Chatfield Mushroom Degradation Trial - Final Report- Jeffrey Ravage, CUSP, COCO

Pile Construction at Chatfield Farms, May 2020

HISTORY- In the spring of 2020, the Coalition for the Upper South Platte (CUSP). Denver Botanic Gardens (DBG), the Chatfield Storage Reallocation Project, and the Colorado Mycological Society (CMS) jointly began a test of industrial scale fungal remediation at the Denver Botanic Gardens Chatfield Farms. With the consent of the Army Corps of Engineers, this project deposited ~70 tons of wood chips in a large windrow, 100 meters in length. CUSP's North Fork Watershed Coordinator, Jeff Ravage, used his then experimental technique of fungal degradation to attempt the wholesale decay of this massive pile. Work the previous winter at CUSP's facilities and at the labs at Mile High Fungi in Conifer, Co, had trained and amplified 50 bags of natively collected wood rotting mushrooms. This mushroom spawn was inserted into the pile with the help of dozens of volunteers from the Denver touring company of "Up with People", as well as members of the CMS and other interested persons. Thus, began the largest test of myco-remediation at the time in the United States.

The pile was monitored for three and one half years to measure progress and document the chip's progress. This report chronicles the results.

1Monitoring at Chatfield

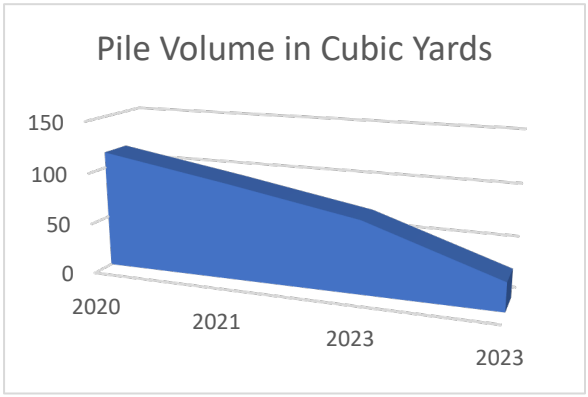
METHODS- Wood for the pile came both from the Chatfield reallocation project (Cottonwood) and from a post and pole mill in Evergreen, Colorado (Ponderosa and lodgepole pine). The Chatfield chips had been inadvertently mixed with large amounts of dirt, the one contaminant that could stop wood-rotting mushrooms from doing their job. These deliveries were regrettably stopped and only the pure wood from Evergreen was considered for this experiment. When the pile was constructed, steel spikes were driven into the ground every ten feet to mark data collection points. There were 22 spikes placed along the 210' of pile un-contaminated by dirt. Measurements of pile height and width were made at each point, once a year for the following years. Samples of the raw woodchips were taken to measure baseline friability, the chips structural strength when rubbed

against a standard ¼” screen, and the chips chemcal characteristics. These samples were also used for archival and chemical analysis.

Pile Before

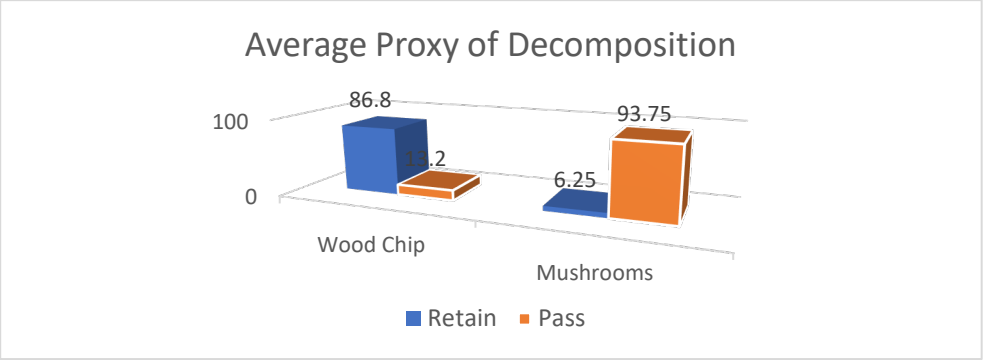
Pile After

RESULTS- The initial pile measurements were 210’ in length with an average width of 11.7’ and average height of 2.58’[i]. The bulk volume was 115. 2 cubic yards, with an estimated weight of 70 tons. The final measurements showed an expanded width of 13.6’ and an average height of 0.53’. This equates to 27.6 cubic yards and approximately 7.9 tons. The pile had experienced an 89% reduction in volume. True mass reductions will be noted by mushroom species.



We use friability as a proxy measurement of decay. Friability is tested by a simple screen test. One volumetric liter of substrate is agitated against a ¼” screen for two minutes. The resulting material is measured as the fraction that passes through the screen versus the amount that is

retained (too tough to be abraded). Sample wood chips retained over 86% of the material and passed just over 13%. Our finished compost passed between 86% and 98% of the material (n=6).



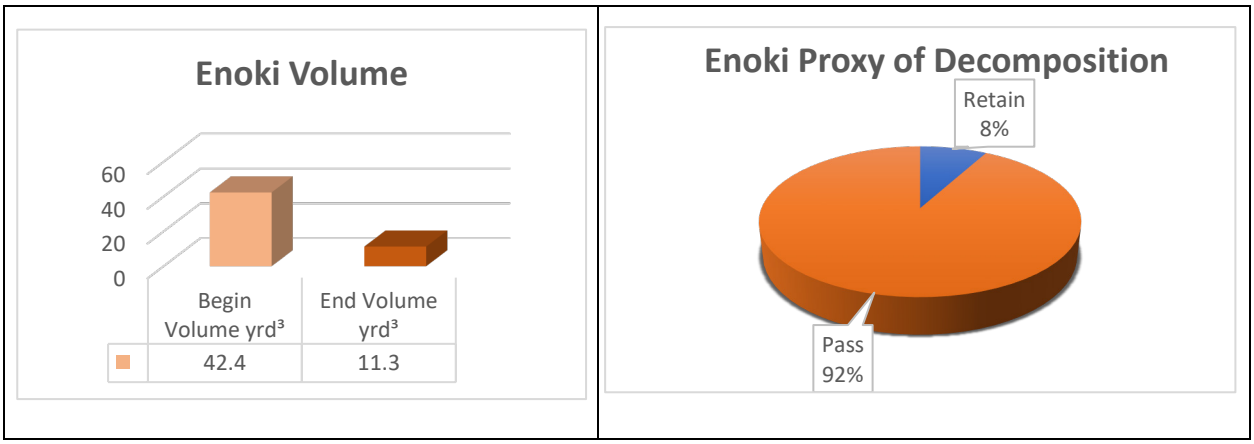
DECOMPOSITION BY SPECIES-
This test used four species of locally collected, lab conditioned mushrooms. All results are calculated using the base relative density of raw wood chip of 0.677, as measured on delivery. Each individual species has differing specific densities as noted in their section.

←210' →

North ←46' →	←49' →	←58' →	←58' → South
Flammulina velutipes	Trametes versicolor	Ganoderma applanatum	Pleurotus ostreatus
Bags @ 3.5' on center	Bags @ 3.7' on center	Bags @ 4.8' on center	Bags @ 4.8' on center

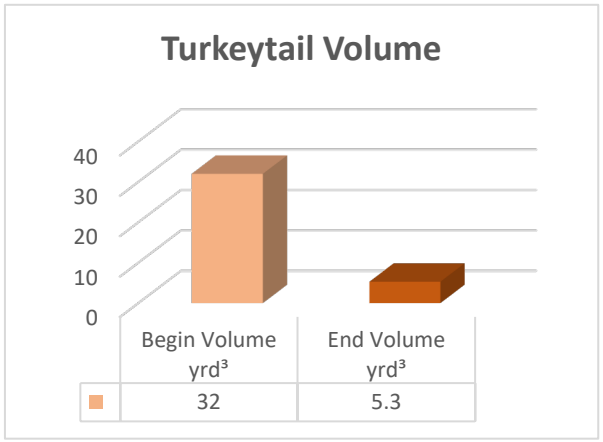
Chatfield pile layout as built

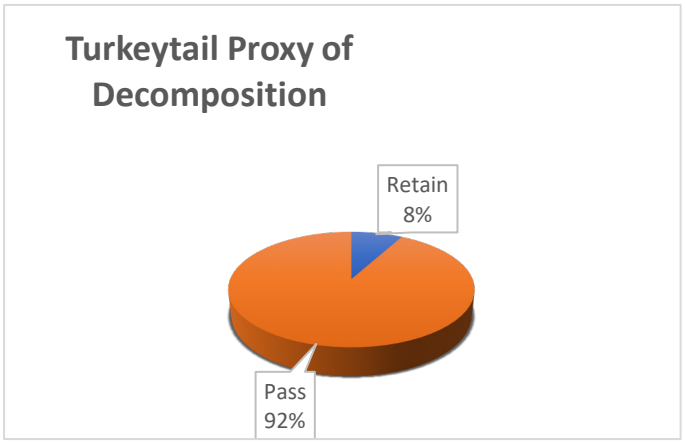
.**Flammulina velutipes** -the Velvet foot mushroom aka, Enoki (Strain designated: Fvelu2020CUSP01-WC) -collected in Fort Collins, Colorado. Enoki is a white-rotter.[ii] Post decay compost standard density: 0.231



In this test run, the Enoki achieved a 74% reduction in pile volume and a 91% reduction in mass. Its segment had a starting length of 46’ ft, a height of 3.3’ and a width of 15.1’. The end measurements were 46’ in length, 0.94’ in height and 14.1’ in width. These measurements are averages.

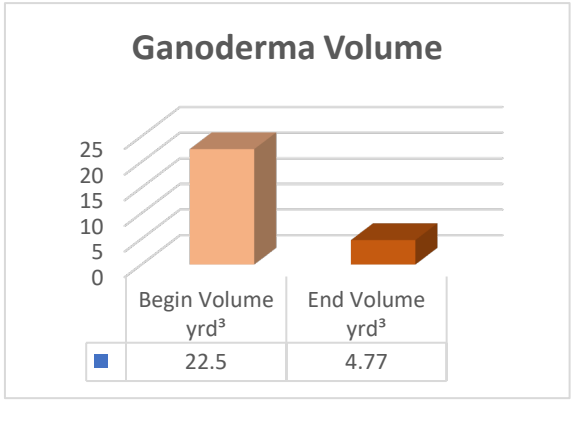
Trametes versicolor -the Turkey tail mushroom (Strain designated Tversi2019CUSP01-WC) - collected in Lakewood, Colorado. Turkey tail is a white rotter. Compost standard density: 0.393

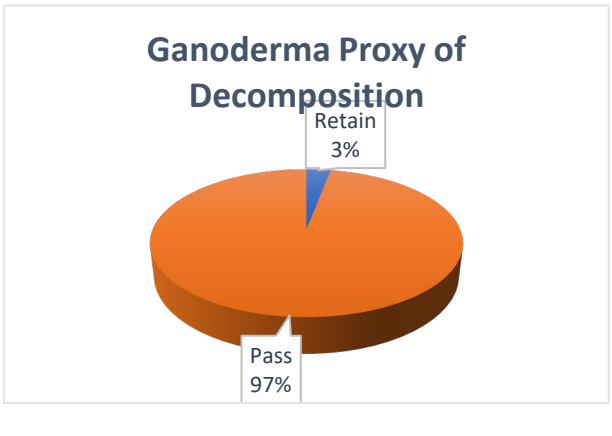




In this test run, the Turkey tail achieved a 84% reduction in pile volume and a 90% reduction in mass. Its segment had a starting length of 49’ ft, a height of 2.72’ and a width of 12.9’. The end measurements were 49’ in length, 0.41’ in height and 14.3’ in width. These measurements are averages.

Ganoderma applanatum -the Artist’s bracket mushroom (Strain designated: Gapp2021CUSP01-WC) -collected near Conifer, Colorado. The Artist’s bracket is a brown rot mushroom.[iii] Compost standard density: 0.367

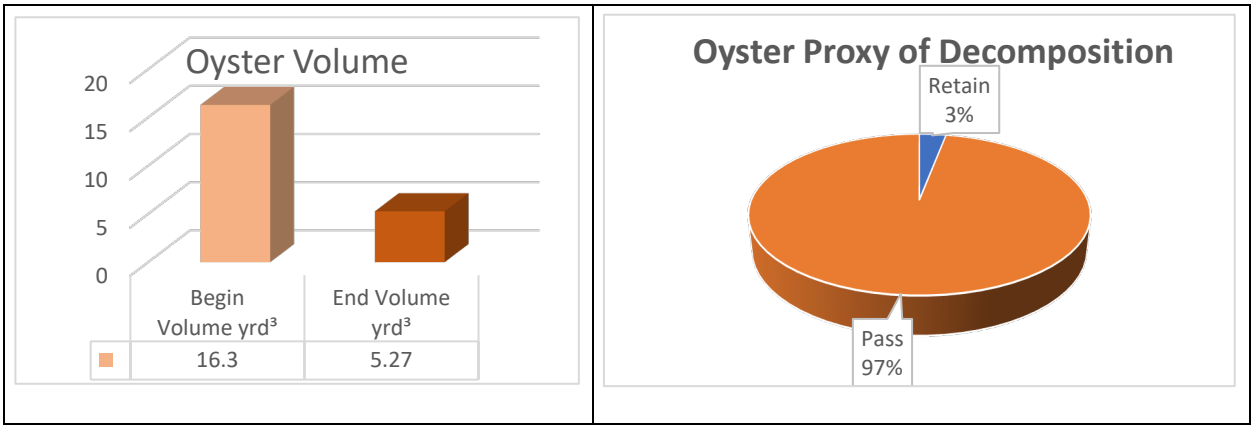




In this test run, the Artist’s conk achieved a 79% reduction in pile volume and an 89% reduction

in mass. Its segment had a starting length of 58’ ft, a height of 2.1’ and a width of 10’. The end measurements were 58’ in length, 0.35’ in height and 12.7’ in width. These measurements are averages.

Pleurotus ostreatus -the Oyster mushroom (Strain designated: Post2019CUSP01-WC) - collected near Conifer, Colorado. Oyster mushrooms are white rotters. The compost standard density: 0.379



In this test run, the Oyster achieved a 68% reduction in pile volume and an 82% reduction in mass. Its segment had a starting length of 58’ ft, a height of 21.9’ and a width of 8’. The end measurements were 58’ in length, 0.39’ in height and 12.6’ in width. These measurements are averages.

CONCLUSIONS- Unattended piles of woody waste can linger in Colorado’s mountainous climate for 20 to 50 years (Wagener 1972). The speed at which we can remove this material from the fire cycle and return it to the soil cycle is the primary goal of our investigations. This is our fourth test of fungal decomposition in a forestry or remediation context. It is our second trial with industrial levels of tonnage. This pile would represent the waste material generated on 10-20 acres of forest mitigation.

Our best performing strains were the Turkey tail and the Artist’s conk. The Ganoderma is the only species that is native rotter of conifers. Turkey tail and Enoki are generally found on hardwoods, and the Oyster is a denizen of cottonwoods. We have continually demonstrated the ability of lignicolous saprophytes (wood rotting mushrooms) to cross over to different wood types when properly pre-conditioned. These results are completely consistent with our previous findings. Trained wood rotting mushrooms can rapidly decompose forestry waste and convert it into a valuable soil amendment. Our work will continue in partnership with CUSP and Coalitions and Collaboratives (COCO), as we move directly into the implementation phase. We are accepting inquiries for projects for 2024 and 2025 at this time. We are also now experimenting with the carbon capture potentials of this technique as well as expanding into post-fire and petroleum-based pollution scenarios.

Decomposed wood chips

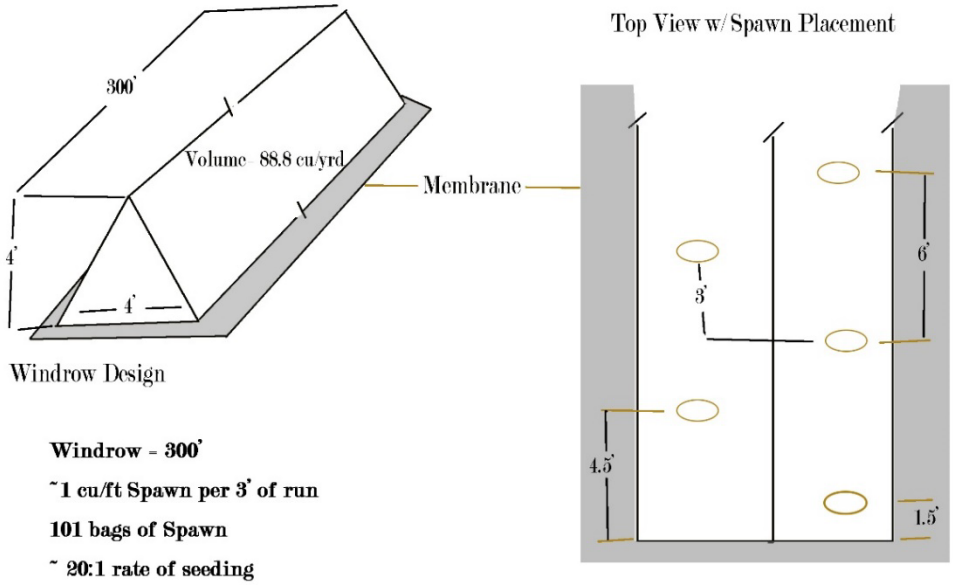
Mycelial bonding of wood chips

Many thanks to all of the organizations involved: CUSP, DBG, the Chatfield reallocation team, CMS, Jefferson County Open Space, Mile High Fungi, Aurora Water, Up with People, and the nearly 100 volunteers who have helped at some stage in this project.

Up with People Volunteers

Appendix One Design Drawings.

Chatfield Chip Degradation Project Pile Design



Windrow - 300'

~1 cu/ft Spawn per 3' of run

101 bags of Spawn

~ 20:1 rate of seeding

Prepared by: J. Ravage, Coalition for the Upper south Platte. Sept. 2018

[i] All measurements for this project were made using the metric system. They have been converted in this paper for a wider audience.

[ii] White rotters consume primarily lignin in the wood, leaving behind the white strands of cellulose.

[iii] Brown rotters consume cellulose leaving behind the lignin. This is the characteristic cuboidal brown rot often seen in the forest.

Citations:

Wagener, W. 1972. *Logging slash: it's breakdown and decay at two forests in northern California.* Berkeley, Ca: Pacific SW. Forest & Range Experimental Station, USDA Forest Service.