MATTHEW SILVA
Chairman,
NM Tree Farm Committee

9204 Camino Del Sol, NE
Albuquerque, NM 87111
505-270-0339
matthewksilva@msn.com
www.treefarmsystem.org/new-mexico

July 2017

TREE FARM BULLETIN

Ruminations on Forest Soil Health Revisited: Duff or Litter?

By Carl Struck, NM Tree Farm #2 & Max Steenbock, Univ. of Colorado, Boulder

"What's in a name? A rose by any other name would smell as sweet." Or maybe not. Often words have an alternative meaning that carry a negative connotation. On a recent walk through our Ponderosa forest I realized we often refer to the accumulated woody material beneath our feet as either "duff" or "litter". You know…the spent pine needles, pine cones, twigs, branches, etc. that rain down, especially in autumn, when a cold wind strips all that is loose, dead or no longer necessary and blankets and past layers of woody material that overlay the forest soil. But when we refer to this layer as "litter" I always feel like this label carries with it the erroneous notion that it is somehow refuse, trash, messy, undesirable waste on the ground and we would be better off to clean it away. After all, any good scout knows you can make a "one match fire" with dry pine needles and pine cones that will then ignite your twigs and branches into a roaring bonfire in no time at all. This is the kind of childhood memory that might give some of us Tree Farmers food for thought on a hot, dry, windy summer afternoon. We might be forgiven for harboring the desire to "clean up" all this "litter" from our forest floor. And "hey…wouldn't that let the rain reach the roots more efficiently as well as encourage grass to grow?"

I've come to realize I much prefer to use the word "duff" these days after enjoying a springtime ramble with my friend Max Steenbock who is forest biologist with the University of Colorado. Max and I meandered slowly through the forest sharing our questions and observations about how we thought the forest might work, trying to track down the "who is connected to who" mystery of how seemingly simple forest ecosystems function. Yes, believe it or not, there is a complex community of microscopic organisms interacting and changing everyday beneath our feet. One study suggests that there are at least 8 billion bacterial cells, representing at least 50,000 different species, in one gram of soil [1]. In this case we were discussing the role of the forest duff in maintaining nutrients in the forest top soil, which helps to support grass, shrub and tree development. And on the other hand, we also considered how our sporadic and frustrating 1/8"-1/4" rain events during our hot dry New Mexico summers, the kind of rain that only dampens the "duff", could possibly reach the roots of our Ponderosa Pine trees. In short, we wondered about the role our forest "duff" plays in a healthy forest ecosystem. About this

time Max will usually say something like "let's take a closer look, shall we?" and with a conspiratorial look, will pull out a couple of pocket optical hand lenses and we'll be laying on our stomachs down on the forest floor looking at the springtime cobwebby traces of the fungal mycelial mat left on the duff surface as the snowbanks recede. Note the melting snow on the upper margin of the photo (above) & silky mycelium strands connecting the needles (photo by J. Riddick).

In this photo (left), the mycelia strands are a bit dryer and thus easier to see. As the top layer of duff dries out, these 'cobwebby' strands will no longer be seen near the surface. (photo by J. Riddick)

To understand just a small part of what is happening in this critical but often overlooked niche in our woodland, let's take that "closer look" at the role of fungal mycelia. First, it is important to define the role of two different types of fungi.

Saprophytic fungi, with the help of other microorganisms, decompose woody material helping to break down their chemical components into usable nutrients (adding to the topsoil) for new plant growth. An example of a Saprophytic fungus found among conifers is the *Agaricus silvicola* group (Woodland Agaricus) which is edible, with caution…very easy to mistake with poisonous look-a-likes! Another saprophytic

mushroom associated with woodland meadows in our area is the *Calvatia booniana* or Western Giant Puffball, one of our favorite choice edibles. Below is a photo of some I found a few years back (photo by J. Riddick).

Mycorrhizal fungi, on the other hand, utilizing their extensive network of mycelia as a sort of delivery system, can help transport nutrients and moisture that originate in the duff and the topsoil, to the roots of our trees and other plants. The mycorrhizal fungi in return gets excess sugars from the photosynthesis of the plant, thus making this a symbiotic relationship (and arrangement beneficial to both parties). Examples of mycorrhizal fungi associated with Ponderosa pines are *Boletus barrowsii* (a form of Porcini mushroom) and *Sullius granulatus* (Slippery Jack), the former edible and choice the latter edible but slimy and not very tasty, in my opinion anyway. Our forest duff is basically a huge mat infiltrated by competing and cooperating fungal mycelium strands interwoven with pine needles, wood chips, twigs, etc. The mycorrhizal mycelium component of the mat greatly expands the effectiveness and area of absorption for the deeper roots of our Ponderosa trees, as well as the roots of other forest plants, thus answering the question about how a light rain can penetrate to those deeper roots! Amazing!

Of course, there are other forces and communities at work here… witness the invertebrate diversity (nematodes, ants, beetles, termites), uncountable bacteria, as well as the soil dwelling mammals (mice, moles, voles and the like), all leaving their debris and contributing to the nutrients that give richness to

our soil. Fascinating viewing not unlike a Jurassic world in miniature! In order for these communities of organisms in our forest duff to remain effective and tend to our topsoil creation and the health of our trees it is incumbent on us to understand their role and how we might support them. This comes mainly by us minimally disturbing coarse woody debris (CWD, branches and trunks 3" in diameter or larger laying on the ground), duff and topsoil. More on managing woody debris for forest health can be found in a wonderful paper put together by the Univ. of Idaho Forestry Extension and the US Forest Service (or https://www.nrs.fs.fed.us/pubs/33615). While such a prescription is broad and perhaps vague, this is largely due to the scientific community's ongoing investigation into the mechanisms that link CWD, microbial soil communities, soil nutrients, and forest health (see Achat et al. [2] for a recent review of our current knowledge). This said, it does appear that leaving in place CWD and duff/litter layers (as much as fire risk management will allow) can maximize the total available nutrients in soils – and this alone is compelling. So, in reviewing our best practices for disposing of slash, at least from the standpoint of forest duff health, it would seem that the lop and scatter method, the pile and leave to rot method or the scattered chip method would be the most supportive. The first two methods, because of the imperfect contact between woody matter and the duff, results in the slash being a fire hazard for a few years at least. The scattered chip method forms a more intimate connection between the mycelium rich duff and the chips with the added benefit of mulching the previously air exposed duff layer, thus speeding up decomposition and retaining moisture. For five years this has been my preferred method and in my experience, provided the scattered chips are 2" deep or less, they have lost a great deal of their fuel potential within a year or so. The pile and burn method of slash disposal, again from the forest duff perspective, deprives the microorganisms of some of the raw material they need to make our topsoil, although it certainly deals with the fire hazard aspect of slash disposal, provided the burning itself is done safely. In addition, depending on how hot and deep the pile burns, this method may leave a severely damaged or destroyed hole in the mycelial/microorganism mat that could take decades to restore. In a forest, widely spaced, scattered burn holes may not pose a measurable problem in the long run but in an intensive thinning practice with closely spaced, large slash piles this practice may pose more of a long-term issue and should be considered carefully. See Certini (2005) [3] for a review of the effects of fire on forest soils.

Returning from our Springtime woodland ramble I ask myself again is it "duff" or "litter"? I guess as long as we understand the complex but crucial role this hardworking membrane covering our forest topsoil plays in the long and short-term health of our forest ecosystem, it really doesn't matter!

[1] Roesch LFW et al. ISME 1 283-290 (2007) or
http://www.nature.com/ismej/journal/v1/n4/abs/ismej200753a.html

[2] Achat DL et al. Forest Ecology and Management 348 124-141 (2015) or
http://www.sciencedirect.com/science/article/pii/S0378112715001814

[3] Certini G. Oecologia 143 1-10 (2005) or
https://link.springer.com/article/10.1007/s00442-004-1788-8