Project Update
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FPInnovations
Wildfire Operations Research
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Survival zones for wildland firefighters: data collection in two experimental openings in grass

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DATA COLLECTION

Location: Connor Creek prescribed burn

Date: May 7, 2012

Fuel Type: Grass

Opening: One circular opening 10 m in diameter; one circular opening 15 m in diameter

We created these openings by burning the grass; we had created all our other experimental grass openings by mowing.

Each opening was instrumented with nine flat heat flux sensors, one cube heat flux sensor, and two video cameras in fire-proof boxes, each equipped with a heat flux sensor and temperature sensor (Figure 1). The flat heat flux sensors were placed in an upside down "Y" pattern with the leg of the "Y" at the edge of the opening where the fire was expected to enter it. One fire-proof camera box (0.75 m above the surface) was placed at the center of the opening and the other (25 cm above the surface) was placed at the back end of the opening. The flat heat flux sensors were placed 0.2 m from opening edge. In the 10 m opening they were placed 1.0 m apart and in the 15 m opening they were placed 2.0 m apart. Heat flux sensors are used to measure energy transfer to a point in kW/m^2. This measure is related to flame front size and fireline intensity through flame height and can be used to estimate time to burn injury.

Figure 1. The 10 m survival opening instrumented with flat sensors, 2 cameras and a cube sensor.

Fire Weather

Fire weather conditions were collected using a handheld Kestrel 3500.

Table 1. Weather observations on May 7, 2012 at the Connor Creek prescribed burn.

Time	Temp (°C)	RH (%)	Wind Speed (kph)
0850	14	27	4
1000	17	30	7G12
1115	17	22	2
1155	22	23	0-2
1245	18	18	15
1310	18	19	7
1445	21	18	20
1620	25	24	0

The noon fire weather index (FWI) values at the Vega AESRD weather station were:

DC	202	BUI	27
DMC	17	ISi	6.6
FFMC	89	FWI	12

Findings

Grass Fuel Loads

Grass fuel load ranged from 2.73 t/ha to 3.90 t/ha and the grass was primarily compressed (O1-a) from late season snowfalls. The grass was approximately 95% cured.

Fire Behaviour

Light fuel loads combined with light winds produced only moderate fire behaviour (Figure 2). Observed head fire rates of spread ranged from 14 to 25 m/min with short periods of higher rates. Flame lengths averaged 0.5 m but increased to above 1.0 m for short periods. The FPInnovations Grassland Firebreak Breaching Program (Alexander et. al. 2006) predicted a rate of spread of 10.8 m/min and fire intensity of 1133 kW/m (moderate fire behaviour).

Figure 2. Fire behaviour as the fire approached an opening.

Heat Flux

Fire intensity of 7 kW/m^2 for 90 seconds is considered the threshold for human survival. Figure 3 shows the heat flux values measured in the 10 m survival opening. The highest heat flux (34.0 kW/m^2) occurred at ground level at the front of the opening where the fire entered. All the other ground-level sensors recorded values below 3.4 kW/m^2. The heat flux sensors in the fireproof camera boxes, both of which were above the surface, recorded values higher than 3.4 kW/m^2 (blue squares in Figure 3). The cube sensor (0.70 m above the surface) recorded a value of 5.9 kW/m^2 on the side that faced the fire.

Figure 3. Heat flux values (kW/m^2) inside the 10 m opening. The fire entered the opening at the top.

Lower heat flux values were measured in the 15 m opening, although one elevated sensor (0.75 m) did record values greater than 5 kW/m^2 for up to 8 minutes.

Preliminary Conclusions

The heat flux and fire behaviour in these two openings was the lowest recorded in all tests to date.

The surface heat flux sensors recorded values significantly lower than those of elevated sensors that were in close proximity to them.

Given the light winds and light fuel load, and assuming a firefighter was wearing PPE, we believe that the back end of these two openings were survivable. Heat flux values in the back half of the opening were below the critical threshold and endured for less than two minutes. Air temperature peaked at 41^{o}C. Heat flux values on the surface were lower than that recorded by the elevated sensors, which supports the recommendation to lie down.