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 be 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 be 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:**

Figure 1


**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 (BaCl₂). 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 mss (9000 ft.) at the wilderness boundary to 2947 mss (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 florais. 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 foliiose species (43% or 50 species), followed by crustose species (40% or 46 species), fruticose species (8% or 9
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 (i.e. BYU Herbarium with duplicates to ASU)
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 alphoplaaca (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 lacteoida 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; epitheceum 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 form: 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** (Florke) 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 soredica** (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 hypholeuca** (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 friessii (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 carpinea** (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 polytropa** (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.) Schäerer
- 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)
**Leprocaulon 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 subbolivacea** (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 ambigu**a (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 wulfeniioides 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): Centella 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 atrata** (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
  Deposit 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
  Deposit of specimens: BYU Herbarium #14558 (duplicate specimen sent
  to ASU), 14559, 14653, 14659 & 14790

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

Umbilicaria hirsuta (Swartz ex Westr.) 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
  Deposit 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 form Rustler Park Trail, Centella Trail
  Relative abundance: common
  Pollution sensitivity: unknown
  Comments: none
  Deposit 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.
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Key: R=rare  C=common  A=abundant  L=locally
Table 1: Species List & Relative Abundance Data for Arizona Wilderness Areas
Key: R=rare  C=common  A=abundant  L=locally

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41
Table 1: Species List & Relative Abundance Data for Arizona Wilderness Areas

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

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49
Table 1: Species List & Relative Abundance Data for Arizona Wilderness Areas

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

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

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<td><em>Usnea subfloridana</em></td>
<td>39.8 (35-46)</td>
<td>25 (22-28)</td>
<td>.156 (.15-.18)</td>
</tr>
</tbody>
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BIBLIOGRAPHY


