Valuable instruments melt in gorse burn

Temperatures in a Scion/FENZ controlled gorse burn reached up to 1500°C and in some cases went off the charts, surprising scientists and firefighters and endangering an extremely expensive collection of recording gear.

The burns in a block of mature gorse in the Rakaia Gorge were successfully carried out during March in challenging conditions to investigate fire behaviour in heavy, scrub-type fuels.

Preparation for the experimental burns took two years of careful planning by Scion's rural fire research team working with FENZ, the Department of Conservation, environmental experts and local landowners. As part of the ground work, extensive firebreaks were bulldozed through around 50 hectares of gorse on land near the upper Rakaia River and the land was mapped in detail using drone-mounted cameras and a laser scanner. Close to the scheduled burn window of early March, FENZ carried out controlled burns in blocks surrounding the research plots to create a burnt out buffer.

With site preparation complete, the Scion team and local and international fire researchers set up their instrumentation. This included 30 metre towers carrying sensors to monitor wind and turbulence, and the vertical temperature profile within and above the spreading flame front, as well as loggers across the burn area to record rates of fire spread, heat transfer and flame size, and nearly $1 million of cameras.

The fire's progress was also monitored from the air by thermal and visual cameras mounted on unmanned aerial vehicles.

The sheer amount of instrumentation ensured the recent fires were the most closely observed experimental fires to date.

Overall, six plots were successfully burnt over three burn days from March 2 to 9 with the researchers being able to record data in high and low wind conditions.

Strong winds blew down-valley on the first day and conditions were dry. The plots burnt hot and furious with flames

Setting up instruments in the mature gorse in Rakaia riverbed. Photo: *Scion*

Data loggers recording the rate of fire spread succumb to the heat despite being housed in well-insulated, low-to-the-ground, capsules. Photo: *Scion*

10 metres high. Temperatures got up to around 1500°C in the centre of the plot, testing the limits of measuring instruments. A University of Canterbury infrared camera mounted on a UAV reached the upper limits of its sensing capabilities at approximately 940°C at the edge of the burn.

'Fishbowls' filled with water meant to keep the US Forest Service's experimental 360-degree-cameras cool boiled dry, and the cameras blistered. And some of Scion's rate-of-spread data loggers melted within their well-insulated, low-to-the-ground, capsules. Luckily for the researchers, most of the sensors survived and they were able to retrieve most of the data.

All the research teams put more insulation around their sensors for the second day of burns. Although the weather conditions were less extreme, with rain two days before, and lighter, up-valley winds, flames still reached eight to 10 metres and temperatures of 1200°C were recorded.

The sonic anemometers (wind and turbulence meters) mounted on the tower 20 metres above the ground melted but continued to record data as the fire front hit.

The burns were hot and intense again on the third burn day, but lighter down-valley winds and moist ground due to recent rain meant flames heights were lower than on previous days.

What does it all mean ?

The Scion rural fire research team are lighting these fires to test a new theory on the way fire spreads. Flame fronts have been observed to 'pulse', with flames pushing out ahead of the fire front where they can directly light fuel.

The theory is that (see photos next column), instead of an evenly spreading flame front radiating heat into unburnt fuels ahead, hot air rising from the fire is replaced by cool air sweeping in from behind and pushing the flames forward. This creates a series of peaks and troughs in the burning flame front, with flame peaks in areas where the air is rising and pulling the flame upward, and troughs formed by the cooler air circulating down.

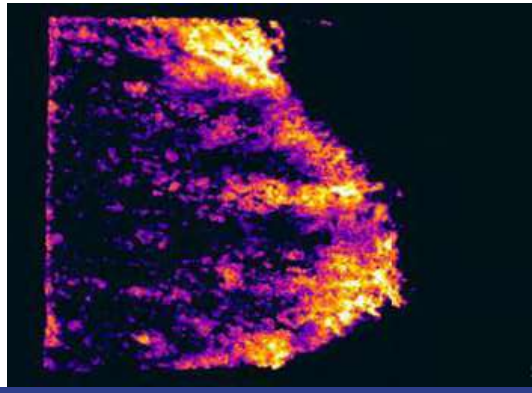
The theory was first proposed by the U.S. Forest Service based on lab-scale fire test carried out in the Missoula Fire Sciences Laboratory, but the best way to study fire behaviour is under real world conditions.

"Real" fire experimentation kicked off with stubble fields near Christchurch in 2018 and 2019. The Rakaia Gorge burns are the latest, focussing on fire behaviour in heavier scrub fuels. Future work with crown fires in wilding conifers up to 12 metres tall is being planned.

Fire researchers are looking for patterns in fire behaviour, such as how updrafts and downdrafts are pushing fire into the fuel and spreading the fire.

Improving understanding and predictions of fire spread rates in different weather, terrain and fuel types will allow fire incident controllers

The video and thermal images from the Scion IR/RGB drone.



New Zealand is one of the few countries where full-scale controlled burns can be safely conducted. The mature gorse patch in the Rakaia riverbed was cut into squares for comparitive results.

to make more informed decisions, including where to concentrate fire control efforts, when to pull firefighters back, and evacuating people and animals in danger, ultimately preventing the loss of life and property.

The research will also help prepare New Zealand to respond to the increased risk and possibility of extreme fires such as the 2017 Port Hills Fire. While the country's maritime climate has largely protected us up until now, more extreme fires are expected here with climate change as the number of extreme fire risk days increases.

Scion's rural fire research will help ensure communities and the country are more aware of fire risks and better prepared for extreme fires. By the end of 2020, the team hopes to have a prototype system ready for testing that links fire detection, fire growth and smoke models with weather forecast data for near real-time prediction of fire spread and its effects.

Incorporating this into fire responders' everyday operations will give organisations like Fire and Emergency faster, more accurate information on fire occurrence, spread and potential effects allowing firefighting resources to be mobilised rapidly and effectively.

A big thank you

New Zealand is one of the very few countries where experimental fire burns are still possible. Around 40-50 fire personnel from Canterbury, Otago and the West Coast helped each day with the burns.

The Scion rural fire team is very grateful for FENZ's support and assistance, and they acknowledge they would not have been able to achieve their research objectives without them.

The team is also indebted to the volunteer firefighters who came out to help, many doing the difficult and dirty job of mopping up and wetting down after the burns.

Local and international collaborators included researchers from the US Forest Service, San Jose State University and the University of Canterbury.

American and NZ fire scientists watch from a mobile grandstand, while a Scion drone hovers over the site. Photo: *Scion*

Simply the best – again

Chief Executive Rhys Jones congratulates all Fire and Emergency personnel for the organisation being voted – for the fifth year in a row – the most trusted agency within the public sector in Colmar Brunton's annual Public Sector Reputation Index Survey.

"We are rated most highly overall, and across each of the four pillars that shape reputation – trust, social responsibility, leadership and fairness. Furthermore, our results have improved against the 2019 levels, which was the first year we were assessed as Fire and Emergency New Zealand." To quote Colmar Brunton: "Fire and Emergency remains the benchmark agency when it comes to reputation."

K1

The New Zealand firefighter magazine

June 2020

This issue:

Cover photo

Spare a thought for many USA first responders caught in the middle of a cycle of madness that has risen from yet another needless African American death. Buildings and vehicles in several cities have been torched and the more extreme protesters have interfered with firefighters trying to deal with the situation, some being injured as a result. Photo: *Hawaii Herald-Tribune.*

June 2020

K1 is an independent magazine produced by the K1 Group.

Editors: Ross Miller and Russell Postlewaight.

All correspondence to: k.1group@ymail.com

ISSN 179-928X