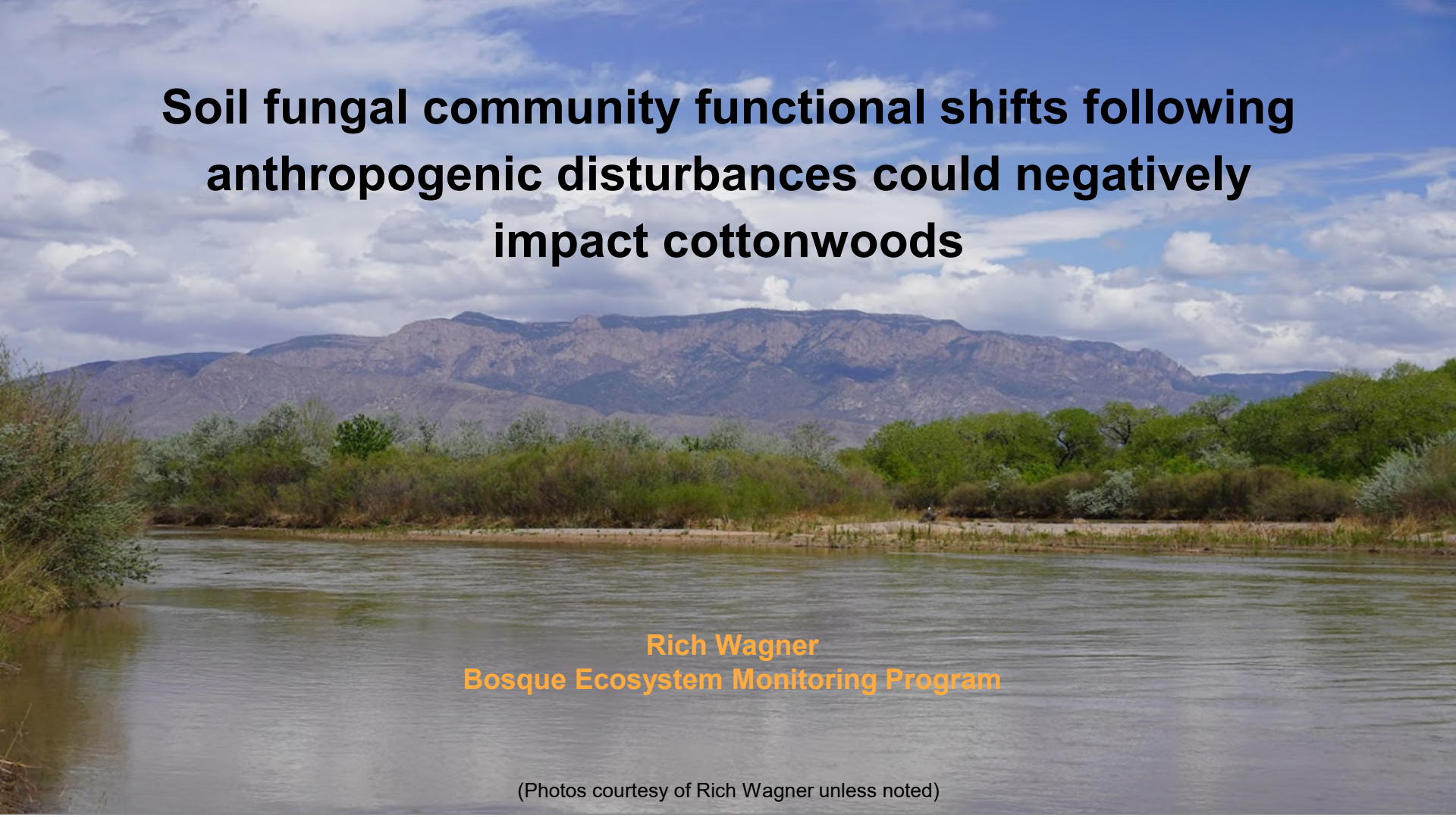


Soil fungal community functional shifts following anthropogenic disturbances could negatively impact cottonwoods

Rich Wagner
Bosque Ecosystem Monitoring Program

(Photos courtesy of Rich Wagner unless noted)

How do we bring fungi and our problem together?

Goals:

1) To assess how bosque soil fungal community composition and diversity are impacted by new, multi-factor disturbance regimes

2) To provide a more holistic tool for cottonwood restoration

Predictions:

1) Less disturbed mature cottonwood habitats would be characterized by lower fungal diversity, a greater abundance of ectomycorrhizal fungi than arbuscular mycorrhizal fungi and fewer pathogenic fungi

2) Access to water would significantly impact community composition

This is the bosque!

(the pretty parts, anyway)

Middle Rio Grande; Google Earth

The problem: a disconnected forest

Historic Rio Grande flooding; mrgcd.com

Jetty-jacks

Human impacts and interests force the transition from a dynamic, flood-driven system to a disconnected, highly regulated system.

Cottonwood gallery

Increasing water use, climate change, fires and the spread of exotics put additional stress on a (still beautiful) senescing cottonwood gallery forest.

Fire

Cochiti dam; ejatlas.org

What is being done about the problem, and who is doing it?

Salt cedar

What: Collaborative restoration and ecological monitoring projects

- Pole planting
- Clearing exotics
- Bank lowering and swales
- Restoring river function (flooding)
- Long-term monitoring

Jr. Rangers?

Collecting water chemistry data

Who:

- Federal, state and local agencies
- NGOs
- Pueblos, communities and educational partners
- BEMP (shameless plug)
- My Kids (not so shameless)

Pole planting

Mycorrhizae are a lovely marriage!

Ectomycorrhizal
Lactarius sp. in bosque

+

Cottonwood roots

=

Ectomycorrhizal fungi on cottonwood roots

Mukes = Greek for fungus **Rhiza = Greek for root** **Mycorrhizae**

- Cottonwoods colonized by ecto- (ECM) and arbuscular (AM) mycorrhizal fungi
- AM pretty rare in cottonwoods
- ECM ~70% Basidiomycota and ~30% Ascomycota; AM ~100% Glomeromycota

What do (mycorrhizal) fungi have to do with it?

Roles of mycorrhizal fungi in riparian ecosystems:

- Provide soil structure
- Build organic matter and cycle nutrients
- Aid in plant water and nutrient uptake
- Protect plants
    - Ectomycorrhizal dominance

Bosque fungus

Bosque fungus

Impacts of disturbance on fungi and restoration:

- Alter diversity and community compositions
- Increase fungal pathogens
- Remove mycorrhizal networks and reduce colonization
- But restoration can cause shifts towards historic structures
- Mycorrhizal inoculation in restoration

What do (mycorrhizal) fungi have to do with it?

Some things we know about mycorrhizal fungi and cottonwoods in southwest riparian areas:

- Greater colonization by ECM fungi in older stands
- Greater colonization with regular flooding
- Exotics reduce colonization
- Exotic clearing reduces inoculation potential

Bosque fungus

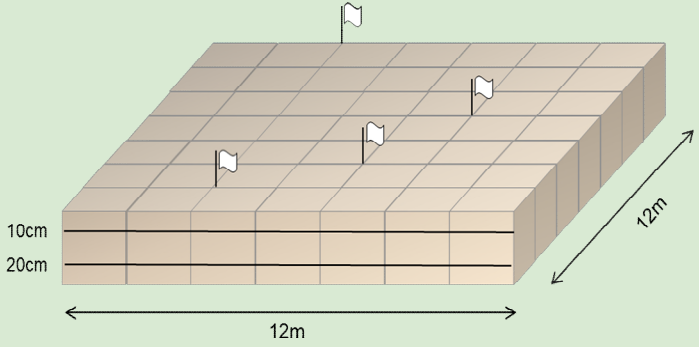
Ectomycorrhizae on cottonwood root

What we know about mycorrhizal fungi and Rio Grande cottonwoods in the bosque:

- Flooding temporarily increases inoculation potential
- Frequency of flooding may not impact colonization
- Very little data…that's about it

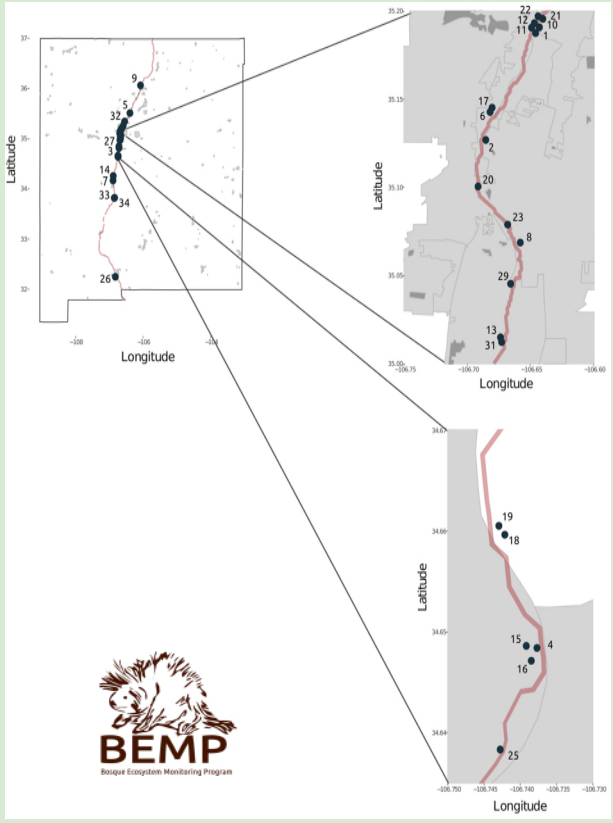
Methods (highly simplified version!)

- Collect **DIRT** from 6 replicates of 5 disturbed **HABITAT TYPES** in BEMP long-term ecological monitoring sites
- Turn **DIRT** into **DNA** using **MOLECULAR WIZARDRY**
- Analyze site specific **DNA SEQUENCE LIBRARIES** using fancy **BIOINFORMATICS** approaches



Sampling grid

Soil core (turd)



34 BEMP sites; bemp.org

So what did we find in these different habitat types?
A really cool pattern!

Mature

Young
14 yrs.

Exotic

Cleared
10 yrs.

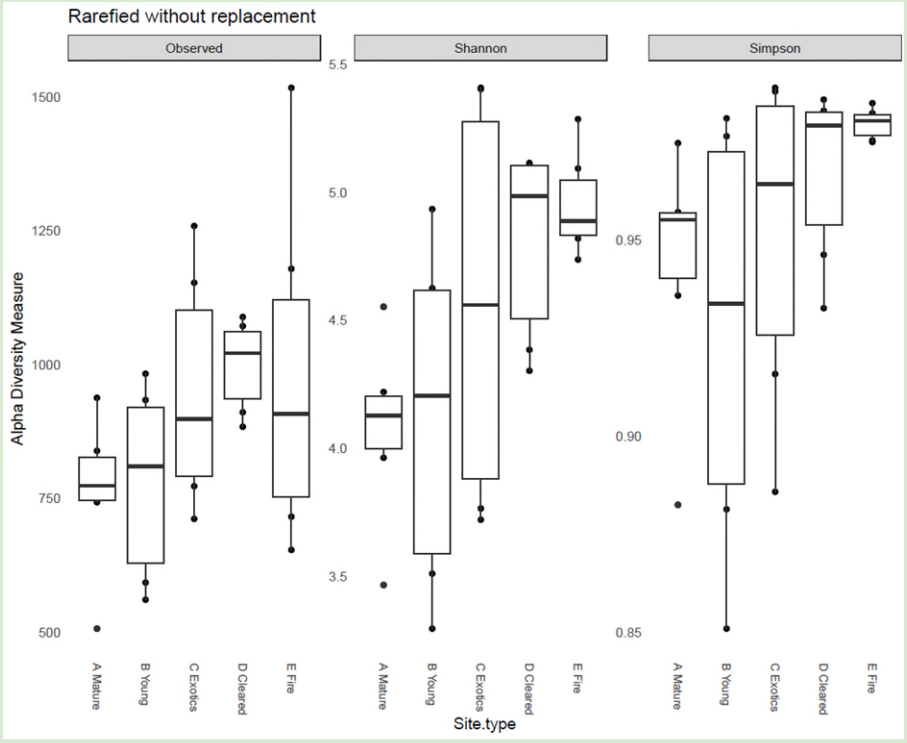
Fire
7 yrs.

Less disturbed

More Disturbed

Diversity increases along a disturbance gradient

Bosque fungus

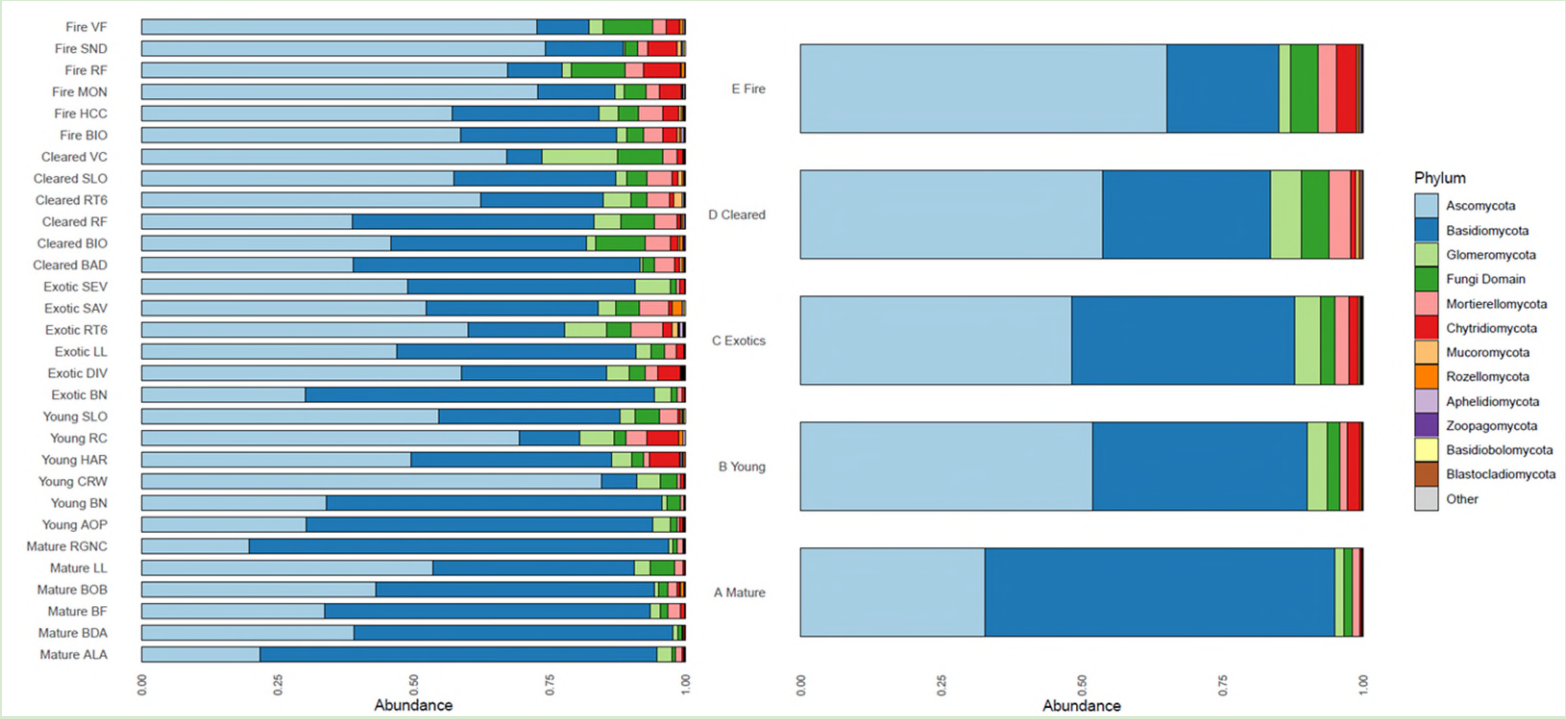


Bosque fungus

Increasing disturbance

Community composition by phylum varies along a disturbance gradient

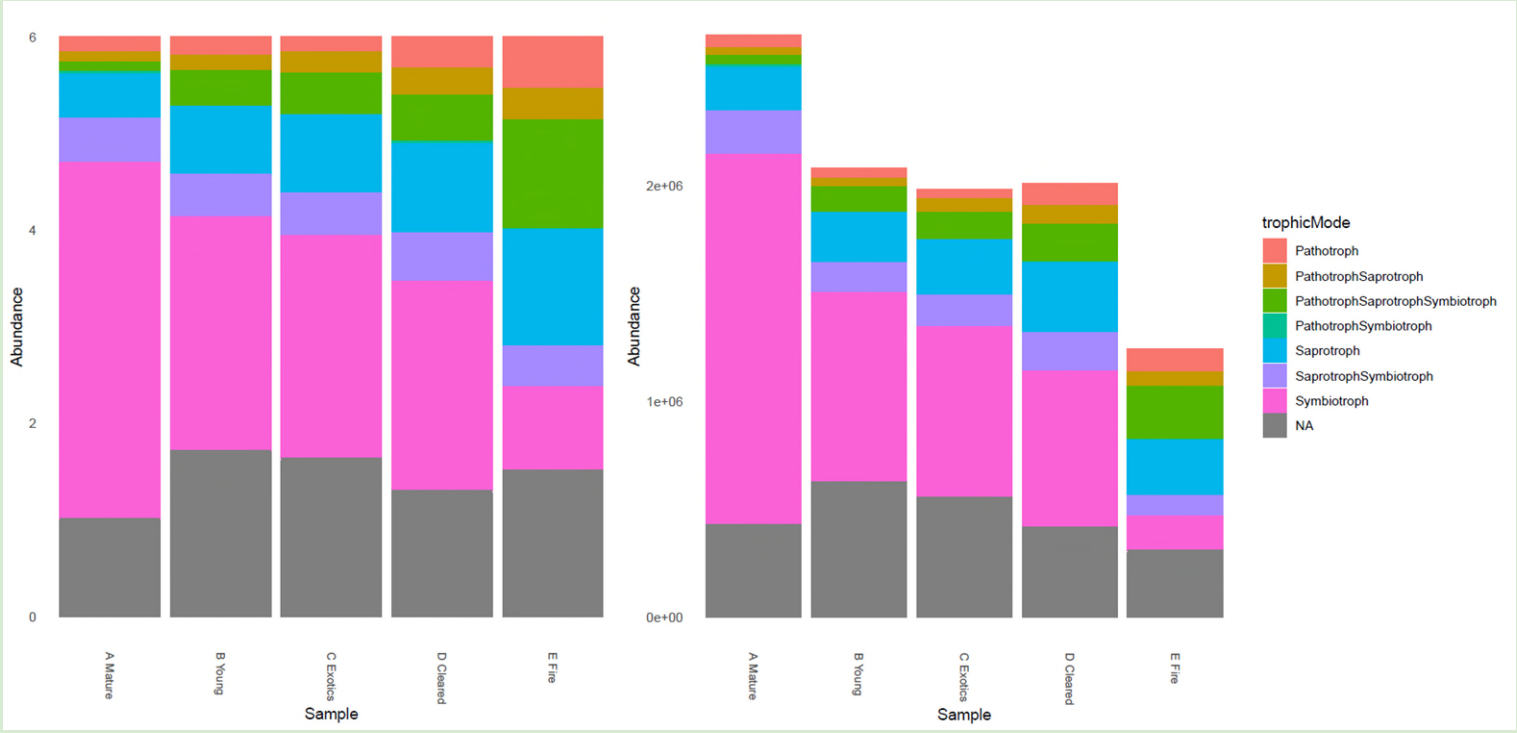
Increasing disturbance



Increasing disturbance

As disturbance increases: Ascomycetes ↑ and Basidiomycetes ↓

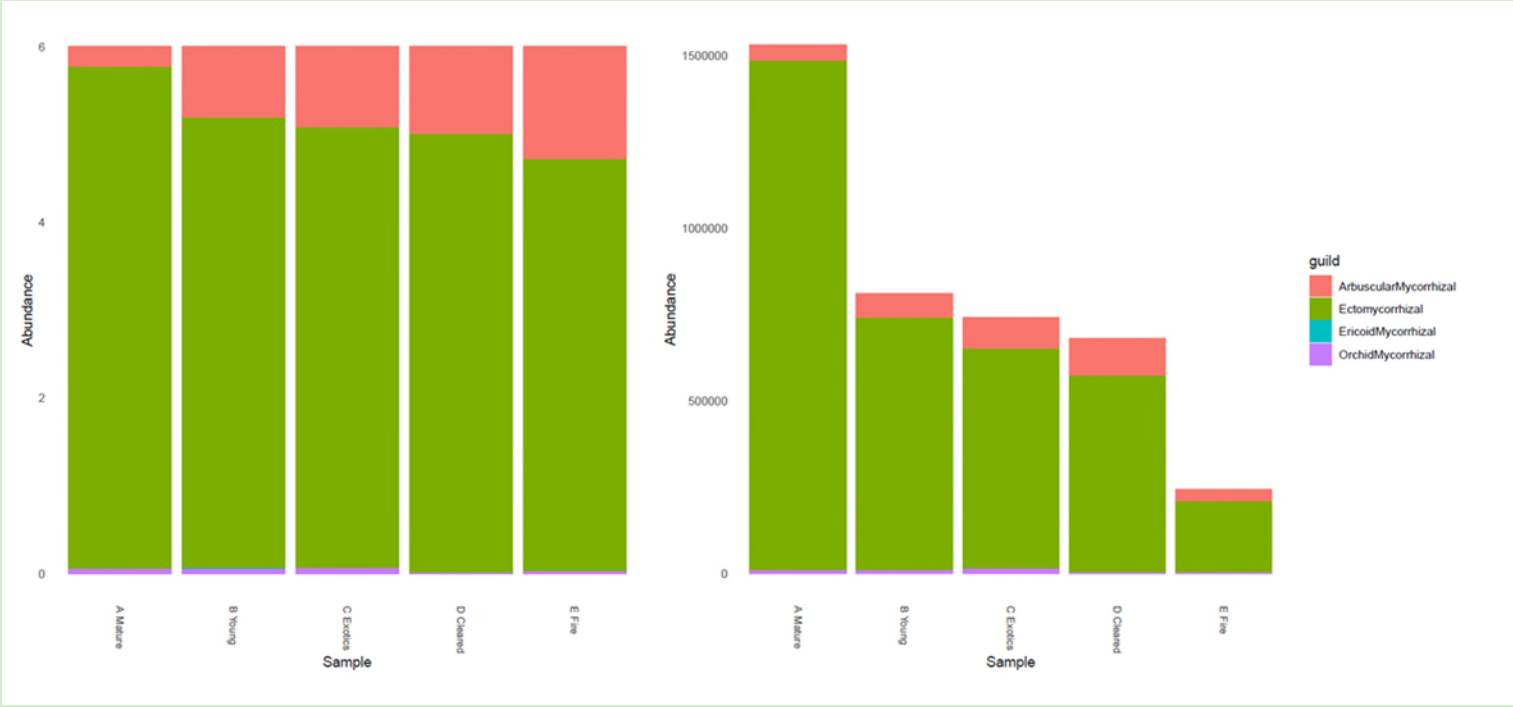
Trophic modes vary along a disturbance gradient



Increasing disturbance

As disturbance increases: Symbionts ↓, Saprotrophs ↑ and Pathogens ↑

Mycorrhizal guilds shift along a disturbance gradient

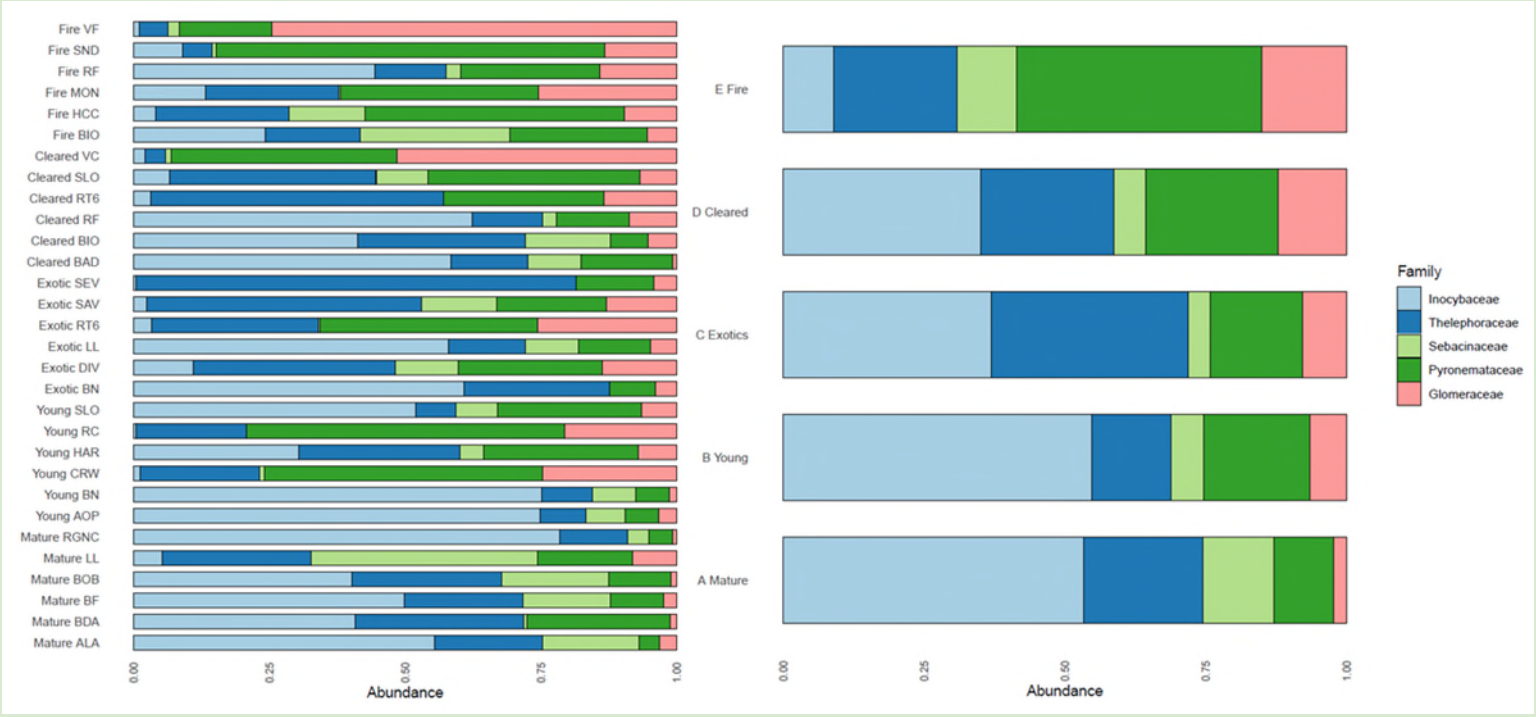


Increasing disturbance

As disturbance increases: Ectomycorrhizae↓, Arbuscular mycorrhizae ↑

Common mycorrhizal families vary along a disturbance gradient

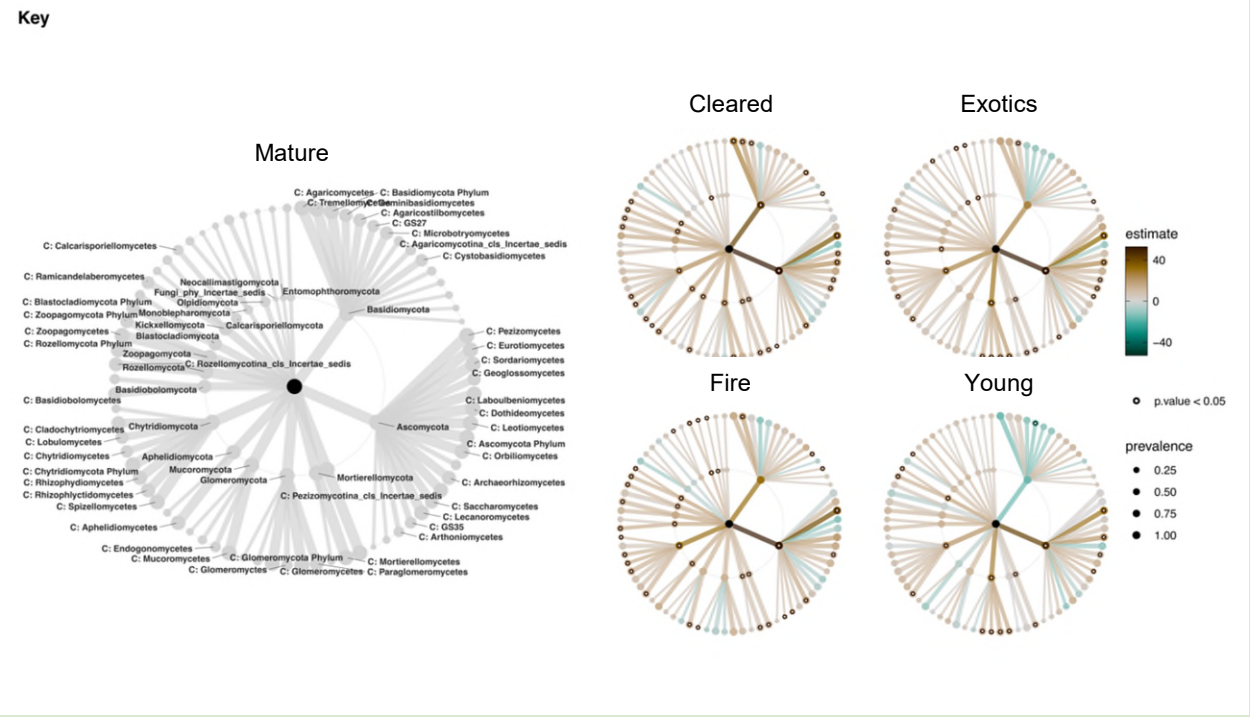
Increasing disturbance



Increasing disturbance

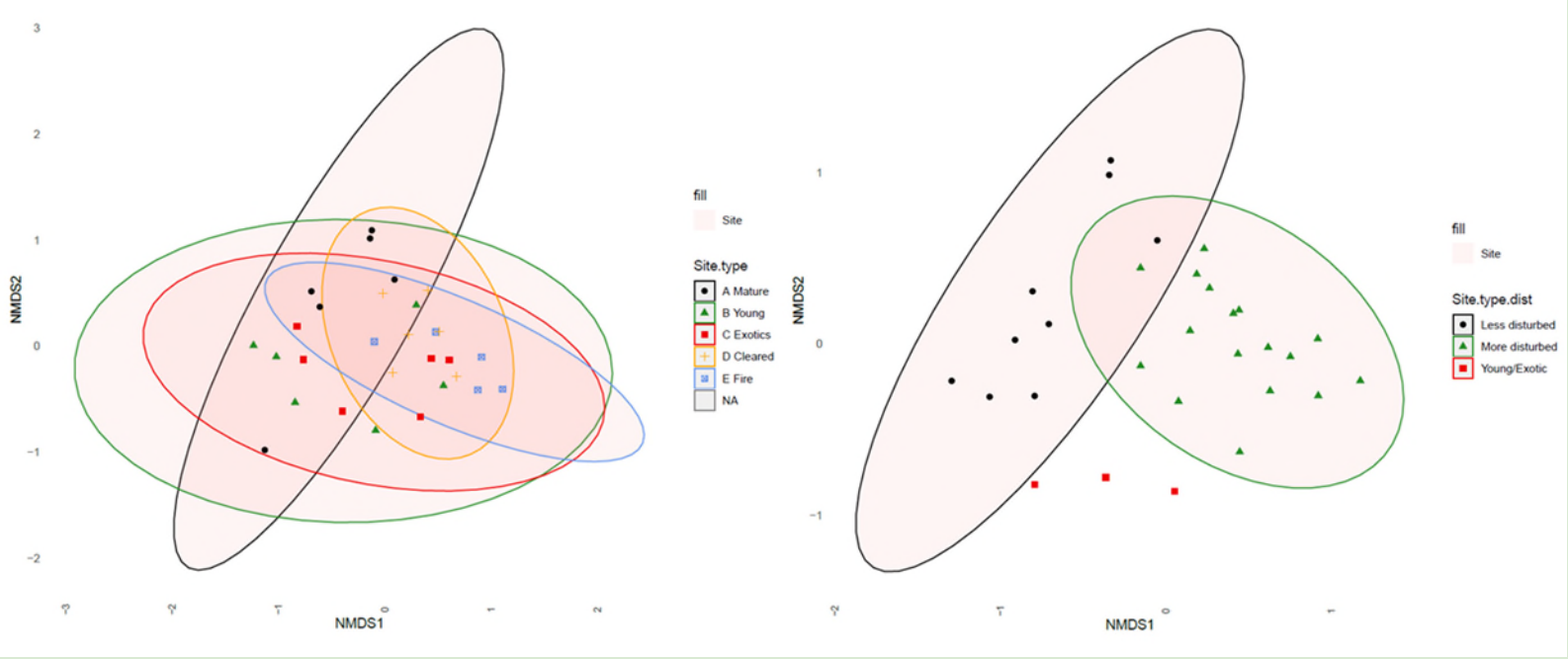
As disturbance increases: Ectomycorrhizal Basidiomycetes↓, Disturbance loving Ascomycetes↑ and Arbuscular mycorrhizal Glomeromycetes↑

Differential abundance of taxa driven by disturbance regime



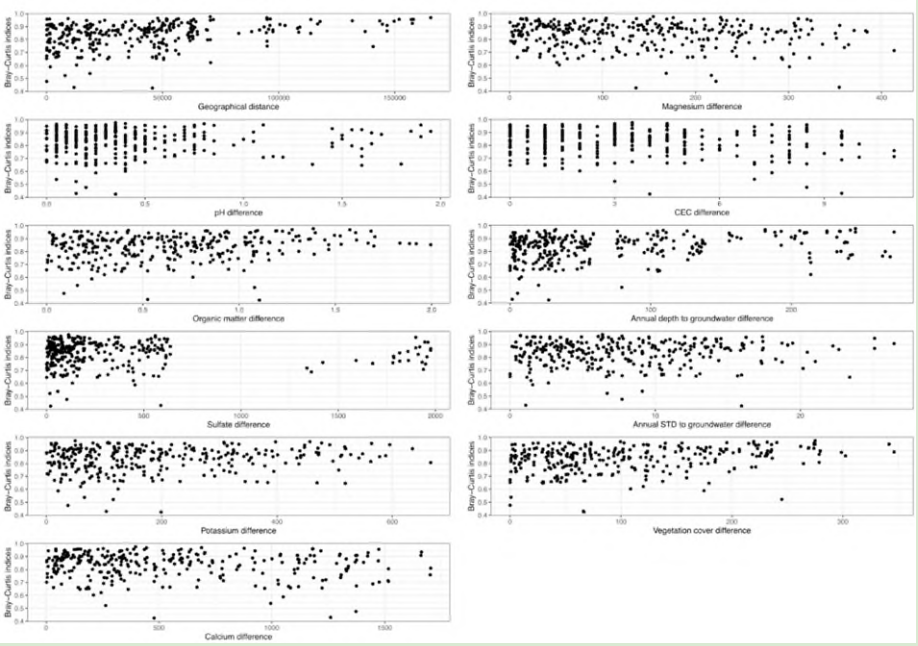
As difference in disturbance severity ↑ the number of species driving differences ↑

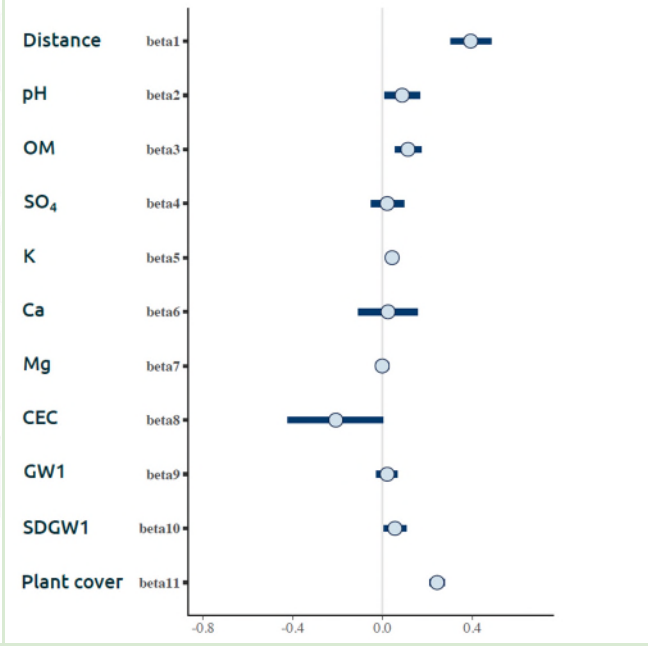
Habitat types cluster by disturbance regime



Pairings	Mature, Fire	Mature, Cleared	Mature, Exotics	Mature, Young	Cleared, Fire	Cleared, Exotics	Cleared, Young	Fire, Exotics	Fire, Young	Exotics, Young	More, Less
P	0.0002	0.0085	0.0348	0.0568	0.5458	0.3721	0.1578	0.0448	0.0438	0.7891	0.0001

Environmental factors influence similarities





Variable	pH	Organic matter	Groundwater	Groundwater variability	Flood Frequency	Plant cover	Cottonwood cover
P (DISTLM)	0.005	0.071	0.057	0.0014	0.086	0.0006	0.02

Reynolds forest BEMP station; Pre-Big hole fire

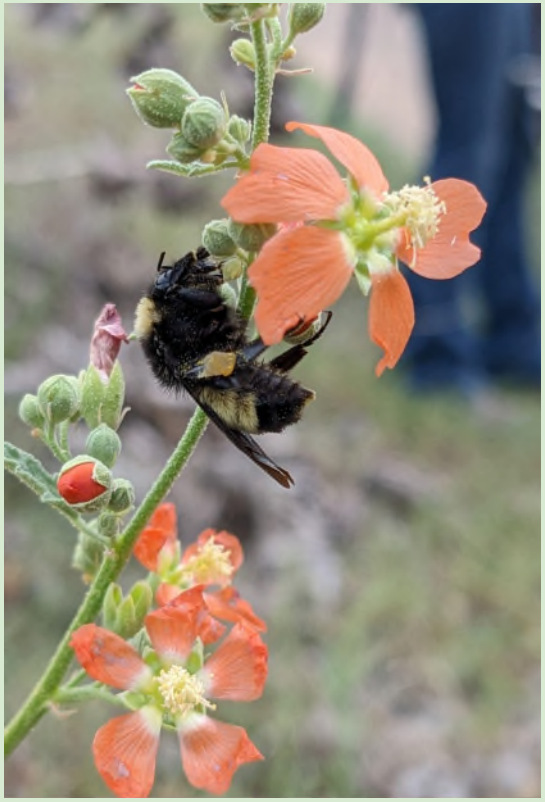
Why do we actually care?

- **Future of the bosque**
- **Restoration goals**
- **Plants need fungi**
- **Fire and clearing**
- **Mature, young and historic structure**

Owl tree; Whitfield Wildlife Conservation Area; Post-Big hole fire

A new tool for restoration

- **Support** restoration by identifying areas with fungal communities best suited to support native riparian plants
  - Ectomycorrhizal dominance
- **Identify** whole soils for inoculation of pole plantings
- **Monitor** long-term fungal community shifts
  - Project success/Santa Ana
  - Identify cryptic disturbance



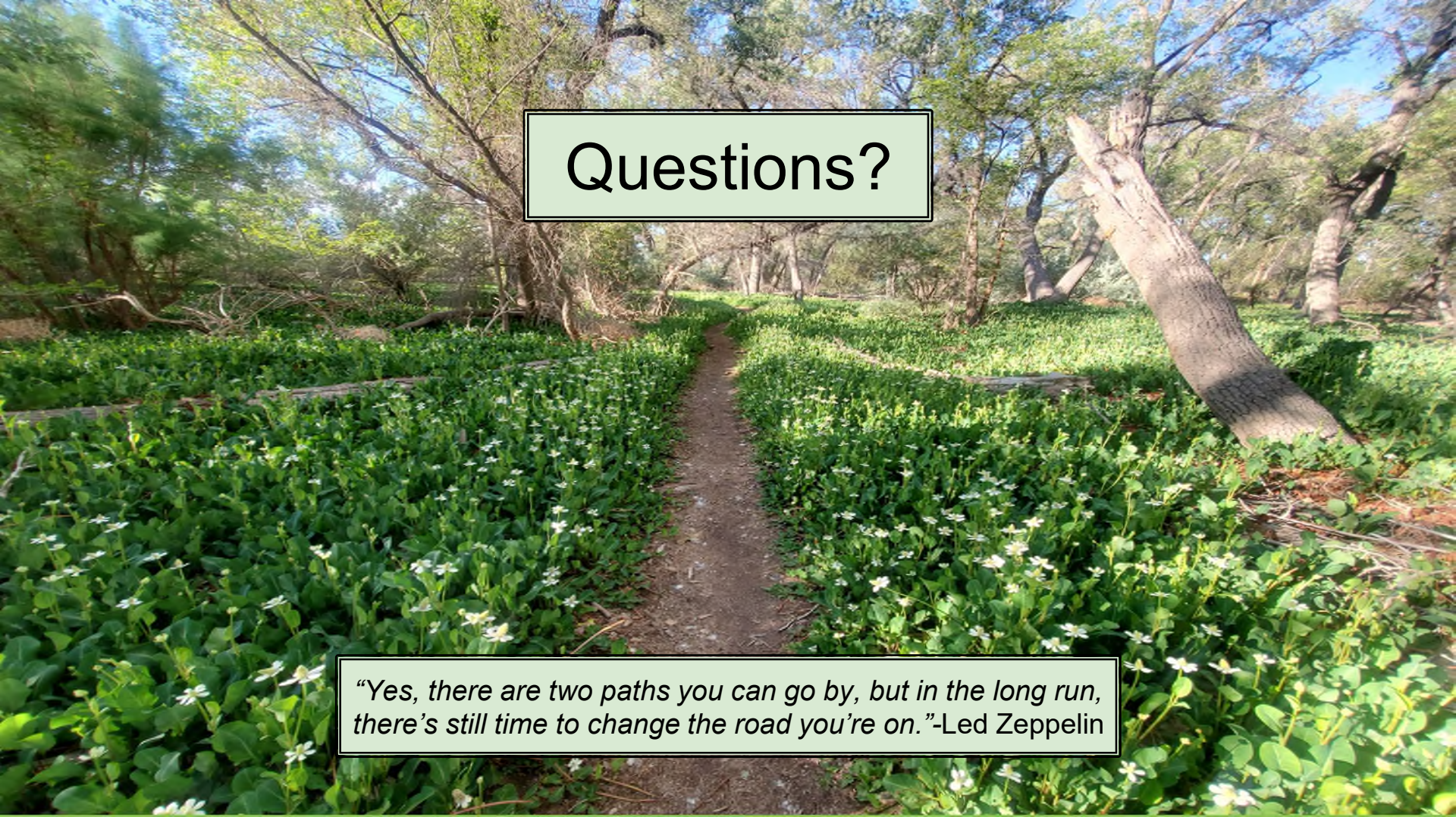
BEMP BioPark site; Dr. Ara Winter

Future directions

- **Identify** root-associated ectomycorrhizal fungi and their abundances
- **Sample** fungal community biomass for a more accurate measure of abundance
- **Explore** roles of important indicator species
- **Assess** impact of crucial water metrics on community and indicator species
- **Expand** study scope (fancy way of saying we need more data)
  - Willow swales/ SWFL
  - Islands and bars
  - Baseline community

Yesterday

The future?


Questions?
“Yes, there are two paths you can go by, but in the long run, there’s still time to change the road you’re on.”-Led Zeppelin