CLIMATE ADAPTATION AND BIOCRUST RESTORATION IN DRYLANDS

AT A GLANCE

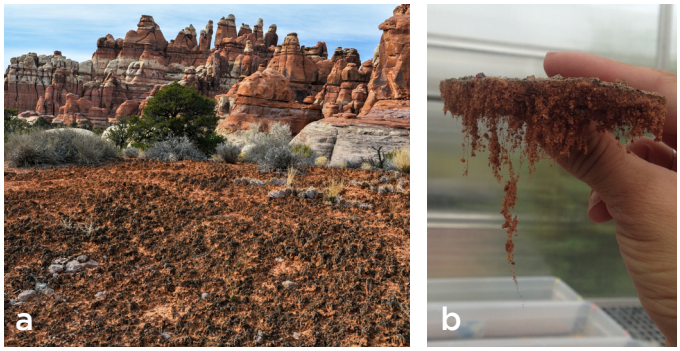
Effective and sustainable land management may depend on our ability to restore biological soil crusts that will survive not only today but in the predicted future climate.

Climate-adapted restoration efforts could offer new opportunities to restore biocrusts and their functions — such as stabilizing soils — in communities that can be resilient in the face of climatic change.

WHAT IS BIOCRUST & WHY IS IT IMPORTANT?

Biological soil crusts (biocrusts) are a surface community of lichens, mosses, cyanobacteria, and related organisms living on soils worldwide. Wherever soils have direct access to the sun, biocrusts have the potential to exist. Biocrusts occur on all continents and a recent global estimate says that biocrusts cover about 12% of the Earth's total land surface. Biocrusts are particularly common in arid and semi-arid ecosystems, such as in the deserts of the southwestern United States.

Biocrust communities play critical roles in ecosystems, fertilizing and stabilizing soils. This delicate "skin" is crucial to plants and wildlife, and prevents erosion caused by wind and rainstorms.



(a) Biological soil crust on the Colorado Plateau. Biocrusts are the black bumpy soil in the spaces between plants. Biocrusts perform many critical ecosystem functions in drylands worldwide. Photo: Bill Bowman (b) One important function biocrusts perform is soil stabilization. This photo shows biocrust tendrils holding soil together. Photo: Kristina Young

KEY MESSAGES

- Biocrust restoration offers land managers new ways to increase soil stability and ecosystem resilience.
- Biocrust restoration practices may require intact biocrusts in order to "inoculate" disturbed lands. You can salvage biocrusts slated for development (which would otherwise be destroyed) and use them for restoration.
- As with the planting of grasses and shrubs, using organisms more likely to survive in the predicted future climate increases restoration opportunities and success.
- The assisted migration of biocrusts between North American deserts may provide successful restoration options, although risks must be simultaneously evaluated.
- New research is improving our understanding of the opportunities and challenges associated with climate-adapted biocrust restoration.
- Biocrust restoration offers powerful outreach and educational opportunities.

BIOCRUSTS ARE VULNERABLE

While resistant to wind and water erosion, biocrusts are highly susceptible to compressional forces, such as those generated by vehicles, bikes, hooves and human foot traffic. The changing climate, however, poses an even bigger threat to biocrust. In a study conducted by the U.S. Geological Survey in Utah, long-term experimental climate warming resulted in major changes to the biocrust ecosystem ecosystem, including dramatic loss of biocrust mosses, which provide high levels of ecosystem services. These patterns are in line with biocrust losses with warming climate that have been suggested at the global scale.

The two illustrations depict a dryland ecosystem: (left) with intact biocrust communities providing soil stability and fertility; and (right) without intact biocrusts that result in erosional soil losses, dust production, and ecosystem function decline. Illustrations: Brooke Weiland Studios LLC

HOW DOES CLIMATE-ADAPTED RESTORATION WORK?

Scientists are researching how to restore biocrust communities that can survive in the hotter, drier climates predicted for the southwestern United States.

Assisted migration of biocrusts from hotter, drier climates and large-scale cultivation of climate-adapted biocrusts in "biocrust farms" has been demonstrated on the Colorado Plateau. These efforts have also led to large-scale, climate-adapted biocrust restoration projects, working to restore many acres of degraded drylands.

A recent outdoor cultivation experiment showed that biocrusts collected from the Mojave and Sonoran Deserts grew better in a biocrust farm on the Colorado Plateau compared to biocrusts locally collected on the Colorado Plateau. This study suggests biocrust from hotter deserts may enhance establishment and restoration success in some settings.

To date, biocrust inoculum source has been mostly cultivated under lab and greenhouse conditions, but scaling up restoration efforts to larger areas could benefit from large-scale cultivation in outdoor nurseries or "biocrust farms." These organisms may also be naturally "hardened" to survive. This is the world's first outdoor biocrust farm near Moab, Utah. Photo: Kara Dohrenwend

POTENTIAL RISKS

During the cultivation experiment on the Colorado Plateau, weeds from some of the source locations also grew and needed to be dealt with carefully. It's important to consider the potential risks associated with assisting in the migration of biocrusts (for example, unintentionally bringing in foreign species or disease) and weigh those risks against the climate-induced loss of existing biocrust communities and their function.

LEARN MORE

This is an exciting time for biocrust restoration and a great deal of work is informing innovative practices. Salvage, cultivation, and application of biocrusts done in a framework of climate adaptability may provide improved restoration success that can be sustained into the future.

Progress on climate-adapted biocrust restoration and new knowledge has been synthesized in a Biocrust Restoration Manual, which will be a "living document," updated as our knowledge grows. The manual gives additional information about restoration options and considerations. You can access the current Biocrust Restoration Manual at: canyonlandsresearchcenter.org

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