SHORT COMMUNICATION

A broad brush-stroke test of an assumption: does increasing *Callitris* cover reduce native species richness (species density)?

John T. Hunter

School of Behavioural, Cognitive and Social Sciences, University of New England, Armidale, NSW 2351 AUSTRALIA
jhunter8@bigpond.com

Abstract: Does an increase in the cover/abundance of *Callitris glaucophylla* or *Callitris endlicheri* affect the number of species recorded in plots (species density) or do other factors such as altitude or logging, fire or grazing history have greater explanatory power? This was tested using survey data from 1351 plots from northern New South Wales. Altitude was found to have the greatest explanatory power in predicting the number of species per plot. Increasing cover/abundance of *Callitris glaucophylla* was found to be positively correlated with increasing species density. Fire was found to have a minor negative effect on species density in *Callitris glaucophylla* stands and grazing a small positive correlation in *Callitris endlicheri* stands.

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Introduction

Thirteen *Callitris* species (family Cupressaceae) occur in New South Wales. The two most common are *Callitris glaucophylla* Joy Thomps. & L.A.S. Johnson (White Cypress Pine), a tree, 20–30 m tall when mature that occurs across all mainland Australian states, and *Callitris endlicheri* (Parl.) F.M. Bailey (Black Cypress Pine), a shorter tree (approximately 15–20 m at maturity) that occurs along the eastern mainland states. Both species can form seemingly single-age stands, that continue to become denser to a point where other trees are outcompeted, the stand growth is limited and mortality is low (Lacey 1973; FCNSW 1988).

Some authors have suggested that increasing cover of the dominant *Callitris* reduces the diversity and suppresses the growth of understorey species (Walker *et al.* 1972; Boland *et al.* 1984; Clayton-Green & Ashton 1990). Thinning is frequently carried out on private lands and in state forests to release the overstorey and open up the canopy (Noland 1997) and there is some pressure to continue these practices in lands recently incorporated into National Parks, Nature Reserves and State Conservation Areas. However more recent evidence suggests that a reduction in species richness/density with increasing *Callitris* density does not occur. Andrews (2003) showed that grazing had a greater impact on understorey cover than *Callitris glaucophylla* density, and more recently Thompson and Eldridge (2005a) could find no clear relationships between *Callitris glaucophylla* cover, stem density or wood density and the density, cover or diversity of understorey species; differences were attributed to past disturbances such as forestry practices or grazing rather than increased *Callitris glaucophylla* density.

Here I test whether increased cover of *Callitris glaucophylla* or *Callitris endlicheri* has a measureable effect on species richness (species density) or whether other factors have a greater predictive power, using data from surveyed plots in northern New South Wales.

Methods

The study used existing data recorded from full native floristic 0.04 ha survey sites (20 x 20 m plots) in a 360 km square primarily from the western parts of the Northern Tablelands (west of the New England Highway), Nandewar and Brigalow Belt South Bioregions of New South Wales. Within this area altitude ranges from 50 to 1 210 m above sea level. Sites were chosen if they had some component of either *Callitris glaucophylla* or *Callitris endlicheri* (Fig 1), both species being found across all areas of this region. Two datasets were created, one for each *Callitris* species. Only sites surveyed by the author where chosen in order to limit the error introduced by other surveyors. All data were retrieved from the author's own relational database (Paradox

12 for windows). A total of 809 sites containing *Callitris glaucophylla* and 542 sites containing *Callitris endlicheri* where chosen.

Within each plot all species present were scored on a modified Braun-Blanquet cover abundance scale (1–6), though the non-native species were excluded from this for the current analyses. Projected cover codes were as follows: 1 <5% few individuals; 2 <5% any number of individuals; 3 = 6–25%; 4 = 26–50%; 5 = 51–75%; 6 >75%. Slope and horizontal elevation were measured using a 'SUUNTO Optical Reading Clinometer'. Horizontal elevation was measured at eight equidistant compass bearings. Aspect was measured using a compass with reference to magnetic north. Slope, Aspect and horizontal information was included within the analysis as raw scores. Additional attributes scored at each site included altitude, and logging, grazing and fire disturbances. The disturbance categories were scored based on a subjective severity score of one to five, with one being no visible signs of disturbance and five being obvious and severe disturbance. For instance a score of five for logging would include wholesale removal of all overstorey species, similarly a score of five for fire would include an intense and complete crown fire, and five for grazing would include heavy stocking rates within the past twelve months. The subjectivity of these disturbance scores has been reduced by recording by the same observer. Scores are subjective but considered appropriate for the level of analysis. The Braun-Blanquet score for *Callitris glaucophylla* and *Callitris endlicheri* was also used as a variable for each site. Multiple forward stepwise linear regressions of variables were carried out on the variance in the number of species per plot (species density).

Results

A summary of attributes of each dataset used for the analysis are presented (Table 1). No *Callitris* stands scored a foliage cover of more than 75% (score of 6). Overall no significant difference was found between any *Callitris* cover/abundance

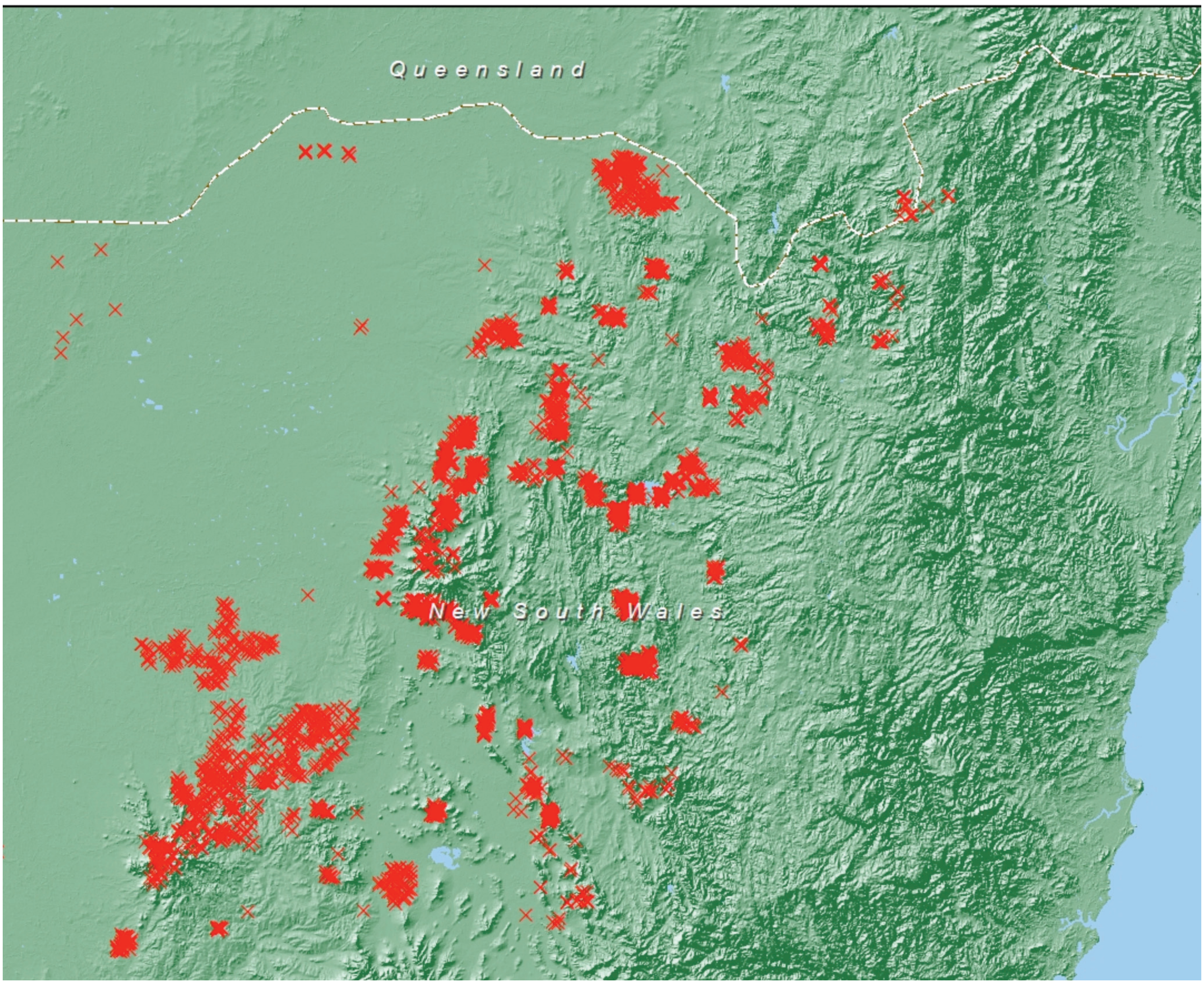


Figure 1: Location of sites within the study area.

Table 1. Selected attributes of the data used for the analysis

Selected Attributes	*Callitris glaucophylla*	*Callitris endlicheri*
Number of plots (sites)	809	542
Altitude range	50–1030 m	100–1210 m
Total number of taxa recorded	1032	995
Minimum number of taxa per plot	5	8
Maximum number of taxa per plot	84	93
Average number of taxa per plot	31	33
Percentage of plots with more than 30 taxa	45%	49%
Number of plots with less than 10 taxa	6	1
Number of Plots with *Callitris* cover/abundance score 1	182	146
Number of Plots with *Callitris* cover/abundance score 2	32	41
Number of Plots with *Callitris* cover/abundance score 3	315	150
Number of Plots with *Callitris* cover/abundance score 4	315	185
Number of Plots with *Callitris* cover/abundance score 5	14	30
Number of Plots with *Callitris* cover/abundance score 6	0	0

Table 2. Explanation of variation in species density (number of species per site) based on forward stepwise multiple linear regression in sites containing a) *Callitris glaucophylla* (*n* = 809). Overall variance explained 10% (p<0.00000) and **b)** *Callitris endlicheri* (*n* = 542). Overall variance explained 23% (p<0.00000). Only significant variables are presented.

a)

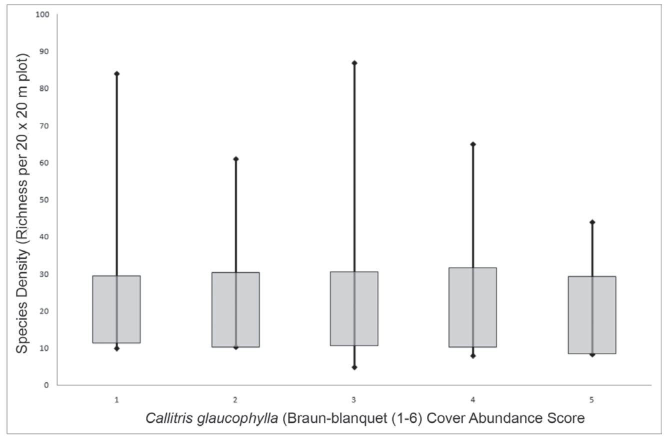
Variable	Correlation	r^2 change	P
1. Altitude	Positive	0.311	<0.00000
2. *Callitris glaucophylla* Cover/Abundance Score	Positive	0.093	0.00514
3. Fire	Negative	0.076	0.00235

b)

Variable	Correlation	r^2 change	P
1. Altitude	Positive	0.471	0.00000
2. Grazing	Positive	0.111	0.00610
3. *Callitris endlicheri* Cover/Abundance Score	Not significant		

score and species density (number of taxa per plot) from either dataset (Fig 2a, b). Regressions on both *Callitris* datasets showed altitude as the most significant predictor of the variance in species density (number of taxa per plot), far in excess of any other variable analysed (Table 2a,b). The data showed a small positive effect of increased species density with increasing *Callitris glaucophylla* cover/abundance, and a reduced species density with increase in the severity of fire (Table 2a). In contrast no significant effect positive or negative was found on species density with an increase

a)



b)

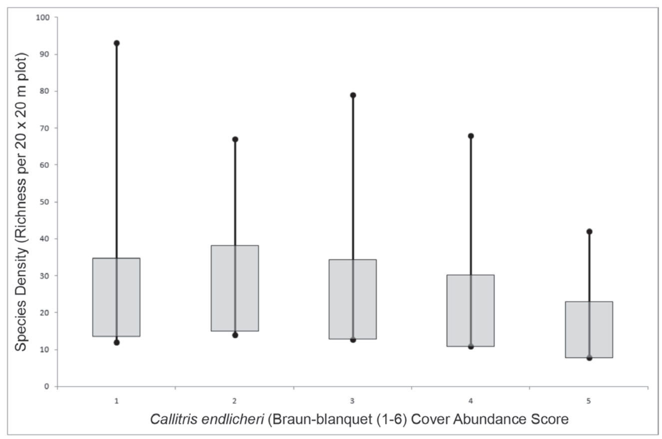


Fig 2. Variance in species density (number of species per site) for different cover abundance scores for **a)** *Callitris glaucophylla* and **b)** *Callitris endlicheri*. Maximum, minimum and standard deviation about the mean presented. Cover codes: 1 <5% few individuals; 2 <5% any number of individuals; 3 = 6–25%; 4 = 26–50%; 5 = 51–75%; 6 >75%.

in *Callitris endlicheri* cover/abundance (Table 2b). Fire severity did not have a significant effect on the species density in *Callitris endlicheri* sites though grazing had a small positive affect (Table 2b). Logging severity was not found to have a significant effect on species density within either dataset.

Discussion

Multiple linear regressions of data from 1,347 sites across the New England, Nandewar and Brigalow Belt South Bioregions showed no negative effect of increasing *Callitris* cover on the number of species per site. This is in contrast to anecdotal reports from some researchers (Walker *et al.* 1972; Boland *et al.* 1984; Clayton-Green & Ashton 1990) but in agreement with others (Andrews 2003; Thompson & Eldridge 2005a). In their analyses Thompson and Eldridge (2005a) showed that rainfall, potentially soil texture and carbon, and past disturbance history were greater predictors of change in understorey species richness, density and cover. Their results parallel the strong correlation with altitude presented here. Altitude relates closely with rainfall in the region studied (Hunter 2003ab; Hunter 2005). Scale of investigation is of importance as it effects the importance of local and regional factors in regression studies, with local factors becoming less important as the scale of the investigation increases (Hunter 2002; Hunter 2005). Thus local topographic factors may be important at a smaller local scale but were found to be unimportant in this broad-scale investigation.

One point of difference to previous works is the increase in species density found with an increase in cover/abundance of *Callitris glaucophylla*. It is difficult to speculate on the reasons why richness may have increased in this instance without more on ground manipulative experimentation. It could potentially be that *Callitris glaucophylla* provides a cover that ameliorates the extremes of climate, allowing species to establish and/or persist. This was not seen with *Callitris endlicheri*. Fire was found to have a significant negative effect on species density in *Callitris glaucophylla* sites but not *Callitris endlicheri,* and conversely grazing had a positive effect on the species density of *Callitris endlicheri* sites but had no significant effect on *Callitris glaucophylla* sites. The reasons for these differences cannot be explained based on the information contained in this broad study and require further detailed investigation.

Species density (number of species per plot) is only one aspect of landscape management (Hunter 2005). However species density is a score that is commonly used as a surrogate for other diversity measures and widely used as an indicator for management decisions. The results of this brief study should not be used as a sole basis for management decisions; however they provide evidence against to the widespread belief that increased *Callitris* cover/abundance is necessarily detrimental to species density. Land managers with dense *Callitris* stands who are concerned about abundance of all species are faced with the challenge of whether to leave the stands as they are, or to use one or more of the various techniques available to thin them, such as burning or mechanical thinning (Thompson & Eldridge 2005b; Lunt *et al.* 2006). Different paths are likely to cause different long-term outcomes resulting in locations perhaps diverging markedly from each other. Which is the right choice or choices for biodiversity within the landscape is still open to question, and needs further manipulative research.

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