Spatial and Temporal Variability of Forest Floor Duff Characteristics in Long-Unburned *Pinus palustris* Forests

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INTRODUCTION

Consumption of forest floor duff (fermentation (F) and humus (H) soil horizons) during fires is often heterogeneous. Duff depth, bulk density, and moisture content all influence duff combustion, yet little is know about their spatial variability. Evaluating their spatial nature may inform our understanding of the patchiness of duff consumption, but also the heterogeneity of forest floor fuels in general and the potential ecological impacts of such variation.

Objective:

Quantify the spatial and temporal variability of duff depth, bulk density, and moisture content in long-unburned longleaf pine (*Pinus palustris* Mill.) forests.

METHODS

Forest Floor Spatial Sampling

- Three parallel sampling transects (105 m long; 10 m apart) were established in each of 3 long-unburned longleaf pine stands at the Ordway-Swisher Biological Preserve (FL) .
- Each of the 3 transects per stand were randomly assigned for destructive sampling under 3 moisture sampling periods (dry, intermediate, wet) (Fig. 2).
- Along each transect 21 duff samples were extracted (43 cm^2 corer) from 3 sub-transects in a spatial design where distance between samples ranged from 0.1 to 105 m (Fig. 3). F and H depths were measured and horizons separated.

Data Analysis

- Depth and bulk density were each compared between F and H horizons; and moisture content was compared across horizon and sample period (GLM ANOVA with interaction).
- Spatial autocorrelation was determined for depth, bulk density, and moisture content (Moran's I Correlation).

Laboratory Drying Experiments

- 15 duff samples (15×45 cm) were extracted from a nearby stand, separated into three 15×15 cm subsamples, and 25 g of plastic "pseudo-litter" placed onto 1 subsample. Samples were air-dried, wetted, and dried under controlled laboratory conditions to determine drying rates.
- Drying response times were calculated for each duff sample and modeled with depth, bulk density, and pseudo-litter presence as predictors (Multiple Regression).

Figure 1. Forest floor duff (fermentation and humus horizons) beneath needle litter in a long-unburned longleaf pine (*Pinus palustris*) at the Ordway-Swisher Biological Preserve in Florida.

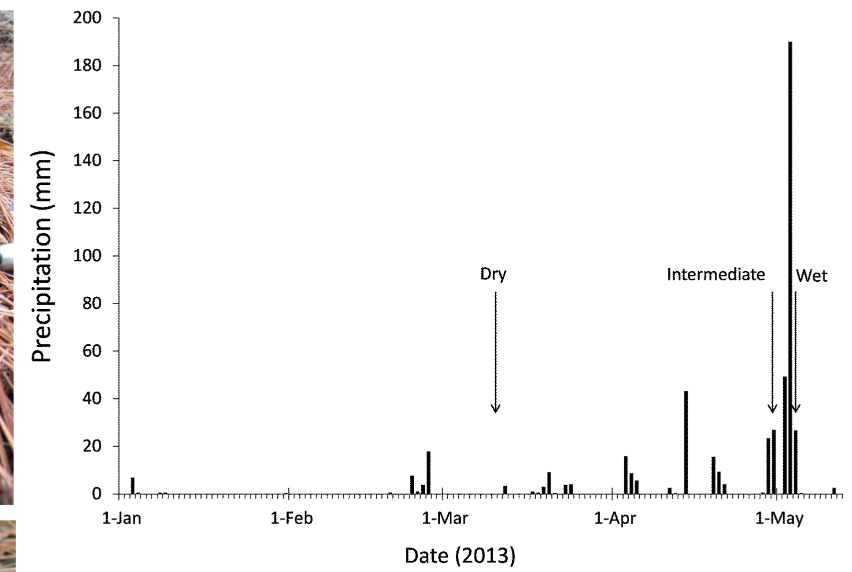

Figure 2. Forest floor duff was sampled under 3 different moisture sampling periods (dry, intermediate, wet).

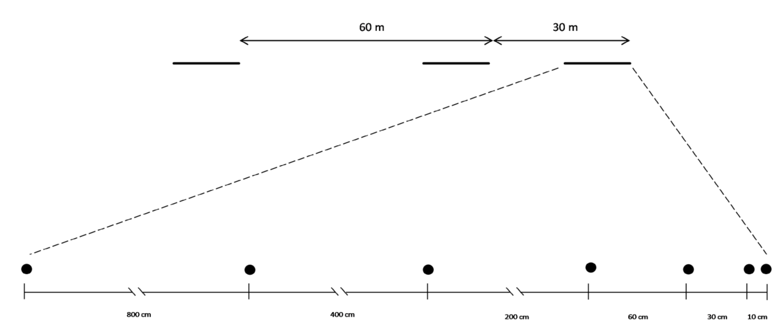

Figure 3. Spatial sampling design. Each transect consists of three 15 m sub-transects from which 7 duff samples were extracted at increasingly greater distances apart.

RESULTS

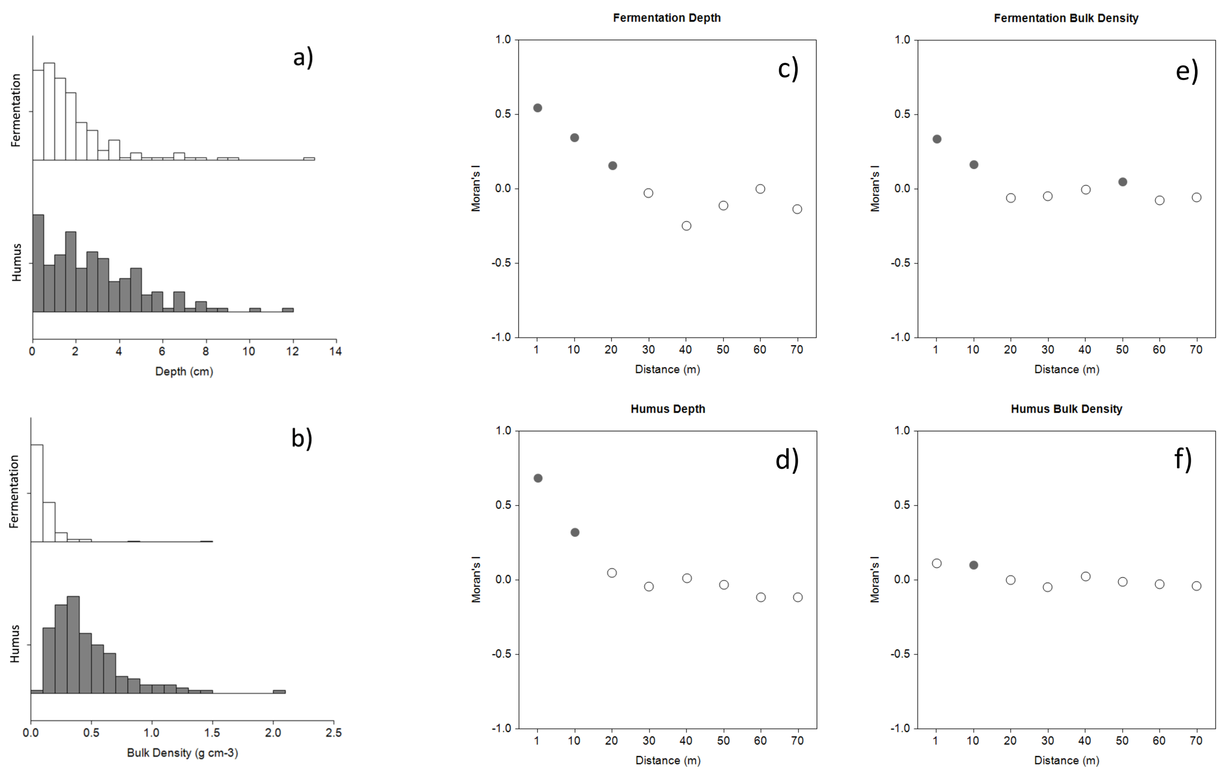

Fig 4. Variation in duff depth (a) and bulk density (b) of fermentation (white) and humus (dark) horizons; and Moran's I correlograms showing positive spatial autocorrelation (dark circles) of depths (c,d) and bulk densities (e,f) of fermentation (c,e) and humus (d,f) horizons.

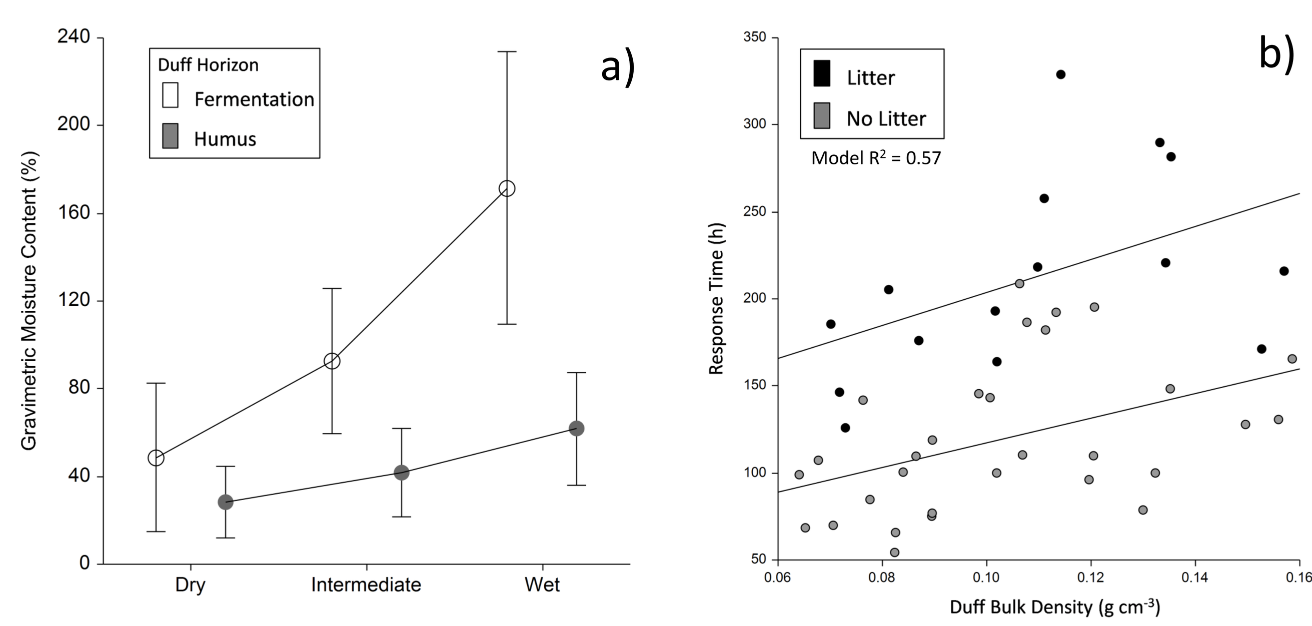

Fig 5. a) Moisture content of fermentation and humus duff horizons under 3 sampling periods (error bars are standard deviation). b) Drying response time ("timelag") of duff samples with (dark circles) and without (gray circles) the addition of a 25 g layer of plastic pseudo-litter.

RESULTS cont.

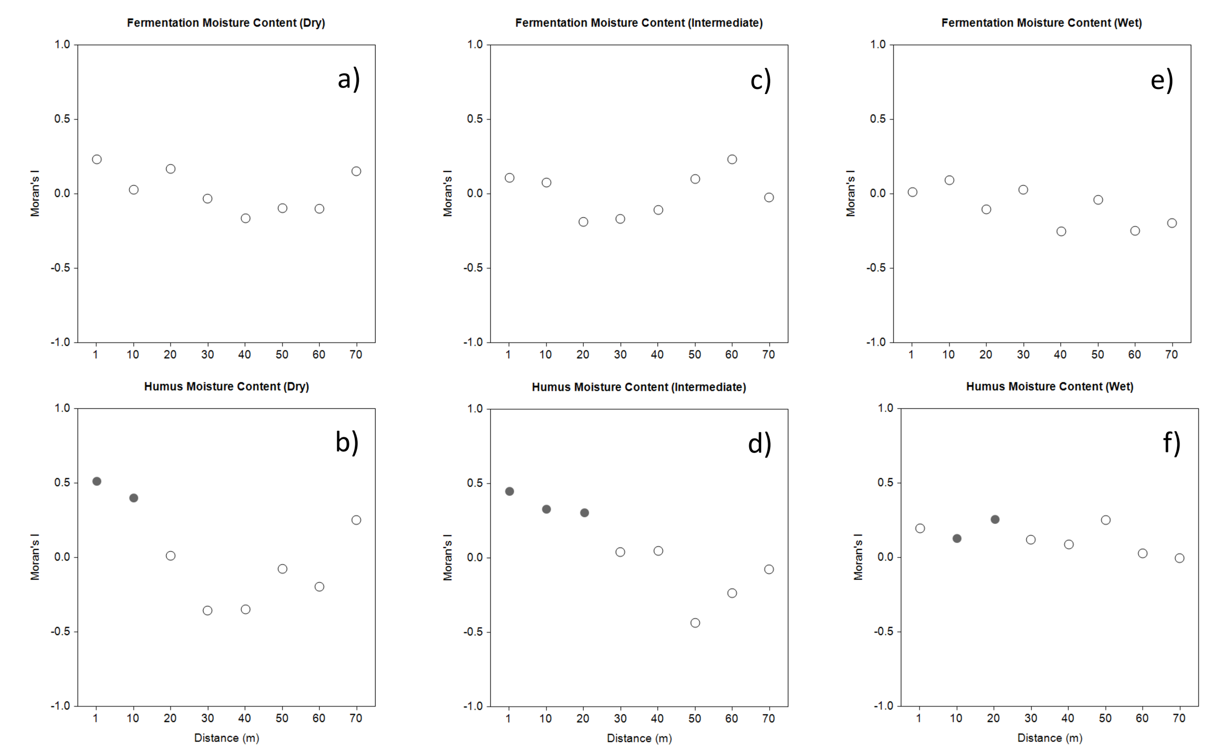

Fig 6. Moran's I correlograms showing positive spatial autocorrelation (dark circles) of fermentation (a,c,e) and humus (b,d,f) moisture during dry (a,b), intermediate (c,d), and wet (e,f) sampling periods.

Results & Discussion

- Humus was thicker (2.86 ± 2.23 cm) than the fermentation horizons above them (1.90 ± 1.86 cm) and humus bulk densities were much greater and more variable (0.46 ± 0.30) than fermentation horizons (0.12 ± 0.14 g cm^{-3}) (Fig. 4 a,b).
- Horizon depth showed stronger spatial autocorrelation than bulk density, but autocorrelation generally occurred at small (10^1 m) spatial scales (Fig. 4 c-f).
- Fermentation horizons were wetter than underlying humus and more variable in moisture content, especially following rain (Fig. 5).
- Humus moisture showed moderate spatial autocorrelation (at small scales 10^1 m) during dry and intermediate sampling and weak autocorrelation following heavy rain, however fermentation moisture showed no spatial autocorrelation during any sampling.
- Drying response time (often called "timelag") of duff samples were highly variable (54-349 h). The addition of pseudo-litter (simulating the physical barrier of litter) slowed response time by 88 h and bulk density explained a portion of the remaining variation (Fig. 5b), with depth not being significant. The influence of bulk density on drying rates (increasing response time) was similar with or without the addition of litter (no interaction), but high variability still existed.

CONCLUSIONS

High spatial variation of forest floor duff characteristics may contribute to heterogeneous duff consumption patterns during fires and should be considered when developing prescribed burns for ecological restoration of long-unburned ecosystems.

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