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Is the reptile community affected by *Eucalyptus wandoo* tree condition?

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Context. Large portions of the world's forests and woodlands are currently affected by declines in canopy condition of dominant tree species; however, the effects of these declines on faunal communities are largely unknown. *Eucalyptus wandoo* woodlands in the South-west region of Western Australia have demonstrated declines in condition since the early 1990s. Such declines in tree condition can result in reduced understorey vegetation, increased leaf-litter cover and coarse woody debris, potentially altering the habitat and resource available to reptiles. Prescribed fire events, another mechanism of habitat change for reptiles, are a common occurrence in these woodlands.

Aims. The present research investigated whether reptile communities were influenced by *E. wandoo* tree condition, and the changes in the habitat associated with *E. wandoo* decline.

Methods. Reptile trapping was conducted at 24 *E. wandoo*-dominated sites (of varying condition) in Dryandra State Forest and Wandoo Conservation Park, Western Australia. Overall, reptile abundance, species richness and individual reptile species abundances (only those species captured in sufficient numbers for analysis) were compared with a range of habitat characteristics that are likely to be altered by changes in *E. wandoo* tree condition.

Key results. Overall, higher reptile abundance and species richness were observed at sites with longer time since fire and more site litter cover. There was also a greater abundance and diversity of reptiles at sites where *E. wandoo* trees exhibited fewer symptoms of tree decline. Similar analyses for the five most common skink species indicated species-specific relationships with tree-condition measures, time since last fire, site litter cover, distance to drift fence from *E. wandoo* trees, understorey vegetation density and the density of coarse woody debris.

Conclusions. Abundance and species diversity of the reptile communities in *E. wandoo* woodlands were strongly related to time since last fire, *E. wandoo* tree condition and habitat characteristics such as site litter cover and the density of coarse woody debris.

Implications. Decline in the condition of *E. wandoo* trees and the fire events in *E. wandoo* woodlands are both mechanisms of change correlated with reptile habitat and resources. Future management of *E. wandoo* woodlands may include reducing prescribed fire events in areas demonstrating symptoms of tree decline, to conserve reptile abundance and species richness.

TOC Abstract

Eucalyptus wandoo woodlands of Western Australia are one of the many forests and woodlands declining worldwide. Live capture trapping of reptile communities in *E. wandoo* woodlands determined that reptile abundance and species richness was higher in areas exhibiting fewer *E. wandoo* decline symptoms, more site leaf litter and a longer time since

fire. Management of *E. wandoo* woodlands in the future should consider reducing the occurrence of fire events, particularly in areas undergoing a decline in condition.

Additional keywords: fire history, microhabitat, skinks, Western Australia, woodlands.

Across the globe, mass declines in tree condition have been noted in many woodlands and forests (Close *et al*. 2009; Allen *et al*. 2010). Tree decline is the slow, progressive deterioration of trees (Stone 1999) as a result of the persistent action of damaging agents (Manion and Lachance 1981; Jurskis 2005). Many agents induce tree decline, including climate change and associated drought (Jurskis and Turner 2002; Jurskis 2005), fungal attack reducing canopy growth (Carnegie 2007), pathogens such as *Phytophthora* spp. (Newhook and Podger 1972; Hartmann *et al*. 1989), other diseases (Sturrock *et al*. 2011), or insect-facilitated tree declines (Landsberg 1988; LeBlanc and Foster 1992; Stone *et al*. 1998). Symptoms of tree declines are often apparent by the death of upper portions of the tree foliage, resulting in an overall reduction in crown density (Carnegie 2007; Davidson *et al*. 2007; Robinson 2008). Although the effects of tree decline on fauna are not well understood, a decline in tree condition could potentially lead to a loss of habitat and resources for fauna, and reduced biodiversity (Loyn and Middleton 1980; Gorrod 2006; Wentzel 2010). For example, in central Victoria, the natural decline and decay of older trees lead to a loss of resources for fauna through the loss of tree hollows and, consequently, the number of dens for arboreal mammals (Lindenmayer *et al*. 1997).

A reduction in canopy cover as a result of tree decline can result in modified understorey vegetation, changes in litter and bare ground cover, and increased coarse woody debris density (Jurskis 2005). Some changes may benefit reptiles; for example, increased coarse woody debris density may be used as refuge for reptiles (McElhinny *et al*. 2006), whereas the abundance of some reptile species is related to more bare ground and others to increased leaf litter (Valentine *et al*. 2012). An open environment such as a declining woodland, with reduced canopy cover, may contain more basking opportunities for reptiles (Greenberg and Waldrop 2008; D'Cruze *et al*. 2009; Craig *et al*. 2010). However, the higher exposure to wind, variable soil and air temperatures and overhead predators may be detrimental for other species (McLeod and Gates 1998; Poulin *et al*. 2001; Todd and Andrews 2008). Increased insolation resulting from a loss of canopy cover often reduces the understorey vegetation (Langkilde *et al*. 2003) because of altered soil moisture and pH (Reid and Landsberg 2000). These changes alter the microclimate available for reptiles, potentially reducing refugia for reptiles from extreme weather conditions (Jurskis and Turner 2002; Wentzel 2010) as well as the availability of litter-dwelling prey as a result of the reduction of the moist leaf-litter layer (McElhinny *et al*. 2006).

Eucalyptus wandoo is a smooth-barked tree endemic to the South-west region of Western Australia (Mercer 2003; Whitford *et al*. 2008). *E. wandoo* woodlands once covered most of the greater agricultural area of south-west Western Australia (Yates and Hobbs 1997; Doughty 2000; Reid and Landsberg 2000); however, only 40% of the original *E. wandoo*-dominated woodlands remain (Mattiske Consulting Pty Ltd and Havel Land Consultants. 1998; Wandoo Recovery Group 2006). Since 2002, many patches of remnant *E. wandoo* woodlands have undergone a substantial decline in condition (Mercer 2003; Whitford *et al*. 2008). Unlike other declines, such as 'sudden oak death' in the USA (LeBlanc and Foster 1992; Shifley *et al*. 2006) and the decline of *Eucalyptus marginata* in Western Australia, where complete canopy loss is seen (Shea *et al*. 1983), the decline *E. wandoo* is cyclic and patchy, where only a portion of the trees lose their canopy and can have some recovery (Brouwers *et al*. 2012). Very little is known about the reptile communities in these woodlands, particularly about their relationship with tree condition. It is also important to note that these woodlands undergo prescribed management burns and the influence of these burns on reptile communities is an important management issue. Fire can alter habitat by reducing understorey complexity and habitat resources, leading to the creation of a homogenous habitat for reptiles (Penn *et al*. 2003; Pianka and Goodyear 2012). The present study investigated the effect of habitat variables (e.g. crown dieback, time since last fire, density of coarse woody debris, site litter cover, understorey vegetation cover) on reptile species and communities in declining *E. wandoo* woodlands.

Materials and methods

Site description

Study sites were located in *E. wandoo*-dominated woodlands in Dryandra State Forest (32°48′S, 116°53′E) and Wandoo Conservation Park (31°54′S, 116°27′E), 160 km south-east and 75 km east of Perth, respectively. *E. wandoo* woodlands have an open canopy (~30% canopy cover), a patchy understorey of small shrubs usually less than 1 m high, including *Gastrolobium* spp., *Macrozamia riedlei* and *Xanthorrhoea preissii* (sites with a high number of *X. preissii* were avoided because they are classified as another habitat type) and a grassy herb layer (Yates and Hobbs 1997). Both reserves have similar histories of land clearing, stock grazing, timber harvesting and prescribed fire management, despite their differences in tenure (Department of Conservation and Land Management 1980). These reserves were chosen because they are some of the largest blocks of remnant vegetation in the Western Australian farming region, an area with substantial historic land clearing for agricultural practices. In total, 24 sites were chosen, including 12 sites in each reserve. Sites were chosen using Vegmachine (Commonwealth Scientific and Industrial Research Organisation 2010) to locate six healthy and six declining *E. wandoo* sites in each reserve (total 24 sites), at least 500 m away from the edges of the remnant vegetation. Briefly, Vegmachine assesses changes in vegetation condition over a landscape through differences in reflectance of the vegetation

(Landsat imagery) over time; 1999–2009 was the time window selected for the present study because this is the period during which the decline in *E. wandoo* had been noted (Mercer 2003; Whitford *et al*. 2008). Initially, this project was not focussed on the fire history of the reserves and a balanced range of post-fire ages was therefore not considered during site selection for the study.

Trapping design

At each site, a range of traps were placed along a 29-m drift fence. Pit-trap types used included three 20-L buckets, two PVC tubes (with flywire in the base to stop reptiles escaping, dug into the ground), four 400-mL cylinder-shaped takeaway containers, buried to the lip. Additionally, four funnel traps, and Elliot traps were placed around the drift fence (). All 12 sites in each reserve were trapped concurrently over four nights in each of four trapping sessions, as follows: September/October 2009, November 2009, December 2009 and March/April 2010, giving a total of 6528 trap-nights from all 24 sites.

Seven reptile variables of interest included overall reptile abundance, reptile species richness and the abundance of the five most common reptile species (*Cryptoblepharus buchananii*, *Ctenotus schomburgkii*, *Lerista distinguenda*, *Menetia greyii* and *Morethia obscura*). The cut-off for individual species analysis was n = 20 captures. Data from 16 nights from all five trap types were pooled to estimate these dependant variables and then square root-transformed (Zar 1998) to meet assumptions of parametric statistics.

Measuring tree condition and other habitat characteristics

A range of tree and habitat characteristics (Tables 1, 2) was recorded to assess the condition of the *E. wandoo* at each site and to compare with reptile-community parameters.

Tree condition was recorded for six trees central to each site (the six trees closest to the trapping line with a diameter >20 cm; hereafter referred to as ‘site trees’, totalling 144 trees over the 24 sites) using several condition measures. Whitford tree condition measure (1–6) rates individual trees on a pictorial scale, giving them a single overall value (Whitford *et al*. 2008). We performed the following six individual measures of *E. wandoo* condition, based on measures from the literature (Schomaker *et al*. 2007) and unpublished studies (Wentzel 2010): visual estimates of crown density (%), crown dieback (%) and uncompacted live-crown ratio (%), the proportion of dead branches (%), epicormic growth (%) and canopy cover (%; Table 1). Each of these tree condition values were averaged across the six site trees for each site.

A range of other habitat characteristics was estimated across each site (Table 2). It is important to note that two measures of leaf-litter cover were used, including (1) tree litter cover that measures leaf litter at the base of the site trees, and (2) site litter cover that estimates the leaf-litter cover over the entire site averaged across the 16 (1-m^2) quadrats. The percentage cover values were arcsine-square-root transformed; tree density was log-transformed to meet the assumptions of ANOVAs and Pearson’s correlations (Zar 1998).

Comparison between the reptile community and tree condition and habitat characteristics

Generalised additive mixed models (GAMMs) are powerful statistical analyses that allow blending of generalised linear models and additive models (non-parametric models). GAMMs (REML-restricted maximum likelihood) were used to explore the relationships between reptile species richness, reptile abundance and abundance of the five most common reptile species, with the tree condition and habitat characteristics. Location (Dryandra State Forest or Wandoo National Park) was present in all models as a random factor. The number of independent factors varied between one and five in each model; however, a maximum of five independent variables was used in each model so as not to exceed the ratio of independent factors to replicates, to avoid over-fitting, and to strive for parsimony in terms of numbers of parameters (Burnham and Anderson 2002). In total, 447 models were created for each dependent variable, capturing combinations of all parameters.

Independent variables included in the models included Whitford tree condition measure, crown density, crown dieback, uncompacted live-crown ratio, epicormic growth, proportion of dead branches, canopy cover, time since last fire, distance to drift fence, site litter cover, understorey vegetation cover <1 m, tree litter cover, coarse woody debris density and tree density. To determine the independence of factors, a correlation matrix of all parameters was carried out. A cut off of $r \geq 0.35$ was used and correlated variables were not included in the same models (Pearson's *r*; Microsoft Excel). Time since last fire and tree leaf litter were not included in the same models because of high correlation ($r = 0.57$). No other parameters were highly correlated.

GAMMs were fitted using the GAM function of the MGCV package in R (Tinn-R and R 1.12.1; R Development Core Team 2011). Akaike information criterion adjusted for small sample size (AIC_c) was used to rank models within each model set. Each parameter within the model produced standardised β and *P*-values and an adjusted R^2-value was calculated for each model. The standardised β coefficients are the regression coefficients you would have obtained had you first standardised all of your variables to a mean of 0 and a standard deviation of 1; thus, the standardised β value allows direct assessment of the relative contribution of each independent variable (i.e. tree and habitat characteristics) in the prediction of the dependant variable (i.e. reptile community) (Statistica 9, Statsoft). Where the standardised β value was insignificant in a model, the model was compared against the same model, but excluding that parameter. Only models with a ΔAIC_c of <2 were dealt with further. The AIC_c model weight (w_i) was calculated for each of the models; w_i values therefore indicate the likelihood that each model is the best model of the model set to describe the data. Model-averaged β values ($\Sigma\beta \bullet w_i$; Burnham and Anderson 2002) were calculated to determine the importance of each habitat variable in the prediction of the dependent variable.

Two-way scatterplots between the reptile captures and tree condition and habitat characteristics present in the best models are shown for visual display only (Microsoft Excel).

Results

In total, 217 individuals from six families (Gekkonidae, Scincidae, Agamidae, Varanidae, Typhlopidae, Elapidae) were caught over the 16 nights of trapping (Table S1, available as Supplementary Material for this paper).

Reptile abundance and species richness in *E. wandoo* woodlands were best explained by a single model. Higher reptile abundance was evident at sites with longer time since last fire (Fig. 1*a*) and with more site litter cover (Fig. 1*b*) and less crown dieback (Tables 3, 4). More reptile species were captured at sites with longer time since last fire (Fig. 1*c*), more site litter cover (Fig. 1*d*) and coarse woody debris (Tables 3, 4).

Abundance of *Morethia obscura* (n = 49 captures) was best described by a single model containing the variables distance to drift fence, density of coarse woody debris, tree density, tree litter cover and understorey vegetation cover. The highest numbers of *M. obscura* individuals were trapped at sites with *E. wandoo* trees closer to the drift fence (i.e. less open areas) (Fig. 2*a*), a lower density of coarse woody debris (Fig. 2*b*), fewer *E. wandoo* trees, less tree litter cover, and a higher understorey vegetation cover (Tables 3, 4). *Menetia greyii* abundance was also best described by a single model including time since last fire (n = 20 captures; Fig. 2*g*). The small skink was captured at sites with longer time since last fire.

Abundances of the other three skink species (*Cryptoblepharus buchananii*, *Ctenotus schomburgkii*, *Lerista distinguenda*) were each best explained by more than one model (Tables 3, 4). Abundance of *C. buchananii* (n = 34 captures) was best described by site litter cover, time since last fire, Whitford tree condition measure, tree density and the density of coarse woody debris (Tables 3, 4). There were more *C. buchananii* individuals captured at sites with a higher site litter cover (Fig. 2*c*), longer time since last fire (Fig. 2*d*), a lower density of coarse woody debris, and fewer *E. wandoo* trees with more symptoms of tree decline. Time since last fire was again included in the two best models describing *C. schomburkgii* abundance (n = 20 captures), either alone or in combination with Whitford tree condition measure. Although *C. schomburkgii* was not captured at every site, more individuals were captured at sites with longer time since fire (Fig. 2*e*), and at sites demonstrating some symptoms of tree decline. Site litter cover was present in the three best models describing abundance of *L. distinguenda* (n = 31 captures), either alone or in combination with epicormic growth, tree density, Whitford tree condition measure, understorey vegetation cover, tree litter cover and canopy cover. More *L. distinguenda* individuals were captured at sites with a higher site litter cover (Fig. 2*f*).

Discussion

Decline of *E. wandoo* condition results in changes in habitat available for fauna. A loss of canopy not only reduces canopy cover, increasing insolation, but also temporarily increases leaf-litter cover in the understorey. Increased sunlight will alter the soil chemistry and in turn the understorey vegetation (Jurskis and Turner 2002). Coarse woody debris may also accumulate as a result of falling dead branches (Reid and Landsberg 2000; Jurskis 2005).

These changes may affect the reptile community as changes in the microhabitat or the overall condition of woodland trees occur. Tree condition measures (both individual measures as well as the holistic tree condition measure, Whitford) were present in the best models describing reptile abundance, species richness and abundances of the most common species. These data suggest that the models revealed relationships between the reptile community and changes in the overall and individual habitat characteristics as a result of changes in tree condition.

A loss of canopy foliage can result in more basking opportunities and shelter sites for reptiles, but also variation in litter prey availability (Webb *et al*. 2005; Pike *et al*. 2011) as a result of the build up of leaf litter. Site litter cover was present in best models for overall reptile abundance, species richness and abundance of *C. buchananii* and *L. distinguenda.* Site litter may act both as a refuge and as a source of suitable litter-dwelling invertebrate prey (Jellinek *et al*. 2004; Greenberg and Waldrop 2008; Matthews *et al*. 2010).

Changes in *E. wandoo* condition were related to the abundance of individual skink species. Abundance of *C. schomburgkii* and *C. buchananii* were positively related to Whitford tree condition measure, indicating their preference for declining *E. wandoo* sites. *C. schomburgkii* feeds on termites in dead wood (Pianka 1969), and *C. buchananii* is an arboreal species (Craig *et al*. 2012; Valentine *et al*. 2012). Decay and decline of *E. wandoo* trees may be producing more dead wood and, in turn, more invertebrate prey for the skinks to feed on. Conversely, *L. distinguenda* was negatively related to the Whitford tree condition measure, indicating its preference for healthier trees. Other studies have indicated that trees with a full canopy offer protection from predation (Poulin *et al*. 2001). Perhaps a similar scenario is occurring in *E. wandoo* woodlands, with full *E. wandoo* canopies providing a shield from predation. *M. obscura* was captured more commonly at sites were the drift fences were closer to *E. wandoo* trees, which may relate to their preferred use of tree cover. Requirements of individual reptile species are therefore likely to be driving their responses to the habitat characteristics recorded.

In addition to tree condition, fire also shapes landscapes and alters vegetation complexity. In south-western Western Australia, prescribed burning is carried out by land managers for a range of ecosystems. Its purpose is to reduce fuel loads, mitigating the potential for wild fires that can devastate homes and property, as well as to ensure that biodiversity is maintained (Burrows and Abbott 2003; Valentine *et al*. 2012). Several species and the overall reptile community measures demonstrated links to the fire history of the sites. Overall reptile community measures and some individual species (with the exception of *M. obscura* and *C. schomburgkii*) were captured in higher numbers at sites with longer time since last fire. In long unburnt areas, the build-up of litter, woody debris and understorey habitat provides food and shelter resources for some species of reptiles (Taylor and Fox 2001; Singh *et al*. 2002; Greenberg and Waldrop 2008).

There is little literature on the influence of tree decline on fauna, especially relating to potential interactions with time since last fire, or on the relationship between fire and tree condition. One of the few studies suggested that decline in eucalypt condition is directly linked with fewer fires over recent decades (Close *et al*. 2009), and these authors recommended more frequent burning of woodlands (such as *E. wandoo*). However, our research indicated that reptile abundance, species richness and abundance of individual species were lower at recently burnt sites. Management practices, therefore, need to be designed and implemented taking into account the interaction with tree condition.

Monitoring the changes in tree condition, particularly in cognisance of regular prescribing burning, climate change and competing land uses (e.g. for tree harvesting, or agricultural activities) (Shea *et al*. 1983; Allen *et al*. 2010; Brouwers *et al*. 2012), is important to better manage woodlands for the conservation of biodiversity. Tree decline is a mechanism of change that substantially alters the habitat available for fauna and, consequently, plays a role in determining reptile abundance and species richness by the modification of microhabitat availability. However, until the causes behind declines in *E. wandoo* condition are well understood, management of declining woodlands for biodiversity is difficult, and less frequent prescribed burning of declining *E. wandoo* woodlands is recommended.

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Fig. 1. Scatterplots showing reptile captures and (*a*) time since last fire (years) and (*b*) site litter cover and reptile species richness and (*c*) time since last fire and (*d*) site litter cover. Each data point represents one of the 24 *Eucalyptus wandoo*-dominated sites, some points overlap.

Fig. 2. Habitat factors that showed the strongest relationships with abundance of five of the most common skink species: *Morethia obscura* (n = 49 captures), and (*a*) distance to drift fence, and (*b*) density of coarse woody debris, (*c*) *Crytoblepharus buchananii* (n = 34 captures) and site litter cover, (*d*) *Crytoblepharus buchananii* and time since last fire, (*e*)

Ctenotus schomburgkii (*n* = 30 captures) and time since last fire, (*f*) *Lerista distinguenda* (*n* = 31 captures) and site litter cover and (*g*) *Menetia greyii* (*n* = 20 captures) and time since last fire. Although raw data are shown for these graphs, please note that data were transformed where required.

Table 1. Tree condition variables estimated for 144 individual *Eucalyptus wandoo* trees in Dryandra State Forest and Wandoo National Park

Each tree characteristic was visually assessed

Tree characteristic	Definition
Crown density (%)	Percentage of crown that contains foliage, branches and reproductive structures (Schomaker *et al*. 2007).
Crown dieback (%)	Percentage of crown that has undergone recent dieback. Crown dieback is often an early indication of stress (Schomaker *et al*. 2007).
Uncompacted live-crown ratio (%)	Percentage of live crown to above-ground tree length (i.e. ratio of crown to tree trunk). Uncompacted means that crown length is not reduced to compensate for gaps between live-crown base and live top of the tree. Trees that are older should have smaller ratios (Schomaker *et al*. 2007).
Proportion of dead branches (%)	Percentage of all major branches (diameter >20 cm) that are senescent.
Epicormic growth (%)	Percentage of foliage in the canopy that is epicormic growth (Podger 1980; Stone 1999).
Canopy cover (%)	An average of four canopy-cover measurements were taken on each tree at north, south, east and west facings by using a spherical densitometer, 1.5 m from the base of the tree.

Table 2. Habitat characteristics recorded at each of the 24 trapping sites at Dryandra State Forest and Wandoo National Park

Habitat characteristic	Definition	Ecological justification
Time since last fire (years)	Database: years since last burn maps; Custodian: Department of Environment and Conservation (Hills and Great Southern Districts).	Fires can significantly alter the habitat for reptiles (Greenberg and Waldrop 2008).
Distance to the drift fence (m)	Distance measured from each trap (20-L buckets, PVC pipes and takeaway containers) along the drift fence to the closest *E. wandoo* tree. An average value was calculated for each site. This estimate was recorded because there were significant differences in the distance of trees to the trapping grids among sites, because the location of trapping grids were chosen in more open areas for the ease of putting in grids.	Drift-fence set up and design can influence capture rates (Morton *et al*. 1988).
Understorey vegetation <1 m (%)	Visually assessed for 16 quadrats (1 m^2) at each site and averaged to create a value for the site.	Understorey vegetation, leaf litter, coarse woody debris and tree density (or woodland openness) are just some of the few habitat characteristics that other literature has indicated influence reptile communities and are likely to undergo change in a declining woodland (Brown 2001; D'Cruze *et al*. 2009; Greenberg and Waldrop 2008; Mac Nally and Brown 2001; Mac Nally *et al*. 2001).
Site litter cover (%)	Visually assessed for 16 quadrats (1 m^2) at each site and averaged to create a value for the site. Site litter cover was significantly correlated with percentage bare ground ($r = -0.88$, $P < 0.001$), so the inverse relationship is assumed for bare ground.	
Tree leaf-litter cover (%)	Measured at the base of the six site trees within two 1-m^2 quadrats, then averaged across each site.	
Coarse woody-debris density (number ha^{-2})	Count of all logs (diameter >20 cm) in a 1-ha area around the drift fence.	
Tree density (number ha^{-2})	Calculated from the nearest-neighbour method (Barbour *et al*. 1987) from distance measures collected from the six site trees to the nearest tree.	

Table 3. Generalised additive mixed models investigating the relationship between the habitat/tree condition variables (standardised β, *P*-value) and the overall reptile abundance, species richness and the abundances of five common skink species, namely *Morethia obscura*, *Cryptoblepharus buchananii*, *Ctenotus schomburgkii*, *Lerista distinguenda* and *Menetia greyii*

Only those models with an Akaike information criterion adjusted for small sample size (AIC_c) of <2 are shown (these models have the greatest likelihood of all the model-set to adequately describe the dataset). Models are ranked according to their ΔAIC_c and the AIC_c model weight (w_i); variables are ordered in terms of decreasing absolute standardised β values. The numbers of captures of each of the five most common skink species are shown in Table S1, available as Supplementary Material for this paper. Uncompacted live-crown ratio, crown density and proportion of dead branches were not included in the top models for any analysis and are therefore not shown. TSLF, time since last fire; WH, Whitford tree condition measure; SLC, site litter cover; TLC, tree leaf litter; UV, understorey vegetation (<1 m) density; CWD, coarse woody-debris density; TD, tree density; DF, distance to drift fence; EG, epicormic growth; DB, crown dieback; and CC, canopy cover

Dependant parameter	Model	Adjusted R^2	ΔAIC_c	w_i
Abundance	TSLF (0.67, 0.0001) + SLC (0.54, 0.0009) + DB (–0.11, 0.45)	0.61	1	0.21
Species richness	TSLF (0.68, 0.0003) + SLC (0.51, 0.002) + CWD (0.09, 0.04)	0.57	0	0.34
Morethia obscura	DF (–0.37, 0.29) + CWD (–0.26, 0.32) + TD (–0.23, 0.29) + TLC (–0.13, 0.87) + UV (0.05, 0.81)	0.28	0	0.75
Cryptoblepharus buchananii	SLC (0.40, 0.04) + TSLF (0.38, 0.05) + CWD (–0.18, 0.35)	0.32	0.00	0.34

	WH (0.34, 0.09) + CWD (–0.28, 0.18) + TD (–0.24, 0.25)	0.28	1.31	0.17
Ctenotus schomburgkii	TSLF (0.45, 0.02)	0.20	0	0.14
	TSLF (0.41, 0.04) + WH (0.09, 0.63)	0.21	0.98	0.08
Lerista distinguenda	SLC (0.53, 0.004) + e.g. (–0.44, 0.01) + TD (–0.23, 0.18)	0.44	1	0.15
	SLC (0.54, 0.01)+ WH (–0.22, 0.27) + TD (–0.19, 0.31)	0.30	0.94	0.14
	SLC (0.48, 0.01) + e.g. (–0.42, 0.03) + UV (0.24, 0.29) + TLC (–0.06, 0.95) + CC (0.03, 0.094)	0.45	0.56	0.08
Menetia greyii	TSLF (0.47, 0.01)	0.22	1.00	0.06

Table 4. Averaged standardised β values of the top models (with a delta Akaike information criterion adjusted for small sample size; ΔAIC_c of <2) explaining overall reptile abundance, species richness and the abundances of the five most common skink species

Uncompacted live-crown ratio, crown density, and proportion of dead branches were not included in the top models for any analysis and are therefore not shown. TSLF, time since last fire; WH, Whitford tree condition measure; SLC, site litter cover; TLC, tree leaf litter; UV, understorey vegetation (<1 m) density; CWD, coarse woody debris density; TD, tree density; DF, distance to drift fence; EG, epicormic growth; DB, crown dieback; and CC, canopy cover

Parameter	TSLF	WH	SLC	TLC	UV	CWD	TD	DF	EG	DB	CC
Abundance	0.14	–	0.11	–	–	–	–	–	–	–0.02	–
Species richness	0.23	–	0.17	–	–	0.03	–	–	–	–	–
Morethia obscura	–	–	–	–0.10	0.04	–0.19	–0.17	–0.27	–	–	–
Cryptoblepharus buchananii	0.13	0.05	0.13	–	–	–0.1	–0.04	–	–	–	–
Ctenotus schomburgkii	0.09	0.007	–	–	–	–	–	–	–	–	–
Lerista distinguenda	–	–0.03	0.19	–0.004	0.01	–	–0.06	–	–0.09	–	0.002
Menetia greyii	0.05	–	–	–	–	–	–	–	–	–	–

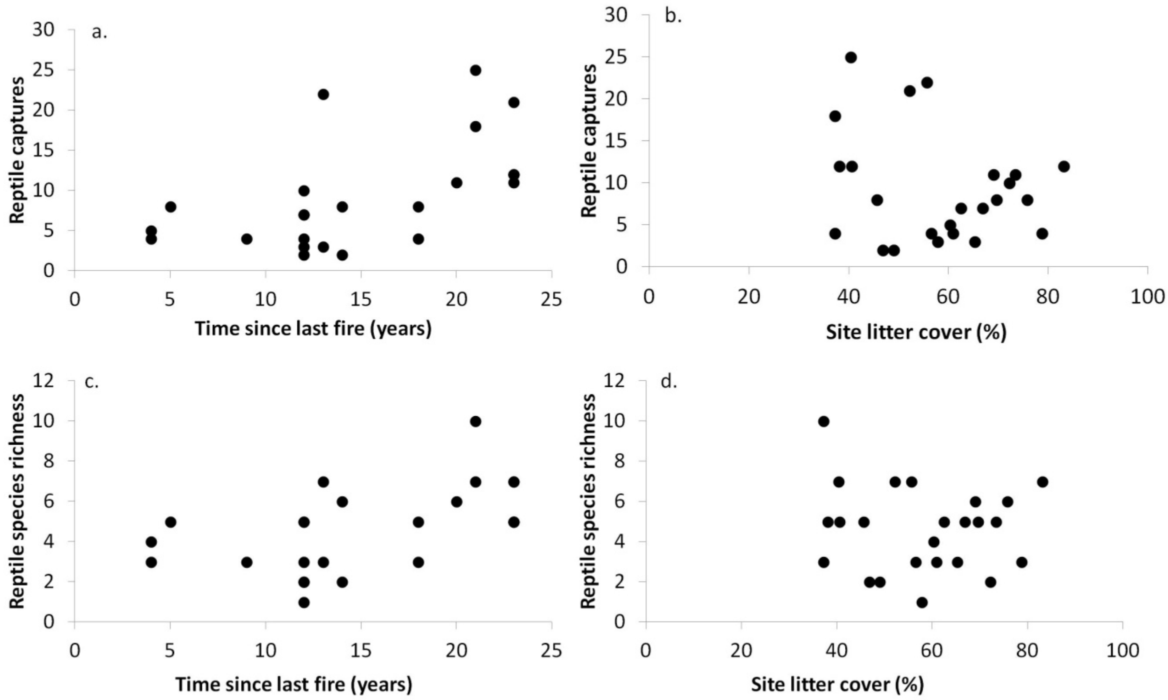

Figure 1: Scatterplots showing reptile captures and time since last fire (years) (a) and site litter cover (b) and reptile species richness and time since last fire (c) and site litter cover (d). Each data point represents one of the 24 *Eucalyptus wandoo*-dominated sites, some points overlap.

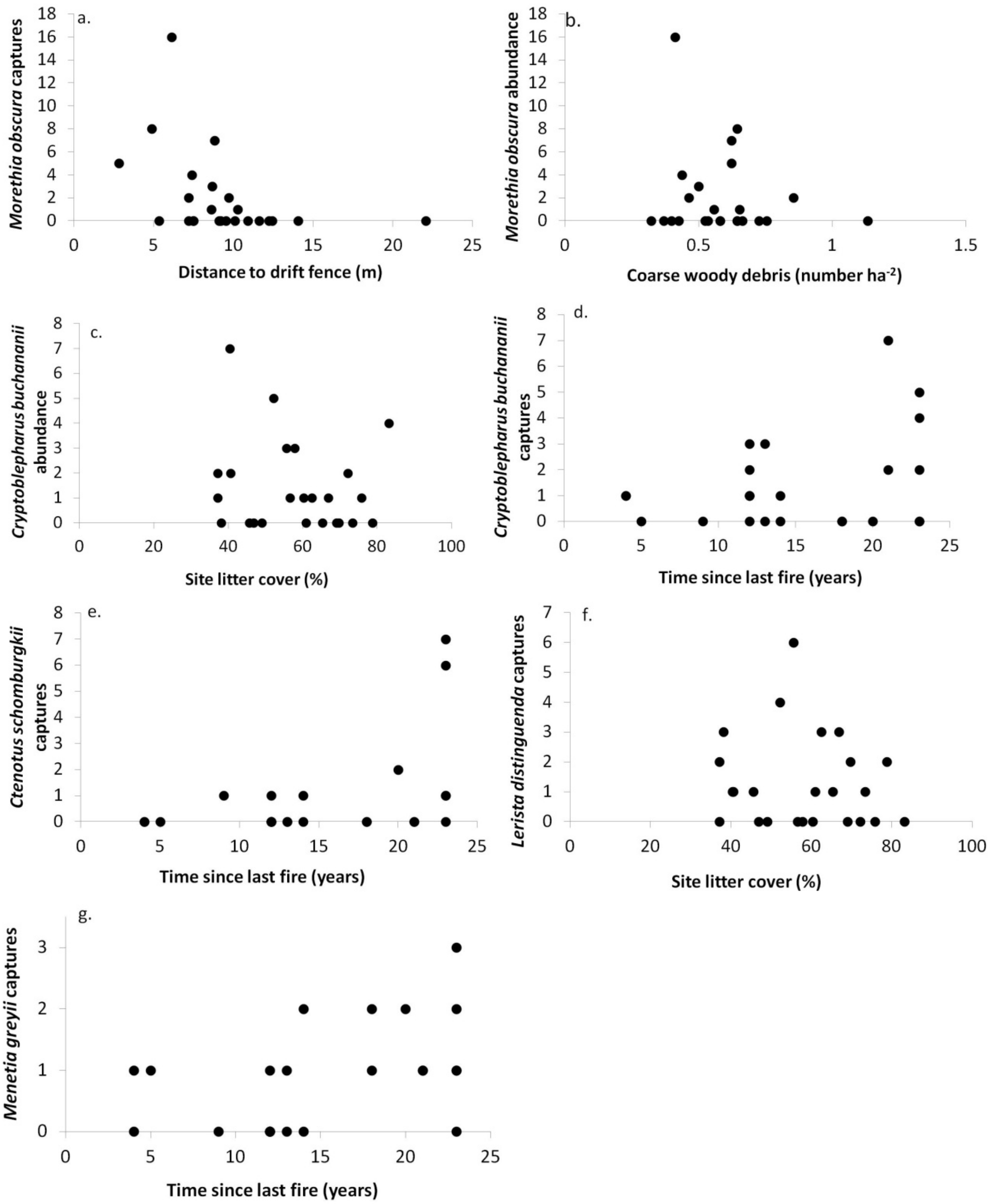

Figure 2: Habitat factors that showed the strongest relationships with abundance of five of the most common skink species *Morethia obscura* (n=49 captures) and distance to drift fence (a), and coarse woody debris (b), *Crytoblepharus buchananii* (n=34 captures) and site litter cover (c), *Crytoblepharus buchananii* and time since last fire (d), *Ctenotus schomburgkii* (n=30 captures) and time since last fire (e), *Lerista distinguenda* (n=31 captures) and site litter cover (f) and *Menetia greyii* (n=20 captures) and time since last fire and (g). Although raw data are shown for these graphs, please note that data were transformed where required.