

**PRELIMINARY
LICHEN BIOMONITORING PROGRAM
AND AIR QUALITY BASELINE**

**IN SELECTED CLASS I WILDERNESS AREAS
OF CORONADO, COCONINO, KAIBAB, PRESCOTT AND TONTO
NATIONAL FORESTS, ARIZONA**

COPY

FINAL REPORT

CHIRICAHUA WILDERNESS AREA

SUBMITTED BY

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INTRODUCTION

Project objectives:

1. Collect, curate, and identify lichen species from selected sites in the Sycamore Canyon, Pine Mountain, Mazatzal, Sierra Ancha, Superstition, Galiuro and Chiricahua wilderness areas.
2. Identify potential sites in each wilderness area for establishing lichen monitoring transects and plots.
3. Identify and collect pollution-sensitive lichen species for elemental analyses from 5-7 reference sites in each wilderness area. Rare species will not be sampled for analysis, but their distribution will be noted.
4. Determine baseline thallus concentrations of sulfur, lead, and copper, using ten replicate samples of one documented pollution-sensitive species from each wilderness area.
5. Prepare and submit a draft report by 28 December 1990.
6. Prepare and submit 3 copies of a final report detailing the results of this study by 11 July 1991. This final report will include:
 - a. a map and a brief habitat description of the study sites in each wilderness area, and reasons for their selection.
 - b. a preliminary list of lichen species for each wilderness area with relative abundance and substrate data for each species.
 - c. a list of pollution-sensitive or potentially pollution-sensitive lichen species for each wilderness area.
 - d. color photographs/slides of lichens known or suspected to be sensitive to specified air pollutants for each wilderness area.
 - e. baseline concentrations of lead, sulfur, and copper for one indicator species from each wilderness area.
 - f. a map of recommended sites for establishing transects and plots for future long-term monitoring.
 - g. a list of references, protocols, equipment and supplies used in this study.
 - h. other pertinent information or unusual observations.

Lichens as sensitive receptors:

The use of lichens as bioindicators of air quality is a well-documented procedure (Ske 1979; Richardson & Nieboer 1981; Fields & St. Clair 1984; St. Clair 1989; Rope & Pearson 1990). Hale (1983) noted that lichens have been used in three 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 and elemental analysis of tissues from selected indicator species (St. Clair 1989; Wetmore 1981, 1989).

Because lichens accumulate many different pollutants from atmospheric outwash, lichen tissues (or thalli) provide a record of the kinds and relative quantities of pollutants in any particular airshed (Gough & Erdman 1977; Schutte 1977; Wetmore 1989; Rope & Pearson 1990). Pollution patterns for specific elements can be monitored over time by determining thallus growth rates and elemental concentrations in excised portions of the thallus (Lawrey & Hale 1981). Lichen physiological processes indicate pollution-related damage long before other, more visible changes in color, morphology, or community structure can be detected or even monitored (Sundstrom and Hallgren 1973; Fields and St. Clair 1984).

Lists of pollution-sensitive lichen species have commonly been published in conjunction with floristic and ecological surveys (Wetmore 1981, 1989; Rushforth et al. 1982). As certain lichen species form particular substrates 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 the original baseline data.

General habitat description for Arizona:

The state of Arizona includes several of North America's major biotic provinces: Sonoran, Chihuahuan, Mojave, Great Basin, and Colorado Plateau deserts; Rocky Mountain, Sierra Madrean, encinal, and pinyon-juniper woodlands; and inland chaparral. Elevation ranges from less than one hundred feet above sea level in Yuma County to over twelve thousand feet in Coconino County. Precipitation varies, but almost all portions of the state are watered to some extent by winter rain or snow and summer monsoons, with occasional *chubascos* in early fall. The Mogollon Escarpment divides Arizona's two major geologic provinces: the Basin and Range Province to the south and west, and the Colorado Plateau to the north and east. This project has involved a preliminary survey of seven of the eight Class I Wilderness areas in Arizona (figure 1).

General description of the Arizona lichen flora:

With over 600 species reported, Arizona's rich lichen flora results from the state's habitat diversity. The forests of the White Mountains, the Mogollon Escarpment, the Chiricahuas, and other high elevations throughout the state, also the encinal of Cochise and eastern Pima counties, support a rich epiphytic lichen flora. Crustose forms predominate on igneous substrates of the southern deserts and sedimentary rocks of the Colorado Plateau.

Bibliography of lichen studies in Arizona:

Darrow, R. A. 1950. The arboreal lichen flora of southeastern Arizona. *Am. Midl. Nat.* 42:484-502.

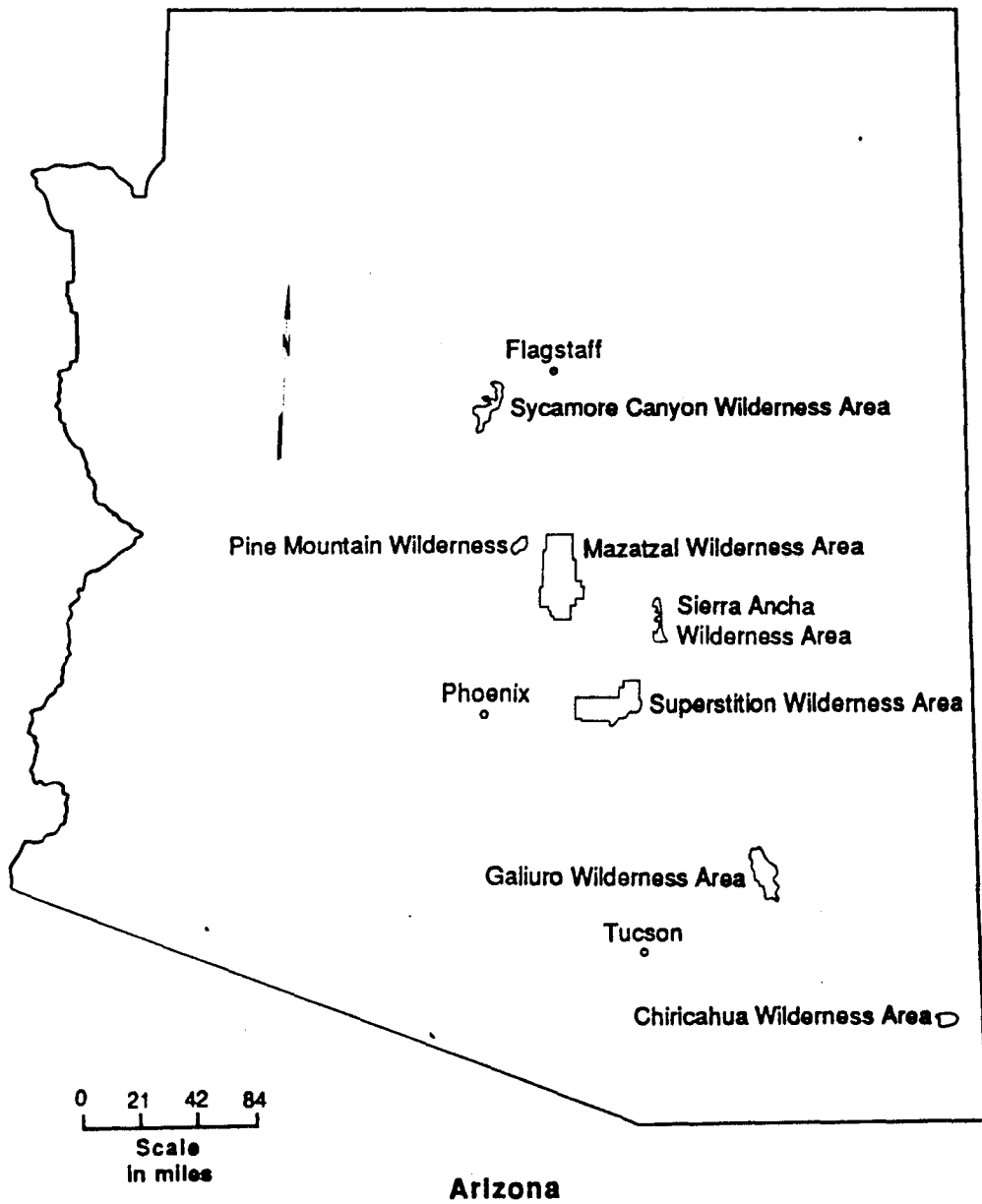


Figure 1

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General habitat description for the Chiricahua Wilderness Area:

The Chiricahua Mountains are composed of Oligocene tuff overlying Paleozoic and Mesozoic strata. Topography is mountainous, ranging from 3200 ft. to almost 10,000 ft. Vegetation throughout the region is rich and varies with elevation, with Chihuahuan Desert grassland at the base of the mountains, followed sequentially by encinal and inland chaparral, and finally montane to subalpine coniferous forests. Narrow canyons in the wilderness area

occasionally support Madro-Tertiary relics such as *Arbutus arizonica*, *Juglans major*, *Platanus wrightii*, and *Cupressus arizonica*.

Likely pollution sources impacting the Chiricahua Wilderness Area are the Tuscon metropolitan area and the copper smelters in Morenci, AZ, San Manuel, AZ, Playas, NM, and Nacozari, Sonora. Apache Powder Plant near St. David may also contribute to air pollution in Cochise County and in the Chiricahuas. In the past, air quality in the Chiricahuas was probably impacted by the now-defunct copper smelter near Bisbee, AZ.

Previous lichen floristic studies are available for the Chiricahua Mountains (Darrow 1950; Weber 1963). Information in these publications will be valuable in evaluating subsequent changes in the lichen flora.

METHODS

Procedures for selecting reference sites:

Specific locations for specimen collection (reference sites) in the wilderness were determined in consultation with Forest Service personnel. Sites were selected for accessibility, substrate diversity and habitat diversity. Specifically, occurrence of unusual geologic substrates, vascular plant communities, soil types, mesic canyons, and spring or wet wall areas were given particular consideration. Baseline data from the reference sites (species diversity, relative abundance, and elemental analysis data for indicator species) forms the foundation for evaluating future air pollution-related changes in lichen communities. Because lichen distribution is directly influenced by substrate, moisture, and sunlight, all available substrates and habitats around each reference site were carefully examined. Small amounts of each lichen species was removed directly from the substrate where possible, or, depending on the species, with small pieces of bark, soil or rock.

Collection, preparation and identification of lichen specimens:

Specimens were put in carefully labeled paper sacks and taken to the BYU Herbarium of Nonvascular Cryptogams, where they were washed, curated, and placed in permanent herbarium packets labeled with collection site, habitat and substrate information. Species were identified using standard lichen keys and taxonomic treatises. Where appropriate standard chemical and thin-layer chromatography techniques were used to finalize species identifications. A permanent collection of the lichen species from each reference site has been prepared and will be maintained in the BYU Herbarium of Nonvascular Cryptogams. As requested by the Forest Service a set of duplicate specimens will be sent to the Lichen Herbarium at Arizona State University.

Collection of lichen thalli for laboratory analyses:

After careful consideration of species abundance, substrate, growth form, documented/suspected pollution sensitivity, and distribution patterns of the lichens at each

reference site, 3-5 taxa were designated as indicator species for all laboratory chemical analyses.

At all reference sites sufficient material (10-15 grams) of each indicator species was collected for laboratory analyses. This material was stored in Hubco cloth bags to prevent sulfur contamination. One or two indicator species from one reference site was analyzed for sulfur, lead and copper, some of the most common air pollutants in the general vicinity of the wilderness area. Analysis for these pollutants was determined in consultation with Forest Service personnel. Excess material for all indicator species is currently stored in Hubco cloth bags at the Herbarium of Nonvascular Cryptogams at Brigham Young University.

Determination of elemental concentrations in lichen tissues:

In the laboratory, all surface debris was carefully removed from elemental analysis samples. Samples were then oven dried and ground to powder. Ten 500 mg replicates of one - two indicator species from one reference site in the wilderness were then analyzed for sulfur, lead and copper. Following digestion of samples with nitric and perchloric acid, lead and copper content was assessed using atomic absorption spectrophotometry. Sulfur was subsequently analyzed turbidimetrically using Barium chloride (BaCl_2). All analyses were performed by the Brigham Young University Plant and Soil Analysis Laboratory.

RESULTS AND RECOMMENDATIONS

Habitat information and specific location for each reference site:

Three days were spent collecting lichens from various sites along trails 263 and 270 in Chiricahua Wilderness Area--more specifically along Crest Trail and from the vicinity of Round Park, Fly Peak and Centella Point. A rich forest of douglas fir and ponderosa pine predominates at all sites, with southwestern white pine occasionally. Gambel oak is associated with some of the rocky areas along Crest Trail; quaking aspens are common on the north-facing slopes of Fly Peak. Elevation ranges from about 2740 msm (9000 ft.) at the wilderness boundary to 2947 msm (9667 ft.) on the summit of Fly Peak. Figure 2 details collections sites for the Chiricahua Wilderness Area.

Preliminary observations and recommendations:

1. The corticolous lichen flora of Chiricahua Wilderness Area is diverse. Coniferous trees support well developed micro- and macrolichen floras. Deciduous trees, though much less common, also support substantial lichen communities. A total of 122 species in 48 genera were identified from the Chiricahua Wilderness Area during the course of this study (see "Checklist of Lichen Species Chiricahua Wilderness Area, Arizona" for details). This list represents approximately 50 - 60% of the total lichen flora for the wilderness. All the lichen growth forms are well represented in the wilderness. Specifically, the flora is dominated by foliose species (43% or 50 species), followed by crustose species (40% or 46 species), fruticose species (8% or 9

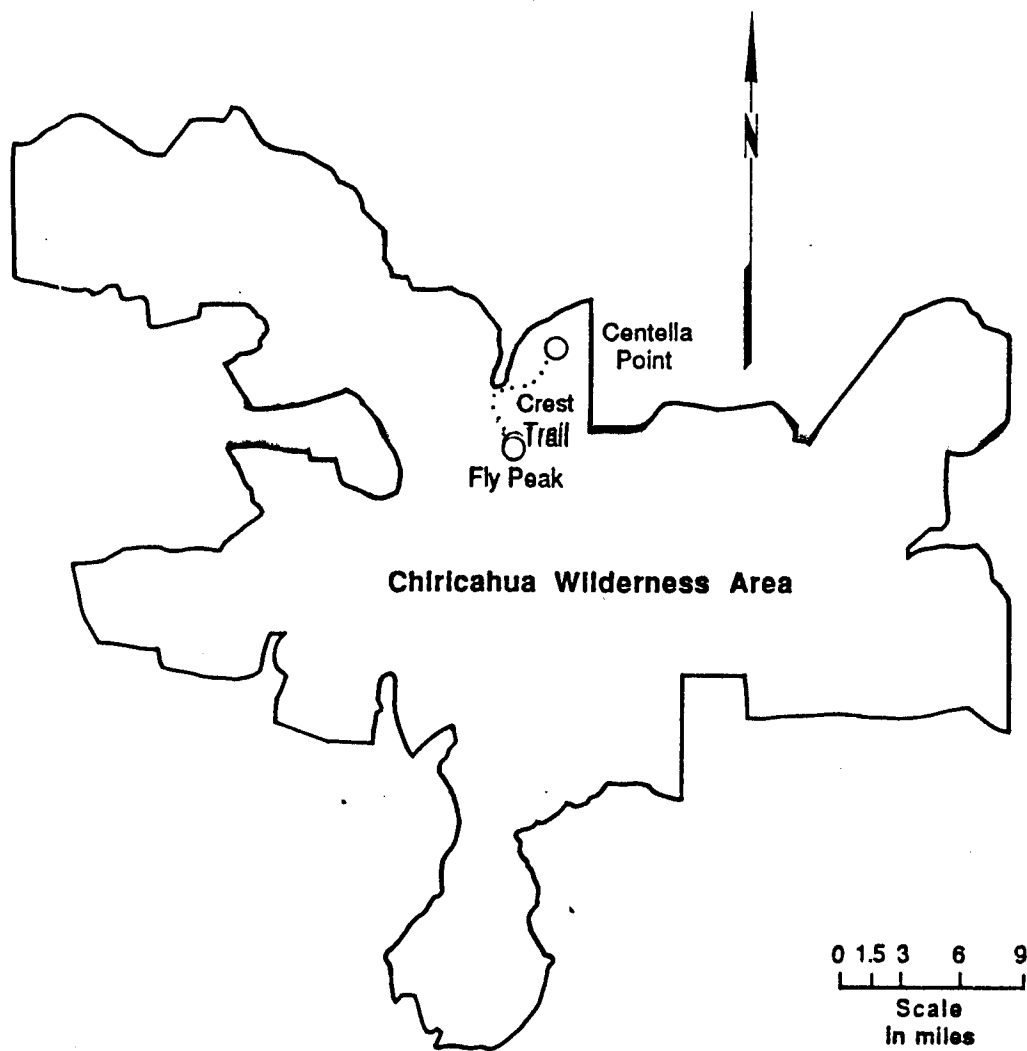


Figure 2

- species), squamulose species (7% of 7 species) and umbilicate species (3% of 3 species). Bark and rock lichens dominate the flora (corticolous species 52% and saxicolous species 52%) followed by terricolous species (5%).
2. Significant precipitation in the Chiricahua Wilderness Area is a significant factor in the development and maintenance of the rich corticolous lichen community.
 3. Certain locations also support fairly diverse terricolous floras consisting principally of various species of *Cladonia* and *Peltigera*.
 4. Rock substrates, particularly those along Crest Trail, also support diverse lichen floras.
 5. On the first day significant haze was observed west of the wilderness in the general vicinity of the coal-fired power plant.
 6. Preliminary visual observations suggest that there have not been major air pollution problems in the northern portion of the wilderness. However, other areas particularly in the western and southern portions of the wilderness may have been impacted by emissions from copper smelters located in Mexico and the coal-fired power plant located west of the wilderness.
 7. Table 2 contains a list of several lichen species which have been shown to be sensitive to various air pollutants. Photographs of some of these species are included with this report.
 8. Elemental analysis data for *Xanthoparmelia cumberlandia* show elevated sulfur levels (.217%) suggesting the need for careful biomonitoring of sulfur dioxide accumulation in the wilderness. On the other hand both copper and lead concentrations seem to be well within the normal (low-impact) range (Table 3).
 9. The Chiricahua Wilderness supports one of the most diverse and complicated lichen floras in Western North America. The proximity of this resource to significant air pollution sources demands that a comprehensive lichen biomonitoring baseline be developed for the entire class I section of the wilderness as soon as possible.
 10. A list of all lichen species collected from all wilderness areas during the course of this study is included for your information (Table 1).

Format of general species list for the Chiricahua Wilderness Area:

The following data are recorded for each species in the general species list (all species are listed alphabetically by genus):

1. current epithet (genus & species) with authors, nomenclature generally follows Egan (1987, 1989, 1990)
2. lichen growth form (ie fruticose, foliose, crustose, squamulose, umbilicate)
3. substrates (ie rock, soil, bark, decorticated wood)
4. specific collection site(s)
5. relative abundance (ie rare, locally common, common, abundant)
6. documented pollution sensitivity with appropriate literature citation(s) (ie sensitive, intermediate, tolerant)
7. general comments (including occurrence on atypical substrates, unusual morphology, new species records for Arizona, descriptive information for

- unidentified specimens.)
8. deposition of specimens (ie BYU Herbarium with duplicates to ASU)

**CHECKLIST OF LICHEN SPECIES
CHIRICAHUA WILDERNESS AREA, ARIZONA**

Acarospora chlorophana (Wahlenb. ex Ach.) Massal.

Growth form: crustose with effigurate margins

Substrate: on rocks

Site(s): Crest Trail, rocky area east of main
trail from Rustler Park Trailhead

Relative abundance: common

Pollution sensitivity: sensitive to sulfur dioxide
(Hale, 1982)

Comments: none

Deposition of specimens: BYU Herbarium #14364 (duplicate
specimen sent to ASU), 14365

Acarospora fuscata (Nyl.) Arnold

Growth form: crustose, with sublobate margins

Substrate: on rocks

Site(s): Crest Trail,

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14366 (duplicate specimen sent to ASU)

Acarospora sp.1

Growth form: crustose - squamulose

Substrate: on rocks

Site(s): rocky area east of main trail from Rustler Park Trailhead

Relative abundance: rare to locally common

Pollution sensitivity: unknown

Comments: thallus tan to light brown, squamulose, no reactions; apothecia not well-
developed; lower cortex dark.

Deposition of specimens: BYU Herbarium #14366 (duplicate specimen sent to ASU)

Aspicilia alphoplaca (Wahlenb. in Ach.) Poelt & Leuck.

Growth form: crustose with well-developed lobed margins

Substrate: on rocks

Site(s): Centella Point Trail

Relative abundance: rare

Pollution sensitivity: sensitive to sulfur dioxide
(Marsh & Nash, 1979)

Comments: none

Deposition of specimens: BYU Herbarium #14371 (duplicate specimen sent to ASU)

Aspicilia calcarea (L.) Mudd

Growth form: crustose

Substrate: on rocks

Site(s): Crest Trail, Centella Point, rocky area east of main trail from Rustler Park Trailhead

Relative abundance: common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14369, 14536, 14537
(duplicate specimen sent to ASU), 14541, 14542

Aspicilia cinerea (L.) Korber

Growth form: crustose

Substrate: on rocks

Site(s): Crest Trail, rocky area east of main trail from Rustler Park Trailhead

Relative abundance: common - abundant

Pollution sensitivity: unknown

Comments: this species shows some variation in thallus color, ranging all the way from white to gray-green. All specimens, however, give the characteristic KOH+ red reaction.

Deposition of specimens: BYU Herbarium #14370 (duplicate specimen sent to ASU), 14533 (duplicate specimen sent to ASU), 14535

Aspicilia contorta (Hoffm.) Krempelh.

Growth form: crustose

Substrate: on rocks

Site(s): Crest Trail

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14532 (duplicate specimen sent to ASU)

Bryoria furcellata (Fr.) Brodo & D. Hawksw.

Growth form: fruticose

Substrate: on doug fir bark, ponderosa pine bark, decorticated wood, rarely on rock

Site(s): Centella Trail, near wilderness boundary along main trail from Rustler Park Trailhead

Relative abundance: abundant

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14543 (duplicate specimen sent to ASU), 14544, 14545, 14546, 14548

Bryoria simplicior (Vainio) Brodo & D. Hawksw.

Growth form: fruticose
Substrate: on doug fir bark
Site(s): Centella Trail
Relative abundance: rare
Pollution sensitivity: unknown
Comments: this species is a new record for Arizona
Deposition of specimens: BYU Herbarium #14547 (duplicate specimen sent to ASU)

Buellia lacteoidea B. de Lesd. (Egan 1972)

Growth form: crustose
Substrate: on rocks
Site(s): Crest Trail, rocky area east of main trail from Rustler Park Trailhead
Relative abundance: rare-locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14549, 14551, 14372 & 14841 (duplicate specimen sent to ASU)

Buellia punctata (Hoffm.) Massal.

Growth form: crustose
Substrate: on maple bark
Site(s): Centella Trail
Relative abundance: locally common
Pollution sensitivity: tolerant (Wetmore, 1987)
Comments: none
Deposition of specimens: BYU Herbarium #14663
(duplicate specimen sent to ASU)

Buellia semitensis Tuck.

Growth form: crustose
Substrate: on rocks
Site(s): Crest Trail
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14732 (duplicate specimen sent to ASU)

Buellia spuria (Schaerer) Anzi

Growth form: crustose
Substrate: on rocks
Site(s): east of main trail from Rustler Park Trailhead, Centella Point
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14842 (duplicate specimen sent to ASU) & 14843

Buellia turgescens Tuck.

Growth form: crustose, subsquamulose

Substrate: on rocks

Site(s): Crest Trail, Centella Point

Relative abundance: rare - locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14552, 14733

Buellia sp. 1

Growth form: crustose

Substrate: on rocks

Site(s): Crest Trail

Relative abundance: rare

Pollution sensitivity: unknown

Comments: thallus white - gray, with prominent black hypothallus and some lobing along margin of thallus; apothecia black, some single others coalescing into large adnate composite fruiting bodies; hypothecium dark brown; hymenium hyaline; epithecium dark; spores brown, 1 septate, 8x13um.

Deposition of specimens: BYU Herbarium #14550

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

Growth form: crustose

Substrate: on aspen bark

Site(s): West Fly Peak Trail, Crest Trail

Relative abundance: locally common

Pollution sensitivity: sensitive - intermediate
(Wetmore, 1987)

Comments: none

Deposition of specimens: BYU Herbarium #14553 (duplicate specimen sent to ASU), 14640

Caloplaca flavovirescens (Wulfen) Dalla Torre & Sarnth.

Growth form: crustose

Substrate: on rocks

Site(s): Crest Trail

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14557

Caloplaca holocarpa (Hoffm.) Wade

Growth form: crustose

Substrate: on aspen bark

Site(s): West Fly Peak Trail

Relative abundance: locally common

Pollution sensitivity: intermediate (Wetmore, 1987)

Comments: none

Deposition of specimens: BYU Herbarium #14555 (duplicate specimen sent to ASU)

Caloplaca modesta (Zahlbr.) Fink

Growth from: crustose with short effigurate margins
Substrate: on rock
Site(s): Crest Trail
Relative abundance: locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14556 (duplicate specimen sent to ASU)

Caloplaca saxicola (Hoffm.) Nordin

Growth form: crustose with lobate margins
Substrate: on rocks
Site(s): rocky area east of main trail from Rustler Park Trailhead
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14554

Cetraria weberi Essl.

Growth form: foliose
Substrate: on decorticated wood, pine bark, doug fir bark
Site(s): main trail from Rustler Park Trailhead, south slope of Fly Peak, juncture of Fly Peak Trail and Crest Trail, Crest Trail
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14560 (duplicate specimen sent to ASU), 14564, 14652 (duplicate specimen sent to ASU), 14656, 14660

Cladonia cariosa (Ach.) Sprengel

Growth form: squamulose, forming podetia
Substrate: on soil and decomposing wood
Site(s): Crest Trail
Relative abundance: locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14565 (duplicate specimen sent to ASU)

Cladonia coniocraea (Flörke) Sprengel

Growth form: squamulose, forming podetia
Substrate: on ponderosa pine bark, soil and decomposing wood, doug fir bark
Site(s): main trail from Rustler Park Trailhead, Crest Trail, juncture of Fly Peak Trail & Crest Trail
Relative abundance: locally common
Pollution sensitivity: intermediate (Wetmore, 1985)
Comments: none
Deposition of specimens: BYU Herbarium #14567, 14569 (duplicate specimen sent to ASU), 14570, 14573

Cladonia pyxidata (L.) Hoffm.

Growth form: squamulose, forming podetia

Substrate: on soil and decomposing wood, soil over rocks, maple bark, wet rock

Site(s): Crest Trail, Centella Trail, Centella Point

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14566 (duplicate specimen sent to ASU), 14568, 14571, 14572

Cyphelium tigillare (Ach.) Ach.

Growth form: crustose

Substrate: on decorticated wood

Site(s): juncture of Fly Peak Trail & Crest Trail, east of main trail from Rustler Park Trailhead, Crest Trail

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14576, 14577 (duplicate specimen sent to ASU), 14731

Dermatocarpon intestiniforme (Korber) Hasse

Growth form: foliose

Substrate: on rocks

Site(s): Centella Point

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14578 (duplicate specimen sent to ASU)

Dermatocarpon miniatum (L.) Mann

Growth form: foliose

Substrate: on rocks

Site(s): Crest Trail

Relative abundance: locally common

Pollution sensitivity: sensitive (Marsh & Nash, 1979)

Comments: none

Deposition of specimens: BYU Herbarium #14579

Dermatocarpon moulinsii (Mont.) Zahlbr.

Growth form: foliose

Substrate: on rocks

Site(s): Centella Point

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14580

Dermatocarpon reticulatum Magnusson

Growth form: foliose

Substrate: on rocks

Site(s): Centella Point

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14581 (duplicate specimen sent to ASU)

Dimelaena oreina (Ach.) Norman

Growth form: crustose

Substrate: on rocks

Site(s): Crest Trail, east of main trail from
Rustler Park Trailhead

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14582 (duplicate
specimen sent to ASU), 14583 (duplicate specimen sent to ASU)

Diploschistes scruposus (Schreber) Norman

Growth form: crustose

Substrate: on rocks

Site(s): Centella Point

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14584

Flavoparmelia caperata (L.) Hale

Growth form: foliose

Substrate: on doug fir bark, ponderosa pine bark,
rocks (rarely)

Site(s): Centella Trail, east of main trail from
Rustler Park Trailhead, Crest Trail

Relative abundance: locally common

Pollution sensitivity: intermediate (Wetmore, 1987)

Comments: none

Deposition of specimens: BYU Herbarium #14586 (duplicate
specimen sent to ASU), 14589 (duplicate specimen
sent to ASU), 14594, 14878 (duplicate specimen sent to ASU)

Flavopunctelia darrowi (Thomson) Hale

Growth form: foliose

Substrate: on maple bark, rocks (rarely)

Site(s): Centella Trail, east of main trail
from Rustler Park Trailhead

Relative abundance: rare - locally common

Pollution sensitivity: unknown

Comments: lower cortex uniformly tan

Deposition of specimens: BYU Herbarium #14667 (duplicate
specimen sent to ASU), 14670

Flavopunctelia flaventior (Stirton) Hale

Growth form: foliose

Substrate: on ponderosa pine, aspen bark, doug fir bark,
rocks (rarely), decorticated wood, oak bark

Site(s): east of main trail from Rustler Park Trailhead,
West Fly Peak Trail, Crest Trail, juncture of Fly
Peak Trail & Crest Trail, Centella Trail

Relative abundance: common

Pollution sensitivity: sensitive (Windler, 1977)

Comments: none

Deposition of specimens: BYU Herbarium #14587 (duplicate
specimen sent to ASU), 14588 (duplicate specimen
sent to ASU), 14590, 14591, 14592 (duplicate specimen
sent to ASU), 14593, 14596, 14666 (duplicate specimen sent to ASU), 14668

Flavopunctelia praesignis (Nyl.) Hale

Growth form: foliose

Substrate: on oak bark, doug fir bark, maple bark

Site(s): east of main trail from Rustler Park Trailhead,
Centella Trail

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: light brown along margin becoming black towards the center of the
thallus

Deposition of specimens: BYU Herbarium #14585 (duplicate specimen sent
to ASU), 14674, 14679 (duplicate specimen sent to ASU)

Flavopunctelia soledica (Nyl.) Hale

Growth form: foliose

Substrate: on doug fir bark

Site(s): Centella Trail

Relative abundance: rare - locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14595

Heterodermia hypoleuca (Muhl.) Trevisan

Growth form: foliose

Substrate: on oak bark

Site(s): east of main trail from Rustler Park Trailhead

Relative abundance: locally common

Pollution sensitivity: sensitive (Windler, 1977)

Comments: none

Deposition of specimens: BYU Herbarium #14615 (duplicate
specimen sent to ASU)

Heterodermia speciosa (Wulfen) Trevisan

Growth form: foliose
Substrate: on maple bark
Site(s): Centella Trail
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14614

Hypocenomyce castaneocinerea (Rasanen) Timdal

Growth form: squamulose
Substrate: decorticated wood
Site(s): east of main trail from Rustler Park Trailhead,
Crest Trail
Relative abundance: locally common
Pollution sensitivity: unknown
Comments: this species is a new record for Arizona
Deposition of specimens: BYU Herbarium #14599 (duplicate specimen sent to ASU),
14605

Hypocenomyce friesii (Ach.in Liljeblad) P. James & G. Schneider

Growth form: squamulose
Substrate: on decorticated, burned wood, doug fir
Site(s): east of main trail from Rustler Park Trailhead,
Centella Trail, Crest Trail
Relative abundance: locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14600, 14601, 14602, 14604 (duplicate
specimen sent to ASU)

Hypocenomyce scalaris (Ach. ex Liljeblad) M. Choisy

Growth form: squamulose
Substrate: decorticated wood
Site(s): Centella Trail
Relative abundance: locally common
Pollution sensitivity: intermediate (Wetmore, 1987)
Comments: European lichenologists generally regard this a to be a pollution tolerant
species
Deposition of specimens: BYU Herbarium #14603 (duplicate specimen sent to ASU)

Hypogymnia physodes (L.) Nyl.

Growth form: foliose
Substrate: on doug fir bark
Site(s): Centella Trail
Relative abundance: locally common
Pollution sensitivity: Intermediate (Wetmore, 1988)
Comments: none
Deposition of specimens: BYU Herbarium #14606 (duplicate
specimen sent to ASU)

Hypotrachyna pulvinata (Fee) Hale

Growth form: foliose

Substrate: on doug fir bark, decomposing snag, maple bark

Site(s): Centella Trail, Crest Trail, east of trail from Rustler Park Trailhead

Relative abundance: common - abundant

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14598 (duplicate specimen sent to ASU), 14607, 14608 (duplicate specimen sent to ASU), 14609 (duplicate sent to ASU), 14613 (duplicate specimen sent to ASU)

Imshaugia aleurites (Ach.) S.F. Meyer

Growth form: foliose

Substrate: on doug fir bark, decorticated wood, ponderosa pine bark

Site(s): Centella Trail, east of main trail from Rustler Park Trailhead

Relative abundance: rare - locally common

Pollution sensitivity: intermediate (Wetmore, 1987)

Comments: none

Deposition of specimens: BYU Herbarium #14610 (duplicate specimen sent to ASU), 14617 (duplicate specimen sent to ASU), 14618

Imshaugia placorodia (Ach.) S.F. Meyer

Growth form: foliose

Substrate: on ponderosa pine bark, doug fir bark, decorticated wood

Site(s): east of main trail from Rustler Park Trailhead, Centella Trail

Relative abundance: locally common - abundant

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14611 (duplicate, specimen sent to ASU), 14612, 14671

Lecanora argentata (Ach.) Malme

Growth form: crustose

Substrate: on doug fir bark, aspen bark, maple bark

Site(s): Centella Trail, east of main trail from Rustler Park Trailhead, West Fly Peak Trail

Relative abundance: rare - locally common

Pollution sensitivity: unknown

Comments: this species is a new record for Arizona

Deposition of specimens: BYU Herbarium #14622, 14625, 14628, 14637, 14641 (duplicate specimen sent to ASU)

Lecanora carpineae (L.) Vainio

Growth form: crustose

Substrate: on maple bark

Site(s): Centella Trail

Relative abundance: rare

Pollution sensitivity: intermediate (Wetmore, 1987)

Comments: none

Deposition of specimens: BYU Herbarium #14639

Lecanora cenisia Ach.

Growth form: crustose

Substrate: on rocks

Site(s): Crest Trail, east of main trail from Rustler Park Trailhead, Centella Point

Relative abundance: rare - locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14621, 14626, 14642

Lecanora impudens Degel.

Growth form: crustose

Substrate: on oak bark

Site(s): east of main trail from Rustler Park Trailhead

Relative abundance: rare - locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14631

Lecanora piniperda Korber

Growth form: crustose, thallus scant

Substrate: on aspen bark

Site(s): Crest Trail

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14634

Lecanora polytropia (Hoffm.) Rabenh.

Growth form: crustose, thallus scant

Substrate: on rocks

Site(s): Crest Trail, Centella Point

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14538, 14643

Lecanora rupicola (L.) Zahlbr.

Growth form: crustose

Substrate: on rocks

Site(s): east of main trail from Rustler Park Trailhead, Crest Trail

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14619 (duplicate specimen sent to ASU),
14635 (duplicate specimen sent to ASU)

Lecanora saligna (Schrader) Zahlbr.

Growth form: crustose, thallus scant to obsolete

Substrate: on decorticated wood

Site(s): juncture of Fly Peak Trail & Crest Trail

Relative abundance: rare

Pollution sensitivity: intermediate (Wetmore, 1987)

Comments: none

Deposition of specimens: BYU Herbarium #14636

Lecanora varia (Hoffm.) Ach.

Growth form: crustose, thallus scant

Substrate: on decorticated wood, maple bark

Site(s): near Rustler Park Trailhead, Centella Trail

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14627, 14637

Lecidea atrobrunnea (Ramond in Lam. & DC.) Schaerer

Growth form: crustose

Substrate: on rocks

Site(s): Centella Point, east of main trail near Rustler Park Trailhead

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14713 & 14840

Lecidea tessellata Florke

Growth form: crustose

Substrate: on rocks

Site(s): Crest Trail

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14714

Lecidea tornoensis Nyl.

Growth form: crustose

Substrate: on decorticated wood, doug fir bark,

Site(s): Centella Trail, main trail south of Rustler Park Trailhead

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14715 (duplicate specimen sent to ASU),
14716, 14717 (duplicate specimen sent to ASU)

Lecidea turgidula Fr.

Growth form: crustose

Substrate: on decorticated wood

Site(s): juncture of Fly Peak Trail and Crest Trail

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14718

Lecidella euphorea (Florke) Hertel

Growth form: crustose

Substrate: on aspen bark, maple bark

Site(s): Centella Trail, West Fly Peak Trail

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14719, 14720,
14721, 14722 (duplicate specimen sent to ASU)

Lecidella viridans (Flotow) Korber

Growth form: crustose

Substrate: on rocks

Site(s): Crest Trail

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14876

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

Growth form: crustose, leprose

Substrate: on soil

Site(s): Crest Trail

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14644 (duplicate
specimen sent to ASU)

Leptocaulon albicans (Th. Fr.) Nyl. ex Hue

Growth form: fruticose

Substrate: on rocks

Site(s): Centella Point, Crest Trail, east of main trail
from Rustler Park Trailhead

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14645 (duplicate
specimen sent to ASU), 14646 (duplicate specimen sent
to ASU), 14647 (duplicate specimen sent to ASU)

Leptogium arsenei Sierk

Growth form: foliose

Substrate: on oak bark

Site(s): east of main trail from Rustler Park Trailhead

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14650 (duplicate
specimen sent to ASU)

Leptogium cyanescens (Rabenh.) Korber

Growth form: foliose

Substrate: on rocks

Site(s): east of main trail from Rustler Park Trailhead,
Centella Point

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14574 (duplicate
specimen sent to ASU), 14648 (duplicate specimen sent
to ASU)

Leptogium denticulatum Tuck.

Growth form: foliose

Substrate: on oak bark

Site(s): east of main trail from Rustler Park Trailhead

Relative abundance: rare - locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14651

Leptogium furfuraceum (Harm.) Sierk

Growth form: foliose
Substrate: on rocks, aspen bark
Site(s): east of main trail from Rustler Park Trailhead,
Centella Trail
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14575 (duplicate
specimen sent to ASU), 14649 (duplicate specimen sent to ASU)

Lichenothelia scopularia (Nyl.) D. Hawksw.

Growth form: crustose
Substrate: on rocks
Site(s): Crest Trail
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14368 (duplicate
specimen sent to ASU)

Melanelia subolivacea (Nyl. in Hasse) Essl.

Growth form: foliose
Substrate: on aspen bark, maple bark, doug fir bark
Site(s): West Fly Peak Trail, Centella Trail, Crest Trail
Relative abundance: rare - locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14654 (duplicate
specimen sent to ASU), 14657, 14658, 14661

Melanelia substygia (Rasanen) Essl.

Growth form: foliose
Substrate: on rocks
Site(s): east of main trail from Rustler Park Trailhead
Relative abundance: rare
Pollution sensitivity: unknown
Comments: some specimens are esorediate and have a KOH+
yellow - orange reaction in the medulla
Deposition of specimens: BYU Herbarium #14655 (duplicate
specimen sent to ASU)

Mycocalicium subtile (Pers.) Szat.

Growth form: thallus obsolete
Substrate: on decorticated wood
Site(s): east of main trail from Rustler Park Trailhead
Relative abundance: rare - locally common
Pollution sensitivity: unknown
Comments: this species is not lichenized
Deposition of specimens: BYU Herbarium #14662 (duplicate
specimen sent to ASU)

Ochrolechia androgyna (Hoffm.) Arnold

Growth form: crustose
Substrate: on doug fir bark, maple bark
Site(s): near Rustler Park Trailhead, Centella Trail
Relative abundance: rare
Pollution sensitivity: sensitive (Wetmore, 1987)
Comments: none
Deposition of specimens: BYU Herbarium #14632 & 14833

Ochrolechia pallescens (L.) Massal.

Growth form: crustose
Substrate: on doug fir bark, decorticated wood, oak bark, maple bark
Site(s): Centella Trail, east of main trail from Rustler Park Trailhead, along horse trail just outside wilderness boundary near Rustler Park Trailhead
Relative abundance: locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14620 (duplicate specimen sent to ASU), 14623 (duplicate specimen sent to ASU), 14624 (duplicate specimen sent to ASU), 14629, 14633, 14638

Pannaria leucophaea (Vahl.) P. Jorg.

Growth form: squamulose
Substrate: on wet rock
Site(s): Centella Point
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14664 (duplicate specimen sent to ASU)

Pannaria tavaresii P. Jorg.

Growth form: foliose, densely isidiate
Substrate: on wet rock
Site(s): Centella Point
Relative abundance: rare
Pollution sensitivity: unknown
Comments: this species is a new record for Arizona
Deposition of specimens: BYU Herbarium #14665 (duplicate specimen sent to ASU)

Parmelia sulcata Taylor

Growth form: foliose
Substrate: on rocks
Site(s): Crest Trail, Centella Point
Relative abundance: rare
Pollution sensitivity: intermediate - tolerant (Wetmore, 1987)
Comments: none
Deposition of specimens: BYU Herbarium #14672 & 14832

Parmeliopsis ambigua (Wulfen in Jacq.) Nyl.

Growth form: foliose
Substrate: on doug fir bark, maple bark
Site(s): Centella Trail
Relative abundance: locally common
Pollution sensitivity: intermediate (Wetmore, 1987)
Comments: none
Deposition of specimens: BYU Herbarium #14677 (duplicate specimen sent to ASU), 14678

Peltigera canina (L.) Willd.

Growth form: foliose
Substrate: on soil
Site(s): Rustler Park Trailhead, Centella Trail
Relative abundance: locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14680 (duplicate specimen sent to ASU), 14683 (duplicate specimen sent to ASU)

Peltigera malacea (Ach.) Funck

Growth form: foliose
Substrate: on soil
Site(s): Rustler Park Trailhead, Centella Trail
Relative abundance: rare - locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14681, 14682 (duplicate specimen sent to ASU), 14684 (duplicate specimen sent to ASU)

Pertusaria albescens (Huds.) M. Choisy & Werner in Werner

Growth form: crustose
Substrate: on doug fir bark, maple bark
Site(s): Centella Trail
Relative abundance: rare
Pollution sensitivity: unknown
Comments: this species is a new record for Arizona
Deposition of specimens: BYU Herbarium #14691, 14693 (duplicate specimen sent to ASU)

Pertusaria arizonica Dibben

Growth form: crustose
Substrate: on rocks
Site(s): east of main trail from Rustler Park Trailhead
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14686

Pertusaria sommerfeltii (Florke ex Sommerf.) Fr.

Growth form: crustose
Substrate: on decorticated doug fir wood
Site(s): Centella Trail
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14689

Pertusaria wulfenioides B. de Lesd.

Growth form: crustose
Substrate: on doug fir bark, ponderosa pine bark,
decorticated wood, decorticated aspen bark
Site(s): along trail south of Rustler Park Trailhead,
Crest Trail, Centella Trail
Relative abundance: common - abundant
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14685, 14687, 14688 (duplicate specimen
sent to ASU), 14690, 14692 (duplicate specimen sent to ASU), 14694
(duplicate specimen sent to ASU)

Phaeophyscia ciliata (Hoffm.) Moberg

Growth form: foliose
Substrate: on aspen bark
Site(s): West Fly Peak Trail, Crest Trail
Relative abundance: locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14699 (duplicate
specimen sent to ASU), #14712

Phaeophyscia hispidula (Ach.) Moberg

Growth form: foliose
Substrate: on oak bark
Site(s): along trail south of Rustler Park Trailhead
Relative abundance: locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14616

Phaeophyscia orbicularis (Necker) Moberg

Growth form: foliose
Substrate: on rocks (wet wall), oak bark
Site(s): Centella Point, main trail south of Rustler
Park Trailhead
Relative abundance: rare - locally common
Pollution sensitivity: intermediate (Wetmore, 1987)
Comments: none
Deposition of specimens: BYU Herbarium #14695 (duplicate specimen sent to ASU),
14696 (duplicate specimen sent to ASU), 14709

Physcia albinea (Ach.) Nyl.

Growth form: foliose

Substrate: on rocks

Site(s): east of main trail from Rustler Park Trailhead,
Centella Point, Crest Trail

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14704, 14707, 14710

Physcia caesia (Hoffm.) Furnr.

Growth form: foliose

Substrate: on rocks

Site(s): Crest Trail

Relative abundance: locally abundant

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14711

Physcia callosa Nyl.

Growth form: foliose

Substrate: on rocks

Site(s): Centella Point, east of main trail from Rustler Park Trailhead

Relative abundance: rare - locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14697, 14703 (duplicate specimen sent to
ASU)

Physcia crispa Nyl.

Growth form: foliose

Substrate: on aspen bark, rocks (rarely)

Site(s): Centella Trail, West Fly Peak Trail, east of main trail from Rustler Park
Trailhead

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14700 (duplicate
specimen sent to ASU), 14705, 14708

Physcia halei Thomson

Growth form: foliose

Substrate: on rocks

Site(s): east of main trail from Rustler Park Trailhead, Centella Point

Relative abundance: rare - locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14702, 14706

Physcia stellaris (L.) Nyl.

Growth form: foliose

Substrate: on maple bark

Site(s): Centella Trail

Relative abundance: rare - locally common

Pollution sensitivity: intermediate (Wetmore, 1987)

Comments: none

Deposition of specimens: BYU Herbarium #14701 (duplicate specimen sent to ASU)

Physcia subtilis Degel.

Growth form: foliose

Substrate: on rocks

Site(s): east of main trail from Rustler Park Trailhead

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14698

Pseudevernia intensa (Nyl.) Hale

Growth form: foliose

Substrate: on aspen bark, ponderosa pine bark, doug fir bark, maple bark

Site(s): West Fly Peak Trail, east of main trail from

Rustler Park Trailhead, Centella Trail, near Rustler
Park Trailhead, Crest Trail

Relative abundance: common - abundant

Pollution sensitivity: unknown

Comments: this species demonstrates two distinctive
morphotypes, a coarse large morphotype and a finely
dissected morphotype. This species was used to obtain
elemental analysis data for this wilderness

Deposition of specimens: 14723, 14724 (duplicate specimen sent to ASU), 14725
(duplicate specimen sent to ASU), 14726 (duplicate specimen sent to ASU),
14727 (duplicate specimen sent to ASU), 14728 (duplicate
specimen sent to ASU)

Psora nipponica (Zahlbr.) G. Schneider

Growth form: squamulose

Substrate: on wet wall

Site(s): Centalla Point

Relative abundance: rare - locally common

Pollution sensitivity: unknown

Comments:

Deposition of specimens: BYU Herbarium #14782

Punctelia hypoleucites (Nyl.) Krog

Growth form: foliose

Substrate: on rocks, doug fir bark

Site(s): east of main trail from Rustler Park Trailhead, Centella Trail

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14673 & 14783 (duplicate specimens sent
to ASU)

Punctelia subrudecta (Nyl.) Krog

Growth form: foliose

Substrate: on doug fir bark, maple bark

Site(s): Crest Trail, Centella Trail

Relative abundance: rare

Pollution sensitivity: intermediate (Wetmore, 1987)

Comments: none

Deposition of specimens: BYU Herbarium 14675, 14676

Ramalina pollinaria (Westr.) Ach.

Growth form: fruticose

Substrate: on rocks

Site(s): east of main trail from Rustler Park Trailhead

Relative abundance: locally common

Pollution sensitivity: sensitive (Wetmore, 1987)

Comments: none

Deposition of specimens: BYU Herbarium #14729 (duplicate specimen sent to ASU)

Ramalina sinensis Jatta

Growth form: foliose

Substrate: on aspen bark

Site(s): Crest Trail

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14730

Rhizocarpon disporum (Naeg. ex Hepp) Mull. Arg.

Growth form: crustose

Substrate: on rocks

Site(s): Centella Trail, east of main trail from Rustler Park Trailhead

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14784 & 14870

Rhizoplaca chrysoleuca (Sm.) Zopf.

Growth form: umbilicate

Substrate: on rocks

Site(s): east of main trail from Rustler Park Trailhead, Centella Point, Crest Trail

Relative abundance: rare-locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14785 (duplicate specimen sent to ASU), 14786 & 14787

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

Growth form: umbilicate

Substrate: on rocks

Site(s): east of main trail from Rustler Park Trailhead

Relative abundance: rare

Pollution sensitivity: sensitive (Hale, 1982)

Comments: none

Deposition of specimens: BYU Herbarium #14669

Rinodina exigua (Ach.) Gray

Growth form: crustose

Substrate: on maple bark, oak bark

Site(s): Centella Trail, east of main trail from
Rustler Park Trailhead

Relative abundance: rare

Pollution sensitivity: intermediate (Wetmore, 1987)

Comments: none

Deposition of specimens: BYU Herbarium #14540, 14630

Rinodina pyrina (Ach.) Arnold

Growth form: crustose

Substrate: on maple bark

Site(s): Centella Trail

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14539

Staurothele catalepta (Ach.) Blomb. & Forss.

Growth form: crustose

Substrate: on rocks

Site(s): east of main trail from Rustler Park Trailhead

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14788

(duplicate specimens sent to ASU)

Tephromela atra (Huds.) Hafellner

Growth form: crustose

Substrate: on rocks

Site(s): rocky area east of main trail from Rustler Park
Trailhead

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14534

Trapeliopsis granulosa (Hoffm.) Lumbsch.

Growth form: crustose

Substrate: on decorticated wood

Site(s): Crest Trail

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14789

(duplicate specimen sent to ASU)

Tuckermannopsis fendleri (Nyl.) Hale

Growth form: foliose

Substrate: on doug fir bark, pine bark, decorticated wood

Site(s): east of main trail from Rustler Park Trailhead,
Crest Trail, south slope of Fly Peak

Relative abundance: common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14558 (duplicate specimen sent
to ASU), 14559, 14653, 14659 & 14790

Tuckermannopsis pinastris (Scop.) Hale

Growth form: foliose

Substrate: on doug fir bark, maple bark, aspen bark

Site(s): Centella Trail

Relative abundance: locally common

Pollution sensitivity: intermediate - tolerant
(LeBlanc & Rao, 1975)

Comments: none

Deposition of specimens: BYU Herbarium #14561 (duplicate
specimen sent to ASU), 14562, 14563

Umbilicaria hirsuta (Swartz *ex* Westrr.) Hoffm.

Growth form: umbilicate

Substrate: on rocks

Site(s): east of main trail from Rustler Park Trailhead

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14791

Usnea arizonica Mot.

Growth form: fruticose

Substrate: on doug fir bark, oak bark, ponderosa pine bark, maple bark

Site(s): along and east of main trail from Rustler Park Trail, Centella Trail

Relative abundance: common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14834 (duplicate specimen sent to ASU),
14835 (duplicate specimen sent to ASU), 14836, 14844 (duplicate specimen
sent to ASU) & 14846

Usnea cavernosa Tuck.

Growth form: fruticose

Substrate: on doug fir bark, ponderosa pine bark

Site(s): Centella Trail, Crest Trail

Relative abundance: common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium # 14849 & 14853

(duplicate specimen sent to ASU)

Usnea herrei Hale

Growth form: fruticose

Substrate: on rocks

Site(s): east of main trail from Rustler Park Trail

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14852

Usnea hirta (L.) weber *ex* Wigg.

Growth form: fruticose

Substrate: on doug fir bark, aspen bark

Site(s): Crest Trail, West Fly Peak Trail

Relative abundance: rare - locally common

Pollution sensitivity: sensitive - intermediate (Wetmore, 1987)

Comments: none

Deposition of specimens: BYU Herbarium #14850 & 14851

Usnea subfloridana Stirton

Growth form: fruticose

Substrate: on ponderosa pine bark, oak bark, doug fir bark, rocks, aspen bark

Site(s): along and east of main trail from Rustler Park Trail, Centella Trail, West Fly Peak Trail

Relative abundance: rare - locally common - common

Pollution sensitivity: sensitive - intermediate (Wetmore, 1987)

Comments: none

Deposition of specimens: BYU Herbarium #14837 (duplicate specimen sent to ASU),

14838 (duplicate specimen sent to ASU), 14839 (duplicate specimen sent to

ASU), 14845 (duplicate specimen sent to ASU), 14847 (duplicate specimen

sent to ASU), 14848

Xanthoparmelia coloradoensis (Gyelnik) Hale

Growth form: foliose

Substrate: on rocks

Site(s): east of main trail from Rustler Park Trailhead, Crest Trail, Centella Point

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14860, 14865 (duplicate specimen sent to ASU), 14873, 14869

Xanthoparmelia cumberlandia (Gyelnik) Hale

Growth form: foliose

Substrate: on rocks, decorticated wood

Site(s): east of main trail from Rustler Park Trailhead, Centella Trail, Crest Trail

Relative abundance: rare - locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14859, 14861 (duplicate specimen sent to ASU), 14866, 14875, 14868, 14871

Xanthoparmelia neotaractica Hale (Hale 1984)

Growth form: foliose

Substrate: on rocks

Site(s): east of main trail from Rustler Park Trailhead, Crest Trail

Relative abundance: rare - locally common

Pollution sensitivity: unknown

Comments: this species is a new record for Arizona

Deposition of specimens: BYU Herbarium #14863 (duplicate specimen sent to ASU), 14864 (duplicate specimen sent to ASU), 14877

Xanthoparmelia novomexicana (Gyelnik) Hale

Growth form: foliose

Substrate: on rocks

Site(s): Crest Trail, Centella Point

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14867 & 14872

Xanthoparmelia planilobata (Gyelnik) Hale (Hale 1988)

Growth form: foliose

Substrate: on rocks

Site(s): Centella Point

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14862

Xanthoparmelia psoromifera (Kurok. ex D. Dietr.) Hale

Growth form: foliose

Substrate: on rocks

Site(s): Crest Trail

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14874

Xanthoria elegans (Link) Th. Fr.

Growth form: foliose

Substrate: on rocks

Site(s): east of main trail from Rustler Park Trailhead, Crest Trail

Relative abundance: locally common

Pollution sensitivity: sensitive (Hale, 1981)

Comments: none

Deposition of specimens: BYU Herbarium #14855 & 14856 (duplicate specimen sent to ASU)

Xanthoria polycarpa (Hoffm.) Rieber (Hawksworth et al. 1980)

Growth form: foliose

Substrate: on aspen bark

Site(s): West Fly Peak Trail, Crest Trail

Relative abundance: rare - locally common

Pollution sensitivity: intermediate (Wetmore, 1987)

Comments: #14857 is a finely branched gray morph of *Xanthoria polycarpa*

Deposition of specimens: BYU Herbarium #14854 (duplicate specimen sent to ASU), 14857 (duplicate specimen sent to ASU), 14858 (duplicate specimen sent to ASU)

Combined species list for all wilderness areas:

Included with this report is a listing of all the lichen species from all seven Class I wilderness areas included in this project. This table includes current species names, general distribution information by wilderness and relative abundance information for each species. A total of 291 species in 82 genera were collected from all wilderness areas during the course of this project. Due to the fact that each wilderness area is somewhat unique in terms of substrates, microhabitats and physical factors, comparisons between wilderness areas based on absolute species numbers, or even relative abundance of selected species are probably invalid. Furthermore, there is some variance in the actual collecting time between wilderness areas. These species lists are preliminary and depending on the wilderness area, actually represent between 50 and 80% of the total lichen flora. Depending on the wilderness area somewhere between 7 and 12 days of additional collecting will be necessary to bring the list to between 90 and 100% completion.

Table 1: Species List & Relative Abundance Data for Arizona Wilderness Areas

Key: R=rare C=common A=abundant L=locally

Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Acarospora							
cervina var.							
glaucocarpa				R	R-LC		
chlorophana	R-C	R-LC	LC				C
cinereoalba		R		LC	R-LC		
fuscata		C		C			LC
oligospora		R					
oxytona		LC	LC	LC			
peltastica		R					
scheicheri	R-C	LC					
strigata		C		LC		R	
sp. 1	R	R-C		R			R-LC
sp. 2	R	R					
sp. 3		R-LC					
sp. 4		R					
sp. 5		LA					
Anaptychia							
palmulata		C-A	LC			R-C	
Aspicilia							
alphoplaca	R-LC	R-LC	R-LC	LC	LC	R	R
caesiocinerea	R-C		R				
calcareo		C	LC	LC	LC	R-LC	C
cinerea	C	C	C		R-LC	LC	C-A
contorta							R

Table 1: Species List & Relative Abundance Data for Arizona Wilderness Areas

Key: R=rare C=common A=abundant L=locally

Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Aspicilia (cont.)							
desertorum				R	LC		
radiosa		LC					
quartzitica	C		R-LC		R-LC		
sp. 1		R					
Bellemerea							
cinereorufescens				R-LC		R-LC	
Biatora							
botryosa				R			
Bryoria							
furcellata							A
simplicior							R
Buellia							
erubescens	R		R			R-LC	
lacteoidea							R-LC
lepidastra				R-LC			
mamillana		R					
puntata	R	R	R	R		R-LC	LC
retrovertens				R	R		
semitensis							R
spuria						R-LC	R
triphragmioides		R-LC					
turgescens	R						R-LC
sp. 1							R

Table 1: Species List & Relative Abundance Data for Arizona Wilderness Areas

Key: R=rare C=common A=abundant L=locally

Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Caloplaca							
arizonica		LC	C		LC-C	R-LC	
cerina	R	LC	R			R-LC	LC
chysophthalma	R-C	LC	LC	R-LC	LC		
• cinnabarina		C	C	R	LC		
discolor		C	LC			R-LC	
durietzii	C	R-C			LC		
epithallina						R	
exsecuta		R					
flavovirescens	C		C	LC	LC	LC	R
fraudans	R						
holocarpa	R-C	LC				R	LC
microphyllina						LC	
• modesta				C		R-LC	LC
pelodella		R		C	LC		
• saxicola		R				R	R
sideritis	R		R				
Candelaria							
concolor var.							
effusa			LC	R	R	LC	
Candelariella							
aurella	C	C					
deflexa	R-C	R	R	R			
rosulans	C	R-LC	LC	R-LC		LC	

Table 1: Species List & Relative Abundance Data for Arizona Wilderness Areas
Key: R=rare C=common A=abundant L=locally

Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Candelariella (cont.)							
submexicana	R			LC			
vitellina		R-C	LC				
xanthostigma					R		
Candelina							
submexicana						LC	
Carbonea							
vorticosa	R	R					
Catapyrenium							
lachneum	C	LC-A		LC	LC	R	
Cetraria							
coralligera			LC				
weberi		LC					R
Chaenotheca							
furfuracea			R				
Cladonia							
bacillaris						R	
cariosa		R					LC
chlorophaea		LC					
coniocraea			LC				LC
fimbriata						LC	
pyxidata	LC	LC	R		LC		LC

Table 1: Species List & Relative Abundance Data for Arizona Wilderness Areas

Key: R=rare C=common A=abundant L=locally

Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Collema							
coccophorum		R				R	
furfuraceum		R	R		LC	R	
fuscovirens				R	R-LC	R-LC	
polycarpon	R-C			LC	LC		
subflaccidum		LA					
tenax		LC				R-LC	
texanum	R						
undulatum		R					
Cyphelium							
tigillare		R-LC	R				R
Dermatocarpon							
intestiniforme					C		LC
miniatum	LC	LC-A	LA		C		LC
moulinsii			R				R
reticulatum	LC-A	R-C	LA	LC	LC		LC
Dimelaena							
oreina	C	R	LC				LC
Diploschistes							
diacapsis					LC		
muscorum	R				R		
scruposus	R-C	R-C	LC			R	R

Table 1: Species List & Relative Abundance Data for Arizona Wilderness Areas

Key: R=rare C=common A=abundant L=locally

Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Diplotomma alboatrum			LC				
Endocarpon pulvinatum	R						
pusillum	R-C	LC		R	R		
wilmsoides	R						
Flavoparmelia caperata							LC
Flavopuntelia darrowi	R-LC		LC				R-LC
flaventior	R-C	R-LC			LC	R-LC	C
praesignis	R						LC
soredica	C-A	C	LA	R	LC	R-C	R-LC
Heppia lutosa	R						
Heterodermia hypoleuca							LC
rugulosa			R				
speciosa							R
Hyperphyscia adglutinata				LC	LC		
Hypocenomyce castaneocinerea							LC
friesii							LC

Table 1: Species List & Relative Abundance Data for Arizona Wilderness Areas

Key: R=rare C=common A=abundant L=locally

Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Hypocenomyce (cont.)							
<i>scalaris</i>			R				LC
<i>xanthococca</i>			R				
Hypogymnia							
<i>physodes</i>							LC
Hypotrachyna							
<i>pulvinata</i>							C-A
Imshaugia							
<i>aleurites</i>							R-LC
<i>placorodia</i>		LC				R-LC	LC-A
Lasallia							
<i>papulosa</i>	LC						
Lecanora							
<i>argopholis</i>				R			
<i>argentata</i>		R	LC		R-LC	R	R-LC
<i>caesiorubella</i>			R				
subsp. <i>saximontana</i>							
<i>carpineae</i>							R
<i>cenisia</i>			R	R			R-LC
<i>christoi</i>		R		R-LC			
<i>crenulata</i>						R-LC	
<i>dispersa</i>		R					
<i>garovaglii</i>		R		R-LC			
<i>impudens</i>		R	R-LC				R-LC

Table 1: Species List & Relative Abundance Data for Arizona Wilderness Areas

Key: R=rare C=common A=abundant L=locally

Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Lecanora (cont.)							
muralis	C	C	LC	C	LC	LC	
novomexicana	C		LC	R			
piniperda						R	R
polytropa	R						R
rugosella						LC	
rupicola							LC
saligna	R	R	R				R
sierrae		R				R	
symmicta						R	
thallophila					R		
valesiaca				R	R	R	
varia		R-LC				R	R
Lecidea							
atrobrunnea		R-LC	LC				R
auriculata		R-LC		R-LC			
botryosa	R						
elabens						R	
tessellata	C	C			LC	LC	LC
tornoensis							LC
turgidula		R-LC				LC	R
sp. 1		R					

Table 1: Species List & Relative Abundance Data for Arizona Wilderness Areas

Key: R=rare C=common A=abundant L=locally

Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Lecidella							
carpathica		R				C	
euphorea		R-LC			R-LC	LC	LC
stigmatea		R	R-LC			LC	
viridans		LC					R
Lepraria							
finkii		R					R
Leprocaulon							
albicans	LC		R-LC				LC
Leptoloma							
membranaceum			LC-A			R	
Leptogium							
arsenei					R	LC	LC
cyanescens	LC	R-LC	C		LC	LC	LC
denticulatum	LC		LC	R		LC	R-LC
furfuraceum		LC	LC		LC	LC	R
hirsutum			R				
lichenoides	R		R		LC		
saturninum		R				R-LC	
sp.	R-LC						
Letharia							
vulpina		R					

Table 1: Species List & Relative Abundance Data for Arizona Wilderness Areas
Key: R=rare C=common A=abundant L=locally

Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Lichenothelia							
scopularia							R
Megaspora							
verrucosa		R	LC				
Melanelia							
exasperata		R-C		R			
halei						R	
incolorata		R-C					
olivacea						R	
olivaceoides					R		
subargentifera			R				
subolivacea	LC	C	R		R-LC		R-LC
substygia			LC				R
Mycocalicium							
subtile		R	R				R-LC
Neofuscelia							
infrapallida	R-C	R	LC	R-LC	R-LC	C	
Ochrolechia							
androgyna		R	R			R	R
pallescens		LA	LC				LC
Pannaria							
leucophaea	R		R		R-LC	R	R
tavaresii							R

Table 1: Species List & Relative Abundance Data for Arizona Wilderness Areas

Key: R=rare C=common A=abundant L=locally

Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Parmelia sulcata							R
Parmeliopsis ambigua		LC					LC
Parmotrema hababianum	LC		R-LC		LC	LC	
Peccania arizonica	R	R		R			
Peltigera canina	LC	LC			LC		LC
collina		R					
malacea		LC					R-LC
membranacea			LC		R-LC		
Peltula euploca				R			
Pertusaria albescens							R
amara			LC				
arizonica							R
saximontana		LC	LC		LC	R-LC	
sommerfeltii							R
wulfenioides							C-A

Table 1: Species List & Relative Abundance Data for Arizona Wilderness Areas

Key: R=rare C=common A=abundant L=locally

Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Phaeophyscia							
cernohorskyi		R			LC	LC	
ciliata		R	R				LC
hispidula							LC
orbicularis		R	R				R-LC
sciastra		R	R				
Physcia							
aipolia	R		LC		R-LC	LC	
alba		R					
albinea	R					R-LC	R
caesia	R		R	R	R	R-LC	LA
callosa	R						R-LC
crispa	R						LC
dubia		R-LC	LC-A	R	R-LC		
halei						R	R-LC
phaea			R				
stellaris	LC	C	LA	R-LC	R-LC	LC	R-LC
subtilis		R	R				LC
Physconia							
detersa	R				R-LC	R	
enteroxantha	R		LC-A		R-LC	R	
grisea		R	LC-A				
perisidiosa		R	R		R		

Table 1: Species List & Relative Abundance Data for Arizona Wilderness Areas

Key: R=rare C=common A=abundant L=locally

Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Placynthium							
nigrum			R				
Polychidium							
muscicola	R						
sp. 1	R						
Pseudevernia							
intensa							C-A
Psora							
decipiens		LC-A			LC		
himalayana					R		
icterica	C-A			R-LC			
luridella					R	R	
nipponica	R		LC				R-LC
pseudorussellii					R		
tuckermanii		R			LC		
Punctelia							
hypoleucites	LC	LC	LC		R-LC		LC
subrudecta			R				R
Ramalina							
americana			R-LC				
pollinaria			LC-A				LC
sinensis		R	LC				R

Table 1: Species List & Relative Abundance Data for Arizona Wilderness Areas

Key: R=rare C=common A=abundant L=locally

Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Rhizocarpon							
disporum	C	LC	C	LC	LC	C	LC
geographicum					R		
intermediellum	R		R				
Rhizoplaca							
chysoleuca	LC	R-LC	LC			R-LC	
melanophthalma		LC	R-LC				R
Rinodina							
archaea	R						
bischoffii		R					
confragosa			R				
exigua		R				R	R
milvina		R					
pachysperma		C			R-LC	R	
pyrina							LC
Sarcogyne							
regularis		R					
sp.	R						
Scoliciosporum							
umbrinum			R				
Squamarina							
degelii		R		R			

Table 1: Species List & Relative Abundance Data for Arizona Wilderness Areas
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Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Staurothele							
catalepta		R		C		LC	LC
fuscocuprea	R-C						
rufa		R					
Tephromela							
atra		LC	LC				R
Thelidium							
pyrenophorum				R			
Thyrea							
pulvinata				LC			
Toninia							
caeruleonigricans		LC					
tristis		LC					
Trapeliopsis							
granulosa		R					R
Tuckermannopsis							
fendleri		LC					C
pinastri							LC
Umbilicaria							
hirsuta							R
phaea			R				
torrefacta		LC	LC-A				
vellea			LC-A				

Table 1: Species List & Relative Abundance Data for Arizona Wilderness Areas
Key: R=rare C=common A=abundant L=locally

Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Usnea							
arizonica							C
cavernosa							C
herrei							R
hirta		R-A	LC		R-LC	LC	R-LC
subfloridana							R-C
Verrucaria							
lecideoides	R						
muralis		LC					
nigrescens						R	
viridula		R		R			
Xanthoparmelia							
barbatica				R			
coloradoensis		C	LC	R-LC	LC	C	LC
conspersa	LC	LC					
cumberlandia	C	C		C	LC		R-LC
lineola	R-C	R	LC	LC			
monticola		R					
neoconspersa		R-LC					
neotaractica							R-LC
nigropsoromifera	R-C						
novomexicana	R					R	R
planilobata							R
plittii	C	R-LC		C			

Table 1: Species List & Relative Abundance Data for Arizona Wilderness Areas

Key: R=rare C=common A=abundant L=locally

Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Xanthoparmelia (cont.)							
psoromifera	LC	C					R
somloensis	R	LC					
subramigera				C	LC		
weberi				R			
wyomingica	C						
sp. 1		C					
sp. 2		R					
Xanthoria							
elegans		R			LC	R-LC	LC
fallax	LC	LC	LC	LC	R-LC	R-LC	
polycarpa		R-LC	LC				R-LC
sorediata		LC				LC	

AIR POLLUTION SENSITIVE LICHEN SPECIES
(Material collected for elemental analyses)

TABLE 2: List of air pollution sensitive lichen species collected from Chiricahua Wilderness Area, Arizona. Growth form, substrate and site information is given for each species.

GENUS/SPECIES	GROWTH FORM	SUBSTRATE	COLLECTION SITE(S)
Dermatocarpon miniaturum	foliose	rock	Crest Trail
Pseudevernia intensa	foliose	bark	West Fly Peak Trail, near main trail, Centella Trail
Ramalina pollinaria	fruticose	rock	near main trail
Rhizoplaca chrysoleuca	umbilicate	rock	near main trail, Centella Point Crest Trail
Usnea hirta	fruticose	bark	Crest Trail, West Fly Peak Trail
Xanthoparmelia cumberlandia	foliose	rock, lignum	near main trail, Centella Trail, Crest Trail
coloradoensis	foliose	rock	near main trail, Crest Trail, Centella Point

Table 3: Elemental analysis data for selected species of lichens from reference sites in the Chiricahua Wilderness Area, September 1990.

Species Sites (substrate)	Pb (ppm)	Cu (ppm)	S (%)
<i>Pseudevernia intensa</i>	48 (40-55)	60 (53-68)	.19 (.17-.21)
<i>Xanthoparmelia cumberlandia</i>	70 (60-78)	34.8 (30-41)	.217 (.16-.29)
<i>Usnea subfloridana</i>	39.8 (35-46)	25 (22-28)	.156 (.15-.18)

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