



A Field Survey of the Biological Soil Crusts of the Coal Mine Basin Area of Critical Environmental Concern (ACEC), Malheur County, Oregon

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Introduction

The 306 hectare (755 acre) Coal Mine Basin Area of Critical Environment Concern/Research Natural Area (ACEC/RNA) was established in 2002 by the Southeast Oregon Resource Management Plan Record of Decision. This unique area is contiguous with the 650 hectare (1,604 acre) Idaho BLM ACEC of the same name, designated in 1999. The Oregon portion of the ACEC lies within the BLM's Vale District in eastern Malheur County near the Oregon/Idaho border between Jordan Valley, Oregon, and Marsing, Idaho. It is accessed by road south of US Hwy. #95 in Idaho. This is the area described by this report.

The colorful ash beds in Coal Mine Basin have highly scenic vistas, fossils of plants and vertebrate animals, and diverse plant communities. The ACEC, which falls with the Northern Basin and Range Ecoregion, was designated to protect two types of plant communities on ash (*Artemisia tridentata/Grayia spinosa/Artemisia spinescens* and annual forb communities), and two special status plant species: smooth mentzelia (*Mentzelia mollis*) and Cusick's chaenactis (*Chaenactis cusickii*) (BLM 2002). Additional special status plants known from the Idaho side include biennial princesplume (*Stanleya confertiflora*), Packard's lomatium (*Lomatium packardiae*), and Malheur yellow phacelia (*Phacelia lutea* v. *calva*). The area has been recognized by BLM offices in both Oregon and Idaho as representing excellent examples of typical Succor Creek ash habitat for its full complement of common and rare species occurring on ash formations.

The climate is characterized by hot dry summers and cold, moist winters. Average annual precipitation is 20 to 25 cm (8 to 10 in.). Elevation ranges from 1280 to 1370 m (4,200 to 4,500 feet). Soils are derived from ash and basalts, both of volcanic origin. Disturbances include past and current livestock grazing, roads and recreation trails. The ACEC has a high potential for the occurrence of hot springs and epithermal-related gold/silver/mercury deposits and zeolite, a moderate potential for the occurrence of geothermal resources and oil and gas, and a low potential for the occurrence of all other leasable and locatable minerals (BLM 2002).

While the vascular plant flora of Coal Mine Basin ACEC is relatively well known, the lower plants, namely lichens and bryophytes, have not been studied. In eastern Oregon, as elsewhere, surveys of these organisms, particularly those growing on soil (biological soil crusts), have been limited. In 1984, Mayfield and Kjølmyr identified 14 bryophyte and 7 lichen taxa from the Boardman Research Natural Area in north-central Oregon. At the nearby Lawrence Memorial Grassland Preserve, Miller et al. (2011) assessed lichen ecology and diversity in an ungrazed sagebrush steppe preserve. Of 141 species, 45 were biological soil crust taxa. While investigating biological soil crust composition in relation to soil chemistry, climate, and livestock grazing, Ponzetti and McCune (2001) identified 48 taxa or morphological groups at nine shrub-steppe sites in central and eastern Oregon. None of these sites were extensively surveyed, but transect sampling was intensive and to the species level whenever possible. Of their nine study sites, the closest to Coal Mine Basin is still nearly 250 km to the northwest. In closer proximity, DeBolt identified 47 soil crust taxa in Birch Creek (2008) and 45 near Rome (2010), 50 km northwest and 75 km southwest of Coal Mine Basin, respectively. Through the Bureau of Land

Management – U.S. Forest Service Interagency Special Status/Sensitive Species Program (ISSSP) and Oregon State University Botany Department partners, additional biological soil crust surveys are on-going at scattered locations in eastern Oregon, but those data are not yet available.

Biological soil crusts are a close association between soil particles and cyanobacteria, microfungi, algae, lichens, and bryophytes (mosses, liverworts) which live within or on top of the uppermost millimeters of soil (Belnap et al. 2001). They are found in all dryland regions of the world and in all vegetation types within these lands, including the arid and semi-arid regions of North America (Rosentreter and Belnap 2001). Also known as microbiotic, cryptobiotic, biotic, and cryptogamic crusts, biological soil crusts are often overlooked due to their tendency to blend in with the soil; thus, they are seldom collected. Due to the small size and fragility of the specimens, they are difficult to return to the lab intact and suitable for species determination. However, the ecological importance of these organisms in nutrient cycling, moisture storage, and soil stabilization has been well documented (Belnap et al. 2001, Hilty et al. 2004, Ponzetti et al. 2007, Rosentreter et al. 2007, Serpe et al. 2007).

This project was divided into two parts. Part 1 included the field inventory of the Coal Mine Basin ACEC to: (1) identify which soil-occurring lichen and bryophyte taxa are present in this unique area; (2) prepare a herbarium reference collection of all species observed, including duplicates whenever possible; and (3) determine if taxa differ by habitat and soil type. Part 2 consists of the preparation of this report, which consolidates and summarizes all field findings and photographs. It is hoped that the information gained from this study will be useful for future ACEC management and planning document preparation, for ISSSP determinations should any of these taxa prove to be rare, and to bolster previous efforts to gain knowledge of this poorly known component of the ecosystem.

Methods

Lichens and bryophytes were collected in September 2010 within the 306 hectare Coal Mine Basin ACEC, Malheur County, Vale District BLM (Map 1.). This area is located on the Idaho border in Secs. 13 and 24, Township 27S, Range 46E, and Secs. 7, 18, 19, Range 47 E, approx. 24 km NE of Jordan Valley, OR, and about 48 km southwest of Marsing, Idaho. Access is via Highway #95, four-wheel drive roads, and walking.

To objectively assess biological soil crust diversity at the study site, Forest Health Monitoring sampling protocols were loosely followed. A minimum of 30 minutes and a maximum of 2 hours were spent examining 5 plots with a 35 m radius within a given habitat or vegetation type (McCune et al. 1997). As best as could be determined (biological soil crusts are difficult to field identify, particularly given the dry September conditions), each different species encountered within a plot was carefully collected and numbered. Soil-occurring taxa were the primary target, though species on wood and rock were also collected sparingly. Each sample was lightly moistened with a spray bottle, wrapped in tissue, and placed in a small paper bag. Bags were grouped into one large paper bag per plot once sampling was completed. Additional data recorded at each plot included the GPS coordinates, elevation, aspect, slope,

and associated vascular plant species. Soil samples were taken for subsequent texture and pH testing and Munsell soil-color chart evaluations (2009). Digital photographs of each plot and other features were also taken.

This relatively small area (306 ha; 755 ac) has an elevational range of 1259 to 1362 m (4,130 to 4,468 ft) with various aspects and soil types. Largely due to the ash bed variability and their unique edaphic factors, at least five special status vascular plants are known from the ACEC; two in Oregon and three in Idaho. These species and their global, state, and Oregon Bureau ranking are as follows (exceptions are indicated as such):

- *Chaenactis cusickii* A. Gray (Cusick's chaenactis); G3, S3, List 4, Bureau Sensitive
- *Lomatium packardiae* Cronquist (Packard's lomatium); Idaho ranking: G2, S2, BLM TYPE 3; not yet known from the Oregon portion of the ACEC
- *Mentzelia mollis* M. Peck (Smooth stickleaf); G2, S2, List 2, Bureau Sensitive
- *Phacelia lutea* (Hook. & Arn.) J.T. Howell var. *calva* (Malheur yellow phacelia); Idaho ranking: G4T3, S3, BLM TYPE 3; this variety is not confirmed from the Oregon portion of the ACEC, though it is expected; *P. lutea* was observed in September, but specimens were too desiccated to determine varietal status.
- *Stanleya confertiflora* (B.L. Rob.) Howell (Oregon princesplume); Idaho ranking: G5, S2, BLM TYPE 2; not yet known from the Oregon portion of the ACEC.

Five vegetation and/or edaphic types were selected for plot sampling (see Appendix A photos). Three intuitively controlled non-plot sites were collected from but to a lesser extent. The five sites are described as follows, with dominants listed in order of prevalence (from most to least dominant):

Plot 1: Sparsely vegetated gray ash badlands; 10% vegetative cover; 180°-220° aspect; 0-2% slope; clay soil; pH 7; little to no organic matter; Munsell soil-color chart: reddish yellow, 5YR-7/6; associated vegetation - *Phacelia lutea*, *Cleomella* sp., *Elymus elymoides*, *Ericameria nauseosa*. 1326 m (4,351 ft) N 43° 12' 41.01" W117° 1' 59.47"

Plot 2: *Artemisia arbuscula* - *Pseudoroegneria spicata* site; 60% vegetative cover; 120°-160° aspect; 2-4% slope; loamy clay soil; pH 7; low organic matter; Munsell soil-color chart: grayish brown, 10 YR-5/2; associated vegetation - *Chrysothamnus viscidiflorus*, *Poa secunda*, various forbs. 1329 m (4,360 ft) N 43° 12' 41.63" W117° 2' 7.28"

Plot 3: Burned *Artemisia cana* meadow; 100% vegetative cover; flat aspect and slope; heavy clay soil (deeply cracked); pH 7; little to no organic matter; Munsell soil-color chart: dark grey, 10 YR 4/1; associated vegetation - *Taeniatherum caput-medusae*, *Bromus japonicus*, *Sisymbrium altissimum*. 1317 m (4,320 ft) N 43° 12' 43.69" W117° 2' 9.64"

Plot 4: Sparsely vegetated white ash flat; < 10% vegetative cover (with livestock trampling); 180°-240° aspect; 0-3% slope; clay loam soil; pH 7; low organic matter; Munsell soil-color chart: light grey, 10YR 7/1; associated vegetation - *Poa bulbosa*, *Ericameria nauseosa*, *Eriogonum microthecum*, *Poa secunda*, *Phacelia lutea*. 1280 m (4,200 ft) N 43° 11'55.88" W117° 4'9.72"

Plot 5: *Artemisia tridentata* v. *wyomingensis* - *Pseudoroegneria spicata* site; 75% vegetative cover; 250°-300° aspect; 8-15% slope; silt loam soil; pH 7; obvious organic matter; Munsell soil-color chart: dark brown, 7.5 YR 3/2; associated vegetation - *Poa secunda*, *Elymus elymoides*. 1,312 m (4,300 ft) N 43° 11'51.84" W117° 1'50.46"

Specimens were returned to the lab and curated using standard bryological and lichenological techniques (Brodo et al. 2001, McCune and Rosentreter 2007). Species were identified using the floras listed in the "References" section, primarily McCune and Rosentreter (2007) and Rosentreter et al. (2007). Two or more duplicates were prepared when material was sufficient. Soil pH, color and texture were analyzed in the lab using standard techniques.

Results and Discussion

One hundred sixty-one lichen and bryophyte collections were made in the 306 ha Coal Mine Basin ACEC (Table 1, Appendix B), represented by 81 species; **56 of the species are growing as biological soil crusts, including 9 bryophytes, 1 cyanobacteria, and 46 lichens** (Tables 1-3). The other 25 species grew on rock (saxicolous) or wood (lignicolous) and were collected simply to expand our knowledge of this area (many additional saxicolous and lignicolous taxa are expected to occur in this area, but a comprehensive inventory was beyond the scope of this study). Of the 81 taxa, 16 (20%) were not yet identified to species, reflecting the difficult and slow process of cryptogam taxonomy. Five of these are biological soil crusts, which need further investigation by specialists.

The attached table (Table 4), compiled from recent studies in central and eastern Oregon, is noteworthy in that two days of collecting each at Birch Creek, Rome, and Coal Mine Basin (DeBolt 2008, 2010, 2011, respectively) produced biological soil crust results not that dissimilar to those reported for the extensively studied Lawrence Memorial Grassland (Miller et al. 2011). For the much larger Birch Creek area (> 2,000 ha), numbers would undoubtedly increase with additional collecting time, but access to this remote site is slow (via 4 wheel drive in part) and traveling used up a significant portion of the two field days in 2008. Collecting at the Rome site was compromised to some extent by stormy weather and saturated clay soils, making walking difficult. What this table helps illustrate is the large amount and level of data attainable by experienced individuals (this is crucial) and intensive plot sampling in a relatively short period of time.

Table 4. Recent biological soil crust studies in Oregon and number of species reported by taxonomic group.

Study Location and Citation	Bryophytes	Lichens	Cyanobacteria	Total
Birch Creek (DeBolt 2008)	12	34	1	47
Rome (DeBolt 2010)	6	37	1	45
Lawrence Grassland (Miller et al. 2011)	not reported	45	0	45
Coal Mine Basin (DeBolt 2011)	9	46	1	56

Soils differed among plots, ranging from heavy clay to silt loam. Differences are reflected by both vascular and non-vascular vegetation. Color differences are illustrated by the below photo (soils dry), with descriptions reiterated below. Note the shrink-swell of the clay soils in Plots #1 and #3.



- Plot 1:** clay; little to no organic matter; Munsell soil-color reddish yellow, 5YR-7/6
- Plot 2:** loamy clay; low organic matter; Munsell soil-color: grayish brown, 10 YR-5/2
- Plot 3:** heavy clay (deeply cracked); little - no organic matter; Munsell soil-color: dark grey, 10 YR 4/1
- Plot 4:** clay loam; low organic matter; Munsell soil-color: light grey, 10YR 7/1
- Plot 5:** silt loam; obvious organic matter; Munsell soil-color: dark brown, 7.5 YR 3/2

Soil crust diversity was highest (32 taxa) in the Wyoming sagebrush-bluebunch wheatgrass plot (Plot #5) with silt loam soils; 9 of the species were unique to this plot (not collected elsewhere in Coal Mine Basin) (Table 3). Next highest diversity was in Plot #2 (low sagebrush; 25 taxa, 5 unique) and Plot #4 (white ash flat; 26 taxa; 4 unique). Lichens on soil are good indicators of free calcium carbonates (McCune and Rosentreter 2007). Plot #4 is sparsely vegetated with high lichen cover and calcium carbonate. Several taxa indicative of calcareous soils are unique to this plot, including *Aspicilia aspera*, *A. fruticulosa*, and *Xanthoparmelia norchlorochroa*. Table 5 identifies the calcium carbonate indicators collected in each plot.

Table 5. Calcium carbonate indicator species by plot.

Plot #1	Plot #2	Plot #3	Plot #4	Plot #5
<i>Aspicilia hispida</i> <i>Collema tenax</i>	<i>Aspicilia hispida</i> <i>Collema tenax</i> <i>Phaeorrhiza sareptana</i> <i>Psora tuckermanii</i>	n/a	<i>Aspicilia aspera</i> <i>Aspicilia fruticulosa</i> <i>Aspicilia hispida</i> <i>Caloplaca tominii</i> <i>Collema tenax</i> <i>Psora tuckermanii</i> <i>Xanthoparmelia norchlorochroa</i>	<i>Aspicilia hispida</i> <i>Caloplaca tominii</i> <i>Collema tenax</i> <i>Psora tuckermanii</i>

No lichens or mosses were collected on any substrate in Plot #3. This burned site is dominated by exotic annuals with 100% vegetative cover. The site has deeply cracked heavy clay soil. In combination with the dense vegetative cover, it no longer provides suitable habitat for cryptogams.

Although collecting in eastern Oregon has been spotty at best, several species in the study area are believed to be uncommon in Oregon and throughout their range. *Aspicilia fruticulosa*, described as a “fairly rare vagrant species of calcareous sites” (McCune and Rosentreter 2007), was found at 2 locations in the ACEC: Plot #4 (#2679) and one of the 3 non-plot collection sites (#2584). This free-living species has been reported from one other location in Wallowa County, Oregon (“a barren rocky ephemeral seepage site surrounded by Palouse prairie vegetation”; the Zumwalt Prairie). *Aspicilia fruticulosa* has been collected at half a dozen sites in Owyhee County, Idaho, including McBride Creek ACEC, approximately 10 km to the north.

Xanthoparmelia norchlorochroa (#2693) and *X. neochlorochroa* (#2601) were each collected once (Plot #4 and in a non-plot location, respectively). Distinguishing these 2 taxa requires both morphological and chemical review. Thin layer chromatography techniques were used to confirm these species. *Xanthoparmelia neochlorochroa* is so far known from semiarid calcareous rangelands in southwestern Montana to southern Idaho and Wyoming (McCune and Rosentreter 2007). *Xanthoparmelia norchlorochroa* is “rare in southern and central Idaho, usually in shadscale habitats or badlands nearly devoid of vascular plants, often on calcareous soils” (McCune and Rosentreter 2007). The Coal Mine Basin collections may be the first reports for both species in Oregon (Consortium of North American Lichen Herbaria, accessed 2011). While each species was collected only once, *Xanthoparmelias* were observed several times at other sparsely vegetated sites within the ACEC (see photos below; the green color is *Xanthoparmelia*). Undoubtedly, both species have additional subpopulations in the area.



With the exception of Plot #3 (0 taxa), bryophyte diversity amongst plots was not significantly different, ranging from 3 to 6 taxa. The number of taxa (9) and species themselves were similar to those reported in other eastern Oregon biological soil crust studies (DeBolt 2008, 2010), with the exception of *Athalamia hyalina*, a small liverwort collected only in Plot #5. Table 6 assesses the relative abundance of each species in the ACEC. To effectively monitor changes in species abundance over time, Miller et al. (2011) recommend that baseline surveys include this type of information.

Conclusion

During the September 2010 biological soil crust survey of Coal Mine Basin ACEC, Malheur County, Oregon, 81 species were collected. Of the 81 species, 56 are biological soil crusts (9 bryophytes, 1 cyanobacteria, 46 lichens). The remaining 25 species grew on rock (saxicolous) or wood (lignicolous) and were collected to supplement our knowledge of cryptogams in this area.

Plots differed significantly, ranging from zero to 34 cryptogamic taxa (32 for biological soil crusts), and each plot supported a minimum of 5 unique species (species found only in a given plot). Two *Xanthoparmelia* species, *X. neochlorochroa* and *X. norchlorochroa*, are thought to be new records for Oregon. *Aspicilia fruticulosa* was collected at 2 sites in the ACEC; it was previously known from one other Oregon location (in Wallowa County). While some taxonomic puzzles remain, the study served to increase knowledge of one of Oregon BLM's many unique floristic areas.

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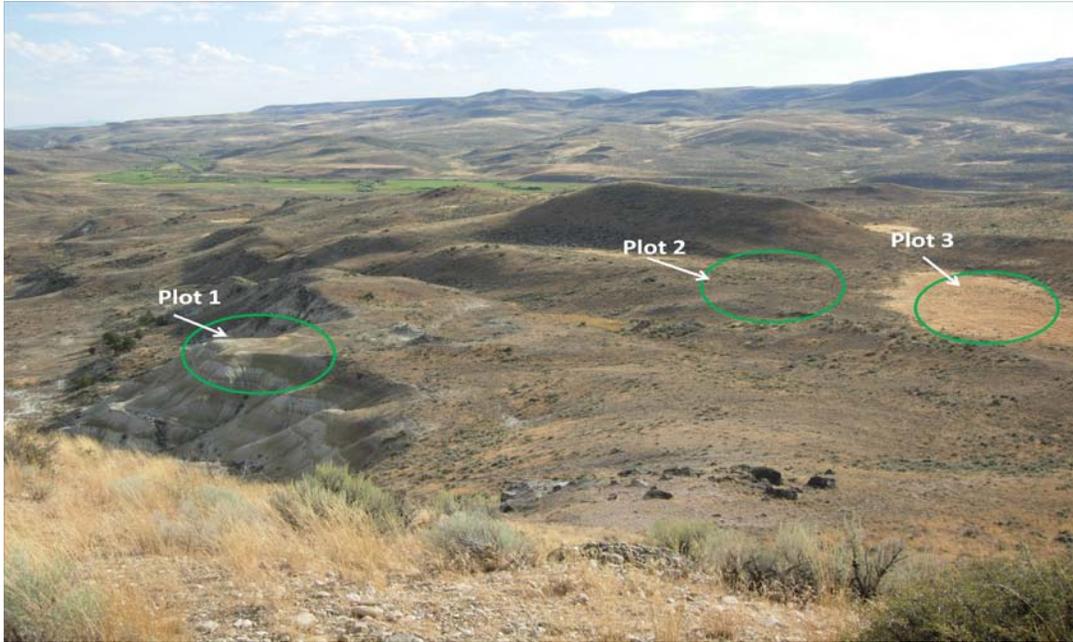
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Appendices, Tables, and Attachments

- 1. Appendix A.** 2 overview photographs of Plots #1-#3 and #4-#5. **They are included in the body of the document.**
- 2. Appendix B.** This is the collection notebook for Part 1 of the study. It includes label and species data for each site. DeBolt collection numbers range from 2571 to 2752. **It is included in the body of this document.**
- 3. Map 1.** Map showing land ownership, Oregon and Idaho ACEC boundaries, Oregon special status plant population data, and relative location of the area. **Separate electronic file.**
- 4. Table 1.** Taxa collected in the Coal Mine Basin ACEC, with authorities, collection numbers, number of duplicates, life form, and substrate. This Excel spreadsheet is an alphabetical list of all taxa. **Separate electronic file.**
- 5. Table 2.** All taxa by collection site and substrate at Coal Mine Basin ACEC. This Excel spreadsheet lists all species by plot number. It includes substrate data. **Separate electronic file.**
- 6. Table 3.** Biological soil crust taxa by collection site at Coal Mine Basin ACEC. This Excel spreadsheet lists only the soil-occurring (biological soil crust) taxa by plot number. **Separate electronic file.**
- 7. Table 4 and Table 5** are included within the body of the document.
- 8. Table 6.** Relative abundance of lichen and bryophyte taxa in the Coal Mine Basin ACEC. This Excel spreadsheet ranks species as Common, Infrequent, or Rare. **Separate electronic file.**
- 9. Figure 1, Figure 2.** Number of lower plant taxa on all substrates in the 5 plots and off-plot locations. Number of lower plant taxa unique to a given plot. **2 Excel graphs in 1 separate electronic file.**
- 10. Figure 3, Figure 4.** Number of biological soil crust taxa in the 5 plots and off-plot locations. Number of biological soil crust taxa unique to a given plot. **2 Excel graphs in 1 separate electronic file.**
- 11. Compact Disc of Digital Photographs.** 111 photos on a separate CD.
- 12. PDF file.** All files (report, tables, figures) incorporated into one document.

APPENDIX A



Appendix A. Overview photographs of Plots #1-#5, as seen from a distance.

APPENDIX B.

Collection Notebook

Coal Mine Basin ACEC Biological Soil Crust Survey, Malheur County, OR
September 5-6, 2010

Except where otherwise indicated, all collections in all plots are on soil and/or organic matter.
xxxxx = numbers not used

Non-plot Collection Site A:

“Aspicilia heaven”, sparsely vegetated clay flats with *Poa secunda* clumps & scattered *Ericameria nauseosa*. Below the pyramid hill. Approx. 47 km SW of Marsing, ID, 1 km E of Hwy. #95, and 1 km W of the ID/OR line. N 43° 11'57.93" W117° 1'52.82" 1304 m (4,280 ft)
5 September 2010

- 2571 *Aspicilia hispida* Mereschk.
- 2572 *Rhizoplaca melanophthalma* (Ram.) Leuck. & Poelt (on rock)
- 2573 *Acarospora fuscata* (Schrader) Th.Fr. (on rock)
- 2574 *Caloplaca tominii* Savicz.
- 2575 *Candelariella rosulans* (Müll. Arg.) Zahlbr. (det: B. McCune 12/10)
- 2576 ??? unknown - small dark moss
- 2577 *Aspicilia desertorum* (Krempelh.) Mereschk. f. *terrestris*

Non-plot Collection Site B:

“Grimmia Moss Bald”, sparsely vegetated volcanic ash on slope of pyramid hill with *Poa secunda*, *Eriogonum microthecum*, *Elymus elymoides*, *Phlox longifolia*. Approximately 48 km SSW of Marsing, ID and @1 km E of Hwy. #95. N 43°12'1.43" W 117°2'8.11" 1323 m (4340 ft)
5 September 2010

- 2578 *Aspicilia hispida* Mereschk.
2579 *Arthonia glebosa* Tuck.
2580 *Lecidea atrobrunnea* sensu lato (on rock)
2581 *Staurothele* sp. (on rock)
2582 *Aspicilia desertorum* (Kremp.) Meresch.
2583 *Grimmia tenerrima* Renauld & Cardot
2584 *Aspicilia fruticulosa* (Eversman) Flagey (vagrant)
2585 *Melanohalea infumata* (Nyl.) O. Blanco et al. (on rock)
2586 *Lecanora muralis* (Schreber) Rabenh. (on rock)
2587 *Lecanora muralis* (Schreber) Rabenh. (on organic matter)
2588 *Rhizoplaca melanophthalma* (Ram.) Leuck. & Poelt (on rock)
2589 *Lecanora pseudomellea* B. D. Ryan (on rock)
2590 *Megaspora verrucosa* (Ach.) Hafellner & V. Wirth
2591 ??? lichenicolous fungus on *Lecanora* (on rock)
2592 *Placidium lachneum* (Ach.) de Lesd.
2593 *Rhizoplaca chrysoleuca* (Sm.) Zopf (on rock)
2594 *Lecidella* sp. (on rock; Det. B. McCune 12/10)
2595 *Acarospora fuscata* (Schrader) Th.Fr. (on rock)
2596 *Lecanora polytropa* (Hoffm.) Rabenh. (on quartz crystals in soil; with #2597)
2597 *Caloplaca epithallina* Lynge (on quartz crystals in soil; with #2596)
2598 *Xanthoria elegans* (Link) Th. Fr. (on rock)
2599 xxxxx

Non-plot Collection Site C:

Sparsely vegetated ash beds with *Poa secunda*, *Artemisia tridentata* ssp. *wyomingensis*, *Eriogonum microthecum*, *E. sphaerocephalum*, *Bromus tectorum*. Approx. 48 km SSW of Marsing, ID and @1 km E of Hwy. #95. N 43°11'59.62" W 117°2'11.75" 1317 m (4320 ft)
5 September 2010

- 2600 *Aspicilia filiformis* Rosentreter
2601 *Xanthoparmelia neochlorochroa* Hale (TLC: norstictic, connorstictic acids, plus other)
2602 *Aspicilia* sp.
2603 ??? unknown white crust (on rock)
2604 *Leptogium lichenoides* (L.) Zahlbr.
2605 *Candelariella rosulans* (Müll. Arg.) Zahlbr.
2606 *Xanthomendoza fulva* (Hoffm.) Søchting, Kärnefelt & S. Kondr. (on *Artemisia* bark)
2607 *Candelaria concolor* (Dickson) Stein (on *Artemisia* bark)
2608 *Psora montana* Timdal
2609 *Aspicilia desertorum* (Kremp.) Mereschk. (on wood)
2610 *Lecanora zosteræ* (Ach.) Nyl. (on old wood; det B. McCune 12/10)
2611 *Candelariella* sp. (on old fence post)
2612 *Thelomma ocellatum* (Körber) Tibell (on old fence post)
2613 *Lepraria* sp.
2614 *Physconia perisidiosa* (Erichsen) Moberg
2615 *Syntrichia caninervis* Mitten
2616 *Acarospora* sp. (on old fence post)
2617 *Letharia vulpina* (L.) Hue (on old fence post)
2618 *Aspicilia desertorum* (Kremp.) Mereschk. (on petrified wood)
2619 *Staurothele* sp. (on petrified wood)
2620 xxxxx
2621 xxxxx
2622 xxxxx
2623 xxxxx
2624 xxxxx

Plot 1: Sparsely vegetated gray ash badlands; 10% vegetative cover; 180°-220° aspect; 0-2% slope; clay soil; pH 7; little to no organic matter; Munsell soil-color chart: reddish yellow, 5YR-7/6; associated vegetation - *Phacelia lutea*, *Cleomella* sp., *Elymus elymoides*, *Ericameria nauseosa*. Approx. 48 km SSW of Marsing, ID and @1 km E of Hwy. #95. 1326 m (4,351 ft) N 43° 12' 41.01" W 117° 1' 59.47" 5 September 2010

- 2625 *Lecanora muralis* (Schreb.) Rabenh. (on rock)
- 2626 *Staurothele* sp. (on rock)
- 2627 *Polyspora* sp. (on rock)
- 2628 *Syntrichia ruralis* (Hedwig) F. Weber & D. Mohr
- 2629 *Acarospora* sp. (on rock)
- 2630 *Megaspora verrucosa* (Ach.) Hafellner & V. Wirth
- 2631 *Lecidea* sp. (on twigs)
- 2632 *Aspicilia hispida* Mereschk.
- 2633 *Caloplaca saxicola* (Hoffm.) Nordin
- 2634 *Lecanora muralis* (Schreb.) Rabenh. (on twigs)
- 2635 *Aspicilia* sp. (sterile) (on twigs)
- 2636 *Grimmia tenerrima* Renaud & Cardot
- 2637 *Pterygoneurum ovatum* (Hedw.) Dix.
- 2638 *Cladonia pocillum* (Ach.) Grognot
- 2639 *Collema tenax* (Sw.) Ach.
- 2640 *Syntrichia caninervis* Mitten
- 2641 xxxxx
- 2642 xxxxx

Plot 2: *Artemisia arbuscula* - *Pseudoroegneria spicata* site; 60% vegetative cover; 120°-160° aspect; 2-4% slope; loamy clay soil; pH 7; low organic matter; Munsell soil-color chart: grayish brown, 10 YR-5/2; associated vegetation - *Chrysothamnus viscidiflorus*, *Poa secunda*, various forbs. Approx. 48 km SSW of Marsing, ID and @1 km E of Hwy. #95. 1329 m (4,360 ft)
 N 43° 12'41.63" W117° 2'7.28" 6 September 2010

- 2643 *Peltigera rufescens* (Weiss) Humb.
- 2644 *Melanohalea infumata* (Nyl.) O. Blanco et al. (on rock)
- 2645 *Ceratodon purpureus* (Hedw.) Brid.
- 2646 *Aspicilia mastrucata* (Wahlenb.) Th. Fr.
- 2647 *Bryum argenteum* Hedw.
- 2648 *Collema tenax* (Sw.) Ach.
- 2649 *Arthonia glebosa* Tuck.
- 2650 *Placidium lacinulatum* (Ach.) Breuss
- 2651 *Acarospora fuscata* (Schrad.) Arnold (on rock)
- 2652 *Aspicilia filiformis* Rosentreter
- 2653 *Psora tuckermanii* R. A. Anderson ex Timdal
- 2654 xxxxx
- 2655 *Psora montana* Timdal
- 2656 *Endocarpon pusillum* Hedwig
- 2657 *Grimmia tenerrima* Renauld & Cardot
- 2658 *Leptogium lichenoides* (L.) Zahlbr.
- 2659 *Candelariella rosulans* (Müll. Arg.) Zahlbr.
- 2660 *Phaeorrhiza sareptana* (Tomin) H. Mayrhofer & Poelt
- 2661 *Aspicilia* sp.
- 2662 *Aspicilia reptans* (Looman) Wetmore (a rarely fertile species)
- 2663 *Aspicilia hispida* Mereschk.
- 2664 *Letharia vulpina* (L.) Hue (on twigs)
- 2665 *Encalypta vulgaris* Hedw.
- 2666 *Megaspora verrucosa* (Ach.) Hafellner & V. Wirth (on twigs)
- 2667 *Caloplaca ammiospila* (Wahlenb.) H. Olivier
- 2668 *Syntrichia ruralis* (Hedwig) F. Weber & D. Mohr
- 2669 *Cladonia pocillum* (Ach.) Grognot
- 2670 *Leptochidium albociliatum* (Desm.) M. Choisy
- 2671 *Microcoleous* sp. (cyanobacteria)
- 2672 *Pterygoneurum ovatum* (Hedw.) Dix.
- 2673 *Rinodina* sp. (on *Atriplex* twigs)
- 2674 xxxxx
- 2675 xxxxx
- 2676 xxxxx
- 2677 xxxxx

Plot 3: Burned *Artemisia cana* meadow; 100% vegetative cover; flat aspect and slope; heavy clay soil (deeply cracked); pH 7; little to no organic matter; Munsell soil-color chart: dark grey, 10 YR 4/1; associated vegetation - *Taeniatherum caput-medusae*, *Bromus japonicus*, *Sisymbrium altissimum*. Approx. 48 km SSW of Marsing, ID and @1 km E of Hwy. #95. 1317 m (4,320 ft) N 43° 12'43.69" W117° 2'9.64" 6 September 2010

No cryptogams were observed or collected in this site, which burned and is dominated by exotic annual grasses and sparse silver sagebrush.

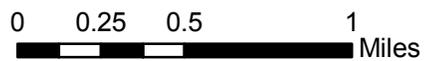
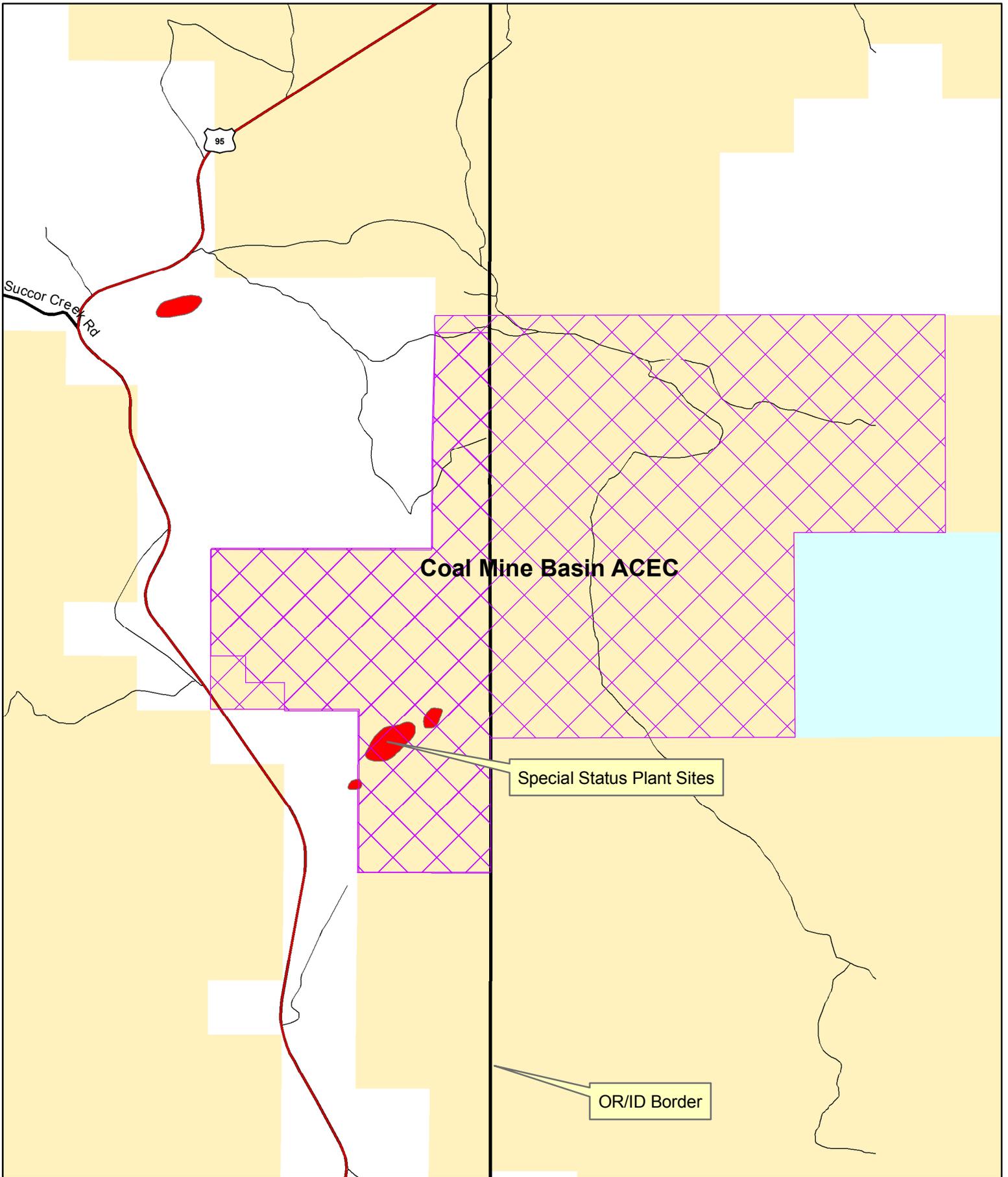
Plot 4: Sparsely vegetated white ash flat; < 10% vegetative cover (with livestock trampling); 180°-240° aspect; 0-3% slope; clay loam soil; pH 7; low organic matter; Munsell soil-color chart: light grey, 10YR 7/1; associated vegetation - *Poa bulbosa*, *Ericameria nauseosa*, *Eriogonum microthecum*, *Poa secunda*, *Phacelia lutea*. Approx. 48 km SSW of Marsing, ID and @1 km E of Hwy. #95. 1280 m (4,200 ft) N 43° 11'55.88" W117° 4'9.72"

6 September 2010

- 2678 *Aspicilia desertorum* (Krempelh.) Mereschk. *f. terrestris*
 2679 *Aspicilia fruticulosa* (Eversm.) Flagey (vagrant)
 2680 *Aspicilia hispida* Mereschk.
 2681 *Placidium lacinulatum* (Ach.) Breuss
 2682 *Melanohalea infumata* (Nyl.) O. Blanco et al. (on rock)
 2683 *Collema tenax* (Sw.) Ach.
 2684 *Leptogium lichenoides* (L.) Zahlbr.
 2685 *Aspicilia aspera* (Mereschk.) Tomin
 2686 *Lecanora garovaglii* (Körber) Zahlbr. (on rock)
 2687 *Rhizoplaca melanophthalma* (DC.) Leuckert & Poelt
 2688 *Candelariella rosulans* (Müll. Arg.) Zahlbr. (det B. McCune 12/10; atypical to be on soil)
 2689 *Lecanora flowersiana* H. Magn. (det B. McCune 12/10)
 2690 *Caloplaca tominii* (Savicz) Ahlner
 2691 *Ceratodon purpureus* (Hedw.) Brid.
 2692 *Toninia ruginosa* (Tuck.) Herre
 2693 *Xanthoparmelia norchlorochroa* Hale (vagrant; TLC: norstictic, connorstictic)
 2694 *Cladonia pocillum* (Ach.) Grognot
 2695 *Aspicilia desertorum* (Kremp.) Mereschk. (on rock)
 2696 xxxxx
 2697 *Syntrichia ruralis* (Hedwig) F. Weber & D. Mohr
 2698 *Psora montana* Timdal
 2699 *Endocarpon pusillum* Hedwig (on rock)
 2700 *Caloplaca* sp. (on rock)
 2701 *Rhizoplaca chrysoleuca* (Sm.) Zopf (on rock)
 2702 *Lecidea atrobrunnea* (Lam. & DC.) Schaerer (on rock)
 2703 *Psora tuckermanii* R. Anderson ex Timdal
 2704 *Grimmia tenerrima* Renauld & Cardot
 2705 *Aspicilia filiformis* Rosentreter
 2706 *Megaspora verrucosa* (Ach.) Hafellner & V. Wirth
 2707 *Candelariella aggregata* M. Westb.
 2708 *Xanthomendoza fulva* (Hoffm.) Søchting, Kärnefelt & S. Kondr. (on *Artemisia* bark)
 2709 *Bryum argenteum* Hedw.
 2710 *Acarospora fuscata* (Schrad.) Arnold (on rock)
 2711 *Staurothele aerolata* (Ach.) Lettau (on rock)
 2712 xxxxx
 2713 xxxxx
 2714 xxxxx

Plot 5: *Artemisia tridentata* v. *wyomingensis* - *Pseudoroegneria spicata* site; 75% vegetative cover; 250°-300° aspect; 8-15% slope; silt loam soil; pH 7; obvious organic matter; Munsell soil-color chart: dark brown, 7.5 YR 3/2; associated vegetation - *Poa secunda*, *Elymus elymoides*.
 Approx. 48 km SSW of Marsing, ID and @1 km E of Hwy. #95. 1,312 m (4,300 ft)
 N 43° 11'51.84" W117° 1'50.46" 6 September 2010

- 2715 *Caloplaca cerina* (Ehrh. ex Hedwig) Th. Fr.
 2716 *Caloplaca tominii* (Savicz) Ahlner
 2717 *Candelariella aggregata* M. Westb. (ver. B. McCune 12/10; atypical on soil)
 2718 *Thrombium epigaeum* (Pers.) Wallr.
 2719 *Acarospora schleicheri* (Ach.) A. Massal.
 2720 *Aspicilia filiformis* Rosentreter
 2721 *Psora montana* Timdal
 2722 *Candelariella rosulans* (Müll. Arg.) Zahlbr.
 2723 *Peltigera rufescens* (Weiss) Humb. (growing over moss)
 2724 *Amandinea punctata* (Hoffm.) Coppins & Scheid.
 2725 *Arthonia glebosa* Tuck.
 2726 *Leptochidium albociliatum* (Desm.) M. Choisy
 2727 *Psora tuckermanii* R. A. Anderson ex Timdal
 2728 *Megaspora verrucosa* (Ach.) Hafellner & V. Wirth (sterile, but morphologically appears to be this species)
 2729 *Collema tenax* (Sw.) Ach.
 2730 *Athalamia hyalina* (Sommerf.) S. Hatt.
 2731 *Diploschistes muscorum* (Scop.) R. Sant.
 2732 *Massalongia carnosa* (Dickson) Körber
 2733 *Endocarpon pusillum* Hedwig
 2734 *Encalypta vulgaris* Hedwig.
 2735 *Rinodina olivaceobrunnea* Dodge & Baker (ver: R. Rosentreter 02/11)
 2736 *Microcoleous* sp. (mixed with *Caloplaca tominii*)
 2737 *Aspicilia desertorum* (Kremp.) Mereschk. f. *terrestrialis*
 2738 *Toninia ruginosa* (Tuck.) Herre
 2739 *Peltigera didactyla* (With.) J. R. Laundon
 2740 *Ceratodon purpureus* (Hedw.) Brid.
 2741 *Cladonia pocillum* (Ach.) Grognot
 2742 *Cladonia pyxidata* (L.) Hoffm.
 2743 *Syntrichia ruralis* (Hedwig) F. Weber & D. Mohr
 2744 *Bryum argenteum* Hedw.
 2745 *Xanthomendoza fulva* (Hoffm.) Søchting, Kärnefelt & S. Kondr.
 2746 *Bryum argenteum* Hedw.
 2747 *Leptogium lichenoides* (L.) Zahlbr.
 2748 *Collema tenax* (Sw.) Ach. (mixed w/*Psora*, moss)
 2749 *Aspicilia hispida* Mereschk.
 2750 xxxxx
 2751 xxxxx



Coal Mine Basin ACEC - Oregon & Idaho



U.S. Department of Interior
Bureau of Land Management



Vale District
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Table 1. Species collected in the Coal Mine Basin Area of Critical Environmental Concern with authorities, collection numbers, number of duplicates, life form, and substrate.

Species and Authorities	DeBolt Collection Numbers	No. of Specimens of Each Collection	Lichen (L), Bryophyte (B), Cyanobacteria (C), Other (O)	Substrate Info and Notes
<i>Acarospora schleicheri</i> (Ach.) A. Massal.	2719	3	L	on soil
<i>Acarospora</i> sp.	2616	2	L	on old wood
<i>Acarospora</i> sp.	2629	1	L	on rock; send to K. Knudsen
<i>Acarospora fuscata</i> (Schrader) Th.Fr.	2573, 2595, 2651, 2710	1, 1, 1, 1	L	on rock
<i>Amandinea punctata</i> (Hoffm.) Coppins & Scheid.	2724	1	L	on soil
<i>Arthonia glebosa</i> Tuck.	2579, 2649, 2725	1, 2, 2	L	on soil
<i>Aspicilia aspera</i> (Mereschk.) Tomin	2685	3	L	on soil
<i>Aspicilia desertorum</i> (Kremp.) Meresch.	2582, 2609, 2618, 2695	3, 1, 2, 2	L	#2582, #2695 - on rock; #2609 - on wood; #2618 - on petrified wood
<i>Aspicilia desertorum</i> (Kremp.) Meresch. f. <i>terrestrialis</i>	2577, 2678, 2737	3, 5, 2	L	on soil
<i>Aspicilia filiformis</i> Rosentreter	2600, 2652, 2705, 2720	3, 2, 2, 3	L	on soil
<i>Aspicilia fruticulosa</i> (Eversman) Flagey	2584, 2679	2, 8	L	vagrant (on soil)
<i>Aspicilia hispida</i> Mereschk.	2571, 2578, 2632, 2663, 2680, 2749	2, 5, 2, 2, 2, 2	L	on soil
<i>Aspicilia mastrucata</i> (Wahlenb.) Th. Fr.	2646	3	L	on soil
<i>Aspicilia reptans</i> (Looman) Wetmore	2662	1	L	on soil
<i>Aspicilia</i> sp. (sterile)	2635	1	L	on twigs
<i>Aspicilia</i> sp.	2661	2	L	on soil
<i>Athalamia hyalina</i> (Sommerf.) S. Hatt.	2730	2	B	on soil
<i>Bryum argenteum</i> Hedw.	2647, 2709, 2744, 2746	2, 2, 3, 1	B	on soil, organic matter
<i>Caloplaca ammiospila</i> (Wahlenb.) H. Olivier	2667	1	L	on soil; mixed with <i>Encalypta vulgaris</i> (#2665) & <i>Megaspora verrucosa</i> (#2666)
<i>Caloplaca cerina</i> (Ehrh. ex Hedwig) Th. Fr.	2715	1	L	on organic matter
<i>Caloplaca epithallina</i> Lyngby	2597	1	L	on quartz crystals in soil; mixed w/ <i>Lecanora polytropa</i> #2596
<i>Caloplaca saxicola</i> (Hoffm.) Nordin	2633	1	L	on soil
<i>Caloplaca tominii</i> Savicz.	2574, 2690, 2716	1, 2, 3	L	on soil
<i>Caloplaca</i> sp.	2700	2	L	on rock
<i>Candelaria concolor</i> (Dickson) Stein	2607	1	L	on bark; mixed with <i>Xanthomendoza fulva</i> (#2606)
<i>Candelariella aggregata</i> M. Westb.	2707, 2717	2, 4	L	on organic matter; ver. by B. McCune
<i>Candelariella rosulans</i> (Müll. Arg.) Zahlbr.	2575, 2605, 2659, 2688, 2722	1, 2, 2, 2, 1	L	on organic matter

Table 1. Species collected in the Coal Mine Basin Area of Critical Environmental Concern with authorities, collection numbers, number of duplicates, life form, and substrate.

Species and Authorities	DeBolt Collection Numbers	No. of Specimens of Each Collection	Lichen (L), Bryophyte (B), Cyanobacteria (C), Other (O)	Substrate Info and Notes
<i>Candelariella</i> sp.	2611	2	L	on old wood; send to Westberg
<i>Ceratodon purpureus</i> (Hedw.) Brid.	2645, 2691, 2740	2, 2, 3	B	on soil
<i>Cladonia pocillum</i> (Ach.) Grognot	2638, 2669, 2694, 2741	1, 2, 2, 2	L	on soil
<i>Cladonia pyxidata</i> (L.) Hoffm.	2742	3	L	on soil
<i>Collema tenax</i> (Sw.) Ach.	2639, 2648, 2683, 2729, 2748	1, 1, 1, 3, 2	L	on soil
<i>Diploschistes muscorum</i> (Scop.) R. Sant.	2731	5	L	on soil
<i>Encalypta vulgaris</i> Hedw.	2665, 2734	1, 2	B	on soil; #2665 is mixed w/ <i>Megaspora verrucosa</i> (#2666) & <i>Caloplaca ammiospila</i> (#2667)
<i>Endocarpon pusillum</i> Hedwig	2656, 2699, 2733	1, 2, 2	L	#2699 - on rock
<i>Grimmia tenerrima</i> Renauld & Cardot	2583, 2636, 2657, 2704	6, 1, 2, 3	B	on soil
<i>Lecanora flowersiana</i> H. Magn.	2689	2	L	on soil; det. by B. McCune
<i>Lecanora garovaglii</i> (Körber) Zahlbr.	2686	2	L	on rock
<i>Lecanora muralis</i> (Schreber) Rabenh.	2586, 2587, 2625, 2634	6, 2, 1, 1	L	#2586, #2625 - on rock; #2587 - on organic matter; #2634 - on wood
<i>Lecanora polytropa</i> (Hoffm.) Rabenh.	2596	1	L	on quartz crystals in soil; mixed w/ <i>Caloplaca epithallina</i> #2597
<i>Lecanora pseudomellea</i> B. D. Ryan	2589	2	L	on rock
<i>Lecanora zosteræ</i> (Ach.) Nyl.	2610	1	L	on old wood; det. by B. McCune
<i>Lecidea atrobrunnea</i> sensu lato	2580, 2702	3, 1	L	on rock
<i>Lecidea</i> sp.	2631	1	L	on wood
<i>Lecidella</i> sp.	2594	1	L	on rock
<i>Lepraria</i> sp.	2613	2	L	on soil; send to J. Lendemer
<i>Leptochidium albociliatum</i> (Desm.) M. Choisy	2670, 2726	2, 2	L	on soil, organic matter
<i>Leptogium lichenoides</i> (L.) Zahlbr.	2604, 2658, 2684, 2747	2, 4, 2, 2	L	on soil, organic matter
<i>Letharia vulpina</i> (L.) Hue	2617, 2664	1, 2	L	on old wood
<i>Massalongia carnosa</i> (Dickson) Körber	2732	1	L	on soil
<i>Megaspora verrucosa</i> (Ach.) Hafellner & V. Wirth	2590, 2630, 2666, 2706, 2728	2, 2, 1, 2, 2	L	on soil; #2666 is mixed with <i>Caloplaca ammiospila</i> (#2667) & <i>Encalypta vulgaris</i> (#2665); #2728 is sterile
<i>Melanohalea infumata</i> (Nyl.) O. Blanco et al.	2585, 2644, 2682	2, 3, 2	L	on rock; #2682 - on soil over rock

Table 1. Species collected in the Coal Mine Basin Area of Critical Environmental Concern with authorities, collection numbers, number of duplicates, life form, and substrate.

Species and Authorities	DeBolt Collection Numbers	No. of Specimens of Each Collection	Lichen (L), Bryophyte (B), Cyanobacteria (C), Other (O)	Substrate Info and Notes
<i>Microcoleus</i> sp.	2671, 2736	2, 1	C	on soil; #2736 mixed with <i>Caloplaca tominii</i>
<i>Peltigera didactyla</i> (With.) J. R. Laundon	2739	2	L	on soil
<i>Peltigera rufescens</i> (Weiss) Humb.	2643, 2723	2, 3	L	on soil
<i>Phaeorrhiza sareptana</i> (Tomlin) H. Mayrhofer & Poelt	2660	2	L	on soil
<i>Physconia perisidiosa</i> (Erichsen) Moberg	2614	1	L	on soil
<i>Placidium lachneum</i> (Ach.) de Lesd.	2592	5	L	on soil
<i>Placidium lacinulatum</i> (Ach.) Breuss	2650, 2681	5, 5	L	on soil
<i>Polyspora</i> sp.	2627	3	L	on rock
<i>Psora montana</i> Timdal	2608, 2655, 2698, 2721	2, 4, 2, 3	L	on soil
<i>Psora tuckermanii</i> R. A. Anderson ex Timdal	2653, 2703, 2727	2, 2, 1	L	on soil
<i>Pterygoneurum ovatum</i> (Hedw.) Dix.	2637, 2672	1, 2	B	on soil
<i>Rhizoplaca chrysoleuca</i> (Sm.) Zopf	2593, 2701	1, 3	L	on rock
<i>Rhizoplaca melanophthalma</i> (Ram.) Leuck. & Poelt	2572, 2588, 2687	2, 8, 2	L	#2572, #2588 - on rock; #2687 - on soil
<i>Rinodina olivaceobrunnea</i> Dodge & Baker	2735	1	L	on organic matter
<i>Rinodina</i> sp.	2673	2	L	on <i>Atriplex</i> twigs
<i>Staurothele aerolata</i> (Ach.) Lettau	2711	2	L	on rock
<i>Staurothele</i> sp.	2581, 2619, 2626	1, 2, 3	L	on rock; #2619 - on petrified wood
<i>Syntrichia caninervis</i> Mitten	2615, 2640	2, 1	B	on soil
<i>Syntrichia ruralis</i> (Hedwig) F. Weber & D. Mohr	2628, 2668, 2697, 2743	1, 2, 3, 2	B	on soil
<i>Thelomma ocellatum</i> (Körber) Tibell	2612	2	L	on old wood
<i>Thrombium epigaeum</i> (Pers.) Wallr.	2718	2	L	on soil
<i>Toninia ruginosa</i> (Tuck.) Herre	2692, 2738	2, 4	L	on soil
<i>Xanthomendoza fulva</i> (Hoffm.) Søchting, Kärnefelt & S. Kondr.	2606, 2708, 2745	1, 2, 2	L	#2606, #2708 - on bark; #2606 is mixed with <i>Candelariella concolor</i> (#2607); #2745 - on soil
<i>Xanthoparmelia neochlorochroa</i> Hale	2601	9	L	on soil; TLC at OSU
<i>Xanthoparmelia norchlorochroa</i> Hale	2693	3	L	on soil; TLC at OSU
<i>Xanthoria elegans</i> (Link) Th. Fr.	2598	1	L	on rock
Undetermined				
Small dark moss	2576	1	B	on soil
Lichenicolous fungus on <i>Lecanora</i>	2591	1	O	on rock
Unknown white crust	2603	1	L	on rock
Life Form Totals			70 L; 9 B; 1 C; 1 O	
GRAND TOTALS		161 specimens	337 packets	81 Species

Table 2. All species by collection site and substrate at Coal Mine Basin Area of Critical Environmental Concern.

"s" = on soil or organic matter; "w" = on wood; "r" = on rock.

Species	Collection Number	Plot 1: Sparsely vegetated gray ash badlands; clay soil	Plot 2: <i>Artemisia arbuscula</i> - <i>Pseudoroegneria spicata</i> site; loamy clay soil	Plot 3: Burned <i>Artemisia cana</i> meadow; heavy clay soil	Plot 4: Sparsely vegetated white ash flat; clay loam soil	Plot 5: <i>Artemisia tridentata wyomingensis</i> - <i>Pseudoroegneria spicata</i> site; silt loam soil	3 Off-plot locations; collection data pooled
<i>Acarospora schleicheri</i>	2719					s	
<i>Acarospora</i> sp.	2616						w
<i>Acarospora</i> sp.	2629	r					
<i>Acarospora fuscata</i>	2573, 2595, 2651, 2710		r		r		r
<i>Amandinea punctata</i>	2724					s	
<i>Arthonia glebosa</i>	2579, 2649, 2725		s			s	s
<i>Aspicilia aspera</i>	2685				s		
<i>Aspicilia desertorum</i>	2582, 2609, 2618, 2695				r		r, w
<i>Aspicilia desertorum</i> f. <i>terrestrials</i>	2577, 2678, 2737				s	s	s
<i>Aspicilia filiformis</i>	2600, 2652, 2705, 2720		s		s	s	s
<i>Aspicilia fruticulosa</i>	2584, 2679				s		s
<i>Aspicilia hispida</i>	2571, 2578, 2632, 2663, 2680, 2749	s	s		s	s	s
<i>Aspicilia mastrucata</i>	2646		s				
<i>Aspicilia reptans</i>	2662		s				
<i>Aspicilia</i> sp. (sterile)	2635	w					
<i>Aspicilia</i> sp.	2661		s				
<i>Athalamia hyalina</i>	2730					s	
<i>Bryum argenteum</i>	2647, 2709, 2744, 2746		s		s	s	
<i>Caloplaca ammiospila</i>	2667		s				

Table 2. All species by collection site and substrate at Coal Mine Basin Area of Critical Environmental Concern.

"s" = on soil or organic matter; "w" = on wood; "r" = on rock.

Species	Collection Number	Plot 1: Sparsely vegetated gray ash badlands; clay soil	Plot 2: <i>Artemisia arbuscula</i> - <i>Pseudoroegneria spicata</i> site; loamy clay soil	Plot 3: Burned <i>Artemisia cana</i> meadow; heavy clay soil	Plot 4: Sparsely vegetated white ash flat; clay loam soil	Plot 5: <i>Artemisia tridentata wyomingensis</i> - <i>Pseudoroegneria spicata</i> site; silt loam soil	3 Off-plot locations; collection data pooled
<i>Caloplaca cerina</i>	2715					s	
<i>Caloplaca epithallina</i>	2597						s
<i>Caloplaca saxicola</i>	2633	s					
<i>Caloplaca tominii</i>	2574, 2690, 2716				s	s	s
<i>Caloplaca</i> sp.	2700				r		
<i>Candelaria concolor</i>	2607						w
<i>Candelariella aggregata</i>	2707, 2717				s	s	
<i>Candelariella rosulans</i>	2575, 2605, 2659, 2688, 2722		s		s	s	s
<i>Candelariella</i> sp.	2611						w
<i>Ceratodon purpureus</i>	2645, 2691, 2740		s		s	s	
<i>Cladonia pocillum</i>	2638, 2669, 2694, 2741	s			s	s	
<i>Cladonia pyxidata</i>	2742					s	
<i>Collema tenax</i>	2639, 2648, 2683, 2729, 2748	s	s		s	s	
<i>Diploschistes muscorum</i>	2731					s	
<i>Encalypta vulgaris</i>	2665, 2734		s			s	
<i>Endocarpon pusillum</i>	2656, 2699, 2733		s		r	s	
<i>Grimmia tenerrima</i>	2583, 2636, 2657, 2704	s	s		s		s
<i>Lecanora flowersiana</i>	2689				s		
<i>Lecanora garovaglii</i>	2686				s		
<i>Lecanora muralis</i>	2586, 2587, 2625, 2634	r, w					s, r

Table 2. All species by collection site and substrate at Coal Mine Basin Area of Critical Environmental Concern.

"s" = on soil or organic matter; "w" = on wood; "r" = on rock.

Species	Collection Number	Plot 1: Sparsely vegetated gray ash badlands; clay soil	Plot 2: <i>Artemisia arbuscula</i> - <i>Pseudoroegneria spicata</i> site; loamy clay soil	Plot 3: Burned <i>Artemisia cana</i> meadow; heavy clay soil	Plot 4: Sparsely vegetated white ash flat; clay loam soil	Plot 5: <i>Artemisia tridentata wyomingensis</i> - <i>Pseudoroegneria spicata</i> site; silt loam soil	3 Off-plot locations; collection data pooled
<i>Lecanora polytropa</i>	2596						s, r
<i>Lecanora pseudomellea</i>	2589						r
<i>Lecanora zosteriae</i>	2610						w
<i>Lecidea atrobrunnea</i> sensu lato	2580, 2702				r		r
<i>Lecidea</i> sp.	2631	w					
<i>Lecidella</i> sp.	2594						s
<i>Lepraria</i> sp.	2613						s
<i>Leptochidium albociliatum</i>	2670, 2726				s	s	
<i>Leptogium lichenoides</i>	2604, 2658, 2684, 2747		s		s	s	s
<i>Letharia vulpina</i>	2617, 2664		w				w
<i>Massalongia carnosa</i>	2732					s	
<i>Megaspora verrucosa</i>	2590, 2630, 2666, 2706, 2728	s	s		s	s	s
<i>Melanohalea infumata</i>	2585, 2644, 2682		r		r (on soil over rock)		r
<i>Microcoleous</i> sp.	2671, 2736		s			s	
<i>Peltigera didactyla</i>	2739					s	
<i>Peltigera rufescens</i>	2643, 2723		s			s	
<i>Phaeorrhiza sareptana</i>	2660		s				
<i>Physconia perisidiosa</i>	2614						s
<i>Placidium lachneum</i>	2592						s
<i>Placidium lacinulatum</i>	2650, 2681		s		s		

Table 2. All species by collection site and substrate at Coal Mine Basin Area of Critical Environmental Concern.

"s" = on soil or organic matter; "w" = on wood; "r" = on rock.

Species	Collection Number	Plot 1: Sparsely vegetated gray ash badlands; clay soil	Plot 2: <i>Artemisia arbuscula</i> - <i>Pseudoroegneria spicata</i> site; loamy clay soil	Plot 3: Burned <i>Artemisia cana</i> meadow; heavy clay soil	Plot 4: Sparsely vegetated white ash flat; clay loam soil	Plot 5: <i>Artemisia tridentata wyomingensis</i> - <i>Pseudoroegneria spicata</i> site; silt loam soil	3 Off-plot locations; collection data pooled
<i>Polyspora</i> sp.	2627	r					
<i>Psora montana</i>	2608, 2655, 2698, 2721		s		s	s	s
<i>Psora tuckermanii</i>	2653, 2703, 2727		s		s	s	
<i>Pterygoneurum ovatum</i>	2637, 2672	s	s				
<i>Rhizoplaca chrysoleuca</i>	2593, 2701				r		r
<i>Rhizoplaca melanophthalma</i>	2572, 2588, 2687				s		r
<i>Rinodina olivaceobrunnea</i>	2735					s	
<i>Rinodina</i> sp.	2673		w				
<i>Staurothele aerolata</i>	2711				r		
<i>Staurothele</i> sp.	2581, 2619, 2626	r					r
<i>Syntrichia caninervis</i>	2615, 2640	s					s
<i>Syntrichia ruralis</i>	2628, 2668, 2697, 2743	s	s		s	s	
<i>Thelomma ocellatum</i>	2612						w
<i>Thrombium epigaeum</i>	2718					s	
<i>Toninia ruginosa</i>	2692, 2738				s	s	
<i>Xanthomendoza fulva</i>	2606, 2708, 2745				w	s	w
<i>Xanthoparmelia neochlorochroa</i>	2601						s
<i>Xanthoparmelia norchlorochroa</i>	2693				s		
<i>Xanthoria elegans</i>	2598						r

Table 2. All species by collection site and substrate at Coal Mine Basin Area of Critical Environmental Concern.

"s" = on soil or organic matter; "w" = on wood; "r" = on rock.

Species	Collection Number	Plot 1: Sparsely vegetated gray ash badlands; clay soil	Plot 2: <i>Artemisia arbuscula</i> - <i>Pseudoroegneria spicata</i> site; loamy clay soil	Plot 3: Burned <i>Artemisia cana</i> meadow; heavy clay soil	Plot 4: Sparsely vegetated white ash flat; clay loam soil	Plot 5: <i>Artemisia tridentata wyomingensis</i> - <i>Pseudoroegneria spicata</i> site; silt loam soil	3 Off-plot locations; collection data pooled
Undetermined							
Small dark moss	2576						s
Lichenicolous fungus on <i>Lecanora</i>	2591						r
Unknown white crust	2603						r
GRAND TOTAL: 81 species		15 species	28 species	0	34 species	33 species	39 species
Lichens		11	21	0	30	28	35
Bryophytes		4	6	0	4	5	3
Other (cyanobacteria, lichenicolous fungus)		0	1	0	0	0	1
Number of species unique to a given plot		5	6	0	6	10	17

Table 3. Biological soil crust (soil-occurring) species by collection site at the Coal Mine Basin Area of Critical Environmental Concern.							
"s" = on soil or organic matter; "w" = on wood; "r" = on rock.							
Species	Collection Number	Plot 1: Sparsely vegetated gray ash badlands; clay soil	Plot 2: <i>Artemisia arbuscula</i> - <i>Pseudoroegneria spicata</i> site; loamy clay soil	Plot 3: Burned <i>Artemisia cana</i> meadow; heavy clay soil	Plot 4: Sparsely vegetated white ash flat; clay loam soil	Plot 5: <i>Artemisia tridentata wyomingensis</i> - <i>Pseudoroegneria spicata</i> site; silt loam soil	3 Off-plot locations; collection data pooled
<i>Acarospora schleicheri</i>	2719					s	
<i>Amandinea punctata</i>	2724					s	
<i>Arthonia glebosa</i>	2579, 2649, 2725		s			s	s
<i>Aspicilia aspera</i>	2685				s		
<i>Aspicilia desertorum</i> f. <i>terrestrialis</i>	2577, 2678, 2737				s	s	s
<i>Aspicilia filiformis</i>	2600, 2652, 2705, 2720		s		s	s	s
<i>Aspicilia fruticulosa</i>	2584, 2679				s		s
<i>Aspicilia hispida</i>	2571, 2578, 2632, 2663, 2680, 2749	s	s		s	s	s
<i>Aspicilia mastrucata</i>	2646		s				
<i>Aspicilia reptans</i>	2662		s				
<i>Aspicilia</i> sp.	2661		s				
<i>Athalamia hyalina</i>	2730					s	
<i>Bryum argenteum</i>	2647, 2709, 2744, 2746		s		s	s	
<i>Caloplaca ammiospila</i>	2667		s				
<i>Caloplaca cerina</i>	2715					s	
<i>Caloplaca saxicola</i>	2633	s					
<i>Caloplaca tominii</i>	2574, 2690, 2716				s	s	s
<i>Candelariella aggregata</i>	2707, 2717				s	s	
<i>Candelariella rosulans</i>	2575, 2605, 2659, 2688, 2722		s		s	s	s
<i>Ceratodon purpureus</i>	2645, 2691, 2740		s		s	s	
<i>Cladonia pocillum</i>	2638, 2669, 2694, 2741	s			s	s	
<i>Cladonia pyxidata</i>	2742					s	

Table 3. Biological soil crust (soil-occurring) species by collection site at the Coal Mine Basin Area of Critical Environmental Concern.							
"s" = on soil or organic matter; "w" = on wood; "r" = on rock.							
Species	Collection Number	Plot 1: Sparsely vegetated gray ash badlands; clay soil	Plot 2: <i>Artemisia arbuscula</i> - <i>Pseudoroegneria spicata</i> site; loamy clay soil	Plot 3: Burned <i>Artemisia cana</i> meadow; heavy clay soil	Plot 4: Sparsely vegetated white ash flat; clay loam soil	Plot 5: <i>Artemisia tridentata wyomingensis</i> - <i>Pseudoroegneria spicata</i> site; silt loam soil	3 Off-plot locations; collection data pooled
<i>Collema tenax</i>	2639, 2648, 2683, 2729, 2748	s	s		s	s	
<i>Diploschistes muscorum</i>	2731					s	
<i>Encalypta vulgaris</i>	2665, 2734		s			s	
<i>Endocarpon pusillum</i>	2656, 2699, 2733		s		r	s	
<i>Grimmia tenerrima</i>	2583, 2636, 2657, 2704	s	s		s		s
<i>Lecanora flowersiana</i>	2689				s		
<i>Lecanora garovaglii</i>	2686				s		
<i>Lecanora muralis</i>	2586, 2587, 2625, 2634	r, w					s, r
<i>Lecanora polytropa</i>	2596						s
<i>Lecidella</i> sp.	2594						s
<i>Lepraria</i> sp.	2613						s
<i>Leptochidium albociliatum</i>	2670, 2726				s	s	
<i>Leptogium lichenoides</i>	2604, 2658, 2684, 2747		s		s	s	s
<i>Massalongia carnosa</i>	2732					s	
<i>Megaspora verrucosa</i>	2590, 2630, 2666, 2706, 2728	s	s		s	s	s
<i>Microcoleous</i> sp.	2671, 2736		s			s	
<i>Peltigera didactyla</i>	2739					s	
<i>Peltigera rufescens</i>	2643, 2723		s			s	
<i>Phaeorrhiza sareptana</i>	2660		s				
<i>Physconia perisidiosa</i>	2614						s
<i>Placidium lachneum</i>	2592						s

Table 3. Biological soil crust (soil-occurring) species by collection site at the Coal Mine Basin Area of Critical Environmental Concern.							
"s" = on soil or organic matter; "w" = on wood; "r" = on rock.							
Species	Collection Number	Plot 1: Sparsely vegetated gray ash badlands; clay soil	Plot 2: <i>Artemisia arbuscula</i> - <i>Pseudoroegneria spicata</i> site; loamy clay soil	Plot 3: Burned <i>Artemisia cana</i> meadow; heavy clay soil	Plot 4: Sparsely vegetated white ash flat; clay loam soil	Plot 5: <i>Artemisia tridentata wyomingensis</i> - <i>Pseudoroegneria spicata</i> site; silt loam soil	3 Off-plot locations; collection data pooled
<i>Placidium lacinulatum</i>	2650, 2681		s		s		
<i>Psora montana</i>	2608, 2655, 2698, 2721		s		s	s	s
<i>Psora tuckermanii</i>	2653, 2703, 2727		s		s	s	
<i>Pterygoneurum ovatum</i>	2637, 2672	s	s				
<i>Rhizoplaca melanophthalma</i>	2572, 2588, 2687				s		r
<i>Rinodina olivaceobrunnea</i>	2735					s	
<i>Syntrichia caninervis</i>	2615, 2640	s					s
<i>Syntrichia ruralis</i>	2628, 2668, 2697, 2743	s	s		s	s	
<i>Thrombium epigaeum</i>	2718					s	
<i>Toninia ruginosa</i>	2692, 2738				s	s	
<i>Xanthoparmelia neochlorochroa</i>	2601						s
<i>Xanthoparmelia norchlorochroa</i>	2693				s		
Undetermined							
Small dark moss	2576						s
Grand Total: 56 species		10 species	25 species	0	26 species	32 species	21 species
Lichens		6	18	0	22	26	18
Bryophytes		4	6	0	4	5	3
Other (cyanobacteria)		0	1	0	0	1	0
Number of species unique to a given plot		1	5	0	4	9	7

Table 6. Relative abundance of lichen and bryophyte species in the Coal Mine Basin Area of Critical Environmental Concern, Malheur County, Oregon.

Species	Collection Number	Lichen (L), Bryophyte (B), Cyanobacteria (C), Other (O)	*Relative Abundance (C = common, I = infrequent, R = rare)
<i>Acarospora schleicheri</i>	2719	L	I
<i>Acarospora</i> sp.	2616	L	I
<i>Acarospora</i> sp.	2629	L	I
<i>Acarospora fuscata</i>	2573, 2595, 2651, 2710	L	C
<i>Amandinea punctata</i>	2724	L	I
<i>Arthonia glebosa</i>	2579, 2649, 2725	L	I
<i>Aspicilia aspera</i>	2685	L	R
<i>Aspicilia desertorum</i>	2582, 2609, 2618, 2695	L	C
<i>Aspicilia desertorum</i> f. <i>terrestrialis</i>	2577, 2678, 2737	L	C
<i>Aspicilia filiformis</i>	2600, 2652, 2705, 2720	L	I
<i>Aspicilia fruticulosa</i>	2584, 2679	L	**R
<i>Aspicilia hispida</i>	2749	L	C
<i>Aspicilia mastrucata</i>	2646	L	I
<i>Aspicilia reptans</i>	2662	L	I
<i>Aspicilia</i> sp. (sterile)	2635	L	R
<i>Aspicilia</i> sp.	2661	L	R
<i>Athalamia hyalina</i>	2730	B	R
<i>Bryum argenteum</i>	2647, 2709, 2744, 2746	B	C
<i>Caloplaca ammiospila</i>	2667	L	I
<i>Caloplaca cerina</i>	2715	L	I
<i>Caloplaca epithallina</i>	2597	L	I
<i>Caloplaca saxicola</i>	2633	L	I
<i>Caloplaca tominii</i>	2574, 2690, 2716	L	C
<i>Caloplaca</i> sp.	2700	L	I
<i>Candelaria concolor</i>	2607	L	C
<i>Candelariella aggregata</i>	2707, 2717	L	C
<i>Candelariella rosulans</i>	2575, 2605, 2659, 2688, 2722	L	C
<i>Candelariella</i> sp.	2611	L	I
<i>Ceratodon purpureus</i>	2645, 2691, 2740	B	C
<i>Cladonia pocillum</i>	2638, 2669, 2694, 2741	L	C
<i>Cladonia pyxidata</i>	2742	L	I
<i>Collema tenax</i>	2639, 2648, 2683, 2729, 2748	L	C
<i>Diploschistes muscorum</i>	2731	L	I
<i>Encalypta vulgaris</i>	2665, 2734	B	C
<i>Endocarpon pusillum</i>	2656, 2699, 2733	L	C
<i>Grimmia tenerrima</i>	2583, 2636, 2657, 2704	B	C
<i>Lecanora flowersiana</i>	2689	L	I
<i>Lecanora garovaglii</i>	2686	L	C
<i>Lecanora muralis</i>	2586, 2587, 2625, 2634	L	C
<i>Lecanora polytropa</i>	2596	L	I
<i>Lecanora pseudomellea</i>	2589	L	I
<i>Lecanora zosteræ</i>	2610	L	I
<i>Lecidea atrobrunnea</i> sensu lato	2580, 2702	L	C
<i>Lecidea</i> sp.	2631	L	I
<i>Lecidella</i> sp.	2594	L	I
<i>Lepraria</i> sp.	2613	L	I

Table 6. Relative abundance of lichen and bryophyte species in the Coal Mine Basin Area of Critical Environmental Concern, Malheur County, Oregon.

Species	Collection Number	Lichen (L), Bryophyte (B), Cyanobacteria (C), Other (O)	*Relative Abundance (C = common, I = infrequent, R = rare)
<i>Leptochidium albociliatum</i>	2670, 2726	L	C
<i>Leptogium lichenoides</i>	2604, 2658, 2684, 2747	L	C
<i>Letharia vulpina</i>	2617, 2664	L	I
<i>Massalonia carnosa</i>	2732	L	R
<i>Megaspora verrucosa</i>	2590, 2630, 2666, 2706, 2728	L	C
<i>Melanohalea infumata</i>	2585, 2644, 2682	L	C
<i>Microcoleus</i> sp.	2671, 2736	C	C
<i>Peltigera didactyla</i>	2739	L	R
<i>Peltigera rufescens</i>	2643, 2723	L	I
<i>Phaeorrhiza sareptana</i>	2660	L	R
<i>Physconia perisidiosa</i>	2614	L	I
<i>Placidium lachneum</i>	2592	L	I
<i>Placidium lacinulatum</i>	2650, 2681	L	C
<i>Polyspora</i> sp.	2627	L	C
<i>Psora montana</i>	2608, 2655, 2698, 2721	L	C
<i>Psora tuckermanii</i>	2653, 2703, 2727	L	C
<i>Pterygoneurum ovatum</i>	2637, 2672	B	C
<i>Rhizoplaca chrysoleuca</i>	2593, 2701	L	C
<i>Rhizoplaca melanophthalma</i>	2572, 2588, 2687	L	C
<i>Rinodina olivaceobrunnea</i>	2735	L	R
<i>Rinodina</i> sp.	2673	L	I
<i>Staurothele aerolata</i>	2711	L	C
<i>Staurothele</i> sp.	2581, 2619, 2626	L	C
<i>Syntrichia caninervis</i>	2615, 2640	B	C
<i>Syntrichia ruralis</i>	2628, 2668, 2697, 2743	B	C
<i>Thelomma ocellatum</i>	2612	L	C
<i>Thrombium epigaeum</i>	2718	L	I
<i>Toninia ruginosa</i>	2692, 2738	L	C
<i>Xanthomendoza fulva</i>	2606, 2708, 2745	L	C
<i>Xanthoparmelia neochlorochroa</i>	2601	L	**R
<i>Xanthoparmelia norchlorochroa</i>	2693	L	**R
<i>Xanthoria elegans</i>	2598	L	C
Undetermined			
Small dark moss	2576	B	R
Lichenicolous fungus on <i>Lecanora</i>	2591	O	R
Unknown white crust	2603	L	R

* an "R" doesn't necessarily imply that the species is rare in Oregon, though several of the taxa are in fact rare throughout their range. Those species are indicated by **.

Figure 1. Number of lower plant taxa (lichens, bryophytes, cyanobacteria) on all substrates in the 5 plots and pooled off-plot locations (see Table 2).

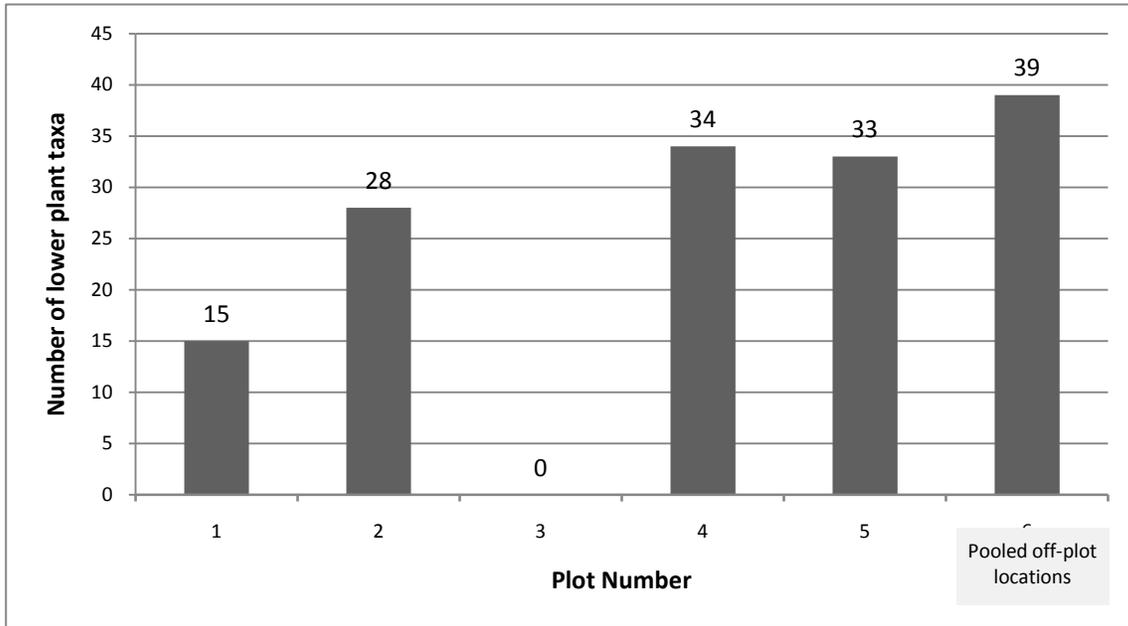


Figure 2. Number of lower plant taxa (lichens, bryophytes, cyanobacteria) unique to each plot and the pooled off-plot locations (ie. not collected elsewhere in the study area) (see Table 2).

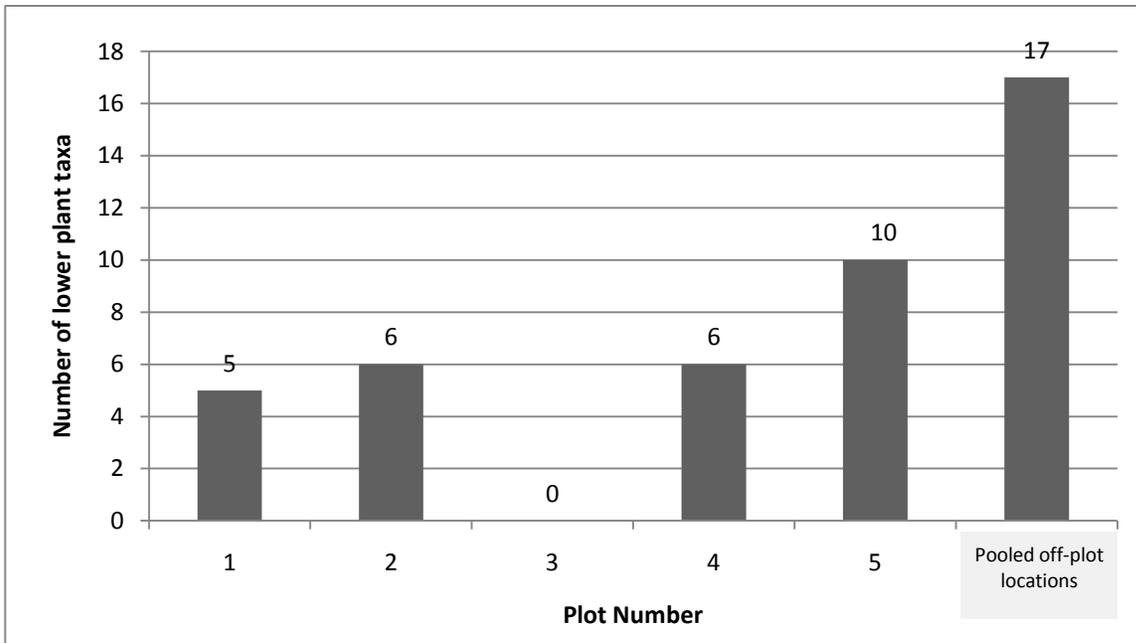


Figure 3. Number of biological soil crust taxa (rock- and wood-occurring species excluded) in each of the 5 plots and in the pooled off-plot locations (see Table 3).

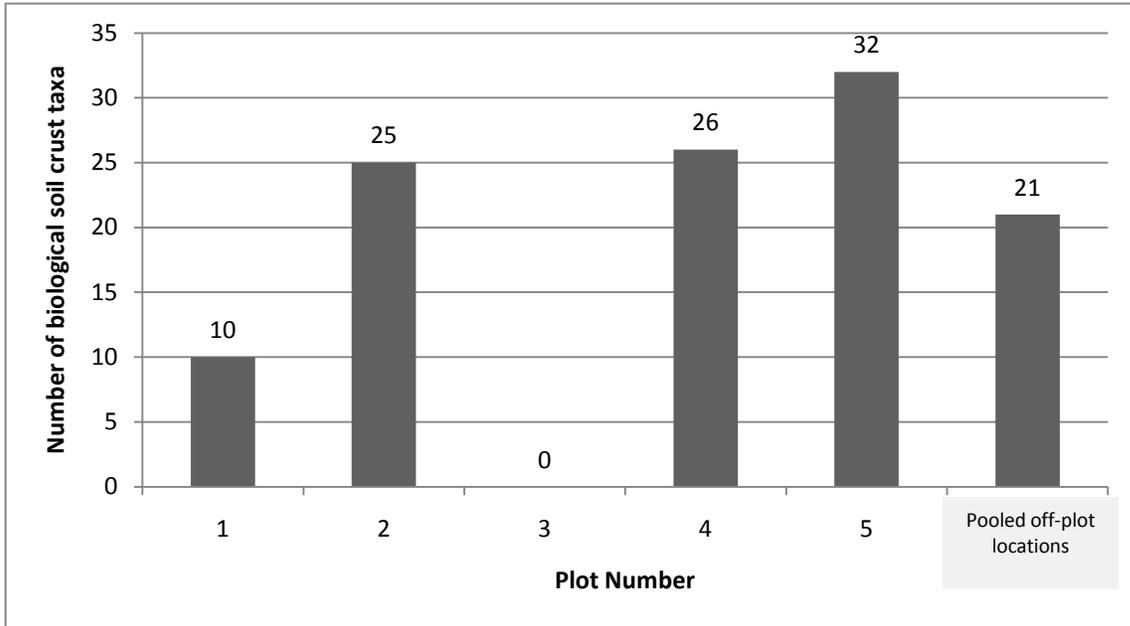


Figure 4. Number of biological soil crust taxa unique to the 5 plots and the pooled off-plot locations (ie. not collected elsewhere in the study area) (see Table 3).

