Biological Soil Crust Survey - Rome Cliffs Area, T31S, R41E, Sec. 32, Malheur County, Oregon

Prepared for the
Bureau of Land Management
Oregon State Office
January 28, 2010

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Introduction

The Rome Cliffs Area and associated zeolite deposits are located in the vicinity of Rome, Oregon, approximately 130 km (as the crow flies) southwest of the town of Vale. Neogene and Quaternary volcanic and sedimentary rocks are the primary outcroppings in this area (Sheppard 1987). The zeolites and associated minerals occur in a sequence of alluvial and lacustrine volcaniclastic rocks known informally as the Rome beds (Sheppard 1987). The beds are nearly 100 m thick and consist of an alluvial and lacustrine sequence of conglomerate, mudstone, sandstone, tuff, and minor limestone and chert (Sheppard 1987). The rocks of the Rome beds are primarily volcanic except for minor limestone, chert, and mudstone. It is largely because of this area's unique and varied geology and soils that botanists have been interested in its flora for many years, as the soils support at least six, and possibly more, edaphic endemic and other uncommon vascular plant species.

Although relatively distant from large population centers, the unique geology and accessibility of this area (near a major highway, moderate topography, 2-track roads traverse the site) lends itself to the potential for unmanageable off-road vehicle activity. It is important to determine resource values under current conditions, since it is expected that planning documents will be needed for this area in the not too distant future.

As mentioned above, vascular plant surveys have turned up several uncommon taxa in the Rome area, specifically at Sec. 32, Township 31S, Range 41E. According to local botanists, additional inventories are still needed in this area (Don Mansfield, College of Idaho, personal communication, 2009). For the lower plants, including lichens and bryophytes, surveys in this or other regions of eastern Oregon have been limited. In 1984, Mayfield and Kjelmyr identified 14 bryophyte and 7 lichen taxa from the Boardman Research Natural Area in north-central Oregon. 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 the nine sites, the closest one to Rome is nearly 180 km to the west. DeBolt (2008) identified 47 biological soil crust taxa during an inventory of the Birch Creek area, 50 km northeast of Rome. Prior to the 2008 inventory, systematic surveys for these organisms in this part of the state are not believed to exist.

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 cryptobiotic crusts, biotic crusts, microbiotic crusts, 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 can be difficult to return to the lab intact and suitable for species determination. However, the ecological importance of these organisms in nutrient

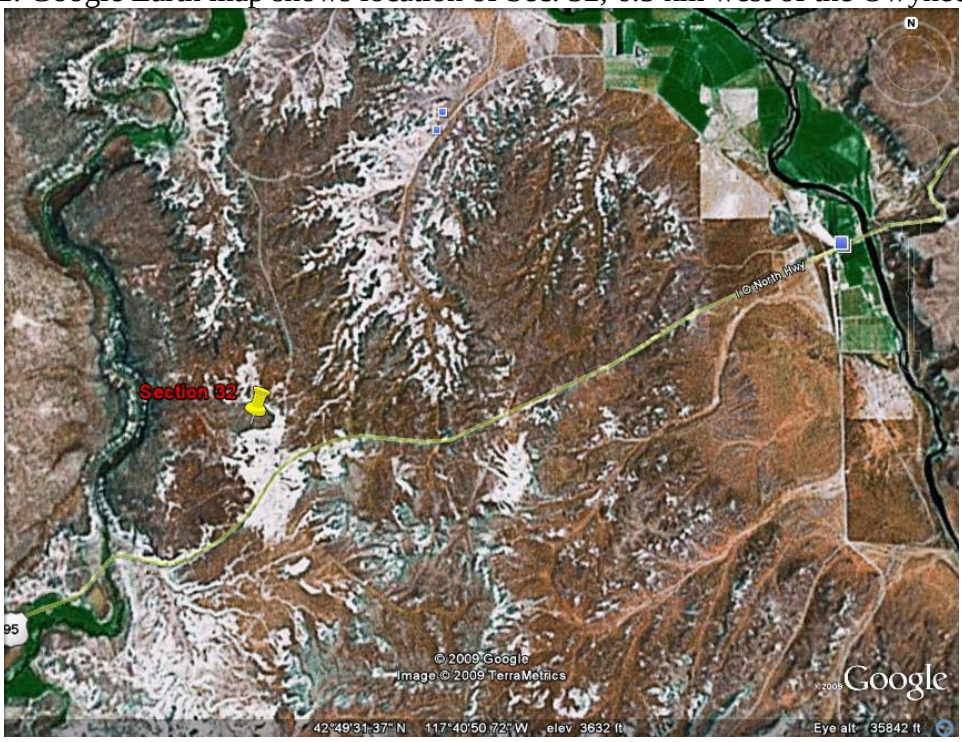
cycling, moisture storage, and soil stabilization has been well documented (Belnap et al. 2001, Hilty et al. 2004, Ponzetti et al. 2007, Rosentreter et al. 2007, Serpe et al. 2007), and will not be discussed further in this report.

At the request of the Bureau of Land Management, this project was divided into two parts. Part 1 included the field inventory of Sec. 32 west of Rome, Oregon 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 1 has been completed and delivered to the BLM. Part 2 consists of the preparation and printing of this report, which consolidates and summarizes all field findings and photographs. It is hoped that these products will be useful to the Bureau during the preparation of future planning documents, and in furtherance of our knowledge of an important but poorly known component of the ecosystem.

Methods

Soil-occurring lichens and bryophytes were collected in June 2009 at the Sec. 32 portion of the Rome (sometimes referred to as the Rome Cliffs) area. This area is located at T31S, R41E, 85 km SW of Jordan Valley, OR, and about 225 km southwest of Boise, Idaho (actual highway km). The area is accessed via Highway #95. More specifically, after crossing the Owyhee River at Rome, OR, continue 6.5 additional kilometers before turning north onto a wide dirt road (Fig. 1). This dirt road slices through the eastern portion of Section 32, from north to south, providing excellent access to the study area.

Figure 1. Google Earth map shows location of Sec. 32, 6.5 km west of the Owyhee River.



To be as objective as possible in assessing 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 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), each different species encountered within a site was carefully collected and numbered. Only soil-occurring species were sampled (wood- and rock-occurring species were collected very sparingly). Each sample was gently wrapped in tissue and placed in a small paper bag. Small bags were then grouped into one large paper bag or box per plot once sampling was completed. Other data recorded at each site included the GPS coordinates, elevation, aspect, slope, and associated vascular plant species. Soil samples were taken for subsequent texture and pH testing.

This relatively small area (640 acres) of limited topographic relief is fairly homogeneous in terms of vascular plant diversity, yet at least six uncommon to rare plant species are known to occur here or in adjacent sections, most likely due to unique edaphic factors. These species and their state and Bureau global rarity status are as follows:

- *Astragalus alvordensis* M.E. Jones (Alvord milk-vetch); G4, S4, List 4
- *Chaenactis cusickii* A. Gray (Cusick's chaenactis); G3, S3, List 4
- *Chaetadelpha wheeleri* A. Gray ex S. Watson (Wheeler's skeleton-weed); G4, S2, List 2, Bureau Sensitive
- *Eatonella nivea* (D.C. Eaton) A. Gray (White eatonella); this former Bureau sensitive plant species occurs in an adjacent section of land
- *Lomatium foeniculaceum* (Nutt.) J.M. Coult. & Rose ssp. *fimbriatum* W.L. Theobald) (Fringed desert-parsley); G5T2T4, S1, List 2, Bureau Sensitive
- *Lomatium ravenii* Mathias & Constance (Raven's lomatium); G4, S1, List 2, Bureau Sensitive

Only four representative vegetation types were selected for sampling, although further exploration of the site would probably increase this sample size. The four sites are described as follows, with dominants listed in order of prevalence (from most dominant to less dominant):

Plot 1: alkaline, clay-silt soil of swale area (pH 8) with no detectable aspect, dominated by *Atriplex nuttallii* S. Watson, *Grayia spinosa* (Hook.) Moq., *Elymus elymoides* (Raf.) Swezey, *Poa secunda* J. Presl.; where burned on south edge of plot, dominated by *Halogeton glomeratus* (M. Bieb.) C.A. Mey. and *Lepidium perfoliatum* L., with few biological soil crusts.

Plot 2: clay soil (pH 7), from flat to 35% slope with a northerly aspect; mostly barren of vasculars but when present, dominated by *Atriplex confertifolia* (Torr. & Frém.) S. Watson, *Elymus elymoides, Poa secunda, Tetradymia spinosa* Hook. & Arn., *Atriplex argentea* Nutt., and *Guiterrezia sarothrae* (Pursh) Britton & Rusby.

Plot 3: fine, sandy-silt soil (pH 7) with cobble surface, flat to slight SW aspect on top of ridge; dominated by *Tetradymia glabrata, Artemisia tridentata* Nutt. ssp. *wyomingensis* Beetle & Young, *Elymus elymoides, Phlox* sp., and *Bromus tectorum* L.

Plot 4: sandy-silt soil (pH 7) of flat area that partially burned a few years ago; dominated by *Bromus tectorum, Halogeton glomeratus, Elymus elymoides, Atriplex confertifolia, Ceratocephala testiculata* (Crantz) Roth (= *Ranunculus testiculatus*), *Sphaeralcea munroana* (Douglas) Spach, and *Salsola tragus* L.

Biological soil crust 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). Soil pH and texture were analyzed in the lab using standard techniques.

Results and Discussion

Among the 94 herbarium specimens prepared for Part 1 of this project (see Appendix A. Collection Notebook), **forty-two lichen, bryophyte, and cyanobacteria taxa were identified**, along with one unknown fungus on a rabbit pellet. Among the 42 taxa, there are 34 lichens (32 on soil, 1 on wood, 1 on pebbles), 6 bryophytes (mosses and liverworts – all on soil), and 2 cyanobacteria (on soil) (Table 1, Fig. 2). The total number of taxa will increase slightly once species are determined by experts, as several collections were identified only to genus (see Appendix A).

Interesting records from the Rome area include the lichen *Lecidea laboriosa* Müll. Arg. This is apparently the first report of this species for Oregon, although its verification is still pending. *Lecidea laboriosa* is typically found on calcareous rock and sandy soil in the southwest U.S., plus a few sites on the Snake River Plain in Idaho (McCune and Rosentreter 2007). It was collected in Plots #1 (#2381) and #2 (#2424), both slightly more diverse than the two other study plots (Table 2, Fig. 2).

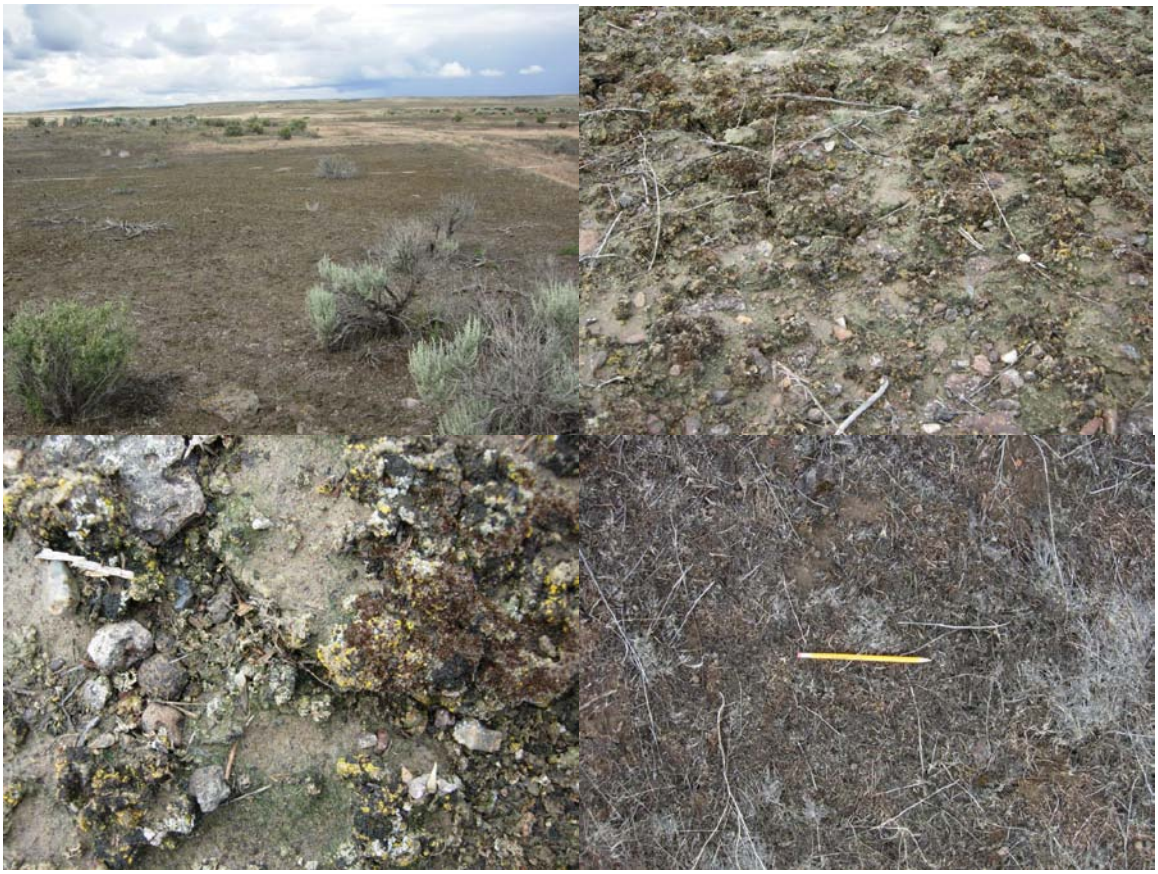
Another possible first report for Oregon is *Heteroplacidium congestum* (Breuss & McCune) Breuss (formerly *Catapyrenium congestum* Breuss & McCune). This brown-colored lichen is uncommon in *Artemisia* and *Atriplex* steppe, often on saline soils (McCune and Rosentreter 2007). It is known from southern Idaho, Utah, and Colorado. *Heteroplacidium congestum* was collected once in Plot #1 (#2395) and several times in Plot #3 (#2424), where it occurred quite abundantly. These two specimens are also pending verification from experts in Europe.

Of the four study plots, Plot #2 supported the most unique taxa, with nine lichen and one cyanobacteria not found elsewhere (Table 2, Fig. 3). Biological soil crust taxa found only in this plot include the lichens *Aspicilia contorta* (Hoffm.) Kremp., *Acarospora fuscata* (Schrad.) Arnold, *A. glaucocarpa* (Ach.) Körber, *Lecanora garovaglii* (Körber) Zahlbr., *L. laatokkaensis* (Räsänen) Poelt, *Megaspora verrucosa* (Ach.) Hafellner & V. Wirth, *Rhizoplaca melanophthalma* (DC.) Leuckert & Poelt, *Staurothele areolata* (Ach.) Lettau, an unknown yellow crustose species, and the cyanobacteria *Nostoc.* This site is characterized by clay soil with a northerly aspect, the greatest slope ranges, from flat to 35%, and it is the most visually distinctive, with multi-colored soils of extensive microtopography and very sparse vascular plant cover (see photos below). *Tetradymia spinosa, Atriplex argentea,* and *Guiterrezia sarothrae* were vascular plant dominants recorded only in Plot #2.

Plot #2 photos illustrate its topographic relief, soil color variation, and sparse vascular plant cover.

The saxicolous lichen, *Rhizoplaca melanophthalma,* was collected on both rock and soil in Plot #2. While the soil-occurring growth form has been observed elsewhere, it is relatively uncommon. Some lichenologists consider the two growth forms as separate subspecies. In Plot #2, *R. melanophthalma* on soil was nearly fruticose, giving it an even more atypical appearance. Other normally saxicolous species growing on the clay soil in this plot included *Acarospora glaucocarpa, A. fuscata, Aspicilia desertorum* (Krempelh.) Mereschk., *Lecanora garovaglii, L. laatokkaensis, Protoparmelia badia* (Hoffm.) Hafellner, and *Staurothele areolata*. Unfortunately, Plot #2, with its combination of sparse vascular plants and relatively steep hillside topography, may be one of the more inviting areas to off-highway vehicle users. Its unique soil crust flora would certainly be impacted by this type of use.

Generally speaking, Plot #1 was not nearly as visually distinctive as Plot #2, though the biological soil crust cover was extensive, except where burned. Four taxa were unique to this plot – two lichens, including one species yet to be determined plus *Placidium rufescens* (Ach.) Breuss, and two bryophytes - *Crossidium aberrans* Holz. & E.B. Bartram and *Grimmia alpestris* (Weber & Mohr) Schleicher (also see Table 2). Plot #1 was the most alkaline, with a pH of 8 (all others were pH 7), clay-silt soil, and the only area occupied by *Atriplex nuttallii*.



Plot #1 photos illustrate the high biological soil crust cover of what superficially looks like barren ground within this swale zone. In the bottom right photo, biological soil crusts are reduced by fire and the increased litter of exotic annuals.

Megaspora verrucosa, a rather widespread species in the western U.S., grows from desert to alpine regions, typically on organic matter over the soil. It is most often found in calcareous habitats. In the Rome area, *Megaspora verrucosa* was collected only in Plot #2. Lichens on soil are good indicators of soil pH, or free calcium carbonates (McCune and Rosentreter 2007). Other Rome area taxa indicative of calcareous soils include *Acarospora glaucocarpa*, *Aspicilia hispida* Mereschk., *Caloplaca tominii Savicz*, *Collema tenax* (Sw.) Ach., *Psora cerebriformis* W.A. Weber, *P. decipiens* (Hedwig) Hoffm., and *P. tuckermanii* R. Anderson ex Timdal, or at least 19% of this area's soil crust flora (Table 3).

Table 3. Calcareous indicator species by plot.

Plot #1	**Plot #2**	**Plot #3**	**Plot #4**
Aspicilia hispida *Caloplaca tominii* *Collema tenax* *Psora decipiens* *Psora tuckermanii*	*Acarospora glaucocarpa* *Caloplaca tominii* *Collema tenax* *Megaspora verrucosa*	*Caloplaca tominii* *Collema tenax* *Psora cerebriformis*	*Caloplaca tominii* *Collema tenax* *Psora decipiens* *Psora tuckermanii*

Biological soil crust taxa unique to Plot #3 include the three lichens, *Candelariella rosulans* (Müll. Arg.) Zahlbr, *Placidium lachneum* (Ach.) Breuss, and *Psora cerebriformis* (Table 2, Fig. 3). Of these, *P. lachneum* probably has the most limited distribution. Plot #3's flat ridgetop area with fine, sandy-silt soil and a cobble surface was dominated by vascular plants including *Tetradymia glabrata, Artemisia tridentata* ssp. *wyomingensis, Elymus elymoides,* and an unidentified *Phlox*. *Tetradymia glabrata* and *Phlox* sp. were not detected in other plots. A total of twenty biological soil crust taxa were collected in Plot #3 (15 lichens, 3 bryophytes, 2 cyanobacteria) (Table 1, Fig. 2). Among the four study plots, this vegetation type is probably the most common in southeast Oregon.

Plot #3 photos illustrate the cobble soil surface, which supported 20 biological soil crust taxa.

No taxa were unique to Plot #4 (Table 2, Fig. 3). This site partially burned several years ago and is currently dominated by exotics including *Bromus tectorum, Halogeton glomeratus, Ceratocephala testiculata* (*Ranunculus testiculatus*), with scattered remnant native perennials such as *Elymus elymoides, Atriplex confertifolia,* and *Sphaeralcea munroana*. In spite of habitat degradation, it is still somewhat remarkable that **14 biological soil crust taxa were collected in this disturbed plot**, including three of the six bryophytes (Table 1). Remnant biological soil crust taxa are often indicators of low intensity burns (Rosentreter 2001). Slickspots, of which there are several within this plot, also serve as refugia from fire for biological soil crust taxa

Plot #4 photos illustrate dominance by exotic annuals after the area partially burned several years ago. Native perennials and biological soil crust taxa continue to persist, suggesting a low intensity burn. Slickspot areas also serve as refugia from fire for biological soil crust taxa.

Taxa collected in the general area of Sec. 32 but not from a specific study plot were *Thelomma occidentale* (Herre) Tibell and *Aspicilia desertorum* f. *contorta*. Both were on non-soil substrates. *Thelomma occidentale* was growing on pieces of old wooden fenceposts, while the *contorta* form of *A. desertorum* encompassed many of the small pebbles. While neither species was on soil, it helps demonstrate substrate specificity of many lichen and bryophyte taxa.

Bryophyte (both moss and liverwort) diversity in the Rome area was 50% lower than Birch Creek, where twelve bryophyte species were observed (DeBolt 2008) (Fig. 4). Birch Creek bryophyte taxa missing from the Rome area included *Brachythecium collinum* (Schleich. ex Müll. Hal.) Schimp., *Cephaloziella byssacea* (Roth) Warnst., *Ceratodon purpureus* (Hedw.) Brid., *Coscinodon calyptratus* (Hook.) C.E.O. Jensen ex Kindb., and *Homalothecium aeneum* (Mitt.) E. Lawton. This is likely because of the more open and gentle topography of Rome (specifically Sec. 32) versus the canyon environment of Birch Creek, with its tremendous topographic diversity and abundance of shaded, sheltered sites.

Additional soil-occurring species would probably be found if more time were spent in the Rome area, as its unique microhabitats and soil outcrops appear endless. However, the information gained during this project, in combination with the 2008 Birch Creek inventory, begin to give us a snapshot of biological soil crust diversity in southeast Oregon.

Conclusion

During the 2009 survey of biological soil crust diversity in the Rome, Oregon area, at least 42 taxa were identified from a 640 acre parcel of public land (T31S, R41E, Sec. 32). Among the 42 taxa, 34 lichens, 6 bryophytes, and 2 cyanobacteria were collected. Two species (*Lecidea laboriosa, Heroplacidium congestum*) are believed to be

new records for Oregon. Verification of both taxa is still pending, as is the identification of several other specimens.

The soil types and dominant vegetation differed considerably among the four study plots, reflected to some extent by the biological soil crust flora. Plots supported between 14 and 25 taxa. Of the 25 taxa collected in Plot #2, ten were unique to this site. This plot is possibly the most vulnerable to off-highway activity, as it has relatively steep slopes largely devoid of shrubs, and would appeal to those wishing to "hill climb" with recreational vehicles. This study helps illustrate that while some may see this landscape as barren, its diversity is remarkable if time is taken to look more closely.

Acknowledgements

I would like to thank Gillian Wigglesworth, Vale District BLM botanist, for proposing the project and providing direction and support, and Kelli VanNorman, Oregon State Office - BLM, for funding. Dr. Bruce McCune graciously identified several specimens, and Drs. Othmar Breuss, John Badina, and Bjorn Owe-Larsson have kindly agreed to examine several others. Roger Rosentreter, local soil crust expert, provided invaluable assistance and recommendations, both in the field and beyond.

References

Belnap, J., R. Rosentreter, S. Leonard, J.H. Kaltenecker, J. Williams, and D. Eldridge. 2001. Biological soil crusts: ecology and management. U.S. Department of Interior, Bureau of Land Management, Technical Reference 1730-2, Denver, CO. 118 pages.

Brodo, I.M., S.D. Sharnoff, and S. Sharnoff. 2001. Lichens of North America. Yale University Press, New Haven and London. 795 pages.

DeBolt, A. 2008. Biological soil crust survey of the Birch Creek area, Malheur County, Oregon. Prepared for the Oregon State Office, Bureau of Land Management. 11 pages, plus Appendices.

Hilty, J.H., D.J. Eldridge, R. Rosentreter, M.C. Wicklow-Howard, and M. Pellant. 2004. Recovery of biological soil crusts following wildfire on the Snake River Plain, Idaho, U.S.A. Journal of Range Management. 57:89-96.

Mayfield, M.M. and J. Kjelmyr. 1984. Boardman Research Natural Area, Supplement No. 17. In: Franklin, Jerry F.; Hall, Fredrick C.; Dyrness, C. T.; Maser, Chris. 1972. Portland, OR: US Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. Federal Research Natural Areas in Oregon and Washington: A guidebook for scientists and educators.

McCune, B. and R. Rosentreter. 2007. Biotic soil crust lichens of the Columbia Basin. Monographs in North American Lichenology 1:1-105. Northwest Lichenologists, Corvallis, OR.

McCune, B., J. Dey, J. Peck, D. Cassell, K. Heiman, S. Will-Wolf & P. Neitlich. 1997. Repeatability of community data: species richness versus gradient scores in large-scale lichen studies. The Bryologist 100: 40-46.

Ponzetti, J. and B.P. McCune. 2001. Biotic soil crusts of Oregon's shrub steppe: community composition in relation to soil chemistry, climate, and livestock activity. The Bryologist 104(2):212-225.

Ponzetti, J., B. McCune, and D.A. Pyke. 2007. Biotic soil crusts in relation to topography, cheatgrass and fire in the Columbia Basin, Washington. The Bryologist 110(4):706-722.

Rosentreter, R. and J. Belnap. 2001. Biological soil crusts of North America. In: Belnap and Lange (eds): Ecological Studies, Vol. 150, Biological Soil Crusts: Structure, Function, and Management.

Rosentreter, R., M. Bowker, and J. Belnap. 2007. A field guide to biological soil crusts of western U.S. drylands. U.S. Government Printing Office, Denver, CO. 103 pages.

Serpe, M., J. M. Orm, T. Barkes and R. Rosentreter. 2004. Germination and seed water status of four grasses on moss-dominated biological soil crusts from arid lands. Plant Ecology. Vol. 185:163-178.

Sheppard, R.A. 1987. Field trip guide to the Sheaville and rome zeolite deposits, southeastern Oregon. Oregon Geology Vol. 49, No. 1:3-10.

Appendices, Tables, Figures, and Attachments

1. **Appendix A.**
   This portion of the document is the collection notebook for Part 1 of the study. It includes label and species data for each site. DeBolt collection numbers range from 2380 to 2485. **It is also included in the body of this document.**

2. **Table 1.** Alphabetical list of taxa collected in the Rome Area.
   This is an Excel spreadsheet. It is an alphabetical list of the species with their respective collection number(s), the number of specimens for each collection, life form (ie. bryophyte or lichen), and notes. **This table is in a separate electronic file.**

3. **Table 2.** Alphabetical list of taxa by collection site in the Rome Area.
   This is an Excel spreadsheet. It is an alphabetical list of species by ecological site. **This table is in a separate electronic file.**

4. **Table 3.** Calcareous indicator species by plot. **This is a Word table within the body of this document.**

5. **Figure 1.** Google Earth map shows location of Sec. 32, 6.5 km west of the Owyhee River. **It is within the body of this Word document.**

6. **Figure 2.** Total number of biological soil crust taxa collected in each of the four plots. This is an Excel graph of the number of taxa found in the different plots. **It is in a separate electronic file.**

7. **Figure 3.** The number of biological soil crust taxa unique to each of the four plots. This is an Excel graph. **It is in a separate electronic file.**

8. **Figure 4.** Pie charts illustrate the number of taxa per life form at Rome (2009) and Birch Creek (2008). This includes two separate pie charts. **It is in a separate electronic file.**

9. **Digital Photographs.** All photos have been copied onto a separate CD.

10. **PDF file.** All files (report plus tables and figures) are incorporated into one document.

APPENDIX A.

Collection Notebook, Rome Cliffs Area, T31S, R41E, Sec. 32, Malheur County, Oregon

PLOT #1:
Alkaline, clay-silt soil of swale area (pH 8) with no detectable aspect. Approx. 6.5 km SW of Rome, OR and the Owyhee River, and 85 km SW of Jordan Valley, OR. *Atriplex nuttallii, Grayia spinosa, Elymus elymoides, Poa secunda* site. Where burned, largely dominated by *Halogeton glomeratus* and *Lepidium perfoliatum*.
N 42° 494' W 117° 424' 1122 m (3679 feet elevation) 14 June 2009

2380 *Psora decipiens* (Hedwig) Hoffm.
2381 *Lecidea laboriosa* Müll. Arg. (new for Oregon)
2382 *Collema tenax* (Sw.) Ach. (fertile)
2383 *Candelariella aggregata* M. Westb. (K- ; on organic matter)
2384 *Placidium rufescens* (Ach.) Breuss
2385 *Psora tuckermanii* R. Anderson ex Timdal
2386 *Placidium rufescens* (Ach.) Breuss
2387 *Placidium lacinulatum* (Ach.) Breuss (fertile)
2388 *Crossidium aberrans* Holz. & E.B. Bartram
2389 *Syntrichia caninervis* Mitten
2390 *Pterygoneurum ovatum* (Hedw.) Dix
2391 *Thrombium epigaeum* (Pers.) Wallr. (1 spec. kept for BSU)
2392 *Aspicilia* sp. (K-) (1 spec. kept for further evaluation)
2393 *Collema tenax* (Sw.) Ach. (on soil)
2394 *Endocarpon pusillum* Hedw. (on organic matter)
2395 *Heteroplacidium congestum* (Breuss & McCune) Breuss
(Syn.: *Catapyrenium congestum*) **(1 spec. sent to Othmar Breuss for verification)**
2396 *Syntrichia ruralis* (Hedw.) Web. & Mohr
2397 *Collema tenax* (Sw.) Ach. (young thalli)
2398 *Caloplaca tominii* Savicz (K+ red)
2399 *Aspicilia desertorum* (Krempelh.) Mereschk. form *terrestris* (K-)
2400 *Grimmia alpestris* (Weber & Mohr) Schleicher (on soil over rock)
2401 *Aspicilia hispida* Mereschk. (on soil)
2402 *Microcoleous* sp. (cyanobacteria)
2403 ? (black crust that turns green when wet) (1 spec. kept for further eval.)
2405 xxxxx
2406 xxxxx

xxxxx = blank numbers

PLOT #2:

Clay soil (pH 7). N aspect, from flat to 35% slope. Approx. 6.5 km SW of Rome, OR and the Owyhee River, and 85 km SW of Jordan Valley, OR. Associated vegetation: *Atriplex confertifolia, Elymus elymoides, Poa secunda, Tetradymia spinosa,* annual *Atriplex,* and *Guiterrezia sarothrae*.

N 42° 492' W 117° 421' 1131 m (3709 feet elevation) 14 June 2009

2407 *Rhizoplaca melanophthalma* (DC.) Leuckert & Poelt (on soil)
(several specimens kept for BSU since this is unusual; will probably send some off)
2408 *Rhizoplaca melanophthalma* (DC.) Leuckert & Poelt (on rock)
2409 *Lecanora garovaglii* (Körber) Zahlbr. (on rock; K-, KC-) Ver. B. McCune
2410 *Staurothele aerolata* (Ach.) Lettau
2411 xxxxx
2412 *Lecanora garovaglii* (Körber) Zahlbr. (on rock) (1 spec. kept for BSU)
2413 *Aspicilia aspera* (Mereschk.) Tomin. (very adnate) (1 spec. kept for BSU)
2414 *Collema tenax* (Sw.) Ach.
2415 *Protoparmelia badia* (Hoffm.) Hafellner (blk apothecia, olive green thallus, disc/thallus K-) (1 spec. kept for BSU)
2416 *Aspicilia desertorum* (Krempelh.) Mereschk. (on rock)
2417 ? (yellow crustose lichen; mixed with *Aspicilia desertorum* and *Staurothele*); (**spec. sent to B. McCune for further evaluation**)
2418 *Staurothele areolata* (Ach.) Lettau
2419 *Bryum argenteum* Hedw. (synonym: *Bryum lanatum)* (very small with long awns)
2420 Fungi on rabbit pellets (1 spec. kept for further evaluation)
2421 *Aspicilia desertorum* (Krempelh.) Mereschk. form *terrestris*
2422 *Synthrichia ruralis* (Hedw.) Web. & Mohr
2423 *Endocarpon pusillum* Hedwig
2424 *Lecidea laboriosa* Müll. Arg. (on soil, K-, spores simple, 8/asci, hyline) (new for Oregon; 1 spec. kept for BSU)
2425 *Caloplaca tominii* Savicz
2426 *Aspicilia* sp. (small apothecia) (1 spec. kept for further evaluation)
2427 *Acarospora fuscata*-like (on pebbles) (1 spec. kept for further evaluation)
2428 *Bryum argenteum* Hedw. (synonym: *Bryum lanatum)*
2429 *Nostoc* sp. (mixed with moss)
2430 *Acarospora fuscata*-like (but on soil) (1 spec. kept for further evaluation)
2431 *Placidium* sp. (small thallus; **1 spec. sent to Othmar Breuss**)
2432 *Microcoleous* sp. (cyanobacteria)
2433 *Megaspora verrucosa* (Ach.) Hafellner & V. Wirth
2434 *Syntrichia caninervis* Mitten **(1 spec. sent to John Badina)**
2435 *Acarospora glaucocarpa* (Ach.) Körber (det. by B. McCune, 7/09)
2436 *Aspicilia contorta* (Hoffm.) Kremp. (on pebbles)
#2435 and #2436 are together in the same packet
2437 *Lecanora laatokkaensis* (Räsänen) Poelt (small thalli on rock)
2438 xxxxx
2439 xxxxx
2440 xxxxx

PLOT #3:

Fine, sandy-silt soil (pH 7) with cobble on surface. Slight SW aspect on top of hills. Approx. 6.5 km SW of Rome, OR and the Owyhee River, and 85 km SW of Jordan Valley, OR. Associated vegetation: *Tetradymia glabrata, Artemisia tridentata* ssp. *wyomingensis, Elymus elymoides, Phlox* sp., and *Bromus tectorum*.
N 42° 491' W 117° 424' 1146 m (3756 feet elevation) 15 June 2009

2441 *Thrombium epigaeum* (Pers.) Wallr.
2442 *Aspicilia aspera* (Mereschk.) Tomin. (poor specimen)
(1 spec. kept for further evaluation)
2443 *Collema tenax* (Sw.) Ach.
2444 *Candelariella aggregata* M. Westb.
2445 *Syntrichia ruralis* (Hedw.) Web. & Mohr
2446 *Placidium* sp. **(1 spec. sent to Othmar Breuss)**
2447 *Caloplaca tominii* Savicz (K+ red)
2448 *Aspicilia desertorum* (Krempelh.) Mereschk. form *terrestris*
2449 *Microcoleous* sp. (cyanobacteria)
2450 *Heteroplacidium congestum* (Breuss & McCune) Breuss
(1 spec. sent to Othmar Breuss)
2451 *Syntrichia caninervis* Mitten
2452 *Aspicilia desertorum* (Krempelh.) Mereschk. (on pebbles)
2453 *Endocarpon pusillum* Hedwig
2454 *Placidium lachneum* (Ach.) Breuss
2455 *Placidium lacinulatum* (Ach.) Breuss
2456 *Psora cerebriformis* W.A. Weber
2457 *Bryum argenteum* Hedw. (synonym: *Bryum lanatum)*
2458 *Candelariella rosulans* (Müll. Arg.) Zahlbr. (K-)
2459 *Psora montana* Timdal
2460 *Aspicilia* sp. (on organic matter)
2461 xxxxx
2462 xxxxx
2463 xxxxx

PLOT #4:

Sandy-silt soil (pH 7). Flat area that partially burned at least a few years ago. Approx. 6.5 km SW of Rome, OR and the Owyhee River, and 85 km SW of Jordan Valley, OR. Associated vegetation: *Bromus tectorum, Halogeton glomeratus, Elymus elymoides, Atriplex confertifolia, Sphaeralcea munroana, Ranunculus testiculatus, Salsola* sp.
N 42° 492' W 117° 423' 1128 m (3699 feet elevation) 15 June 2009

2464 *Aspicilia desertorum* (Krempelh.) Mereschk. (on pebbles)
2465 *Collema tenax* (Sw.) Ach.
2466 *Pterygoneurum ovatum* (Hedw.) Dix.
2467 *Placidium lacinulatum* (Ach.) Breuss
2468 *Psora tuckermanii* R. Anderson ex Timdal
2469 *Psora decipiens* (Hedwig) Hoffm.
2470 *Bryum argenteum* Hedw. (synonym: *Bryum lanatum)*
2471 *Syntrichia ruralis* (Hedw.) Web. & Mohr
2472 *Aspicilia desertorum* (Krempelh.) Mereschk. form *terrestris*
(1 spec. kept for further evaluation)
2473 *Protoparmelia badia* (Hoffm.) Hafellner (on soil, but usually on rock)
2474 *Psora montana* Timdal
2475 *Microcoleous* sp. (cyanobacteria)
2476 *Caloplaca tominii* Savicz
2477 *Candelariella aggregata* M. Westb.
2478 xxxx
2479 xxxx

COLLECTIONS FROM GENERAL AREA BUT NOT FROM A SPECIFIC PLOT

On various substrates. Approx. 6.5 km SW of Rome, OR and the Owyhee River, and 85 km SW of Jordan Valley, OR. Associated vegetation: *Bromus tectorum, Halogeton glomeratus, Elymus elymoides, Atriplex confertifolia, Sphaeralcea munroana, Salsola* sp.
N 42° 493' W 117° 42' 1120 m (3675 feet elevation) 15 June 2009

2480 *Aspicilia desertorum* (Kremp.) Mereschk. form *contorta* (in edit)
(completely encompassing small pebbles) **(1 spec. kept to send to Bjorn Owe-Larsson)**
2481 *Aspicilia hispida* Mereschk. (on soil)
2482 *Thelomma occidentale* (Herre) Tibell (on wood)
2483 *Microcoleous* sp. (cyanobacteria; within the soil)
2484 *Psora tuckermanii* R. Anderson ex Timdal (on soil)
2485 *Aspicilia desertorum* (Kremp.) Mereschk. (on rock)
(small apothecia, more adnate, whiter thallus) **(1 spec. sent to Bjorn Owe-Larsson)**

Table 1. Alphabetical List of Taxa Collected in the Rome Area, Sec. 32 (T31S, R41E)

Species	Collection Number	Number of Specimens for Each Collection Number	Lichen (L), Bryophyte (B), Other	Notes
Aspicilia aspera (Mereschk.) Tomin	2413, 2442	4; 2	L	1 spec. each of #2413, #2442 to BSU
Aspicilia contorta (Hoffm.) Kremp.	2436	1	L	in same packet as #2435 - *Acarospora glaucocarpa*
Aspicilia desertorum (Krempelh.) Mereschk.	2416, 2452, 2464, 2485	1; 2; 2; 1	L	#2485 to B. Owe-Larsson for verification
Aspicilia desertorum (Kremp.) Mereschk. f. *contorta*	2480	4	L	in edit; encompasses small pebbles; 1 spec. to B. Owe-Larsson for verification
Aspicilia desertorum (Krempelh.) Mereschk. f. *terrestris*	2399, 2421, 2448, 2472	4; 2; 3; 5	L	1 spec. #2472 to BSU
Acarospora fuscata (Schrad.) Arnold (?)	2427, 2430	1; 1	L	both specimens kept in Boise for further evaluation
Acarospora glaucocarpa (Ach.) Körber	2435	1	L	det. by B. McCune; in same packet as #2436 - *Aspicilia contorta*
Aspicilia hispida Mereschk.	2401, 2481	1; 1	L	
Aspicilia sp.	2392, 2426, 2460	3; 1; 1	L	1 spec. each of #2392, 2426 kept in Boise for further evaluation
Bryum argenteum Hedw.	2419, 2428, 2457, 2470	1; 1; 2; 1	B	syn: *B. lanatum*
Caloplaca tominii Savicz	2398, 2425, 2447, 2476	4; 3; 2; 1	L	
Candelariella aggregata M. Westb.	2383, 2444, 2477	4; 1; 2	L	
Candelariella rosulans (Müll. Arg.) Zahlbr	2458	1	L	
Collema tenax (Sw.) Ach.	2382, 2393, 2397, 2414, 2443, 2465	2; 2; 1; 3; 5; 5	L	
Crossidium aberrans Holz. & E.B. Bartram	2388	2	B	
Endocarpon pusillum Hedw.	2394, 2423, 2453	1; 3; 3	L	
Grimmia alpestris (Weber & Mohr) Schleicher	2400	2	B	
Heteroplacidium congestum (Breuss & McCune) Breuss	2395, 2450	3; 5	L	1 spec. each of #2395, #2450 to O. Breuss for verification
Lecanora garovaglii (Körber) Zahlbr.	2409, 2412	1; 5	L	1 spec. #2412 to BSU
Lecanora laatokkaensis (Räsänen) Poelt	2437	1	L	
Lecidea laboriosa Müll. Arg.	2381, 2424	1; 1	L	new for OR; 1 spec. #2424 to BSU
Megaspora verrucosa (Ach.) Hafellner & V. Wirth	2433	2	L	
Microcoleous sp.	2402, 2432, 2449, 2475, 2483	3; 2; 3; 1; 4	O	cyanobacteria
Nostoc sp.	2429	1	O	cyanobacteria
Placidium lachneum (Ach.) Breuss	2454	2	L	
Placidium lacinulatum (Ach.) Breuss	2387, 2455, 2467	2; 3; 5	L	

Table 1. Alphabetical List of Taxa Collected in the Rome Area, Sec. 32 (T31S, R41E)

Species	Collection Number	Number of Specimens for Each Collection Number	Lichen (L), Bryophyte (B), Other	Notes
Placidium rufescens (Ach.) Breuss	2384, 2386	2; 2	L	
Placidium sp.	2431, 2446	3; 1	L	1 spec. of #2431, #2446 to O. Breuss for determination
Protoparmelia badia (Hoffm.) Hafellner	2415, 2473	2; 1	L	1 spec. #2415 to BSU
Psora cerebriformis W.A. Weber	2456	1	L	
Psora decipiens (Hedwig) Hoffm.	2380, 2469	1; 1	L	
Psora montana Timdal	2459, 2474	2; 3	L	
Psora tuckermanii R. Anderson ex Timdal	2385, 2468, 2484	2; 2; 2	L	
Pterygoneurum ovatum (Hedw.) Dix	2390, 2466	3; 1	B	
Rhizoplaca melanophthalma (DC.) Leuckert & Poelt	2407, 2408	9; 1	L	#2407on soil, an uncommon substrate; 5 spec. retained in Boise for further evaluation; #2408 is on rock
Staurothele areolata (Ach.) Lettau	2410, 2418	1; 1	L	
Syntrichia caninervis Mitten	2389, 2434, 2451	3; 3; 2	B	1 spec. of #2434 to J. Badina for verification
Syntrichia ruralis (Hedw.) Web. & Mohr	2396, 2422, 2445, 2471	2; 1; 3; 2	B	
Thelomma occidentale (Herre) Tibell	2482	1	L	on wood
Thrombium epigaeum (Pers.) Wallr.	2391, 2441	2; 2	L	1 spec. #2391 to BSU
Unknown; black crust turns green when wet	2403	1	L?	spec. retained in Boise for further evaluation
Unknown; yellow crustose lichen	2417	1	L	spec. sent to B. McCune for further evaluation
Unknown; fungus on rabbit pellets	2420	1	O	spec. retained in Boise for further evaluation
* specimens given to BSU are housed in the Biology Department Herbarium				

Table 2. Alphabetical List of Taxa by Collection Site, Rome Area, Malheur County, OR (T31S, R41E, Sec. 32)

An "x" indicates which species were collected at each site. Highlighted cells indicate species unique to a given plot.

Species	Collection Number	Plot 1 - alkaline, clay-silt soil of swale area; *Atriplex nuttallii, Grayia spinosa, Elymus elymoides, Poa secunda*	Plot 2 - clay soil from flat to 35% slope with northerly aspect; *Atriplex confertifolia, Elymus elymoides, Poa secunda, Tetradymia spinosa,* annual *Atriplex, Guiterrezia sarothrae*	Plot 3 - fine, sandy-silt soil with cobble surface and slight SW aspect on top of hills; *Tetradymia glabrata, Artemisia tridentata* ssp. *wyomingensis, Elymus elymoides* , *Phlox* sp., and *Bromus tectorum*	Plot 4 - sandy-silt soil of flat area, partially burned a few years ago; *Bromus tectorum, Halogeton glomeratus, Elymus elymoides, Atriplex confertifolia, Ranunculus testiculatus, Sphaeralcea munroana,* and *Salsola* sp.	From general area; not within a particular plot
Aspicilia aspera (Mereschk.) Tomin	2413, 2442		x	x		
Aspicilia contorta (Hoffm.) Kremp.	2436		x			
Aspicilia desertorum (Krempelh.) Mereschk.	2416, 2452, 2464, 2485		x	x	x	x
Aspicilia desertorum (Kremp.) Mereschk. f. *contorta*	2480					x
Aspicilia desertorum (Krempelh.) Mereschk. f. *terrestris*	2399, 2421, 2448, 2472	x	x	x	x	
Acarospora fuscata (Schrad.) Arnold (?)	2427, 2430		x			
Acarospora glaucocarpa (Ach.) Körber	2435		x			
Aspicilia hispida Mereschk.	2401, 2481	x				x
Aspicilia sp.	2392, 2426, 2460	x	x	x		
Bryum argenteum Hedw.	2419, 2428, 2457, 2470		x	x	x	
Caloplaca tominii Savicz	2398, 2425, 2447, 2476	x	x	x	x	
Candelariella aggregata M. Westb.	2383, 2444, 2477	x		x	x	
Candelariella rosulans (Müll. Arg.) Zahlbr	2458			x		
Collema tenax (Sw.) Ach.	2382, 2393, 2397, 2414, 2443, 2465	x	x	x	x	
Crossidium aberrans Holz. & E.B. Bartram	2388	x				
Endocarpon pusillum Hedw.	2394, 2423, 2453	x	x	x		
Grimmia alpestris (Weber & Mohr) Schleicher	2400	x				
Heteroplacidium congestum (Breuss & McCune) Breuss	2395, 2450	x		x		
Lecanora garovaglii (Körber) Zahlbr.	2409, 2412		x			
Lecanora laatokkaensis (Räsänen) Poelt	2437		x			
Lecidea laboriosa Müll. Arg.	2381, 2424	x	x			

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An "x" indicates which species were collected at each site. Highlighted cells indicate species unique to a given plot.

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Megaspora verrucosa (Ach.) Hafellner & V. Wirth	2433		x			
Microcoleous sp.	2402, 2432, 2449, 2475, 2483	x	x	x	x	x
Nostoc sp.	2429		x			
Placidium lachneum (Ach.) Breuss	2454			x		
Placidium lacinulatum (Ach.) Breuss	2387, 2455, 2467	x		x	x	
Placidium rufescens (Ach.) Breuss	2384, 2386	x				
Placidium sp.	2431, 2446		x	x		
Protoparmelia badia (Hoffm.) Hafellner	2415, 2473		x		x	
Psora cerebriformis W.A. Weber	2456			x		
Psora decipiens (Hedwig) Hoffm.	2380, 2469	x			x	
Psora montana Timdal	2459, 2474			x	x	
Psora tuckermanii R. Anderson ex Timdal	2385, 2468, 2484	x			x	x
Pterygoneurum ovatum (Hedw.) Dix	2390, 2466	x			x	
Rhizoplaca melanophthalma (DC.) Leuckert & Poelt	2407, 2408		x			
Staurothele areolata (Ach.) Lettau	2410, 2418		x			
Syntrichia caninervis Mitten	2389, 2434, 2451	x	x	x		
Syntrichia ruralis (Hedw.) Web. & Mohr	2396, 2422, 2445, 2471	x	x	x	x	
Thelomma occidentale (Herre) Tibell	2482					x
Thrombium epigaeum (Pers.) Wallr.	2391, 2441	x		x		
Unknown; black crust turns green when wet	2403	x				
Unknown; yellow crustose lichen	2417		x			
Unknown; fungus on rabbit pellets	2420		x			
TOTALS		**21**	**25**	**20**	**14**	**6**

Figure 2. Total number of biological soil crust taxa collected in each of the four plots.

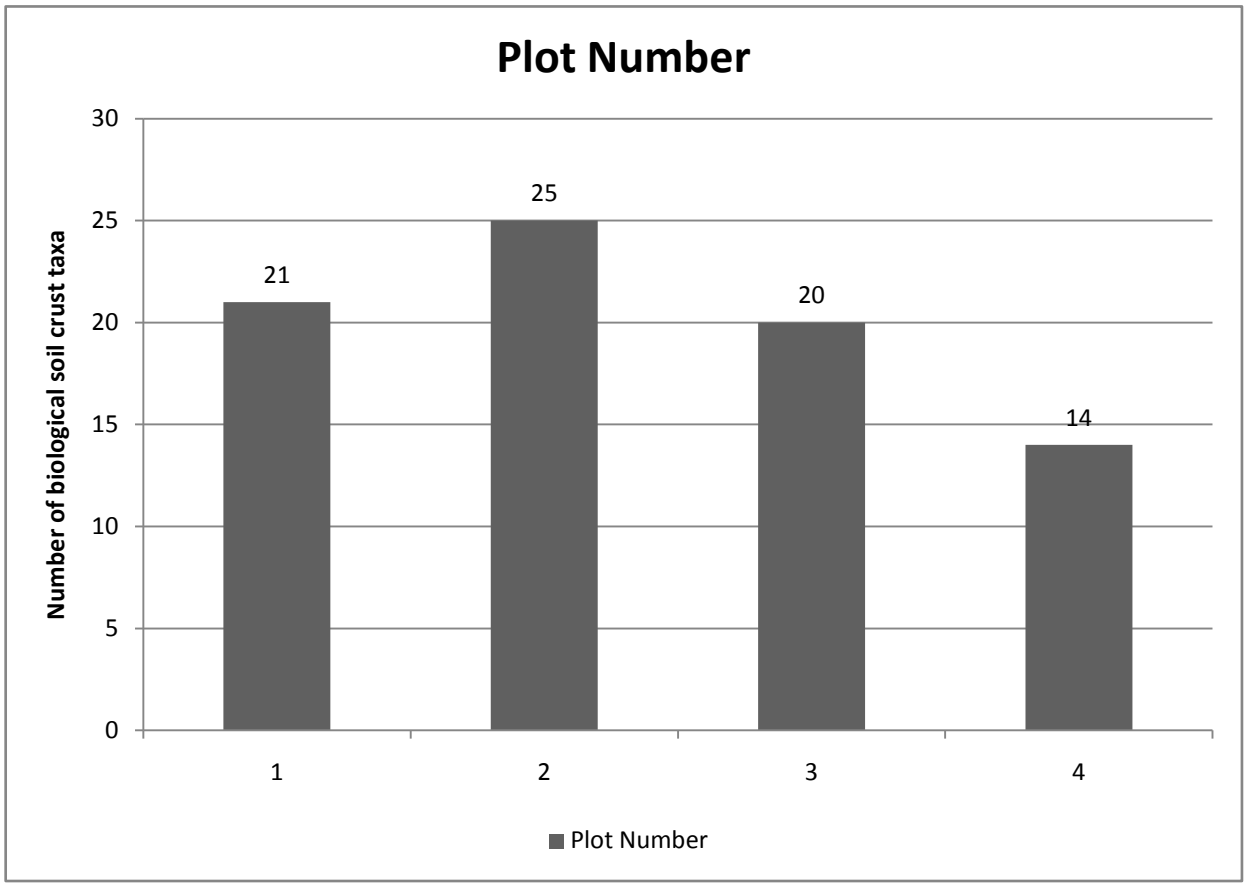


Figure 3. The number of biological soil crust taxa unique to each of the four plots.

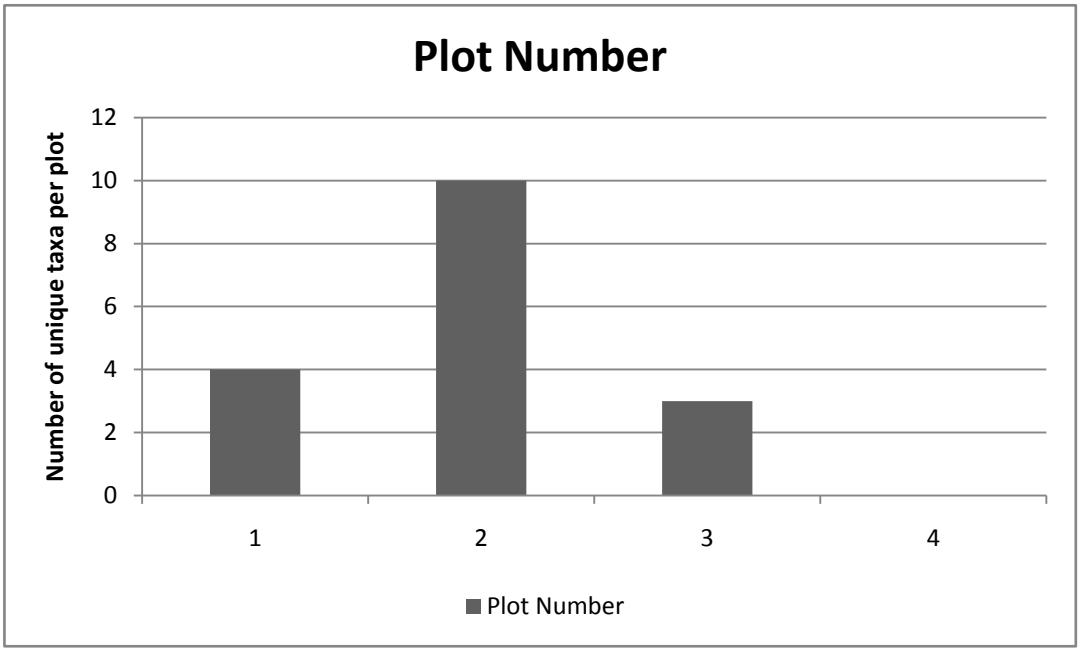
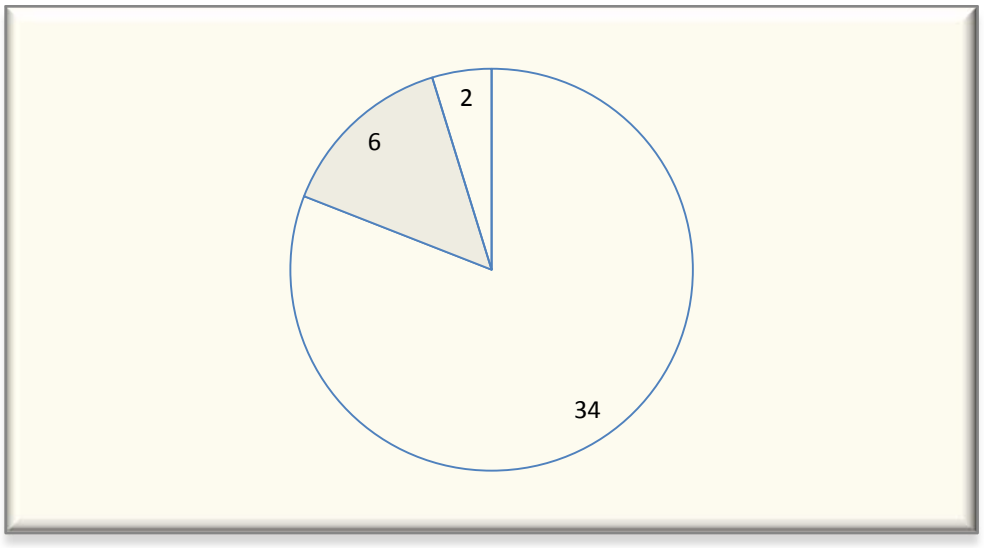


Figure 4. Pie charts illustrate the number of taxa per life form at Rome (2009) and Birch Creek (DeBolt 2008)

2009 Rome Area

Lichens	Bryophytes	Cyanobacteria
34	6	2
81%	14%	5%



2008 Birch Creek Area

Lichens	Bryophytes	Cyanobacteria
34	12	1
72%	26%	2%