Moss and Biocrust Project Update
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Background and purpose

Plant-soil feedbacks affect community development and ecosystem processes. Vascular plants bias our understanding of these feedbacks due to their large biomass, productivity, and diversity. Non-vascular plants (bryophytes) affect communities and ecosystems differently than vascular plants. Mosses function as ecosystem engineers, affecting both the plants around them and the microbial communities below. Bryophytes play a role in hydrology and soil stability, and facilitate soil microbes, fungi, microarthropods, and cyanobacteria. This positively affects ecosystem functioning. Along with vascular plants and soil microorganisms, non-vascular plants cycle carbon (C) and nitrogen (N). Despite their ecological importance, the bryophyte component of ecosystem relationships is historically understudied. Restoration efforts rarely include bryophytes, even when they were present before a disturbance. Inclusion of bryophytes may facilitate land recovery and encourage transition from a degraded state to a more desirable state (Bowker 2007). In an attempt to determine the feasibility of using bryophytes in restoration, we have established manipulative field experiments to investigate the following questions:

1) How can we best "seed" mosses while taking into account the relative ease of restoration, costs, and bryophyte productivity?

2) What are the subsequent effects of these mosses on the soil microbial community?

These experiments provide a novel opportunity to explore the impact of bryophytes on ecosystem recovery.

Protocol

Timing

We installed two treatments to coincide with the seasonal conditions conducive to bryophyte proliferation. We completed the first installation in Fall 2013 after the first rain and the second in Spring 2014 after snowmelt. Treatment timing may determine success. Previous research and personal experience note wind can displace dry moss fragments (Jones 2002). We hope to see greater moss proliferation by coordinating treatments to coincide with precipitation and moss protonema expansion (the first part of the moss life regenerative life cycle).

Species

Cole et al. (2010) found bryophytes transplanted better when origin conditions matched new conditions. We selected two species assemblages present on the property near the experimental plot. *Syntrichia ruralis*, a later seral species, constitutes the most abundant moss in these established sunny intermontane grasslands. Disturbed sites that support an early successional bryophyte community may be more resilient for restoration. We mixed *S. ruralis* and the early successional community mixture in our experiments. We collected plant materials for the slurry application from the MPG Ranch in June of 2013. We dried and stored the moss material according to standard protocol.

Slurry application

Jones (2002) determined dried moss fragments should be applied to soils at a rate of 19.6 g moss tissue (dried) per 20 m^2 of soil. We blended dried moss (3 g per plot) into a slurry with water and then added a substrate within the slurry to better weigh down the moss fragments (Scarlett 1994). We applied ten replicates of two slurry mixtures (with water or with water and clay) to the jute treatments described below.

Jute mesh

We added two jute treatments to reduce material loss from wind and runoff. We applied a moss slurry (either with or without clay) below jute, on top of jute, or with no jute as a control (n=10). We attached the jute to the ground with landscaping staples for stability.

Microbial inoculation

Disturbance can affect not only the plant community but the soil microbial community as well. Since mosses form associations with cyanobacteria, fungi, and other soil microorganisms, we attempted to expedite this process of below-ground reestablishment by inoculating half of our treatments with the local microbes found in co-occurring biological soil crusts. We collected biological soil crusts from the same general area as the mosses we used in the slurry treatment. The biocrust included lichen, algae, fungi, and cyanobacteria. We replicated every treatment (slurry and jute) with or without soil crust inoculant (n=10).

Plug transplantation

Recovery of bryophyte populations in semi-arid grasslands of this sort remains largely unstudied. Relevant research in drier systems suggests that natural recovery of different species of *Syntrichia* could take approximately 15 years (Stark et al. 2000). Cole et al. (2010) transplanted intact cores of bryophytes in the Mojave Desert with relative success. They included the upper cm of soil and sprayed the moss prior to transplanting to rehydrate both the soil and moss. They found hydrated moss transplanted better than dehydrated moss. We transplanted cores of both species assemblages from intact populations into our study site following the protocol of Cole et al. (2010) to determine the efficiency of this method. We added plugs to the plots with or without biocrust inoculum (n=10).

Monitoring

We replicated each treatment twice (slurry, jute, inoculum, and plug). In the first treatment we will monitor above-ground plant growth metrics. We will use the second treatment for below-ground metrics (these require soil removal that could disturb above ground accuracy). A no-treatment, soil-only, control was replicated ten times for comparison.

Statistically adequate replicates of these treatments resulted in the installation of 280 1/4 m^2 plots per season. We will monitor and gently weed plots throughout the growing season. We will record annual measures of percent cover and species abundances. We will take annual soil samples to monitor any potential differences in available nitrogen, soil C:N, enzyme activity, and soil pH.

Visual inspection of our Fall 2013 installed plots reveals intact moss fragments and growing moss plugs. We have allotted four years for this study.

Bryum sp. plugs transplanted fall 2013 adhered to the soil surface. The blue line approximates the frame that delineates each plot.

Syntrichia ruralis, a later seral species, grows throughout the ranch across habitat zones.

References

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