

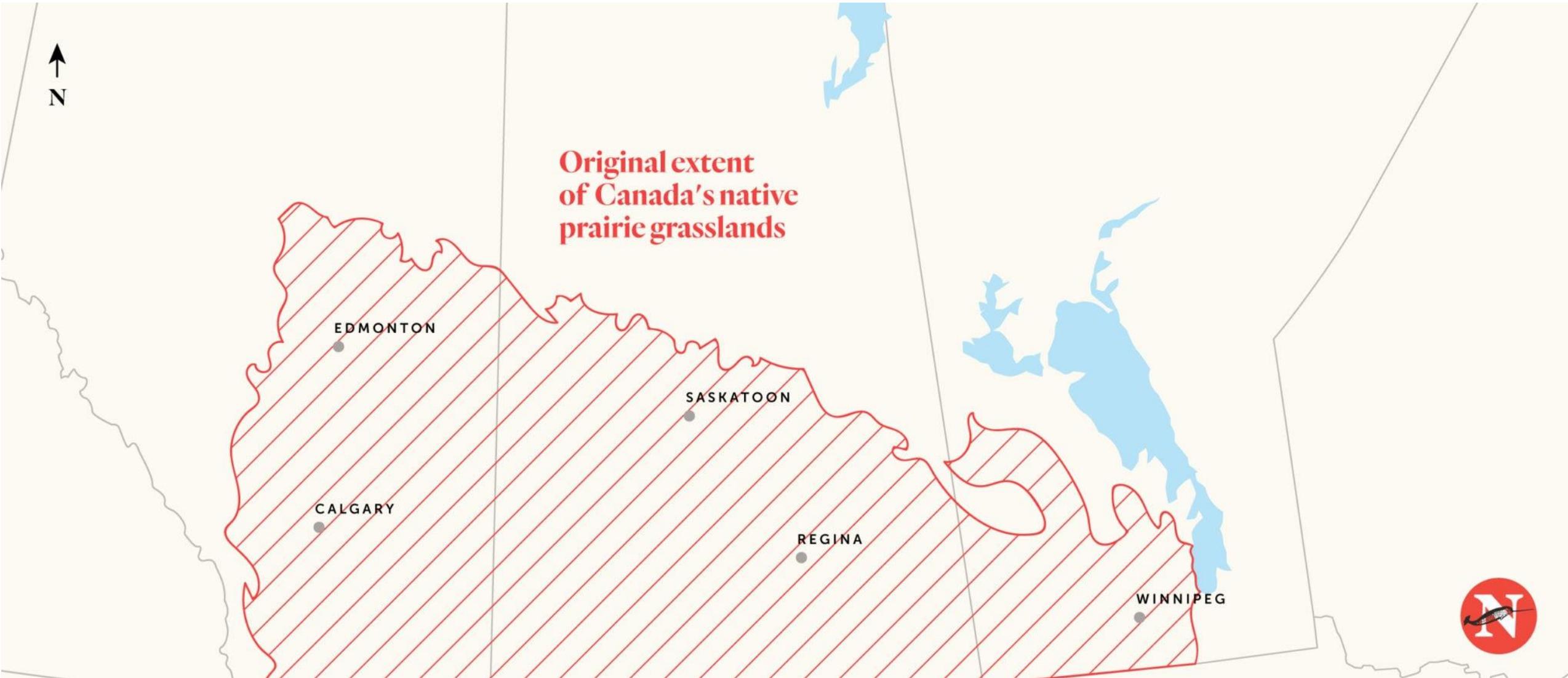
# Estimating Wildfire Rate of Spread in Grasslands

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# Geographical Extent of Western Canada's Prairie Grasslands



# The Great Fire of 1909

By ROBERT J. RODER

Our Prairie pioneers had many enemies to conquer — drought, isolation, lack of transportation and communications were all there but perhaps the biggest challenge was that dread hazard fire. Mr. Roder spent a great deal of time and effort in gathering up these true facts on the Great Fire of 1909.



W. Perehudoff

As soon as papa felt it was safe to leave our homestead he and other neighbors to the south went north and helped neighbors there to save their property."

She further recalls that her father did not come home till around midnight and was so black with soot she could hardly recognize him.

The writer tried to definitely establish the northern and north-eastern limits of the 1909 fire

the fire came so fast it jumped from cut bank to cut bank of the Sounding Creek and never burned the grass in the coulee. Having lost all his hay in the fire, Mr. Rosenau recalls he was able to put up a new supply in the creek bottom.

Mrs. M. H. Peterson of Sylvan Lake, Alberta recalls how she and her brothers and sisters were told to lie low in their dugout home on the banks of the Berry Creek while

# When Time is of the Essence

There will be wildfire situations where there will or no time available to undertake a detailed prediction.



Photo courtesy of South Australia Country Fire Services

**Yet ...** *wildland fire operations personnel* still need to be able to issue warnings to the general public of the fire spread potential in a timely manner.



Two Australian colleagues and I recently developed a simple rule of thumb for estimating the forward spread rate of wildfires in cured grasslands



Dr. Miguel Cruz  
Principal Research Scientist



Dr. Musa Kilinc  
Bushfire Behaviour Analyst

# What is a “Rule of Thumb”?

- A principle with **broad application** that is not intended to be strictly accurate or reliable for every situation.
- It refers to an **easily learned and easily applied** procedure or standard, based on practical experience rather than theory.



# Existing datasets for wildfire spread observations in grasslands

## **Cheney et al. (1998) wildfire dataset:**

Compilation of wildfire rate of spread data and associated environment for 21 wildfires occurring between 1965 and 1990 ( $n = 24$ ).

## **Harris et al. (2011) and Kilinc et al. (2012) wildfire dataset:**

Extended dataset of wildfire rate of spread data in grassland fuels (from 1939 to 2009 ( $n = 187$ )).

### **Prediction of Fire Spread in Grasslands**

**N. P. Cheney<sup>1</sup>, J. S. Gould<sup>1</sup>, and W. R. Catchpole<sup>2</sup>**

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*International Journal of Wildland Fire* 8: 1-13.

Establishing a link between the power of fire and community loss: **The first step towards developing a bushfire severity scale**

Fire and adaptive management

report no. 89

S. Harris<sup>1</sup>, W. Anderson<sup>2</sup>, M. Kilinc<sup>1</sup> and L. Fogarty<sup>3</sup>

**Plus 16 additional wildfire observations from Gould (2006) and Burrows (2015)**

# Imposed Data Constraints on the 227 Observations

We removed data where the:

- Fire run duration  $<1.0$  h
- Degree of curing level  $<90\%$
- Fine dead fuel moisture content  $>10\%$
- 10-m open wind speed  $<20$  km/h

This resulted in 58 observations for analysis

# Dataset Summary

<b>Variable</b>	<b>Mean</b>	<b>Range</b>
Fire run duration (h)	1.9	1-5
Rate of spread (km/h)	6.9	1.6-17
10-m open wind (km/h)	42	20-62
Air temperature (°C)	37	23.7-43
Relative humidity (%)	12.4	3-36
Moisture content (%)	3.7	1.5-9.6

 49 of the 58 observations met the Australian  
EXTREME Fire Danger Class category

# Grassland Fuel Condition

Natural or ungrazed



2 fires

Grazed or cut



38 fires

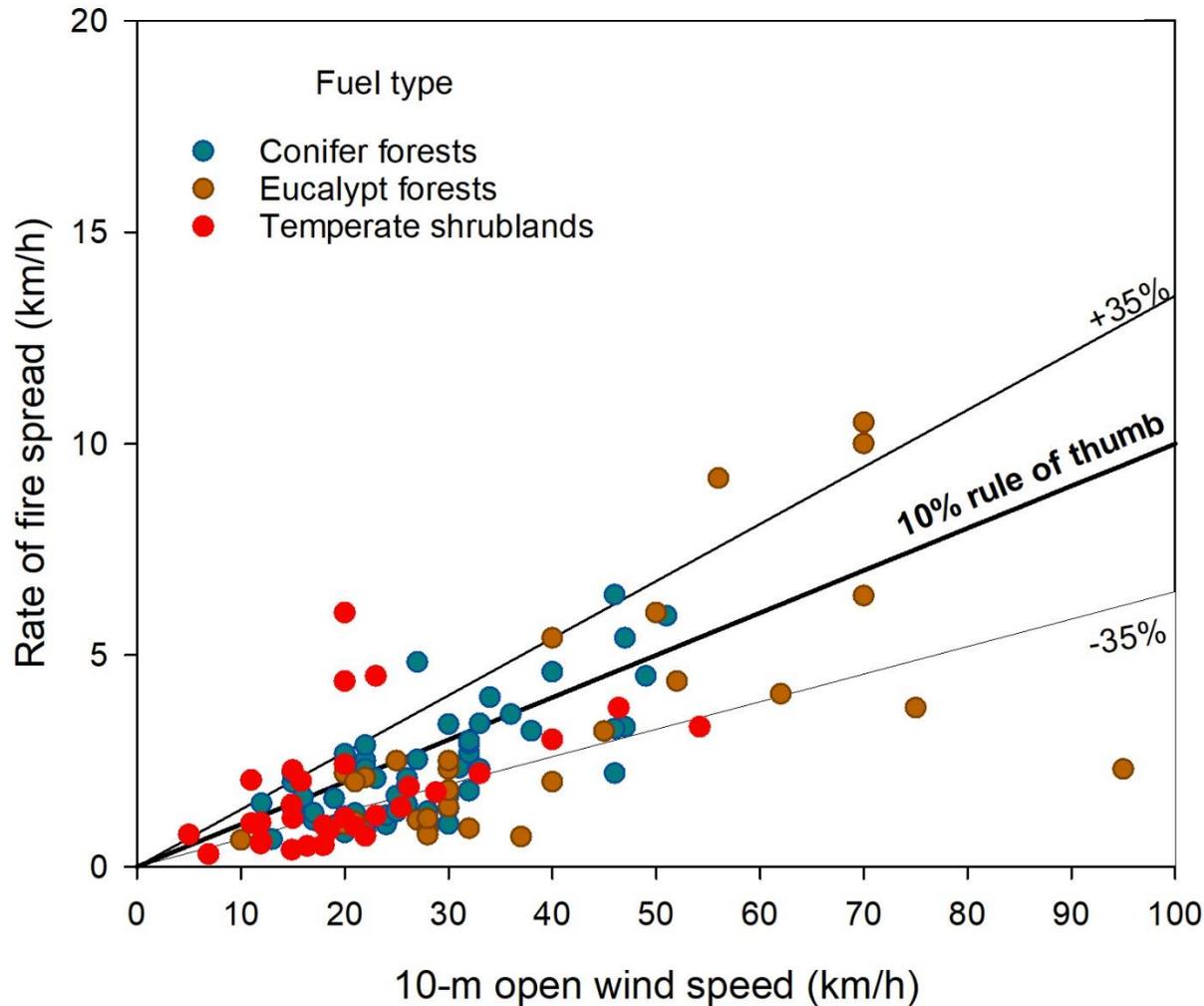
Eaten-out or very heavily grazed



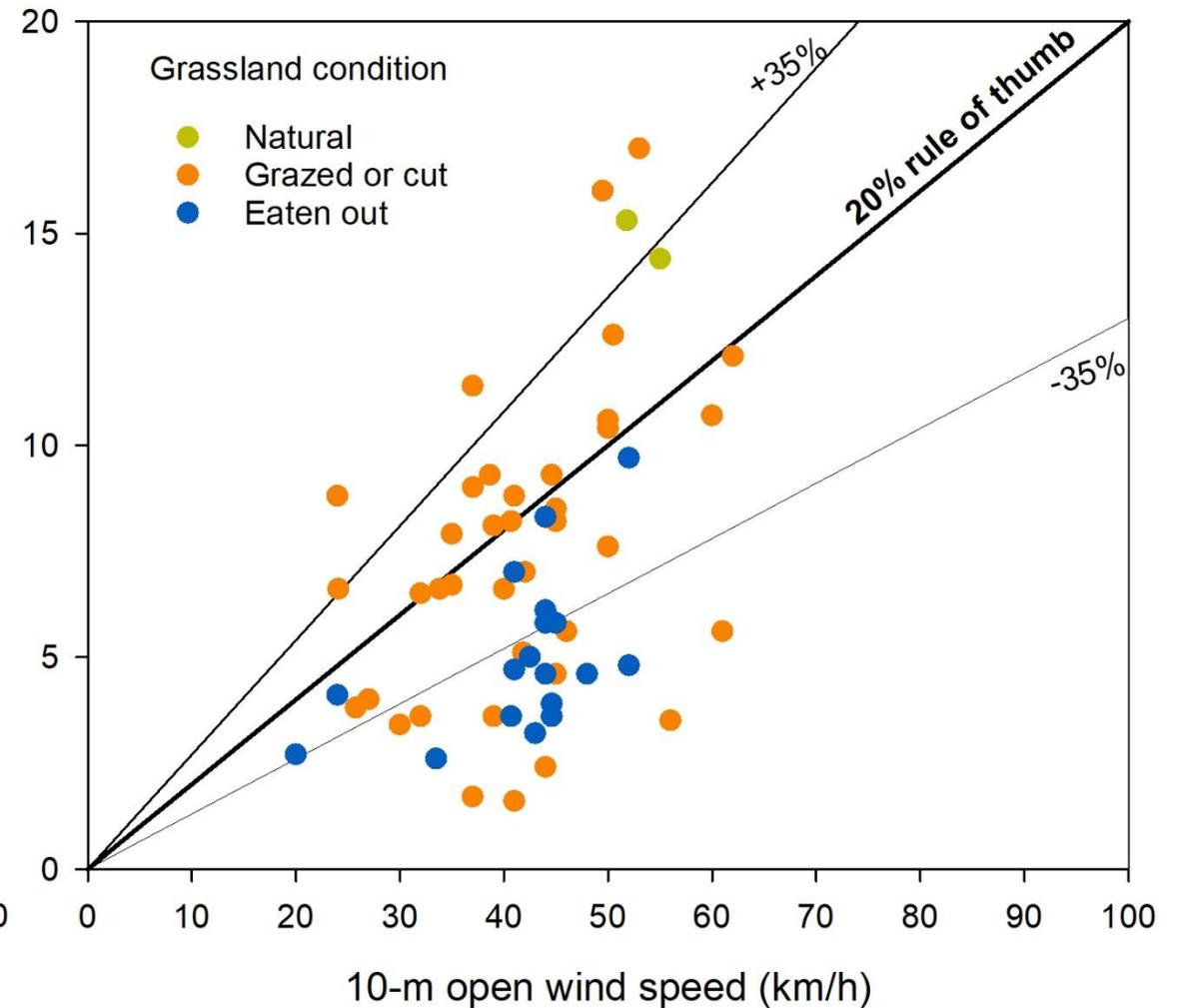
18 fires

# Scatterplots of Wildfire Spread Rate Observations

## Forests & Shrublands



## Cured Grasslands



# The 20% Grassfire Rule of Thumb can be Expressed as an Equation Solved by Mental Math:

Head Fire Rate of Spread  $\approx$   
20% of the Average 10-m Open Wind Speed

For example, for 10-m open winds of 40 km/h, a fire's rate of advance would be approximately 8 km/h.

*Article*

## Wildfire Rates of Spread in Grasslands under Critical Burning Conditions

Miguel G. Cruz <sup>1,\*</sup> , Martin E. Alexander <sup>2</sup> and Musa Kilinc <sup>3</sup>

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<sup>2</sup> Wild Rose Fire Behaviour, 180–50434 Range Road 232, Leduc County, AB T4X 0L1, Canada; mea2@telus.net

<sup>3</sup> Country Fire Authority, P.O. Box 701, Mt Waverley, VIC 3149, Australia; m.kilinc@cfa.vic.gov.au

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**Abstract:** An analysis of a dataset ( $n = 58$ ) of high-intensity wildfire observations in cured grasslands from southern Australia revealed a simple relationship suitable for quickly obtaining a first approximation of a fire's spread rate under low dead fuel moisture contents and strong wind speeds. It was found that the forward rate of fire spread is approximately 20% of the average 10-m open wind speed. The data on rate of fire spread and 10 m open wind speed ranged from 1.6 to 17 and 20 to 62 km h<sup>-1</sup>, respectively. The validity of the resulting rule of thumb was examined across a spectrum of burning conditions and its performance was contrasted against that of established empirical-based fire spread models for three different grassland fuel conditions currently used operationally in Australia. The 20% rule of thumb for grassfires produced error statistics comparable to that of the fire spread rate model for grazed or cut grass fuel conditions as recommended for general use during the summer fire season in southern Australia.

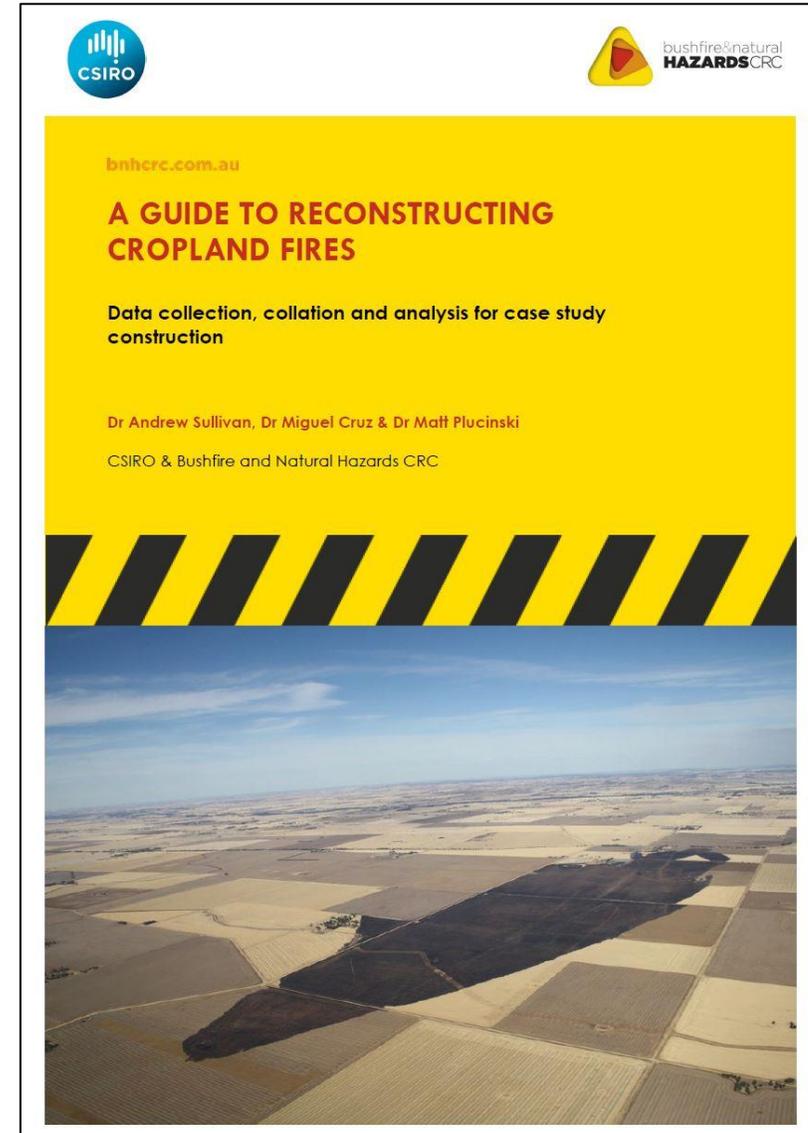
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<https://www.mdpi.com/journal/fire>

# Major Assumptions and Limitations

- For wildfires spreading in open grasslands
- For large wildfires burning for more than 1 h
- For wildfires spreading on level to gently undulating terrain
- Wind speed >30 km/h; either measured, estimated or forecasted for the standard 10-m height in the open.
- Homogeneously dry landscape (degree of curing level >90%) and low fuel moisture content (<6% or FFMC >95).

# Next Steps? – Feedback & Need for Validation Data



# Granum Fire – Southern AB – Dec. 14, 1997

Advanced some 35 km in about 4 h (ROS: 8.75 km/h)

10-m open winds averaged 42 km/h

20% Rule of Thumb estimate: 8.4 km/h



Photo by David Rossiter, Lethbridge Herald

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**Acknowledgement**



*fire*

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## Estimating Wildfire Rate of Spread in Grasslands

Grassfires in Canada's western prairies have been observed to propagate over multi-hour periods with sustained rates of spread in excess of 6.0 km/h. For example, on December 14, 1997, a human-caused grassfire starting west of Claresholm in southern Alberta advanced eastward some 35 km in the span of about four hours before being held up at Highway 2 near the town of Granum.

As a result of their rapid spread rate potential, grassfires advancing under extreme burning conditions (e.g., degree of curing >90%, fuel moisture content <6%) pose a serious threat to both firefighters and members of the general public in rural areas at certain times of the year. The formal capacity to predict fire spread in such situations e.g., a fire behaviour analyst or FBAN with REDapp or Prometheus software; fire suppression personnel with an FBP System "Red Book" or the Grassland Fire Behavior Pocket Card) and in turn issue timely emergency warnings may not be readily available more often than not.

Two Australian colleagues and I recently developed a simple rule of thumb for estimating the forward spread rate of wildfires in cured grasslands (Cruz, M.G.; Alexander, M.E.; Kilinc, M. 2022. Wildfire rates of spread in grasslands under critical burning conditions. *Fire* 5, 55) based on an analysis of a relatively large dataset ( $n = 58$ ) of wildfire observations involving spread rates and 10-m open wind speeds ranging, respectively, from 1.6 to 17 km/h and 20 to 62 km/h.

The rule of thumb can be expressed as an equation:

$$\text{Head Fire Rate of Spread} \approx 20\% \text{ of the Average 10-m Open Wind Speed}$$

For example, for 10-m open winds of 40 km/h, a fire's rate of advance would be approximately 8 km/h.

Assumptions, limitations and potential uses of the rule of thumb will all be discussed.