FHM LICHEN COMMUNITY RESULTS FROM WYOMING, 1997: A PRELIMINARY SUMMARY

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March 17, 1999

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TABLE OF CONTENTS

INTRODUCTION **2**

PREVIOUS WORK IN WYOMING **2**

SUMMARY OF FHM LICHEN COMMUNITY METHODS **2**

DATA SOURCES **4**

SUMMARIES BY ASSESSMENT TOPICS **4**

BIODIVERSITY 4
AIR QUALITY 9

FURTHER RESEARCH NEEDED **11**

ACKNOWLEDGEMENTS **11**

REFERENCES **12**

APPENDIX 1. LIST OF SPECIES BY PLOTS **14**

INTRODUCTION

The Forest Health Monitoring (FHM) program seeks to assess the condition and trend of the forests of the United States (Riiters et al. 1992; NAPAP 1993). FHM is linked with the national sampling grid established by the Environmental Monitoring and Assessment Program (EMAP) of the Environmental Protection Agency. Epiphytic lichen communities were included in FHM because they help to answer several key assessment questions. These questions concern the contamination of natural resources, biodiversity, forest health, and sustainability of timber production.

Hundreds of papers worldwide (chronicled in the series "Literature on air pollution and lichens" in the Lichenologist) and dozens of review papers and books (e.g., Nash & Wirth 1988; Richardson 1992; Seaward 1993; Smith et al. 1993; van Dobben 1993) published during the last century, have documented the close relationship between lichen communities and air pollution, especially SO_2 and acidifying or fertilizing nitrogen and sulfur-based pollutants. In a comparison of biological responses to air pollution between nearby and remote areas surrounding a coal-fired power plant, lichens gave a much clearer response (in terms of diversity, total abundance, and community composition) than either foliar symptoms or tree growth (Muir & McCune 1988). Lichens were one of the few components of terrestrial ecosystems to show a clear relationship to gradients of acidic deposition in the eastern United States (Showman 1992; NAPAP 1991). Much of the sensitivity of epiphytic lichens to air quality apparently results from their lack of a cuticle and their reliance on atmospheric sources of nutrition. Although trees may respond to moderate, chronic levels of air pollution deposition, all of the other influences on tree growth, such as variation in soils, make the responses of trees to pollutants difficult to measure in the field. Lichen communities provide, therefore, not only a measure of air pollution impacts upon lichens, but also suggest air pollution impacts on aspects of forest health that are difficult to measure directly.

In addition to their utility as indicators of air quality, epiphytic lichens are an important component of many forests. Lichens often comprise a large portion of the diversity of macrophytic species in a forest. Lichens have numerous functional roles in temperate forests, including nutrient cycling (especially nitrogen fixation in moist forests; Pike 1978) and as components of food webs (Dawson et al. 1987; Maser et al. 1986; Maser et al. 1985; Rominger & Oldemeyer 1989; Servheen & Lyon 1989). For more information about the lichen indicator please visit the website: http://willow.ncfes.umn.edu/fhm_fact/lichen.htm. For more information about FHM in general see: http://willow.ncfes.umn.edu/fhm/fhm_hp.htm.

The current report documents lichens on FHM plots in Wyoming prior to the establishment of a gradient model, and is thus necessarily limited in the scope of potential findings. The significance of the data presented below for regional climate and air quality gradients will be understood only once a regional gradient model is in place.

PREVIOUS WORK IN WYOMING

The lichens of Wyoming have not been as well studied as those of several neighboring states, but a few studies have been done. Eversman et al. (1987) examined the vertical distribution of epiphytic lichens on three tree species in Yellowstone National Park. The authors found 12 species of epiphytes on the trunks of *Pinus contorta*, *P. albicaulis*, and *Abies lasiocarpa* in the lodgepole pine zone. Several other authors have documented Wyoming lichens in general, but not epiphytes specifically. Hammon and Pearson (1976) documented 87 species of lichens from northern Wyoming in the Ricks College Herbarium. Medina (1994) documents 108 lichens from eastern Wyoming. Wetmore (1967) detailed the lichens of the Black Hills in eastern Wyoming. Other work (e.g., Eversman 1995) has examined terrestrial lichens of alpine areas in the Beartooths and other ranges in Wyoming.

SUMMARY OF FHM LICHEN COMMUNITY METHODS

The lichen community indicator is implemented in two phases (Figure 1): (1) construct a gradient model of lichen communities to isolate and describe climatic and air quality gradients and (2) apply the model to calculate gradient scores for additional plots. Scores for these plots are then used to describe the regional condition and geographic variation in lichen communities. Repeated sampling of these permanent plots will allow us to document changes in the

condition of lichen communities over time. All lichen data are archived with the Information Management group for the Forest Health Monitoring Program in Las Vegas, Nevada.

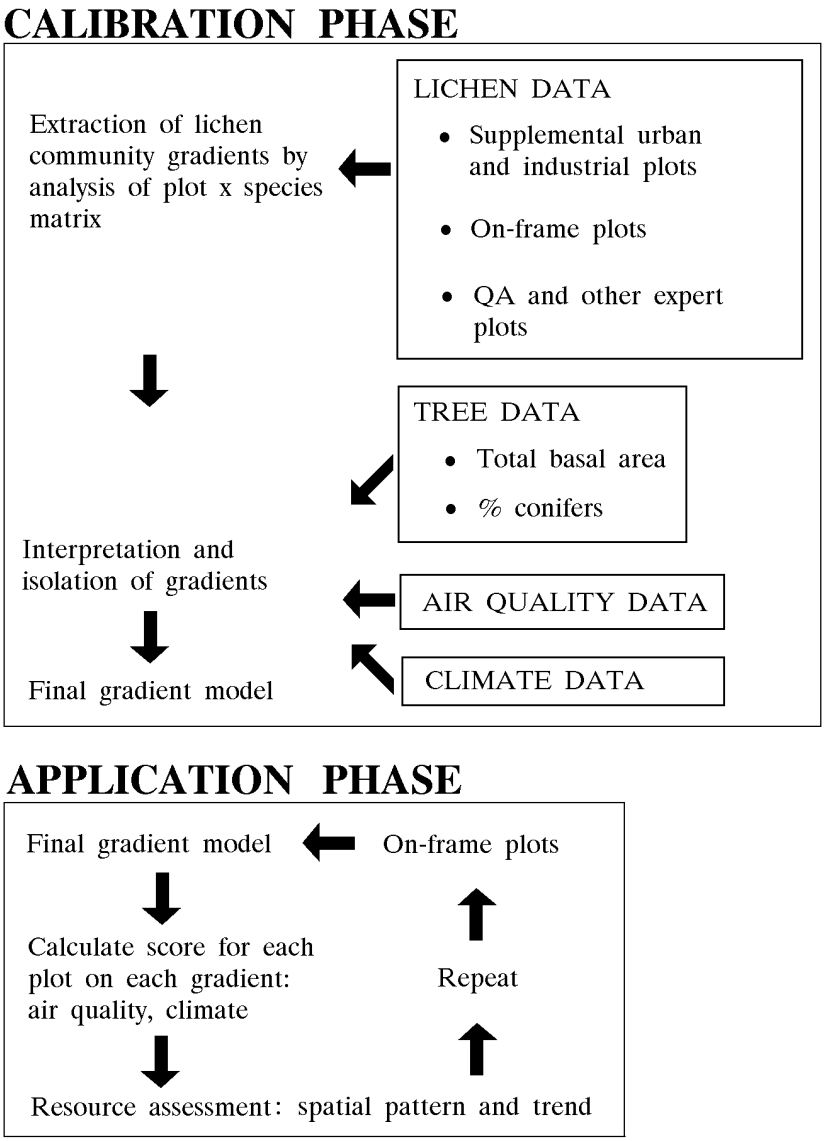


Figure 1. Implementation of the lichen communities as an indicator in the Forest Health Monitoring Program

Field procedures were designed to be conducted by non-lichenologists for practical reasons of staffing field crews. Field crews typically receive 3-4 days of intensive training in the lichen community method, although in Wyoming they received two days. Only crews who attain the required measurement quality objective at the end of training are allowed to conduct plots. The method has two parts that are performed simultaneously. (1) In each plot the field crew collects a sample of each lichen species believed to be different from all standing woody plants in the plot. This collection represents the species diversity of macrolichens in the plot as fully as possible. Specimens are then sent to specialists for identification. The population being sampled consists of all macrolichens occurring on woody plants, excluding the 0.5 m basal portions of trees and shrubs. Lichens on fallen branches and other lichen litter are included. Given the large plot area, fallen branches typically provide an excellent sample of the canopy lichens. (2) The field crew estimates the abundance of each species using a four-step scale: 1 = rare (< 3 individuals in plot); 2 = uncommon (4-10 individuals in plot); 3 = common (> 10 individuals in plot but less than half of the boles and branches have that species present); and 4 = abundant (more than half of boles and branches in the plot have the subject species present). Note that the field crew need not accurately assign species names to the lichens (that is done later by a specialist), but must be able to distinguish among species, and be able to estimate abundances accurately. .

The field methods are described in detail in Tallent-Halsell (1994). Quality assurance (QA) procedures and results are described in Cline (1995) and McCune et al. (1997). Vouchers are stored by the Lichen Communities Indicator Lead.The lichen indicator's methods have been closely scrutinized and documented for repeatability (McCune et al. 1997).

DATA SOURCES

This report summarizes results from 59 plots, as described below.

On-frame 1997 data. Lichen community data were collected by summer field crews in 56 on-frame permanent plots in 1997. "On frame" means that plots were selected on a formal sampling framework, according to standard sampling protocols for the EMAP hexagonal grid (Messer et al. 1991). The strict sampling criteria applied to the on-frame data allow regional estimates of lichen community parameters. On-frame data can be used for assessment of regional status and trends because it consists of an unbiased sample (Messer et al. 1991). In contrast, off-frame data, while useful in building a gradient model, cannot be used to answer such questions as, "Is lichen diversity in Wyoming decreasing through time?"

Reference plots. In 1997 one plot was sampled twice by each crew member. The purpose of the reference plots was to establish repeatability of the method. The reference plots were conducted in Cache County, Utah. They are therefore useful for QA data only, and not for the Wyoming dataset. Only a small number of the reference plots are reported in this study; the majority will be included with the Utah report.

Supplemental urban/industrial plots. None have yet been conducted. Plans are underway to establish such plots at state and/or subregional levels. If such plots are available prior to a gradient model, they would allow for preliminary gradient interpretation.

SUMMARIES BY ASSESSMENT TOPIC

Biodiversity

Wyoming's lichen flora is most diverse and conspicuous in terrestrial habitats, and compared to states in other regions, the epiphytic flora is relatively species-poor. Nonetheless, sufficient numbers of species (averaging 6 per plot; Table 1) were present to make lichen community sampling worthwhile. In total, 40 species were found (Table 2; Appendix 1) in the 56 on-frame plots sampled in 1997 (Table 3). Most of the species collected are fairly common in the western U.S., but their distribution provides insight into climatic and air gradients in both state and regional perspectives. A map of lichen species richness in Wyoming indicates that species richness is highest in the mountainous areas in the west and the north of the state and lowest in the lower elevations of the southern tier (Fig 2). Much of this variation is likely to be due to strong composite elevational-moisture gradients, but final determination will await the establishment of a gradient model to assess the influence of air quality.

Lichens in Wyoming represent several functional groups and provide various kinds of indicator values (Table 4). The most important of these, with respect to the goals of Forest Health Monitoring, is their value as indicators of air quality. Lichen communities provide an inexpensive, sensitive means of detecting effects of air pollutants on ecosystems. In most cases the responsible pollutants are inferred to be nitrogen and sulfur oxides and their acidic and fertilizing reaction products.

Table 1. Alpha (standard deviation), beta and gamma diversity of epiphytic lichens in 59 reference and on-frame plots in Wyoming and Utah, 1997.

Plot Type	Number	Alpha (st.dev.)[1]	Beta[3]	Gamma[2]
Reference Plot* (Utah)	3	6.0 (0.0)	1.3	8
On Frame (Wyoming)	56	5.4 (2.3)	7.4	40

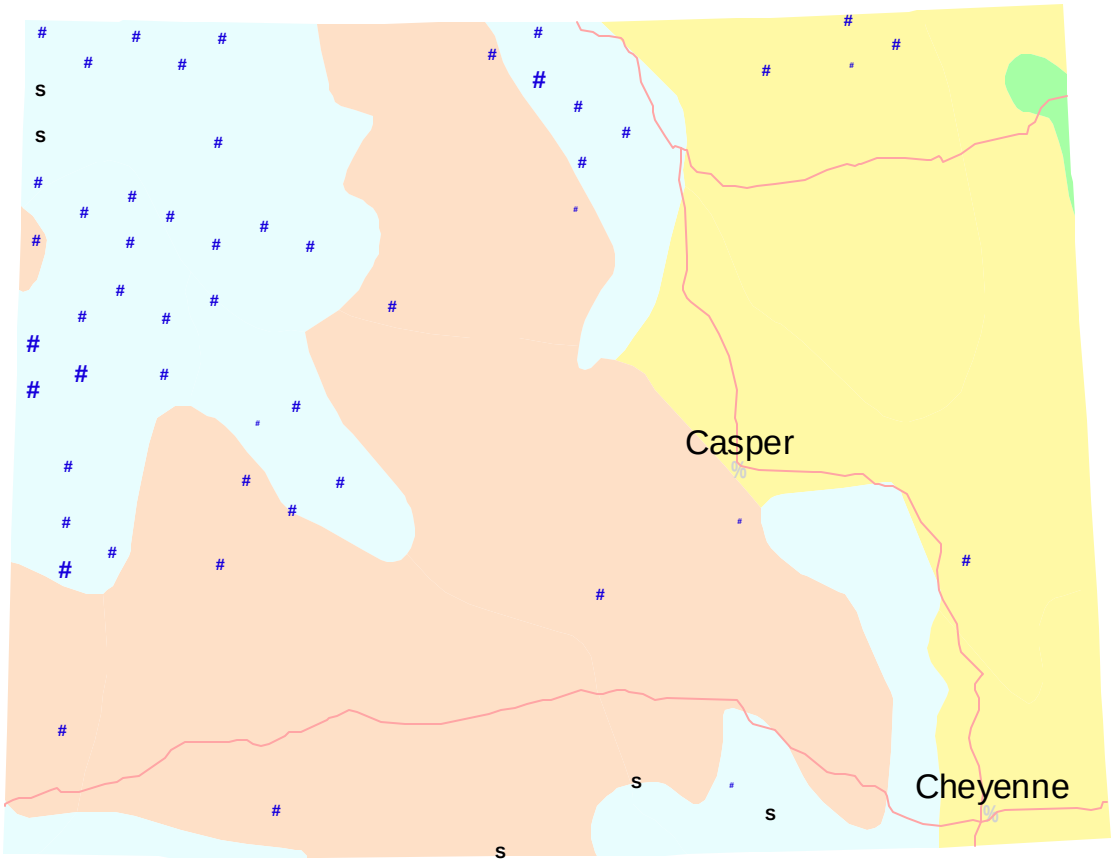
* Reference Plots were conducted in Cache, UT. These plots are not included in the species lists below.
1. Alpha diversity is mean species richness.
2. Gamma diversity is the total number of species found.
3. Beta diversity is Gamma/alpha and is a rough estimate of "community turnover".

Table 2. Summary of 40 lichen species found in 56 on frame plots in Wyoming.

Species	% Frequency	Number of Occurrences	Mean[1]
Alectoria sarmentosa	2	1	0.05
Bryoria sp.	2	1	0.05
Bryoria fremontii	7	4	0.25
Bryoria furcellata	2	1	0.02
Bryoria fuscescens	59	33	1.71
Bryoria lanestris	4	2	0.09
Candelaria concolor	4	2	0.07
Cetraria pinastri	2	1	0.02
Cladonia carneola	2	1	0.04
Cladonia fimbriata	4	2	0.11
Cladonia ochrochlora	2	1	0.05
Flavopunctelia soredica	7	4	0.23
Hypogymnia austerodes	5	3	0.16
Imshaugia aleurites	2	1	0.04
Letharia columbiana	14	8	0.41
Letharia vulpina	52	29	1.45
Melanelia sp.	2	1	0.05
Melanelia elegantula	41	23	1.32
Melanelia exasperatula	61	34	1.91
Melanelia subelegantula	4	2	0.11
Melanelia subolivacea	21	12	0.68
Parmelia sulcata	9	5	0.16
Parmeliopsis ambigua	29	16	0.71
Parmeliopsis hyperopta	4	2	0.07
Phaeophyscia ciliata	2	1	0.04
Physcia sp.	2	1	0.05

Species	% Frequency	Number of Occurrences	Mean[1]
Physcia adscendens	34	19	0.86
Physcia aipolia	2	1	0.05
Physcia dimidiata	20	11	0.48
Physciella chloantha	2	1	0.05
Usnea sp.	20	11	0.52
Usnea hirta	16	9	0.48
Usnea lapponica	50	28	1.64
Xanthoria sp.	2	1	0.04
Xanthoria candelaria	7	4	0.20
Xanthoria fallax	4	2	0.07
Xanthoria fulva	27	15	0.77
Xanthoria hasseana aggr.[2]	14	8	0.25
Xanthoria oregana	5	3	0.14
Xanthoria polycarpa	5	3	0.16
Averages	13.2	7.3	0.380

1. Mean represents the sum of all abundance scores (1-4) of a species in all plots divided by 56 plots.
2. Includes Xanthoria hasseana and X. montana.



Lichen Species Richness

- s 0 - 1
- ″ 1 - 3
- # 4 - 8
- # 9 - 11

Ecoregions

- Black Hills Coniferous Forest Province
- Great Plains-Palouse Dry Steppe Province
- Intermountain Semi-Desert Province
- Southern Rocky Mountain Steppe-Open Woodland-Coniferous Forest-Alpine Meadow Province
- % **Major Cities**
- **Highways**

Fig. 2. Lichen species richness in 56 FHM plots, Wyoming, 1997.

Table 3. Summary of QA plots in Utah and On Frame plots surveyed in Wyoming in 1997.

PLOT	No. of Species	Species Richness Class[2]	Crew Member[3]
QA[1]			
0025562-2	6	2	Lambert
0090082-1	6	2	Rogers
0090082-2	6	2	Rogers
On Frame			
4110622	1	1	Bousquin
4110634	3	1	Bousquin
4110718	1	1	Bousquin
4110731	0	0	Bousquin
4110923	4	1	Spillers
4111056	4	1	Spillers
4210438	5	1	Bousquin
4210653	3	1	Bousquin
4210722	6	2	Bousquin
4210878	6	2	Quinn
4210962	6	2	Lambert
4210975	5	1	Quinn
4210987	4	1	Lambert
4211036	9	2	Rogers
4211044	4	1	Spillers
4211056	7	2	Rogers
4211076	6	2	Rogers
4310865	6	2	Lambert
4310914	3	1	Quinn
4310922	5	1	Quinn
4310967	6	2	Quinn
4310982	7	2	Quinn
4310986	6	2	Quinn
4311028	9	2	Quinn
4311031	5	1	Quinn
4311036	9	2	Quinn
4311048	9	2	Quinn
4311051	5	1	Quinn
4311056	6	2	Quinn
4311063	6	2	Quinn
4311083	6	2	Quinn
4311088	6	2	Rogers
4410565	3	1	Lambert
4410572	7	2	Spillers
4410584	5	1	Rogers
4410671	8	2	Rogers
4410713	2	1	Lambert
4410733	6	2	Spillers
4410741	7	2	Spillers
4410753	7	2	Rogers
4410765	11	2	Rogers
4410778	8	2	Lambert

PLOT	No. of Species	Species Richness Class[2]	Crew Member[3]
4410785	4	1	Lambert
4410914	6	2	Quinn
4410946	7	2	Lambert
4410986	4	1	Lambert
4411011	8	2	Quinn
4411016	5	1	Quinn
4411023	6	2	Lambert
4411028	6	2	Lambert
4411048	1	1	Lambert
4411068	1	1	Lambert
4411071	6	2	Lambert
4411075	5	1	Lambert
4411083	7	2	Lambert
4411088	6	2	Lambert
Mean	5.5		
No. plots in Class 0 (0 species)		1	
No. plots in Class 1 (1-5 species)		23	
No. plots in Class 2 (6-15 species)		32	
No. plots in Class 3 (>15 species)		0	

1. QA Reference plots were conducted in Cache County, Utah near Logan.
2. Species Richness Classes: 0=0; 1-5=1; 6-15=2; >15=3.
3. Crew Members: Paul Rogers, Steve Bousquin, Linda Spillers, Dana Lambert, Ken Quinn.

Air Quality

Although data is limited, species richness appears to be somewhat depressed in the lower latitudes of the state, especially in the eastern section just north of the front range. Species richness is significantly higher in the higher latitudes in both the center and west of the state (Fig 2). A preliminary community analysis shows a greater relative abundance of pollution-tolerant and nitrophilous species (e.g., *Physcia adscendens, Xanthoria fulva*) in the southern areas, and a reduced abundance and/or absence of pollution-sensitive species (e.g., *Bryoria fuscescens, Usnea lapponica*) in these areas. The most pronounced effects appear to be in the southern half of the state from a longitude of approximately 110º east. By contrast, the northern part of the state shows a more diverse community including several pollution-sensitive species and a greatly reduced abundance of pollution-tolerant or nitrophilous species. Although the bulk of the differences between the communities of higher and lower latitudes is probably due to differences in elevation (and hence climate and forest community), it is possible that pollution may have a role as well. A preliminary indicator species analysis of the major lichen community types shows an affinity of either pollution-tolerant or pollution-sensitive species for distinct lichen community sectors. While a gradient analysis is lacking, as is correlation of lichen community structure with its ecoregion, these preliminary analyses suggests that some lichen species are likely to be associated with air quality and climatic gradients (Table 5).

If pollution does play a role in community differences, the sources are most likely from the south. These may include pollution from Colorado's Front Range, local pollution from Cheyenne and Laramie, and emissions from the coal-fired power plants in the Steamboat Springs/Craig area of Colorado. Combined the coal-fired power plants emit an estimated 22,000 short tons (1 short ton = 0.91 metric tons) of sulfur dioxide and 27,000 tons of nitrogen oxides. Snowpacks and precipitation in Colorado's Park Range have elevated sulfate and nitrate as compared with other high elevation sites in Colorado (Ely et al. 1993; Turk et al. 1992). McCune (1998) reported that lichen communities in

Colorado's Steamboat Springs and Denver areas had elevated levels of the same pollution-tolerant species and nitrophilous species as we have detected throughout southern Wyoming.

In constructing the gradient model for Wyoming, we recommend intensive off-frame sampling throughout the state's southern tier. In order to factor out the confounding effects of elevation, it would also be advantageous to sample in cleaner air sites in low elevation zones in the northern parts of the state.

Table 4. Characteristics of some common macrolichen genera growing on trees in Wyoming.

Genus	**Appearance**	**Indicator value and functional roles**
Bryoria	Brown, hairlike	Pollution-sensitive; forage lichen; many uses by animals
Candelaria	Yellow, very small foliose	Pollution and dust tolerant, mainly on hardwoods
Flavopunctelia	Greenish, broad-lobed foliose	Moderate pollution tolerance
Hypogymnia	Grey or brown, foliose, hollow lobes	Mainly on conifers, some species pollution tolerant
Imshaugia	Small white foliose, brown apothecia	Mostly restricted to conifers
Letharia	Yellow to chartreuse shrubby	Widespread in conifer forests; somewhat pollution sensitive.
Melanelia	Brown to olive, foliose, medium size	Nearly ubiquitous; some species pollution tolerant; on both hardwoods and conifers
Parmelia	Grey, foliose, medium size, black below	Widespread, pollution tolerant, on both hardwoods and conifers
Parmeliopsis	Grey or green-grey narrow lobed foliose	Mid to upper elevation conifers; intermediate in pollution sensitivity.
Phaeophyscia	Small, cryptic, grey or brownish, foliose	Usually on hardwoods; most species pollution tolerant
Physcia	Small, white, foliose	Some species nitrogen-loving; some species almost restricted to hardwoods
Physciella	Small, cryptic, grey, foliose	Usually on hardwoods; pollution tolerant
Physconia	Small, frosty-coated, foliose, often forming neat rosettes; brown, grey or white	Usually on hardwoods; pollution tolerant, nitrogen-loving
Usnea	Greenish fruticose, tufted or hanging, branches have a central cord	Abundant in the mountains, somewhat pollution sensitive but persisting in polluted areas as dwarf, compact forms
Xanthoria	Orange or yellow, foliose	Widespread but more abundant in areas of elevated nitrogen, somewhat pollution tolerant

Table 5. Preliminary list of indicator lichens likely to be associated with air quality and climatic gradients in Wyoming, based on Indicator Species Analysis (Dufrene & Legendre 1997) of 3-4 cluster analysis groups in plots x species data matrix.

Pollution-tolerant indicator species likely to be strongly associated with pollution gradient

Physcia adscendens
Xanthoria fulva

Pollution-sensitive indicator species likely to be strongly associated with pollution gradient

Bryoria fuscescens
Hypogymnia austerodes
Melanelia exasperatula
Letharia vulpina
Usnea lapponica

Indicator species likely to be associated with distinct climatic or vegetation zones

Flavopunctelia soredica
Letharia columbiana
Melanelia elegantula
Melanelia subolivacea
Parmeliopsis ambigua
Physcia dimidiata
Usnea hirta

FURTHER RESEARCH NEEDED

At present the data are very sparse, considering Wyoming's diverse climates and mountainous landscape. As suggested above, more intensive sampling is needed in the southern portions of the state both to construct a gradient model and to better monitor future changes in lichen communities resulting from air pollution. We recommend intensifying the EMAP sampling grid by 2X in the most altered areas.

To build a useful gradient model of lichen community response to air pollutants in Wyoming, it is essential to:

1. Obtain a set of approximately 25-30 off-frame plots in urban/industrial areas, focusing heavily on the state's southern tier.
2. Sample in cleaner air sites at elevations analogous to the intensified sampling sites in the southern tier.
3. Factor out climatic gradients by obtaining better estimates of climatic variables at each plot.

Acknowledgements

B. McCune provided the oversight of the program during the sampling year, and the template for this report. The lichen crew members S. Bousquin, L. Spillers, K. Quinn, and D. Lambert did extensive field work for this project. Roger Rosentreter provided training and logistical support.

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APPENDIX 1. List of lichen species by plot collected by crew members in Wyoming FHM plots in 1997. Note: occurrences of *Xanthoria hasseana* should be considered an aggregate of that species and *X. montana*.

Compact format data file:
WY97-4raw.TXT
Species file:
EPIPHYTE.SPP

Matrix size: 59 plots (rows)
40 species (columns)

Group: REF PLOT
Sample unit: 025562-2

Value	Code	Species	Code Name
3.00	8204	Xanthoria hasseana	Xanhas
3.00	8210	Xanthoria fulva	Xanful
3.00	5701	Physcia adscendens	Phyads
3.00	4017	Melanelia subolivacea	Melsol
3.00	4004	Melanelia exasperatula	Melexl
3.00	4002	Melanelia elegantula	Melele

Group: REF PLOT
Sample unit: 090082-1

Value	Code	Species	Code Name
3.00	8204	Xanthoria hasseana	Xanhas
3.00	4002	Melanelia elegantula	Melele
3.00	5701	Physcia adscendens	Phyads
3.00	8210	Xanthoria fulva	Xanful
3.00	4004	Melanelia exasperatula	Melexl
3.00	8041	Usnea hirta	Usnhir

Group: REF PLOT
Sample unit: 090082-2

Value	Code	Species	Code Name
4.00	5701	Physcia adscendens	Phyads
4.00	4002	Melanelia elegantula	Melele
3.00	8210	Xanthoria fulva	Xanful
4.00	4017	Melanelia subolivacea	Melsol
3.00	8204	Xanthoria hasseana	Xanhas
3.00	8215	Xanthoria oregana	Xanore

Group: ON FRAME
Sample unit: 4110622

Value	Code	Species	Code Name
2.00	4004	Melanelia exasperatula	Melexl

Group: ON FRAME
Sample unit: 4110634

Value	Code	Species	Code Name
3.00	4004	Melanelia exasperatula	Melexl
3.00	8044	Usnea lapponica	Usnlap
2.00	613	Bryoria lanestris	Brylan

Group: ON FRAME
Sample unit: 4110718

Value	Code	Species	Code Name
1.00	5710	Physcia dimidiata	Phydim

Sample unit: 4110731

No species encountered in this sample unit.

Group: ON FRAME
Sample unit: 4110923

Value	Code	Species	Code Name
3.00	8204	Xanthoria hasseana	Xanhas
3.00	8215	Xanthoria oregana	Xanore
2.00	5710	Physcia dimidiata	Phydim
3.00	8210	Xanthoria fulva	Xanful

Group: ON FRAME
Sample unit: 4111056

Value	Code	Species	Code Name
3.00	4002	Melanelia elegantula	Melele
4.00	8215	Xanthoria oregana	Xanore
3.00	8204	Xanthoria hasseana	Xanhas
3.00	5710	Physcia dimidiata	Phydim

Group: ON FRAME
Sample unit: 4210438

Value	Code	Species	Code Name
3.00	4017	Melanelia subolivacea	Melsol
3.00	2704	Flavopunctelia soredica	Fpusor
2.00	8041	Usnea hirta	Usnhir
1.00	8215	Xanthoria oregana	Xanore
1.00	5710	Physcia dimidiata	Phydim

Group: ON FRAME
Sample unit: 4210653

Value	Code	Species	Code Name
2.00	5710	Physcia dimidiata	Phydim
3.00	4002	Melanelia elegantula	Melele
3.00	8210	Xanthoria fulva	Xanful

Group: ON FRAME
Sample unit: 4210722

Value	Code	Species	Code Name
2.00	8200	Xanthoria	Xan
3.00	4004	Melanelia exasperatula	Melexl
2.00	8000	Usnea	Usn
3.00	4016	Melanelia subelegantula	Melsel
3.00	8207	Xanthoria polycarpa	Xanpol
3.00	4002	Melanelia elegantula	Melele

Group: ON FRAME
Sample unit: 4210878

Value	Code	Species	Code Name
4.00	4017	Melanelia subolivacea	Melsol
3.00	8207	Xanthoria polycarpa	Xanpol
3.00	8210	Xanthoria fulva	Xanful
2.00	8000	Usnea	Usn
3.00	5701	Physcia adscendens	Phyads
3.00	4004	Melanelia exasperatula	Melexl

Group: ON FRAME
Sample unit: 4210962

Value	Code	Species	Code Name
3.00	4002	Melanelia elegantula	Melele
3.00	8000	Usnea	Usn
3.00	5701	Physcia adscendens	Phyads
2.00	8210	Xanthoria fulva	Xanful
3.00	5201	Parmeliopsis ambigua	Popamb
2.00	610	Bryoria fuscescens	Bryfus

Group: ON FRAME
Sample unit: 4210975

Value	Code	Species	Code Name
3.00	5201	Parmeliopsis ambigua	Popamb
3.00	8044	Usnea lapponica	Usnlap
3.00	3702	Letharia vulpina	Letvul
3.00	8210	Xanthoria fulva	Xanful
3.00	610	Bryoria fuscescens	Bryfus

Group: ON FRAME
Sample unit: 4210987

Value	Code	Species	Code Name
3.00	4002	Melanelia elegantula	Melele
3.00	8207	Xanthoria polycarpa	Xanpol
3.00	5700	Physcia	Phy
2.00	8000	Usnea	Usn

Group: ON FRAME
Sample unit: 4211036

Value	Code	Species	Code Name
2.00	5701	Physcia adscendens	Phyads
3.00	8201	Xanthoria candelaria	Xancan
4.00	4004	Melanelia exasperatula	Melexl
3.00	3702	Letharia vulpina	Letvul
3.00	3701	Letharia columbiana	Letcol
2.00	5201	Parmeliopsis ambigua	Popamb
1.00	4806	Parmelia sulcata	Parsul
4.00	8044	Usnea lapponica	Usnlap
3.00	610	Bryoria fuscescens	Bryfus

Group: ON FRAME
Sample unit: 4211044

Value	Code	Species	Code Name
3.00	5701	Physcia adscendens	Phyads
3.00	4002	Melanelia elegantula	Melele
3.00	4004	Melanelia exasperatula	Melexl
3.00	8210	Xanthoria fulva	Xanful

Group: ON FRAME
Sample unit: 4211056

Value	Code	Species	Code Name

4.00	8044	Usnea lapponica	Usnlap
3.00	4002	Melanelia elegantula	Melele
3.00	4004	Melanelia exasperatula	Melexl
3.00	8210	Xanthoria fulva	Xanful
3.00	5701	Physcia adscendens	Phyads
2.00	8301	Candelaria concolor	Cndcon
1.00	610	Bryoria fuscescens	Bryfus

Group: ON FRAME
Sample unit: 4211076

Value	Code	Species	Code Name
4.00	5701	Physcia adscendens	Phyads
4.00	8210	Xanthoria fulva	Xanful
3.00	4004	Melanelia exasperatula	Melexl
3.00	8044	Usnea lapponica	Usnlap
2.00	610	Bryoria fuscescens	Bryfus
2.00	5201	Parmeliopsis ambigua	Popamb

Group: ON FRAME
Sample unit: 4310865

Value	Code	Species	Code Name
3.00	5701	Physcia adscendens	Phyads
3.00	8210	Xanthoria fulva	Xanful
3.00	5710	Physcia dimidiata	Phydim
3.00	8203	Xanthoria fallax	Xanfal
3.00	5801	Physciella chloantha	Pclchl
3.00	4002	Melanelia elegantula	Melele

Group: ON FRAME
Sample unit: 4310914

Value	Code	Species	Code Name
3.00	3702	Letharia vulpina	Letvul
3.00	8000	Usnea	Usn
3.00	4002	Melanelia elegantula	Melele

Group: ON FRAME
Sample unit: 4310922

Value	Code	Species	Code Name
3.00	5710	Physcia dimidiata	Phydim
4.00	4002	Melanelia elegantula	Melele
2.00	3301	Imshaugia aleurites	Imsale
2.00	8044	Usnea lapponica	Usnlap
2.00	3702	Letharia vulpina	Letvul

Group: ON FRAME
Sample unit: 4310967

Value	Code	Species	Code Name
3.00	8210	Xanthoria fulva	Xanful
3.00	8044	Usnea lapponica	Usnlap
4.00	4002	Melanelia elegantula	Melele
2.00	4004	Melanelia exasperatula	Melexl
3.00	3702	Letharia vulpina	Letvul
2.00	610	Bryoria fuscescens	Bryfus

Group: ON FRAME
Sample unit: 4310982

Value	Code	Species	Code Name
3.00	3701	Letharia columbiana	Letcol
3.00	8044	Usnea lapponica	Usnlap
3.00	4004	Melanelia exasperatula	Melexl
3.00	610	Bryoria fuscescens	Bryfus
3.00	4017	Melanelia subolivacea	Melsol
2.00	4806	Parmelia sulcata	Parsul
2.00	5201	Parmeliopsis ambigua	Popamb

Group: ON FRAME
Sample unit: 4310986

Value	Code	Species	Code Name
3.00	4004	Melanelia exasperatula	Melexl
2.00	5201	Parmeliopsis ambigua	Popamb
3.00	8044	Usnea lapponica	Usnlap
3.00	3702	Letharia vulpina	Letvul
3.00	610	Bryoria fuscescens	Bryfus
2.00	5701	Physcia adscendens	Phyads

Group: ON FRAME
Sample unit: 4311028

Value	Code	Species	Code Name
3.00	4004	Melanelia exasperatula	Melexl
3.00	5701	Physcia adscendens	Phyads
3.00	5710	Physcia dimidiata	Phydim
2.00	5603	Phaeophyscia ciliata	Phacil
3.00	8044	Usnea lapponica	Usnlap
3.00	8000	Usnea	Usn
3.00	3702	Letharia vulpina	Letvul
3.00	610	Bryoria fuscescens	Bryfus
2.00	5201	Parmeliopsis ambigua	Popamb

Group: ON FRAME

Sample unit: 4311031

Value	Code	Species	Code Name
2.00	610	Bryoria fuscescens	Bryfus
3.00	5701	Physcia adscendens	Phyads
3.00	8000	Usnea	Usn
3.00	8210	Xanthoria fulva	Xanful
4.00	4002	Melanelia elegantula	Melele

Group: ON FRAME
Sample unit: 4311036

Value	Code	Species	Code Name
3.00	5201	Parmeliopsis ambigua	Popamb
2.00	5701	Physcia adscendens	Phyads
2.00	8210	Xanthoria fulva	Xanful
4.00	610	Bryoria fuscescens	Bryfus
3.00	3702	Letharia vulpina	Letvul
4.00	4017	Melanelia subolivacea	Melsol
4.00	8044	Usnea lapponica	Usnlap
4.00	4002	Melanelia elegantula	Melele
4.00	4004	Melanelia exasperatula	Melexl

Group: ON FRAME
Sample unit: 4311048

Value	Code	Species	Code Name
3.00	4004	Melanelia exasperatula	Melexl
4.00	8044	Usnea lapponica	Usnlap
4.00	610	Bryoria fuscescens	Bryfus
3.00	5201	Parmeliopsis ambigua	Popamb
2.00	5701	Physcia adscendens	Phyads
3.00	8210	Xanthoria fulva	Xanful
2.00	8204	Xanthoria hasseana	Xanhas
1.00	8203	Xanthoria fallax	Xanfal
4.00	3702	Letharia vulpina	Letvul

Group: ON FRAME
Sample unit: 4311051

Value	Code	Species	Code Name
3.00	8044	Usnea lapponica	Usnlap
3.00	4004	Melanelia exasperatula	Melexl
2.00	3702	Letharia vulpina	Letvul
3.00	8201	Xanthoria candelaria	Xancan
3.00	610	Bryoria fuscescens	Bryfus

Group: ON FRAME
Sample unit: 4311056

Value	Code	Species	Code Name
3.00	4017	Melanelia subolivacea	Melsol
3.00	5701	Physcia adscendens	Phyads
3.00	8000	Usnea	Usn
3.00	610	Bryoria fuscescens	Bryfus
3.00	4002	Melanelia elegantula	Melele
3.00	8210	Xanthoria fulva	Xanful

Group: ON FRAME
Sample unit: 4311063

Value	Code	Species	Code Name
3.00	3702	Letharia vulpina	Letvul
2.00	1208	Cladonia carneola	Clacar
3.00	8044	Usnea lapponica	Usnlap
3.00	4004	Melanelia exasperatula	Melexl
2.00	5201	Parmeliopsis ambigua	Popamb
2.00	610	Bryoria fuscescens	Bryfus

Group: ON FRAME
Sample unit: 4311083

Value	Code	Species	Code Name
3.00	8044	Usnea lapponica	Usnlap
3.00	610	Bryoria fuscescens	Bryfus
3.00	5201	Parmeliopsis ambigua	Popamb
4.00	4004	Melanelia exasperatula	Melexl
3.00	3702	Letharia vulpina	Letvul
2.00	3701	Letharia columbiana	Letcol

Group: ON FRAME
Sample unit: 4311088

Value	Code	Species	Code Name
3.00	3701	Letharia columbiana	Letcol
3.00	613	Bryoria lanestris	Brylan
3.00	8044	Usnea lapponica	Usnlap
3.00	4004	Melanelia exasperatula	Melexl
2.00	5701	Physcia adscendens	Phyads
2.00	610	Bryoria fuscescens	Bryfus

Group: ON FRAME
Sample unit: 4410565

Value	Code	Species	Code Name
2.00	4017	Melanelia subolivacea	Melsol
2.00	610	Bryoria fuscescens	Bryfus

3.00	8041	Usnea hirta	Usnhir

Group: ON FRAME
Sample unit: 4410572

Value	Code	Species	Code Name
3.00	2704	Flavopunctelia soredica	Fpusor
3.00	8041	Usnea hirta	Usnhir
3.00	4017	Melanelia subolivacea	Melsol
4.00	4002	Melanelia elegantula	Melele
3.00	5702	Physcia aipolia	Phyaip
3.00	607	Bryoria fremontii	Bryfre
3.00	8204	Xanthoria hasseana	Xanhas

Group: ON FRAME
Sample unit: 4410584

Value	Code	Species	Code Name
4.00	2704	Flavopunctelia soredica	Fpusor
4.00	4017	Melanelia subolivacea	Melsol
4.00	8041	Usnea hirta	Usnhir
3.00	4004	Melanelia exasperatula	Melexl
1.00	609	Bryoria furcellata	Bryfur

Group: ON FRAME
Sample unit: 4410671

Value	Code	Species	Code Name
3.00	2704	Flavopunctelia soredica	Fpusor
3.00	8041	Usnea hirta	Usnhir
3.00	8044	Usnea lapponica	Usnlap
3.00	5701	Physcia adscendens	Phyads
2.00	4002	Melanelia elegantula	Melele
1.00	4806	Parmelia sulcata	Parsul
3.00	5710	Physcia dimidiata	Phydim
3.00	8204	Xanthoria hasseana	Xanhas

Group: ON FRAME
Sample unit: 4410713

Value	Code	Species	Code Name
3.00	5710	Physcia dimidiata	Phydim
3.00	4002	Melanelia elegantula	Melele

Group: ON FRAME
Sample unit: 4410733

Value	Code	Species	Code Name

4.00	4002	Melanelia elegantula	Melele
3.00	4004	Melanelia exasperatula	Melexl
2.00	3702	Letharia vulpina	Letvul
4.00	610	Bryoria fuscescens	Bryfus
3.00	8041	Usnea hirta	Usnhir
3.00	8044	Usnea lapponica	Usnlap

Group: ON FRAME
Sample unit: 4410741

Value	Code	Species	Code Name
3.00	205	Alectoria sarmentosa	Alesar
4.00	3702	Letharia vulpina	Letvul
4.00	610	Bryoria fuscescens	Bryfus
4.00	4004	Melanelia exasperatula	Melexl
3.00	4002	Melanelia elegantula	Melele
4.00	8044	Usnea lapponica	Usnlap
2.00	5701	Physcia adscendens	Phyads

Group: ON FRAME
Sample unit: 4410753

Value	Code	Species	Code Name
4.00	8044	Usnea lapponica	Usnlap
3.00	610	Bryoria fuscescens	Bryfus
4.00	4004	Melanelia exasperatula	Melexl
3.00	3702	Letharia vulpina	Letvul
3.00	5201	Parmeliopsis ambigua	Popamb
3.00	1217	Cladonia fimbriata	Clafim
1.00	5202	Parmeliopsis hyperopta	Pophyp

Group: ON FRAME
Sample unit: 4410765

Value	Code	Species	Code Name
3.00	5202	Parmeliopsis hyperopta	Pophyp
4.00	8044	Usnea lapponica	Usnlap
4.00	610	Bryoria fuscescens	Bryfus
3.00	3702	Letharia vulpina	Letvul
3.00	3102	Hypogymnia austerodes	Hypaus
3.00	1228	Cladonia ochrochlora	Claoch
3.00	1217	Cladonia fimbriata	Clafim
2.00	8301	Candelaria concolor	Cndcon
4.00	4004	Melanelia exasperatula	Melexl
2.00	4806	Parmelia sulcata	Parsul
1.00	1015	Cetraria pinastri	Cetpin

Group: ON FRAME
Sample unit: 4410778

Value	Code	Species	Code Name
3.00	4806	Parmelia sulcata	Parsul
4.00	8044	Usnea lapponica	Usnlap
3.00	5201	Parmeliopsis ambigua	Popamb
3.00	3702	Letharia vulpina	Letvul
3.00	4004	Melanelia exasperatula	Melexl
3.00	4016	Melanelia subelegantula	Melsel
3.00	3102	Hypogymnia austerodes	Hypaus
3.00	610	Bryoria fuscescens	Bryfus

Group: ON FRAME
Sample unit: 4410785

Value	Code	Species	Code Name
3.00	3702	Letharia vulpina	Letvul
3.00	8041	Usnea hirta	Usnhir
3.00	4017	Melanelia subolivacea	Melsol
3.00	600	Bryoria	Bry

Group: ON FRAME
Sample unit: 4410914

Value	Code	Species	Code Name
2.00	3702	Letharia vulpina	Letvul
3.00	4004	Melanelia exasperatula	Melexl
3.00	4002	Melanelia elegantula	Melele
3.00	4017	Melanelia subolivacea	Melsol
3.00	8000	Usnea	Usn
3.00	610	Bryoria fuscescens	Bryfus

Group: ON FRAME
Sample unit: 4410946

Value	Code	Species	Code Name
3.00	4002	Melanelia elegantula	Melele
3.00	4004	Melanelia exasperatula	Melexl
3.00	8044	Usnea lapponica	Usnlap
3.00	3701	Letharia columbiana	Letcol
3.00	610	Bryoria fuscescens	Bryfus
3.00	4017	Melanelia subolivacea	Melsol
2.00	5201	Parmeliopsis ambigua	Popamb

Group: ON FRAME
Sample unit: 4410986

Value	Code	Species	Code Name
3.00	8041	Usnea hirta	Usnhir

3.00	3702	Letharia vulpina	Letvul
3.00	4004	Melanelia exasperatula	Melexl
3.00	610	Bryoria fuscescens	Bryfus

Group: ON FRAME
Sample unit: 4411011

Value	Code	Species	Code Name
3.00	8044	Usnea lapponica	Usnlap
3.00	3702	Letharia vulpina	Letvul
2.00	5701	Physcia adscendens	Phyads
3.00	4004	Melanelia exasperatula	Melexl
2.00	5201	Parmeliopsis ambigua	Popamb
2.00	8210	Xanthoria fulva	Xanful
4.00	610	Bryoria fuscescens	Bryfus
3.00	607	Bryoria fremontii	Bryfre

Group: ON FRAME
Sample unit: 4411016

Value	Code	Species	Code Name
4.00	607	Bryoria fremontii	Bryfre
4.00	4004	Melanelia exasperatula	Melexl
3.00	610	Bryoria fuscescens	Bryfus
3.00	3702	Letharia vulpina	Letvul
4.00	8044	Usnea lapponica	Usnlap

Group: ON FRAME
Sample unit: 4411023

Value	Code	Species	Code Name
3.00	3702	Letharia vulpina	Letvul
3.00	8044	Usnea lapponica	Usnlap
2.00	5701	Physcia adscendens	Phyads
3.00	3701	Letharia columbiana	Letcol
3.00	610	Bryoria fuscescens	Bryfus
3.00	4004	Melanelia exasperatula	Melexl

Group: ON FRAME
Sample unit: 4411028

Value	Code	Species	Code Name
3.00	8044	Usnea lapponica	Usnlap
4.00	607	Bryoria fremontii	Bryfre
3.00	3702	Letharia vulpina	Letvul
3.00	3701	Letharia columbiana	Letcol
3.00	4004	Melanelia exasperatula	Melexl
3.00	4000	Melanelia	Mel

Group: ON FRAME
Sample unit: 4411048

Value	Code	Species	Code Name
1.00	3702	Letharia vulpina	Letvul

Group: ON FRAME
Sample unit: 4411068

Value	Code	Species	Code Name
1.00	3702	Letharia vulpina	Letvul

Group: ON FRAME
Sample unit: 4411071

Value	Code	Species	Code Name
3.00	4004	Melanelia exasperatula	Melexl
3.00	8000	Usnea	Usn
3.00	3701	Letharia columbiana	Letcol
1.00	5701	Physcia adscendens	Phyads
2.00	8201	Xanthoria candelaria	Xancan
3.00	610	Bryoria fuscescens	Bryfus

Group: ON FRAME
Sample unit: 4411075

Value	Code	Species	Code Name
3.00	3702	Letharia vulpina	Letvul
3.00	4004	Melanelia exasperatula	Melexl
3.00	5201	Parmeliopsis ambigua	Popamb
2.00	8000	Usnea	Usn
3.00	610	Bryoria fuscescens	Bryfus

Group: ON FRAME
Sample unit: 4411083

Value	Code	Species	Code Name
3.00	8041	Usnea hirta	Usnhir
3.00	4002	Melanelia elegantula	Melele
3.00	4017	Melanelia subolivacea	Melsol
3.00	8201	Xanthoria candelaria	Xancan
3.00	5710	Physcia dimidiata	Phydim
3.00	3702	Letharia vulpina	Letvul
3.00	610	Bryoria fuscescens	Bryfus

Group: ON FRAME

Sample unit: 4411088

Value	Code	Species	Code Name
3.00	3702	Letharia vulpina	Letvul
3.00	8044	Usnea lapponica	Usnlap
3.00	610	Bryoria fuscescens	Bryfus
3.00	4002	Melanelia elegantula	Melele
3.00	4004	Melanelia exasperatula	Melexl
3.00	3102	Hypogymnia austerodes	Hypaus

Total number of species occurrences in data = 322