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A Comparison of the lichen floras of four locations in the Intermountain Western United States

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Abstract: The Intermountain Region of the western United States has a rich and diverse lichen flora. Various research projects have examined the lichen communities of this region. This study compares the lichen floras of four Intermountain Area locations, Dinosaur National Monument, Utah and Colorado; the Gila Wilderness Area, New Mexico; the Manti La Sal National Forest, Utah; and the San Juan – Rio Grande National Forest, Colorado. A total of 392 species in 122 genera have been identified from these four general locations. The San Juan – Rio Grande National Forest has the highest number of species (313 species in 109 genera). The Dinosaur National Monument and the Manti La Sal National Forest lichen floras were dominated by crustose species; a condition typical of many Intermountain Area locations; however, the Gila Wilderness Area and San Juan – Rio Grande National Forest were dominated by foliose species. Substrate distribution patterns for all four sites indicated a preponderance of saxicolous species. In addition, a total of 69 pollution sensitive indicator species were identified from the four study areas of which 16 species were common to all 4 locations. The relatively high percentage of pollution sensitive species at all study areas generally suggests that air pollution-related impact on this area has been minimal.

Key Words: Lichens, Floristic survey, Dinosaur National Monument, Gila Wilderness Area, Manti La Sal National Forest, San Juan-Rio Grande National Forest, Intermountain Area, Air pollution

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Introduction: Lichens are important biological components of the various Intermountain Area ecosystems. Over the last thirty years the lichens of many parts of this region have been actively studied (Egan, 1972; Nash & Johnsen, 1975; Newberry, 1991; Newberry & St. Clair 1991; Rushforth et al. ,1982; Schroeder et al., 1975; Shushan & Anderson, 1969; St. Clair et al., 1995). In addition to floristic surveys, studies addressing the various ecological roles of lichens in the Intermountain Area have also been published (Rogers et al. 2009; Rogers et al., 2007; St. Clair et al., 1993; St. Clair et al., 2002). Lichens play an integral role as components of biological soil crust communities which are well developed in many Intermountain Area locations. Biological soil crusts occupy soil surfaces and serve several important ecological roles such as enhanced water infiltration, carbon sequestration, and nutrient cycling (Eldridge & Greene, 1994).

In the western intermountain region, lichens have been used extensively as bio-monitors of air quality. Marsh & Nash (1979) studied the effects of the Four Corners coal-fired power plant on lichen communities in northwestern New Mexico. Their research indicated that arid lichen communities are relatively resistant to SO_2 impacts. Rope & Pearson (1990) conducted a study in the semiarid region of eastern Idaho to evaluate the usefulness of lichens as bio-monitors of air quality. Their research showed that some lichen species, especially *Rhizoplaca melanophthalma*, have potential as air quality bio-monitors. Dillman (1996) conducted a study northwest of Pocatello, Idaho to determine concentrations of various elements in relation to distance and direction from a local phosphate processing plant using the umbilicate rock lichen *Rhizoplaca melanopthalma*. Results of her study showed that concentrations of Cd, Cr, Zn, and P were negatively correlated with distance from the refinery. Studies conducted by Fields & St. Clair (1984) and Pearson (1985) at different sites in the intermountain west demonstrated potential effects of SO_2 and other pollutants on lichens.

Lichens have also been used to monitor the health of vascular plant communities. Rogers et al. (2007) conducted a community survey in the central Rocky Mountains of North America using lichens on aspen trunks as bio-indicators of community health. Their results showed that unique assemblages of lichens could be used to document vascular plant community health.

Other studies have been used to analyze the effects of various disturbances on lichen communities in the Intermountain western United States. St. Clair et al. (2007) studied the effects of snowmelt patterns, vascular plant communities, grazing, substrates, and various soil characteristics on lichens along an alpine tundra ridge in the Uinta Mountains of northeast Utah.

These studies and others show that lichens are important biological components of the Intermountain Area. Therefore, it is important that appropriate steps be taken to develop and implement effective conservation and management strategies to protect lichens – particularly in potentially vulnerable locations. To effectively develop basic conservation strategies it is essential to have solid ecological and floristic information about potentially vulnerable habitats. Further, *a priori* knowledge of air pollution indicator species will enhance efforts to develop effective bio-monitoring baselines and programs.
The primary purpose of this study is to provide detailed floristic information about the lichen floras of four Intermountain Area locations - the San Juan-Rio Grande National Forest (SW Colorado), Dinosaur National Monument (NE Utah), Gila Wilderness Area (west, central New Mexico), and the Manti La Sal National Forest (central and SE Utah). This study compares these four areas in terms of species composition,

growth form distributions, habitat types, substrate patterns, and number of pollution sensitive indicator species.

Study Sites: Research sites for this study are located in three adjacent Intermountain Area states - Colorado, Utah, and New Mexico (Figure 1). All four study sites (San Juan –Rio Grande National Forest, Colorado; Dinosaur National Monument, Utah-Colorado; Manti La Sal National Forest, Utah; and the Gila Wilderness Area in the Gila National Forest, New Mexico) differ in vegetation and geology, along with summer monsoonal precipitation distribution patterns. These combine to generate a wide variety of habitat types which ultimately support diverse and complex lichen communities.

moisture, temperature, and sunlight (Barkman, 1958). At each of the study areas reference sites were selected in consultation with USDA Forest Service and National Park Service personnel with careful attention to potential sources of air pollution. Each reference site covered an area of about 1 hectare. All substrates and habitats at each reference site were carefully examined and voucher collections were prepared for each species collected. A total of 72 reference sites were established in four different study areas between 1991 and 1999. In the San Juan-Rio Grande National Forest, specimen collections was completed between 1993 and 1997; 32 reference sites were established during that period. In Dinosaur National Monument specimens were collected from 18 reference sites

Figure 1: Map showing study areas.

Data Collection: Generally, distribution of lichen species is influenced by a variety of environmental parameters including substrate,

between 1991 and 1999. Lichens were also reviewed and collected at 7 reference sites in the Gila Wilderness Area in the summer of 1996

along with 15 sites in the Manti La Sal National Forest between 1994 and 1997. Field specimens were placed in paper sacks and returned to the BYU Herbarium of Nonvascular Cryptogams, where they were curated, identified, and permanently deposited in the collection. Nomenclature follows Esslinger (2008).

Species sensitivity to air pollution was based on literature references (McCune and Geiser, 2009, Ryan et al., 1990, Wetmore, 1987). The sensitivity of species to various pollutants is also reported (Table 1).

Results: All four study areas support a diverse but often different assemblage of lichen species. A total of 392 lichen species in 122 genera were collected and identified from the 4 study areas (Table 1). The San Juan-Rio Grande National Forest had the greatest number of species with 313 species in 109 genera.

Dinosaur National Monument had 163 species in 57 genera. The Manti La Sal National Forest had 140 species in 50 genera while the Gila Wilderness Area had 138 species in 63 genera. Forty-five species were common to all four study areas. The two genera *Lecanora* and *Caloplaca* had the greatest number of species - 25 and 23 species respectively. Fifty-five genera were represented by only one species. On average, the San Juan – Rio Grande National Forest had the highest number of species per site (48.8) while the Gila Wilderness Area, Dinosaur National Monument, and Manti La Sal National Forest had 47.3, 37.5, and 29.3 species per reference site respectively.

Growth Form Distribution Patterns

All four basic growth form types i.e. crustose, squamulose, foliose and fruticose are reported for all four study areas. Overall, crustose species represented the most common growth form

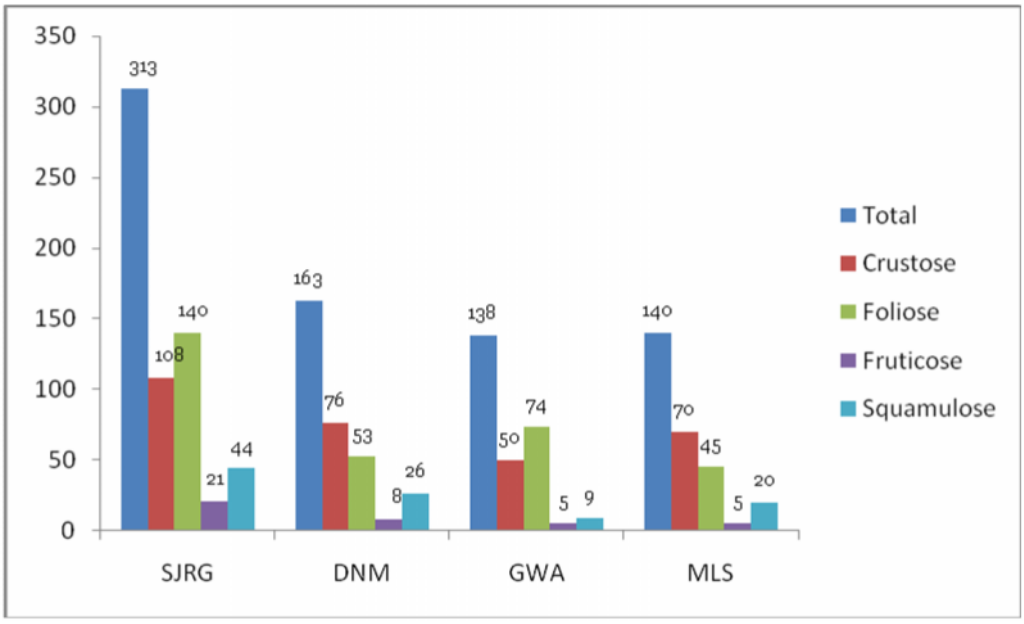

Figure 2: Number of lichen species by growth form type across the four study areas. SJRG = San Juan Rio Grande National Forest; DNM = Dinosaur National Monument; GWA = Gila Wilderness Area; MLS = Manti La Sal National Forest

followed closely by foliose species (Figure 2). This pattern is typical of other lichen floras in the arid Intermountain western United States.

However, in evaluating each study areas, the San Juan –Rio Grande National forest and the Gila Wilderness area, were dominated by foliose species.

Substrate Distribution Patterns

Lichens were collected from a variety of natural substrates at all four study areas. Substrates were classified into five categories – rock, bark/lignum, soil, moss/detritus, and growing over other lichens. About 20% (77) of the species are reported from multiple substrates. Of the different substrate types, rocks supported the largest number of species (189) followed by bark/lignum (135), Soil (94) and moss/detritus (76). Two species; *Caloplaca epithallina* and *Lecanora thallophila* were lichenicolous. One aquatic species *Verrucaria hydrela* was also reported from the Gila Wilderness Area. The number of species for each substrate at each study site is shown in Figure 3.

Pollution Sensitive lichens

Altogether 69 air pollution sensitive indicator species were reported across all four study areas with 16 species common to all four study areas (Table 1). The San Juan – Rio Grande National Forest had the highest total number of pollution sensitive species with the Gila Wilderness Area reporting the fewest (Table 2). In the San Juan-Rio Grande National forest, 20% of the lichen flora was made up of air pollution sensitive species while Dinosaur National Monument, Gila Wilderness Area, and Manti La Sal National Forest had 21%, 20% and 23% of their floras made up of sensitive indicator species respectively. Similarly, the average number of pollution sensitive species per site was 17 in the San Juan-Rio Grande National forest while, for Dinosaur National Monument, Gila Wilderness Area, and Manti La Sal National Forest it was 9.7, 12.3, and 11.1 respectively.

Discussion: The lichen floras at the four study areas differed; however, each was diverse and well developed. A total of 392 species in 122

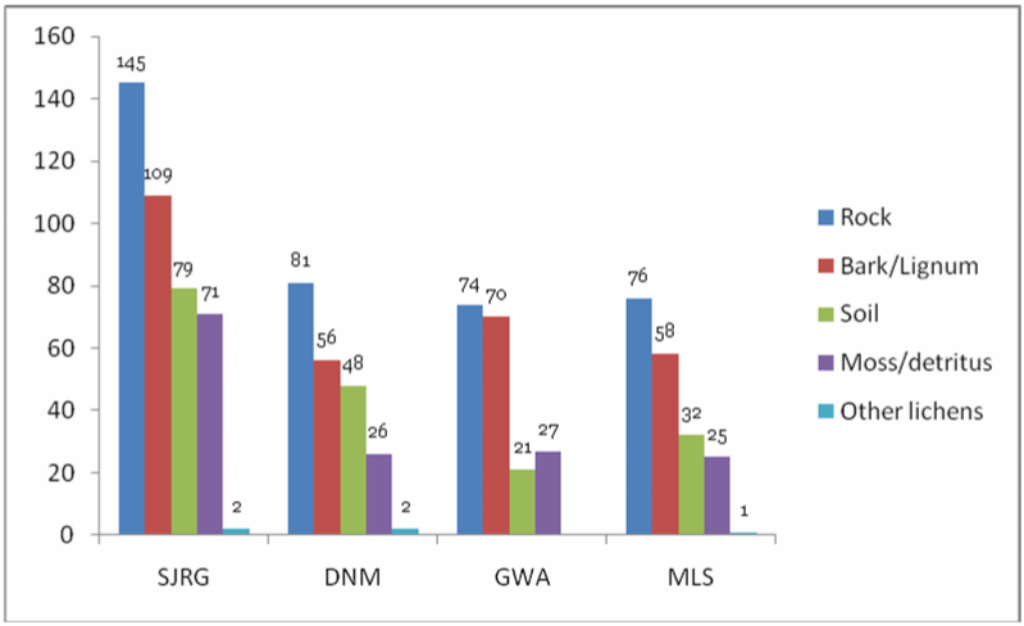

Figure 3: Number of species by substrate type across the four study areas. SJRG = San Juan Rio Grande National Forest; DNM = Dinosaur National Monument; GWA = Gila Wilderness Area; MLS = Manti La Sal National Forest

genera to date have been identified from a total of 72 reference sites extending across the eastern half of Utah, the NW and SW corners of Colorado, and west central New Mexico. Among the four study areas, the San Juan-Rio Grande National Forest had the greatest number of species which is most likely related to three factors: 1. Minimal human-related development in the area, 2. occurrence of a diversity of productive lichen habitats, and 3. summer monsoonal storm patterns. Specifically, the lichen floras at the four study areas differed in terms of growth form and substrate distribution patterns. Generally, Intermountain Area lichen floras are dominated by crustose species (Rushforth et al., 1982). However the lichen floras in the San Juan-Rio Grande National Forest and the Gila Wilderness Area departed from this pattern with a substantial number of foliose and fruticose species. The larger and more structurally complex foliose and fruticose species are generally more abundant in mesic habitats; conditions typical of the San Juan – Rio Grande National Forest and the Gila Wilderness Area. Furthermore, the diversity of substrates and the environments typical of the San Juan – Rio Grande National Forest favor the occurrence of foliose and fruticose species.

Lichens occur on a variety of substrates at all four study sites. However, rock substrates supported the greatest species diversity followed by bark/lignum. This is a common pattern in the Intermountain Western United States.

The high species diversity at all study areas suggest that these areas have generally not been significantly impacted by air pollution. Furthermore, the relatively high percentage of sensitive indicator species at all four study areas (San Juan-Rio Grande National Forest – 20%; Dinosaur National Monument – 21%; Gila Wilderness Area – 20%; and Manti La Sal National Forest – 23%) suggests little or no air pollution related impact. In the San Juan- Rio Grande National Forest an interesting east-west trend in number of sensitive indicator species per reference site was noted. The average number of sensitive indicator species on the west side of the continental divide (San Juan National Forest) is 15.5 while on the east side of the divide (Rio Grande National Forest) the average is 19.1. This pattern could be simply a reflection of habitat differences between the east and west sides of the continental divide; or it could be related to the fact that there are several potentially important air pollution sources (coal-fired power plants and larger more developed human populations) west of the divide. Similarly, in the Manti La Sal National Forest there were some differences in the average number of sensitive indicator species per reference site between the Monticello – Moab districts (11.8) and the Price, San Pete and Ferron districts (8.9). This difference might also be related, at least in part, to the general proximity of the Price, San Pete, and Ferron sites to the air pollution problems of the Wasatch Front and the coal-fired power plants in Emery County. No necrotic and/or bleached thalli (typical visible indicators of air pollution-related impact) were observed at any of the reference sites. This further supports the general conclusion that all study areas are relatively free of significant air pollution-related impact.

In conclusion, all four study sites support diverse lichen floras with the full range of growth forms occupying a variety of substrates. All study sites supported a variety of pollution sensitive indicator species; generally indicating good air quality conditions.

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Table 1. Checklist of lichens from the four study areas. The numbers in columns 3-6 represent the percent occurrence for that species in that study area. SJRG = San Juan Rio Grande National Forest; DNM = Dinosaur National Monument; GWA = Gila Wilderness Area; MLS = Manti La Sal National Forest.

Name of Species	**Herbarium number**	**SJRG**	**DNM**	**GWA**	**MLS**	**Sensitivity**
Acarospora badiofusca (Nyl.) Th. Fr.	BRY-C 34460	-	-	-	7%	
Acarospora fuscata (Schrader) Arnold	BRY-C 29029	28%	44%	29%	33%	
Acarospora glaucocarpa (Ach.) Körber	BRY-C 35270	3%	-	14%	-	
Acarospora schleicheri (Ach.) A. Massal.	BRY-C 33354	6%	-	43%	-	
Acarospora smaragdula (Wahlenb.) A. Massal.	BRY-C 35358	3%	-	-	-	
Acarospora stapfiana (Müll. Arg.) Hue	BRY-C 34915	3%	33%	-	33%	
Acarospora strigata (Nyl.) Jatta	BRY-C 29051	13%	56%	14%	27%	
Acarospora veronensis A. Massal.	BRY-C 38469	3%	6%	-	-	
Allocetraria madreporiformis (Ach.) Kärnef. & Thell	BRY-C 31586	3%	-	-	-	
Amandinea punctata* (Hoffm.) Coppins & Scheid.	BRY-C 26676	72%	33%	57%	53%	SO_2
Anaptychia elbursiana (Szatala) Poelt	BRY-C 38611	-	11%	-	-	
Anaptychia ulotrichoides (Vainio) Vainio	BRY-C 34912	3%	-	-	-	
Arthrorhaphis alpina (Schaerer) R. Sant.	BRY-C 29325	3%	-	-	-	
Aspicilia caesiocinerea (Nyl. ex Malbr.) Arnold	BRY-C 31529a	3%	-	-	-	
Aspicilia calcarea (L.) Mudd	BRY-C 34886	3%	11%	-	-	
Aspicilia cinerea (L.) Körber	BRY-C 26740	59%	22%	57%	20%	
Aspicilia contorta (Hoffm.) Kremp.	BRY-C 31156	6%	-	-	-	
Aspicilia desertorum (Kremp.) Mereschk.	BRY-C 26735	56%	33%	-	53%	
Aspicilia fruticulosa (Eversm.) Flagey	BRY-C 26205	-	6%	-	-	
Aspicilia hispida Mereschk.	BRY-C 37347	-	22%	-	-	
Aspicilia quartzitica W. A. Weber	BRY-C 33304	6%	-	-	-	
Aspicilia terrestris Tomin	BRY-C 21605	-	17%	-	-	
Aspicilia uxoris (Werner) V. J. Rico, Aragón & Esnault	BRY-C 35721	16%	-	-	-	
Bellemerea alpina (Sommerf.) Clauzade & Cl. Roux	BRY-C 34961	6%	-	-	-	
Bellemerea cinereorufescens (Ach.) Clauzade & Cl. Roux	BRY-C 34967	3%	-	-	-	
Biatora vernalis (L.) Fr.	BRY-C 30952	25%	6%	29%	-	
Brodoa oroarctica (Krog) Goward	BRY-C 31625	3%	-	-	-	
Bryoria chalybeiformis (L.) Brodo & D. Hawksw.	BRY-C 35905	3%	-	-	-	
Bryoria fuscescens* (Gyelnik) Brodo & D. Hawksw.	BRY-C 26724	44%	-	-	-	SO_2
Bryoria lanestris (Ach.) Brodo & D. Hawksw.	BRY-C 36457a	3%	-	-	-	
Buellia badia (Fr.) A. Massal.	BRY-C 34928	3%	-	-	-	
Buellia concinna Th. Fr.	BRY-C 32442	-	-	14%	-	

Buellia disciformis (Fr.) Mudd	BRY-C 32690	-	-	-	7%	
Buellia dispersa A. Massal.	BRY-C32454	-	-	14%	-	
Buellia elegans Poelt	BRY-C 34844	3%	6%	-	-	
Buellia erubescens Arnold	BRY-C 34855b	3%	-	14%	7%	
Buellia spuria (Schaerer) Anzi	BRY-C 32282	-	-	29%	-	
Calicium abietinum Pers.	BRY-C 32226	-	-	29%	-	
Caloplaca ammiospila (Wahlenb.) H. Olivier	BRY-C 26744	9%	-	-	-	
Caloplaca arizonica H. Magn.	BRY-C 26726	16%	67%	-	13%	
Caloplaca atroalba (Tuck.) Zahlbr.	BRY-C 38388	-	6%	-	7%	
Caloplaca cerina* (Ehrh. ex Hedwig) Th. Fr.	BRY-C 26864	19%	28%	14%	13%	SO_2
Caloplaca chrysophthalma Degel.	BRY-C 38818	-	6%	-	-	
Caloplaca cinnabarina (Ach.) Zahlbr.	BRY-C 26770	16%	6%	-	-	
Caloplaca cladodes (Tuck.) Zahlbr.	BRY-C 31138	3%	33%	-	13%	
Caloplaca decipiens (Arnold) Blomb. & Forssell	BRY-C 29173	6%	22%	-	13%	
Caloplaca durietzii H. Magn	BRY-C 26141	-	28%	14%	20%	
Caloplaca epithallina Lynge	BRY-C 29393	25%	6%	-	13%	
Caloplaca flavovirescens (Hudson) J. R. Laundon	BRY-C 26896	6%	-	29%	7%	
Caloplaca fraudans (Th. Fr.) H. Olivier	BRY-C 26764	53%	22%	57%	60%	
Caloplaca holocarpa* (Hoffm. ex Ach.) A. E. Wade	BRY-C 26758	9%	-	43%	20%	SO_2
Caloplaca jungermanniae (Vahl) Th. Fr.	BRY-C 31798	3%	-	-	-	
Caloplaca microphyllina (Tuck.) Hasse	BRY-C 29147	6%	11%	14%	-	
Caloplaca pinicola H. Magn.	BRY-C 21612	-	6%	-	-	
Caloplaca saxicola (Hoffm.) Nordin	BRY-C 31016	6%	-	29%	7%	
Caloplaca sideritis (Tuck.) Zahlbr.	BRY-C 26878	9%	6%	-	-	
Caloplaca subsoluta (Nyl.) Zahlbr.	BRY-C 35319	9%	17%	29%	7%	
Caloplaca tiroliensis Zahlbr.	BRY-C 29303	13%	6%	-	-	
Caloplaca tominii (Savicz) Ahlner	BRY-C 34848	9%	6%	-	-	
Caloplaca trachyphylla (Tuck.) Zahlbr.	BRY-C 29044	3%	56%	-	47%	
Caloplaca xanthostigmoidea (Räsänen) Zahlbr.	BRY-C 31240	-	-	71%	-	
Calvitimela armeniaca (DC.) Hafellner	BRY-C 29249	6%	-	-	-	
Candelaria concolor* (Dickson) Stein	BRY-C 32262	-	-	29%	-	SO_2, Fluoride
Candelariella aurella (Hoffm.) Zahlbr.	BRY-C 26925	16%	6%	-	20%	
Candelariella citrina B. de Lesd.	BRY-C 31626	6%	11%	-	-	
Candelariella placodizans (Nyl.) H. Magn.	BRY-C 38394	-	6%	-	-	
Candelariella rosulans (Müll. Arg.) Zahlbr.	BRY-C 26900	34%	61%	14%	40%	
Candelariella subdeflexa (Nyl.) Lettau	BRY-C 35191	3%	-	14%	7%	
Candelariella vitellina* (Hoffm.) Müll. Arg.	BRY-C 29046	41%	78%	29%	60%	SO_2, Fluoride

Candelariella xanthostigma (Ach.)Lettau	BRY-C 29343	13%	-	-	-	
Candelina submexicana (B. de Lesd.) Poelt	BRY-C 32203	-	-	57%	-	
Catapyrenium cinereum (Pers.) Körber	BRY-C 29230	9%	-	-	-	
Catapyrenium daedaleum (Kremp.) Stein	BRY-C 32350	-	6%	14%	-	
Cetraria aculeata (Schreber) Fr.	BRY-C 31597	3%	-	-	-	
Cetraria ericetorum Opiz	BRY-C 31587a	3%	-	-	-	
Cetraria islandica (L.) Ach.	BRY-C 31587b	3%	-	-	-	
Cladonia cariosa (Ach.) Sprengel	BRY-C 26742	50%	6%	14%	13%	
Cladonia cenotea (Ach.) Schaerer	BRY-C 36547	3%	-	-	-	
Cladonia chlorophaea (Flörke ex Sommerf.) Sprengel	BRY-C 26731	25%	-	29%	-	
Cladonia coniocraea* (Flörke) Sprengel	BRY-C 26669	44%	-	29%	13%	SO_2
Cladonia ecmocyna Leighton	BRY-C 26741	6%	-	-	-	
Cladonia fimbriata* (L.) Fr.	BRY-C 29241	28%	6%	-	7%	SO_2
Cladonia macrophyllodes Nyl.	BRY-C 35211	3%	-	-	-	
Cladonia pocillum (Ach.) Grognot	BRY-C 26738	34%	-	-	-	
Cladonia pyxidata (L.) Hoffm.	BRY-C 26729	47%	17%	29%	13%	
Cladonia stricta* (Nyl.) Nyl.	BRY-C 30960	3%	-	-	-	O_3
Cladonia sulphurina (Michaux) Fr.	BRY-C 26673	9%	-	-	7%	
Collema ceraniscum Nyl.	BRY-C 31604	3%	-	-	-	
Collema coccophorum* Tuck.	BRY-C 34838	6%	17%	-	-	O_3
Collema crispum* (Hudson) F. H. Wigg.	BRY-C 29219	9%	17%	-	-	O_3
Collema cristatum* (L.) F. H. Wigg.	BRY-C 35271	3%	-	14%	13%	O_3
Collema cristatum var. marginale (Hudson) Degel.	BRY-C 37375	-	33%	-	-	
Collema furfuraceum (Arnold) Du Rietz	BRY-C 31734	9%	-	-	-	
Collema fuscovirens* (With.) J. R. Laundon	BRY-C 29229	9%	28%	-	-	O_3
Collema glebulentum* (Nyl. ex Crombie) Degel.	BRY-C 29284	3%	-	-	-	O_3
Collema polycarpon* Hoffm.	BRY-C 27130	-	22%	-	20%	O_3
Collema subflaccidum* Degel.	BRY-C 35685b	3%	-	-	-	O_3
Collema tenax* (Sw.) Ach.	BRY-C 34918	3%	78%	-	7%	O_3
Collema undulatum var. granulosum Degel.	BRY-C 26875	6%	-	-	-	
Cyphelium tigillare (Ach.) Ach.	BRY-C 31043	3%	-	29%	-	
Cystocoleus ebeneus (Dillwyn) Thwaites	BRY-C 35364	3%	-	-	-	
Dermatocarpon intestiniforme (Körber) Hasse	BRY-C 29267	9%	22%	14%	13%	
Dermatocarpon lorenzianum Anders	BRY-C 31617	6%	-	-	-	
Dermatocarpon miniatum (L.) W. Mann	BRY-C 26699	50%	44%	43%	20%	
Dermatocarpon moulinsii (Mont.) Zahlbr.	BRY-C 29050	3%	6%	29%	-	

Dermatocarpon reticulatum H. Magn.	BRY-C 26739	38%	33%	-	27%	
Dermatocarpon vellereum Zschacke	BRY-C38714	-	11%	-	-	
Dimelaena oreina (Ach.) Norman	BRY-C 29199	25%	11%	43%	20%	
Diploschistes actinostomus (Ach.) Zahlbr.	BRY-C 34864	6%	22%	-	7%	
Diploschistes muscorum (Scop.) R. Sant.	BRY-C 29296	25%	11%	-	-	
Diploschistes scruposus (Schreber) Norman	BRY-C 26779	13%	28%	29%	7%	
Diplotomma alboatrum (Hoffm.) Flotow	BRY-C 34902	3%	11%	-	-	
Endocarpon pulvinatum Th. Fr.	BRY-C 26794	3%	6%	-	-	
Endocarpon pusillum Hedwig	BRY-C 27040	-	17%	-	7%	
Evernia divaricata (L.) Ach.	BRY-C 26723	22%	-	-	20%	
Flavocetraria nivalis (L.) Kärnefelt & Thell	BRY-C 31588	3%	-	-	-	
Flavoparmelia baltimorensis (Gyelnik & Fóriss) Hale	BRY-C 32518	-	-	14%	-	
Flavoparmelia caperata* (L.) Hale	BRY-C 29074	9%	-	29%	-	SO_2
Flavoparmelia rutidota (Hooker f. & Taylor) Hale	BRY-C 31231	-	-	14%	-	
Flavopunctelia darrowi (J. W. Thomson) Hale	BRY-C 31785c	3%	-	-	-	
Flavopunctelia flaventior (Stirton) Hale	BRY-C 31073	22%	-	100%	-	
Flavopunctelia praesignis (Nyl.) Hale	BRY-C 31785b	3%	-	57%	-	
Flavopunctelia soredica (Nyl.) Hale	BRY-C 26858	34%	6%	86%	-	
Fulgensia bracteata (Hoffm.) Räsänen	BRY-C 37482	-	11%	-	7%	
Fulgensia desertorum (Tomin) Poelt	BRY-C 34846	9%	17%	-	-	
Fulgensia fulgens (Sw.) Elenkin	BRY-C 26057	-	17%	-	-	
Fuscopannaria leucosticta (Tuck.) P. M. Jørg.	BRY-C 29326	9%	-	-	-	
Glypholecia scabra (Pers.) Müll. Arg.	BRY-C 34931	3%	28%	-	-	
Haematomma fenzlianum A. Massal.	BRY-C 32192	-	-	14%	-	
Heppia lutosa (Ach.) Nyl.	BRY-C 34875	3%	22%	-	-	
Heterodermia diademata (Taylor) D. D. Awasthi	BRY-C 29078	3%	-	14%	-	
Heterodermia microphylla (Kurok.) Skorepa	BRY-C 35693	3%	-	-	-	
Heterodermia rugulosa (Kurok.) Wetmore	BRY-C 31236	-	-	86%	-	
Heterodermia speciosa (Wulfen) Trevisan	BRY-C 31184	13%	-	43%	-	
Hypocenomyce friesii (Ach.) P. James & Gotth. Schneider	BRY-C 31036	3%	-	-	-	
Hypocenomyce scalaris* (Ach.) M. Choisy	BRY-C 38838	-	6%	-	-	SO_2
Hypogymnia austerodes (Nyl.) Räsänen	BRY-C 26831	31%	-	-	-	
Hypogymnia bitteri (Lynge) Ahti	BRY-C 35750b	3%	-	-	-	
Hypogymnia physodes* (L.) Nyl.	BRY-C 31759	3%	-	-	-	SO_2
Hypotrachyna pseudosinuosa (Asahina) Hale	BRY-C 32436	-	-	14%	-	
Imshaugia aleurites* (Ach.) S.F. Meyer	BRY-C 32412	-	-	14%	-	SO_2

Imshaugia placorodia (Ach.) S. F. Meyer	BRY-C 30999	6%	-	86%	-	
Lasallia papulosa (Ach.) Llano	BRY-C 31706	9%	-	14%	-	
Lasallia pustulata (L.) Mérat	Not collected	3%	-	-	-	
Lecanora albellula Nyl.	BRY-C 21611	-	6%	-	7%	
Lecanora argentata (Ach.) Malme	BRY-C 32424	-	-	14%	-	
Lecanora argopholis (Ach.) Ach.	BRY-C 26798	38%	67%	43%	27%	
Lecanora bicincta Ramond	BRY-C 26771	22%	-	-	7%	
Lecanora caesiorubella Ach.	BRY-C 32242	-	-	14%	-	
Lecanora caesiorubella ssp. saximontana Imshaug & Brodo	BRY-C 38510	-	17%	-	-	
Lecanora carpinea* (L.) Vainio	BRY-C 31059	16%	-	-	-	SO_2
Lecanora cenisia Ach.	BRY-C 26730	25%	39%	14%	13%	
Lecanora chlarotera* Nyl.	BRY-C 32057	3%	-	-	-	SO_2
Lecanora crenulata* Hooker	BRY-C 36423	9%	22%	-	27%	SO_2
Lecanora dispersa (Pers.) Sommerf.	BRY-C 35641	3%	6%	-	7%	
Lecanora garovaglii (Körber) Zahlbr.	BRY-C 26921	34%	28%	-	33%	
Lecanora hagenii (Ach.) Ach.	BRY-C 26842	28%	28%	-	40%	
Lecanora impudens Degel.	BRY-C 29088	19%	-	-	-	
Lecanora meridionalis H. Magn.	BRY-C 29209	31%	6%	-	-	
Lecanora mughicola Nyl.	BRY-C 29279	9%	-	-	7%	
Lecanora muralis* (Schreber) Rabenh.	BRY-C 31032	28%	50%	86%	47%	SO_2
Lecanora novomexicana H. Magn.	BRY-C 26766	53%	22%	-	27%	
Lecanora phaedrophthalma Poelt	BRY-C 26924	19%	18%	14%	20%	
Lecanora polytropa (Hoffm.) Rabenh.	BRY-C 26747	34%	-	-	20%	
Lecanora rupicola (L.) Zahlbr.	BRY-C 26775	25%	-	-	7%	
Lecanora saligna* (Schrader) Zahlbr.	BRY-C 26285	38%	6%	14%	33%	SO_2
Lecanora thallophila H. Magn.	BRY-C 31004	3%	22%	-	-	
Lecanora valesiaca (Müll. Arg.) Stizenb.	BRY-C 26906	13%	6%	29%	7%	
Lecanora varia (Hoffm.) Ach.	BRY-C 29278	19%	-	-	40%	
Lecidea atrobrunnea (Lam. & DC.) Schaerer	BRY-C 26692	25%	33%	-	60%	
Lecidea lapicida (Ach.) Ach.	BRY-C 35366	3%	-	-	-	
Lecidea leucothallina Arnold	BRY-C 26693	9%	3%	-	7%	
Lecidea plana (J. Lahm) Nyl.	BRY-C 32696	-	-	-	7%	
Lecidea syncarpa Zahlbr.	BRY-C 35369	3%	-	-	-	
Lecidea tessellata Flörke	BRY-C 26732	75%	72%	43%	80%	
Lecidella carpathica Körber	BRY-C 32727	-	-	-	7%	
Lecidella euphorea (Flörke) Hertel	BRY-C 29328	25%	28%	57%	13%	
Lecidella stigmatea (Ach.) Hertel & Leuckert	BRY-C 26695	72%	39%	71%	33%	
Lecidella viridans (Flotow) Körber	BRY-C 26783	9%	-	14%	-	
Lecidoma demissum (Rutstr.) Gotth. Schneider & Hertel	BRY-C 31666	3%	-	-	-	

Lepraria diffusa (J. R. Laundon) Kukwa *var. diffusa*	BRY-C 32062	3%	-	-	-	
Lepraria incana (L.) Ach.	BRY-C 31580	3%	-	-	-	
Leprocaulon albicans (Th. Fr.) Nyl. ex Hue	BRY-C 32193	-	-	29%	-	
Leptogium arsenei Sierk	BRY-C 31682	3%	-	43%	-	
Leptogium denticulatum Nyl.	BRY-C 32026	3%	-	43%	-	
Leptogium gelatinosum (With.) J. R. Laundon	BRY-C 35694	3%	-	-	7%	
Leptogium hirsutum Sierk	BRY-C 32033	3%	-	14%	-	
Leptogium intermedium (Arnold) Arnold	BRY-C 37378	-	6%	-	-	
Leptogium lichenoides (L.) Zahlbr.	BRY-C 31034	16%	-	-	-	
Leptogium pseudofurfuraceum (L.) Zahlbr.	BRY-C 29091	6%	-	71%	-	
Leptogium saturninum* (Dickson) Nyl.	BRY-C 26666	25%	6%	-	-	SO_2
Leptogium tenuissimum (Dickson) Körber	BRY-C 36501	3%	-	-	-	
Leptogium teretiusculum (Wallr.) Arnold	BRY-C 35406	3%	-	-	-	
Lichinella nigritella (Lettau) P. P. Moreno & Egea	BRY-C 31140	3%	-	14%	-	
Lobothallia alphoplaca (Wahlenb.) Hafellner	BRY-C 26767	53%	39%	14%	27%	
Lobothallia praeradiosa (Nyl.) Hafellner	Not collected	6%	-	-	-	
Lobothallia radiosa (Hoffm.) Hafellner	BRY-C 31648	3%	-	-	-	
Megaspora verrucosa (Ach.) Hafellner & V. Wirth	BRY-C 26863	22%	28%	71%	7%	
Melanelia panniformis (Nyl.) Essl.	BRY-C 35267	3%	-	-	-	
Melanelia sorediata (Ach.) Goward & Ahti	BRY-C33393	9%	-	-	-	
Melanelia stygia (L.) Essl.	BRY-C 35677b	3%	-	14%	-	
Melanelia tominii (Oxner) Essl.	BRY-C 29163	22%	22%	-	13%	
Melanelixia fuliginosa* (Fr. ex Duby) O. Blanco et al.	BRY-C 32098	6%	-	-	-	SO_2
Melanelixia subargentifera* (Nyl.) O. Blanco et al.	BRY-C 31696	13%	-	-	-	SO_2
Melanelixia subaurifera (Nyl.) O. Blanco et al.	BRY-C 33403	3%	-	-	-	
Melanohalea elegantula (Zahlbr.) O. Blanco et al.	BRY-C 26856	41%	39%	-	60%	
Melanohalea exasperatula* (De Not.) O. Blanco et al.	BRY-C 26827	63%	33%	-	33%	SO_2
Melanohalea subelegantula* (Essl.) O. Blanco et al.	BRY-C 33360	6%	17%	-	-	SO_2
Melanohalea subolivacea* (Nyl.) O. Blanco et al.	BRY-C 26869	69%	33%	100%	67%	SO_2, O_3
Micarea lignaria (Ach.) Hedl.	BRY-C 29381	3%	-	-	-	
Mycobilimbia berengeriana (A. Massal.) Hafellner & V. Wirth	BRY-C 31178	9%	-	-	7%	
Mycocalicium subtile (Pers.) Szatala	BRY-C 29281	6%	-	-	-	
Nephroma bellum (Sprengel) Tuck.	BRY-C 32063	3%	-	-	-	
Nephroma helveticum Ach. *subsp. helveticum*	BRY-C 35957	3%	-	-	-	

Nephroma laevigatum Ach.	BRY-C 31129	3%	-	-	-	
Nephroma parile (Ach.) Ach.	BRY-C 29315	28%	-	14%	-	
Normandina pulchella* (Borrer) Nyl.	BRY-C 35689a	3%	-	-	-	SO_2
Ochrolechia androgyna* (Hoffm.) Arnold	BRY-C 31071	16%	-	-	-	SO_2
Ochrolechia upsaliensis (L.) A. Massal.	BRY-C 31594	9%	-	-	-	
Omphalora arizonica (Tuck. ex Willey) T. H. Nash & Hafellner	BRY-C 35804	3%	-	-	-	
Pannaria tavaresii P. M. Jørg.	BRY-C 31674	13%	-	-	-	
Parmelia saxatilis* (L.) Ach.	BRY-C 33416	3%	-	-	-	SO_2
Parmelia sulcata* Taylor	BRY-C 29068	31%	-	29%	-	SO_2, O_3, Fluoride
Parmelinopsis minarum (Vainio) Elix & Hale	BRY-C 31715	3%	-	-	-	
Parmeliopsis ambigua* (Wulfen) Nyl.	BRY-C 26671	25%	-	14%	-	SO_2
Parmeliopsis hyperopta* (Ach.) Arnold	BRY-C 26672	16%	-	-	-	SO_2
Parmotrema reticulatum(Taylor) M. Choisy	BRY-C 35696	3%	-	43%	-	
Parmotrema subtinctorium (Zahlbr.) Hale	BRY-C 32515	-	-	14%	-	
Parmotrema ultralucens (Krog) Hale	BRY-C 32465	-	-	14%	-	
Peccania arizonica Tuck. ex Herre	BRY-C 29165	3%	6%	-	-	
Peccania subnigra (B. de Lesd.) Wetmore	BRY-C 38761	-	6%	-	-	
Peltigera aphthosa* (L.) Willd.	BRY-C 26753	22%	-	-	7%	SO_2
Peltigera canina* (L.) Willd.	BRY-C 26667	47%	17%	14%	13%	O_3
Peltigera collina* (Ach.) Schrader	BRY-C 32281	-	-	14%	-	O_3
Peltigera didactyla* (With.) J. R. Laundon	BRY-C 35931	3%	-	-	-	O_3
Peltigera malacea (Ach.) Funck	BRY-C 35284	3%	-	-	-	
Peltigera neckeri Hepp ex Müll. Arg.	BRY-C 30975	13%	-	-	-	
Peltigera polydactylon (Necker) Hoffm.	BRY-C 26687	25%	-	14%	-	
Peltigera praetextata (Flörke ex Sommerf.) Zopf	BRY-C 31076	9%	11%	-	-	
Peltigera rufescens* (Weiss) Humb.	BRY-C 26670	50%	28%	-	27%	O_3
Peltigera venosa (L.) Hoffm.	BRY-C 26809	13%	-	14%	7%	
Peltula euploca (Ach.) Poelt	BRY-C 32194	-	-	29%	-	
Peltula obscurans var. hassei (Zahlbr.) Wetmore	BRY-C 34841	3%	-	-	-	
Pertusaria saximontana Wetmore	BRY-C 31855	3%	6%	29%	-	
Pertusaria wulfenioides B. de Lesd.	BRY-C 32413	-	-	29%	-	
Phaeophyscia ciliata (Hoffm.) Moberg	BRY-C 31569	22%	-	14%	-	
Phaeophyscia constipata (Norrlin & Nyl.) Moberg	BRY-C 32091	9%	-	-	-	
Phaeophyscia decolor (Kashiw.) Essl.	BRY-C 34990	9%	11%	-	7%	
Phaeophyscia endococcina (Körber) Moberg	BRY-C 26697	16%	-	-	7%	

Phaeophyscia endococcinodes (Poelt) Essl.	BRY-C 32526	-	-	14%	-	
Phaeophyscia hirsuta (Mereschk.) Essl.	BRY-C 26838	6%	-	14%	-	
Phaeophyscia hirtella Essl.	BRY-C 31238	-	-	71%	-	
Phaeophyscia hispidula (Ach.) Essl.	BRY-C 31773	9%	-	43%	-	
Phaeophyscia kairamoi (Vainio) Moberg	BRY-C 35264	6%	-	-	-	
Phaeophyscia nigricans* (Flörke) Moberg	BRY-C 26874	9%	-	-	7%	SO_2
Phaeophyscia orbicularis* (Necker) Moberg	BRY-C 26847	16%	-	43%	7%	O_3, SO_2, Fluoride
Phaeophyscia sciastra* (Ach.) Moberg	BRY-C 26846	19%	11%	-	7%	O_3
Phaeorrhiza nimbosa (Fr.) H. Mayrhofer & Poelt	BRY-C 29298	9%	-	-	-	
Phaeorrhiza sareptana (Tomin) H. Mayrhofer & Poelt	BRY-C 29297	6%	-	-	-	
Physcia adscendens* (Fr.) H. Olivier	BRY-C 26835	44%	11%	-	53%	SO_2, Fluoride
Physcia aipolia* (Ehrh. ex Humb.) Fürnr.	BRY-C 26680	22%	-	29%	7%	SO_2, Fluoride
Physcia albinea (Ach.) Nyl.	BRY-C 33408	9%	-	57%	-	
Physcia biziana (A. Massal.) Zahlbr.	BRY-C 31564	3%	11%	-	7%	
Physcia caesia* (Hoffm.) Fürnr.	BRY-C 26797	44%	22%	57%	60%	SO_2
Physcia dimidiate (Arnold) Nyl.	BRY-C 37473	-	22%	-	-	
Physcia dubia* (Hoffm.) Lettau	BRY-C 26777	47%	78%	43%	60%	Fluoride
Physcia magnussonii Frey	BRY-C 35767	3%	-	-	7%	
Physcia phaea (Tuck.) J. W. Thomson	BRY-C 32095	3%	-	43%	-	
Physcia sorediosa (Vainio) Lynge	BRY-C 32392	-	-	14%	-	
Physcia stellaris* (L.) Nyl.	BRY-C 26844	56%	33%	71%	67%	SO_2
Physciella chloantha (Ach.) Essl.	BRY-C 34940	9%	17%	14%	13%	
Physciella nepalensis (Poelt) Essl.	BRY-C 35463	3%	6%	-	-	
Physconia detersa* (Nyl.) Poelt	BRY-C 32055a	3%	-	-	13%	SO_2
Physconia enteroxantha (Nyl.) Poelt	BRY-C 29158	19%	-	-	13%	
Physconia isidiigera (Zahlbr.) Essl.	BRY-C 31735	6%	17%	-	7%	
Physconia muscigena (Ach.) Poelt	BRY-C 29300	22%	33%	-	-	
Physconia perisidiosa* (Erichsen) Moberg	BRY-C 29196	16%	6%	-	-	SO_2
Placidium acarosporoides (Zahlbr.) Breuss	BRY-C 38398	-	6%	-	7%	
Placidium arboretum (Schwein. *ex* Michener) Lendemer	BRY-C 27053	-	11%	-	7%	
Placidium squamulosum (Ach.) Breuss	BRY-C 29065	22%	72%	-	33%	
Placopyrenium stanfordii (Herre) K. Knudsen	BRY-C 26894	6%	32%	-	20%	
Placynthium asperellum (Ach.) Trevisan	BRY-C 35599	3%	-	-	-	
Placynthium nigrum (Hudson) Gray	BRY-C 31019	3%	-	-	-	
Platismatia glauca* (L.) W. L. Culb.. & C. F. Culb.	BRY-C 29346	3%	-	-	-	O_3, SO_2
Pleopsidium chlorophanum* (Wahlenb.) Zopf	BRY-C 29242	16%	-	-	-	SO_2

Pleopsidium flavum* (Bellardi) Körber	BRY-C 33325	13%	6%	14%	-	SO_2
Polysporina simplex (Davies) Vězda	BRY-C 38464	-	17%	-	-	
Protopannaria pezizoides (Weber) P. M. Jørg. & S. Ekman	BRY-C 26833	13%	-	-	-	
Protoparmelia badia (Hoffm.) Hafellner	BRY-C 30942	16%	-	-	7%	
Pseudephebe minuscula* (Nyl. ex Arnold) Brodo & D. Hawksw	BRY-C 30941	6%	-	-	-	O_3
Pseudephebe pubescens* (L.) M. Choisy	BRY-C 29331	6%	-	-	-	O_3
Pseudevernia intensa (Nyl.) Hale & W. L. Culb..	BRY-C 26677	31%	-	29%	-	
Pseudoparmelia uleana (Müll. Arg.) Elix & T. H. Nash	BRY-C 32435	-	-	14%	-	
Psora cerebriformis W. A. Weber	BRY-C 34837	9%	78%	-	7%	
Psora decipiens (Hedwig) Hoffm.	BRY-C 31665	6%	39%	-	7%	
Psora globifera (Ach.) A. Massal.	BRY-C 29314	9%	17%	29%	13%	
Psora himalayana (Church. Bab.) Timdal	BRY-C 29232	9%	28%	-	-	
Psora luridella (Tuck.) Fink	BRY-C 29233	3%	6%	-	13%	
Psora nipponica (Zahlbr.) Gotth. Schneider	BRY-C 31106	19%	11%	14%	7%	
Psora rubiformis (Ach.) Hooker	BRY-C 30940	3%	-	-	-	
Psora tuckermanii R. A. Anderson ex Timdal	BRY-C 26876	34%	83%	14%	40%	
Psoroma hypnorum (Vahl) Gray	BRY-C 26752	38%	-	-	7%	
Punctelia graminicola (B. de Lesd.) Egan	BRY-C 31217	-	-	43%	-	
Punctelia hypoleucites (Nyl.) Krog	BRY-C 35923	3%	-	57%	-	
Punctelia stictica (Duby) Krog	BRY-C 35925	3%	-	-	-	
Ramalina intermedia (Delise ex Nyl.) Nyl.	BRY-C 32196	-	-	29%	-	
Ramalina obtusata (Arnold) Bitter	BRY-C 35743	3%	-	-	-	
Ramalina sinensis Jatta	BRY-C 26682	41%	-	-	27%	
Ramboldia elabens (Fr.) Kantvilas & Elix	BRY-C 32138	-	-	-	7%	
Rhizocarpon disporum (Nägeli ex Hepp) Müll. Arg.	BRY-C 26745	47%	17%	57%	33%	
Rhizocarpon geminatum Körber	BRY-C 38425	-	6%	-	-	
Rhizocarpon geographicum* (L.) DC.	BRY-C 26691	50%	6%	-	20%	Fluoride
Rhizocarpon macrosporum Räsänen	BRY-C 26696	16%	-	-	-	
Rhizocarpon superficiale (Schaerer) Vainio	BRY-C 32773	-	6%	-	7%	
Rhizoplaca chrysoleuca* (Sm.) Zopf	BRY-C 26934	50%	22%	29%	13%	SO_2, NO_x/PAN
Rhizoplaca melanophthalma* (DC.) Leuckert & Poelt	BRY-C 31834	66%	89%	-	53%	SO_2
Rhizoplaca peltata (Ramond) Leuckert & Poelt	BRY-C 34877	9%	67%	-	33%	
Rinodina archaea (Ach.) Arnold	BRY-C 35395	6%	6%	-	-	
Rinodina calcigena (Th. Fr.) Lynge	BRY-C 38431	-	6%	-	-	
Rinodina castanomela (Nyl.) Arnold	BRY-C 34527	-	-	-	7%	

Rinodina milvina (Wahlenb.) Th. Fr.	BRY-C 31683	3%	-	-	-	
Rinodina mniaraea (Ach.) Körber	BRY-C 31574	3%	-	-	-	
Rinodina turfacea (Wahlenb.) Körber	BRY-C 29334	6%	-	-	-	
Sarcogyne dakotensis H. Magn.	BRY-C 32102	-	-	-	7%	
Sarcogyne regularis Körber	BRY-C 31027	3%	6%	-	7%	
Seirophora contortuplicata (Ach.) Fröden	BRY-C 35774	3%	33%	-	-	
Solorina bispora Nyl.	BRY-C 31669	3%	-	-	-	
Solorina octospora (Arnold) Arnold	BRY-C 29282	3%	-	-	-	
Solorina spongiosa (Ach.) Anzi	BRY-C 29283	3%	-	-	-	
Spilonema revertens Nyl.	BRY-C 32028	3%	-	-	-	
Sporastatia testudinea (Ach.) A. Massal.	BRY-C 26774	9%	-	-	-	
Squamarina lentigera (Weber) Poelt	BRY-C 34842	3%	28%	-	7%	
Staurothele areolata (Ach.) Lettau	BRY-C 31544	25%	50%	14%	7%	
Staurothele drummondii (Tuck.) Tuck.	BRY-C 29133	22%	28%	14%	40%	
Staurothele elenkinii Oxner	BRY-C 37477	-	6%	-	13%	
Staurothele fissa (Taylor) Zwackh	BRY-C 31150	6%	-	-	-	
Staurothele monicae(Zahlbr.) Wetmore	BRY-C 38433	-	11%	-	-	
Stereocaulon rivulorum H. Magn.	BRY-C 31605	3%	-	-	-	
Stereocaulon tomentosum Fr.	BRY-C 35240	3%	-	-	-	
Sticta sylvatica (Hudson) Ach.	BRY-C 31220	-	-	14%	-	
Tephromela atra (Hudson) Hafellner	BRY-C 32603	-	-	57%	7%	
Tetramelas papillatus (Sommerf.) Kalb	BRY-C 31634	3%	-	-	-	
Thamnolia subuliformis (Ehrh.) W. L. Culb..	BRY-C 31585	3%	-	-	-	
Thyrea confusa Henssen	BRY-C 32087	9%	28%	-	-	
Toninia candida (Weber) Th. Fr.	BRY-C 31086	3%	6%	-	7%	
Toninia philippea (Mont.) Timdal	BRY-C 38768	-	6%	-	-	
Toninia ruginosa (Tuck.) Herre	BRY-C 21811	-	11%	-	-	
Toninia sedifolia (Scop.) Timdal	BRY-C 34836	3%	72%	-	7%	
Toninia tristis (Th. Fr.) Th. Fr.	BRY-C 26076	-	22%	-	7%	
Trapeliopsis granulosa (Hoffm.) Lumbsch	BRY-C 26674	9%	-	14%	-	
Tremolecia atrata (Ach.) Hertel	BRY-C 29338	3%	-	-	-	
Tuckermanella coralligera (W. A. Weber) Essl.	BRY-C 29154	9%	-	71%	-	
Tuckermanella fendleri (Nyl.) Essl.	BRY-C 36460	3%	-	86%	-	
Tuckermannopsis subalpina (Imshaug) Kärnefelt	BRY-C 29335	3%	-	-	-	
Umbilicaria americana Poelt & T. H. Nash	BRY-C 29333	9%	-	14%	-	
Umbilicaria decussata (Vill.) Zahlbr.	BRY-C 31660	3%	-	-	-	
Umbilicaria deusta (L.) Baumg.	BRY-C 33384	3%	-	-	-	
Umbilicaria hyperborea (Ach.) Hoffm.	BRY-C 26780	38%	-	-	-	

Umbilicaria krascheninnikovii (Savicz) Zahlbr.	BRY-C 29323	13%	-	-	-	
Umbilicaria lyngei Schol.	BRY-C 29317	3%	-	-	-	
Umbilicaria torrefacta (Lightf.) Schrader	BRY-C 35876	13%	-	-	-	
Umbilicaria vellea (L.) Hoffm.	BRY-C 29316	6%	-	-	-	
Umbilicaria virginis Schaerer	BRY-C 26772	22%	11%	-	7%	
Usnea amblyoclada (Müll. Arg.) Zahlbr.	BRY-C 31219	-	-	43%	-	
Usnea cavernosa Tuck.	BRY-C 26689	41%	-	-	-	
Usnea cirrosa Motyka	BRY-C 29367	16%	-	43%	-	
Usnea hirta* (L.) F. H. Wigg.	BRY-C 31851	59%	17%	100%	7%	SO_2
Usnea subfloridana* Stirton	BRY-C 31064	78%	6%	-	7%	SO_2
Vahliella leucophaea (Vahl) P. M. Jørg.	BRY-C 29326	9%	-	-	-	
Verrucaria compacta (A. Massal.) Jatta	BRY-C 32108	-	-	-	7%	
Verrucaria hydrela Ach.	BRY-C 32562	-	-	14%	-	
Verrucaria viridula (Schrader) Ach.	BRY-C 21505	-	6%	-	-	
Vulpicida pinastri* (Scop.) J.-E. Mattsson & M. J. Lai	BRY-C 26688	28%	-	14%	-	SO_2
Xanthomendoza fallax* (Hepp ex Arnold) Søchting, Kärnefelt & S. Kondr.	BRY-C 26848	34%	39%	71%	47%	SO_2, NO_x/PAN
Xanthoparmelia atticoides (Essl.) Crespo, O. Blanco, A. Crespo, Elix, D. Hawksw. & Lumbsch	BRY-C 32393	-	-	29%	-	
Xanthoparmelia brunella (Essl.) Crespo, O. Blanco, A. Crespo, Elix, D. Hawksw. & Lumbsch	BRY-C 32211	-	-	14%	-	
Xanthoparmelia chlorochroa (Tuck.) Hale	BRY-C 32085	13%	11%	-	-	
Xanthoparmelia coloradoënsis (Gyelnik) Hale	BRY-C 31876	44%	-	43%	13%	
Xanthoparmelia cumberlandia* (Gyelnik) Hale	BRY-C 26668	78%	6%	100%	20%	SO_2
Xanthoparmelia lineola (E. C. Berry) Hale	BRY-C 32265	-	-	14%	-	
Xanthoparmelia mexicana (Gyelnik) Hale	BRY-C 34873	6%	6%	-	7%	
Xanthoparmelia novomexicana (Gyelnik) Hale	BRY-C 35919	3%	-		-	
Xanthoparmelia occidentalis (Essl.) Crespo, O. Blanco, A. Crespo, Elix, D. Hawksw. & Lumbsch	BRY-C 33310	3%	-	14%	-	
Xanthoparmelia plittii (Gyelnk) Hale	BRY-C 29149	28%	39%	29%	13%	
Xanthoparmelia pustulosa (Essl.) Crespo, O. Blanco, A. Crespo, Elix, D. Hawksw. & Lumbsch	BRY-C 38458	-	11%	-	-	
Xanthoparmelia subdecipiens (Vainio) Hale	BRY-C 32264	-	-	29%	-	
Xanthoparmelia subhosseana (Essl.) Crespo, O. Blanco, A. Crespo, Elix, D. Hawksw. & Lumbsch	BRY-C 32334	-	-	29%	-	
Xanthoparmelia wyomingica (Gyelnik) Hale	BRY-C 29390	9%	-	14%	-	
Xanthoria candelaria* (L.) Th. Fr.	BRY-C 35412	3%	17%	14%	27%	SO_2, O_3
Xanthoria elegans* (Link) Th. Fr.	BRY-C 31829	63%	78%	-	67%	SO_2

Xanthoria polycarpa* (Hoffm.) Th. Fr. ex Rieber	BRY-C 26828	81%	50%	71%	100%	SO_2
Xanthoria sorediata (Vainio) Poelt	BRY-C 26778	16%	22%	-	7%	
Xylographa parallela (Ach. : Fr.) Behlen & Desberger	BRY-C 38885	-	6%	-	7%	
Total		313	163	138	140	

Bolded names with an asterisk document air pollution sensitive species
Underlined names represent a rare occurrence for this species

Table 2: Total number and percent of air pollution sensitive species by study area

Study Area	Total number of air pollution sensitive species	Percentage of total species
San Juan Rio Grande National Forest	62	20
Dinosaur National Monument	36	21
Gila Wilderness Area	28	20
Manti La Sal National Forest	33	23