Data from the UoW fuel hazard study, by vegetation type and time-since-fire

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February 2012

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1 Introduction

This document presents data from the University of Wollongong's research into the development of fuel hazard in NSW forests and grassy woodlands (UoW Fuel Hazard Study). It fulfils a milestone outlined in the 2011/12 contract between the University and the NSW Rural Fire Service, providing a "summary of findings by vegetation type and time-since-fire."

A further report drawing together aspects of the four-year fuel modelling project will be presented in May 2012.

2 Study methods

To provide context for the data that follow, this section gives an overview of study methods.

2.1 Vegetation types

Eight vegetation types were investigated in this study. All are described in Keith (2004). They include six classes from the dry sclerophyll forest formation (four in the shrubby subformation and two in the shrub/grass category), one grassy woodland class, and a wet sclerophyll forest.

The four shrubby dry sclerophyll forest (DSF) classes were:

- North Coast Dry Sclerophyll Forests (North Coast DSF). This class is found on coastal hills and plateaus of north-eastern NSW, on sites with impoverished, sandstone-derived soils. A diverse tree species complement includes rough-barked angophoras (*A. robur*, *A. woodsiana*), eucalypts (*E. planchoniana*, *E. baileyana*, *E. umbra*), and corymbias (*C. gummifera*, *C. intermedia*). The prominent hard-leaved shrub layer includes banksias, leptospermums, *Lambertia formosa* and *Xanthorrhoea latifolia*. Ground cover is often dominated by grasses. Tree height in our sites ranged from 17 to 24 m.
- Sydney Coastal Dry Sclerophyll Forests (Sydney Coastal DSF). This class is one of three occurring on the infertile, sandstone-derived soils of the Greater Sydney basin. It is characterized by a diverse understorey of hard-leaved shrubs with substantial representation of species in the Proteaceae and Fabaceae families. Dominant trees include *Angophora costata*, *Corymbia gummifera*, *Eucalyptus racemosa* and *E. piperita*. The ground layer consists of a varying array of sedges, ferns and occasional grasses. Sydney Coastal DSF grows where mean annual rainfall ranges from 1000 to over 1300 mm. Tree height in our study sites varied from seven to 20 m.[1]
- South East Dry Sclerophyll Forests (South East DSF). This extensive class spans altitudes from sea level to 1300 m, on coastal ranges and the escarpment of the Great Divide from the Shoalhaven River to the Victorian border and beyond. In order to maximise the environmental gradient covered by our study, sampling effort in this forest class was concentrated around Eden in the south of the state. Common tree species include the stringybarks *E. agglomerata* and *E. globoidea*; as well as *E.*

[1] Figures for tree height given in this section are site means, calculated by averaging tree height figures from the 5-7 plots surveyed in each in a site. In each plot, the height of the tallest tree in a circular area with a radius of 10 m, was estimated.

sieberi and *E. consideniana*. Shrub cover in this forest type is relatively open, while ground cover includes both grasses and sedges. Tree height in our sites ranged from 17 to 30 m.

- Southern Tableland Dry Sclerophyll Forests (Southern Tableland DSF). This vegetation type occurs further west, and at higher altitude, than the other vegetation classes in our study. Found on "stony ridges ... and rugged ranges" of the Southern and Central Tablelands at altitudes from 600 up to at least 1100 m, on a wide variety of substrates, these forests have an open understorey of sclerophyll shrubs and a relatively sparse ground layer. Signature tree species include the smooth-barked *Eucalyptus rossii* and the stringybark *E. macrorhyncha*. Peppermints (*E. radiata*, *E. robertsonii*, *E. dives*) are also common. Tree height ranged from 12 to 23 m.

The two shrub/grass dry sclerophyll forests were:

- Hunter-Macleay Dry Sclerophyll Forests (Hunter-Macleay DSF). This class is found in rainshadow areas of the Macleay, Manning and Hunter valleys; the majority of our sites were near Cessnock in the Hunter. Smooth-barked tree species such as *Corymbia maculata* and *Eucalyptus punctata* grow with ironbarks, particularly *E. crebra*, and rough-barked species such as *Syncarpia glomulifera*. A variable shrub layer in which wattle and pea species are prominent is accompanied by a semi-continuous cover of grasses. Tree height in study sites ranged from 16 to 24 m.

- Cumberland Dry Sclerophyll Forests (Cumberland DSF). This vegetation class occurs on alluvial soils overlaying the shales of Western Sydney's Cumberland Plain. Tree dominants include *Eucalyptus fibrosa* and *Melaleuca decora*. These forests grow in a rainshadow zone that receives a mean precipitation of 800-960 mm per annum. Shrubs include species in the Fabaceae and Asteraceae families. Grasses dominate the ground layer. Tree height ranged from 16 to 23 m.

The remaining two vegetation types were:

- Coastal Valley Grassy Woodlands (Coastal Valley GW). The only near-coastal class in the grassy woodlands formation, this vegetation type occurs in rainshadow valleys up and down the length of the NSW coast. Our survey work was limited to one variant of the class, Cumberland Plain Woodland (CPW) which grows on the shale soils of Western Sydney. Tree dominants in CPW are *E. moluccana*, *E. crebra* and *E. tereticornis*, while the most common shrub is *Bursaria spinosa*. A diverse mix of grasses and herbs commonly provides a near-continuous ground layer. Tree height in our study sites ranged from 16 to 26 m.

- North Coast/Northern Hinterland Wet Sclerophyll Forests (North Coast/Hinterland WSF). These two tall forest classes, which intergrade throughout their range, are found where soils are relatively fertile and rainfall is high. Although both stretch north from the Illawarra and the lower Blue Mountains to above the Queensland border, our study area was limited to sites in the southern part of this range, from just north of Wollongong to the Watagan Mountains east of Newcastle. These forests share several tree species including *E. pilularis*, *E. microcorys* and *Syncarpia glomulifera*. The understorey contains a variable mix of sclerophyll and mesophyll shrubs. Ferns, grasses and twiners are prominent in the ground layer. Tree height in our study sites ranged from 24 to 31 m.

2.2 Sampling strategy

Within each vegetation type, fuel was assessed in sites representing a range of post-fire ages, stratified into three time-since-fire (TSF) categories:

- Less than 6 years
- 6 to 9 years
- Greater than 9 years, or where possible, 15 years

Within each vegetation type we aimed to survey at least six sites in each of these three categories. Availability of sites of particular post-fire ages was constrained both by the extent of the vegetation class, and by the timing of fires; much of the study region had burned between 2001 and 2004. Despite these limitations, planned site numbers were achieved in almost all cases (Table 1). Partly because of its prominence on Sydney's urban fringe, we sampled a greater number of sites in Sydney Coastal DSF than in the other seven vegetation types. The total number of sites included in the dataset reported here is 157.

Information on post-fire age was sourced from management agencies. In most instances the time of the last fire was clearly documented. For nine sites which had not burned since record-keeping began, an exact post-fire age could not be determined; all, however, clearly belonged in the > 9 year post-fire category.

Table 1. Number of sites surveyed in eight vegetation types as part of the UoW fuel hazard study.[2]

Vegetation type	**Time-since-fire category**			**Total**
	< 6 years	**6-9 years**	**> 9 yrs**	
North Coast DSF	6	6	6	**18**
Sydney Coastal DSF	9	12	11	**32**
South East DSF	6	6	6	**18**
Southern Tableland DSF	6	6	6	**18**
Hunter-Macleay DSF	6	6	6	**18**
Cumberland DSF	4	6	6	**16**
Coastal Valley GW	7	6	6	**19**
North Coast/Hinterland WSF	5	7	6	**18**
Total	**49**	**55**	**53**	**157**

[2] A small number of additional sites surveyed over the study period have been excluded from this table, and from the results reported below. Four wet sclerophyll sites near Port Macquarie were excluded because they appeared somewhat different to the more southerly sites. Several Sydney Coastal DSF sites surveyed near the start of the project by assessment teams which did not include someone from the UoW survey team have also been excluded, due to findings on variability between assessors (Watson *et al.* in press).

All sites were dominated by native species and were substantially free of disturbance by factors other than fire such as recent logging, weed invasion and heavy grazing. Field work was carried out between July 2009 and November 2011.

Within each site, 5 to 7 replicate plots (usually 7) were assessed. Plots were at least 30 m apart.

In order to maximize consistency in the application of assessment methods (Watson *et al.* in press), all assessments were carried out by teams that included at least one of the authors.

2.3 Fuel characteristics assessed

When the study commenced in 2009, two primary methods of assessing fuel hazard were available in Australia.

The Overall Fuel Hazard Guide (McCarthy *et al.* 1999) was developed by the Department of Sustainability and Environment (DSE) in Victoria. This DSE guide aims to predict the probability of first attack success in suppressing a bushfire given specified weather conditions and resources (McCarthy *et al.* 1999; Wilson 1992).

The second fuel hazard assessment system was developed as part of Project Vesta, a series of fire behaviour experiments in dry sclerophyll forest in Western Australia (Gould *et al.* 2007a). This system, informed by the Victorian work but developed separately, was designed to provide quantitative measures of fuel hazard, with a view to empirically assessing the relationship between these composite fuel parameters and fire behaviour measures. Hazard scores assessed using the Vesta guide (Gould *et al.* 2007b) are used to predict rate of spread, flame height and spotting distance in the empirical fire behaviour models developed from the Vesta experiments (Gould *et al.* 2007a).

We used both the DSE (McCarthy *et al.* 1999) and the Vesta (Gould *et al.* 2007b) methods of assessing fuel hazard. Both address four fuel components or strata:

- Surface fuel – fallen litter lying on the ground
- Near-surface fuel – "grasses, low shrubs, creepers and collapsed understorey" whose orientation "includes a mixture ranging from horizontal to vertical" (Gould et al. 2007b:10)
- Elevated fuel – "tall shrubs and other understorey plants" with a primarily upright orientation (Gould et al. 2007b:12)
- Bark fuel – flammable bark on tree boles

In our study, surface, near-surface and elevated fuel characteristics were assessed within a 5m radius of the centre of each plot, while a 10 m radius was used for assessing bark characteristics.

In both systems, fuel hazard is rated on a five-point scale of Low, Moderate, High, Very High and Extreme.

In the DSE system, near-surface fuel acts as a modifier of surface fuel hazard, whereas in the Vesta system it is rated in its own right. We increased the DSE surface hazard rating by one level in plots where the projective cover of near-surface fuel was estimated at ≥ 40% (DSE adjusted surface hazard rating; McCarthy et al. 1999:2). In the DSE system only, hazard ratings for individual components can be combined to give an overall hazard rating. The DSE overall fuel hazard rating for each plot was determined by combining the DSE adjusted surface hazard rating with DSE ratings for elevated and bark fuel, using the tables in McCarthy *et al.* (1999:24).

For each site, values recorded in plots were averaged to give values at a site level. To determine 'mean' site-level hazard ratings, plot-level hazard ratings were allocated a numeric fuel hazard score. DSE hazard ratings were converted to integers of 1 (Low) to 5 (Extreme) in line with current practice (McCarthy and Tolhurst 1998; Plucinski *et al.* 2007; Tolhurst *et al.* 2007). Vesta hazard ratings were converted to numeric equivalents given in Gould *et al.* (2007b): these Vesta scores are mostly integers on a scale from 0 to 4, but with a value of 3.5 allocated to Very High for most fuel components. Plot-level scores were then averaged, and the average converted back to the nearest hazard rating level.

Data on attributes of vegetation structure which underpin hazard ratings, such as cover, height, and proportion of dead material, were also collected for each fuel layer. Variables and assessment methods are summarised in Table 2.

Table 2. Fuel attributes assessed as part of the UoW Fuel Hazard study. DSE guide, McCarthy *et al.* (1999); Vesta guide, Gould *et al.* (2007b).

Variable	Assessment method
Surface fuel	
Litter depth	Average of five random measurements per plot, taken to nearest mm using a litter gauge as per DSE guide
Litter cover	Estimated to nearest 10%
DSE surface hazard rating	Allocated as per DSE guide on basis of average litter depth
DSE adjusted surface hazard rating	Adjustment for near-surface hazard as per DSE guide: hazard level increased by one if near-surface cover ≥ 40%
Vesta surface hazard rating	As in Vesta guide
Near-surface fuel	
Near-surface cover	Projective cover, estimated to nearest 10%
Near-surface height	Typical height, measured to nearest 5 cm
Near-surface percent dead	Estimated to nearest 10%
Quantity of suspended litter	Scale 0-3, where 0 = none, 1 = small, 2 = moderate, 3 = large
Vesta near-surface hazard rating	As in Vesta guide
Elevated fuel	
Elevated fuel cover	Projective cover, estimated to nearest 10%
Elevated fuel height	Typical height. If < 2 m, measured to nearest 10 cm; if > 2 m, estimated; maximum 5 m.
Elevated percent dead	Estimated to nearest 10%
DSE elevated hazard rating	As in DSE guide
Vesta elevated hazard rating	As in Vesta guide
Bark fuel	
Bole char	On tree boles up to a height of 5 m, estimated to nearest 10%, for stringy and subfibrous bark types separately
Quantity of flammable bark	Scale 0-4 for each of three bark types: stringybark, subfibrous bark, ribbon bark. Considers tree numbers and size as well as bark condition.
DSE bark hazard rating	As in DSE guide
Vesta bark hazard rating	As in Vesta guide
Overall fuel hazard rating	Calculated using DSE adjusted surface, DSE elevated and DSE bark hazard ratings, as per DSE guide

3 Data presentation

We have used three formats to present the data obtained during the study.

3.1 Table of Vesta parameters

This one-page table focuses on the fuel parameters found in the Vesta fire behaviour models. Data are presented for each of our three time-since-fire categories, within each vegetation type. Hazard parameters are presented as both ratings and scores. The aim of this table is to provide convenient ball-park figures for fire behaviour analysts wishing to use the Vesta models.

This table includes a column giving the mean time-since-fire in each category. Note that while post-fire age in the 6-9 year group is roughly equivalent across vegetation types (range 7.0 to 8.1 years), this is not the case in the 0-6 year age class, where mean post-fire age varies from 1.8 to 3.4 years, nor in the 9+ age class.

3.2 Bar charts

These charts show how the fuel parameters measured in this study differ between post-fire categories within a vegetation class and also across vegetation classes.

These charts, one for each fuel parameter listed in Table 2, visually present the mean and standard error for each post-fire age class, in each vegetation type. These charts provide an overview of the level reached by each parameter as well as of the rate at which it develops.

3.3 Stacked bar charts

Hazard ratings vary within a time-since-fire category, even within a single vegetation class. This is illustrated by stacked bar charts which present fuel hazard ratings as a proportion of sites sampled in each age class. There are eight charts for each vegetation type, presented over two pages, with DSE hazard ratings on the first page (DSE adjusted surface, elevated, bark and overall fuel hazard), and Vesta hazard ratings on the second (Vesta surface, near-surface, elevated and bark hazard).

These charts illustrate the range of ratings that we have recorded in our study and may have some use for applications that include likelihood. However, the proportions should be used cautiously as the number of sites within each post-fire age category is low (most are based on n=6). While we have categorised the data into the three time-since-fire intervals around which the study was designed, a split with some shorter intervals, particularly for the early post-fire years, could be more useful (eg 0-3 years, 3-6 years). Data for additional sites would be needed, however, for proportions in these categories to be meaningful.

NOTE: L = Low, M = Moderate, H = High, VH = Very High, E = Extreme, throughout the figures in this report.

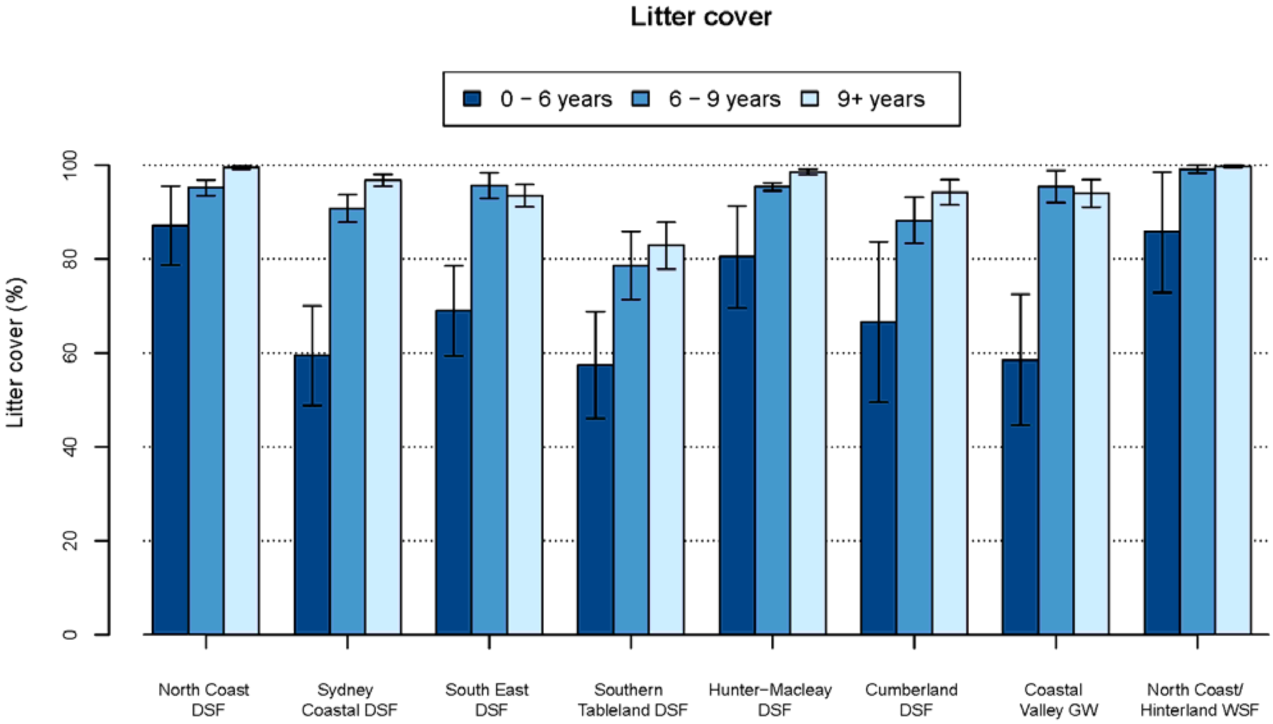
4 Vesta fuel parameters

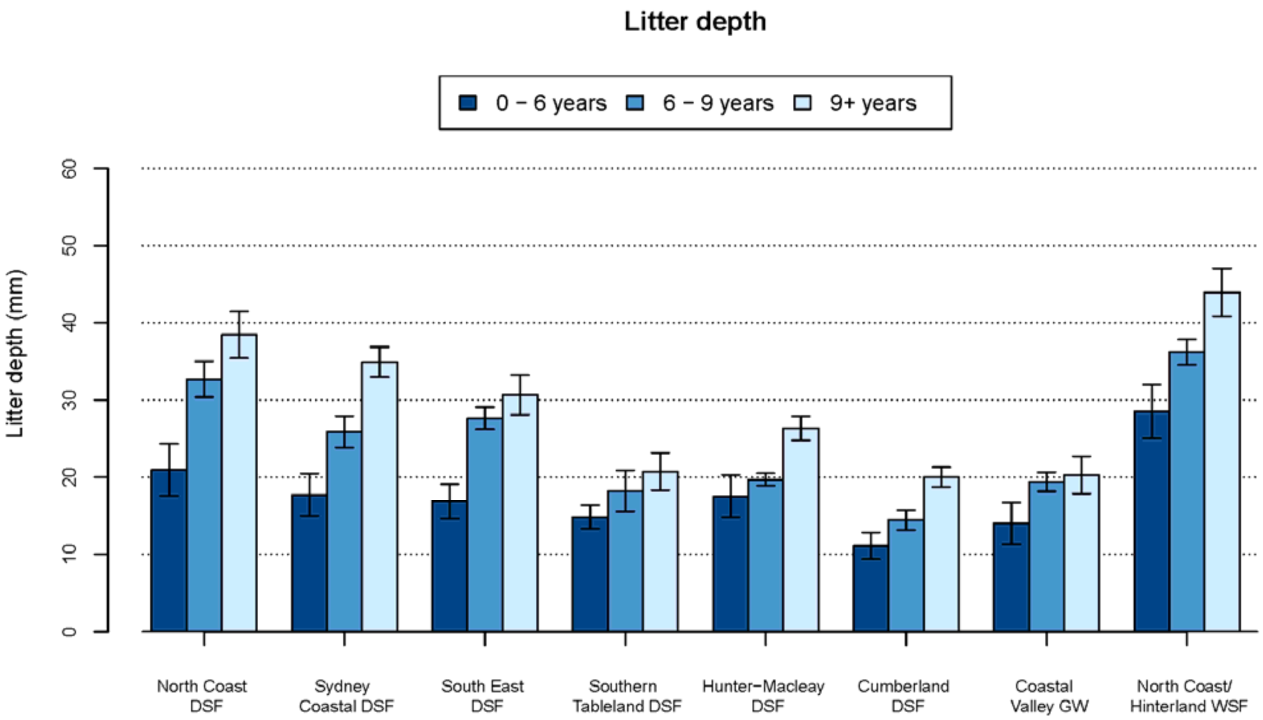
					Surface Fuel		Near-surface Fuel			Elevated Fuel			Bark Fuel	
Veg Class	Veg Formation	TSF category (yrs)	N	Mean TSF (yrs)	Vesta Score	Vesta Rating	Height (cm)	Vesta Score	Vesta Rating	Height (cm)	Vesta Score	Vesta Rating	Vesta Score	Vesta Rating
North Coast DSF	DSF (shrubby)	0 to 6	6	3.1	2.7 (0.3)	H	29.6 (1.6)	2.8 (0.2)	H	140 (14)	2.8 (0.1)	H	2.3 (0.2)	H
		6 to 9	6	8.1	3.3 (0.1)	VH	29.6 (1.4)	3.2 (0.1)	H	148 (19)	3.0 (0.1)	H	2.5 (0.1)	H
		9 plus	6	15.7	3.7 (0.1)	VH	38.6 (1.5)	3.7 (0.1)	VH	226 (30)	3.0 (0.1)	H	3.1 (0.2)	VH
Sydney Coastal DSF	DSF (shrubby)	0 to 6	9	2.7	2.1 (0.3)	M	23.7 (3.9)	2.2 (0.2)	M	182 (34)	2.6 (0.2)	H	1.5 (0.2)	H
		6 to 9	12	7.3	2.9 (0.2)	H	27.5 (1.8)	3.0 (0.1)	H	162 (17)	3.1 (0.1)	H	2.1 (0.1)	H
		9 plus*	11	21.3	3.5 (0.1)	VH	31.6 (3.2)	3.4 (0.1)	VH	280 (25)	3.5 (0.1)	VH	2.1 (0.2)	H
South East DSF	DSF (shrubby)	0 to 6	6	3.3	2.0 (0.3)	M	27.0 (3.4)	2.3 (0.3)	M	145 (22)	1.6 (0.2)	M	2.0 (0.3)	H
(survey sites on far		6 to 9	6	7.3	3.2 (0.1)	H	28.2 (1.8)	2.9 (0.1)	H	140 (13)	2.0 (0.2)	M	2.0 (0.4)	H
south coast)		9 plus	6	30.1	3.4 (0.1)	VH	39.9 (5.1)	3.1 (0.1)	H	211 (38)	2.5 (0.2)	H	3.0 (0.2)	VH
Southern Tableland	DSF (shrubby)	0 to 6	6	3.4	1.9 (0.3)	M	15.9 (4.0)	2.0 (0.2)	M	74 (14)	1.8 (0.3)	M	2.1 (0.4)	H
DSF		6 to 9	6	7.5	2.5 (0.2)	M	15.0 (1.6)	2.1 (0.2)	M	96 (18)	1.9 (0.5)	M	2.2 (0.3)	H
		9 plus^	6	35.3	2.8 (0.3)	H	22.7 (2.5)	2.8 (0.2)	H	104 (15)	2.0 (0.3)	M	3.2 (0.3)	VH
Hunter-Macleay DSF	DSF (shrub/grass)	0 to 6	6	3.2	2.3 (0.3)	M	24.3 (3.6)	2.4 (0.3)	M	126 (14)	2.2 (0.2)	M	2.0 (0.3)	H
		6 to 9	6	7.8	2.7 (0.1)	H	26.0 (2.4)	3.3 (0.1)	VH	184 (34)	2.8 (0.2)	H	2.1 (0.3)	H
		9 plus	6	23.9	3.2 (0.1)	H	29.0 (1.0)	3.4 (0.2)	VH	233 (38)	2.7 (0.1)	H	2.9 (0.1)	VH
Cumberland DSF	DSF (shrub/grass)	0 to 6	4	3.2	1.8 (0.4)	M	20.4 (5.3)	2.7 (0.4)	H	110 (4)	2.6 (0.1)	H	1.2 (0.2)	M
		6 to 9	6	7.0	2.5 (0.2)	M	16.0 (1.7)	2.9 (0.2)	H	133 (10)	2.6 (0.2)	H	1.0 (0.1)	M
		9 plus*	6	24.8	2.9 (0.1)	H	13.7 (0.3)	3.0 (0.1)	H	167 (32)	3.1 (0.1)	H	2.5 (0.2)	H
Coastal Valley GW	Grassy woodlands	0 to 6	7	1.8	1.9 (0.3)	M	13.4 (2.5)	2.0 (0.6)	M	185 (20)	2.8 (0.2)	H	2.0 (0.2)	H
(Cumberland Plain		6 to 9	6	7.8	2.6 (0.1)	H	17.1 (2.1)	2.9 (0.3)	H	177 (10)	2.6 (0.2)	H	2.0 (0.1)	H
variant only)		9 plus*	6	30.2	3.0 (0.1)	H	18.0 (1.6)	3.2 (0.3)	H	189 (7)	3.2 (0.0)	H	2.3 (0.1)	H
North Coast/ Hinterland WSF	WSF (shrub, grass)	0 to 6	5	2.7	3.0 (0.4)	H	30.4 (5.2)	2.9 (0.3)	H	137 (15)	2.1 (0.3)	M	1.8 (0.2)	H
(survey sites around		6 to 9	7	7.5	3.7 (0.0)	VH	38.1 (6.2)	3.4 (0.1)	VH	163 (21)	2.5 (0.3)	M	1.7 (0.2)	H
Sydney)		9 plus*	6	18.5	3.8 (0.1)	E	33.2 (7.4)	3.4 (0.1)	VH	254 (24)	3.0 (0.1)	H	2.5 (0.2)	VH

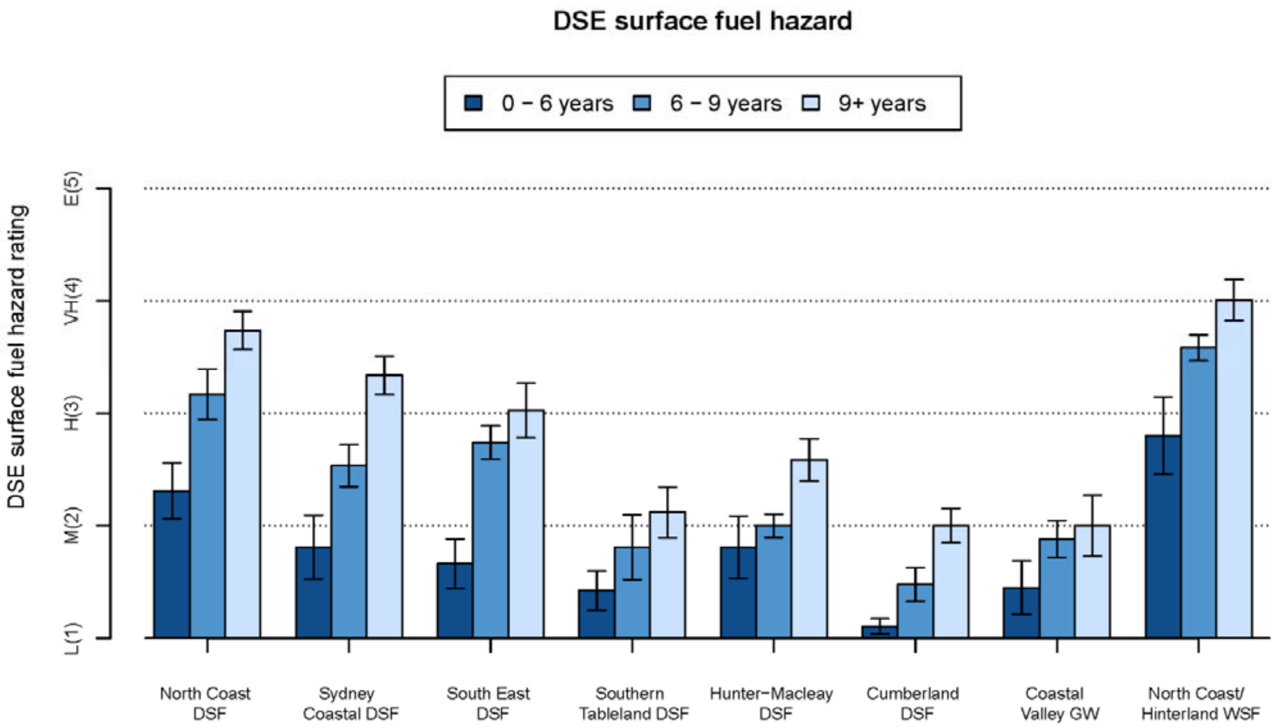
values averaged across N sites with standard error in brackets
* includes long unburnt sites with no known fire history allocated a post-fire age of 35 years
^ includes one long unburnt site with no known fire history allocated a post-fire age of 60 years

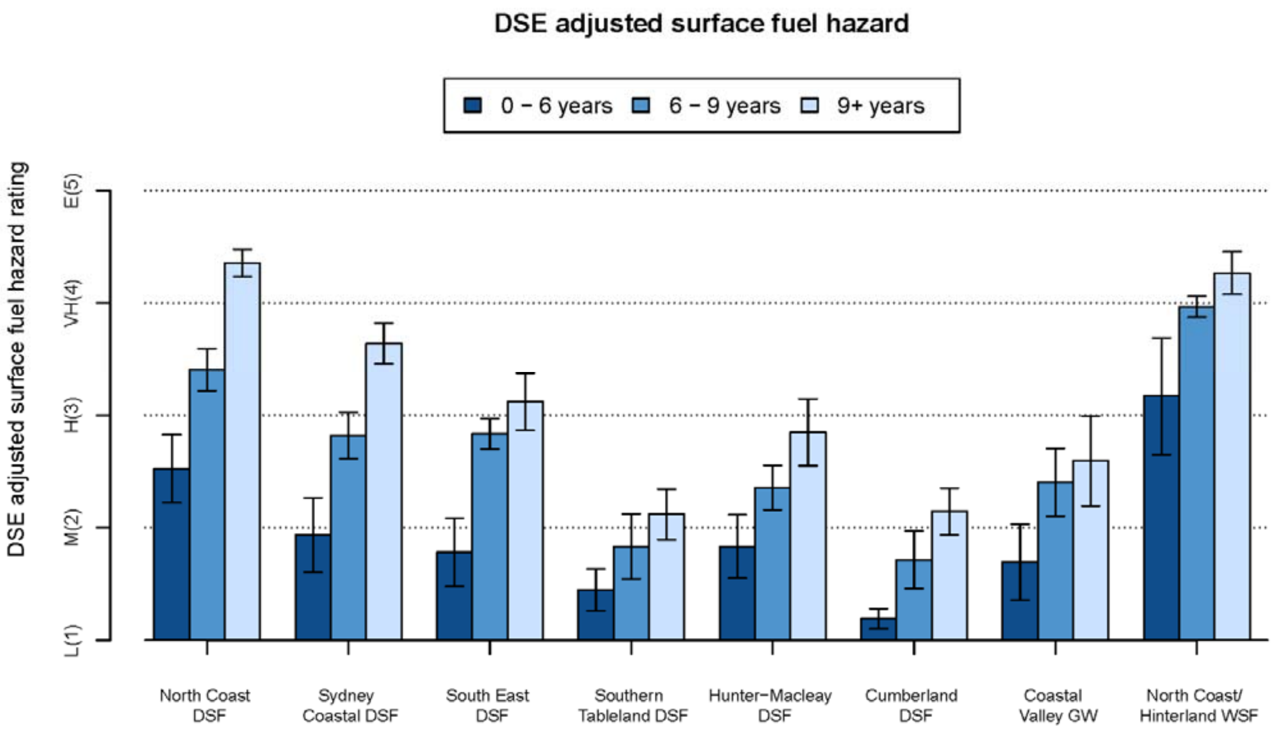
5 **Bar charts –** fuel parameters by TSF and vegetation class

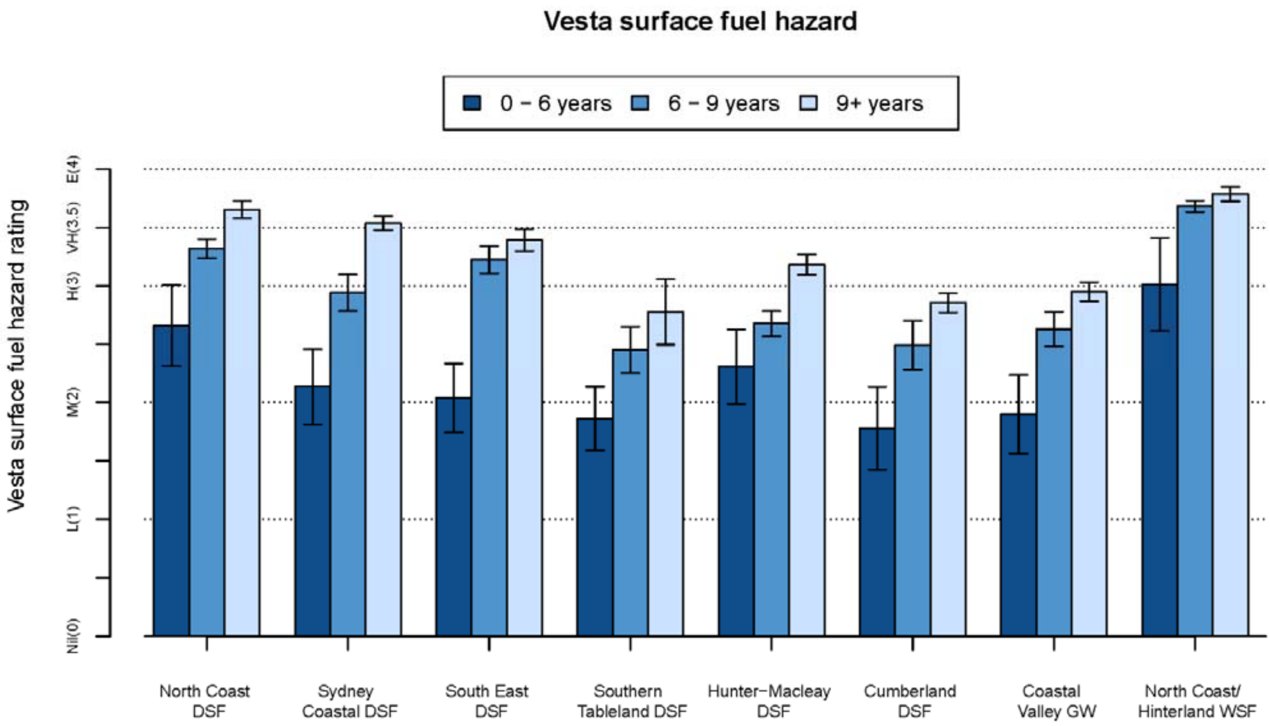
5.1 Surface fuel parameters



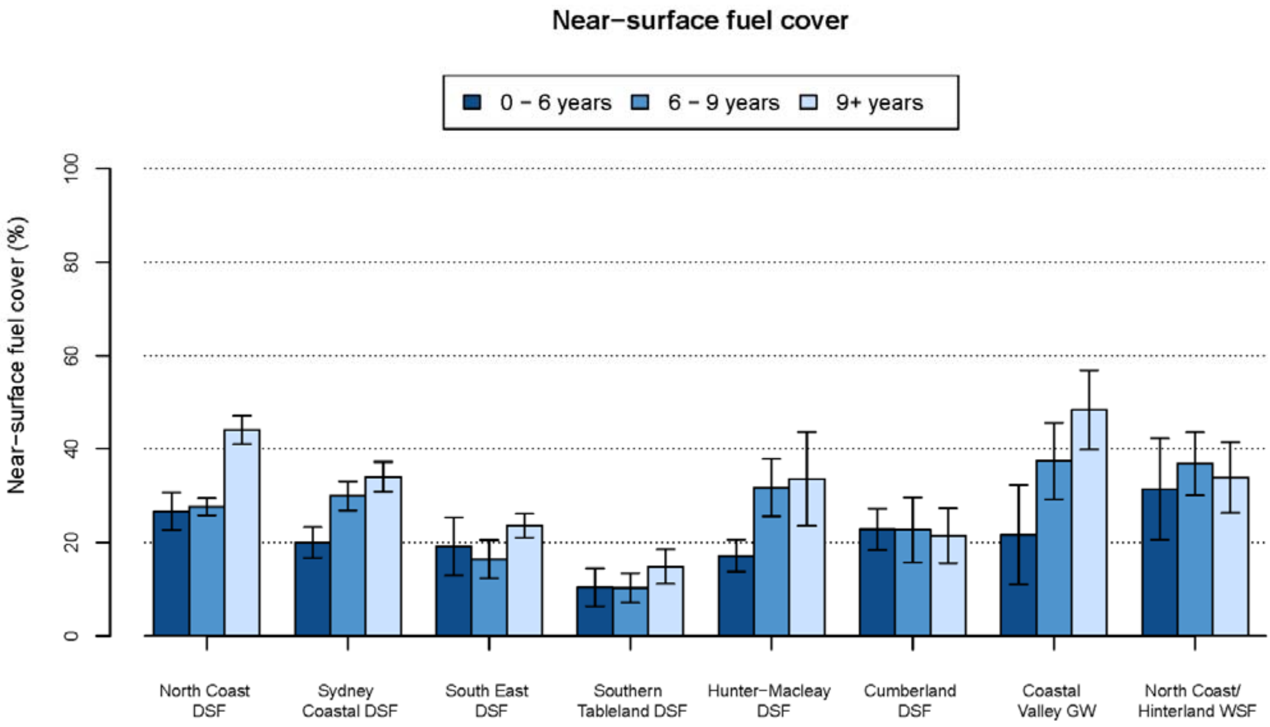


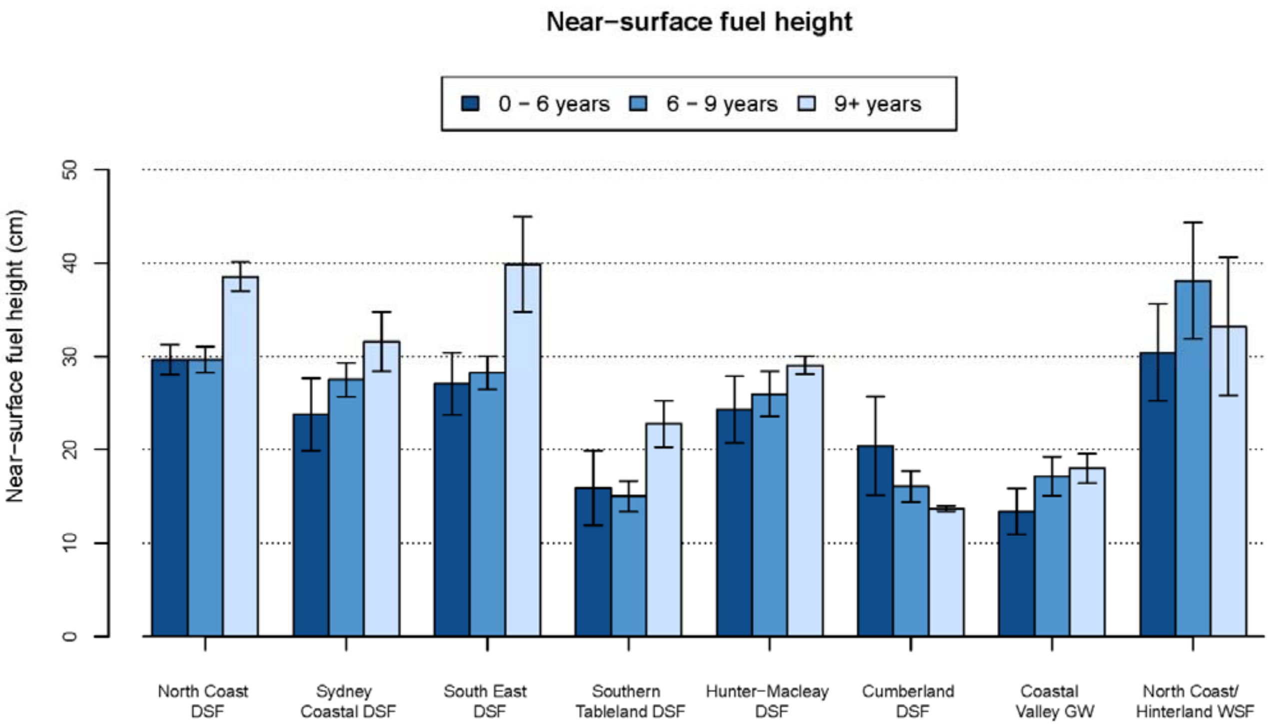

DSE surface fuel hazard
0 – 6 years
6 – 9 years
9+ years
DSE surface fuel hazard rating
E(5)
VH(4)
H(3)
M(2)
L(1)
North Coast DSF
Sydney Coastal DSF
South East DSF
Southern Tableland DSF
Hunter–Macleay DSF
Cumberland DSF
Coastal Valley GW
North Coast/ Hinterland WSF

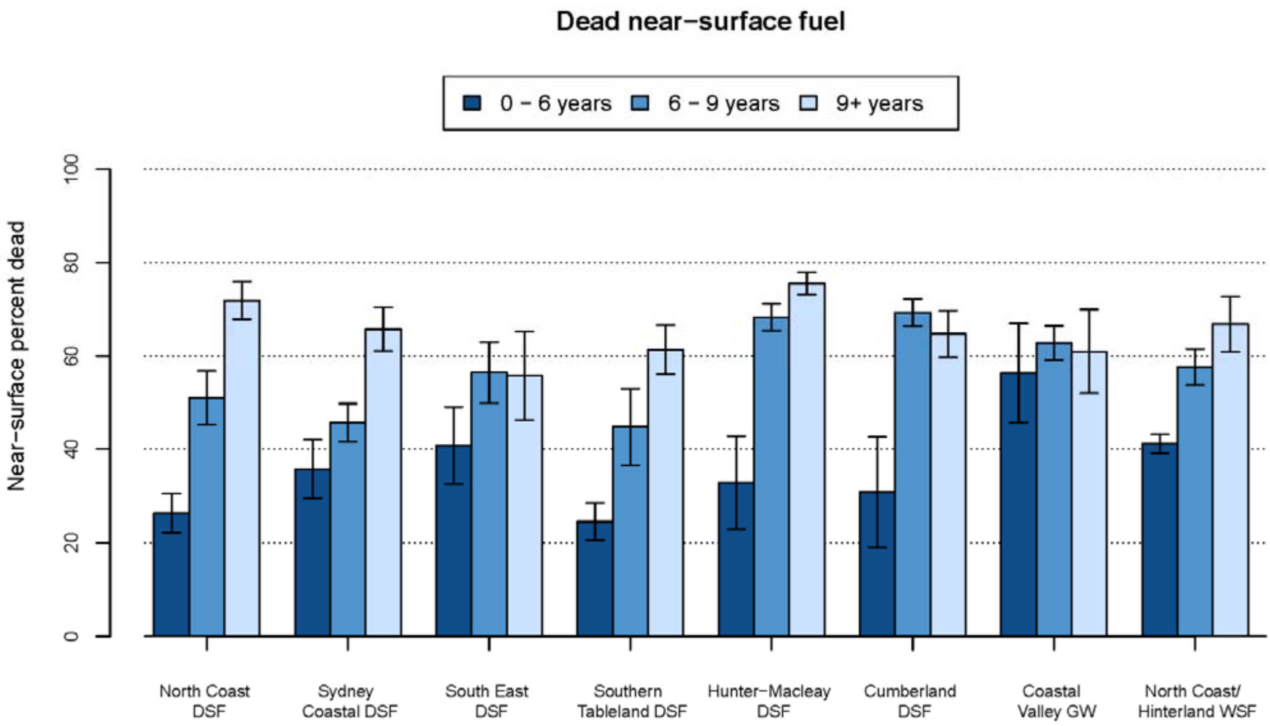

DSE adjusted surface fuel hazard
0 – 6 years
6 – 9 years
9+ years
DSE adjusted surface fuel hazard rating
E(5)
VH(4)
H(3)
M(2)
L(1)
North Coast DSF
Sydney Coastal DSF
South East DSF
Southern Tableland DSF
Hunter–Macleay DSF
Cumberland DSF
Coastal Valley GW
North Coast/ Hinterland WSF

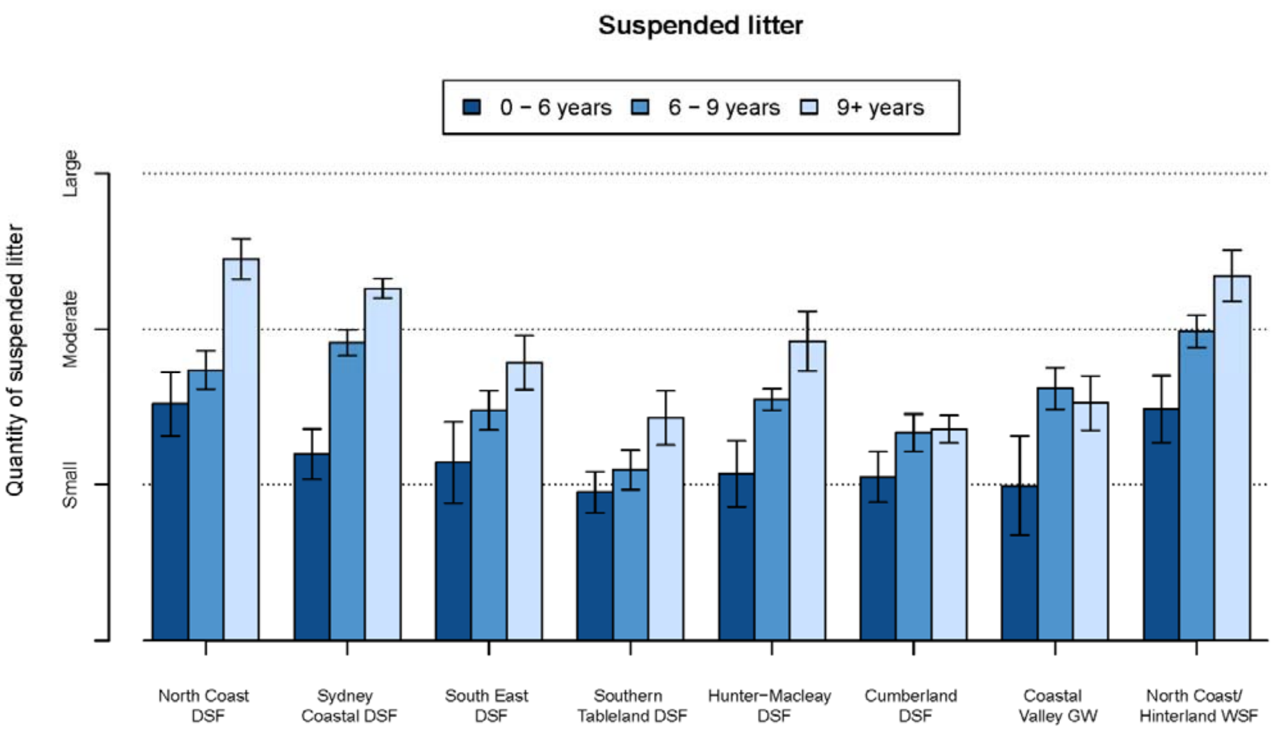

Vesta surface fuel hazard
0 – 6 years
6 – 9 years
9+ years
Vesta surface fuel hazard rating
E(4)
VH(3.5)
H(3)
M(2)
L(1)
Nil(0)
North Coast DSF
Sydney Coastal DSF
South East DSF
Southern Tableland DSF
Hunter–Macleay DSF
Cumberland DSF
Coastal Valley GW
North Coast/ Hinterland WSF

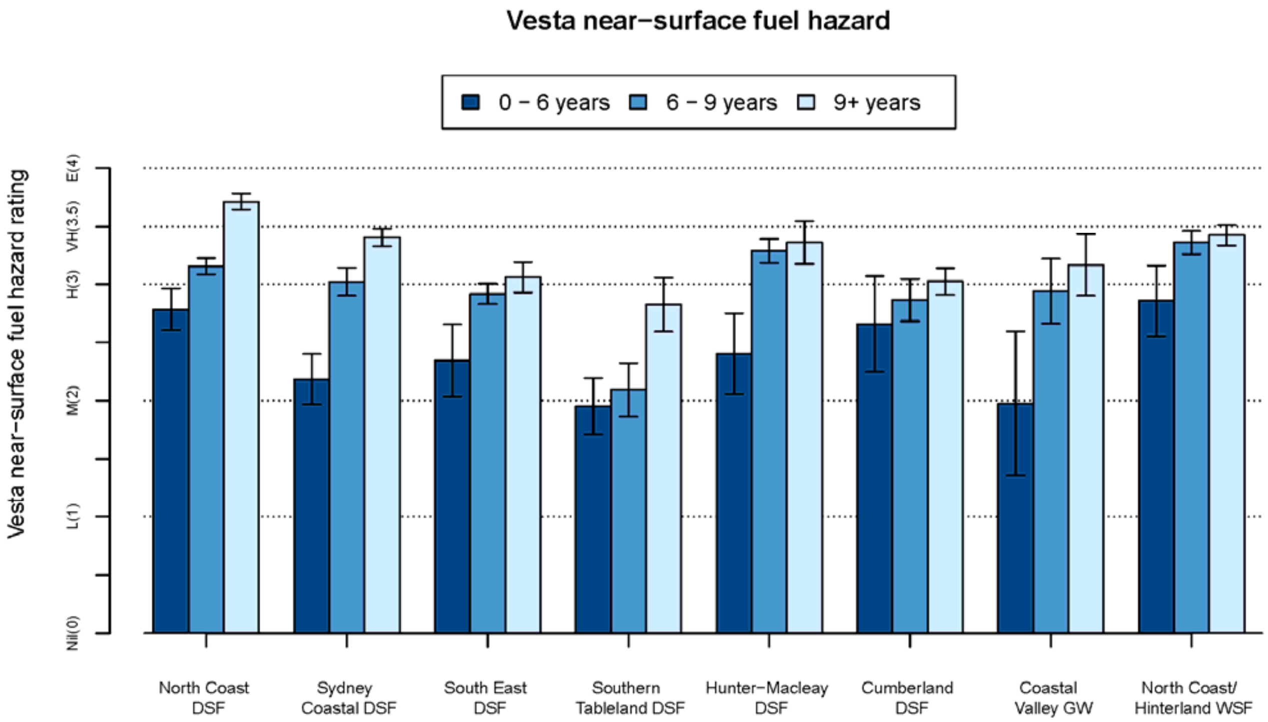
5.2 Near-surface fuel parameters





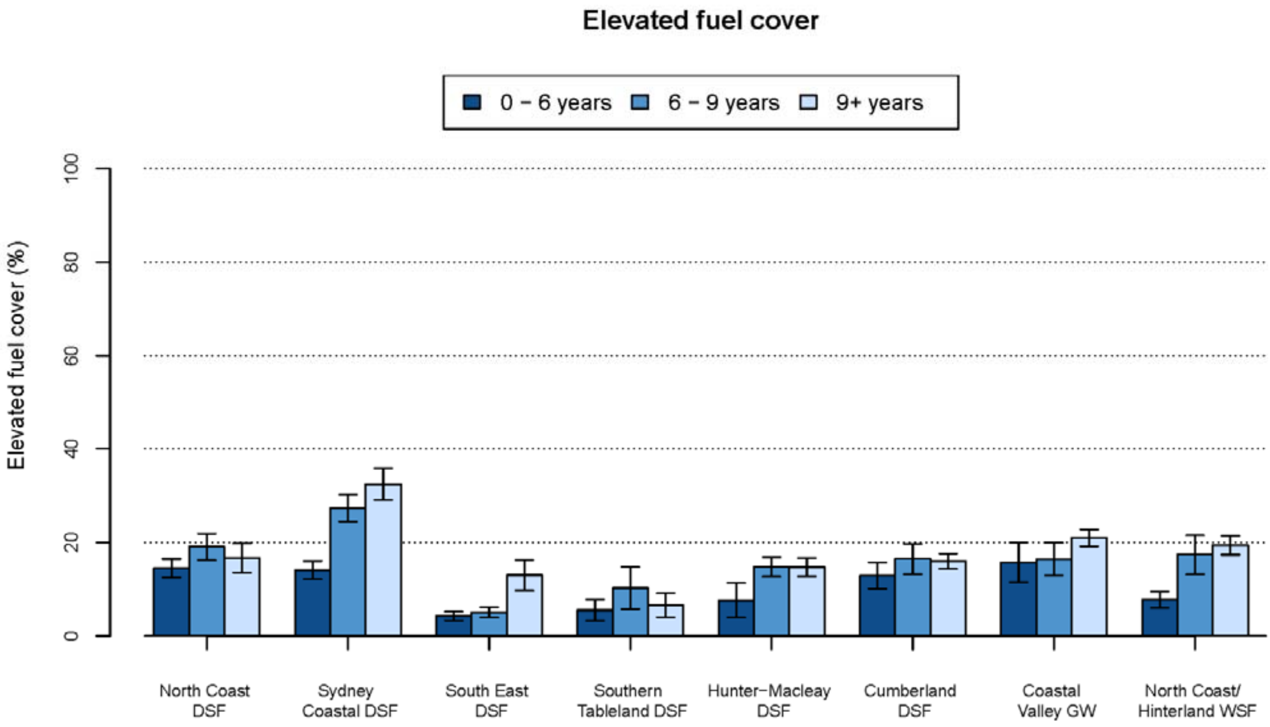

Dead near−surface fuel
0 − 6 years
6 − 9 years
9+ years
Near−surface percent dead
0
20
40
60
80
100
North Coast DSF
Sydney Coastal DSF
South East DSF
Southern Tableland DSF
Hunter−Macleay DSF
Cumberland DSF
Coastal Valley GW
North Coast/ Hinterland WSF

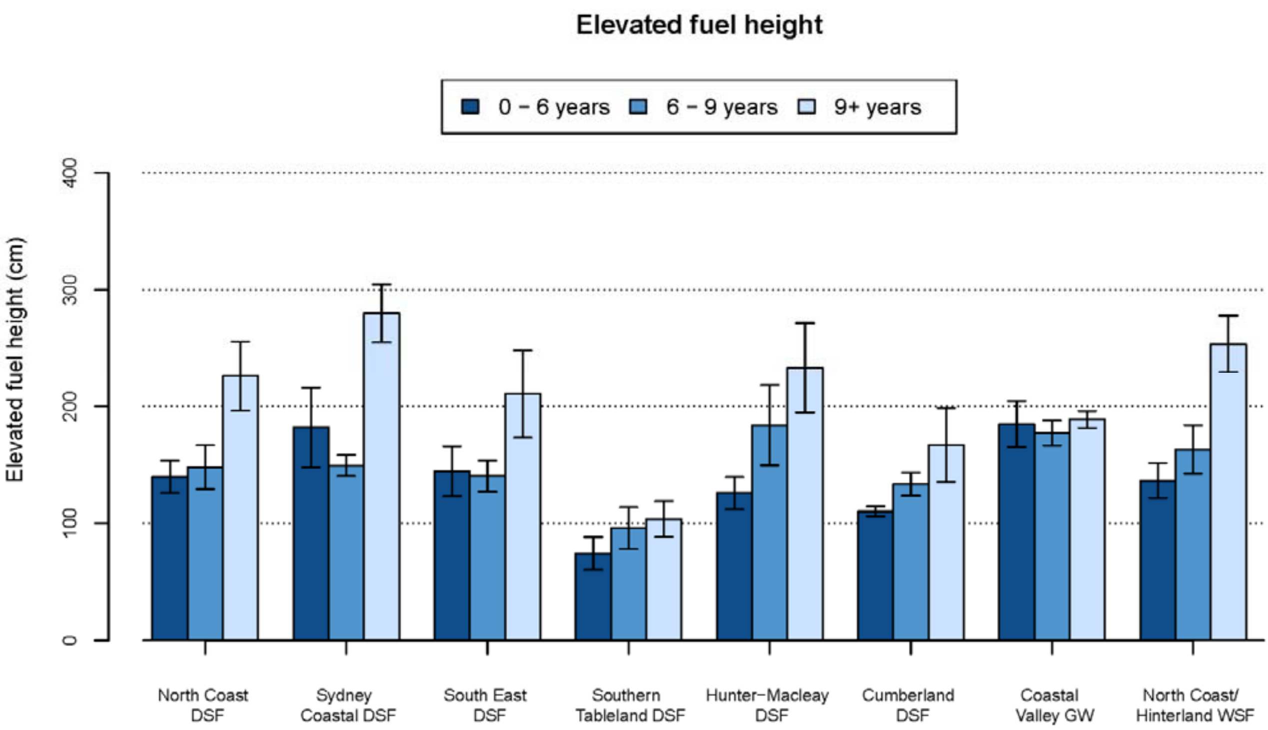

Suspended litter
0 − 6 years
6 − 9 years
9+ years
Quantity of suspended litter
Small
Moderate
Large
North Coast DSF
Sydney Coastal DSF
South East DSF
Southern Tableland DSF
Hunter−Macleay DSF
Cumberland DSF
Coastal Valley GW
North Coast/ Hinterland WSF

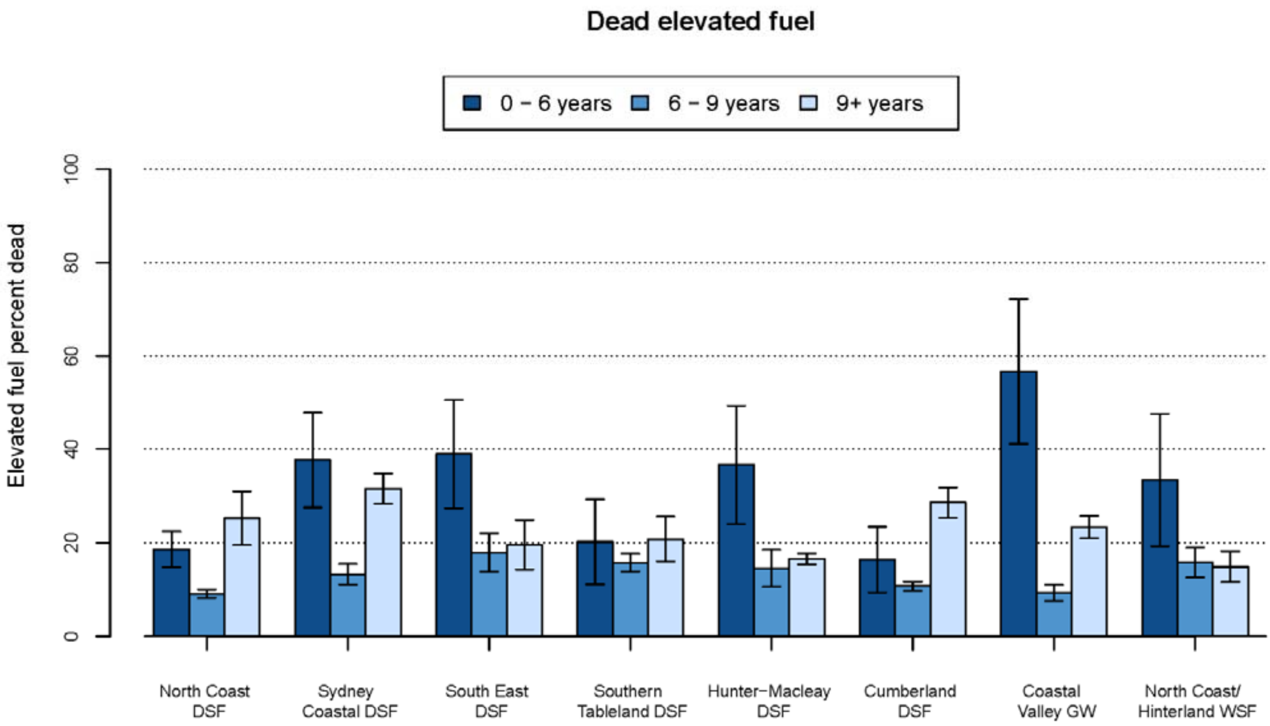


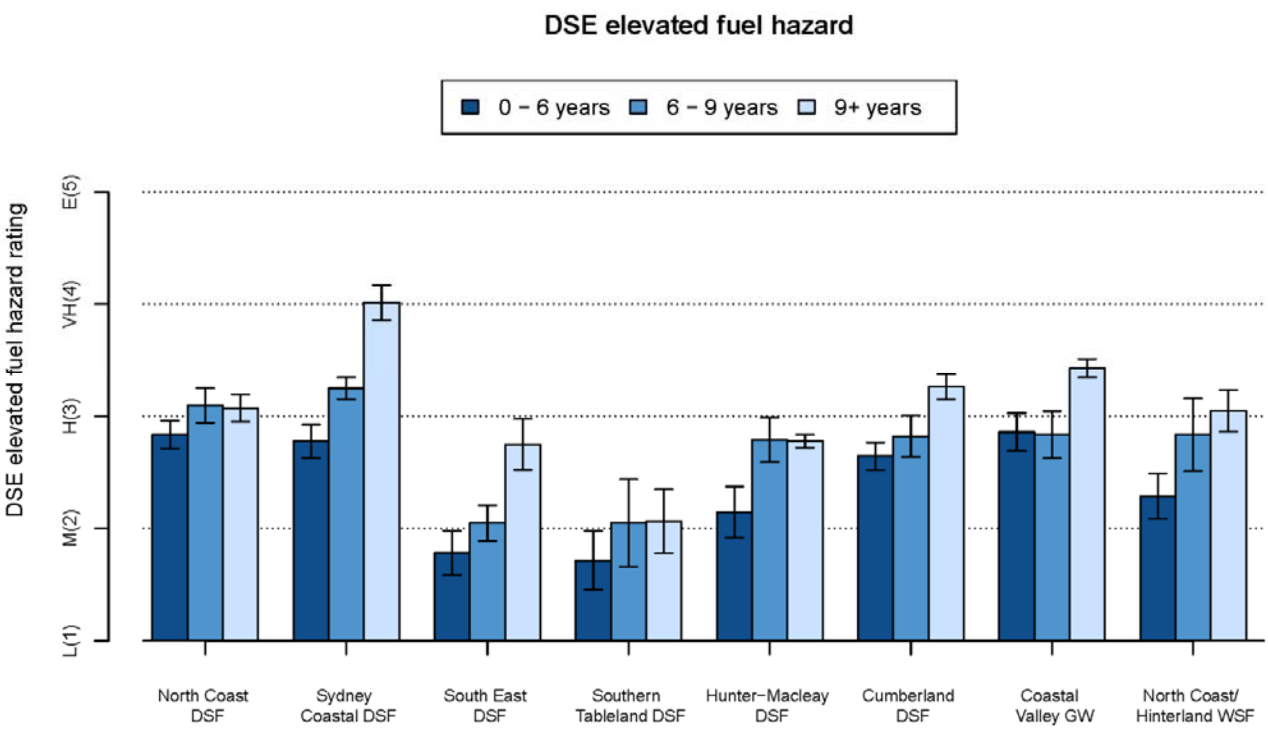
Vesta near−surface fuel hazard
0 − 6 years
6 − 9 years
9+ years
Vesta near−surface fuel hazard rating
E(4)
VH(3.5)
H(3)
M(2)
L(1)
Nil(0)
North Coast DSF
Sydney Coastal DSF
South East DSF
Southern Tableland DSF
Hunter−Macleay DSF
Cumberland DSF
Coastal Valley GW
North Coast/ Hinterland WSF

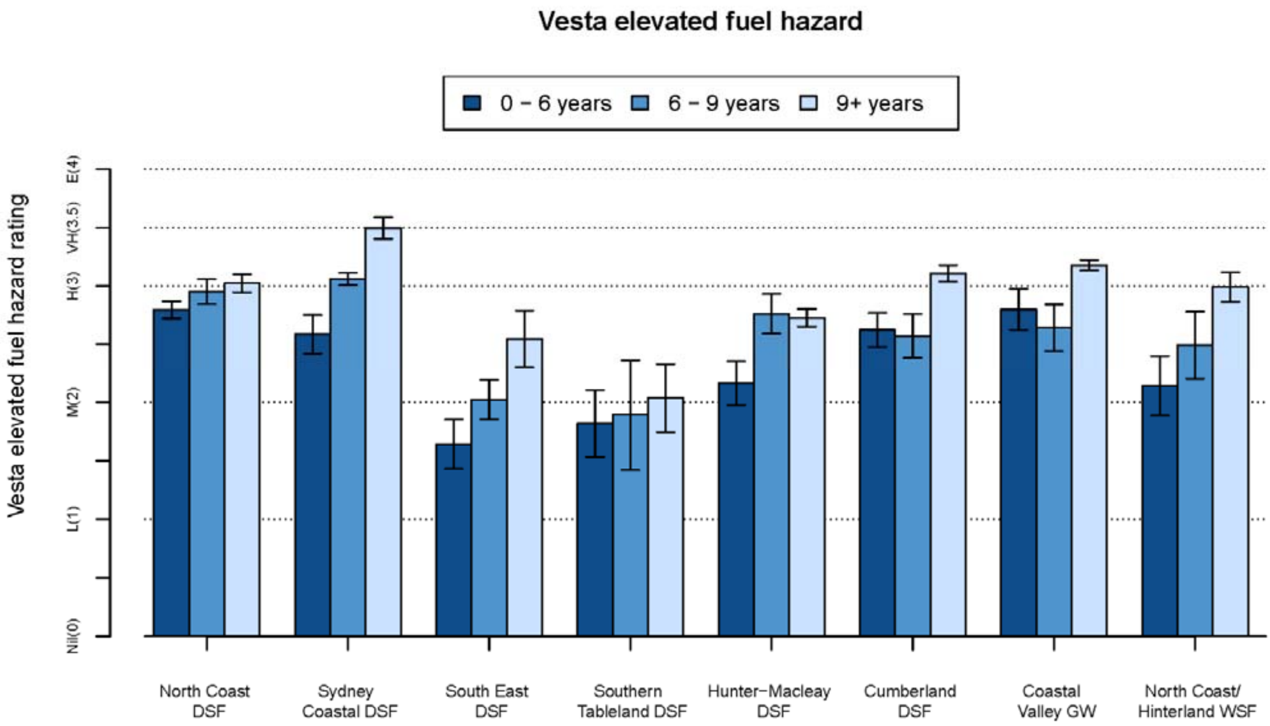
5.3 Elevated fuel parameters



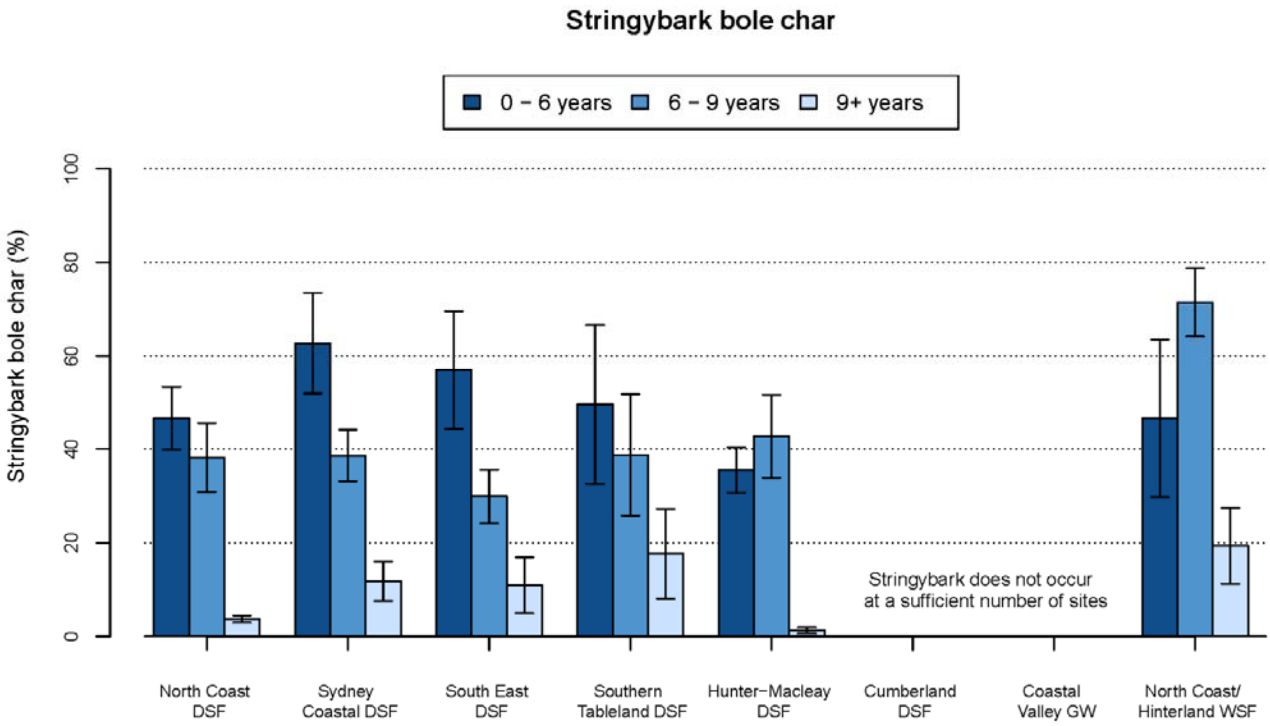


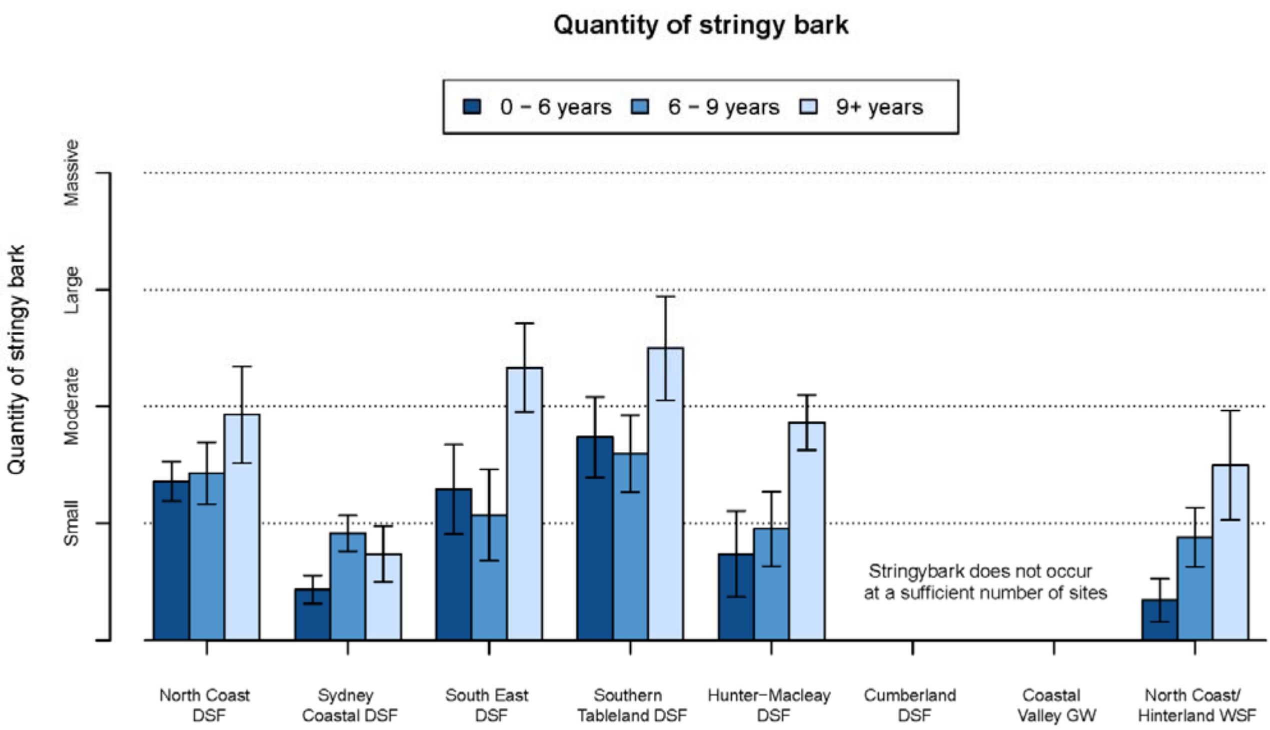

Dead elevated fuel
0 – 6 years
6 – 9 years
9+ years
Elevated fuel percent dead
0
20
40
60
80
100
North Coast DSF
Sydney Coastal DSF
South East DSF
Southern Tableland DSF
Hunter–Macleay DSF
Cumberland DSF
Coastal Valley GW
North Coast/ Hinterland WSF

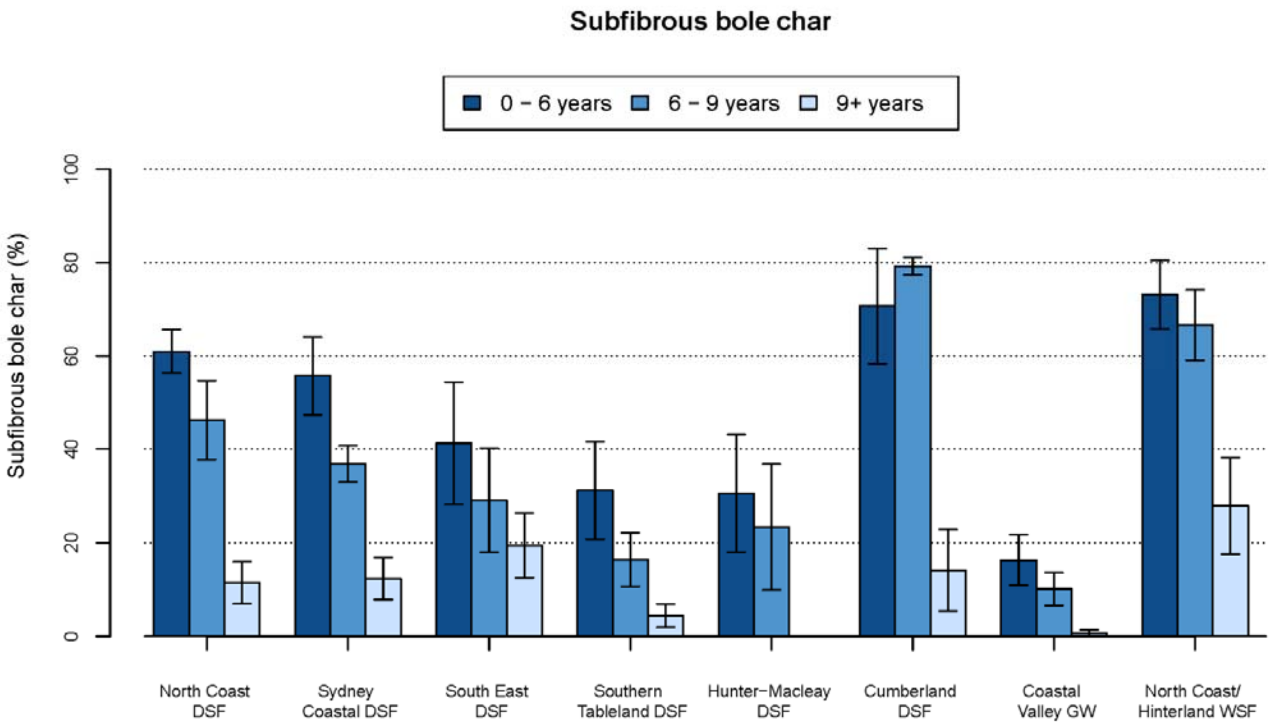

DSE elevated fuel hazard
0 – 6 years
6 – 9 years
9+ years
DSE elevated fuel hazard rating
L(1)
M(2)
H(3)
VH(4)
E(5)
North Coast DSF
Sydney Coastal DSF
South East DSF
Southern Tableland DSF
Hunter–Macleay DSF
Cumberland DSF
Coastal Valley GW
North Coast/ Hinterland WSF

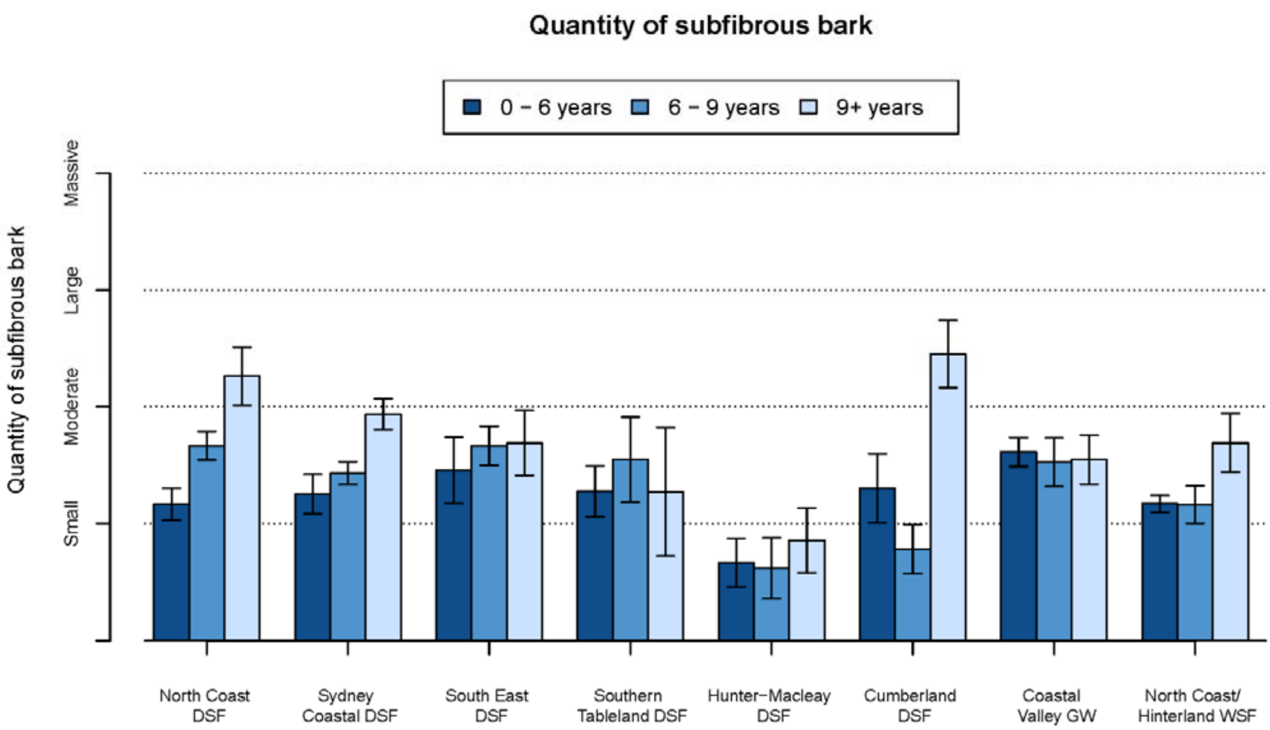

Vesta elevated fuel hazard
0 – 6 years
6 – 9 years
9+ years
Vesta elevated fuel hazard rating
E(4)
VH(3.5)
H(3)
M(2)
L(1)
Nil(0)
North Coast DSF
Sydney Coastal DSF
South East DSF
Southern Tableland DSF
Hunter–Macleay DSF
Cumberland DSF
Coastal Valley GW
North Coast/ Hinterland WSF

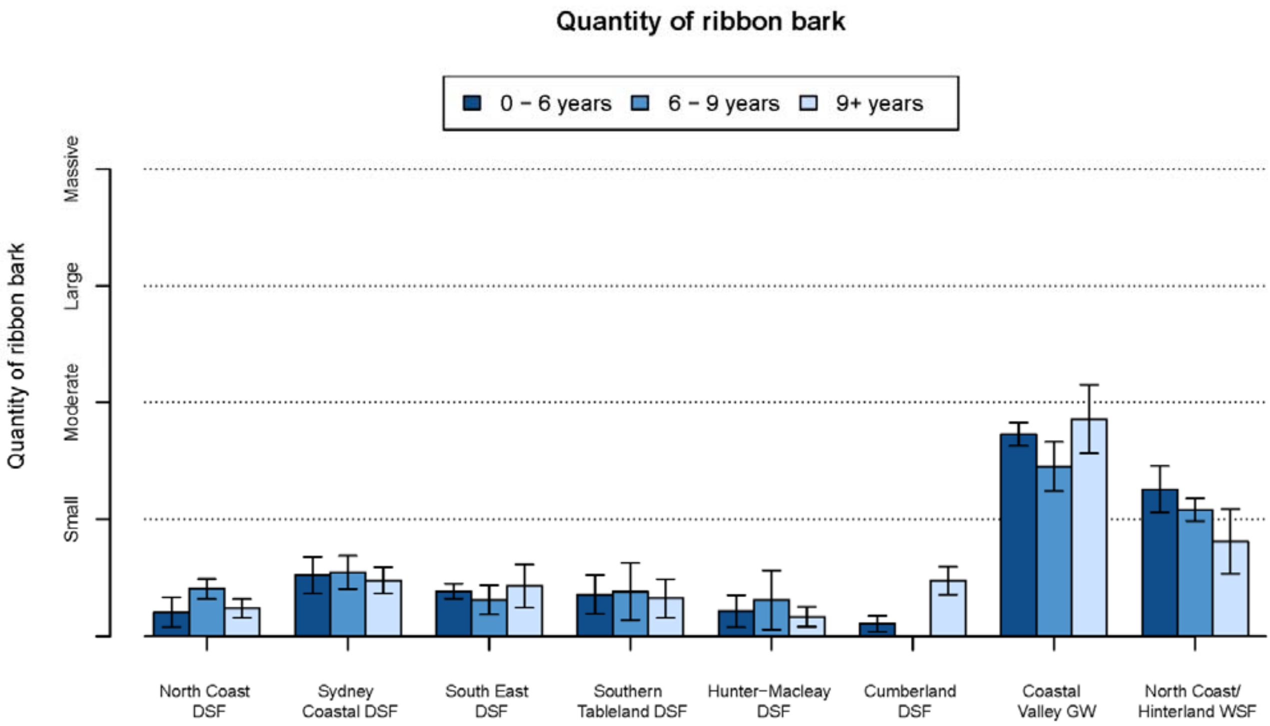
5.4 Bark fuel parameters

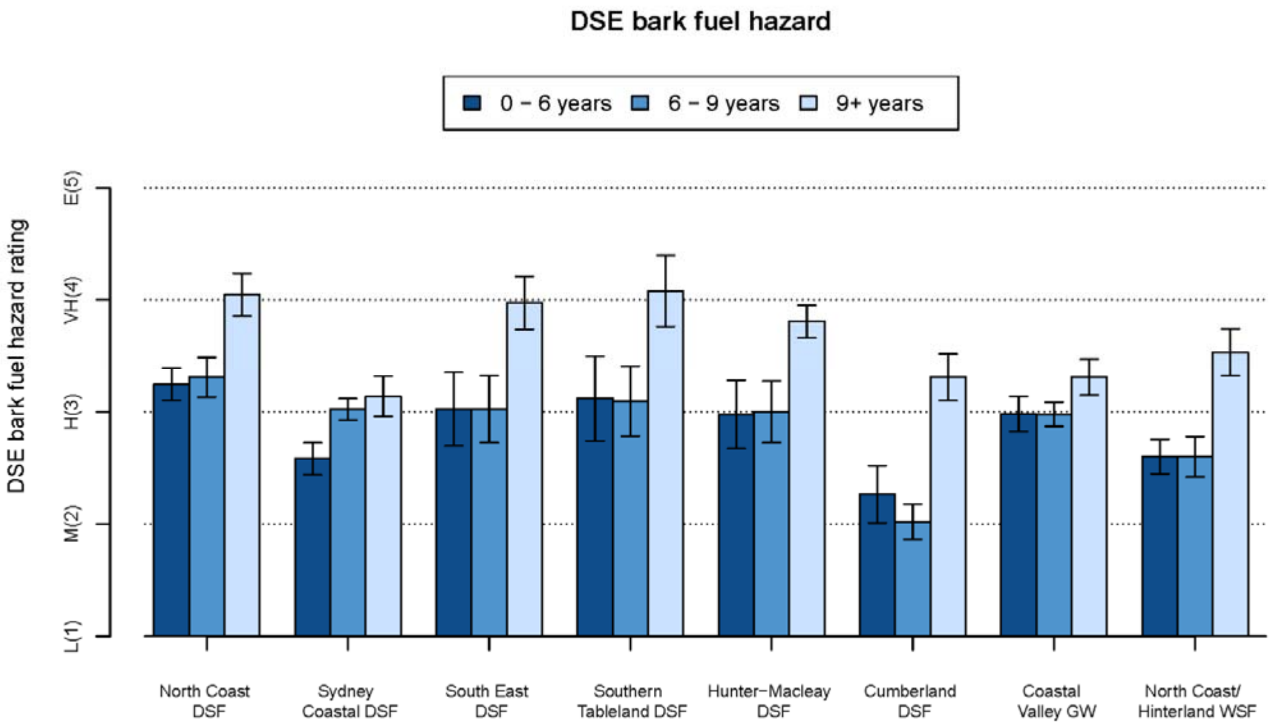


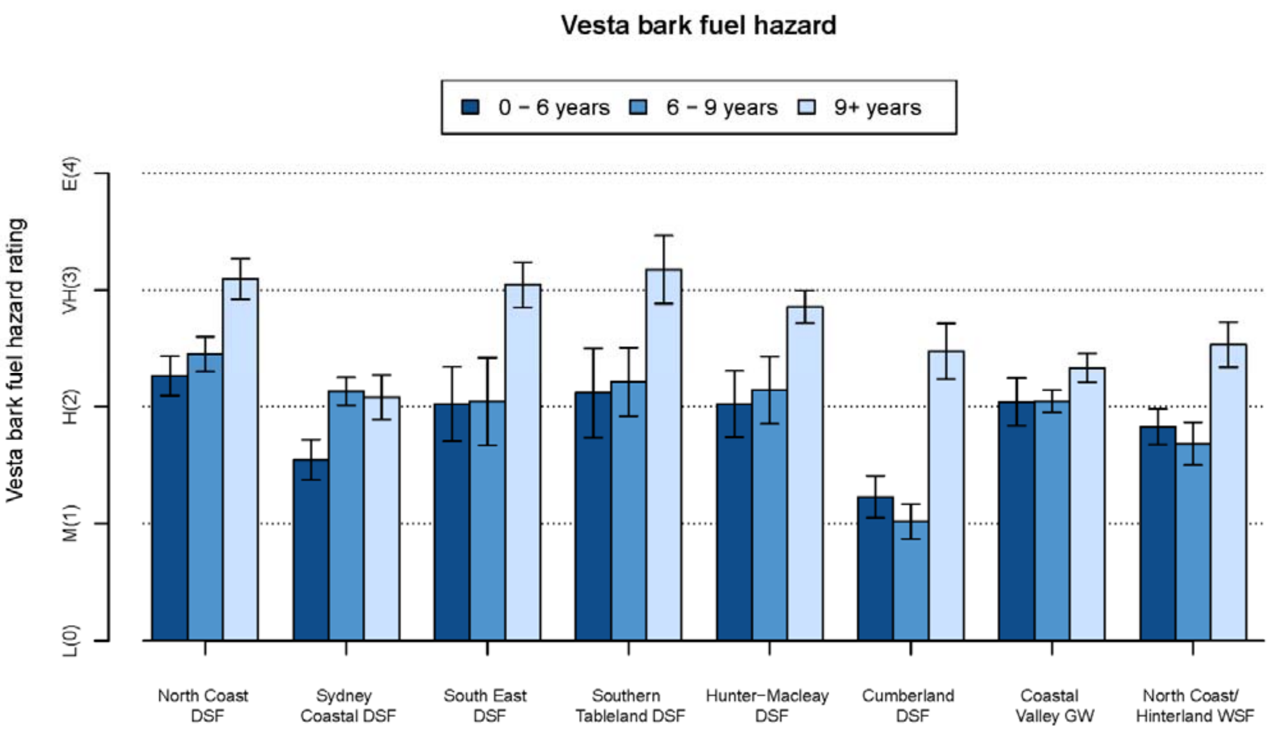



Subfibrous bole char
0 – 6 years
6 – 9 years
9+ years
Subfibrous bole char (%)
0
20
40
60
80
100
North Coast DSF
Sydney Coastal DSF
South East DSF
Southern Tableland DSF
Hunter–Macleay DSF
Cumberland DSF
Coastal Valley GW
North Coast/ Hinterland WSF

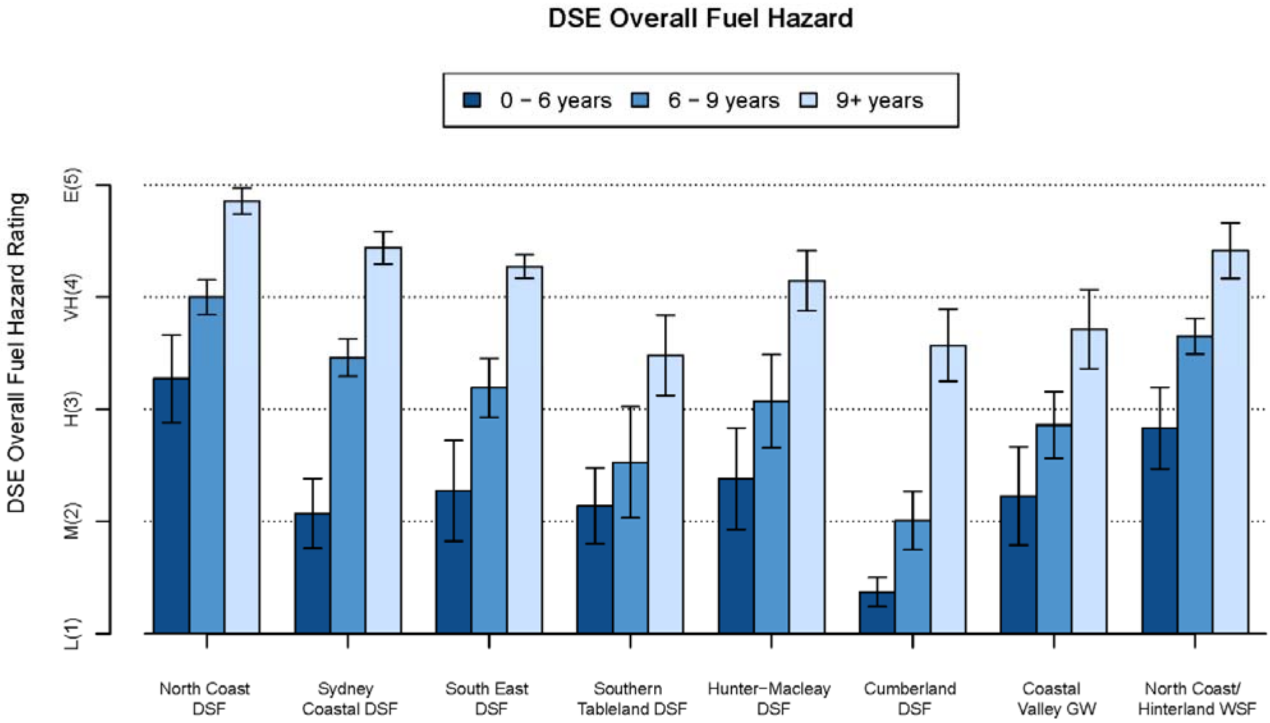

Quantity of subfibrous bark
0 – 6 years
6 – 9 years
9+ years
Quantity of subfibrous bark
Small
Moderate
Large
Massive
North Coast DSF
Sydney Coastal DSF
South East DSF
Southern Tableland DSF
Hunter–Macleay DSF
Cumberland DSF
Coastal Valley GW
North Coast/ Hinterland WSF


Quantity of ribbon bark
0 – 6 years
6 – 9 years
9+ years
Quantity of ribbon bark
Massive
Large
Moderate
Small
North Coast DSF
Sydney Coastal DSF
South East DSF
Southern Tableland DSF
Hunter–Macleay DSF
Cumberland DSF
Coastal Valley GW
North Coast/ Hinterland WSF


DSE bark fuel hazard
0 – 6 years
6 – 9 years
9+ years
DSE bark fuel hazard rating
E(5)
VH(4)
H(3)
M(2)
L(1)
North Coast DSF
Sydney Coastal DSF
South East DSF
Southern Tableland DSF
Hunter–Macleay DSF
Cumberland DSF
Coastal Valley GW
North Coast/ Hinterland WSF


Vesta bark fuel hazard
0 – 6 years
6 – 9 years
9+ years
Vesta bark fuel hazard rating
E(4)
VH(3)
H(2)
M(1)
L(0)
North Coast DSF
Sydney Coastal DSF
South East DSF
Southern Tableland DSF
Hunter–Macleay DSF
Cumberland DSF
Coastal Valley GW
North Coast/ Hinterland WSF

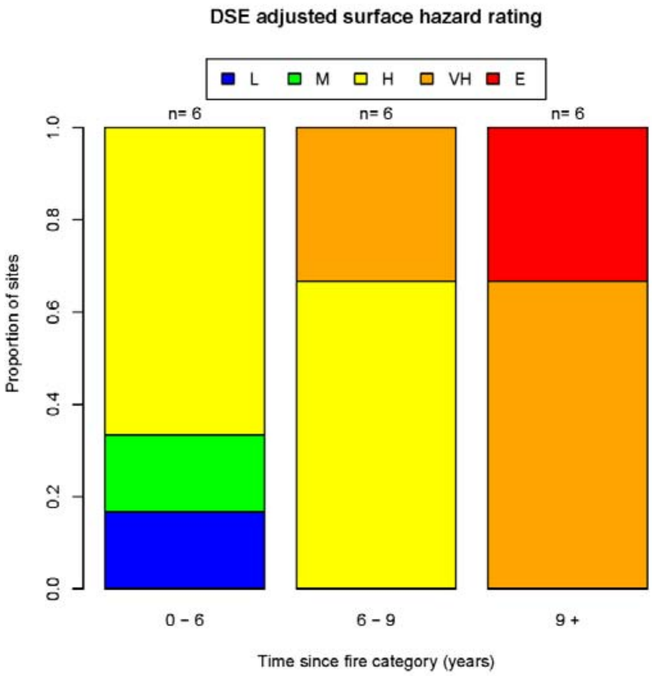
5.5 Overall fuel hazard

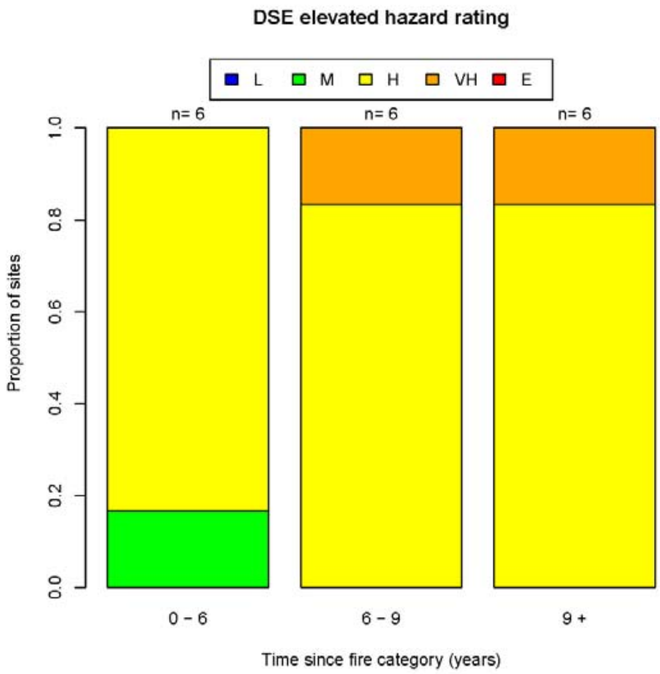


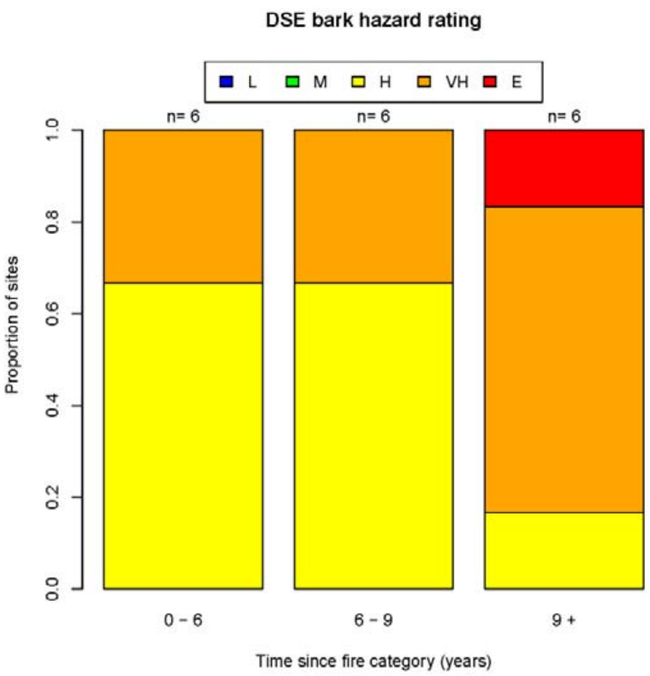
6 **Vegetation class stacked bar charts –** fuel hazard ratings by TSF

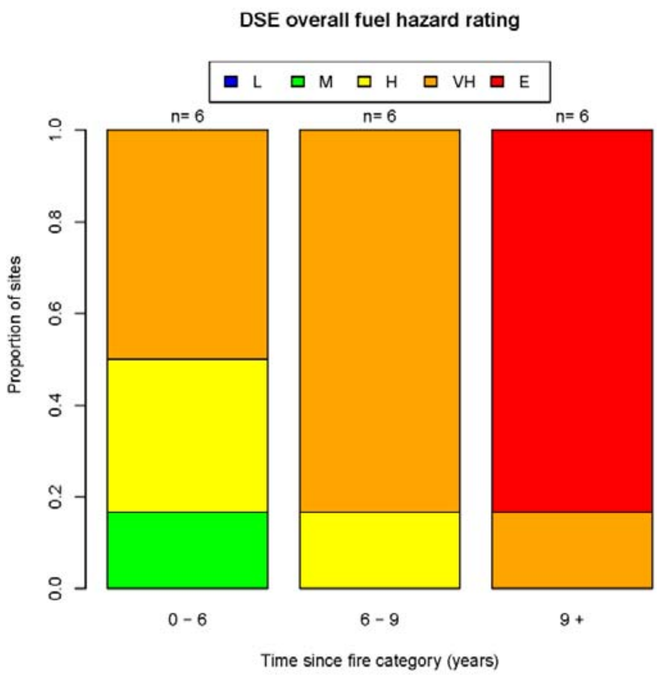
6.1 North Coast DSF

DSE hazard ratings



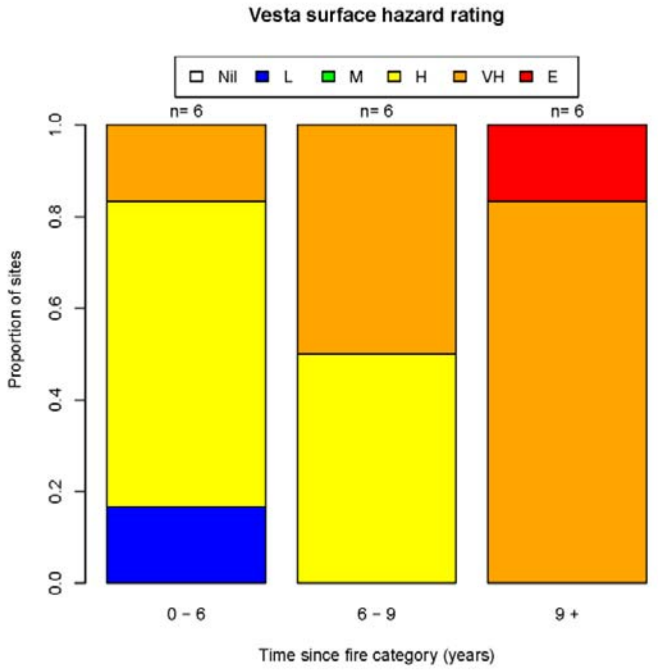


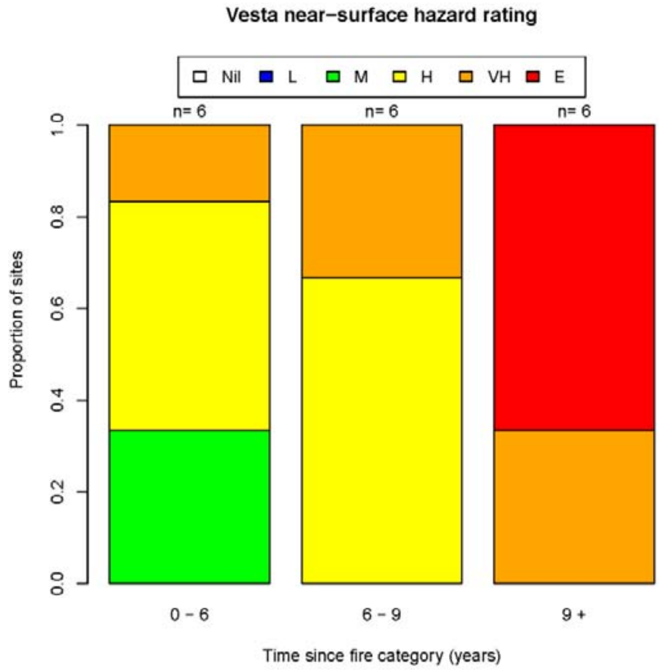


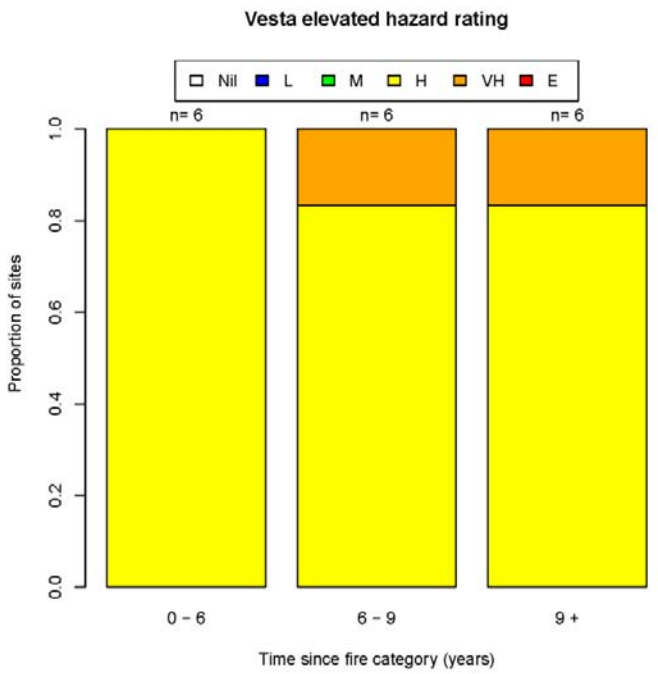


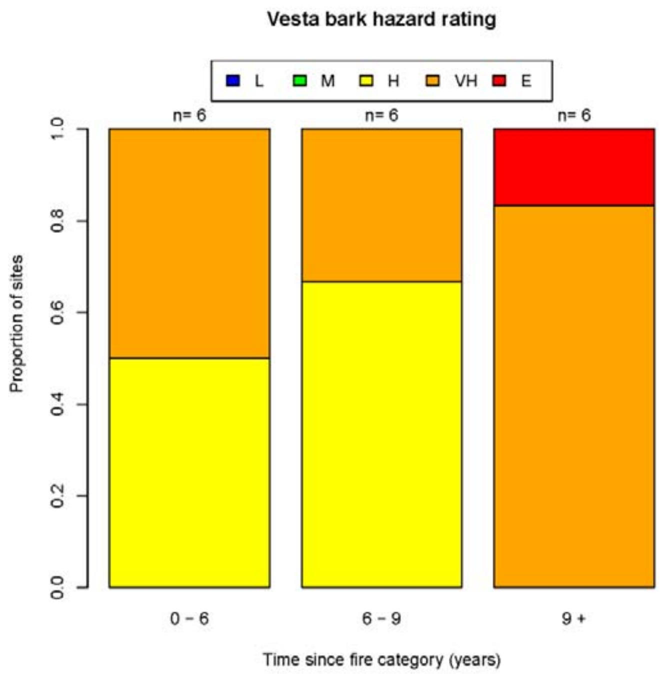
North Coast DSF

Vesta hazard ratings



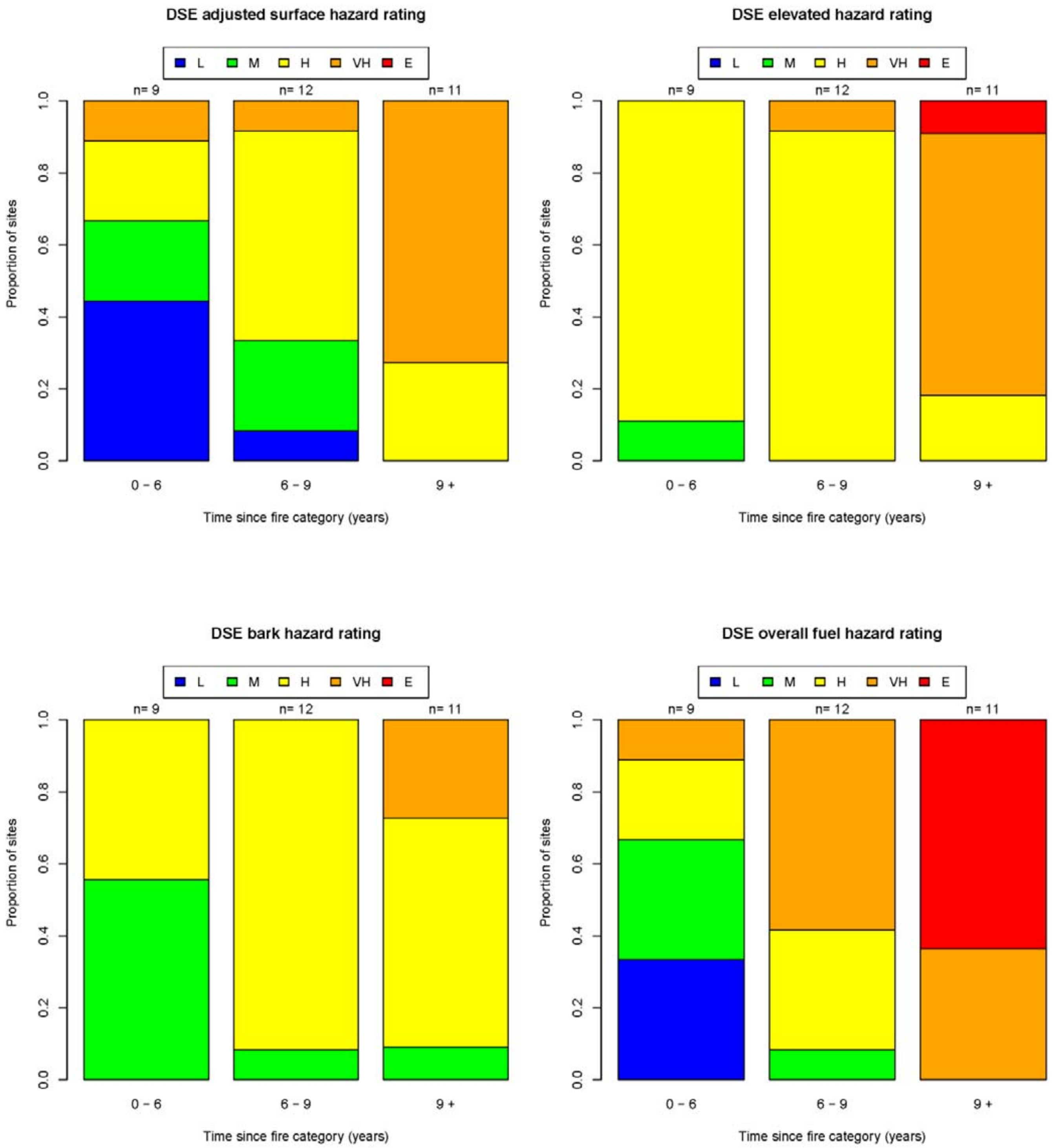






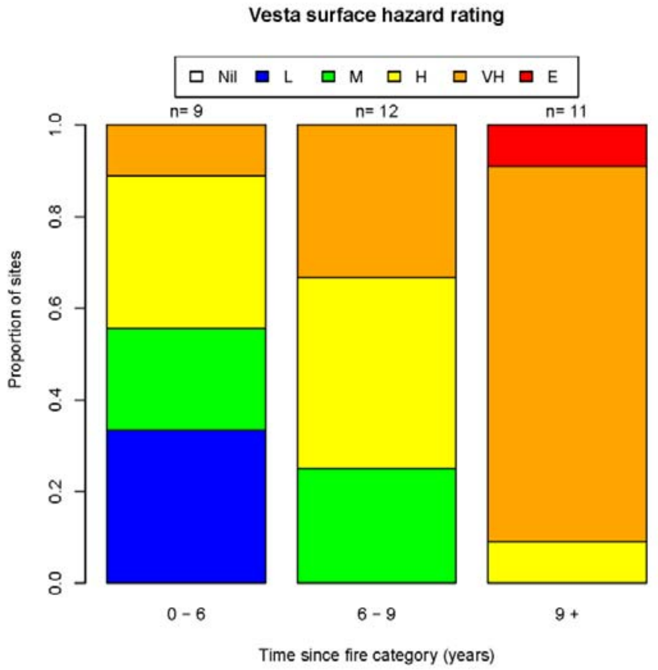
6.2 Sydney Coastal DSF

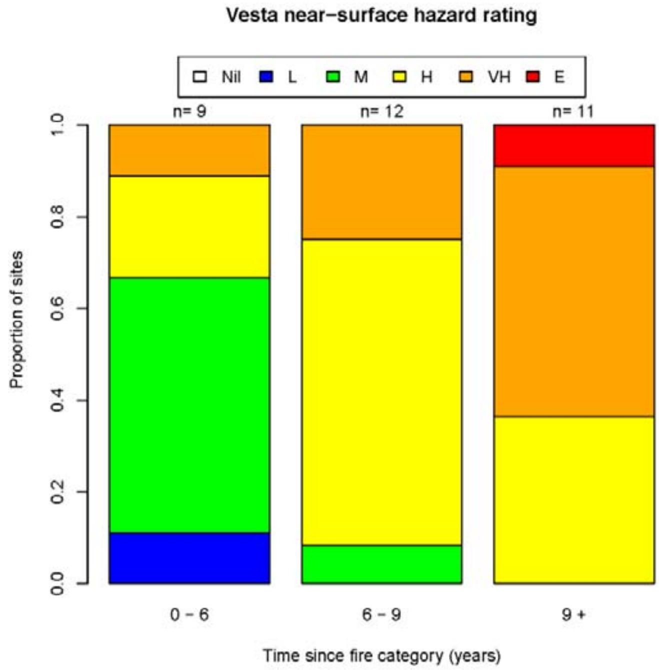
DSE hazard ratings

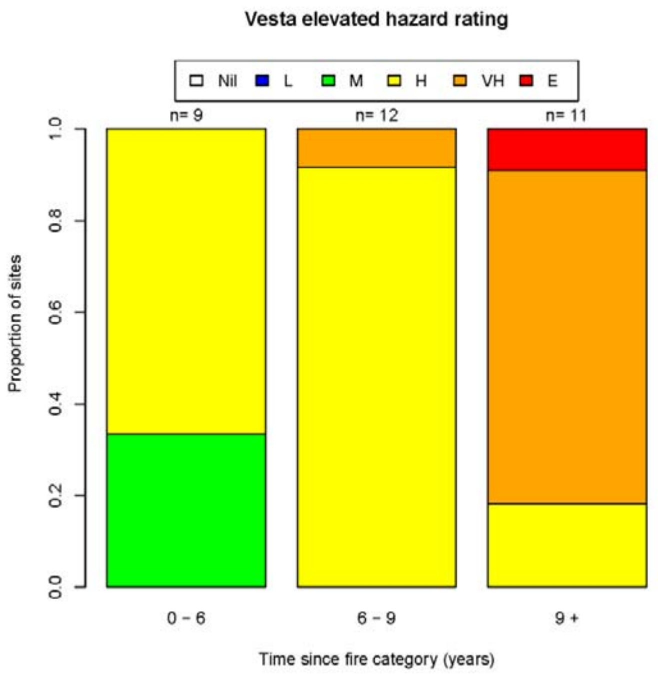


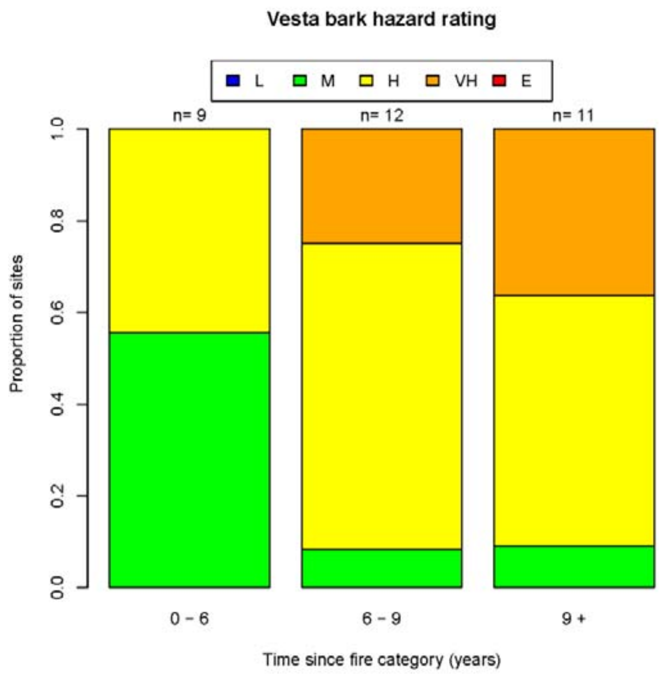
Sydney Coastal DSF

Vesta hazard ratings



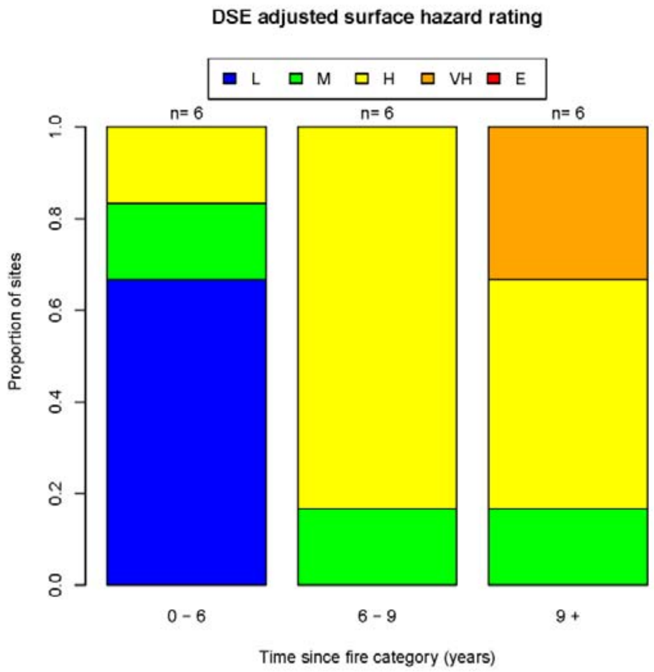


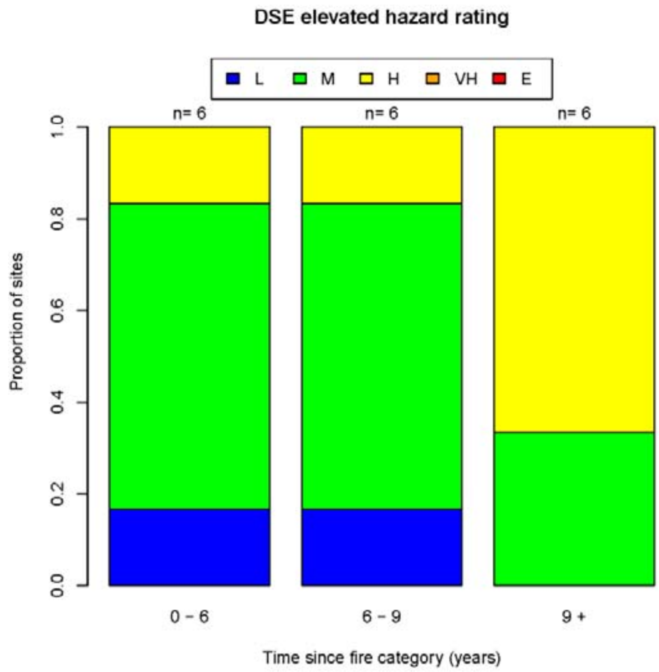


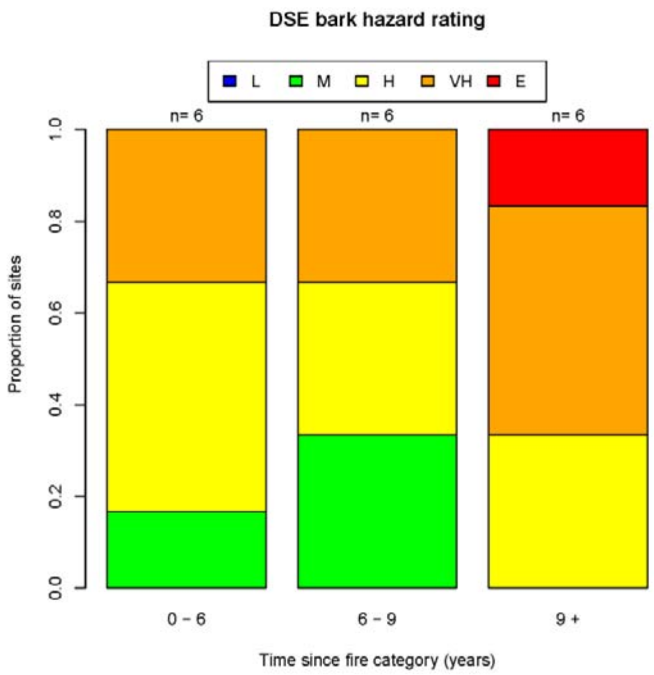


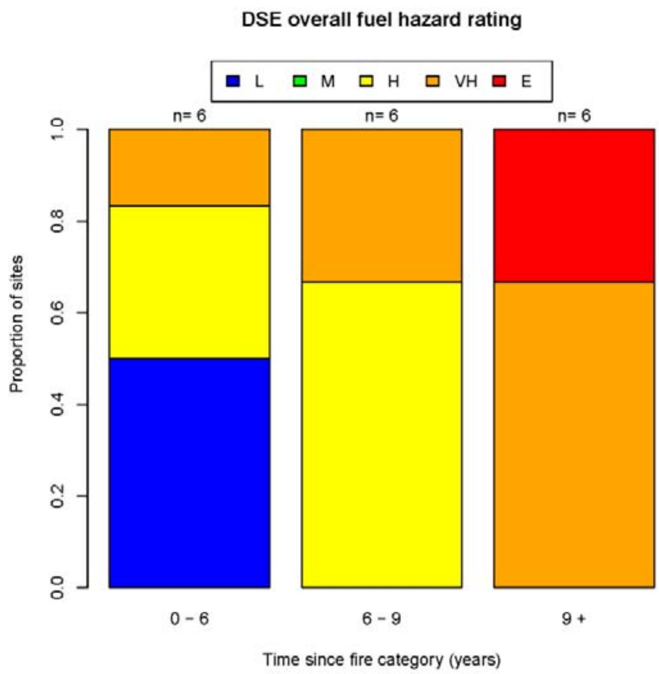
6.3 South East DSF

DSE hazard ratings



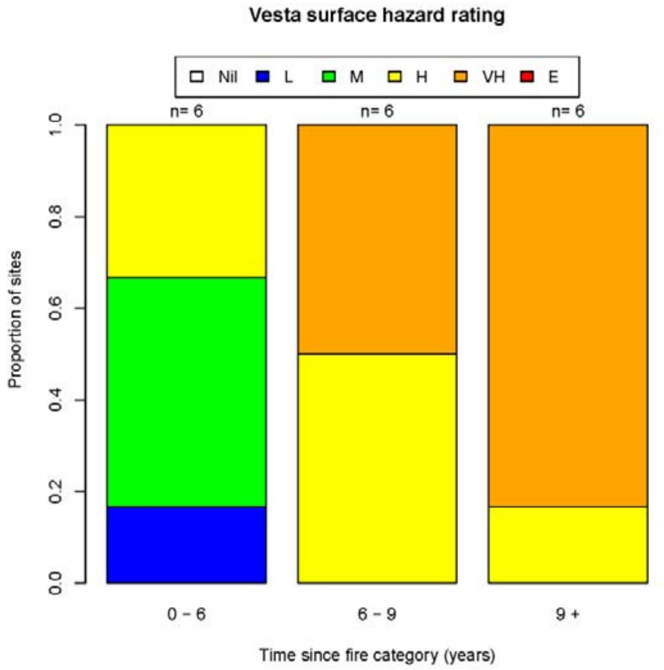


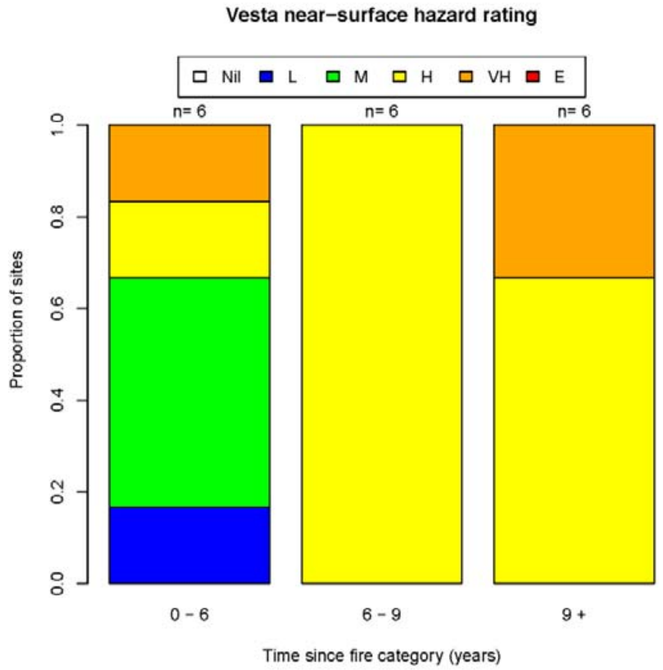


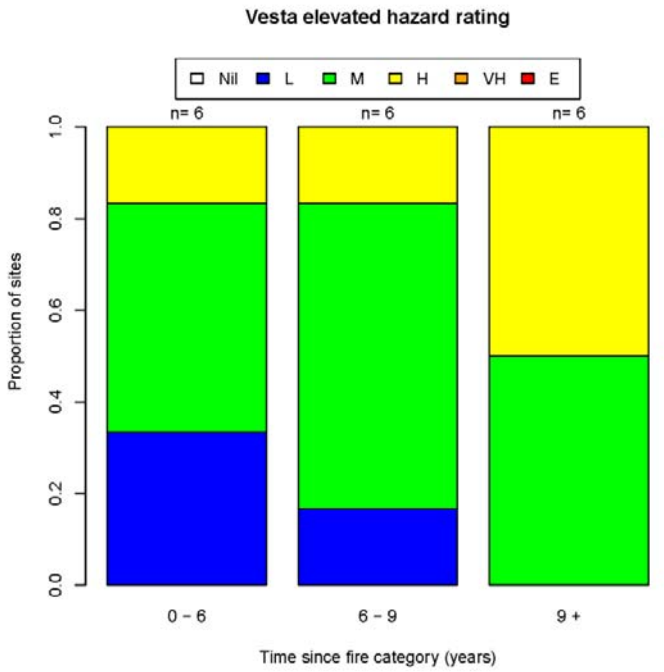


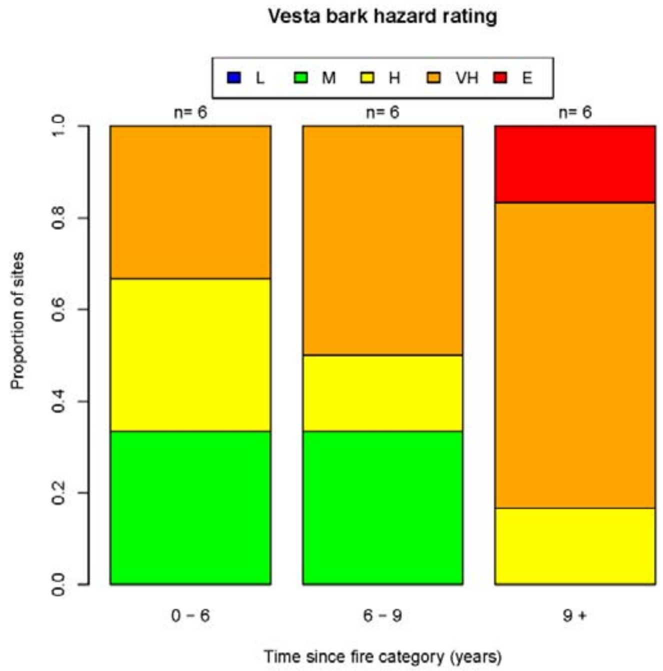
South East DSF

Vesta hazard ratings



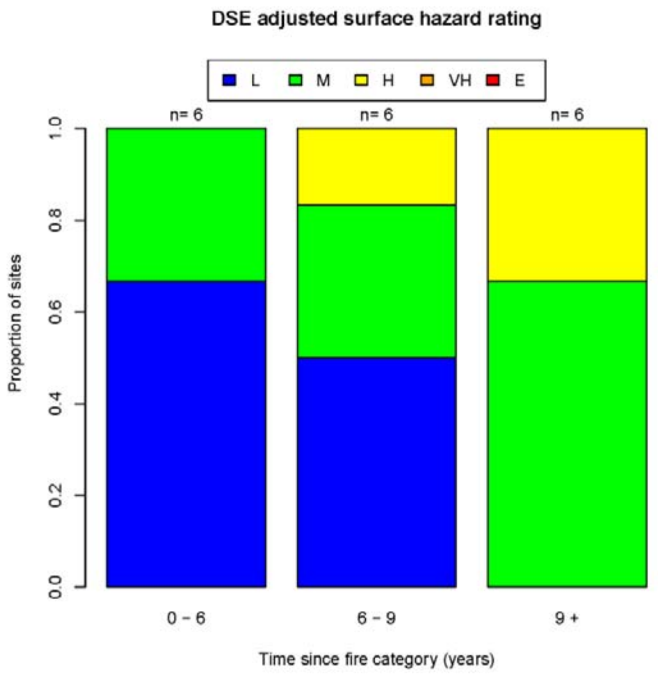


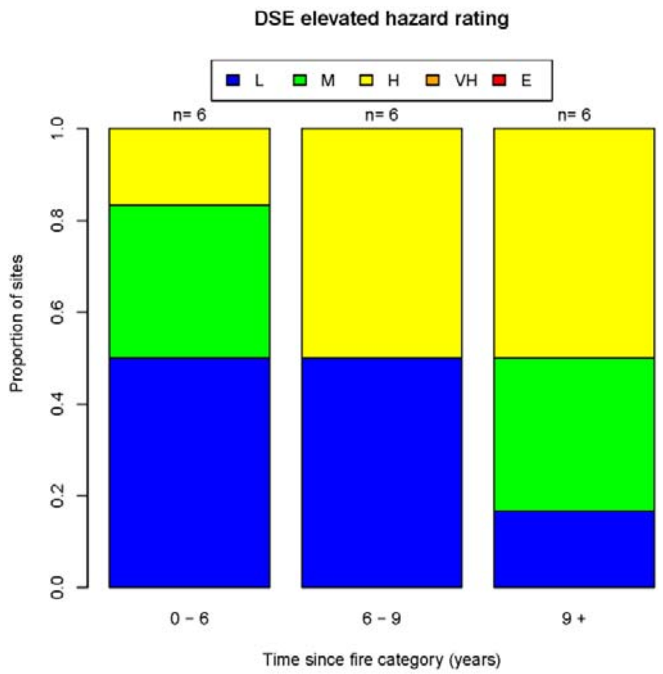


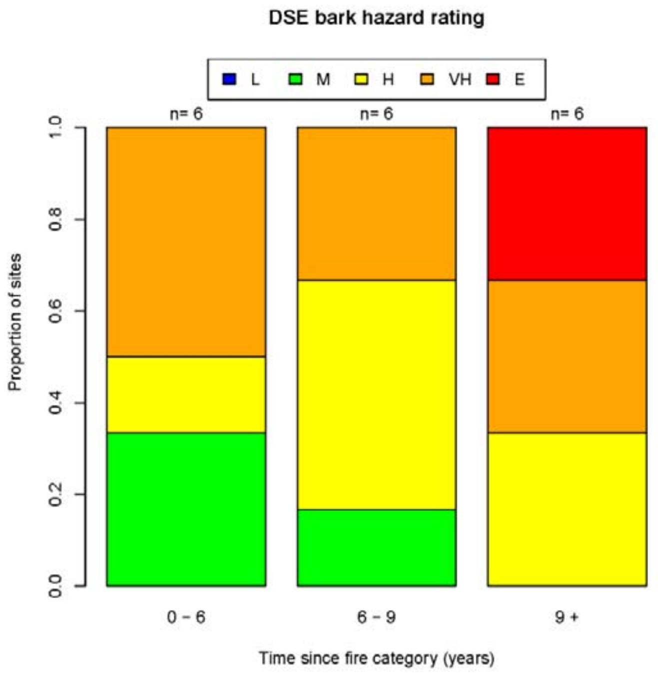


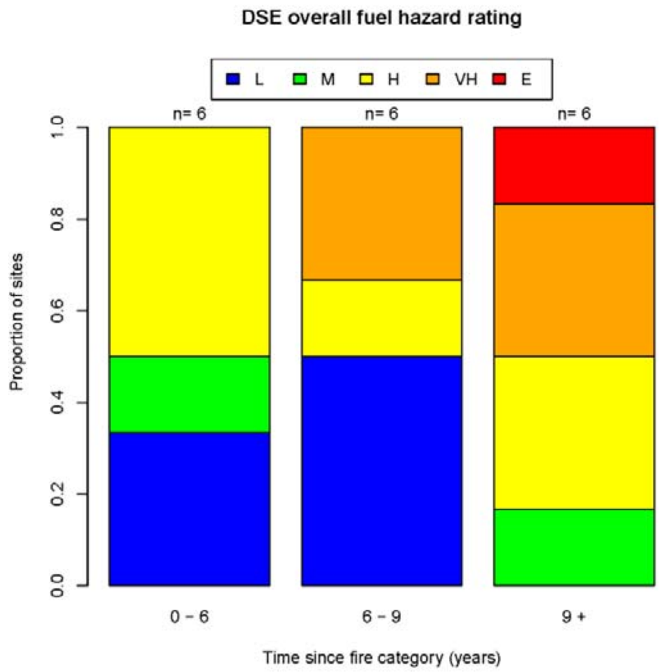
6.4 Southern Tableland DSF

DSE hazard ratings



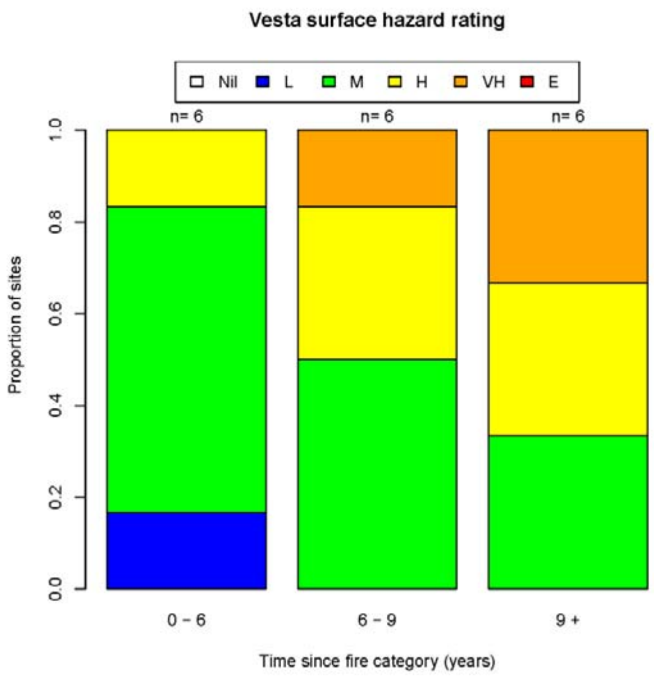


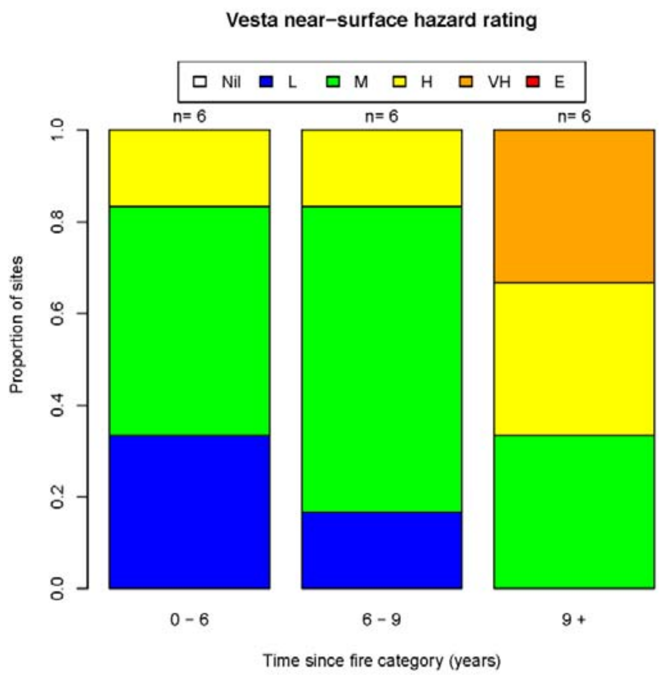


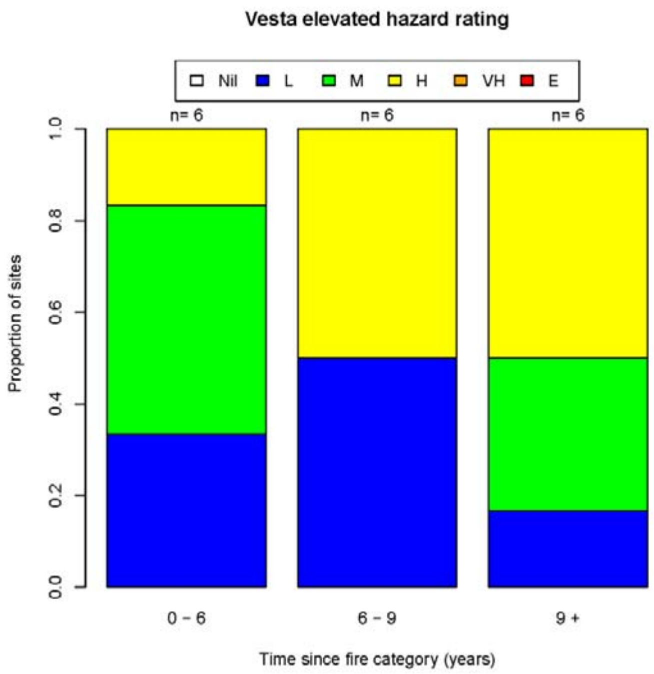


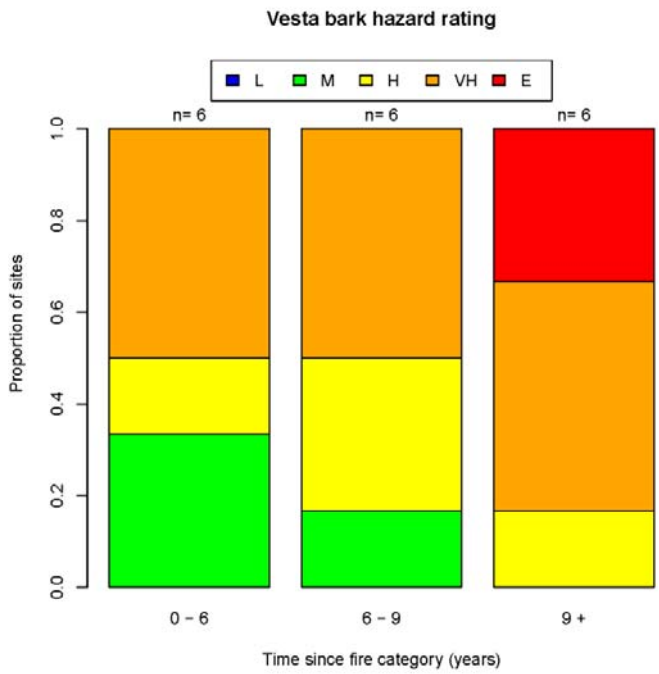
Southern Tableland DSF

Vesta hazard ratings



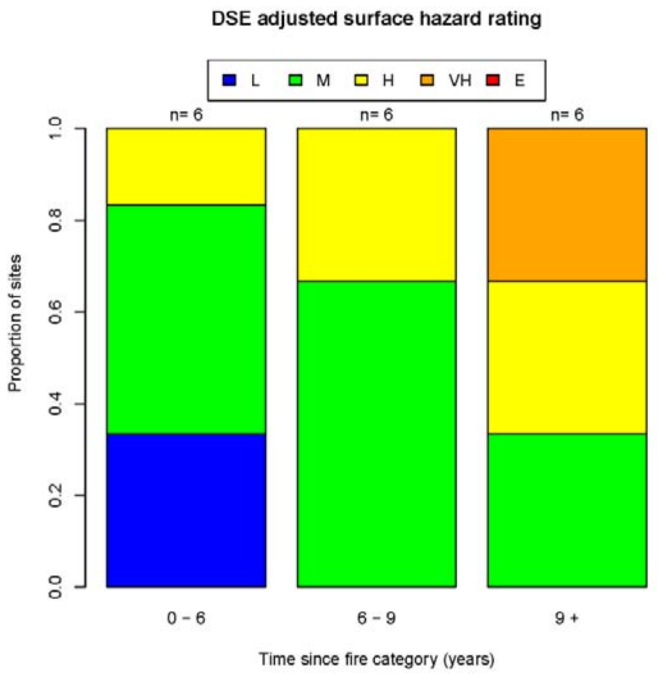


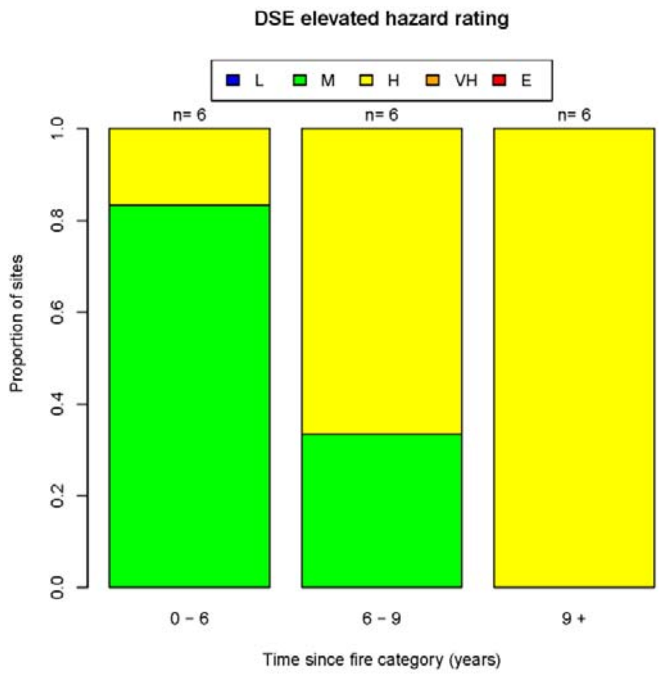


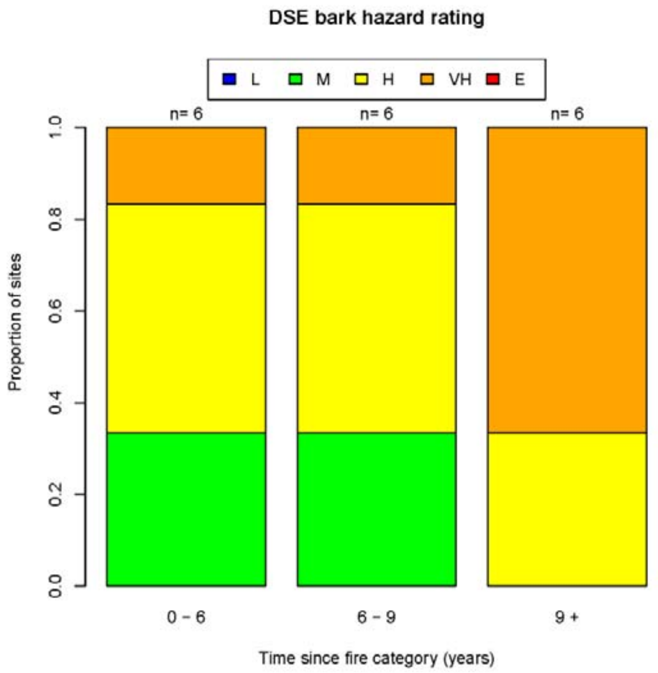


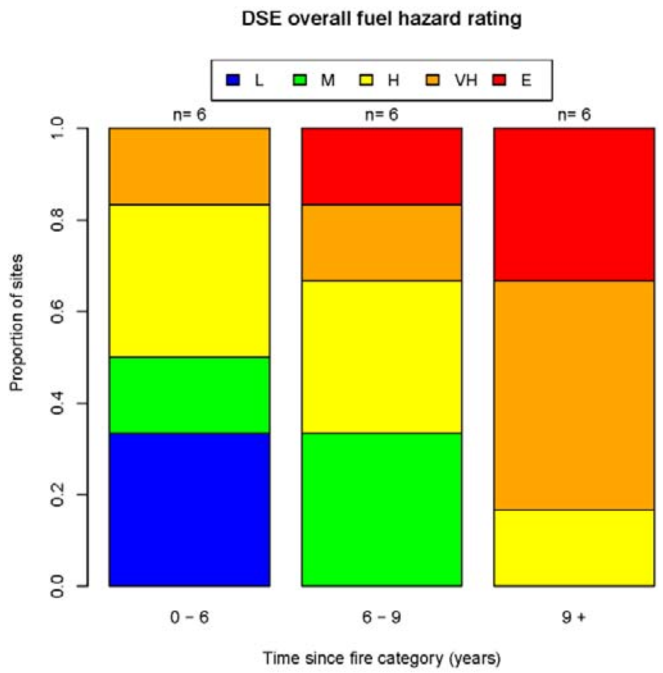
6.5 Hunter-Macleay DSF

DSE hazard ratings



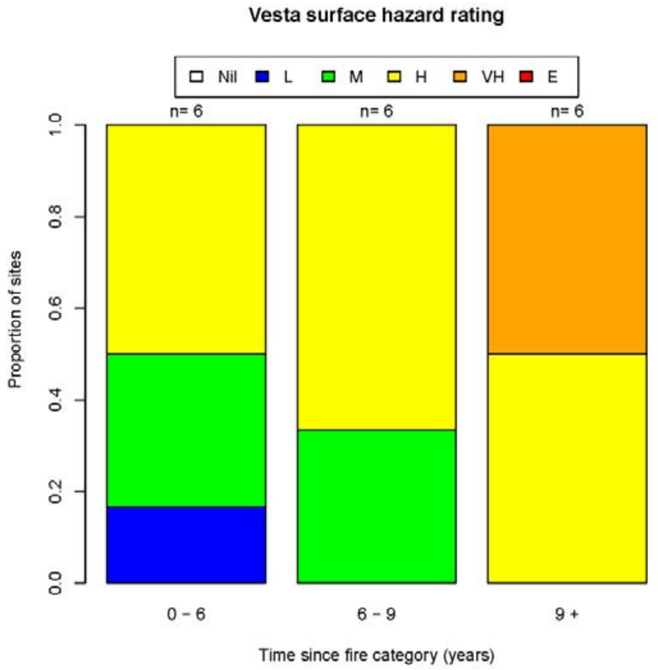


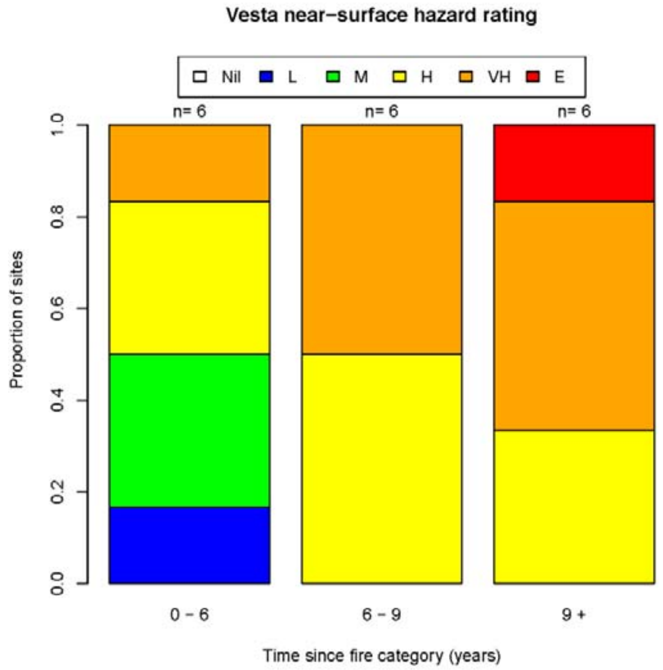


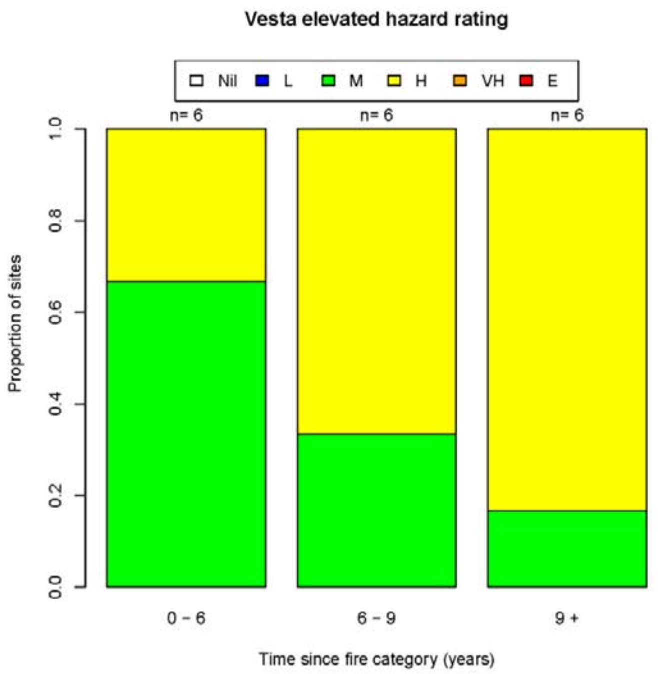


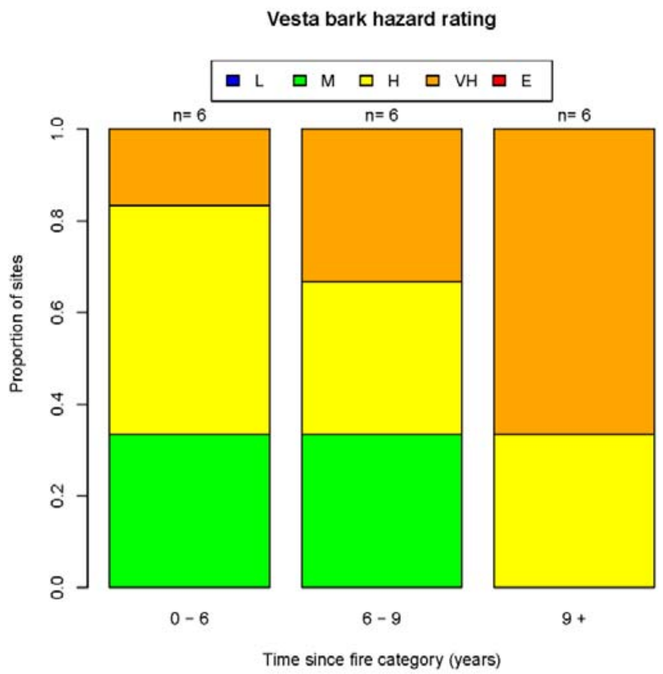
Hunter-Macleay DSF

Vesta hazard ratings



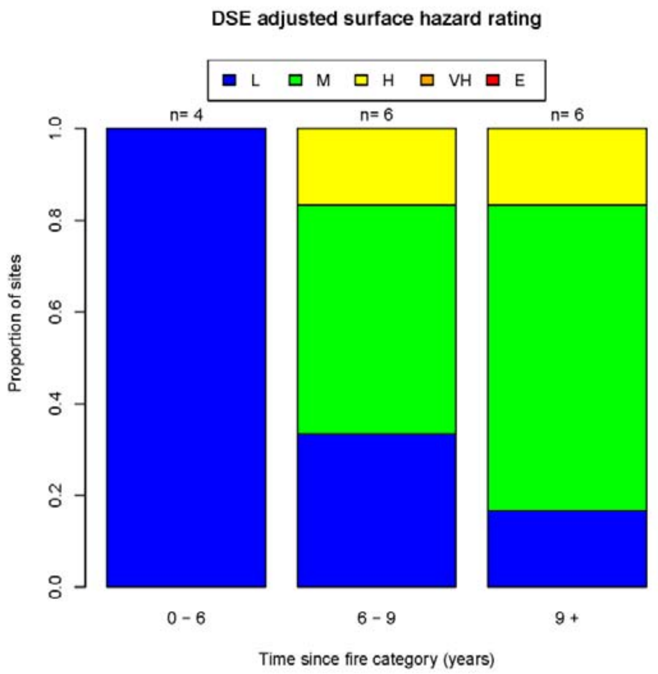


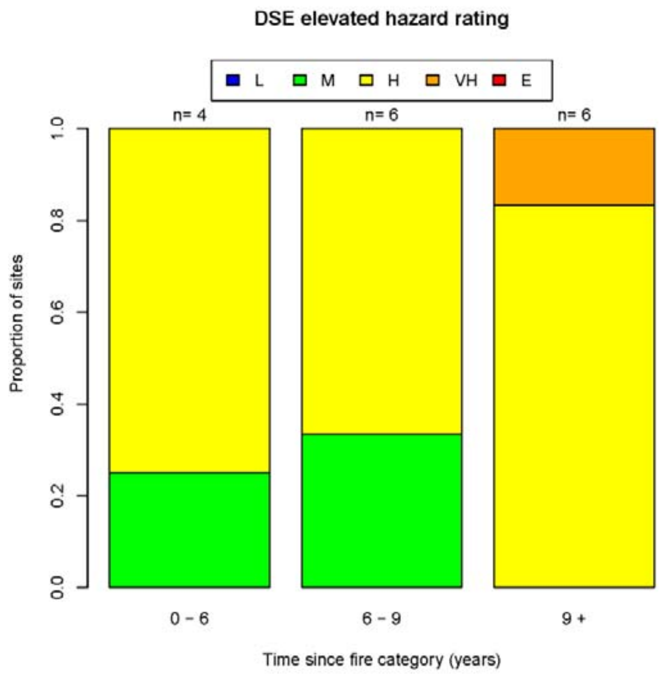


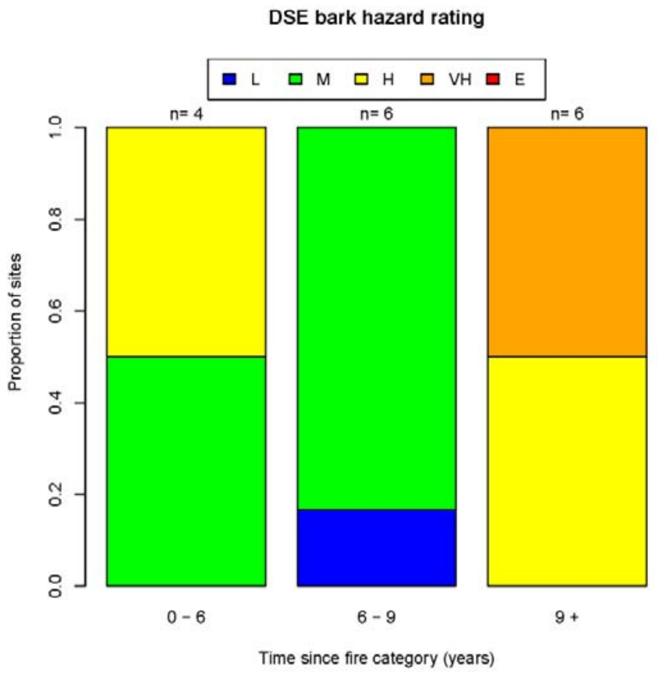


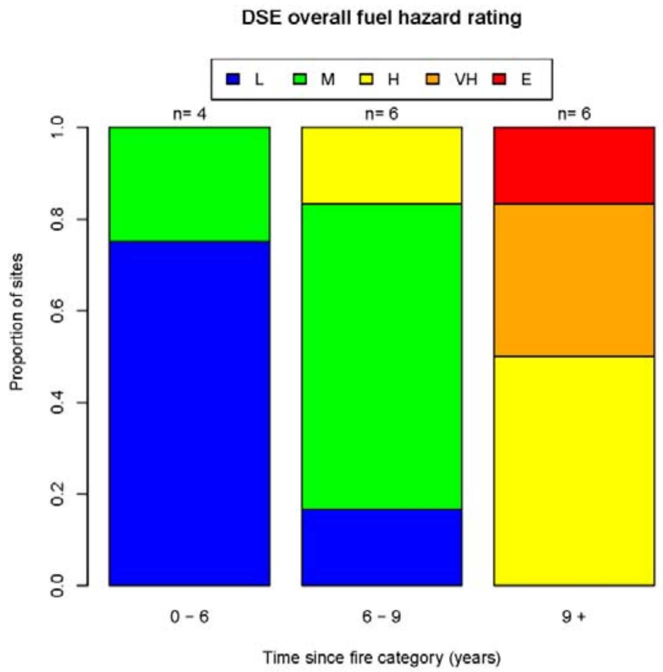
6.6 Cumberland DSF

DSE hazard ratings



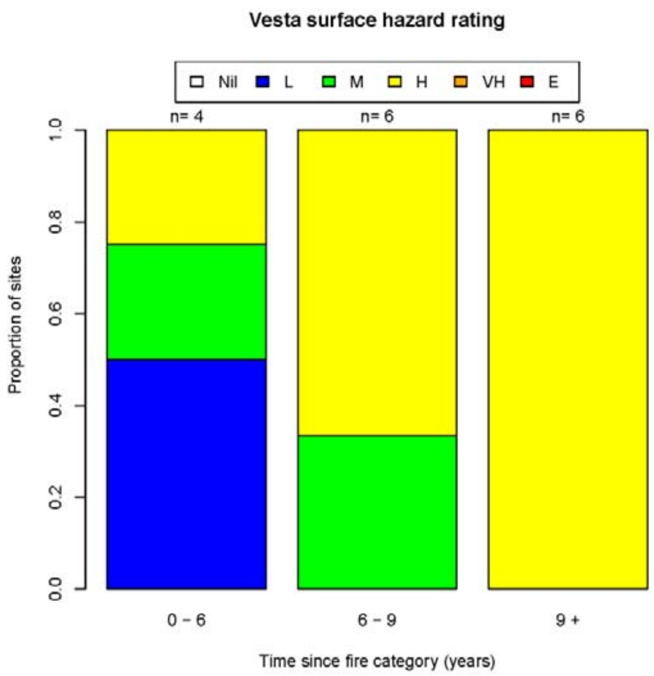


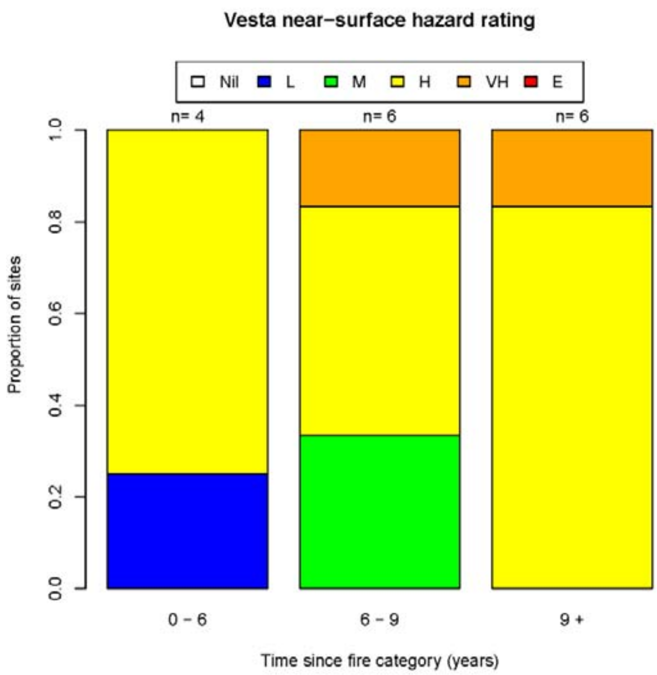


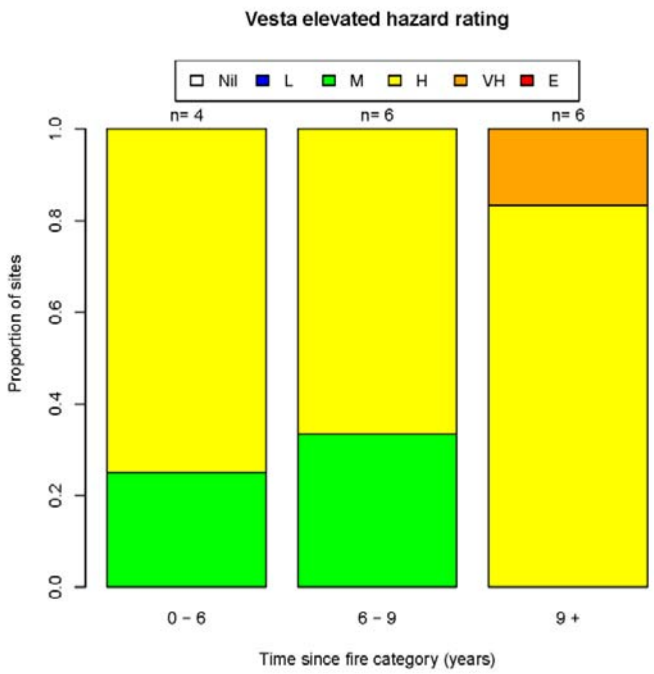


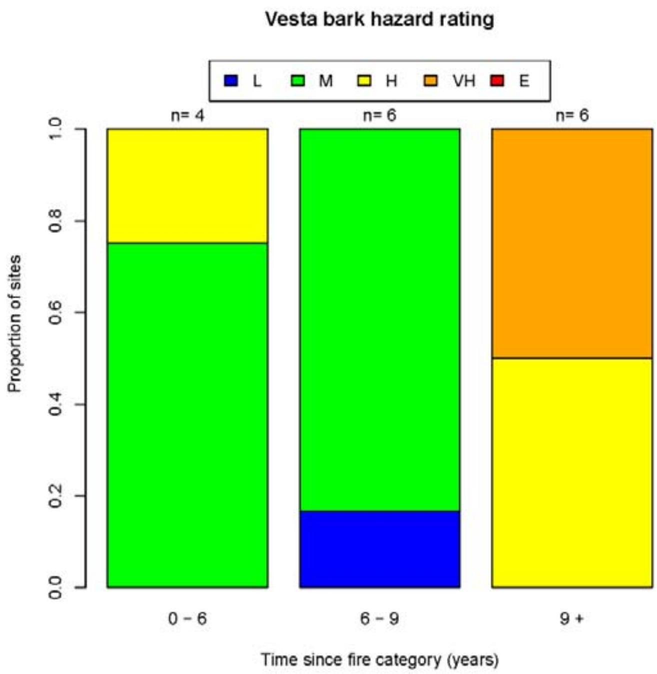
Cumberland DSF

Vesta hazard ratings



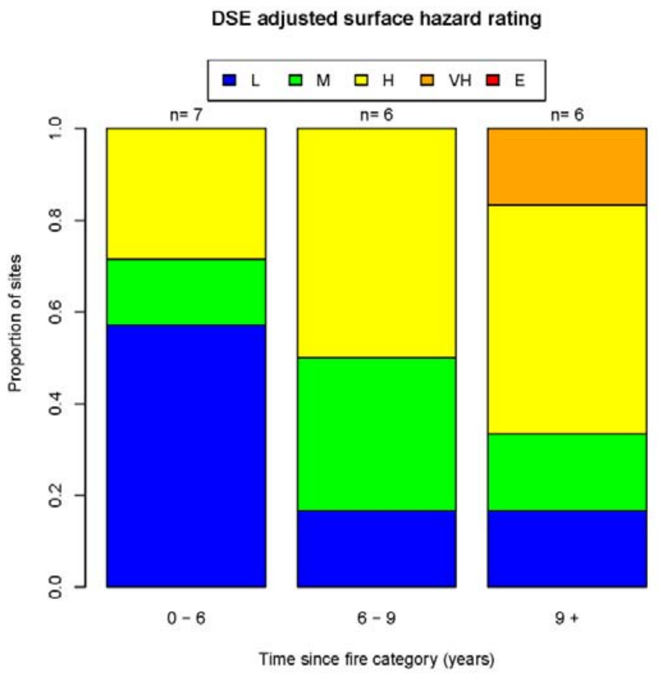


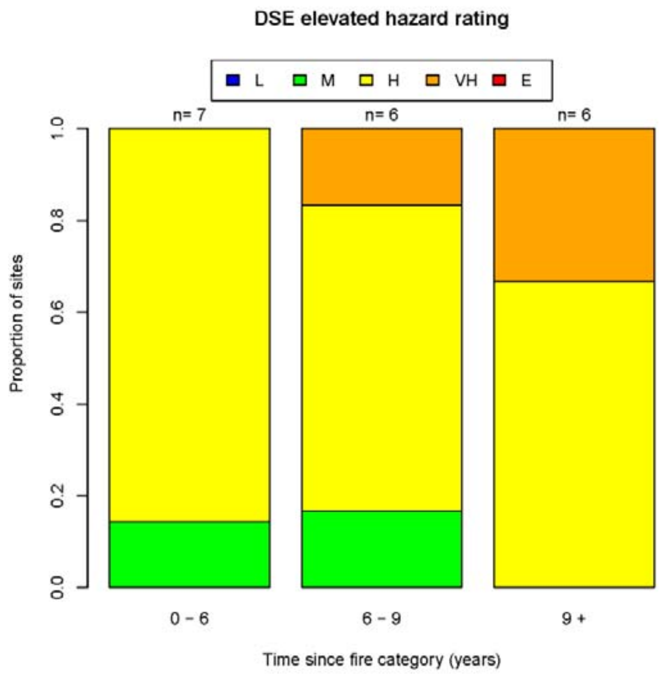


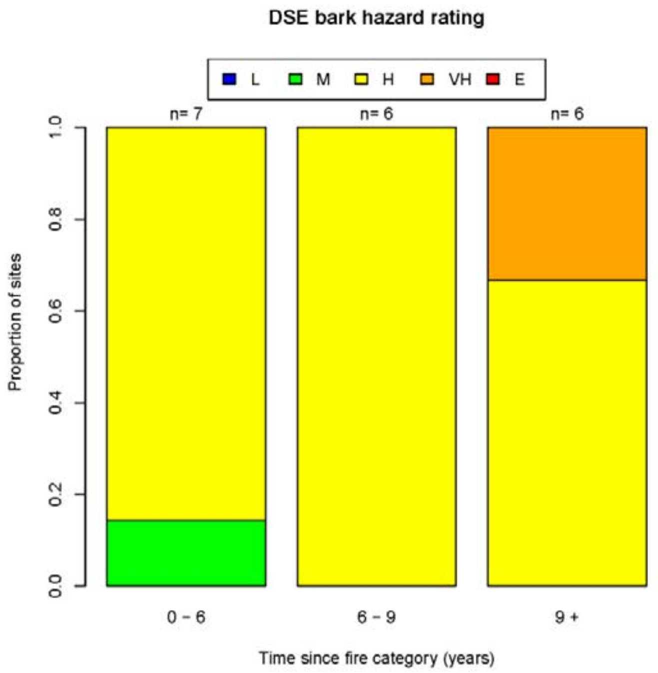


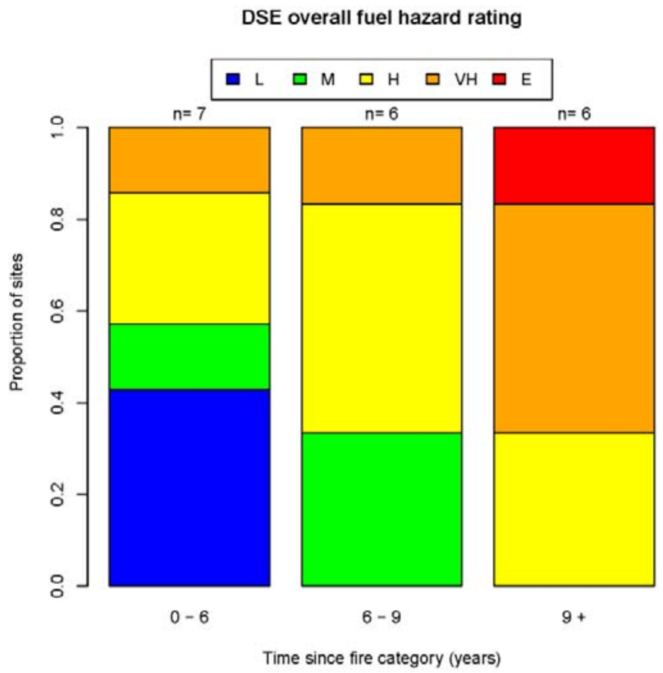
6.7 Coastal Valley GW

DSE hazard ratings



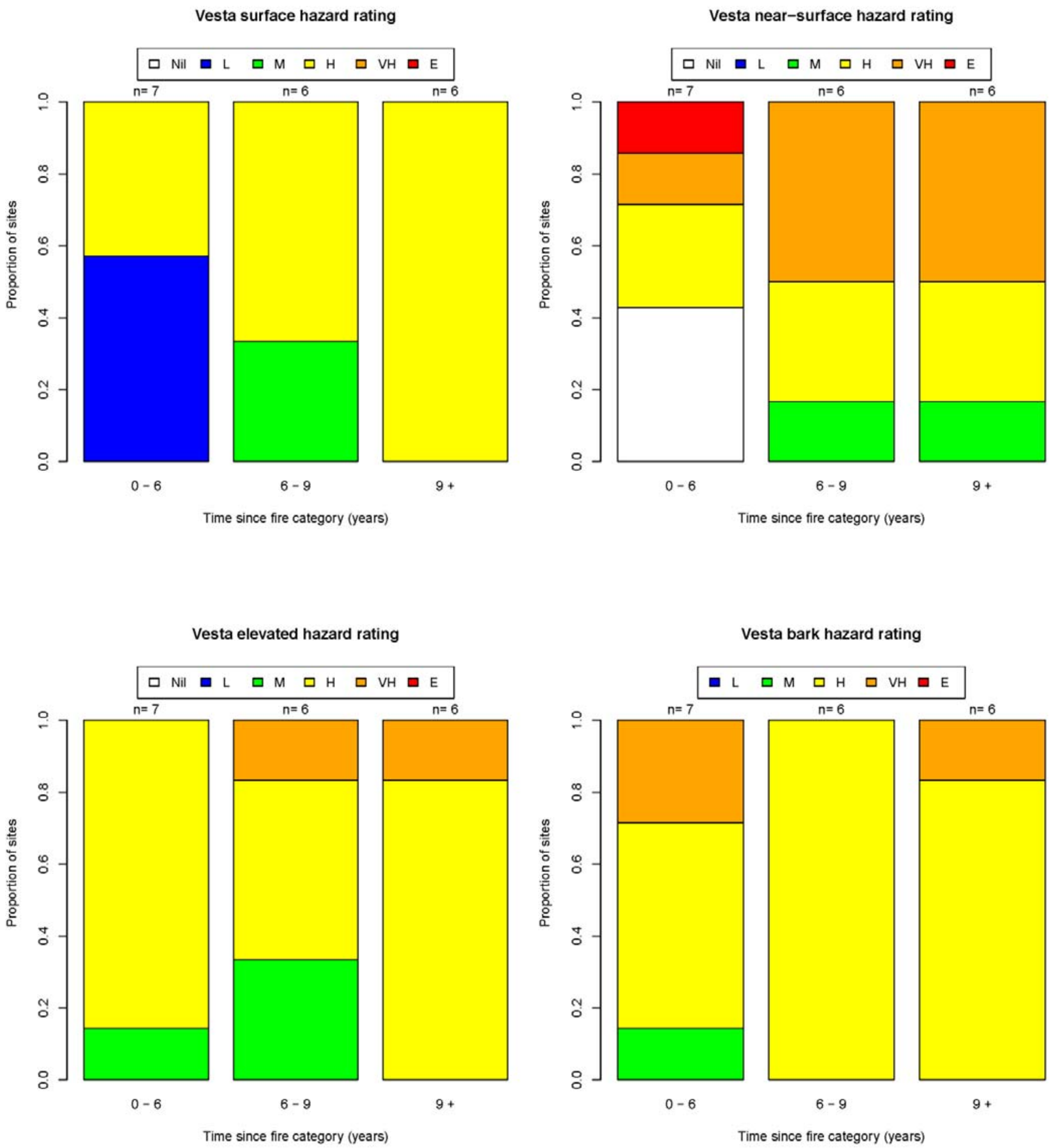






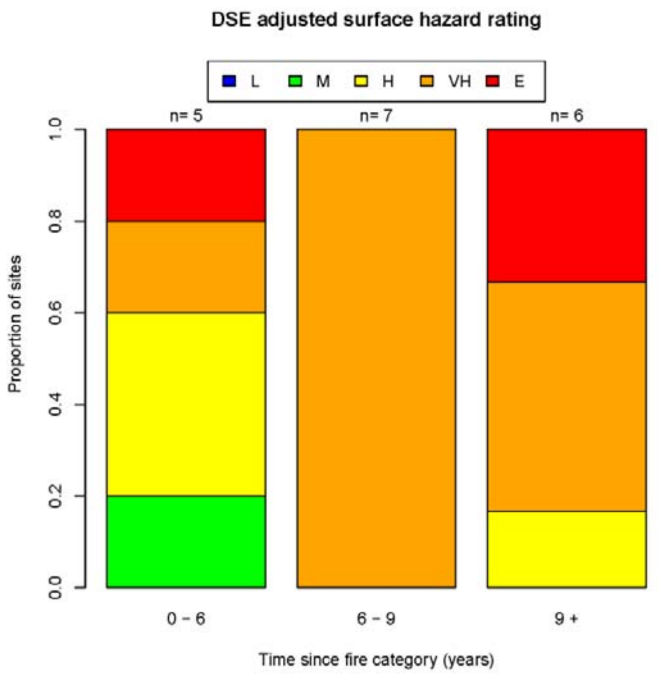
Coastal Valley GW

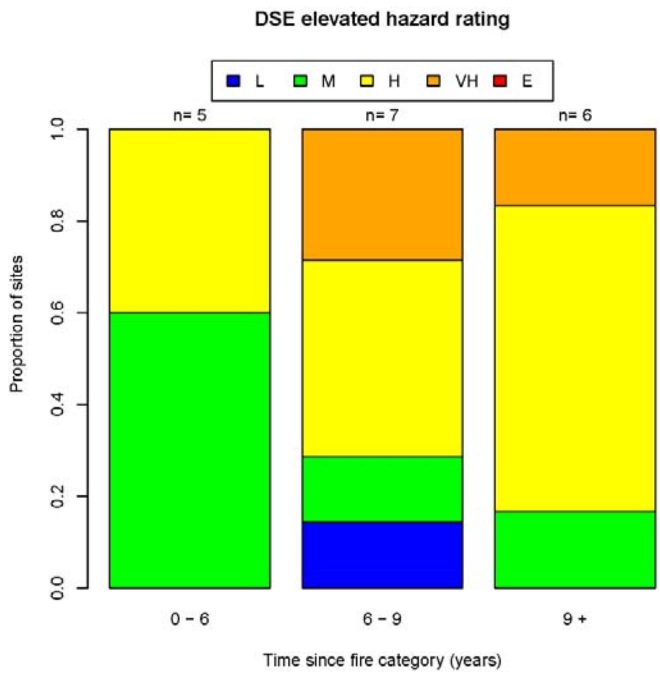
Vesta hazard ratings

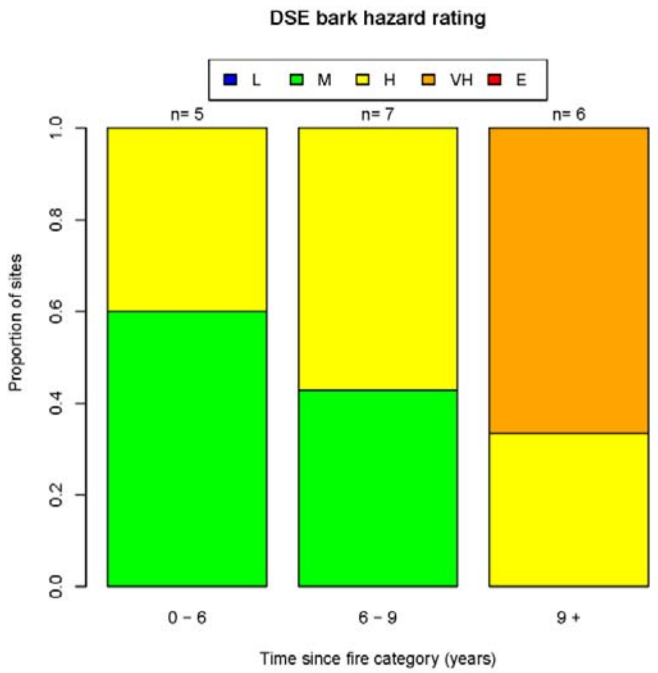


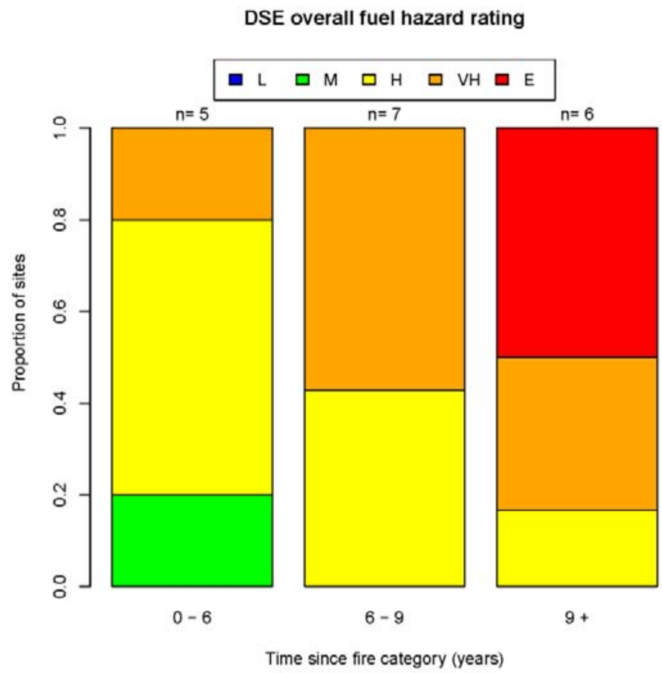
6.8 North Coast/Hinterland WSF

DSE hazard ratings



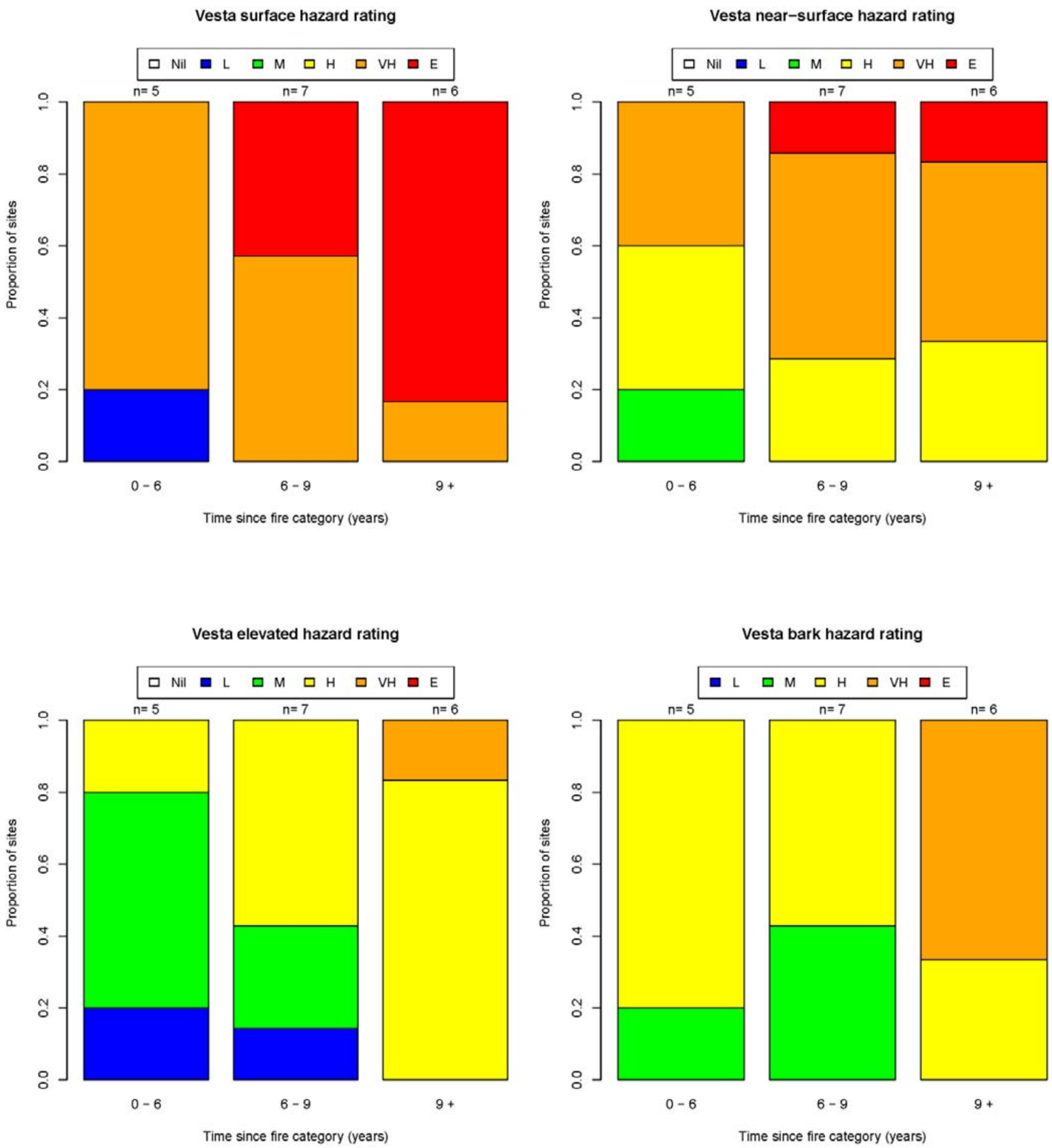






North Coast/Hinterland WSF

Vesta hazard ratings



7 Further research

The data presented here goes some way towards documenting the development of fuel structure and hazard in NSW forests and woodlands, the vegetation types surveyed to date represent a small proportion of the flammable vegetation in NSW. In discussion with RFS Project Officer Danielle Meggos in July 2011, the following priorities were identified:

- Southern Lowland WSF: Data on fuel development in this vegetation class would provide information on a second wet sclerophyll forest type, which could then be compared with the data presented here for North Coast/Hinterland WSF in the Sydney region. Southern Lowland WSF occurs along the South Coast of NSW, an area where development is proceeding rapidly.

- North Coast / Northern Hinterland WSF: north from Newcastle to the Queensland border. This would supplement the data for these vegetation classes which has already been collected for the Sydney region. These forest classes abut settlements along the North Coast.

- Clarence DSF: A comparison of data collected in the two shrub/grass dry sclerophyll forest classes surveyed so far suggests that fuel development is more rapid, and reaches higher levels, in the more northerly Hunter/Macleay DSF than in Cumberland DSF. A third class in this subformation would increase understanding of the range of fuel accumulation scenarios in this widespread vegetation group.

- Sydney Montane DSF: This shrubby DSF vegetation class occurs in the Upper Blue Mountains, where fire hazard to settlements is considerable.

- Western Slopes DSF: This shrubby DSF class covers a wide band in the central west of the state, and includes the Pilliga and Dubbo regions. Fuel development data sourced from this vegetation class in a relatively low rainfall region would increase understanding of effects of environmental gradients on fuel hazard in the widespread and flammable shrubby dry sclerophyll forest subformation.

- Sydney Sand Flats DSF: This vegetation class is small in extent, but occurs in urban fringe areas of Western Sydney, and burns often. There is currently no information at all on fuel or vegetation development in this class.

There may also be merit in extending survey effort in the early post-fire years in the vegetation types covered in this report, to provide sufficient data to populate bar charts for a 0-3 year and a 3-6 year post-fire category.

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