Dynamics of Pine Bark Microrelief as a Potential Factor in Firebrand Production

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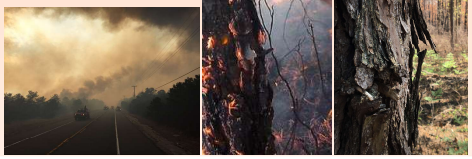
Introduction

Firebrands or embers are combusting fragments of fuel that can be lofted into a fire's plume and transported great distances ahead of a fire front, igniting structures or new spot fires. (Caton-Kerr, et al., 2019). Spot fires can become entirely new fires if they are not extinguished quickly, adding to the overall impact, as well as possibly creating dangerous situations for firefighters, such as entrapments (Koo, et al., 2010). A study in the New Jersey Pine Barrens found that 70% of firebrands collected from a prescribed fire were bark flakes (El Houssami et al., 2015). The conditions for firebrands are separation, lofting, and transportation. The structure of bark or its "flakiness" will affect the drag forces acting to separate, loft, and transport it. Fire frequency, size and severity is expected to increase with climate change (Caton-Kerr, et al., 2019), along with factors suspected to create bark structure that promotes firebrand generation, such as temperatures and durations of dryness.



Objectives

Characterize fine scale bark structure changes at hourly intervals and the effects temperature, moisture, and aspect has on structure.

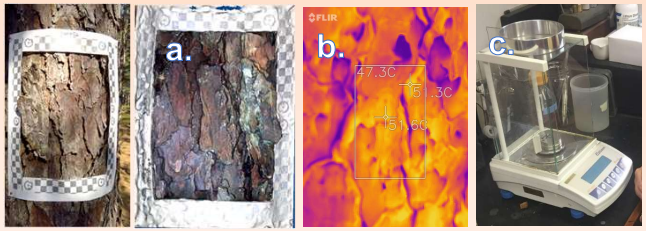
Study Area

- 3 *Pinus rigida* (Pitch Pine) trees at the Silas Little Experimental Forest in New Lisbon, New Jersey.

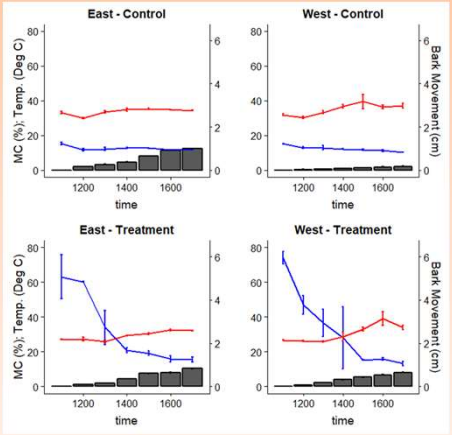
Materials and Methods

Sampling occurred on August 9th 2018 at one hour intervals starting at 11:00 AM and ending at 5:00 PM.

Bark Structure	Modeling using photogrammetry to measure changes in microrelief (a.)
Temperature	FLIROne IR images to measure surface temperature (b.)
Moisture	Calculated bark moisture content by weighing, drying, and reweighing (c.)
Aspect	Sample at East and West aspect to account for morning and afternoon sun, respectively
Treatment	Simulated rain event (treatment) vs sunny and dry for 3 days (control)



Results



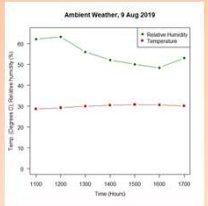


Figure 4. (Top) Ambient Temperature (°C) and Relative Humidity (%) at each sample time.
Figure 3. (Left) Moisture Content (%), Temperature (°C), and Bark Movement (cm) at each sampling time.

Results cont.

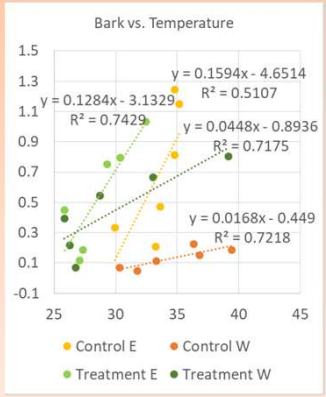


Figure 1. Bark Movement (cm) plotted against temperature (°C) for Control East and West as well as Treatment East and West.

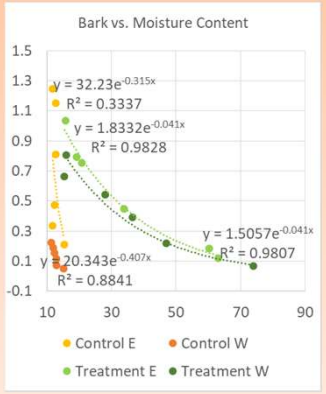


Figure 2. Bark Movement (cm) plotted against moisture content (%mass) for Control East and West as well as Treatment East and West.

Discussion

Photogrammetry and infrared photography proved to be effective off the shelf ways for quantifying fine scale bark structure and temperature changes at hourly time intervals. The results of the study indicate that:

- The bark structure of pitch pine can change throughout the day, and is best described as peeling.
- Moisture and temperature conditions were influenced by wetting, while bark flaking was influenced by aspect.
- Results of modelling data using a Bayesian multiple regression approach shows that temperature and moisture can be significant predictors of bark peeling, but peeling has a more complex relationships with aspect and treatment.

Sampling was repeated on several days during the primary fire season in NJ in May, June, and August of 2019 with several adjustments to the methods. These adjustments were aimed to address the limitations of the 2018 sampling methods: only one species was considered, measurements were only taken on one day not in the primary fire season, and treatment may have been insufficient. Results are yet to be determined

Acknowledgements

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