific name	**Guild Membership**						
	CWD	**Epiphyte**	**Forest Floor**	**Hydrophyte**	**Llithophyte**	**Mineral Soil**	**Terrestrial**
Andreaea rupestris					1		
Aneura pinguis				1			
Antitrichia curtipendula		1					
Atrichum selwynii						1	
Aulacomnium androgynum	1						
Aulacomnium palustre				1			
Barbilophozia floerkei					1		
Barbilophozia hatcheri					1		
Bartramia pomiformis							1
Bazzania ambigua	1						
Bazzania denudata	1						
Blepharostoma trichophyllum subsp. trichophyllum	1						
Blindia acuta				1			
Brachythecium albicans							1
Brachythecium asperrimum							1
Brachythecium erythrorrhizon							1
Brachythecium frigidum				1			
Brachythecium hylotapetum							1
Brachythecium leibergii							1
Brachythecium oedipodium							1
Brachythecium salebrosum							1
Bryum caespiticium						1	
Bryum calobryoides				1			
Bryum capillare							1
Bryum lisae							1
Bryum pseudotriquetrum				1			
Buxbaumia viridis	1						
Calliergonella cuspidata				1			
Calypogeia azurea	1						
Calypogeia fissa	1						
Calypogeia integristipula							1
Calypogeia muelleriana							1

Cedar River Municipal Watershed Bryophytes							
Scientific name	Guild Membership						
	CWD	Epiphyte	Forest Floor	Hydrophyte	Llithophyte	Mineral Soil	Terrestrial
Calypogeia neesiana	1						
Calypogeia suecica	1						
Cephalozia bicuspidata	1						
Cephalozia leucantha	1						
Cephalozia lunulifolia	1						
Cephaloziella divaricata							1
Cephaloziella divaricata var. scabra							1
Ceratodon purpureus							1
Chiloscyphus pallescens	1						
Chiloscyphus polyanthos				1			
Claopodium bolanderi					1		
Claopodium crispifolium		1					
Climacium dendroides				1			
Conocephalum conicum				1			
Cynodontium jenneri					1		
Dichodontium pellucidum				1			
Dicranella heteromalla						1	
Dicranella rufescens						1	
Dicranoweisia cirrata		1					
Dicranoweisia crispula var. crispula					1		
Dicranum fuscescens		1					
Dicranum howellii		1					
Dicranum pallidisetum							1
Dicranum scoparium							1
Dicranum tauricum		1					
Didymodon vinealis var. vinealis							1
Diplophyllum albicans							1
Diplophyllum obtusifolium						1	
Diplophyllum taxifolium					1		
Ditrichum ambiguum						1	
Ditrichum montanum						1	
Douinia ovata		1					
Drepanocladus aduncus var. polycarpus				1			

Cedar River Municipal Watershed Bryophytes							
Scientific name	Guild Membership						
	CWD	Epiphyte	Forest Floor	Hydrophyte	Llithophyte	Mineral Soil	Terrestrial
Dryptodon patens					1		
Eurhynchium oreganum			1				
Eurhynchium praelongum			1				
Eurhynchium pulchellum var. pulchellum							1
Fontinalis neomexicana				1			
Frullania nisquallensis		1					
Geocalyx graveolens	1						
Grimmia anomala				1			
Gymnomitrion obtusum					1		
Gyrothyra underwoodiana						1	
Heterocladium macounii					1		
Heterocladium procurrens					1		
Homalothecium fulgescens		1					
Homalothecium nuttallii		1					
Hookeria lucens				1			
Hygrohypnum ochraceum				1			
Hylocomium splendens			1				
Hypnum circinale		1					
Hypnum dieckii				1			
Hypnum subimponens		1					
Isothecium stoloniferum		1					
Jamesoniella autumnalis			1				
Jungermannia hyalina				1			
Jungermannia obovata				1			
Kiaeria starkei					1		
Lepidozia reptans	1						
Leucolepis acanthoneuron				1			
Lophocolea bidentata	1						
Lophocolea heterophylla	1						
Lophozia incisa	1						
Lophozia longiflora	1						
Lophozia obtusa							1
Lophozia opacifolia							1

Cedar River Municipal Watershed Bryophytes							
Scientific name	**Guild Membership**						
	CWD	**Epiphyte**	**Forest Floor**	**Hydrophyte**	**Llithophyte**	**Mineral Soil**	**Terrestrial**
Lophozia sudetica							1
Lophozia ventricosa					1		
Lophozia wenzelii							1
Marsupella emarginata					1		
Marsupella emarginata var. aquatica				1			
Marsupella sphacelata					1		
Metaneckera menziesii		1					
Metzgeria conjugata		1					
Metzgeria temperata		1					
Mnium marginatum							1
Mnium spinulosum							1
Nardia scalaris						1	
Neckera douglasii		1					
Oligotrichum aligerum						1	
Oncophorus wahlenbergii				1			
Orthotrichum consimile		1					
Orthotrichum papillosum		1					
Orthotrichum pulchellum		1					
Orthotrichum speciosum		1					
Orthotrichum striatum		1					
Palustriella commutata				1			
Pellia neesiana				1			
Philonotis fontana var. americana				1			
Philonotis fontana var. pumila							1
Plagiochila asplenioides				1			
Plagiochila porelloides							1
Plagiomnium insigne							1
Plagiomnium rostratum				1			
Plagiomnium venustum		1					
Plagiothecium cavifolium			1				
Plagiothecium denticulatum			1				
Plagiothecium laetum			1				
Plagiothecium piliferum					1		

Cedar River Municipal Watershed Bryophytes							
Scientific name	Guild Membership						
	CWD	Epiphyte	Forest Floor	Hydrophyte	Llithophyte	Mineral Soil	Terrestrial
Plagiothecium undulatum			1				
Pleurozium schreberi							1
Pogonatum contortum							1
Pogonatum urnigerum							1
Pohlia cruda							1
Pohlia nutans			1				
Polytrichastrum alpinum							1
Polytrichum commune				1			
Polytrichum formosum							1
Polytrichum juniperinum							1
Polytrichum piliferum							1
Porella cordaeana		1					
Porella navicularis		1					
Pseudoleskea atricha					1		
Pseudoleskea baileyi							1
Pseudoleskea incurvata					1		
Pseudoleskea patens					1		
Pseudoleskea saviana					1		
Pseudoleskea stenophylla		1					
Pseudotaxiphyllum elegans			1				
Ptilidium californicum		1					
Racomitrium aciculare				1			
Racomitrium affine					1		
Racomitrium aquaticum					1		
Racomitrium elongatum							1
Racomitrium heterostichum					1		
Racomitrium lanuginosum					1		
Racomitrium obesum					1		
Racomitrium occidentale					1		
Racomitrium varium					1		
Radula bolanderi		1					
Radula complanata		1					
Rhizomnium glabrescens	1						

Cedar River Municipal Watershed Bryophytes							
Scientific name	**Guild Membership**						
	CWD	**Epiphyte**	**Forest Floor**	**Hydrophyte**	**Llithophyte**	**Mineral Soil**	**Terrestrial**
Rhizomnium magnifolium				1			
Rhizomnium nudum							1
Rhytidiadelphus loreus			1				
Rhytidiadelphus squarrosus				1			
Rhytidiadelphus triquetrus			1				
Rhytidiopsis robusta			1				
Riccardia chamedryfolia				1			
Riccardia latifrons	1						
Riccardia multifida				1			
Roellia roellii			1				
Sanionia uncinata							1
Scapania americana				1			
Scapania bolanderi	1						
Scapania irrigua							1
Scapania subalpina							1
Scapania uliginosa				1			
Scapania umbrosa	1						
Scapania undulata				1			
Schistidium rivulare var. rivulare				1			
Schistidium strictum					1		
Schofieldia monticola							1
Scleropodium obtusifolium				1			
Sphagnum girgensohnii				1			
Sphagnum palustre				1			
Sphagnum recurvum var.brevifolium				1			
Sphagnum squarrosum				1			
Tetraphis pellucida	1						
Tetraplodon mnioides							1
Thamnobryum neckeroides					1		
Ulota megalospora		1					
Ulota obtusiuscula		1					
Warnstorfia exannulata				1			
Zygodon viridissimus var. rupestris		1					

Appendix B: Lichen Species List

Cedar River Municipal Watershed, King County, Washington, U.S.A.

Compiled by Katherine Glew

October 2007

GENUS	SPECIES	AUTHOR	COMMENT/TYPICAL HABITAT	TYPICAL SUBSTRATE	OBSERVER	VOUCHERED
Alectoria	*sarmentosa*	(Ach.) Ach.	Late seral conifer forests		T. Stout	Yes
Alectoria	*sarmentosa*	(Ach.) Ach.	Tends to be in older forests, but may occur in younger forests. Litterfall	Epiphytic on trees, mainly conifers, often on the main trunk	K. Glew	Yes
Alectoria	*vancouverensis*	(Gyelnik) Gyelnik ex Brodo & D. Hawksw.	Reflects a more coastal influence, but can be in western Cascades. Litterfall	Bark and wood	K. Glew	Yes
Bryoria		Brodo et D. Hawksw.	Young second-growth conifer forest dominated by *Tsuga heterophylla*	On dead twigs and branches of conifer	D. Wagner	Yes
Bryoria	*capillaris*	(Ach.) Brodo & D. Hawksw.	Late seral conifer forests		T. Stout	Yes
Bryoria	*capillaris*	(Ach.) Brodo & D. Hawksw.	Most common in Abies, Picea, Pseudotsuga and *Thuja* forests. Litterfall	On bark and wood of conifers. Can be on hardwoods	K. Glew	Yes
Bryoria	*fremontii*		Typical in dry *Pinus* and *Pseudotsuga* forests. Treetops of mesic lowland forests. Litterfall	On bark and wood of conifers. Can be on hardwoods	K. Glew	Yes
Byoria	*friabilis*	Brodo & D. Hawksw.	Most often found in moist elevations at lower elevations	On bark of conifers and hardwoods.	K. Glew	Yes
Bryoria	*fuscescens*	(Gyeln.) Brodo & D. Hawksw.	Late seral conifer forests		T. Stout	Yes
Bryoria	*fucescens*	(Gyeln.) Brodo & D. Hawksw.	Typical of mature conifer forests. Litterfall	Conifer bark or wood	K. Glew	Yes
Bryoria	*glabra*	(Motyka) Brodo & D. Hawksw.	Montain conifer forests – low to mid elevations. Litterfall	Conifer bark or wood	K. Glew	Yes
Bryoria	*lanestris*	(Ach.) Brodo & D. Hawksw.	Conifer forests	Conifer bark and wood	K. Glew	Yes

GENUS	SPECIES	AUTHOR	COMMENT/TYPICAL HABITAT	TYPICAL SUBSTRATE	OBSERVER	VOUCHERED
Bryoria	*pseudofuscescens*	(Gyeln.) Brodo & D. Hawksw.	Late seral conifer forests		T. Stout	Yes
Bryoria	*trichodes*	(Michaux) Brodo & D. Hawksw.	Wet forests with a cool coastal influence. Litterfall	Bark, wood or conifers	K. Glew	Yes
Bryoria sp.	*sp.*	Brodo & D. Hawksw.	Litterfall		K. Glew	Yes
Candelaria	*concolor*	(Dickson) Stein	Crustose Valleys and foothills, occasionally in mountains. Intermediat pollution tolerance	On nutrient-rich rock. More typically on bark, mainly hardwoods. Nitrophlous	K. Glew	Yes
Candellariella	*vitellina*	Mosbach	Crustose - Cosmopolitan	On rock	K. Glew	Yes
Cavernularia	*hultenii*	Degelius	Moist conifer forests at mid to low elevation	On bark and wood of conifers. Can be on hardwoods	K. Glew	Yes
Cetraria	*sp.*	Ach. s.s.	Young second-growth conifer forest dominated by Tsuga heterophylla	On trunk of conifer, at base; on rotting wood, mostly of stumps	D. Wagner	Yes
Cetrelia	*cetrariodes*	(Del. ex Duby) W.Culb. & C.Culb.	Riparian areas and valleys in lower forests. Especially on *A. rubra* in swampy areas	Bark – mainly *Alnus rubra* and other hardwoods Found in litterfall	K. Glew	Yes
Chaenotheca	*ferruginea*	(Turner ex Sm.) Mig.	Crustose		K. Glew	Yes
Chrysothrix	*granulosa*	G. Thor	Crustose		K. Glew	Yes
Cladonia	*albonigra*	Brodo & Ahti	Open road cuts in CRMW. Moist conifer forests, low to mid elevations	Humus over rock or soil	K. Glew	Yes
Cladonia	*arbuscula*	(Wallr.) Rabenh.	Cool rocky sites at low elevation	Soil and soil over rock	K. Glew	Yes
Cladonia	*asahinae*	J.W. Thomson	Open road cut	Rotten wood or soil	K. Glew	Yes
Cladonia	*bacillaris*	(Ach.) Nyl., Not. Sällsk.	Young to middle age forests	Humus, tree bases and rotten logs	K. Glew	Yes
Cladonia	*bellidiflora*	(Ach.) Schaer.	Talus and rock		T. Stout	Yes
Cladonia	*bellidiflora*	(Ach.) Schaer.	Cool, moist talus slopes, occasionally in forests	Mossy rocks, bark, wood	K. Glew	Yes
Cladonia	*borealis*	S. Stenroos	Widespread at all elevations	Moss and soli over rock, old	K. Glew	Yes

GENUS	SPECIES	AUTHOR	COMMENT/TYPICAL HABITAT	TYPICAL SUBSTRATE	OBSERVER	VOUCHERED
				stumps		
Cladonia	*cariosa*	(Ach.) Spreng.	Exposed road cuts in CRMW, disturbed sites	Soil	K. Glew	Yes
Cladonia	*carneola*	(Fr.) Fr.	Adjacent to streams		T. Stout	Yes
Cladonia	*carneola*	(Fr.) Fr.	Low to mid range forests previously logged	Humus-rich soil, stumpsrotten wood	K. Glew	Yes
Cladonia	*cenotea*	(Fr.) Fr.	Cool moist valleys from lowlands to subalpine. Shaded and exposed sites	Rotten logs, tree bases	K. Glew	Yes
Cladonia	*chlorophaea (aff.)*	(Flörke ex Sommerf.) Spreng.	Talus and rock		T. Stout	
Cladonia	*chlorophaea*	(Flörke ex Sommerfelt) Sprengel	Forests and open areas. Shaded or exposed, roadcuts	Soil, humus, bark, rotten wood, moss and detritus	K. Glew	Yes
Cladonia	*coniocraea*	(Flörke) Spreng.			T. Stout	Yes
Cladonia	*coniocraea*	(Flörke) Spreng.	Occurs in a wide variety of forests – shaded and exposed	Rotten wood, tree bases, chest high	K. Glew	Yes
Cladonia	*cornuta*	(L.) Hoffm.			T. Stout	Yes
Cladonia	*cornuta*	(L.) Hoffm.	Cool, moist montane habitats	Peaty soil and on fallen logs	K. Glew	Yes
Cladonia	*crispata*	(Ach.) Flot.		Soil, soil over rock rotten wood	K. Glew	Yes
Cladonia	*cyanipes ?*	(Sommerf.) Nyl.			K. Glew	Yes
Cladonia	*digitata*	(L.) Hoffm.			K. Glew	Yes
Cladonia	*ecmocyna*	Leighton	Talus, rock, and wetland		T. Stout	Yes
Cladonia	*ecmocyna*	Leighton	Exposed to lightly shaded areas, especially talus slopes and rock outcrops	Soil, humus, moss	K. Glew	Yes
Cladonia	*fimbriata*	(Linnaeus) Fries	Found in a variety of habitats, exposed to shaded, low to mid elevations	Soil, rotten wood, bark, stumps and roadcuts	K. Glew	Yes
Cladonia	*furcata*	(Hudson) Schrader			T. Stout	Yes
Cladonia	*furcata*	(Hudson) Schrader	Moist forests, low to mid elevations, partly shaded roadcuts	Soil, moss, humus. Occasionally tree base, rotton wood	K. Glew	Yes
Cladonia	*gracilis*	(L.) Willd.	Exposed to lightly shaded areas, especially talus slopes and rock outcrops	Soil humus, soil over rock, rotten logs	K. Glew	Yes

GENUS	SPECIES	AUTHOR	COMMENT/TYPICAL HABITAT	TYPICAL SUBSTRATE	OBSERVER	VOUCHERED
Cladonia	*macilenta*	Hoffm.	Shaded and open sites, clear cuts to old growth, mid to low elevations	Bark, wood, tree bases, stumps, fallen logs	K. Glew	Yes
Cladonia	*mitis*	Sandst.	Rock outcrops and talus slopes. Cool, moist areas	Soil, humus, soil over rock	K. Glew	Yes
Cladonia	*norvegica*	Tønsberg & Holien	Humid forests	Rotten wood and tree base	K. Glew	Yes
Cladonia	*ochrochlora*	Flörke	Occurs in a wide variety of forests – shaded and exposed	Rotten wood, tree bases and chest high	K. Glew	Yes
Cladonia	*pyxidata*	(L.) Hoffm.	Seim-open to open areas, disurbed to undisturbed, roadcuts	Mineral soil or soil.moss over rock	K. Glew	Yes
Cladonia	*rangiferina*	(L.) Nyl.	Talus slopes and rock outcrops. Cool moist slopes in narrow valleys	Humus, soil over rock	K. Glew	Yes
Cladonia	*rei ?*	**= C.** subulata	Rare – in forests	Soil, sometimes wood	K. Glew	Yes
	scabriuscula	(Delise) Nyl.	Talus and rock		T. Stout	Yes
Cladonia	*scabriuscula*	(Delise) Nyl.	Mainly coastal	Soil and mossy rock	K. Glew	Yes
Cladonia	*squamosa*	(Scop.) Hoffm.	Humid forests at low to mid elevation	Soil, soil over rock, tree base, rotten logs	K. Glew	Yes
Cladonia	*subsquamosa ?*	Kremp.	Humid forests at low to mid elevation	Soil, soil over rock, tree base, rotten logs	K. Glew	Yes
Cladonia	*subulata ?*	(L.) F. H. Wigg		Soil and rotten wood	K. Glew	Yes
Cladonia	*sulphurina*	(Michxaux) Fr.			T. Stout	Yes
Cladonia	*sulphurina*	(Michxaux) Fr.	Lowland to sublalpine forests. Rock oucrops and talus slopes	Rotten wood, bark, humus-rich soil	K. Glew	Yes
Cladonia	*transcendens*	(Vain.) Vain.	Late seral conifer forests		T. Stout	Yes
Cladonia	*transcendens*	(Vainio) Vainio	Shaded and open sites, clear cuts to old growth, mid to low elevations	Bark, wood, tree bases, stumps, fallen logs	K. Glew	Yes
Cladonia	*umbricola*	Tønsberg & Ahti			T. Stout	Yes
Cladonia	*umbricola*	Tønsberg & Ahti	Low to mid elevation forests – canyons, stream bottoms, valleys	Bark or decaying wood	K. Glew	Yes
Cladonia	*verruculosa*	(Vain.) Ahti	Disturbed sites – open to partly open	Soil and rotten wood	K. Glew	Yes

GENUS	SPECIES	AUTHOR	COMMENT/TYPICAL HABITAT	TYPICAL SUBSTRATE	OBSERVER	VOUCHERED
			sites. Roadcuts, clearcuts, Humid low to mid elevations			
Cladonia	*sp.*	P. Browne	Young second-growth conifer forest dominated by *Tsuga heterophylla*	On trunk of conifer, at base; on rotting wood, mostly of stumps	D. Wagner	Yes
Cladonia	*sp.*	P. Browne			K. Glew	Yes
Collema	*nicrescens ?*	(Hudson) D.C.	Low elevation hardwood forests, often riparian areas	On bark of deciduous trees and shrubs	K. Glew	Yes
Collema	*sp.*	F.H. Wigg			K. Glew	Yes
Cystocoleus ?		Thwaites	Cliff walls and moist habitats	Less often on bard and needles	K. Glew	Yes
Diploschistes	*scruposus*	(Schreber) Norman	Crustose – exposed, arid sites	On rock	K. Glew	Yes
Ephebe	*lanata ?*	(L.) Vainio	Damp or seepy areas	Usually on rock	K. Glew	Yes
Evernia	*prunastri*	(L.) Ach.	Mid-seral conifer forests, and adjacent to streams		T. Stout	Yes
Evernia	*prunastri*	(L.) Ach.	Common in lowland habitats, especially hardwood forests.	Wood or bark, especially on hardwoods and shrubs	K. Glew	Yes
Fuscopannaria	*cyanolepra*	(Tuck.) PM Jørg.	Leprose – roadcuts with strong oceanic influence	Seepy soils	K. Glew	Yes
Fuscopannaria	*pacifica*	P.M. Jørg.	Squamulose		K. Glew	Yes
Fuscopannaria	*sp.*		Squamulose – sheltered humid habitats		K. Glew	Yes
Graphis	*scripta*	(L.) Ach.	Crustose – common in riparian habitats on *Alnus rubra*	bark	K. Glew	Yes
Halecania ?			Crustose	Bark	K. Glew	Yes
Hymenelia ?		Kremp.	Crustose – humid/moist habitats	Rock	K. Glew	Yes
Hypogymnia	*apinnata*	Goward & McCune	Young second-growth conifer forest dominated by *Tsuga heterophylla*	On dead twigs and branches of conifer	D. Wagner	Yes
Hypogymnia	*apinnata*	Goward & McCune	Humid conifer forests, low to mid elevation	Bark and wood, mainly on conifers. Litterfall	K. Glew	Yes
Hypogymnia	*bitteri ?*				K. Glew	Yes
Hypogymnia	*duplicata*	(Ach.) Rass.	Cool moist coastal forests, low elevations	Bark and wood of conifers	K. Glew	Yes

GENUS	SPECIES	AUTHOR	COMMENT/TYPICAL HABITAT	TYPICAL SUBSTRATE	OBSERVER	VOUCHERED
			to coastal mountain tops, inland			
Hypogymnia	*enteromorpha*	(Ach.) Nyl.	Mid-seral and Late seral conifer forests		T. Stout	Yes
Hypogymnia	*enteromorpha*	(Ach.) Nyl.	Humid low to mid elevation forests	Wood and bark, mainly conifers	K. Glew	Yes
Hypogymnia	*imshaugii*	Krog	early, mid-, and late seral Late seral conifer forests		T. Stout	Yes
Hypogymnia	*imshaugii*	Krog	Low elevations to subaline forests, humid	Bark and wood. Litterfall	K. Glew	Yes
Hypogymnia	*inactiva*	(Krog) Ohlsson	Young second-growth conifer forest dominated by *Tsuga heterophylla*	On dead twigs and branches of conifer.	D. Wagner	Yes
Hypogymnia	*inactiva*	(Krog) Ohlsson	Humid low to mid elevation forests. More shade toerand than most hypogymnias	Bark and wood – b oth conifers and hardwoods. Litterfall	K. Glew	Yes
Hypogymnia	*occidentalis*	L. Pike	Humid low elevation to subalpine forests. Common on *Thuja* and *Psuedotsuga*	Bark and wood – usually conifers	K. Glew	Yes
Hypogymnia	*physodes*	(L.) Nyl.	Young second-growth conifer forest dominated by Tsuga heterophylla	On dead twigs and branches of conifer	D. Wagner	Yes
Hypogymnia	*physodes*	(L.) Nyl.	Common in forests from low to mid elevation	Bark and wood	K. Glew	Yes
Hypogymnia	*rugosa*	(G. Merr.) L. Pike	Mid- and late seral conifer forests		T. Stout	Yes
Hypogymnia	*rugosa*	(G. Merr.) L. Pike	Humid mid elevation to subalpine forests. Often in mixed *Abies* and *Tsuga* stands	Conifer bark	K. Glew	Yes
Hypogymnia	*tubulosa*	(Schaerer) Havaas.	Mid-seral conifer forests	d	T. Stout	Yes
Hypogymnia	*tubulosa*	(Schaerer) Havaas.	Open to semi-open habitats – low to mid elevations, riparian areas, wooded wetlands	Bark and wood	K. Glew	Yes
Hypotrachyna	*sinuosa*	(Sm.) Hale	Mid-seral conifer forests, and adjacent to streams		T. Stout	Yes
Hypotrachyna	*sinuosa*	(Sm.) Hale	Moist riparian forests at low elevations	Mainly *Alnus rubra*, but also on other hardwoods, conifers	K. Glew	Yes
Icmadophila	*ericetorum*	(L.) Zahlbr.	Crustose	Tree stumps old wood	K. Glew	Yes
Lecanora	*allophana (group)*	Nyl.	Crustose		K. Glew	Yes

GENUS	SPECIES	AUTHOR	COMMENT/TYPICAL HABITAT	TYPICAL SUBSTRATE	OBSERVER	VOUCHERED
Lecanora	*farinaria ?*	Borrer	Crustose	Bark	K. Glew	Yes
Lecanora	*pacifica*	Tuck.	Crustose	Bark and twigs	K. Glew	Yes
Lecanora	*polytropa*	(Hoffm.) Rabenh.	Crustose	Rock	K. Glew	Yes
Lecanora	*symmicta*	(Ach.) Ach.	Crustose	Bark and twigs	K. Glew	Yes
Lecanora	*sp.*	Ach.	Crustose		K. Glew	Yes
Lecidea	*lapicida*	(Ach.) Ach.	Crustose	Rock	K. Glew	Yes
Lecidea	*tesselata*	(Sm.) Flörke - Szatala	Crustose	Rock	K. Glew	Yes
Lecidea	*spp.*	Ach.	Crustose		K. Glew	Yes
Lepraria	*sp.*	Ach.	Crustose	Mostly bark	K. Glew	Yes
Leptogium	*lichenoides ?*	(L.) Zahlbr.	Rock outcrops and talus slopes, humid climates	Soil and moss (over rock)	K. Glew	Yes
Leptogium	*palmatum*	(Huds.) Mont.	Roadcuts, disturbed areas, outcrops and talus	Soil and moss (over rock)	K. Glew	Yes
Lichenomphalia	*umbellifera*	(L.) Redhead, Lutzoni, Moncalvo & Vilgalys	Moist lowland forests	On moss or tree stumps	K. Glew	Yes
Lobaria	*linita*	(Ach.) Rabenh.	Montane, mainly epiphytic; moist habitats with oceanic influence	Trees, shrubs, mossy rocks	K. Glew	Yes
Lobaria	*oregana*	(Tuck.) Müll. Arg.	Oceranic forest, mid elevatins to old growth forests. Sometimes in humid low elevation forests, foothills	Usually on conifer trees – *Psuedotsuga, Tsuga heterophylla*	K. Glew	Yes
Lobaria	*pulmonaria*	(L.) Hoffm.	Humid low to mid elevation forests, in areas of strong oceanic influence	Conifers and hardwoods, shrubs and mossy rocks	K. Glew	Yes
Loxosporopsus	*corallifera*	Brodo, Henssen & Imshaug	Crustose	Ba rk	K. Glew	Yes
Melanelia	*sp.*	Essl.			K. Glew	Yes
Melanelixia	*subaurifera*	(Nyl.) O. Blanco, A. Crespo, Divakar, Essl., D. Hawksw. & Lumbsch	Forest and shrub habitats at low to mid elevation	Bark and wood, mainly hardwoods, shrubs	K. Glew	Yes
Melanohalea	*exasperatula*	(Nyl.) O. Blanco, A. Crespo, Divakar, Essl., D. Hawksw. &	Wide range of habitats from low to mid elevation; continental to oceanic	Bark and wood, conifers and hardwoods	K. Glew	Yes

GENUS	SPECIES	AUTHOR	COMMENT/TYPICAL HABITAT	TYPICAL SUBSTRATE	OBSERVER	VOUCHERED
		Lumbsch	climates,;shade to open, exposed areas			
Menegazzia	*substerilis*	(H. Magn.) R. Sant.			K. Glew	Yes
Menegazzia	*terebrata*	(Hoffm.) A. Massal.	Adjacent to streams		T. Stout	Yes
Menegazzia	*terebrata*	(Hoffm.) A. Massal.			K. Glew	Yes
Micarea	*sp.*	Fr.	Crustose		K. Glew	Yes
Mycoblastus	*affinis*	(Schaerer) Schauer	Crustose		K. Glew	Yes
Mycoblastus	*sanguinarius*	(L.) Norman	Crustose		K. Glew	Yes
Nephroma	*bellum*	(Sprengel) Tuck.			K. Glew	Yes
Nephroma	*parile*	(Ach.) Ach.			K. Glew	Yes
Nodobryoria	*oregana*	(Tuck.) Common & Brodo			K. Glew	Yes
Ochrolechia	*oregonensis*	H. Magn.			K. Glew	Yes
Ochrolechia	*sp.*	A. Massal.	Crustose		K. Glew	Yes
Parmelia	*hygrophila*	Goward & Ahti	Mid-seral conifer forests		T. Stout	Yes
Parmelia	*hygrophila*	Goward & Ahti			K. Glew	Yes
Parmelia	*pseudosulcata*	Gyelnik.			K. Glew	Yes
Parmelia	*sulcata*	Taylor	Mid-seral and Late seral conifer forests		T. Stout	Yes
Parmelia	*sulcata*	Taylor			K. Glew	Yes
Parmelia	*saxatilis*	(L.) Ach.			K. Glew	Yes
Parmeliopsis	*ambigua*	(Wulfen) Nyl.	Late seral conifer forests		T. Stout	Yes
Parmeliopsis	*ambigua*	(Wulfen) Nyl.			K. Glew	Yes
Parmeliopsis	*hyperopta*	(Ach.) Arnold	Young second-growth conifer forest dominated by Tsuga heterophylla	On trunk of conifer, 1+ meter above base and below	D. Wagner	Yes
Parmeliopsis	*hyperopta*	(Ach.) Arnold			K. Glew	Yes
Peltigera	*britannica*	(Gyeln.) Holt.-Hartw. & Tønsberg			K. Glew	Yes
Peltigera	*canina*	(L.) Willd.			K. Glew	Yes

GENUS	SPECIES	AUTHOR	COMMENT/TYPICAL HABITAT	TYPICAL SUBSTRATE	OBSERVER	VOUCHERED
Peltigera	*cinnamomea*	Goward			K. Glew	Yes
Peltigera	*collina*	(Ach.) Schrad.			K. Glew	Yes
Peltigera	*collina*	(Ach.) Schrad.			T. Stout	Yes
Peltigera	*didactyla*	(With.) JR Laundon			K. Glew	Yes
Peltigera	*digenii*	Gyelnik			K. Glew	Yes
Peltigera	*malacea ?*	(Ach.) Funck			K. Glew	Yes
Peltigera	*membranacea*	(Ach.) Nyl.			T. Stout	Yes
Peltigera	*membranacea*	(Ach.) Nyl.			K. Glew	Yes
Peltigera	*neckeri*	Hepp ex Müll.Arg.			K. Glew	Yes
Peltigera	*neopolydactyla*	(Gyeln.) Gyeln.			K. Glew	Yes
Peltigera	*pacifica*	Vitik.			K. Glew	Yes
Peltigera	*praetextata*	(Flörke ex Sommerf.) Zopf			K. Glew	Yes
Peltigera	*retifoveata*	Vitik.			K. Glew	Yes
Peltigera	*venosa*	(L.) Hoffm.	Talus and rock		T. Stout	Yes
Peltigera	*venosa*	(L.) Hoffm.			K. Glew	Yes
Peltigera ?	*cyanomorph ?*				K. Glew	Yes
Peltigera	*sp.*	Willd.			K. Glew	Yes
Pertusaria	*amara*	(Acharius) Nylander	Crustose		K. Glew	Yes
Pertusaria	*sp.*	*Peltigera*	Willd.	**Lichen**	K. Glew	Yes
Physcia	*tenella*	(Scop.) DC			K. Glew	Yes
Pilophorus	*acicularis*	(Ach.) Th. Fr.	Crustose		K. Glew	Yes
Pilophorus	*clavatus*	L.	Crustose		K. Glew	Yes
Placopsis	*lambii*	Hertel & V. Wirth	Crustose		K. Glew	Yes
Placynthiella	*sp.*	Elenkin	Crustose		K. Glew	Yes
Plasitmatia	*lacunosa ?*	(Ach.) Culb. & C. Culb.			K. Glew	Yes

GENUS	SPECIES	AUTHOR	COMMENT/TYPICAL HABITAT	TYPICAL SUBSTRATE	OBSERVER	VOUCHERED
Platismatia	*glauca*	(L.) Culb. & C. Culb.	Young second-growth conifer forest dominated by Tsuga heterophylla	On dead twigs and branches of conifer	D. Wagner	Yes
Platismatia	*glauca*	(L.) Culb. & C. Culb.			K. Glew	Yes
Platismatia	*herrei*	(Imshaug) W. L. Culb. & C. F. Culb.	Late seral conifer forests		T. Stout	Yes
Platismatia	*herrei*	(Imshaug) W. L. Culb. & C. F. Culb.			K. Glew	Yes
Platismatia	*norvegica*	(Lynge) WL Culb. & CF Culb.			K. Glew	Yes
Platismatia	*stenophylla*	(Tuck.) Culb. & C. Culb.			K. Glew	Yes
Protopannaria	*pezizoides*	(Weber) P. M. Jørg. & S. Ekman.	Squamulose		K. Glew	Yes
Pseudocyphellaria	*rainierensis*	Imshaug.			K. Glew	Yes
Ramalina	*dilacerata*	(Hoffm.) Wain.			K. Glew	Yes
Ramalina	*farinacea*	(L.) Ach.	Early seral conifer forests		T. Stout	Yes
Ramalina	*farinacea*	(L.) Ach.			K. Glew	Yes
Rhizocarpon	*disporum/geminitum*		Crustose		K. Glew	Yes
Rhizocarpon	*geographicum group*	(L.) DC	Crustose		K. Glew	Yes
Rhizocarpon	*geographicum group*	(L.) DC	Crustose		K. Glew	Yes
Rhizocarpon	*grande ?*	(Flörke ex Flotow) Arnold	Crustose		K. Glew	Yes
Rinodina	*sp.*	(Ach.) Gray	Crustose		K. Glew	Yes
Sphaerophorus	*globosus*	(Huds.) Vainio	Late seral conifer forests		T. Stout	Yes
Sphaerophorus	*globosus*	(Huds.) Vainio			K. Glew	Yes
Sporastatia	*testudinea*	(Ach.) A. Massal.	Crustose			
Stereocaulon	*alpinum*	Laurer			K. Glew	Yes
Stereocaulon	*glareosum ?*	(Savicz) H. Magn.			K. Glew	Yes
Stereocaulon	*paschale*	(L.) Hoffm.			K. Glew	Yes

GENUS	SPECIES	AUTHOR	COMMENT/TYPICAL HABITAT	TYPICAL SUBSTRATE	OBSERVER	VOUCHERED
Stereocaulon	*sterile*	(Savicz) Lamb ex Kro			K. Glew	Yes
Stereocaulon	*vesuvianum*	Pers.			K. Glew	Yes
Stereocaulon	*sp.*	Hoffm.	Adjacent to streams		T. Stout	Yes
Stereocaulon	*sp.*	Hoffm.	Found in rock areas and on rock outcrops		K. Glew	Yes
Sticta	*fuliginosa ADM*	(Hoffm.) Ach.			K. Glew	Yes
Tephromela	*atra*	(Huds.) Hafellner	Crustose. On bark and rock		K. Glew	Yes
Thelotrema	*lepadinum*	(Ach.) Ach.	Crustose		K. Glew	Yes
Trapeliopsis	*granulosa*	(Hoffm.) Lumbsch	Crustose		K. Glew	Yes
Trapeliopsis	*sp.*	Hertel & Gotth. Schneider	Crustose		K. Glew	Yes
Tremolechia	*atrata*	(Ach.) Hertel	Crustose		K. Glew	Yes
Tuckermannopsis	*chlorophylla*	(Willd.) Hale	Mid-seral and Late seral conifer forests.		T. Stout	Yes
Tuckermannopsis	*chlorophylla*	(Willd.) Hale	Exposed sites to dry forest interiors – full sun to full shade. Litterfall	Bark, wood, fallen trees	K. Glew	Yes
Tuckermannopsis	*orbata*	(Nyl.) M. J. Lai	Mid-seral and Late seral conifer forests		T. Stout	Yes
Tuckermannopsis	*orbata*	(Nyl.) MJ Lai	Mainly low elevation mesic forests from shade to exposed sites. Litterfall	On bark and wood of conifers. Can be on hardwoods	K. Glew	Yes
Tuckermannopsis	*platyphylla*	(Tuck.) Hale	Crowns of trees in low elevation mesic forests. Litterfall	On bark and wood of conifers. Can be on hardwoods	K. Glew	Yes
Tuckermannopsis	*subalpina*	(Imshaug) Karnefelt	Semi open to open subalpine forests	Base of conifer trees or soil. Also on ericaceous shrubs	K. Glew	Yes
Umbilicaria	*angulata*	Tuck.			K. Glew	Yes
Umbilicaria	*cylindrica ?*	(L.) Delise ex Duby			K. Glew	Yes
Umbilicaria	*hyperborea*	(Ach.) Hoffm.			K. Glew	Yes
Umbilicaria	*polyphylla*	(L.) Baumg.			K. Glew	Yes
Umbilicaria	*sp.*	Hoffm.			K. Glew	Yes
Usnea	*ceratina ?*	Ach.			K. Glew	Yes

GENUS	SPECIES	AUTHOR	COMMENT/TYPICAL HABITAT	TYPICAL SUBSTRATE	OBSERVER	VOUCHERED
Usnea	*chaetophora ?*	Stirton			K. Glew	Yes
Usnea	*cornuta ?*	Körber			K. Glew	Yes
Usnea	*diplotypus*	Vainio			K. Glew	Yes
Usnea	*diplotypus ?*	Vainio			K. Glew	Yes
Usnea	*filipendula*	Stirton	Late seral conifer forests		T. Stout	Yes
Usnea	*filipendula*	Stirton			K. Glew	Yes
Usnea	*flavocardia (wirthii)*	Räsänen (syn.: U. wirthii. P. Clerc)	Late seral conifer forests		T. Stout	Yes
Usnea	*flavocardia (wirthii)*	Räsänen (syn.: U. wirthii. P. Clerc)			K. Glew	Yes
Usnea	*glabrata*	(Ach.) Vain.			K. Glew	Yes
Usnea	*lapponica*	Vainio	Late seral conifer forests		T. Stout	Yes
Usnea	*lapponica*	Vainio			K. Glew	Yes
Usnea	*longissima*	Ach.			K. Glew	Yes
Usnea	*longissima*	Ach.			K. Glew	Yes
Usnea	*pacificana*	Halonen.			K. Glew	Yes
Usnea	*scabrata*	Nyl.			K. Glew	Yes
Usnea	*subfloridana*	Stirton	Mid-seral conifer forests		T. Stout	Yes
Usnea	*subfloridana*	Stirton			K. Glew	Yes
Usnea	*substerilis*	Motyka			K. Glew	Yes
Usnea	*sp.*	Dill. ex Adans.	Young second-growth conifer forest dominated by Tsuga heterophylla	On dead twigs and branches of conifer; on trunk of conifer, at base	D. Wagner	Yes
Xanthoria	*candelaris*	(L.) Th. Fr.			K. Glew	Yes
Xanthoria	*polycarpa*	(Hoffmann) Rieber			K. Glew	Yes
Xanthoria	*sp.*	(Fr.) Th. Fr.			K. Glew	Yes