Fire behaviour in black spruce forest fuels following mulch fuel treatments: A case study at Red Earth Creek, Alberta

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Main questions or issues that you addressed

Mulching of forest fuels is a vegetation management practice commonly applied in the wildland urban interface to mitigate the risk of wildfire. This experimental fire at the Red Earth Creek FireSmart research area was designed and conducted to document how two different mulch fuel treatments modified fire behaviour when challenged by an approaching crown fire. The two fuel treatments applied at the Red Earth Creek study site included mulch thinning and strip mulching. We ignited a strip of natural black spruce forest upwind of these treatments to observe and document changes in fire behaviour as crown fire encountered the mulch treatments.

Location and ecosystem investigated

The town of Red Earth Creek is 167 km north of Slave Lake, Alberta. The overstory species in the treated and natural stands was 100% black spruce. The mulch thinning treatment resulted in stem spacing of 5 to 7 m with a reduction in stand density from 1,400 stems/ha to 400 stems/ha (stems greater than 9 cm DBH). The strip mulching treatment resulted in mulch strips and strips of standing stems (residual strips) approximately 4 m wide (Figure 3). The stem density in this treatment area was reduced from 1,450 stems/ha to 650 stems/ha. The Red Earth Creek experimental fire was conducted under conditions of severe fuel moisture deficit with temperature/relative humidity crossover and moderate wind conditions.

Key Findings of Your Research

Strip mulching: The observed rate of spread at the head of the strip mulch treatment was similar to the forecast value for the C-2 fuel type. However, we observed intermittent crown fire within residual strips, suggesting the treatment had a small effect on fire intensity. Intermittent crown fire in the residual strips easily breached the mulched strips and sustained crown-to-crown fire spread. Hence, the strips did not mitigate the fire spread rate, but marginally reduced fire intensity. Widening the strips might reduce the intensity; however, in-fire imagery indicates that the residual strips would still generate crown fire and produce additional ember transfer. The rate of spread documented in the thinned stand suggests that wider mulched strips would not slow down the fire.
Mulch thinned: results compromised due to influence of fire in the strip mulch treatment. It was expected that

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the strip mulch would not support such an intense fire and therefore interaction would be minimal but under the severe weather conditions that was not the case.

How Did You Answer the Main Questions or Inform the Issues?

This experimental fire represents one of few documented case studies of fire behaviour in black spruce fuels that have had fuel management treatments. And of those case studies, the Red Earth experimental fire was conducted at the highest fire danger indices. The strip mulching treatment in a black spruce stand had a limited effect on rate of spread and fireline intensity when compared to the observed fire behaviour and calculated outputs for the natural black spruce fuel stand (FBP C-2 fuel type). Calculated spread rate and head fire intensity were lower than the C-2 outputs, but still supported a crown fire that would have been difficult to suppress. Fire behaviour in the thinned stand was observed to be influenced by the adjacent strip mulch, and as a result we cannot draw a conclusion about the effectiveness of this treatment in a wind-driven fire. The effect of the interaction did show that black spruce stands thinned by mulching can support a fastmoving fire that can exceed fireline intensity levels under which direct attack is deemed to be successful.

How Might/Will It Influence Fire Management Decisions or Practices?

This case study demonstrates the effect of changing fuel structure as a fuel management treatment. Mulching alone does not remove fuel; rather, the intent is to limit crown fire activity by displacing fuel to the ground. In other words, the total fuel load was not changed after treatment, nor was it different between the treatments. However, the amount of available fuel is increased. The mulch increased the potential volatility of surface fuels by adding to the fuel volume through conversion of stems and large branches to fine mulched fuels. The chipped debris and feathermoss in the surface fuel layer were desiccated by very low relative humidity. Additionally, there was limited migration of moisture from deeper peat layers caused by an ice layer at the 7 cm depth below the duff surface. All of these factors contributed collectively to a dry surface fuel layer that was very receptive to ember transfer and supportive of volatile fire behaviour. Candling of residual stems and ignition of canopy fuels can be problematic even in aggressively thinned and pruned fuel stands. In-stand video from this fire suggests that an intense surface fire can overcome the live crown base height of 2 m typically prescribed in FireSmart guidelines. In addition, abundant lichen in the canopy fuels, common in black spruce, are easily ignited and create additional airborne embers as well as being capable of igniting from embers mid-canopy rather than from below. A reasonable target for FireSmart fuel management treatments is to limit fire behaviour to fire intensity that will not exceed 4000 kW/m, a value that is determined to be the limit for direct ground attack. Fires with higher intensity can be suppressed with the aid of airtankers and rotary wing aircraft. Our fireline intensity calculations indicate that direct suppression would have had limited success in both treatment types.

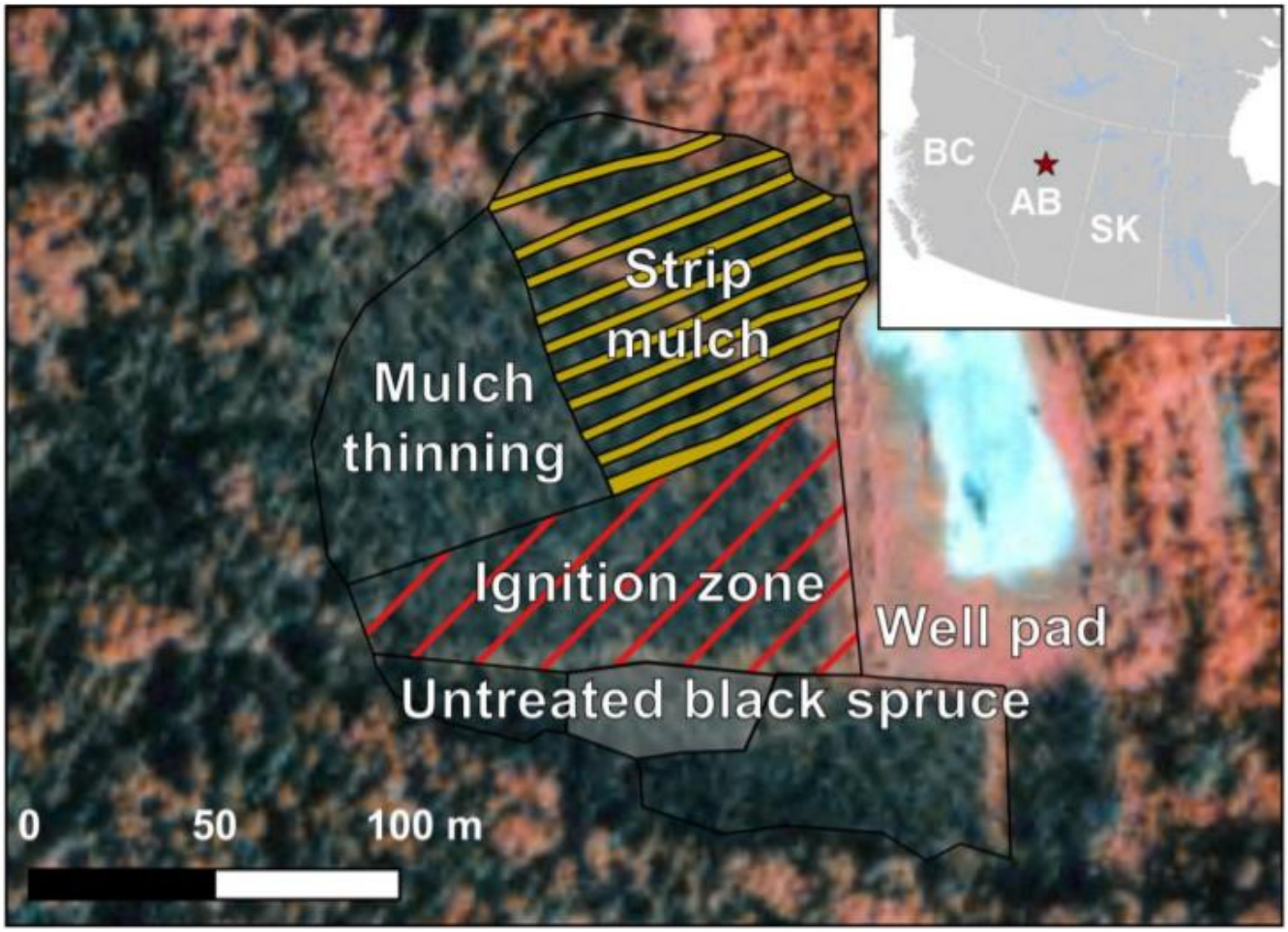
Full report is available online here:
http://wildfire.fpinnovations.ca/119/RedEarthCreekexperimentalfiretechrep.pdf.

Who Is the Main End-user of Your Research?

Wildland fire managers

Congress Session

Case Studies and Lessons Learned


BC
AB
SK
Strip mulch
Mulch thinning
Ignition zone
Well pad
Untreated black spruce
0
50
100 m