

FINAL REPORT SUBMITTED

**TO
LORI D. CLARK**

REGARDING

**THE RE-INVENTORY OF THE LICHEN BIOMONITORING PROGRAM AND
BASELINE
FOR**

**SELECTED SITES IN THE ANADCONDA-PINTLER, CABINET MOUNTAINS, AND
SELWAY BITTERROOT WILDERNESS AREAS, MONTANA AND IDAHO
(ORIGINALLY COLLECTED IN JULY-AUGUST 1992, 1993, and 1994)**

AND

**ESTABLISHMENT OF LICHEN BIOMONITORING PROGRAMS AND BASELINES
IN THE GATES OF THE MOUNTAINS, MISSION MOUNTAINS, AND BOB
MARSHALL WILDERNESS AREAS, MONTANA**

SUBMITTED BY

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INTRODUCTION

In accordance with the objectives of our research proposal we are submitting this interim report summarizing our efforts to date concerning the re-evaluation of the lichen air quality biomonitoring baseline in the Anaconda-Pintler, Selway Bitterroot, and Cabinet Mountains wilderness areas in western Montana. This report also contains preliminary information concerning the establishment of a lichen air quality biomonitoring baseline and program in the Gates of the Mountains Wilderness Area. The information in this report is based on our 2000 - 2003 summer field collections. Included is a detailed location description for each reference site, as well as a list of the sensitive indicator species collected for elemental analysis from each reference site. A total of 111 elemental analysis samples have been collected from the Anaconda Pintler (18), Cabinet Mountains (6), Selway Bitterroot (45), Gates of the Mountains (7), Mission Mountains (9), Bob Marshall (28) wilderness areas. The sites in the Anaconda Pintler and Cabinet Mountains wilderness areas were originally collected during the summer of 1992 and the sites in the Selway Bitterroot Wilderness Area were collected over three summers (1992,1993,and 1994). The summer 2000 - 2002 collections represent the first evaluation of the baseline in the Anaconda Pintler, Selway Bitterroot, and Cabinet Mountains wilderness areas since they were originally established. Data from the Gates of the Mountains, Mission Mountains, and Bob Marshall wilderness areas represent a major extension of the original lichen air quality biomonitoring baseline and program. The final report will compare elemental analysis data from both the baseline samples (1992, 1993, and 1994) and the reevaluation samples (2000 - 2002). The final report will also include a general reevaluation of the air quality biomonitoring baseline. The final report will also include all of the baseline information for the new sites (Gates of the Mountains, Mission Mountains, and Bob Marshall wilderness areas).

METHODS

COLLECTION OF SENSITIVE INDICATOR SPECIES FOR ELEMENTAL

ANALYSES: All elemental analysis samples were collected using a ceramic knife to avoid metal contamination. At each reference site sufficient material of 1-3 sensitive indicator species was collected for elemental analyses (3-6 grams dry weight). All elemental analysis material was air dried and placed in Nasco sterile plastic bags (to avoid contamination) and transported back to the BYU Herbarium of Nonvascular Cryptogams. Excess material is permanently stored in Nasco sterile plastic bags in the Archival Collection of Elemental Analysis Samples at the BYU Herbarium of Nonvascular Cryptogams. This material is available for additional testing upon request.

DETERMINATION OF POLLUTANT ELEMENT CONCENTRATIONS IN TISSUES OF SENSITIVE INDICATOR SPECIES:

In the herbarium, surface debris and substrate material were removed from all elemental analysis samples. Clean one gram samples of at least one sensitive indicator species from each reference site were then delivered to the Elemental Analysis Laboratory at Brigham Young University.

Samples were prepared for PIXE analysis using the methods of Duflou et al. (1987). Samples were placed in Teflon containers with a Teflon coated steel ball, cooled to liquid nitrogen temperature, powdered by brittle fracture techniques using a Braun Mikro-

Dismemberator II, and then dried in an Imperial IV Microprocessor Oven for 14 hours at 80° C. Sub-samples weighing 150 mg were then placed in Teflon containers and spiked with 1 ml of a 360 ppm Yttrium solution. The samples were then oven dried again for 14 hours at 80° C. Samples were then homogenized using the Mikro-Dismemberator. Approximately 1 mg of powdered lichen tissue was then carefully weighed out onto a thin polycarbonate film in an area of 0.5 cm². A 1.5% solution of polystyrene in toluene was used to secure the sample to the film.

Samples were analyzed using a 2 MV Van de Graaff accelerator with a 2.28 MeV proton beam which passed through a 1.1 mg/cm² pyrolytic graphite diffuser foil. The proton beam was collimated to irradiate an area of 0.38 cm² on the sample. Typically, 10-100 nA proton beam currents were used. X-rays were detected using a Tracor X-ray Spectrometer (model TX-3/48-206) with a 10 mm² by 3 mm thick Si(Li) detector positioned at 90° to the proton beam. Samples were analyzed twice using different X-ray absorbers between the samples and the detector. One was a 49 mg/cm² Mylar absorber with a 0.27 mm² pinhole (2.8% of detector area) backed with a 8.5 mg/cm² Beryllium foil. A 98 mg/cm² Mylar absorber was also used.

To insure adequate quality control, samples of NIST SRM 1571 orchard leaves and other standards were prepared and analyzed using the same protocol.

RESULTS

REFERENCE SITES: During the summer of 1992 a total of 10 reference sites were established in or near the Anaconda Pintler Wilderness Area along with three sites in the Cabinet Mountains Wilderness Area. In addition, 16 reference sites were established in or near the Selway Bitterroot Wilderness Area during the summers of 1992, 1993, and 1994. Baseline sensitive indicator species samples were collected and analyzed from each reference site. The original reference sites were recollected during the summers of 2000 - 2002 in order to detect any changes in the pollutant element loads in the tissues of sensitive indicator species from the respective wilderness areas. In addition, during the summers of 2000 - 2003 three baseline reference sites were established in or near the Gates of the Mountains Wilderness Area; four in or near the Mission Mountains Wilderness Area, and 12 in or near the Bob Marshall wilderness areas. Specifically, over the course of this study (1992-1994 and 2000-2003) collections have been made at the following locations:

Reference sites re-collected in or near the Anaconda Pintler Wilderness Area:

Site No. 1: 19 July 2000 (originally collected: 25 July 1992). Montana, Ravalli County, Anaconda Pintler Wilderness Area, vicinity of McCart Lookout; GPS reading: 45E 53.081! north latitude, 113E 43.004! west longitude; elevation: 7115 feet (2169 m). Elemental analysis material collected: *Letharia vulpina* (from Lodgepole Pine) and *Rhizoplaca melanophthalma* (from rock). Collectors: Larry L. St. Clair and Samuel B. St. Clair. Herbarium Numbers: BRY c-38120.

Site No. 2: 19 July 2000 (originally collected 25 July 1992). Montana, Ravalli County, Anaconda Pintler Wilderness Area, along East Fork of the Bitterroot River (U.S. Forest Service Trail No. 433); GPS reading: 45E 54.468! north latitude,

113E 42.024! west longitude; elevation: 5500 feet (1676 m). Elemental analysis material collected: *Letharia vulpina* (from Douglas Fir). Collectors: Larry L. St. Clair and Samuel B. St. Clair. Herbarium Numbers: none.

Site No. 3: 20 July 2000 (originally collected 27 July 1992). Montana, Deerlodge County, Anaconda Pintler Wilderness Area, Pintler Creek Trailhead (along U.S. Forest Service Trail No. 37); GPS reading: 45E 51.737! north latitude, 113E 26.367! west longitude; elevation: 6400 feet (1951 m). Elemental analysis material collected: *Letharia vulpina* (from Douglas Fir), *Umbilicaria americana* (from rock), and *Rhizoplaca melanophthalma* (from rock). Collectors: Larry L. St. Clair and Samuel B. St. Clair. Herbarium Numbers: none.

Site No. 4: 20 July 2000 (originally collected 28 July 1992). Montana, Deerlodge County, Mt. Haggin Wildlife Management Area, along U.S. Forest Service Road No. 2483; GPS reading: 45E 59.847! north latitude, 113E 02.971! west longitude; elevation: 6400 feet (1951 m). Elemental analysis material collected: *Letharia vulpina* (from deadwood). Collectors: Larry L. St. Clair and Samuel B. St. Clair. Herbarium Numbers: BRY C-38124-38125.

Site No. 5: 20 July 2000 (originally collected 28 July 1992). Montana, Deerlodge County, Beaverhead National Forest, at Tenmile Creek Crossing along U.S. Forest Service Road No. 2483; GPS reading: 46E 00.043! north latitude, 113E 03.956! west longitude; elevation: 6600 feet (2012 m). Elemental analysis material collected: *Letharia vulpina* (from deadwood). Collectors: Larry L. St. Clair and Samuel B. St. Clair. Herbarium Numbers: BRY C-38121-38123.

Site No. 6: 20 July 2000 (originally collected 28 July 1992). Montana, Deerlodge County, Mt. Haggin Wildlife Management Area, along Cabbage Gulch, about 1.5 km from SR 274; GPS reading: 46E 04.150! north latitude, 112E 55.018! west longitude; elevation: 5700 feet (1737 m). Elemental analysis material collected: none available. Collectors: Larry L. St. Clair and Samuel B. St. Clair. Herbarium Numbers: none.

Site No. 7: 20 July 2000 (originally collected 28 July 1992). Montana, Deerlodge County, private property, about 16 km southwest of SR 1, along SR 274, basalt dike, in rocky area above SR 274; GPS reading: 46E 03.387! north latitude, 112E 58.925! west longitude; elevation: 6300 feet (1920 m). Elemental analysis material collected: *Rhizoplaca melanophthalma* (from rock). Collectors: Larry L. St. Clair and Samuel B. St. Clair. Herbarium Numbers: none.

Site No. 8: 21 July 2000 (originally collected 30 July 1992). Montana, Granite County, Anaconda Pintler Wilderness Area, Goat Flat; GPS reading: 46E 03.256! north latitude, 113E 16.580! west longitude; elevation: 9400 feet (2865 m). Elemental analysis material collected: *Letharia vulpina* (from branches of

Potentilla sp.), *Flavocetraria nivalis* (from alpine sod), and *Rhizoplaca melanophthalma* (from rock). Note: an additional elemental analysis collection (site 8a) was made along U.S. Forest Service Trail No. 41, in a hanging valley below Storm Lake Pass and above and south of Storm Lake, *Letharia vulpina* (from Engelman Spruce). Collectors: Larry L. St. Clair and Samuel B. St. Clair. Herbarium Numbers: BRY C-38126-38130.

Site No. 9: 21 July 2000 (originally collected 31 July 1992). Montana, Granite County, Anaconda Pintler Wilderness Area, Middle Fork of Rock Creek Trailhead (along U.S. Forest Service Trail No. 28); GPS reading: 45E 59.213! north latitude, 113E 31.808! west longitude; elevation: 6640 feet (2024 m). Elemental analysis material collected: *Letharia vulpina* (from conifer lignum), *Alectoria sarmentosa* (from conifer lignum). Collectors: Larry L. St. Clair and Samuel B. St. Clair. Herbarium Numbers: none.

Site No. 10: 22 July 2000 (originally collected 29 July 1992). Montana, Deerlodge County, Deerlodge National Forest, Fourmile Basin; GPS reading: 46E 05.680! north latitude, 113E 13.918! west longitude; elevation: 8000 feet (2438 m). Elemental analysis material collected: *Letharia vulpina* (from conifer lignum) and *Rhizoplaca melanophthalma* (from rock). Collectors: Larry L. St. Clair and Samuel B. St. Clair. Herbarium Numbers: none.

Reference sites re-collected in the Cabinet Mountains Wilderness Area:

Site No. 11: 23 July 2000 (originally collected 2 August 1992). Montana, Sanders County, Kootenai National Forest, Cabinet Mountains Wilderness Area, East Fork of the Bull River (along U.S. Forest Service Trail No. 646); GPS reading: 48E 07.322! north latitude, 115E 41.885! west longitude; elevation: 3200 feet (975 m). Elemental analysis material collected: *Lobaria pulmonaria* (from bark of *Thuja plicata*) and *Alectoria sarmentosa* (from bark of *Tsuga heterophylla*). Collectors: Larry L. St. Clair and Samuel B. St. Clair. Herbarium Numbers: BRY C-38131-38133.

Site No. 12: 24 July 2000 (originally collected 3 August 1992). Montana, Sanders County, Kootenai National Forest, Cabinet Mountains Wilderness Area, vicinity of Milwaukee Pass and Chicago Peak; GPS reading: 48E 04.437! north latitude, 115E 41.011! west longitude; elevation: 6600 feet (2012 m). Elemental analysis material collected: *Letharia vulpina* (from conifer bark/wood) and *Umbilicaria americana* (from rock). Collectors: Larry L. St. Clair and Samuel B. St. Clair. Herbarium Numbers: none.

Site No. 13: 24 July 2000 (originally collected 4 August 1992). Montana, Sanders County, Kootenai National Forest, Cabinet Mountains Wilderness Area, along Engel Peak Trail; GPS reading: 48E 00.497! north latitude, 115E 38.801! west longitude; elevation: 6400 feet (1951 m). Elemental analysis material collected: *Letharia vulpina* (from conifer bark/wood) and *Alectoria*

sarmentosa (from conifer bark/wood). Collectors: Larry L. St. Clair and Samuel B. St. Clair. Herbarium Numbers: BRY C-38135.

Reference sites collected in or near the Gates of the Mountains Wilderness Area:

Site No. 14: 26 July 2000 (new collection site). Montana, Lewis and Clark County, Helena National Forest, Gates of the Mountains Wilderness Area, at Meriwether Canyon, along U.S. Forest Service Trail No. 253; GPS reading: 46E 52.151 ! north latitude, 111E 54.017 ! west longitude; elevation: 3800 feet (1158 m). Elemental analysis material collected: *Letharia vulpina* (from Douglas Fir) and *Usnea hirta* (from Douglas Fir). Collectors: Larry L. St. Clair and Samuel B. St. Clair. Herbarium Numbers: BRY C-38136-38187.

Site No. 15: 30 July 2001 (new collection site). Montana, Lewis and Clark County, Helena National Forest, Gates of the Mountains Wilderness Area, at Refrigerator Canyon, along U.S. Forest Service Trail No. 260; GPS reading: 46E 50.891' north latitude, 111E 44.259' west longitude; elevation: 5300 feet (1615 m). Elemental analysis material collected: *Letharia vulpina* (from conifer bark), *Usnea* sp. (from conifer bark), and *Rhizoplaca melanophthalma* (from rock). Collectors: Larry L. St. Clair, Samuel B. St. Clair, and Benjamin D. St. Clair. Herbarium Numbers: BRY C-38958-38998 and 39043-39076.

Site No. 16: 30 July 2001 (new collection site). Montana, Lewis and Clark County, Helena National Forest, Gates of the Mountains Wilderness Area, at Hunter's Gulch, along U.S. Forest Service Trail No. 255; GPS reading: 46E 49.355' north latitude, 111E 48.898' west longitude; elevation: 4200 feet (1280 m). Elemental analysis material collected: *Letharia vulpina* (from conifer lignum) and *Usnea* sp. (from conifer bark). Collectors: Larry L. St. Clair, Samuel B. St. Clair, and Benjamin D. St. Clair. Herbarium Numbers: BRY C-38999-39042.

Reference sites re-collected in or near the Selway Bitterroot Wilderness Area:

Site No. 17: 31 July 2001 (originally collected 27 July 1993). Idaho, Idaho County, Nez Perce National Forest, Selway River, along Race Creek Trail (U.S. Forest Service Trail No. 4); GPS reading: 46E 02.552' north latitude, 115E 16.599' west longitude; elevation: 2460 feet (750 m). Elemental analysis material collected: *Lobaria pulmonaria* (from *Thuja plicata*) and *Alectoria sarmentosa* (from Douglas Fir). Collectors: Larry L. St. Clair, Samuel B. St. Clair, and Benjamin D. St. Clair. Herbarium Numbers: none.

Site No. 18: 31 July 2001 (originally collected 28 July 1993). Idaho, Idaho County, Nez Perce National Forest, vicinity of Indian Hill, along U.S. Forest Service Trail No. 621; GPS reading: 45E 59.252' north latitude, 115E 14.459' west longitude; elevation: 6100 feet (1859 m). Elemental analysis material collected: *Letharia vulpina* (from Douglas Fir), *Alectoria sarmentosa* (from conifer branches), and *Umbilicaria americana* (from rock). Collectors: Larry L. St. Clair, Samuel B. St. Clair, and Benjamin D. St. Clair. Herbarium

Numbers: none. Note: an additional elemental analysis sample was collected 5 miles above the bridge (across the Selway River), along Indian Hill Road (site 18a).

Site No. 19: 31 July 2001 (originally collected 29 July 1993). Idaho, Idaho County, Nez Perce National Forest, vicinity of Fog Mountain saddle, along U.S. Forest Service Trail No. 693; GPS reading: 46E 06.842' north latitude, 115E 12.179' west longitude; elevation: 5900 feet (1798 m). Elemental analysis material collected: *Letharia vulpina* (from Douglas Fir) and *Umbilicaria hyperborea* (from rock). Collectors: Larry L. St. Clair, Samuel B. St. Clair, and Benjamin D. St. Clair. Herbarium Numbers: none.

Site No. 20: 1 August 2001 (originally collected 23 July 1992). Montana, Ravalli County, Bitterroot National Forest, vicinity of Nez Perce Pass; GPS reading: 45E 43.012' north latitude, 114E 30.110' west longitude; elevation: 6600 feet (2012 m). Elemental analysis material collected: *Bryoria fremontii* (from Lodgepole Pine), *Letharia vulpina* (from Douglas Fir), and *Parmelia saxatilis* (from rock; note: this sample (20a) was collected at the Castlerock turnout). Collectors: Larry L. St. Clair, Samuel B. St. Clair, and Benjamin D. St. Clair. Herbarium Numbers: none.

Site No. 21: 1 August 2001 (originally collected 14 July 1994). Idaho, Idaho County, Bitterroot National Forest, along U.S. Forest Service Road No. 468 (half way between "Observation Point" and Salmon Base Camp); GPS reading: 45E 39.558' north latitude, 114E 48.950' west longitude; elevation: 7800 feet (2377 m). Elemental analysis material collected: *Letharia vulpina* (from conifer lignum), *Bryoria fremontii* (from Subalpine Fir), and *Umbilicaria hyperborea* (from rock). Collectors: Larry L. St. Clair, Samuel B. St. Clair, and Benjamin D. St. Clair. Herbarium Numbers: none.

Site No. 22: 1 August 2001 (originally collected 13 July 1994). Idaho, Idaho County, Bitterroot National Forest, vicinity of Mac Gruder Ranger Station, along U.S. Forest Service Trail No. 4 (south of Ranger Station); GPS reading: 45E 42.129' north latitude, 114E 42.887' west longitude; elevation: 4500 feet (1372 m). Elemental analysis material collected: *Letharia vulpina* (from Douglas Fir), *Bryoria fremontii* (from Douglas Fir), *Alectoria sarmentosa* (from Douglas Fir), and *Umbilicaria americana* (from rock). Collectors: Larry L. St. Clair, Samuel B. St. Clair, and Benjamin D. St. Clair. Herbarium Numbers: 39077.

Site No. 23: 1 August 2001 (originally collected 12 July 1994). Idaho, Idaho County, Bitterroot National Forest, along White Cap Creek Trail (U.S. Forest Service Trail No. 24); GPS reading: 45E 52.035' north latitude, 114E 43.818' west longitude; elevation: 3000 feet (914 m). Elemental analysis material collected: *Letharia vulpina* (from Ponderosa Pine), *Bryoria fremontii* (from Ponderosa Pine), *Lobaria pulmonaria* (from Douglas Fir), *Alectoria*

sarmentosa (from Douglas Fir), and *Umbilicaria americana* (from rock).
Collectors: Larry L. St. Clair, Samuel B. St. Clair, and Benjamin D. St. Clair.
Herbarium Numbers: none.

Site No. 24: 2 August 2001 (originally collected 16 July 1994). Idaho, Idaho County, Clearwater National Forest, at Wilderness Gateway Trailhead (U.S. Forest Service Trail No. 211); GPS reading: 46E 20.117' north latitude, 115E 18.869' west longitude; elevation: 2100 feet (640 m). Elemental analysis material collected: *Bryoria fremontii* (from Douglas Fir), *Bryoria capillare* (from Douglas Fir), *Alectoria sarmentosa* (from Douglas Fir), *Usnea* sp. (from Douglas Fir), and *Xanthoparmelia coloradoensis* (from rock).
Collectors: Larry L. St. Clair, Samuel B. St. Clair, and Benjamin D. St. Clair.
Herbarium Numbers: none.

Site No. 25: 2 August 2001 (originally collected 15 July 1994). Idaho, Idaho County, Clearwater National Forest, vicinity of Walton Lakes Trailhead; GPS reading: 46E 26.550' north latitude, 114E 43.362' west longitude; elevation: 7400 feet (2256 m). Elemental analysis material collected: *Bryoria fremontii* (from Subalpine Fir), *Letharia vulpina* (from lignum), and *Umbilicaria hyperborea* (from rock). Collectors: Larry L. St. Clair, Samuel B. St. Clair, and Benjamin D. St. Clair. Herbarium Numbers: none.

Site No. 26: 2 August 2001 (originally collected 16 July 1994). Idaho, Idaho County, Clearwater National Forest, vicinity of Eagle Mountain Trailhead; GPS reading: 46E 25.765' north latitude, 115E 08.018' west longitude; elevation: 2400 feet (732 m). Elemental analysis material collected: *Alectoria sarmentosa* (from Douglas Fir), *Lobaria pulmonaria* (from Douglas Fir).
Collectors: Larry L. St. Clair, Samuel B. St. Clair, and Benjamin D. St. Clair.
Herbarium Numbers: none.

Site No. 27: 2 August 2001 (originally collected 17 July 1994). Idaho, Idaho County, Clearwater National Forest, along U.S. Forest Road No. 362, south of fish hatchery (old growth forest); GPS reading: 46E 30.391' north latitude, 114E 40.868' west longitude; elevation: 3700 feet (1128 m). Elemental analysis material collected: *Bryoria fremontii* (from Douglas Fir), *Alectoria sarmentosa* (from Douglas Fir), and *Lobaria pulmonaria* (from *Thuja plicata*). Collectors: Larry L. St. Clair, Samuel B. St. Clair, and Benjamin D. St. Clair. Herbarium Numbers: none.

Site No. 28: 3 August 2001 (originally collected 21 July 1992). Montana, Ravalli County, Bitterroot National Forest, vicinity of Bear Creek Pass; GPS reading: 46E 06.976' north latitude, 114E 29.552' west longitude; elevation: 6562 feet (2000 m). Elemental analysis material collected: *Letharia vulpina* (from lignum) and *Umbilicaria hyperborea* (from rock). Collectors: Larry L. St. Clair, Samuel B. St. Clair, and Benjamin D. St. Clair. Herbarium Numbers: none.

Site No. 29: 3 August 2001 (originally collected 21 July 1992). Montana, Ravalli County, Bitterroot National Forest, Lost Horse Canyon at Tenmile Creek; GPS reading: 46E 08.524' north latitude, 114E 24.458' west longitude; elevation: 5577 feet (1700 m). Elemental analysis material collected: *Letharia vulpina* (from lignum) and *Umbilicaria americana* (from rock). Collectors: Larry L. St. Clair, Samuel B. St. Clair, and Benjamin D. St. Clair. Herbarium Numbers: none.

Site No. 30: 3 August 2001 (originally collected 21 July 1992). Montana, Ravalli County, Bitterroot National Forest, Lost Horse Canyon, vicinity of South Fork of Lost Horse Creek; GPS reading: 46E 06.455' north latitude, 114E 16.982' west longitude; elevation: 4757 feet (1450 m). Elemental analysis material collected: *Letharia vulpina* (from lignum). Collectors: Larry L. St. Clair, Samuel B. St. Clair, and Benjamin D. St. Clair. Herbarium Numbers: none.

Site No. 31: 3 August 2001 (originally collected 24 July 1992). Montana, Ravalli County, Bitterroot National Forest, St. Mary's Peak; GPS reading: 46E 30.42' north latitude, 114E 14.326' west longitude; elevation: 9300 feet (2835 m). Elemental analysis material collected: *Letharia vulpina* (from *Pinus albicaulis*) and *Umbilicaria virginis* (from rock). Collectors: Samuel B. St. Clair and Benjamin D. St. Clair. Herbarium Numbers: none. Note: An additional elemental analysis sample (31a) was collected along the trail (U.S. Forest Service Trail No. 116) to St. Mary's Peak (*Letharia vulpina* from lignum).

Site No. 32: 15 July 2002 (originally collected 22 July 1992). Montana, Missoula County, Bitterroot National Forest, vicinity of Carlton Lake; GPS reading: 46° 41.703' north latitude, 114° 12.560' west longitude; elevation 8000 feet (2462 m). Elemental analysis material collected: *Letharia vulpina* (on conifer bark). Collectors: Samuel B. St. Clair, Laura S. Cooper, Katherine S. St. Clair, and Benjamin D. St. Clair. Herbarium Numbers: none.

Reference sites collected in or near the Mission Mountains Wilderness Area:

Site No. 33: 16 July 2002 (new collection site). Montana, Missoula County, Mission Mountains, vicinity of Glacier Lake Trailhead (along U.S. Forest Service Trail No. 690); GPS reading: 47° 22.657' north latitude, 113° 47.509' west longitude; elevation 5160 feet (1588 m). Elemental analysis material collected: *Letharia vulpina* and *Alectoria sarmentosa* (on Douglas Fir bark). Collectors: Larry L. St. Clair, Samuel B. St. Clair, Laura S. Cooper, Katherine S. St. Clair, and Benjamin D. St. Clair. Herbarium Numbers: BRY C- 39180-39203 and 39268-39294.

Site No. 34: 16 July 2002 (new collection site). Montana, Missoula County, Mission Mountains, vicinity of Beaver Creek at Crystal Lake Trailhead (U.S. Forest Service Trail No. 351); GPS reading: 47° 20.036' north latitude, 113° 43.742' west longitude; elevation 5100 feet (1569 m). Elemental analysis material

collected: *Letharia vulpina* and *Alectoria sarmentosa* (on conifer wood). Collectors: Larry L. St. Clair, Samuel B. St. Clair, Laura S. Cooper, Katherine S. St. Clair, and Benjamin D. St. Clair. Herbarium Numbers: BRY C-39204-39267.

Site No. 35: 17 July 2002 (new collection site). Montana, Lake County, Mission Mountains, vicinity of Cedar Lake/Fatty Lake Trailhead; GPS reading: 47° 41.313' north latitude, 113° 55.330' west longitude; elevation 5400 feet (1662 m). Elemental analysis material collected: *Letharia vulpina* and *Usnea* sp. (on Sub-alpine Fir bark). Collectors: Larry L. St. Clair, Samuel B. St. Clair, Laura S. Cooper, Katherine S. St. Clair, and Benjamin D. St. Clair. Herbarium Numbers: BRY C-39295-39329.

Site No. 36: 17 July 2002 (new collection site). Montana, Missoula County, Mission Mountains, vicinity of Cold Lakes Trailhead (U.S. Forest Service Trail No. 121); GPS reading: 47° 33.619' north latitude, 113° 51.283' west longitude; elevation 5100 feet (1569 m). Elemental analysis material collected: *Letharia vulpina* (On Spruce) and *Alectoria sarmentosa* (on Sub-alpine Fir). Collectors: Larry L. St. Clair, Samuel B. St. Clair, Laura S. Cooper, Katherine S. St. Clair, and Benjamin D. St. Clair. Herbarium Numbers: BRY C-39330-39371.

Reference sites collected in or near the Bob Marshall Wilderness Area:

Site No. 37: 18 July 2002 (new collection site). Montana, Missoula County, along Holland Falls Trail (U.S. Forest Service Trail No. 416), near boundary of Bob Marshall Wilderness Area; GPS reading: 47° 26.983' north latitude, 113° 36.053' west longitude; elevation 4100 feet (1262 m). Elemental analysis material collected: *Letharia vulpina* and *Alectoria sarmentosa* (on Douglas Fir bark). Collectors: Larry L. St. Clair, Samuel B. St. Clair, Laura S. Cooper, Katherine S. St. Clair, and Benjamin D. St. Clair. Herbarium Numbers: BRY C-39372-39472.

Site No. 38: 18 July 2002 (new collection site). Montana, Powell County, vicinity of Pyramid Pass Trailhead, near boundary of Bob Marshall Wilderness Area; GPS reading: 47° 15.589' north latitude, 113° 25.470' west longitude; elevation 5300 feet (1631 m). Elemental analysis material collected: *Letharia vulpina* and *Alectoria sarmentosa* (on Douglas Fir bark). Collectors: Larry L. St. Clair, Samuel B. St. Clair, Laura S. Cooper, Katherine S. St. Clair, and Benjamin D. St. Clair. Herbarium Numbers: BRY C-39473-39536.

Site No. 39: 19 July 2002 (new collection site). Montana, Powell County, vicinity of Lodgepole Creek Trailhead, near boundary of Bob Marshall Wilderness Area; GPS reading: 47° 13.409' north latitude, 113° 11.686' west longitude; elevation 5300 feet (1631 m). Elemental analysis material collected: *Letharia vulpina* and *Alectoria sarmentosa* (on Lodgepole Pine bark). Collectors: Larry L. St. Clair, Samuel B. St. Clair, Laura S. Cooper, Katherine S. St. Clair.

Clair, and Benjamin D. St. Clair. Herbarium Numbers: BRY C-39537-39558 and 39737-39778.

Site No. 40: 7 July 2003 (new collection site). Montana, Missoula County, Flathead National Forest, vicinity of Smith Creek Trailhead (U.S. Forest Service Trail No. 29), near boundary of Bob Marshall Wilderness Area; GPS reading: 47° 32.979' north latitude, 113° 40.009' west longitude; elevation 4400 feet (1354 m). Elemental analysis material collected: *Letharia vulpina* and *Usnea* sp. (on Douglas Fir bark). Collectors: Larry L. St. Clair, Samuel B. St. Clair, Laura S. Cooper, Kathryn B. Knight, and Benjamin D. St. Clair. Herbarium Numbers: BRY C-39962-39999 and 48560-48610.

Site No. 41: 7 July 2003 (new collection site). Montana, Lake County, Flathead National Forest, along U.S. Forest Service Road No. 10502, vicinity of intersection with No Name Creek, near boundary of Bob Marshall Wilderness Area; GPS reading: 47° 46.570' north latitude, 113° 41.766' west longitude; elevation 4500 feet (1385 m). Elemental analysis material collected: *Alectoria sarmentosa* and *Usnea* sp. (on Cottonwood bark). Collectors: Larry L. St. Clair, Samuel B. St. Clair, Laura S. Cooper, Kathryn B. Knight, and Benjamin D. St. Clair. Herbarium Numbers: BRY C-48611-48683.

Site No. 42: 8 July 2003 (new collection site). Montana, Flathead County, Flathead National Forest, vicinity of Silvertip Trailhead (U.S. Forest Service Trail No. 83), near boundary of Bob Marshall Wilderness Area; GPS reading: 47° 56.185' north latitude, 113° 18.446' west longitude; elevation 5800 feet (1785 m). Elemental analysis material collected: *Letharia vulpina*, *Bryoria fremontii*, and *Alectoria sarmentosa* (on Lodgepole Pine bark). Collectors: Larry L. St. Clair, Samuel B. St. Clair, Laura S. Cooper, Kathryn B. Knight, and Benjamin D. St. Clair. Herbarium Numbers: BRY C-48684-48740.

Site No. 43: 8 July 2003 (new collection site). Montana, Flathead County, Flathead National Forest, vicinity of Meadow Creek Trailhead, near boundary of Bob Marshall Wilderness Area; GPS reading: 47° 50.019' north latitude, 113° 25.152' west longitude; elevation 4000 feet (1231 m). Elemental analysis material collected: *Letharia vulpina*, and *Alectoria sarmentosa* (on Lodgepole Pine bark). Collectors: Larry L. St. Clair, Samuel B. St. Clair, Laura S. Cooper, Kathryn B. Knight, and Benjamin D. St. Clair. Herbarium Numbers: BRY C-48741-48819.

Site No. 44: 10 July 2003 (new collection site). Montana, Pondera County, Blackfeet Indian Reservation, along Eagle Creek, north of Swift Reservoir, near boundary of Bob Marshall Wilderness Area; GPS reading: 48° 9.691' north latitude, 112° 54.043' west longitude; elevation 5000 feet (1539 m). Elemental analysis material collected: *Letharia vulpina* (on Spruce bark), *Usnea* sp. (on Douglas Fir bark), and *Xanthoria elegans* (on rock). Collectors: Larry L. St. Clair, Samuel B. St. Clair, Laura S. Cooper, Kathryn

B. Knight, and Benjamin D. St. Clair. Herbarium Numbers: BRY C-48820-48881.

Site No. 45: 10 July 2003 (new collection site). Montana, Teton County, Lewis and Clark National Forest, vicinity of West Fork of the Teton Campground, near boundary of Bob Marshall Wilderness Area; GPS reading: 47° 57.542' north latitude, 112° 48.216' west longitude; elevation 5600 feet (1723 m). Elemental analysis material collected: *Letharia vulpina* (on Spruce bark), *Usnea* sp. (on dead conifer wood). Collectors: Larry L. St. Clair, Samuel B. St. Clair, Laura S. Cooper, Kathryn B. Knight, and Benjamin D. St. Clair. Herbarium Numbers: BRY C-48882-48950.

Site No. 46: 10 July 2003 (new collection site). Montana, Teton County, Lewis and Clark National Forest, vicinity of South Fork Teton Trailhead, near boundary of Bob Marshall Wilderness Area; GPS reading: 47° 50.849' north latitude, 112° 46.872' west longitude; elevation 5800 feet (1785 m). Elemental analysis material collected: *Letharia vulpina*, *Usnea* sp., and *Alectoria sarmentosa* (on Sub-alpine Fir bark). Collectors: Larry L. St. Clair, Samuel B. St. Clair, Laura S. Cooper, Kathryn B. Knight, and Benjamin D. St. Clair. Herbarium Numbers: BRY C-48951-49013.

Site No. 47: 11 July 2003 (new collection site). Montana, Teton County, Lewis and Clark National Forest, vicinity of Mortimer Gulch Trailhead, near boundary of Bob Marshall Wilderness Area; GPS reading: 47° 36.408' north latitude, 112° 46.022' west longitude; elevation 4900 feet (1508 m). Elemental analysis material collected: *Letharia vulpina* and *Usnea* sp. (on Douglas Fir bark). Collectors: Larry L. St. Clair, Samuel B. St. Clair, Laura S. Cooper, Kathryn B. Knight, and Benjamin D. St. Clair. Herbarium Numbers: BRY C-49014-49078.

Site No. 48: 11 July 2003 (new collection site). Montana, Lewis and Clark County, Lewis and Clark National Forest, vicinity of South Fork Sun River Trailhead (along U.S. Forest Service Trail No. 202), near boundary of Bob Marshall Wilderness Area; GPS reading: 47° 30.196' north latitude, 112° 53.261' west longitude; elevation 5200 feet (1600 m). Elemental analysis material collected: *Letharia vulpina*, (on Lodgepole Pine bark) and *Usnea* sp., (on Spruce bark). Collectors: Larry L. St. Clair, Samuel B. St. Clair, Laura S. Cooper, Kathryn B. Knight, and Benjamin D. St. Clair. Herbarium Numbers: BRY C-49079-49138

STATUS OF ELEMENTAL ANALYSIS COLLECTIONS: Sensitive indicator species samples were collected for elemental analyses. Archival material is currently stored in Nasco Whirlpak plastic bags (to avoid contamination). These samples are permanently housed in the Elemental Analysis Archive Collection at the Herbarium of Nonvascular Cryptogams at Brigham Young University in Provo, Utah. Sub-samples of all elemental analysis samples

are currently being analyzed using Proton Induced X-ray Emission (PIXE) techniques. Concentrations of 23 potential pollutant elements will be determined for each sample.

LICHEN MATERIAL COLLECTED FOR ELEMENTAL ANALYSIS: During the summers of 2000 - 2003 a total of 113 samples including two growth forms (foliose and fruticose) 14 species in 11 genera from four substrates (rock, lignum, bark, and alpine sod) were collected for elemental analysis. Below is a list of the elemental analysis samples indicating sample number, species, substrate, and collection site (the first number represents the storage drawer and the second number indicates the bag number). Reference site numbers correspond to the numbers listed in the site description section of this report.

<u>Sample No.</u>	<u>Taxa</u>	<u>Substrate</u>	<u>Reference Site</u>
53-784	Rhizoplaca melanophthalma	Rock	1
53-785	Letharia vulpina	Bark	1
53-786	Letharia vulpina	Lignum	4
53-787	Letharia vulpina	Bark	5
53-788	Letharia vulpina	Lignum	5
53-789	Letharia vulpina	Bark	3
53-790	Rhizoplaca melanophthalma	Rock	3
53-791	Umbilicaria americana	Rock	3
53-792	Rhizoplaca melanophthalma	Rock	7
53-793	Letharia vulpina	Bark	2
53-794	Letharia vulpina	Lignum	9
53-795	Alectoria sarmentosa	Lignum	9
53-796	Flavocetraria nivalis	Alpine sod	8
53-797	Letharia vulpina	Bark	8
53-798	Rhizoplaca melanophthalma	Rock	8
53-799	Letharia vulpina	Lignum	8a
53-800	Rhizoplaca melanophthalma	Rock	10
53-801	Letharia vulpina	Lignum	10
53-802	Alectoria sarmentosa	Lignum	11
53-803	Lobaria pulmonaria	Bark	11
53-804	Letharia vulpina	Bark/lignum	12
53-805	Umbilicaria americana	Rock	12
53-806	Letharia vulpina	Bark/lignum	13
53-807	Alectoria sarmentosa	Bark/lignum	13
53-808	Usnea hirta	Bark	14
53-809	Letharia vulpina	Bark	14
53-838	Bryoria fremontii	Bark	27
53-839	Lobaria pulmonaria	Bark	27
53-840	Alectoria sarmentosa	Bark	27
53-841	Umbilicaria hyperborea	Rock	25
53-842	Bryoria fremontii	Bark	25
53-843	Letharia vulpina	Lignum	25
53-844	Bryoria fremontii	Bark	24

Sample No.	Taxa	Substrate	Reference Site
53-845	<i>Alectoria sarmentosa</i>	Bark	24
53-846	<i>Usnea</i> sp.	Bark	24
53-847	<i>Bryoria capillare</i>	Bark	24
53-848	<i>Xanthoparmelia coloradoensis</i>	Rock	24
53-849	<i>Alectoria sarmentosa</i>	Bark	26
53-850	<i>Lobaria pulmonaria</i>	Bark	26
53-851	<i>Letharia vulpina</i>	Bark	23
53-852	<i>Umbilicaria americana</i>	Rock	23
53-853	<i>Alectoria sarmentosa</i>	Bark	23
53-854	<i>Lobaria pulmonaria</i>	Bark	23
53-855	<i>Bryoria fremontii</i>	Bark	23
53-856	<i>Letharia vulpina</i>	Lignum	21
53-857	<i>Bryoria fremontii</i>	Bark	21
53-858	<i>Umbilicaria hyperborea</i>	Rock	21
53-859	<i>Alectoria sarmentosa</i>	Bark	22
53-860	<i>Bryoria fremontii</i>	Bark	22
53-861	<i>Umbilicaria americana</i>	Rock	22
53-862	<i>Letharia vulpina</i>	Bark	22
54-864	<i>Letharia vulpina</i>	Bark	18a
54-865	<i>Umbilicaria americana</i>	Rock	18
54-866	<i>Alectoria sarmentosa</i>	Bark	18
54-867	<i>Letharia vulpina</i>	Bark	18
54-868	<i>Lobaria pulmonaria</i>	Bark	17
54-869	<i>Alectoria sarmentosa</i>	Bark	17
54-870	<i>Umbilicaria hyperborea</i>	Rock	19
54-871	<i>Letharia vulpina</i>	Bark	19
54-872	<i>Umbilicaria virginis</i>	Rock	31
54-873	<i>Letharia vulpina</i>	Bark	31
54-874	<i>Letharia vulpina</i>	Lignum	31a
54-875	<i>Letharia vulpina</i>	Bark	20
54-876	<i>Bryoria fremontii</i>	Bark	20
54-877	<i>Parmelia saxatilis</i>	Rock	20a
54-878	<i>Umbilicaria hyperborea</i>	Rock	28
54-879	<i>Letharia vulpina</i>	Lignum	28
54-880	<i>Letharia vulpina</i>	Lignum	30
54-881	<i>Letharia vulpina</i>	Lignum	29
54-882	<i>Umbilicaria americana</i>	Rock	29
54-883	<i>Letharia vulpina</i>	Bark	15
54-884	<i>Rhizoplaca melanophthalma</i>	Rock	15
54-885	<i>Usnea</i> sp.	Bark	15
54-886	<i>Letharia vulpina</i>	Lignum	16
54-887	<i>Usnea</i> sp.	Bark	16
54-921	<i>Letharia vulpina</i>	Bark	32
54-922	<i>Letharia vulpina</i>	Bark	33
54-923	<i>Alectoria sarmentosa</i>	Bark	33

Sample No.	Taxa	Substrate	Reference Site
54-924	Alectoria sarmentosa	Bark	36
54-925	Letharia vulpina	Bark	36
54-926	Letharia vulpina	Bark	37
54-927	Alectoria sarmentosa	Bark	37
54-928a	Alectoria sarmentosa	Bark	38
54-928b	Usnea sp.	Bark	38
54-929	Letharia vulpina	Bark	38
54-930	Alectoria sarmentosa	Bark	39
54-931	Letharia vulpina	Bark	39
55-984	Letharia vulpina	Bark	45
55-985	Usnea sp.	Bark	45
55-986	Alectoria sarmentosa	Bark	46
55-987	Usnea sp.	Bark	46
55-988	Letharia vulpina	Bark	46
55-989	Usnea sp.	Bark	41
55-990	Alectoria sarmentosa	Bark	41
55-991	Alectoria sarmentosa	Bark	43
55-992	Letharia vulpina	Bark	43
55-993	Usnea sp.	Bark	47
55-994	Letharia vulpina	Bark	47
55-995	Xanthoria elegans	Rock	44
55-996	Usnea sp.	Bark	44
55-997	Letharia vulpina	Bark	44
55-998	Letharia vulpina	Bark	42
55-999	Alectoria sarmentosa	Bark	42
55-1000	Bryoria fremontii	Bark	42
55-1001	Letharia vulpina	Bark	40
55-1002	Usnea sp.	Bark	40
55-1003	Usnea sp.	Bark	48
55-1004	Letharia vulpina	Bark	48
56-1046	Alectoria sarmentosa	Bark	34
56-1047	Letharia vulpina	Bark	34
56-1048	Letharia vulpina	Bark	35
56-1049a	Usnea sp.	Bark	35
56-1049b	Alectoria sarmentosa	Bark	35

**PRELIMINARY CHECKLIST OF THE LICHENS FROM SELECTED SITES IN
THE GATES OF THE MOUNTAINS WILDERNESS AREA, HELENA NATIONAL
FOREST, MONTANA**

(Note: site numbers refer to the numbers listed in the site description section of this report)

Taxa	BRY C No.	Substrate	Growth form	Site
Acarospora cervina	38175	Rock	Squamulose	14
Acarospora glaucocarpa	38159	Rock	Squamulose	14
Amandinea punctata	38183, 38964	Bark	Crustose	14, 15
Anaptychia setifera	38166	Moss over rock	Foliose	14
Aspicilia calcarea	38173	Rock	Crustose	14

Taxa	BRY C No.	Substrate	Growth form	Site
Aspicilia cinerea	38980	Rock	Crustose	15
Aspicilia desertorum	39001	Rock	Crustose	16
Aspicilia hispida	39042	Soil	Fruticose	16
Bryoria fremontii	39065	Dead conifer branches	Fruticose	15
Bryoria fuscescens	38142, 39038, 38962	Bark, lignum	Fruticose	14, 15, 16
Candelariella rosulans	38994	Rock	Crustose	15
Candelariella vitellina	39005	Soil over rock	Crustose	16
Cladonia cariosa	38958	Decomp. wood	Squamulose	15
Cladonia chlorophaea	39041	Lignum	Squamulose	16
Cladonia coniocraea	38177, 38959	Decomp. wd.	Squamulose	14, 15
Cladonia fimbriata	38158, 38975	Moss over rock, soil	Squamulose	14, 15
Collema cristatum	38991	Rock	Foliose	15
Collema fuscovirens	38160, 38970	Rock, moss over rock	Foliose	14, 15
Cyphelium tigillare	39012	Lignum	Crustose	16
Dermatocarpon miniatum	38161, 39010, 38977b	Rock	Foliose	14, 15, 16
Dermatocarpon reticulatum	38977a	Rock	Foliose	15
Diploschistes actinostomus	39025	Rock	Crustose	16
Diploschistes muscorum	39039	Decomp. wd	Crustose	16
Hypocenyomyce scalaris	38150	Bark	Squamulose	14
Hypogymnia imshaugii	38181, 39034, 39054	Bark, lignum	Foliose	14, 15, 16
Hypogymnia physodes	38149, 39053	Bark, lignum	Foliose	14, 15
Lecanora argopholis	39029	Rock	Crustose	16
Lecanora dispersa	39027b	Rock	Crustose (scant)	16
Lecanora garovaglii	39028	Rock	Crustose	16
Lecanora hageni	38145a	Bark	Crustose (scant)	14
Lecanora impudens	38978	Bark	Crustose	15
Lecanora meridionalis	39047	Bark	Crustose	15
Lecanora muralis	38156, 39000	Rock	Crustose	14, 16
Lecanora saligna	39014	Lignum	Crustose	16
Lecanora varia	39033	Bark	Crustose (scant)	16
Lecidea tessellata	39009, 38998	Rock	Crustose	15, 16
Lecidella stigmathea	38985	Rock	Crustose	15
Leptogium intermedium	39002	Moss over rock	Foliose	16
Leptogium lichenoides	38174	Moss over rock	Foliose	14
Leptogium saturninum	38976, 39073	Moss over rock & bark	Foliose	15
Letharia columbiana	39050	Bark	Fruticose	15
Letharia vulpina	38186, 39011, 39051	Bark/lignum	Fruticose	14, 15, 16
Lobothallia praeradiosa	39004	Rock	Crustose	16
Melanelia exasperatula	39076	Bark	Foliose	15
Melanelia subelegantula	39006	Rock, moss over rock	Foliose	16
Melanelia subolivacea	39035, 39046	Bark, lignum	Foliose	15, 16
Melanelia tominii	39008	Rock	Foliose	16
Mycobilimbia berengeriana	38179, 38966	Detritus	Crustose	14, 15
Parmelia sulcata	38137, 39037, 38961	Bark, lignum, rock	Foliose	14, 15, 16
Parmeliopsis ambigua	38147	Bark	Foliose	14
Peltigera aphthosa	38990	Moss over soil	Foliose	15
Peltigera canina	38968	Moss over rock	Foliose	15
Peltigera elisabethae	38169, 39056	Moss over rock, soil	Foliose	14, 15
Phaeophyscia sciastra	38155, 39016, 38971	Moss over rock, rock	Foliose	14, 15, 16
Physcia adscendens	38140	Bark	Foliose	14
Physcia albinea	38983	Rock	Foliose	15
Physcia caesia	38152, 38965, 38981	Rock, bark	Foliose	14, 15
Physcia dubia	39018, 38984	Rock	Foliose	15, 16
Physconia muscigena	38164, 38974	Moss over rock	Foliose	14, 15
Psora himalayana	38162b	Moss over rock	Squamulose	14
Psora tuckermanii	38162a, 39026	Soil over rock	Squamulose	14, 16
Rhizocarpon disporum	38999, 38988	Rock	Crustose	15, 16
Rhizoplaca chrysoleuca	38993	Rock	Foliose (umbilicate)	15
Rhizoplaca melanophthalma	38992	Rock	Foliose (umbilicate)	15
Thyrea confusa	39024	Rock	Foliose	16

Taxa	BRY C No.	Substrate	Growth form	Site
Toninia sedifolia	38163, 38967	Moss over rock	Squamulose	14, 15
Tuckermannopsis chlorophylla	38138, 38963	Bark, lignum	Foliose	14, 15
Tuckermannopsis fendleri	38139	Bark	Foliose	14
Tuckermannopsis platyphylla	38184, 39043	Bark	Foliose	14, 15
Umbilicaria hyperborea	38986	Rock	Foliose (umbilicate)	15
Usnea hirta	38136a, 39032, 39049	Bark, lignum	Fruticose	14, 15, 16
Usnea subfloridana	38136b, 38960	Bark, lignum	Fruticose	14, 15
Vulpicida pinastri	38178	Decomp. wd.	Foliose	14
Xanthoparmelia coloradoensis	39022, 38996	Loosely attached to rocks	Foliose	15, 16
Xanthoparmelia cumberlandia	39020	Rock	Foliose	16
Xanthoparmelia plittii	39007	Rock	Foliose	16
Xanthoparmelia wyomingica	39003	Over gravelly soil	Foliose	16
Xanthoria elegans	38153, 39019, 38979	Rock	Foliose	14, 15, 16
Xanthoria fallax	38141	Bark	Foliose	14
Xanthoria montana	39069	Bark	Foliose	15
Xanthoria soorediata	38168	Rock	Foliose	14

GATES OF THE MOUNTAINS WILDERNESS AREA LIST OF POLLUTION SENSITIVE INDICATOR SPECIES BY REFERENCE SITE

Meriwether Canyon:

- Bryoria fuscescens* (Sensitive to intermediately sensitive to sulfur dioxide)
- Cladonia coniocraea* (Intermediately sensitive to sulfur dioxide)
- Cladonia fimbriata* (Sensitive to intermediately sensitive to sulfur dioxide)
- Collema fuscovirens* (Sensitive to intermediately sensitive to ozone)
- Hypocenomyce scalaris* (Intermediately sensitive to sulfur dioxide)
- Hypogymnia imshaugii* (Intermediately sensitive to sulfur dioxide)
- Leptogium lichenoides* (Sensitive to sulfur dioxide)
- Letharia vulpina* (Intermediately sensitive to ozone)
- Parmelia sulcata* (Sensitive to intermediately sensitive to ozone; intermediately sensitive to sulfur dioxide; sensitive to fluoride)
- Parmeliopsis ambigua* (Intermediately sensitive to sulfur dioxide)
- Phaeophyscia sciastra* (Sensitive to ozone)
- Physcia adscendens* (Intermediately sensitive to sulfur dioxide; sensitive to fluoride)
- Physcia caesia* (Intermediately sensitive to sulfur dioxide)
- Tuckermannopsis chlorophylla* (Sensitive to sulfur dioxide)
- Usnea hirta* (Sensitive to intermediately sensitive to sulfur dioxide)
- Usnea subfloridana* (Sensitive to intermediately sensitive to sulfur dioxide)
- Vulpicida pinastri* (Sensitive to intermediately sensitive to sulfur dioxide)
- Xanthoria elegans* (Intermediately sensitive to sulfur dioxide)
- Xanthoria fallax* (Sensitive to intermediately sensitive to sulfur dioxide; sensitive to N_{ox} and PAN)

Refrigerator Canyon:

- Bryoria fremontii* (Sensitive to sulfur and ozone)
- Bryoria fuscescens* (Sensitive to intermediately sensitive to sulfur dioxide)
- Cladonia coniocraea* (Intermediately sensitive to sulfur dioxide)
- Cladonia fimbriata* (Sensitive to intermediately sensitive to sulfur dioxide)
- Collema cristatum* (Sensitive to intermediately sensitive to ozone)

Refrigerator Canyon (cont.):

- Collema fuscovirens* (Sensitive to intermediately sensitive to ozone)
Hypogymnia imshaugii (Intermediately sensitive to sulfur dioxide)
Leptogium saturninum (Sensitive to sulfur dioxide)
Letharia columbiana (Intermediately sensitive to ozone)
Letharia vulpina (Intermediately sensitive to ozone)
Melanelia exasperatula (Intermediately sensitive to sulfur dioxide)
Melanelia subolivacea (Intermediately sensitive to ozone)
Parmelia sulcata (Sensitive to intermediately sensitive to ozone; intermediately sensitive to sulfur dioxide; sensitive to fluoride)
Peltigera aphthosa (Intermediately sensitive to sulfur dioxide)
Peltigera canina (Sensitive to ozone)
Phaeophyscia sciastra (Sensitive to ozone)
Physcia caesia (Intermediately sensitive to sulfur dioxide)
Physcia dubia (Sensitive to intermediately sensitive to fluoride)
Rhizoplaca chrysoleuca (Sensitive to sulfur dioxide)
Rhizoplaca melanophthalma (Sensitive to sulfur dioxide; sensitive to N_{ox} and PAN)
Tuckermannopsis chlorophylla (Sensitive to sulfur dioxide)
Usnea hirta (Sensitive to intermediately sensitive to sulfur dioxide)
Usnea subfloridana (Sensitive to intermediately sensitive to sulfur dioxide)
Xanthoria elegans (Intermediately sensitive to sulfur dioxide)
Xanthoria montana (Intermediately sensitive to sulfur dioxide)

Hunter's Gulch:

- Bryoria fuscescens* (Sensitive to intermediately sensitive to sulfur dioxide)
Candelariella vitellina (Intermediately sensitive to sulfur dioxide; sensitive to fluoride)
Hypogymnia imshaugii (Intermediately sensitive to sulfur dioxide)
Lecanora saligna (Intermediately sensitive to sulfur dioxide)
Letharia vulpina (Intermediately sensitive to ozone)
Melanelia subelegantula (Sensitive to sulfur dioxide)
Melanelia subolivacea (Intermediately sensitive to ozone)
Parmelia sulcata (Sensitive to intermediately sensitive to ozone; intermediately sensitive to sulfur dioxide; sensitive to fluoride)
Phaeophyscia sciastra (Sensitive to ozone)
Physcia dubia (Sensitive to intermediately sensitive to fluoride)
Usnea hirta (Sensitive to intermediately sensitive to sulfur dioxide)
Xanthoparmelia cumberlandia (Sensitive to sulfur dioxide)
Xanthoria elegans (Intermediately sensitive to sulfur dioxide)

**PRELIMINARY CHECKLIST OF THE LICHENS FROM SELECTED SITES IN
 THE MISSION MOUNTAINS WILDERNESS AREA, MONTANA**

(Note: site numbers refer to the numbers listed in the site description section of this report)

Taxa	BRY C No.	Substrate	Growth form	Site
<i>Acarospora fuscata</i>	39222	Rock	Crustose	34, 35, 36
<i>Alectoria imshaugii</i>	39238	Bark	Fruticose	33, 34
<i>Alectoria sarmentosa</i>	39240	Bark	Fruticose	33, 34, 35, 36

Taxa	BRY C No.	Substrate	Growth form	Site
Amandinea punctata	39237	Bark	Crustose	33, 34, 35, 36
Bellemerea alpina	39212	Rock	Crustose	34
Bellemerea cinereorufescens	39181b	Rock	Crustose	33
Bryoria capillaris	39268a	Bark	Fruticose	33, 35, 36
Bryoria fremontii	39229	Bark	Fruticose	33, 34, 35, 36
Bryoria fuscescens	39261b	Bark	Fruticose	33, 34, 35
Caloplaca fraudans	39223	Rock	Crustose (sct)	34, 36
Caloplaca holocarpa	39236	Bark	Crustose	33, 34
Candelariella vitellina	39311	Soil over rock	Crustose	35
Cladonia cariosa	39193	Moss over rock	Squamulose w/pod	33, 36
Cladonia coniocraea	39209	Duff over rock	Squamulose w/pod	34, 35, 36
Cladonia ecmocyna	39214	Duff over soil	Squamulose w/pod	33, 34
Cladonia fimbriata	39190	Duff over rock	Squamulose w/pod	33, 35, 36
Cladonia sulphurina	39215	Deadwood	Squamulose w/pod	34
Cyphelium inquinans	39347b	Lignum	Crustose	36
Diploschistes actinostomus	39206	Rock	Crustose	34
Hypogymnia enteromorpha	39358e	Bark	Foliose	36
Hypogymnia imshaugii	39233a	Bark	Foliose	34, 35, 36
Hypogymnia metaphysodes	39233b	Bark	Foliose	34, 35
Hypogymnia physodes	39241b	Bark	Foliose	33, 34, 35, 36
Hypogymnia tubulosa	39274	Bark	Foliose	33, 35, 36
Kaernefeltia merrillii	39232	Bark	Foliose	34
Lecanora argopholis	39189	Rock	Crustose	33
Lecanora impudens	39362	Bark	Crustose	36
Lecanora meridionalis	39321	Bark	Crustose	35
Lecanora polytropa	39211	Rock	Crustose (sct)	33, 34, 35, 36
Lecidea atrobrunnea	39186	Rock	Crustose	33, 35, 36
Lecidea tessellata	39213	Rock	Crustose	33, 34, 35, 36
Lecidella stigmataea	39205	Rock	Crustose (sct)	33, 34
Letharia vulpina	39234	Bark	Fruticose	33, 34, 35, 36
Melanelia disjuncta	39200	Rock	Foliose	33, 35
Melanelia exasperatula	39267	Bark	Foliose	34, 35, 36
Pannaria pezizoides	39228	Soil	Squamulose	34
Parmelia saxatilis	39198a	Rock, moss over rock	Foliose	33
Parmelia sulcata	39265	Bark	Foliose	34, 35, 36
Parmeliopsis ambigua	39220	Lignum, bark	Foliose	33, 34, 35, 36
Parmeliopsis hyperopta	39219	Lignum	Foliose	33, 34, 36
Peltigera apthosa	39226	Soil	Foliose	33, 34
Peltigera canina	39221	Soil over rock	Foliose	33, 34, 36
Peltigera collina	39309	Soil over rock	Foliose	35
Peltigera rufescens	39224	Soil	Foliose	34
Peltigera venosa	39227	Soil	Foliose	34
Platismatia glauca	39242	Bark	Foliose	33, 34, 35, 36
Protoparmelia badia	39305	Rock	Crustose	35
Psora tuckermanii	39310	Soil over rock	Squamulose	35
Rhizocarpon disporum	39181	Rock	Crustose	33, 35, 36
Rhizocarpon geographicum	39207	Rock	Crustose	33, 34, 35, 36
Rhizocarpon superficiale	39208	Rock	Crustose	34, 35
Staurothele areolata	39332	Rock	Crustose	36
Stereocaulon tomentosum	39341	Moss over rock	Crustose w/pseudopod	36
Tuckermannopsis chlorophylla	39230	Bark	Foliose	34, 36
Tuckermannopsis platyphylla	39231	Bark	Foliose	33, 34, 35
Umbilicaria deusta	39216	Rock	Foliose (umbilicate)	33, 34
Umbilicaria hyperborea	39307	Rock	Foliose (umbilicate)	35
Usnea hirta	39316a	Bark	Fruticose	35

Taxa	BRY C No.	Substrate	Growth form	Site
Usnea subfloridana	39239	Bark	Fruticose	34, 35
Vulpicida canadensis	39235	Bark	Foliose	34

MISSION MOUNTAINS WILDERNESS AREA LIST OF POLLUTION SENSITIVE INDICATOR SPECIES BY REFERENCE SITE

Vicinity of Glacier Lake Trailhead:

- Alectoria imshaugii* (Sensitive to sulfur dioxide)
- Alectoria sarmentosa* (Sensitive to sulfur dioxide)
- Amandinea punctata* (Intermediately sensitive to sulfur dioxide)
- Bryoria capillaris* (Sensitive to sulfur dioxide and fluoride)
- Bryoria fuscescens* (Sensitive to intermediately sensitive to sulfur dioxide; sensitive to ozone)
- Caloplaca holocarpa* (Intermediately sensitive to sulfur dioxide)
- Candelariella vitellina* (Intermediately sensitive to sulfur dioxide)
- Cladonia fimbriata* (Sensitive to intermediately sensitive to sulfur dioxide)
- Hypogymnia physodes* (Intermediately sensitive to sulfur dioxide)
- Letharia vulpina* (Intermediately sensitive to ozone)
- Parmelia saxatilis* (Intermediately sensitive to sulfur dioxide; sensitive to fluoride)
- Parmeliopsis ambigua* (Intermediately sensitive to sulfur dioxide)
- Parmeliopsis hyperopta* (Intermediately sensitive to sulfur dioxide)
- Peltigera aphthosa* (Intermediately sensitive to sulfur dioxide)
- Peltigera canina* (Sensitive to ozone)
- Platismatia glauca* (Sensitive to ozone; intermediately sensitive to sulfur dioxide)
- Rhizocarpon geographicum* (Sensitive to fluoride)

Vicinity of Crystal Lake Trailhead:

- Alectoria imshaugii* (Sensitive to sulfur dioxide)
- Alectoria sarmentosa* (Sensitive to sulfur dioxide)
- Amandinea punctata* (Intermediately sensitive to sulfur dioxide)
- Bryoria fremontii* (Sensitive to sulfur dioxide; sensitive to ozone)
- Bryoria fuscescens* (Sensitive to intermediately sensitive to sulfur dioxide; sensitive to ozone)
- Caloplaca holocarpa* (Intermediately sensitive to sulfur dioxide)
- Cladonia coniocraea* (Intermediately sensitive to sulfur dioxide)
- Hypogymnia imshaugii* (Intermediately sensitive to ozone)
- Hypogymnia physodes* (Intermediately sensitive to sulfur dioxide)
- Kaernelfeltia merrillii* (Sensitive to intermediately sensitive to sulfur dioxide and ozone)
- Letharia vulpina* (Intermediately sensitive to ozone)
- Melanelia exasperatula* (Intermediately sensitive to sulfur dioxide)
- Parmelia sulcata* (Intermediately sensitive to sulfur dioxide; sensitive to intermediately sensitive to ozone; sensitive to fluoride)
- Parmeliopsis ambigua* (Intermediately sensitive to sulfur dioxide)
- Parmeliopsis hyperopta* (Intermediately sensitive to sulfur dioxide)
- Peltigera aphthosa* (Intermediately sensitive to sulfur dioxide)
- Peltigera canina* (Sensitive to ozone)

Vicinity of Crystal Lake Trailhead (cont.):

- Peltigera rufescens* (Sensitive to intermediately sensitive to sulfur dioxide and ozone)
- Platismatia glauca* (Sensitive to ozone; intermediately sensitive to sulfur dioxide)
- Rhizocarpon geographicum* (Sensitive to fluoride)
- Tuckermannopsis chlorophylla* (Sensitive to sulfur dioxide)
- Usnea subfloridana* (Sensitive to intermediately sensitive to sulfur dioxide)
- Vulpicida canadensis* (Sensitive to sulfur dioxide)

Vicinity of Cedar Lake Trailhead:

- Alectoria sarmentosa* (Sensitive to sulfur dioxide)
- Amandinea punctata* (Intermediately sensitive to sulfur dioxide)
- Bryoria capillaris* (Sensitive to sulfur dioxide and fluoride)
- Bryoria fremontii* (Sensitive to sulfur dioxide; sensitive to ozone)
- Bryoria fuscescens* (Sensitive to intermediately sensitive to sulfur dioxide; sensitive to ozone)
- Candelariella vitellina* (Intermediately sensitive to sulfur dioxide)
- Cladonia coniocraea* (Intermediately sensitive to sulfur dioxide)
- Cladonia fimbriata* (Sensitive to intermediately sensitive to sulfur dioxide)
- Hypogymnia imshaugii* (Intermediately sensitive to ozone)
- Hypogymnia physodes* (Intermediately sensitive to sulfur dioxide)
- Letharia vulpina* (Intermediately sensitive to ozone)
- Melanelia exasperatula* (Intermediately sensitive to sulfur dioxide)
- Parmelia sulcata* (Intermediately sensitive to sulfur dioxide; sensitive to intermediately sensitive to ozone; sensitive to fluoride)
- Parmeliopsis ambigua* (Intermediately sensitive to sulfur dioxide)
- Peltigera collina* (Sensitive to sulfur dioxide)
- Platismatia glauca* (Sensitive to ozone; intermediately sensitive to sulfur dioxide)
- Rhizocarpon geographicum* (Sensitive to fluoride)
- Usnea subfloridana* (Sensitive to intermediately sensitive to sulfur dioxide)
- Usnea hirta* (Sensitive to intermediately sensitive to sulfur dioxide)

Vicinity of Cold Lakes Trailhead:

- Alectoria sarmentosa* (Sensitive to sulfur dioxide)
- Amandinea punctata* (Intermediately sensitive to sulfur dioxide)
- Bryoria capillaris* (Sensitive to sulfur dioxide and fluoride)
- Bryoria fremontii* (Sensitive to sulfur dioxide; sensitive to ozone)
- Cladonia coniocraea* (Intermediately sensitive to sulfur dioxide)
- Cladonia fimbriata* (Sensitive to intermediately sensitive to sulfur dioxide)
- Hypogymnia enteromorpha* (Intermediately sensitive to sulfur dioxide)
- Hypogymnia imshaugii* (Intermediately sensitive to ozone)
- Hypogymnia physodes* (Intermediately sensitive to sulfur dioxide)
- Letharia vulpina* (Intermediately sensitive to ozone)
- Melanelia exasperatula* (Intermediately sensitive to sulfur dioxide)
- Parmelia sulcata* (Intermediately sensitive to sulfur dioxide; sensitive to intermediately sensitive to ozone; sensitive to fluoride)

Vicinity of Cold Lakes Trailhead (cont.):

Parmeliopsis ambigua (Intermediately sensitive to sulfur dioxide)

Parmeliopsis hyperopta (Intermediately sensitive to sulfur dioxide)

Peltigera canina (Sensitive to ozone)

Platismatia glauca (Sensitive to ozone; intermediately sensitive to sulfur dioxide)

Rhizocarpon geographicum (Sensitive to fluoride)

Tuckermannopsis chlorophylla (Sensitive to sulfur dioxide)

**PRELIMINARY CHECKLIST OF THE LICHENS FROM SELECTED SITES IN
THE BOB MARSHALL WILDERNESS AREA, MONTANA**

(Note: site numbers refer to the numbers listed in the site description section of this report)

Taxa	BRYC No.	Substrate	Growth form	Site
<i>Acarospora fuscata</i>	39481	Rock	Crustose	38,39,41,44,45,47,48
<i>Acarospora glaucocarpa</i>	39964	Rock	Crustose	40,41,43,44,45,46,47
<i>Alectoria imshaugii</i>	39410b	Bark	Fruticose	37,39,40,42,43
<i>Alectoria sarmentosa</i>	39410a	Bark	Fruticose	37,38,39,40,41,42,43,46
<i>Amandinea punctata</i>	39404	Bark, lignum	Crustose	37,38,39,40,41,42,43,44,45,47,48
<i>Aspicilia cinerea</i>	39386	Rock	Crustose	37,38,45,47
<i>Aspicilia desertorum</i>	39741	Rock	Crustose	39
<i>Bellemeria alpina</i>	48699	Rock	Crustose	42,43
<i>Bellemeria cinereorufescens</i>	39491	Rock	Crustose	38,39,40,41,42,43,46,48
<i>Biatora vernalis</i>	39751	Bark	Crustose	39,41
<i>Bryoria capillaris</i>	39457	Bark	Fruticose	37,40,41,43,46
<i>Bryoria fremontii</i>	39426	Bark	Fruticose	37,38,39,40,41,42,43,45,46,48
<i>Bryoria fuscescens</i>	39410c	Bark	Fruticose	37,39,40,41,42,43,45,47,48
<i>Caloplaca cerina</i>	49119	Bark	Crustose (sct)	48
<i>Caloplaca epithallina</i>	49034	Growing over other lichens	Crustose (sct)	47
<i>Caloplaca fraudans</i>	39501	Rock	Crustose (sct)	38,40,41,43,44,45,46
<i>Caloplaca holocarpa</i>	39519	Bark	Crustose (sct)	38,45,47,48
<i>Caloplaca saxicola</i>	48823	Rock	Crustose (\pm lobed)	44
<i>Candelariella aurella</i>	39392	Rock	Crustose (sct)	37,44,46,48
<i>Candelariella deflexa</i>	48787	Bark	Crustose (sct)	43,48
<i>Candelariella rosulans</i>	39502	Rock	Crustose (sct)	38,44,47,48
<i>Candelariella vitellina</i>	48766c	Conifer twigs	Crustose	43,44,45
<i>Chaenotheca chrysocephala</i>	39402	Conifer twigs	Crustose	37,39
<i>Cladonia cariosa</i>	39505	Duff over soil	Squam/wpod	38,39,40,41,46
<i>Cladonia carneola</i>	39475	Decomp. wood	Squam/wpod	38,39
<i>Cladonia cenotea</i>	39543	Decomp. wood	Squam/wpod	39
<i>Cladonia cervicornis</i> ssp. vert.	39540	Soil	Squam/wpod	39
<i>Cladonia chlorophaea</i>	48737	Decomp. wood	Squam/wpod	42,43,48
<i>Cladonia coniocraea</i>	39395	Moss over rock	Squam/wpod	37,38,40,42
<i>Cladonia ecmocyna</i>	39479	Duff over soil	Squam/w/pod	38,39,40,42,43,45,46
<i>Cladonia fimbriata</i>	39373	Moss over rock	Squam/wpod	37,38,39,40,41,42,43,45,46,47,48
<i>Cladonia gracilis</i> ssp. turbinata	48706	Moss over soil	Squam/wpod	42
<i>Cladonia multiformis</i>	48607	Duff over soil	Squam/wpod	40,42,43,45
<i>Cladonia phyllophora</i>	48913	Duff over soil	Squam/wpod	45
<i>Cladonia pyxidata</i>	48747	Duff over soil	Squam/wpod	43,45,47
<i>Cladonia sulphurina</i>	39545	Decomp. wood	Squam/wpod	39,42,46
<i>Collema crispum</i>	48809a	Rock	Foliose (umb)	43
<i>Collema cristatum</i>	48829	Rock	Foliose	44,47
<i>Collema fuscovirens</i>	48809b	Rock	Foliose (umb)	43
<i>Cyphelium inquinans</i>	49102	Wood	Crustose	48

Taxa	BRYC No.	Substrate	Growth form	Site
<i>Dermatocarpon reticulatum</i>	39499	Rock	Foliose (umb)	38
<i>Diploschistes actinostomus</i>	48686	Rock	Crustose	42,48
<i>Esslingeriana idahoensis</i>	39423	Bark	Foliose	37,40,45
<i>Hypogymnia apinnata</i>	39405b	Bark	Foliose	37
<i>Hypogymnia austerodes</i>	48965	Decomposing wood	Foliose	46,47
<i>Hypogymnia bitteri</i>	48931	Bark	Foliose	45,46,47,48
<i>Hypogymnia enteromorpha</i>	39436b	Bark	Foliose	37,39,41,43
<i>Hypogymnia imshaugii</i>	39429b	Bark	Foliose	37,38,39,40,41,42,43,44,45,48
<i>Hypogymnia metaphysodes</i>	39745c	Bark	Foliose	39,45,46,48
<i>Hypogymnia physodes</i>	39405a	Bark	Foliose	37,38,39,40,41,42,43,44,45,46,47,48
<i>Hypogymnia rugosa</i>	48645	Bark	Foliose	41
<i>Hypogymnia subobscura</i>	49024	Rock	Foliose	47
<i>Hypogymnia tubulosa</i>	39433a	Bark	Foliose	37,40,43,44,45,47
<i>Icmadophila ericetorum</i>	48964	Decomposing wood	Crustose	46
<i>Kaernefeltia merrillii</i>	39511b	Bark	Foliose	38,42,43,45,48
<i>Lecanora bicincta</i>	49014	Rock	Crustose	47
<i>Lecanora cenisia</i>	48698	Rock	Crustose	42,47
<i>Lecanora crenulata</i>	48826	Rock	Crustose (sct)	44,46
<i>Lecanora dispersa</i>	39967	Rock	Crustose (sct)	40,43,44
<i>Lecanora hagenii</i>	48948	Bark	Crustose (sct)	45,47
<i>Lecanora impudens</i>	39467	Bark	Crustose	37,38,43,46
<i>Lecanora meridionalis</i>	39415	Bark	Crustose	37,38,40,41,43,44,45,48
<i>Lecanora muralis</i>	39383	Rock, bone	Crustose	37,44
<i>Lecanora piniperda</i>	48846	Bark	Crustose (sct)	44,47
<i>Lecanora polytropia</i>	39381	Rock	Crustose (sct)	37,38,39,40,41,42,43,45,46,48
<i>Lecanora saligna</i>	48780	Bark	Crustose (sct)	43,45
<i>Lecanora varia</i>	39507	Bark	Crustose (sct)	38,44,45,48
<i>Lecidea atrobrunnea</i>	39398	Rock	Crustose	37,39,42,45,46
<i>Lecidea tessellata</i>	39965	Rock	Crustose	40,41,42,43,44,45,48
<i>Lecidella stigmataea</i>	39495	Rock	Crustose	38,40,41,43,44,45,46,47,48
<i>Leptogium lichenoides</i>	39497	Soil over rock	Foliose	38,43,46
<i>Letharia columbiana</i>	39508c	Bark	Fruticose	38,48
<i>Letharia vulpina</i>	39417	Bark	Fruticose	37,38,39,40,42,43,44,45,46,47,48
<i>Melanelia elegantula</i>	48876	Bark	Foliose	44,45,47,48
<i>Melanelia exasperatula</i>	39437	Bark	Foliose	37,38,40,41,43,44,45,46,48
<i>Melanelia multisporea</i>	39453	Bark	Foliose	37,38,40
<i>Melanelia sorediata</i>	49033	Rock	Foliose	47
<i>Melanelia subaurifera</i>	39416a	Bark	Foliose	37
<i>Melanelia subolivacea</i>	48852	Bark	Foliose	44,45,47,48
<i>Nephroma parile</i>	39374	Rock	Foliose	37
<i>Nodobryoria abbreviata</i>	39508a	Bark	Fruticose	38,39,40,41,43,48
<i>Ochrolechia androgyna</i>	48783	Bark	Crustose	43
<i>Ochrolechia oregonensis</i>	39458	Bark	Crustose	37,38,40,43
<i>Parmelia saxatilis</i>	39397	Rock	Foliose	37,38,40
<i>Parmelia sulcata</i>	39379	Rock, bark	Foliose	37,38,40,41,43,44,45,46,47,48
<i>Parmeliopsis ambigua</i>	39385	Rock & Bark	Foliose	37,38,39,40,41,42,43,44,45,46,47,48
<i>Parmeliopsis hyperopta</i>	39409	Bark & Rock	Foliose	37,38,39,42,43,45,46,48
<i>Peltigera apthosa</i>	39372	Duff over rock	Foliose	37,40,43,45,46,48
<i>Peltigera canina</i>	39377	Duff over soil	Foliose	37,38,39,40,41,42,43,45,46,47,48
<i>Peltigera didactyla</i>	49074	Duff over soil	Foliose	47
<i>Peltigera rufescens</i>	39484	Duff over soil	Foliose	38,39,41,44,45,46,47
<i>Peltigera venosa</i>	39487	Soil	Foliose	38,40
<i>Phaeophyscia sciastra</i>	39490	Rock	Foliose	38,43,47
<i>Physcia adscendens</i>	39436c	Bark, rock (rare)	Foliose	37,38,43,44,47,48
<i>Physcia biziana</i>	49037	Rock	Foliose	47

Taxa	BRYC No.	Substrate	Growth form	Site
<i>Physcia caesia</i>	39480	Rock	Foliose	38,47
<i>Physcia callosa</i>	48999	Rock	Foliose	46,47
<i>Physcia dubia</i>	39382	Rock	Foliose	37,41,43,48
<i>Physcia stellaris</i>	39452	Bark	Foliose	37,38,47
<i>Physcia tenella</i>	49063	Bark	Foliose	47
<i>Physciella chloantha</i>	49061	Bark	Foliose	47
<i>Physconia muscigena</i>	39394	Moss over rock	Foliose	37,47
<i>Placidium squamulosum</i>	39498	Soil over rock	Squamulose	38
<i>Platismatia glauca</i>	39407	Bark	Foliose	37,39,40,41,43,44,45,46
<i>Protoblastenia rupestris</i>	48885	Rock	Crustose	45
<i>Psora himalayana</i>	48811a	Soil over rock	Squamulose	43
<i>Psora nipponica</i>	39496	Soil over rock	Squamulose	38
<i>Pyrrhospora cinnabarina</i>	48775	Bark	Crustose	43
<i>Ramalina thrausta</i>	39403b	Bark	Fruticose	37
<i>Rhizocarpon disporum</i>	39375	Rock	Crustose	37,38,39,40,42,48
<i>Rhizocarpon geographicum</i>	39494	Rock	Crustose	38,39,40,41,42,43
<i>Rhizoplaca chrysoleuca</i>	49026	Rock	Foliose (umb)	47
<i>Rhizoplaca melanophthalma</i>	39492	Rock	Foliose (umb)	38,47
<i>Rinodina archaea</i>	39520	Bark	Crustose (sct)	38,41
<i>Rinodina milvina</i>	48691	Rock	Crustose	42
<i>Sarcogyne regularis</i>	39973	Rock	Crustose (abs)	40,46,48
<i>Staurothele areolata</i>	48891	Rock	Crustose	45
<i>Staurothele drummondii</i>	48622	Rock	Crustose	41
<i>Stereocaulon tomentosum</i>	39547	Moss over rock	Crustose w/psepod	39,42
<i>Toninia sedifolia</i>	48802	Soil over rock	Squamulose	43
<i>Trapeliopsis granulosa</i>	48740	Decomp. wood	Crustose	42
<i>Tuckermannopsis chlorophylla</i>	39406	Bark	Foliose	37,39,40,41,43,44,45,47,48
<i>Tuckermannopsis coralligera</i>	48978	Bark	Foliose	46
<i>Tuckermannopsis orbata</i>	39416b	Bark	Foliose	37,40,41,42,43,45
<i>Tuckermannopsis platyphylla</i>	39454	Bark	Foliose	37,38,39,40,41,42,43
<i>Umbilicaria hyperborea</i>	39488	Rock	Foliose (umb)	38,40,41,42,47
<i>Umbilicaria polyphylla</i>	39399	Rock	Foliose (umb)	37
<i>Umbilicaria torrefacta</i>	49032	Rock	Foliose (umb)	47
<i>Usnea hirta</i>	39526	Bark	Fruticose	38,44,46,47
<i>Usnea scabrata</i>	48938	Bark	Fruticose	45,46
<i>Usnea subfloridana</i>	39403a	Bark	Fruticose	37,38,40,41,42,43,44,45,46,47,48
<i>Vulpicida canadensis</i>	39418	Bark	Foliose	37,40,42,43
<i>Vulpicida pinastri</i>	48870	Bark	Foliose	44,45,48
<i>Xanthoria candelaria</i>	39468	Bark	Foliose	37,38,40,43
<i>Xanthoria elegans</i>	48614	Rock, bone	Foliose	41,43,44,46,47
<i>Xanthoria fallax</i>	49053	Bark	Foliose	47
<i>Xanthoria fulva</i>	49067	Bark	Foliose	47
<i>Xanthoria hasseana</i>	48788	Bark	Foliose	43
<i>Xanthoria sorediata</i>	39378	Rock	Foliose	37,38,43

**BOB MARSHALL WILDERNESS AREA LIST OF POLLUTION SENSITIVE
INDICATOR SPECIES BY REFERENCE SITE**

Holland Falls Trail:

- Alectoria imshaugii* (Sensitive to sulfur dioxide)
- Alectoria sarmentosa* (Sensitive to sulfur dioxide)
- Amandinea punctata* (Intermediately sensitive to sulfur dioxide)
- Bryoria capillaris* (Sensitive to sulfur dioxide; sensitive to fluoride)

Holland Falls Trail (cont.):

- Bryoria fremontii* (Sensitive to sulfur dioxide; sensitive to ozone)
Bryoria fuscescens (Sensitive to intermediately sensitive to sulfur dioxide; sensitive to ozone)
Cladonia coniocraea (Intermediately sensitive to sulfur dioxide)
Cladonia fimbriata (Sensitive to intermediately sensitive to sulfur dioxide)
Hypogymnia apinnata (Sensitive to sulfur dioxide)
Hypogymnia enteromorpha (Intermediately sensitive to sulfur dioxide)
Hypogymnia imshaugii (Intermediately sensitive to ozone)
Hypogymnia physodes (Intermediately sensitive to sulfur dioxide)
Lecanora polytropa (Sensitive to fluoride)
Letharia vulpina (Intermediately sensitive to ozone)
Melanelia exasperatula (Intermediately sensitive to sulfur dioxide)
Melanelia subaurifera (Intermediately sensitive to sulfur dioxide)
Nephroma parile (Sensitive to sulfur dioxide)
Parmelia saxatilis (Intermediately sensitive to sulfur dioxide)
Parmelia sulcata (Intermediately sensitive to sulfur dioxide; sensitive to intermediately sensitive to ozone; sensitive to fluoride)
Parmeliopsis ambigua (Intermediately sensitive to sulfur dioxide)
Parmeliopsis hyperopta (Intermediately sensitive to sulfur dioxide)
Peltigera aphthosa (Intermediately sensitive to sulfur dioxide)
Peltigera canina (Sensitive to ozone)
Physcia adscendens (Intermediately sensitive to sulfur dioxide; sensitive to fluoride)
Physcia dubia (Sensitive to intermediately sensitive to fluoride)
Physcia stellaris (Intermediately sensitive to sulfur dioxide)
Platismatia glauca (Sensitive to sulfur dioxide)
Ramalina thrausta (Sensitive to intermediately sensitive to sulfur dioxide; sensitive to ozone)
Tuckermannopsis chlorophylla (Sensitive to sulfur dioxide)
Tuckermannopsis orbata (Intermediately sensitive to sulfur dioxide)
Umbilicaria polyphylla (Intermediately sensitive to sulfur dioxide)
Usnea subfloridana (Sensitive to intermediately sensitive to sulfur dioxide)
Vulpicida canadensis (Sensitive to sulfur dioxide)
Xanthoria candelaria (Intermediately sensitive to sulfur dioxide; Sensitive to ozone)

Pyramid Pass Trailhead:

- Alectoria sarmentosa* (Sensitive to sulfur dioxide)
Amandinea punctata (Intermediately sensitive to sulfur dioxide)
Bryoria fremontii (Sensitive to sulfur dioxide; sensitive to ozone)
Caloplaca holocarpa (Intermediately sensitive to sulfur dioxide)
Cladonia coniocraea (Intermediately sensitive to sulfur dioxide)
Cladonia fimbriata (Sensitive to intermediately sensitive to sulfur dioxide)
Hypogymnia imshaugii (Intermediately sensitive to ozone)
Hypogymnia physodes (Intermediately sensitive to sulfur dioxide)
Kaernefeltia merrillii (Sensitive to intermediately sensitive to ozone)
Lecanora polytropa (Sensitive to fluoride)

Pyramid Pass Trailhead (cont.):

- Leptogium lichenoides* (Sensitive to sulfur dioxide)
- Letharia columbiana* (Intermediately sensitive to ozone)
- Letharia vulpina* (Intermediately sensitive to ozone)
- Melanelia exasperatula* (Intermediately sensitive to sulfur dioxide)
- Nodobryoria abbreviata* (Sensitive to sulfur dioxide; sensitive to ozone)
- Parmelia saxatilis* (Intermediately sensitive to sulfur dioxide)
- Parmelia sulcata* (Intermediately sensitive to sulfur dioxide; sensitive to intermediately sensitive to ozone; sensitive to fluoride)
- Parmeliopsis ambigua* (Intermediately sensitive to sulfur dioxide)
- Parmeliopsis hyperopta* (Intermediately sensitive to sulfur dioxide)
- Peltigera canina* (Sensitive to ozone)
- Peltigera rufescens* (Sensitive to intermediately sensitive to ozone)
- Phaeophyscia sciastra* (Sensitive to ozone)
- Physcia adscendens* (Intermediately sensitive to sulfur dioxide; sensitive to fluoride)
- Physcia caesia* (Intermediately sensitive to sulfur dioxide)
- Physcia stellaris* (Intermediately sensitive to sulfur dioxide)
- Rhizocarpon geographicum* (Sensitive to fluoride)
- Rhizoplaca melanophthalma* (Sensitive to sulfur dioxide)
- Usnea hirta* (Sensitive to intermediately sensitive to sulfur dioxide)
- Usnea subfloridana* (Sensitive to intermediately sensitive to sulfur dioxide)
- Xanthoria candelaria* (Intermediately sensitive to sulfur dioxide; Sensitive to ozone)

Lodgepole Creek Trailhead:

- Alectoria imshaugii* (Sensitive to sulfur dioxide)
- Alectoria sarmentosa* (Sensitive to sulfur dioxide)
- Amandinea punctata* (Intermediately sensitive to sulfur dioxide)
- Bryoria fremontii* (Sensitive to sulfur dioxide; sensitive to ozone)
- Bryoria fuscescens* (Sensitive to intermediately sensitive to sulfur dioxide)
- Cladonia fimbriata* (Sensitive to intermediately sensitive to sulfur dioxide)
- Hypogymnia enteromorpha* (Intermediately sensitive to sulfur dioxide)
- Hypogymnia imshaugii* (Intermediately sensitive to ozone)
- Hypogymnia physodes* (Intermediately sensitive to sulfur dioxide)
- Lecanora polytropa* (Sensitive to fluoride)
- Letharia vulpina* (Intermediately sensitive to ozone)
- Nodobryoria abbreviata* (Sensitive to sulfur dioxide; sensitive to ozone)
- Parmeliopsis ambigua* (Intermediately sensitive to sulfur dioxide)
- Parmeliopsis hyperopta* (Intermediately sensitive to sulfur dioxide)
- Peltigera canina* (Sensitive to ozone)
- Peltigera rufescens* (Sensitive to intermediately sensitive to ozone)
- Plastimatia glauca* (Sensitive to sulfur dioxide)
- Rhizocarpon geographicum* (Sensitive to fluoride)
- Tuckermannopsis chlorophylla* (Sensitive to sulfur dioxide)

Smith Creek Trailhead:

- Alectoria imshaugii* (Sensitive to sulfur dioxide)

Smith Creek Trailhead (cont.):

Alectoria sarmentosa (Sensitive to sulfur dioxide)
Amandinea punctata (Intermediately sensitive to sulfur dioxide)
Bryoria capillaris (Sensitive to sulfur dioxide; sensitive to fluoride)
Bryoria fremontii (Sensitive to sulfur dioxide; sensitive to ozone)
Bryoria fuscescens (Sensitive to intermediately sensitive to sulfur dioxide; sensitive to ozone)
Cladonia coniocraea (Intermediately sensitive to sulfur dioxide)
Cladonia fimbriata (Sensitive to intermediately sensitive to sulfur dioxide)
Hypogymnia imshaugii (Intermediately sensitive to ozone)
Hypogymnia physodes (Intermediately sensitive to sulfur dioxide)
Lecanora polytropa (Sensitive to fluoride)
Letharia vulpina (Intermediately sensitive to ozone)
Melanelia exasperatula (Intermediately sensitive to sulfur dioxide)
Nodobryoria abbreviata (Sensitive to sulfur dioxide; sensitive to ozone)
Parmelia saxatilis (Intermediately sensitive to sulfur dioxide)
Parmelia sulcata (Intermediately sensitive to sulfur dioxide; sensitive to intermediately sensitive to ozone; sensitive to fluoride)
Parmeliopsis ambigua (Intermediately sensitive to sulfur dioxide)
Peltigera aphthosa (Intermediately sensitive to sulfur dioxide)
Peltigera canina (Sensitive to ozone)
Platismatia glauca (Sensitive to sulfur dioxide)
Rhizocarpon geographicum (Sensitive to fluoride)
Tuckermannopsis chlorophylla (Sensitive to sulfur dioxide)
Tuckermannopsis orbata (Intermediately sensitive to sulfur dioxide)
Usnea subfloridana (Sensitive to intermediately sensitive to sulfur dioxide)
Vulpicida canadensis (Sensitive to sulfur dioxide)
Xanthoria candelaria (Intermediately sensitive to sulfur dioxide; Sensitive to ozone)

Vicinity of No Name Creek:

Alectoria sarmentosa (Sensitive to sulfur dioxide)
Amandinea punctata (Intermediately sensitive to sulfur dioxide)
Bryoria capillaris (Sensitive to sulfur dioxide; sensitive to fluoride)
Bryoria fremontii (Sensitive to sulfur dioxide; sensitive to ozone)
Bryoria fuscescens (Sensitive to intermediately sensitive to sulfur dioxide; sensitive to ozone)
Cladonia fimbriata (Sensitive to intermediately sensitive to sulfur dioxide)
Hypogymnia enteromorpha (Intermediately sensitive to sulfur dioxide)
Hypogymnia imshaugii (Intermediately sensitive to ozone)
Hypogymnia physodes (Intermediately sensitive to sulfur dioxide)
Lecanora polytropa (Sensitive to fluoride)
Melanelia exasperatula (Intermediately sensitive to sulfur dioxide)
Nodobryoria abbreviata (Sensitive to sulfur dioxide; sensitive to ozone)
Parmelia sulcata (Intermediately sensitive to sulfur dioxide; sensitive to intermediately sensitive to ozone; sensitive to fluoride)
Parmeliopsis ambigua (Intermediately sensitive to sulfur dioxide)

Vicinity of No Name Creek (cont.):

Peltigera canina (Sensitive to ozone)
Peltigera rufescens (Sensitive to intermediately sensitive to ozone)
Physcia dubia (Sensitive to intermediately sensitive to fluoride)
Platismatia glauca (Sensitive to sulfur dioxide)
Rhizocarpon geographicum (Sensitive to fluoride)
Tuckermannopsis chlorophylla (Sensitive to sulfur dioxide)
Tuckermannopsis orbata (Intermediately sensitive to sulfur dioxide)
Usnea subfloridana (Sensitive to intermediately sensitive to sulfur dioxide)
Xanthoria elegans (Intermediately sensitive to sulfur dioxide)

Silvertip Trailhead:

Alectoria imshaugii (Sensitive to sulfur dioxide)
Alectoria sarmentosa (Sensitive to sulfur dioxide)
Amandinea punctata (Intermediately sensitive to sulfur dioxide)
Bryoria fremontii (Sensitive to sulfur dioxide; sensitive to ozone)
Bryoria fuscescens (Sensitive to intermediately sensitive to sulfur dioxide; sensitive to ozone)
Cladonia chlorophaea (Intermediately sensitive to sulfur dioxide)
Cladonia coniocraea (Intermediately sensitive to sulfur dioxide)
Cladonia fimbriata (Sensitive to intermediately sensitive to sulfur dioxide)
Hypogymnia imshaugii (Intermediately sensitive to ozone)
Hypogymnia physodes (Intermediately sensitive to sulfur dioxide)
Kaernefeltia merrillii (Intermediately sensitive to ozone)
Lecanora polytropa (Sensitive to fluoride)
Letharia vulpina (Intermediately sensitive to ozone)
Parmeliopsis ambigua (Intermediately sensitive to sulfur dioxide)
Parmeliopsis hyperopta (Intermediately sensitive to sulfur dioxide)
Peltigera canina (Sensitive to ozone)
Rhizocarpon geographicum (Sensitive to fluoride)
Tuckermannopsis orbata (Intermediately sensitive to sulfur dioxide)
Usnea subfloridana (Sensitive to intermediately sensitive to sulfur dioxide)
Vulpicida canadensis (Sensitive to sulfur dioxide)

Meadow Creek Trailhead:

Alectoria imshaugii (Sensitive to sulfur dioxide)
Alectoria sarmentosa (Sensitive to sulfur dioxide)
Amandinea punctata (Intermediately sensitive to sulfur dioxide)
Bryoria capillaris (Sensitive to sulfur dioxide; sensitive to fluoride)
Bryoria fremontii (Sensitive to sulfur dioxide; sensitive to ozone)
Bryoria fuscescens (Sensitive to intermediately sensitive to sulfur dioxide; sensitive to ozone)
Candelariella vitellina (Intermediately sensitive to sulfur dioxide; sensitive to fluoride)
Cladonia chlorophaea (Intermediately sensitive to sulfur dioxide)
Cladonia fimbriata (Sensitive to intermediately sensitive to sulfur dioxide)
Collema crispum (Sensitive to intermediately sensitive to ozone)

Meadow Creek Trailhead (cont.):

Collema fuscovirens (Sensitive to intermediately sensitive to ozone)
Hypogymnia enteromorpha (Intermediately sensitive to sulfur dioxide)
Hypogymnia imshaugii (Intermediately sensitive to ozone)
Hypogymnia physodes (Intermediately sensitive to sulfur dioxide)
Kaernefeltia merrillii (Sensitive to intermediately sensitive to ozone)
Lecanora polytropa (Sensitive to fluoride)
Lecanora saligna (Intermediately sensitive to sulfur dioxide)
Leptogium lichenoides (Sensitive to sulfur dioxide)
Letharia vulpina (Intermediately sensitive to ozone)
Melanelia exasperatula (Intermediately sensitive to sulfur dioxide)
Nodobryoria abbreviata (Sensitive to sulfur dioxide; sensitive to ozone)
Ochrolechia androgyna (Sensitive to sulfur dioxide)
Parmelia sulcata (Intermediately sensitive to sulfur dioxide; sensitive to intermediately sensitive to ozone; sensitive to fluoride)
Parmeliopsis ambigua (Intermediately sensitive to sulfur dioxide)
Parmeliopsis hyperopta (Intermediately sensitive to sulfur dioxide)
Peltigera aphthosa (Intermediately sensitive to sulfur dioxide)
Peltigera canina (Sensitive to ozone)
Phaeophyscia sciastra (Sensitive to ozone)
Physcia adscendens (Intermediately sensitive to sulfur dioxide; sensitive to fluoride)
Physcia dubia (Sensitive to intermediately sensitive to fluoride)
Platismatia glauca (Sensitive to sulfur dioxide)
Rhizocarpon geographicum (Sensitive to fluoride)
Tuckermannopsis chlorophylla (Sensitive to sulfur dioxide)
Tuckermannopsis orbata (Intermediately sensitive to sulfur dioxide)
Usnea subfloridana (Sensitive to intermediately sensitive to sulfur dioxide)
Vulpicida canadensis (Sensitive to sulfur dioxide)
Xanthoria candelaria (Intermediately sensitive to sulfur dioxide; Sensitive to ozone)
Xanthoria elegans (Intermediately sensitive to sulfur dioxide)

Along Eagle Creek:

Amandinea punctata (Intermediately sensitive to sulfur dioxide)
Candelariella vitellina (Intermediately sensitive to sulfur dioxide; sensitive to fluoride)
Collema cristatum (Sensitive to intermediately sensitive to ozone)
Hypogymnia imshaugii (Intermediately sensitive to ozone)
Hypogymnia physodes (Intermediately sensitive to sulfur dioxide)
Letharia vulpina (Intermediately sensitive to ozone)
Melanelia exasperatula (Intermediately sensitive to sulfur dioxide)
Melanelia subolivacea (Intermediately sensitive to ozone)
Parmelia sulcata (Intermediately sensitive to sulfur dioxide; sensitive to intermediately sensitive to ozone; sensitive to fluoride)
Parmeliopsis ambigua (Intermediately sensitive to sulfur dioxide)
Peltigera rufescens (Sensitive to intermediately sensitive to ozone)
Physcia adscendens (Intermediately sensitive to sulfur dioxide; sensitive to fluoride)
Platismatia glauca (Sensitive to sulfur dioxide)

Along Eagle Creek (cont.):

- Tuckermannopsis chlorophylla* (Sensitive to sulfur dioxide)
- Usnea hirta* (Sensitive to intermediately sensitive to sulfur dioxide)
- Usnea subfloridana* (Sensitive to intermediately sensitive to sulfur dioxide)
- Vulpicida pinastri* (Sensitive to intermediately sensitive to sulfur dioxide)
- Xanthoria elegans* (Intermediately sensitive to sulfur dioxide)

West Fork of the Teton Campground:

- Amandinea punctata* (Intermediately sensitive to sulfur dioxide)
- Bryoria fremontii* (Sensitive to sulfur dioxide; sensitive to ozone)
- Bryoria fuscescens* (Sensitive to intermediately sensitive to sulfur dioxide; sensitive to ozone)
- Caloplaca holocarpa* (Intermediately sensitive to sulfur dioxide)
- Candelariella vitellina* (Intermediately sensitive to sulfur dioxide; sensitive to fluoride)
- Cladonia fimbriata* (Sensitive to intermediately sensitive to sulfur dioxide)
- Hypogymnia imshaugii* (Intermediately sensitive to ozone)
- Hypogymnia physodes* (Intermediately sensitive to sulfur dioxide)
- Kaernefeltia merrillii* (Sensitive to intermediately sensitive to sulfur dioxide)
- Lecanora polytropa* (Sensitive to fluoride)
- Lecanora saligna* (Intermediately sensitive to sulfur dioxide)
- Letharia vulpina* (Intermediately sensitive to ozone)
- Melanelia exasperatula* (Intermediately sensitive to sulfur dioxide)
- Melanelia subolivacea* (Intermediately sensitive to ozone)
- Parmelia sulcata* (Intermediately sensitive to sulfur dioxide; sensitive to intermediately sensitive to ozone; sensitive to fluoride)
- Parmeliopsis ambigua* (Intermediately sensitive to sulfur dioxide)
- Parmeliopsis hyperopta* (Intermediately sensitive to sulfur dioxide)
- Peltigera aphthosa* (Intermediately sensitive to sulfur dioxide)
- Peltigera canina* (Sensitive to ozone)
- Peltigera rufescens* (Sensitive to intermediately sensitive to ozone)
- Platismatia glauca* (Sensitive to sulfur dioxide)
- Tuckermannopsis chlorophylla* (Sensitive to sulfur dioxide)
- Tuckermannopsis orbata* (Intermediately sensitive to sulfur dioxide)
- Usnea subfloridana* (Sensitive to intermediately sensitive to sulfur dioxide)
- Vulpicida pinastri* (Sensitive to intermediately sensitive to sulfur dioxide)

South Fork Teton Trailhead:

- Alectoria sarmentosa* (Sensitive to sulfur dioxide)
- Bryoria capillaris* (Sensitive to sulfur dioxide; sensitive to fluoride)
- Bryoria fremontii* (Sensitive to sulfur dioxide; sensitive to ozone)
- Cladonia fimbriata* (Sensitive to intermediately sensitive to sulfur dioxide)
- Hypogymnia physodes* (Intermediately sensitive to sulfur dioxide)
- Lecanora polytropa* (Sensitive to fluoride)
- Leptogium lichenoides* (Sensitive to sulfur dioxide)
- Letharia vulpina* (Intermediately sensitive to ozone)
- Melanelia exasperatula* (Intermediately sensitive to sulfur dioxide)

South Fork Teton Trailhead (cont.)

- Parmelia sulcata* (Intermediately sensitive to sulfur dioxide; sensitive to intermediately sensitive to ozone; sensitive to fluoride)
- Parmeliopsis ambigua* (Intermediately sensitive to sulfur dioxide)
- Parmeliopsis hyperopta* (Intermediately sensitive to sulfur dioxide)
- Peltigera aphthosa* (Intermediately sensitive to sulfur dioxide)
- Peltigera canina* (Sensitive to ozone)
- Peltigera rufescens* (Sensitive to intermediately sensitive to ozone)
- Platismatia glauca* (Sensitive to sulfur dioxide)
- Usnea hirta* (Sensitive to intermediately sensitive to sulfur dioxide)
- Usnea subfloridana* (Sensitive to intermediately sensitive to sulfur dioxide)
- Vulpicida canadensis* (Sensitive to sulfur dioxide)
- Xanthoria elegans* (Intermediately sensitive to sulfur dioxide)

Mortimer Gulch Trailhead:

- Amandinea punctata* (Intermediately sensitive to sulfur dioxide)
- Bryoria fuscescens* (Sensitive to intermediately sensitive to sulfur dioxide; sensitive to ozone)
- Caloplaca holocarpa* (Intermediately sensitive to sulfur dioxide)
- Cladonia fimbriata* (Sensitive to intermediately sensitive to sulfur dioxide)
- Collema cristatum* (Sensitive to intermediately sensitive to ozone)
- Hypogymnia physodes* (Intermediately sensitive to sulfur dioxide)
- Letharia vulpina* (Intermediately sensitive to ozone)
- Melanelia subolivacea* (Intermediately sensitive to ozone)
- Parmelia sulcata* (Intermediately sensitive to sulfur dioxide; sensitive to intermediately sensitive to ozone; sensitive to fluoride)
- Parmeliopsis ambigua* (Intermediately sensitive to sulfur dioxide)
- Peltigera canina* (Sensitive to ozone)
- Peltigera didactyla* (Sensitive to sulfur dioxide)
- Peltigera rufescens* (Sensitive to intermediately sensitive to ozone)
- Phaeophyscia sciastra* (Sensitive to ozone)
- Physcia adscendens* (Intermediately sensitive to sulfur dioxide; sensitive to fluoride)
- Physcia caesia* (Intermediately sensitive to sulfur dioxide)
- Physcia stellaris* (Intermediately sensitive to sulfur dioxide)
- Physcia tenella* (Sensitive to sulfur dioxide; sensitive to fluoride)
- Rhizoplaca chrysoleuca* (Sensitive to sulfur dioxide; sensitive to NO_x and PAN)
- Rhizoplaca melanophthalma* (Sensitive to sulfur dioxide)
- Tuckermannopsis chlorophylla* (Sensitive to sulfur dioxide)
- Usnea hirta* (Sensitive to intermediately sensitive to sulfur dioxide)
- Usnea subfloridana* (Sensitive to intermediately sensitive to sulfur dioxide)
- Xanthoria elegans* (Intermediately sensitive to sulfur dioxide)

South Fork Sun River Trailhead:

- Amandinea punctata* (Intermediately sensitive to sulfur dioxide)
- Bryoria fremontii* (Sensitive to sulfur dioxide; sensitive to ozone)

South Fork Sun River Trailhead (cont.):

- Bryoria fuscescens* (Sensitive to intermediately sensitive to sulfur dioxide; sensitive to ozone)
- Caloplaca cerina* (Sensitive to intermediately sensitive to sulfur dioxide)
- Caloplaca holocarpa* (Intermediately sensitive to sulfur dioxide)
- Cladonia chlorophaea* (Intermediately sensitive to sulfur dioxide)
- Cladonia fimbriata* (Sensitive to intermediately sensitive to sulfur dioxide)
- Hypogymnia imshaugii* (Intermediately sensitive to ozone)
- Hypogymnia physodes* (Intermediately sensitive to sulfur dioxide)
- Kaernefeltia merrillii* (Sensitive to intermediately sensitive to ozone)
- Lecanora polytropa* (Sensitive to fluoride)
- Letharia columbiana* (Intermediately sensitive to ozone)
- Letharia vulpina* (Intermediately sensitive to ozone)
- Melanelia exasperatula* (Intermediately sensitive to sulfur dioxide)
- Melanelia subolivacea* (Intermediately sensitive to ozone)
- Nodobryoria abbreviata* (Sensitive to sulfur dioxide; sensitive to ozone)
- Parmelia sulcata* (Intermediately sensitive to sulfur dioxide; sensitive to intermediately sensitive to ozone; sensitive to fluoride)
- Parmeliopsis ambigua* (Intermediately sensitive to sulfur dioxide)
- Parmeliopsis hyperopta* (Intermediately sensitive to sulfur dioxide)
- Peltigera aphthosa* (Intermediately sensitive to sulfur dioxide)
- Peltigera canina* (Sensitive to ozone)
- Physcia adscendens* (Intermediately sensitive to sulfur dioxide; sensitive to fluoride)
- Physcia dubia* (Sensitive to intermediately sensitive to fluoride)
- Tuckermannopsis chlorophylla* (Sensitive to sulfur dioxide)
- Usnea subfloridana* (Sensitive to intermediately sensitive to sulfur dioxide)
- Vulpicida pinastri* (Sensitive to intermediately sensitive to sulfur dioxide)

GENERAL OBSERVATIONS AND CONCLUSIONS

1. A field review of the lichen floras in the Anaconda Pintler, Cabinet Mountains, and Selway Bitterroot wilderness areas during the 2000 – 2002 field seasons indicates that the floras are still diverse and healthy.
2. All substrates (bark, lignum, rock and soil) still support diverse and abundant lichen communities.
3. An abundance of pollution sensitive growth forms, especially foliose and fruticose, still suggests minimal air pollution-related impact.
4. The general absence of necrotic and/or bleached thalli also suggests that the lichen flora is still relatively unimpacted by air pollution.
5. Re-evaluation and comparison of the elemental analysis data between the baseline and reevaluation collections provides additional insights into the status of the lichen communities in the three original wilderness areas.

- a. Our review work in the Anaconda Pintler Wilderness Area resulted in some differences in the sensitive indicator species collected for elemental analyses between the baseline and reevaluation periods. In some cases additional sensitive indicator species were collected and analyzed while in others the baseline species could not be relocated during the reevaluation sampling period. However, in cases where species could not be relocated similar species of the same growth form and from the same substrate were substituted. **Elemental analysis data** from the **Anaconda Pintler** Wilderness Area showed decreases in some element loads with increases in others (Table 1). Sulfur concentrations were still within background levels at all sites with some minor patterns of decline. There was also a significant decline in nickel concentrations at both the East Fork of the Bitterroot site and the basalt dike site west of the old smelter stack (Figure 1). The drop was precipitous in both cases: 10 ppm → 1 ppm and 90 ppm → 6 ppm respectively. A similar pattern for lead concentrations at the basalt dike and Four Mile Basin was observed – 110 ppm → 54 ppm and 47 → 26 ppm respectively. However, three sites (basalt dike, Four Mile Basin, and Goat Flat) showed elevated levels of cobalt – 14 ppm, 38 ppm, and 11 ppm respectively. Arsenic concentrations continue to be elevated at several sites: Pintler Creek – 4 → 5 ppm; basalt dike – 58 → 63 ppm; Four Mile Basin – 6 → 7 ppm; and 3 ppm at Goat Flat and vicinity of Tenmile Creek. Cu/Zn ratios almost doubled at the basalt dike site – 0.612 → 1.15, suggesting increasing levels of airborne copper in that area. Fe/Ti ratios also increased at the basalt dike site – 8.14 → 10.4. Fe/Ti ratios were also high at Pintler Creek and Four Mile Basin. Persistently elevated heavy metal concentrations in samples east of the Wilderness Area are still most likely due to smelter debris stockpiled near the old smelter site. However, some improvements were noted.
- b. **Elemental analysis data** from the **Cabinet Mountains** Wilderness Area showed essentially no change between the original samples and the follow up samples (Table 2). One sample from Milwaukee Pass (no. 805) showed elevated sulfur levels (0.205%) in the 2000 collection and one sample (no. 803) from East Fork of Bull River, also from the 2000 collections, showed moderately elevated (3 ppm) Arsenic concentrations (Figure 1).
- c. Our review work in the Selway Bitterroot Wilderness Area resulted in some differences in the sensitive indicator species collected for elemental analyses between the baseline and reevaluation periods. In some cases additional sensitive indicator species were collected and analyzed while in others the baseline species could not be relocated during the reevaluation sampling period. However, in cases where species could not be relocated similar species of the same growth form and from the same substrate were substituted. **Elemental analysis data** from the **Selway-Bitterroot** Wilderness Area showed decreases in some element loads with increases in others (Table 3). Four sites (Carlton Lakes, St. Mary's Peak, Fog Mountain and Walton Lakes) showed moderately elevated sulfur concentrations (0.151 → 0.164%) in the 2001 samples. It is interesting to note that all four of these sites are higher elevation sites – suggesting the possibility of long range transport. Overall nickel and lead concentrations are within

background levels (Figure 1). However, there was some increase in cobalt levels at several sites (Bear Creek, Nez Perce Pass, Walton Lakes, and Wilderness Gateway ranging between 10 → 36.9 ppm. During the reevaluation study, better sample analysis technology allowed for better assessment of arsenic concentrations; therefore, arsenic concentrations were moderately to significantly elevated across almost all reference sites; with values ranging from 3.05 → 12.4 ppm. There were also some issues with element ratios. Fe/Ti ratios were elevated at 6 reference sites with values ranging between 8.843 and 12.56 suggesting elevated airborne iron at some sites. Cu/Zn ratios were within background levels at all sites in the most recent survey.

6. Likewise, the **baseline evaluation of the lichen floras** in the **Gates of the Mountains, Mission Mountains, and Bob Marshall** wilderness areas suggest healthy and diverse lichen communities. From our fieldwork, we report 38 genera with 81 species for the Gates of the Mountains Wilderness Area; 31 genera with 60 species for the Mission Mountains Wilderness Area; and 54 genera and 139 species from the Bob Marshall Wilderness Area. The **abundance of sensitive indicator species** and the **diversity of species** as well as **substrate and growth form distribution patterns** further documents that the lichen flora in these wilderness areas is healthy and relatively unimpacted by air pollution. **Gates of the Mountains and Mission Mountains** wilderness areas each averaged **19 sensitive indicator species per reference site**; while **Bob Marshall** had **25 sensitive indicator species per reference site**. These are among the highest per reference site averages for any of our 8 state (Montana, Idaho, Wyoming, Utah, Nevada, Colorado, New Mexico, and Arizona) lichen air quality baseline projects in the Intermountain western United States; across more than 400 air quality reference sites.
7. Distribution of **growth form categories** in the **Gates of the Mountains** Wilderness Area further documents the occurrence of a large number of pollution-sensitive lichen species (foliose (51%) and fruticose (9%) species. While, crustose (28%) and squamulose (12%) species which are generally less sensitive to air pollution represent a smaller overall percentage of the lichen community. This pattern of high numbers of foliose and fruticose is typical of other clean air sites in the Intermountain Area.
8. Distribution of lichen species in the **Gates of the Mountains** Wilderness Area, by **substrate categories**, also supports a similar air pollution sensitivity interpretation with 38% of the species on bark, lignum, or decomposing wood (generally considered to support more sensitive species) ; 42% on rock (generally considered to support less sensitive species), with 20% on soil/mosses/detritus (sensitivities variable).
9. Distribution of **growth form categories** in the **Mission Mountains** Wilderness Area further documents the occurrence of a large number of pollution-sensitive species with foliose species and fruticose species representing 38% and 13% of the flora respectively (these growth forms are typically more sensitive to air pollution impact). While, crustose and squamulose species, representing 36% and 12% of the flora respectively, are generally less sensitive to air pollution. Again, this pattern of high

numbers of foliose and fruticose is typical of other clean air sites in the Intermountain Area.

10. Distribution of lichen species in the **Mission Mountains** Wilderness Area, by **substrate categories**, again supports a similar air pollution sensitivity interpretation with 47% of the species on bark, lignum, or decomposing wood (substrates that generally support more sensitive species); 32% on rock (a substrate that generally supports more pollution tolerant species), with 22% on soil/mosses/detritus (sensitivities variable).
11. Distribution of **growth form categories** in the **Bob Marshall** Wilderness Area follows the same pattern with the occurrence of a large number of pollution-sensitive lichen species (foliose (44%) and fruticose (9%) species. While, crustose (35%) and squamulose (12%) species are generally less sensitive to air pollution. Again, this pattern of high numbers of foliose and fruticose is typical of other clean air sites in the Intermountain Area.
12. Distribution of lichen species in the **Bob Marshall** Wilderness Area, by **substrate categories**, also supports a similar air pollution sensitivity interpretation with 50% of the species on bark, lignum, or decomposing wood (generally considered to support more sensitive species) with 34% of the species on rock (a substrate), 15% on soil/mosses/detritus (sensitivities variable), and over other lichens (1%).
13. Evaluation of the **elemental analysis data** provides additional insights into the condition of the lichen flora in the three wilderness areas added to the baseline:
 - a. **Elemental analysis data** from the **Gates of the Mountains** Wilderness Area showed several areas of concern (Table 4). Sulfur concentrations were elevated in five out of seven samples; two samples were clearly elevated at 0.214 and 0.321 while three others showed moderate elevation ranging between 0.159 and 0.175. Lead concentrations were moderately elevated in three samples ranging between 41.9 ppm and 44 ppm (Figure 1). Arsenic was elevated in two samples (6-10.4 ppm) and moderately elevated in five samples (3.87-4.95 ppm). One sample (Refrigerator Canyon) showed moderately elevated levels of Cobalt and one sample, also from Refrigerator Canyon, had a slightly elevated Iron/Titanium ratio at 8.601.
 - b. **Elemental analysis data** from the **Mission Mountains** Wilderness Area were generally at or below background levels (Figure 1) except for Arsenic samples from two sites (Glacier Lake Trail and Cold Lakes Trailhead) which were moderately elevated (Table 5).
 - c. **Elemental analysis data** from the **Bob Marshall** Wilderness Area were also at or below background levels (Figure 1) except for one sample (Table 6) that showed moderately elevated levels of sulfur (0.159%), Cobalt (15.3 ppm), and Arsenic (4.46 ppm). This sample was from the Eagle Creek site.

RECOMMENDATIONS

1. Reevaluation of potential pollutant element concentrations in sensitive indicator species from the Cabinet Mountains, Bob Marshall, and Mission Mountains wilderness areas will not be necessary until 2010 unless a point source polluter develops in close proximity to these wilderness areas. Gates of the Mountains Wilderness Area, the eastern half of the Anaconda Pintler, and key sites in the Selway Bitterroot Wilderness area should be reviewed on a more frequent schedule (2008).
2. Reevaluation of species diversity and abundance/occurrence of sensitive indicator species at reference sites can be accomplished on the same schedule.

