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Partnering With Fungi to Steward Urban Natural Areas

By Toby Query, Portland Bureau of Environmental Services Ecologist

In the Treeline survey conducted last spring, the adaptation action respondents expressed the most interest in learning more about was pre-conditioning seedlings with mycorrhizae and beneficial bacteria; 68% of practitioners wanted to know more. This has been the subject of research for several decades and considering the mycorrhizal component of ecosystems has important implications for soil water holding capacity, infiltration capacity, hydraulic connectivity, erodibility and drought tolerance.

There is also interesting research that indicates plant-fungus communities are highly genetically controlled, reminding us that it is important to consider seed source and specific adaptations in ecological communities when deciding when and how to incorporate fungal inoculants.

Here, Portland Bureau of Environmental Services Ecologist Toby Query shares how he has been thinking about and incorporating local species of fungi into his restoration work:

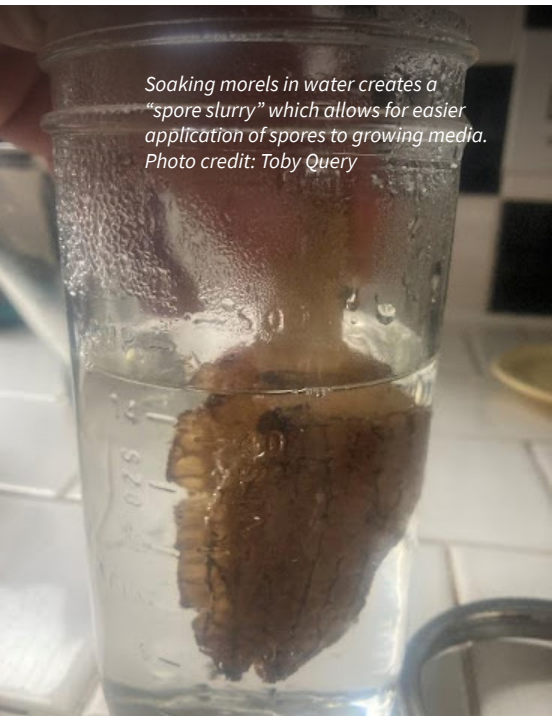
From the work of **Dr. Suzanne Simard** and others, we know the importance of the mycorrhizal network that connects, communicates, supports, and redistributes nutrients between mother trees and offspring, between alders and firs, and builds soil and resiliency over time. Besides connectors, fungi are transformers: they break down wood and create healthy soils and medicines. Many "white rot" fungi can degrade human-created persistent toxic chemicals such as PCB's, PAH's, and TNT into their nontoxic building blocks. Taxol, the powerful anti-cancer drug found in Pacific Yew tree, is produced by an endophytic fungus living in its bark that is thought to function as an immune system for the tree (Tiwari et al. 2022). Most every plant contains endophytic fungi, within and between their cells that may have many yet-undiscovered mutualistic interactions. What if forestry incorporated Simard's science and protected mother trees and mycelial connections? What if our job as land stewards was to protect beneficial fungi and improve soil ecology?

Learning ways to integrate fungi into land stewardship can have enormous benefits. I'm at an early stage of my own mycological education, but I've learned a few low-cost techniques that can introduce us to working with fungi.

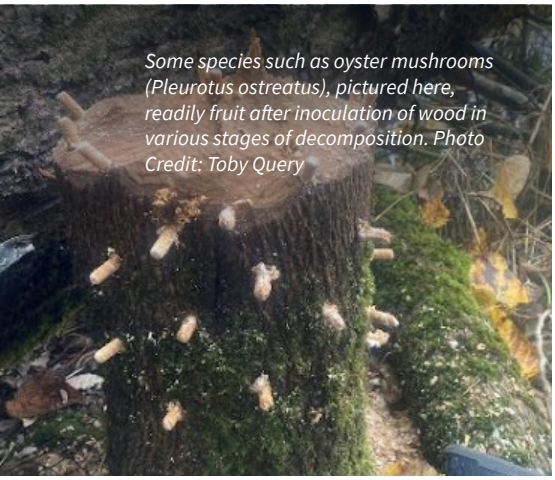
First, get to know the fungi around you. What species occur in different areas? Are they mycorrhizal or saprophytic? Do they produce medicine or food or dye? Do they break down toxic substances that occur in your area? What species don't occur in your area that live in "healthy" surrounding areas?

Lion's Mane Mushroom. Public Domain

Oyster Mushroom. Photo Credit: Gail Hampshire and licensed under CC by 2.0



Soaking morels in water creates a "spore slurry" which allows for easier application of spores to growing media. Photo credit: Toby Query



Some species such as oyster mushrooms (Pleurotus ostreatus), pictured here, readily fruit after inoculation of wood in various stages of decomposition. Photo Credit: Toby Query

Author Toby Query shows off the fruits of his labor: 3 mature queen stropharia mushrooms.

Next, experiment with incorporating fungi where it meets the goals of your stewardship. Below are a few techniques that I am experimenting with.

MYCORRHIZAL SPECIES: We know the importance of the mycorrhizal network, but how do we help and improve it? And how do different treatments such as chemical use, soil compaction, and removal of vegetation that are connected to the network impact the mycorrhizalsphere? To help support the network, I think it's important to assess and improve the soil first. Healthy soil means high organic matter (usually 3-4% or higher), fluffy soil, and soil that has a balance of nutrients, as well as the right mix of sand/silt/clay, for the site. I've been adding more organic matter including biochar and compost to amend soils, as well as decompacting imported soils after construction, using Dave Polster's **"Rough and Loose" technique**. With organic rich soil, we encourage the growth and spread of many types of fungi, which are an essential part of long lasting soil health. Beneficial fungi can be collected and propagated for use elsewhere. There are simple techniques to make spore slurries to help germinate spores and spread locally occurring species to nearby areas. This technique involves collecting a mushroom, soaking it in sterilized water, allowing it to germinate, and then spreading the spores to conducive areas.

Morels, which can be both saprophytic and mycorrhizal, can be amplified in this way with a few extra steps. I am experimenting using morel spore slurries and spawn to inoculate constructed beds of sawdust that will create food for the fungi and will eventually connect this food source to surrounding trees. This can improve the soil, increase water retention in the soil, increase climate resiliency for the forest, and produce tasty treats to land stewards!

DEAD WOOD: I've become skilled at planting and growing plants, but much less skilled in transitioning those plants back to soil when they die. We can partner with saprophytic fungi to inoculate recently killed trees (by drought, fire, beaver, wind throw, thinning, etc.) to hasten their transition to organic soil particles. By increasing nutrient cycling fungi can decrease fire risk, add more habitat for mycophagists (including flies and flying squirrels), and provide other mammals with food and medicine. You must match the fungi species with a compatible wood species, and timing and proper technique are important. Oyster mushrooms are a good starter species as they grow on many different types of wood, can be inoculated using wood dowels, and they are vigorous. I'm also experimenting with turkey tail, shiitake, lion's mane and other species using dowels and other methods.

WOOD CHIPS: Wood chips can be useful to suppress weeds during early project phases and promote increased water retention. I've found it easy to inoculate wood chips with the Queen Stropharia mushroom *(Stropharia rugosoannulata)* which can help increase nutrient cycling, which in turn promotes more rapid soil development. This species also is known to break down toxins (Kabiersh et al. 2001), **reduce levels of E. coli**, and shoot out spikes, called acanthocytes, that impale nematodes!

Next Steps

There is a need to continue learning and acknowledging the importance of fungi in our soil, in alive and dead plants, and in our water and air. After learning basic cultivation techniques using commercially available spawn, cultivation can expand to include culturing tissue of different species and strains as well as preserving and spreading spores of locally occurring species. In addition, fungi can be "trained" to eat different substrates (think of your locally occurring abundant **introduced plant**, pathogen, or **pesticide**). If this practice gains steam we may see the development of sterile labs, the fungal equivalent of seed collection and nursery operations, that can help propagate useful species that are local and useful to the area. The possibilities of incorporating fungi are almost limitless.

There is some caution to be thought through about introducing different strains or fungi species into project sites, as we have done and continue to do with plant species. I imagine a future where mycology, soil science, and botany and indigenous knowledge are equally valued to improve our ecosystems. Partnering with fungi in restoration is imperative for a future that cultivates connections.

BES hosted a workshop to explore methods that practitioners can use to boost the mycorrhizal diversity at restoration and remediation sites, including spreading wood chips that have been inoculated with mushroom spores. Photo Credit: Kas Guillozet

Questions For Future Consideration and Research:

- What effect does plant handling and storage have on mycorrhizae associated with roots after inoculation in the nursery?
- How to minimize the risk of introducing harmful pathogens and fungi into natural systems?
- What tools can practitioners use for low input analysis of fungi present at their restoration sites, so they choose the right inoculant for the site?
- What does this look like at scale?

Further Reading Recommendations

RADICAL MYCOLOGY by Peter McCoy

ORGANIC MUSHROOM FARMING AND MYCOREMEDIATION by Tradd Cotter

Works Cited

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Do you use fungal inoculants in plants that you grow or plant at restoration sites?

We'd love to hear from you. Reach out to kseaforth@b-e-f.org to connect.