UNDERSTANDING SEASONAL FIRE RISK IN LIVE FUELS

Presenting a new mechanistic live fuel moisture content (LFMC) model

Tegan Brown

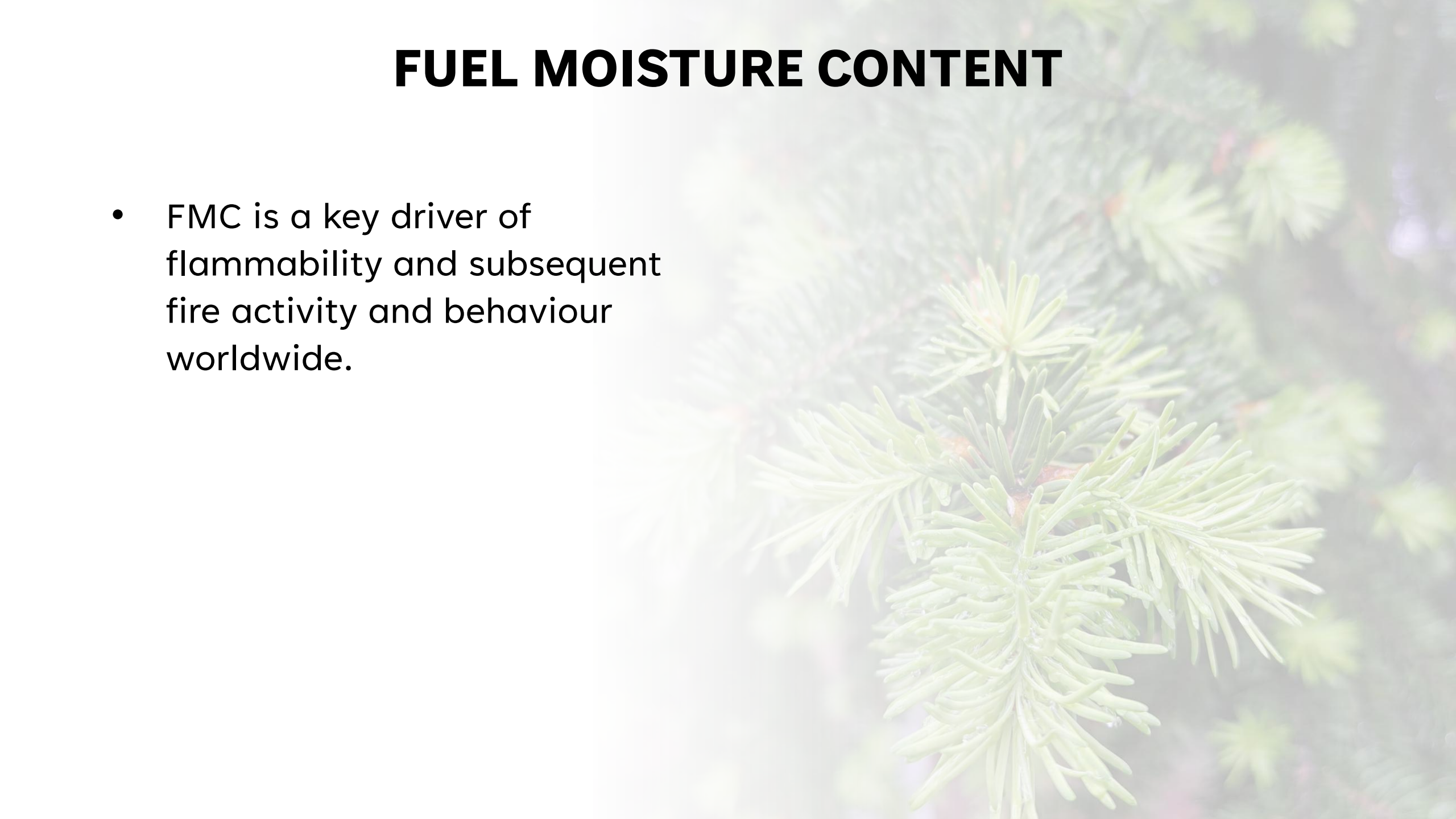
Matt Jolly, Elliott Conrad, Zach Cope & Sam Hillman

VICTORIA State Government | Energy, Environment and Climate Action

FOREST SERVICE U.S. DEPARTMENT OF AGRICULTURE

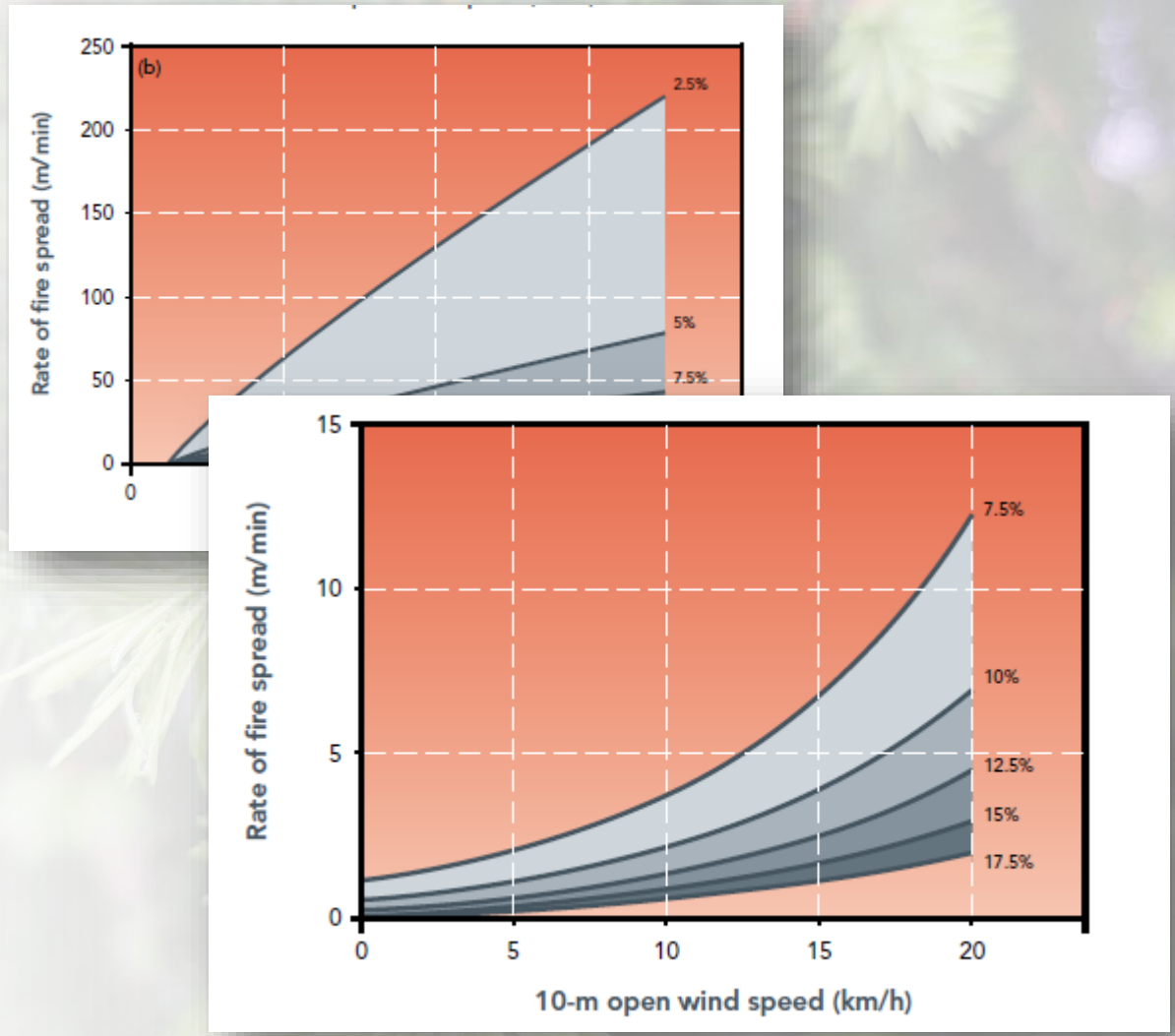
FUEL MOISTURE CONTENT

- FMC is a key driver of flammability and subsequent fire activity and behaviour worldwide.



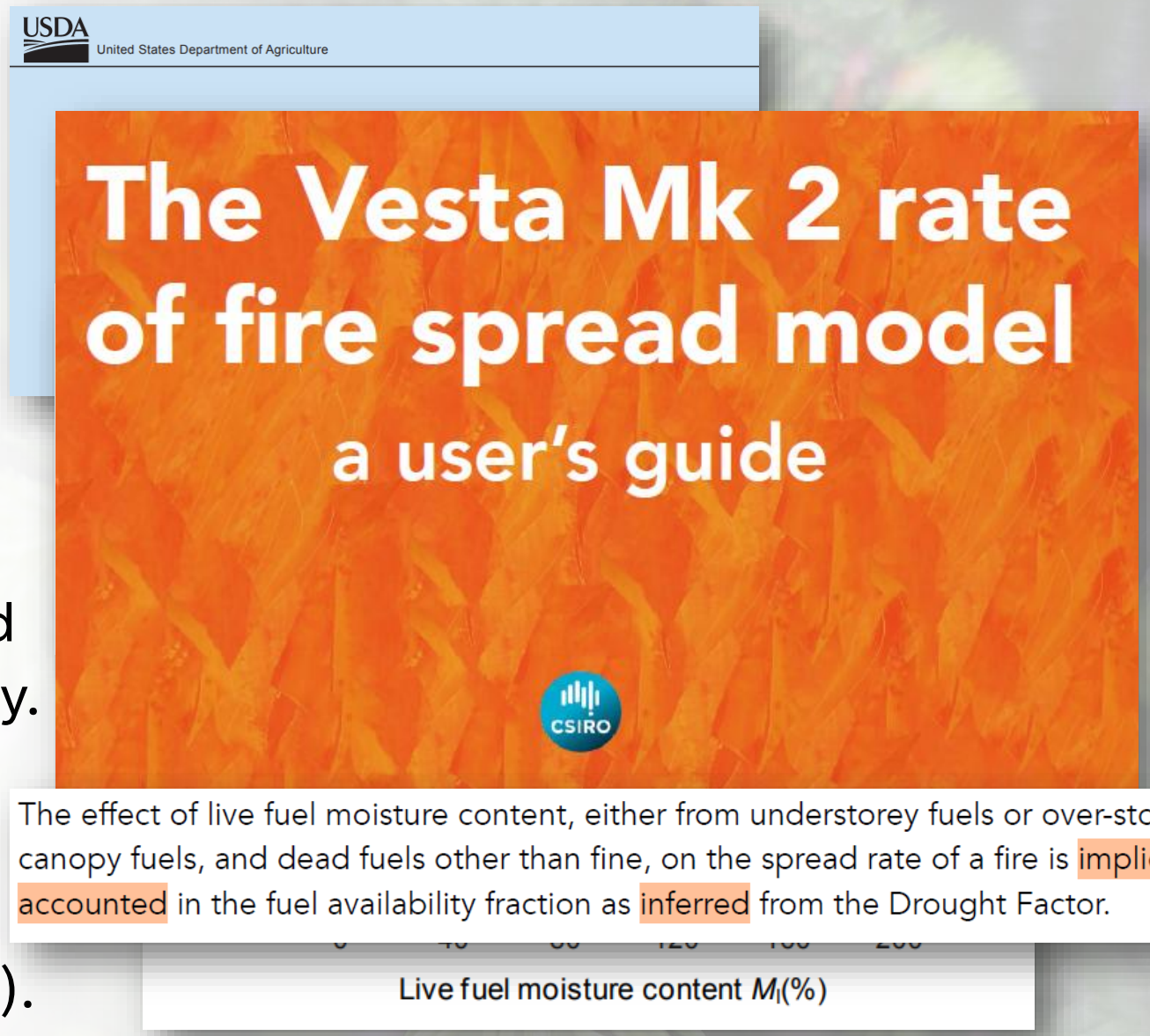
FUEL MOISTURE CONTENT

- FMC is a key driver of flammability and subsequent fire activity and behaviour worldwide.
- The role of dead FMC on fire behaviour are well established with strong modelling capacity.



FUEL MOISTURE CONTENT

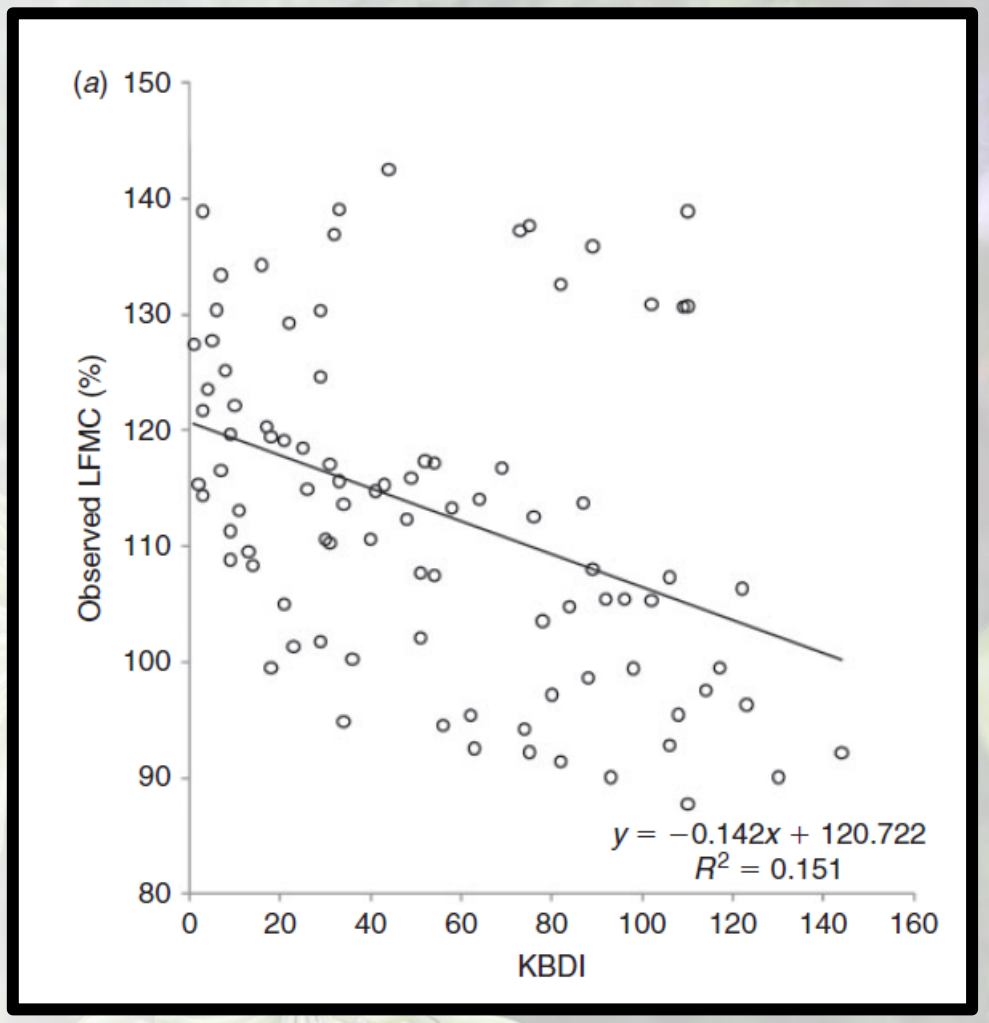
- FMC is a key driver of flammability and subsequent fire activity and behaviour worldwide.
- The role of dead FMC on fire behaviour are well established with strong modelling capacity.
- Contribution of live fuel moisture to fire behaviour has received less attention (in Aus).



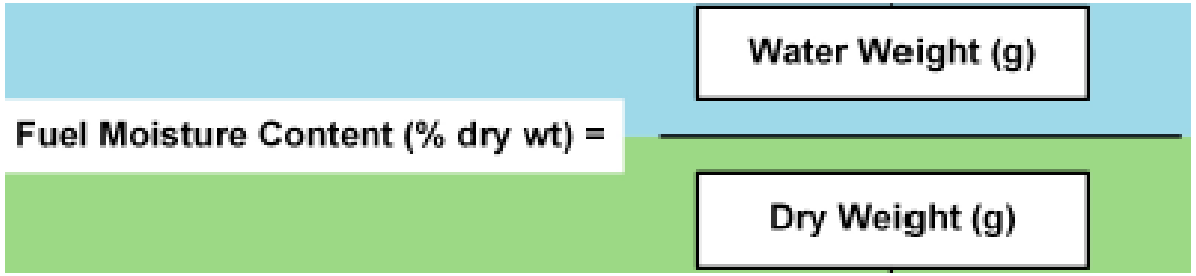
Rossa *et al.* (2016)

Live fuel moisture content

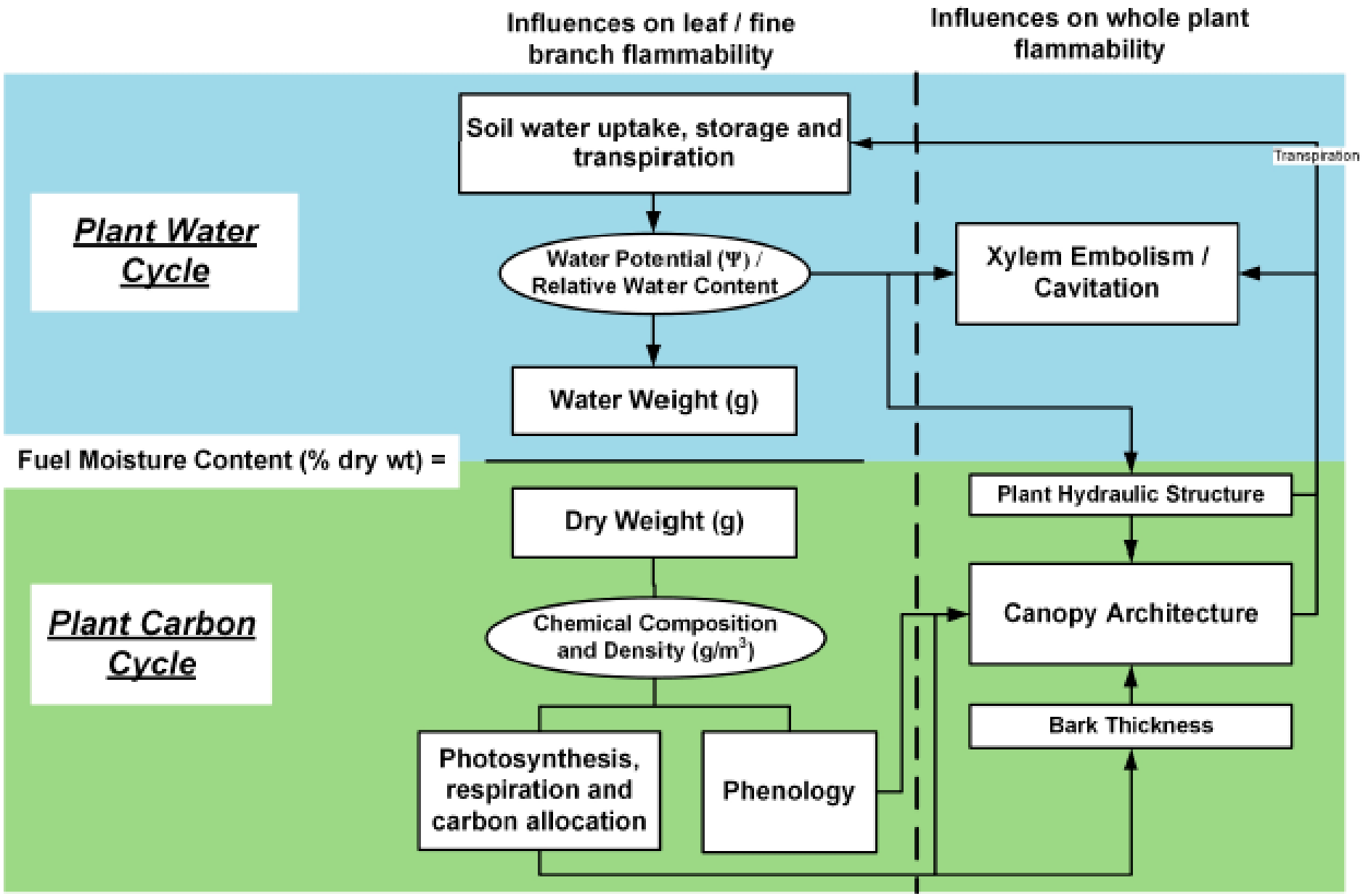
- Typically estimated live fuel flammability using drought indices (e.g. KBDI).
- Works well for some species, poorly for others.
- Live fuels are not passive; therefore, these approaches struggle to resolve all variability.



Caccamo *et al.* (2012)



Jolly & Johnson (2018)



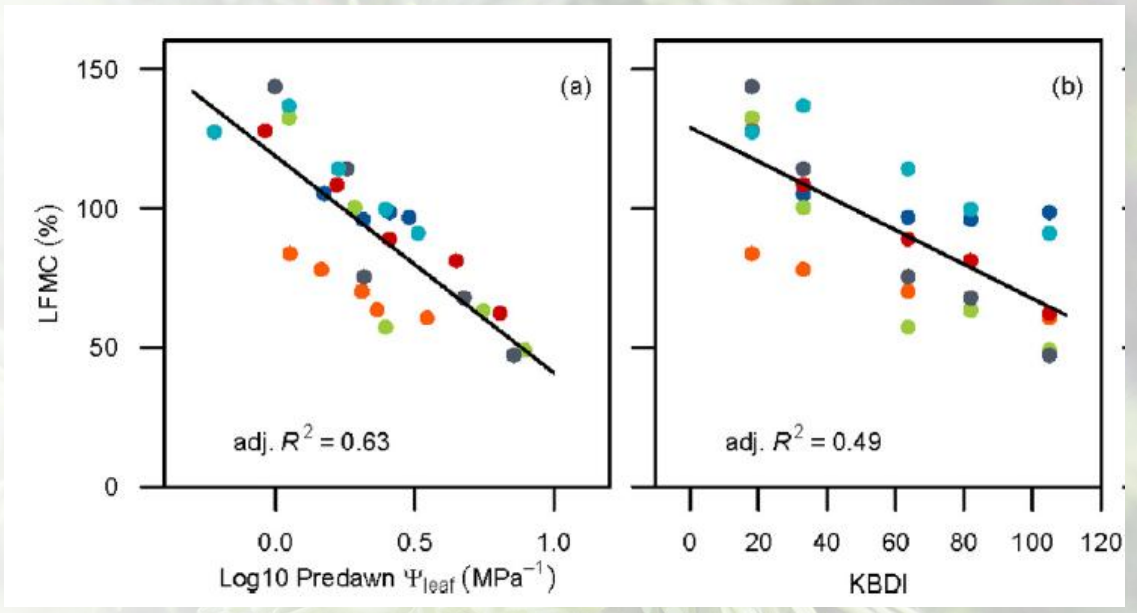
Jolly & Johnson (2018)

WHY IS THIS IMPORTANT?

EMERGING FIELD OF PYRO-ECOPHYSIOLOGY

- Pyro-ecophysiology attempts to link critical components of plant water, carbon and nutrient cycles to better capture live fuel flammability dynamics.

- Bringing these approaches together will allow us to bridge decades of plant physiology and combustion science.



Nolan et al. (2018)

PRESENTING A NEW MECHANISTIC LFMC MODEL

Two key questions:

1. Can we model LFMC mechanistically from physiology & combustion science inputs?
2. What influence do those inputs have on fire behaviour?

PRESENTING A NEW MECHANISTIC LFMC MODEL

$$LFMC = \frac{RWC \times k}{LMA \times SAV}$$

RWC: Relative water content

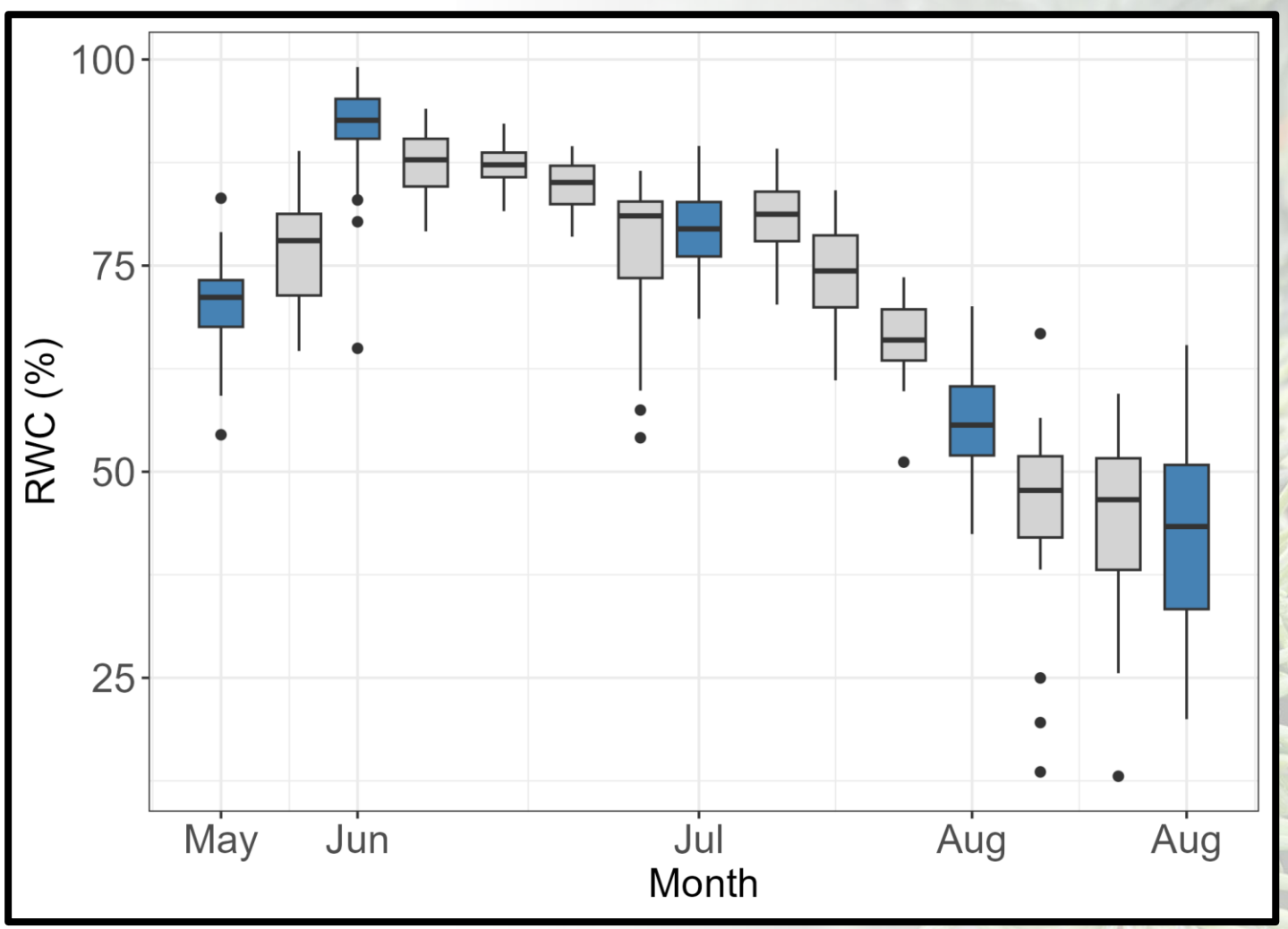
Kappa: maximum saturated water holding capacity

LMA: Leaf mass per unit area

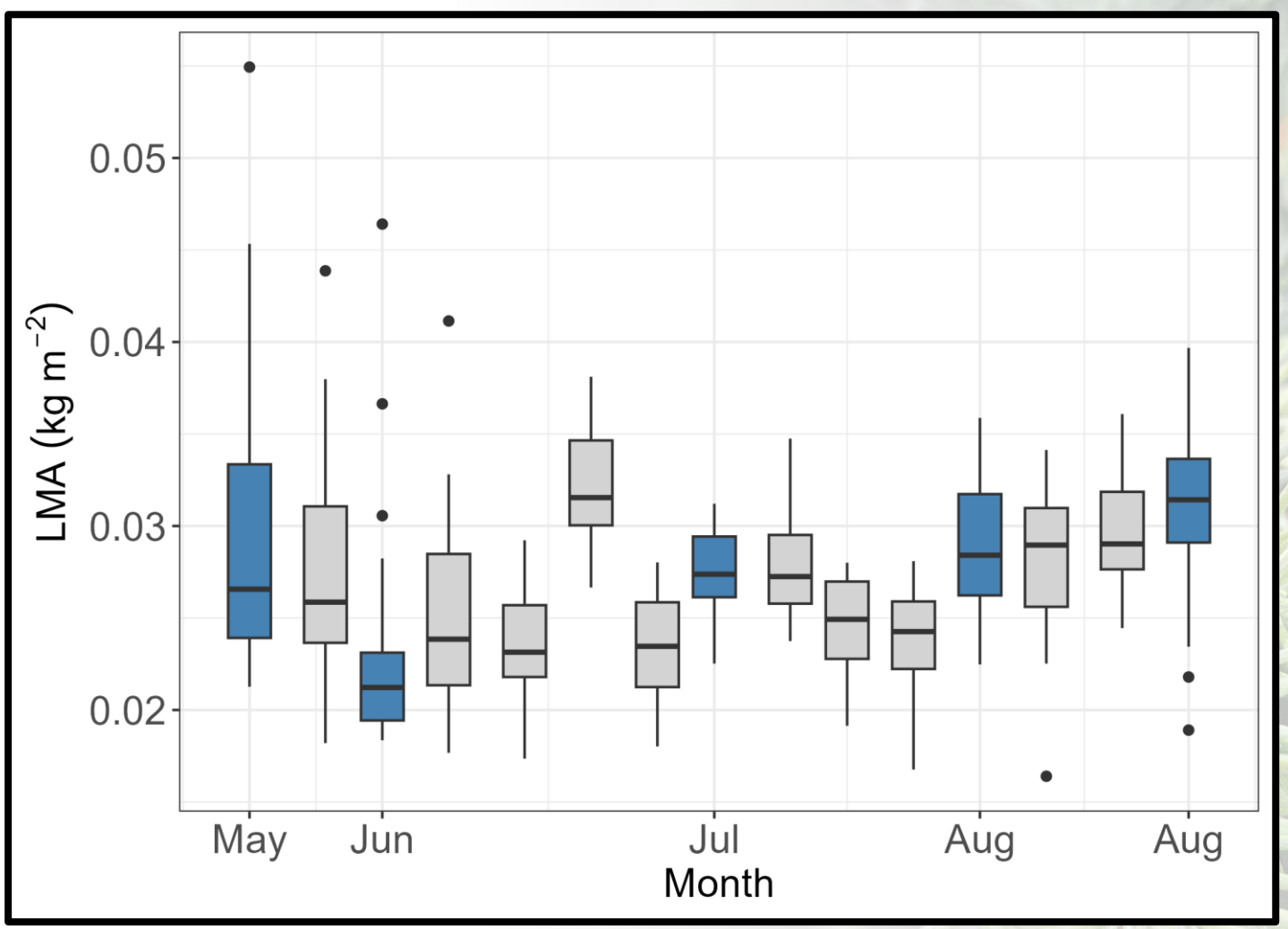
SAV: Surface area to volume ratio

Jolly et al. (2025)

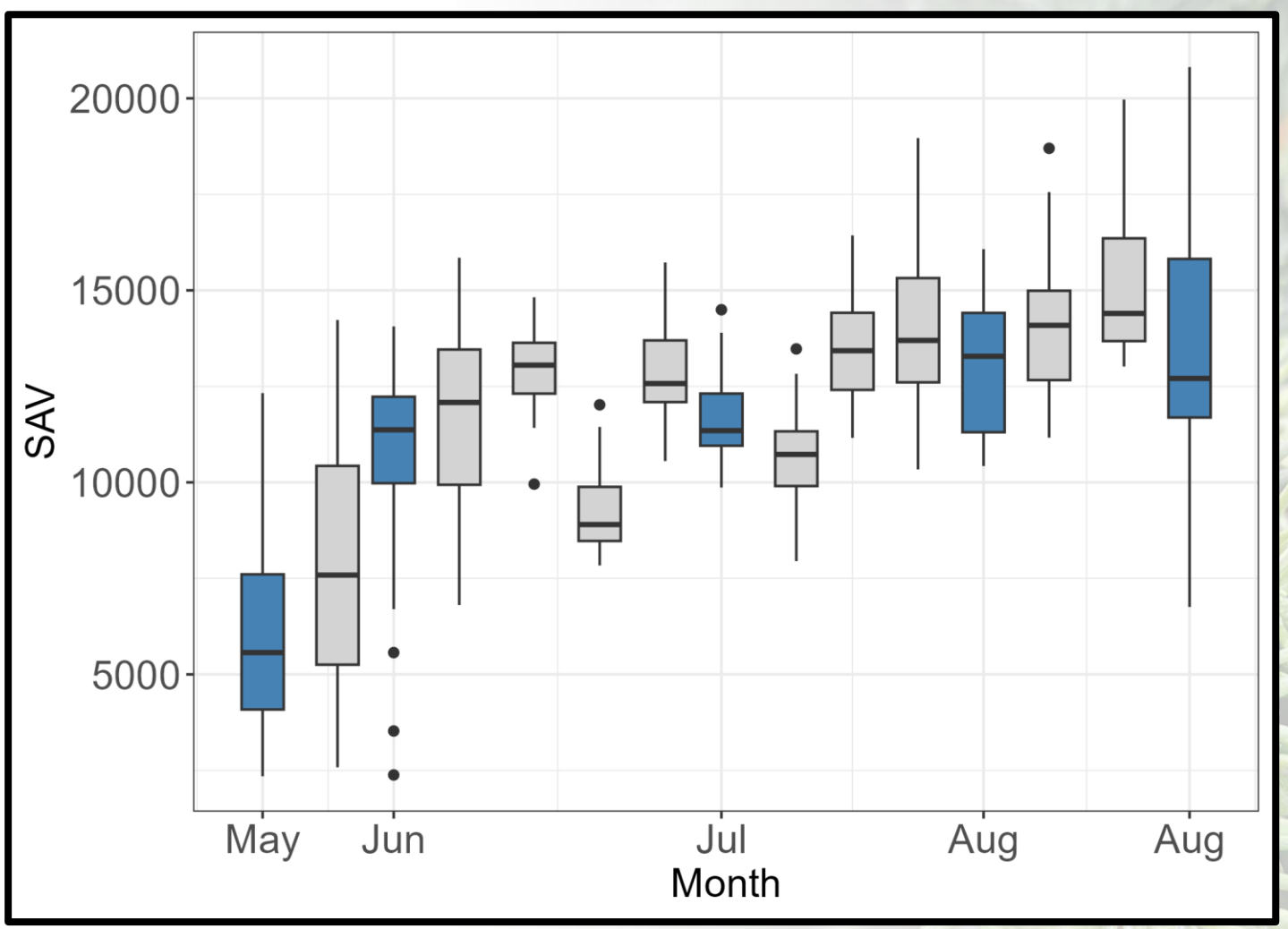
Relative water content (RWC)



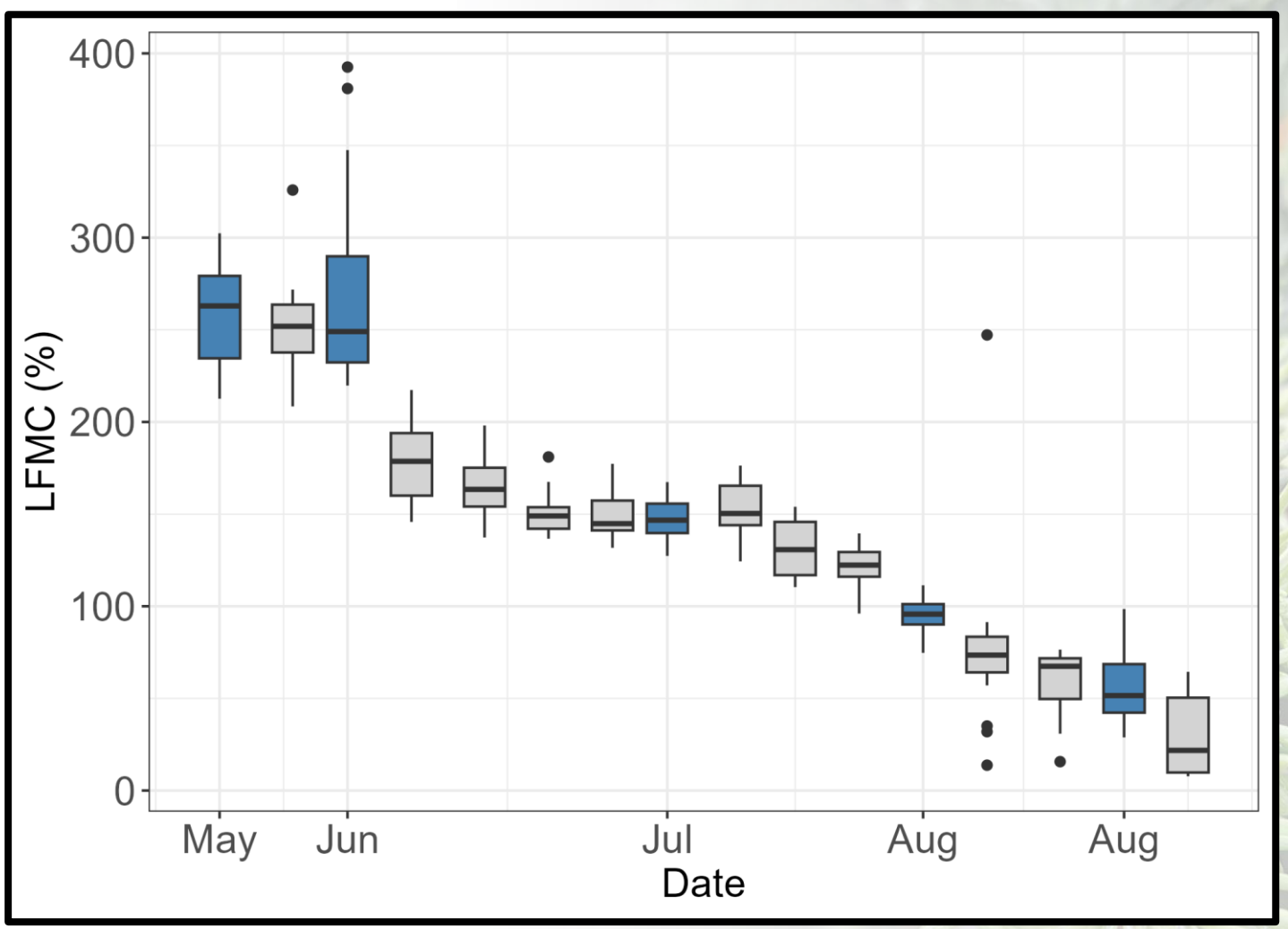
Leaf mass area (LMA)



Surface area to volume ratio (SAV)



Live fuel moisture content (LFMC)

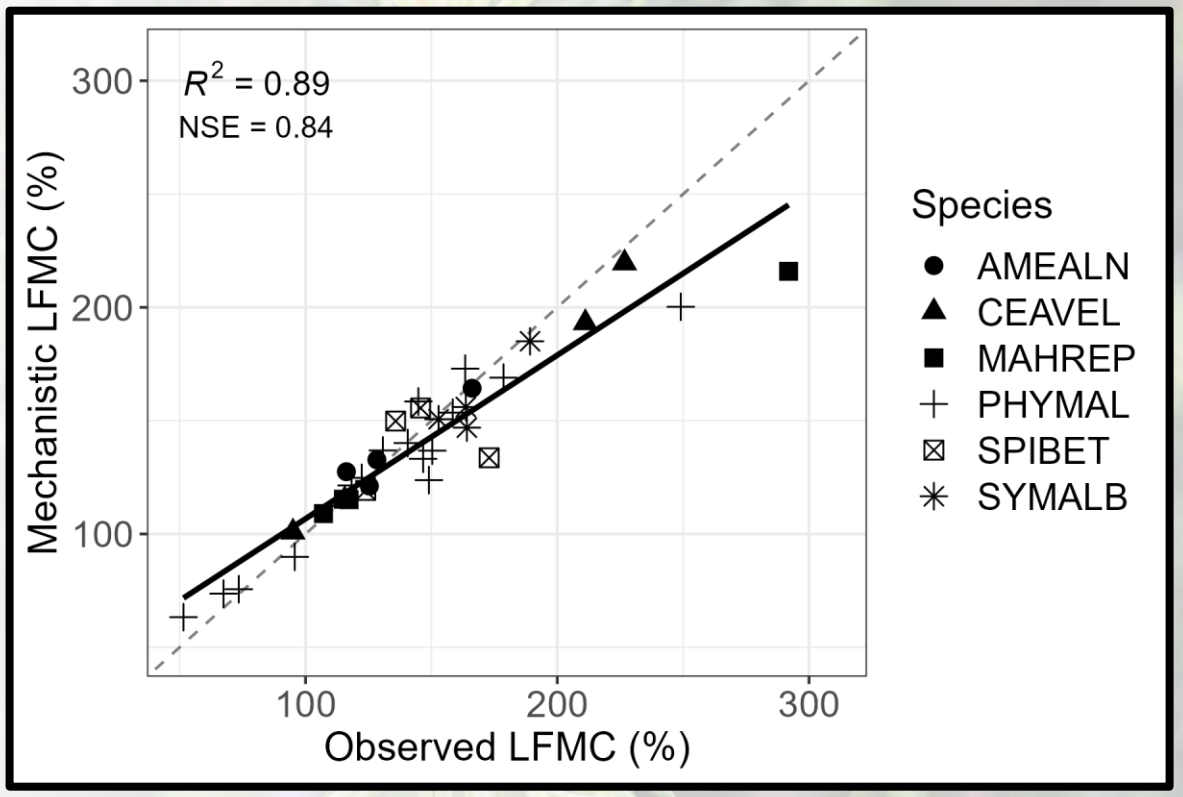


Brown et al. (2025)

TESTED MODEL ACROSS 6 COMMON SHRUBS

- Model performs well using summarised inputs across 6 common deciduous shrubs.
- Important to capture seasonal dynamics in RWC (water) and LMA (dry matter).

$$LFMC = \frac{RWC \times k}{LMA \times SAV}$$



PRESENTING A NEW MECHANISTIC LFMC MODEL

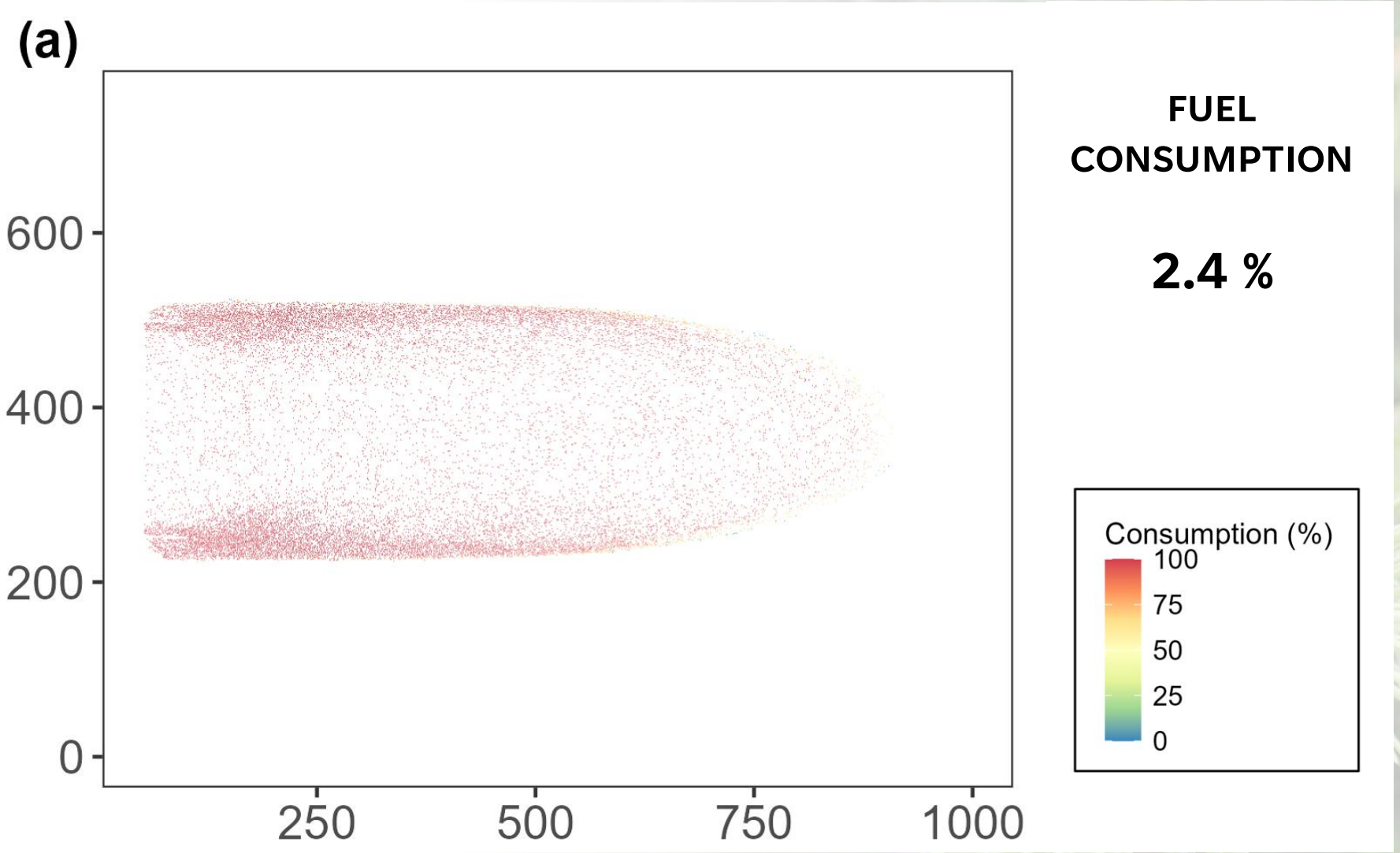
Two key questions:

1. Can we model LFMC mechanistically from physiology & combustion science inputs?
2. What influence do those inputs have on fire behaviour?

LIVE FUEL DYNAMICS – IMPACTS ON MODELLED FIRE BEHAVIOUR

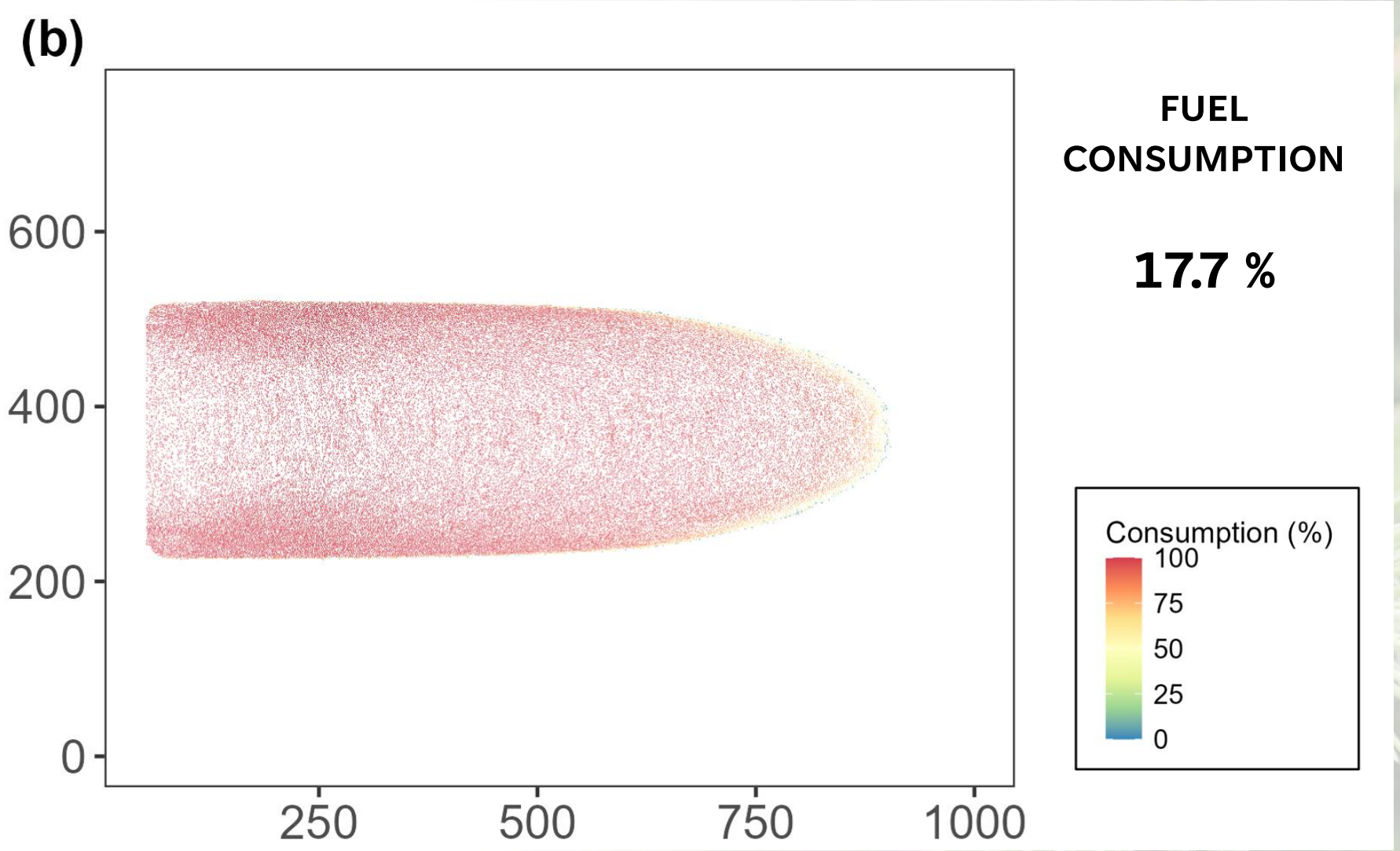
- Modelled changes in fire behaviour using QUIC-Fire platform.
- Seasonal fluctuations in LFMC, SAV, and bulk density.
- Substantial seasonal differences in fire behaviour.

MAY



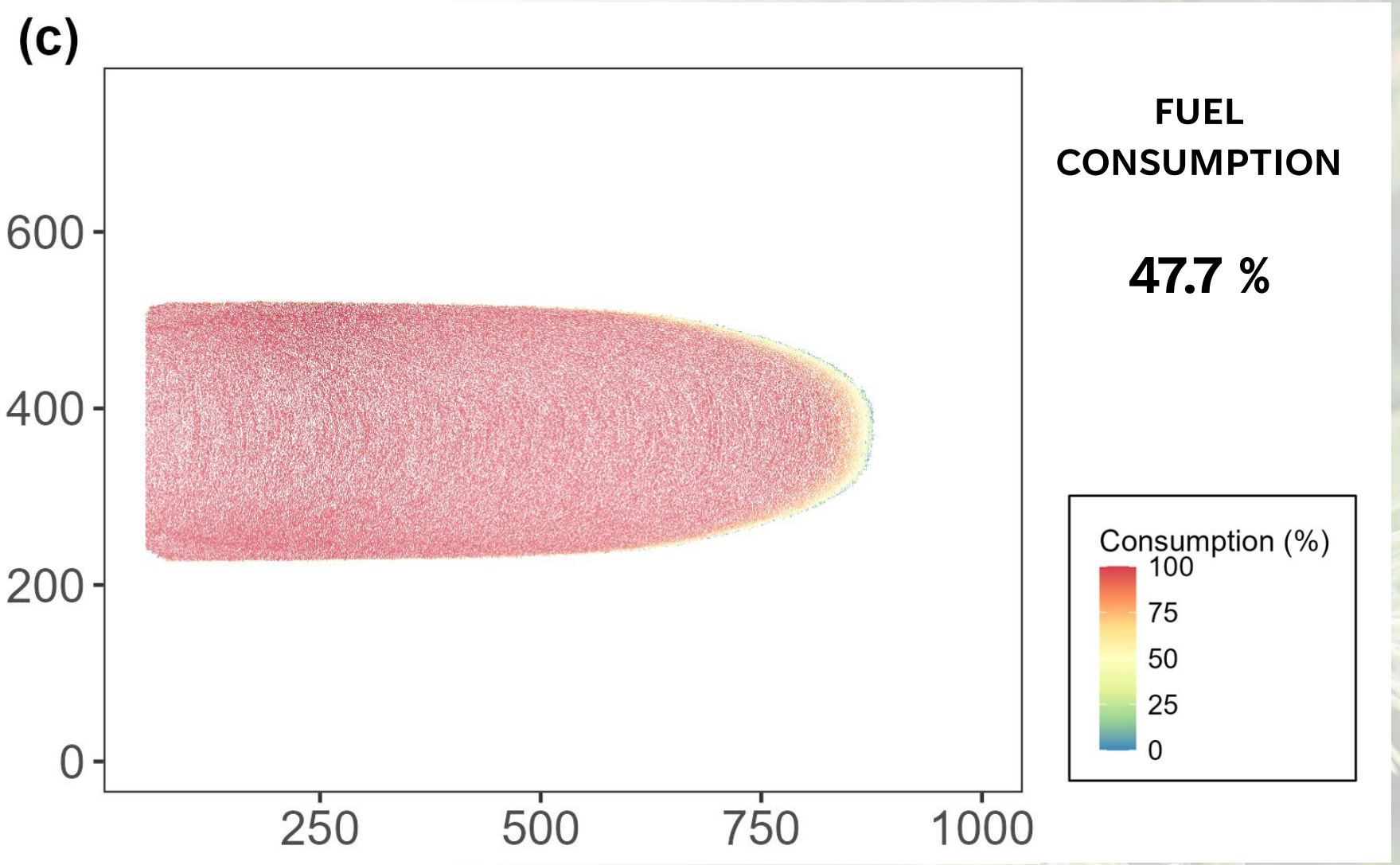
QUIC-Fire: Zachary Cope

JUNE



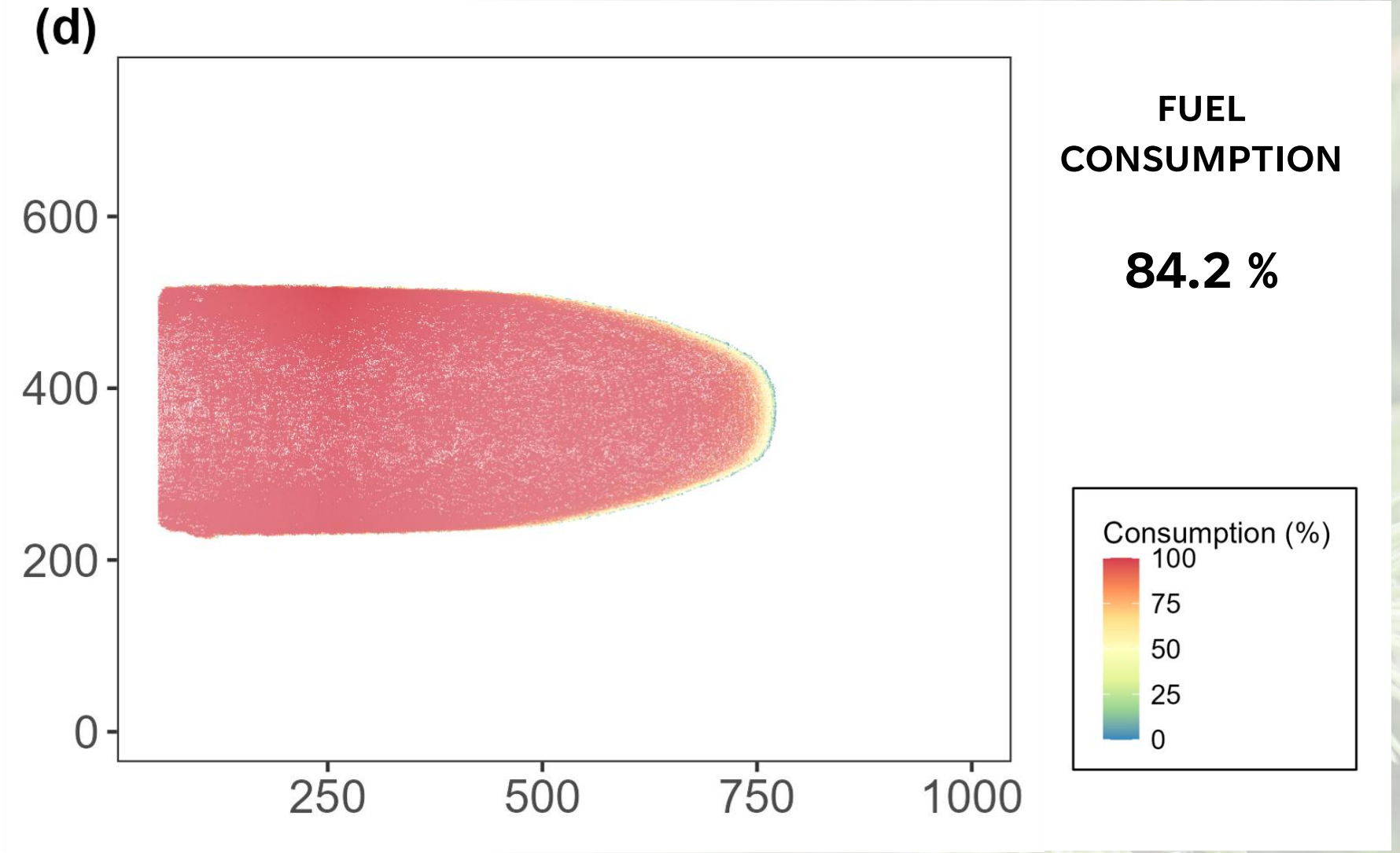
QUIC-Fire: Zachary Cope

JULY



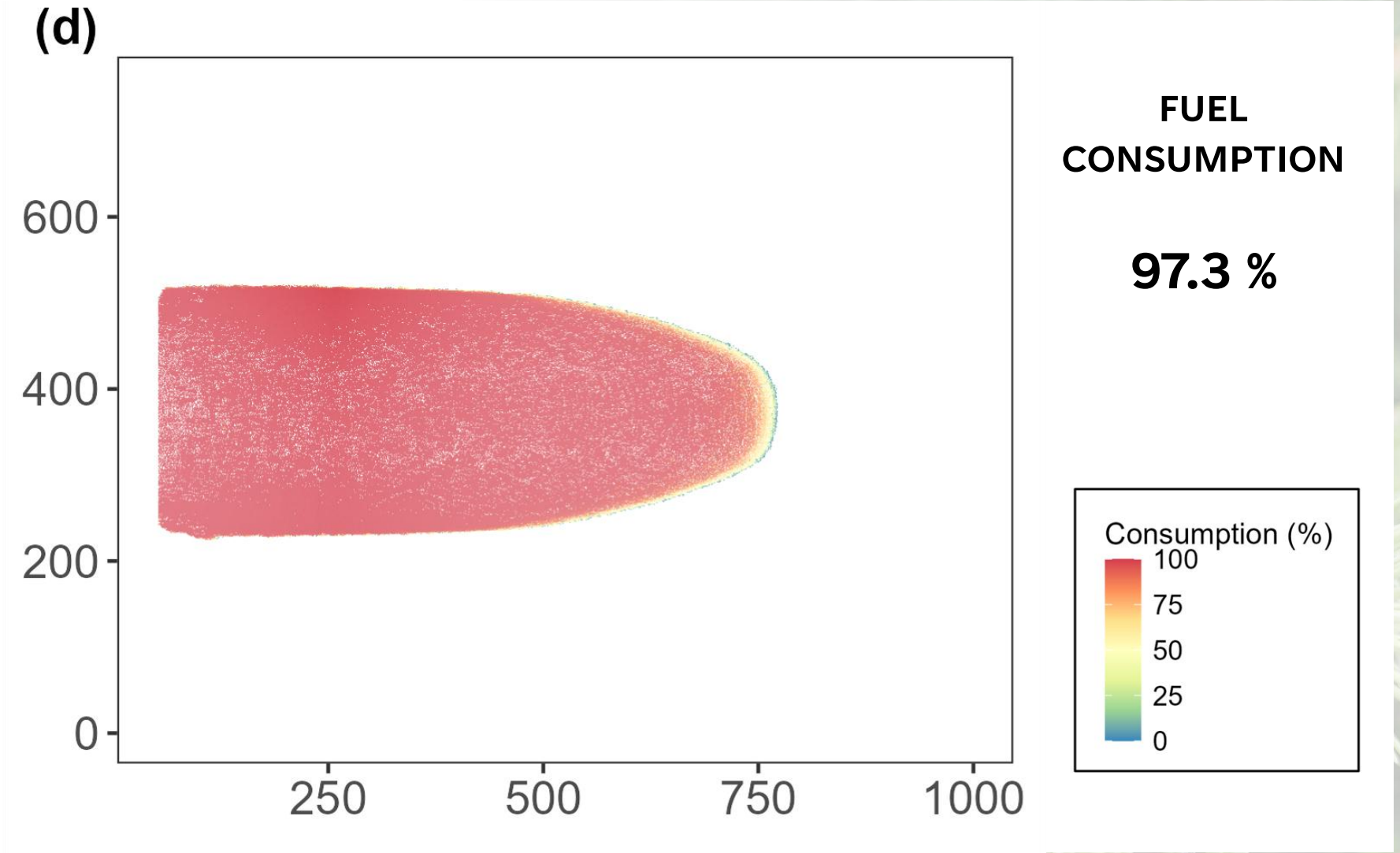
QUIC-Fire: Zachary Cope

EARLY AUGUST



QUIC-Fire: Zachary Cope

LATE AUGUST



QUIC-Fire: Zachary Cope

PRESENTING A NEW MECHANISTIC LFMC MODEL

Two key questions:

1. Can we model LFMC mechanistically from physiology & combustion science inputs?
2. What influence do those inputs have on fire behaviour?

WHAT WILL BETTER UNDERSTANDING OF LFMC HELP US TO DO?

WHAT'S (COULD BE) NEXT?

- Testing application and performance of model to different vegetation types.
- LFMC data collection and validation against observed fire ROS.
- Scaling up from single foliage element.
  - Remote sensing.
  - Terrestrial ecosystem models.

Thank you, any questions?

tegan.brown@deeca.vic.gov.au

Tegan Brown

Matt Jolly, Elliott Conrad, Zach Cope & Sam Hillman

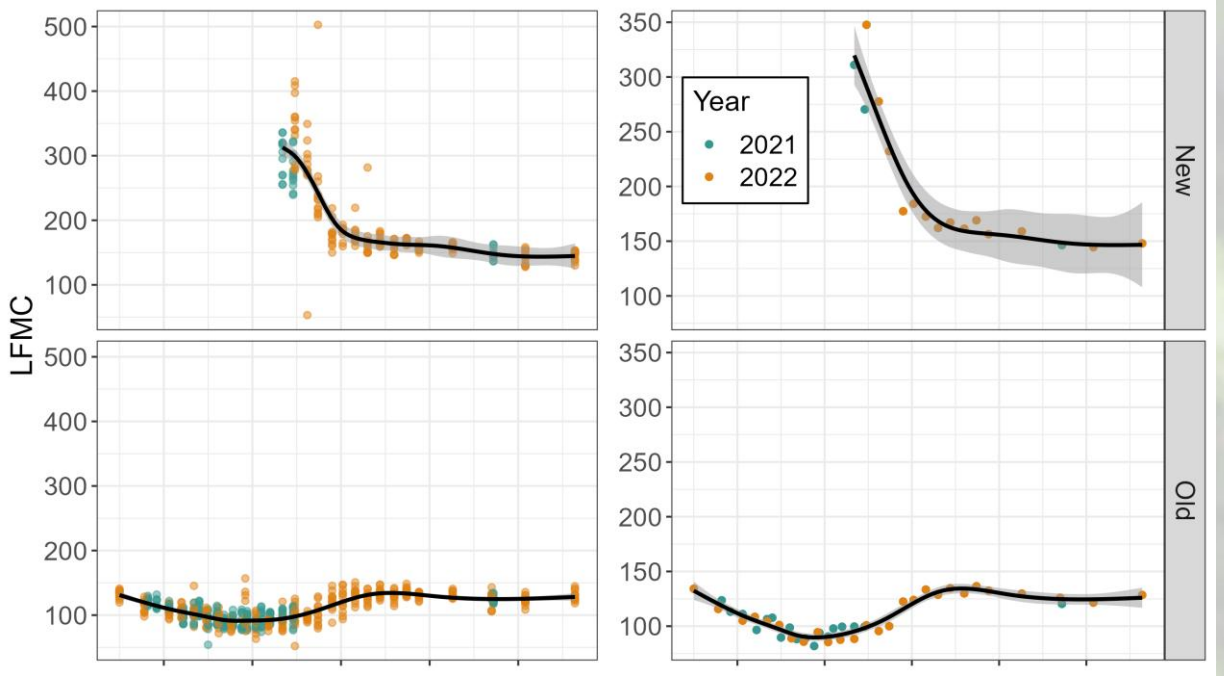
VICTORIA State Government | Energy, Environment and Climate Action

FOREST SERVICE US DEPARTMENT OF AGRICULTURE

Our current LFMC models are limited

Contrasting LFMC for new and old foliage

- Raw data (left) and sampling period median for new and old foliage.
- Clear seasonal dynamics in LFMC for Douglas fir needles.



Contrasting LFMC for new and old foliage

- Average of new and old foliage for Douglas fir
- Large differences between new and old foliage for water, and lots of other stuff!
- Important to combustion literature.