MPG Ranch Lichen Survey

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Image 1. Split peg lichen (A, *Cladonia cariosa*) grows with dog/felt lichen and other cup lichens near the summit of Mt. Baldy.

Introduction

Lichens are symbioses between fungi and photosynthetic green algae or cyanobacteria. Distinct lichen species consist of two cell types from two dissimilar organisms. The algae convert air and sunlight into food and live just below the lichen surface in a tangle of fungal hyphae. These well-orchestrated symbioses result in approximately 17,000 species where moisture, light, and suitable surfaces exist. Lichens live in every non-oceanic ecosystem on the planet. They peek into open niches and burgeon in pinholes of opportunity. They creep over rock, nestle between mosses, and thrive on soil. Lichens add ecological intricacy to the landscape.

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Ecological role and background

Lichens are vital organisms in ecological systems. They serve as forage for small mammals, ungulates, and invertebrates. They build soil and colonize bare surfaces.

Cyanolichens fix nitrogen and add it to the soil. Dog/felt lichens (*Peltigera* spp.) are common cyanolichens. Some birds use lichens as nesting materials. Humans have used lichens for dyes and as a food source (McCune 2009).

Image 2 and 3. Common freckle pelt (*Peltigera aphthosa*) is a cyanolichen that fixes nitrogen. Wet lichens often have a different appearance due to moistened algae.

Lichens can be a valuable source of food for ungulates, especially during winter months when other forage is unavailable. A lichen forage study of deer and elk in western Montana revealed that enclosed areas had higher lichen biomass than browsed areas (Ward and Marcum, 2005). These ungulates favored tree-hair lichen (*Bryoria fremontii*) and tufted foxtail lichen (*Nodobryoria abbreviata*). Both species are common forest macrolichens in western Montana and can be essential components of wildlife diets. A study of ungulate browse in Maine showed that up to 30% of winter forage was lichen biomass (Ditchkoff and Serviello 1998).

Image 4. Horsehair lichen (*Bryoria spp.*) is potential browse for ungulates.

Lichens can indicate air quality, show signs of stress or damage from air pollutants, and be extirpated by poor air conditions. Air pollutants can be quantified by chemical analysis of moist lichens that continuously accumulate the substances from the air. Common pollutants studied with macrolichens include nitrogen compounds (NO, NO3, and NH3), sulfur compounds (SO2), fluorine, certain metals, and volatile compounds.

Image 5. Dog/felt lichens (*Peltigera* spp.) are sensitive to excess nitrogen.

Lichens have different sensitivity levels to pollutants. Camouflage lichen (*Melanohalea* spp.), rosette lichen (*Physcia* spp.), and sunburst lichen (*Xanthoria* spp.) thrive in elevated levels of nitrogen. High abundances of these species can be an indicator of excess nitrogen (McCune 2009). At MPG, nitrogen sensitive genera such as beard lichen (*Usnea* spp.), horsehair lichen (*Bryoria* spp.), and dog/felt lichen (*Peltigera* spp.) occur in high abundance. This suggests that excess nitrogen is not a problem at MPG.

Image 6. Camouflage lichens, such as elegant camouflage lichen (*Melanohalea elegantula*), thrive in high nitrogen areas.

Image 7. Beard lichens, including powdered beard lichen (*Usnea lapponica),* are sensitive to excess nitrogen.

Lichens contain a variety of novel secondary chemical compounds. Humans use these secondary compounds in dyes and medicine. As with plants, useful medicinal compounds continue to be discovered in lichens. Some lichens are used as popular herbal medicine, such as rock-shield (*Xanthoparmelia*). Although there is no scientific basis for rock-shield correcting sexual dysfunction, compounds isolated from rock-shield are active against human tumor cells (Moerman, 2003). Wolf lichen (*Letharia vulpina*) is a common lichen found at MPG on the bark and branches of exposed conifers and some shrubs. People use it to dye natural and synthetic fibers. Its fluorescent color is due to vulpinic acid, which is toxic to humans and animals. The name "wolf lichen" is due to a historic practice of poisoning wolves. The lethal dose for an average dog is about 10 fist-sized thalli (McCune, personal communication). Most lichen compounds are not poisonous.

Image 8. Rock-shield (*Xanthoparmelia* spp.) is used as a herbal remedy for sexual dysfunction.

Image 9. Wolf lichen (*Letharia vulpina*) and brown-eyed wolf lichen (*Letharia columbiana*) contain the poisonous dye vulpinic acid.

Tumbleweed shield lichen (*Xanthoparmelia chlorochroa*) is another lichen with potentially poisonous substances. It killed hundreds of elk in the winter of 2004 at a wildlife refuge in Wyoming. Feeding captive elk the lichen reproduced the toxicity, confirming the lichen as the cause of death. Dailey (2008) studied the compounds in this species and found that usnic acid was not the poisoning agent. The exact secondary chemical is still unknown. Tumbleweed shield lichen is locally abundant in pockets of shrubland dominated by sagebrush at MPG.

Image 10. Tumbleweed shield lichen (*Xanthoparmelia chlorochroa*) is potentially toxic to ungulates.

Chemicals can be used for lichen identification. This involves testing the lichen with solutions that indicate the presence of species-specific compounds. The most commonly used reagents for spot tests are bleach (C test), potassium hydroxide (K test), and p-phenylenediamine (P test). They produce a color change when added to a lichen. Some species such as dog lichens (*Peltigera* ssp.) do not contain any secondary compounds, and morphological characteristics alone must be used for identification.

Image 11. Color change with reagents can determine species.

Image 12 and 13. Peltigera species do not contain secondary compounds, so morphology alone must be used for identification. The round, flat apothecia are characteristic of fan lichen (*Peltigera venosa*, above). Lobe size, tomentum, and rhizines distinguish dog-lichen (*Peltigera canina,* below).

Macrolichens at MPG Ranch

Land managers often overlook lichens in favor of more charismatic organisms. Many public land agencies do not have resources allocated to lichen conservation and research. At MPG, we collect and identify lichens as a first step in their research. We target macrolichens first due to the ease of identification. During the 2012 field season, we sampled lichens at Bird Point Count grid locations and other places visited during fieldwork. We identified lichens with dichotomous keys from "Macrolichens of the Pacific Northwest" (McCune, 2009) and "Lichens of North America" (Brodo, 2001). We catalogued and processed the collections for herbarium specimens.

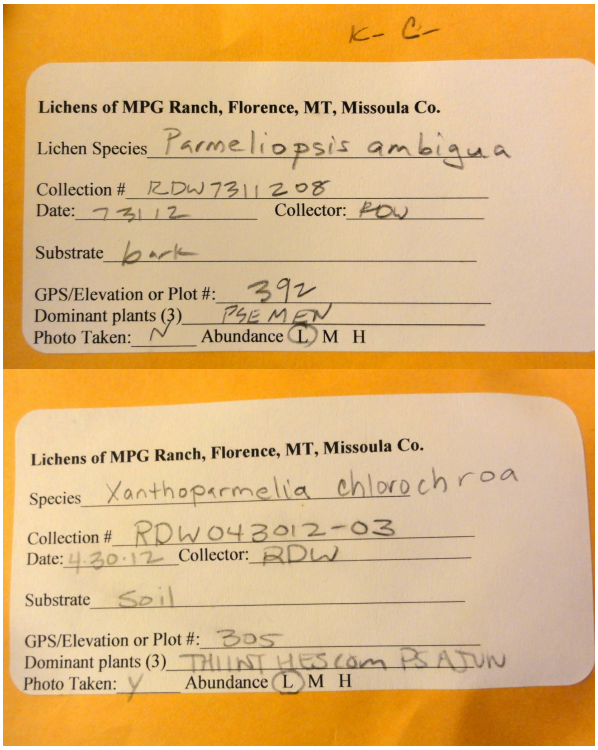


Image 14. Species identified are catalogued and kept as herbarium specimens.

Some lichens exist in many climate types and have circumboreal distribution. Other lichens live in distinct geographical ranges due to climatic tolerances and requirements. MPG Ranch consists of the Western Montane Element and Western Temperate Element distribution types. It provides a variety of general habitats for lichens like dry and moist forests, grasslands/shrublands, and scree/rock. Ponderosa pine, Douglas-fir, and southern exposures dominate dry forest types. Moist forest types have a higher density of trees, higher humidity, and north facing slopes. They usually have greater moss cover and a more complex understory than dry forest. Subalpine fir, larch, and spruce are common trees in moist forest types. Sagebrush dominates old shrublands that contain a high density of lichens. Grasslands and areas of low vegetation cover offer habitat for soil-colonizing lichens. Grassland and converted grassland comprise a large portion of available lichen habitat. Rock and scree also exist across MPG. Large areas of scree are interspersed among dry and moist forest types. Rock outcrops and boulders are present throughout the grassland and shrubland. Images 15-23 depict some of these communities and where they can be found on the ranch.

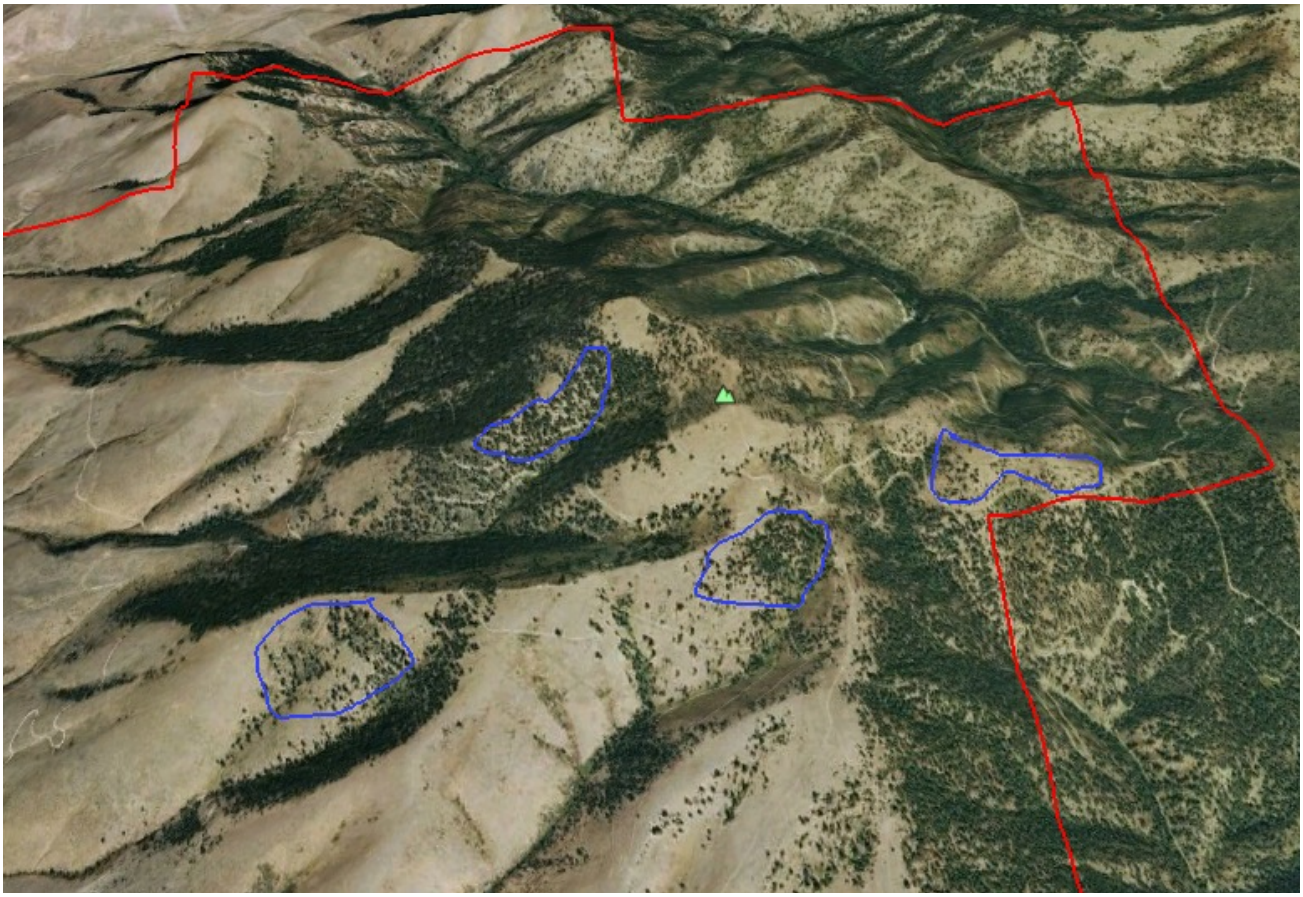


Image 15 and 16. Dry forests have sparse tree cover and southern exposures.

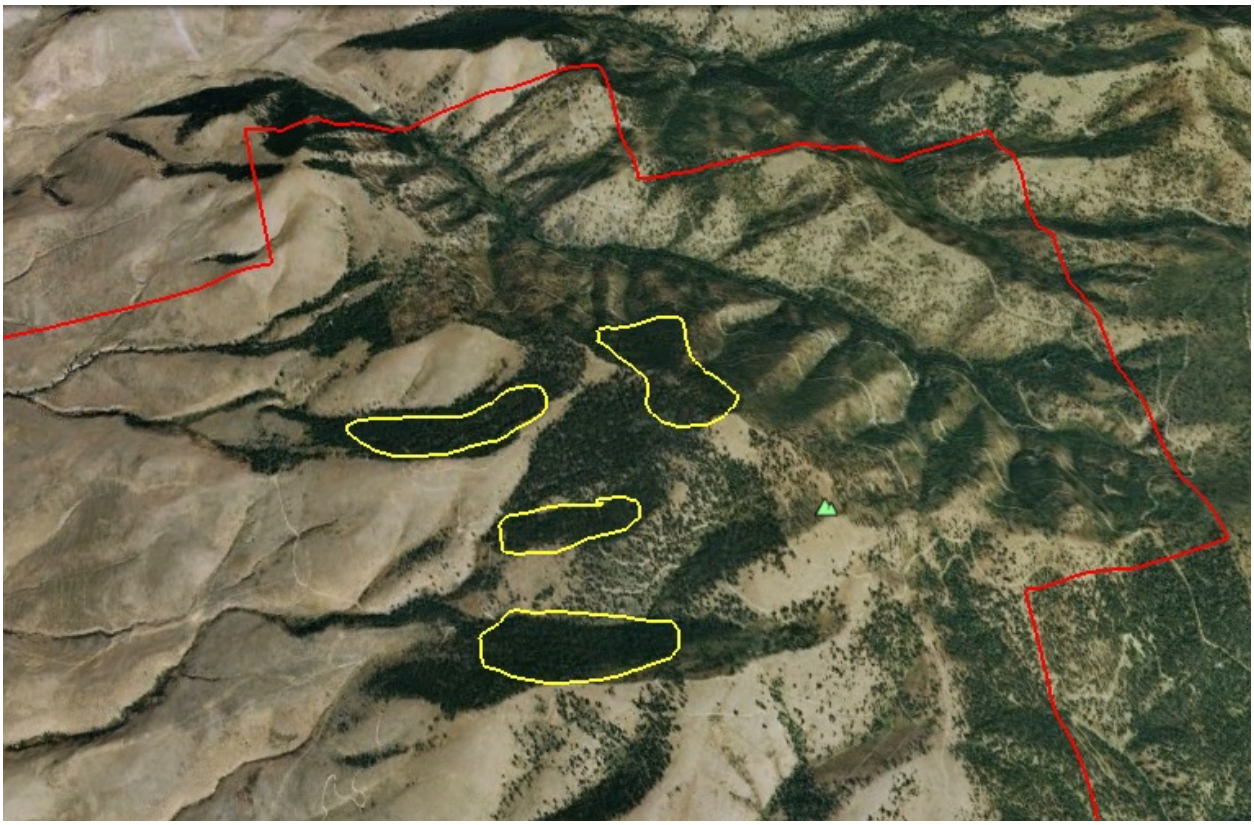


Image 17 and 18. Moist forest areas have a higher density of trees and a northern aspect. Pendulous epiphytic lichens such as beard lichen are abundant.

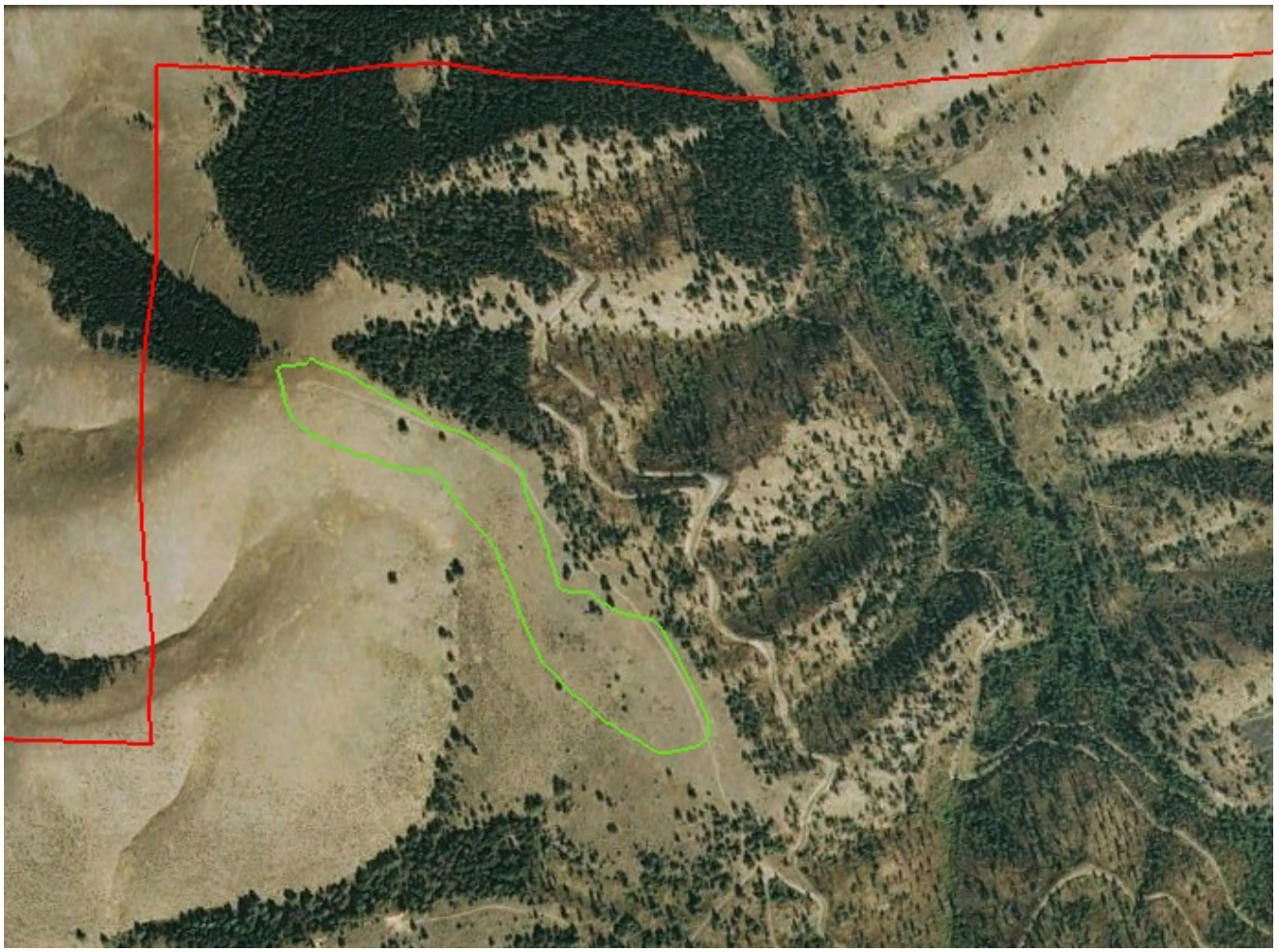
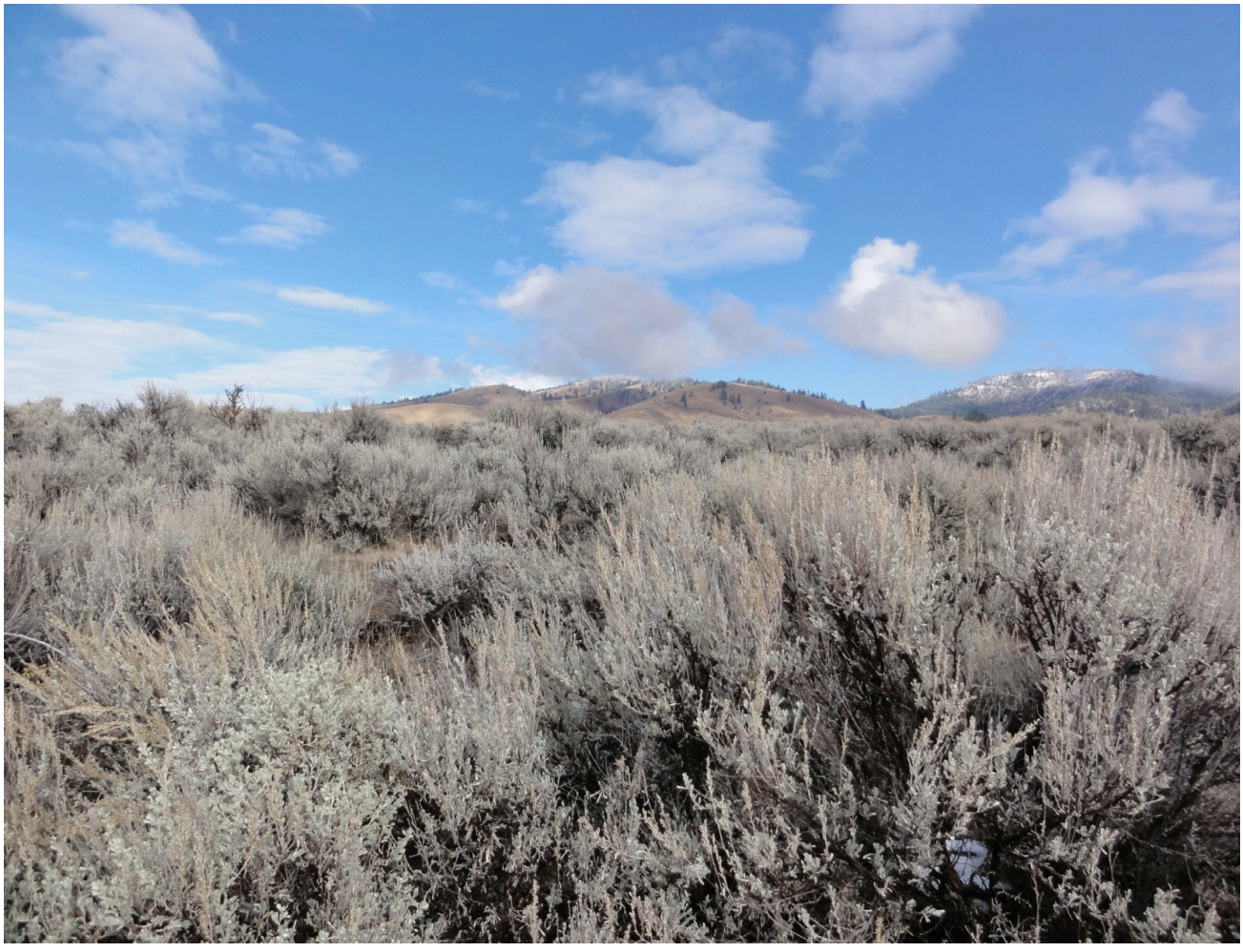


Image 19 and 20. Grasslands offer habitat for soil dwelling lichens. Lichens growing as a part of biological soil crusts are abundant in exposed windswept ridges with sparse vegetation cover.

Image 21 and 22. Macrolichens abound in old decadent sagebrush stands. The map above shows two areas of dense sagebrush where many lichens were found.



Images 23-25. Scree slopes and rock outcrops offer a concentration of crustose lichens and some macrolichens. Scree is interspersed throughout forested areas of the ranch. Lichen covered rock also exists across habitat types such as outcrops and boulders.

Table 1 lists the macrolichens identified to date. There are more collected specimens to identify and more species to be encountered. Crustose species have yet to be examined, but they will likely comprise a majority of lichen diversity at MPG.

Table 1. Species found to date and the habitat in which they were encountered.

Species	Common name	General habitat type
Bryoria capillaris	gray horsehair lichen	moist forest
Bryoria fremontii	tree-hair lichen	moist forest
Bryoria fuscescens	pale-footed horsehair lichen	moist forest, shrubland
Bryoria glabra	shiny horsehair lichen	moist forest
Bryoria lanestris	brittle horsehair lichen	moist forest
Cladonia cariosa	split-peg lichen	dry forest
Cladonia carneola	crowned pixie cup	moist forest
Cladonia cenotea	cup lichen	moist forest
Cladonia chlorophaea	mealy pixie-cup	grassland, moist forest
Cladonia coniocraea	common powderhorn	moist forest
Cladonia fimbriata	trumpet lichen	shrubland
Cladonia multiformis	sieve lichen	moist forest
Cladonia pyxidata	pebbled pixie-cup	grassland, moist forest, shrubland
Cladonia sulphurina	greater sulphur-cup	moist forest
Hypogymnia imshaugii	forked tube lichen	dry forest, moist forest, shrubland
Hypogymnia physodes	hooded tube lichen	moist forest
Letharia columbiana	brown-eyed wolf lichen	dry forest, moist forest, shrubland
Letharia vulpina	wolf lichen	dry forest
Melanohalea elegantula	elegant camouflage lichen	moist forest, shrubland
Melanohalea exasperatula	lustrous camouflage lichen	dry forest, moist forest
Melanohalea subelegantula	melanelia lichen	moist forest, shrubland

Melanohalea subolivacea	brown-eyed camouflage lichen	moist forest
Nephroma parile	powdery kidney lichen	moist forest
Nodobryoria abbreviata	tufted foxtail lichen	moist forest
Parmelia hygrophila	western shield lichen	dry forest, moist forest, shrubland
Parmelia sulcata	hammered shield lichen	moist forest, shrubland
Parmeliopsis ambigua	green starburst lichen	moist forest
Peltigera aphthosa	common freckle pelt	moist forest
Peltigera canina	dog-lichen	moist forest
Peltigera malacea	veinless pelt	scree (moist)
Peltigera ponojensis	pale-bellied dog-lichen	dry forest
Peltigera praetextata	felt lichen	moist forest
Peltigera rufescens	field dog-lichen	moist forest, shrubland, grassland
Peltigera venosa	fan lichen	moist forest
Physcia adscendens	hooded rosette lichen	shrubland
Platismatia glauca	varied rag lichen	moist forest
Tuckermannopsis chlorophylla	powdered wrinkle-lichen	dry forest, shrubland
Tuckermannopsis orbata	variable wrinkle-lichen	moist forest
Tuckermannopsis platyphylla	broad wrinkle-lichen	moist forest
Umbilicaria hyperborea	blistered rock tripe	rock/scree
Umbilicaria phaea	emery rock tripe	rock/scree
Usnea lapponica	powdered beard lichen	dry forest, moist forest, shrubland
Vulpicida pinastri	powdered sunshine lichen	moist forest, shrubland
Xanthoparmelia chlorochroa	tumbleweed shield lichen	grassland, shrubland

Humidity level and habitat type can create different lichen communities. In southeastern Montana, Eversman (1982) found that lichen density increased with moisture and that lichen communities varied with habitat type and exposure. At MPG, higher elevation forests with northern aspects provide favorable conditions for species associated with maritime influence such as horsehair lichen (*Bryoria spp.*). Dry, southern aspect habitat types, such as Ponderosa pine forests, support lichen communities with tufted foxtail lichen (*Nodobryoria abbreviata*), wolf lichen (*Letharia vulpina*), and brown-eyed wolf lichen (*Letharia columbiana*).

Image 26 and 27. Tufted foxtail lichen (*Nodobryoria abbreviata*) and wolf lichen (*Letharia vulpina*) frequently grow on Ponderosa pine in dry forests.

Image 28-30. Field dog lichen (*Peltigera rufescens,* above left) is a ground-dwelling lichen. Beard lichen (*Bryoria spp*., above) grows thickly in northern aspect moist forest. Some cup lichens, such as common powderhorn (*Cladonia coniocraea, below*), are found in the the moist shaded forest.

In forested areas, lichens live on decaying bark amongst soil and moss on the ground. Common ground-dwelling species in the forest are cup lichens (*Cladonia* spp.) and dog/felt lichens (*Peltigera* spp.). Lichens also grow epiphytically on branches and bark of living and dead trees. Forked tube lichen (*Hypogymnia imshaugii*) is a nearly ubiquitous forest epiphyte in dry and moist forest areas. Hammered shield lichen (*Parmelia sulcata*) is also quite common.

Image 31 and 32. Forked tube lichen (*Hypogymnia imshaugii,* above) and hammered shield lichen (*Parmelia sulcata,* below) are common in moist and dry forest habitat types.

Image 33 and 34. Ponderosa pine bark devoid of lichens contrasts with the the adjacent lichen-rich bark (left). Powdered beard lichen (*Usnea lapponica*) can reach high density on Douglas-fir trunks (right).

Some tree species support lichens better than others. Lichens often cover the trunks and branches of Douglas-fir and spruce. Image 33 shows two adjacent tree trunks with identical microclimate. The ponderosa pine trunk lacks lichens despite being much older. In a study of lichen distribution on tree trunks in Colorado, Gough (1975) noted that ponderosa pine was devoid of lichens compared to adjacent conifers. He measured physical attributes of the trees like pH and bark moisture levels. The data did not reveal any significant microclimate differences between conifer species. He attributed the lack of lichens on ponderosa pines to the constant shedding of bark scales. Lichens are slow growing, but they can reach high densities on undisturbed bark.

Image 35. Lichens establish on Ponderosa pine regions that are no longer shedding bark.

Image 36. Wolf lichen can reach high density on Douglas-fir trunks.

We often found some lichen species on hardwood bark or shrub branches. Hooded rosette lichen (*Physcia adsendens*) and shrubby sunburst lichen (*Xanthoria candelaria*) are common species in deciduous draws and on old sagebrush and bitterbrush branches.

Image 37 and 38. Hooded rosette lichen (*Physcia adsendens*) and shrubby sunburst lichen (*Xanthoria candelaria,* below) freckle branches in shrublands and deciduous draws.

Young shrubs do not have much lichen biomass on their branches. This may be due to the slow colonization and growth of lichens or microclimate changes in old, dense shrubs. Lichen species that live in forested areas are also found in old, decadent sagebrush stands. These include beard lichen (*Usnea*), camouflage lichen (*Melanohalea* spp.), forked tube lichen (*Hypogymnia imshaugii*), powdered wrinkle-lichen (*Tuckermannopsis chlorophylla*), and horsehair lichen (*Bryoria* spp.).

Image 39 and 40. Powdered wrinkle-lichen (*Tuckermannopsis chlorophylla*, left) and elegant camouflage lichen (*Melanohalea elegantula)* often live on decadent sagebrush.

Image 41. Trumpet lichen *(Cladonia fimbriata)* is often found under sagebrush.

Cup lichens and dog lichens often nestle at the base of shrubs with a thick carpet of moss. Trumpet lichen *(Cladonia fimbriata)* frequently associates with pebbled pixie-cup (*Cladonia pyxidata*) in sagebrush habitat. Field dog lichen (*Peltigera rufescens*) is one of the most common dog lichens at MPG. It grows in open sites of shrublands and grasslands.

Image 42. Field dog lichen (*Peltigera rufescens*) is common in open areas.

Lichens are an important component of biological soil crusts (BSC), or cryptogamic crusts, on dry, exposed ridge tops and grasslands/shrublands. BSC are common in arid areas with low vegetation cover. Free-living cyanobacteria and green algae initially colonize bare surfaces. The cyanobacteria contribute nitrogen and the algae create a little organic matter and structure. Next, lichens and mosses establish. BSC lichens include cup lichens (*Cladonia* spp.), dog lichens (*Peltigera* spp.), and a variety of crustose lichens. Lichens and cyanobacteria also secrete substances that increase the availability of phosphorus, often a limiting nutrient (Rosentreter, 2007). At MPG, we frequently encounter field-dog lichen (*Peltigera rufescens*) and pebbled pixie cup (*Cladonia pyxidata*) in BSC. Prairie spikemoss (*Selaginella densa*), a primitive plant, is also quite common in areas with high BSC cover.

Image 42 and 43. Lichens are an important component of biological soil crusts. Spikemoss (*Selaginella densa*, below) peeks above a biological soil crust rich with cyanobacteria, algae, bacteria, and lichens.

Crustose lichens often dominate rock and scree habitats, but some macrolichens will also grow there. The aspect and tree cover of scree provides moist or dry microsites for lichens. Moist scree can accumulate soil and moss and support macrolichens also found on soil. Rock tripe (*Umbilicaria* spp.) frequently dwells on exposed scree and rock. Many species of rock tripe are edible as an emergency survival food. We found blistered rock tripe (*Umbilicaria hyperborea*) and emery rock tripe (*Umbilicaria phaea*) on exposed rock and scree at MPG.

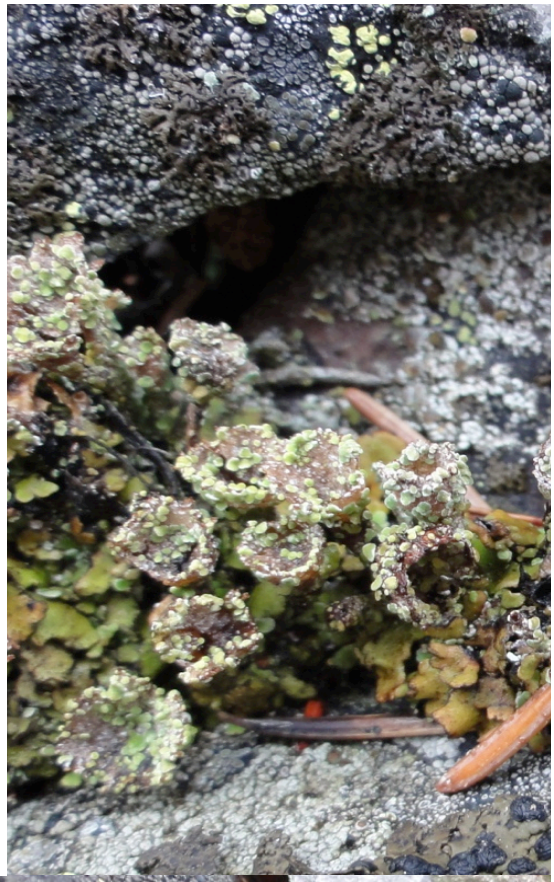


Image 44 and 45. Veinless pelt (*Peltigera malacea,* below) and pebbled pixie-cup (*Cladonia pyxidata, right*) nestle between rocks on north facing scree.

Image 46-48. Emery rock tripe (*Umbilicaria phaea)* and rock tripe (*Umbilicaria hyperborea*) grow amongst crustose lichens on exposed boulders.

Future directions

Species checklist:

What additional macrolichens live at MPG?

What crustose lichen species exist on the ranch?

What lichens are found at MPG North? How does the MPGN lichen community compare to the MPG Ranch community?

Potential research questions:

What heavy metals can be found in lichen thalli? How do these levels compare to other studies and anthropogenic activities of the area?

What associations exist between macrolichen communities and plant communities?

Are nitrogen levels beneath cyanolichens detectably higher than adjacent soil?

What microsite conditions such as aspect and slope correlate to highest lichen cover?

To what extent are ungulates using lichens as forage at MPG Ranch and MPG North?

We often find common forest lichens in very old, decadent sagebrush communities. At what age or density are sagebrush stands likely to support these species? What factors contribute to lichen colonization?

What species first recolonize areas harvested for timber? What forest conditions are present?

Image 49. Brown eyed wolf lichen (*Letharia columbiana).*

Supporting literature

Bennett, J. P., & Wetmore, C. M. (1999). Geothermal elements in lichens of Yellowstone National Park, USA. *Environmental and Experimental Botany,* 42(3), 191-200.

Berryman, S., & McCune, B. (2006). Estimating epiphytic macrolichen biomass from topography, stand structure and lichen community data. *Journal of Vegetation Science,* 17(2), 157-170.

Brodo, I. M., Sharnoff, S.D., and Sharnoff, S. *Lichens of North America.* New Haven: Yale University Press, 2001. 828 pp.

Dailey, R. N. (2008). Toxicity of *Xanthoparmelia chlorochroa* and the lichen substance usnic acid in ruminants. University of Wyoming, ProQuest Dissertations and Theses, 152p.

Debolt, A., & McCune, B. (1993). Lichens of Glacier National Park, Montana. *The Bryologist,* 96(2), 192-204.

Dettki, H., & Esseen, P. (1998). Epiphytic macrolichens in managed and natural forest landscapes: A comparison at two spatial scales. *Ecography,* 21(6), 613-624.

Ditchkoff, S.S and Servello, F.A. (1998). Litterfall: An overlooked food source for wintering white-tailed deer. *Journal of Wildlife Management*, 62 (1), 250-255.

Esseen, P., & Renhorn, K. (1998). Edge effects on an epiphytic lichen in fragmented forests. *Conservation Biology,* 12(6), 1307-1317.

Eversman, S. (1990). Lichens of Yellowstone National Park. *The Bryologist*, 93(2) 197-205.

Eversman, S., & Horton, D. (2004). Recolonization of burned substrates by lichens and mosses in Yellowstone National Park. *Northwest Science,* 78(2), 85-92.

Eversman, S., Wetmore, C. M., Glew, K., & Bennett, J. P. (2002). Patterns of lichen diversity in Yellowstone National Park. *The Bryologist,* 105(1), 27-42.

Eversman, S. (1982). Epiphytic lichens of a Ponderosa pine forest in southeastern Montana. *The Bryologist*, 85 (2) 204-213.

Gough, L. P. (1975). Cryptogam distributions on *Pseudotsuga menziesii* and *Abies lasiocarpa* in the Front Range, Boulder County, Colorado. *The Bryologist*, 78 (2), 124-145.

Lesica, P., McCune, B., Cooper, S. V., & Won Shic Hong. (1991). Differences in lichen and bryophyte communities between old-growth and managed second-growth forests in the Swan Valley, Montana. *Canadian Journal of Botany,* 69(8), 1745-1755.

Lõhmus, A., & Lõhmus, P. (2010). Epiphyte communities on the trunks of retention trees stabilize in 5 years after timber harvesting, but remain threatened due to tree loss. *Biological Conservation,* 143(4), 891-898.

McCune, B. and Geiser, L. *Macrolichens of the Pacific Northwest.* Corvallis: Oregon State University Press, 2009. 464 pp.

McCune, B. (2000). Lichen communities as indicators of forest health. *The Bryologist,* 103(2), 353-356.

McCune, B. (1984). Lichens with oceanic affinities in the Bitterroot Mountains of Montana and Idaho. *The Bryologist,* 87(1), 44-50.

Moerman, K.L, Chai, C.L., Waring, P. (2003). Evidence that the lichen-derived scabrosin esters target mitochondrial ATP synthase in P388D1 cells. *Toxicology and Applied Pharmacology,* 190, (3)1, 232-240.

Peterson, E. B., & McCune, B. (2001). Diversity and succession of epiphytic macrolichen communities in low-elevation managed conifer forests in western Oregon. *Journal of Vegetation Science,* 12(4), 511-524.

Pipp, A. K., Henderson, C., & Callaway, R. M. (2001). Effects of forest age and forest structure on epiphytic lichen biomass and diversity in a Douglas-fir forest. *Northwest Science, 75*(1), 12-24.

Sillett, S. C., McCune, B., Peck, J. E., Rambo, T. R., & Ruchty, A. (2000). Dispersal limitations of epiphytic lichens result in species dependent on old-growth forests. *Ecological Applications,* 10(3), 789-799.

Rosentreter, R., M. Bowker, and J. Belnap. *A Field Guide to Biological Soil Crusts of Western U.S. Drylands*. Denver: U.S. Government Printing Office. 2007. 103pp.

Rosso, A. L., McCune, B., & Rambo, T. R. (2000). Ecology and conservation of a rare, old-growth-associated canopy lichen in a silvicultural landscape. *The Bryologist,* 103(1), 117-127.

Ward, R. L. and Marcum, C. L. (2005). Lichen litterfall consumption by wintering Deer and Elk in Western Montana. *The Journal of Wildlife Management*, Vol. 69(3), 1081-1089.

Glossary

apothecia- spore producing fungal reproductive structures
crustose lichens- minute lichens that form a tightly adhered crust to a substrate from which they cannot easily be removed
cyanolichens- lichens that contain cyanobacteria (blue-green algae)
foliose lichens- lichens which have a distinct upper and lower surface such as dog-lichen and shield lichen
fruticose lichens- lichens with a three-dimensional thallus such as beard lichen
macrolichens- lichens that are usually fruticose or foliose and have a relatively large thallus
rhizines- root-like filaments that help adhere lichens to the substrate
thallus- the body of the lichen
tomentum- minute hair-like structures that often grow on the "veins" of dog/pelt lichens

Image 50. Cup lichens (*Cladonia* spp.) grace fallen logs.