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FINAL REPORT SUBMITTED TO

**THOMAS HENRY, SUPERINTENDENT
CEDAR BREAKS NATIONAL MONUMENT
NATIONAL PARK SERVICE**

REGARDING:

**ESTABLISHMENT OF A LICHEN BIOMONITORING PROGRAM
AND AIR QUALITY BASELINE AT CEDAR BREAKS NATIONAL
MONUMENT, UTAH**

PREPARED & SUBMITTED

BY

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INTRODUCTION

PROJECT OBJECTIVES:

1. Identify 3 reference sites within the monument.
2. Collect, curate, and identify lichen species from various habitats and substrates at each reference site.
3. Identify 3-5 pollution-sensitive lichen species at each reference site. Collect enough tissue of one sensitive indicator species (approximately 6-10 grams dry weight) from each reference site for elemental analyses. Rare species will not be sampled for analysis, but their distribution will be noted.
4. Determine baseline thallus concentrations of 20 potential pollutant elements (including sulfur, selenium, arsenic, copper, bromine, manganese, lead, vanadium, potassium, iron, etc.), using replicate samples of one documented pollution-sensitive species collected at each reference site. Samples will be analyzed using Proton Induced X-ray Emission (PIXE) techniques.
5. Prepare and submit a final report by 31 December 1994.

LICHENS AS BIOLOGICAL INDICATORS OF AIR QUALITY:

Protocol for using lichens as bioindicators of air quality is well-established (Fields & St. Clair 1984; St. Clair 1989; Richardson 1992). Hale (1983) noted that lichens have been used in three basic ways to monitor the effects of air pollution on biological systems: 1) elemental analysis of lichen tissues, 2) mapping of all (or selected) lichen species found in areas adjacent to pollution sources, and 3) transplant studies. Currently, the most common approach involves a floristic survey along with elemental analyses of tissues from sensitive indicator species (St. Clair 1989; Wetmore 1989).

As lichens accumulate many different pollutants from atmospheric outwash, lichen tissues provide a record of the kinds and relative quantities of air pollutants in any particular airshed (Schutte 1977; Wetmore 1989; Rope & Pearson 1990). Pollutant accumulation patterns for specific elements have been monitored over time by correlating thallus growth rates and pollutant

concentrations in excised portions of lichen thalli (Lawry & Hale 1981). Changes in lichen physiological processes indicate pollution-related damage long before other, more easily detectable changes in thallus color, morphology, or community structure become apparent (Fields & St. Clair 1984).

Lists of pollution-sensitive lichen species have commonly been published in conjunction with floristic and ecological surveys (Rushforth et al. 1982; Wetmore 1989). As certain lichen species are inherently more sensitive to airborne contaminants, air quality can be effectively monitored by occasionally reevaluating lichen community and/or physiological parameters. Pollution-related changes can then be documented by comparing follow-up data to original baseline data.

GENERAL HABITAT DESCRIPTION OF CEDAR BREAKS NATIONAL MONUMENT:

Cedar Breaks National Monument is located in eastern Iron County, on the western edge of the Markagunt Plateau. The monument consists of approximately 6,500 acres located between 37° 40' and 37° 36' north latitude, and 112° 52' 30" and 112° 49' west longitude. Elevation in the monument ranges from 2,469 to 3,250 m. The monument is surrounded by Dixie National Forest. Brian Head Peak (3446 m) is located approximately one kilometer north of the monument. Ashdown Gorge Wilderness Area (8,200 acres) is located along the western boundary of the monument (figure 1).

GEOLOGY

The Pacific Ocean floor driving under the west coast of North America caused uplift in the late Jurassic or early Cretaceous, and is responsible for Cretaceous sedimentation across southern Utah. A shifting shoreline in this shallow regressing sea, and brackish lagoons deposited alternating layers of the Cretaceous Wahweap and Straight Cliffs sandstones (Stokes and Heylmun 1963; Van De Graaff 1963; Harris and Tuttle 1983; Stokes 1986; Hintze 1988; Stanley 1989). The Cretaceous Kaiparowits sandstones and conglomerates exhibit features suggestive of deposition on late Cretaceous sandbars, deltas, river flats, meandering streams, and fresh water lakes and ponds (Stokes and Heylmun 1963; Van De Graaff 1963; and Harris and Tuttle 1983). Further subduction of the Pacific floor caused the uplift of the Rockies, Uintas, San Rafael Swell, and other monoclinals

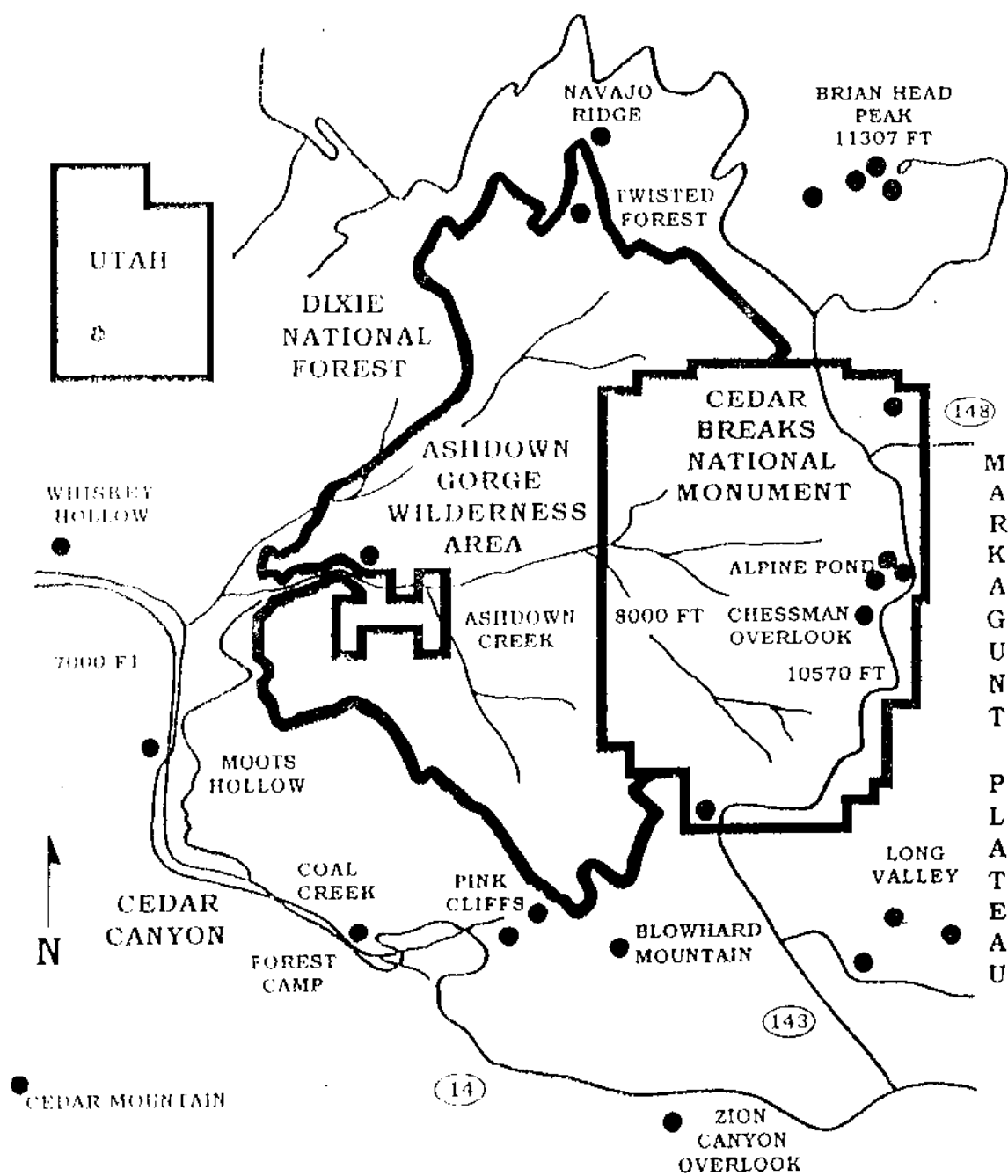


Figure 1 - Collection Sites

flexures (Harris and Tuttle 1983; Stokes 1986; Hintze 1988; Stanley 1989; and Wicander and Monroe 1993). Tertiary Claron limestones, sandstones, shales, and conglomerates, which dominate the geology of the monument, were deposited by uplift episodes during the Paleocene and Eocene. Conglomerates and sandstones were deposited first, in or near streams and rivers with limestones and shales deposited later in a shallow, oscillating Tertiary Lake (Harris and Tuttle 1983; Stokes 1986; Hintze 1988; Stanley 1989; and Wicander and Monroe 1993). Lava flows, volcanic mudflows, airfall and waterlaid tuffs, ash flow tuffs, and dioritic magmas were characteristic of the Eocene, Oligocene, and early Miocene in North America. Continued pressure from the colliding oceanic and continental plates caused the formation of the basin and range geology of Nevada and western Utah, eventually resulting in a regional uplift, which included the entire state of Utah. Uplifting, subsidence, downwarping, and block faulting along the Wasatch-Las Vegas Line formed the Colorado Plateau/Great Basin margin. Near Cedar City, the Hurricane Fault, a normal slip fault, is downthrown 4,000 feet to the west resulting in a deeply eroded and battered fault escarpment, part of which forms the Hurricane Cliffs and Cedar Breaks amphitheatre (Stokes and Heylmun 1963; Threet 1963; Harris and Tuttle 1983; Stokes 1986; and Hintze 1988).

VEGETATION

Drastic elevational changes in the "Breaks" significantly affects the structure and distribution of vascular plant communities in the monument. The west face of the Markagunt Plateau has a variety of vegetation zones; however, because of steep elevational gradients Ponderosa Pine, spruce/fir, and aspen communities may be scattered or in some cases even combined.

Riparian plant communities are well developed along the streams of the Markagunt plateau. Dominant components of this habitat type include species from the following genera: *Betula*, *Carex*, *Cornus*, *Equisetum*, *Populus*, *Phragmites*, and *Salix*.

The pinyon/juniper, mountain brush, and ponderosa communities occur together near the west end of the monument at about 2400 m. This area receives 46 cm (18 in.) precipitation per year (Crockett and Nelson 1963), and is characterized by wash bottoms, ridges, rocky outcrops, and alluvial deposits. Common genera found in this area are *Acer*, *Amelanchier*, *Artemisia*, *Cercocarpus*, *Juniperus*, *Pinus*, *Purshia*, *Quercus*, as well as various grass species.

Scattered Ponderosa Pine communities occur between 2438 and 2560 m, and receive 56 cm (22 in.) precipitation annually (Crockett and Nelson 1963). These sites are characterized by flat wash bottoms and hillsides below the breaks. Dominant genera include: *Arctostaphylos*, *Pinus*, *Populus*, and various grass species.

Spruce/fir communities are also scattered, but generally occur between 2438 and 2621 m. This habitat type receives 61 cm (24 in.) precipitation annually (Crockett and Nelson 1963), and is characterized by steep cliffs and shallow soils. Dominant genera in this area include: *Abies*, *Picea*, *Pseudotsuga*, *Populus*, and various grass species.

Aspen communities in the monument often intermix with the Ponderosa Pine and spruce/fir vegetation zones, between 2621 and 2804 m. Aspen stands are particularly common at moderate to high elevation sites and along the basalt flats on the east side of the monument. These areas receive an average of 64 cm (25 in.) precipitation per year (Crockett and Nelson 1963), and include the following genera: *Abies*, *Picea*, *Populus*, as well as several grass species.

Higher elevation sites in the monument, between 2800 and 3200 m, are dominated by Engelmann Spruce and Subalpine Fir. These areas average 76 cm (30 in.) precipitation annually (Crockett and Nelson 1963). High elevation meadows and glaciated valleys characterize the area, with spruce and fir often forming tree islands in the middle of subalpine meadows. Common genera in these areas include: *Abies*, *Picea*, and various herb and grass species.

LANDTYPES

The National Forest Service has identified six basic landtype associations for the area surrounding Cedar Breaks National Monument (unpublished data). The topography, soils, and vegetation of these landtype associations, are heavily influenced by the geology of the area. The six landtypes are as follows:

Faultlands Association: consists of undulating benchlands where the parent material is mixed colluvium and volcanic rock. Steep dissected hills with narrow canyon bottoms characterize the lower elevation faultlands and the parent rock is made up of limestones, shales, and conglomerates. The lower slope soils are moderately deep silty loams, and the upper slope soils are cobbly loams and clay loams. Engelmann Spruce, Subalpine Fir, and Quaking Aspen are common higher elevation species, while Ponderosa Pine, Pinyon Pine, Utah Juniper, and Mountain Mahogany dominate lower elevation sites.

Steep Sideslopes Association: includes volcanic rock which decomposes to form shallow, gravelly loam soils; while adjacent valleys are filled with alluvium which produces deep clay loam soils. Engelmann Spruce and Subalpine Fir are common on the steep sideslopes, while Silver Sage dominates the valley floors.

Rimlands Association: includes the pink cliffs area and associated ridges. Although soils are not developed on the barren pink cliffs, limestone, sandstone, and shale debris accumulates on the benches to form deep gravelly silty clay loam and clay loam soils. Ponderosa Pine, Engelmann Spruce, Subalpine Fir, Quaking Aspen, and Gambel Oak, are species commonly found in this association.

Rocklands Association: includes the benchlands, cinder cones, and lava flows. Where soils have developed, they are moderately deep to deep loams and clay loams. Large basalt boulders are common throughout this area. Because of the extensive basalt flows, plant communities are slow to develop; although Engelmann Spruce, Subalpine Fir, Quaking Aspen, and Ponderosa Pine are common where soils exist. Aspen tends to grow particularly well in the basalt flows.

Glaciated Headslopes Association: comprises the open valleys and low hills located east of the "Breaks". These valleys and ridges are commonly covered with cobbles and boulders; however, significant decomposition of limestone and volcanic rock has yielded deep gravelly clay loam soils in many areas. Silver Sage, various grass and forb species dominate this association. In the higher elevation areas Engelmann Spruce, Subalpine Fir, and Quaking Aspen commonly form tree islands in open meadows.

Mesas and Valleys Association: include gently sloping mesa tops and shallow open valleys. Basalt, limestone, shale, and mixed alluvium form the parent material of this association. Mesa tops have moderately deep gravelly clay loam soils, while the valleys have deep silty clay loam soils. The valley rim and bench soils are shallow. Ponderosa Pine, Engelmann Spruce, Sagebrush, and various grass and forb species dominate this association.

LICHEN BIOMONITORING REFERENCE SITES IN AND AROUND CEDAR BREAKS NATIONAL MONUMENT:

A total of 22 reference sites were established in or near CBNM -Cedar Breaks National Monument (figure 1). Specifically, reference sites established within the monument include: Chessman Overlook, east Alpine Pond Trail, south Alpine Pond Trail, west Alpine Pond Trail, south entrance, and intersection of state roads 143 and 148.

Reference sites established in the AGWA - Ashdown Gorge Wilderness Area (Dixie National Forest) include: Ashdown Gorge cliffs and the Twisted Forest. Reference sites in other parts of the DNF - Dixie National Forest include: Blowhard Mountain (Radar Station), Blowhard Mountain (south Pink Cliffs), Blowhard Mountain (south wash), Brian Head Peak at end of FS 047, east Brian Head Peak, south Brian Head Peak, and west Brian Head Peak, Forest Camp near SR 14, Long Valley basalt flows along FS 039, Long Valley, Navajo Ridge along FS 265, near southeast corner of monument, west Brian Head Peak ski lift access road, and Zion Canyon Overlook. Reference sites established on private property include: near Moots Hollow west of SR14.

METHODS

COLLECTION, CURATION, IDENTIFICATION, AND DEPOSITION OF LICHEN SPECIES:

Because lichen distribution is directly influenced by substrate, moisture and sunlight, all available substrates and habitats at each reference site were carefully examined. Small amounts of each lichen species were either removed directly from the substrate, or depending on the species, with a small piece of the substrate (bark, wood, soil, or rock).

All specimens were placed in carefully labeled paper sacks and taken back to the BYU Herbarium of Nonvascular Cryptogams, where they were curated, identified, placed in permanent herbarium packets, and labeled with the current epithets and authors' names as well as detailed information about the collection site, habitat, and substrate.

Species were identified using standard lichen keys and taxonomic treatises. Standard chemical spot tests and, where necessary, thin-layer chromatography techniques were used to finalize species identifications.

One set of specimens collected from each reference site will be on permanent loan to the BYU Herbarium of Nonvascular Cryptogams in Provo, Utah. A second set of voucher specimens will be sent to any herbarium designated by the National Park Service. Numbering, labeling and accountability for specimens follow Park Service protocol.

COLLECTION OF LICHEN THALLI FOR LABORATORY ANALYSES:

After careful consideration of species abundance, substrate, growth form, documented/suspected pollution sensitivity and general distribution patterns of the lichens at each reference site, one species was designated as the sensitive indicator species and used for all laboratory chemical analyses.

At each reference site sufficient material of at least one sensitive indicator species was collected for laboratory analyses (6-10 grams dry weight). All lichen material collected for elemental analyses was placed in Hubco cloth bags (to avoid contamination) and transported back to the BYU Herbarium of Nonvascular Cryptogams. Excess material is permanently stored in Hubco cloth bags in the elemental analysis collection at the BYU Herbarium of Nonvascular Cryptogams. This material is available for additional testing upon request.

DETERMINATION OF ELEMENTAL CONCENTRATIONS IN LICHEN TISSUES:

In the laboratory, surface debris and dust were removed from all samples. Clean, two gram samples of one indicator species from each reference site were delivered to the Elemental Analysis Laboratory at Brigham Young University.

Samples were prepared for PIXE analysis using the methods of Duflou et al. (1987). Lichen samples were placed in Teflon containers with a teflon coated steel ball, cooled to liquid nitrogen temperature, powdered by brittle fracture using a Braun Micro-Dismemberator II, and then dried in an Imperial IV Microprocessor Oven for 14 hours at 80°C. Subsamples weighing 150 mg were then weighed into 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 again using the micro-dismemberator. Approximately 1 mg of the powdered lichen was then carefully weighed onto a thin polycarbonate film in an area of 0.5cm². 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). The Mylar was backed with 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 also prepared and analyzed using the same procedures.

RESULTS

LICHEN MATERIAL COLLECTED FOR ELEMENTAL ANALYSES:

A total of 4 elemental analysis samples including 2 species from 1 substrate (rock) were collected from four reference sites. Analyses of sensitive species samples were performed using Proton Induced X-Ray Emission (PIXE) technology. Below is a list of the elemental analysis samples by sample number, species, substrate, and reference site (the first number represents the storage drawer and the second number indicates the bag number). All specimens are stored in Hubco cloth bags in the elemental analysis collection at the Herbarium of Nonvascular Cryptograms at Brigham Young University. Elemental analyses have been performed for the following samples:

<u>Sample#</u>	<u>Taxa</u>	<u>Substrate</u>	<u>Collection Site</u>
22-177	Rhizoplaca melanophthalma	Rock	So. Pond Trail
22-178	Xanthoparmelia cumberlandia	Rock	So. Entrance
22-179	Xanthoparmelia cumberlandia	Rock	So. East corner of monument
27-221	Rhizoplaca melanophthalma	Rock	Brian Head Peak

LIST OF POLLUTION SENSITIVE INDICATOR SPECIES:

Acarospora chlorophana (sensitive to sulfur dioxide)
Buellia punctata (intermediately sensitive to sulfur dioxide)
Caloplaca cerina (sensitive to intermediately sensitive to sulfur dioxide)

Caloplaca holocarpa (intermediately sensitive to sulfur dioxide)
Candelaria concolor (sensitive to intermediately sensitive to sulfur dioxide, and sensitive to Fluoride)
Candelariella vitellina (intermediately sensitive to sulfur dioxide and sensitive to fluoride)
Cladonia coniocraea (intermediately sensitive to sulfur dioxide)
Cladonia fimbriata (sensitive to intermediately sensitive to sulfur dioxide)
Melanelia exasperatula (intermediately sensitive to sulfur dioxide)
Melanelia subolivacea (intermediately sensitive to ozone)
Peltigera canina (sensitive to ozone)
Peltigera rufescens (sensitive to intermediately sensitive to ozone)
Phaeophyscia orbicularis (sensitive to ozone, intermediately sensitive to sulfur dioxide, and sensitive to Fluoride)
Physcia adscendens (intermediately sensitive to sulfur dioxide, and sensitive to Fluoride)
Physcia aipolia (intermediately sensitive to sulfur dioxide, and sensitive to Fluoride)
Physcia caesia (intermediately sensitive to sulfur dioxide)
Physcia dubia (sensitive to intermediately sensitive to Fluoride)
Physcia stellaris (intermediately sensitive to sulfur dioxide)
Physconia detera (sensitive to intermediately sensitive to sulfur dioxide)
Rhizoplaca chrysoleuca (sensitive to sulfur dioxide and sensitive to nitrous oxides and PAN)
Rhizoplaca melanophthalma (sensitive to sulfur dioxide)
Usnea subfloridana (sensitive to intermediately sensitive to sulfur dioxide)
Xanthoria candelaria (sensitive to ozone, and intermediately sensitive to sulfur dioxide)
Xanthoria fallax (sensitive to intermediately sensitive to sulfur dioxide, and sensitive to nitrous oxides and PAN)
Xanthoria polycarpa (sensitive to intermediately sensitive to sulfur dioxide)

**CHECKLIST OF LICHEN SPECIES FROM SELECTED SITES IN
CEDAR BREAKS NATIONAL MONUMENT, UTAH**

Acarospora americana Magnusson

Growth form: crustose
Substrate: Tertiary volcanics
Site(s): DNF: Brian Head Peak.
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BRY C25818

Acarospora cervina var. glaucocarpa (Wahlenb. in Ach.) Korber

Growth form: squamulose
Substrate: moss over Straight Cliffs Formation, Straight Cliffs
Formation.
Site(s): DNF: Forest Camp. Private: near Moots Hollow.
Relative abundance: Locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BRY C25550, C25555, and C25718.

Acarospora chlorophana (Wahlenb. ex Ach) Massal.

Growth form: crustose with effigurate margins
Substrate: Tertiary volcanics and Quaternary volcanics.
Site(s): CBNM: west Alpine Pond Trail. DNF: Brian Head Peak,
east Brian Head Peak, south Brian Head Peak, west Brian
Head Peak ski lift access road, Long Valley basalt flows,
Navajo Ridge.
Relative abundance: locally common
Pollution sensitivity: sensitive to SO₂ (Ryan 1990)
Comments: none
Deposition of specimens: BRY C25516, C25574, C25611,
C25629, C25687, and C25800.

Acarospora Schleicheri (Ach.) Massal.

Growth form: crustose

Substrate: Claron formation and Tertiary volcanics.

Site(s): DNF: Blowhard Mountain (south Pink Cliffs), south Brian Head Peak, east Brian Head Peak.

Relative abundance: rare

Pollution sensitivity: unknown

Comments: This species commonly occurs on soil in alpine tundra habitats, occurrence of rock is unusual.

Deposition of specimens: BRY C25662 and C25693.

Acarospora stapfiana (Müll. Arg.) Hue

Growth form: crustose

Substrate: Rock, Tertiary volcanics, and Claron formation.

Site(s): DNF: Blowhard Mountain (south Pink Cliffs), Navajo Ridge.

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: This species commonly grows over *Caloplaca trachyphylla*

Deposition of specimens: BRY C25610 and C25663

Acarospora strigata (Nyl.) Jatta

Growth form: crustose

Substrate: Claron formation

Site(s): DNF: Blowhard Mountain (south Pink Cliffs).

Relative abundance: rare to locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BRY C25660

Aspicilia cinerea (L.) Korber

Growth form: crustose

Substrate: Tertiary volcanics.

Site(s): DNF: west Brian Head Peak ski lift access road, Blowhard Mountain (Radar Station), near southeast corner of the monument.

Relative abundance: rare to locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BRY C25520, C25559, and C25713.

Aspicilia desertorum (Krempelh.) Mereschk.

Growth form: crustose

Substrate: Tertiary volcanics and Quaternary volcanics.

Site(s): CBNM: south Alpine Pond Trail, intersection of SR 143 and SR 148. DNF: Brian Head Peak, east Brian Head Peak, south Brian Head Peak, Long Valley basalt flows, Navajo Ridge, near southeast corner of the monument.

Relative abundance: locally common to abundant

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BRY C25588, C25613, C25635, C25650, C25690, C25701, C25705, and C25804.

Bellemeria alpina (Sommerf.) Clauz & Roux

Growth form: crustose

Substrate: Tertiary volcanics

Site(s): CBNM: intersection of SR 143 and SR 148.

Relative abundance: rare to locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BRY C25647

Bellemeria cinereorufescens (Ach.) Clauz. & Roux

Growth form: crustose

Substrate: Tertiary volcanics.

Site(s): CBNM: intersection of SR 143 and SR 148.

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BRY C25645

Buellia elegans Poelt

Growth form: crustose with deeply effigurate margins

Substrate: soil

Site(s): DNF: Blowhard Mountain (south Pink Cliffs).

Relative abundance: rare to locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BRY C25656

Buellia erubescens Arnold

Growth form: crustose
Substrate: lignum
Site(s): DNF: near southeast corner of the monument.
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BRY C25101 and C25102

Buellia punctata (Hoffm.) Massal.

Growth form: crustose
Substrate: lignum, *Picea engelmannii*, and *Pseudotsuga menziesii*
Site(s): CBNM: west Alpine Pond Trail, intersection of SR 143 and SR 148. DNF (AGWA): Ashdown Gorge Cliffs. DNF: west Brian Head Peak.
Relative abundance: common
Pollution sensitivity: intermediately sensitive to SO₂
Comments: none
Deposition of specimens: BRY C25135, C25181, C25323, and C25392

Caloplaca arizonica Magnusson

Growth form: crustose
Substrate: lignum and *Pinus longaeva* lignum
Site(s): DNF (AGWA): Twisted Forest.
Relative abundance: locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BRY C25193-C25199

Caloplaca atroalba (Tuck.) Zahlbr.

Growth form: crustose
Substrate: Claron formation
Site(s): DNF: Blowhard Mountain (south wash).
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BRY C25789

Caloplaca cerina (Ehrh. ex Hedwig) Th. Fr.

Growth form: crustose

Substrate: *Abies lasiocarpa* and lignum

Site(s): CBNM: south entrance. DNF: near southeast corner of the monument.

Relative abundance: common

Pollution sensitivity: sensitive to intermediately sensitive to SO₂ (Wetmore 1987)

Comments: none

Deposition of specimens: BRY C25103, C25104, C25437, and C25438

Caloplaca cladodes (Tuck.) Zahlbr.

Growth form: minutely fruticose

Substrate: Claron Formation.

Site(s): DNF: Blowhard Mountain (south wash).

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BRY C25790

Caloplaca epithallina Lynge

Growth form: obsolete

Substrate: epiphytic on lichen species

Site(s): DNF: Brian Head Peak, Long Valley basalt flows.

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BRY C25630 and C25825.

Caloplaca fraudans (Th. Fr.) H. Olivier

Growth form: crustose

Substrate: *Juniperus scopulorum*

Site(s): DNF (AGWA): Ashdown Gorge Cliffs.

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BRY C25324

Caloplaca holocarpa (Hoffm.)

Growth form: crustose

Substrate: lignum, *Pinus flexilis*, and *Pinus longaeva*
lignum

Site(s): CBNM: Chessman Overlook. DNF (AGWA): Twisted
Forest.

Relative abundance: common

Pollution sensitivity: intermediately sensitive to SO₂

Comments: none

Deposition of specimens: BRY C25200 - C25202 and C25424

Caloplaca pinicola Magnusson

Growth form: crustose

Substrate: lignum

Site(s): DNF: Long Valley.

Relative abundance: rare

Pollution sensitivity: unknown

Comments: this taxon is a new species record for Utah

Deposition of specimens: BRY C25128

Caloplaca tirolensis Zahlbr.

Growth form: obsolete

Substrate: detritus

Site(s): DNF: Brian Head Peak.

Relative abundance: rare

Pollution sensitivity: unknown

Comments:

Deposition of specimens: BRY C25814.

Caloplaca trachyphylla (Tuck.) Zahlbr.

Growth form: crustose with well-developed effigurate margins

Substrate: Tertiary volcanics, Claron formation, and
Quaternary volcanics.

Site(s): DNF (AGWA): Twisted Forest. DNF: Blowhard
Mountain (south Pink Cliffs), Brian Head Peak, east Brian
Head Peak, south Brian Head Peak, west Brian Head Peak.

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BRY C25602, C25666, C25679,
C25689, and C25822.

Candelaria concolor (Dickson) B. Stein

Growth form: foliose
Substrate: *Abies lasiocarpa*
Site(s): CBNM: south entrance.
Relative abundance: rare
Pollution sensitivity: Sensitive to intermediately sensitive to SO₂ (Wetmore 1987)
Comments: none
Deposition of specimens: BRY C25439

Candelariella aurella (Hoffm.) Zahlbr.

Growth form: crustose
Substrate: lignum
Site(s): DNF (AGWA): Twisted Forest.
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BRY C25203

Candelariella deflexa (Nyl.) Zahlbr.

Growth form: crustose
Substrate: lignum, *Pinus longaeva* lignum, *Pseudotsuga menziesii*, detritus
Site(s): CBNM: Chessman Overlook. DNF (AGWA): Twisted Forest. DNF: Blowhard Mountain (south Pink Cliffs), Brian Head Peak.
Relative abundance: common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BRY C25186, C25204, C25408, C25425, C25426, and C25817.

Candelariella vitellina (Hoffm.) Mull. Arg.

Growth form: crustose
Substrate: *Abies lasiocarpa*
Site(s): CBNM: south entrance.
Relative abundance: rare
Pollution sensitivity: intermediately sensitive to SO₂ (Wetmore 1987)
Comments: none
Deposition of specimens: BRY C25440

Candelariella rosulans (Mull. Arg.) Zahlbr.

Growth form: crustose with effigurate margins

Substrate: Tertiary volcanics, Claron formation, and Quaternary volcanics.

Site(s): CBNM: east Alpine Pond Trail. DNF (AGWA): Twisted Forest. DNF: Blowhard Mountain (south Pink Cliffs), east Brian Head Peak, south Brian Head Peak, west Brian Head Peak, Long Valley basalt flows.

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BRY C25590, C25605, C25625, C25667, C25674, C25686, and C25828.

Candelariella xanthostigma (Ach.) Lettau

Growth form: crustose, sorediose

Substrate: *Abies lasiocarpa*

Site(s): CBNM: south entrance.

Relative abundance: rare to common

Pollution sensitivity: unknown

Comments: none

Deposition of specimen: BRY C25441 and C25442

Catapyrenium cinereum (Pers.) Korber

Growth form: squamulose

Substrate: soil

Site(s): DNF (AGWA): Twisted Forest.

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BRY C25600

Catapyrenium lachneum (Ach.) R. Sant

Growth form: squamulose

Substrate: soil

Site(s): DNF: Brian Head Peak, Long Valley basalt flows.
Private: near Moots Hollow.

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium BRY C25556, C25617, C25807 and C25808.

Catapyrenium plumbeum (B. de Lesd.) Thomson

Growth form: squamulose
Substrate: soil over rock
Site(s): DNF (AGWA): Ashdown Gorge Cliffs.
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BRY C25545

Catapyrenium tuckermannii (Rav. ex Mont.) Thomson

Growth form: squamulose
Substrate: lignum and *Pinus flexilis* lignum
Site(s): DNF (AGWA): Twisted Forest.
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BRY C25249 - C25253

Catapyrenium zahlbruckneri (Hasse) Thomson

Growth form: squamulose
Substrate: Claron formation
Site(s): DNF: Blowhard Mountain (south Pink Cliffs).
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BRY C25668

Catillaria glauconigrans (Tuck.) Hasse

Growth form: crustose
Substrate: *Pinus longaeva* lignum
Site(s): DNF (AGWA): Twisted Forest.
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BRY C25409

Cladonia cariosa (Ach.) Sprengel

Growth form: squamulose with podetia

Substrate: lignum, moss over lignum, soil, moss over soil,
and moss over detritus.

Site(s): CBNM: intersection of SR 143 and SR 148, and south
entrance. DNF (AGWA): Ashdown Gorge Cliffs. DNF:
Blowhard Mountain (south Pink Cliffs), Forest Camp, Long
Valley basalt flows, near southeast corner of the
monument. Private: near Moots Hollow.

Relative abundance: common to abundant

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BRY C25009, C25105 - C25109,
C25325 - C25327, C25500, C25502, C25622, C25640,
C25642, C25659, C25698, C25781.

Cladonia chlorophaea (Flörke ex Sommerf.) Sprengel

Growth form: squamulose with podetia

Substrate: lignum, moss over lignum and moss over soil , and
moss over detritus.

Site(s): CBNM: west Alpine Pond Trail, intersection of SR 143
and SR 148. DNF: Brian Head Peak, west Brian Head Peak
ski lift access road, near southeast corner of the
monument. Private: near Moots Hollow.

Relative abundance: common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BRY C25010 - C25015, C25513,
C25571, C25655, C25710, and C25816.

Cladonia coniocraea auct. (fide Ahti)

Growth form: squamulose with podetia

Substrate: lignum and moss over lignum

Site(s): CBNM: intersection of SR 143 and SR 148.

Relative abundance: rare to common

Pollution sensitivity: intermediately sensitive to SO₂ (Ryan
1990)

Comments: none

Deposition of specimens: BRY C25136 - C25138

Cladonia fimbriata (L.) Fr.

Growth form: squamulose with podetia

Substrate: lignum, moss over lignum, detritus, and moss over soil.

Site(s): CBNM: west Alpine Pond Trail, intersection of SR 143 and SR 148, south entrance. DNF (AGWA): Ashdown Gorge Cliffs. DNF: Forest Camp, Long Valley basalt flows. Private: near Moots Hollow.

Relative abundance: abundant

Pollution sensitivity: sensitive to intermediately sensitive to SO₂ (Wetmore 1987)

Comments: none

Deposition of specimens: BRY C25016 - C25020, C25328, C25329, C25415, C25416, C25443 - C25446, C25562, C25620, and C25641.

Cladonia pocillum (Ach.) O. Rich

Growth form: squamulose with podetia

Substrate: detritus and moss over soil.

Site(s): CBNM: west Alpine Pond Trail. DNF: Brian Head Peak.

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of species: BRY C25563 and C25810.

Cladonia pyxidata (L.) Hoffm.

Growth form: squamulose with podetia

Substrate: lignum, moss over soil, and soil.

Site(s): CBNM: west Alpine Pond Trail, intersection of SR 143 and SR 148. DNF: Brian Head Peak. Private: near Moots Hollow.

Relative abundance: rare to common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BRY C25021, C25139, C25565, C25809, and C25815.

Collema fuscovirens (With.)

Growth form: gelatinous

Substrate: Straight Cliffs Formation, soil over rock, and Claron Formation.

Site(s): DNF (AGWA): Twisted Forest. DNF: Blowhard Mountain (south Pink Cliffs), Blowhard Mountain (south wash). Private: near Moots Hollow.

Relative abundance: rare to locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium BRY C25558, C25596, C25609, C25783 and C25838.

Collema polycarpon Hoffm.

Growth form: gelatinous

Substrate: moss over Straight Cliffs Formation, Straight Cliffs Formation, Claron formation, soil over rock.

Site(s): DNF (AGWA): Ashdown Gorge Cliffs and the Twisted Forest. DNF: Blowhard Mountain (south Pink Cliffs), Blowhard Mountain (south wash). Private: near Moots Hollow.

Relative abundance: rare to locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BRY C25536, C25553, C25595, C25784, C25787 and C25835.

Collema tenax (Swartz)

Growth form: gelatinous

Substrate: soil

Site(s): DNF (AGWA): Twisted Forest. DNF: Blowhard Mountain (south Pink Cliffs), Brian Head Peak.

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BRY C25598, C25658, and C25799.

Dermatocarpon intestiniforme (Korber) Hasse

Growth form: foliose, umbilicate

Substrate: Tertiary volcanics, Claron Formation, and Quaternary volcanics.

Site(s): CBNM: south entrance. DNF: Blowhard Mountain (south Pink Cliffs), Long Valley basalt flows.

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BRY C25507, C25639 and C25833.

Dermatocarpon miniatum (L.) Mann

Growth form: foliose, umbilicate

Substrate: Tertiary volcanics, Straight Cliffs Formation, Claron formation, and Quaternary volcanics.

Site(s): CBNM: south Alpine Pond Trail, intersection of SR 143 and SR 148, south entrance. DNF: Blowhard Mountain (south Pink Cliffs), Blowhard Mountain (south wash), Brian Head Peak, west Brian Head Peak ski lift access road, Long Valley basalt flows, near southeast corner of the monument. Private: near Moots Hollow.

Relative abundance: locally common to abundant

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BRY C25508, C25532, C25552, C25586, C25638, C25653, C25699, C25794, C25798 and C25834.

Dermatocarpon reticulatum Magnusson

Growth form: foliose, umbilicate

Substrate: moss over rock, Straight Cliffs Formation, Claron Formation and Tertiary volcanics.

Site(s): CBNM: west Alpine Pond Trail, intersection of SR 143 and SR 148. DNF (AGWA): Ashdown Gorge Cliffs. DNF: Blowhard Mountain (south Pink Cliffs), Blowhard Mountain (south wash), Brian Head Peak, west Brian Head Peak ski lift access road. Private: near Moots Hollow.

Relative abundance: locally common to abundant

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BRY C25515, C25548, C25551, C25582, C25654, C25795, C25831 and C25843.

Dimelaena oreina (Ach.) Norman

Growth form: crustose with effigurate margins

Substrate: Tertiary volcanics.

Site(s): CBNM: west Alpine Pond Trail. DNF: west Brian Head
Peak ski lift access road.

Relative abundance: rare to locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BRY C25524 and C25575

Diplotomma alboatrum (Hoffm.)

Growth form: crustose

Substrate: lignum

Site(s): DNF (AGWA): Twisted Forest.

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BRY C25205

Endocarpon pusillum Hedwig

Growth form: squamulose

Substrate: soil over rock (Quaternary volcanics)

Site(s): DNF: Long Valley basalt flows.

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BRY C25632

Evernia divaricata (L.) Ach.

Growth form: fruticose

Substrate: *Abies lasiocarpa* and *Picea engelmannii* (11)

Site(s): CBNM: intersection of SR 143 and SR 148. DNF: near
southeast corner of the monument.

Relative abundance: locally rare to common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BRY C25097, C25098, C25110 -
C25121, and C25140

Glypholecia scabra Nyl.

Growth form: foliose (umbilicate)
Substrate: Claron Formation
Site(s): DNF: Blowhard Mountain (south Pink Cliffs).
Relative abundance: rare to locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BRY C25672, C25832

Lecania fuscella (Schaerer) Körber

Growth form: crustose
Substrate: *Pinus flexilis*
Site(s): DNF (AGWA): Twisted Forest.
Relative abundance: rare
Pollution sensitivity: unknown
Comments: this taxon is a new species record for Utah
Deposition of specimens: BRY C25206

Lecanora argopholis (Ach.) Ach.

Growth form: crustose
Substrate: Tertiary volcanics.
Site(s): CBNM: west Alpine Pond Trail. DNF (AGWA): Twisted Forest. DNF: near southeast corner of the monument.
Relative abundance: rare to locally common
Pollution sensitivity: unknown
Comments: none
Deposition of species: BRY C25581, C35604, and C25704.

Lecanora crenulata Hook.

Growth form: crustose
Substrate: lignum, Straight Cliffs Formation, and Claron Formation.
Site(s): CBNM: Chessman Overlook. DNF (AGWA): Ashdown Gorge Cliffs, Twisted Forest. DNF: west Brian Head Peak, Zion Canyon Overlook.
Relative abundance: rare to common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BRY C25393, C25394, C25410, C25411, C25427 - C25140, C25544, C25595, and C25717.

Lecanora dispersa (Pers.) Sommerf.

Growth form: crustose, obsolete

Substrate: Tertiary volcanics and Claron formation.

Site(s): DNF: Blowhard Mountain (south wash), west Brian Head Peak.

Relative abundance: rare to locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BRY C25681 and C25791.

Lecanora garovaglii (Korber) Zahlbr.

Growth form: crustose with distinctly effigurate margins

Substrate: Tertiary volcanics

Site(s): CBNM: south Alpine Pond Trail.

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BRY C25584

Lecanora hagenii (Ach.) Ach.

Growth form: crustose, obsolete

Substrate: *Abies lasiocarpa*, *Juniperus scopulorum*,
lignum, *Picea engelmannii*, *Pinus flexilis*, *Pinus flexilis* lignum, and *Populus tremuloides*

Site(s): CBNM: Chessman Overlook, south Alpine Pond Trail, intersection of SR 143 and SR 148. DNF (AGWA): Ashdown Gorge Cliffs, Twisted Forest. DNF: west Brian Head Peak, Navajo Ridge. Private: near Moots Hollow.

Relative abundance: common to abundant

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BRY C25022, C25023, C25141 - C25144, C25207 - C25211, C25264 - C25271, C25330 - C25332, C25395, C25398, and C25430 - C25433

Lecanora muralis (Schreber)

Growth form: crustose with effigurate margins
Substrate: Tertiary volcanics and Claron formation.
Site(s): CBNM: south Alpine Pond Trail, intersection of SR 143 and SR 148. DNF (AGWA): Twisted Forest. DNF: Blowhard Mountain (south Pink Cliffs), west Brian Head Peak, near southeast corner of the monument.
Relative abundance: locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BRY C25587, C25603, C25649, C25673, C25677, and C25702.

Lecanora novomexicana (B. de Lesd.) Zahlbr.

Growth form: crustose with effigurate margins
Substrate: Tertiary volcanics and Quaternary volcanics.
Site(s): CBNM: west Alpine Pond Trail. DNF: Brian Head Peak, east Brian Head Peak, south Brian Head Peak, west Brian Head Peak, Navajo Ridge.
Relative abundance: locally common
Pollution sensitivity: unknown
Comments: none
Deposition of species: BRY C25576, C25615, C25676, C25688, and C25806.

Lecanora piniperda Körber

Growth form: crustose
Substrate: lignum
Site(s): CBNM: intersection of SR 143 and SR 148.
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BRY C25145

Lecanora polytropia (Hoffm.) Rabenh.

Growth form: crustose, obsolete
Substrate: Tertiary volcanics
Site(s): CBNM: intersection of SR 143 and SR 148. DNF: Navajo Ridge, near southeast corner of the monument.
Relative abundance: locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BRY C25616, C25648, and C25714.

Lecanora rugosella Zahlbr.

Growth form: crustose

Substrate: lignum

Site(s): DNF (AGWA): Twisted Forest.

Relative abundance: rare

Pollution sensitivity: unknown

Comments: this taxon is a new species record for Utah

Deposition of specimens: BRY C25212 and C25213

Lecanora rupicola (L.) Zahlbr.

Growth form: crustose

Substrate: Tertiary volcanics and Quaternary volcanics.

Site(s): CBNM: east Alpine Pond Trail. DNF: Long Valley basalt flows, Brian Head Peak.

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BRY C25592, C25633, and C25823.

Lecanora symmicta (Ach.) Ach.

Growth form: crustose

Substrate: lignum and *Picea engelmannii*

Site(s): CBNM: intersection of SR 143 and SR 148, south entrance.

Relative abundance: common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BRY C25146 - C25150 and C25447 - C25449

Lecanora varia (Hoffm.) Ach.

Growth form: crustose

Substrate: lignum, *Pinus flexilis* lignum.

Site(s): CBNM: south entrance. DNF (AGWA): Twisted Forest.

DNF: Blowhard Mountain (south wash), Long Valley, near southeast corner of the monument.

Relative abundance: common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BRY C25122, C25129, C25214, C25450, C25451, and C25785.

Lecanora valesiaca (Müll. Arg.) Stizenb.

Growth form: crustose, with effigurate margins
Substrate: rock (Claron Formation)
Site(s): DNF: Blowhard Mountain (south Pink Cliffs).
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BRY C25830

Lecidea atrobrunnea Ach.

Growth form: crustose
Substrate: Tertiary volcanics and Quaternary volcanics.
Site(s): CBNM: intersection of SR 143 and SR 148, south entrance. DNF (AGWA): Twisted Forest. DNF: Brian Head Peak, east Brian Head Peak, south Brian Head Peak, west Brian Head Peak, west Brian Head Peak ski lift access road, Long Valley basalt flows, Navajo Ridge, near southeast corner of the monument.
Relative abundance: locally common to abundant
Pollution sensitivity: unknown
Comments: This taxon is one of the most common saxicolous lichens in western North America
Deposition of specimens: BRY C25504, C25522, C25606, C25612, C25627, C25651, C25678, C25692, C25708, and C25802.

Lecidea leucothallina Arnold.

Growth form: crustose
Substrate: Tertiary volcanics.
Site(s): CBNM: east Alpine Pond Trail, intersection of SR 143 and SR 148, south entrance.
Relative abundance: rare to locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BRY C25518, C25591, and C25652.

Lecidea tessellata Florke

Growth form: crustose, occasionally obsolete
Substrate: Straight Cliffs Formation, Tertiary volcanics,
Quaternary volcanics and Claron formation.
Site(s): CBNM: south Alpine Pond Trail. DNF (AGWA):
Ashdown Gorge Cliffs. DNF: Blowhard Mountain (south
Pink Cliffs), Long Valley basalt flows.
Relative abundance: locally common to abundant
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BRY C25541, C25589, C25631, and
C25670.

Lecidella euphorea (Flörke) Hertel

Growth form: crustose
Substrate: *Abies concolor*, *Abies lasiocarpa*, *Betula*
occidentalis, lignum, *Picea engelmannii*, *Picea*
pungens, *Pinus flexilis* lignum, *Pinus longaeva*
lignum, *Populus tremuloides*, *Pseudotsuga*
menziesii
Site(s): CBNM: intersection of SR 143 and SR 148, south
entrance. DNF (AGWA): Twisted Forest. DNF: Blowhard
Mountain (south Pink Cliffs), Blowhard Mountain (south
wash), Long Valley, Navajo Ridge. Private: near Moots
Hollow.
Relative abundance: abundant
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BRY C25024 - C25029, C25075 -
C25080, C25132, C25151 - C25156, C25187, C25216 -
C25220, C25263, C25333 - C25339, C25413, and C25452
- C25456

Lecidella stigmatea (Ach.) Hertel & Leuck.

Growth form: crustose

Substrate: lignum, *Pinus flexilis* lignum, Tertiary volcanics, Quaternary volcanics, Claron formation and Straight Cliffs Formation.

Site(s): CBNM: Chessman Overlook, south Alpine Pond Trail, west Alpine Pond Trail. DNF (AGWA): Twisted Forest.

DNF: Blowhard Mountain (Radar Station), Blowhard Mountain (south wash), east Brian Head Peak, south Brian Head Peak, west Brian Head Peak, Forest Camp.

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BRY C25093 - C25096, C25221 - C25227, C25396, C25434, C25435, C25577, C25583, C25607, C25685, C25780, and C25792.

Lepraria finkii (B. de Lesd. in Hue) R.C. Harris

Growth form: crustose (leprose)

Substrate: soil over rock (Straight Cliffs Formation).

Site(s): DNF (AGWA): Ashdown Gorge Cliffs.

Relative abundance: rare to locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BRY C25540

Lepraria membranacea auct.

Growth form: crustose (leprose)

Substrate: soil

Site(s): DNF: Brian Head Peak.

Relative abundance: rare to locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BRY C25813

Megaspora verrucosa (Ach.) Hafellner & V. Wirth

Growth form: crustose

Substrate: lignum

Site(s): DNF (AGWA): Twisted Forest.

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BRY C25228 and C25229

Melanelia elegantula (Zahlbr.) Essl.

Growth form: foliose

Substrate: *Abies lasiocarpa*, lignum, *Picea engelmannii*,
Picea pungens, *Pinus flexilis*, *Pinus flexilis*
lignum, *Pseudotsuga menziesii*, and Quaternary volcanics.

Site(s): CBNM: south Alpine Pond Trail, intersection of SR 143
and SR 148. DNF (AGWA): Twisted Forest. DNF:
Blowhard Mountain (south wash), Long Valley basalt
flows, Navajo Ridge, near southeast corner of the
monument. Private: near Moots Hollow.

Relative abundance: common to abundant

Pollution sensitivity: unknown

Comments: this taxon is a new species record for Utah

Deposition of specimens: BRY C25030, C25081 - C25084,
C25099, C25157 - C25170, C25230 - C25237, C25272 -
C25276, C25340, C25341, C25400, C25401, and C25623.

Melanelia exasperatula (Nyl.) Essl.

Growth form: foliose

Substrate: *Abies lasiocarpa*, lignum, *Picea engelmannii*, moss
over Tertiary volcanics, rock and moss over soil.

Site(s): CBNM: west Alpine Pond Trail, intersection of SR 143
and SR 148. DNF: Brian Head Peak, east Brian Head Peak,
south Brian Head Peak, Long Valley basalt flows, near
southeast corner of the monument.

Relative abundance: rare to common

Pollution sensitivity: intermediately sensitive to SO₂ (Ryan
1990)

Comments: this taxon is a new species record for Utah

Deposition of specimens: BRY C25123, C25171, C25172,
C25183, C25390, C25517, C25566, and C25621.

Melanelia subelegantula (Essl.) Essl.

Growth form: foliose

Substrate: lignum, *Pinus longaeva*, and *Pinus ponderosa*

Site(s): DNF (AGWA): Twisted Forest. DNF: Navajo Ridge.
Private: near Moots Hollow.

Relative abundance: rare to common

Pollution sensitivity: unknown

Comments: this taxon is a new species record for Utah

Deposition of specimens: BRY C25031, C25238, C25277, and
C25342

Melanelia subolivacea (Nyl. in Hasse) Essl.

Growth form: foliose

Substrate: *Abies concolor*, *Abies lasiocarpa*, lignum,
Picea engelmannii, *Picea pungens*, *Pinus flexilis*, *Pinus ponderosa*, *Populus tremuloides*, *Pseudotsuga menziesii*

Site(s): CBNM: south Alpine Pond Trail, intersection of SR 143 and SR 148. DNF (AGWA): Twisted Forest. DNF: Blowhard Mountain (south wash), Forest Camp, Navajo Ridge, near southeast corner of the monument. Private: near Moots Hollow.

Relative abundance: locally common to abundant

Pollution sensitivity: intermediately sensitive to ozone (Ryan 1990)

Comments: none

Deposition of specimens: BRY C25032 - C25037, C25085 - C25087, C25100, C25124, C25125, C25173, C25174, C25184, C25239, C25240, C25278 - C25298, C25343 - C25352, C25402, C25403, C25417, C25418, and C25716.

Melanelia substygia (Rasanen) Essl.

Growth form: foliose

Substrate: soil, Tertiary volcanics, and Quaternary volcanics.

Site(s): DNF: Long Valley basalt flows, west Brian Head Peak ski lift access road.

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BRY C25510, C25525, and C25634.

Micarea peliocarpa (Anzi) Coppins & R. Sant. in Coppins & P. James

Growth form: crustose

Substrate: *Pseudotsuga menziesii*

Site(s): Private: near Moots Hollow.

Relative abundance: rare

Pollution sensitivity: unknown

Comments: this taxon is a new species record for Utah

Deposition of specimens: BRY C25038

Micarea prasina Fr.

Growth form: crustose

Substrate: lignum

Site(s): CBNM: intersection of SR 143 and SR 148.

Relative abundance: rare

Pollution sensitivity: unknown

Comments: this taxon is a new species record for Utah

Deposition of specimens: BRY C25175-C25177

Peltigera canina (L.) Willd.

Growth form: foliose

Substrate: lignum , moss over lignum, soil.

Site(s): CBNM: west Alpine Pond Trail. DNF (AGWA):

Ashdown Gorge Cliffs. DNF: Forest Camp, near southeast corner of the monument. Private: near Moots Hollow.

Relative abundance: locally common

Pollution sensitivity: sensitive to ozone (Ryan 1990)

Comments: none

Deposition of specimens: BRY C25000 - C25004, C25053 - C25061, C25419, C25420, C25564, C25680.

Peltigera rufescens (Weis) Humb.

Growth form: foliose

Substrate: moss over soil, moss over detritus, soil, and detritus.

Site(s): CBNM: west Alpine Pond Trail, intersection of SR 143 and SR 148. DNF (AGWA): Ashdown Gorge Cliffs. DNF: Brian Head Peak, west Brian Head Peak ski lift access road, Long Valley basalt flows, near southeast corner of the monument. Private: near Moots Hollow.

Relative abundance: locally common

Pollution sensitivity: sensitive to intermediately sensitive to ozone (Ryan 1990)

Comments: none

Deposition of specimens: BRY C25509, C25539, C25557, C25572, C25619, C25643, C25696, C25697, and C25812.

Phaeophyscia endococcina (Körber) Moberg

Growth form: foliose

Substrate: lignum, Tertiary volcanics, moss over Tertiary volcanics, and rock.

Site(s): CBNM: west Alpine Pond Trail, south entrance. DNF: near southeast corner of the monument. Private: near Moots Hollow.

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BRY C25039, C25503, C25519, C25569, C25573, and C25711.

Phaeophyscia orbicularis (Necker) Moberg

Growth form: foliose

Substrate: Straight Cliffs Formation.

Site(s): DNF (AGWA): Ashdown Gorge Cliffs.

Relative abundance: rare

Pollution sensitivity: sensitive to ozone, intermediately sensitive to SO₂, sensitive to Fluoride (Ryan 1990)

Comments: none

Deposition of specimens: BRY C25547

Phaeophyscia nigricans (Flörke) Moberg

Growth form: foliose

Substrate: *Abies lasiocarpa* and *Populus tremuloides*

Site(s): CBNM: south Alpine Pond Trail. DNF (AGWA): Ashdown Gorge Cliffs. DNF: Navajo Ridge.

Relative abundance: rare to common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BRY C25299, C25300, C25362, and C25404

Phaeorrhiza nimbosa (Fr.) Mayrh. & Poelt

Growth form: squamulose

Substrate: soil

Site(s): DNF: Brian Head Peak.

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BRY C25811

Physcia adscendens (Fr.) H. Olivier

Growth form: foliose

Substrate: *Abies concolor*, *Abies lasiocarpa*, *Betula occidentalis*, lignum (1), *Picea engelmannii*, *Picea pungens*, *Pinus ponderosa*, *Pseudotsuga menziesii*

Site(s): CBNM: south Alpine Pond Trail. DNF (AGWA): Ashdown Gorge Cliffs. DNF: Navajo Ridge. Private: near Moots Hollow.

Relative abundance: common to abundant

Pollution sensitivity: intermediately sensitive to SO₂, and sensitive to Fluoride (Ryan 1990)

Comments: none

Deposition of specimens: BRY C25040, C25041, C25301, C25363 - C25366, C25405, and C25457

Physcia aipolia (Ehrh. ex Humb.) F  rnr.

Growth form: foliose

Substrate: *Pseudotsuga menziesii*

Site(s): Private: near Moots Hollow.

Relative abundance: locally common

Pollution sensitivity: intermediately sensitive to SO₂, and sensitive to Fluoride (Ryan 1990)

Comments: none

Deposition of specimens: BRY C25042 - C25046

Physcia biziana (Massal.) Zahlbr.

Growth form: foliose

Substrate: *Abies lasiocarpa*, *Juniperus scopulorum*, lignum, *Picea engelmannii*, *Picea pungens*, *Pinus flexilis*, *Populus tremuloides*, and *Pseudotsuga menziesii*, rock.

Site(s): CBNM: west Alpine Pond Trail. DNF (AGWA): Ashdown Gorge Cliffs, Twisted Forest. DNF: Blowhard Mountain (south Pink Cliffs), Blowhard Mountain (south wash), Brian Head Peak, Navajo Ridge. Private: near Moots Hollow.

Relative abundance: locally common on bark; rare on rock

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BRY C25047 - C25050, C25088 - C25091, C25241 - C25245, C25302, C25367 - C25371, C25567, C25836 and C25840.

Physcia caesia (Hoffm.) Furnr. (Hawksworth et al.1980)

Growth form: foliose

Substrate: moss over soil, Tertiary volcanics, and Quaternary volcanics.

Site(s): DNF: west Brian Head Peak ski lift access road, Long Valley basalt flows, near southeast corner of the monument.

Relative abundance: rare to locally common

Pollution sensitivity: intermediate sensitivity to SO₂
(Ryan 1990)

Comments: none

Deposition of specimens: BRY C25512, BRY C25533, C25624, and C25700.

Physcia dubia (Hoffm.) Lettau

Growth form: foliose

Substrate: *Pseudotsuga menziesii* and on moss over Tertiary volcanics and Tertiary volcanics.

Site(s): CBNM: east Alpine Pond Trail. DNF: Blowhard Mountain (south wash), Brian Head Peak, west Brian Head Peak ski lift access road, near southeast corner of the monument. Private: near Moots Hollow.

Relative abundance: rare

Pollution sensitivity: sensitive to intermediately sensitive to Fluoride (Ryan 1990)

Comments: none

Deposition of specimens: BRY C25051, C25052, C25458, C25514, C25593, C25712, C25786, and C25803.

Physcia stellaris (L.) Nyl.

Growth form: foliose

Substrate: *Pseudotsuga menziesii*

Site(s): Private: near Moots Hollow.

Relative abundance: rare

Pollution sensitivity: intermediately sensitive to SO₂
(Wetmore 1987)

Comments: none

Deposition of specimens: BRY C25053

Physcia phaea (Tuck.) Thomson

Growth form: foliose
Substrate: Straight Cliffs Formation
Site(s): DNF (AGWA): Ashdown Gorge Cliffs.
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BRY C25549

Physconia detersa (Nyl.) Poelt

Growth form: foliose
Substrate: moss over Straight Cliffs Formation.
Site(s): DNF (AGWA): Ashdown Gorge Cliffs.
Relative abundance: rare
Pollution sensitivity: sensitive to intermediately sensitive to
SO₂ (Ryan 1990)
Comments: none
Deposition of specimens: BRY C25537

Physconia muscigena Ach. Poelt

Growth form: foliose
Substrate: moss over soil
Site(s): DNF: Brian Head Peak, west Brian Head Peak ski lift
access road.
Relative abundance: locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BRY C25511 and C25844

Physconia perisidiosa (Erichsen) Moberg

Growth form: foliose
Substrate: moss over soil
Site(s): DNF (AGWA): Twisted Forest.
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BRY C25601

Pseudephebe minuscula (Nyl. ex Arnold) Brodo & D. Hawksw.
Growth form: fruticose
Substrate: Tertiary volcanics
Site(s): DNF: Brian Head Peak, west Brian Head Peak ski lift
access road.
Relative abundance: locally common
Pollution sensitivity: intermediately sensitive to ozone
(Ryan 1990)
Comments: none
Deposition of specimens: BRY C25526 and C25825

Psora crenata (Taylor) Reinke
Growth form: squamulose
Substrate: soil over rock (Claron Formation)
Site(s): DNF: Blowhard Mountain (south Pink Cliffs).
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BRY C25661

Psora decipiens (Hedwig) Hoffm.
Growth form: squamulose
Substrate: soil
Site(s): DNF: Long Valley basalt flows.
Relative abundance: rare to locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BRY C25618

Psora himalayana (Church. Bab.) Timdal (Timdal 1986)
Growth form: squamulose
Substrate: soil over rock (Straight Cliffs Formation).
Site(s): DNF (AGWA): Ashdown Gorge Cliffs.
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: Bry C25543

Psora tuckermanii R. Anderson ex Timdal

Growth form: squamulose

Substrate: soil, moss over soil, soil over rock (Straight Cliffs Formation)

Site(s): CBNM: west Alpine Pond Trail. DNF (AGWA):

Ashdown Gorge Cliffs, Twisted Forest. DNF: Blowhard Mountain (south Pink Cliffs), Blowhard Mountain (south wash), east Brian Head Peak, south Brian Head Peak, Forest Camp. Private: near Moots Hollow.

Relative abundance: locally common

Pollution: unknown

Comments: none

Deposition of specimens: BRY C25534, C25538, C25554, C25570, C25599, C25657, C256, C25719, C25796, C25797 and C25837.

Psora nipponica (Zahlbr.) G. Schneider

Growth form: squamulose

Substrate: soil

Site(s): CBNM: south entrance. DNF: near southeast corner of the monument. Private: near Moots Hollow.

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BRY C25501, BRY C25554, and C25709.

Ramalina sinensis Jatta

Growth form: fruticose

Substrate: *Pseudotsuga menziesii*

Site(s): Private: near Moots Hollow.

Relative abundance: locally rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BRY C25005 - C25008, C25054 - C25057

Rhizocarpon disporum (Naeg. ex Hepp) Mull.

Growth form: crustose
Substrate: Tertiary volcanics
Site(s): DNF: Navajo Ridge.
Relative abundance: rare to locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BRY C25614

Rhizocarpon geographicum (L.) DC.

Growth form: crustose
Substrate: Tertiary volcanics
Site(s): CBNM: intersection of SR 143 and SR 148. DNF: west
Brian Head Peak, near southeast corner of the monument.
Relative abundance: locally common to abundant
Pollution sensitivity: sensitive to Fluoride
Comments: none
Deposition of specimens: BRY C25521, C25646, and C25707.

Rhizoplaca chrysoleuca (Sm.) Zopf

Growth form: foliose, umbilicate
Substrate: Tertiary volcanics and Quaternary volcanics.
Site(s): CBNM: west Alpine Pond Trail. DNF: Brian Head Peak,
west Brian Head Peak ski lift access road, Long Valley
basalt flows.
Relative abundance: locally common
Pollution sensitivity: sensitive to SO₂ and NO_x (Ryan 1990)
Comments: none
Deposition of specimens: BRY C25531, C25579, C25628 and
C25842.

Rhizoplaca melanophthalma (DC. in Lam. & DC.) Leuck. & Poelt

Growth form: foliose, umbilicate

Substrate: Tertiary volcanics and Quaternary volcanics.

Site(s): CBNM: south entrance. DNF: Brian Head Peak, east Brian Head Peak, south Brian Head Peak, west Brian Head Peak, west Brian Head Peak ski lift access road, Long Valley basalt flows, near southeast corner of the monument.

Relative abundance: locally common to abundant

Pollution sensitivity: sensitive to SO₂ (Ryan 1990)

Comments: none

Deposition of specimens: BRY C25506, BRY C25530, C25637, C25682, C25694, C25703 and C25841.

Rinodina annulata Magnusson

Growth form: crustose

Substrate: lignum

Site(s): DNF (AGWA): Twisted Forest.

Relative abundance: rare

Pollution sensitivity: unknown

Comments: this taxon is a new species record for Utah

Deposition of specimens: BRY C25254

Rinodina grandilocularis Sheard

Growth form: crustose

Substrate: lignum

Site(s): Private: near Moots Hollow.

Relative abundance: rare

Pollution sensitivity: unknown

Comments: this taxon is a new species record for Utah

Deposition of specimens: BRY C25058 and C25059

Sporastatia testudinea (Ach.) Massal.

Growth form: crustose

Substrate: Tertiary volcanics

Site(s): DNF: Brian Head Peak, west Brian Head Peak ski lift access road.

Relative abundance: locally common to abundant

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BRY C25527 and C25826

Staurothele drummondii (Tuck.)

Growth form: crustose

Substrate: Tertiary volcanics , Claron formation and Quaternary volcanics.

Site(s): CBNM: west Alpine Pond Trail. DNF: Blowhard Mountain (Radar Station), Blowhard Mountain (south wash), west Brian Head Peak, Long Valley basalt flows.

Relative abundance: locally common to abundant

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BRY C 25560, C25578, C25626, C25683, and C25793.

Tephromela armeniaca (DC.) Hertel & Rambold

Growth form: crustose

Substrate: Tertiary volcanics

Site(s): DNF: Brian Head Peak.

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BRY C25821

Teloschistes contortuplicatus (Ach.) Clauz. & Rondon ex Vezda

Growth form: foliose

Substrate: rock

Site(s): DNF: Blowhard Mountain (south Pink Cliffs).

Relative abundance: rare

Pollution sensitivity: unknown

Comments: unknown

Deposition of specimens: BRY C25671

Thyrea pulvinata (Schaerer) Massal.

Growth form: foliose

Substrate: soil over rock

Site(s): DNF (AGWA): Twisted Forest. DNF: Blowhard Mountain (south Pink Cliffs).

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BRY C25597 and C25839

Toninia philippea (Mont.) Timdal

Growth form: crustose
Substrate: Claron formation
Site(s): DNF: Blowhard Mountain (south Pink Cliffs).
Relative abundance: rare to locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BRY C25664 and C25827.

Umbilicaria decussata (Vill.) Zahlbr.

Growth form: foliose, umbilicate
Substrate: Quaternary volcanics
Site(s): DNF: west Brian Head Peak ski lift access road, Long Valley basalt flows.
Relative abundance: locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BRY C25529 and C25636

Umbilicaria krascheninnioyii (Savicz) Zahlbr.

Growth form: foliose, umbilicate
Substrate: Rock, Tertiary volcanics.
Site(s): DNF: Brian Head Peak.
Relative abundance: locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BRY C25845

Umbilicaria virginis Schaerer

Growth form: foliose, umbilicate
Substrate: Tertiary volcanics
Site(s): CBNM: west Alpine Pond Trail. DNF: Brian Head Peak, east Brian Head Peak, south Brian Head Peak, west Brian Head Peak ski lift access road.
Relative abundance: locally common to abundant
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BRY C25528, C25580, C25691, C25824.

Usnea subfloridana Stirton

Growth form: fruticose

Substrate: *Pinus ponderosa*

Site(s): DNF (AGWA): Ashdown Gorge Cliffs.

Relative abundance: rare

Pollution sensitivity: sensitive to intermediately sensitive to
SO₂ (Ryan 1990)

Comments: none

Deposition of specimens: BRY C25374

Xanthoparmelia cumberlandia (Vainio) Hale

Growth form: foliose

Substrate: Tertiary volcanics,

Site(s): CBNM: south entrance. DNF: Brian Head Peak, near
southeast corner of the monument.

Relative abundance: locally common

Pollution sensitivity: sensitive to SO₂ (Ryan 1990)

Comments: none

Deposition of specimens: BRY C25505, C25706, and C25819.

Xanthoparmelia wyomingica (Gyelnik) Hale

Growth form: foliose

Substrate: soil and Tertiary volcanics.

Site(s): DNF: Brian Head Peak.

Relative abundance: rare to locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BRY C25805 and C25820.

Xanthoria candelaria (L.) Th. Fr.

Growth form: minutely foliose

Substrate: *Pseudotsuga menziesii*

Site(s): DNF: Blowhard Mountain (south Pink Cliffs).

Relative abundance: rare

Pollution sensitivity: sensitive to ozone, and intermediately
sensitive to SO₂ (Ryan 1990)

Comments: none

Deposition of specimens: BRY C25188

Xanthoria elegans (Link) Th. Fr.

Growth form: fruticose

Substrate: Tertiary volcanics, Straight Cliffs Formation, rock, Claron Formation, and moss over soil.

Site(s): CBNM: Chessman Overlook, south Alpine Pond Trail, west Alpine Pond Trail, intersection of SR 143 and SR 148. DNF (AGWA): Ashdown Gorge Cliffs, Twisted Forest. DNF: Blowhard Mountain (Radar Station), Blowhard Mountain (south Pink Cliffs), Blowhard Mountain (south wash), Brian Head Peak, east Brian Head Peak, south Brian Head Peak, west Brian Head Peak, west Brian Head Peak ski lift access road.

Relative abundance: common to abundant

Pollution sensitivity: unknown

Comments: this species is one of the most common saxicolous lichens in western North America

Deposition of specimens: BRY C25523, C25546, C255561, C25568, C25585, C25594, C25608, C25644, C25669, C25675, C25695, C25782, C25788, C25801, C25829.

Xanthoria fallax (Hepp in Arnold) Arnold

Growth form: foliose

Substrate: *Abies lasiocarpa*, *Pinus flexilis*, moss over Straight Cliffs Formation.

Site(s): CBNM: Chessman Overlook. DNF (AGWA): Ashdown Gorge Cliffs, Twisted Forest.

Relative abundance: rare to locally common

Pollution sensitivity: sensitive to intermediately sensitive to SO₂, and sensitive to NO_x and PAN (Ryan 1990)

Comments: none

Deposition of specimens: BRY C25255, C25256, C25436, and C25535.

Xanthoria polycarpa (Hoffm.) Rieber

Growth form: foliose

Substrate: *Abies concolor*, *Abies lasiocarpa*, *Betula occidentalis*, lignum, *Juniperus scopulorum*, *Picea engelmannii*, *Picea pungens*, *Pinus flexilis*, *Pinus longaeva*, *Populus angustifolia*, *Populus tremuloides*, *Pseudotsuga menziesii*

Site(s): CBNM: south Alpine Pond Trail, west Alpine Pond Trail, intersection of SR 143 and SR 148. DNF (AGWA): Ashdown Gorge Cliffs, Twisted Forest. DNF: Blowhard Mountain (south Pink Cliffs), Blowhard Mountain (south wash), Forest Camp, Navajo Ridge, near southeast corner of the monument. Private: near Moots Hollow.

Relative abundance: abundant

Pollution sensitivity: sensitive to intermediately sensitive to SO₂ (Ryan 1990)

Comments: none

Deposition of specimens: BRY C25060 - C25072, C25092, C25127, C25178 - C25180, C25185, C25189, C25257 - C25261, C25303 - C25322, C25375 - C25389, C25406, C25407, C25422, and C25459

Xanthoria soorediata (Vainio) Poelt

Growth form: foliose

Substrate: Straight Cliffs Formation, Claron Formation, and Tertiary volcanics.

Site(s): DNF (AGWA): Ashdown Gorge Cliffs. DNF: Blowhard Mountain (south Pink Cliffs), near southeast corner of the monument.

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BRY C25542, C25665, and C25715.

CONCLUSIONS AND RECOMMENDATIONS

OBSERVATIONS AND CONCLUSIONS:

1. The lichen flora of Cedar Breaks National Monument and adjacent areas of Dixie National Forest is diverse and well developed. From our collections at 22 reference sites in and around the monument we have identified a total of 128 species in 46 genera. Our collections include eight new species record for the state of Utah. All growth forms are well represented in our collections. As expected the flora is dominated by crustose lichens (48%, 62 species), followed by foliose species (32%, 41 species). Squamulose species comprise 15% of the flora (19 species) while fruticose species make up only 5% of the flora (6 species). This pattern of growth form distribution is typical of dry western U.S. habitats.

We were somewhat surprised at the high percentage of foliose species. However, following careful evaluation of this group it became clear that most of the taxa are either small corticolous species of the genera *Phaeophyscia* and *Physcia*, or umbilicate saxicolous members of the genera *Rhizoplaca* and *Dermatocarpon*. All of these groups are commonly found throughout the western United States. Comparison with similar studies from other areas in the Rocky Mountain Region demonstrates that the percentage of foliose species identified during this study is relatively high (i.e. percent foliose species from Bridger Wilderness area = 28%, and percent foliose species from High Uinta Wilderness Area = 29%). Likely the diversity of habitat types examined during this study is at least partially responsible for the large number of species and the distinct distribution of growth forms.

2. During this study lichens were collected from 5 basic substrates including: rocks (various types), lignum/bark, moss/detritus, soil and the thalli of other lichen species. Rock was the single most important substrate, followed closely by combined bark/lignum substrates. A total of 54 species (42% of the flora) were collected from various rock substrates, while 46 species (36% of the flora) was collected from various corticolous (bark and lignum) substrates. Terricolous (soil) lichens included 17 species (13%); while moss/detritus lichens were represented by 10 species (8%). The lichenicolous group was the smallest consisting of only one species (>1%).

3. High species diversity, abundance of all growth forms and occurrence of several (25) pollution sensitive indicator species indicates that the lichen communities in and around the monument appear to be healthy and essentially unimpacted by air pollution.
4. The general absence of necrotic and/or bleached thalli also suggests that the lichen flora has not been significantly impacted by air pollution.
5. Baseline concentrations of 20 potential pollutant elements were evaluated in 2 species of lichens collected from four reference sites in or near the monument. Specifically, *Rhizoplaca melanophthalma* and *Xanthoparmelia cumberlandia*, both from rock substrates, were analyzed for pollutant accumulation. Elemental analysis data are contained in Table 1. Figure 2 provides data on background and elevated levels for several of the pollutant elements evaluated during this study.
6. Generally, sulfur concentrations above .20% in the thalli of sensitive indicator species indicates significant potential for sulfur related-damage to lichen communities. Sulfur values from sensitive indicator species collected in and around Cedar Breaks National Monument (Table 1.) clearly show that there has been no significant impact from sulfur pollution. The highest sulfur concentration in any sample was .13% (*Rhizoplaca melanophthalma* from Chessman Overlook) well below the .20% level.
7. Thallus concentrations of most of the other pollutant elements are also well within background levels (figure 2.). However, concentrations of arsenic were somewhat elevated in two species (*Rhizoplaca melanophthalma* from Chessman Overlook, 8 ppm; and *Xanthoparmelia cumberlandia* from the southeast corner of the Monument, 3.7 ppm). There does not seem to be any clearly identifiable air pollution-related source for this pattern, especially when arsenic was not detected at all in the other two samples. We suspect that these results are likely due to contamination from a local substrate which contains some arsenic. At first we were also concerned about what appeared to be higher than usual thallus concentrations of rubidium and strontium; however, closer investigation showed that this phenomenon is again probably caused by

Table 1. Mean concentrations of potential pollutant elements in sensitive indicators species from air quality biomonitoring reference sites in Cedar Breaks National Monument.

	Elements (ppm except where indicated)							
	S%	Cl	K%	Ca%	Ti	V	Cr	Mn
<i>Rhizoplaca melanophthalma</i> (Chessman Overlook)	.13	50	.90	5.30	1080	nd*	nd	97
<i>Xanthoparmelia cumberlandia</i> (South Entrance)	.06	330	.338	5.5	430	nd	nd	75
<i>Xanthoparmelia cumberlandia</i> (Southeast corner of Monument)	.0493	420	.50	3.2	1030	nd	18.1	156
<i>Rhizoplaca melanophthalma</i> (Brian Head Peak)	.0890	nd	.3040	3.9	384	nd	1.3	50

Table 1 cont. Mean concentrations of potential pollutant elements in sensitive indicators species from air quality biomonitoring reference sites in Cedar Breaks National Monument.

	Elements (ppm except where indicated)							
	Fe	Co	Ni	Cu	Zn	Pb	As	Se
<i>Rhizoplaca melanophthalma</i> (Chessman Overlook)	6200	nd	6.4	12	56	19	8	nd
<i>Xanthoparmelia cumberlandia</i> (South Entrance)	3200	nd	5.4	12	32	50	nd	nd
<i>Xanthoparmelia cumberlandia</i> (Southeast corner of Monument)	7900	nd	5.54	15	37	20.8	3.7	nd
<i>Rhizoplaca melanophthalma</i> (Brian Head Peak)	2400	nd	2.5	9.9	24.5	52	nd	nd

Table 1 cont. Mean concentrations of potential pollutant elements in sensitive indicators species from air quality biomonitoring reference sites in Cedar Breaks National Monument.

	Elements (ppm except where indicated)			
	P	Br	Rb	Sr
<i>Rhizoplaca melanophthalma</i> (Chessman Overlook)	1600	8	40	71
<i>Xanthoparmelia cumberlandia</i> (South Entrance)	1600	29	22	63
<i>Xanthoparmelia cumberlandia</i> (Southeast corner of Monument)	1400	23	37.7	90
<i>Rhizoplaca melanophthalma</i> (Brian Head Peak)	1000	7	13	54

Fig. 2 Lichen Biomonitoring Program and Baseline

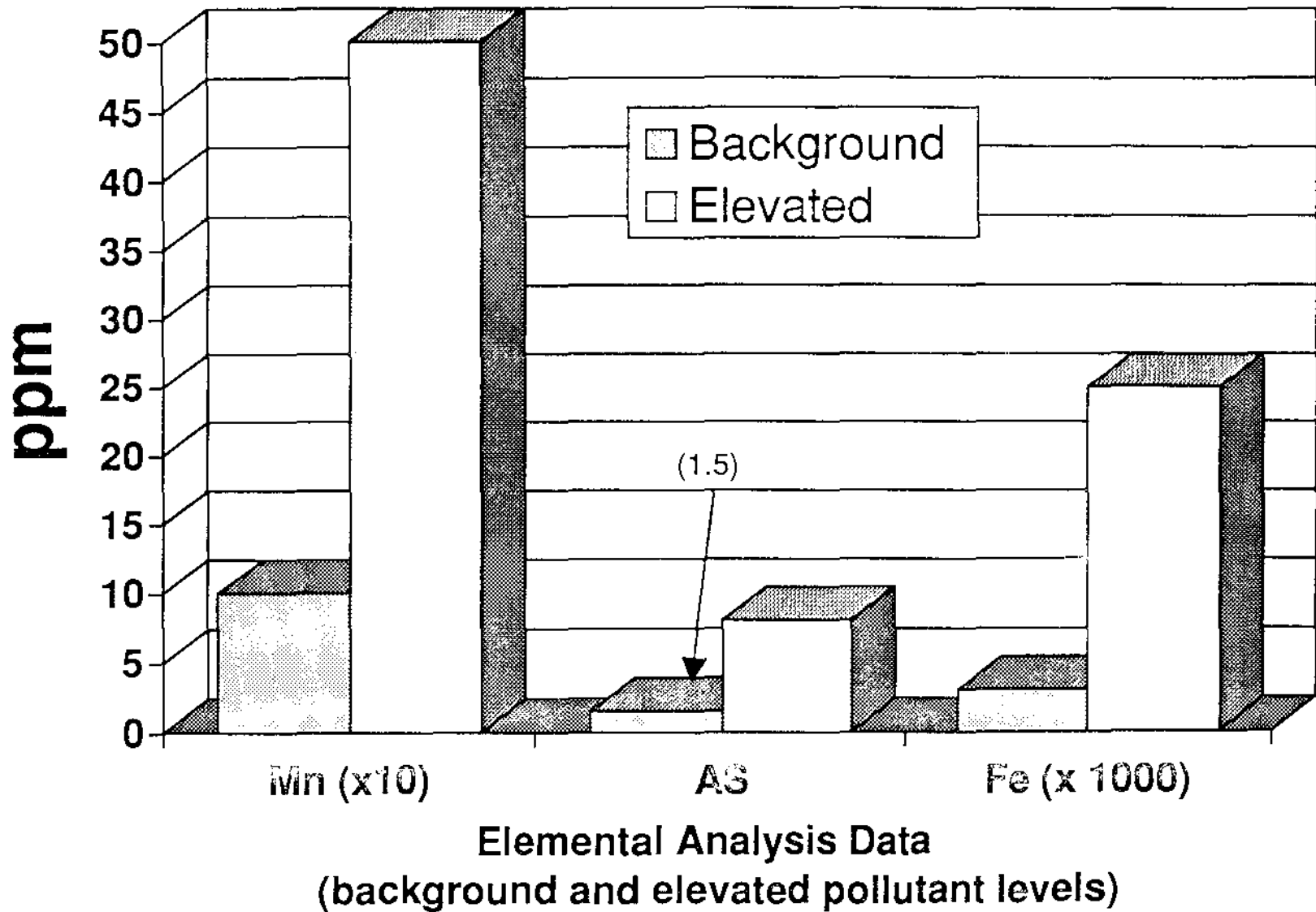


Fig. 2 cont. Lichen Biomonitoring Program and Baseline

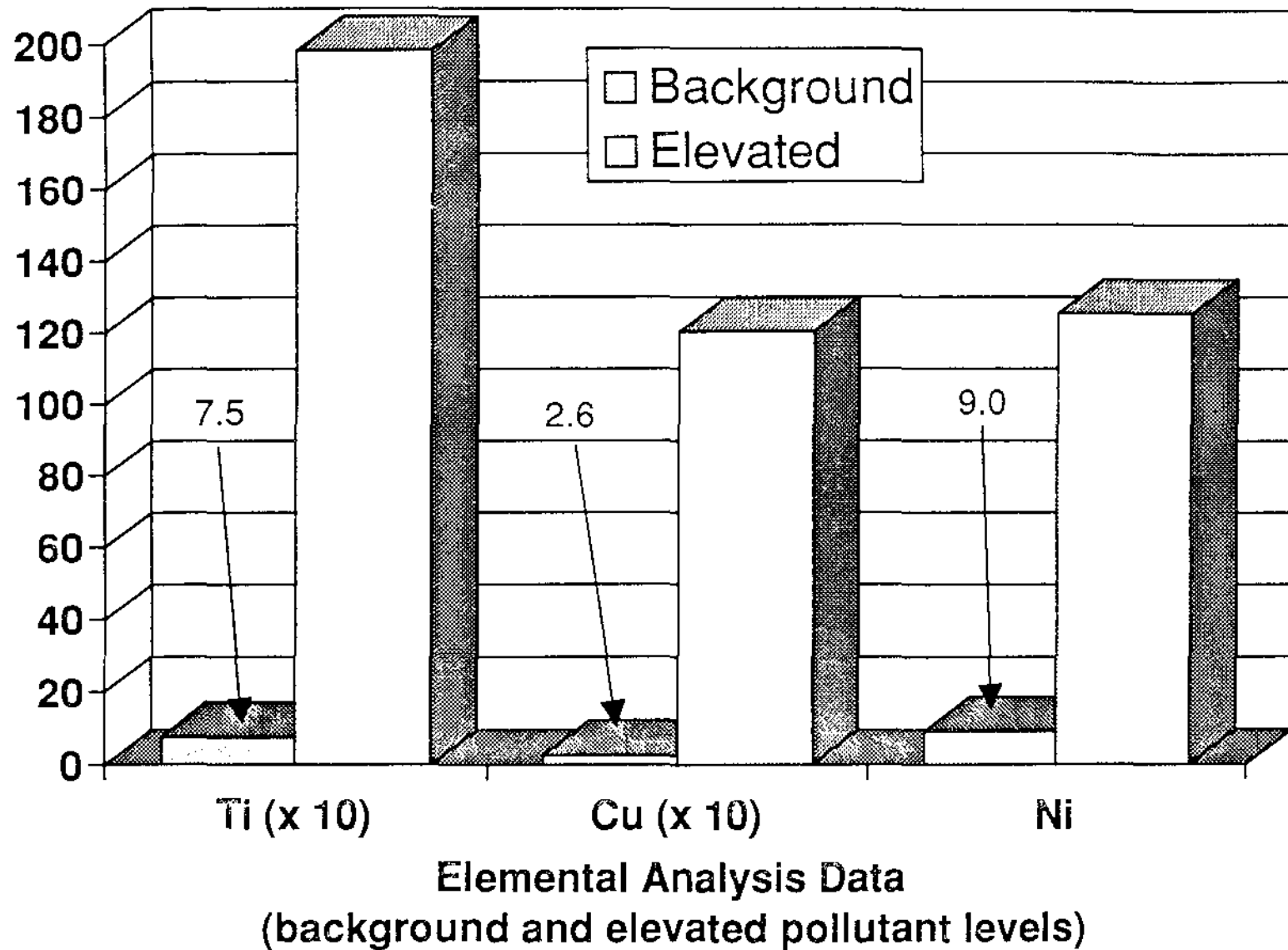
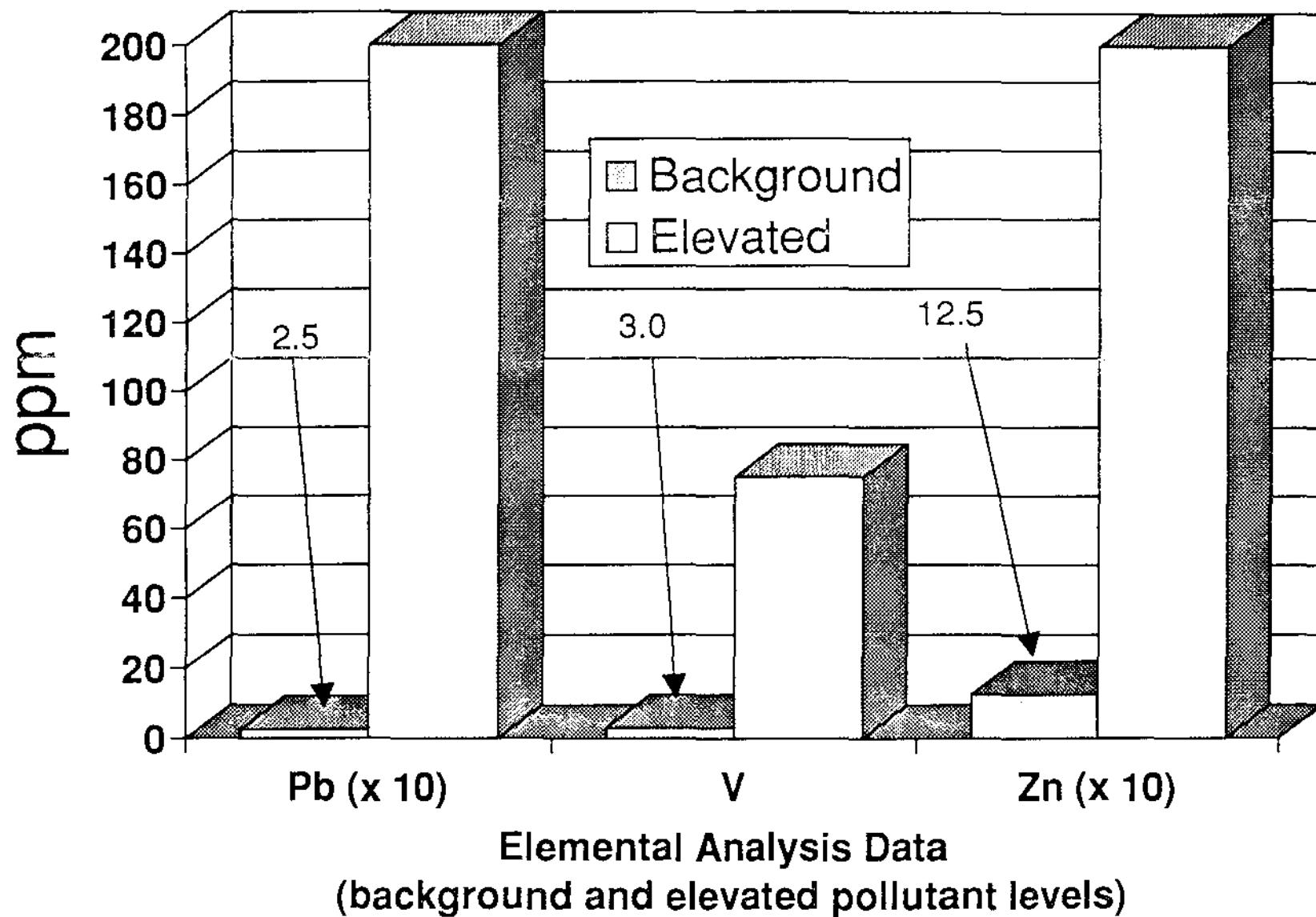


Fig. 2 cont. Lichen Biomonitoring Program and Baseline



contamination from area substrates which are rich in these elements.

RECOMMENDATIONS:

1. Eventually, additional sensitive indicator species should be collected from other reference sites in the monument and analyzed for pollutant content.
2. Elemental analysis of sensitive indicator species should be performed and re-evaluated every 5 to 8 years. Timing on re-evaluation studies will depend on changes in either local or regional air pollution patterns.
3. Re-evaluation of the lichen flora at the existing reference sites is generally not necessary, unless sensitive indicator species begin to show either increasing levels of problem pollutant elements, or significant changes in relative abundance.

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