Mount Pisgah Lichen Inventory Project

Final Report

Mount Pisgah Arboretum
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Design by August Jackson. Maps by August Jackson with Carson Kunigisky and advice from James Meacham. HBRA shapefiles courtesy of Jim Reed.

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Cover Photo: *Ramalina menziesii* by August Jackson. iNaturalist observation # 147363647

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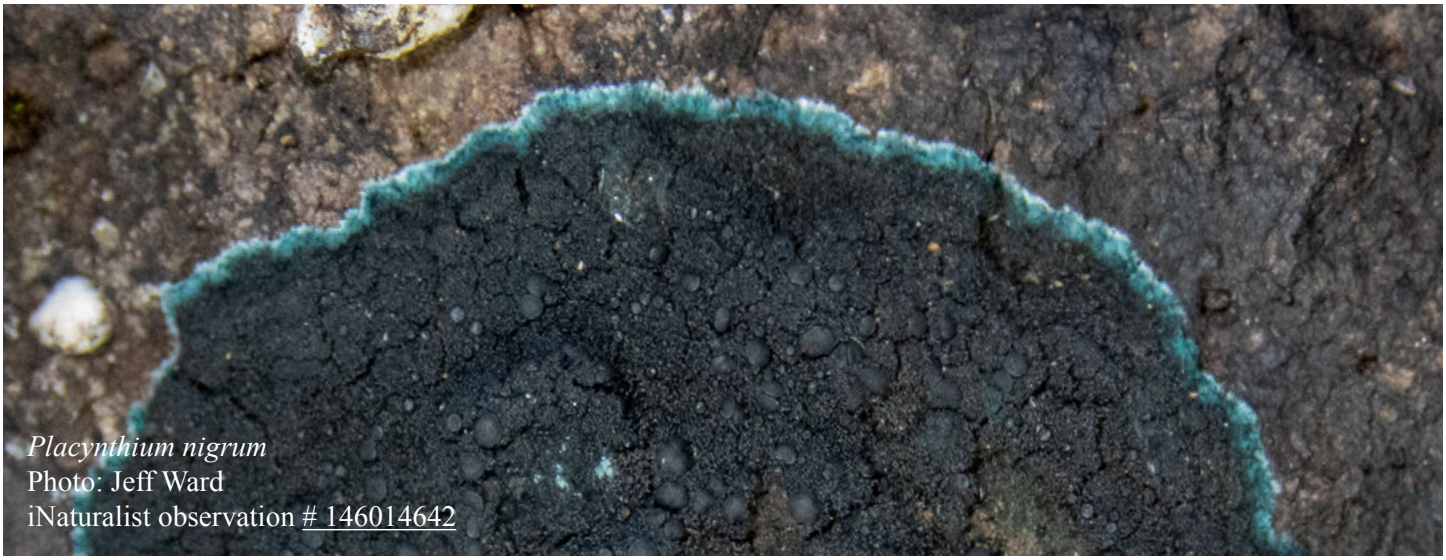
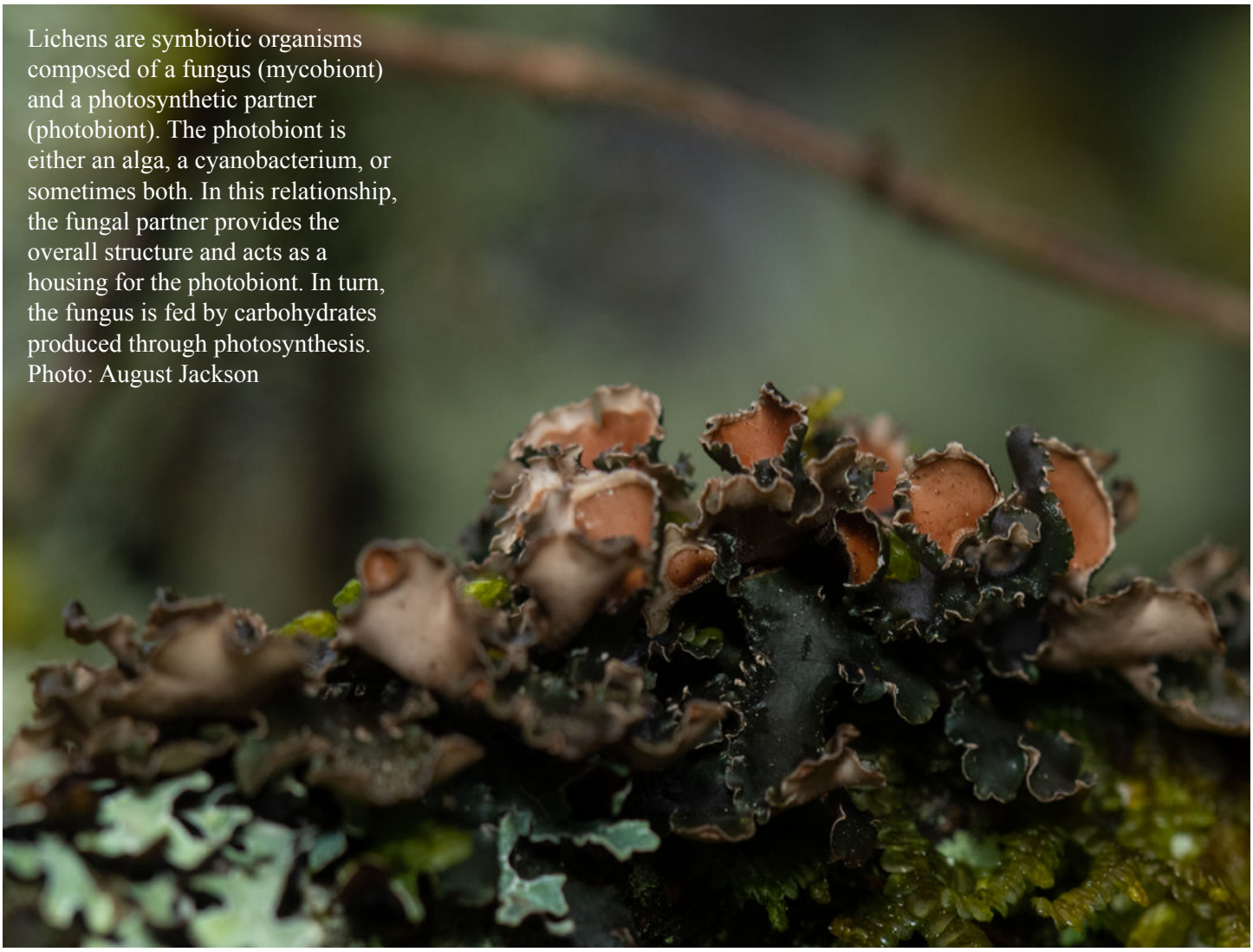


Placynthium nigrum
Photo: Jeff Ward
iNaturalist observation # 146014642

Introduction

The Mount Pisgah Lichen Inventory Project was designed to assess the distribution of sensitive species on Mount Pisgah, contribute to a baseline understanding of lichen community composition, serve as a tool for public education, and explore whether trained amateur volunteers can be effective in locating target species and documenting diversity. From December 2022 through mid-March of 2023, volunteers were engaged in recording observations of macrolichens on Mount Pisgah within the Howard Buford Recreation Area. Volunteers were asked to prioritize locating and recording a dozen pollution-intolerant species alongside trails. These sensitive species, particularly the large foliose lichens with a cyanobacterial component, tend to cluster together in microhabitats (Sillett & Neitlich, 1996; Sillett & McCune, 1998) which may represent priority areas for conservation. As far as we are aware, this is the first instance of a project leveraging community science efforts to identify priority areas for conserving lichen habitats in a large regional park.



Lichens are symbiotic organisms composed of a fungus (mycobiont) and a photosynthetic partner (photobiont). The photobiont is either an alga, a cyanobacterium, or sometimes both. In this relationship, the fungal partner provides the overall structure and acts as a housing for the photobiont. In turn, the fungus is fed by carbohydrates produced through photosynthesis. Photo: August Jackson

Lichens in the Ecosystem

Epiphytic macrolichens play a significant role in Pacific Northwest ecosystems. Foliose and pendant lichens provide crucial habitat and food for invertebrates like springtails, mites, and snails (Bokhorst et al., 2015). These lichens appear to increase the diversity and abundance of invertebrates in comparison to forests deficient in lichens, and intact epiphytic lichen communities may significantly enhance prey availability for insectivorous songbirds (Pettersson et al., 1995). A number of bird species also regularly use lichens as nesting material. Additionally, some lichens serve as winter food sources for ungulates, and populations of the Humboldt's flying squirrel feed extensively on fruticose beard lichens (Maser et al., 1986).

Epiphytic lichens are a critical source of nutrients in forest systems. Lichens with a cyanobacterial photobiont are among the few organisms able to fix atmospheric nitrogen and convert it into a form usable by terrestrial plant life. *Lobaria oregana*, a lichen ubiquitous in the rainforests of the Pacific Northwest, may contribute more than 50% of annual nitrogen inputs in some of these forests (Antoine, 2004). Although other species of cyanolichens never comprise such a significant portion of the biomass, they nonetheless make valuable contributions of nitrogen to forest systems. Lichens with only an algal photobiont (i.e, unable to fix nitrogen) still contribute considerable nutrients when they fall to the ground and decompose. In a study of an oak woodland in California, *Ramalina menziesii* (a lichen widespread on Mount Pisgah) was found to contribute substantially to the annual nutrient turnover (Boucher & Nash, 1990).

Saxicolous lichens–those found on rock substrates–are also of great ecological importance and contribute markedly to the generation of soils through the weathering of rocks. This weathering action has an extraordinary effect on moderating the Earth's climate in the production of fertile soils which are supportive of plant life (Schwartzman & Volk, 1989). The more foliose of these lichens also provide food and shelter for invertebrates.

Pendant fishntet lichens (*Ramalina menziesii*) drape the outstretched branches of Oregon white oak (*Quercus garryana*).
Photo: August Jackson

Site Description

Mount Pisgah is located near the southern terminus of the Willamette Valley at the confluence of the Coast Fork and Middle Fork of the Willamette River, directly adjacent to the communities of Eugene and Springfield, Oregon (Figure 1). The Howard Buford Recreation Area is owned by Lane County Parks and encompasses nearly all of Mount Pisgah other than portions of the north-eastern slopes. The park includes two lease areas and is cooperatively managed by multiple partners. The Howard Buford Recreation Area is home to the second largest tracts of prairie and oak habitats under conservation in the Willamette Valley, exceeded only by the William L. Finley National Wildlife Refuge. The park is home to a number of plant and animal species that are endemic, regionally rare, and/or of conservation concern (Lane County Parks, 2018).

As a result of industrial and agricultural pollution, the Willamette Valley ecoregion has some of the highest levels of atmospheric nitrogen in the Pacific Northwest (Geiser & Neitlich, 2007). During active growth, the body of a lichen is open to gas exchange with the environment. Though physiological responses vary by species, some lichens are particularly susceptible to damage by air pollution. As a result, many sensitive species are absent or

Figure 1

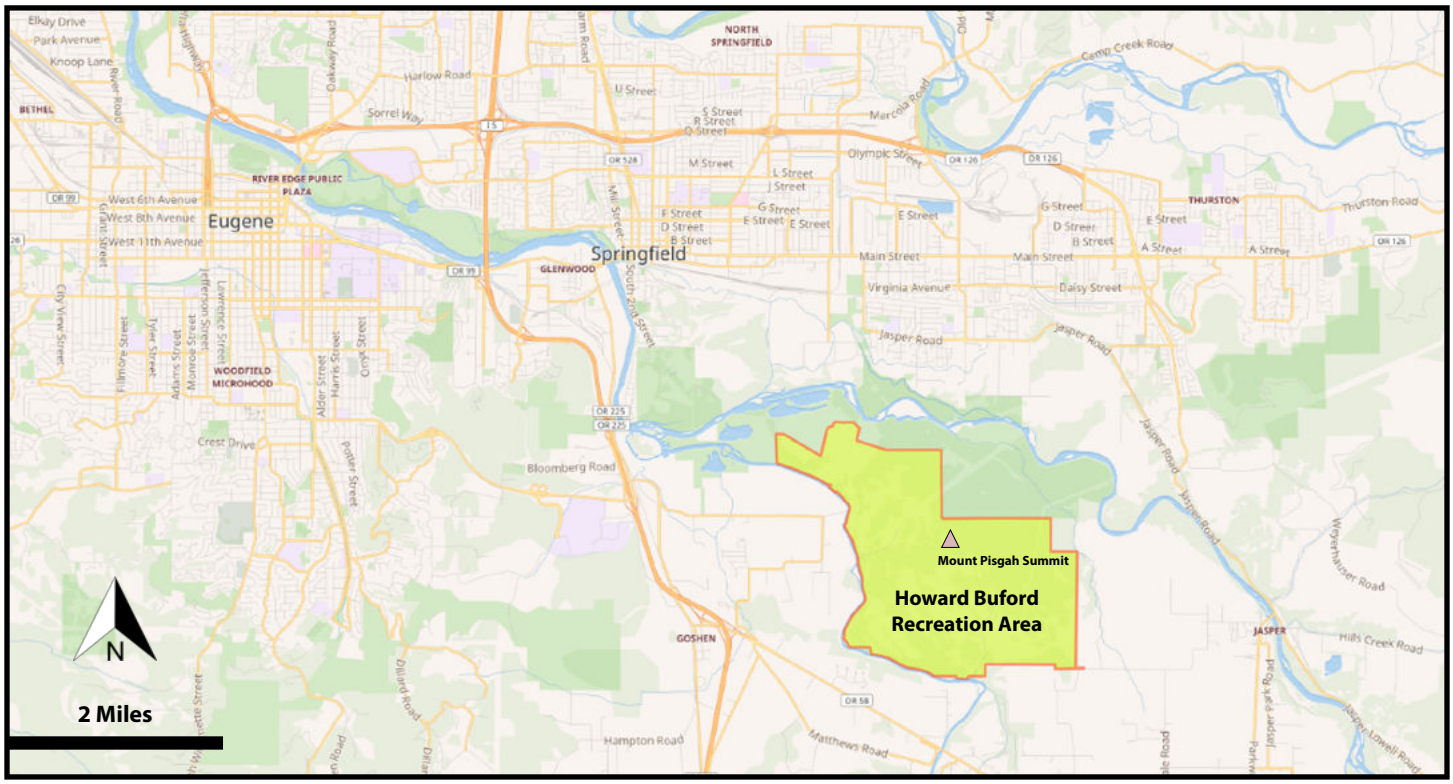


Figure 1: The location of Mount Pisgah and the Howard Buford Recreation Area in the context of the communities of Eugene and Springfield, Oregon.

nearly absent from urban and agricultural areas within the Willamette Valley, and the deleterious effects of increased nitrogen deposition on lichen communities extend outward into the surrounding foothills (Geiser & Neitlich, 2007).

Bounded by rivers on three sides, the hydrography of Mount Pisgah may influence the local climatic conditions and moderate regional-scale effects of atmospheric pollution and climate-induced stress. Sensitive lichen species persist on Mount Pisgah in high numbers, whereas they are absent or limited in directly adjacent natural areas closer to Interstate 5 and the urban core. However, the community composition on Mount Pisgah does show the potential impact of nitrogen-induced stress in the higher relative abundance of mesophilic species, which thrive in moderately elevated levels of atmospheric nitrogen. These species are abundant in exposed locations with sparse tree cover, suggesting that site-specific habitat conditions significantly affect the lichen community and may limit the presence of sensitive species, even in the absence of nitrogen-induced effects.

The historical vegetation of the Willamette Valley was shaped by the cultural burning practices of the Kalapuya people, which was regular enough that sparsely-treed savanna and prairies dominated the valley floor outside of river courses (Christy & Alverson, 2011). Following a ban on indigenous burning practices and the forced removal of Kalapuya peoples to reservations, vegetational succession proceeded apace. A substantial increase in tree cover on Mount Pisgah is well documented in historical photographs, representing an expansion in habitat for epiphytic macrolichens. Provided this landscape alteration, it is possible that populations of sensitive lichen species are expanding on Mount Pisgah, despite an increase in nitrogen deposition which may be placing an upper limit on their relative abundance.

An oak branch with a common assortment of mesophilic lichens, including *Hypogymnia physodes*, *Platismatia glauca*, and *Parmelia sulcata*. Photo: August Jackson

Project Description

Community science is a powerful tool for assessing ecological conditions while simultaneously engaging community members in stewarding local natural areas. Projects with a training component can also provide extensive opportunities for broadening ecological understanding and developing a sense of place. Relatively few studies have investigated the potential for community science efforts to aid in documenting lichen communities, and these have not generally engaged volunteers in the process of identification (e.g. Casanovas et al., 2014; Tregidgo et al., 2013; Welden et al., 2018). To our knowledge, this project is novel in its approach of engaging volunteers to detect high-value lichen habitats with the goal of informing conservation actions.

Volunteers were recruited for the Mount Pisgah Lichen Inventory Project beginning in November, 2022. We published a digital guide to 30 species of lichens on Mount Pisgah (Jackson, 2022) which served as the primary reference for project volunteers. In addition, volunteers were provided with a simplified handout of a dozen sensitive species to prioritize locating while making trailside observations. These species included *Hypotrachyna sinuosa, Lobaria anomala, Nephroma helveticum, Nephroma laevigatum, Parmotrema perlatum, Peltigera membranacea, Ramalina menziesii, Sphaerophorus tuckermanii, Sticta fuliginosa, Sticta limbata, Sulcaria badia,* and *Usnea longissima*. A three-hour field training on lichen identification was provided, as well as a brief orientation to the project and the iNaturalist platform. Additional follow-up trainings in lichen identification were also provided. Volunteers uploaded all observations to the Mount Pisgah Lichen Inventory Project on iNaturalist. The iNaturalist platform is a joint initiative of the California Academy of Sciences and the National Geographic Society. The platform enables users to contribute geolocated observations and the process of identification is participatory and consensus-based. All steps in the identification process are public and transparent. Identifications are readily challengeable so that the process of data collection is open source from start to finish. With attentive curation, iNaturalist projects can result in a living dataset that adjusts to taxonomic revisions, expert attention, and novel identification methods. All observations can be found on the project page and we encourage review of identifications.

Revealing the underside of *Sticta fuliginosa* to aid in identification. Photo: Carson Kunigisky iNaturalist observation # 150463179

Results

At the culmination of the project, 30 volunteers contributed more than 400 hours of their time, amassing 1,715 observations. At the time of publication almost 75% (1,278) of these observations are research grade, i.e. having two or more agreeing identifications at species level. Prior to the initiation of the project, roughly 170 observations of lichens in the Howard Buford Recreation area were considered research grade, and there were approximately 5,100 research grade observations in the state of Oregon. The project increased the number of research grade observations in the state by about 20%. The entirety of research grade observations can be viewed on the project page. Figures 3-9 on the following pages show the spatial distribution of a selection of the target lichen species. In addition to the target species, several other sensitive species were identified through the project, including regionally uncommon lichens like *Peltigera pacifica*, *Leptochidium albociliatum*, and *Menegazzia terrebrata*.

Volunteers achieved comprehensive coverage of the trail system in the Howard Buford Recreation Area and successfully identified several locations of high-value lichen habitat. Figure 2 illustrates the density of observations of sensitive lichen species. Lichen species were determined to be sensitive to air pollution based on rankings in *The Macrolichens of the Pacific Northwest* (McCune & Geiser, 2009). Additionally, Figure 9 in the Appendix shows the locations of the least abundant of the sensitive lichen species, which also tend to cluster in the identified hot spots, reinforcing the habitat value of these locations.

While sensitive species are broadly distributed across Mount Pisgah, they occur with greater frequency in some locations and tend to cluster in proximity to seasonal creek drainages and wetlands where humidity is generally higher. Similar patterns have been observed elsewhere (Sillett & McCune, 1998), and in the Western Cascades of Oregon, it was determined that riparian forests adjacent to large streams support higher species richness of epiphytic macrolichens, particularly cyanolichens, as well as a greater number of rare species (McCune et al., 2002). Given that larger, perennial streams are rare in the Willamette Valley, seasonal drainages may represent analogous microhabitats with a similar effect in concentrating cyanolichens and other sensitive species. Survey effort was not equal across the landscape and primarily restricted to trails, thus it is likely there are additional locations in which sensitive lichen species can be found at a high density. Creek drainages appear to present a microhabitat important for the regional lichen flora, and presumably this habitat is enhanced along the full length of these drainages.

Mennegazzia terebrata Photo: Lynn Coody
iNaturalist observation # 146159699

Figure 2

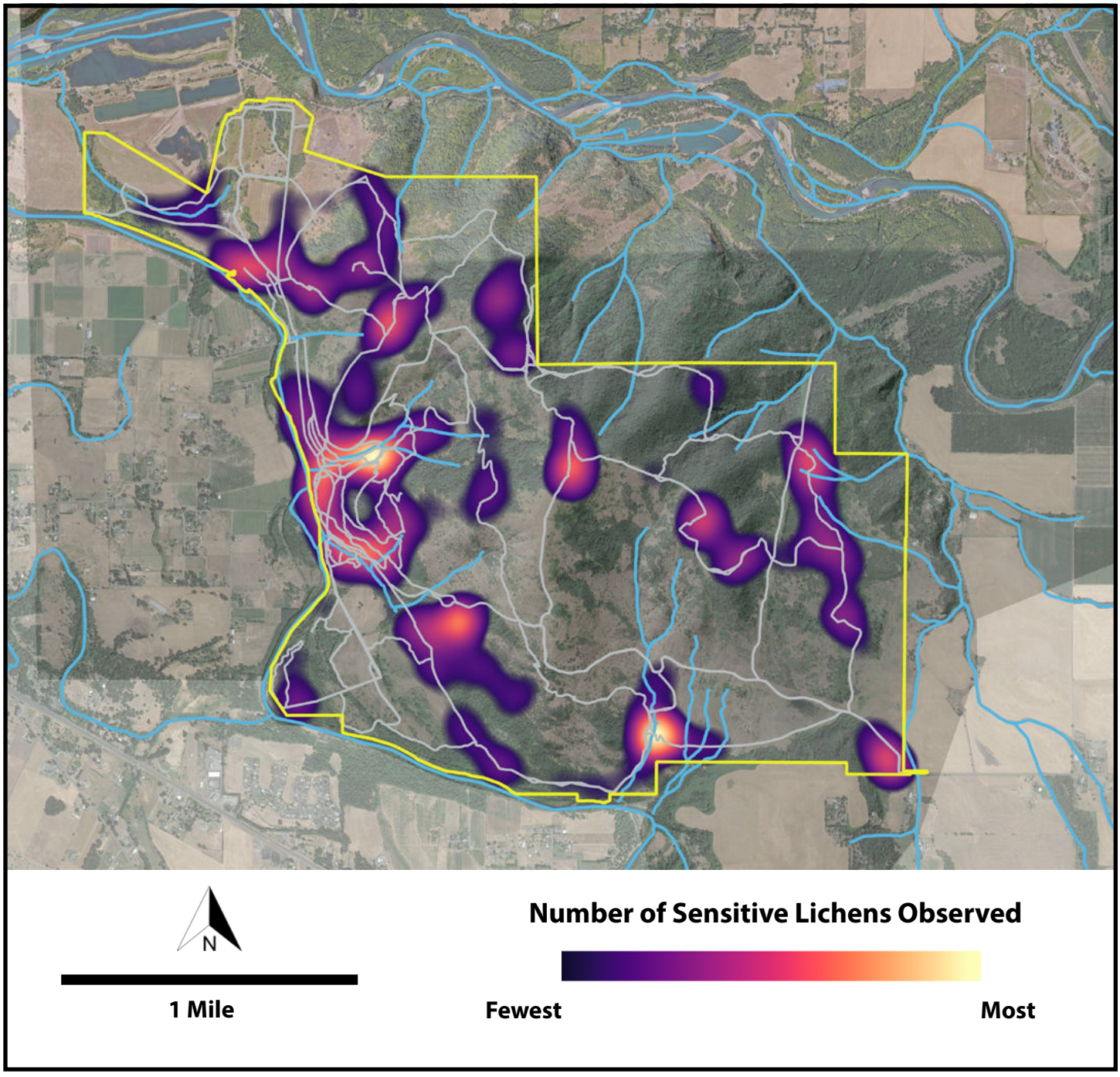


Figure 2: The density of observations of senstive lichen species in the Howard Buford Recreation Area as illustrated in a heatmap. **Species included in analysis:** *Hypotrachyna sinuosa, Leptochidium albociliatum, Letharia vulpina, Lobaria anomala, Lobaria pulmonaria, Menegazzia terebrata, Nephroma helveticum, Nephroma laevigatum, Nephroma resupinatum, Parmotrema perlatum, Peltigera britannica, Peltigera leucophlebia, Peltigera membranacea, Platismatia herrei, Ramalina menziesii, Scytinium lichenoides, Scytinium palmatum, Sphaerophorus tuckermanii, Sticta fuliginosa, Sticta limbata, Tuckermanopsis chlorophylla, Tuckermanopsis orbata, Usnea longissima*

Figure 3a, 3b

netted speckle-belly (*Lobaria anomala*)

Photo: Jeff Morey
iNaturalist observation # 147044054

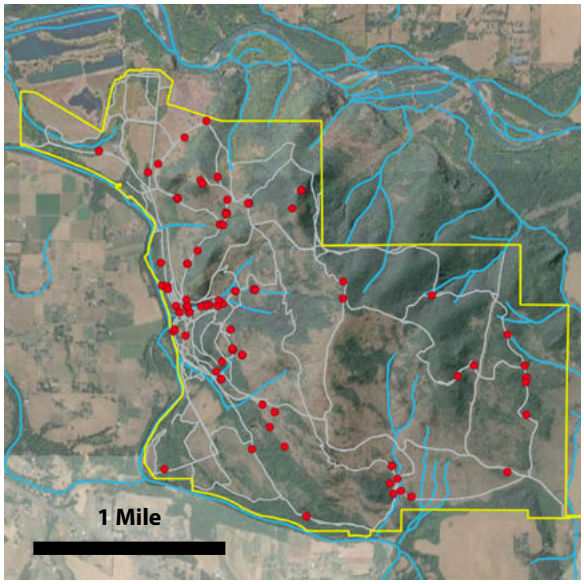


Figure 4a, 4b

green loop lichen (*Hypotrachyna sinuosa*)

Photo: Aliscia Niles
iNaturalist observation # 149249856

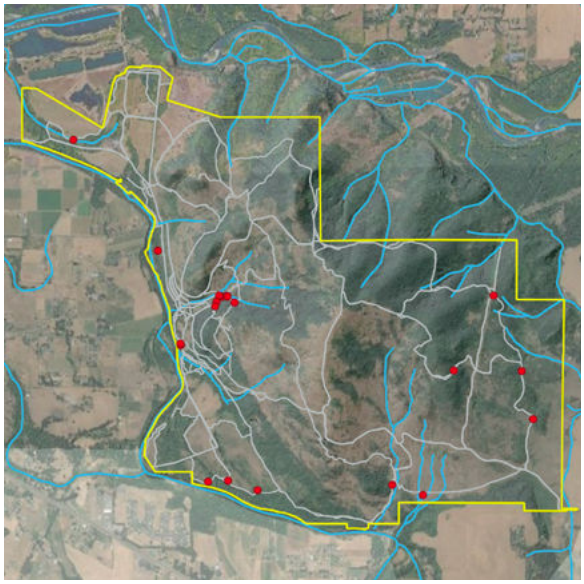


Figure 5a, 5b

old man's beard (*Usnea longissima*)

Photo: Tim Miller
iNaturalist observation # 148934808

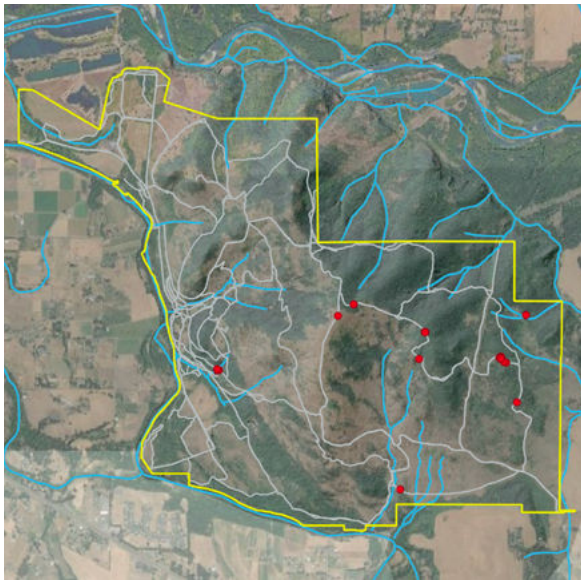


Figure 6a, 6b

lace lichen (*Ramalina menziesii*)

Photo: Andrea Wuenschel
iNaturalist observation # 146495027

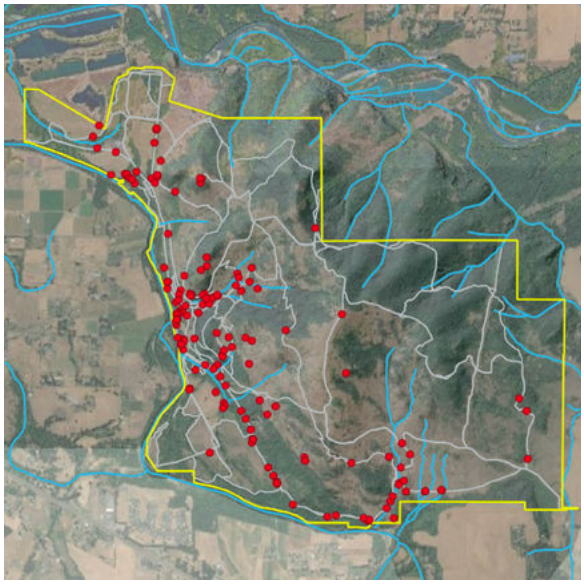


Figure 7a, 7b

peppered moon lichen (*Sticta fuliginosa)**

*The *S. fuliginosa* morphodeme was revised after the start of this project (Di Meglio & Goward, 2023). Most (all?) of ours are now the species *S. gretae*.

Photo: Tim Miller
iNaturalist observation # 147298486

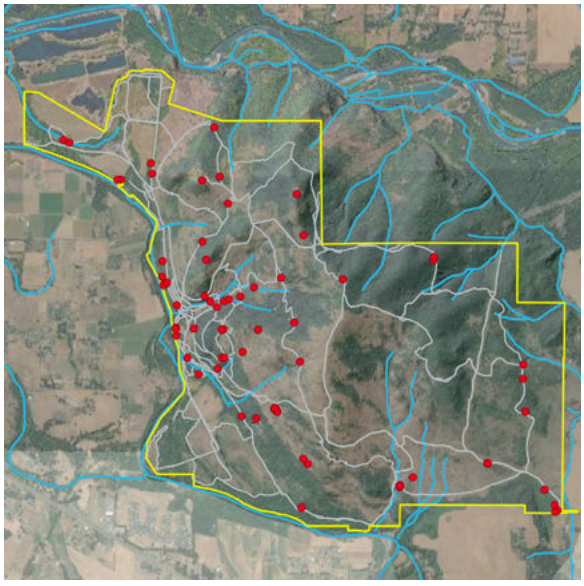
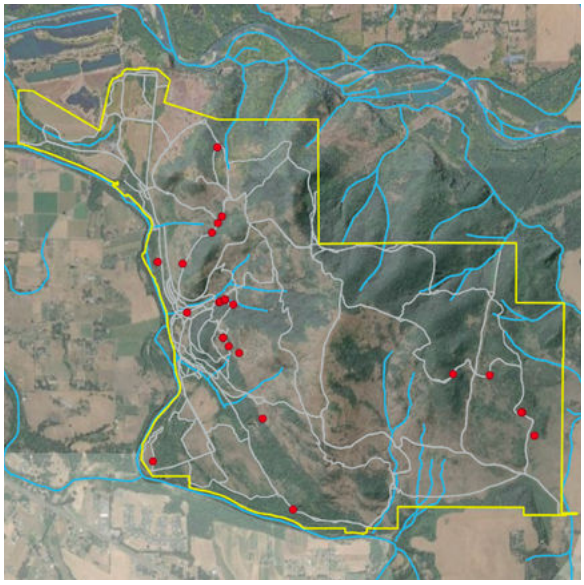


Figure 8a, 8b

fringed kidney lichen (*Nephroma helveticum*)

Photo: Carson Kunigisky
iNaturalist observation # 148339318



Saxicolous Lichens

In the course of this project, volunteers incidentally documented a number of non-epiphytic lichens growing on rock, mosses, or soil. Several of the species found are regionally rare or uncommon in the Willamette Valley.

The geology underlying Mount Pisgah is primarily basalt and other volcanic rocks, with some younger sedimentary deposits in the lowland areas near the rivers (Smith, 2015). The two largest outcrops were historically used as quarries and now have a relatively low diversity of saxicolous lichens. Compared to other nearby sites like Spencer Butte, there are no large lichen-covered cliffs. Instead, the saxicolous species colonize many boulders and small outcroppings scattered across the upland areas of Mount Pisgah. Some lichen species (specifically, *Fuscopannaria aurita* and *Phaeophyscia sciastra*) were found abundantly colonizing a single boulder but were absent from all other rocks surveyed in the area.

The most commonly observed saxicolous macrolichen was *Xanthoparmelia* cf. *cumberlandia*, which stands out with abundant brown apothecia contrasting against the large yellow-green thallus. Among mosses over rock, several gelatinous species were frequently observed including *Scytinium lichenoides*, *Scytinium palmatum*, *Leptochidium albociliatum*, and the fruticose *Polychidium muscicola*. The uniformly dark color of these lichens can make them difficult to distinguish from debris among bryophytes without magnification. Many species of crustose microlichens were found, but most cannot be identified from photographs. Among the more distinctive are the saxicolous *Diploschistes scruposus* and the similar *Diploschistes muscorum*, which begins life as a lichenicolous parasite on *Cladonia* and later grows over mosses (Brodo, 2002).

Phaeophyscia sciastra was found on only one boulder in the park. Photo: Jeff Ward
iNaturalist observation # 147273874

The regionally rare *Dermatocarpon intestiniforme* was found along small seasonal streams on the west and south sides of Mount Pisgah. The thalli were abundant at some locations, which would be inundated during heavy winter rains but completely dry during late summer. Identification has not yet been confirmed by microscopy. This species has only one digitized herbarium record from Oregon (Rosentreter, 1997) but has also been reported from Horse Rock Ridge, which is 20 miles northeast of Mount Pisgah (Curtis, 2003).

An isidiate species of *Xanthoparmelia* was frequently found growing on rocks alongside *Xanthoparmelia* cf. *cumberlandia*. These could be either *X. plitti* or *X. mexicana*; the species can only be distinguished via thin-liquid chromatography (McCune & Geiser, 2009). *X. plitti* is common in eastern Oregon, but both species are rare west of the Cascade mountains (McCune, 2022).

Diploschistes muscorum parasitizing *Cladonia* and spreading over mosses. Photo: August Jackson iNaturalist observation # 147804051

Dermatocarpon intestiniforme grows in colonies on rocks along the edges of seasonal streams. Photo: Jeff Ward iNaturalist observation # 147271694

Xanthoparmelia plitti/Mexicana showing the isidiate thallus over rock. Photo: Jeff Ward iNaturalist observation #148465725

Sulcaria badia

Sulcaria badia was first detected in 2020 on an annual guided walk with lichenologist Dr. Daphne Stone at Mount Pisgah Arboretum. Jeff Ward subsequently made additional detections of the species in the same vicinity in the following years. Though not a component of this project, with minimal effort we have found the species to be widespread across portions of Mount Pisgah.

Sulcaria badia is listed by the Oregon Biodiversity Information Center as threatened or endangered throughout its range (ORBIC, 2019) and is listed as endangered by the International Union for the Conservation of Nature (McMullin et al., 2019). The species is known from only a small range in Oregon, California, and Washington, though it is presumed extirpated in the latter. *S. badia* is known from 13 locations, with only seven known to be extant (Sims & Lazar, 2020). Despite past search efforts for this species in the Willamette Valley, the Mount Pisgah population had gone undetected (Peterson et al., 1998). Many locations consist of only a small number of individual lichens occupying a small number of trees. In the largest sites, occupation is estimated to be under 100 trees (Carlberg & Toren, 2006). Occupation on Mount Pisgah appears to be significantly greater, and may be found to represent the largest known site. Additionally, recruitment appears to be healthy, with younger thalli found to be present on Douglas-firs (*Pseudotsuga menziesii*), which have declined or died within the past seven years as a result of regional drought conditions. Additional efforts will be made to better inventory this species in the near future.

Branches of *Sulcaria badia* showing the distinctive, twisting pseudocyphellae (pale cracks). Photo: August Jackson

Discussion

The Mount Pisgah Lichen Inventory Project contributed significant, publicly accessible data, offering one of the most thorough biogeographical accounts of lichen species at a single site in the Willamette Valley. This dataset permits further analyses and facilitates future monitoring of lichen species on Mount Pisgah by more thoroughly establishing a baseline of species distributions across the landscape.

Mount Pisgah hosts a significantly species-rich lichen flora and may be acting as something of a refugium for sensitive lichens which have become relatively rare in large portions of the Willamette Valley due to land conversion and air pollution. Lichens are not currently addressed in the Habitat Management Plan for the Howard Buford Recreation Area (Lane County Parks, 2018), but we encourage the consideration of lichen communities in future management activities, particularly in the areas identified as hot spots for sensitive species. Efforts should be made to continue to reduce the risk of catastrophic fire, which would have long-lasting effects on the lichen community. Additionally, we recommend photo-monitoring of the effects of prescribed burns on saxicolous lichen communities as little research has been conducted in this area and monitoring may better inform management practices.
The lichen community on Mount Pisgah will face continued threats from anthropogenic and natural sources, including increasing urbanization, climate change, wildfire, and the invasion of the emerald ash borer (*Agrilus planipennis*), which will likely have a significant impact on forest structure and available habitat for epiphytic lichens. Repeating this project in future years may be able to detect changes in the lichen community, though it is unlikely that a project of this scope would be able to detect small-scale shifts in species composition. It may be more appropriate to monitor a smaller area (perhaps one of the locations identified as a lichen hot spot), or to repeat the project following a significant event resulting in tree mortality or a lengthened period of decreased air quality.

Public education and community science will continue to play an important role in the conservation of lichen communities on Mount Pisgah. In addition, there is strong potential for community science to be utilized to effectively and efficiently document lichen communities in other natural areas in the region.

A Steller's Jay (*Cyanocitta stelleri*) rips off a thallus of *Lobaria pulmonaria* in search of invertebrate food. Photo: August Jackson

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Appendix

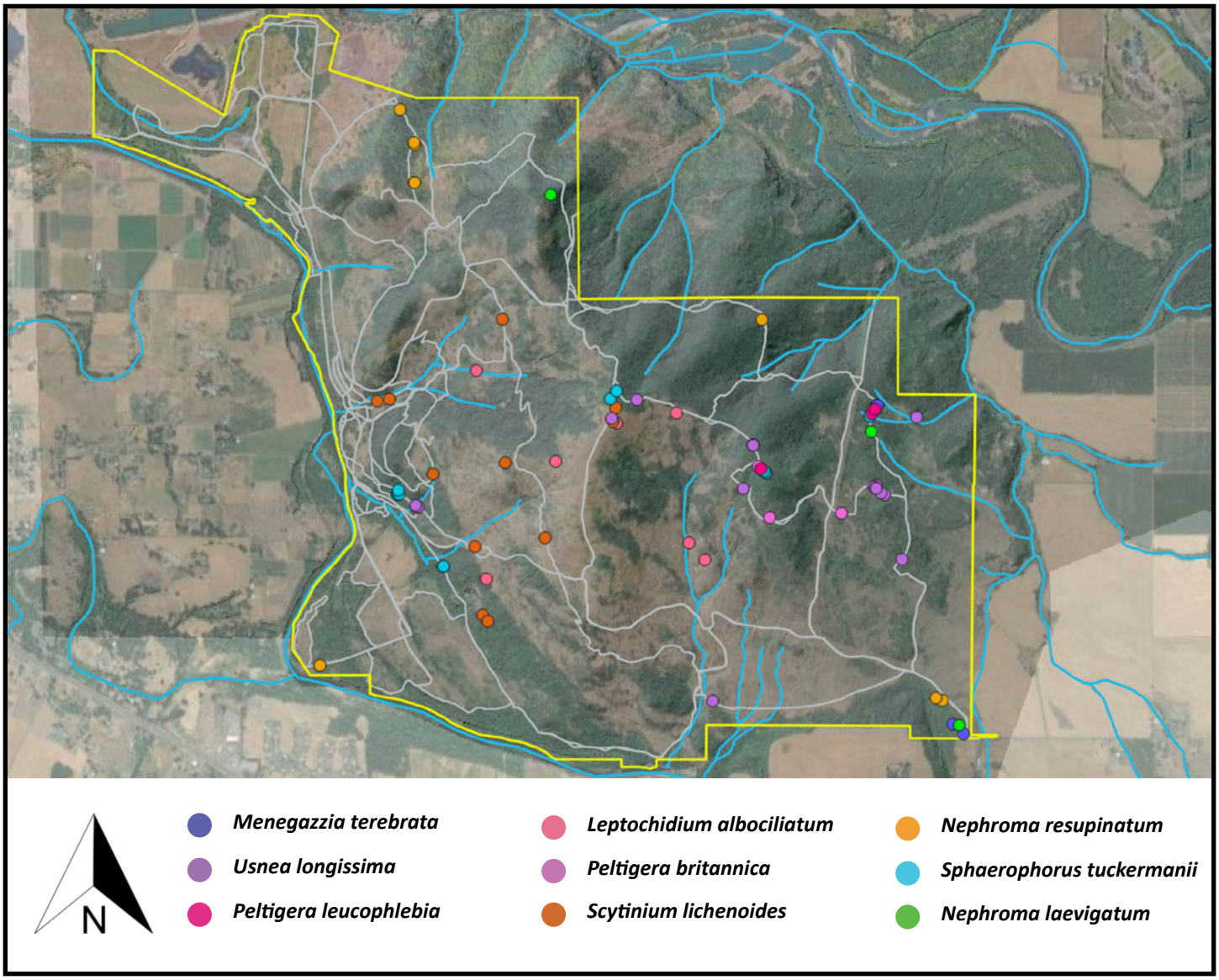

Figure 9: This map illustrates the locations of the nine sensitive lichen species which had the lowest relative species abundance (fewer than 20 observations) in comparison to all sensitive lichen species observed.