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Research Brief for Resource Managers

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Restoring Desert Biocrusts after Severe Disturbances

Chiquoine, L.P., S.R. Abella, and M.A. Bowker. 2016. Rapidly restoring biological soil crusts and ecosystem functions in a severely disturbed desert ecosystem. Ecological Applications 26: 1260-1272.
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Biocrusts can include lichens, mosses, fungi, and microorganisms (e.g., cyanobacteria) that form a layer on top of soils. While biocrusts occur in many ecosystems, they are particularly abundant in deserts. Biocrusts provide several ecological functions, such as stabilizing soil to limit erosion, influencing nutrient cycling, affecting vascular plant establishment, and augmenting biodiversity.

Strategies for successfully restoring biocrusts and their ecological functions would be useful for many applications, including restoration after severe soil disturbances and in post-fire rehabilitation. However, most conventional wisdom holds that once disturbed, biocrusts can require decades to centuries to recover naturally and are not necessarily amenable to rapid restoration.

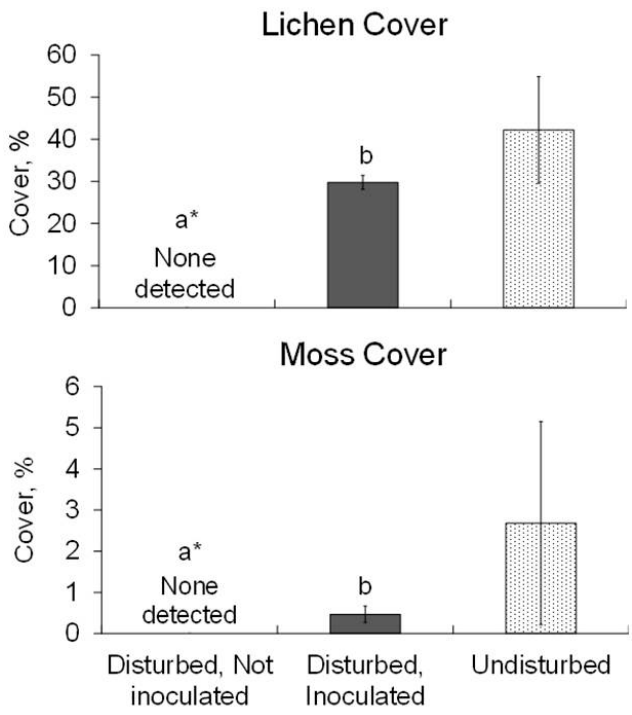
Collaboratively with the National Park Service, we performed a study along Northshore Road in Lake Mead National Recreation Area (eastern Mojave Desert, Nevada) to develop biocrust restoration strategies. Periodic highway maintenance – including re-routing portions of the road – severely disturbed soil in several sections of the park. Before construction, we salvaged and stored biocrust material. In 2010, after construction, we applied the salvaged biocrust material and other soil amendments at restoration sites.

Management Implications

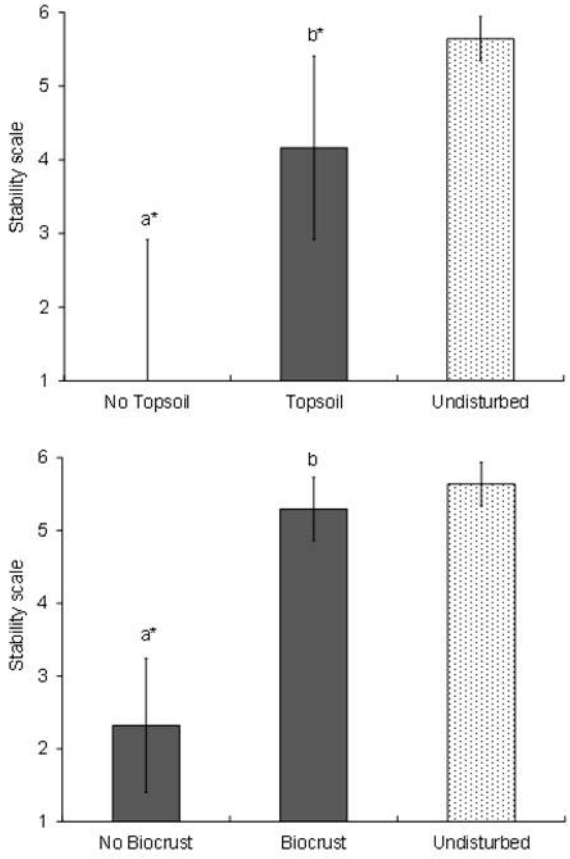
- Salvaging and reapplying biocrust material resulted in surprisingly rapid recovery of biocrust communities and soil stability within two years.
- Other soil amendments, like wood shavings, planting shrubs, and applying salvaged topsoil, had variable effects on soil recovery, with topsoil salvage being most beneficial among these other amendments.
- When soil material can be salvaged prior to planned disturbances, it can increase subsequent options for restoration.

Within two years, biocrust cover at restoration sites did not differ significantly from undisturbed reference plots. Furthermore, lichen and moss species composition was 58-91% similar between restoration and reference plots. This surprisingly rapid recovery was driven by inoculation with the salvaged biocrust material.

View of site severely disturbed by road construction activities in Lake Mead National Recreation Area (2009). One of the sites where efficacy of restoration was examined using a variety of treatments. Photos by L.P. Chiquoine.



Effects of inoculation with salvaged biocrust material on the cover of lichens and mosses at restoration sites and compared to undisturbed reference plots, Lake Mead National Recreation Area. Letters note differences significant at P < 0.05 between treatments. Error bars are 2 standard errors of means.



Effects of applying salvaged topsoil (top graph) and biocrust (bottom graph) on a soil stability index and compared with undisturbed reference plots, Lake Mead National Recreation Area. Letters note differences significant at P < 0.05 between treatments. Error bars are 2 standard errors of means.

Other soil amendments, including applying salvaged topsoil, wood shavings, and planting shrubs, had inconsistent effects but sometimes positively influenced biocrusts. For example, applying salvaged topsoil increased the abundance of cyanobacteria and chlorophyll concentrations.

Disturbed but unrestored plots had highly unstable soils susceptible to wind and water erosion. In contrast, plots receiving either salvaged topsoil or biocrust material exhibited soil stability indices approaching those of undisturbed soils.

Results demonstrated that applying salvaged biocrust material to severely disturbed soil rapidly reestablished favorable biocrust characteristics and stabilized soil relative to doing nothing. This is likely a useful restoration strategy when unavoidable soil disturbances are planned and there are opportunities to salvage material.