

**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

SUPERSTITION WILDERNESS AREA

Arizona, Maricopa County
Tonto National Forest
Superstition Wilderness Area

SUBMITTED BY

**LARRY L. ST. CLAIR, Ph.D.
ASSOCIATE PROFESSOR OF BOTANY
AND CLAYTON C. NEWBERRY, RESEARCH ASSOCIATE
DEPARTMENT OF BOTANY AND RANGE SCIENCE
BRIGHAM YOUNG UNIVERSITY
PROVO, UTAH 84602**

11 JULY 1991

Table of Contents

Introduction	Page 2
Methods	Page 5
Results and Recommendations	Page 6
Bibliography	Page 41

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 thalli, 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.

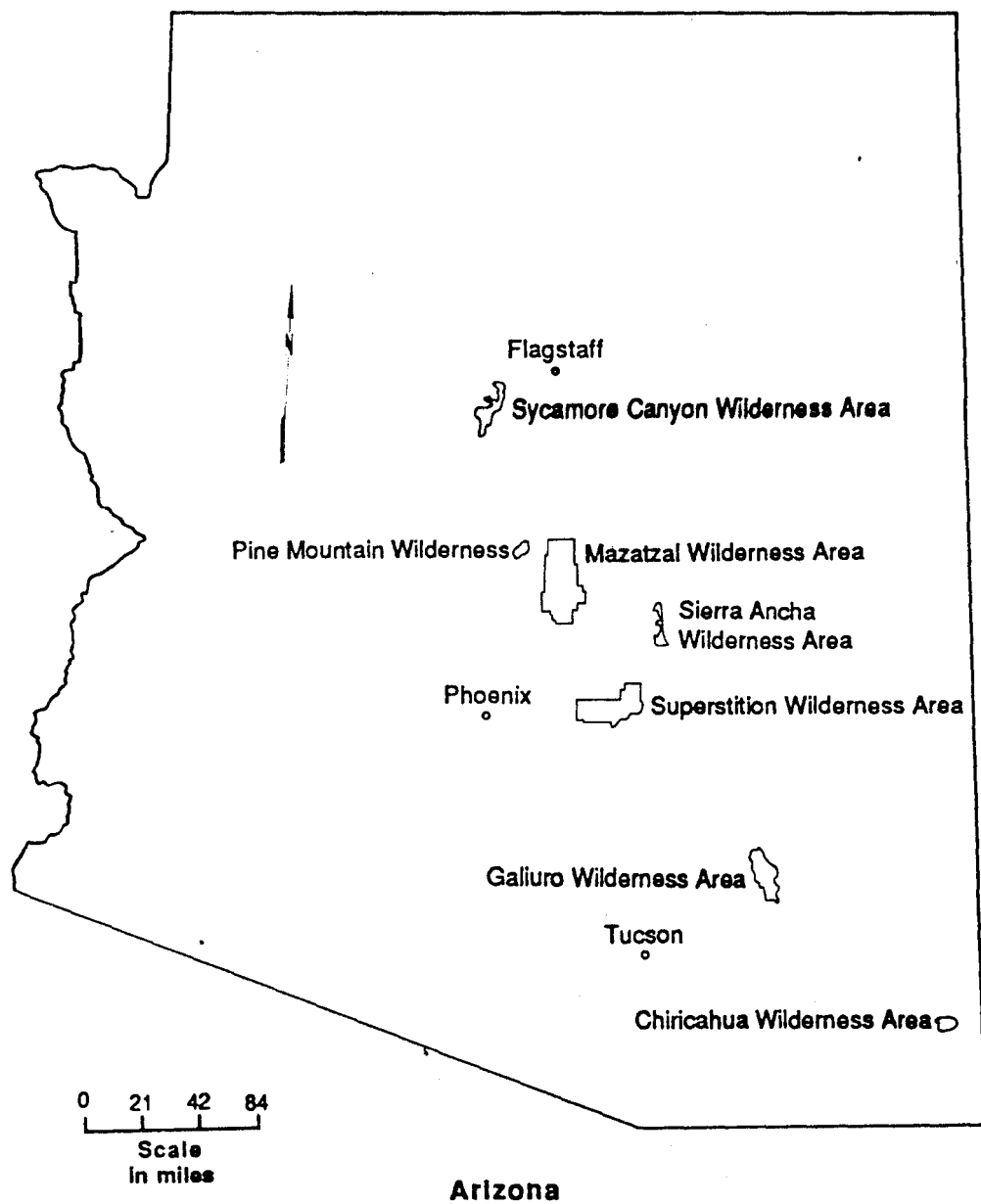


Figure 1

- Flowers, S. 1963. The lichen and moss flora of Betatakin Canyon and vicinity, Navajo National Monument, Arizona. Univ. Utah Div. Biol. Sci. Misc. Pap. 10pp.
- Johnsen, A. B. 1965. Some Lichens from West Fork, Coconino County, Arizona. *The Bryologist* 68: 241-243.
- Nash, T. H. 1973. Additions to the lichen flora of Arizona I. *The Bryologist* 76: 545-547.
- , 1974. Lichens of the Page environs as potential indicators of air pollution. *Journ. Ariz. Acad. Sci.* 9:97-101.
- , 1975. Lichens of Maricopa County, Arizona. *Journ. Ariz. Acad. Sci.* 10: 119-125.
- , 1976. Lichens of the White Mountains, Arizona. *Journ. Ariz. Acad. Sci.* 12: 53-56.
- , 1985. Additions to the lichen flora of Arizona III. *The Bryologist* 88(1): 19-22.
- & A. B. Johnsen. 1975. Catalog of the lichens of Arizona. *The Bryologist* 77: 472-474.
- & W. Weber. 1974. Additions to the lichen flora of Arizona II. *The Bryologist* 77: 472-474.
- Nebeker, G. T. & L. L. St. Clair. 1984. The lichen flora of Navajo National Monument, Arizona. *Mycotaxon* 19: 413-422.
- Rudolph, E. D. 1953. A contribution to the lichen flora of Arizona and New Mexico. *Ann. Mo. Bot. Gard.* 40: 63-72.
- Weber, W. A. 1963. Lichens of the Chiricahua Mountains, Arizona. *Univ. Colo. Stud. Ser. Biol.* 10: 1-27.

General habitat description for Superstition Wilderness Area:

The Superstition Mountains are a complex of Tertiary calderas. Lithology includes volcanics and associated tuff overlying older intrusive and metamorphic rock. The terrain is rugged, ranging from 2000 ft. in western portions of the wilderness area to 6265 ft. at Mound Mountain. Plant communities change with increasing elevation from sonoran desert scrub to semi-desert grasses and chaparral, to isolated stands of ponderosa pine in the highest

elevations.

Sources of pollution include metropolitan Maricopa County to the west, the Globe copper smelter to the east, and the San Manuel copper smelter to the southeast.

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.

Collection, preparation and identification of lichen specimens:

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.

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:

In Superstition Wilderness Area lichens were collected along First Water Trail, Peralta Trail, and Reavis Trail. First Water Trail, starting at 732 msm (2400 ft. elevation), is characterized by Sonoran Desert elements such as saguaro, paloverde, creosote, bursage, jojoba, agave, yucca, sotol, and hopbush. Peralta Trail, also starting at 732 msm, is floristically similar but slightly more mesic, with more grasses and herbaceous annuals along the watercourse, dense stands of arborescent sugar sumac, and, in upper elevations, pinyon pines. Both trail exhibit similar lithologies of basalt and tuff. Reavis Trail differs from the other two trails floristically and lithologically, with live oak chaparral over a granitic substrate withering into unstable and highly erosive grus slopes, and a trailhead elevation of 1097 msm (3600 ft.) Figure 2 details collections sites for the Superstition Wilderness Area.

Preliminary observations and recommendations:

1. Superstition Wilderness Area has a typical arid land lichen flora consisting of 61 species in 32 genera (see "Checklist of Lichen Species Superstition Wilderness Area, Arizona" for details). This represents approximately 65 - 75% of the total lichen flora for the wilderness. All growth forms are represented in the flora. The flora is dominated by crustose species (54% or 33 species) followed by foliose species (31% or 19 species), squamulose species (8% or 5 species), fruticose species (2% or 1 species) and umbilicate species (2% or 1 species). Rock lichens dominate the flora (80%) followed by bark lichens (21%) and soil lichens (5%).
2. Fruticose lichens were rare to absent in Superstition Wilderness Area. Foliose and especially crustose lichens are extremely common on extrusive igneous substrates.
3. The crustose lichen flora was richest in the tuff formations along First Water Trail. Tuff is an exceptionally good substrate for lichen growth.
4. The lichen flora of Peralta Trail was poor by comparison to First Water Trail. As the predominant lithology in Peralta Trail is basaltic or tuffaceous--relatively good

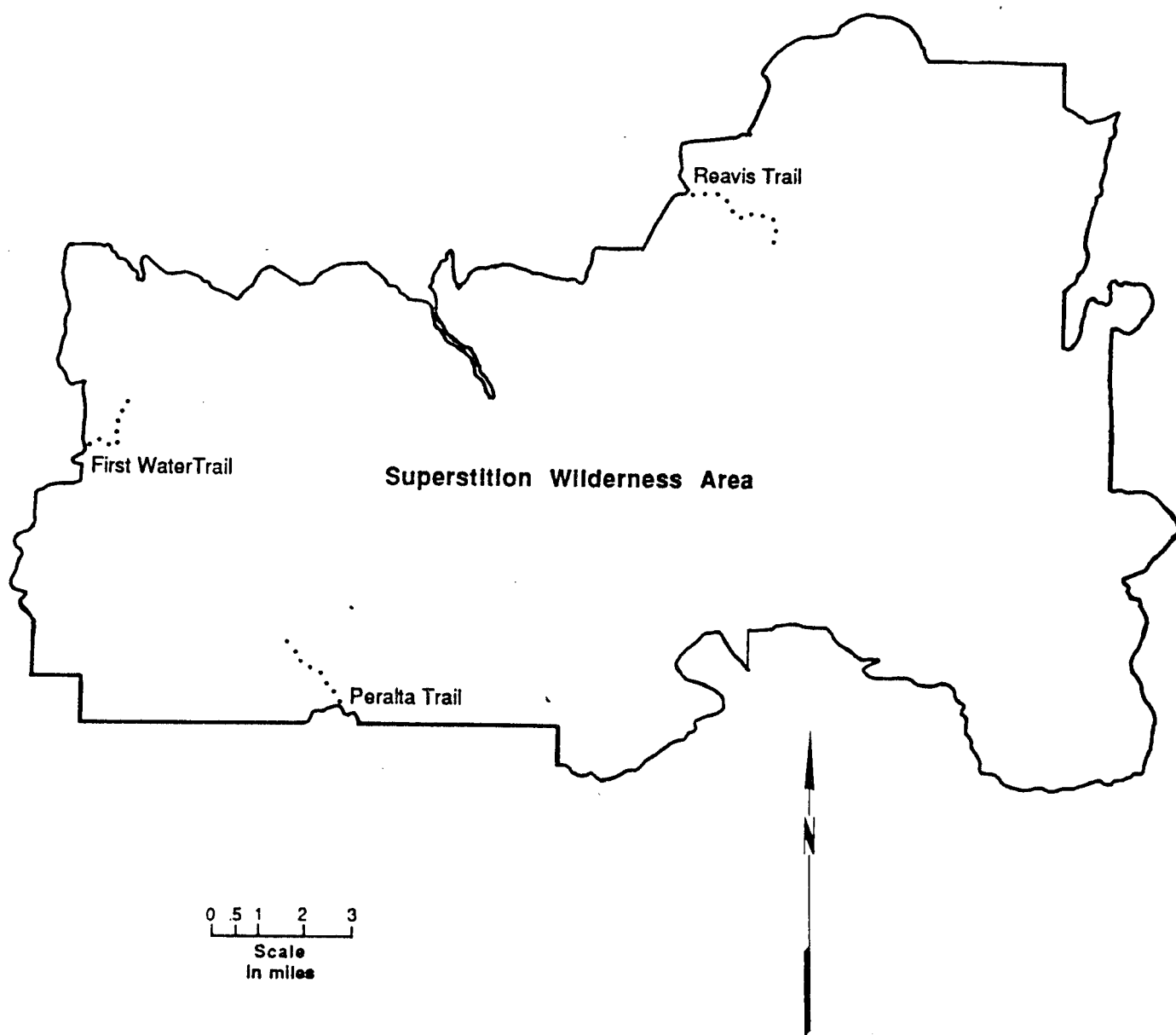


Figure 2

- substrates--low lichen diversity may be related to air pollution from urban Maricopa County.
5. Reavis Trail exhibited the poorest lichen diversity of any area sampled in Arizona, but probably for natural reasons. Coarse soils of highly erosive grus are poor surfaces for terricolous lichens; rapidly exfoliating granitics are equally poor surfaces for saxicolous lichens; and the bark and wood of Arizona's chaparral are generally poor substrates for corticolous lichens.
 6. No pollution-related thallus damage was observed.
 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* shows elevated sulfur levels (.223%) suggesting the need for further biomonitoring of sulfur dioxide accumulation in the wilderness area. The proximity of this wilderness area to metropolitan Phoenix probably accounts for this pattern. Lead and copper are well within the normal (low-impact) range for these pollutants. Urban encroachment complicates air quality problems in this airshed. Careful planning and biomonitoring are essential.
 9. 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 Superstition 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
SUPERSTITION WILDERNESS AREA, ARIZONA**

Acarospora cinereoalba (Fink) Magnusson

Growth form: crustose

Substrate: on rocks (tuff)

Site(s): First Water Trail, Peralta Canyon Trail

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14748 (duplicate specimen sent to ASU),
14750 (duplicate specimen sent to ASU) & 14758

Acarospora fuscata (Nyl.) Arnold

Growth form: crustose

Substrate: on rocks (tuff)

Site(s): First Water Trail

Relative abundance: common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14751 (duplicate specimen sent to ASU),
14752 (duplicate specimen sent to ASU) & 14755

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

Growth form: crustose

Substrate: on rocks

Site(s): Peralta Canyon Trail

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14759

Acarospora oxytona (Ach.) Massal.

Growth form: crustose (with lobed margins)

Substrate: on rocks (tuff)

Site(s): First Water Trail, Peralta Canyon Trail

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14754 & 14757

Acarospora strigata (Nyl.) Jatta

Growth form: crustose
Substrate: on rocks (tuff)
Site(s): First Water Trail
Relative abundance: locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14749
(duplicate specimen sent to ASU)

Acarospora sp. 1

Growth form: crustose
Substrate: on rocks (tuff)
Site(s): First Water Trail
Relative abundance: rare
Pollution sensitivity: unknown
Comments: thallus deeply fissured
Deposition of specimens: BYU Herbarium #14753

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

Growth form: crustose (margin with prominent lobes)
Substrate: on rocks (tuff)
Site(s): First Water Trail, Peralta Canyon Trail
Relative abundance: locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14739 & 14761
(duplicate specimen sent to ASU)

Aspicilia calcarea (L.) Mudd.

Growth form: crustose
Substrate: on rocks (tuff)
Site(s): First Water Trail, Peralta Canyon Trail
Relative abundance: locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14741 & 14756

Aspicilia desertorum (Krempelh.) Mereschk.

Growth form: crustose
Substrate: on rocks
Site(s): Peralta Canyon Trail
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14760

Bellemeria cinereorufescens (Ach.) Clauz. & Roux

Growth form: crustose
Substrate: on rocks (tuff)
Site(s): First Water Trail
Relative abundance: rare-locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14744
(duplicate specimen sent to ASU)

Biatora botryosa Fr.

Growth form: crustose
Substrate: on Cercocarpus bark
Site(s): Reavis Trail
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14792
(duplicate specimen sent to ASU)

Buellia lepidastr (Tuck.) Tuck.

Growth form: crustose
Substrate: on rocks (tuff)
Site(s): First Water Trail, Peralta Canyon Trail
Relative abundance: rare-locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14793, 14794
(duplicate specimens sent to ASU)

Buellia punctata (Hoffm.) Massal.

Growth form: crustose
Substrate: on rocks (tuff), mesquite bark
Site(s): First Water Trail, Reavis Trail
Relative abundance: rare
Pollution sensitivity: tolerant to sulfur dioxide (Wetmore, 1987)
Comments: none
Deposition of specimens: BYU Herbarium #14795, 14796
(duplicate specimen sent to ASU)

Buellia retrovertens Tuck.

Growth form: crustose
Substrate: on rock
Site(s): Peralta Canyon Trail
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14797

Caloplaca chrysophthalma Degel.

Growth form: crustose

Substrate: on mesquite bark

Site(s): First Water Trail, Reavis Trail

Relative abundance: rare-locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14798, 14799

Caloplaca cinnabarina (Ach.) Zahlbr.

Growth form: crustose

Substrate: on rocks

Site(s): Peralta Canyon Trail

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14800

Caloplaca flavovirescens (Wulfen) Dalla Torre & Sarnth.

Growth form: crustose (with effigurate margin)

Substrate: on rocks

Site(s): Peralta Canyon Trail

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14801

(duplicate specimens sent to ASU)

Caloplaca modesta (Zahlbr.) Fink

Growth form: crustose (with small lobes)

Substrate: on rocks (tuff)

Site(s): First Water Trail

Relative abundance: common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14802

(duplicate specimen sent to ASU)

Caloplaca pelodella (Nyl.) Hasse

Growth form: crustose

Substrate: on rocks (tuff)

Site(s): First Water Trail, Peralta Canyon Trail

Relative abundance: common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14803, 14804

(duplicate specimen sent to ASU)

Candelaria concolor var. effusa (Tuck.) Burnham

Growth form: minutely foliose

Substrate: on Cercocarpus bark

Site(s): Reavis Trail

Relative abundance: rare

Pollution sensitivity: sensitive-intermediate (Wetmore, 1987)

Comments: none

Deposition of specimens: BYU Herbarium #14805

Candelariella deflexa (Nyl.) Zahlbr.

Growth form: crustose, obsolete

Substrate: on Mesquite bark

Site(s): Reavis Trail

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14806

Candelariella rosulans (Mull. Arg.) Zahlbr.

Growth form: crustose (with effigurate margins)

Substrate: on rocks (tuff)

Site(s): First Water Trail

Relative abundance: rare-locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14807

(duplicate specimen sent to ASU)

Candelina submexicana (B. de Lesd.) Poelt

Growth form: crustose (with well developed lobes)

Substrate: on rocks (tuff)

Site(s): First Water Trail

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14808

(duplicate specimen sent to ASU)

Catapyrenium lachneum (Ach.) R. Sant.

Growth form: squamulose

Substrate: on rock (tuff), soil, soil over rock

Site(s): First Water Trail, Peralta Canyon Trail

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14809, 14810 & 14811

(duplicate specimens sent to ASU)

Collema fuscovirens (With.) Laundon

Growth form: squamulose

Substrate: on soil

Site(s): First Water Trail

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14812

Collema polycarpon

Growth form: squamulose

Substrate: on rocks (tuff)

Site(s): First Water Trail

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14813

Dermatocarpon reticulatum Magnusson

Growth form: umbilicate

Substrate: on rocks (tuff)

Site(s): First Water Trail

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14814

(duplicate specimen sent to ASU)

Endocarpon pusillum Hedwig

Growth form: squamulose

Substrate: on rocks (tuff)

Site(s): First Water Trail

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14815

Flavopuntelia soledica (Nyl.) Hale

Growth form: foliose

Substrate: on mesquite bark

Site(s): Reavis Trail

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14816

Hyperphyscia adglutinata (Florke) Mayrh. & Poelt

Growth form: foliose

Substrate: on mesquite bark

Site(s): First Water Trail

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14767

(duplicate specimen sent to ASU)

Lecanora argopholis (Ach.) Ach.

Growth form: crustose

Substrate: on rocks (tuff)

Site(s): First Water Trail

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14747

(duplicate specimen sent to ASU)

Lecanora cenisia Ach.

Growth form: crustose

Substrate: on rocks (tuff)

Site(s): First Water Trail

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14742

Lecanora christoi W. Weber

Growth form: crustose (with lobed margins)

Substrate: on rocks (tuff)

Site(s): First Water Trail

Relative abundance: rare-locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14734

Lecanora garovaglii (Korber) Zahlbr.

Growth form: crustose (with lobed margins)

Substrate: on rocks (tuff)

Site(s): First Water Trail

Relative abundance: rare-locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14746

(duplicate specimen sent to ASU)

Lecanora novomexicana (B. de Lesd.) Zahlbr.

Growth form: crustose (with effigurate margins)

Substrate: on rocks (tuff)

Site(s): First Water Trail

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14735

Lecanora muralis (Schreber) Rabenh.

Growth form: crustose (with lobed margins)

Substrate: on catapyrenium on tuff, rock (tuff), cercocarpus bark

Site(s): First Water Trail, Peralta Canyon Trail, Reavis Trail

Relative abundance: common

Pollution sensitivity: tolerant to sulfur dioxide (Wetmore, 1987)

Comments: none

Deposition of specimens: BYU Herbarium #14736 (duplicate specimens sent to ASU),
14737, 14738 (duplicate specimens sent to ASU), & 14740 (duplicate
specimens sent to ASU)

Lecanora valesiaca (Mull. Arg.) Stizenb.

Growth form: crustose (with lobed margins)

Substrate: on rocks (tuff)

Site(s): First Water Trail

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14745

Lecidea auriculata Th. Fr.

Growth form: crustose

Substrate: on rocks (tuff), decomposing granite

Site(s): Peralta Canyon Trail, Reavis Trail, First Water Trail

Relative abundance: rare-locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14817, 14818 & 14819
(duplicate specimens sent to ASU)

Leptogium denticulatum Tuck.

Growth form: foliose

Substrate: on rocks (tuff)

Site(s): First Water Trail

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14820

Melanelia exasperata (de Not.) Essl.

Growth form: foliose

Substrate: on mesquite bark

Site(s): Reavis Trail

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14821

Neofuscelia infrapallida (Essl.) Essl.

Growth form: foliose

Substrate: on rocks

Site(s): Peralta Canyon Trail

Relative abundance: rare-locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14822

Peccania arizonica (Tuck.) Herre

Growth form: minutely fruticose

Substrate: on rocks (tuff)

Site(s): First Water Trail

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14823

(duplicate specimen sent to ASU)

Peltula euploca (Ach.) Ozenda & Clauz.

Growth form: foliose, peltate

Substrate: on rocks (tuff)

Site(s): First Water Trail

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14780

(duplicate specimen sent to ASU)

Physcia caesia (Hoffm.) Furnr.

Growth form: foliose

Substrate: on rocks

Site(s): Reavis Trail

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14763

Physcia dubia (Hoffm.) Lettau

Growth form: foliose
Substrate: on rocks, mesquite bark
Site(s): Peralta Canyon Trail, Reavis Trail
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14764 & 14765

Physcia stellaris (L.) Nyl.

Growth form: foliose
Substrate: on mesquite bark, cercocarpus bark
Site(s): Reavis Trail
Relative abundance: rare-locally common
Pollution sensitivity: intermediate (Wetmore, 1987)
Comments: none
Deposition of specimens: BYU Herbarium #14762 & 14766

Psora icterica (Mont.) Mull. Arg.

Growth form: squamulose
Substrate: on soil over rock (tuff)
Site(s): First Water Trail
Relative abundance: locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14824
(duplicate specimen sent to ASU)

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

Growth form: crustose
Substrate: on rocks (tuff)
Site(s): First Water Trail, Peralta Canyon Trail
Relative abundance: locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14825 & 14826
(duplicate specimen sent to ASU)

Squamarina degelii Poelt

Growth form: crustose (with lobed margins)
Substrate: on rocks (tuff)
Site(s): First Water Trail
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14743
(duplicate specimen sent to ASU)

Staurothele catalepta (Ach.) Blomb. & Forss.

Growth form: crustose
Substrate: on rocks (tuff)
Site(s): First Water Trail
Relative abundance: common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14826

Thelidium pyrenophorum (Ach.) Mudd

Growth form: crustose
Substrate: on rocks
Site(s): Peralta Canyon Trail
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14827

Thyrea pulvinata (Schaerer) Massal.

Growth form: minutely foliose
Substrate: on rocks (tuff)
Site(s): First Water Trail
Relative abundance: locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14828

Verrucaria viridula (Schrader) Ach.

Growth form: crustose
Substrate: on rocks (tuff)
Site(s): First Water Trail
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14781

Xanthoparmelia barbatica (Elix) Egan

Growth form: foliose
Substrate: on rocks (tuff)
Site(s): First Water Trail
Relative abundance: rare
Pollution sensitivity: unknown
Comments: this species is a new record for Arizona
Deposition of specimens: BYU Herbarium #14779

Xanthoparmelia coloradoensis (Gyelnik) Hale

Growth form: foliose

Substrate: on rocks (tuff)

Site(s): First Water Trail

Relative abundance: rare-locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14774

(duplicate specimen sent to ASU)

Xanthoparmelia cumberlandia (Gyelnik) Hale

Growth form: foliose

Substrate: on rocks (tuff)

Site(s): Reavis Trail, Peralta Canyon Trail, First Water Trail

Relative abundance: common

Pollution sensitivity: sensitive (Hale, 1982)

Comments: none

Deposition of specimens: BYU Herbarium #14768 (duplicate specimen sent to ASU),

14770 (duplicate specimen sent to ASU) & 14777

Xanthoparmelia lineola (Berry) Hale

Growth form: foliose

Substrate: on rocks (tuff)

Site(s): First Water Trail

Relative abundance: locally common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14773

(duplicate specimen sent to ASU)

Xanthoparmelia plittii (Gyelnik ex D. Dietr.) Hale

Growth form: foliose

Substrate: on decomposing granite, rocks (tuff), catapyrenium on tuff

Site(s): Reavis Trail, First Water Trail

Relative abundance: common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14775, 14776 (duplicate specimen sent to ASU) & 14778

Xanthoparmelia subramigera (Gyelnik) Hale

Growth form: foliose

Substrate: on rocks (tuff)

Site(s): First Water Trail

Relative abundance: common

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14769

(duplicate specimen sent to ASU)

Xanthoparmelia weberi (Hale) Hale

Growth form: foliose

Substrate: on palo verde bark, rocks (tuff)

Site(s): First Water Trail

Relative abundance: rare

Pollution sensitivity: unknown

Comments: none

Deposition of specimens: BYU Herbarium #14771 & 14772

Xanthoria fallax (Hepp *in* Arnold) Arnold

Growth form: foliose

Substrate: on mesquite bark, cercocarpus bark

Site(s): Reavis Trail, First Water Trail

Relative abundance: locally common

Pollution sensitivity: sensitive to sulfur dioxide (Wetmore, 1987)

Comments: none

Deposition of specimens: BYU Herbarium #14829 (duplicate specimen sent to ASU),
14830, & 14831

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			
caesiocinerea	R-C		R			R	R
calcareo		C	LC		LC	LC	C
cinerea	C	C	C			R-LC	C-A
contorta						LC	R

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

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

Genus/ Species	Galuro	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
simplior							R
Buellia							
erubescens	R		R			R-LC	R-LC
lacteoidea							
lepidastr		R		R-LC			
mamillana		R		R		R-LC	LC
puntata	R	R	R	R	R		
retrovertens							R
semitensis							R
spuria						R-LC	
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			
cinnabarina		C	C	R			
discolor		C	LC			R-LC	
durietzii	C	R-C			LC		
epithallina						R	
exsecuta		R					
flavovirescens	C		C	LC	LC	LC	R
fraudans	R					R	LC
holocarpa	R-C	LC				R-LC	LC
microphyllina				C		R-LC	LC
modesta				C	LC		
pelodella		R					
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				R
weberi							
Chaenotheca							
furfuracea			R				
Cladonia							
bacillaris						R	
cariosa		R					LC
chlorophaea		LC					
coniocraea			LC				LC
fimbriata							
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					
texanum	R					R-LC	
undulatum		R					
Cypselium							
tigillare		R-LC	R				R
Dermatocarpon							
intestiniforme							
miniaturum	LC	LC-A	LA		C		LC
moulinii			R		C		LC
reticulatum	LC-A	R-C	LA	LC	LC		LC
Nimelaena							
veina	C	R	LC				LC
Phioschistes							
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				R
speciosa							
Hyperphyscia adglutinata					LC		
Hypocenomys 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
Hypocenomys (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-A
Lasallia							
<i>papulosa</i>	LC						
Lecanora							
<i>argopholis</i>				R			
<i>argentata</i>		R	LC		R-LC	R	R-LC
<i>caesiurubella</i>			R				
subsp. <i>saximontana</i>							
<i>carpinea</i>							
<i>cenisia</i>			R	R			R
<i>christoi</i>		R		R-LC			R-LC
<i>crenulata</i>						R-LC	
<i>dispersa</i>		R					
<i>garovaglii</i>		R					
<i>impudens</i>		R	R-LC	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.)							
<i>muralis</i>	C	C	LC		LC	LC	
<i>novomexicana</i>	C		LC	C R			
<i>piniperda</i>						R	R
<i>polytropa</i>	R						R
<i>rugosella</i>						LC	
<i>rupicola</i>							LC
<i>saligna</i>	R	R	R				R
<i>sierrae</i>		R				R	
<i>symmicta</i>					R	R	
<i>thallophila</i>					R	R	
<i>valesiaca</i>				R		R	
<i>varia</i>		R-LC			R	R	R
Lecidea							
<i>atrobrunnea</i>		R-LC	LC				R
<i>auriculata</i>		R-LC		R-LC			
<i>botryosa</i>	R						
<i>elabens</i>							
<i>tessellata</i>	C	C			LC		LC
<i>tornoensis</i>							LC
<i>turgidula</i>		R-LC				LC	
<i>sp. 1</i>		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
Lecidella							
carpathica		R				C	
euphorea		R-LC			R-LC	LC	LC
stigmatea		R				LC	
viridans		LC	R-LC				R
Lepraria							
finkii		R					R
Leprocaulon							
albicans	LC		R-LC				LC
Leptroloma							
membranaceum			LC-A			R	
Leptogium							
arsenei							
cyanescens	LC	R-LC	C		R	LC	LC
denticulatum	LC		LC	R		LC	LC
furfuraceum		LC	LC		LC	LC	R-LC
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		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
wulfenoides							C-A

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

Genus/ Species	Galluro	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
Iysconia							
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							
musciicola	R						
sp. 1	R						
Pseudevernia							
intensa							C-A
Psora							
decipiens		LC-A			LC		
himalayana					R		
icterica	C-A			R-LC	R		
luridella						R	
nipponica	R		LC				R-LC
pseudorussellii					R		
tuckermanni		R			LC		
Punctelia							
hypoleucites	LC	LC	LC		R-LC		LC
subrudecta			R				R
Ramalina							
americana							R-LC
pollinaria							LC-A
sinensis		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	Galuro	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						
bischoffi		R					
confragosa			R				
exigua		R				R	R
milvina		R					
pachysperma		C			R-LC	R	LC
pyrina							
Sarcogyne							
regularis		R					
sp.	R						
Scoliciosporum							
umbrinum			R				
Squamarina							
degelii		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	Supersition	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							LC-A
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					R
nigrescens							
viridula		R		R			
Xanthoparmelia							
barbatica				R			
coloradoensis		C		R-LC			LC
conspersa	LC	LC	LC			C	
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
planilobata							R
pittii	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	Supersition	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 Superstition Wilderness Area, Arizona. Growth form, substrate and site information is given for each species.

GENUS/SPECIES	GROWTH FORM	SUBSTRATE	COLLECTION SITE(S)
Xanthoparmelia			
coloradoensis	foliose	rock	First Water Trail
cumberlandia	foliose	rock	Reavis Trail, Peralta Canyon Trail, First Water Trail
Xanthoria			
fallax	foliose	bark	Reavis Trail, First Water Trail

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

Species Sites (substrate)	Pb (ppm)	Cu (ppm)	S (%)
<i>Xanthoparmelia cumberlandia</i>	57.1 (49-53)	44.9 (33-56)	.223 (.16-.28)

BIBLIOGRAPHY

- Egan, Robert S. 1987. A Fifth Checklist of the Lichen-Forming, Lichenicolous and Allied Fungi of the Continental United States and Canada. THE BRYOLOGIST 90(2).
- Egan, Robert S. 1989. Changes to the "Fifth Checklist of the Lichen-Forming, Lichenicolous and Allied Fungi of the Continental United States and Canada." Edition I. THE BRYOLOGIST 92(1): 68-72.
- Egan, Robert S. 1990. Changes to the "Fifth Checklist of the Lichen-Forming, Lichenicolous and Allied Fungi of the Continental United States and Canada." Edition II. THE BRYOLOGIST 93(2): 211-219.
- Fields, R. D. and L. L. St. Clair. 1984. A comparison of methods for evaluation SO₂ impact on selected lichen species: *Parmelia chlorochroa*, *Collema polycarpon* and *Lecanora muralis*. THE BRYOLOGIST 87: 297-301.
- Fields, R. D. and L. L. St. Clair. 1984. The effects of SO₂ on photosynthesis and carbohydrate transfer in the two lichens: *Collema polycarpon*, *Parmelia chlorochroa*. American Journal of Botany 71: 986-998.
- Gough, L. P. and J. A. Erdman. 1977. Influence of a coal-fired power plant on the element content of *Parmelia chlorochroa*. THE BRYOLOGIST 80: 492-501.
- Hale, M. E. 1983. The Biology of Lichens, pp. 1-190. Arnold Publishers, London.
- Lawrey, J. D. and Hale, M. E. 1981. Retrospective study of lichen lead accumulation in the northeastern United States. THE BRYOLOGIST 84: 449-56.
- Richardson, D. H. S., and E. Nieboer. 1981. Lichens and pollution monitoring. Endeavour, new Series 5 (3): 127-133.
- Rope, S. K. and L. C. Pearson. 1990. Lichens as Air Pollution Biomonitors in a Semiarid Environment in Idaho. THE BRYOLOGIST 93 (1): 50-61.
- Rushforth, S. R., L. L. St. Clair, J. D. Brotherson, and G. T. Nebeker. 1989. Lichen Community Structure in Zion National Park. THE BRYOLOGIST 85(2): 185-192.
- St. Clair, L. L. 1989. Report concerning Establishment of a Lichen Biomonitoring Program for the Jarbidge Wilderness Area, Humboldt National Forest, Nevada. U. S. Forest Service Technical Report
- Schutte, J. A. 1977. Chromium in two corticolous lichens from Ohio and West Virginia. THE BRYOLOGIST 80: 279-283.

Skye, E. 1979. Lichens as biological indicators of air pollution. *Annual Review of Phytopathology* 17: 325-341.

Sundstrom, K. R., and J. E. Hallgren. 1973. Using lichens as physiological indicators of sulfurous pollutants. *AMBIO* 2: 13-21.

Wetmore, C. M. 1981. Lichens and air quality in Big Bend National Park, Texas. *THE BRYOLOGIST* 84: 426-433.

Wetmore, Clifford M. 1987. Lichens and Air Quality in Saguaro National Monument. Technical report submitted to the US National Park Service, CX 0001-2-0034.

Wetmore, C. M. 1989. Lichens and air quality in Cuyahoga National Recreation Area, Ohio. *THE BRYOLOGIST* 92(3): 273-281.