Biological Soil Crusts

Importance to Wilderness Character

In arid and semi-arid lands, vegetation cover often appears sparse or absent. Nevertheless, in the open spaces between the higher order plants, communities of highly specialized organisms exist. They are referred to as biological soil crusts and may constitute up to 70% of the living soil cover in some ecosystems. Occurring in hot and cold arid ecosystems, the soil surface appears lumpy, dark, and somewhat fuzzy. This is a complex mosaic of cyanobacteria, green and brown algae, lichens, mosses, microfungi, and bacteria, living symbiotically in patches within the top few millimeters of soil, and in some areas can build up over long periods of time becoming up to 15 cm deep. Each species in the soil crust carries out different roles: soil stabilizing species, stress tolerant species, water conserving species, and armoring species. These crusts are brittle, however, and so very sensitive to impact by human activity.

The organisms that form soil crusts can dry out and temporarily suspending respiration without negative effects. They are only metabolically active when wet, and when rare moisture is received, their growth leaves a trail of sticky mucilaginous sheaths as they grow, which aggregate soil particles. Cyanobacterial and microfungal filaments create the crust by weaving through the soil and gluing otherwise loose particles together into a matrix. This stabilizes and protects soil surfaces from water and wind erosion, increases soil fertility, facilitates water infiltration, preserves soil moisture, carries out carbon and nitrogen cycling, and provides germination sites for higher order plants. Otherwise unstable and highly erosion-prone surfaces become stable. Biological soil crusts are important to the health of arid land ecosystems.

Without biological soil crusts, non-biotic, or physical, soil crusts form in many arid regions. Physical crusts form with raindrop impact, which breaks up soil aggregates. With raindrop impact, smaller soil particles wash into spaces between larger particles. As drying takes place, surface tension pulls soil components together, forming a dense, strong layer which clogs soil pores and dramatically reduces water infiltration rates and increases water runoff and soil erosion, resulting in a loss of the stability, diversity, and productivity of the ecosystem. Management practices that promote plant and biological soil crust cover are the only lasting solution to prevent physical soil crusts from forming in many arid ecosystems.

Protecting biological soil crusts is a part of protecting the Natural Quality of wilderness character. Arguably, in some places where soil crusts are particularly distinctive, they may contribute to the Other Features of Value quality of wilderness character as an ecological or scientific value, and sometimes because of their scenic values (a well-developed soil crust sometimes gives an area a distinctive look). The presence of soil crusts contributes to ecological functions and stability of the wilderness ecosystem, so they are not only important for their own sake, they play an important role in the health of other organisms and the ecosystem as a whole. Consequently, wilderness managers may need to take special actions to protect this resource. This can include informing visitors of the resource, threats to it, and encouraging wilderness visitors to modify their behavior when visiting arid wilderness areas.

Implications to Wilderness Management

Recreation

Biological soil crust surfaces are frequently overlooked by even the most active arid lands hiker. Disturbance may result from activities that trample the soil crust, including that from animals and people hiking and camping. Though we don't have control over how wild animals travel, we can choose how we travel through and interact with arid lands, including the management of packstock and livestock. Trampling can eliminate soil crusts, but even when soil crust is not entirely lost, species richness may diminish, impacting the ecosystem functions soil crusts provide. Soil crusts are very fragile, especially during dry seasons; which is most of the time. Even the smallest amounts of pressure can expose the sublayers beneath the surface, leaving the crust susceptible to erosion. Within minutes, visitors walking on a well developed patch of biological soil crust can destroy decades of growth. Consequently, the way in which visitors recreate in arid lands is important to preserving biological crusts and the area's wilderness character.

Once a visitor has been made aware of the importance of biological crusts, and has been instructed on how to recognize them, visitors need to know how to travel and enjoy arid wilderness areas in a way compatible with protecting crusts. Key messages to provide visitors to arid wilderness areas include:

- Mature healthy cryptobiotic areas are easily recognized once you know what to look for, but more newly forming crusts often are without distinctive coloration or visible features.
- Stay on the designated trail. Going off-trail increases a visitor's likelihood of accidentally tramping soil crusts.
- Since many arid wilderness areas have few trails, visitors will inevitably hike cross country. Visitors should be informed to follow washes and other natural drainages where cryptobiotic crusts do not form. Walking or rock helps to avoid soil crusts, and a single step on a living bunch grass plant is less impacting than a step that breaks up soil crusts.
- If visitors do encounter crusts that they are unable to avoid, and so must walk across, they should know the best practice is for the group to walk in a single-file line, following each other's footsteps to minimize the impact.
- Because cryptogamic soils are very brittle and more easily harmed when dry, visitors should plan visits during the wetter time of year.
- Encourage visitors to camp in previously camped-in sites. Setting up a campsite in a pristine area is likely to destroy a large area of soil crust.
- If there are no campsites, visitors should look for a campsite on exposed bedrock or in a wash – **however, do not camp in a wash during rain or with thunderstorm activity present (even thunderstorms occurring many miles away) as flash flooding would be a life-threatening potential.**

Wilderness managers should make extra effort to monitor visitation activity in arid landscapes. If an area is becoming popular, acting before crusts become greatly impacted is important, because once they are gone, their recovery is typically very slow. Pay attention to social media posts that indicate growing popularity of a particular area. It would be better to have a single, properly located trail through an area than widespread trampling that destroys large areas of biological soil crusts.

Visitor Information Examples:

https://www.nps.gov/jotr/learn/nature/cryptocrusts.htm

https://www.nps.gov/articles/seug-soil-crust.htm

Grazing

Cryptobiotic crusts should be considered when making decisions regarding changes to grazing systems in wilderness. For example, the Congressional Grazing Guidelines (see the Grazing Toolbox) state that increases in AUMs may be permissible when there is no adverse impact on wilderness values such as plant communities, primitive recreation, and wildlife populations or habitat. Because biological soil crusts are very sensitive to impact, and because of their role in ecosystem stability, the impact to soil crusts must be a consideration in decisions to change grazing activity in wilderness. Likewise, consideration of grazing decreases should consider biological soil crusts. Per the Congressional Grazing Guidelines, curtailment of grazing must not be made simply because an area is designated as wilderness. Adjustments to grazing are only made based on range condition and the protection of range resources from deterioration. To the extent that damage to soil crusts causes range condition and resources to deteriorate, there may be a need to adjust grazing systems to provide protection from deterioration.

Restoration

The wilderness manager must keep in mind that engaging in restoration activities degrades the untrammeled quality of wilderness character. That is, taking actions that intentionally control or manipulate flora, fauna, or natural processes, degrades this quality even when the intended outcome is a positive one (such as returning an area to pre-disturbance condition). Attention must be given to all qualities of wilderness character to assure that whatever action is taken (including no action) preserves wilderness character as a whole, or in other words, on balance maximizes the preservation of all qualities of wilderness character. Experimental restoration attempts in wilderness would generally not be appropriate. Four different approaches have been used in restoration work, and all four must address the symbiotic mosaic of biological soil crust species that include soil stabilizing species, stress tolerant species, water conserving species, and armoring species.

1. Passive stabilization

   Restoration through stabilizing a site and allowing for natural recovery is estimated to take 10 to 50 years, or more for a fully functional soil crust ecosystem. Some sites may never recover as once damaged, the site continues to degrade with pieces of the crust carried away by wind and water, and in addition, exposed mineral soil blows onto adjacent patches, covering and killing them. This approach does not degrade the untrammeled quality of wilderness character.

2. Collect soil crusts from elsewhere and crumble them into a restoration site

This is a very effective technique, but another site has to be disturbed. The plus is that more area is restored than the area disturbed. Generally this is practiced by salvaging soil crust from places where impact is imminent (for example, from an oil well drilling site outside the wilderness. Since crusts don't store well, they need to be put into the restoration site immediately.

3. Collect crusts, enhance volume in the greenhouse and reintroduce

   Small collections of crusts can be collected from near the restoration area, then grown and multiplied 50 to 100 times before being put into the restoration site. This technique requires a lot of greenhouse capability.

4. Culture species in the greenhouse and reintroduce

   Growing species from the region in the greenhouse for general large scale reintroduction is desirable because the other techniques tend to be small inputs to large impacted areas. Species could be efficiently "planted" much like aerial seeding, thereby addressing large areas. The drawbacks are that this technique is costly, logistically difficult, and unanswered biological questions are present. To fully evaluate this technique for appropriateness in wilderness, the genetics of species need to be better understood to determine how genetics vary throughout the region, and thus, how diverse species are, to assure that genetic variation is preserved. Consequently, this technique is not appropriate in wilderness at this time.