Tallgrass Prairie and Oak Savanna
Fire Science Consortium

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Research Brief for Resource Managers

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Fire behavior observations from southern Ontario

Kidnie, Susan, and B. Mike Wotton. 2015. Characterisation of the fuel and fire environment in southern Ontario's tallgrass prairie. International Journal of Wildland Fire 24: 1118-1128.

Management Implications

- Default settings in commonly used fuel models may underestimate fuel loads and fire behavior in tallgrass prairie
- The Robel pole was found to be an accurate rapid assessment of fuel loads in tallgrass prairie sites

Understanding how fuels and fire behavior are linked is important for those using prescribed fire as a land management tool. Practitioners use fire behavior prediction models to predict fire behavior as part of their planning process, but **few studies have evaluated the model predictions as compared to quantitative fire behavior measurements** taken during a burn.

To better understand the relationship between fuels and fire behaviour in southern Ontario's tallgrass prairie fuel type, and compare observed fire behavior to model predictions the authors of this study collected detailed fuel and fire behavior measurements. Data were collected from sites throughout southern Ontario that were burned with prescribed fires between 2006 and 2010. The authors sought to 1) Compare rapid assessment tools for fuel loading, 2) measure fire behavior, and 3) compare observed fire behavior to model predictions (Canadian FBP, Behave, Australian grass).

Accurately measuring fire behavior is a challenge, and the intensive sampling for this study is an example of how to collect detailed quantitative fire behavior measurements.

The authors measured:

- Fuel load using destructive sampling as well as assessing three rapid assessment techniques (Robel pole, falling plate meter, and fuel height).
- Heat of combustion for common C4 grasses. Samples were collected at prescribed fire sites and analyzed using an oxygen bomb calorimeter.
- Flame temperature and residence time were measured using thermocouples connected to data loggers. It is important to note that the researchers used 0.127mm chromel-alumen thermocouples, which respond rapidly to change in gas temperature. Using these variables the authors were also able to calculate rate of spread and fireline intensity (FI).
- Fuel moisture was measured by taking samples immediately prior to the burn and were oven dried to calculate gravimetric fuel moisture content.
- Weather conditions (temperature, relative humidity, wind speed) were measured on site using a handheld Kestrel during burns.

These detailed fire behavior measures enabled researchers to calculate additional fire behavior variables, such as fireline intensity, which can be compared across studies.

The authors found that **fuels loads were variable across sites, but generally higher than the default settings in the Canadian FBP system** of .3 kg m^{-2}. This would lead to an underestimate of fire intensity if using the default settings.

There were no significant differences in fuel load based on the dominant grass. However, it was notable that sites dominated by little bluestem had the lowest average fuel load (0.32 kg m^{-2}) and those dominated by switchgrass had the greatest average fuel load (0.93 kg m^{-2}). Of the three rapid assessments, **the Robel pole method was determined to be the most accurate predictor of fuel loading in these sites**.

Heat of combustion of fuels ranged from 15,419 to 18,244 kJ kg^{-1} and were close to the defaults of the Canadian FBP model (18,000 kJ kg^{-1}) and Behave model (18,666 kJ kg^{-1}). Bromegrass, which had the lowest average heat of combustion, was the only species with a significant difference from the other species tested.

Maximum temperature of the flaming front ranged from 642°C to 1097°C with a mean value of 900°C. The average residence time across all plots was 27 seconds (only data from head fires were included in the analysis). Residence time was positively correlated with fuel load, but not rate of spread or fuel bed depth.

When comparing the model predictions to observed rate of spread, **models typically under predicted fire behavior**. Even the custom Behave model, which had the highest correlation with observed values, was found to under predict fire spread. The authors found that the model with the most reasonable fit, when considering both correlation and prediction bias, was the Australian grassland fire spread model. Understanding strength and weaknesses of model assumptions and predictions can help prescribed burn practitioners plan and achieve successful burns.

A field guide developed from this research is available online.

http://cfs.nrcan.gc.ca/publications?id=33093