The native, C_3 grass Festuca costata alters grassland fuels and fire spread in the Drakensberg

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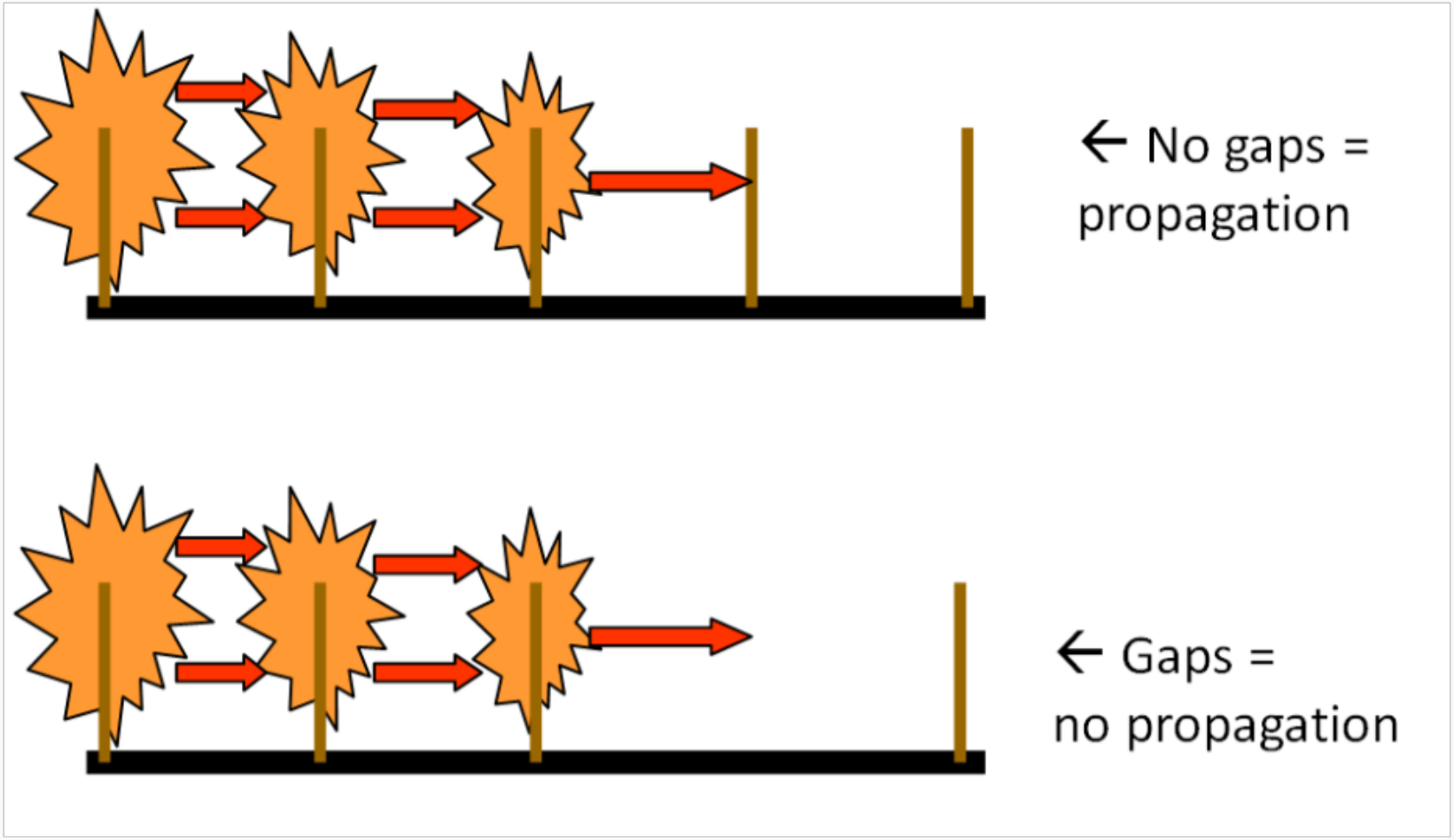
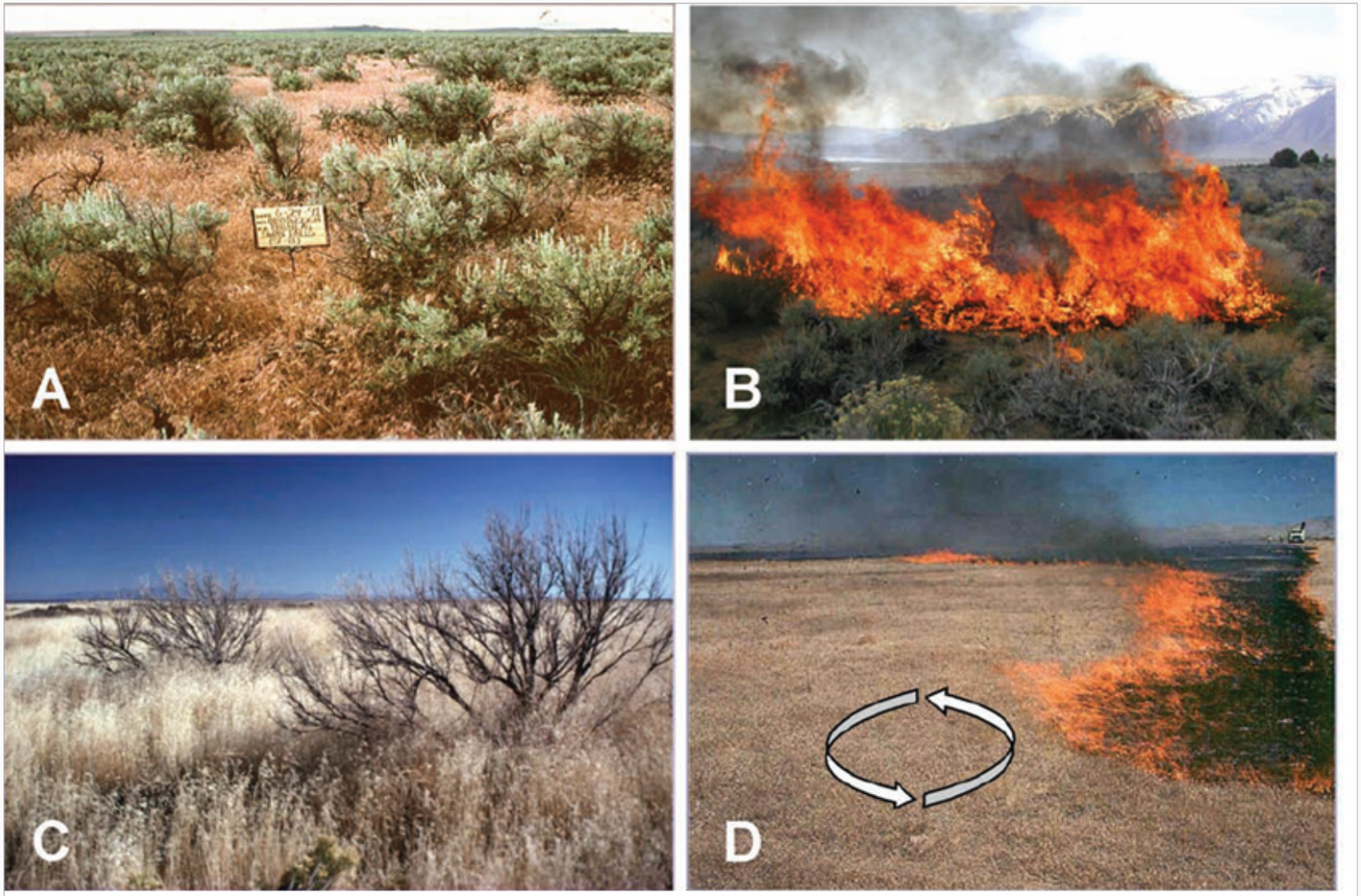
Veld fire spread requires continuous fuels

- Fire spreads by heat transfer from one particle to the next
- Primarily convection by wind carries heat across gaps



Cheatgrass: Classic example of the 'grass-fire cycle'

In terms of invasive species, most grasses reduce fuel gaps



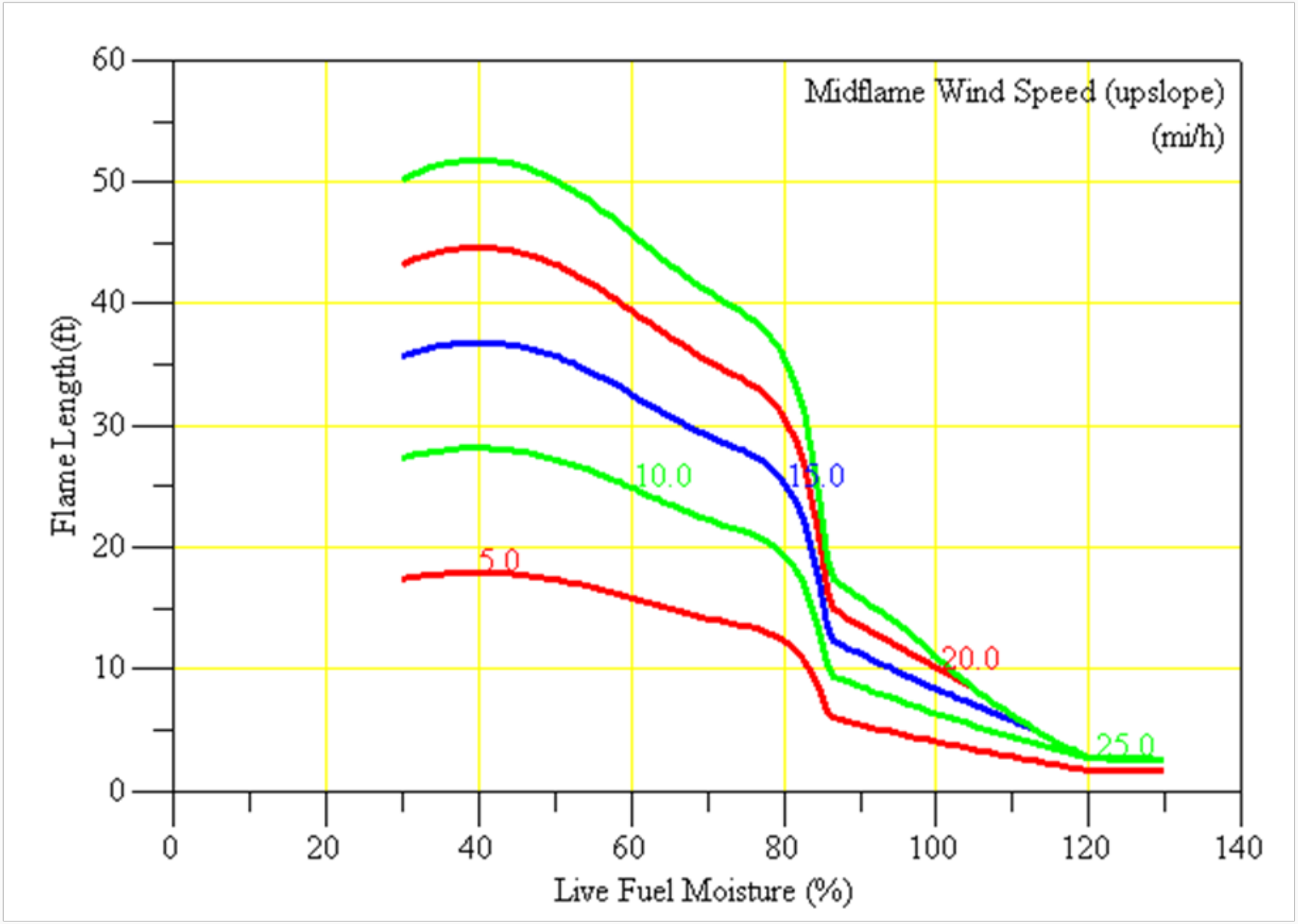
Brooks (2008) US Forest Service

Spinning the grass-fire cycle the opposite direction

- Unseasonally high fuel moisture = reduced fire spread
- Novel example: tall fescue *Festuca arundinacea* in tallgrass prairie

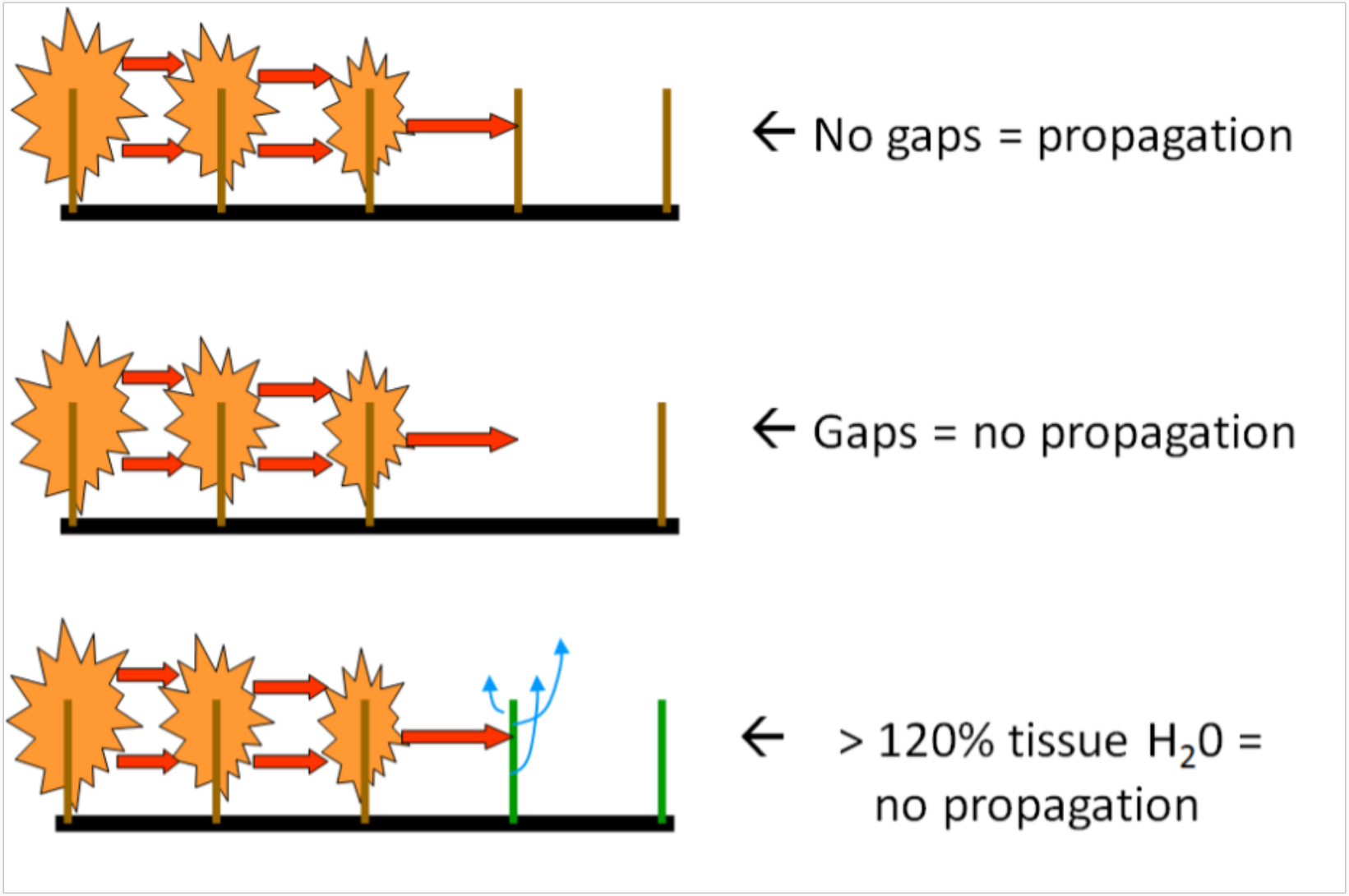
Spinning the grass-fire cycle the opposite direction

Live fuel moisture greater than 120% = reduced fire spread



Spinning the grass-fire cycle the opposite direction

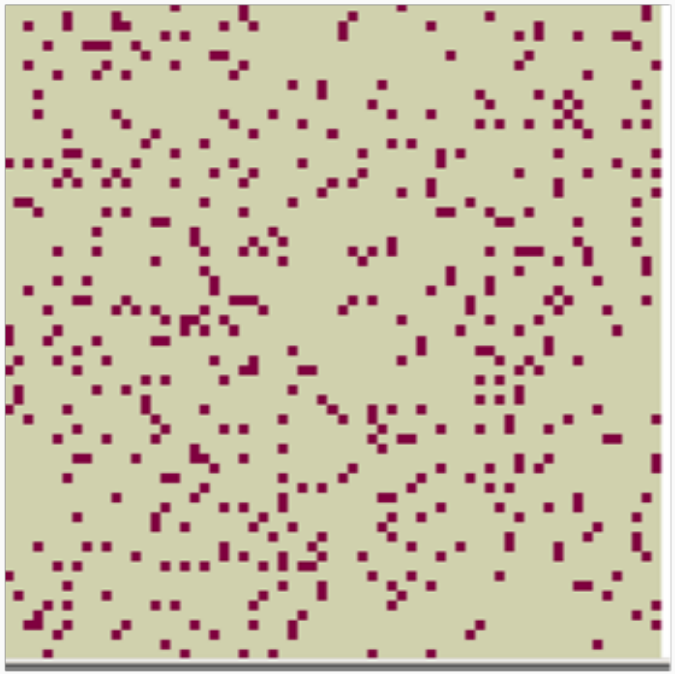
High-moisture fuel creates a gap that saps energy, prevents propagation



Modelling fire spread through hypothetical landscapes

Extent of tall fescue invasion

10%



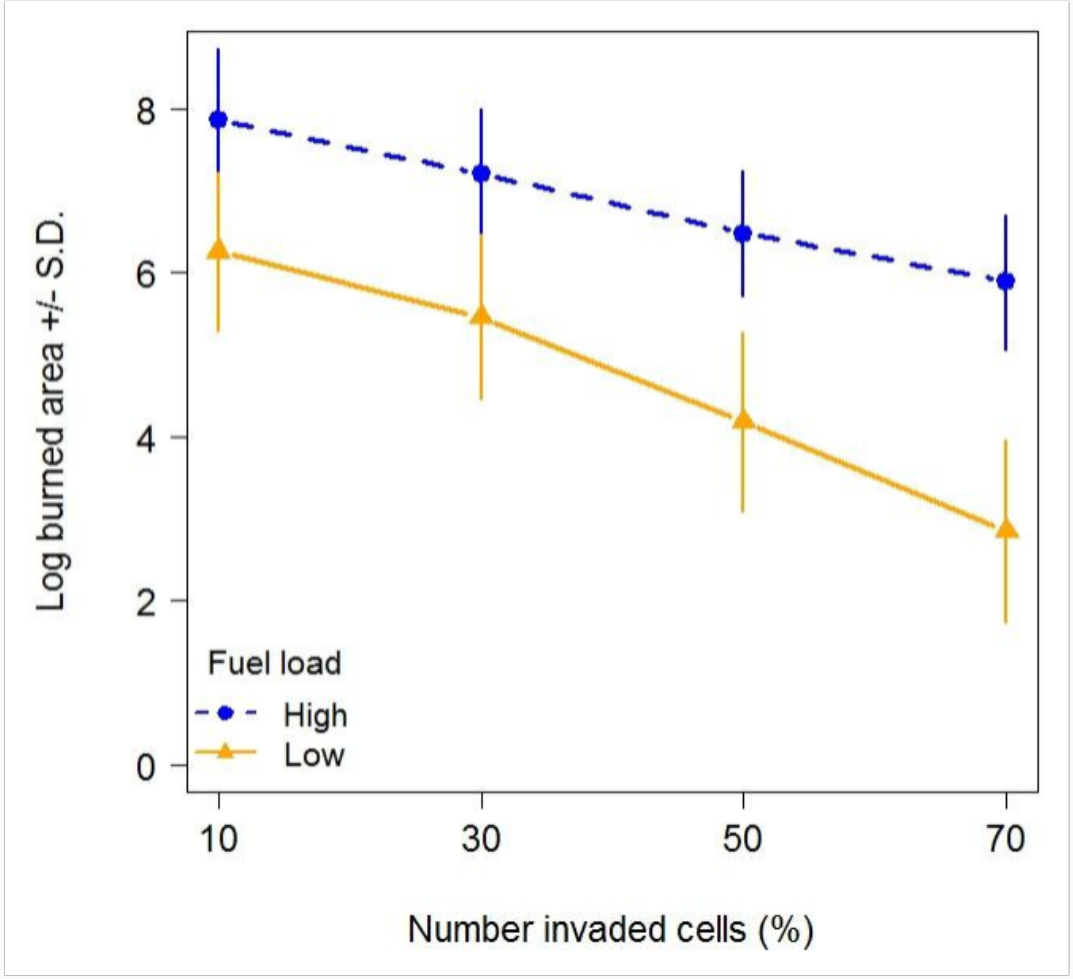
60%

High-moisture fuels reduce burned area[1]

FARSITE fire area simulations indicated:

- Greater number of invaded cells, less fire spread
- The effect was exacerbated by low fuel load (heavy stocking)
- Increased wind speed mitigated effect of high moisture

Fuels are still all "just grass"!



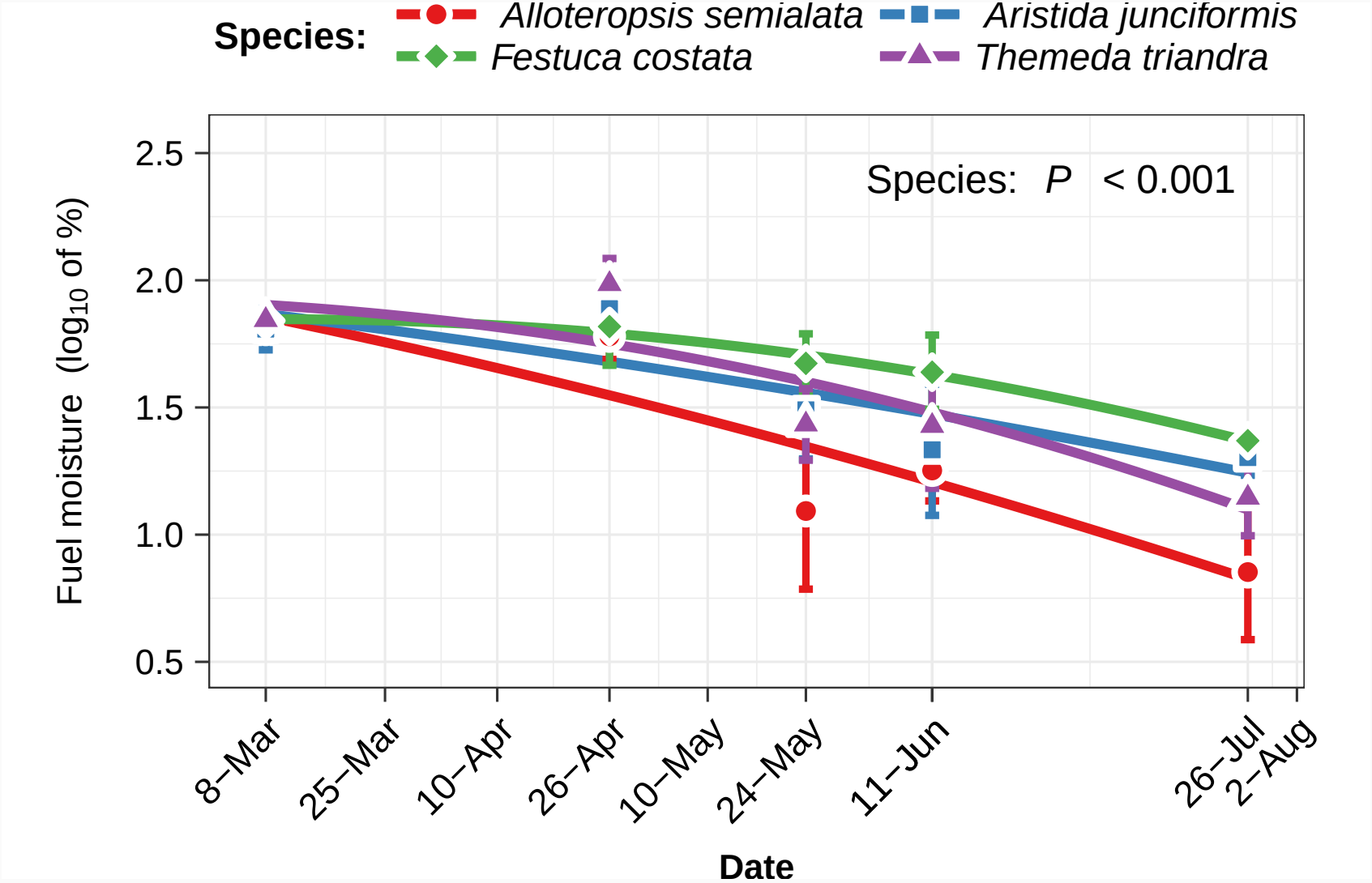
[1] McGranahan et al. 2013 Ecosystems

Festuca in South Africa

Novel example of native grass-fire cycle?

Fuel moisture variability in South Africa

C_3 *F. costata* cures more slowly than C_4 veld grasses[2]



[2]McGranahan et al. 2016 Fire Ecology

Modeling F. costata effect on fire spread in Drakensberg

Data for *F. costata* and C_4 veld grasses:

- Fuel load (one end-of-season clipping)
- Fuel moisture (samples before/after first spring rains)

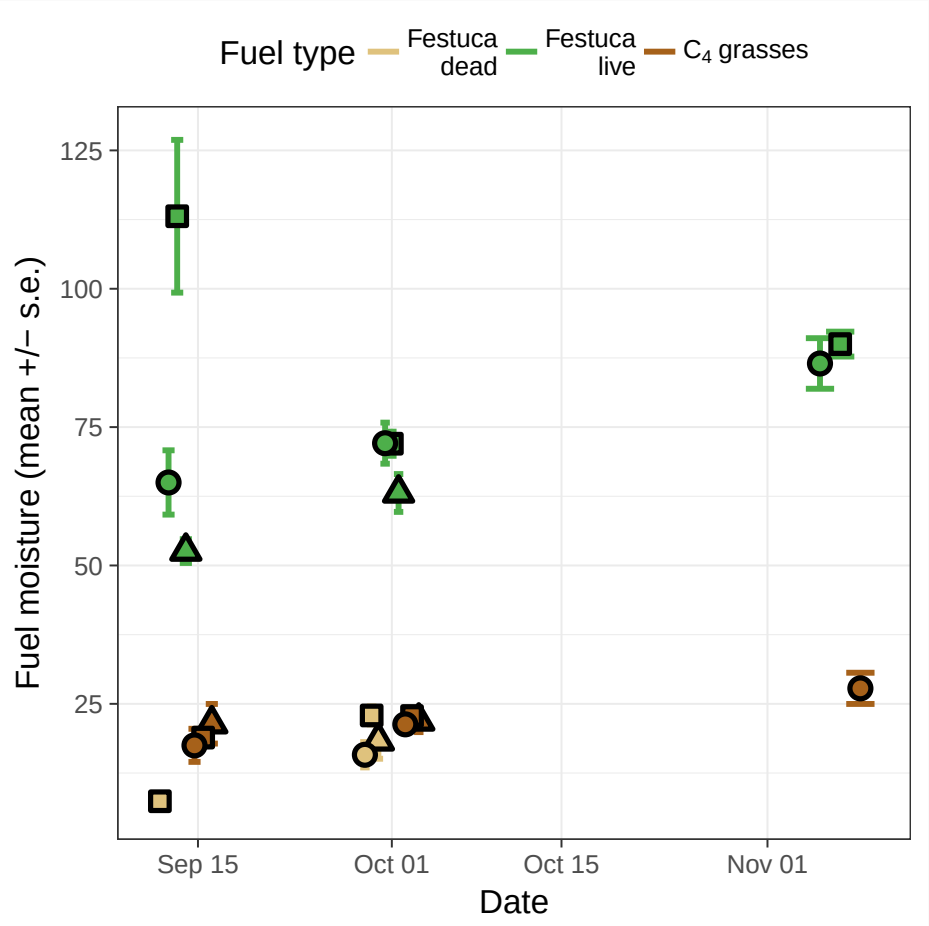
Two fire spread models used:

- BehavePlus: Rothermel fire spread equation customised with above data
- FlamMap: spatial model that allows patches of *F. costata* in veld matrix

Festuca in South Africa[3]

Drakensberg grasslands are highly fire dependent and C_4 grasses burn every two years on average.

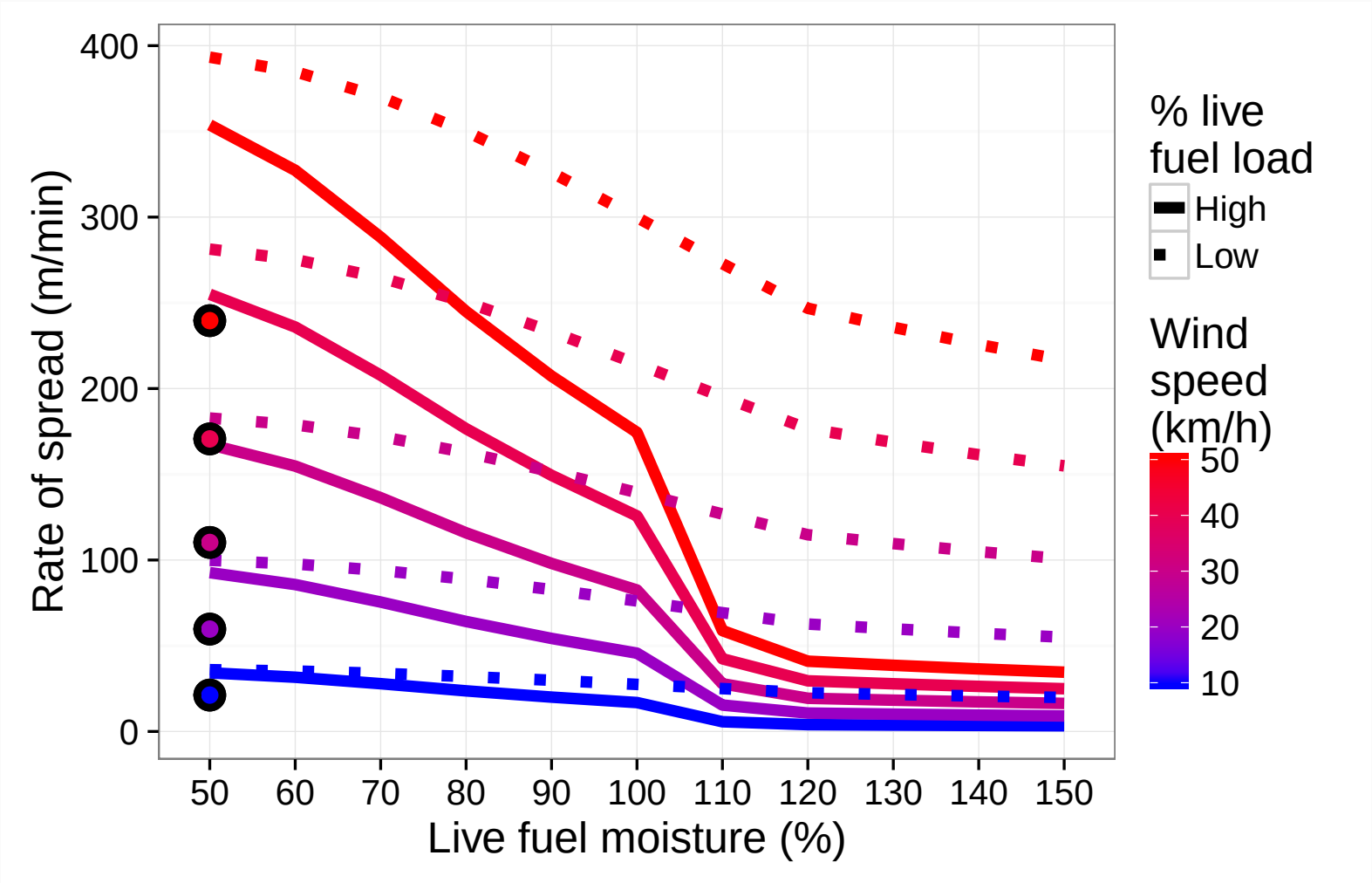
Festuca costata stays green year-long, but also increases fuel load



[3]McGranahan et al. in review

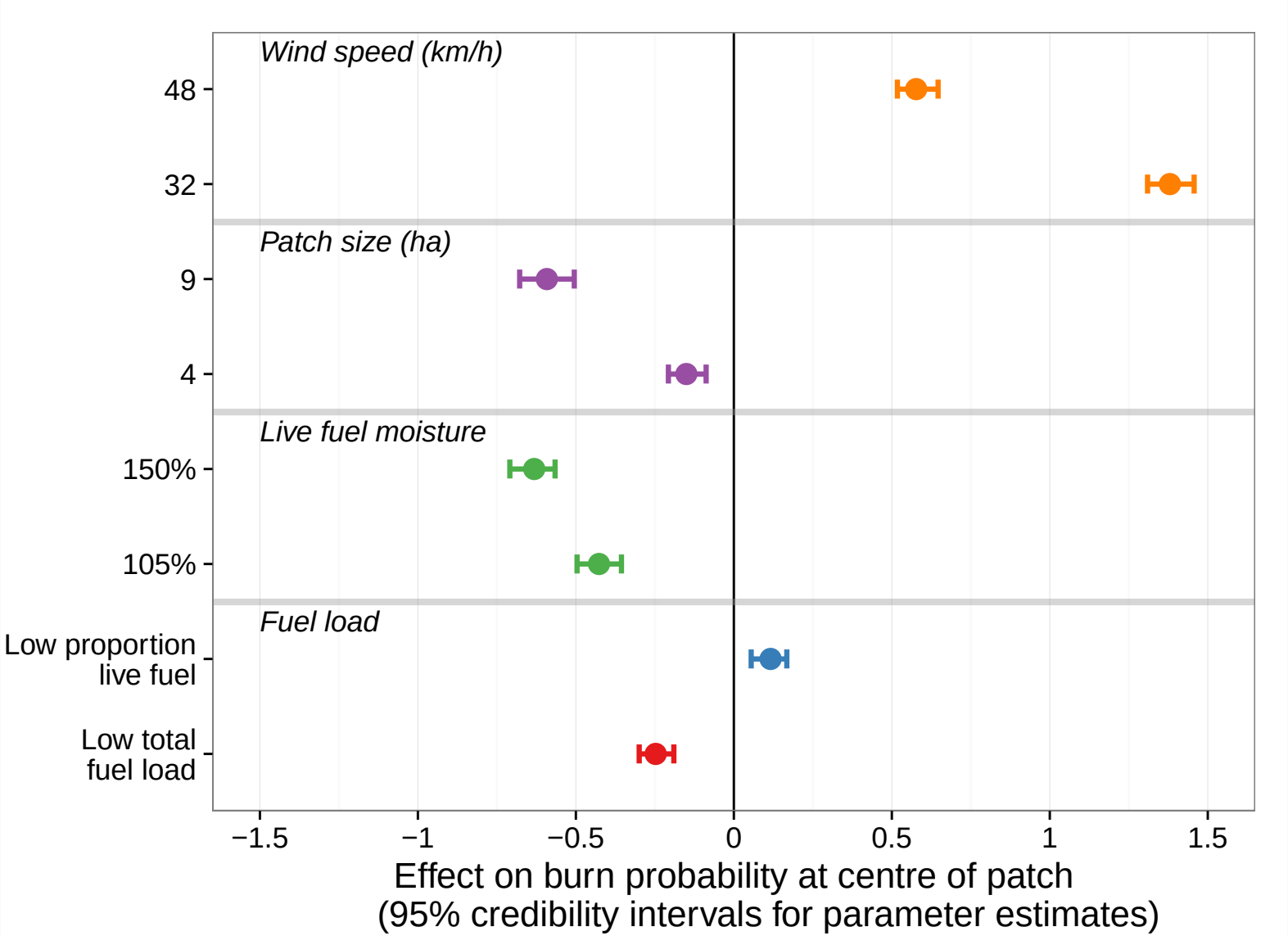
F. costata reduces fire spread in modeled grassland

- Slower rates of spread as *F. costata* tissue moisture increases
- Note effects of fuel load, wind



F. costata reduces burn probability in spatial models

Effect of each model variable on burn probability at patch centre



Anecdotal evidence of model results

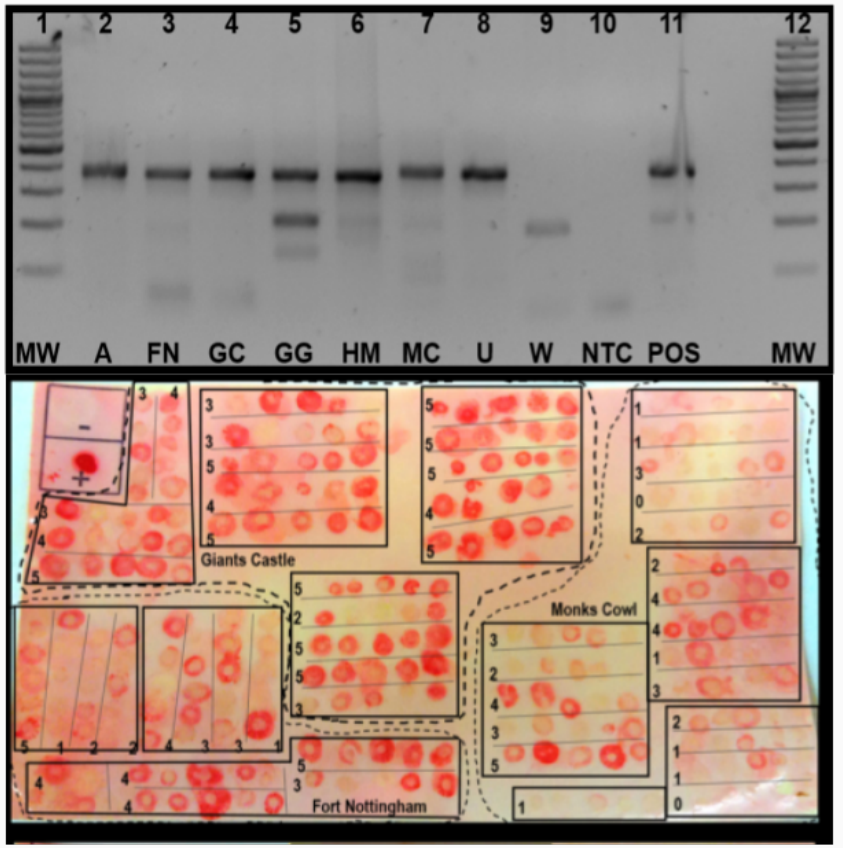
- While effects are yet to be field-validated, anedcotal evidence supports models
- Here, flanking fires appear to have been impeded by *F. costata* (right) but spread well through C_4 stand (left)

Take-home points

- *F. costata* likely increases variability in fire behaviour, effects
  - Exacerbated by high live moisture, large patches, low fuels
  - Mitigated by wind, more fuel (longer time-since-fire)
- Dependent on fuelbed, slope, patch size, time-since-fire, wind
- *F. costata* could increase fire return interval at centre of large patches
- Potential community succession effects if low FRI allows woody establishment

Fescue, fungus, and fire[4]

- Some describe *F. costata* expansion at lower altitudes, contrary to how we expect C_3 grasses to move given global warming
- Epichloae endophytes often confer advantages like drought tolerance onto hosts, which include most *Festuca* species worldwide.
- We found the endophyte in *F. costata* throughout SA range[5]
- Endophytes might shape *Festuca* response to global change, exacerbate impact on fire regimes



[4]McGranahan et al. 2015 Plant Biology

Any burning questions??