Tackling the two-way relationships between fire and fire-adapted invasive plants

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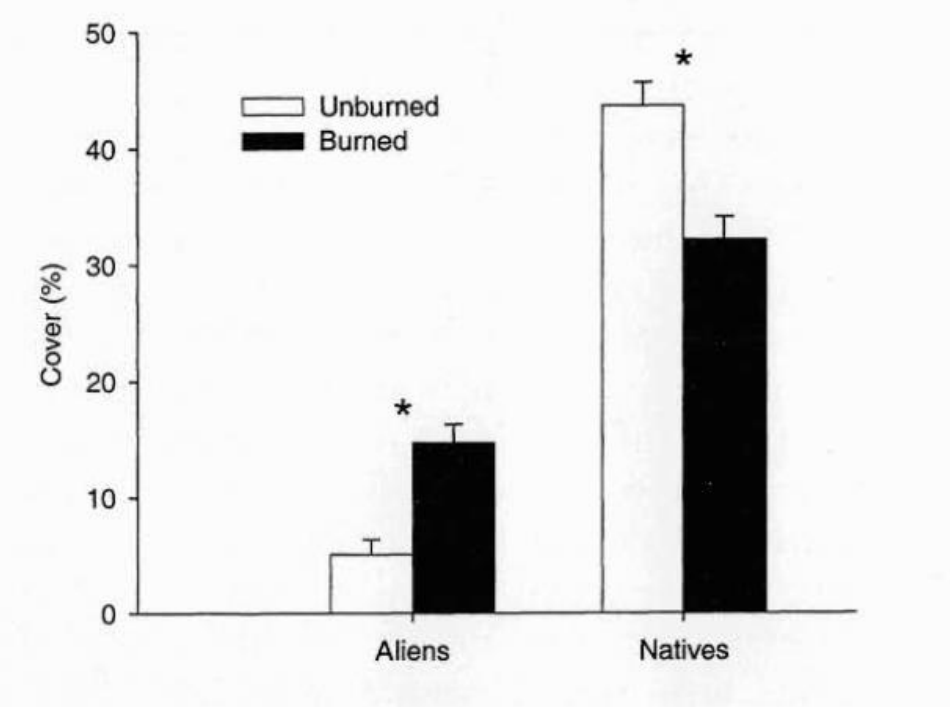
Summary

- Ecological aspects
- Management aspects
- Portugal, as a case-study
- The special case of *Eucalyptus globulus*
- The Aliens & Flames project

Ecological aspects

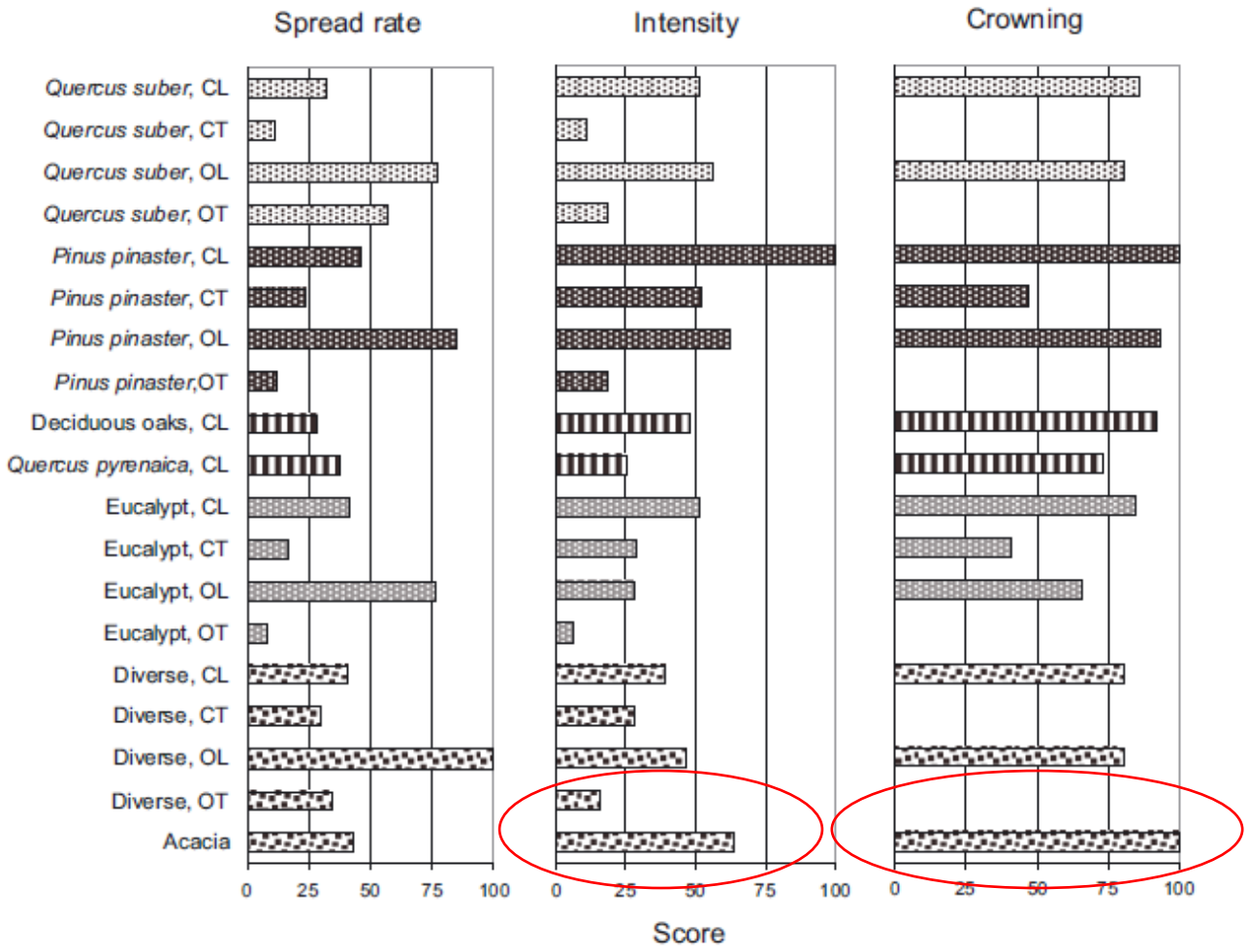
There is plenty of evidence about the role of fire in promoting the expansion of alien plants; an example from blackbrush (*Coleogne ramosissima;* Rosaceae) shrublands in the Mojave Desert, Utah, USA



(Brooks and Matchett, 2003)

Not so clear is the contribution of plant invasions to change the fire regime, as most works are based on fire simulations or subjective appraisal, not on real-world fire behaviour data

(Fernandes, 2009)



In case of a positive reciprocal effect between fire and fire-adapted plant species, a positive feedback loop may develop

(Brooks *et al.* 2004)

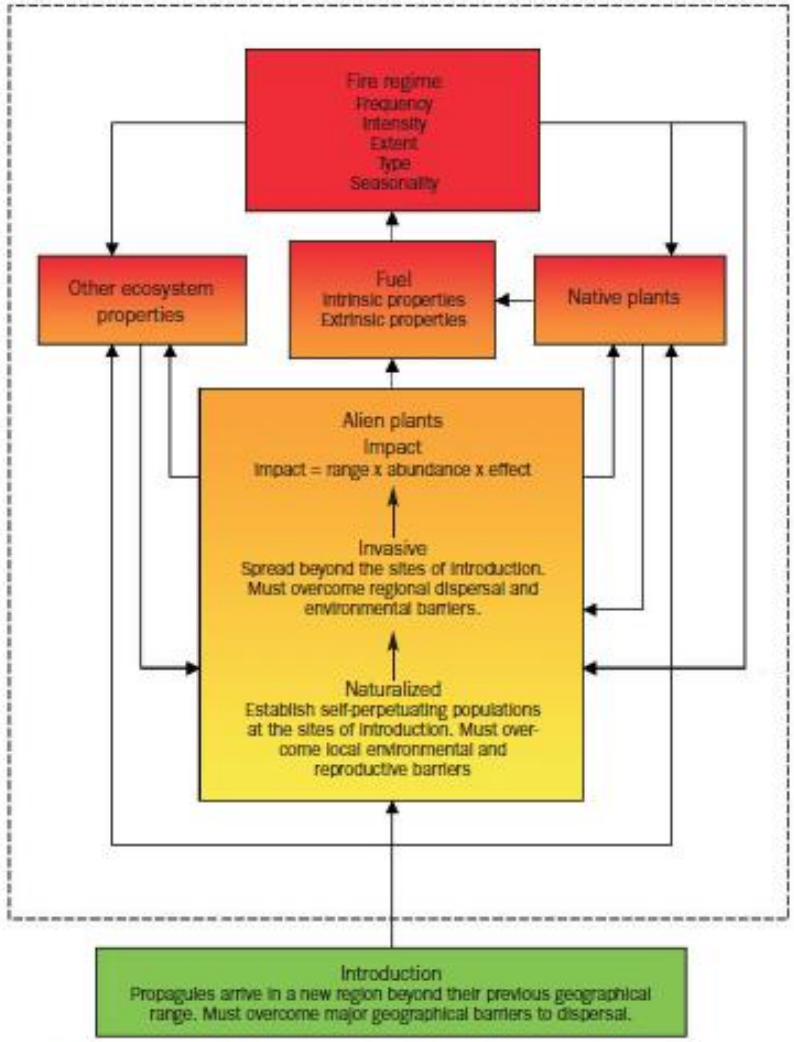
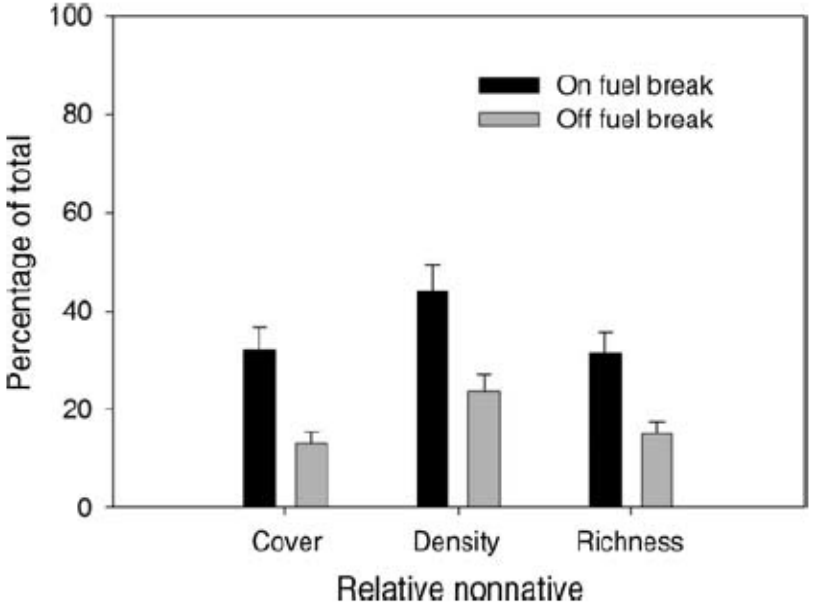


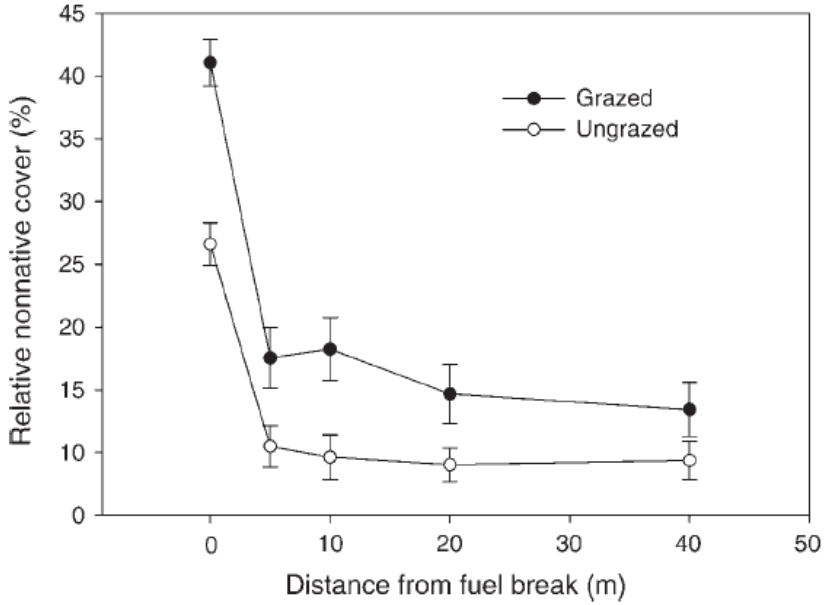
Figure 2. The invasive plant–fire regime cycle. Green, phase 1; yellow, phase 2; orange, phase 3; red, phase 4.

- Changes in the fire regime may be also negative (lower fire hazard), as some IAS populations may be less flammable than the invaded ecosystems, e.g:
  - *Myrica faya* in Hawaii (D'Antonio, 2000)
  - *Robinia pseudoacacia* in northeastern U.S (Richburg *et al*. 2004)
  - *Ailanthus altissima* in Europe (?)
- In other cases there might be a «positive» change in the structural characteristics of fuels, such as those reported by Van Wilgen and Richardson (1985) for *Hakea sericea* in South Africa
- In many cases we are probably just replacing one fire-prone ecosystem, by another fire-prone ecosystem

Management aspects

- Besides the particular case of fire, it is well known the general role of ecosystem disturbance in promoting the invasion of alien plants
- Removing vegetation either by cutting, tillage, grazing or fire, often creates better conditions for the establishment of invasive alien plant species
- Most fuel management practices aimed at reducing fire hazard may potentially aggravate the problem of plant invasions



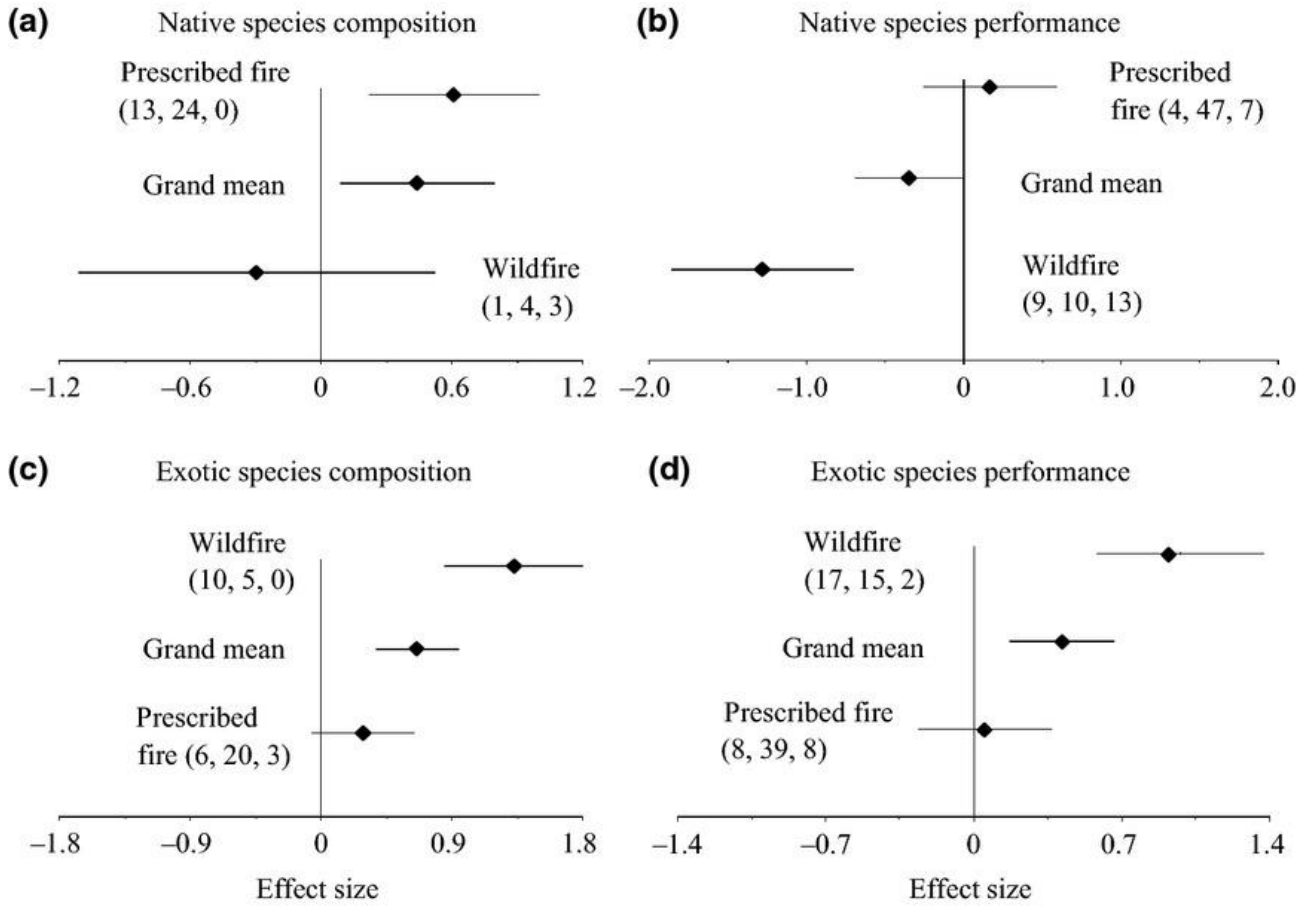


The Effect of fuel breaks in California (Merriam et al. 2006):

"We found that nonnative plant abundance was over 200% higher on fuel breaks than in adjacent wildland areas"

- The use of fire as a fuel management tool may also aggravate the problem of plant invasions
- Proper management may, however, minimize the risk of expanding the invasive plants, using an appropriate fire prescription
- Prescribed fire can even contribute to locally eliminate or control some invasive plant species

Native and exotic plant species respond differently to wildfire and prescribed fire as revealed by meta-analysis



(Alba *et al*. 2015)

Burn, March 2014

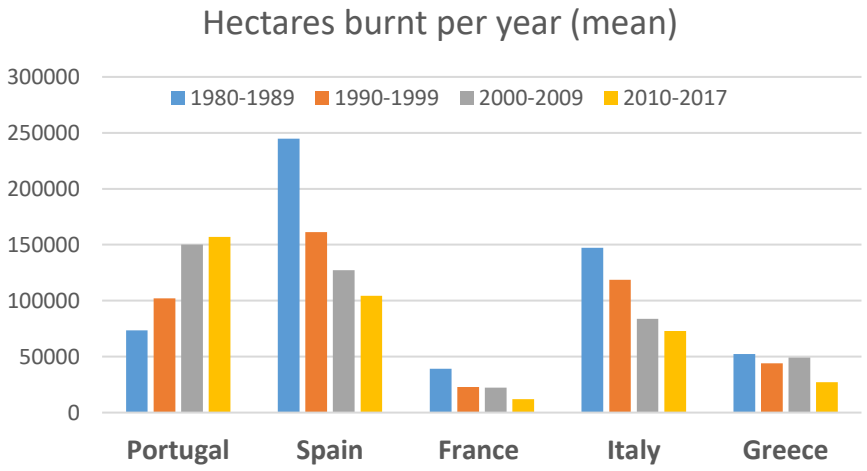
March 2016

April 2018

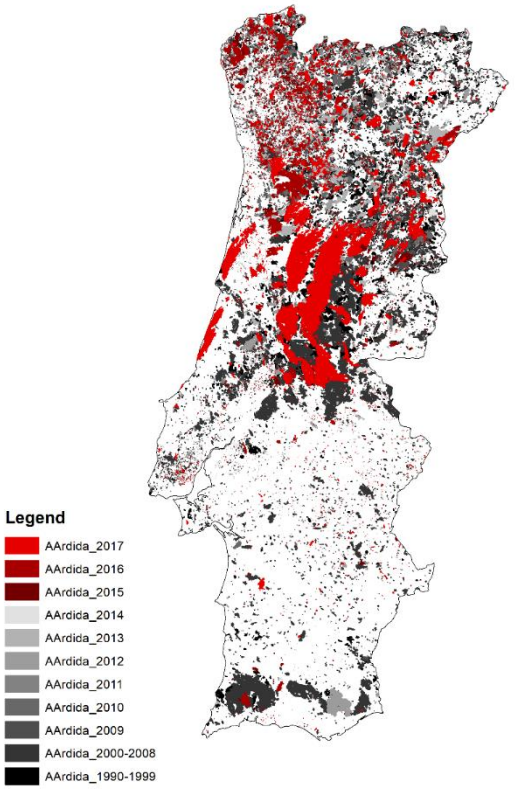
May 2019

Portugal as a case-study

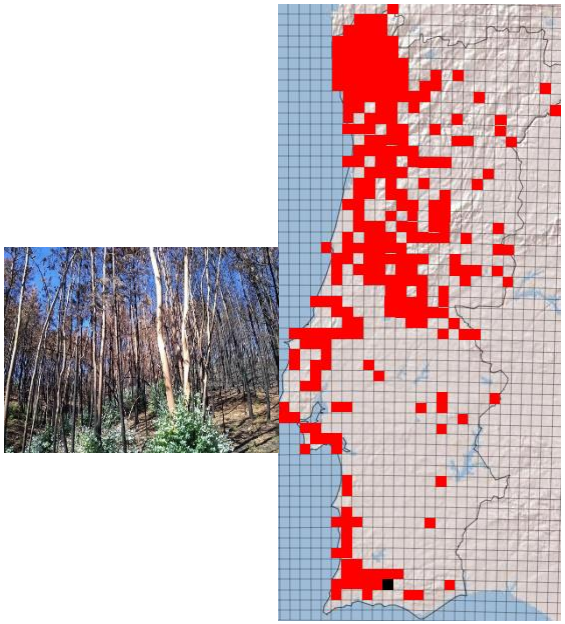
- Portugal is an invasion-prone country, given its mild climate, the current fire regime and the introduction of many fire-adapted alien plant species
- These conditions are leading to widespread expansion of novel ecosystems, still poorly studied and understood
- Most problems are related with species of Australian origin


Hectares burnt per year (mean)
300000
250000
200000
150000
100000
50000
0
1980-1989
1990-1999
2000-2009
2010-2017
Portugal
Spain
France
Italy
Greece

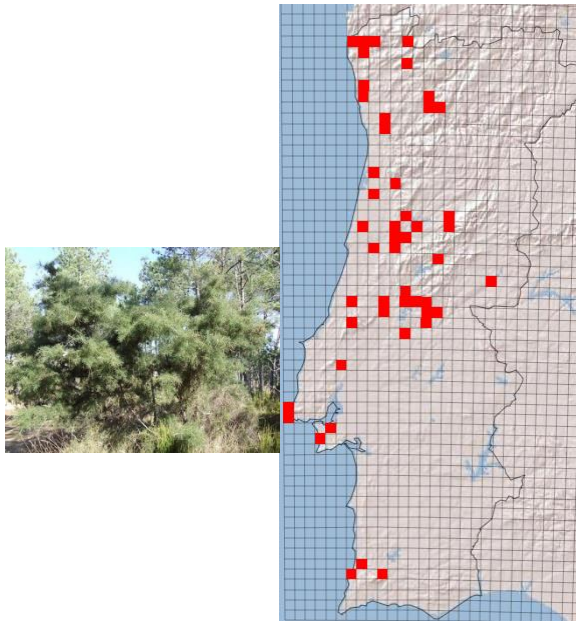
EFFIS


Legend
AArdida_2017
AArdida_2016
AArdida_2015
AArdida_2014
AArdida_2013
AArdida_2012
AArdida_2011
AArdida_2010
AArdida_2009
AArdida_2000-2008
AArdida_1990-1999

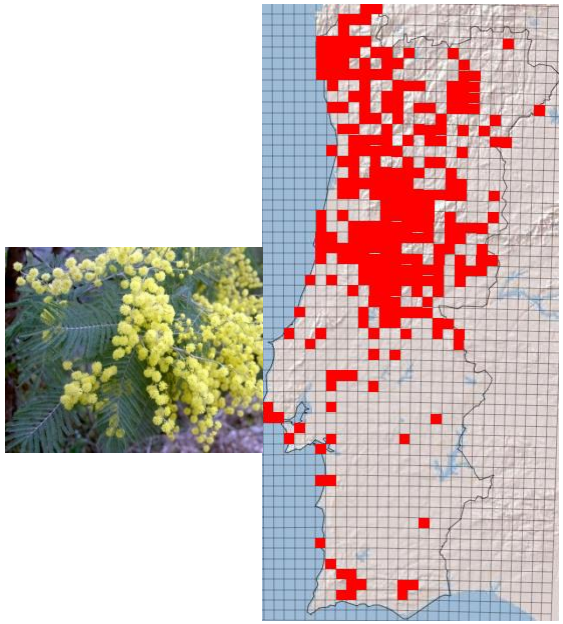
Widespread fire-adapted alien species



Eucalyptus globulus



Hakea sericea



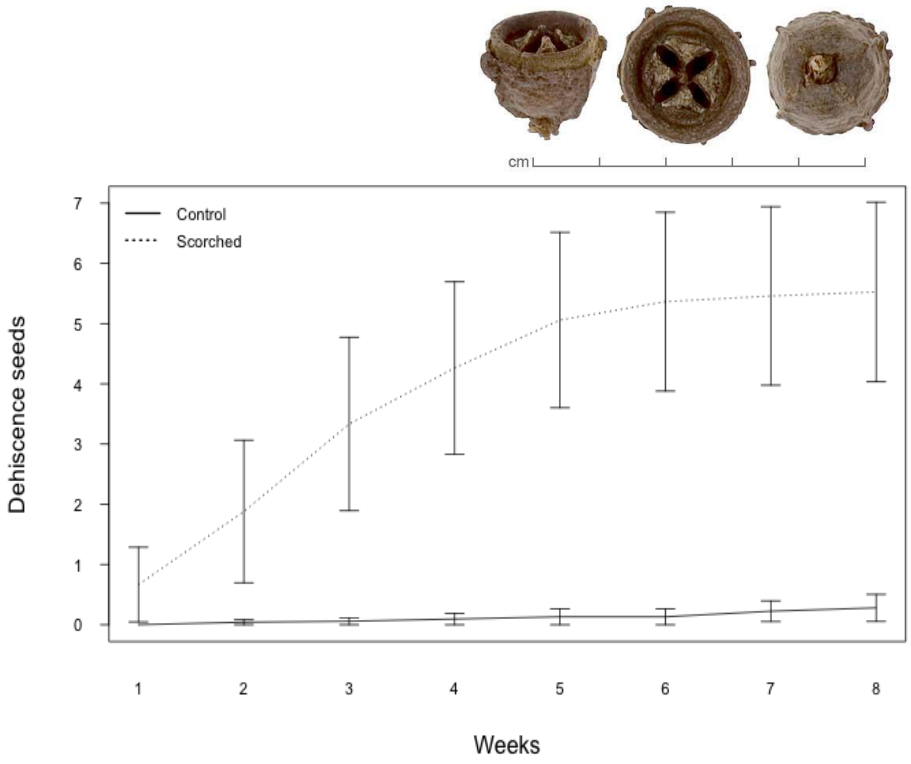
Acacia dealbata

A.Carapeto, P.V.Araújo, J.Lourenço, J.D.Almeida, D.T.Holyoak, F.Clamote, E.Portela-Pereira, P.Pereira, et al. (2021). Eucalyptus globulus Labill. - Flora-On: Flora de Portugal Interactiva, Sociedade Portuguesa de Botânica. http://www.flora-on.pt/#wEucalyptus+globulus. 11/05/2021

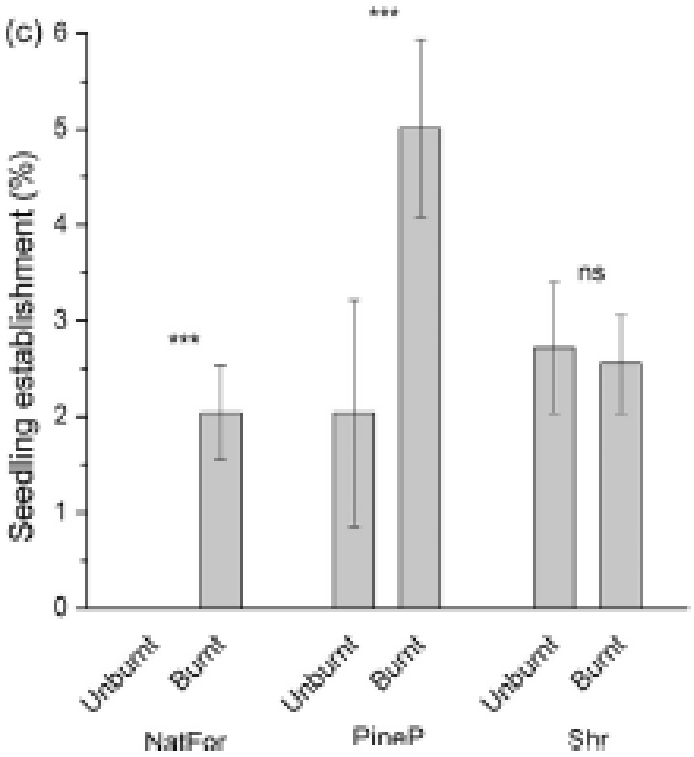
The special case of *Eucalyptus globulus*

Eucalyptus globulus

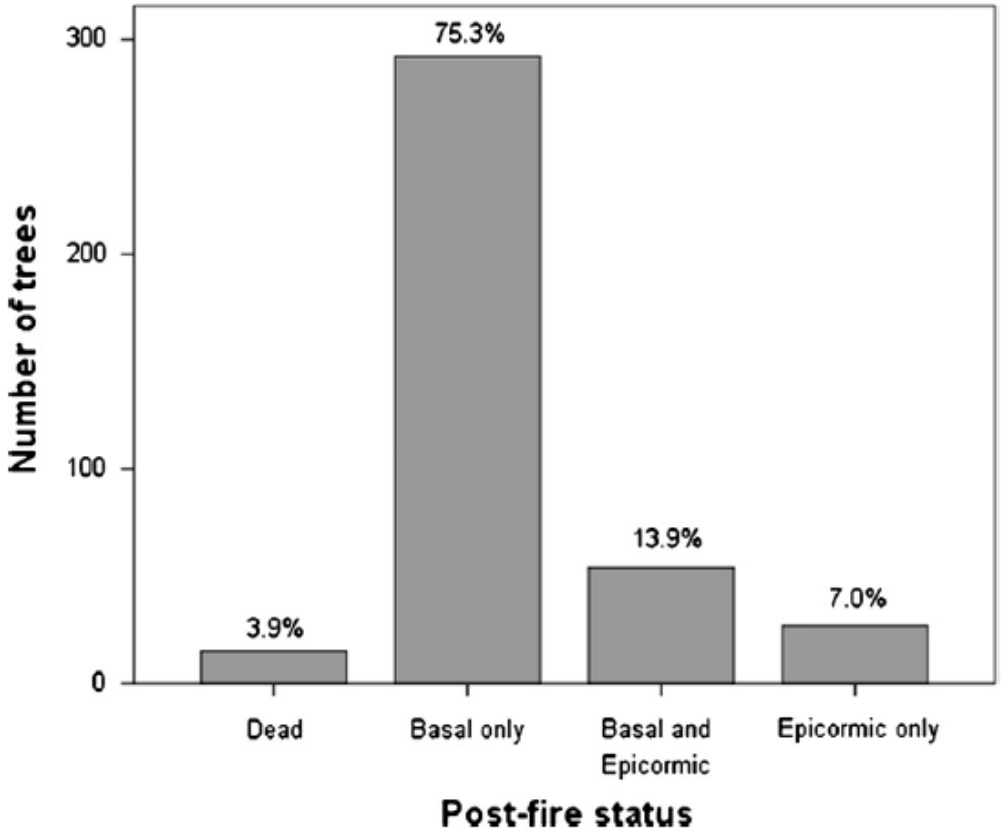
- Native from Australia
- Widely planted across the country and in Galicia, Spain
- Highly resistant to fire
- Massive seed shed after fire from “old” trees
- Not a serious problem if plantations are properly managed
- A potential problem when plantations are abandoned
- Given its economic importance it is not legally considered an invasive species



(Santos *et al.*, 2015)



(Calviño-Cancela *et al.*, 2018)



(Catry *et al*. 2013)

2011

(Larcombe *et al.* 2013)

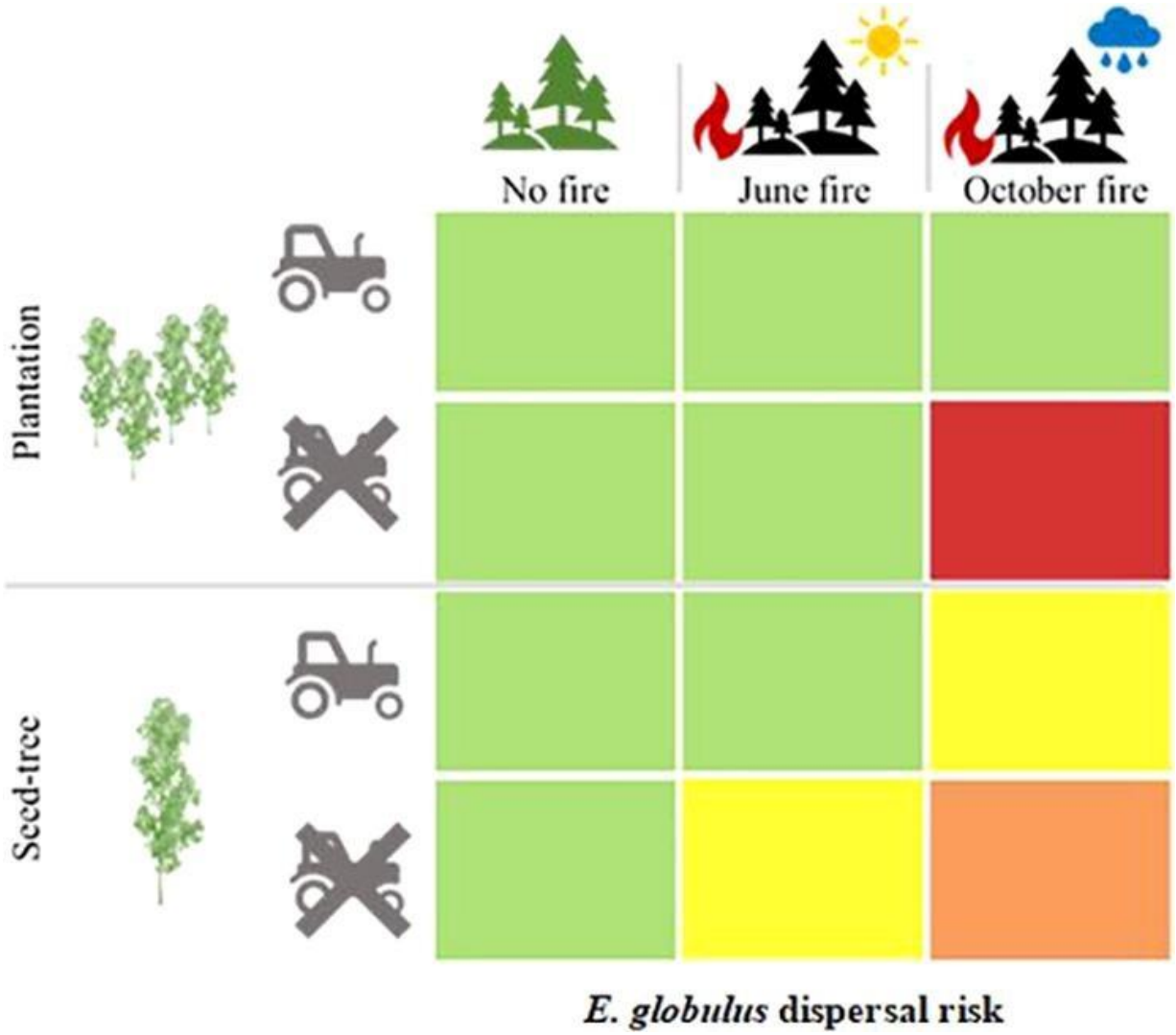
One year after the 2017 fires in Central Portugal

HIGH FIRE HAZARD

2018

2021

Critical factors affecting post-fire *E. globulus* dispersal

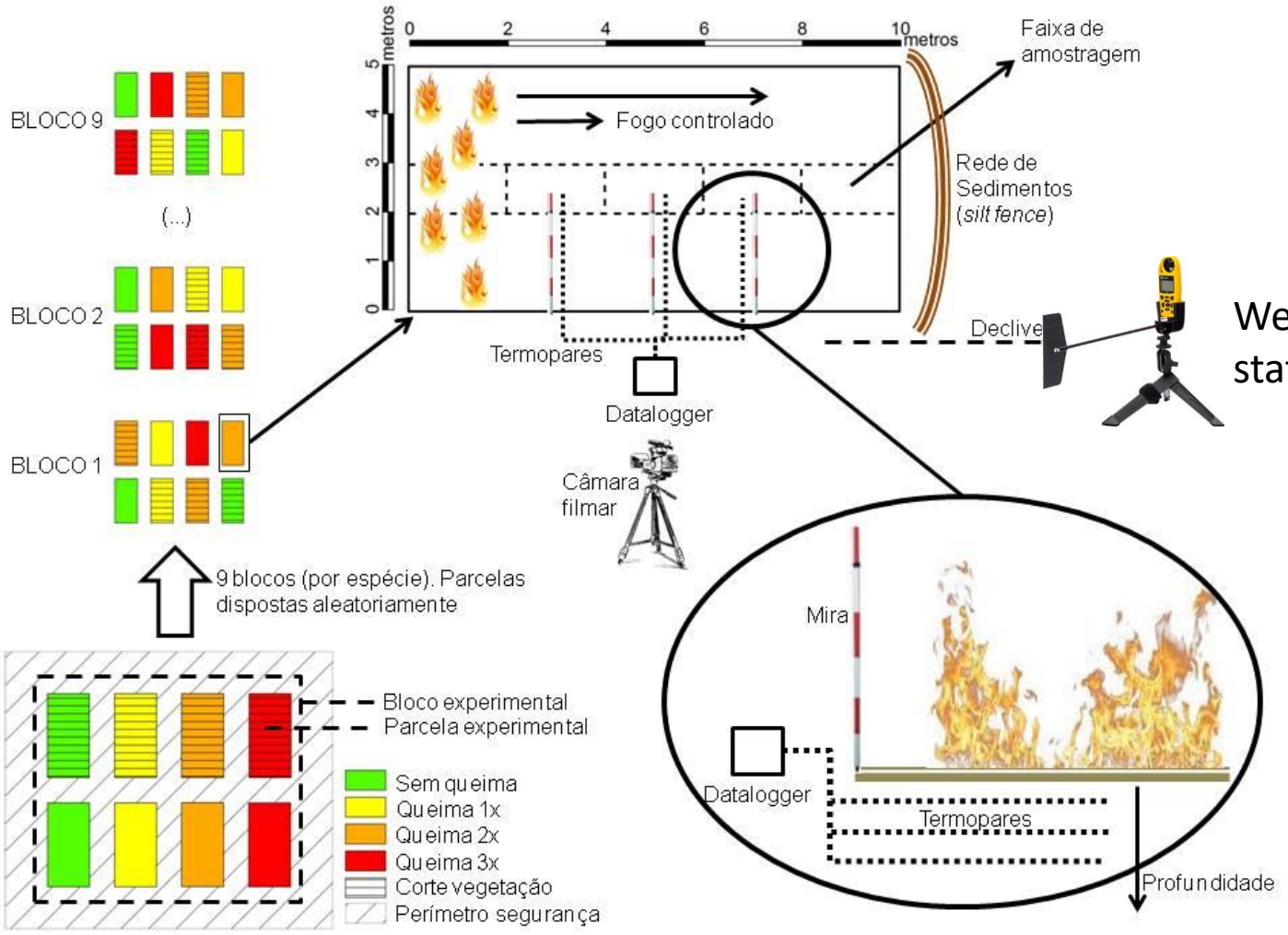


(Anjos *et al*. 2021)


80 m

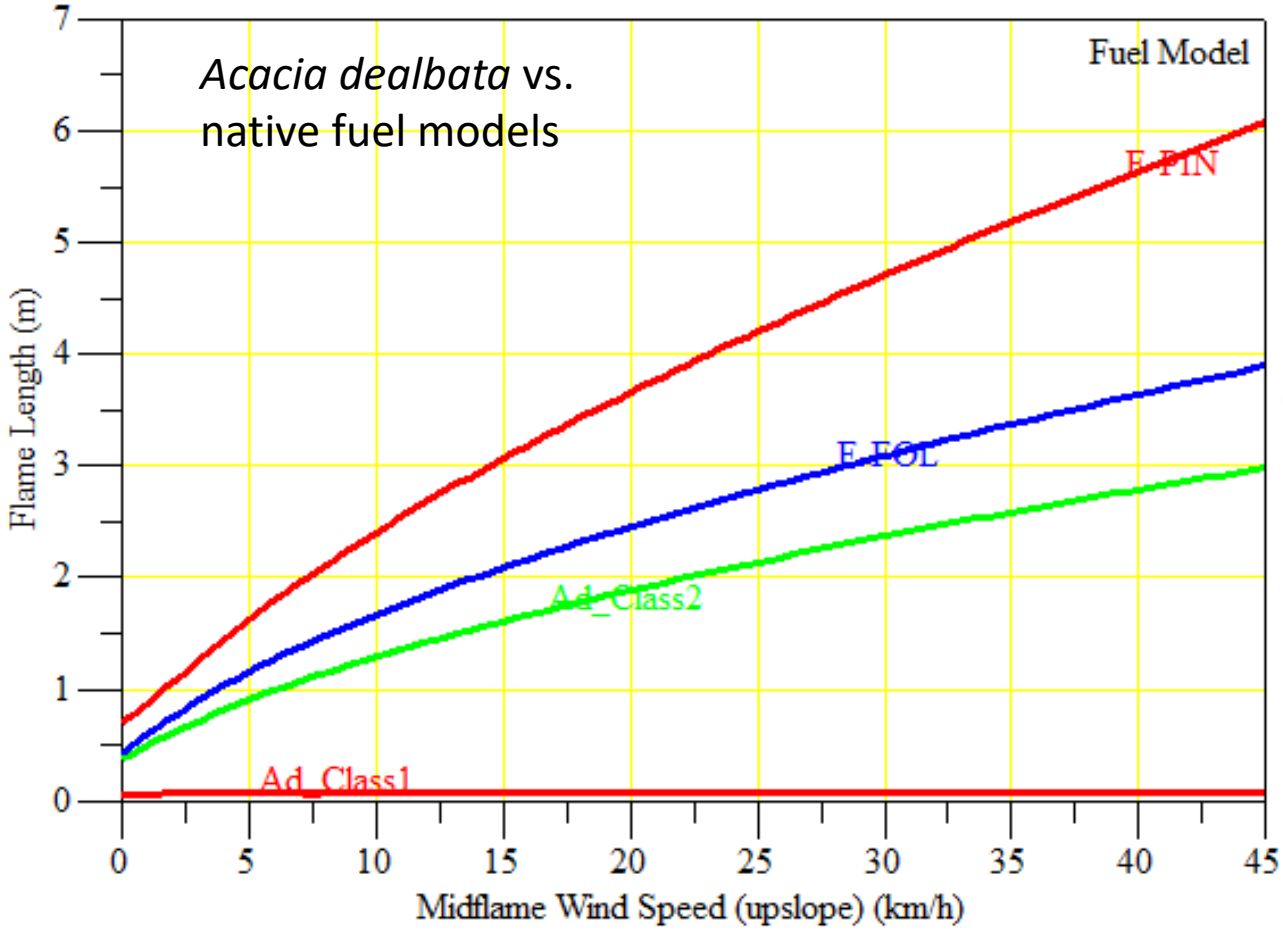
The Aliens & Flames project

- The Aliens & Flames project started in 2017 and is running for 5 years
- It comprises tasks dedicated to:
  - **Assess the fire hazard** of ecosystems dominated by two fire-adapted alien plant species (*Hakea sericea* and *Acacia dealbata*)
  - Study the effects of **burn treatments** on the seed banks and on the individual plants
  - Produce a **guide of best practices** for dealing with the two species



Weather station

No slope; D1L1 fuel moisture scenario (Scott and Burgan, 2005) 3,4,5, 30, 60 %

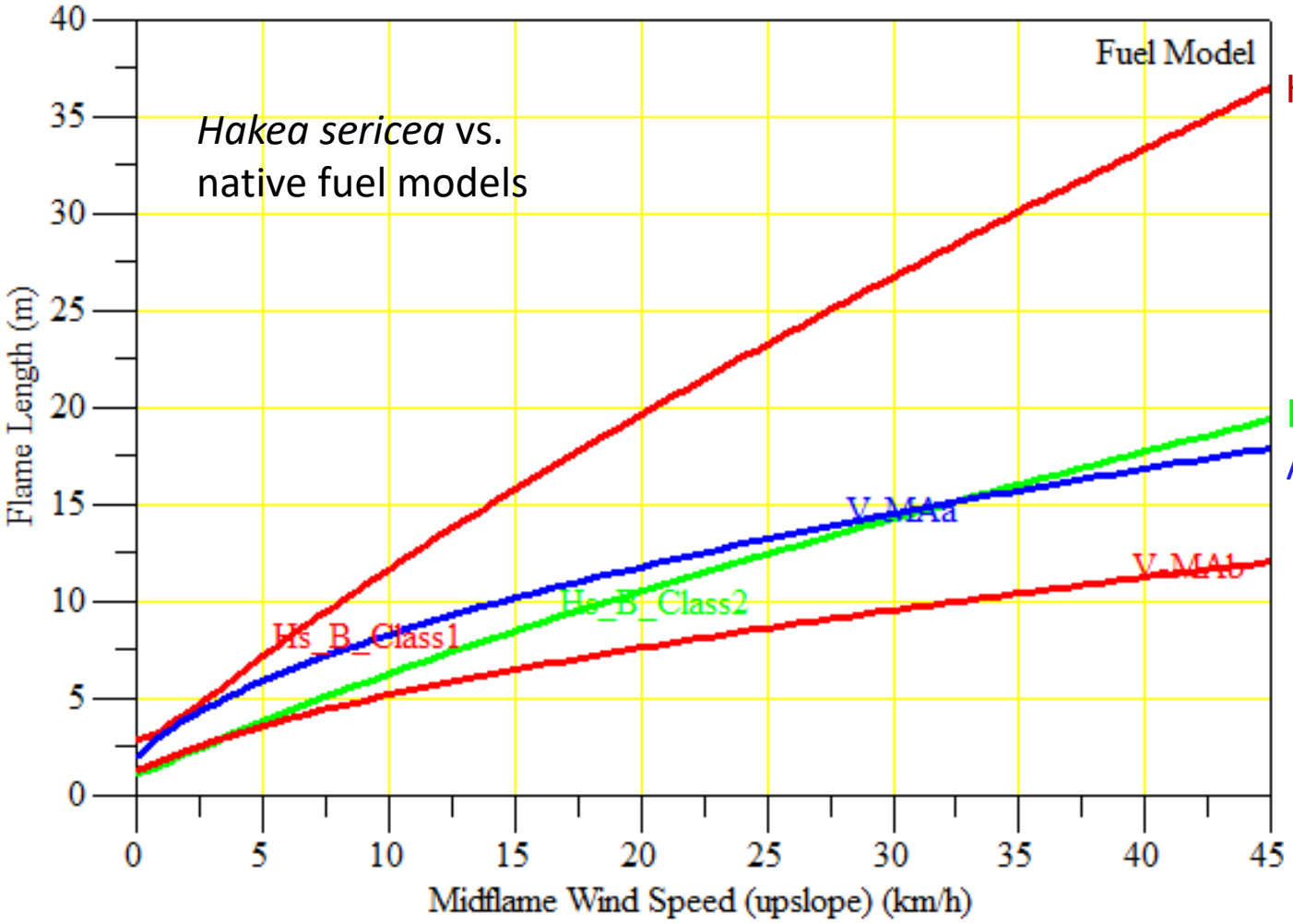


Pine Litter-dominated fuel

Broadleaf Litter-dominated fuel

Acacia <5m

Acacia >5m

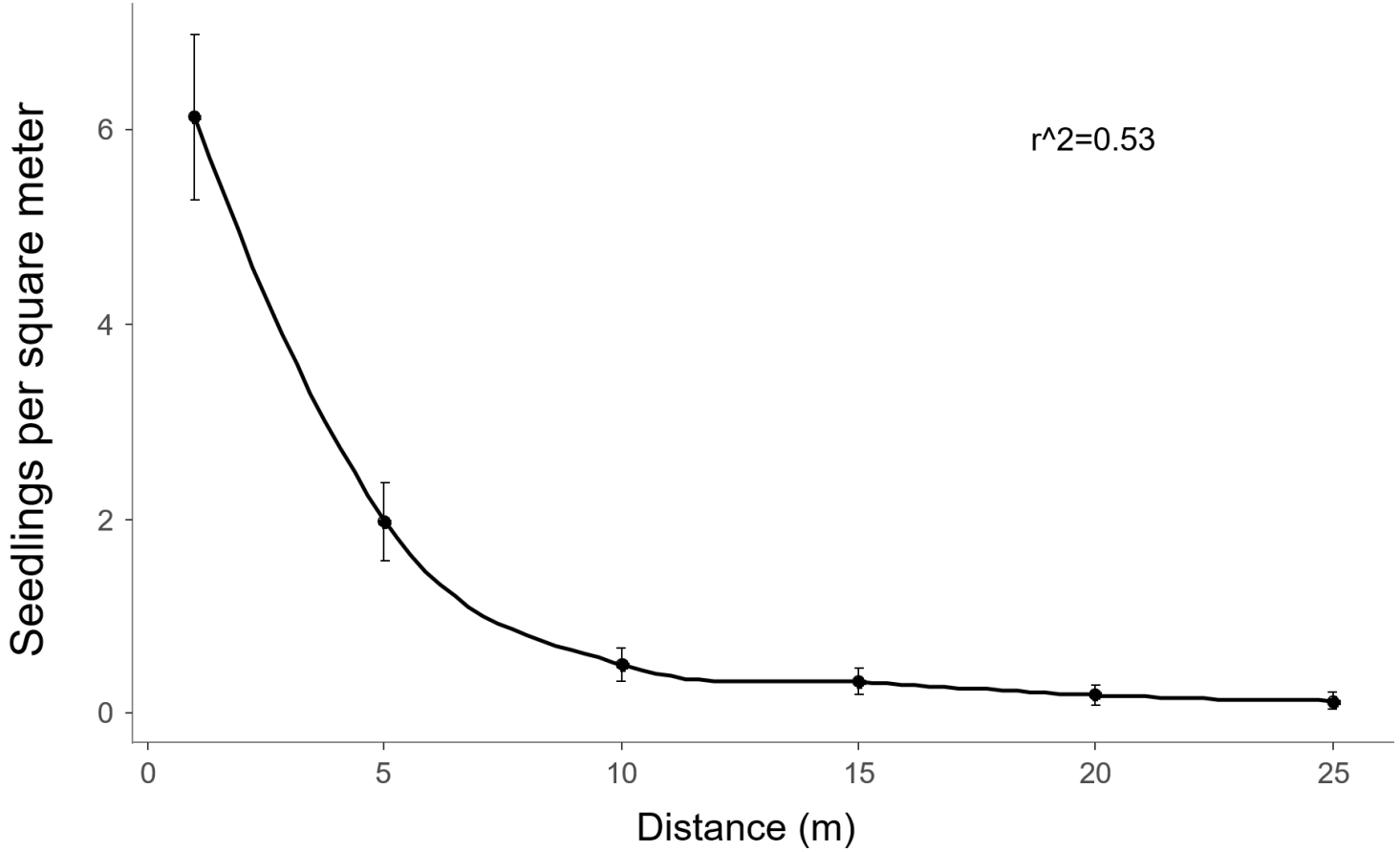


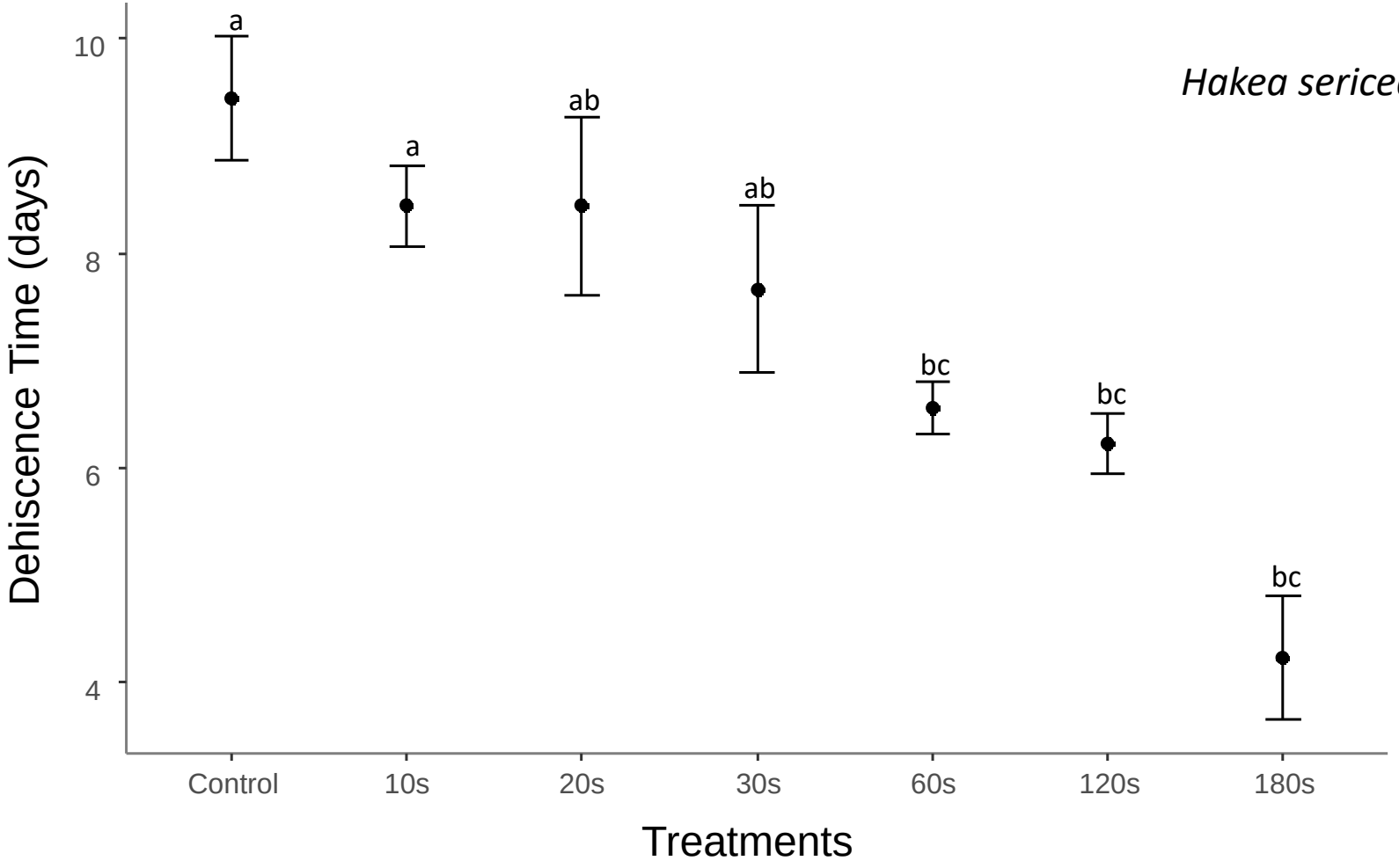
Hakea sericea vs. native fuel models

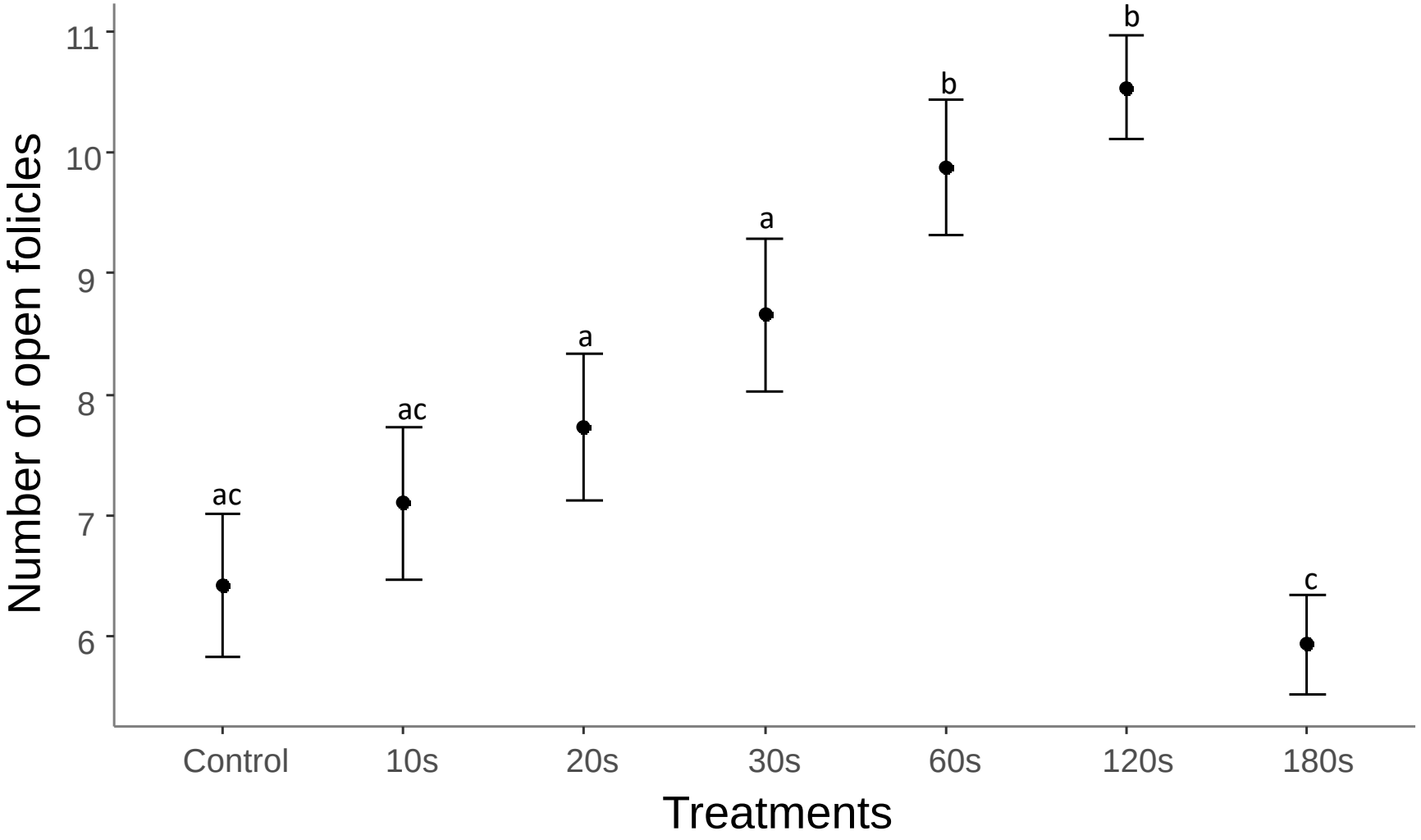
Hakea >2.5m

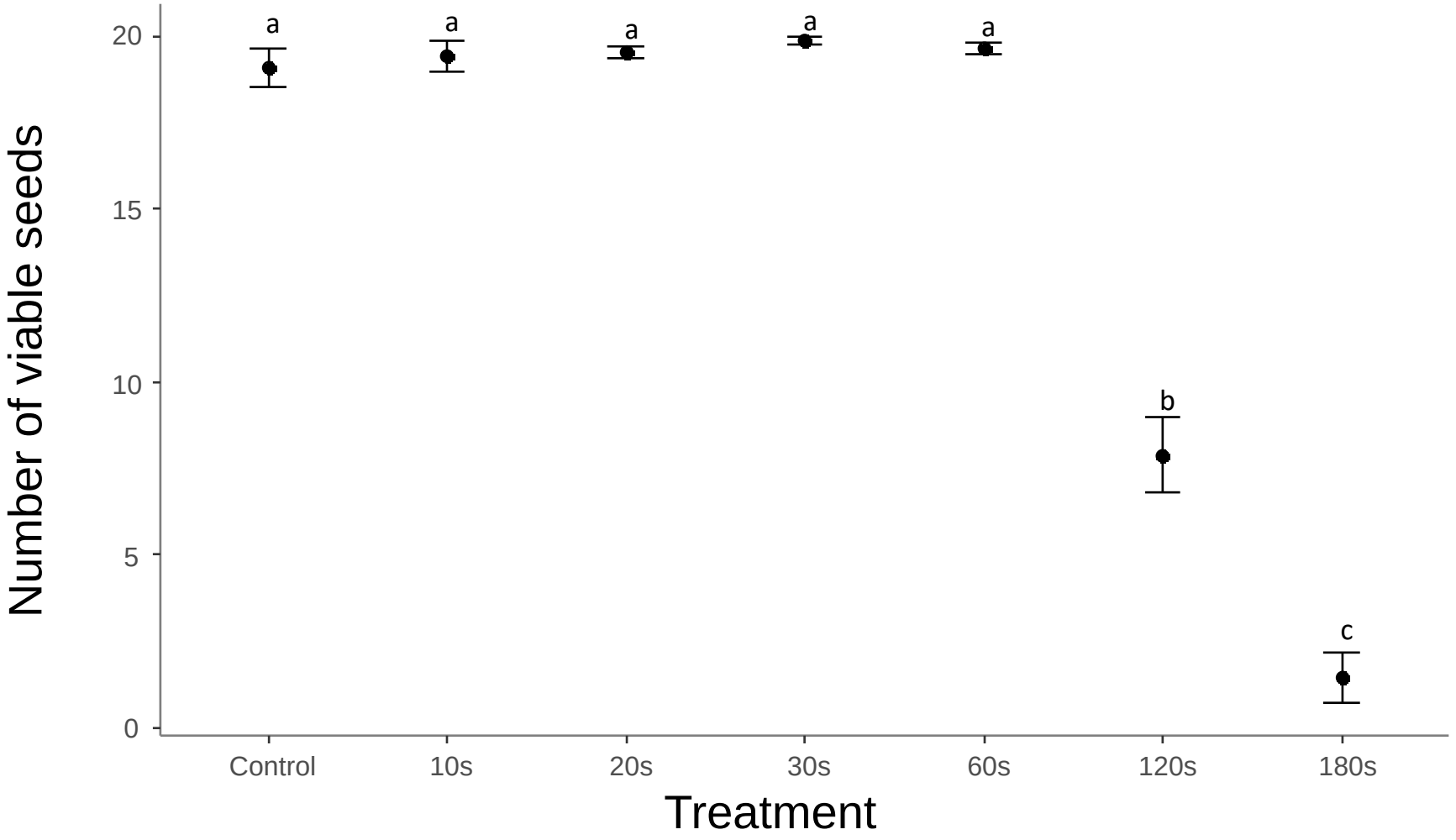
Hakea <2.5m
Atlantic Tall Shrubs

Mediterranean Tall Shrubs


Seedlings per square meter
0
2
4
6
0
5
10
15
20
25
Distance (m)
r^2=0.53


Hakea sericea
Dehiscence Time (days)
10
8
6
4
a
a
ab
ab
bc
bc
bc
Control
10s
20s
30s
60s
120s
180s
Treatments


Number of open folicles
11
10
9
8
7
6
ac
ac
a
a
b
b
c
Control
10s
20s
30s
60s
120s
180s
Treatments


Number of viable seeds
20
15
10
5
0
a
a
a
a
a
b
c
Control
10s
20s
30s
60s
120s
180s
Treatment

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Thank you!