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ARTICLE

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Assessment of tree fern browsing by introduced Sambar Deer in south-eastern Australia

By Ami Bennett

Summary Browsing on tree ferns (*Cyathea australis* and *Dicksonia antarctica*) was assessed at Mt Toolebewong, Victoria, Australia, where a population of Sambar (*Rusa unicolor*), a large deer species, is known to occur and compared with tree fern browsing at Tarra-Bulga National Park, Victoria, where Sambar are uncommon. At Mt Toolebewong, 52% of surveyed tree ferns had been browsed, with most damage occurring on individuals up to 130 cm high and typically involving removal of most or all of a frond to the base of the rachis. In contrast, only 7% of tree ferns had been browsed at Tarra-Bulga, with none browsed above 85 cm and only the frond tips removed. Browsing of whole fronds on mid-size tree ferns at Mt Toolebewong is attributed to the population of Sambar, and the lower intensity of browsing on smaller tree ferns at Tarra-Bulga to native herbivores. Populations of Sambar in wet forests of south-eastern Australia may, therefore, hinder recruitment of tree ferns into larger size-classes, at least at sites where tree ferns are favoured browse. The potential ecological consequences and management implications are discussed. Information is lacking on the severity and spatial scale over which deer impact tree fern populations. Tree fern browsing may be locally severe with site- and height-based browse evidence suggesting that this can largely be attributed to introduced Sambar. Browsing by deer has the potential to decrease growth, reduce survival and prevent recruitment of tree ferns into larger class sizes, with potentially detrimental implications for tree fern populations, associated species such as epiphytic flora, and the structure and function of wet forest ecosystems. Collection of appropriate field data will provide a better understanding of tree fern browsing and identify if and where management intervention is required.

Key words: *Cyathea australis*, deer, *Dicksonia antarctica*, Rusa unicolor, vegetation management, wet forests.

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Introduction

Tree ferns (Order Cyatheales) are a critical component of wet forests in eastern Australia and a conspicuous element of the understorey (Donoghue & Turner 2022). Six species of tree fern are native to Victoria (Donoghue & Turner 2022). Two species, Rough Tree Fern (*Cyathea australis* (R.Br.) Domin) and Soft Tree Fern (*Dicksonia antarctica* Labill.) are widespread in Victorian wet forests and riparian systems, where they may be locally abundant (Ough & Murphy 1996). Tree ferns are long-lived (~250 years) and slow growing (Donoghue & Turner 2022), with Rough Tree Fern growing 2–4 times faster than Soft Tree Fern (Blair *et al*. 2017; Fedrigo *et al*. 2019).

Tree ferns are often described as keystone species because of the microclimate they create (Ough & Murphy 2004; Volkova *et al*. 2010) and their role as a food source and habitat for native fauna. Mountain Brushtail Possum (*Trichosurus cunninghami*) and Swamp Wallaby (*Wallabia bicolor*) consume tree fern fronds (Edwards & Early 1975; Seebeck *et al*. 1984; Hollis *et al*. 1986); Crimson Rosella (*Platycercus elegans*) feed on tree fern spores (DNRE 2002); and native bees (*Exoneura* spp.) use dead tree fern fronds for nesting sites (Sugden 1988). Tree ferns also provide an important substrate for many epiphytic lichens, moss, ferns and orchids (e.g. Roberts *et al*. 2005). Some epiphytes, such as Fork Ferns (*Tmesipteris* spp.) and the endangered moss *Calomnion complanatum* are obligate epiphytes of tree ferns (Ough & Murphy 1996; Meagher 1999), while others are associated with specific tree fern species: e.g. the endangered Jungle Bristle-fern (*Abrodictyum caudatum*) associates with Rough Tree Fern and the endangered Mountain Helmet-orchid (*Corybas grumulus*) with Soft Tree Fern trunks (caudex; DELWP 2021; Royal Botanic Gardens Victoria 2022). Tree ferns are also described as a nursery site for some trees and shrubs, e.g. Banyalla (*Pittosporum bicolor*; Royal Botanic Gardens Victoria 2022).

In a recent review of the ecology of Australian tree ferns, Donoghue and Turner (2022) identified a number of knowledge gaps, including the potential for impacts caused by invasive species. They noted that while browsing of tree ferns occurred elsewhere, e.g. New Zealand, it did not arise in their search of Australian published literature. However, a targeted search revealed three peer-reviewed publications that have reported browsing on tree ferns by introduced deer in Australia: Peel *et al*. (2005) observed browsed and dead Rough, Soft and Prickly (*C. leichardtiana*) Tree Ferns in eastern Victoria, which they attributed to Sambar (*Rusa unicolor*); Forsyth and Davis (2011) recorded Rough and Soft Tree Ferns as minor components in rumen contents of

Implications for Managers

- Tree fern browsing by deer may be locally severe with site- and height-based browse evidence suggesting this can largely be attributed to introduced Sambar.
- Browsing by deer has the potential to decrease growth, reduce survival and prevent recruitment of tree ferns into larger class sizes, with potentially detrimental implications for tree fern populations, associated species such as epiphytic flora, and the structure and function of wet forest ecosystems.
- Collection of appropriate field data will provide a better understanding of tree fern browsing and identify if, and where, management intervention is required.

Sambar in Yarra Ranges National Park, Victoria, and recently, Bennett *et al*. (2022) included tree ferns in a field method for assessing deer impacts on forest vegetation because tree ferns were commonly observed to be browsed. Many unpublished reports (Claridge 2016a,b; GHD 2019; Greet *et al*. 2022) and theses (Bennett 2002, 2008; Stockwell 2003; Bowman 2014) also comment on or describe Sambar impacts to tree ferns. Similarly, there are numerous anecdotal observations of deer impacts to tree ferns by land and wildlife managers, scientists and hunters. These are mostly observations of frond browsing but also frond breakage while browsing, and face or body rubs on tree fern trunks, together with dead tree ferns exhibiting evidence of past severe browsing.

Sambar is a large-bodied deer species (110–230 kg, around 1.2 m tall at shoulder; Menkhorst & Knight 2011). First introduced to Victoria, the species is now widespread and abundant in south-eastern Australia (Davis *et al*. 2016). Sambar have large home ranges (Leslie 2011) and broad diets, variously described as browsers to intermediate mixed feeders, consuming a variety of trees, shrubs, ferns and forbs (Parker 2009; Forsyth & Davis 2011) that are able to reach foliage >2 m in height (Geist 1998). Sambar are listed in Victoria as a Potentially Threatening Process for the reduction of biodiversity of native vegetation (DELWP 2016), and the Victorian government is in the process of implementing a strategy to control deer populations and reduce their environmental impacts (DELWP 2020). This study aimed to determine if Sambar have a significant impact upon tree ferns by comparing tree fern browsing at Mt Toolebewong, Victoria, where Sambar are considered abundant, with browsing at Tarra-Bulga National Park, Victoria, where deer are largely absent.

Method

Study area

Mt Toolebewong is located on Wurundjeri Woiwurrung Country, 60 km north east of Melbourne, Victoria. The majority of the vegetation at Mt Toolebewong is classified as the Ecological Vegetation Class (EVC) Wet Forest with some areas of Damp Forest. Sambar are considered well established at Mt Toolebewong. Frequent observations of Sambar and their impacts at Mt Toolebewong, including browsing, tree rubbing, tracks and heavily worn trails, formed the impetus for the landowner of Mt Toolebewong, the Moora Cooperative Community, to commence an intermittent control program by ground shooting. Tarra-Bulga National Park (1522 ha) is located on Gunaikurnai Country, 220 km south east of Melbourne, near Traralgon, Victoria in the Strzelecki Ranges, with vegetation mostly comprised of EVCs Wet Forest and Cool Temperate Rainforest. No observations of deer had been reported at Tarra-Bulga National Park and local park managers considered deer to be uncommon, if not absent. Native herbivores likely to be present at both sites include the Swamp Wallaby (*Wallabia bicolour*), Mountain Brushtail Possum (*Trichosurus cunninghami*), Common Brushtail Possum (*Trichosurus vulpecula*) and Common Wombat (*Vombatus ursinus*). Neither site has domestic stock.

Survey design

Field surveys were conducted during July and August 2002. Quadrats (15 × 15 m; 225 m^2) in forest were selected to contain a mixture of Rough Tree Fern and Soft Tree Fern at a range of heights. This was a practical size that fit within most patches of forest understorey that contained tree ferns. Four quadrats (MT1–MT4) at Mt Toolebewong were located within 1 km of the summit (145°34′E, 37°43′S), and three quadrats (TB1–TB3) were surveyed at Tarra-Bulga, two within 1 km of 146°34′E, 38°25′S, and the third at 146°32′E, 38°26′S.

The species and height of each individual tree fern was recorded, with height measured to the top of the trunk to the nearest 1 cm for individuals below 2 m and estimated to the nearest 10 cm for individuals above 2 m. Tree ferns were classified as dead if they showed no green foliage. Live tree ferns were scored as browsed or not browsed. A Browsing Intensity Index (BII) was developed for rapid classification of visual estimates of frond loss on individual tree ferns (BII 1 = 0%; 2 = 1–25%; 3 = 26–50%; 4 = 51–75%; 5 = 76–100%). Estimation of frond loss assumed that fronds were intact before browsing.

Data analyses

Statistical analyses were performed using Minitab v10.5 and SPSS for Windows 12.0.1 (for non-parametric analyses). Assumptions of normality and equal variance were checked using graphical techniques, the Anderson-Darling test for Normality, and Bartlett's and Levene's tests for Homogeneity of Variance. ANOVAs were performed using square-root-transformed data, and significant differences between quadrat pairs were determined using Fisher's Least Square Differences (Sokal & Rohlf 1987); data were back-transformed before presentation. Significant differences in proportions were determined by calculation of standardised residuals for contingency tables.

Results

The physical, structural and floristic characteristics of the seven quadrats containing tree ferns across the two sites were similar (Table 1). All quadrats contained three to four vegetation strata and were located on steep slopes except for quadrat TB2 and part of MT2, which were relatively flat. Elevation was 400–620 m, with quadrats generally facing south-east where moister and cooler conditions are optimal for tree ferns (Table 1).

In total, 155 living tree ferns were examined at Mt Toolebewong, and 121 living tree ferns at Tarra-Bulga. Quadrats contained 19–75 tree ferns (Table S1), 85–100% of these being alive. Soft Tree Fern was the most common tree fern in quadrats MT1, MT2, TB1 and TB3, while Rough Tree Fern was the most common tree fern in quadrats MT3 and MT4, and quadrat TB2 contained approximately even numbers of each species. Overall,

Table 1. Site and quadrat characteristics.

	MT1	MT2	MT3	MT4	TB1	TB2	TB3
Location	Mt Toolebewong	Mt Toolebewong	Mt Toolebewong	Mt Toolebewong	Tarra-Bulga NP	Tarra-Bulga NP	Tarra-Bulga NP
Elevation (m, ASL)	575	475	525	590	610	620	400
Aspect	SE	E	SW	SE	SE	SSE	W
Slope (degrees)	45	5–45	40	30–47	38–50	5	45–50
Descriptive forest type	Wet forest	Wet forest	Damp forest	Wet forest	Cool temperate rainforest	Wet forest	Cool temperate rainforest
Structural forest type	Tall woodland	Closed scrub – Regenerating tall forest	Tall woodland – Regenerating tall open-forest	Tall shrubland – Regenerating tall forest	Tall closed-forest	Tall open-forest	Tall forest
Canopy							
Height (m)	40	40	40	40	30	30	55
Cover (%)	15	2	20	10	70	50	30
Dominant species†	*Eucalyptus regnans*	*Acacia melanoxylon*	*Eucalyptus regnans*	–	*Nothofagus cunninghamii*	*Acacia melanoxylon*	*Eucalyptus regnans* *Nothofagus cunninghamii*
Mid stratum							
Height (m)	1.5–6	1–6	2–5	2–6	2–4	2–6	2–6
Cover (%)	50	90	15	90	90	90	90
Dominant species†	*Coprosma quadrifida* *Cyathea australis* *Dicksonia antarctica* *Hedycarya angustifolia* *Olearia argophylla*	*Coprosma quadrifida* *Cyathea australis* *Dicksonia antarctica* *Hedycarya angustifolia* *Olearia argophylla*	*Coprosma quadrifida* *Cyathea australis* *Dicksonia antarctica* *Hedycarya angustifolia* *Olearia argophylla*	*Coprosma quadrifida* *Cyathea australis* *Dicksonia antarctica* *Hedycarya angustifolia* *Olearia argophylla*	*Cyathea australis* *Dicksonia antarctica* *Hedycarya angustifolia*	*Cyathea australis* *Dicksonia antarctica* *Hedycarya angustifolia*	*Cyathea australis* *Dicksonia antarctica* *Olearia argophylla*
Lower stratum							
Height (m)	0.5–1.5	0.5–1.5	0.5–1.5	2–6	2–4	2–6	0.5–1.5
Cover (%)	60	15	30	90	90	90	15
Dominant species†	*Dicksonia antarctica* *Polystichum proliferum*	*Blechnum cartilagineum* *Cyathea australis* *Dicksonia antarctica* *Polystichum proliferum*	*Blechnum nudum* *Calochlaena dubia* *Cyathea australis* *Dicksonia antarctica* *Gahnia* sp *Goodenia ovata* *Olearia lirata* *Pandorea pandorana* *Polystichum proliferum* *Tetrarrhena juncea*	*Calochlaena dubia* *Cyathea australis* *Dicksonia antarctica* *Polystichum proliferum* *Tetrarrhena juncea*	*Blechnum wattsii* *Dicksonia antarctica* *Grammitis billardieri*	*Blechnum wattsii* *Cyathea australis* *Dicksonia antarctica* *Grammitis billardieri* *Polystichum proliferum*	*Blechnum wattsii* *Cyathea australis* *Dicksonia antarctica* *Grammatis billardieri* *Polystichum proliferum*

†Only species present within the individual quadrats are listed.

Rough Tree Fern individuals were substantially larger than Soft Tree Fern individuals (Table S1), many individual Rough Tree Fern being several metres tall. The mean height of tree ferns was greater at Tarra-Bulga (209 cm) than at Mt Toolebewong (152 cm), but the distribution of tree fern heights was non-normal (skewed to low heights), and variances for height at the two sites were significantly different (Bartlett's and Levene's tests for Homogeneity of Variances, $P < 0.001$). There was a significant difference in median height between sites when data from the quadrats at each site were merged (Mt Toolebewong median = 109 cm, Tarra-Bulga median = 145 cm, $P = 0.005$, Mood's median test), and a significant difference between sites in the overall distribution of tree fern heights ($P = 0.011$, Kruskall-Wallis Test).

A large number of tree ferns were browsed at Mt Toolebewong, often involving the loss of entire fronds (Fig. 1a). In comparison, only a few tree ferns were browsed at Tarra-Bulga, with browsing limited to frond tips (Fig. 1b). The proportion of tree ferns browsed at Mt Toolebewong (52%) was much higher than at Tarra-Bulga (7%; Table 2). In general, a greater proportion of the Soft Tree Fern individuals were browsed than the Rough Tree Fern individuals in all quadrats and quadrats with less browsing contained taller ferns (Table 2).

The intensity of browsing also differed between the two sites, with a BII site mean at Mt Toolebewong of 2.37 compared with a site mean BII of 1.09 at Tarra-Bulga (Table 2). The distribution of BII values was non-normal (skewed to low values), with variances for BII at the two sites being significantly different (Bartlett's and Levene's tests for Homogeneity of Variances, $P < 0.001$). There was a significant difference in median BII between sites (Mt Toolebewong median = 2.00, Tarra-Bulga median = 1.00, $P < 0.001$, Mood's median test), and a significant difference between sites in the distribution of BII values ($P < 0.001$, Jonckheere-Terpstra test).

The intensity of browsing within each site was also strongly dependent on tree fern height. At Mt Toolebewong, Soft Tree Fern had a mean height of 98 cm and were browsed heavily (mean BII of 2.88), whereas the taller Rough Tree Fern (mean height of 233 cm) were browsed less intensely (mean BII of 1.60). Soft Tree Fern at Tarra-Bulga were taller (mean height of 164 cm) than at Mt Toolebewong and experienced a very low intensity of browsing (mean BII of 1.12), while Rough Tree Fern at Tarra-Bulga (mean height of 344 cm) were not browsed at all. In a Two-Way ANOVA across site and species using square-root-transformed data (error DF = 10), BII values differed significantly ($F = 11.41$, $P = 0.007$) between quadrats located at Mt Toolebewong and Tarra-Bulga, but did not differ significantly between species ($F = 3.09$, $P = 0.109$), and there was no significant interaction between species and site in the variation of BII values ($F = 1.58$, $P = 0.238$). Data from the two tree fern species were, therefore, pooled for analysis of the height-dependence of browsing.

The greatest amount of browsing at Mt Toolebewong was seen on tree ferns between 24 and 86 cm high with 98% of individuals in this height range being browsed, and substantial levels of browsing in individuals up to 130 cm high. Some individuals over 130 cm high were browsed (the tallest showing evidence of browsing was 211 cm high), but these individuals were physically accessible to Sambar, such as on a creek bank, steep slope or in proximity to a "step" such as a fallen log. Browsing at Tarra-Bulga was observed only in the two height classes below 86 cm; the most browsing was seen on individuals in the height range 0–23 cm, with 33% in this range being browsed. Browsed tree ferns thus extended into much larger height-classes at Mt Toolebewong than at Tarra-Bulga.

A similar pattern of height dependence of browsing intensity was evident between the sites (Fig. 2b). At Mt Toolebewong, tree ferns with moderate to severe levels of browsing (BII = 2–4) were found throughout the height range 0–170 cm but were concentrated in the 24–86 cm (only one individual was unbrowsed) and 87–130 cm height classes, with browsing intensity values frequently above three (Fig. 3a). In comparison, browsing at Tarra-Bulga was limited to the two lower height classes (0–86 cm; Fig. 3b) and was less intense (mean BII = 1.44, maximum BII = 3), with no individual having lost more than half of its frond area.

Analysis of square-root-transformed quadrat mean BII values in a Two-Way ANOVA with site and height class as variables (error DF = 25) showed significant differences in browsing intensity between Mt Toolebewong and Tarra-Bulga ($F = 28.02$, $P < 0.001$), as well as significant differences between height classes ($F = 4.02$, $P = 0.012$). There was also a significant interaction between site and height class in the variation of BII values ($F = 3.11$, $P = 0.033$). The higher browsing intensity at Mt Toolebewong thus remained significant when the effects of both species and size were removed from the analysis.

Discussion

This is the first study to specifically examine browsing damage to tree ferns in Australia. At Mt Toolebewong, a greater proportion of tree ferns had been browsed, browsing damage was present on taller tree ferns, and was significantly more severe than at Tarra-Bulga. There was also a species difference: Soft Tree Fern was more frequently browsed than Rough Tree Fern. This study is correlative, limited to comparative observations of browsing at two sites similar in attributes except that deer were only present at one site. To explicitly demonstrate which fauna species browsed these tree ferns, techniques such as camera traps (Comte *et al.* 2022), exclusion fences (Bennett & Coulson 2008) or environmental DNA (Nichols *et al.* 2012) would be required. Nonetheless, given the considerable difference in height and severity of browsing on tree ferns between sites, it strongly suggests that browsing damage at Mt Toolebewong, particularly of the taller tree ferns, can largely be attributed to the population of Sambar, while browsing at Tarra-Bulga is likely due to smaller native herbivores such as Swamp Wallaby. This is supported by a differential exclosure experiment which demonstrated native herbivore browsing largely occurs below 60 cm (Bennett 2008). Furthermore, this study shows that browsing by Sambar has the potential to restrict the growth of tree ferns into larger class sizes, and over time could reduce the abundance of tree ferns and alter the structure and function of wet forests, with significant ecological consequences for the flora and fauna reliant on them.

In this study, Soft Tree Fern were browsed more frequently than Rough Tree Fern. Because Soft Tree Fern is slower growing than Rough Tree Fern (Blair *et al*. 2017; Fedrigo *et al*. 2019), impacts to Soft Tree Fern populations may thus be more severe. While tree ferns readily recover from the loss of fronds from a single disturbance event such as fire or logging (Volkova *et al*. 2010), it is unknown how many years of repeated browsing a tree fern can sustain before death occurs. Repeated measurements of marked tree ferns would enhance our understanding of the effect of repeated severe browsing events on the survival of tree ferns.

All anecdotal reports of tree fern browsing by deer in Victoria are considered to have been caused by Sambar, as determined by their location and absence of other deer species. Although the majority of unpublished reports of tree fern browsing are from central Victoria, observations by Peel *et al*. (2005) from East Gippsland, Victoria and Claridge (2016a) near the Geehi River on the western side of Kosciuszko National Park, NSW (A. Claridge, DPI NSW, pers. comm., 2022) suggest that tree fern browsing by Sambar may be widespread. Deer browsing of tree ferns may also have implications for the persistence of rare tree ferns: the Slender Tree Fern (*C. cunninghamii*) and Prickly Tree Fern are listed as Critically Endangered under the Victorian *Flora and Fauna Guarantee Act* 1988 (DELWP 2021), and severe Prickly Tree Fern browsing has been observed (Peel

(a) (b)

Figure 1. Typical observations of browsed tree ferns at (a) Mt Toolebewong where whole fronds are removed and (b) Tarra-Bulga where tips of individual frond pinnae only are removed. For scale, the tree fern trunk depicted in (a) is approximately 20 cm diameter, and the section of frond shown in (b) is approximately 25 cm long.

Table 2. Tree fern browsing observed in each quadrat separated by site and tree fern species.

Quadrat	Mt Toolebewong					Tarra-Bulga			
	MT1	MT2	MT3	MT4	MT total	TB1	TB2	TB3	TB total
All species									
Live individuals	33	39	18	65	155	54	44	23	121
Browsed individuals	29	28	12	12	81	2	6	1	9
% browsed	89	72	67	18	52	4	14	4	7
Mean BII†	3.94	2.56	2.72	1.35	2.37	1.06	1.16	1.04	1.09
BII SE	0.24	0.19	0.35	0.11	0.12	0.04	0.06	0.04	0.03
Rough Tree Fern – *Cyathea australis*									
Live individuals	2	6	15	39	62	3	19	8	30
Browsed individuals	0	2	9	2	13	0	0	0	0
% browsed	0	33	60	5	21	0	0	0	0
Mean BII†	1.00	1.83	2.73	1.15	1.60	1.00	1.00	1.00	1.00
Soft Tree Fern – *Dicksonia antarctica*									
Live individuals	31	33	3	26	93	51	25	15	91
Browsed individuals	29	26	3	10	68	2	6	1	9
% browsed	94	79	100	38	73	4	24	6	10
Mean BII†	4.13	2.70	2.67	1.65	2.88	1.06	1.28	1.07	1.12

†BII = 1, no browsing.
SE, standard error of the mean.

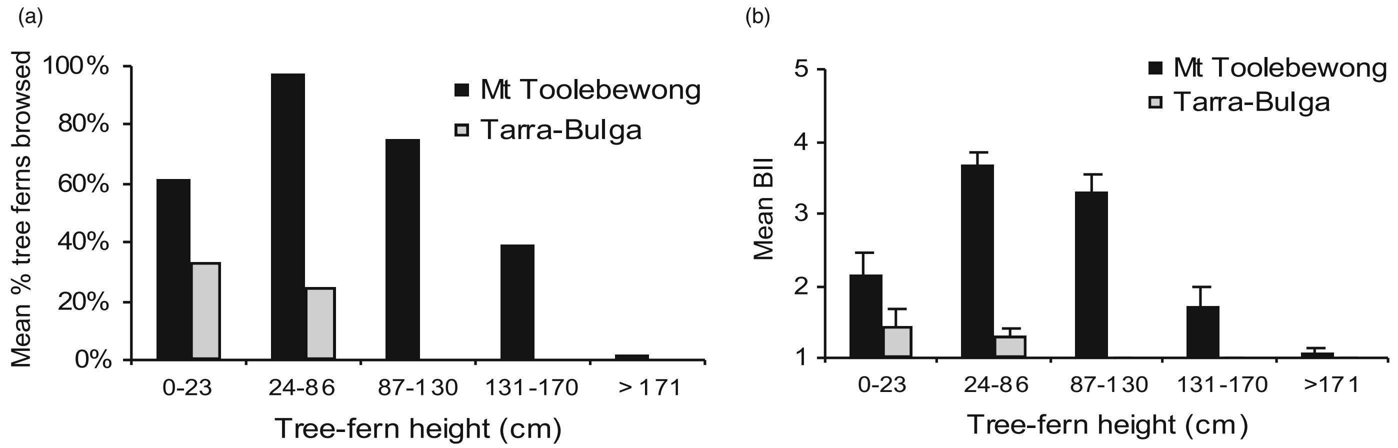

Figure 2. Browsing on tree ferns of different height ranges at Mt Toolebewong (MT1–4) and Tarra-Bulga (TB1–3). (a) Mean percentage of tree-fern individuals browsed and (b) Mean Browsing Intensity Index (BII) values where 1 = 0%; 2 = 1–25%; 3 = 26–50%; 4 = 51–75%; 5 = 76–100% frond area removed. Error bars are standard error of the mean.

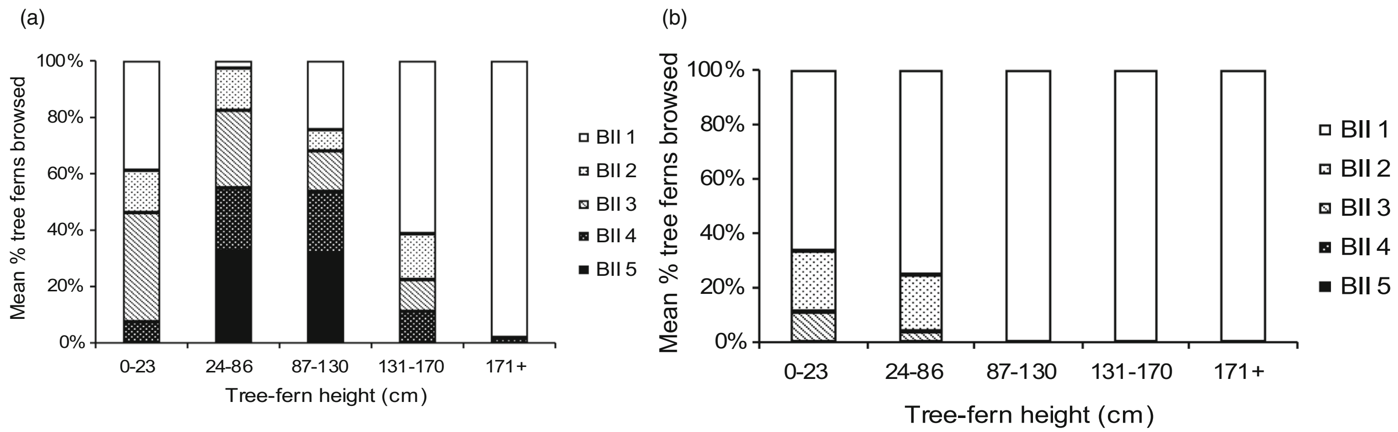

Figure 3. Browsing Intensity Index (BII) distributions of tree ferns of different heights at (a) Mt Toolebewong (MT1–4) and (b) Tarra-Bulga (TB1–3). Value plotted is the percentage of tree-ferns within each size class that have a specified BII where 1 = 0%; 2 = 1–25%; 3 = 26–50%; 4 = 51–75%; 5 = 76–100% frond area removed.

et al. 2005). Differential exclosures (Bennett & Coulson 2008) have been used to separate deer and native herbivore browsing damage to native vegetation, including to tree ferns (Bennett 2008; GHD 2019; Greet *et al.* 2022). While exclosure experiments are important for quantifying and understanding changes in vegetation structure and composition over time (Davis *et al.* 2016), they are generally limited by plot size, the number of replicates and spatial distribution due to high establishment and on-going maintenance costs (Scofield *et al.* 2011). Broad-scale field surveys of tree ferns are required to assess browsing damage to individuals and populations in order to understand the severity and scale of the issue. Targeted surveys would likely be most informative, but the inclusion of tree ferns in general browsing impact surveys (e.g. Bennett *et al.* 2022) can also provide a better understanding of the problem of tree fern browsing by deer.

Tree ferns are an important element of wet forest systems (Donoghue & Turner 2022). In New Zealand, Gaxiola *et al.* (2008) found that understorey plant seedlings growing on tree fern trunks <2 m are browsed by deer, and Bee *et al.* (2007) argued that the ability to use tree fern trunks as a substrate for germination above browse height can explain the persistence of some highly palatable plant species in forests that have been altered by introduced deer. Although the potential has been implied, there has been no demonstration in Australia of selective browsing by deer reducing the abundance of common plant species in forested habitats (Davis *et al.* 2016). Similarly, no study has examined the frequency with which tree and shrub seedlings grow on tree ferns in Australia, or if using tree ferns as a substrate improves the persistence of species palatable to deer. A species such as Banyalla, which grows on tree fern trunks (Ough & Murphy 1996; Royal Botanic Gardens Victoria 2022) and has long been considered highly palatable to Sambar (e.g. Burke 1982), would be a good candidate to investigate such questions.

This study highlights the potentially severe ecological consequences of deer browsing on tree fern populations. These effects may be compounded or accelerated given the predictions for increased abundance and distribution of deer across Australia (Davis *et al.* 2016) and stress from climate change (e.g., prolonged droughts and more intense wildfires; Bureau of Meteorology 2022). Land managers, including all tiers of government, local practitioners and the scientific community should consider this potential threat to wet forest systems in their research, monitoring, and management practice. In particular, further research is required to better understand: how widespread and severe tree fern browsing is; the long-term implications of deer damage to tree fern recruitment, including to individual tree fern species; the effect of deer browsing on the persistence of flora and fauna associated with tree ferns; and how deer browsing effects wet forest ecosystem function and resilience.

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Conflicts of Interest

The author declares no conflicts of interest.

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Supporting Information

Additional supporting information can be found in the following online files.

Table S1.