Effects of Duff Bulk Density on Water Retention

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Motivation and Literature Review:

Fire exclusion in naturally fire-maintained ecosystems such as longleaf pine savanna causes litter fuel accumulation known as “duff”. Fire reintroduction where duff has accumulated is problematic because duff fires are hard-to-detect, can smolder for days, generate large amounts of noxious smoke, and kill even large pines (Varner et al. 2016).

Fig 1. Long unburned long leaf pine forest floor profile (Hood 2010).

What is known about duff?

- Partially decayed organic matter that lies between the litter layer and the surface mineral layer of the forest floor (Varner et al. 2016)
- 2 Regions : slight/moderate decomposed region (Oe Fermentation) , decomposed region (Oa Humus)
- Moisture content > 60% ideal for burns (Kreye at al. 2016)

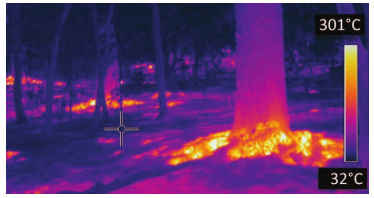


Fig 2. Thermal infrared images illustrating concentrated prolonged smoldering combustion of duff (Kreye et al. 2016)

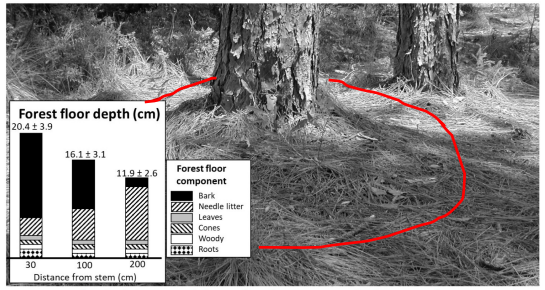
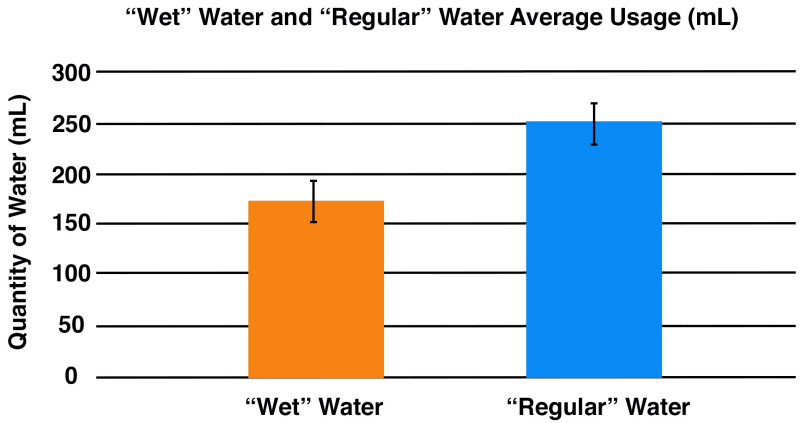


Fig 3. Forest floor depth increase with distance from stem. (Varner et al. 2016).

Previous Experiment (2020):

I conducted a pilot study on the benefits of surfactants for extinguishing duff fires.

Results: On average, water with surfactants extinguished fires with less volume than plain water. Duff is mostly composed of bark rich in suberin, which is hydrophobic. Presumably, the added surfactant (“wet” water) broke the surface tension and hence extinguished more efficiently.



An unpaired two sample t-test (α= 0.05) was used on the 10 replicates. A rejection of the null-hypothesis was determined with a P-value = 0.04, α= 0.05, t-value= 2.12.

Learning from and addressing mistakes:

- Assumed that fresh duff samples would readily ignite
- Sampling bias: large proportion collected from fermentation layer (Oe)

Improvements:

- Duff samples oven-dried before experimental manipulation.
- Samples of both fermentation and humus layer to better assess the influence of bulk density.

New Research Prospectus:

Effects of duff bulk density on water retention

Hypothesis: All “wet” water treatments will retain more water than regular water and that in both treatments, duff with a higher bulk density will retain less water than duff with a lower bulk density.

Methods/Materials/Procedure:

- Oven dried duff collection from fermentation (Oe) and humus (Oa) layers
- Variation of Oa and Oe composition placed in AMS soil sample rings with bulk density calculation
- Sample then fully saturated using either “wet” water or “regular” water.
- Calculate mass difference between dry and wet samples

"Regular" Water				
		25% Oe // 75% Oa	50% Oe // 50% Oa	75% Oe // 25% Oa
	Sample 1 of 5	Bulk Density:	Bulk Density:	Bulk Density:
		Dry Mass:	Dry Mass:	Dry Mass:
		Wet Mass:	Wet Mass:	Wet Mass:
		Difference:	Difference:	Difference:
"Wet" Water				
		25% Oe // 75% Oa	50% Oe // 50% Oa	75% Oe // 25% Oa
	Sample 1 of 5	Bulk Density:	Bulk Density:	Bulk Density:
		Dry Mass:	Dry Mass:	Dry Mass:
		Wet Mass:	Wet Mass:	Wet Mass:
		Difference:	Difference:	Difference:

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References:

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Varner, J. M., Kreye, J. K., & O'Brien, J. (2016). Recent advances in understanding duff consumption and post-fire longleaf pine mortality. In In: Proceedings of the 18th biennial southern silvicultural research conference. e-Gen. Tech. Rep. SRS-212. Asheville, NC: US Department of Agriculture, Forest Service, Southern Research Station. 614 p. (Vol. 212, pp. 335-338).

Kreye, J. K., Varner, J. M., Dugaw, C. J., Engber, E. A., & Quinn-Davidson, L. N. (2016). Patterns of duff ignition and smoldering beneath old Pinus palustris: influence of tree proximity, moisture content, and ignition vectors. Forest Science, 63(2), 165-172.