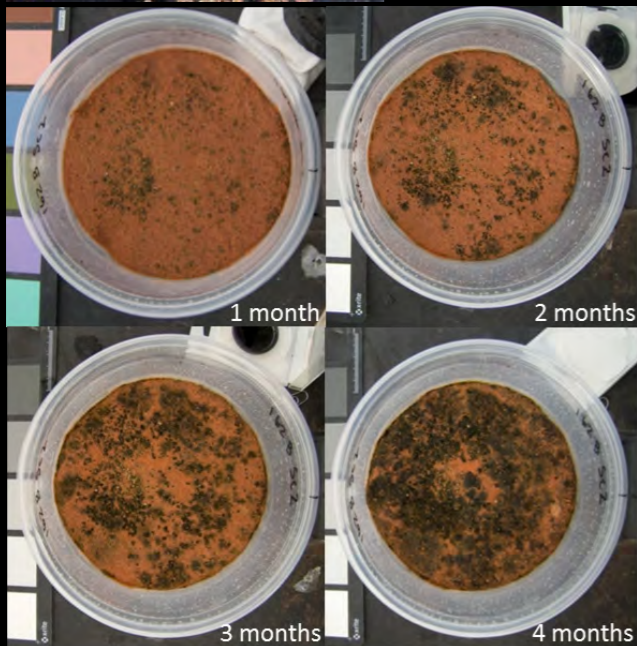
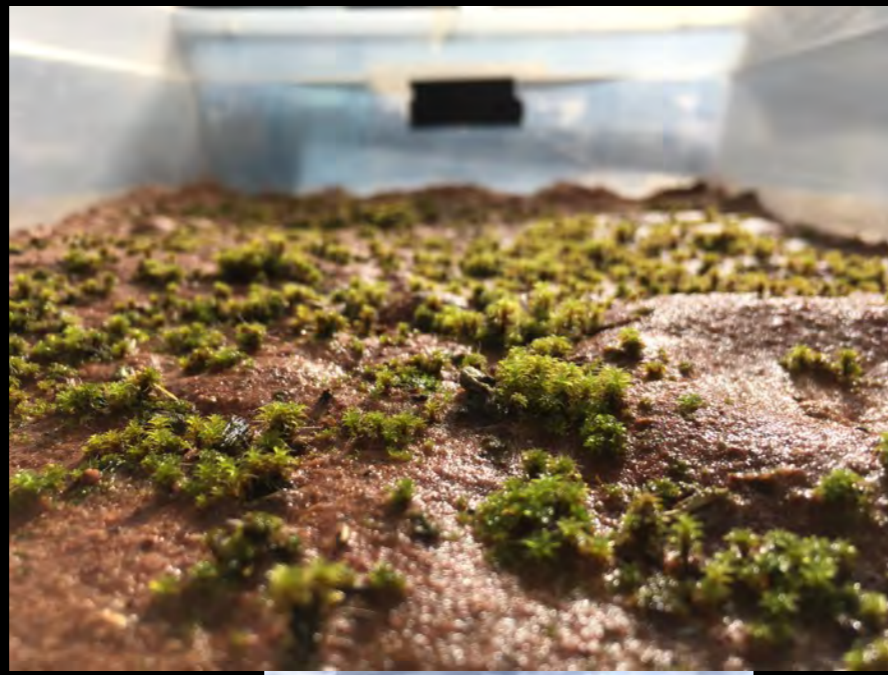


# Soils rehabilitation with biocrusts: A review of current technologies

Kyle Doherty, Matthew Bowker, Anita Antoninka, Henry Grover, Kristina Young, Rebecca Durham



# Roadmap

- Intro: What are biocrusts?
- Advances in propagation
- Hardening and establishment
- Importance of timing treatments
- Ongoing projects and future directions

# Biocrust!

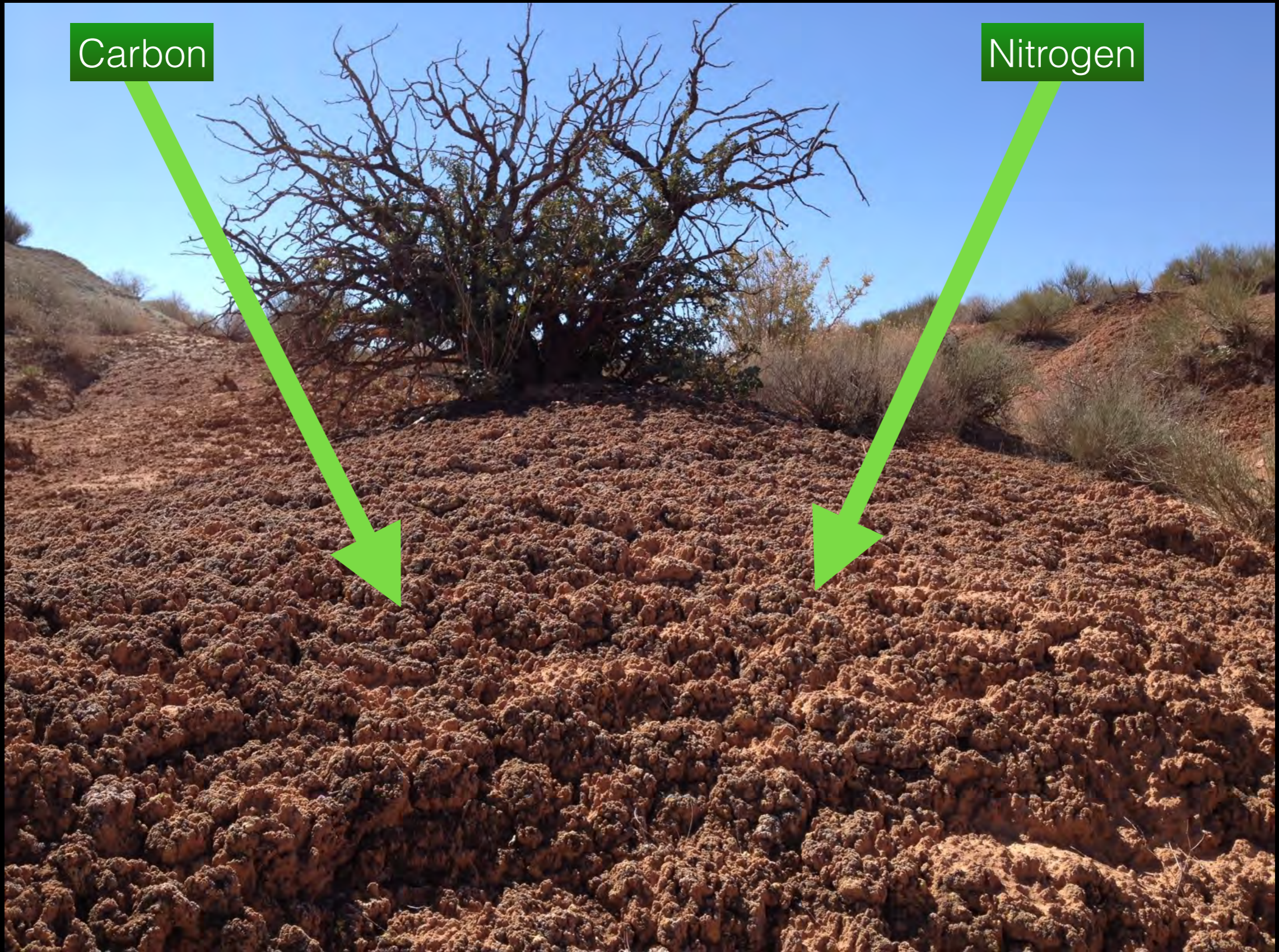


# Soil Stabilization



Carbon

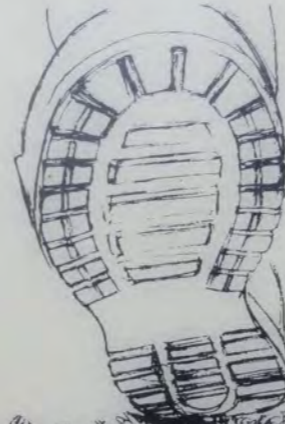
Nitrogen



At first glance the desert topsoil  
looks like an old dry crust.  
TAKE A CLOSER LOOK.

## It's Alive!

That lumpy  
black crust  
is actually a  
living web of  
bacteria,  
moss, lichen,  
fungus and  
liverworts.



Microbiotic  
crust controls  
erosion, stores  
water, fertilizes  
soil and provides  
seed beds for  
all plants from  
wildflowers  
to trees.



Don't bust the crust

## Stay On The Trail

One footprint can crush  
a decade's worth of growth.



...but I heard they grow slowly?

# Forest and Rangeland Soil Ecology Lab Group



**School of Forestry**

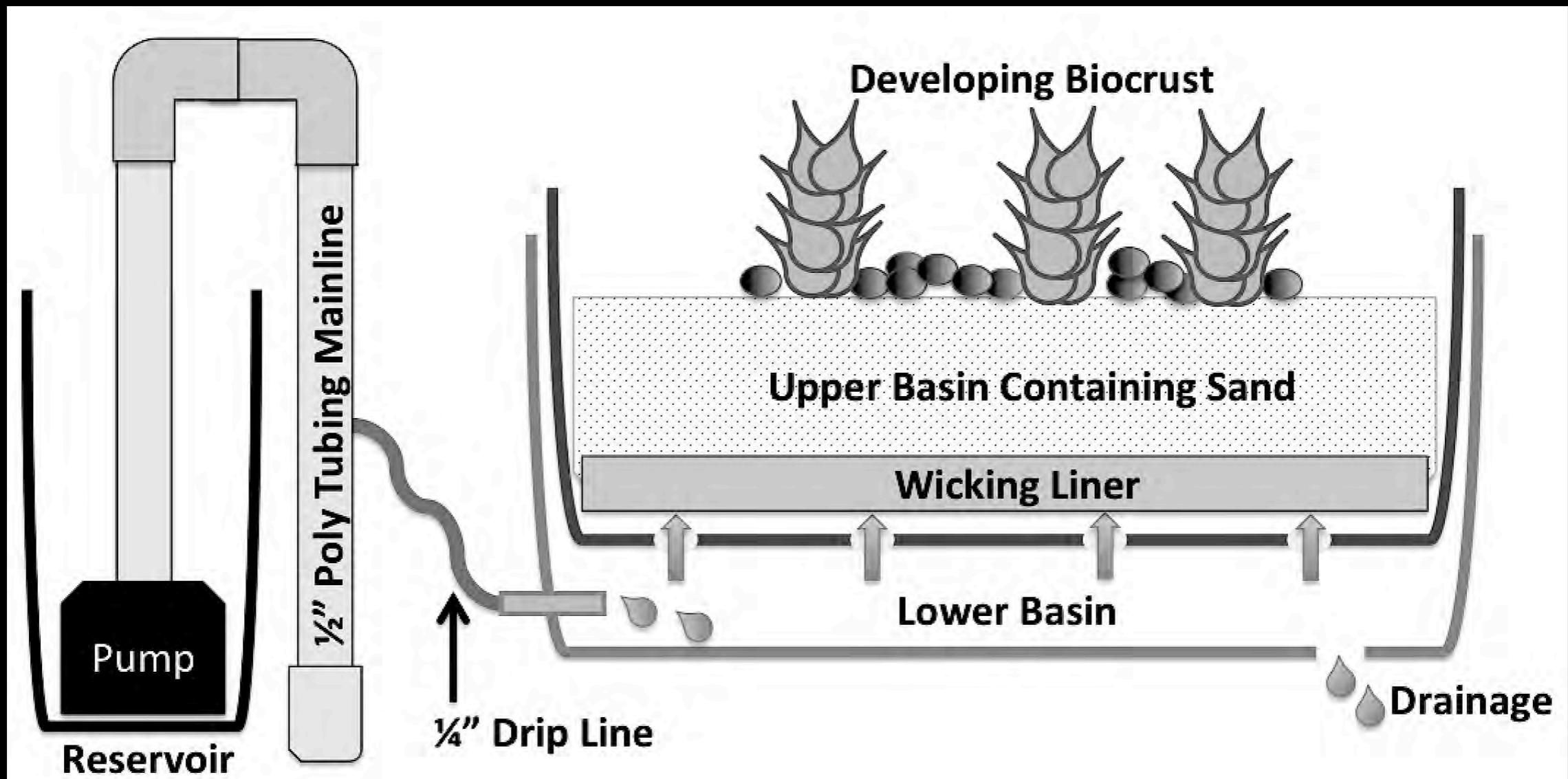
# Forest and Rangeland Soil Ecology Lab Group



School of Forestry



# Propagation



**Doherty et al. 2015**

# THE BRYOTRON



# Experiments with *Syntrichia ruralis*

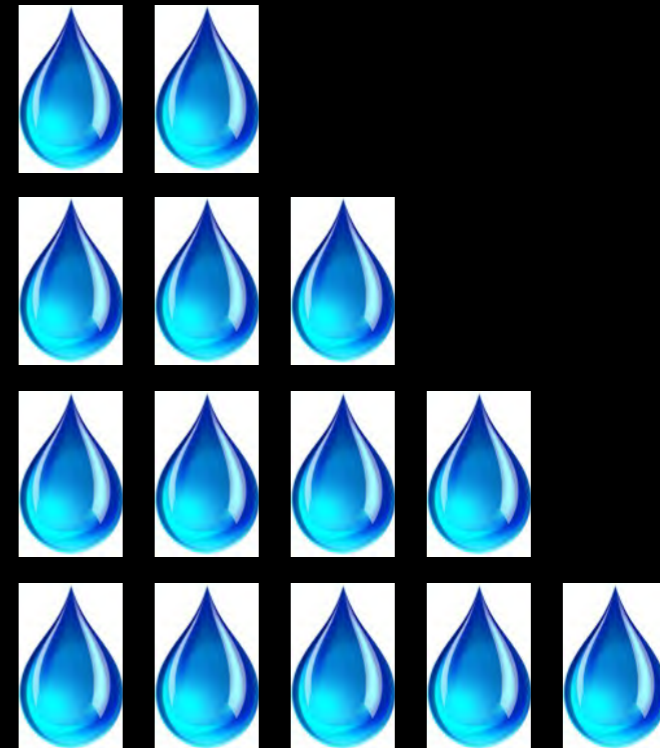


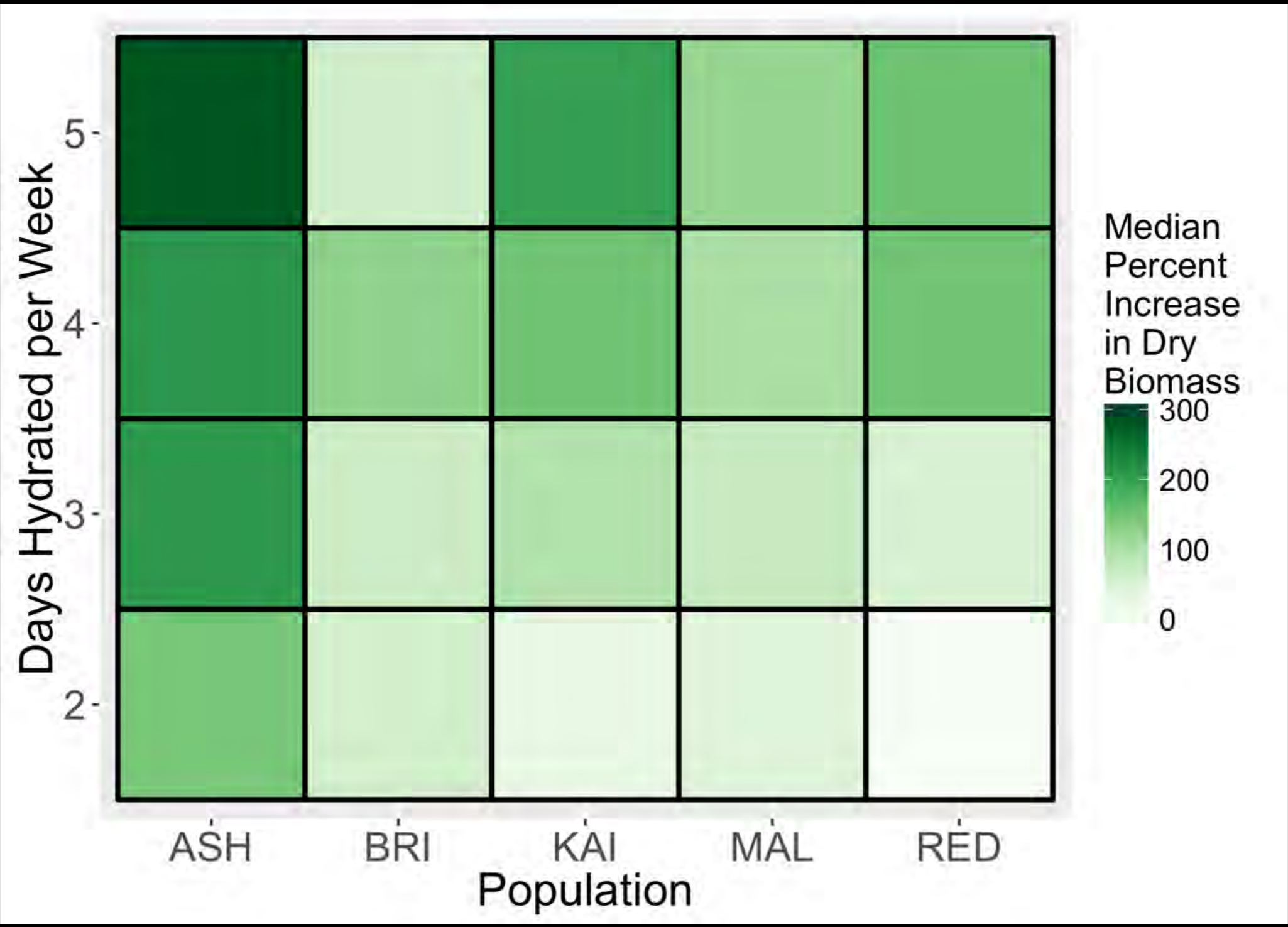
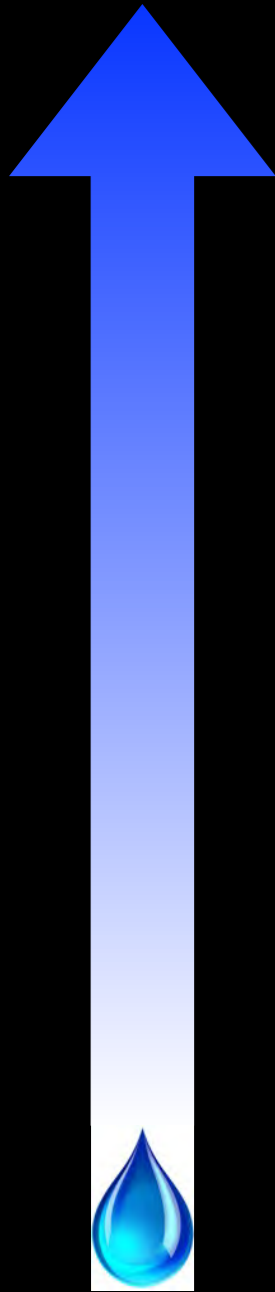
5 Populations



X

Days per week hydrated





### ANOVA result

Effect	DF	F-value	p-value
Population	4	7.9242	<0.0001
Hydration	3	29.5009	<0.0001
Interaction	12	2.2048	0.0244

(5 month exp.)

# Physiologically stressful watering



Rapid drying  
<1hr

Pulse of mist

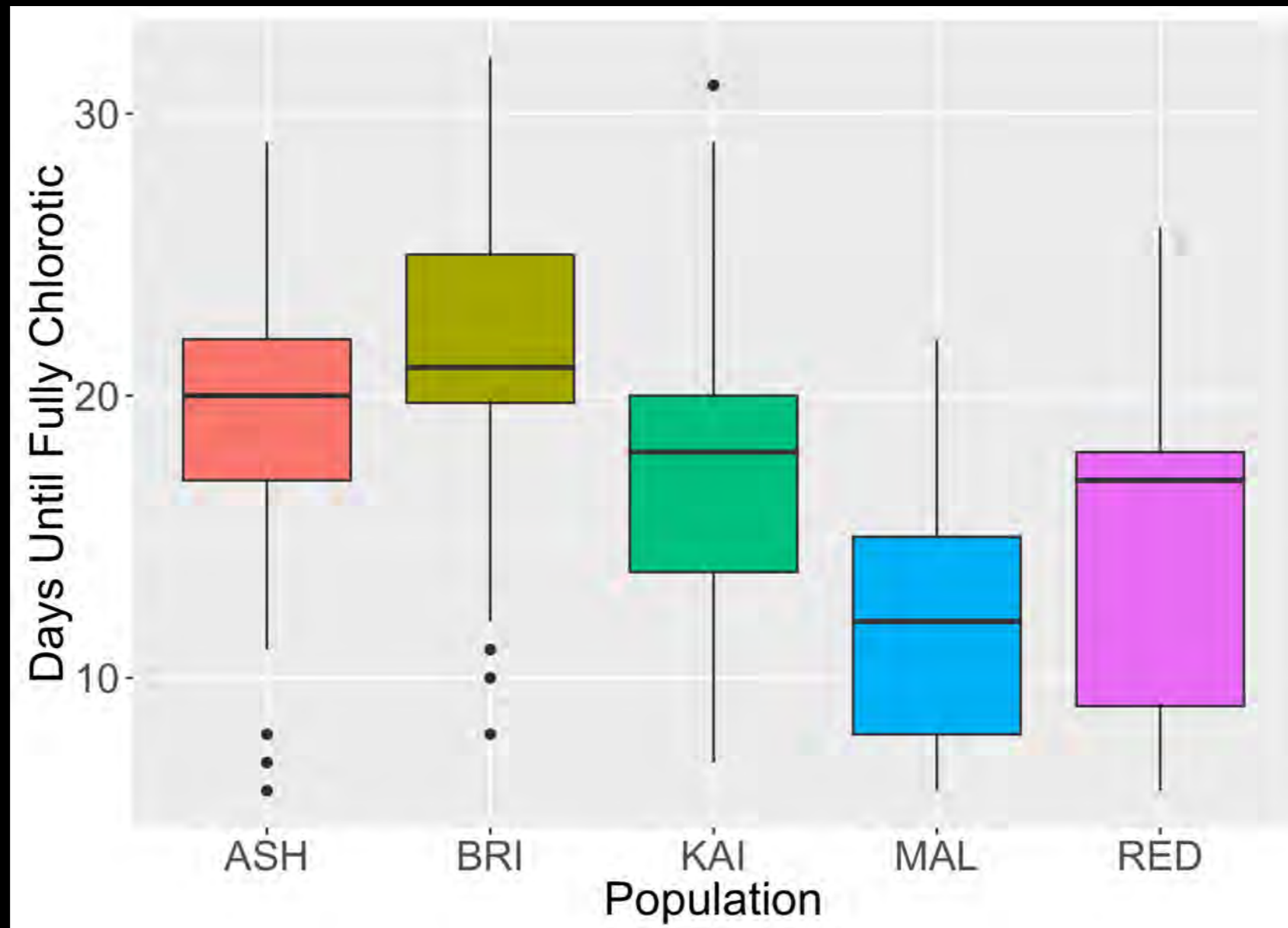


Green cultivated moss

Measured how many spritzes until yellowing?

Experiment performed by our technician **Jeff Wright**

# Yes, differential acclimation/adaptation to watering stress



Effect	DF	F-value	p-value
Population	4	8.5496	4.946E-06 ***
Prior Watering	3	1.4229	0.2401
Interaction	12	1.1358	0.3394

***Prior watering from first experiment had no effect!***

# Fire Moss



2 years post-fire







***Bryum argenteum***



***Funaria hygrometrica***



***Ceratodon purpureus***

# Potential applications: Burned Area Emergency Response (BAER)



Two Species

Sandy or  
Organic  
Soils

Ash,  
charcoal,  
or both



X

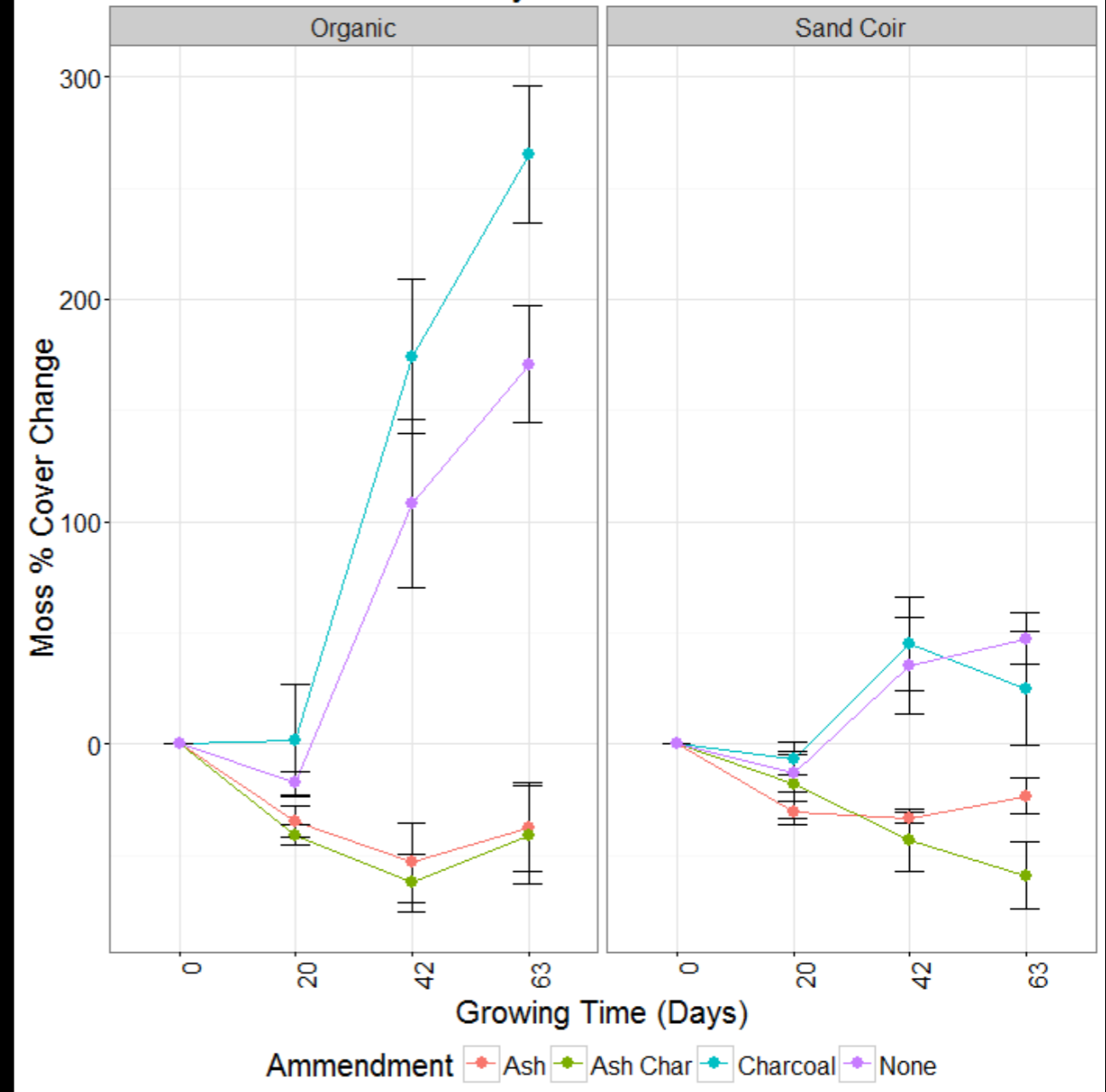
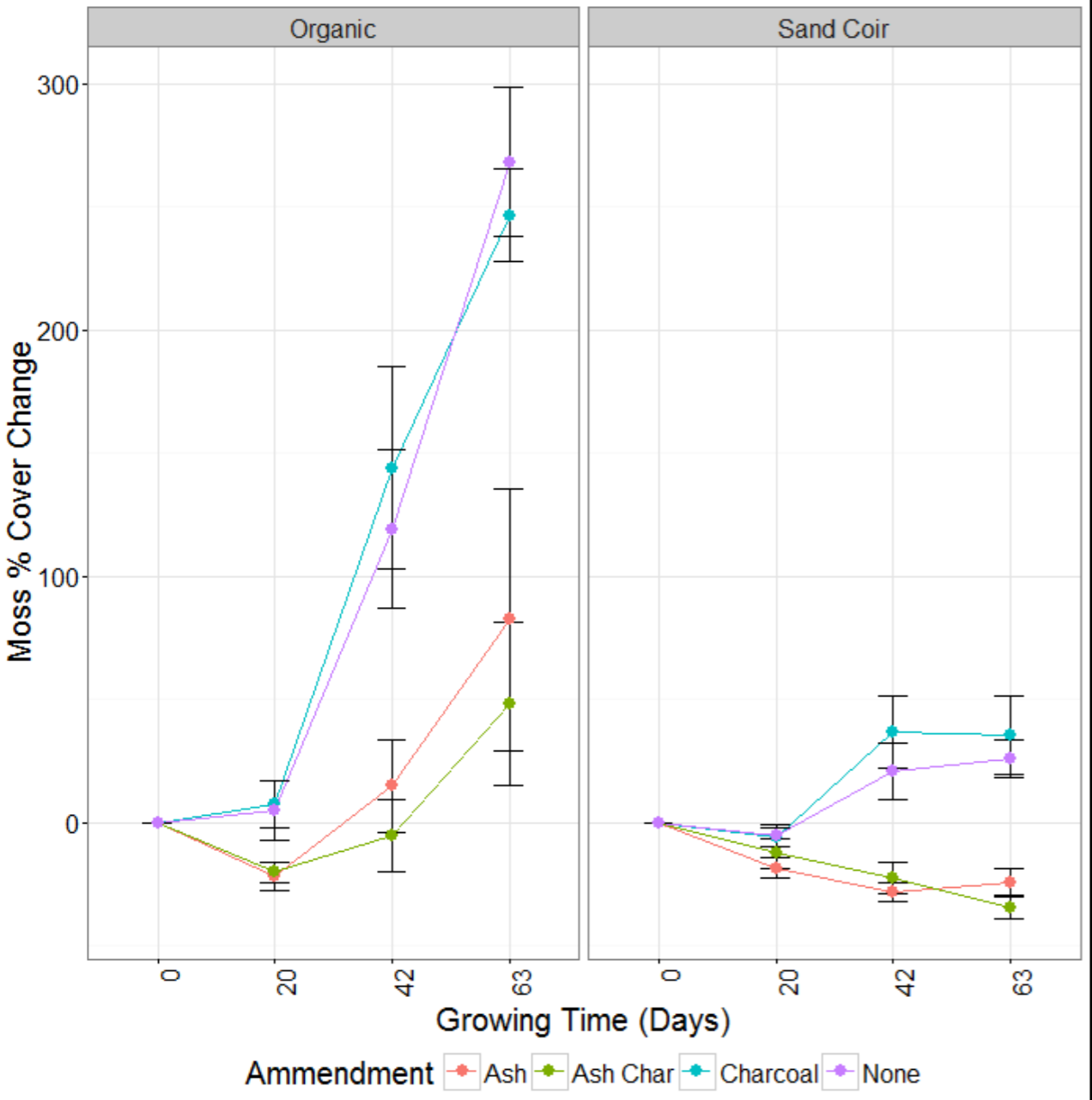
X





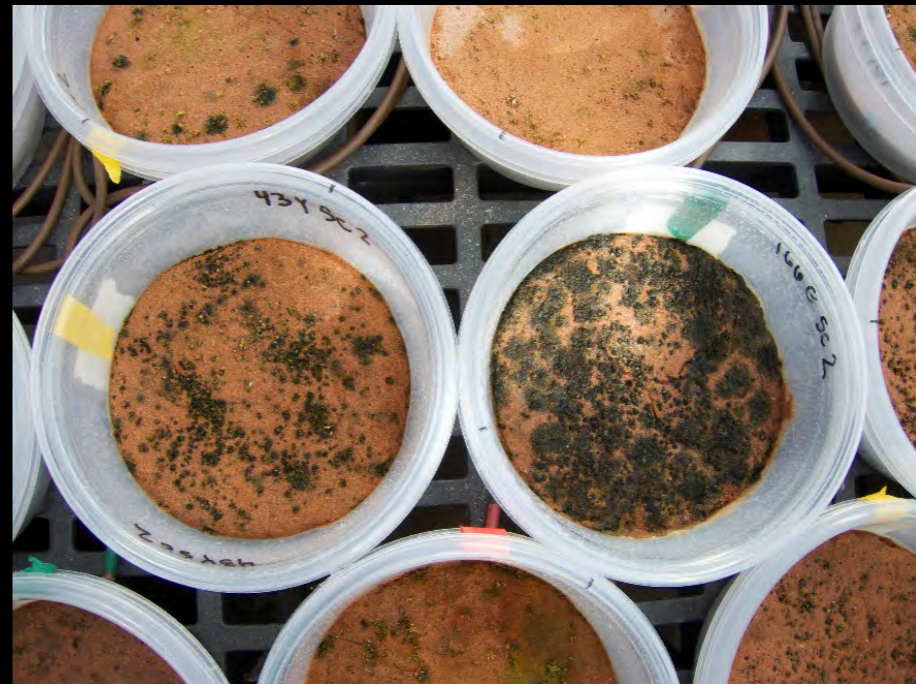
Funaria Addition

Bryum Addition



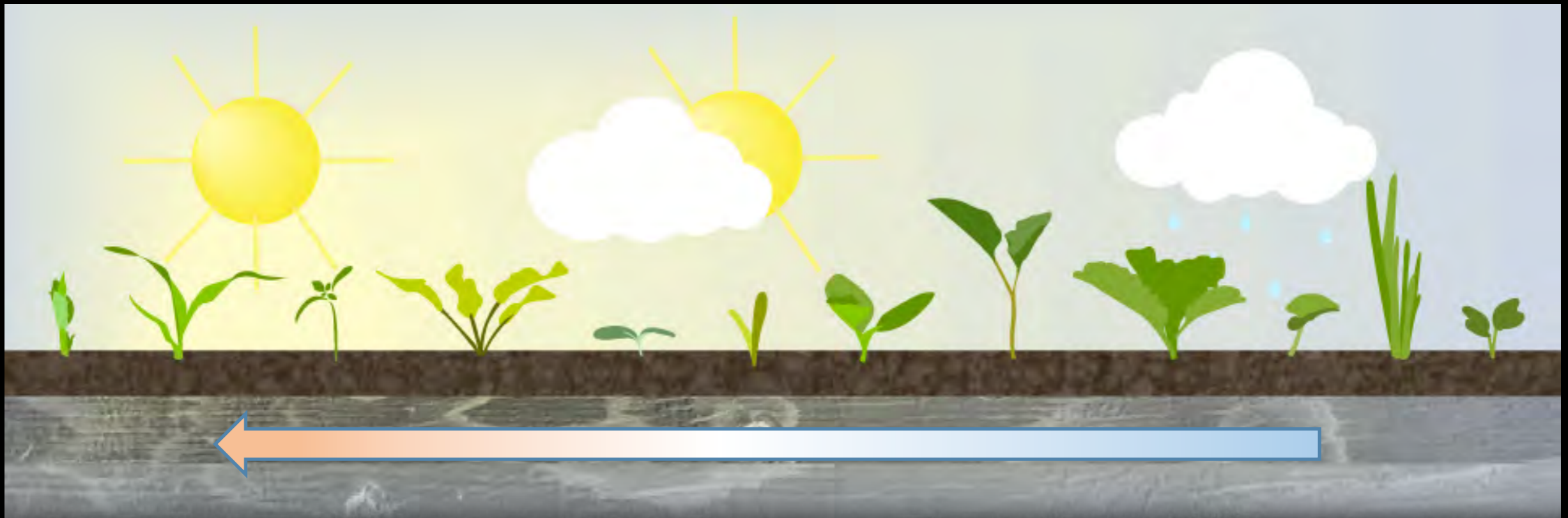
## Early on we established:

1. We can rapidly cultivate diverse and functional biocrusts from most starting material
2. Optimal culture conditions vary depending upon the organism and system



# **Hardening and Field Establishment**

# Maximizing field hardiness



As with nursery plants, biocrust might need some help adapting from the luxurious greenhouse conditions to the harsh field conditions

# How well does our inoculum survive in the field?



4 watering treatments (2,3,4,5 days continuous hydration; from Antoninka et al. 2015)

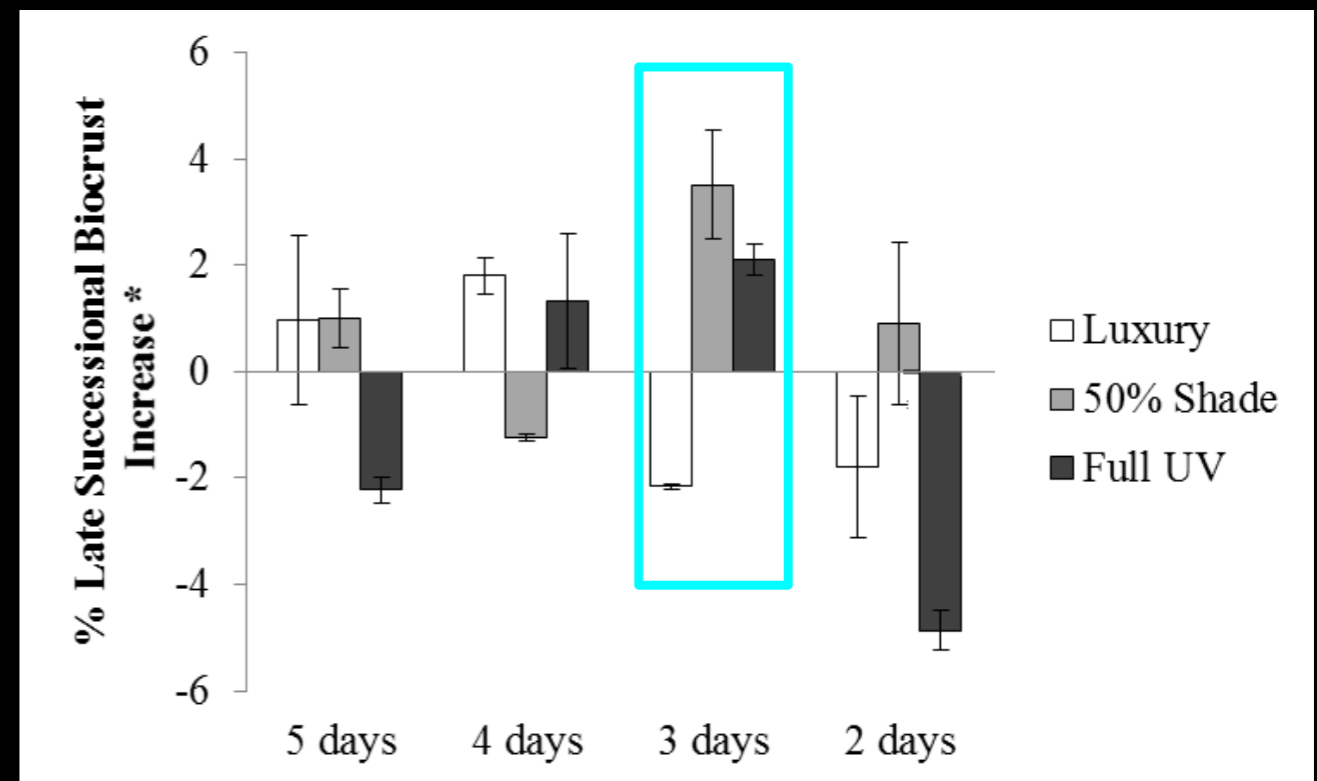
Hardening for 21 days:

1. **Luxury** (GH conditions, 24 hours water)
2. **Full UV** and 2-3 hours hydration
3. **½ UV** 2-3 hours hydration





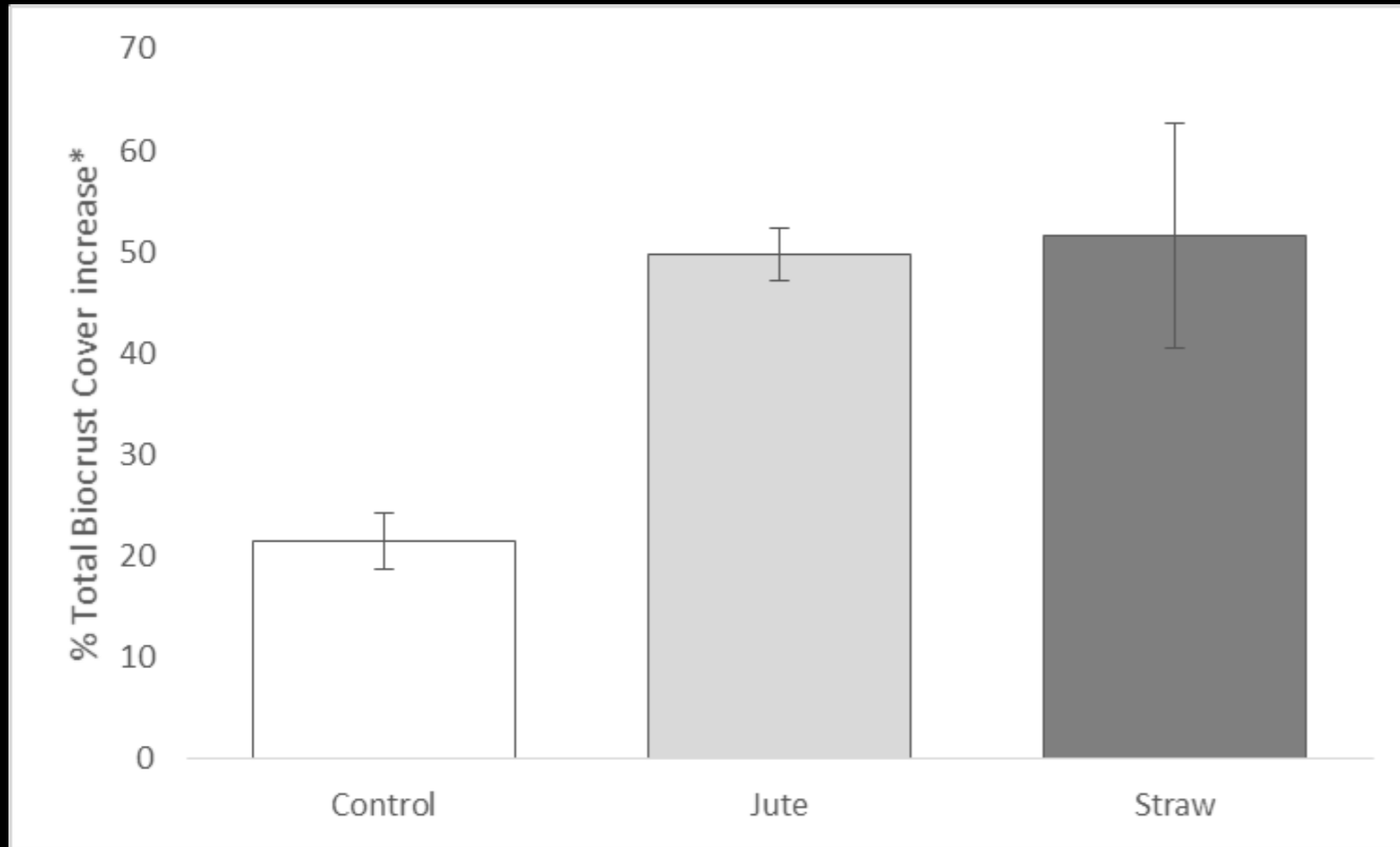
# Best results with outdoor hardening and short duration watering during cultivation period



\*Total cover-inoculum addition-cover in control plots

# Results so far:

## 1. Jute and Straw improved biocrust establishment

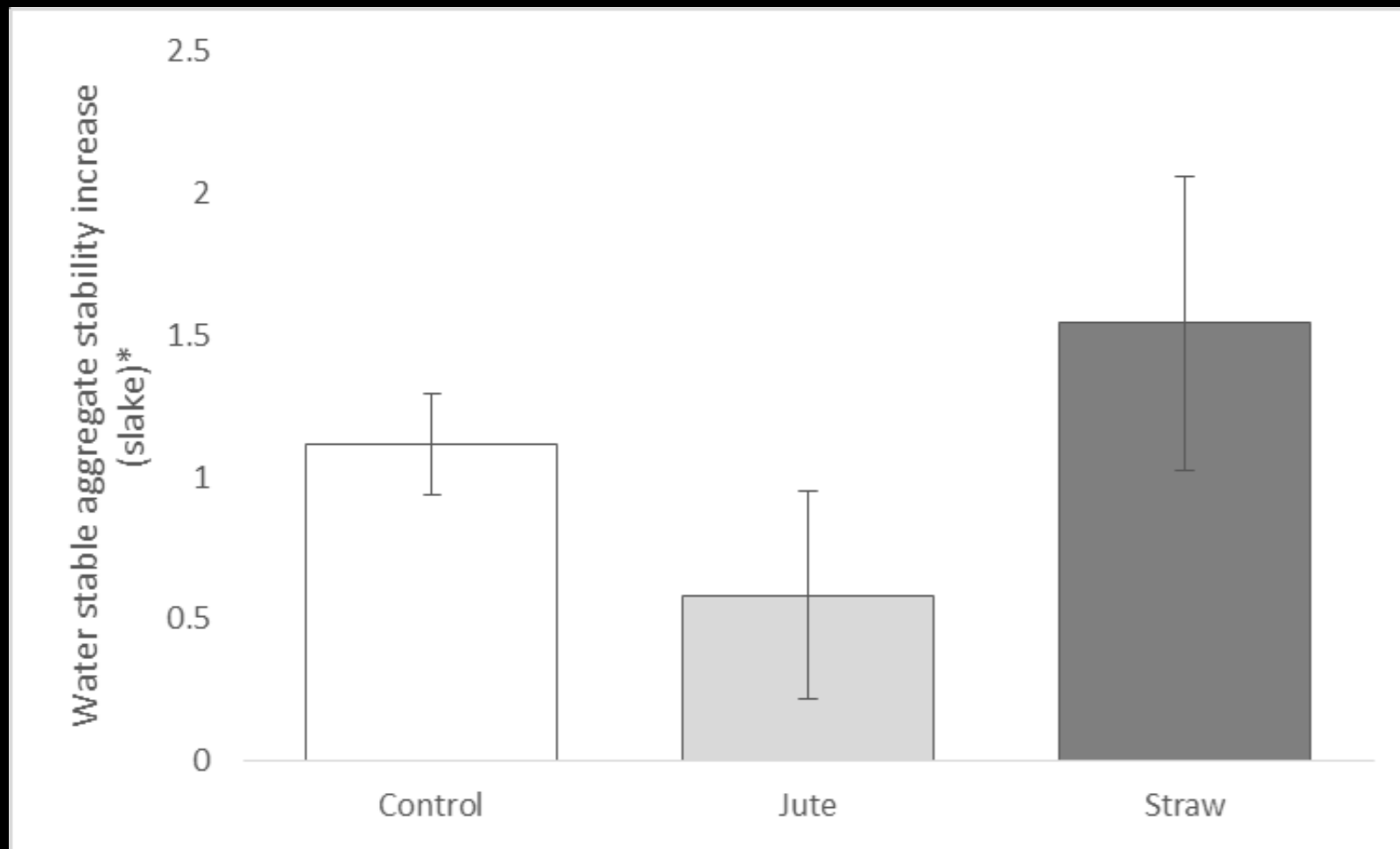


\*Total cover-inoculum addition-cover  
in control plots



# Results so far:

1. Jute and Straw improved biocrust establishment
2. Straw better for stability

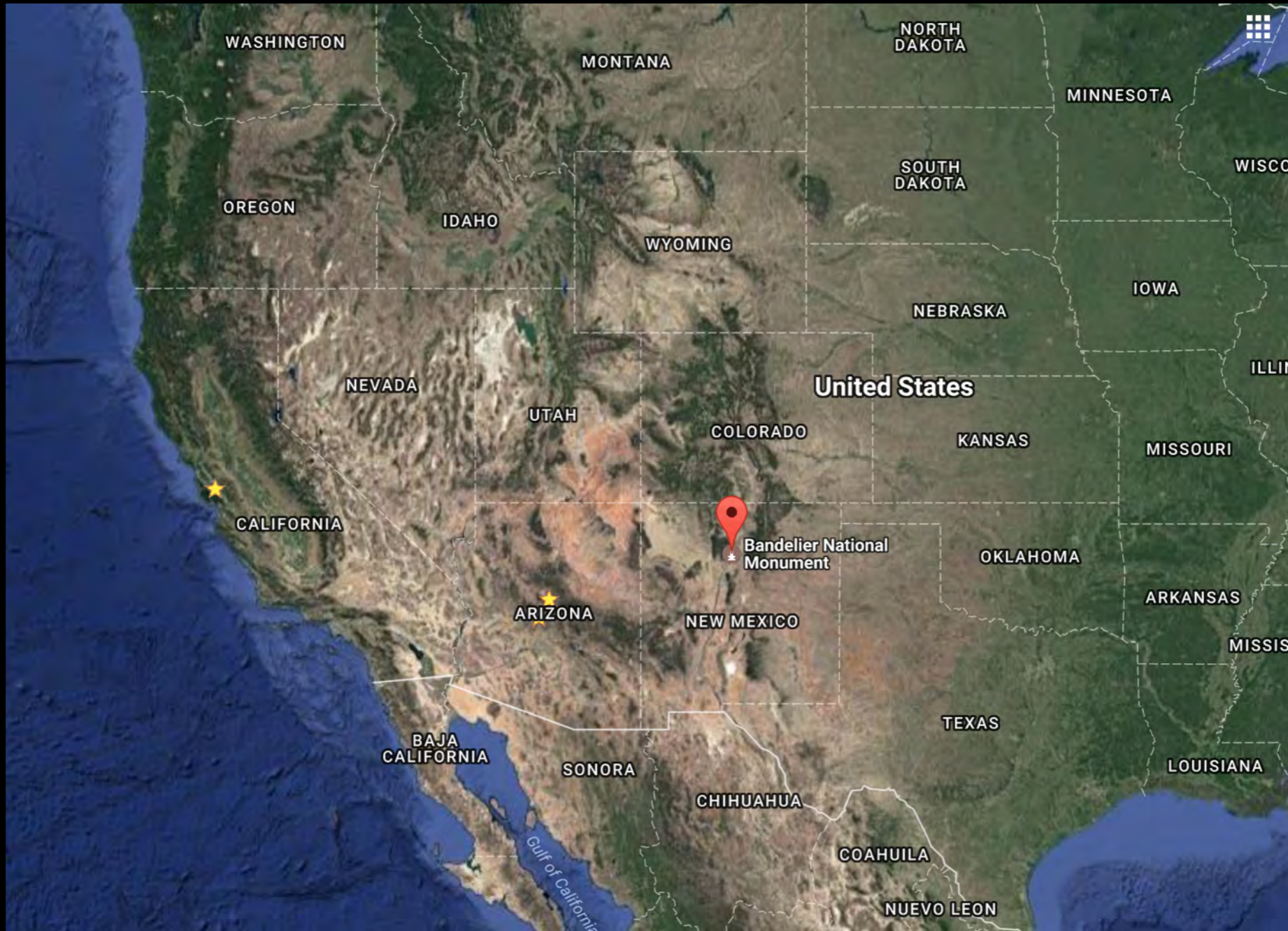


\*Treatment slake-control slake



**Timing**

# Bandelier National Monument



# History of Bandelier National Monument, NM





May 2015 Install plots and collect pre-treatment data

July 2015 Added inoculum

October 2015 1<sup>st</sup> post treatment data collection

May 2016 2<sup>nd</sup> post-treatment data collection

# Results

We saw **no** biocrust growth 11 months after we applied inoculum

We saw **no** increase in soil stability related to our treatments of flashing, slashing, and seeding

We saw **large** seasonal changes in soil quality and stability unrelated to our treatments.

This is a very dynamic system



# **Future Directions**

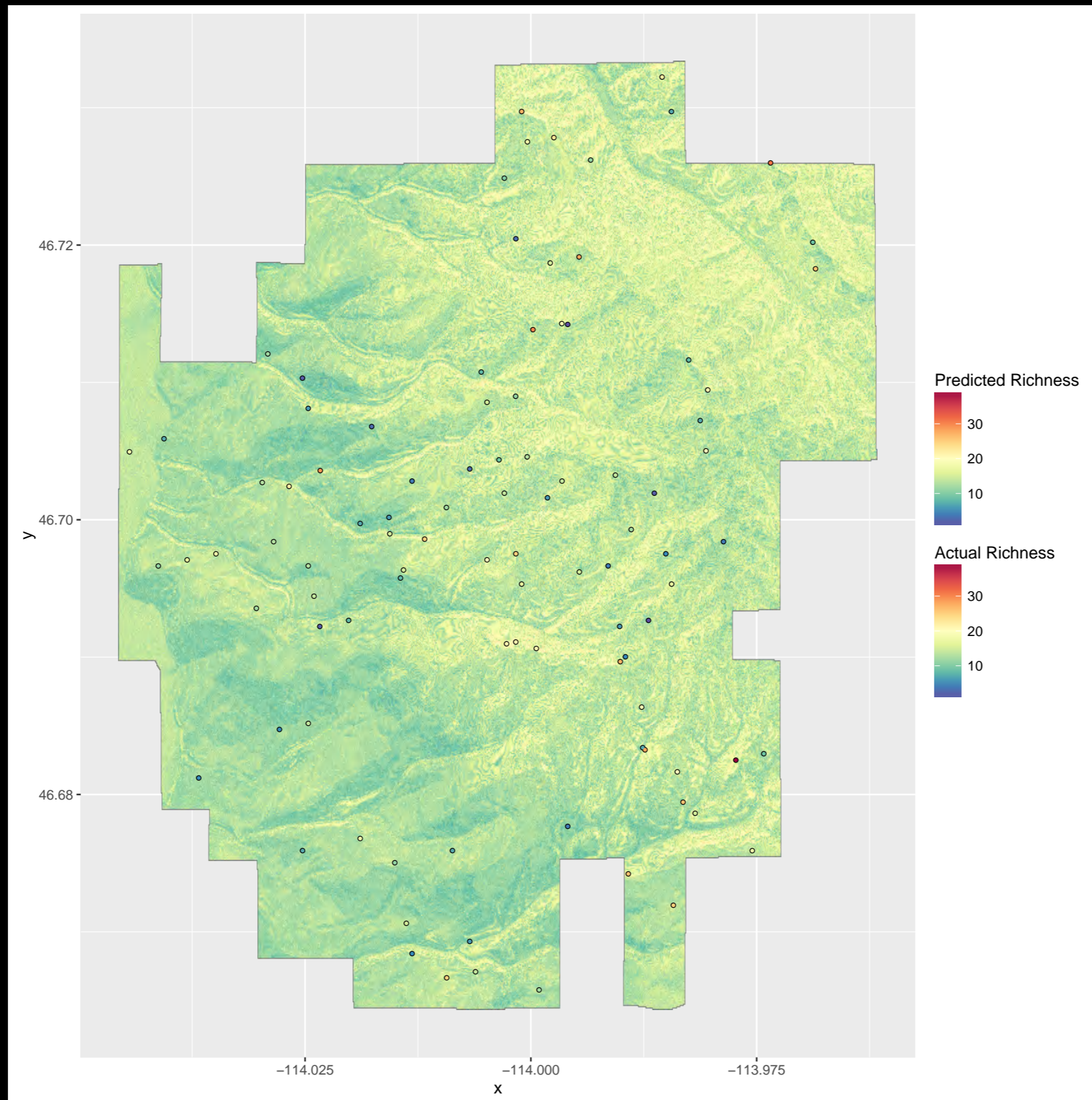
# Delivery mechanisms



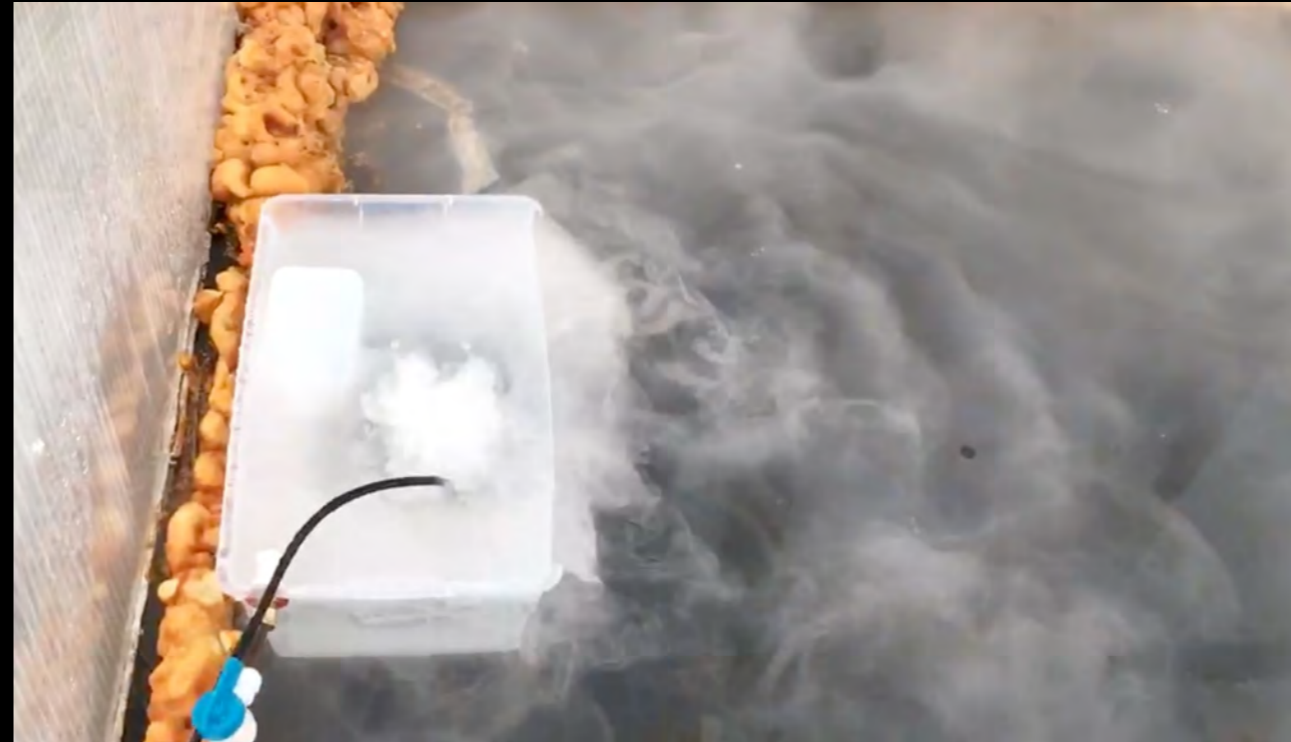
# Exploring effects on vascular plants



# Modeling biocrust abundance and richness



# Fogponics



# Takeaways

- Yes we can grow biocrust components rapidly
- We are approaching biocrusts from a plant materials mentality, mosses are plants too!
- Biocrusts are essential to ecosystem function in western US, please include them in management and funding strategies

# Acknowledgements

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