Small things matter
Understanding the role of soil microbes in maintaining grassland health, drivers of weed invasions and persistence, restoration, and sustainability.

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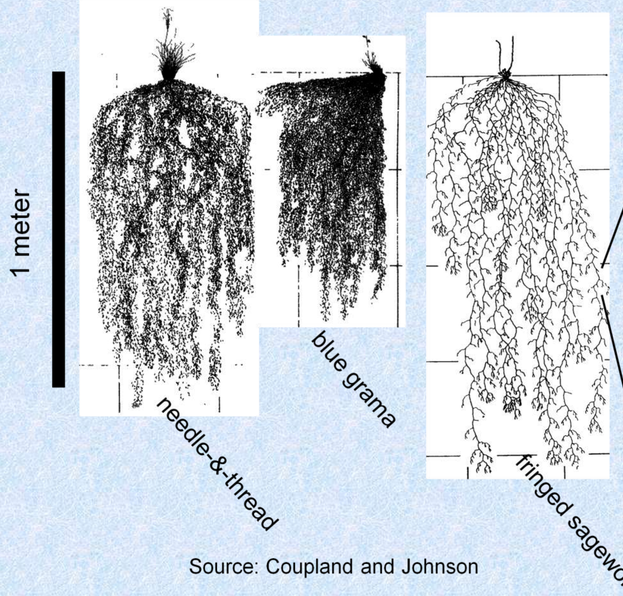
"Soil, and specifically sound soil management, is essential in our continued quest to increase the production of food, feed, fiber, and fuel while maintaining and improving the environment, and mitigating the effects of climate change."

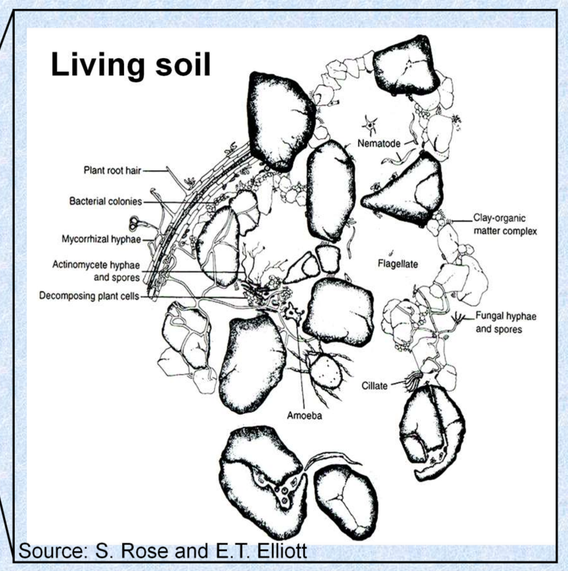
Quote from Dr. Rattan Lal, former president of the Soil Science Society of America

Story in brief-
In our regional grasslands, approximately 80-95% of a plant's biomass is made up of roots (see figure to right). Roots are as important, if not more important, to a plants growth and survival than leafs. Roots are a major component of soil and drive soil processes (e.g. nutrient cycling, soil carbon). New understanding resulting from improved methods and technological advances reveal, more than ever, the important role that soil microbes have on plant populations and communities (both positive and negative).

Take home message- Understanding plant-soil microbe interactions has the potential to revolutionize our understanding of ALL aspects of grassland ecology including: composition, production, restoration, invasion, stress tolerance, etc. and inform rangeland management



Source: Coupland and Johnson



Source: S. Rose and E.T. Elliott

The major challenge is the scale of the interactions, the microbial diversity, and the opaque nature of the soil itself. However, illuminating these interactions and their effects will help improve our understanding of plant ecology and more specifically the processes and interactions that shape our grasslands and inform your management decisions

- Challenges and opportunities- We are surrounded by some of the largest intact grasslands in the nation; however, all aspects of their ecology are comparatively less understood than some other grassland types (e.g. tallgrass prairie).

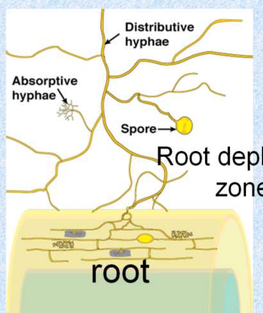
- Interactions with microbes can have positive and negative effects on plants. Feedbacks are starting to be revealed in other systems where plants alter soil microbes and the microbes then alter the plants and affect what we observe aboveground. Unknown is how grazing management affects these belowground interactions. Understanding the nuances of these interactions and how they vary among plants is critical for making headway in understanding how they affect: restoration, plant invasions, etc..

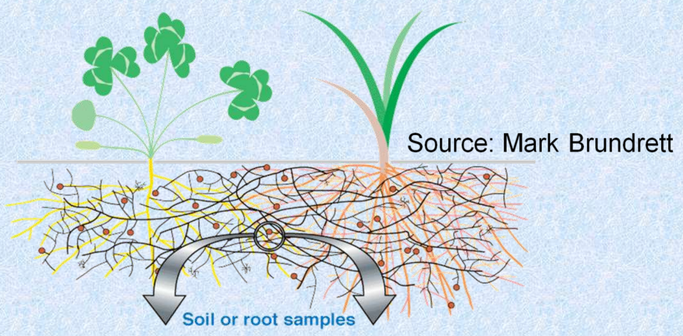
- Invasive weedy plants can disrupt soil microbes and degrade resident plant communities. These belowground disruptions help invaders persist, impact resident species, and impede restoration efforts.

- Mycorrhizal fungi are an important soil microbe that affect plant productivity, soil health (see pictures below), drought tolerance, etc..

- Mycorrhizal fungi have benefitted many restoration programs nationally and likely have untapped potential here. Improved selection criteria of mycorrhizal fungi and which plant species are most dependent on mycorrhizal fungi coupled with improved application methods are necessary to make progress.

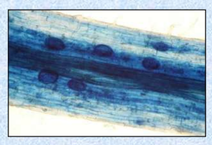
Mycorrhizal fungi form a mutually beneficial relationship with the roots of most plant species (e.g. 95% of plant families are mycorrhizal).

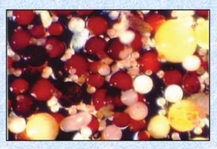




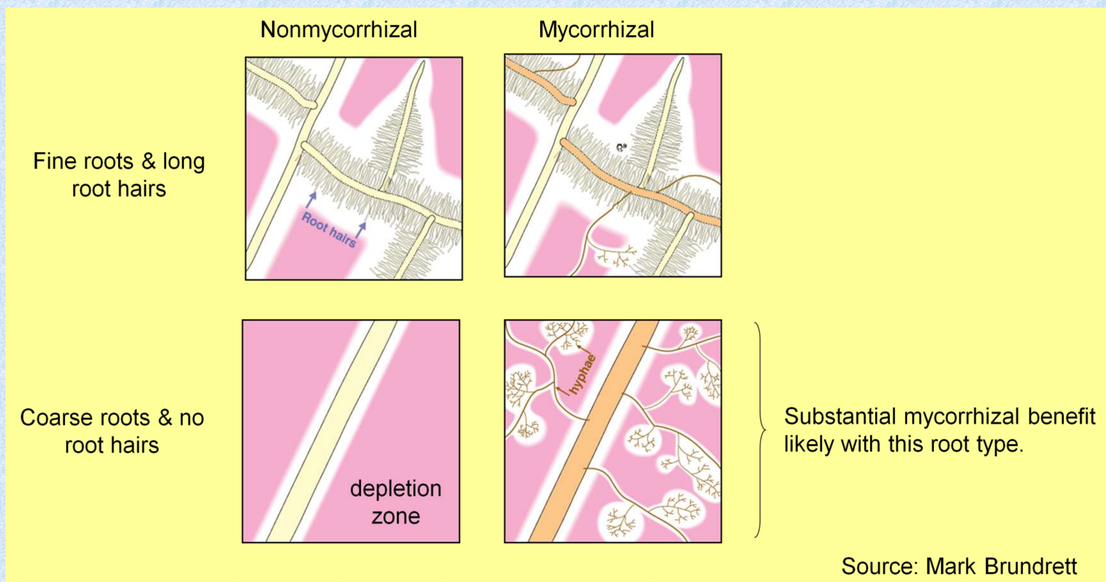
Source: Mark Brundrett

Big sagebrush root colonized by mycorrhizal fungi



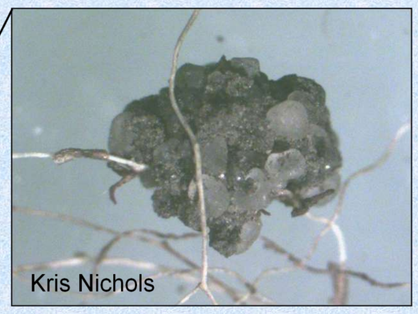


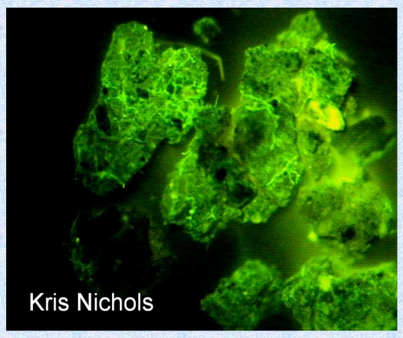
Mycorrhizal spores extracted from soil
Source: James Bever



Source: Mark Brundrett

Regional rangelands lack earthworms, which are a major builder of soil. Instead, mycorrhizal fungi perform a similar role in building soil aggregates and healthy soils.





Healthy soils= lots of water stable aggregates

To build aggregates, we must encourage the growth of mycorrhizal fungi.

Green is good! Glomalin (stained green) is the protein that holds aggregates together. Discovered in 1996 by an ARS scientist, Glomalin is thought to be produced by mycorrhizal fungi and to be the most abundant protein in the world. It is a key ingredient to building water stable soil aggregates that increase soil organic matter, increase water infiltration rates, aeration, and improve soil health. This protein is likely to play a major role in maintaining healthy and sustainable ecosystems.