JOINT VENTURE AGROFORESTRY PROGRAM

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Measurement and integration of fauna biodiversity values in Queensland agroforestry systems

A report for the RIRDC/ Land and Water Australia/ FWPRDC Joint Venture Agroforestry Program Supported by the Natural Heritage Trust

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Foreword

Farm forestry is an emerging industry in Australia, and sub-tropical south east Queensland and northeastern New South Wales are major growth areas for the industry. In south east Queensland alone 330,000 ha is available to farm forestry. By June 2003 some 5,000 ha of this potential farm forestry land is expected to be planted in south east Queensland under State government sponsored schemes with private landholders.

Polls of private landholders involved in farm forestry both in Queensland and elsewhere in Australia indicate plantations are set up for a variety of reasons. For many, one significant reason for planting is the enhancement of wildlife values. There are also other imperatives for enhancing biodiversity through farm forestry. Land clearing Australia wide, especially for agriculture, has impacted on biodiversity and ecological processes. Farm forestry using native species has the potential to partly contribute to the return of biodiversity and ecological function to the farm. However, technical information is lacking on what native flora and fauna will use farm forestry plantations and how these plantings may be made more biodiversity friendly.

This project aims to improve our technical knowledge of what vertebrate fauna uses farm forestry plantations in south east Queensland. Through the necessity to measure habitat attributes, this project has also documented flora occurring in these plantations. The project also commences to identify ways to enhance vertebrate diversity in farm forestry plantations. From this project and similar studies elsewhere in Australia, the technical information generated will allow further development of farm forestry planting guidelines to ensure the potential of farm forestry to contribute to biodiversity maintenance and restoration is realized.

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This report, a new addition to RIRDC's diverse range of over 700 research publications, forms part of our Agroforestry and Farm Forestry R&D program, which aims to integrate sustainable and productive agroforestry within Australian farming systems.

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Abbreviations

cm	centimetre
dbh	trunk diameter at 1.3 m (commonly referred to as 'diameter at breast height')
DNR	Queensland Department of Natural Resources
DPI	Queensland Department of Primary Industries
F&M	Forestry and Wildlife Division
ha	hectare
JVAP	Joint Venture Agroforestry Program
m	meter
NR&M	Queensland Department of Natural Resources and Mines
QPWS	Queensland Parks and Wildlife Service
RFA	Regional Forest Agreement
RIRDC	Rural Industries Research & Development Corporation
SLATS	Statewide Landcover and Trees Study
VMA	Queensland *Vegetation Management Act 1999*

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Executive Summary

The broad objectives of this study were to expand knowledge of the importance of farm forestry to biodiversity in south east Queensland and to commence assessment of how biodiversity can be enhanced within plantations. The broad objectives rely on the premise that management and design options recommended for enhancing biodiversity values in farm forestry plantations are practical and ecologically sustainable and can be successfully incorporated into farm forestry practices without significantly compromising timber production costs.

Specific objectives of this study were to:

1. Identify, quantify and compare vertebrate fauna within:
    a. Various age, single species, eucalypt plantations;
    b. Cleared, grazed, improved pasture; and
    c. Selectively logged, eucalypt forest;
2. Measure habitat attributes and relate to vertebrate fauna diversity;
3. Commence identification of economic, practical and ecologically sustainable farm forestry practices to enhance vertebrate diversity and nature conservation values; and
4. Provide research findings and management recommendations to agencies providing farm forestry decision support.

The field assessment in this project was conducted between June 1999 and January 2001. Fauna surveys and associated habitat assessments were conducted over two winter and two summer periods. Eighteen survey sites were established; 3 on cleared, grazed, improved pasture; 11 in various age Gympie messmate (*Eucalyptus cloeziana*) plantations; and 4 in selectively logged eucalypt forests. The age classes of plantations surveyed were 0.3 to 1.8, 2.1 to 3.8, 15 to 16.5 and 38 to 40.5 years of age. Mean plantation area was 7 hectares (range 1.5 to 10.5 ha). Vertebrate fauna, both native and introduced, were surveyed using a range of systematic techniques. Opportunistic fauna records were also kept. Fauna surveyed included mammals (bats, arboreal and ground species), birds, reptiles and frogs. Habitat measurements were taken on the study sites, and included plant species (native and introduced), ground cover, vegetation structure, plantation tree growth, logs and stumps.

A total of 205 vertebrate species were recorded during the survey period, of which 175 were found in the Gympie Messmate plantations. The 175 species from the plantations represent a third of the vertebrate species occurring in the bioregion provinces in which the survey sites were located. Biggest contributors to vertebrate species richness in the plantations were birds with 100 species. All other vertebrate groups contributed to the remaining 75 vertebrate species, the arboreal mammals contributing least with three species. Greatest vertebrate species richness was in the plantations 38 to 40.5 years of age with a mean vertebrate diversity of 63.7 species, which was not significantly different from the mean of 69.7 for the selectively logged eucalypt forest sites. Species composition changed with plantation age, 66 species restricted to plantations less than 16. 5 years of age and 38 restricted to the 38 to 40.5 year old plantations. Mean number of vertebrate fauna species recorded was higher in the four plantation age classes than on the cleared, grazed, improved pasture sites. Two bird species and the introduced cane toad were the only species recorded in all 11 plantations surveyed. Five of the six introduced vertebrate species recorded were found in plantations. A rare

frog, lizard and blind snake species and one threatened frog species were recorded in the 38 to 40.5 year old plantations. Seven of the eight rodent species occurring in the plantations are known major or minor pests in crops, orchards or food/grain storage facilities. Two of the potentially most serious rodent pest species (house mouse - *Mus musculus*; grassland melomys - *Melomys burtoni*), showed a clear preference for plantations with a thick, grassy understorey. A further five vertebrate species recorded in the plantations are potential pests in eucalypt plantations.

Except for birds as a group and a few individual vertebrates species (*e.g.* some rodents), there was insufficient data to compare vertebrate abundance between the four plantation age classes, selectively logged eucalypt forest and cleared, grazed, improved pasture. Bird abundance in the plantations 38 to 40.5 years old was significantly higher than for cleared, grazed, improved pasture and the plantations 0.3 to 1.8 years of age. Bird abundance was split into diet guilds and showed that birds with diets of either vegetable matter, fruit and invertebrates or seed and invertebrates were either absent or in low numbers on all plantation sites. Nectivorous birds were significantly more abundant in the 38 to 40.5 year old plantations compared to the plantations 0.3 to 1.8 years of age.

Comparing various plantation habitat attributes with vertebrate species richness found the best positive correlation was with percentage vegetation cover above 1.8 m (correlation of 0.81). Other plantation habitat attributes with positive correlations with vertebrate species richness were plant density above 5 m (0.78), plantation tree trunk diameter at 1.3 m [dbh] (0.74), plantation tree height (0.73), plant density above 8 m (0.72) and plantation age (0.68). There was no correlation between species richness and plantation area within the range of 1.5 to 10.5 hectares. Vertebrate species richness was negatively correlated (-0.67) with the number of grass, sedge and herb species present. The 38 to 40.5 year old plantations, where the greatest number of vertebrate species were recorded, were significantly more complex in habitat structure than the younger plantations. The plantations 38 to 40.5 years of age had significantly more stumps and logs, higher plant densities in a number of height classes, more leaf litter, less grass species and less combined grass, sedge and herb species. They were also not grazed, had good connectivity to native forest, had no evidence of recent fire and had minimal plantation maintenance since initial planting, tending and thinning. The relative importance of each of these habitat attributes to high species richness in the 38 to 40.5 year old plantations was not determined in this study.

The results of this study show vertebrate diversity was low on cleared, grazed, improved pasture and that single species eucalypt plantations of 10 hectares or less with connectivity to some form of natural habitat, even without any special management to enhance biodiversity, will support more vertebrate species. There should therefore be continuing effort to encourage plantation establishment on cleared lands. With a clear benefit to vertebrate diversity through establishment of single species eucalypt plantations, it is worth investigating the benefit of multi-species eucalypt plantings to vertebrate diversity.

This study clearly shows all vertebrate groups, not just birds, will benefit from eucalypt plantations and that even rare and threatened species may use these plantations. Rare and threatened species should be encouraged, but the grower's rights to cut timber should be protected. Unless it is planned to replant plantations after timber harvesting, farm forestry plantations will only provide a short to medium term gain to vertebrate diversity on the farm. The impact on vertebrate fauna of timber harvesting and subsequent replanting is unknown and requires further investigation. Where more than one plantation block is planned, establish adjacent to each other and stagger harvest times by at least four years. Where pest species can potentially use habitat within a plantation to breed and threaten adjacent crops, etc, management of the plantation understorey or groundcover may be required. Such habitat management could potentially affect vertebrate diversity.

With highest vertebrate diversity recorded in the 38 to 40.5 year old plantations, it is recommended that the siting, establishment and management of new eucalypt plantations incorporate habitat features found in these older plantations. These features include good connectivity to native forest, the retention of logs and stumps, suppression of a thick grassy groundcover, a good litter layer, encouragement of a layered understorey of shrubs and small trees and exclusion of grazing animals and hot fires. For practical purposes, retention of stumps and logs and development of a complex shrubby understorey should occur every second planting row. To provide reasonable time for development and use of a complex shrubby understorey by vertebrates, maximize time between planting and harvest by growing trees for longer term products such as pole timbers. It is recommended measuring the biodiversity benefits of establishing a complex shrubby understorey beneath plantation trees, by using commercial, shade-tolerant, native species that can be harvested for foliage, flower, and other products.

1. Introduction

1.1 Farm forestry and biodiversity in south east Queensland

The Australian plantation estate stood at an estimated 1,484,743 ha in September 2000, the small but expanding farm forestry component totalling 66,980 ha (Wood *et al.*, 2001). A further 168, 000 ha of the Australian plantation estate are industrial plantations specifically set up through leasehold and joint venture arrangements with private landholders (Wood *et al.*, 2001). Of the available data on previous land use, 53% of plantations in Australia have been established on agricultural land, this percentage increasing compared to establishment on forested land (Wood *et al.*, 2001).

In sub-tropical eastern Australia, commercial farm forestry planting schemes are in their infancy, but the area potentially available for plantation establishment is large. In south east Queensland 330,000 ha is available for farm forestry (Anderson and Halpin, 2001), while in coastal northern NSW 253,600 ha has been identified as potentially suitable for eucalypt plantations (Novak, 2001). In 1996, the Queensland Government instigated the Private Forestry Plantation Initiative to encourage and promote the development of commercial plantations of native species on privately-owned, cleared, agricultural land in south east Queensland and far north Queensland (Anderson and Halpin, 2001). A corner stone of the initiative was a Joint Venture Scheme between Queensland DPI and landowners. In the first two years of the scheme 398 ha of sawlog plantations were established in south east Queensland (Anderson and Halpin, 2001). In 1999 the Queensland Government replaced the Private Forestry Plantation Initiative with the South East Queensland Hardwood Plantation Program (Halpin, pers. comm.). This new scheme was set up to meet a Queensland Government commitment, under the South East Queensland Forest Agreement, to establish 5,000 ha of hardwood, sawlog plantations in south east Queensland by June 2003 (DPI, 2001). The scheme operates through equity joint ventures and leasing arrangements with landholders, although two land parcels were acquired by Government as Crown Freehold for plantation establishment under the scheme (N. Halpin, pers. comm.). Private companies are also setting up hardwood plantations in south east Queensland through lease and land acquisition, the plantations for woodchip or sawlogs (N. Halpin, pers. comm.).

There have been other Queensland Government sponsored tree planting schemes operating in south east Queensland. Between 1981 and 1990 a Windbreak and Forest Plot Scheme was successfully run in south east Queensland on the sunshine coast north of Brisbane (Sewell, 2000). The aim of the scheme was to encourage community recognition of the value of trees in land rehabilitation, as windbreaks, as shelterbelts, for timber production and to a limited extent in the sustainable management of native forest on private lands (Sewell, 2000). From 1990 to 2000 a Treecare program was operated across Queensland (Sewell, 2000). The program included a Tree Assistance Scheme that in four local authorities alone in south east Queensland processed 2,272 applications, supplied over 709, 000 trees and saw the establishment of approximately 246 ha of plantations from 0.5 to 5 ha in area (Sewell, 2000; Sewell, pers. comm.).

In addition to the promotion of farm forestry as a commercial enterprise, there is potential to contribute to biodiversity, conservation, aesthetics and pest management. The need to enhance and encourage biodiversity and conservation values has never been higher. Biodiversity has decreased in Australia due to clearing since European settlement (Bradstock *et al.*, 1995). Clearing rates on freehold land have increased in Queensland since 1993, clearing largely for pasture purposes (DNR, 2000). Queensland accounted for an estimated 88 % of all clearing in Australia from 1991 to 1999 (Australian Greenhouse Office, 2000). During the period 1997 to 1999, the average annual clearing rate was calculated by the Queensland Statewide Landcover and Trees Study (SLATS) to be 425,000 ha per year, or 0.24% of the Queensland land area (DNR, 2000). In the period 1997 to 1999, DNR (2000) calculated 3.7% of the 65,681 ha in the South east Queensland Bioregion was cleared. Catterall and Kingston (1993) also provide evidence of significant and ongoing clearing in south east Queensland.

The process to reduce Queensland clearing rates has commenced with the enactment of the Queensland *Vegetation Management Act 1999* (VMA). The VMA serves to regulate vegetation clearing on freehold land and freeholding leases to maintain biodiversity and ensure ecologically sustainable land use. Queensland also has a broad scale tree clearing policy for State lands, and there are vegetation management provisions under a number of other State Acts.

Farm forestry offers an opportunity to reforest cleared farmland, with an expectation of contributing to biodiversity values and improving ecological function. There is also a social context to enhancing biodiversity. ABARE (1995) census data indicates "Native Vegetation and Wildlife Values" are a significant reason for tree planting on Australian farms. Landholders surveyed in north and south east Queensland considered environmental benefits such as land and water protection and the creation of wildlife habitat as being the most important reasons for farm forestry plantings (Harrison *et al.*, 2001). Under the Queensland Government sponsored Tree Assistance Scheme between 1990 and 2000, 65% of the applicants from four local authorities in south east Queensland cited wildlife as at least one of the end uses for establishing a tree planting (Sewell, 2000; Sewell, pers. comm.). This is supported by informal feedback from farm forestry extension officers in south east Queensland, which indicate a growing awareness by landholders of environmental values (N. Halpin, pers. comm.).

Although there is a desire by landholders to incorporate biodiversity values into the management of farm forestry plantations, there is still little technical information on the potential of farm forestry to contribute to biodiversity and conservation values on farmland (AACM, 1998; Lamb, 1998), and how this might be achieved through economic, practical and ecologically sustainable management practices and design options (AACM, 1998). Tucker (2000) has examined small mammal colonisation of restoration plantings of trees linking native forest blocks in the Wet Tropics of North Queensland. In plantings up to 5 years of age he found a trend toward increasing ground mammal species diversity and abundance with age of the planting and proximity to existing native forest. Tucker (2000) reports on unpublished data by A. Jansen indicating a rapid colonization by bird species of the restoration plantings. In a south east Queensland study, vertebrate and invertebrate fauna were surveyed in ungrazed, unburnt, single-species, agroforestry plots and mixed species shelter belts, these compared with adjacent lightly grazed pasture and nearby lightly grazed, partially cleared, grassy, eucalypt forest (White, 1992; Borsboom, 1993; Hug, 1993.). The agroforestry plots were surveyed at about two years of age. Native vertebrate species diversity was highest in the grassy, lightly grazed, partially cleared, eucalypt forest. Native vertebrate species diversity was not significantly different between the agroforestry plots and the adjacent lightly grazed pasture. The combined native mammal, reptile and amphibian species recorded was lower in the shelter belt plantings compared to adjacent lightly grazed pasture.

Other Queensland research relevant to biodiversity and planted landscapes includes a study in progress, which is examining how biodiversity and ecological function is restored on cleared land under various revegetation programs (Kanowski, 2001). In October 2000, the study commenced surveys of flora, fauna and selected ecological processes in north Queensland, southern Queensland and north-east New South Wales. Sites include monoculture and mixed species plantings, established pasture and intact forest. Research into the enhancement of biodiversity in plantations has also been carried out in Queensland. Smith and Agnew (in press) surveyed fauna usage of bat boxes erected in farm forestry plantations. Fauna using the boxes included microbats, marsupial mice and smaller gliders, all of which are known to feed on insects (Smith and Agnew in press), and could possibly contribute to an integrated pest management approach to insect control.

1.2 Objectives

The broad objectives of this study are to expand knowledge of the importance of farm forestry to biodiversity in south east Queensland and to commence assessment of how biodiversity can be enhanced within plantations. The broad objectives rely on the premise that management and design options recommended for enhancing biodiversity values in farm forestry plantations are practical and ecologically sustainable and can be successfully incorporated into farm forestry practices without significantly compromising timber production costs.

Specific objectives were:

1. Identify, quantify and compare vertebrate fauna within:
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2. Measure habitat attributes and relate to vertebrate fauna diversity;
3. Commence identification of economic, practical and ecologically sustainable farm forestry practices to enhance vertebrate diversity and nature conservation values; and
4. Provide research findings and management recommendations to agencies providing farm forestry decision support.

2. Methods

2.1 Experimental Design and Site Selection

The original design was to compare vertebrate fauna species diversity in two young age classes of DPI Joint Venture plantations of *Eucalyptus cloeziana* (Gympie messmate), one older age class of DPI *E. cloeziana* plantations in State Forest and to compare with reference sites in selectively logged eucalypt forest with *E. cloeziana* in the overstorey, and reference sites on cleared, grazed, improved, pasture. Selectively logged eucalypt forest sites were used because of the difficulty of trying to locate unlogged eucalypt forest close to the plantation sites. In this original experimental design three replicates of each treatment and reference vegetation type were to be chosen in south east Queensland, a total of 15 sites. Site selection for these initial 15 sites was undertaken in collaboration with the DPI Joint Venture farm forestry extension officer for south east Queensland, and required liaison and permission from farm forestry landholders to use sites. During inspection of potential sites, two privately owned mid-age *E. cloeziana* plantations (15 years old) were also located. These were incorporated into the survey program, although one of the sites was only about 1.5 ha in area. This brought the number of survey sites to 17 (Figure 1). Only two of the three selectively logged, eucalypt forest sites had *E. cloeziana* in the overstorey. The third forest site was selected because of the practicality of having survey sites grouped in threes and the need to have a native forest reference site at the southern end of the survey area. All three selectively logged eucalypt forest sites were in State forest. Mean area of the plantations surveyed was 7.03 ha (range 1.5 to 10.5 ha).

Mid way through the survey period one of the selectively logged, eucalypt forest sites (NF4) was abandoned and a new forest site set up (NF3). Site NF4 was abandoned because of its closeness to site NF2 and the problem of pseudo-replication. Sites were either on mid slopes, lower slopes or lower slopes/flats. Table 1 provides a full explanation of survey site names given in figures, tables and text within this report. General site information is provided in Table 2. Table 3 outlines pre- and post-planting management on the sites. See Figure 1 for site locations.

Table 1: Survey site names and treatments

SITE NAME	TREATMENT
CG1	Cleared, grazed, improved pasture; Replicate 1
CG2	Cleared, grazed, improved pasture; Replicate 2
CG3	Cleared, grazed, improved pasture; Replicate 3
P(0.3-1.8yrs)1	DPI Joint Venture *E. cloeziana* plantation; 0.3 to 1.8 year age class during survey period; Replicate 1
P(0.3-1.8yrs)2	DPI Joint Venture *E. cloeziana* plantation; 0.3 to 1.8 year age class during survey period; Replicate 2
P(0.3-1.8yrs)3	DPI Joint Venture *E. cloeziana* plantation; 0.3 to 1.8 year age class during survey period; Replicate 3
P(2.1-3.8yrs)1	DPI Joint Venture *E. cloeziana* plantation; 2.1 to 3.8 year age class during survey period; Replicate 1
P(2.1-3.8yrs)2	DPI Joint Venture plantation *E. cloeziana*; 2.1 to 3.8 year age class during survey period; Replicate 2
P(2.1-3.8yrs)3	DPI Joint Venture *E. cloeziana* plantation; 2.1 to 3.8 year age class during survey period; Replicate 3
P(15-16.5yrs)1	Private *E. cloeziana* plantation; 15 to 16 year age class during survey period; Replicate 1
P(15-16.5yrs)2	Private *E. cloeziana* plantation; 15 to 16 year age class during survey period; Replicate 2
P(38-40.5yrs)1	DPI *E. cloeziana* plantation; 38 to 40.5 year age class during survey period; Replicate 1
P(38-40.5yrs)2	DPI *E. cloeziana* plantation; 38 to 40.5 year age class during survey period; Replicate 2
P(38-40.5yrs)3	DPI *E. cloeziana* plantation; 38 to 40.5 year age class during survey period; Replicate 3
NF1	Selectively logged eucalypt forest, no *E. cloeziana* in overstorey; Replicate 1
NF2	Selectively logged eucalypt forest; *E. cloeziana* in overstorey Replicate 2
NF3	Selectively logged eucalypt forest; *E. cloeziana* in overstorey Replicate 3
NF4	Selectively logged eucalypt forest; *E. cloeziana* in overstorey Replicate 4

Table 2: General summary information for survey sites

Site	Land Owner	Land Tenure	Plantation Area (ha)	Link to Native Vegetation
CG1	P. & K. Franzmann	Freehold		One edge to narrow weed infested roadside forest corridor leading to wet sclerophyll eucalypt forest remnants on private land.
CG2	J. & M. Gilbert	Freehold		One edge within 50 m of eucalypt forest with links to a large eucalypt forest block on army reserve. Within 150 m of riparian vegetation corridor on a second edge.
CG3	R. & K. Morrison	Freehold		One edge within 100 m of eucalypt forest on private land on a ridge above the site.
P(0.3-1.8 yrs)1	B. & A. Johnson	Freehold	5.11	Part of one edge within 100 m of eucalypt forest on private land. A second edge to rank, grassy degraded riparian zone.
P(0.3-1.8yrs)2	J. & D. North	Freehold	9.67	One edge within 50 m of eucalypt forest and eucalypt forest with rainforest elements on private land on a ridge and slopes above the site.
P(0.3-1.8yrs)3	M. & N. Dittrich	Freehold	10.53	One upper slope edge to rank, grassy partially cleared eucalypt forest that merged with large eucalypt forest block on State forest

Site	Land Owner	Land Tenure	Plantation Area (ha)	Link to Native Vegetation
P(2.1-3.8yrs)1	J. & A. Johnson	Freehold	4.02	Upper slope edge to eucalypt forest on private land
P(2.1-3.8yrs)2	R. Hirst	Freehold	6.93	Linked on one edge to riparian forest linked to grazed eucalypt forest. Second edge within 100 m of rocky peak with various native vegetation types.
P(2.1-3.8yrs)3	G. & B. Bianchi	Freehold	7.62	Linked to riparian forest on two edges. A third edge linked to an upper slope with a forest mix of wet sclerophyll and rainforest species. Forest on private land.
P(15-16.5yrs)1	A. Raineri	Freehold	10 (+ 6ha that died shortly after planting)	One edge linked to dry sclerophyll forest on private land. A second edge to rank grassy ground cover linking to a roadside eucalypt forest corridor
P(15-16.5yrs)2	P. & K. Franzmann	Freehold	~1.5	One edge to narrow weed infested roadside forest corridor leading to remnant forest blocks on private land
P(38-40.5yrs)1	Qld Government	State forest SF 997	7.2	Four sides abut either native eucalypt forest or eucalypt plantations that link to eucalypt native forest. One side with direct link to riparian forest.
P(38-40.5 yrs)2	Qld Government	State forest SF 997	5.9	Three sides abut native eucalypt forest or eucalypt plantations that link to eucalypt native forest
P(38-40.5 yrs)3	Qld Government	State forest SF 997	8.9	Three sides abut either native eucalypt forest or eucalypt plantations that link to eucalypt native forest. Links include riparian forest.
NF1	Qld Government	State forest SF 729		Linked on three sides to large eucalypt forest block
NF2	Qld Government	State forest SF 997		Linked all sides to large eucalypt forest block
NF3	Qld Government	State forest SF 997		Linked all sides to large eucalypt forest block
NF4	Qld Government	State forest SF 997		Linked all sides to large eucalypt forest block

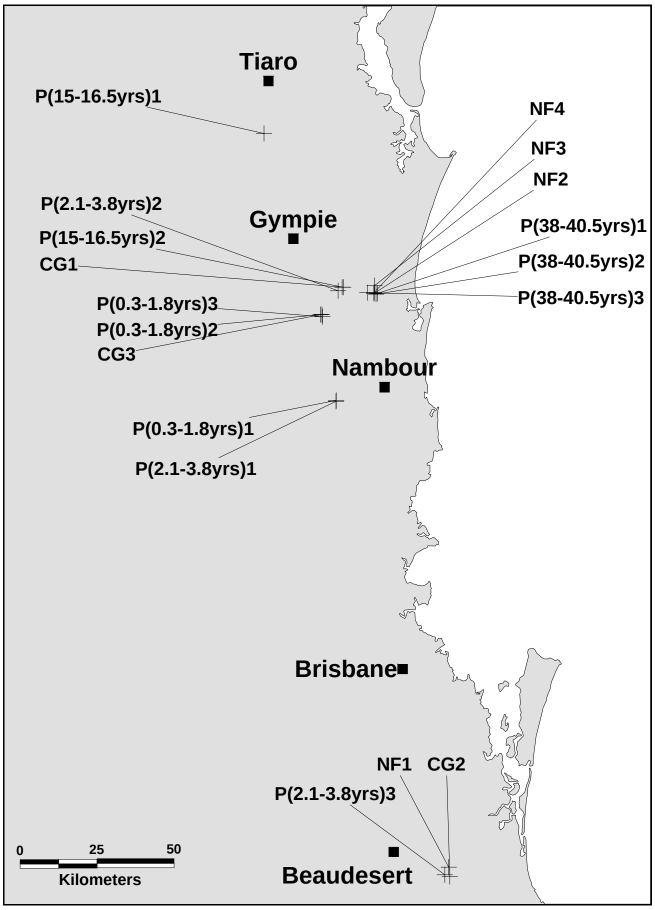
Table 3: Site management history.

Site	Pre-planting management or pre-survey management for non-plantations	Planting Date and Spacing	Pre-survey Post-planting management	Management During Survey Period
CG1	Improved pasture; cattle grazed; no fire 10 years prior to survey; irregular slashing;	Not applicable	Not applicable	No fire; grazed by cattle; grass slashed once
CG2	Improved pasture; horse grazed; no fire 10 years prior to survey, owner suspects never burnt while cleared pasture;	Not applicable	Not applicable	No fire; grazed by horses; grass slashed once
CG3	Improved pasture; grazed most of the time by cattle or cattle & horses; no evidence of past fire;	Not applicable	Not applicable	No fire; grazed most of time by cattle or cattle and some horses; grass slashed once; top dressed once.
P(0.3-1.8 yrs)1	Cattle and/or horse grazed pasture; Prior to planting site slashed, herbicide on planting rows, lightly burnt and ripped ;	Planted March 1999; planting rows 4-5m apart; trees 2-3m apart (830-1000 trees/ha);	No thinning, grazing or fire; ¾ of site slashed once, rest inaccessible to slasher;	No fire, grazing or slashing; Spot-spraying of herbicide three times;
P(0.3-1.8yrs)2	Cattle grazed pasture; no fire 10 years prior to planting; planting holes prepared by excavator; herbicide applied on planting rows just prior to planting;	Planted March-April 1999; planting rows 4-5m apart; trees 2-3m apart (830-1000 trees/ha);	No thinning, grazing or fire;	No fire or grazing; grass slashed once; spot spraying of herbicide once;
P(0.3-1.8yrs)3	Cattle grazed pasture; no fire 10 years prior to planting; herbicide applied on planting rows just prior to planting; Trees planted in contoured rows dug by excavator;	Planted March 1999; planting rows 4-5m apart; trees 2-3m apart (830-1000 trees/ha);	No thinning, grazing or fire; slashed once; spot-spraying of herbicide once.	No fire; no grazing; three grass slashings; spot spraying of two herbicides in August 1999.
P(2.1-3.8yrs)1	Cattle and/or horse grazed pasture; just prior to planting slashed, lightly burnt, soil ripped and turned and herbicide applied	Planted April 1997 in rows 4-5m apart, trees 2-3m apart (830-1000 trees/ha);	Slashed twice; no fire; grazed by horses or horses & cattle from May ’99 onwards; once herbicide applied.	No fire; grazed by cattle and horses; thinned to 400 trees/ha in November 1999

Site	Pre-planting management or pre-survey management for non-plantations	Planting Date and Spacing	Pre-survey Post-planting management	Management During Survey Period
P(2.1-3.8yrs)2	Stock grazing land with some paddock trees; just prior to planting most paddock trees cleared, ground ripped with planting rows mounded and herbicide applied;	Planted March 1997; planting rows 4-5m apart; trees 2-3m apart (830-1000 trees/ha);	Slashed twice; Grazed by cattle from about early March 1999 to early May 1999.	No fire; grazed by cattle for all but 6 weeks in the period Jan 2000 to July 2000; Thinned to 400 trees/ha Nov. 1999
P(2.1-3.8yrs)3	Dairy farm, beef cattle and horse grazing; No fire 10 years prior to planting; mainly cleared land; just prior to planting the planting rows were furrowed, mounded and herbicide applied, some timber logged, some pushed mounded and burnt, some big stumps left. No grazing several months prior to planting;	Planted Late May-June 1997; planting rows 4-5m apart; trees 2-3m apart (830-1000 trees/ha);	Slashed four times; no fire or grazing;	No fire; thinned to 400 trees/ha Dec 1999; Pesticide sprayed Jan. 2000; grazed by cattle from late May 2000 onwards;
P(15-16.5yrs)1	Just prior to planting machine cleared to bare ground with trees & stumps mounded, soil ploughed and mounded;	Planted 1984, trees 2-3 m apart	Herbicide used once within 12 months of planting; Low intensity fire about 1994-95 with little tree damage; Horse grazing 1996-97; not slashed but some acacias felled; no thinning;	No fire, logging or grazing;
P(15-16.5yrs)2	Cattle-grazed improved pasture; no fire 10 years prior to planting; site slashed, herbicide applied and soil ripped just prior to planting.	Planted 1984; planting rows ~3-4m apart; row trees ~3m apart;	Irregular slashing of undergrowth; burnt in 1994 to control undergrowth; light periods of grazing after 1994; no thinning;	No fire or grazing; spot-sprayed with herbicide and slashed once.

Site	Pre-planting management or pre-survey management for non-plantations	Planting Date and Spacing	Pre-survey Post-planting management	Management During Survey Period
P(38-40.5yrs)1	Farm land with some general hardwood trees prior to becoming State Forest; Pre-planting: machine cleared, timber windrowed and burnt, soil rotary hoed and mounded.	Planted Dec 1961; 360 trees/ac	No grazing or fire; annual tending to Jan. 1965 to cut and remove groundsel and/or acacias; Suspect plantation thinning in 1965-66 financial year.	No fire, logging or grazing.
P(38-40.5 yrs)2	Farm land with some standing general hardwoods prior to becoming State Forest; Pre-planting: machine cleared, timber windrowed & burnt, soil rotary hoed and mounded.	Planted Dec 1961; 360 trees/ac	No grazing or fire; annual tending to cut and remove groundsel and/or acacias up to Jan. 1965; Suspect plantation thinning in 1965-66 financial year.	No fire, logging or grazing.
P(38-40.5 yrs)3	Farm land with acacia & remnant forest trees prior to becoming State Forest; Pre-planting: site machine cleared, timber windrowed & burnt, soil rotary hoed & mounded.	Planted Dec 1960	No grazing or fire; annual tending to cut and remove groundsel and/or acacias up to 1964; Thinned to 270 trees /ac in Jan. 1965.	No fire, logging or grazing
NF1	Semi-cleared freehold grazing land prior to 1945; army tent settlement during WW2; gazetted State forest immediately after war; Selectively logged 1998-99.	Not applicable	Not applicable	No fire; no timber felled with logging ban from the 31-12-99; some previously felled timber cut & removed for fencing.
NF2	Selective logging pre 1950 (no DPI Forestry records); Selective logging sometime during the period 1991 to February 1996;	Not applicable	Not applicable	No fire, logging or grazing.
NF3	Some evidence of past selective logging but no records of DPI Forestry saw log harvesting.	Not applicable	Not applicable	No fire, logging or grazing.
NF4	Selective logging pre 1950 (no DPI Forestry records); Selective logging sometime 1991 to February 1996.	Not applicable	Not applicable	No fire, logging or grazing.

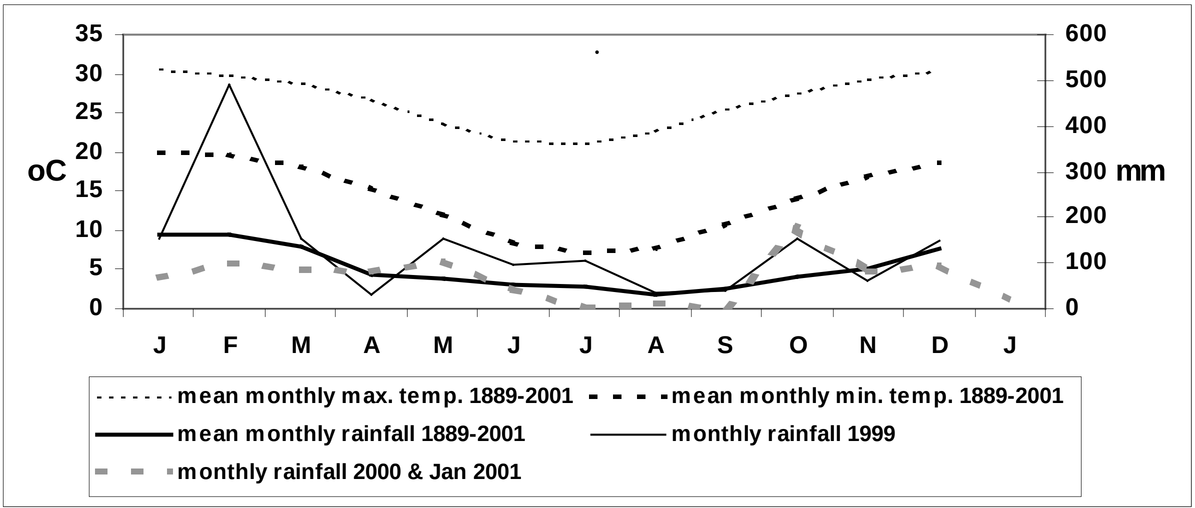
Figure 1: Locations of survey sites.
+ = Site locations



2.2 Temperature and Rainfall

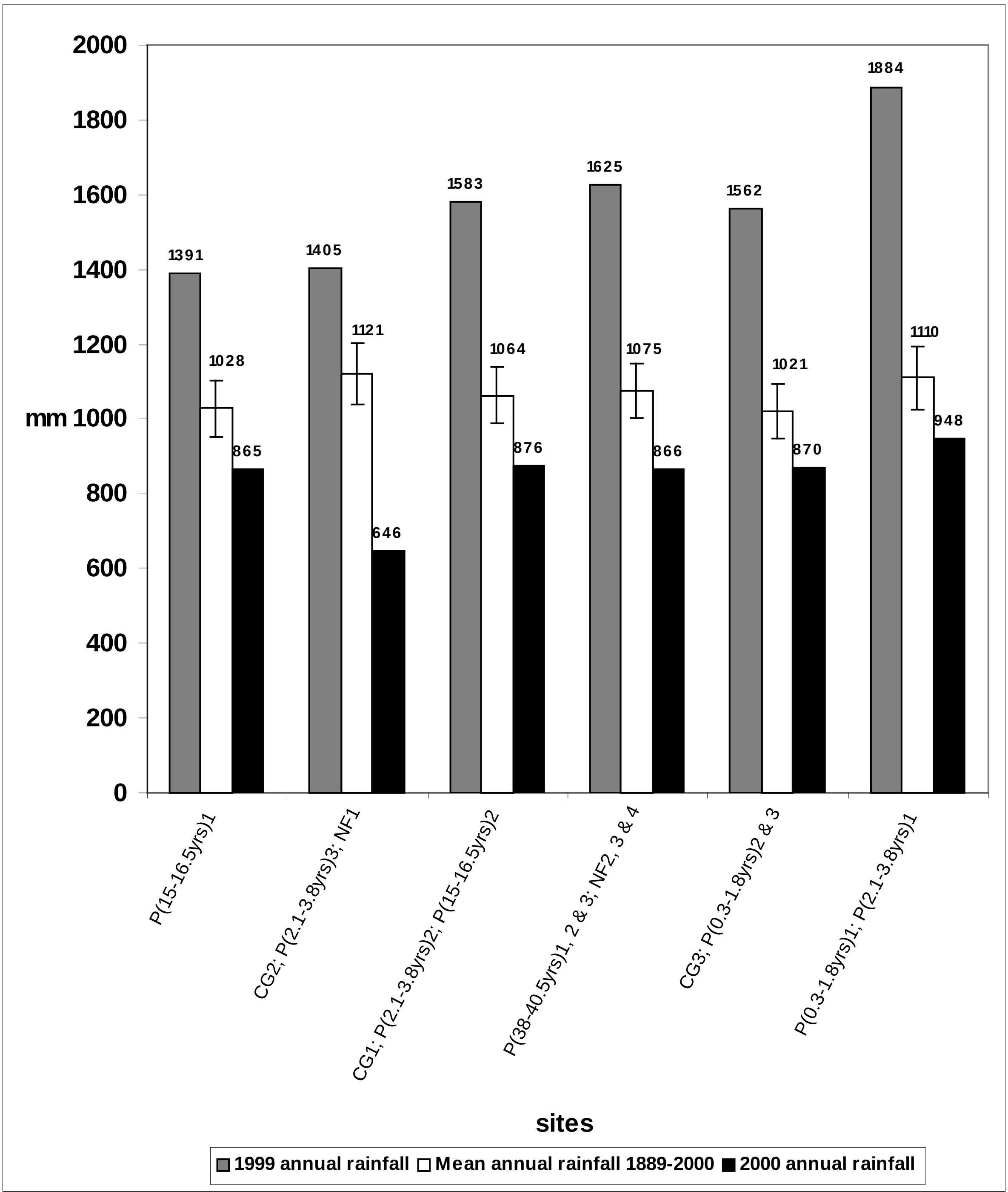
Actual temperature and rainfall data is unavailable for all survey sites. However, the Queensland Department of Natural Resources and Mines provides access to a facility that interpolates rainfall and climatic data using meteorological data collected by the Australian Bureau of Meteorology from nearby weather stations. Figures 2 presents interpolated rainfall and temperature patterns for six close together study sites, and are typical of temperature and rainfall patterns for the other sites.

Figure 2: Interpolated mean monthly temperature and rainfall data for study sites P(38-40.5yrs)1, 2 and 3, and NF2, 3 and 4.



Mean interpolated annual rainfall for the first half of the survey period was significantly wetter than average on all sites (Figure 3). In the second half of the survey period annual rainfall was significantly lower than average (Figure 3). In the wetter than average period, high rainfalls were experienced on all 15 sites north of Brisbane in the month of February, three months prior to the first fauna survey. This resulted in higher than normal water table levels during the winter survey of 1999. In the drier than average second half of the survey period, the three sites south of Brisbane had below average rainfall from January to September. At the same time most sites north of Brisbane had below average rainfall from January to March and from July to September.

Figure 3: Comparison of annual rainfall in 1999 and 2000 on the study sites. Sites grouped based on proximity to each other. The 99% confidence limits are marked on the mean annual rainfall columns. Source data interpolated as per data in Figures 3.



2.3 Fauna Survey Effort and Methods

Two mid-winter and two early/mid-summer fauna surveys were conducted on all but two sites between June 1999 and January 2001. Selectively logged eucalypt forest sites NF3 and NF4 were only surveyed twice each (one winter, one summer). Methodology and effort per survey per site are detailed below.

2.3.1 Live trapping

i. Twenty-five Type A Elliott traps (100mm high x 95mm wide x 325mm long) were set 8m apart over three consecutive nights for a total of 75 trap nights. On plantation sites one line of 13 traps was set on the plantation edge, a second line of 12 traps set inside the plantation at least 25 m from the edge. Traps were baited with peanut paste, rolled oats and honey, and were checked early each morning. Captured animals were identified, sexed and their reproductive status recorded. Animals were marked with nail polish either on the head fur or the hind foot claws. The same trap lines were used each survey.

ii. Ten bait-triggered wire traps (105mm high x 150mm wide x 305mm long) were set 8m apart over three consecutive nights for a total of 30 trap nights. On plantation sites one line of 5 traps was set on the plantation edge, a second line of 5 traps set inside the plantation at least 25 m from the edge. Traps were baited with peanut paste, rolled oats and honey and were checked early each morning. Measurement and marking procedure for captured animals the same as for animals caught in the Elliot traps.

Preliminary analysis of the winter 1999 trapping results found wire traps were not catching species additional to the Elliott traps. As the Elliott traps were also easier to transport and set, use of the wire traps was discontinued and the number of Elliott traps used increased to 40 (20 traps per trap line in plantations).

iii. Four pit-traps were set at least 50 m apart, each with a 10m drift fence of flywire mesh 300 mm high. Pits-traps were open for 60-71 hours, which included three nights. On plantation sites, two pit-traps were set on the edge and two at least 25 m inside the plantation. Pit-traps consisted of 236 mm internal diameter PVC pipe 425 mm deep with a flywire mesh bottom and a funnel at the top to minimise escape. A plastic stool was secured over each pit with metal pegs, to prevent injury to livestock on grazed sites. Pit-traps were checked at least daily early each morning. Captured animals were identified, sexed, reproductive status recorded and released at point of capture. Ground mammals were marked with nail polish prior to release.

iv. One bat harp trap was set for two consecutive nights. In forest and older plantations the harp trap was set along a potential bat flyway. Harp traps were checked early each morning. Captured animals were identified, sexed, reproductive status recorded and released. The same trap sites were used each survey.

2.3.2 Call detectors and call playback

i. One Titley Ecopro animal call detector with associated battery, microphone and tape recorder was set up at each site to record frog, bird and mammal calls. It was set for three 30-minute detecting periods (sunrise, late afternoon and early evening), for a total detecting time of 90 minutes. Taped calls were analysed on return from the field.

Preliminary analysis of the 1999 call tapes found it was impossible to distinguish on site calls from off site calls. As a result the technique was discontinued and the results not used.

ii. One bat call detecting period of 30 minutes was conducted at each site, commencing within 30 minutes of sunset. Two handheld Titley Anabat bat call detectors (with associated tape recorders) were used simultaneously at least 75 m apart. On plantation sites one operator was positioned on the plantation edge, the second at least 50 m inside the plantation. The same recording sites were used each survey. Calls were analysed on return from the field.

iii. Nocturnal owl call tape playback was used for 30 minutes at each site. The calls played were powerful owl, masked owl, barking owl and sooty owl. The calls were used to elicit a call response from owls and some arboreal mammals.

The nocturnal call playback survey technique was discontinued after the winter 1999 survey, as it was realized the call playback had the potential to draw owls to the call from habitat adjoining plantations.

2.3.3 Systematic search

i. One diurnal ground fauna search at each site. A survey plot 100 x 50 m (= 0.5 ha) was split into two 100 x 25 m sub-plots, each sub-plot surveyed simultaneously for 30 minutes by one person. For plantation sites or sites with a defined edge (eg roadway), one of the 100 m sub-plot boundaries was on the edge. An active search method was used, which included log-rolling and raking through leaf litter. The same plot was used each time the site was surveyed. Searches in summer were not conducted between 1200 and 1400 hrs to avoid the hottest part of the day. In winter searches were conducted sometime between 1100 and 1530 hrs to avoid the cooler times of the day. Diurnal search plots and nocturnal ground search plots were different. Information recorded included species, numbers and location.

ii. One nocturnal ground fauna search at each site, normally in the first two hours after nightfall. A survey plot 100 x 50 m (= 0.5 ha) was split into two 100 x 25 m sub-plots, each sub-plot surveyed simultaneously for 30 minutes by one person using a head torch. For plantation sites or sites with a defined edge (eg roadway), one of the 100 m sub-plot boundaries was on the edge. A passive search method was used (eg no log-rolling or leaf litter racking). Searches were not conducted in the rain. The same plot was used each time a site was surveyed. Information recorded included species, numbers and location.

iii. One nocturnal arboreal survey per site. Conducted on foot with a hand held spotlight and binoculars over a 300m long transect, surveying 25 m either side (= 1.5 ha). Surveys were normally undertaken in the first two hours after nightfall. For plantation sites or sites with a defined edge (eg roadway), one of the transect boundaries was on the edge. Two surveyors were used, each surveying a 150 m section of the transect for a maximum of 30 minutes (i.e. 25 m/5minutes). This allowed time to conduct a thorough search of the canopy. On some plantation sites the duration of the survey was down to as little as 20 minutes per person, because of the limited arboreal habitat that required searching. Cleared grazing land sites and plantations with an average height less than 2 m were not surveyed. Surveys were not conducted in the rain. The same transect was used each time a site was surveyed. Information recorded included species, numbers and location.

iv. Two diurnal bird surveys per site. One survey was conducted in the first two hours after sunrise, the second survey on a different day between 2 and 4 hours after sunrise. Each survey conducted by one observer on foot with binoculars for 30 minutes along a transect 200m long by 50m wide (= 1 ha). The same transect was used each time a site was surveyed. Information recorded included species, numbers, location and microhabitat. Details of birds detected beyond the transect boundary were also recorded each survey.

2.3.4 Opportunistic records

During the course of systematic fauna surveys and flora and habitat measurements on all sites, opportunistic records were made of fauna species not detected by other survey methods.

2.4 Flora and Habitat Survey Effort and Methods

On all sites regular flora and habitat assessments were made. On the six DPI Joint Venture plantations sites (P(0.3-1.8yrs)1, 2 & 3 and P(2.1-3.8yrs)1, 2 & 3) the attributes **i.** to **ix.** below were measured in each of the four survey periods between June 1999 and January 2001. On these sites vegetation and habitat attributes were changing rapidly. On the five older plantations sites (P(15-16.5yrs)1 & 2 and P(38-40.5yrs)1, 2 & 3) and the selectively logged, eucalypt forest sites NF1 and NF2, changes to the attributes listed below were expected to be minimal over the 18 month survey period. Therefore, for these sites measurements were only taken at the beginning and end of the survey period. The exception was plantation site P(15-16.5yrs)2, where changes to understorey due to slashing required three measurement of attributes **i.** to **iv.** below. For the cleared grazing land sites (CG1, 2 & 3) attributes **i.** to **iv.** were also measured three times to measure changes to pasture height. Selectively logged, eucalypt forest sites NF 3 and NF4 were only measured once. An outline of the vegetation and habitat attributes measured and the measurement techniques used are provided below.

i. Ground cover was an estimated percentage (categories <5%, 5%, 10%, etc to 100%). Categories were: vegetation cover 0 ≤ 0.25 m ht class; bare soil; rocks/stones; fine litter (.≤ 2 cm diameter); course litter (2 ≤ 10 cm diameter); charcoal; stump (≥ 15 cm diameter); tree trunk (living); log/branch (> 10 cm diameter and > 0.3 m length); and other (unspecified).

ii. Flora species composition was measured and vegetation cover estimated below 1.8 m in the height classes: 0 ≤ 0.25 m; 0.25 m ≤ 0.5 m; and 0.5 m ≤ 1.8 m.

iii. Logs and stumps recorded and measured. Diameter measured using a girthing tape; length or height measured using a tape measure. Logs were any fallen timber > 10 cm diameter and > 0.3 m in length that were at least part in a 5 m x 5 m plot. A stump was any dead standing timber less than two meters in height with a diameter ≥ 15 cm that was at least part in a 5 m x 5 m plot.

iv. Vegetation cover over 1.8 m was measured. Twelve vegetation cover measurements were taken in each 5 m x 5 m plot as illustrated in Figure 2. Measured using a foliage projection cover tube, scoring cover at the alignment point of the two sets of cross hairs.

v. Flora species composition and numbers above 1.8 m were recorded in the height classes 1.8 m ≤ 3 m; 3 m. ≤ 5 m; 5 m ≤ 8 m; 8 m ≤ 15 m; and > 15 m. Heights were determined using a telescoping height pole for heights up to 8 m. For height measurement above 8 m a digital hypsometer (Forestor Vertex) was used, the height calculated for each tree based on the average of three height readings by the hypsometer.

vi. A telescoping height pole determined plantation tree heights up to 8 m. For heights above 8 m a digital hypsometer (Forestor Vertex) was used, tree height an average of three hypsometer height readings.

vii. Diameter of plantation tree trunks was measured at 1.3 m height (dbh) using a girthing tape to the nearest 0.1 cm.

viii. Condition of plantation trees was ranked based on foliage health and insect damage.

ix. Dbh and height of native forest trees above 15 m in height was measured. Dbh measured to the nearest 0.1 cm using a girthing tape. Height determined using a digital hypsometer, the height calculated for each tree based on the average of three height readings by the hypsometer.

On each site the vegetation and habitat measurements were taken on twelve 5 m x 5 m plots and twenty-four 1 m x 1 m plots. Two 1 m x 1 m plots were nested inside each 5 m x 5 m plot. Vegetation and habitat attributes, as outlined in **i.** and **ii.** above, were measured in the 1 m x 1 m plots. All other attributes (**iii. to ix.** above) were measured in the 5 m x 5 m plots. Figure 4 shows the schematic of the nested plot layout. Locations of the twelve 5 m x 5 m plots on each site were:

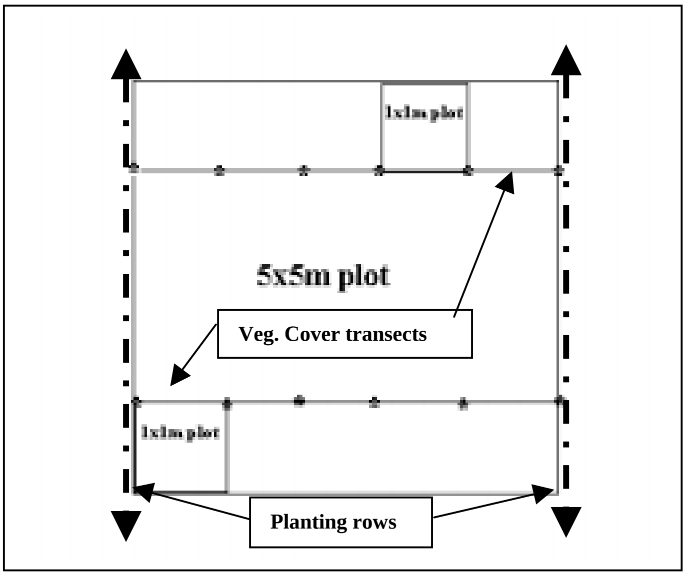
i. Four equally spaced along the trap line. On plantation sites there was an edge trap line and an interior trap line, and on these sites two plots were equally spaced on each line.

ii Four at pit-trap locations, with the pit-trap as the centre of the plot.

iii Two were positioned 1/3 and 2/3 along a 100 m edge of the diurnal search plot.

v. Two were positioned 1/3 and 2/3 along the centre line of the diurnal search plot.

Figure 4: Schematic of the vegetation and habitat plot layout. Shows the position of the 1 x 1 m plots inside each 5 x 5 m plot, the alignment of the 5 x 5 m plot in relation to plantation planting rows, and the position of the two vegetation cover transects with their 12 measurement points (= $*$).



2.5 Data analysis

The analysis program in microsoft excel 2000 was used for t-tests, F tests to determine homogeneity of the sample mean variances, χ^2, confidence limits and standard errors. The t-tests were either for paired data, comparison of two sample means with equal variance or comparison of two sample means with unequal variance. Choice of the latter t tests was determined by an F test for variance homogeneity. The Griffith University PATN program initially developed by Belbin (1993) was used for ordinations. All ordinations except for bird abundance were based on the Bray-Curtis similarity metric, ordinations using the SSH-NMDS algorithm (non-metric multidimensional scaling) using standard PATN program defaults. The Gower similarity metric was used for the bird abundance ordination. The S-Plus 2000 statistical package was used for deriving Pearson correlation coefficients, log and log (x+1) transformations and analysis of variance using multiple t-test comparisons with the simultaneous confidence intervals derived by the Bonferroni method. Arcsin transformations as per Zar (1984).

3. Results

3.1 Vertebrate fauna

A summary of vertebrate fauna species recorded in *Eucalyptus cloeziana* plantations compared to cleared improved pasture and selectively logged eucalypt forest is presented in Table 5. A total of 205 vertebrate species were recorded during 68 surveys across 18 sites over the 18-month survey period. For a list of species recorded on each site refer to Appendix 1. The 205 species do not include a number of records where identification to species was not possible (e.g. some bats listed in Appendix 1). The 175 vertebrate fauna species recorded in *E. cloeziana* plantations represents 85% of the 205 species recorded across all 18 sites. On face value this far exceeds species recorded on cleared improved pasture and selectively logged native forest. However, survey effort in *E. cloeziana* plantations was over three times as high as in the other vegetation types, with 65% of the 68 surveys in the plantations. Survey effort was the same for cleared improved pasture and selectively logged eucalypt forest. On cleared improved pasture 53 vertebrate species were recorded, which was less than half (47%) of the 113 species recorded in selectively logged eucalypt forest.

Table 4: Summary of vertebrate fauna survey results comparing species recorded in *E. cloeziana* plantations with cleared improved pasture and selectively logged eucalypt forest.

	VEGETATION TYPES			
TAXA	**CLEARED IMPROVED PASTURE**	***E. cloeziana* PLANTATIONS**	**SELECTIVELY LOGGED EUCALYPT FOREST**	**TOTAL SPECIES**
GROUND MAMMALS	5	20	12	21
BATS	9	12	7	13
ARBOREAL MAMMALS	0	3	3	5
BIRDS	29	100	76	120
REPTILES	2	19	9	23
AMPHIBIANS	8	21	6	23
ALL SPECIES	53	175	113	205
NO. OF SURVEY SITES	3	11	4	
NO. OF SURVEYS	12	44	12	

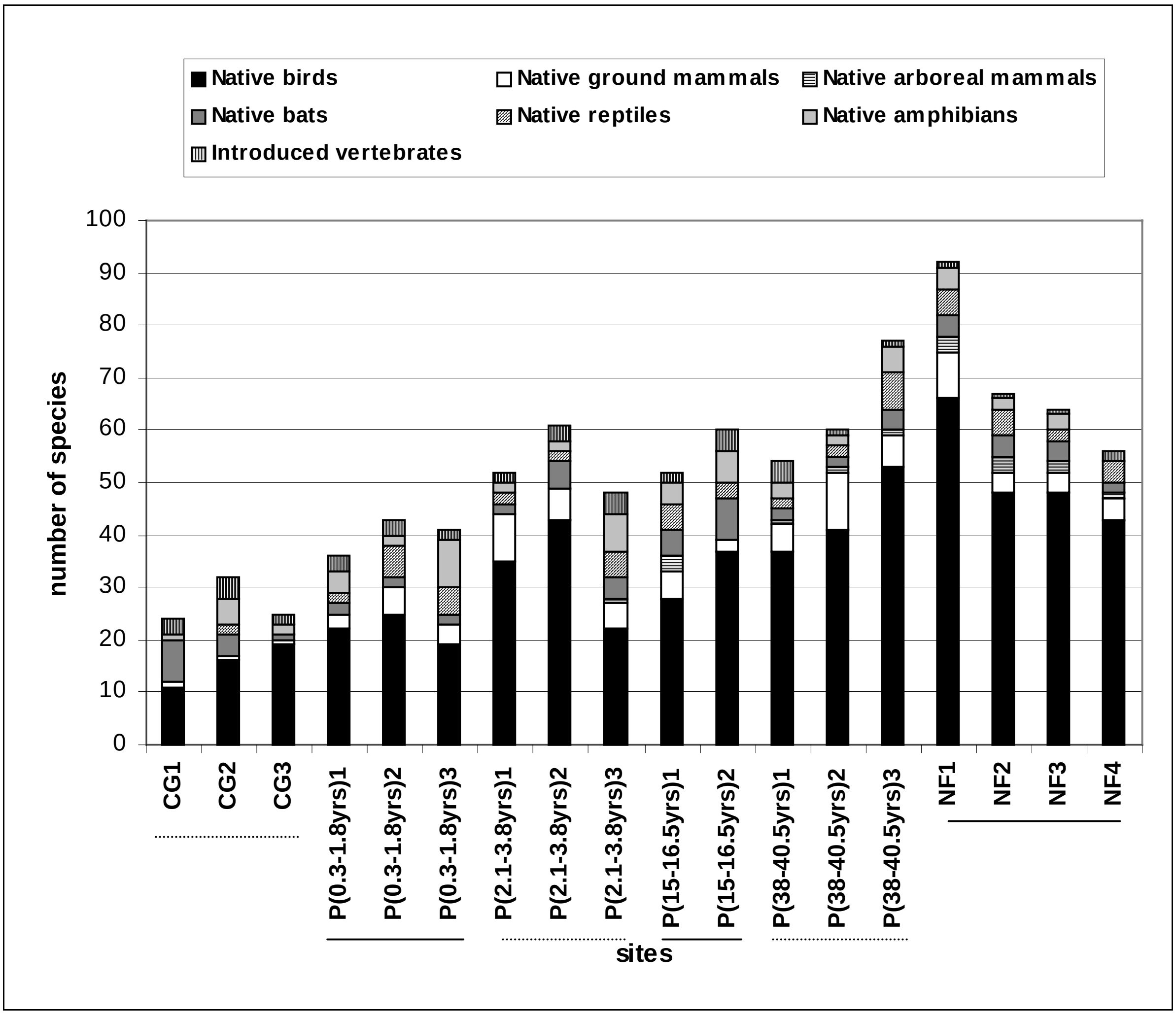
Species richness in *E. cloeziana* plantations may change with plantation age, possibly the result of changes to vegetation structure and composition. Figure 5 presents the number of vertebrate species recorded on each of the 18 survey sites during the survey period with plantation sites grouped according to age. All *E. cloeziana* plantation sites surveyed regardless of age had more vertebrate species present than the cleared improved pasture sites. There were six introduced vertebrate species recorded during the survey period, with at least one introduced species recorded on each survey site. Five of these six introduced species were recorded in the plantations. In the 38-40.5 year old *E. cloeziana* plantations in State Forest SF 997, three rare and one threatened vertebrate species were recorded. There were single records of the threatened frog *Crinia tinnula*, the rare frog *Litoria brevipalmata,* the rare reptile *Ramphotyphlops silvia* and 4 records of the rare reptile *Eroticoscincus graciloides*.

For the 11 *E. cloeziana* plantation survey sites, the mean vertebrate species recorded was 53 (range 36-77). The P(38-40.5yrs) plantation age class had the highest mean vertebrate species for the four plantation age classes with 63.7 species. The highest total number of vertebrate species recorded was 92 on selectively logged eucalypt forest site **NF1**, the lowest was 24 species on cleared improved pasture site **CG1**.

Figure 5: Number of vertebrate fauna species (native and introduced) recorded on the 18 survey sites during the survey period from June 1999 to January 2001. Two winter & two summer surveys per site except sites NF3 and NF4 with only one winter and one summer survey each.

CG = cleared, improved, grazed pasture; P(age class) = *E. cloeziana* plantation; NF = selectively logged eucalypt forest

(Full description of site names in Table 1, section **2.1** of this report)



A comparison of the mean total number of vertebrate species for cleared improved pasture, selectively logged eucalypt forest and four age classes of plantation is presented in Figure 6. Cleared improved pasture had the lowest mean number of species. The mean number of species in the plantation classes rises with plantation age. Highest mean number of vertebrate species was 69.8 for selectively logged eucalypt forest, this in spite of two of the four survey sites for this vegetation type having only half the survey effort. The mean number of species for cleared improved pasture was 27.0, which was significantly lower than the mean number of species in all four plantation age classes and in logged eucalypt forest (Table 5). The mean number of species in the 0.3-1.8 year plantation age class was also significantly lower than the means for the other plantation age classes and for selectively logged eucalypt forest (Table 5).

Native birds contributed most to vertebrate species richness, representing 46-76 % of the total species recorded at each site (Figure 7). The contribution of other vertebrate taxa to species richness varied between sites. Contributing least to vertebrate species richness were the arboreal mammals, which represented from 0-5.8 % of species recorded at each site. The only species to be recorded on all sites was the introduced species *Bufo marinus* (Cane toad) (refer Appendix 1). The next most recorded species were the Torresian crow (*Corvus orru*) and the grey fantail (*Rhipidura fuliginosa*), which were on 16 of the 18 survey sites.

Apart from the introduced cane toad the next most common amphibian species was the striped marshfrog (*Limnodynastes peronii*), which was recorded on 11 of the 18 sites. The most common reptile species was the eastern grass skink (*Lampropholis delicata*), which was recorded on 14 sites. The introduced house mouse (*Mus musculus*) was the most common mammal species with records from 13 sites. The yellow-footed antechinus (*Antechinus flavipes*) and the red-necked wallaby (*Macropus rufogriseus*) were the most recorded native mammal species, each recorded on 10 sites. The only species other than the cane toad, which were recorded on all 11 various age plantation sites were the grey fantail and the silvereye (*Zosterops lateralis*).

Figure 6: Mean number of vertebrate fauna species (native and introduced) for each vegetation treatment. Three replicates per vegetation type except NF with four and P(15-16.5yrs) with two. The 95% confidence limits are shown, except P(15-16.5yrs) where a standard error is marked. Two winter and two summer surveys per site except sites NF3 and NF4 with only one winter and one summer survey each.

CG = cleared, improved, grazed pasture; P(age class) = *E. cloeziana* plantation; NF = selectively logged eucalypt forest

(Full description of site names in Table 1, section **2.1** of this report)

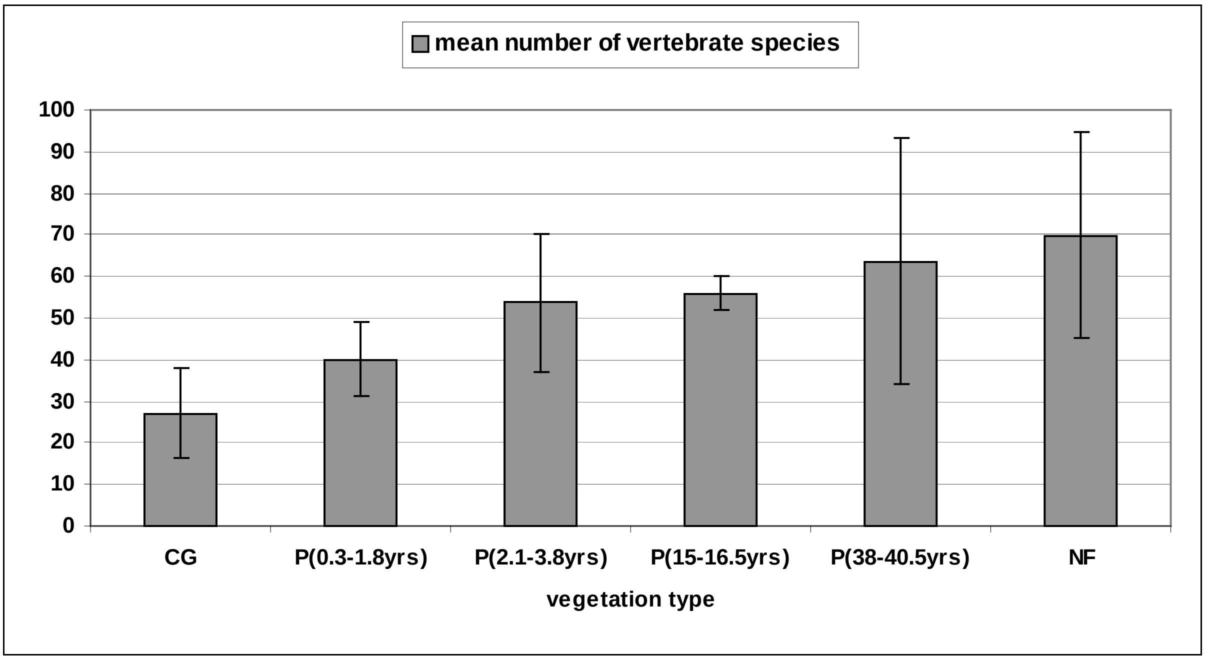


Table 5: Significance levels for the t-test comparisons of mean number of vertebrate species for the six vegetation types. F-test for equal variances was conducted for each comparison to determine the appropriate t-test.

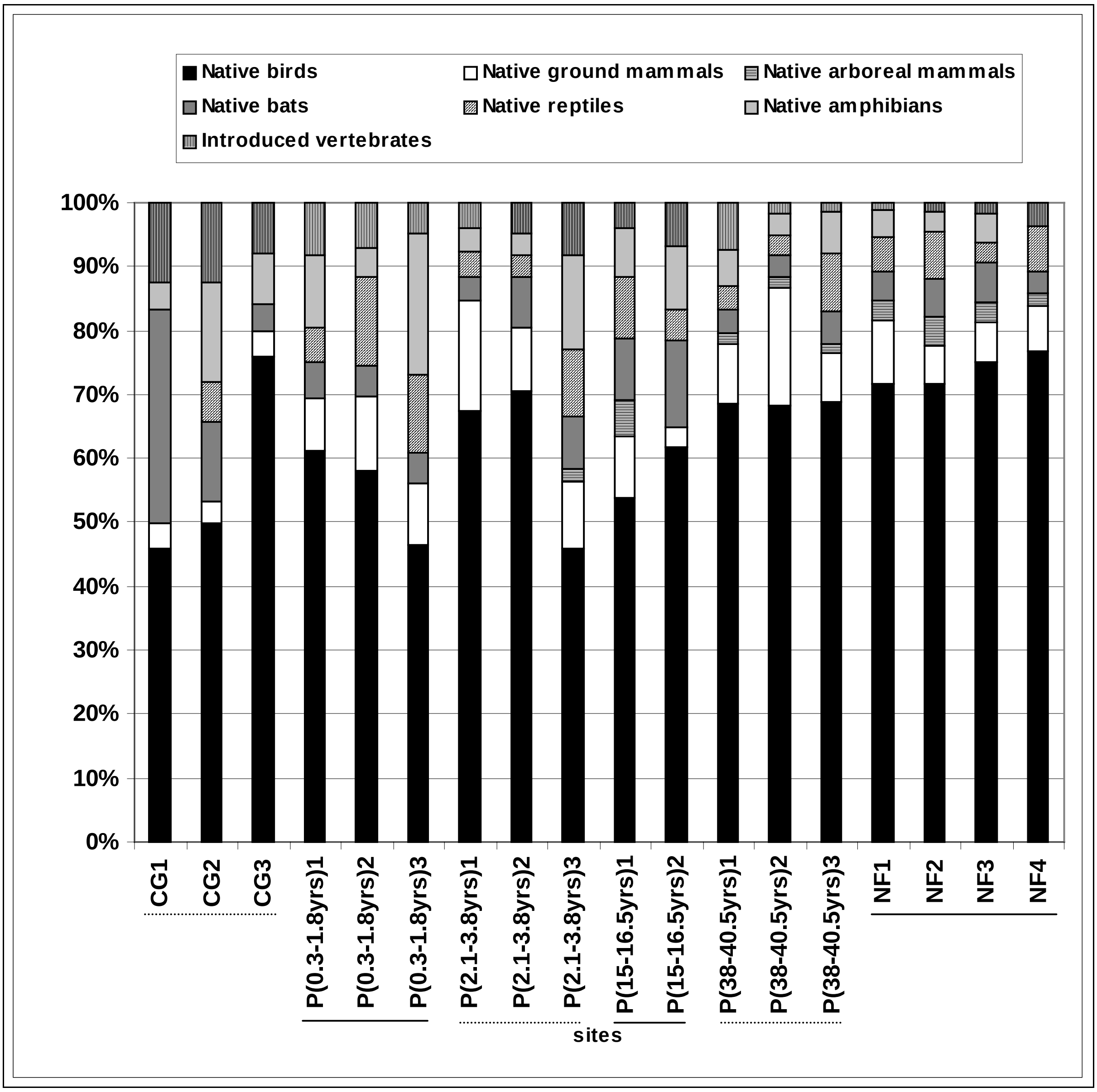
CG = cleared, improved, grazed pasture; P(age class) = *E. cloeziana* plantation; NF = selectively logged eucalypt forest

Vegetation type	P(0.3-1.8yrs)	P(2.1-3.8yrs)	P(15-16.5yrs)	P(38-40.5yrs)	NF
CG	<0.05	<0.01	<0.01	<0.01	<0.01
P(0.3-1.8yrs)		<0.05	<0.05	<0.05	<0.05
P(2.1-3.8yrs)			n.s.	n.s.	n.s.
P(15-16.5yrs)				n.s.	n.s.
P(38-40.5yrs)					n.s.

Figure 7: Vertebrate taxa percentage composition for all vertebrate species (native and introduced) recorded on each of the 18 survey sites. Two winter and two summer surveys per site except NF3 and NF4 with only one winter and one summer survey each.

CG = cleared, improved, grazed pasture; P(age class) = *E. cloeziana* plantation; NF = selectively logged eucalypt forest

(Full description of site names in Table 1, section **2.1** of this report)

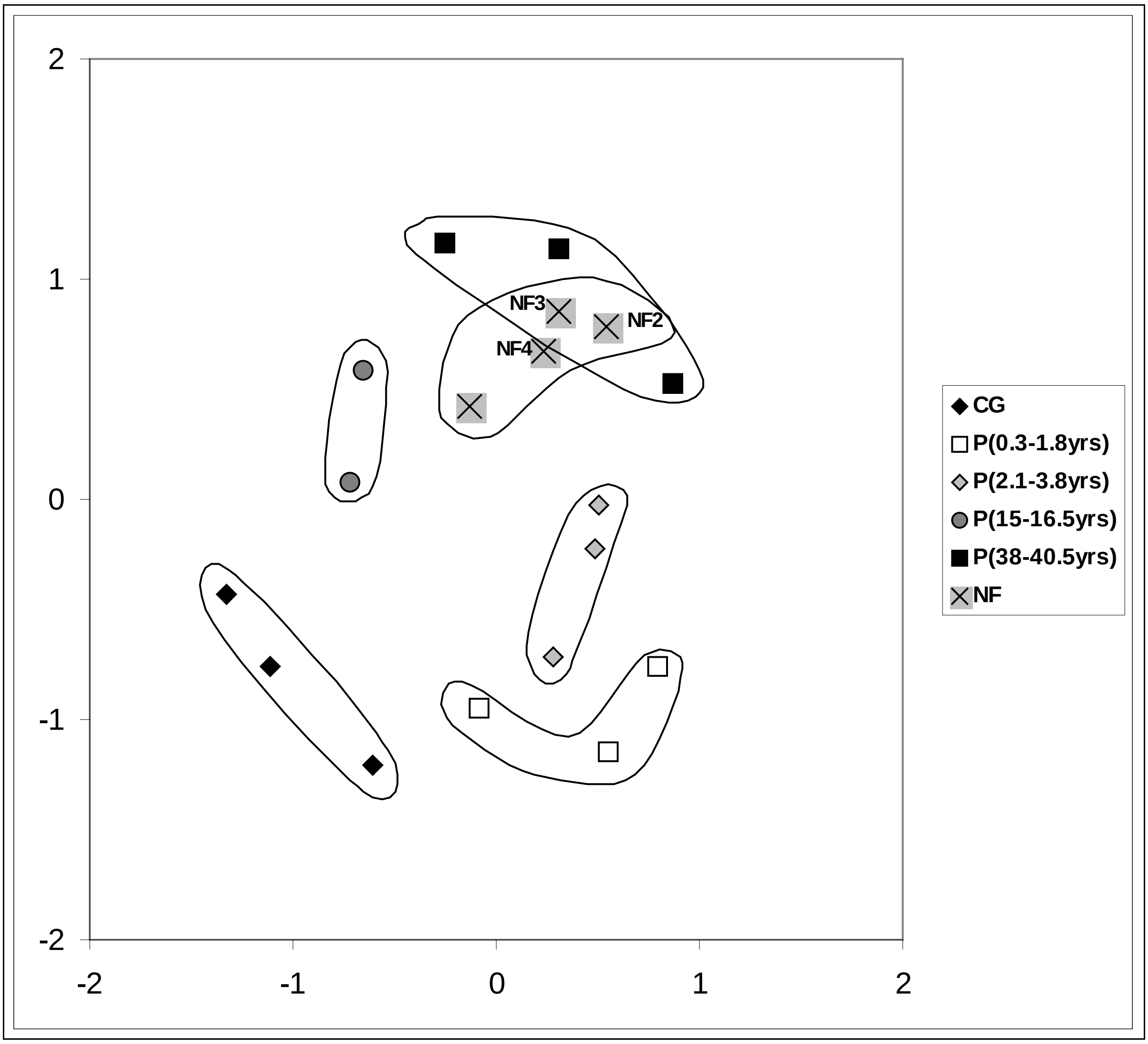


Although total species may be similar between sites, species composition can vary. Pattern analysis was undertaken comparing species composition between sites (Figure 8). Sites closest together in Figure 8 are most similar. Based on vertebrate species composition, all replicates of each vegetation type were closely clustered. All vegetation types separated from each other except the 38-40.5 year plantation age class sites, which had a species composition that overlapped that of the selectively logged eucalypt forest sites. The cleared improved pasture sites were significantly different to the plantation sites and the selectively logged eucalypt forest sites. The cleared improved pasture sites were closest in species composition to the 0.3-1.8 year plantation age class sites.

Figure 8: Two-dimensional ordination of vertebrate fauna species recorded on the 18 survey sites. Ordination stress 0.23.

CG = cleared, improved, grazed pasture; P(age class) = *E. cloeziana* plantation; NF = selectively logged eucalypt forest

(Full description of site names in Table 1, section **2.1** of this report)



3.1.1 Birds

Birds were the highest contributor to vertebrate species on the survey sites (Figures 5 and 6). Pattern analysis was used to provide a visual presentation of the similarity in bird species composition between sites (Figure 9). All cleared improved pasture sites were very different in bird species composition to the plantation and selectively logged eucalypt forest sites. Replicate sites for each vegetation type were tightly clustered. The plantations 38-40.5 years of age were most similar to selectively logged eucalypt forest in bird species composition

Figure 10 presents a comparison of the mean number of bird species recorded in winter and summer on cleared improved pasture, selectively logged eucalypt forest and four age classes of *E. cloeziana* plantations. There was a non-significant trend towards more bird species in winter on cleared improved pasture and the 0.3-1.8 year and 15-16.5 year plantation age classes. There was also a non-significant trend towards more bird species in summer in the selectively logged eucalypt forest and the 38-40.5 year plantation age class. Bird species recorded on the study sites during the survey period were broken down into diet guilds and a comparison made between vegetation types (Figure 11). Diet guild assignment of most bird species was based on a review of unpublished DNR notes on the bird guilds of South-eastern Queensland. The diet guilds in the unpublished notes were compiled from information in Higgins (1999), Higgins and Davies (1996), Frith (1993), Marchant & Higgins (1990, 1993), Austeco (1993), Loyn (1985), Blakers *et al.* (1984), Storr (1973) and M. Schulz (pers. obs.). Diet guild assignment of the few birds not included in the unpublished notes was based on information in Frith (1993), Blakers *et al.* (1984) and M. Mathieson (pers. obs.).

The P(38-40.5 yrs) plantation age class was the closest in bird species diet guild composition to selectively logged eucalypt forest (Figure 11). Invertebrate and nectar feeders formed the highest percentage of species. Nectivorous birds were absent from cleared improved pasture. There were significantly less nectivorous birds species in the P(0.3-1.8yrs) plantations age class compared to the P(15-16.5yrs) and P(38-40.5yrs) plantation age classes and the selectively logged eucalypt forest ($t = 3.600$, $p < 0.05$; $t = 5.422$, $p < 0.01$; $t = 3.836$, $p < 0.05$). Invertebrate feeding bird species were significantly higher in the P(2.1-3.8yrs) and P(38-40.5yr) plantation age classes and selectively logged eucalypt forest compared to cleared improved pasture ($t = 3.190$, $p < 0.05$; $t = 6.725$, $p < 0.01$; $t = 4.757$, $p < 0.01$). The P(38-40.5yrs) plantation age class and the selectively logged eucalypt forest had significantly more invertebrate feeding bird species than the P(0.3-1.8yr) and P(15-16.5yr) plantation age classes ($t = 6.247$, $p < 0.01$; $t = 4.380$, $p < 0.01$; $t = 3.732$, $p < 0.05$; $t = 2.866$, $p < 0.05$).

The selectively logged eucalypt forest had significantly more bird species with fruit and/or seed in the diet compared to cleared improved pasture and all plantation age classes except P(15-16.5yrs) ($t = 10.427$, $p < 0.01$; $t = 3.669$, $p < 0.05$; $t = 2.902$, $p < 0.05$; $t = 4.508$, $p < 0.01$). Fruit and/or seed feeding species were also significantly higher in the P(0.3-1.8yrs) and P(38-40.5yrs) plantation age classes compared to cleared improved pasture ($t = 4.919$, $p < 0.01$; $t = 4.025$, $p < 0.05$). Bird species feeding on invertebrates and vertebrates were significantly higher in selectively logged eucalypt forest than cleared improved pasture and the P(0.3-1.8yrs) plantation age class ($t = 4.298$, $p < 0.01$; $t = 2.731$, $p < 0.05$). Fruit and invertebrate feeders were significantly higher in selectively logged eucalypt compared to cleared improved pasture and the P(2.1-3.8yrs) and P(15-16.5yrs) plantation age classes ($t = 4.781$, $p < 0.01$; $t = 4.183$, $p < 0.01$; $t = 4.899$, $p < 0.01$). Bird species with vegetable matter in the diet were only recorded on cleared improved pasture.

Figure 12 compares the residence status of bird species recorded on cleared improved pasture, selectively logged eucalypt forest and four age classes of *E. cloeziana* plantations. The residence status assignment of most bird species was based on a review of unpublished DNR notes on the bird guilds of South-eastern Queensland. The status guilds in the unpublished notes were compiled using species information from Higgins (1999), Higgins and Davies (1996), Marchant & Higgins (1990, 1993), Blakers *et al.* (1984), Storr (1973), and M. Schulz (pers. obs.). Guild assignment of the few birds not included in the unpublished notes was based on information in Frith (1993), Blakers *et al.* (1984) and M. Mathieson (pers. obs.).

Resident bird species were significantly higher in selectively logged eucalypt forest than on cleared improved pasture and the P(0.3-1.8yrs) and P(15-16.5yrs) plantations ($t = 4.914$, $p < 0.01$; $t = 5.125$, $p < 0.01$; $t = 2.953$, $p < 0.05$). There were significantly more local seasonal movement bird species in selectively logged eucalypt forest and the P(38-40.5yrs) plantation age class than on cleared improved pasture and the P(0.3-1.8yrs) plantation age class ($t = 3.678$, $p < 0.05$; $t = 4.462$, $p < 0.01$; $t = 3.023$, $p < 0.05$; $t = 4.221$, $p < 0.05$). Year round bird species with highest numbers in summer were significantly lower on cleared improved pasture compared to selectively logged eucalypt forest and the plantation age classes P(2.1-3.8yrs), P(15-16.5yrs) and P(38-40.5yrs) ($t = 6.047$, $p < 0.01$; $t = 8.485$, $p < 0.01$; $t = 4.977$, $p < 0.05$; $t = 3.889$, $p < 0.05$). They were also significantly lower for the P(0.3-1.8yrs) plantation age class compared to selectively logged eucalypt forest and the P(38-40.5yrs) plantation age class ($t = 4.140$, $p < 0.01$; $t = 4.000$, $p < 0.05$).
Year round bird species with highest numbers in winter were significantly lower on cleared improved pasture than in selectively logged eucalypt forest and the P(2.1-3.8yrs) and P(15-16.5yrs) and P(38-40.5yrs) plantation age classes ($t = 3.630$, $p < 0.05$; $t = 6.971$, $p < 0.01$; $t = 6.641$, $p < 0.01$; $t = 3.004$, $p < 0.05$). They were also significantly lower in the P(0.3-1.8yrs) plantation age class compared to the P(15-16.5yrs) and P(38-40.5yrs) age classes ($t = 3.429$, $p < 0.05$; $t = 4.588$, $p < 0.05$). No nomadic bird

species were recorded on the cleared improved pasture and were significantly higher in the P(38-40.5yrs) plantation age class and selectively logged eucalypt forest than in the P(2.1-3.8yrs) plantation age class ($t = 3.536$, $p < 0.05$; $t = 3.300$, $p < 0.05$). The summer migrant species were significantly higher in selectively logged eucalypt forest than all other vegetation types except the P(38-40.5yrs) plantation class ($t = 3.673$, $p < 0.05$; $t = 3.673$, $p < 0.05$; $t = 3.315$, $p < 0.05$; $t = 2.787$, $p < 0.05$).

Figure 9: Two-dimensional ordination of bird species recorded on the 18 survey sites. Ordination stress 0.21.

CG = cleared, improved, grazed pasture; P(age class) = *E. cloeziana* plantation;NF = selectively logged eucalypt forest

(Full description of site names in Table 1, section **2.1** of this report)

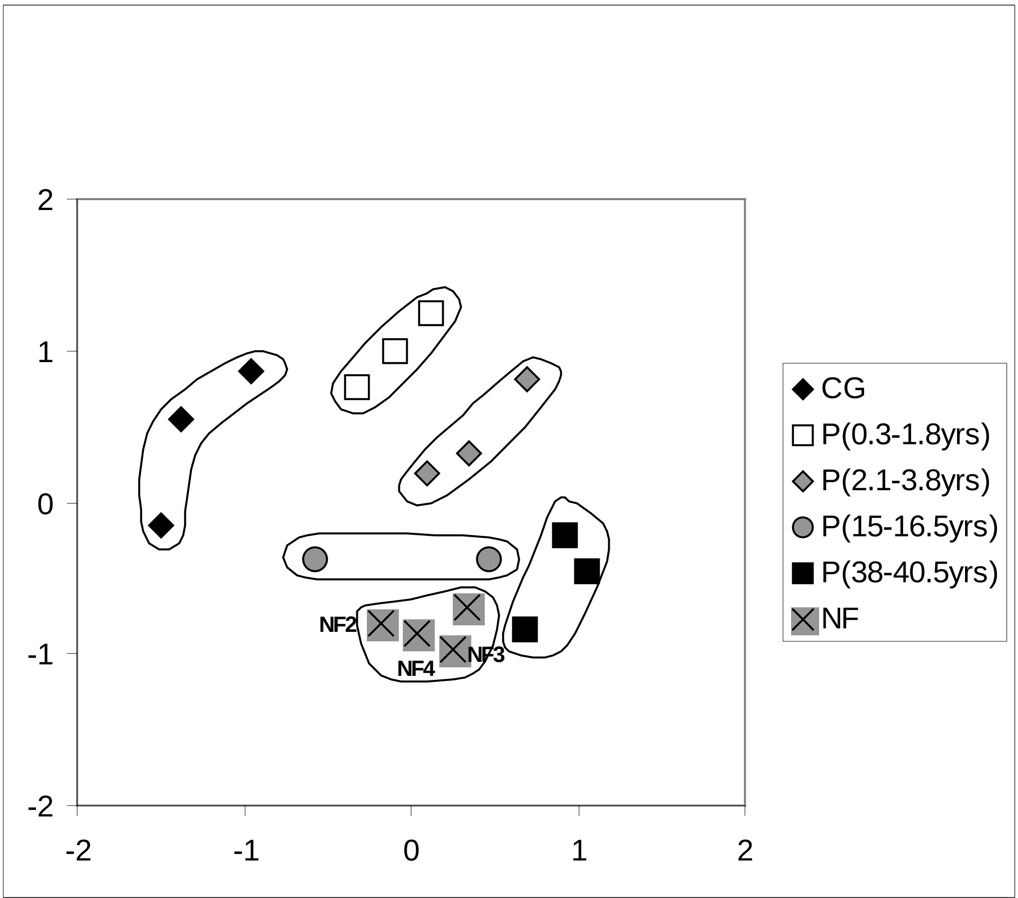


Figure 10: Winter-summer comparison of mean bird species on all vegetation treatments. Results of two winter and two summer survey periods per site, except sites NF3 and NF4 with one winter and one summer survey period each. Three replicates each vegetation type, except P(15-16.5yrs) with two and NF with four. The 95% confidence limits marked, except P(15-16.5yrs) with only a standard error.

CG = cleared, improved, grazed pasture; P(age class) = *E. cloeziana* plantation; NF = selectively logged eucalypt forest

(Full description of site names in Table 1, section **2.1** of this report)

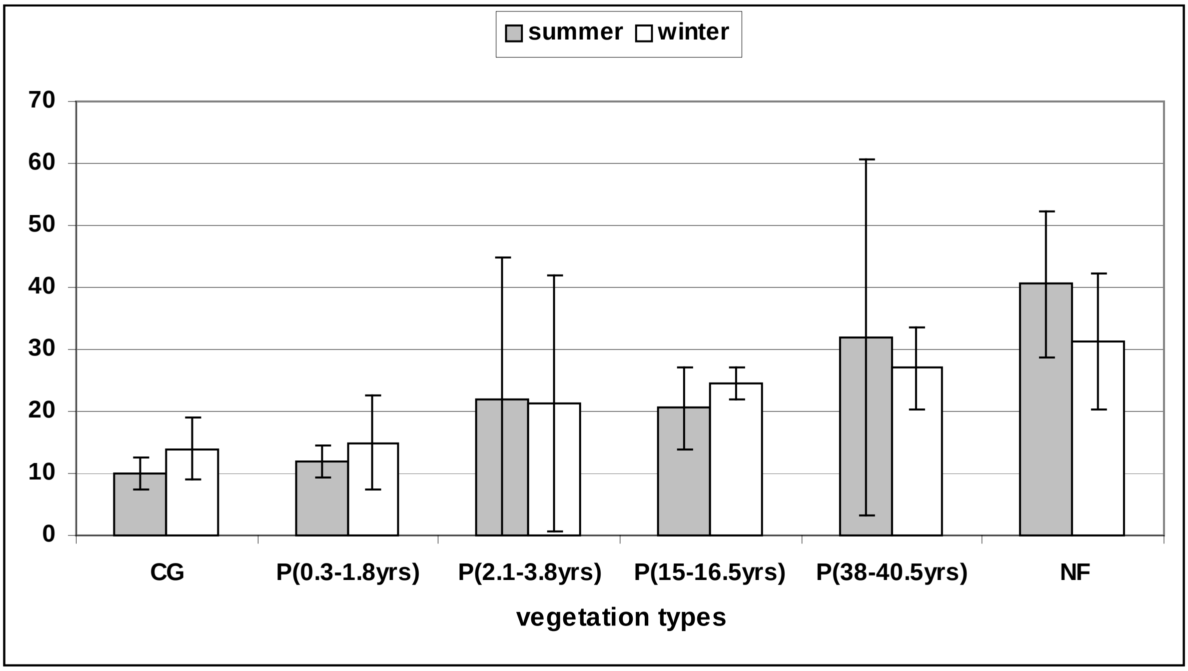


Figure 11: Mean diet guild breakdown of bird species on all vegetation treatments. Results of two winter and two summer survey periods per site, except sites NF3 and NF4 with only one winter and one summer survey period. Three replicates each vegetation type, except P(15-16.5yrs) with two and NF with four. The 95% confidence limits marked, except P(15-16.5yrs) with a standard error.

CG = cleared, improved, grazed pasture; P(age class) = *E. cloeziana* plantation; NF = selectively logged eucalypt forest

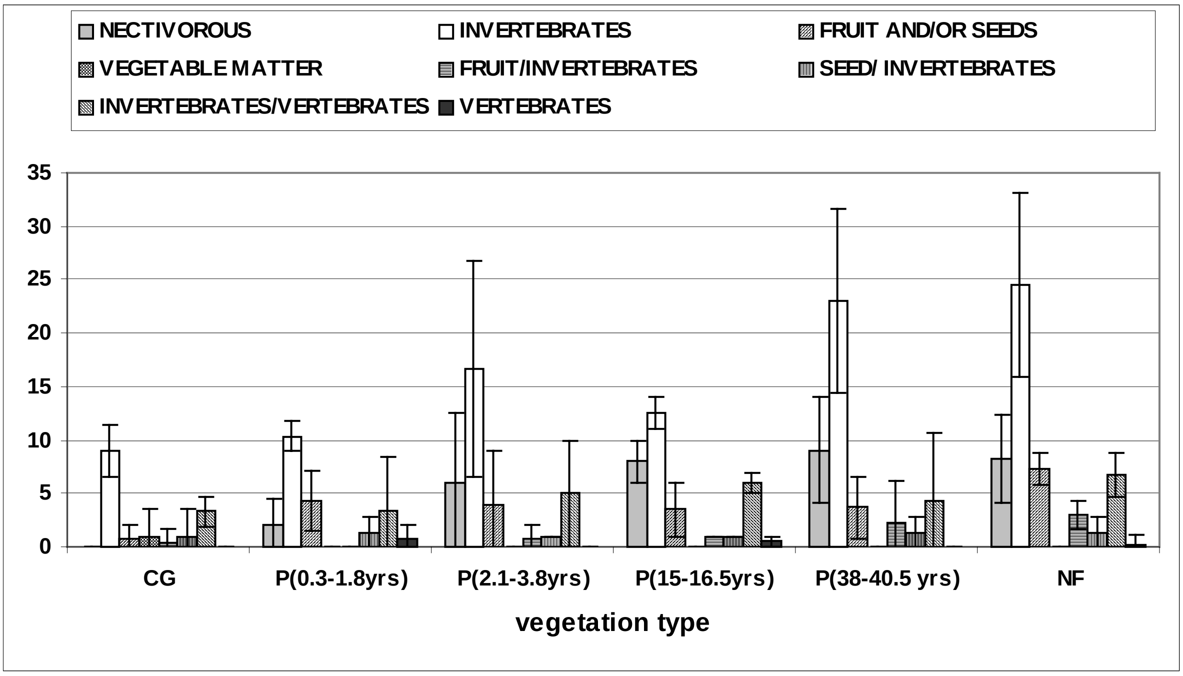
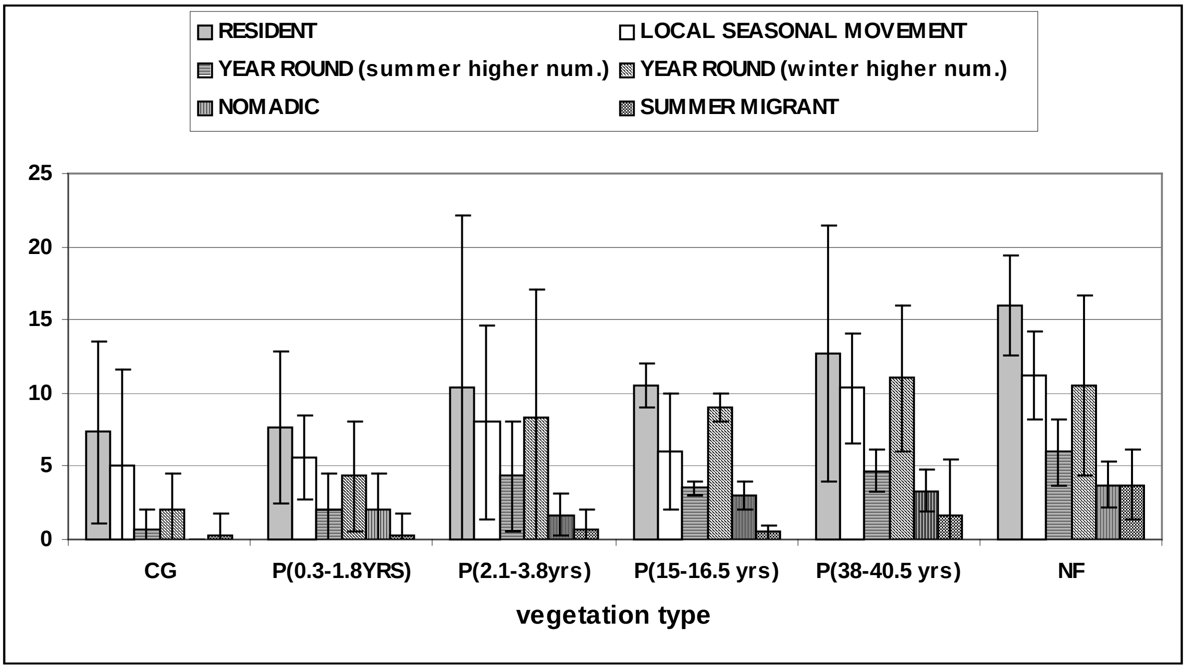


Figure 12: South east Queensland residence status of bird species recorded on all vegetation treatments. The mean for each vegetation type derived from two winter and two summer survey periods per site, except sites NF3 and NF4 with only one winter and one summer survey period. Three replicates of each vegetation type, except P(15-16.5yrs) with two and NF with four. The 95% confidence limits marked, except for P(15-16.5yrs) with a standard error.

CG = cleared, improved, grazed pasture; P(age class) = *E. cloeziana* plantation; NF = selectively logged eucalypt forest



Bird survey plot results were used to derive a two-dimensional ordination plot of bird abundance (Figure 13). Abundance data for each site is derived from four sets of two surveys, each set consisting of an early morning and mid-morning survey, with two survey sets in winter and two survey sets in summer. The data was a cumulative total of the highest single survey count for each species from each of the four sets of two surveys. Within each vegetation class, replicate sites grouped tightly, showing bird abundance was similar between replicates. Except for the overlap of the two selectively logged eucalypt forest sites with the three 38-40.5 year plantation age class sites, all other vegetation types were clearly different in bird abundance. Of the 91 bird species used in the analysis, 19 species contributed most to the ordination. These 19 bird species and the direction each drove the bird abundance ordination is presented in Figure 13. Table 6 lists the 19 bird species in full with their residence status and diet guild. Eight of the 19 species (42%) we have identified as birds that exhibit local seasonal movement in south east Queensland. Eleven of the bird species (58%) are insect feeders.

Similar to the assignment of bird species into diet guilds in Figure 11, bird abundance has been broken down into diet guilds in Figure 14. Bird numbers in four of the guilds were too low to compare abundance between vegetation types. Absent from cleared improved pasture were fruit and/or seedeaters, fruit/invertebrate feeders, nectar in the diet feeders and vertebrate feeders. Birds with vegetable matter in the diet were absent from all plantation age classes and selectively logged eucalypt forest. Also absent from all plantation age classes were birds with a fruit/invertebrate diet. Birds with a seed/invertebrate diet were either absent or very low in numbers in all plantation age classes.

Nectivorous birds were very significantly more abundant in selectively logged eucalypt forest and the P(38-40.5yrs) plantation age class than in the P(0.3-1.8yrs) plantation age class ($t = 15.197$ $p < 0.001$; $t = 6.278$, $p < 0.01$). Abundance of birds feeding on invertebrates was significantly higher in the P(38-40.5yrs) plantation age class compared to cleared improved pasture and the P(15-16.5yrs) plantation age class ($t = 4.161$, $p < 0.05$; $t = 3.953$, $p < 0.05$). Fruit and/or seed feeders were significantly more abundant in selectively logged eucalypt forest than in the P(38-40.5yrs) plantation age class (t = 3.454, p< 0.05). Birds feeding on both vertebrates and invertebrates were significantly more abundant in the:

a. P(15-16.5yrs) plantation age class compared to selectively logged eucalypt forest, cleared improved pasture and the P(0.3-1.8yrs) plantation age class (t = 9.391, p< 0.05; t = 22.543, p< 0.001; t = 7.484, p< 0.01);
b. P(38-40.5yrs) plantation age class compared to cleared improved pasture (t = 3.741, p< 0.05).

Pooling data in Figure 14 and comparing mean total bird abundance between each vegetation type there was significantly higher bird abundance in the P(38-40.5yrs) plantation age class compared to cleared improved pasture and the P(0.3-1.8yrs) plantation age class (t = 6.897, p< 0.01; t = 3.243, p < 0.05).

Figure 13: Bird abundance two-dimensional ordination plot derived from bird survey plot data from all sites except NF3 and NF4. The first letter of the genus and species name marks the main bird species driving the ordination. Table 6 lists the 19 bird names in full. Ordination stress was 0.19.

CG = cleared, improved, grazed pasture; P(age class) = *E. cloeziana* plantation; NF = selectively logged eucalypt forest

(Full description of site names in Table 1, section **2.1** of this report)

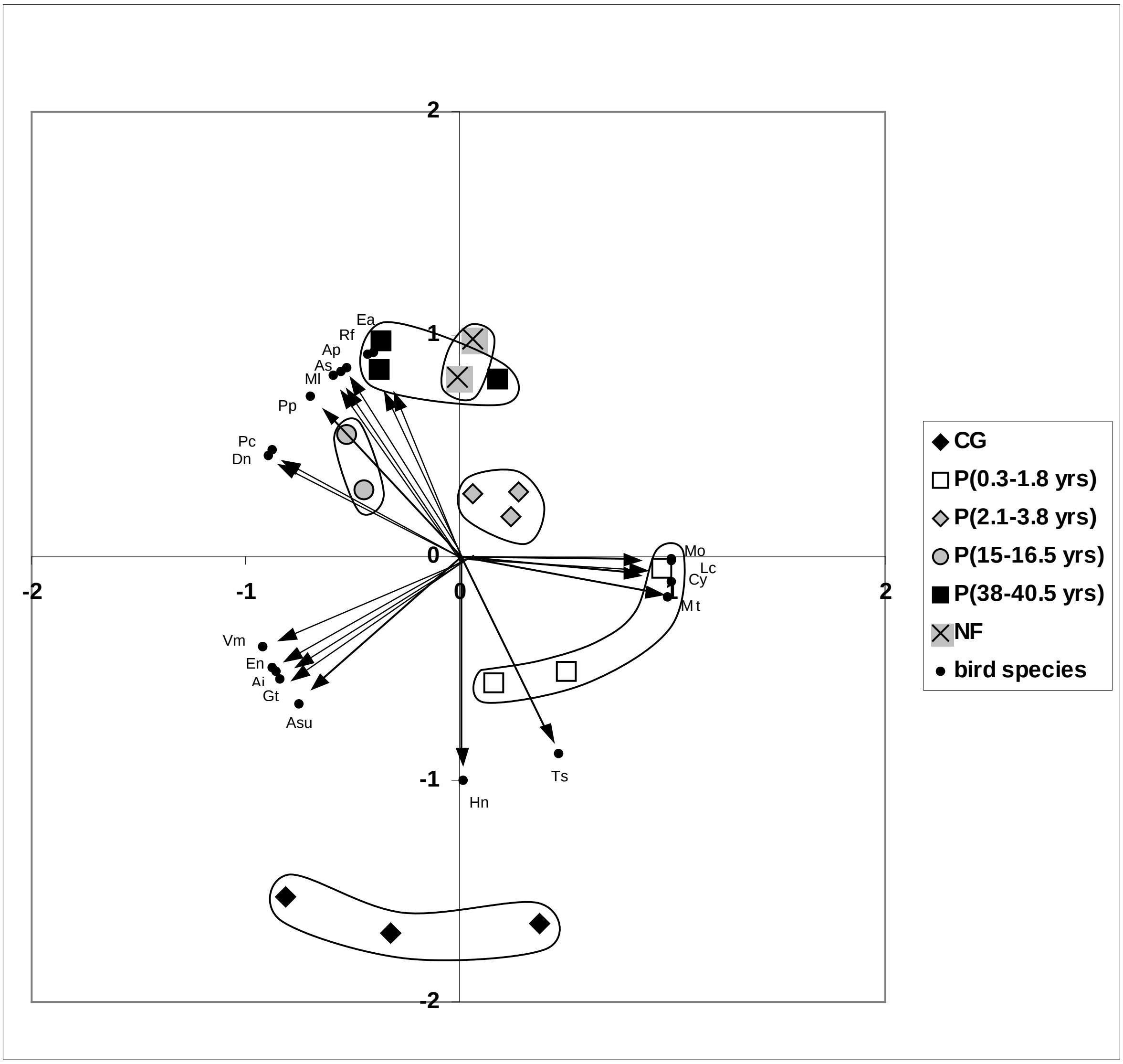


Table 6: Bird species driving the bird abundance ordination in Figure 18.

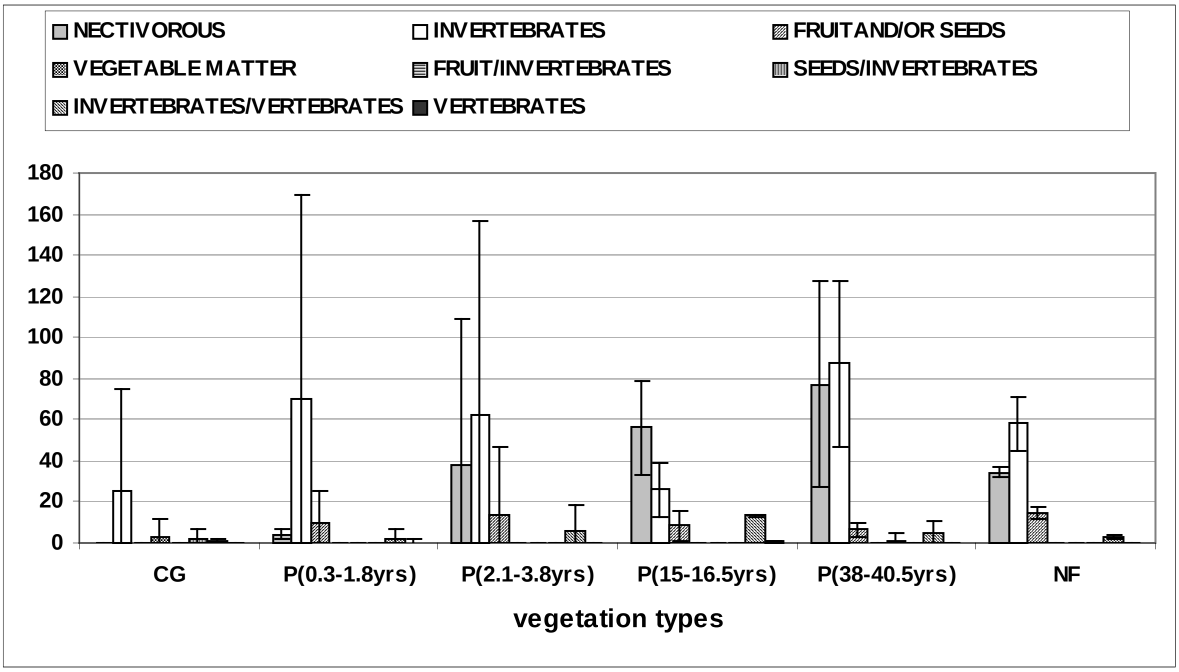
ORDINATION CODE	SCIENTIFIC NAME	COMMON NAME	RESIDENCE STATUS	DIET GUILD
Ai	*Ardea ibis*	cattle egret	LM	IN
Ap	*Acanthiza pusilla*	brown thornbill	RE	IN
As	*Alisterus scapularis*	Australian king-parrot	LM	FS
Asu	*Anus superciliosa*	Pacific black duck	LM	SI
Cy	*Coturnix ypsilophora*	brown quail	RE	SE
Dn	*Dacelo novaeguineae*	laughing kookaburra	RE	IV
Ea	*Eopsaltria australis*	eastern yellow robin	LM	IN
En	*Egretta novaehollandiae*	white-faced heron	LM	IV
Gt	*Gymnorhinia tibicen dorsalis*	Australian magpie	RE	IN
Hn	*Hirundo neoxena*	welcome swallow	WH	IN
Lc	*Lonchura castaneothorax*	chestnut-breasted manikin	LM	SE
Ml	*Meliphaga lewinii*	Lewin's honeyeater	LM	NE
Mo	*Merops ornatus*	rainbow bee-eater	SH	IN
Mt	*Megalurus timoriensis*	tawny grassbird	LM	IN
Pc	*Philemon corniculatus*	noisy friarbird	NM	NE
Pp	*Pachycephala pectoralis*	golden whistler	WH	IN
Rf	*Rhipidura fuliginosa*	grey fantail	WH	IN
Ts	*Threskiornis spinicollis*	straw-necked ibis	RE	IN
Vm	*Vanellus miles*	masked lapwing	RE	IN

DIET GUILD CODES
FS: fruit/seed
IN: invertebrates
IV: invertebrates/vertebrates
NE: nectivorous
SE: seeds
SI: seeds/invertebrates

RESIDENCE STATUS CODE
LM: local seasonal movement
NM: nomadic
RE: resident
SH: year round, numbers highest in summer
WH: year round, numbers highest in winter

Figure 14: Diet guild breakdown of mean bird abundance for all vegetation types. Three replicates of each vegetation type, except P(15-16.5yrs) and NF2 with two. The results from four sets of two surveys per plot (two winter and 2 summer survey sets). The 95% confidence limits marked, except for P(15-16.5yrs) and NF with standard errors.

CG = cleared, improved, grazed pasture; P(age class) = *E. cloeziana* plantation; NF = selectively logged eucalypt forest



3.1.2 Rodents

Eight species of rodents, including two introduced species, were trapped on the survey sites (Table 7). Data from rodents caught in baited live traps and to a lesser extent in pit-traps. Highest number of rodent species recorded was 6 in the P(2.1-3.8yrs) and P(38-40.5yrs) *E. cloeziana* plantation age classes. The introduced *Mus musculus* (house mouse) was the only rodent species caught on all vegetation types and was the only rodent recorded on cleared improved pasture. The native rodents *Melomys cervinipes* (fawn-footed melomys)and *Rattus fuscipes* (bush rat) were only caught in the P(38-40.5yrs) plantation age class and the selectively logged eucalypt forest. *Pseudomys gracilicaudatus* (eastern chestnut mouse) was restricted to the grassy understories of the plantations under 3.8 years of age and were absent from the older plantations and other vegetation types not dominated by tall grass (Figure 26). The grassland melomys (*Melomys burtoni*) was mainly restricted to these younger plantations. The native rat *Rattus tunneyi* (pale-field rat) and the introduced *Rattus rattus* (black rat) were only caught in plantations. Five of the eight *R. rattus* caught were in an *E. cloeziana* plantation that had a boundary with a macadamia orchard.

Although *M. musculus* was recorded on 13 of the 18 study sites (Table 7), the rodent abundance data presented in Figure 15 shows the species was virtually absent from the selectively logged eucalypt forest and the P(38-40.5yrs) plantation age class. Numbers were high in the P(0.3-1.8 yrs) and P(2.1-3.8yrs) plantation age classes. Both these young plantation classes had mainly grassy understories for most of the survey period (Figure 26). *M. musculus* abundance was significantly higher in the P(2.1-3.8yrs) plantation age class compared to the P(38-40.5yrs) plantation class ($t = 3.382$, $p < 0.05$). The 95% confidence limits in Figure 15 are wide because of variability in rodent numbers between sites within vegetation types (see Figure 16). The abundance of both *M. cervinipes* and *R. fuscipes* were not significantly different between the P(38-40.5yrs) plantation age class and selectively logged native forest ($t = 0.93$, $p > 0.4$; $t = 1.473$, $p > 0.2$).

Table 7: Introduced and native rodent species recorded on the 18 study sites. Results of two winter and two summer survey periods per site, except NF3 and NF4 with one winter and one summer survey period each.

CG = cleared, improved, grazed pasture; P(age class) = *E. cloeziana* plantation; NF = selectively logged eucalypt forest

(Full description of site names in Table 1, section **2.1** of this report)

	INTRODUCED RODENTS		**NATIVE RODENTS**					
SITES	*Mus musculus*	*Rattus rattus*	*Rattus fuscipes*	*Melomys cervinipes*	*Melomys burtoni*	*Pseudomys gracilicaudatus*	*Rattus lutreolus*	*Rattus. tunneyi*
CG1	X							
CG2	X							
CG3	X							
P(0.3-1.8yrs)1	X				X			
P(0.3-1.8yrs)2	X				X	X		
P(0.3-1.8yrs)3	X				X	X	X	
P(2.1-3.8yrs)1	X				X	X	X	X
P(2.1-3.8yrs)2	X	X			X		X	
P(2.1-3.8yrs)3	X					X	X	
P(15-16.5yrs)1	X							X
P(15-16.5yrs)2	X	X						
P(38-40.5yrs)1	X	X	X	X				
P(38-40.5yrs)2			X	X	X		X	
P(38-40.5yrs)3			X	X				
NF1			X	X			X	
NF2			X	X				
NF3			X	X	X			
NF4	X		X	X				

Figure 15: Mean rodent abundance for six of the eight rodent species trapped on the six vegetation types. Three replicates per vegetation type except P(15-16.5yrs) and NF with two. A cumulative total of captures from two winter and two summer trapping periods, recaptures each survey period excluded. The 95% confidence limits marked, except P(15-16.5yrs) and NF with a standard error.
*= Introduced rodent species
CG = cleared, improved, grazed pasture; P(age class) = *E. cloeziana* plantation; NF = selectively logged eucalypt forest

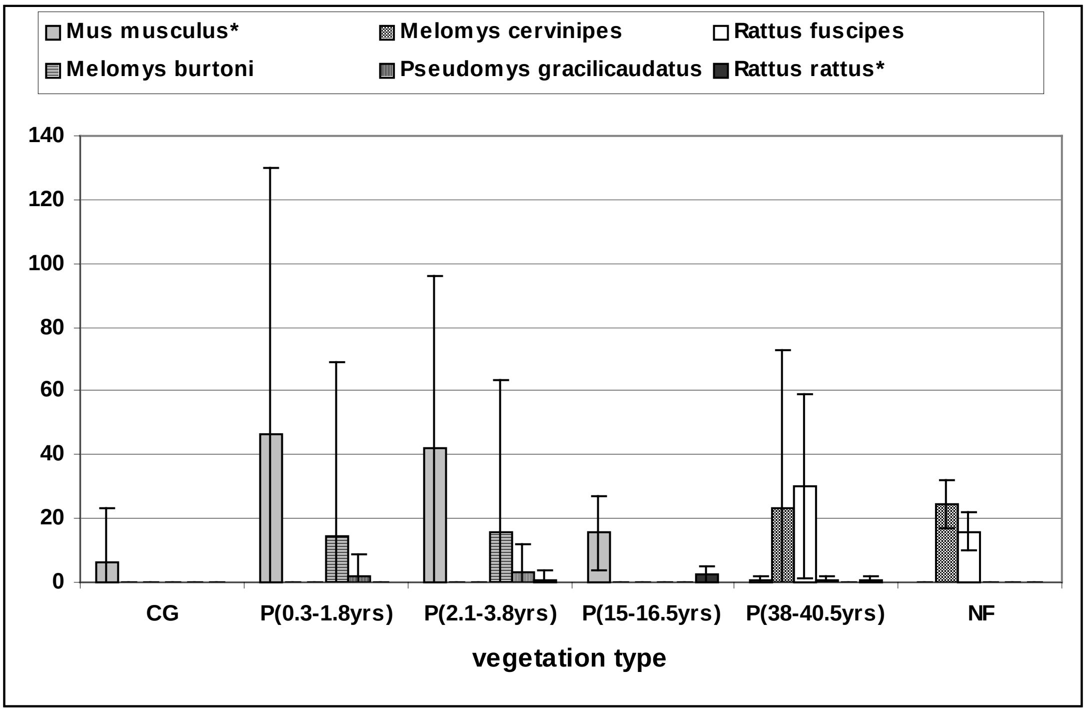
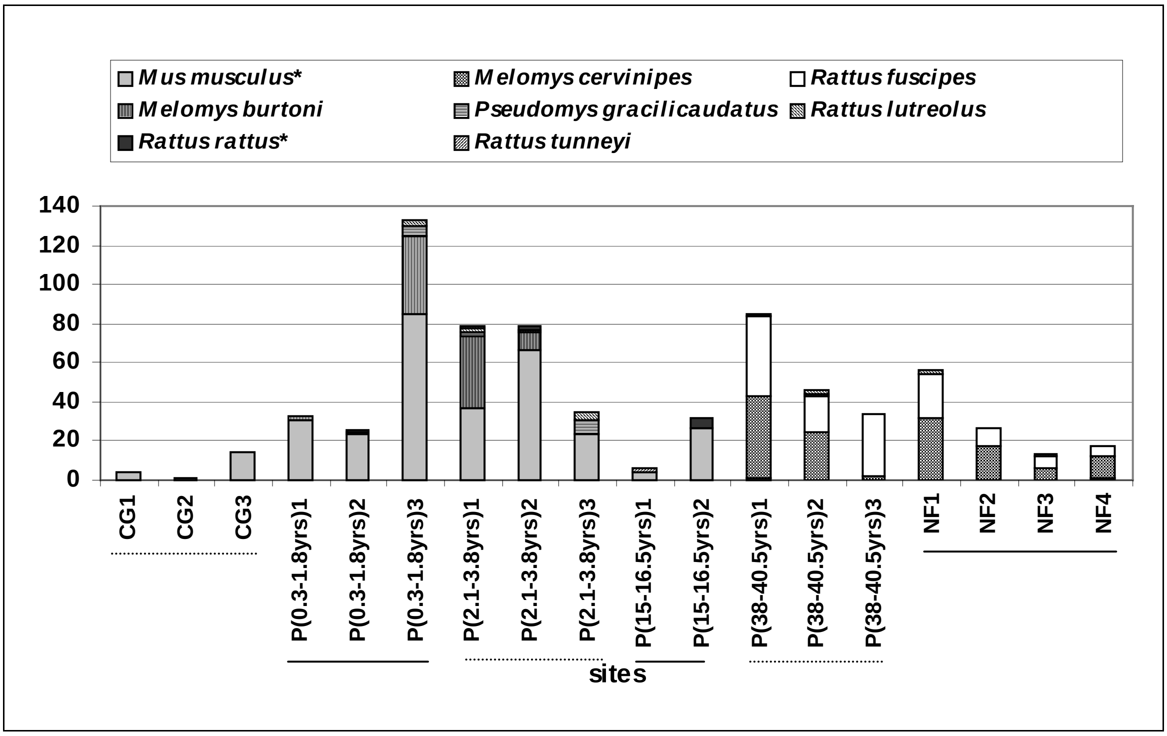


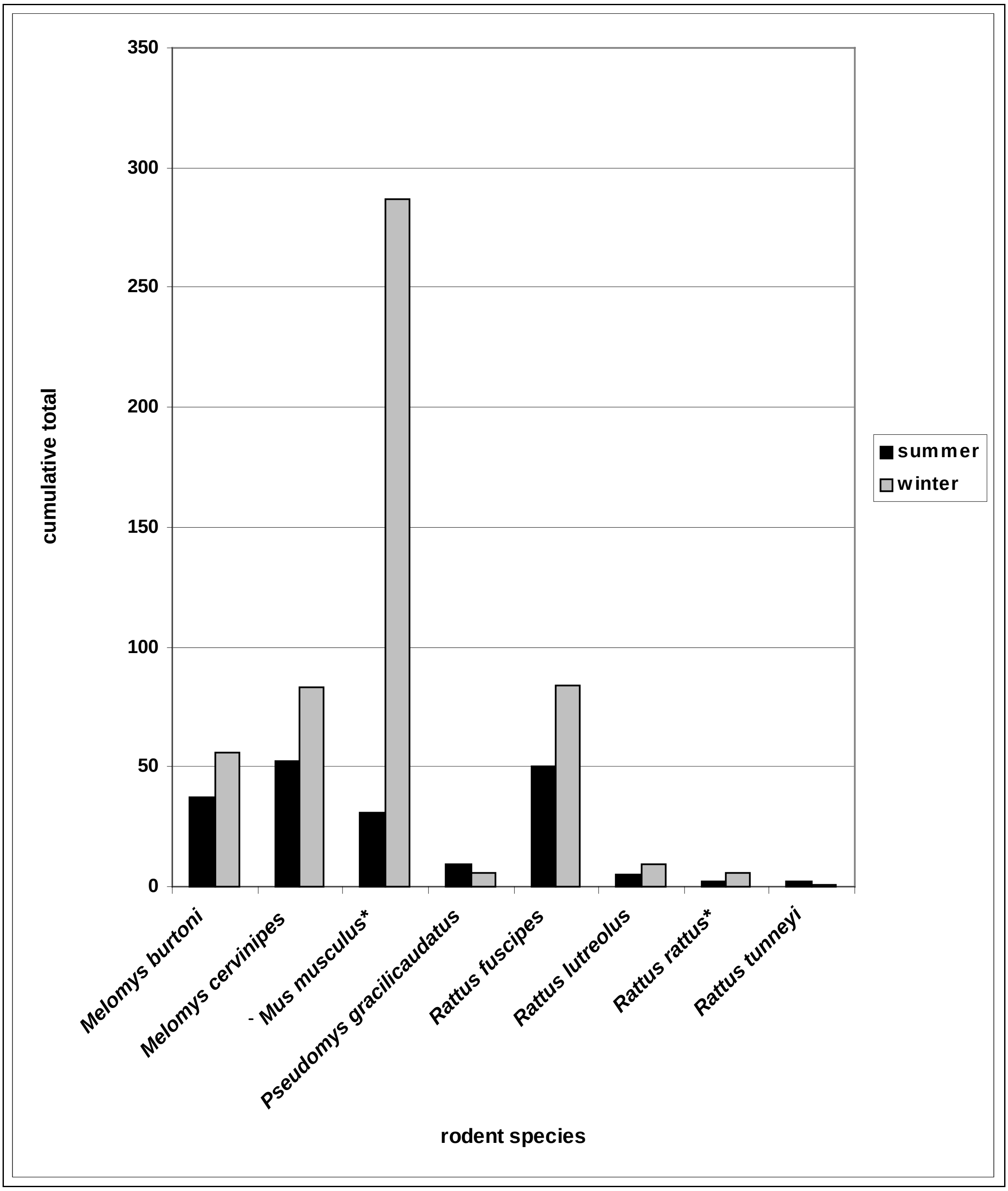
Figure 16: Rodent abundance for the eight rodent species trapped on the 18 study sites. Totals a cumulative total of captures from two winter and two summer trapping periods, except sites NF3 and NF4 with only one winter and one summer trapping period. Recaptures each survey period excluded.
* = Introduced rodent species
CG = cleared, improved, grazed pasture; P(age class) = *E. cloeziana* plantation; NF = selectively logged eucalypt forest



A winter summer comparison of total captures for each rodent species on the 18 survey sites is presented in Figure 17. Chi-square analysis of the combined rodent capture records found captures were very significantly higher in winter compared to summer, based on (χ^2 = 164.356, df = 1, p < 0.005). For individual rodent species, the numbers in winter were significantly higher for *Melomys burtoni* (χ^2 = 3.8808.626, df = 1, p < 0.05) and very significantly higher for *Melomys cervinipes* (χ^2 = 7.118, df = 1, p < 0.01), *Rattus fuscipes* (χ^2 = 8.626, df = 1, p < 0.005) and the introduced *Mus musculus* (χ^2 = 206.088, df = 1, p < 0.005).

Figure 17: Winter-summer comparison of total captures for each rodent species on the 18 survey sites. The results of two winter and two summer trapping periods, except NF3 and NF4 with only one winter and one summer trapping period each. Recaptures for each trapping period were excluded.

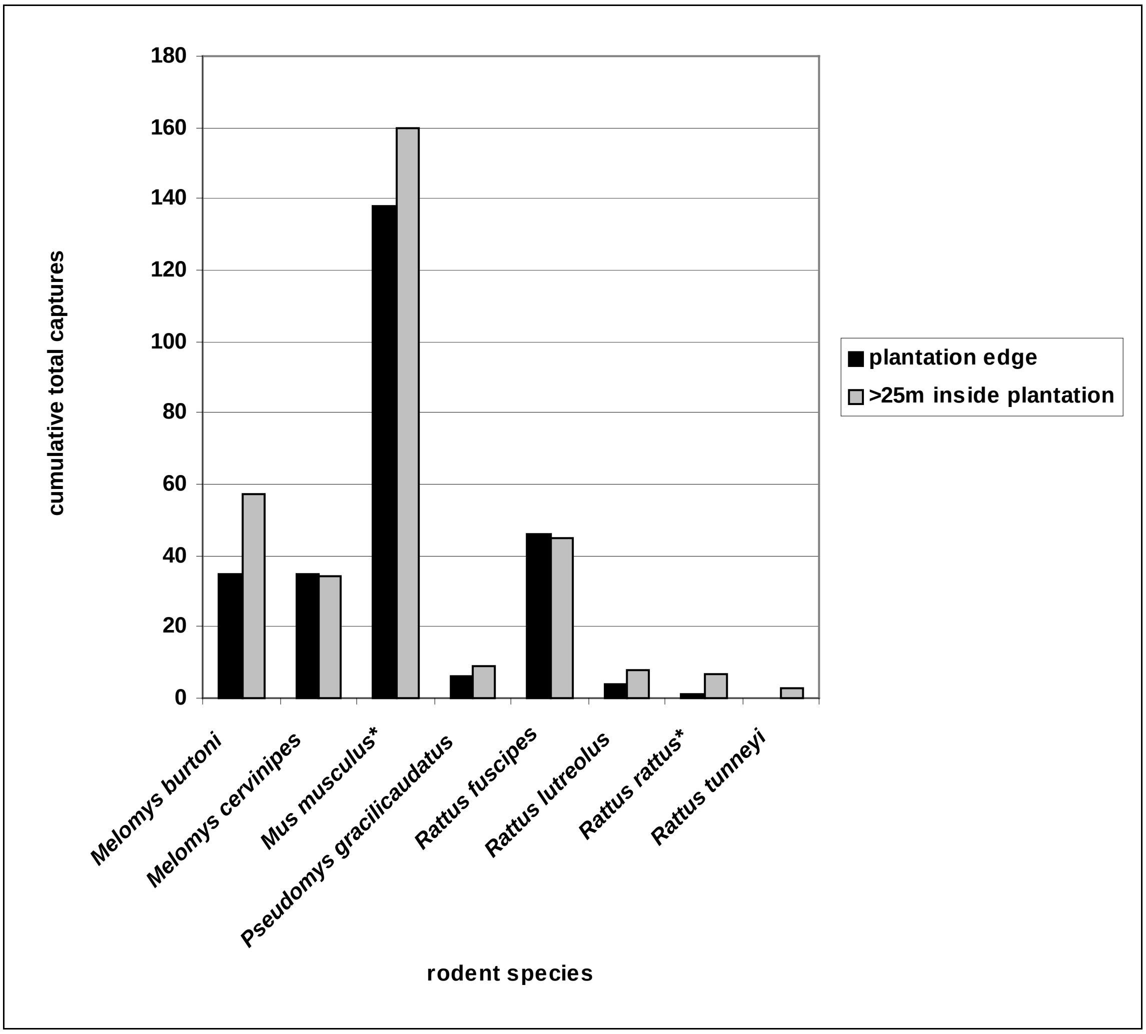
***** = Introduced rodent species



A chi-square comparison of total rodent captures on the 11 *E. cloeziana* plantation sites, found significantly lower numbers trapped on the plantation edge compared to >25 m inside the plantation (χ^2 = 5.720, df = 1, p < 0.05). Trapping effort was the same on the edge and the inside of the plantations. Figure 18 provides a comparison of captures on the edge and >25 m inside the plantations for each rodent species. Chi-square analysis of the results in Figure 18 found *M. burtoni* and the introduced *Rattus rattus* were the only two species where captures were significantly lower on the plantation edge (χ^2 = 5.260, df = 1, p < 0.05; χ^2 = 4.500, df = 1, p < 0.05).

Figure 18: Comparison of the cumulative capture totals on the edge and > 25 m inside the 11 *E. cloeziana* plantations for two introduced and five native rodent species. The results of two winter and two summer survey periods per site. Recaptures in each survey period were excluded.

***** = Introduced rodent species



3.1.3 Marsupial abundance

Numbers for the 16 marsupial species recorded during the survey period were mainly too low to make a meaningful comparison between sites and between vegetation types on abundance. The 59 captures of *Antechinus flavipes* (yellow-footed antechinus), which exclude recaptures, represent the most records for any marsupial species. Cumulative captures of *A. flavipes* and two other marsupial mice species recorded on the study sites are presented in Figure 19. The cumulative totals for *Sminthopsis murina* (common dunnart) and *Planigale maculata* (common planigale) were 9 and 11 respectively. *A flavipes* appears to mainly prefer the selectively logged eucalypt forest and the 38-40.5 year old plantations. Selectively logged eucalypt forest site NF2 had significantly higher cumulative captures (22) of *A. flavipes* than all the other selectively logged eucalypt forest sites combined (12) (χ^2 = 8.470, df=1, p< 0.005).

The data in Figure 19 was grouped as a mean for cleared improved pasture, selectively logged eucalypt forest and four age classes of *E. cloeziana* plantations (Figure 20). All three marsupial mice were recorded in selectively logged eucalypt forest and in the 38-40.5 year plantation age class, but there was no significant difference between these vegetation types for the three species. No marsupial mice species were recorded on cleared improved pasture. No *Sminthopsis murina* were recorded in plantations less than 16.5 years of age. A winter summer comparison of cumulative marsupial mouse captures on the 18 study sites (Figure 21), found their numbers based on trappability were very significantly higher in winter compared to summer. Tested using Chi-square analysis (χ^2 = 10.646, df = 1, p < 0.005). For *A. flavipes*, numbers trapped in winter were very significantly higher in winter (χ^2 = 20.762, df = 1, p < 0.005). *Planigale maculata* numbers trapped in summer were significantly higher than winter (χ^2 = 4.454, df = 1, p < 0.05).

Figure 19: Cumulative capture totals for the three marsupial mice species recorded on the 18 study sites. Results of two winter and two summer survey periods per site, except NF3 and NF4 with only one winter and one summer survey period each. Recaptures in each survey period were excluded from the cumulative totals. *A. flavipes* image courtesy of the Queensland Museum.

CG = cleared, improved, grazed pasture; P(age class) = *E. cloeziana* plantation; NF = selectively logged eucalypt forest

(Full description of site names in Table 1, section **2.1** of this report)

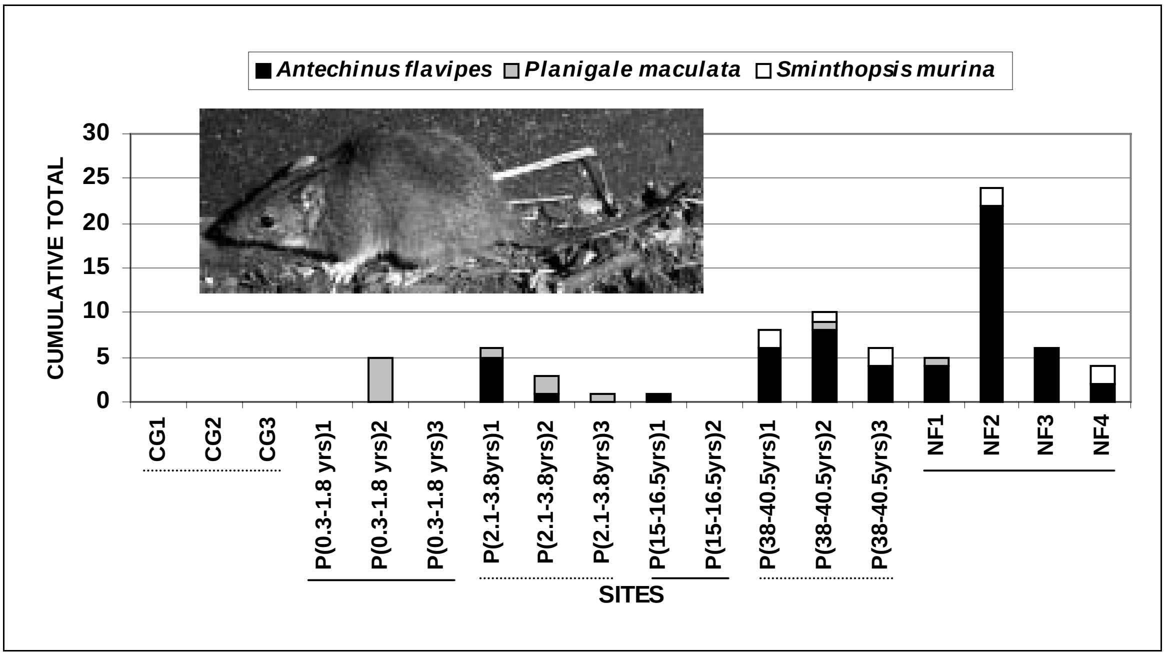


Figure 20: Mean abundance for three marsupial mouse species trapped in the six vegetation treatments. Three replicates each vegetation type except P(15-16.5yrs) and NF with two. Total animals each species for each survey site is a cumulative total from two winter and two summer trapping periods. Recaptures each survey period were excluded. The 95% confidence limits marked, except for P(15-16.5yrs) and NF with standard errors.

CG = cleared, improved, grazed pasture; P(age class) = *E. cloeziana* plantation; NF = selectively logged eucalypt forest

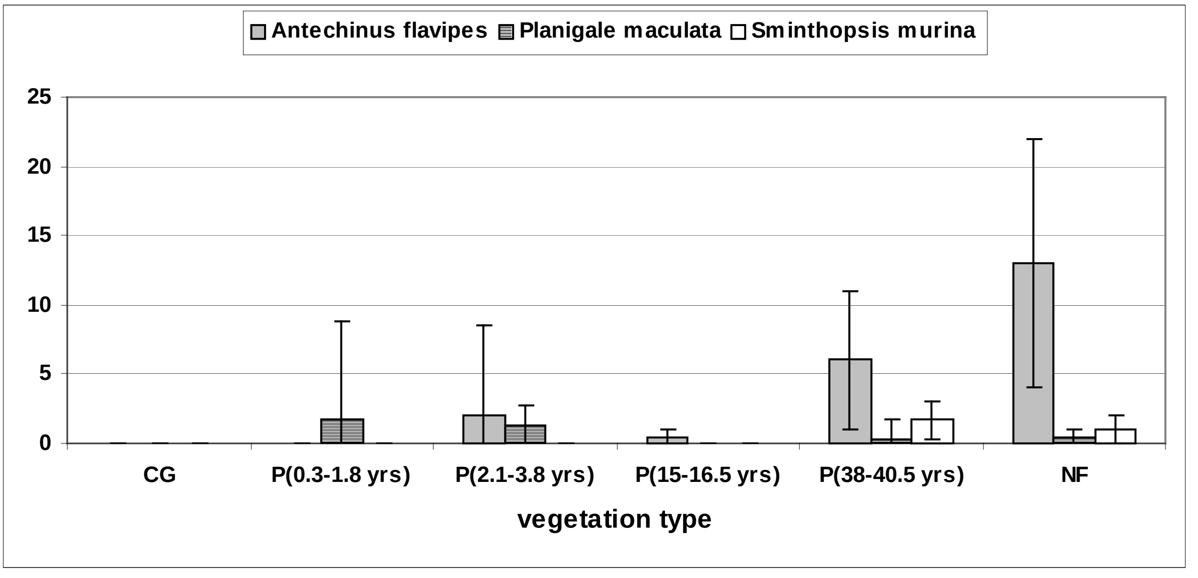
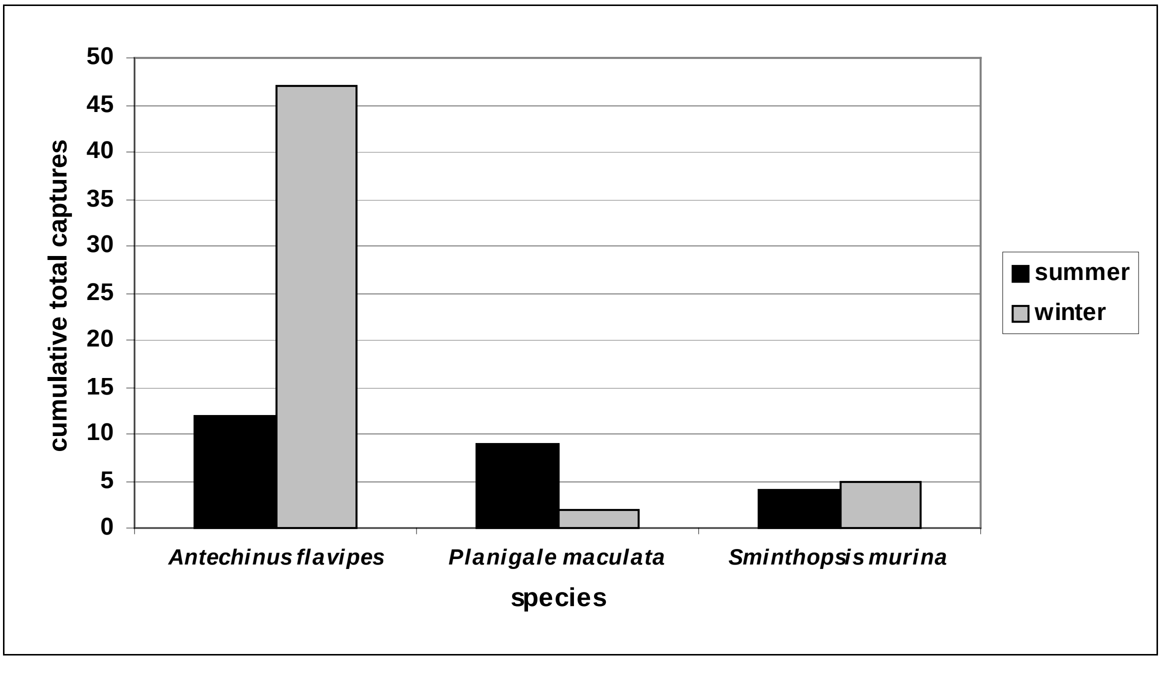


Figure 21: Winter-summer comparison of the cumulative capture totals for the three marsupial mouse species recorded on the 18 study sites. Results of two winter and two summer survey periods per site, except NF3 and NF4 with only one winter and one summer survey period each. Recaptures each survey period not included.

CG = cleared, improved, grazed pasture; P(age class) = *E. cloeziana* plantation; NF = selectively logged eucalypt forest



3.1.4 Frog abundance

Twenty-three amphibian species were recorded on the study sites, of these 19 (86%) occurred in the *E. cloeziana* plantations (Table 4). For all except one native frog species, numbers were too low to make a meaningful comparison of abundance between sites and between vegetation types.

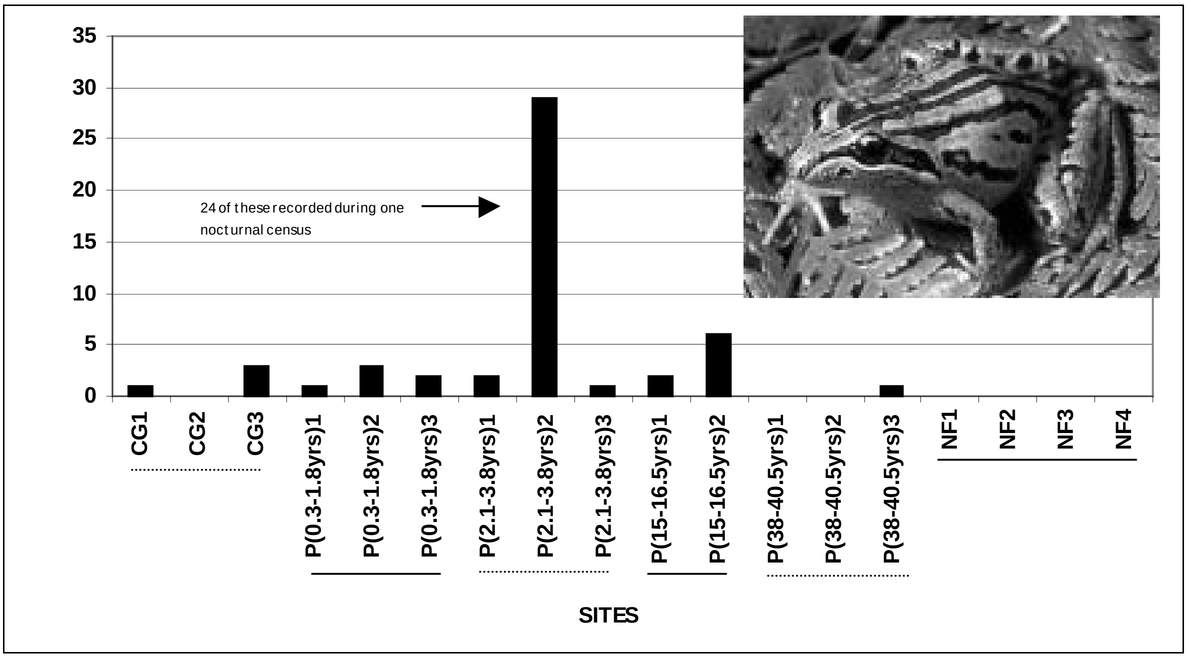
The striped marshfrog *Limnodynastes peronii* was the most recorded native frog, occurring on 11 of the 18 study sites. Abundance of the frog across the sites is presented in Figure 22. There are a total of 51 records for the frog, but its abundance is distorted as 24 (47%) were recorded on a single evening's survey on one site during brief favourable conditions for the frog (Figure 22). The frog appears to favour cleared improved pasture and the plantations under 3.8 years of age. All cleared improved pasture sites and plantation sites under 3.8 years of age had either nearby dams or creeks. Only a single specimen of the frog was recorded on the three 38-40.5 year old plantation sites and none in the selectively logged eucalypt forest.

A comparison of plantation records of *L. peronii* (n = 43) found no significant difference in the number of frogs recorded <25 m inside the plantation compared to >25 m inside (χ^2= 1.800, df = 1, p > 0.05).

Figure 22: Cumulative total *Limnodynastes peronii* (striped marshfrog) records (sightings, captures and calling frogs) for each study sites. Results of two winter and two summer survey periods per site, except NF3 and NF4 with only one winter and one summer survey period each. Image courtesy of the Queensland Museum.

CG = cleared, improved, grazed pasture; P(age class) = *E. cloeziana* plantation; NF = selectively logged eucalypt forest

(Full description of site names in Table 1, section **2.1** of this report)



3.1.5 Reptile abundance

Of the 23 reptile species recorded on the study sites, 19 (83%) occurred in the *E. cloeziana* plantations (Table 4). For most species the number recorded was too low to compare abundance between sites and between vegetation types. *Lampropholis delicata* (eastern grass skink) was the most recorded reptile (n =72), occurring on 14 of the 18 study sites. Next most recorded reptile was *Lampropholis amicula* (friendly skink) with 21 records. Abundance of the two skinks across the sites is presented in Figure 23. Highest numbers for *L. delicata* were recorded on the selectively logged eucalypt forest sites. The skink was recorded in all plantation age classes, with low numbers in the young grassy plantations less than 1.8 years of age. It was only recorded on one of the cleared improved pasture sites, with just two records from the site. *L. amicula* was only recorded on five sites, four in plantations and one site in selectively logged eucalypt forest.

The abundance of the two skinks on cleared improved pasture, selectively logged eucalypt forest and four age classes of plantations is presented in Figure 24. The 95% confidence limits are wide because of replicate variation in skink numbers within vegetation types and the low number of records within most of the vegetation types. Consequent testing found no significant difference between the vegetation classes for the abundance of each skink (t-test, $p > 0.1$). There was no significant difference on plantation sites in the number of *L. delicata* and *L. amicula* recorded 0-25 m inside the plantation and 25-50 m inside (Figure 25) (*L. delicata* $\chi^2 = 0.400$, df = 1, $p > 0.5$; *L. amicula* $\chi^2 = 0.077$, df = 1, $p > 0.5$).

Figure 23: Cumulative records (sightings and captures) for *Lampropholis delicata* (eastern grass skink) and *L. amicula* (friendly skink) on the 18 study sites. Results of two winter and two summer survey periods per site, except NF3 and NF4 with only one winter and one summer survey period each. Photograph of *L. delicata* courtesy of the Queensland Museum.

CG = cleared, improved, grazed pasture; P(age class) = *E. cloeziana* plantation; NF = selectively logged eucalypt forest

(Full description of site names in Table 1, section **2.1** of this report)

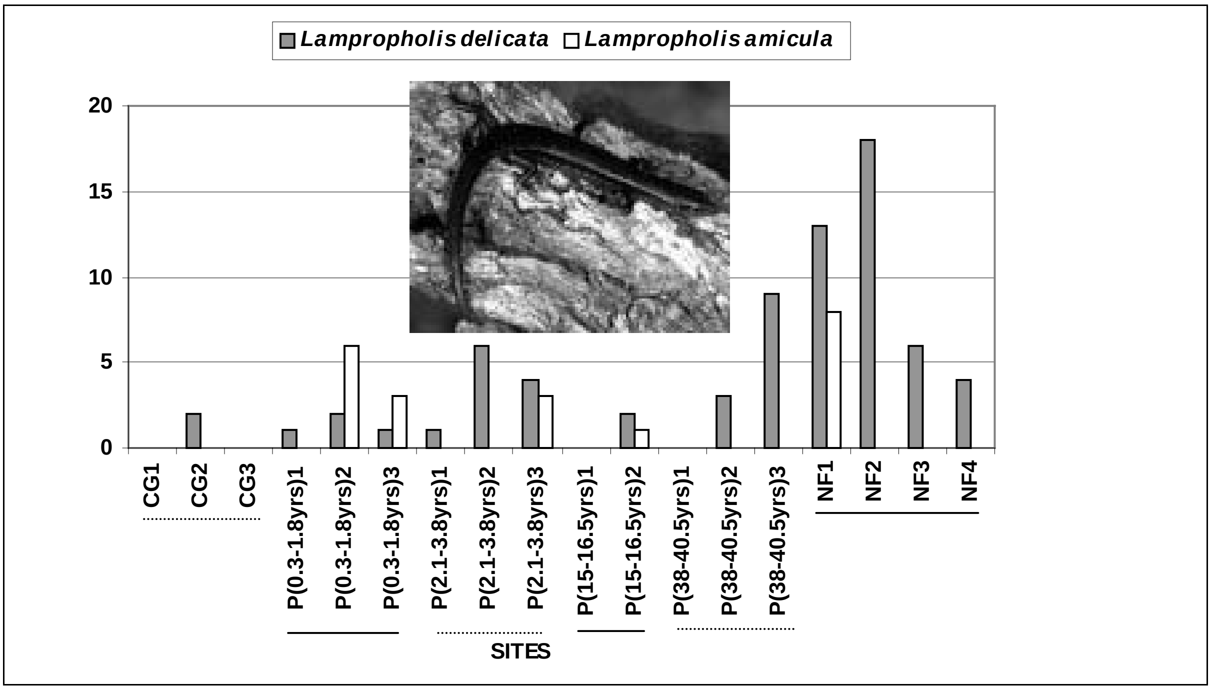


Figure 24: Mean cumulative records of *Lampropholis delicata* (eastern grass skink) and *L. amicula* (friendly skink) for the 18-month survey period on the six vegetation treatments. Three replicates for each vegetation class except P(15-16.5yrs) with two and NF with four. A cumulative total from two winter and two summer survey periods, except NF3 and NF4 with only one winter and one summer survey period each. The 95% confidence limits marked, except P(15-16.5yrs) with a standard error.

CG = cleared, improved, grazed pasture; P(age class) = *E. cloeziana* plantation; NF = selectively logged eucalypt forest
(Full description of site names in Table 1, section **2.1** of this report)

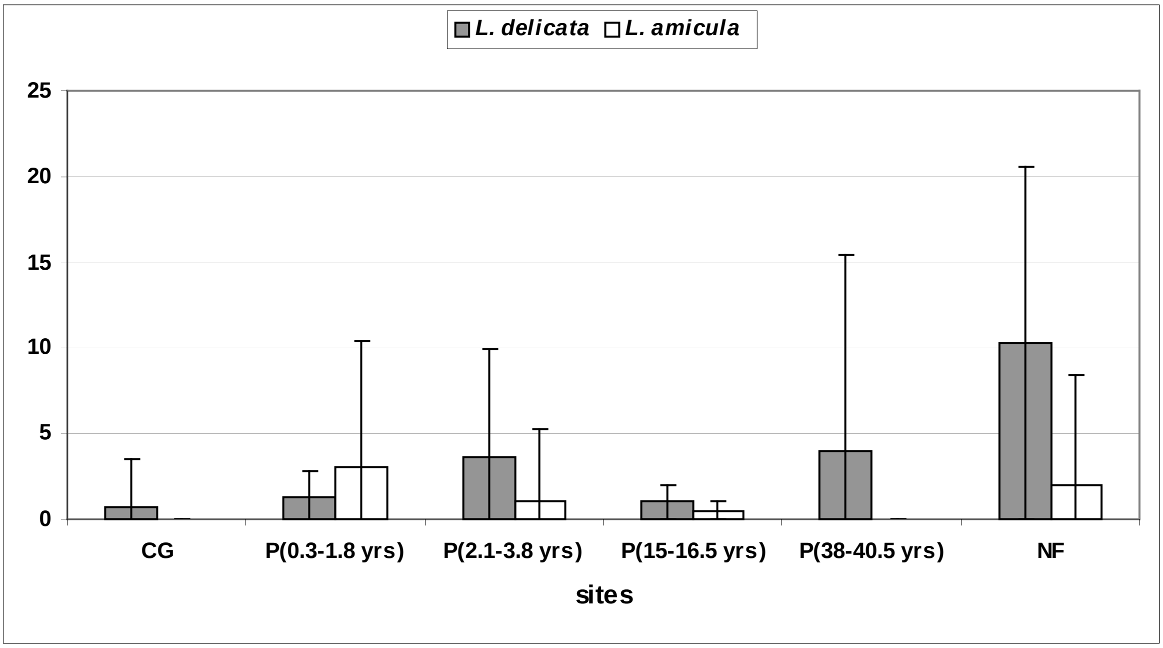
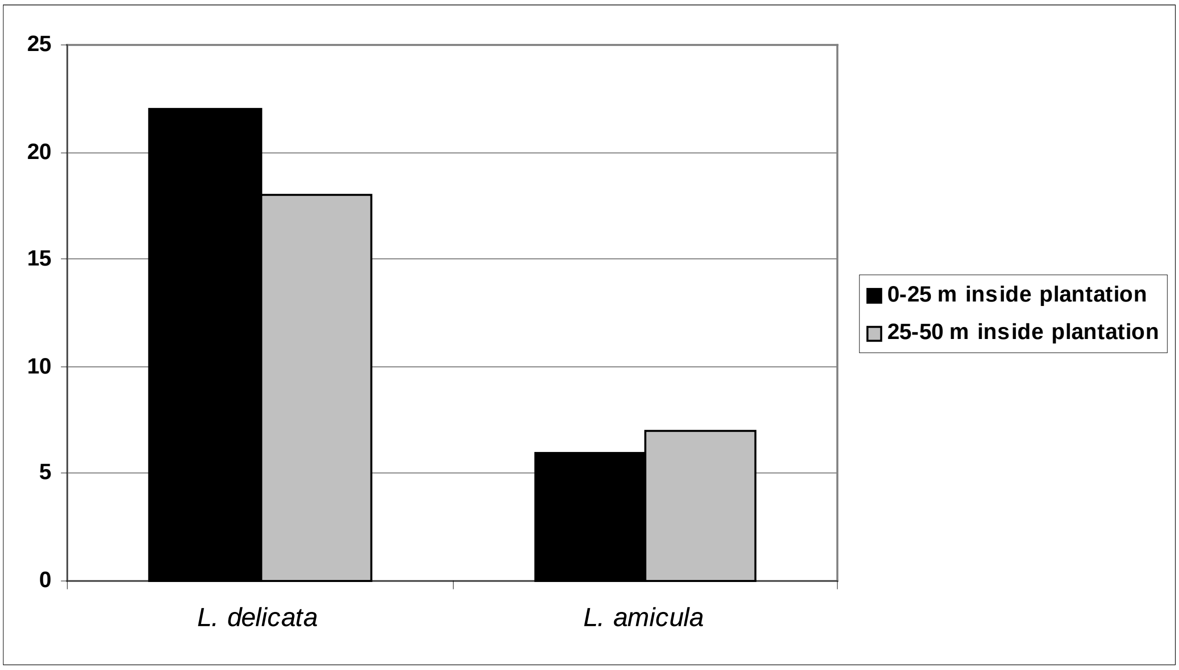


Figure 25: *Lampropholis delicata* (eastern grass skink) and *L. amicula* (friendly skink) recorded in *E. cloeziana* plantations 0-25 m and 25-50 m from the plantation edge.



3.2 Habitat

The vegetation types surveyed varied as habitat for fauna (See Figure 26 for examples). A number of habitat attributes were measured, most related to floristic composition and structure.

3.2.1 Flora species

Presented in Figure 27 are total plants species recorded on each survey site, species split into introduced species and native species for south east Queensland. Introduced species include native species not native to south east Queensland (e.g. *Corymbyia torelliana*). See Appendix 2 for a full list of native and introduced plant species categorised into plant types. The two sites with the highest number of plant species recorded were plantation sites P(2.1-3.8yrs)3 and P(2.1-3.8yrs)1 with 138 and 131 species respectively. The two lowest were on cleared improved pasture sites CG1 and CG3 with 35 and 55 species respectively. The percentage of introduced plant species was higher on the cleared improved pasture sites and the plantation sites up to 3.8 years of age compared to the selectively logged native forest sites and the plantations over 38-40.5 years of age. Mean total native and introduced plant species for each vegetation type is presented in Figure 28. The number of native plants species was significantly higher than introduced species in the 38-40.5 year plantation age class ($t = 9.882$, $df = 2$, $p < 0.05$), and very significantly higher in the selectively logged native forest ($t = 57.067$, $df = 3$, $p < 0.001$). The difference was not significant for the other vegetation types. A comparison between vegetation types of total plant species (introduced + native) found cleared improved pasture had significantly less species than the P(2.1-3.8yrs) plantation age class and the selectively logged eucalypt forest ($t = 2.889$ $p< 0.05$; $t = 3.712$, $p< 0.05$). There was no significant difference between the other vegetation types.

Total species may be similar between sites and vegetation types but species composition can vary. Pattern analysis comparing flora species composition between sites found the cleared improved pasture sites were clearly distinct from the selectively logged eucalypt forest and the three oldest plantation age classes (Figure 29). Most replicates of each vegetation type showed quite strong similarities, the ordination grouping most replicates together with little overlap between vegetation types. Plantation site P(0.3-1.8yrs)3 overlapped in species composition with the cleared improved pasture sites. The most similar in flora species composition were the P(38-40.5yrs) sites.

For the six vegetation types the highest mean number of grass species was 20.7 in the 2.1-3.8 year plantation age class, the lowest was 4.7 in the 38-40.5 years plantation age class (Figure 30). The t-test comparisons of the log 10 transformed mean number of grass species in the six vegetation types found the 38-40.5 year plantation age class had significantly fewer grass species than all other vegetation types (Table 8). Selectively logged eucalypt forest had significantly fewer grass species than the 2.1-3.8 year plantation age class. The mean number of combined tree, shrub, palm, vine, parasitic and orchid species was highest in selectively logged eucalypt forest with 70 species and 67.7 in the 38-40.5 year old plantation age class, lowest in the cleared improved pasture with 8.7 species (Figure 31). The selectively logged eucalypt forest had significantly more combined tree, shrub, vine, parasitic and orchid species than all other vegetation types except the 38-40.5 year old plantation age class (Table 9).

The mean number of combined grass, sedge and herb species was highest in the 2.1-3.8 year and 0.3-1.8 year plantation age classes with 71.3 and 68.3 species respectively, lowest in the 38-40.5 year plantation age class with 13.7 species (Table 32). The 38-40.5 year plantation age class had significantly fewer combined grass, sedge and herb species than all other vegetation types except selectively logged eucalypt forest (Table 10). The selectively logged eucalypt forest had significantly fewer combined grass, sedge and herb species than the three youngest plantation age classes (Table 10).

Figure 26a: Cleared improved pasture site CG2 in foreground.

Figure 26b: Grassy *E. cloeziana* plantation site P(0.3-1.8yrs)2 at approximately 10 months of age. Native forest on slope behind plantation.

Figure 26c: Grassy *E. cloeziana* plantation site P(2.1-3.8yrs)3 at approximately 32 months of age.

Figure 26d: *E. cloeziana* plantation site P(15-16.5yrs)1 at 16 years of age.

Figure 26e: *E. cloeziana* plantation site P(38-40.5yrs)3 at 39 years of age.

Figure 26f: Selectively logged eucalypt forest site NF2.

Figure 27: Total native and introduced plant species recorded on the 18 study sites. Introduced species include all species not native to south east Queensland.

CG = cleared, improved, grazed pasture; P(age class) = *E. cloeziana* plantation; NF = selectively logged eucalypt forest

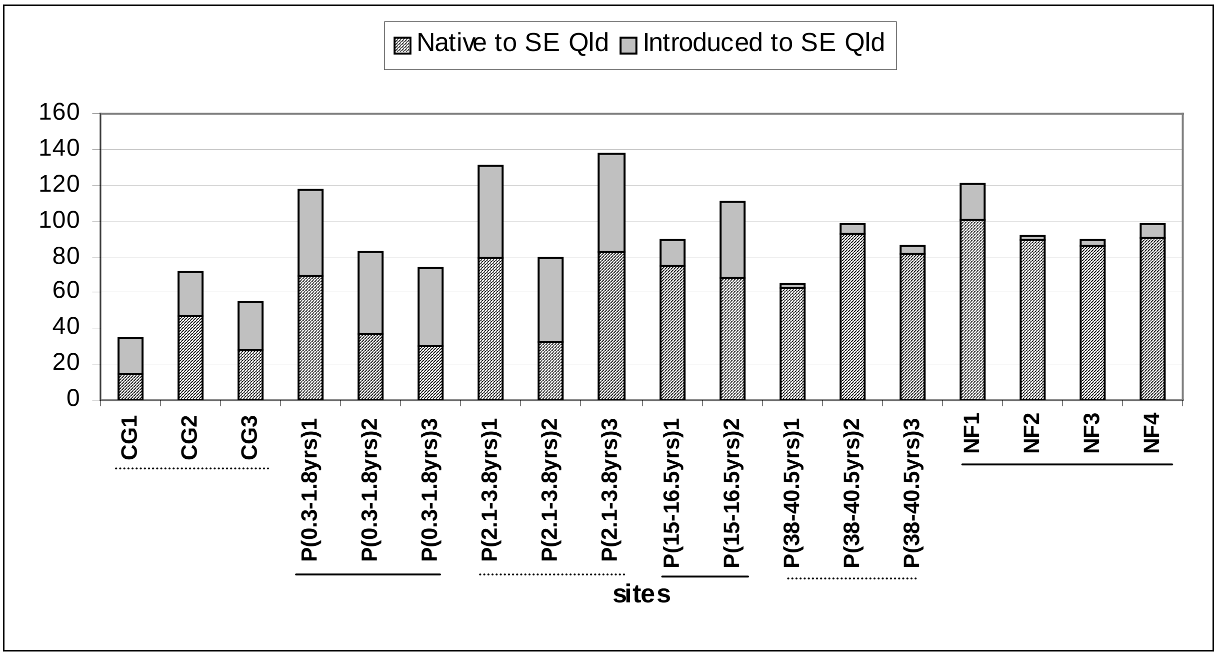


Figure 28: Mean number of plant species (native and introduced to south east Queensland) for six vegetation types. Three replicates per vegetation type except NF with four and P(15-16.5yrs) with two. The 95% confidence limits marked, except P(15-16.5yrs) with only a standard error.

CG = cleared, improved, grazed pasture; P(age class) = *E. cloeziana* plantation; NF = selectively logged eucalypt forest

(Full description of site names in Table 1, section **2.1** of this report)

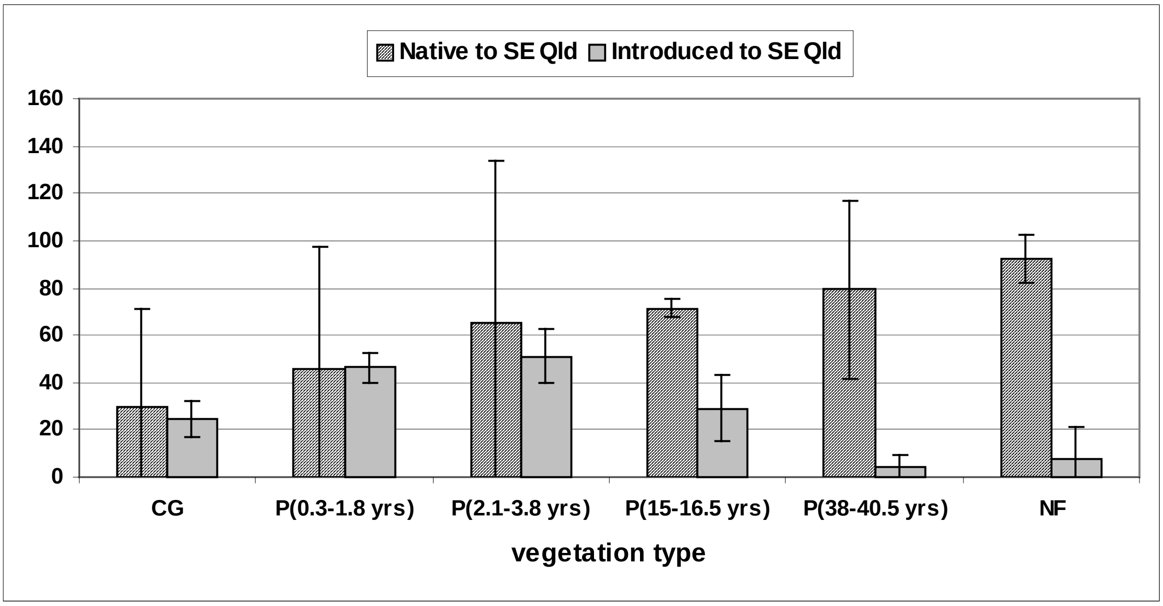


Figure 29: Two-dimensional ordination of plant species (native and introduced) recorded on the 18 survey sites. Site NF4 directly adjacent to site NF2. Ordination stress 0.22.
CG = cleared, improved, grazed pasture; P(age class) = *E. cloeziana* plantation; NF = selectively logged eucalypt forest
(Full description of site names in Table 1, section **2.1** of this report)

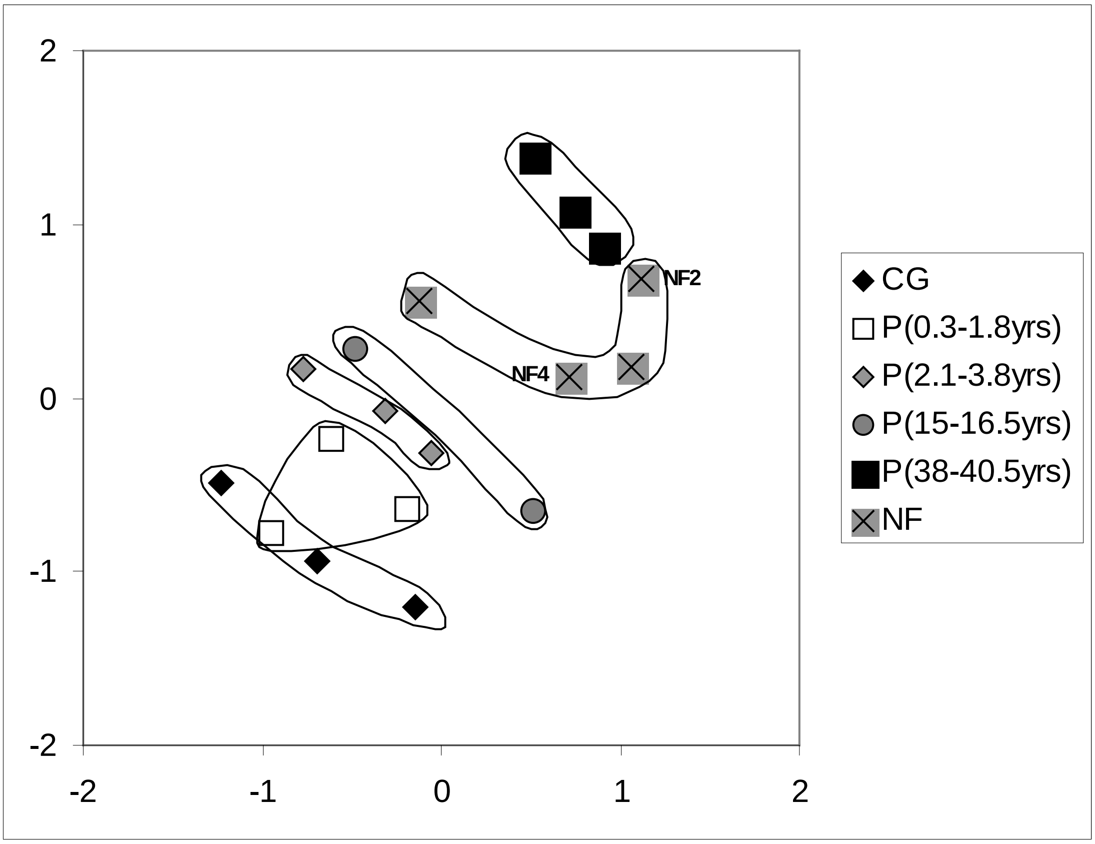


Figure 30: Mean number of grass species (native and introduced to south east Queensland) for six vegetation types. Three replicates per vegetation type except NF with four and P(15-16.5yrs) with two. The 95% confidence limits marked, except P(15-16.5yrs) with a standard error.
CG = cleared, improved, grazed pasture; P(age class) = *E. cloeziana* plantation; NF = selectively logged eucalypt forest

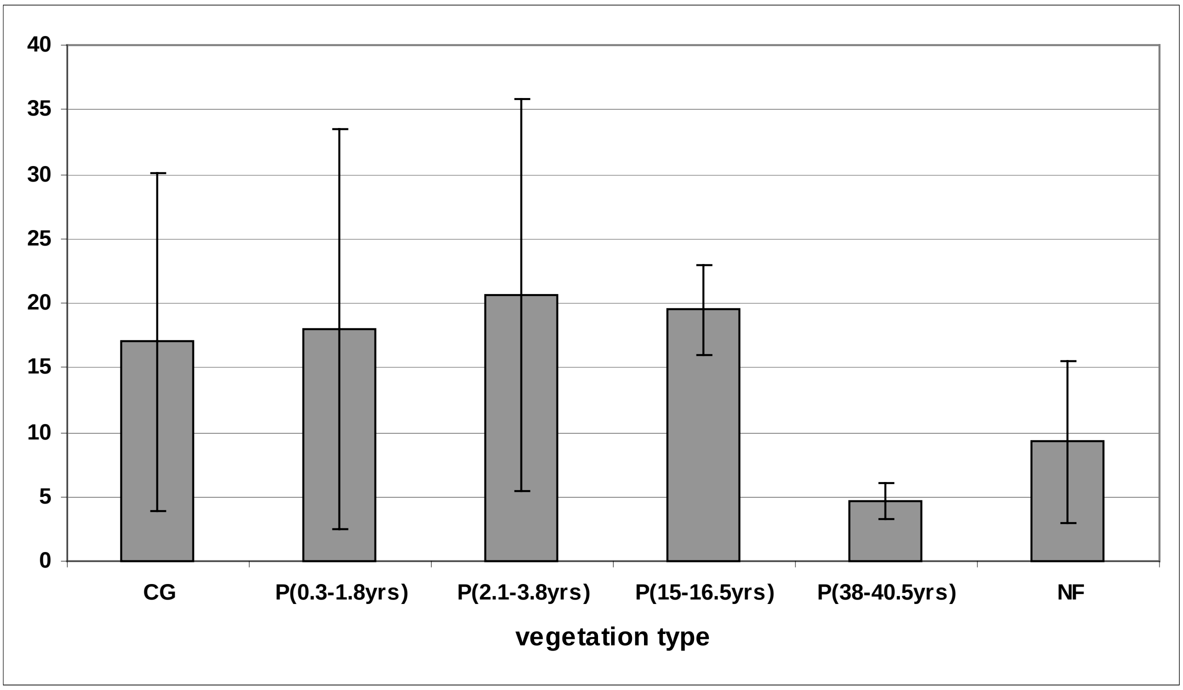


Table 8: Significance levels for the t-test comparisons of the log 10 transformed mean number of grass species for the six vegetation types. F-test for equal variances was conducted for each comparison to determine the appropriate t-test.

CG = cleared, improved, grazed pasture; P(age class) = *E. cloeziana* plantation; NF = selectively logged eucalypt forest

Vegetation type	P(0.3-1.8yrs)	P(2.1-3.8yrs)	P(15-16.5yrs)	P(38-40.5yrs)	NF
CG	n.s.	n.s.	n.s.	<0.005	n.s.
P(0.3-1.8yrs)		n.s.	n.s.	<0.005	n.s.
P(2.1-3.8yrs)			n.s.	<0.005	<0.05
P(15-16.5yrs)				<0.005	n.s.
P(38-40.5yrs)					<0.05

Figure 31: Mean number of combined tree, shrub, palm, vine, parasitic and orchid species (native and introduced to south east Queensland) for six vegetation types. Three replicates per vegetation type except NF with four and P(15-16.5yrs) with two. The 95% confidence limits marked, except P(15-16.5yrs) with a standard error.

CG = cleared, improved, grazed pasture; P(age class) = *E. cloeziana* plantation; NF = selectively logged eucalypt forest

(Full description of site names in Table 1, section **2.1** of this report)

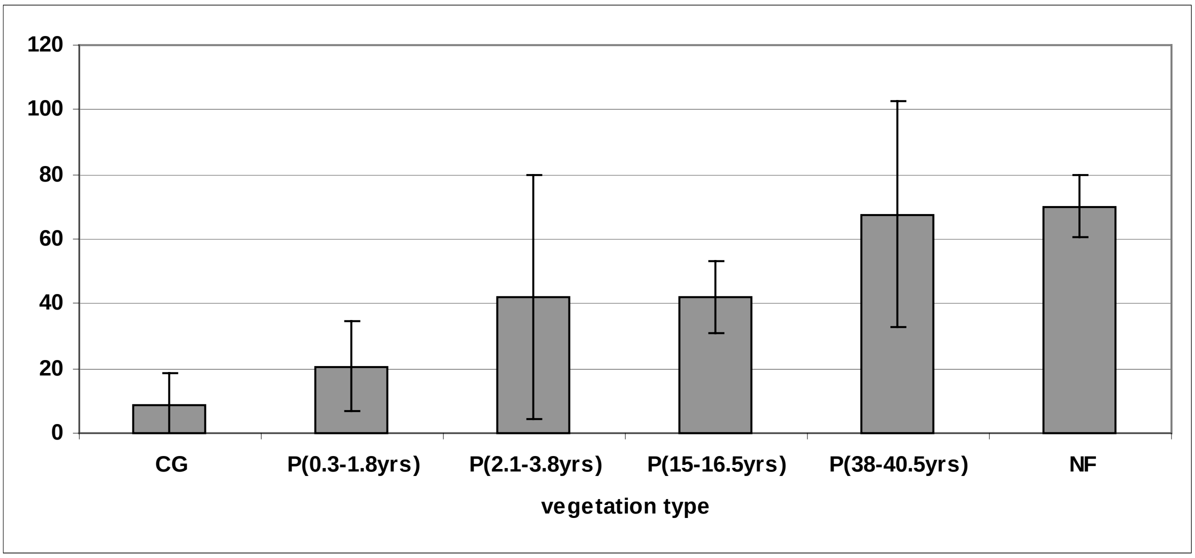


Table 9: Significance levels for the t-test comparisons of the mean number of combined tree, shrub, vine, parasitic and orchid species for the six vegetation types. F-test for equal variances was conducted for each comparison to determine the appropriate t-test.

CG = cleared, improved, grazed pasture; P(age class) = *E. cloeziana* plantation; NF = selectively logged eucalypt forest

Vegetation type	P(0.3-1.8yrs)	P(2.1-3.8yrs)	P(15-16.5yrs)	P(38-40.5yrs)	NF
CG	<0.05	<0.05	<0.05	<0.005	<0.001
P(0.3-1.8yrs)		n.s.	n.s.	<0.01	<0.001
P(2.1-3.8yrs)			n.s.	n.s.	<0.05
P(15-16.5yrs)				n.s.	<0.05
P(38-40.5yrs)					n.s.

Figure 32: Mean number of combined grass, sedge and herb species (native and introduced to south east Queensland) for six vegetation types. Three replicates per vegetation type except NF with four and P(15-16.5yrs) with two. The 95% confidence limits marked.

CG = cleared, improved, grazed pasture; P(age class) = *E. cloeziana* plantation; NF = selectively logged eucalypt forest

(Full description of site names in Table 1, section **2.1** of this report)

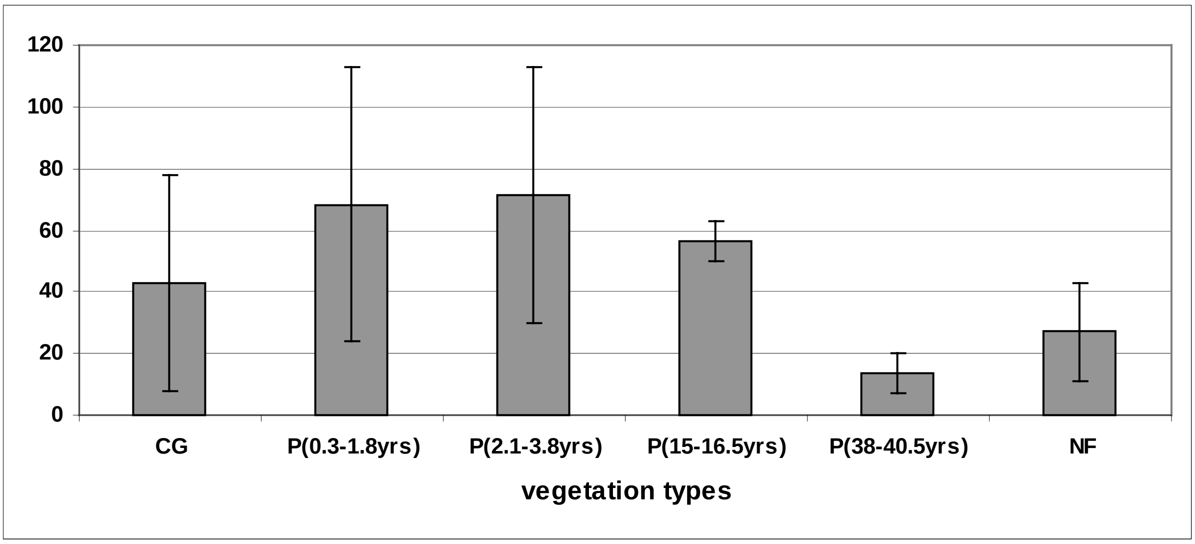


Table 10: Significance levels for the t-test comparisons of the mean number of combined grass, sedge and herb species for the six vegetation types. F-test for equal variances was conducted for each comparison to determine the appropriate t-test.

CG = cleared, improved, grazed pasture; P(age class) = *E. cloeziana* plantation; NF = selectively logged eucalypt forest

Vegetation type	P(0.3-1.8yrs)	P(2.1-3.8yrs)	P(15-16.5yrs)	P(38-40.5yrs)	NF
CG	n.s.	n.s.	n.s.	<0.05	n.s.
P(0.3-1.8yrs)		n.s.	n.s.	<0.01	<0.05
P(2.1-3.8yrs)			n.s.	<0.005	<0.01
P(15-16.5yrs)				<0.001	<0.05
P(38-40.5yrs)					n.s.

3.2.2 Other vegetation and plantation attributes

Mean percentage vegetation cover during the survey period in three height strata below 1.8 m on the 1 x 1 m plots in the six vegetation types is presented in Figure 33. The sample size for each vegetation type in Figure 33 is the total number of 1 x 1 m plots across all the replicate sites for that vegetation type. Remainder of the ground cover in the 0-0.25 m stratum consisted of varying proportions of bare soil, rocks and stones, logs, stumps, course litter, fine litter, tree trimming/thinning trash, animal dung and other cover.

The mean percentage vegetation cover values in Figure 33 were arcsin transformed and multiple t-tests carried out on the transformed values (Figures 34,35 and 36). Arcsin transformed mean vegetation cover in the 0-0.25 m height stratum was significantly higher ($p < 0.05$) on cleared improved pasture compared to all plantation age classes and selectively logged eucalypt forest (Figure 34). All plantation age classes in this height stratum, except the P (38-40.5yrs) age class, were significantly higher ($p < 0.05$) in arcsin transformed vegetation cover ($p<0.05$) than selectively logged native forest. The plantation age class P(0.3-1.8yrs) also had significantly higher ($p < 0.05$) arcsin transformed vegetation cover ($p < 0.05$) than the P(15-16.5yrs) and P(38-40.5yrs) plantation age classes. In the 0.25-0.5 m height class, the arcsin transformed mean vegetation cover for the P(0.3-1.8yrs) plantation age class was significantly higher ($p < 0.05$) than the three older plantation age classes (Figure 35).

In contrast to the 0-0.25 m height stratum (Figure 34), cleared improved pasture had significantly lower ($p < 0.05$) arcsin transformed vegetation cover in the 0.25-0.5 m and 0.5-1.8 m height strata than all other vegetation types except the P(15-16.5yrs) plantation age class (Figures 35 and 36). The P(15-16.5 yrs) plantation age class had significantly lower ($p < 0.05$) arcsin transformed vegetation cover in the 0.25-0.5 m and 0.5 –1.8 m height strata than the P(2.1-3.8yrs) and P(38-40.5 yrs) plantation age classes and the selectively logged eucalypt forest (Figures 35 and 36).

Mean percentage litter cover for the six vegetation types was highest in selectively logged eucalypt forest and the P(38-40.5yrs) plantation age class with values of 45.7 and 41.4 % respectively, the lowest on cleared improved pasture with 2.8% (Figure 37). Arcsin transformed mean percentage litter cover was significantly lower ($p < 0.05$) on cleared improved pasture compared to all plantation age classes and selectively logged eucalypt forest (Figure 38). The P(38-40.5yrs) plantation age class had significantly higher ($p < 0.05$) arcsine transformed percentage litter cover than the P(0.3-1.8yrs) and P(2.1-3.8yrs) plantation age classes (Figure 38). The mean percentage vegetation cover above 1.8 m for the six vegetation types is presented in Figure 39. Mean percentage vegetation cover above 1.8 m was similar between the two oldest plantation age classes and selectively logged eucalypt forest. Highest mean percentage vegetation cover above 1.8 m was in the P(38-40.5yrs) plantation age class with 76.4 %. The mean percentage vegetation cover values in Figure 39 were arcsin transformed and multiple t-tests carried out on the transformed values (see Figure 40). The transformed vegetation cover means were significantly lower ($p < 0.05$) in the 0.3-1.8 year plantation age class compared to all other plantation age classes and selectively logged eucalypt forest. The 2.1 –3.8 year plantation age class was also significantly lower than the 38-40.5 year plantation age class and the selectively logged eucalypt forest. The 15-16.5 year and 38-40.5 year plantation age classes were not significantly different to the selectively logged eucalypt forest.

See Figures 41 and 43 for the mean height and dbh of selectively logged eucalypt forest and the three plantation age classes during the 18-month survey period. The P(38-40.5yrs) plantation age class had the tallest mean height at 40.1 m and the greatest mean dbh at 41.8 cm. Comparison of mean heights using t-tests, found all plantation age classes and selectively logged eucalypt forest were significantly different from each other (Figure 42). Except for the dbh comparison between P(38-40.5yrs) and selectively logged eucalypt forest, all other dbh comparisons were significantly different ($p < 0.05$) (Figure 44).

Figure 45 shows mean combined log and stump biomass on the six vegetation types. The combined log and stump biomass density for each site was derived from the cumulative total of the combined log and stump biomass on the twelve 5 x 5 m habitat sample plots divided by the total area of the 12 plots. No log and stumps were recorded on the habitat sample plots on the three cleared improved pasture sites. There was significantly more combined log and stump biomass in selectively logged eucalypt forest compared to the four age classes of plantations (Table 11). The P(38-40.5yrs) plantation age class had significantly more combined log and stump biomass than the other three plantation age classes (Table 11).

Mean plant density in nine height classes above 1.8 m for the six vegetation types are presented in Figures 46 and 47. No plants taller than 1.8 m were recorded on cleared improved pasture. To accommodate zero counts the mean plant density for the 5 x 5 m plots in each vegetation type for the nine height classes were log (x+1) transformed, and the means of the transformed data compared (Figures 48 and 49). The P(38-40.5yrs) plantations and the selectively logged eucalypt forest, which had the highest vertebrate species diversity (Figure 6), were both significantly different in transformed mean plant density from cleared improved pasture and all other plantation types in all height classes except the 5-8 m and 8-15 m classes in the P(2.1-3.8yrs) plantations, and the >8 m class for the P(15-16.5yrs) plantations (Figures 48 and 49). The transformed mean plant density for the P(38-40.5yrs) plantations were not significantly different from the selectively logged eucalypt forest in the 1.8-3 m, 5-8 m, 8-15 m, >8 m, >5 m, >3 m and >1.8 m height classes (Figure 48 and 49).

Figure 33: Mean percentage vegetation cover in three height strata below 1.8 m on 1 x 1 m plots in six vegetation types. For each vegetation type the 95% confidence limits and number of sample plots are marked.

CG = cleared, improved, grazed pasture; P(age class) = *E. cloeziana* plantation; NF = selectively logged eucalypt forest

(Full description of site names in Table 1, section **2.1** of this report)

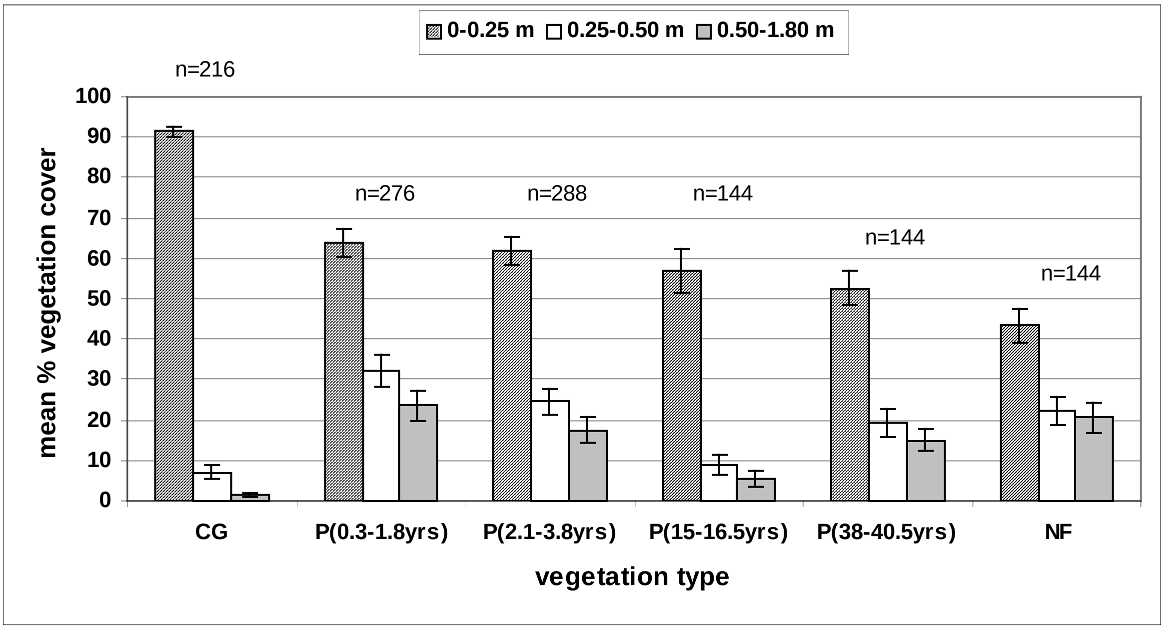


Figure 34: Multiple t-tests results comparing arcsin transformed mean percentage vegetation cover in the 0-0.25 m height stratum between the six vegetation types. The 95% simultaneous confidence intervals are marked. Comparisons where a confidence interval crosses the zero vertical axis are not significantly different (p>0.05).

CG = cleared, improved, grazed pasture; P(age class) = *E. cloeziana* plantation; NF = selectively logged eucalypt forest

(Full description of site names in Table 1, section **2.1** of this report)

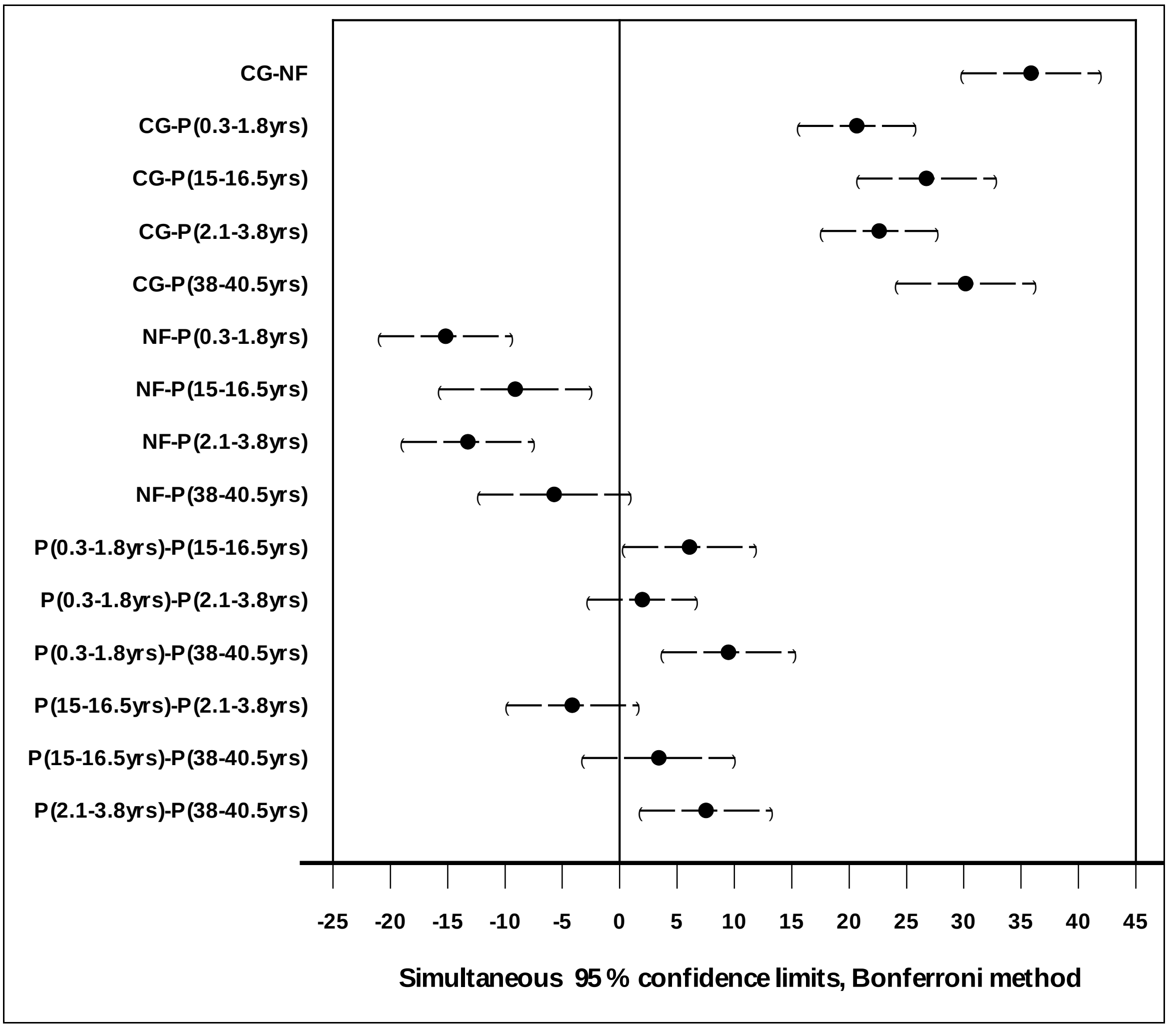


Figure 35: Multiple t-tests results comparing arcsin transformed mean percentage vegetation cover in the 0.25-0.50 m height stratum between the six vegetation types. The 95% simultaneous confidence intervals are marked. Comparisons where a confidence interval crosses the zero vertical axis are not significantly different (p>0.05).

CG = cleared, improved, grazed pasture; P(age class) = *E. cloeziana* plantation; NF = selectively logged eucalypt forest

(Full description of site names in Table 1, section **2.1** of this report)

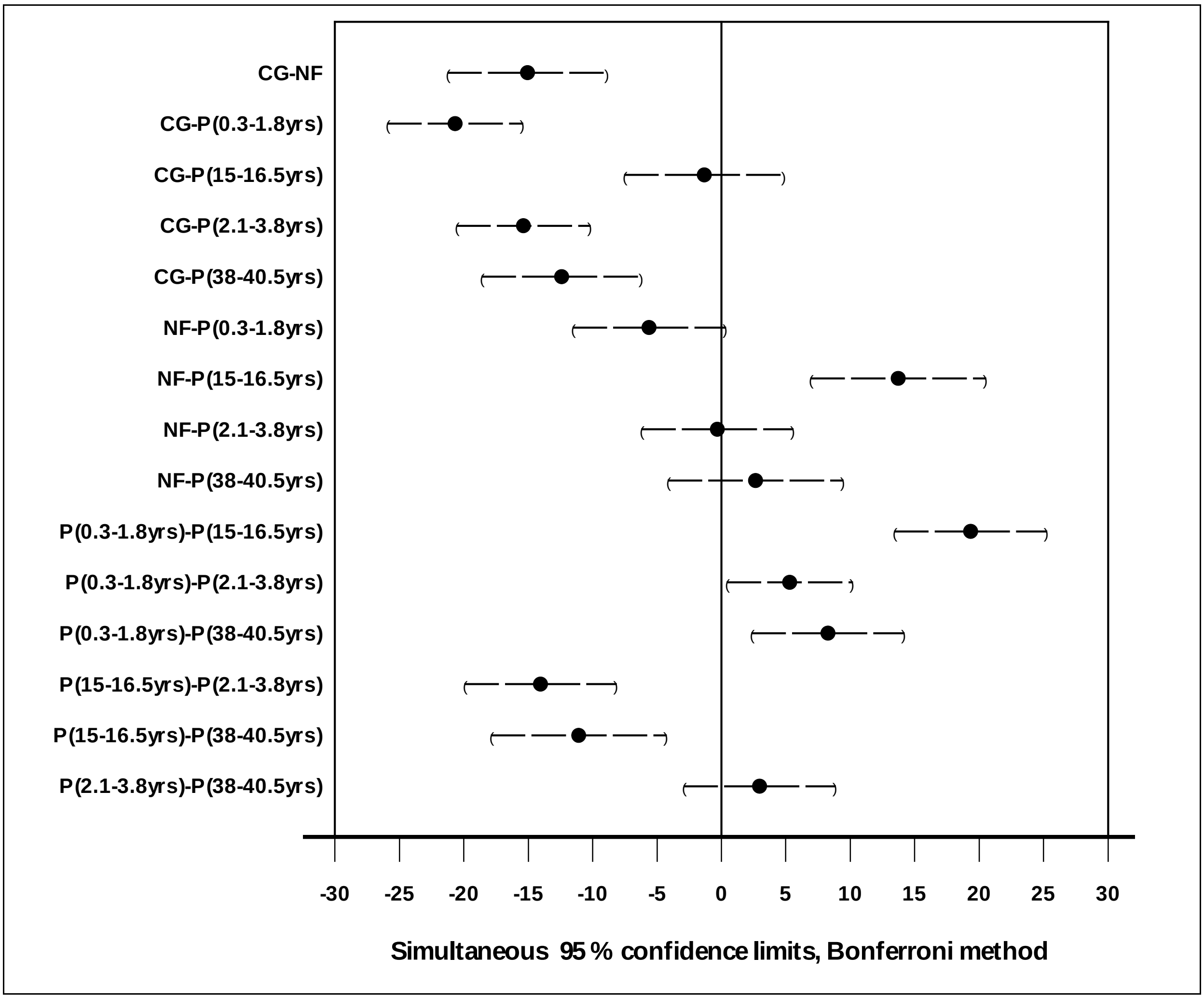


Figure 36: Multiple t-tests results comparing arcsin transformed mean percentage vegetation cover in the 0.5-1.8 m height stratum between the six vegetation types. The 95% simultaneous confidence intervals are marked. Comparisons where a confidence interval crosses the zero vertical axis are not significantly different (p>0.05).

CG = cleared, improved, grazed pasture; P(age class) = *E. cloeziana* plantation; NF = selectively logged eucalypt forest

(Full description of site names in Table 1, section **2.1** of this report)

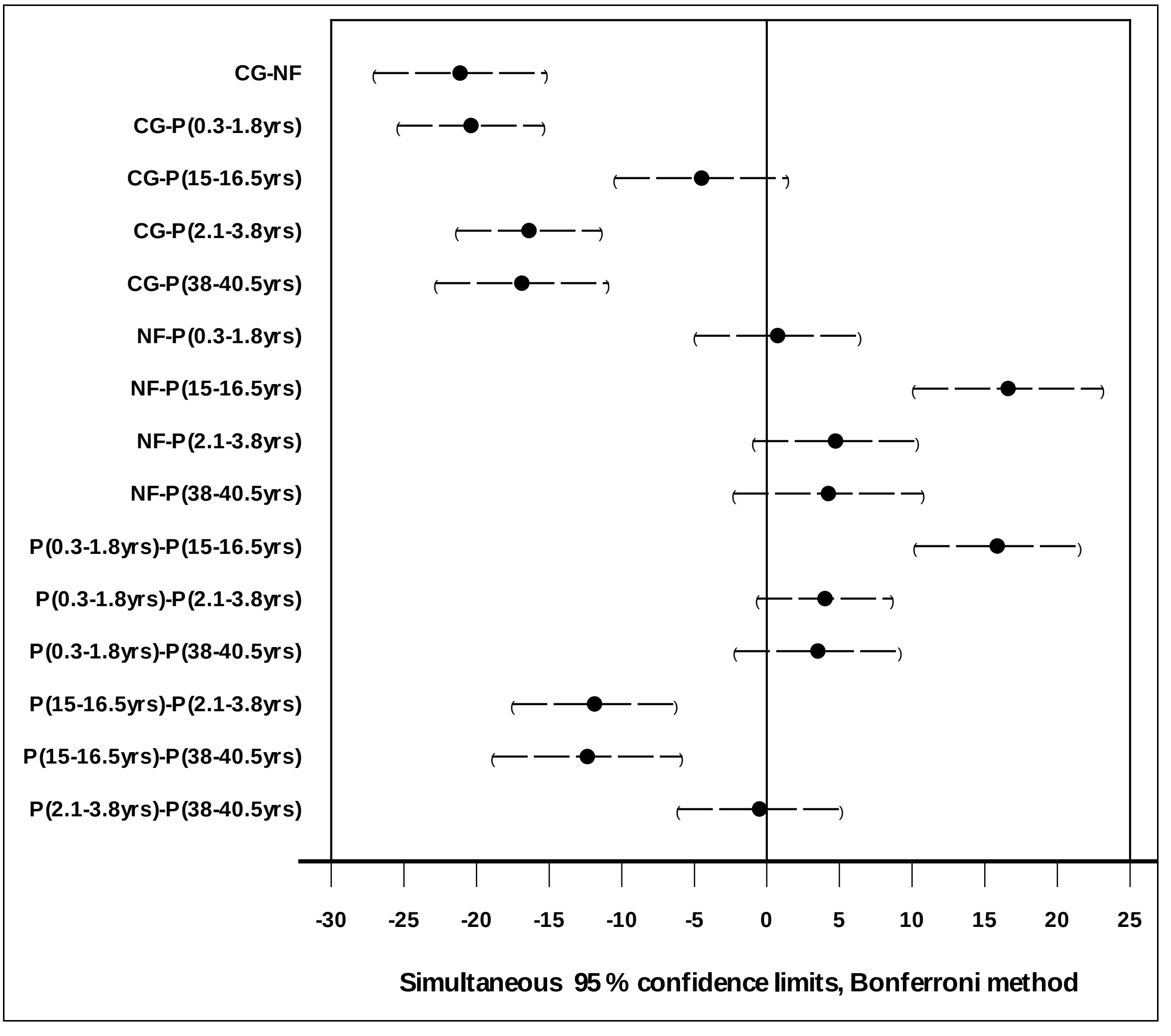


Figure 37: Mean percentage litter cover on six vegetation types. Includes fine litter and course litter (<10 cm diameter). In *E. cloeziana* plantations litter included thinning trash. For each vegetation type the 95% confidence limits and the number of 1 x 1 m sample plots are marked.

CG = cleared, improved, grazed pasture; P(age class) = *E. cloeziana* plantation; NF = selectively logged eucalypt forest

(Full description of site names in Table 1, section **2.1** of this report).

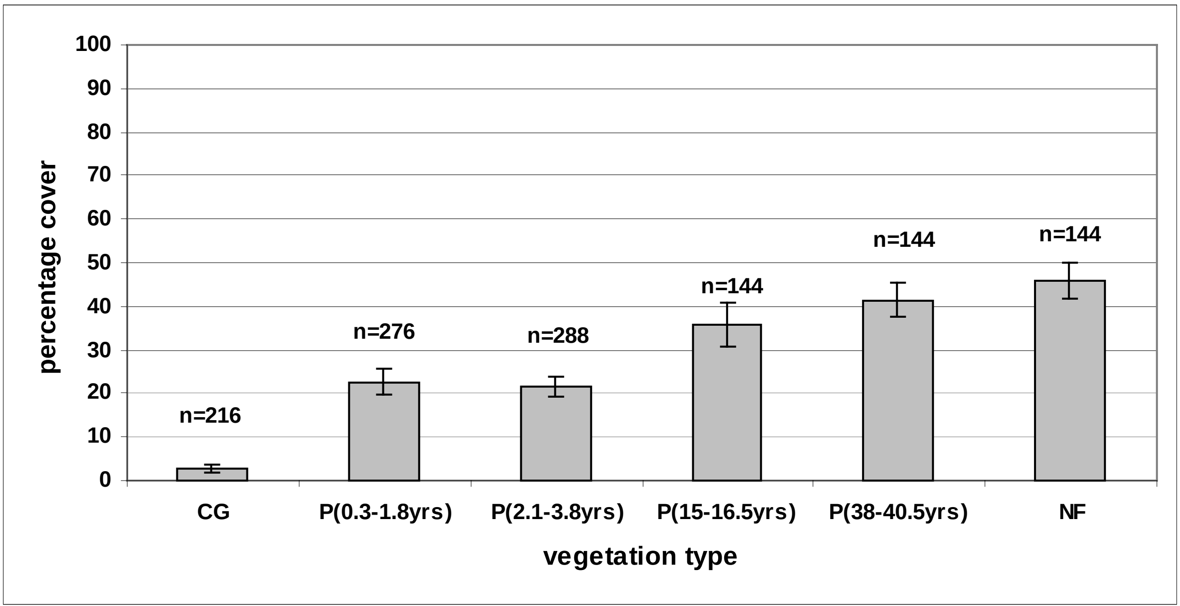


Figure 38: Multiple t-tests results comparing arcsin transformed mean percentage litter cover (< 10 cm diameter) between the six vegetation types. Litter includes thinning trash in *E. cloeziana* plantations. The 95% simultaneous confidence intervals are marked. Comparisons where a confidence interval crosses the zero vertical axis are not significantly different (p>0.05).

CG = cleared, improved, grazed pasture; P(age class) = *E. cloeziana* plantation; NF = selectively logged eucalypt forest
(Full description of site names in Table 1, section **2.1** of this report).

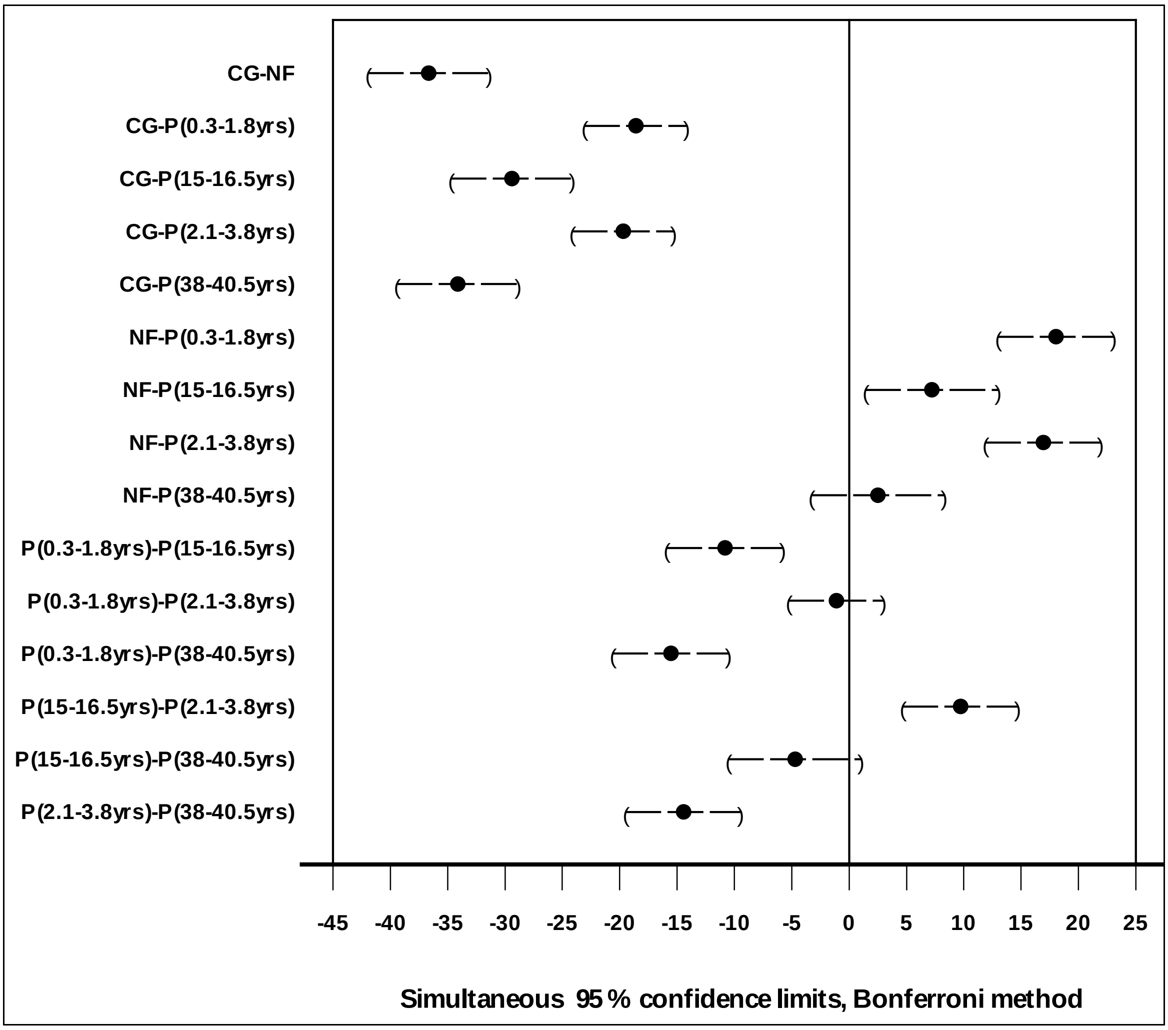


Figure 39: Mean percentage vegetation cover above 1.8 m during the 18-month survey period for six vegetation types. The 95% confidence limits and the total number of times each vegetation type was sampled are marked.

CG = cleared, improved, grazed pasture; P(age class) = *E. cloeziana* plantation; NF = selectively logged eucalypt forest

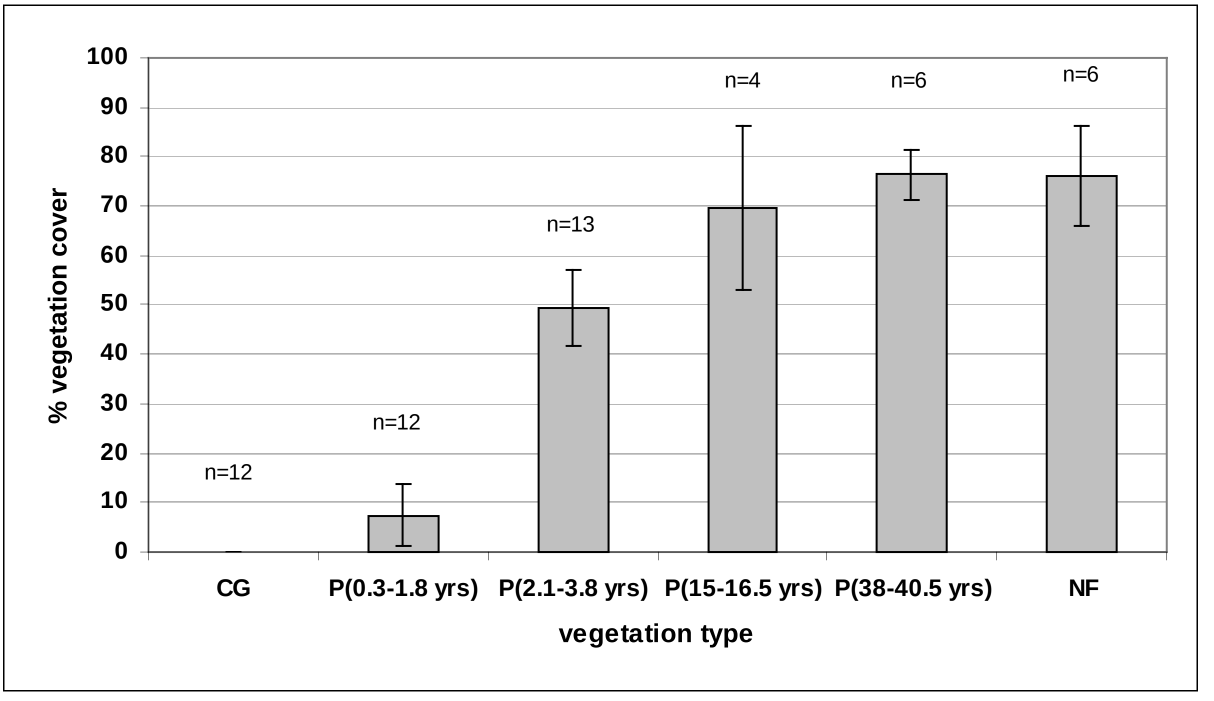


Figure 40: Multiple t-test results comparing arcsine transformed percentage vegetation cover above 1.8 m between four *E. cloeziana* plantation age classes and selectively logged eucalypt forest. The 95% simultaneous confidence intervals are marked. Comparisons where a confidence interval crosses the zero vertical axis are not significantly different (p>0.05).

CG = cleared, improved, grazed pasture; P(age class) = *E. cloeziana* plantation; NF = selectively logged eucalypt forest

(Full description of site names in Table 1, section **2.1** of this report)

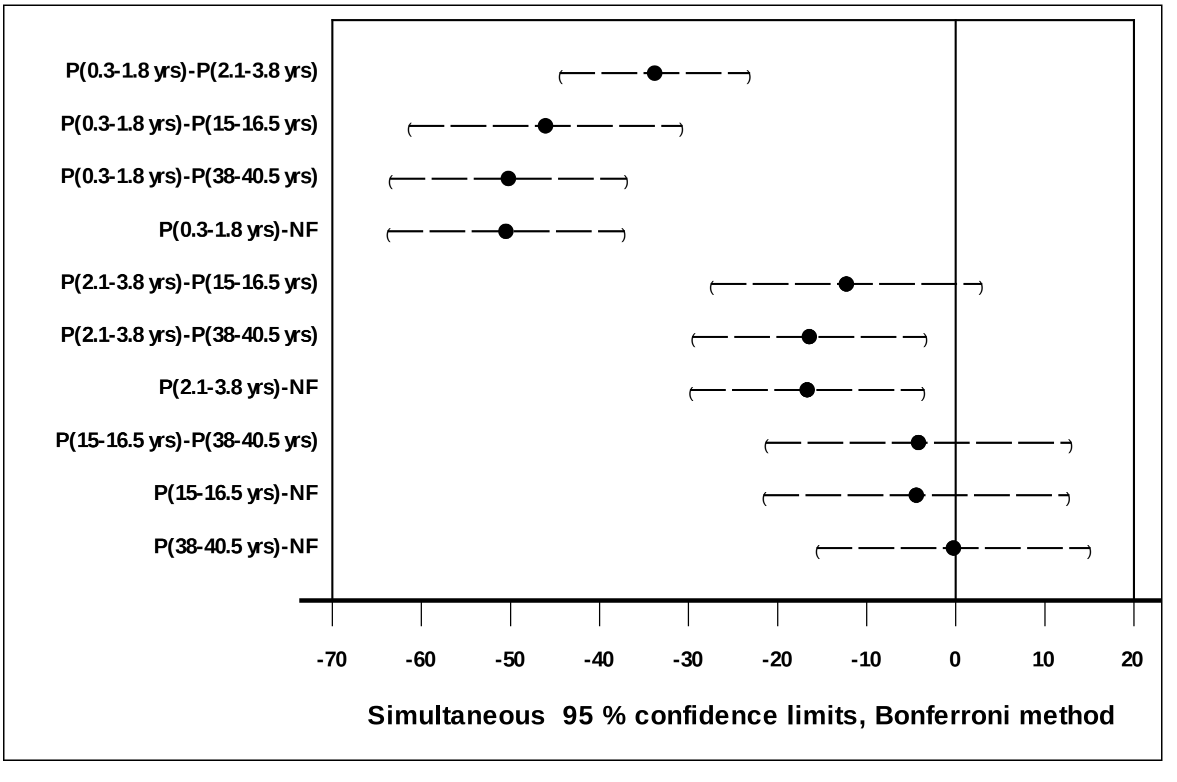


Figure 41: Mean height of selectively logged eucalypt forest and various age *E. cloeziana* plantations during the 18-month survey period. For selectively logged eucalypt forest only trees >15 m in height with a dbh >20 cm were included. The 95 % confidence limits and sample sizes are marked for each vegetation type.

P(age class) = *E. cloeziana* plantation; NF = selectively logged eucalypt forest

(Full description of site names in Table 1, section **2.1** of this report).

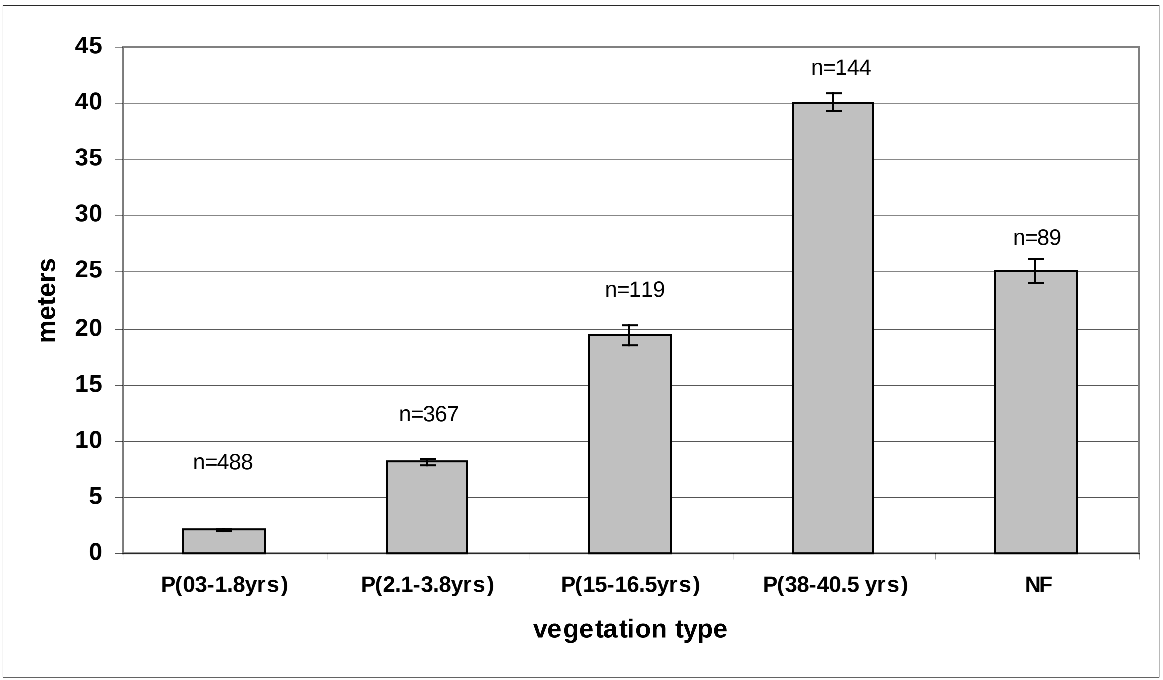


Figure 42: Multiple t-test results comparing mean height of four *E. cloeziana* plantation age classes with selectively logged eucalypt forest. The 95% simultaneous confidence intervals are marked. Comparisons where a confidence interval crosses the zero vertical axis are not significantly different (p>0.05).

CG = cleared, improved, grazed pasture; P(age class) = *E. cloeziana* plantation; NF = selectively logged eucalypt forest

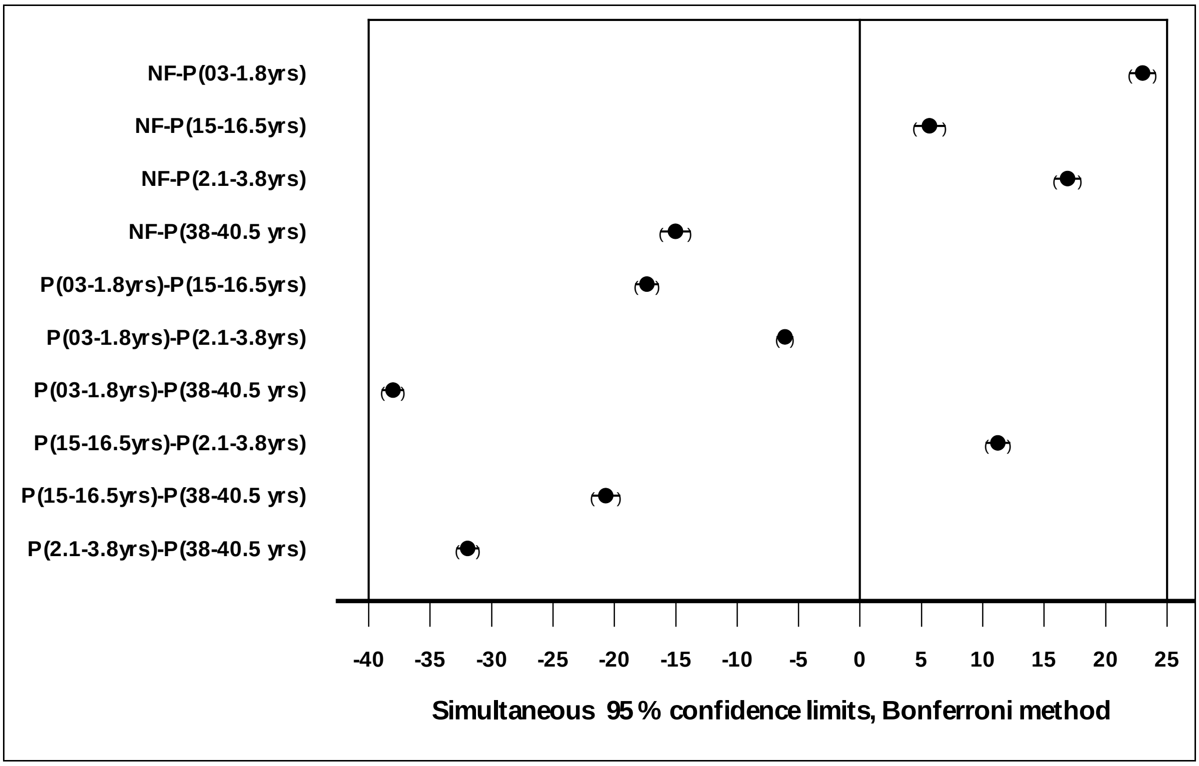


Figure 43: Mean tree trunk diameter at 1.3 m height (dbh) for selectively logged eucalypt forest and three *E. cloeziana* plantation age classes over the 18-month survey period. For selectively logged eucalypt forest only trees with a dbh >20 cm, which had a height >15 m were included. The 95 % confidence limits and sample sizes are marked for each vegetation type.

P(age class) = *E. cloeziana* plantation; NF = selectively logged eucalypt forest

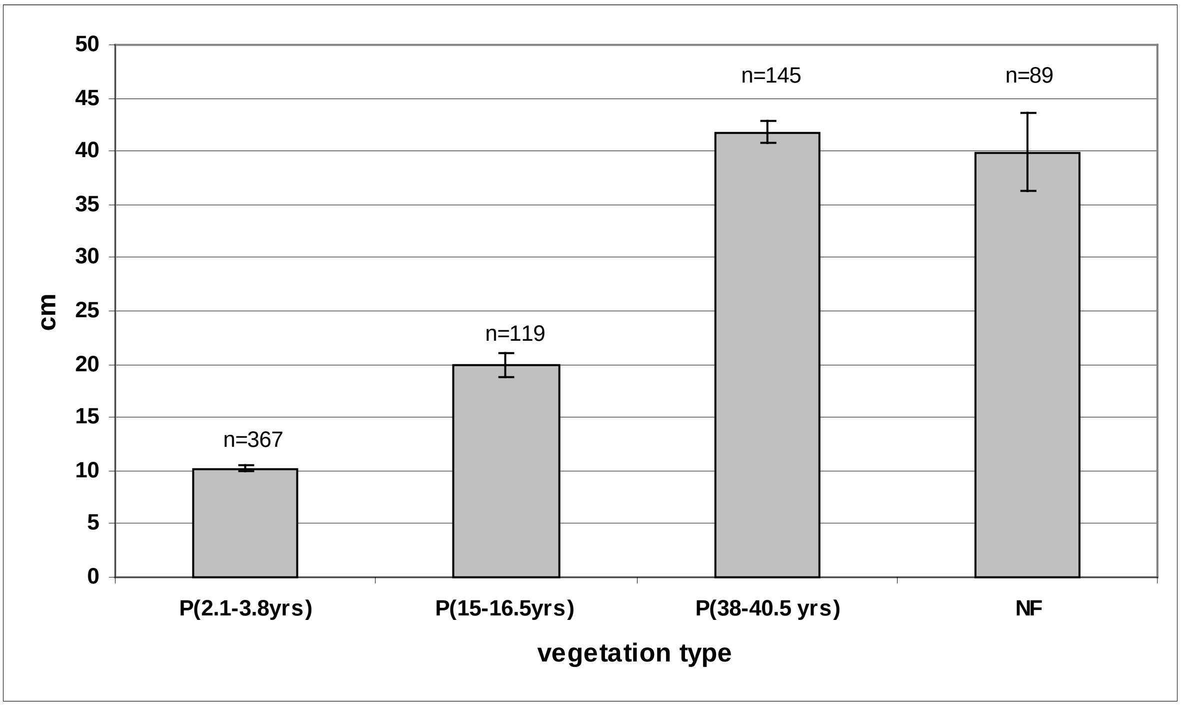


Figure 44: Multiple t-test results with 95% simultaneous confidence intervals, comparing mean dbh between selectively logged eucalypt forest and three *E. cloeziana* plantation age classes. Comparisons with a confidence interval crossing the zero vertical axis are not significantly different (p>0.05).

CG = cleared, improved, grazed pasture; P(age class) = *E. cloeziana* plantation; NF = selectively logged eucalypt forest

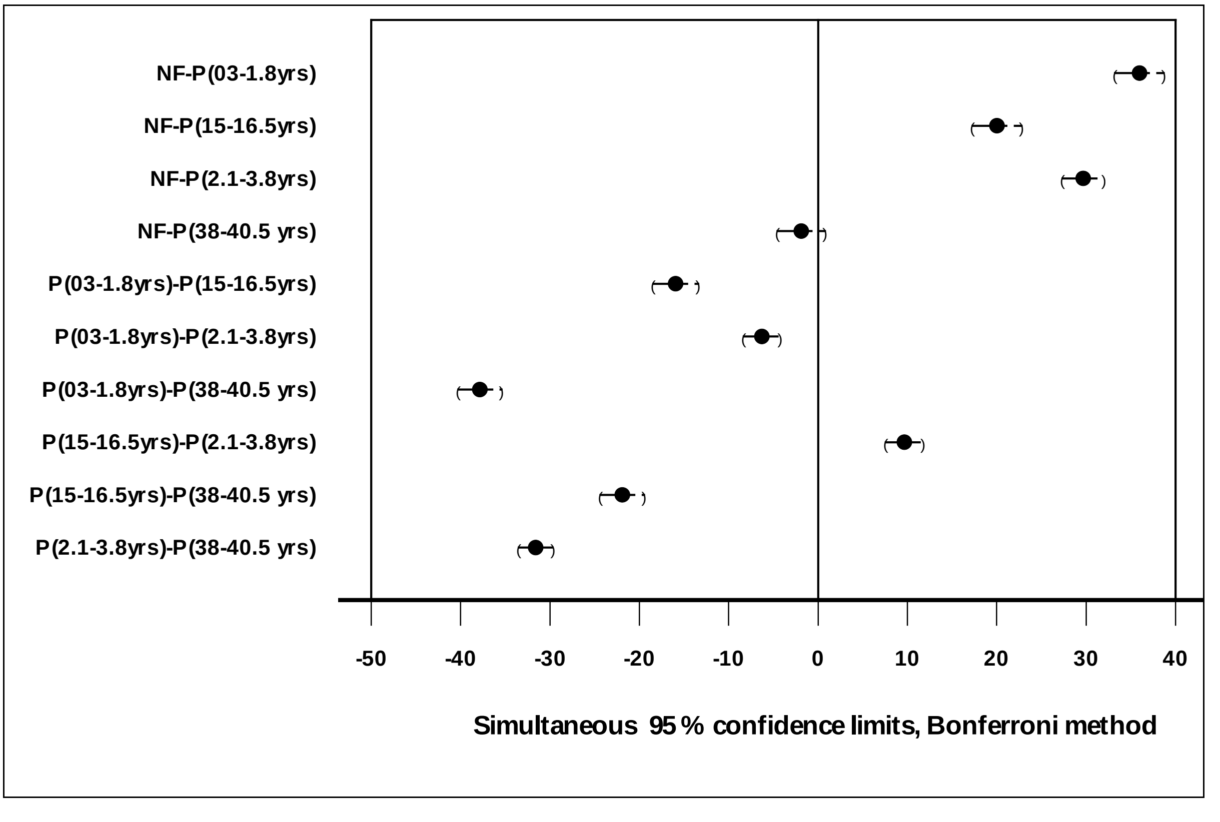


Figure 45: Mean combined biomass of logs and stumps for six vegetation types. Biomass expressed as m^3 per m^2. The 95% confidence limits of the means are marked, except for the P(15-16.5 yrs) plantation age class with a standard error marked.

CG = cleared, improved, grazed pasture; P(age class) = *E. cloeziana* plantation; NF = selectively logged eucalypt forest
(Full description of site names in Table 1, section **2.1** of this report)

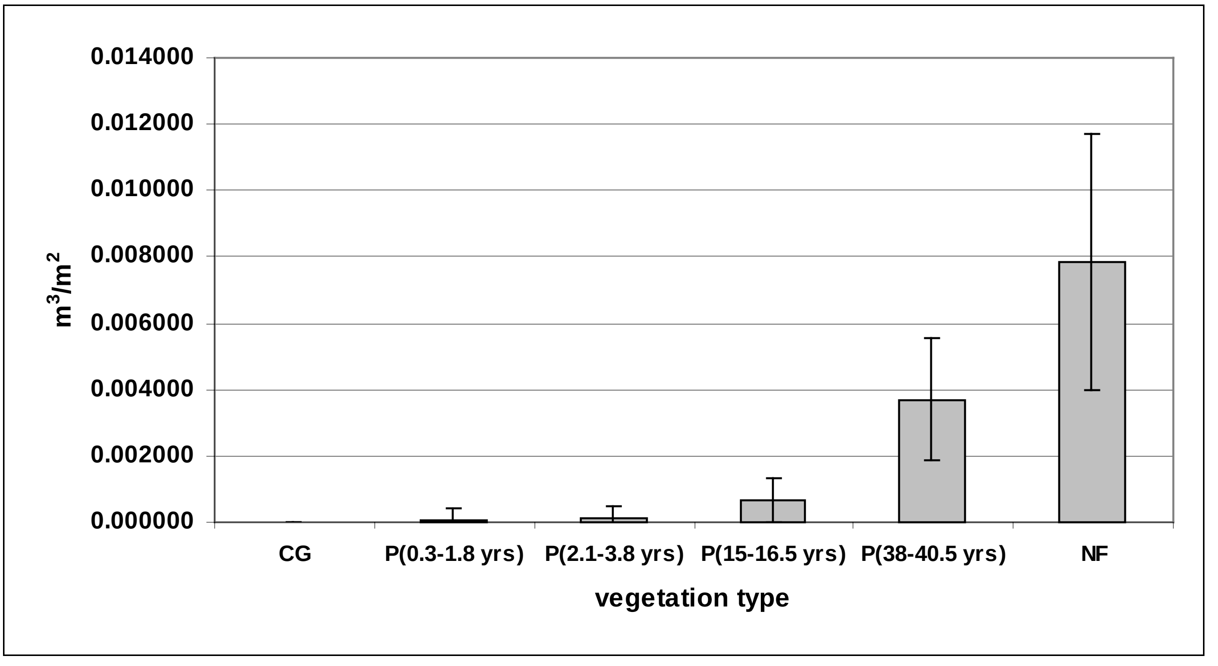


Table 11: Significance levels for the t-test comparisons of mean combined log and stump biomass for the six vegetation types. F-test for equal variances was conducted for each comparison to determine the appropriate t-test. No t-test comparisons between cleared improved pasture and the other vegetation types, as no stumps or logs were recorded on cleared improved pasture.

CG = cleared, improved, grazed pasture; P(age class) = *E. cloeziana* plantation; NF = selectively logged eucalypt forest
(Full description of site names in Table 1, section **2.1** of this report)

Vegetation type	**P(0.3-1.8yrs)**	**P(2.1-3.8yrs)**	**P(15-16.5yrs)**	**P(38-40.5yrs)**	**NF**
CG					
P(0.3-1.8yrs)		n.s.	n.s.	<0.01	<0.01
P(2.1-3.8yrs)			n.s.	<0.01	<0.01
P(15-16.5yrs)				<0.05	<0.05
P(38-40.5yrs)					<0.05

Figure 46: Mean plant density in five height classes above 1.8 m for the six vegetation types. Data derived from plant counts on the 5 x 5 m habitat measurement plots. For each height class only plants were counted whose maximum height was in the height class. The 95% confidence limits of the means are marked, except for P(15-16.5 yrs) where only standard errors are marked.

CG = cleared, improved, grazed pasture; P(age class) = *E. cloeziana* plantation; NF = selectively logged eucalypt forest

(Full description of site names in Table 1, section **2.1** of this report)

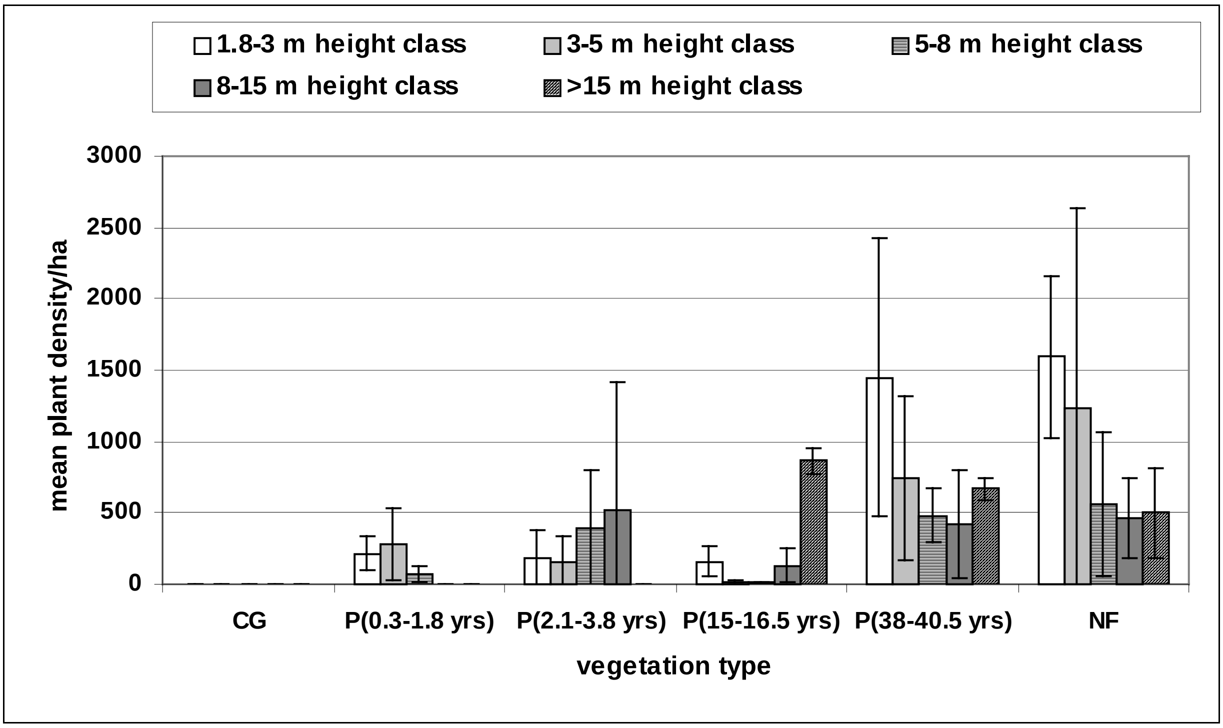


Figure 47: Mean plant density above 1.8 m, 3 m, 5 m, 8 m and 15 m on the six vegetation types. Data derived from plant counts on the 5 x 5 m habitat measurement plots. The 95% confidence limits of the means are marked, except for P(15-16.5 yrs) where a standard error is marked.

CG = cleared, improved, grazed pasture; P(age class) = *E. cloeziana* plantation; NF = selectively logged eucalypt forest

(Full description of site names in Table 1, section **2.1** of this report)

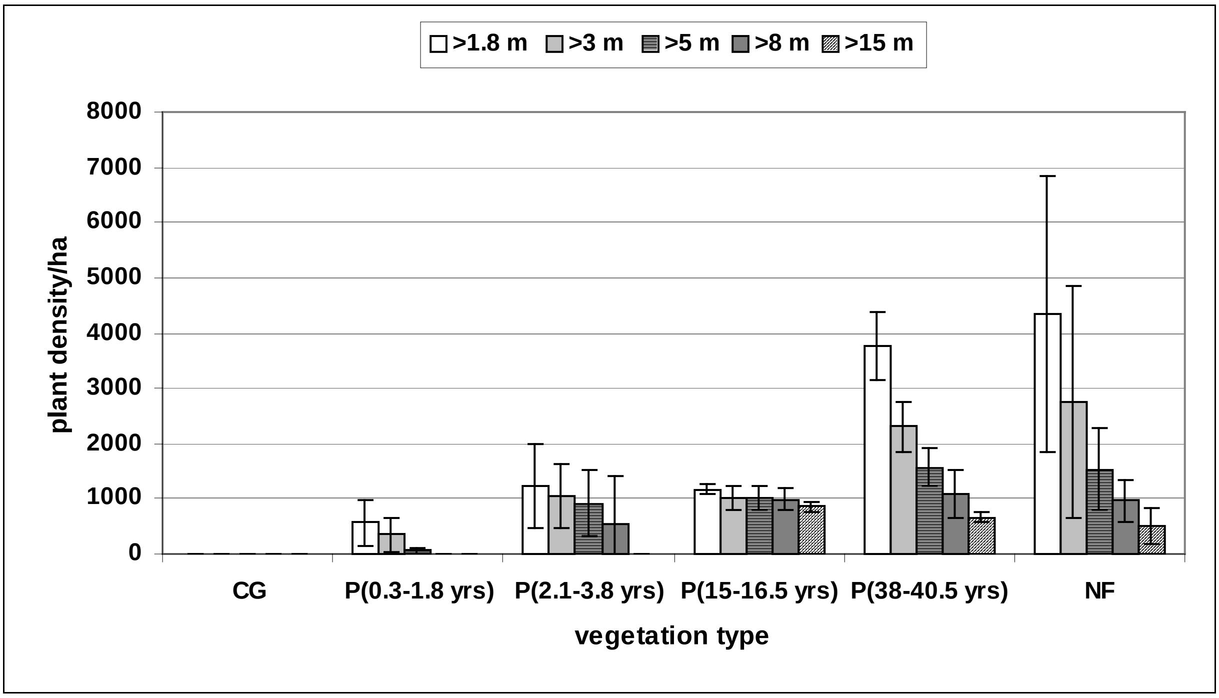


Figure 48: Multiple t-tests results comparing log (x+1) transformed mean plant density between the six vegetation types in the height classes 1.8-3 m, 3-5 m, 5-8 m and 8-15 m. The 95% simultaneous confidence intervals are marked. Comparisons where a confidence interval crosses the zero vertical axis are not significantly different (p>0.05).

CG = cleared, improved, grazed pasture; P(age class) = *E. cloeziana* plantation; NF = selectively logged eucalypt forest

(Full description of site names in Table 1, section **2.1** of this report)

Figure 48a: 1.8 –3 m height class.

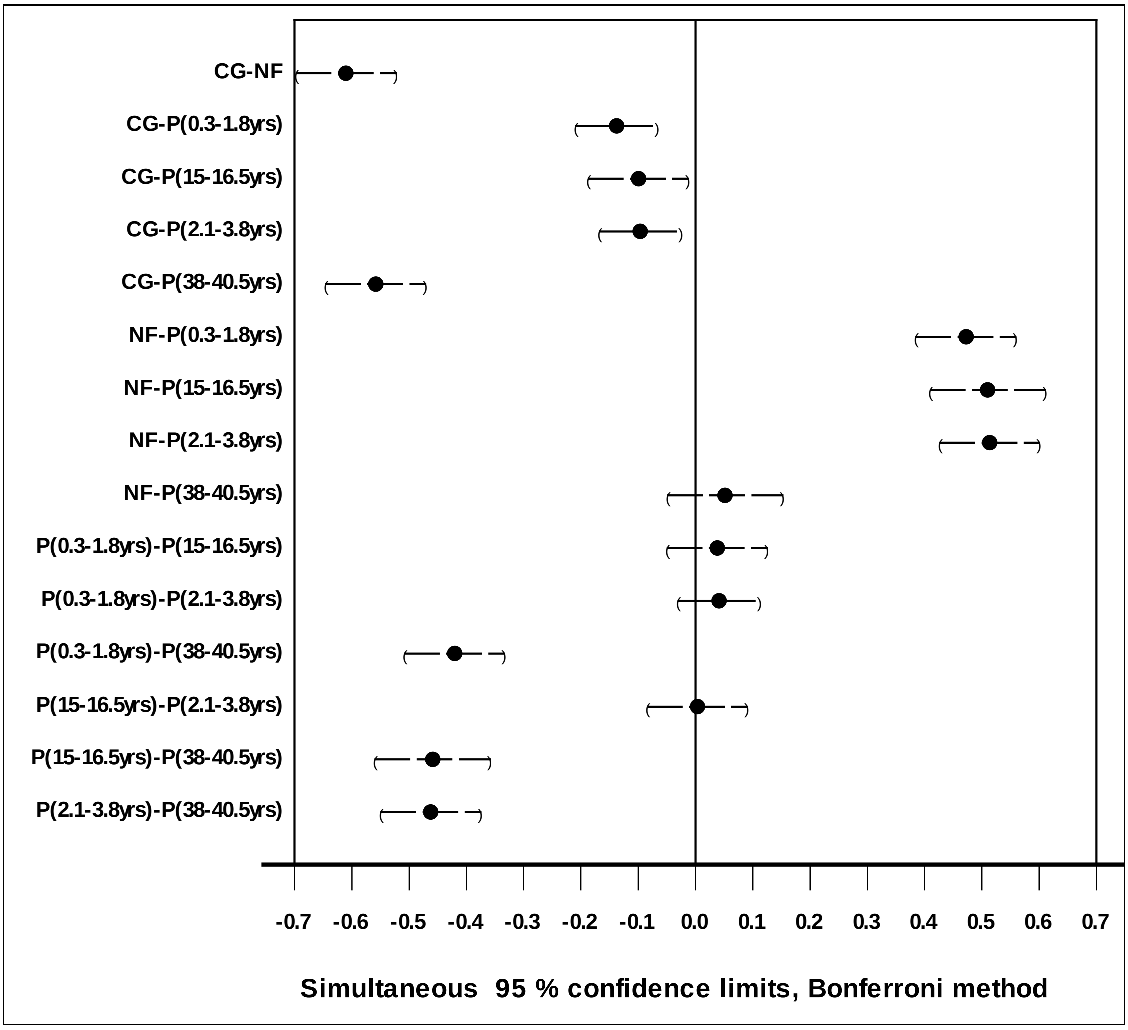


Figure 48b: 3-5 m height class.

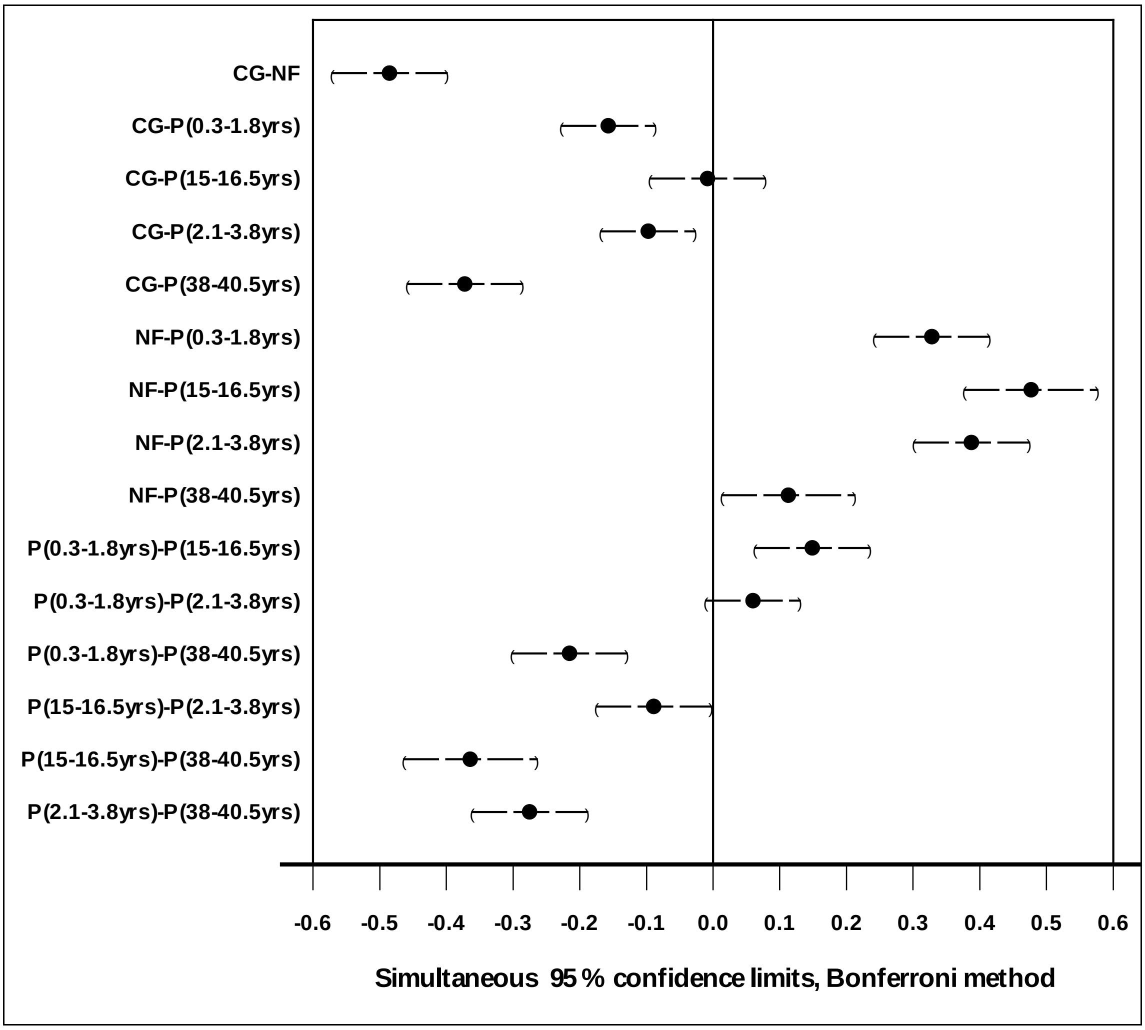


Figure 48c: 5–8 m height class.

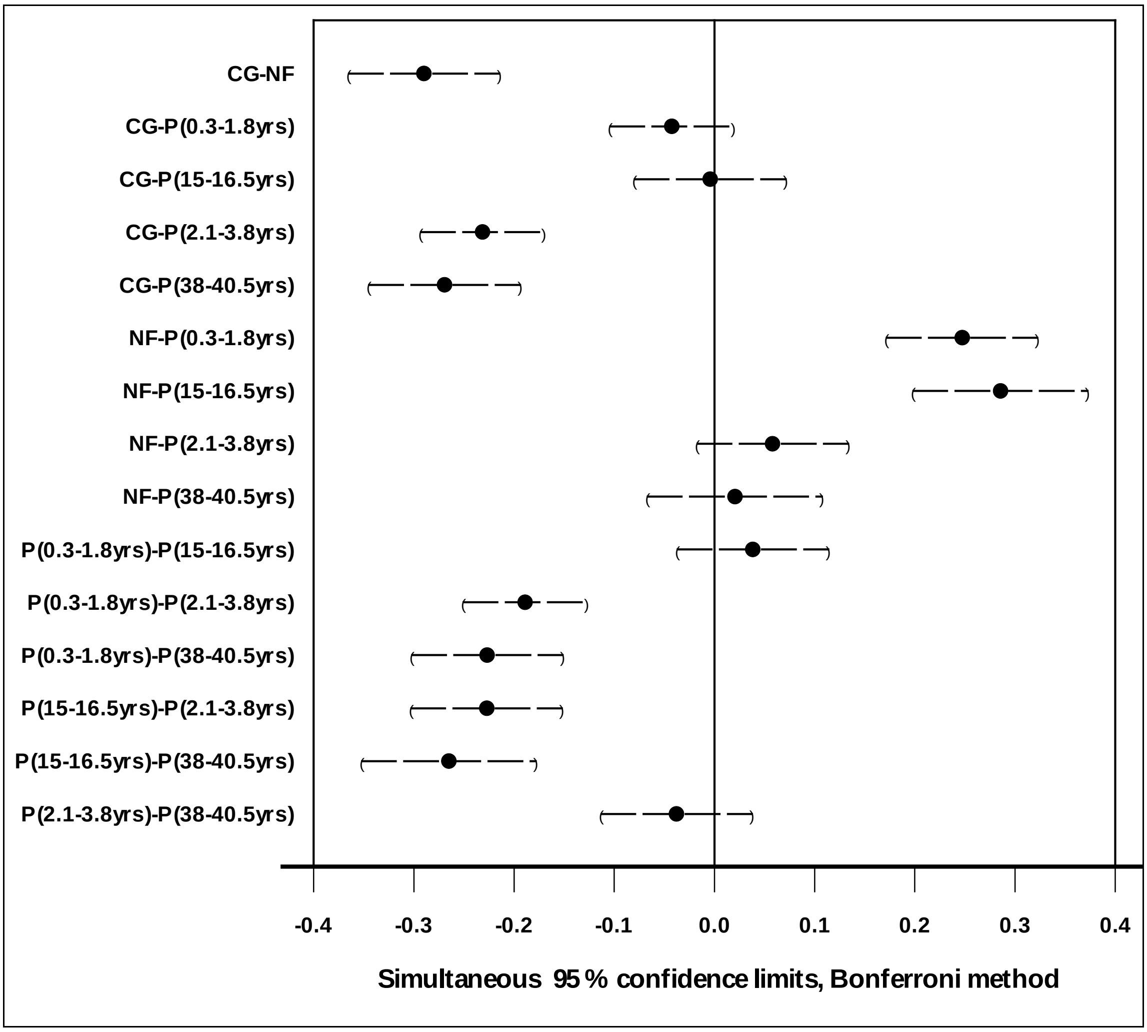


Figure 48d: 8-15 m height class.

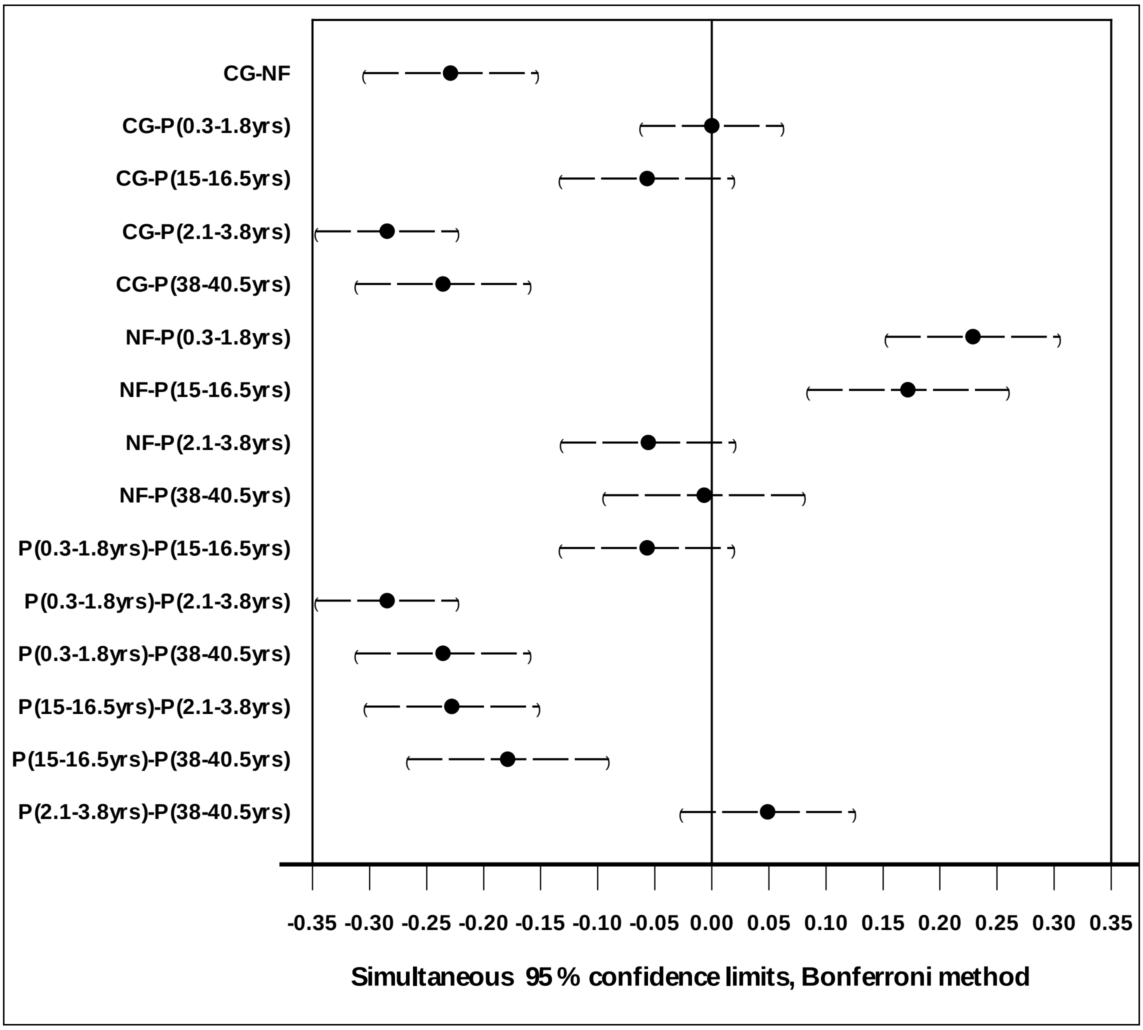


Figure 49: Multiple t-tests results comparing log (x+1) transformed mean plant density between the six vegetation types in the height classes >15 m, >8 m, >5 m, >3 m and >1.8 m. The 95% simultaneous confidence intervals are marked. Comparisons where a confidence interval crosses the zero vertical axis are not significantly different (p>0.05).

CG = cleared, improved, grazed pasture; P(age class) = *E. cloeziana* plantation; NF = selectively logged eucalypt forest

(Full description of site names in Table 1, section **2.1** of this report)

Figure 49a: >15 m height class.

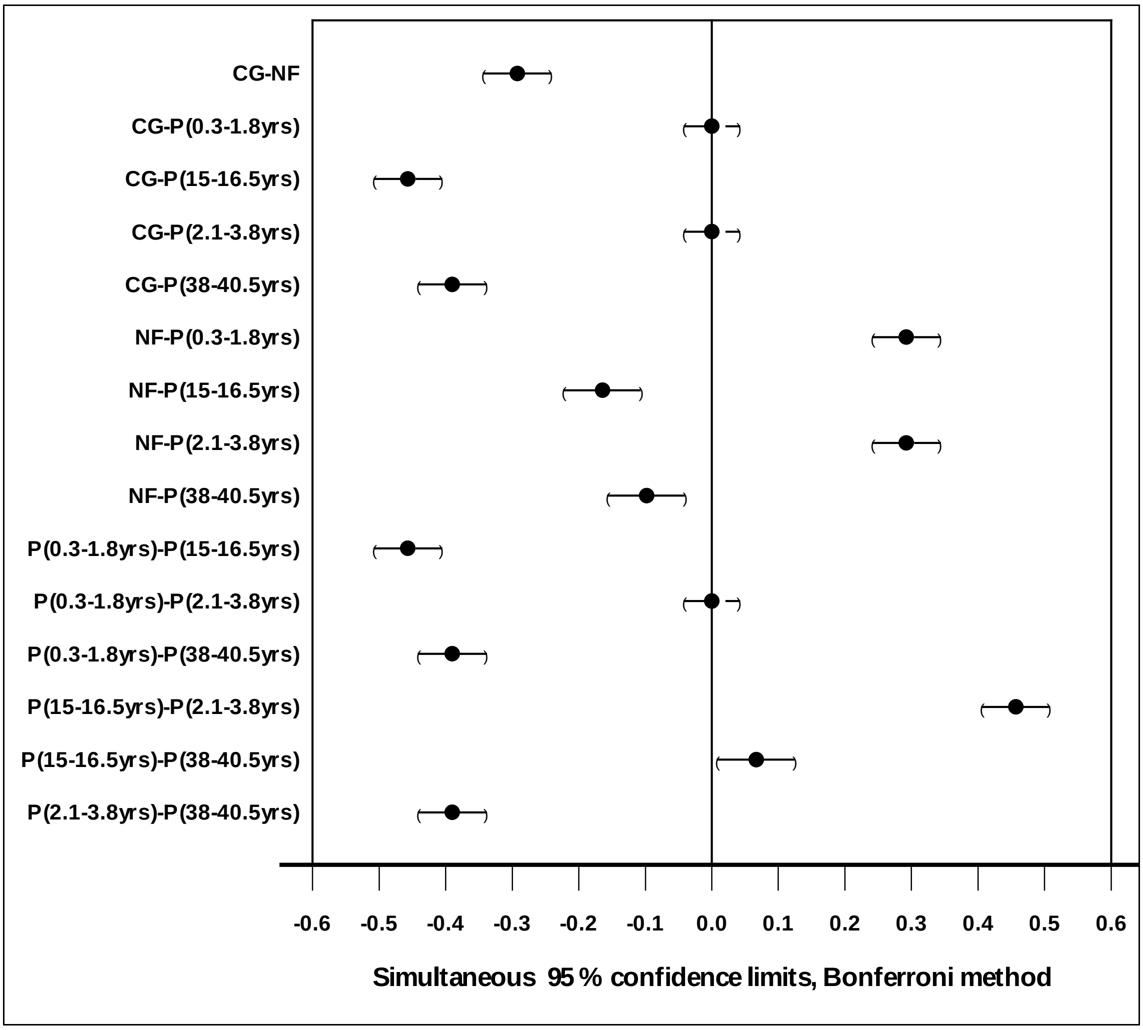


Figure 49b: >8 m height class.

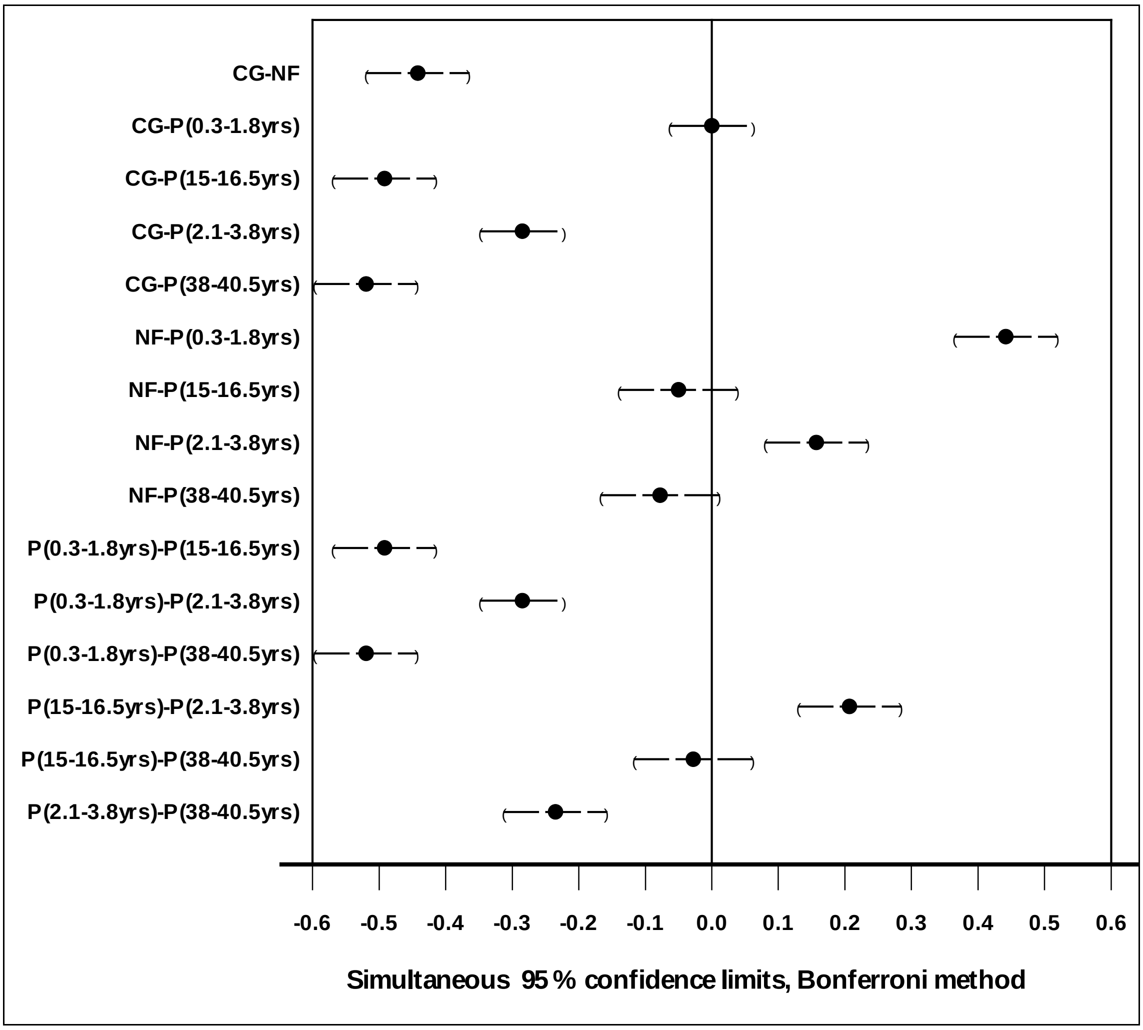


Figure 49c: >5 m height class.

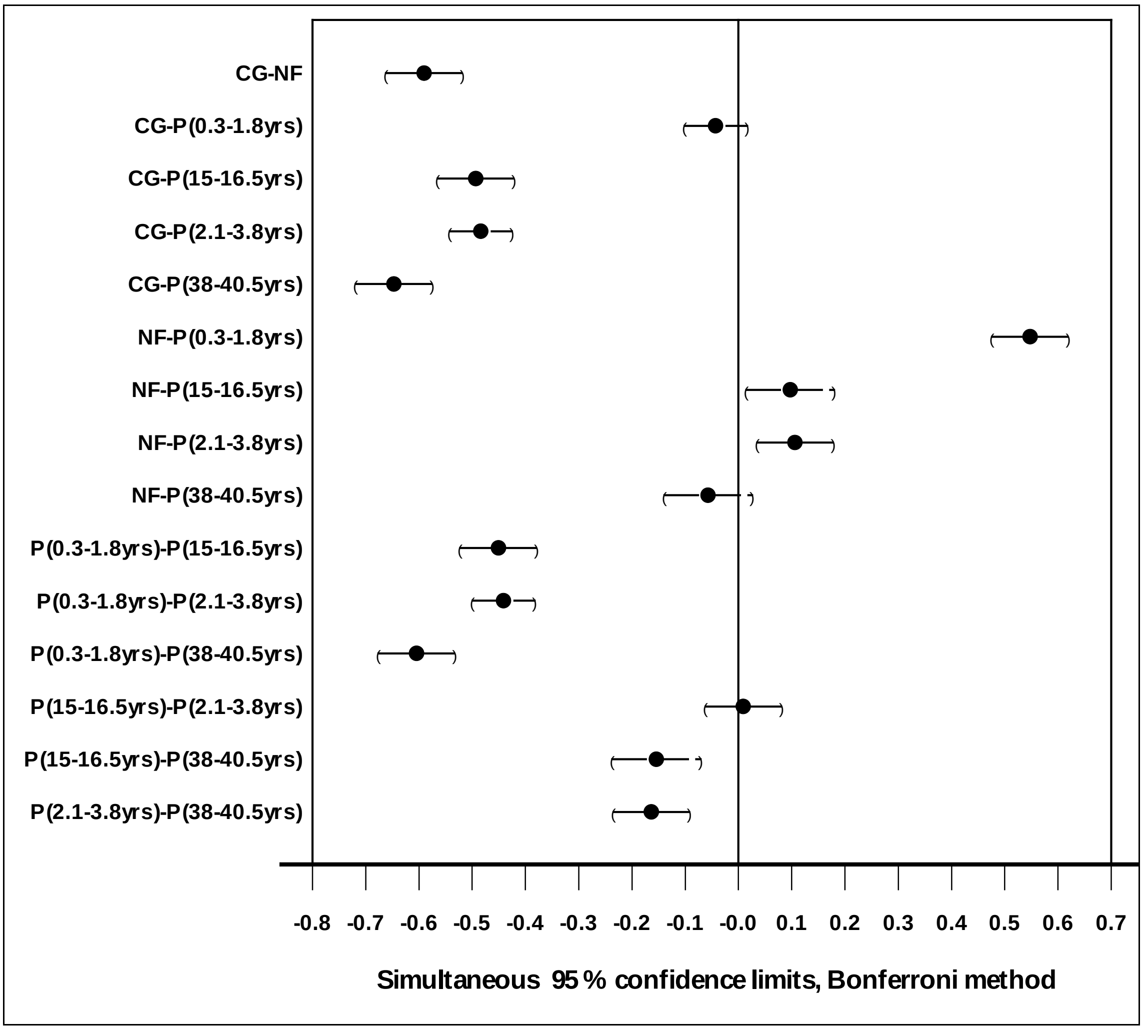


Figure 49d: >3 m height class.

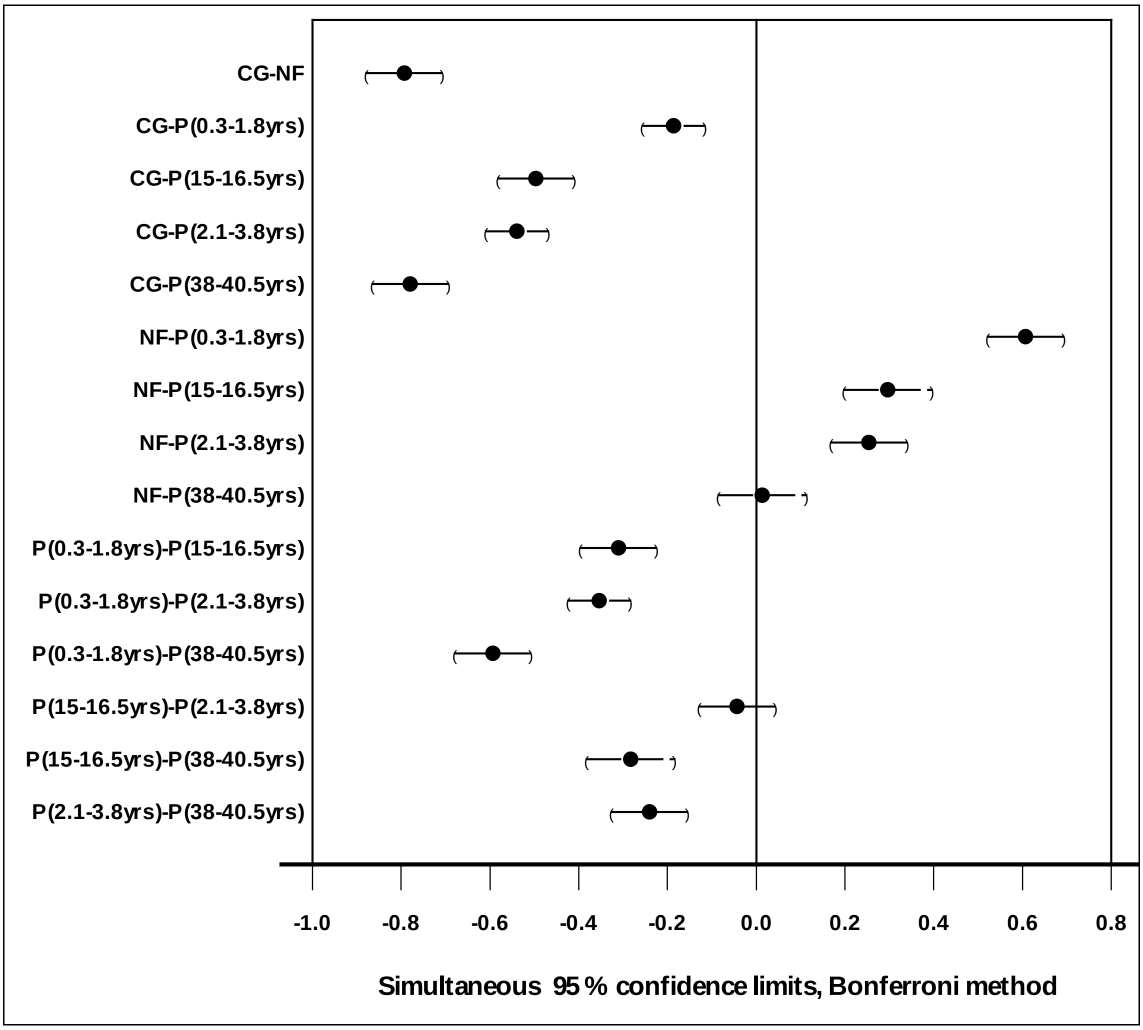
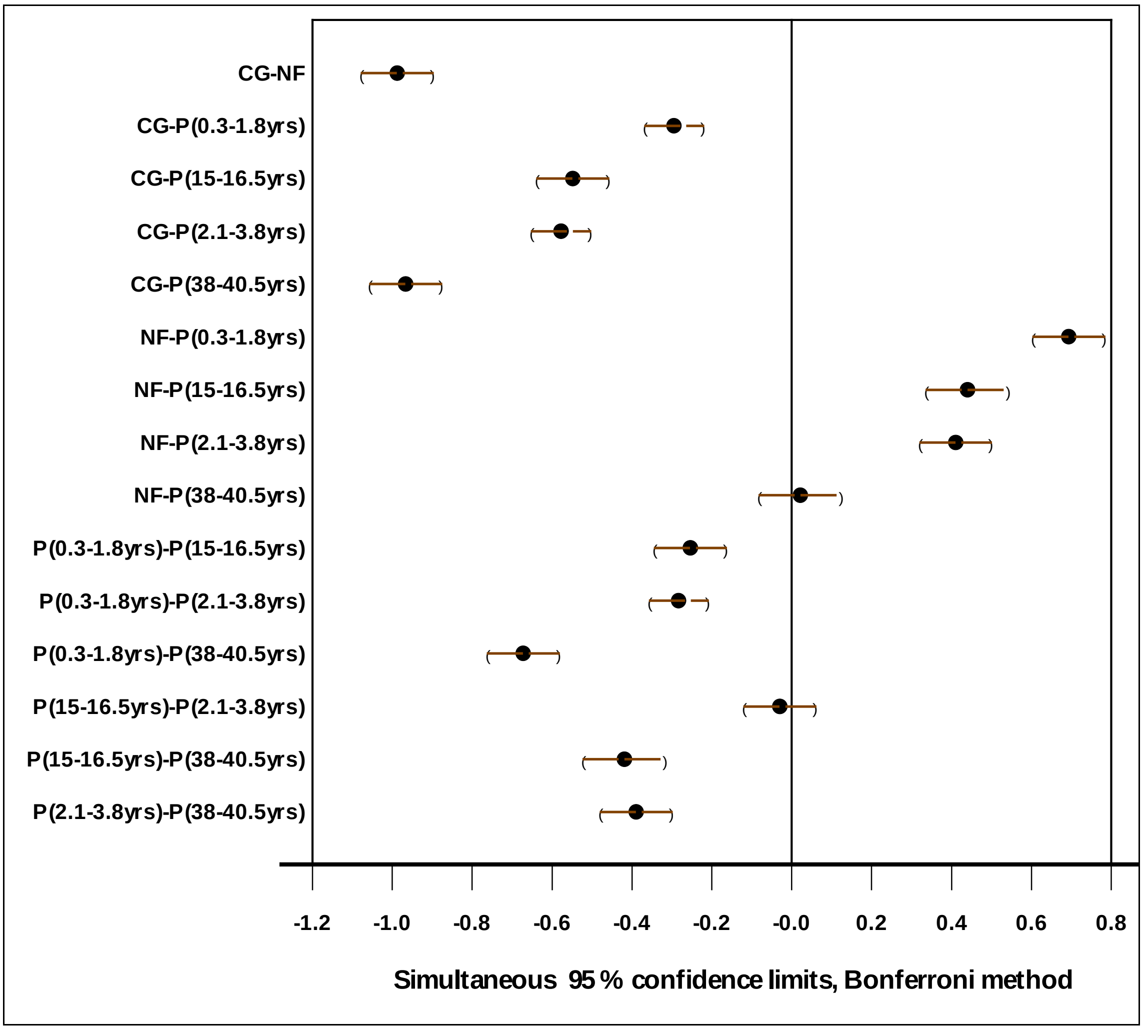


Figure 49e: >1.8 m height class.



3.3 The relationship between vertebrate species and plantation attributes

Correlations and comparisons in this section exclude data from survey sites on cleared improved pasture and selectively logged eucalypt forest.

Pearson correlation coefficients were determined comparing the number of vertebrate species recorded on the 11 *E. cloeziana* plantation sites with various plantation attributes (Table 12). The plantation attribute with the highest positive correlation with vertebrate species (= 0.81) was percentage vegetation cover above 1.8 m. The next highest positive correlation was 0.78 for plant density above 5 m height. There were also strong positive correlations with plantation height and dbh and plant density above 8 m. The highest negative correlation was 0.67 for the number of combined grass, sedge and herb species present. There was no correlation between vertebrate species present and plantation area in the 1.5-10.5 ha range and with the number of plants with maximum height in the 3-5 m height class.

Table 12: Pearson correlation coefficients between total vertebrate species and various plantation attributes. Attribute range in brackets.

PLANTATION ATTRIBUTE	CORRELATION COEFFIENT
Age (0.3-40.5 years)	0.68
Area (1.5-10.5 ha)	-0.13
Plantation tree mean height (2.6-42.5 m)	0.73
Plantation tree mean diameter at 1.3 m (0.95-46.00 cm)	0.74
% litter cover that includes thinning trash on plantation sites (1.4-60.2)	0.55
% vegetation cover in 0-25 cm height class (34.8-71.4)	-0.42
% vegetation cover in 25-50 cm height class (3.7-41.4)	-0.40
% vegetation cover in 50-180 cm height class (0.4-28.4)	-0.27
% vegetation cover above 1.8 m (5.3-78.8)	**0.81**
Log and stump biomass (0.00000-0.01047 m^3/m^2)	0.52
Native plant species (30-93)	0.36
Introduced plant species (2-55)	-0.57
Tree, palm, shrub, vine, parasitic and orchid species (16-84)	0.65
Tree and palm species (2-37)	0.69
Grass, sedge and herb species (11-92)	**-0.67**
Grass species (4-26)	-0.53
Density of plants with maximum height in 1.8-3 m height class (50-1833 plants/ha)	0.64
Density of plants with maximum height in 3-5 m height class (0-983 plants/ha)	0.16
Density of plants with maximum height in 5-8 m height class (0-575 plants/ha)	0.49
Density of plants with maximum height in 8-15 m height class (0-850 plants/ha)	0.48
Plant density above 1.8 m (417-3933 plants/ha)	0.69
Plant density above 3 m (250-2433 plants/ha)	0.68
Plant density above 5 m (50-1700 plants/ha)	**0.78**
Plant density above 8 m (0-1283 plants/ha)	0.72
Plant density above 15 m (0-950 plants/ha)	0.52

The P(38-40.5yrs) plantation age class compared to all younger age classes had significantly fewer grass species (Table 8; Figure 30), significantly fewer combined grasses, sedge and herb species

(Table 10; Figure 32), significantly more combined stump and log biomass (Table 11; Figure 45), and significantly higher plant densities between 1.8-3 m (Figure 48a), 3-5 m (Figure 48c), >1.8 m (Figure 49e), >3 m (Figure 49d), >5 m (Figure 49c) and >15 m (Figure 49a). This plantation age class also had significantly higher leaf litter cover (Figures 37 and 38) and significantly higher vegetation cover above 1.8 m (Figures 39 and 40) than the P(0.3-18yrs) and P(2.1-3.8yrs) plantation age classes. These differences in habitat attributes may link to differences in vertebrate species present within the four plantation age classes. Using only vertebrate species records from the plantations, Table 13 compares the number of species only recorded in the 38-40.5 year old *E. cloeziana* plantations compared to the species only recorded in either the 0.3-1.8, 2.1-3.8 or 15-16.5 year old plantations. It is clear from Table 13 that species composition varies. There were also 21 bird species recorded in the P(03-1.8yrs) and P(2.1-3.8yrs) plantation age classes that were not recorded in the P(38-40.5yrs) plantation age class.

Table 13: Number of vertebrate species only recorded in the 38-40.5 year old *E. cloeziana* plantations compared to the species only recorded in the 0.3-1.8, 2.1-3.8 or 15-16.5 year old plantations.

	Plantation age class	
Vertebrate Taxa	**38-40.5 years**	**0.3-1.8, 2.1-3.8 and 15-16.5 years**
Amphibians	3	11
Reptiles	7	10
Birds	22	29
Bats	3	7
Arboreal mammals	0	2
Ground mammals	3	7
All species	**38**	**66**

4. Discussion

4.1 Site management, survey methodology and climate

Replicates for each plantation age class varied in their management prior to and during the survey period, their management out of our control (see Table 3). Management factors pre-planting included clearing history, fire management, grazing duration and intensity, weed control, pasture improvement and site preparation just prior to planting. Post-planting management factors that varied between sites included the timing and frequency of slashing, the method, timing and frequency of weed and insect control, timing of thinning and pruning, grazing period and grazing intensity. This variation is likely to have contributed to the differences in vertebrate fauna diversity within each set of replicates.

The three cleared improved pasture sites were on private land, and their management was also variable and out of our control, especially in relation to grazing. In the original design of this study, it was hoped to use three unlogged eucalypt forest sites with *E. cloeziana* as a co-dominant in the overstorey. However, it was not possible to find large tracts of unlogged eucalypt forest or three sites with *E. cloeziana* in the overstorey within practical distances of the plantation survey sites. This forced the use of eucalypt forest that had been selectively logged and for one site not to have *E. cloeziana* as an overstorey co-dominant.

A range of survey methodologies were employed to cover all potential vertebrate types. All methodologies added to the total fauna list, although their efficiencies varied. While some methods such as pit-trapping recorded a range of vertebrate types (e.g. frogs, reptiles and small ground mammals), other methods were important in recording difficult to trap species (e.g. anabat call detection of micro-bats). The least effective of the survey methods in this study was the nocturnal ground fauna searches. However, in some regions nocturnal ground searches have proved very successful in recording reptile species (T. Eyre, pers. comm.). Although bird survey results can be influenced by the presence of an observer (Lindenmayer *et al.*, 1997), there are also problems using automated bird-call recorders, especially when habitats being surveyed are small in area. The automated bird-call recorders initially used in this study were discontinued because of the difficulty of distinquishing calls from adjacent habitats. The data from the recorders was omitted from the analysis. Using nocturnal birdcall playback to ellicit a call response also has problems when habitat being surveyed is small in area, as birds can move temporarily from adjacent habitats before responding. For this reason nocturnal birdcall playback was discontinued part way through the survey period and the results excluded from analysis.

The harp trapping and ultrasonic call detection used in this study are important microbat survey techniques. Each technique will record different species in south east Queensland (Eyre *et al.*, 1998). Bat call identification relies on a good field survey recording and a comprehensive library of reference calls. The south east Queensland bat call library is comprehensive but not complete, as bats flying in different environments and in different stages of navigating or searching for food can modify their call characteristics (Reinhold *et al.*, 2001). Some species also have very similar calls and cannot be distinguished reliably (Reinhold *et al.*, 2001). These limitations, plus variability in quality and length of recorded calls, resulted in not all calls being identified to species.

Four of the systematic survey techniques used in this study relied on direct observation to record species. It is especially important for observational survey techniques to standardise search times and methods. The results from such survey techniques can be affected by differences in species visibility due to variation in vegetation structure and density, intra-specific behavioural differences and by intra/inter-observer variation. Whilst recognising these short comings, analysis was not adjusted to compensate for this variation. However, inter-observer variation was reduced by limiting the vertebrate survey team to four, of which only two carried out the systematic bird surveys.

Seasonal and annual climatic patterns have the potential to influence the presence, detectability and trapability of vertebrate fauna. For example, the timing and intensity of rainfall can influence frog activity (Tyler, 1999; Dadds, 2000). On all survey sites, annual rainfall during the first two surveys was significantly above average, whilst for the third and fourth surveys annual rainfall was significantly lower than average (Figure 3). What impact this annual rainfall pattern has on frog detectability in south east Queensland is unclear. However, it is worth noting that on one surevy site, a number of *Crinia signifera* (clicking froglet) were heard calling during the first winter survey from a boggy section of pasture. In the second winter survey, during the significantly drier year, the boggy section was dry and the frog was not heard calling. Regardless of the reason for the frog not being detected, had the first winter survey not been conducted, this frog would not have been recorded for the site.

4.2 Vertebrate diversity

The 18 fauna survey sites were located in six of the 10 provinces of the Southeast Queensland Bioregion (Young and Dillewaard, 1999). A total of about 518 terrestrial forest/woodland species occur in these six provinces, comprising 488 native species listed by McFarland (1988), 16 additional native bird species (Blakers *et al.*, 1984; Eyre *et al.*, 1998, Appendix 1 this report) and 14 introduced vertebrate species (Ingram and Raven, 1991; Blakers *et al.*, 1984; Eyre *et al.*, 1998; Appendix 1 this report). The 175 vertebrate species recorded in the various age *E. cloeziana* plantations represents 34 % of the 518 species, which is a significant proportion. All vertebrate types found in native forest in south east Queensland by Eyre *et al.* (1998) were also recorded in the plantations. The least represented vertebrate type in the plantations was arboreal mammals. This is not surprising as most arboreal mammals require tree hollows for shelter (Strahan, 1995), and all the plantation sites surveyed had no obvious tree hollows. Use of the plantations by arboreal mammals is probably dependent on connectivity to native forest with suitable hollows for shelter. The plantations 38 to 40.5 yrs of age had the highest vertebrate species diversity after selectively logged eucalypt forest, and were not significantly different in many habitat attributes from the selectively logged eucalypt forest. The increase in vertebrate species diversity and the changes in species composition with increasing plantation age are correlated to changes in floristic habitat attributes.

It was initially planned to look at abundance for as many vertebrate species as possible. However, abundance data was limited for most species recorded. The exceptions were some of the rodent species (see 4.2.1 below) and birds recorded on the bird survey plots (see 4.2.3).

4.2.1 Ground mammals

The most frequently trapped native rodents in this study were the bush rat (*Rattus fuscipes*) and the fawn-footed melomys (*Melomys cervinipes*), which was the same result Eyre *et al.* (1998) obtained in their forest fauna surveys in the Southeast Queensland Bioregion. In this study the two species were only captured in selectively logged eucalypt forest and the *E. cloeziana* plantations 38 to 40.5 years of age. Both habitats compared to cleared improved pasture and the other plantation age classes had significantly less vegetation cover below 25 cm, especially of grass, sedge and herb species, significantly more combined stump and log biomass, significantly higher plant density above 1.8 m, mostly significantly more vegetation cover above 1.8 m and mostly significantly more leaf litter. *M. cervinipes* has a prehensile tail and is adept at using arboreal forest environments (Wood, 1971; Dwyer *et al.*, 1979; Smith, 1985). An important feature of forests in south east Queensland where *M. cervinipes* occurs is a groundcover of leaf litter and logs (Redhead, 1995). The 40+ percentage litter cover, structured shrubby understorey, logs and stumps of the 38 to 40.5 year old plantations provide the habitat requirements of this rodent. *R. fuscipes* also prefers non-grassy habitats with a preference for forest with a dense groundcover (Watts and Aslin, 1981; Lunney, 1995), but unlike *M. cervinipes* rarely climbs (Wood, 1971). The habitat preference of these two rodent species also explains their absence from the young, grassy plantations with little understorey structure.

Most captures of the grassland melomys (*Melomys burtoni*)and the house mouse (*Mus musculus*), as well as all captures of the eastern chestnut mouse (*Pseudomys gracilicaudatus*) were in plantations 0.3

to 1.8 and 2.1 to 3.8 years of age (Figures 15 and 16). These plantations had significantly more grass, sedge and herb species, a higher percentage vegetation cover below 0.25 m and more introduced plant species and than the 38 to 40.5 year old plantations. In these older plantations the three rodent species were either absent or present in very low numbers. The preference of *P. gracilicaudatus* for plantations with a grass dominated ground cover, is similar to elsewhere in Queensland, where it is mainly associated with a grassy ground cover (Borsboom, 1975; I. Gynther, pers. obs.; EPA, 2002), including tall grassy, ungrazed farm forestry plots 1.8 to 2.3 years of age at Warrill View in south east Queensland (Borsboom, 1993). This preference for grassy habitats in Queensland contrasts with New South Wales, where it is more often associated with heath land (Fox, 1995). *M. burtoni* will live in a wide range of habitats (Dyer *et al.*, 1979; Watts and Aslin, 1981; Smith, 1985; Kerle, 1995), but in Queensland prefers some form of grassy or sedge habitat (Kerle, 1995).

The introduced house mouse *Mus musculus* was the most recorded ground mammal, occurring in all age classes of *E. cloeziana* plantations, the cleared improved pasture and the selectively logged eucalypt forest. While *M. musculus* can be found in a range of habitats (Watts and Aslin, 1981; Cantrill, 1992; Singleton, 1995; Caughley, 2001; EPA, 2002), our trapping returns found it had a clear preference for plantations with a grass-dominated ground cover. This is consistent with its preference in Queensland for grassy habitats or grain crops (Cantrill, 1992; Caughley, 2001). *M. musculus* numbers on our survey sites were significantly higher in mid-winter compared to early and mid-summer. Cantrill (1992) and Caughley (2001) also found *M. musculus* numbers in grain crops and adjacent grassy habitats are highest in winter on the Darling Downs in southern Queensland.

4.2.2 Bats
A number of bat species were recorded over the cleared improved pasture sites or trapped/recorded in the plantations, even though roost sites in these vegetation types were absent or very limited due to a lack of hollows. This is not unexpected as the few Australian microbat species where foraging distances have been recorded, were found to range as far as 1.4 to 15 km from roost sites (Churchill, 1998; Barclay *et al.*, 2000; Reinhold and Hogan, 2002). This would suggest setting up bat boxes in plantations may not necessarily increase the number of bats feeding within the plantation if enough roosts are located within 1.4 km or more of the plantation. However, bat boxes in plantations have been shown to be important shelter sites for small arboreal mammals that include insects in their diet (Smith and Agnew, in press). Smith and Agnew (in press) suggest that the presence of insect feeding arboreal mammals and bats might be of some benefit to plantations.

4.2.3 Birds
No analysis of edge effect was considered for data from the plantation bird survey plots. Data from Sisk and Margules (1993) and Sisk *et al.* (1997) indicated all *E. cloeziana* plantations surveyed in this this study would constitute edge habitat for birds, as no point in any plantation was further than 150 m from an edge. One hundred bird species were recorded in the *E. cloeziana* plantations, which shows single species eucalypt plantations of less than 11 hectares can make a significant contribution to bird species richness. The importance of small forest blocks to birds is supported by Fischer and Lindenmayer (in press) and Seddon *et al.* (2001), who found native forest blocks up to 10 hectares in area can make a significant contribution to bird species richness.

Some bird species common in the plantations were also common in native forest. The grey fantail (*Rhiphidura fuliginosa*) was one of only three vertebrate species recorded on all 11 plantation survey sites. It was also recorded on all 4 selectively logged eucalypt forest sites and was the most frequently recorded bird species in forests surveys by Eyre *et al.* (1998) in south-east Queensland. The next most recorded forest bird species by Eyre *et al.* (1998) were Lewin's honeyeater (*Meliphaga lewinii*) and the spotted pardalote (*Pardalotus punctatus*). Lewin's honeyeater was recorded on 8 of the 11 plantation sites and on all 4 of the selectively logged eucalypt forest sites. The spotted pardalotte was recorded on 7 of the 11 plantation sites and on 3 of the 4 selectively logged eucalypt forest sites.

Not all native birds may be desirable in a plantation. The noisy miner (*Manorina melanocephala*) will exclude smaller bird species from forest in which they occur (Dow, 1977; Dow, 1979; Grey *et al.*, 1997; Grey *et al.*, 1998; Seddon *et al.*, 2001). Loyn (1985) reports eucalypt dieback caused by defoliating insects was more severe in forest patches where the noisy miner occurred compared to forest patches where the bird was absent, the understorey was intact and there were high numbers of forest birds. In this study the noisy miner was not recorded in the 38 to 40.5 year old plantations, which had a well structured understorey of shrubs and small trees, but was found on five of the 8 remaining plantation sites, all of which had poorly developed understories. This is consistent with research by Loyn (1985), Loyn (1987), Grey *et al.* (1997) and Grey *et al.* (1998), who found the bird prefers forest with an open understorey that lacks shrubs. To minimize the potential adverse impact of noisy miners on other bird species in a plantation, development of a well structured understorey would be desirable. Regardless of the presence or absence of noisy miners, a well structured understorey is still desirable for maximizing bird species richness. Seddon *et al.* (2001) found some bird species present in small forest remnants with a medium or high percentage shrub cover were absent from those with a low percentage shrub cover.

4.2.4 Reptiles and amphibians

Because of habitat preference, not all 518 forest/woodland species known to occur in the regional provinces where the survey sites were located, would be expected to occur on the sites. However, further survey effort on these sites would expect to find more vertebrate species than currently recorded, especially amphibian and reptile species. Resource constraints only allowed for four fauna surveys on most survey sites, covering the mid-winter and early summer periods only. This has limited the prospect of recording all vertebrate species on a site. The detectability or trapability of many reptile species (*e.g.* blind snakes, fossorial skinks, many snakes) is low year round (Wilson and Knowles, 1988; Eyre *et al.*, 1998; G. Czechura, pers. obs.). To highlight the difficulty of finding reptile species using systematic survey techniques, 25% of the larger reptiles recorded in surveys by by Eyre *et al.* (1999) were incidental records. However, systematic surveys are still important. Like Eyre *et al.* (1998), the diurnal herpetofauna surveys in this study were the most successful technique, recording 13 of the 25 reptile species found.

Results from this study indicate the frog *Limnodynastes peronii* is not averse to using modified habitats, which is supported by Frost and Morgan (1999), who consider it the most commonly seen frog in urban Brisbane. It was the only frog with sufficient records in this study to make some comparison of habitat preference. Part of the problem with surveying for frogs is that the detectability or trapability of a number of frog species in south east Queensland is low for significant periods of the year. Cryptic frogs such as *Litoria brevipalmata*, *Limnodynastes ornatus* and *Limnodynastes terraereginae* have short periods of breeding/calling, which are determined by a suitable rain event during the breeding season (Barker *et al.*, 1995; Frost and Morgan, 1999; Dadds, 2000; A. Borsboom, pers. obs.). Surveying during these peak activity periods can skew numbers. For example, 47% of the *L. peronii* recorded in this study were from a single survey at one site. This makes comparisons of abundance between this and other frog species difficult. The comprehensive regional fauna surveys of the Southeast Queensland Bioregion also experienced this skewing of numbers. Approximately 135 *L. peronii* were recorded from surveys on 267 systematic survey sites and a number of opportunistic survey sites, but 80 *L. peronii* were recorded during a single survey at one site (Eyre *et al.*, 1998; EPA data base, 2002).

4.2.5 Pest vertebrates

Of the eight rodent species recorded in the *E. cloeziana* plantations, seven are considered minor or major pest species, although none are considered pests in eucalypt plantations. The pale field rat (*Rattus tunneyi*) can cause significant damage to young hoop pine plantations (Kehl, 1980). Young hoop pines in south east Queensland can also be damaged by the swamp rat (*R. lutreolus*) (L. Hogan, pers. obs.). The bush rat (*R. fuscipes*) and *R. lutreolus* can be pests of *Pinus radiata* plantations in Victoria (McDougall, 1944; McNally, 1955). The grassland melomys (*Melomys burtoni*) is a significant pest in sugar canefields in Queensland (McDougall, 1944; McDougall, 1968; Redhead and Saunders, 1980; Watts and Aslin, 1981; Kerle, 1995). The fawn–footed melomys (*M. cervinipes*) is considered a minor pest of sugercane (McDougall, 1968: Redhead, 1995). However, it is very difficult to distinguish from *M. burtoni* in north Queensland (J. Wilson, pers. comm.), so its pest status in the north requires further investigation. The black rat (*R. rattus*) is introduced and is a coloniser of disturbed and degraded habitats, being a pest in urban environments such as food warehouses (McDougall 1968;Watts and Aslin, 1981; Watts, 1995). The rat is believed to cause minor damage in sugarcane (Watts and Aslin, 1981), and is a major pest of Australian macadamia plantations (White *et al.*, 1997). *R. rattus* is also known to predate on bird nestlings and eggs (Watts and Braithwaite, 1978). The introduced house mouse (*Mus musculus*) can be a serious pest of grain crops in Queensland and elsewhere in Australia (Cantrill, 1992; Singleton, 1995; Caughley, 2001).

A literature review by Lees (2000) found no published quantitative data on browsing damage by vertebrates in Queensland eucalypt plantations. However, based on observational data from Queensland and quantitative data from elsewhere in Australia, Lees (2000) lists a number of vertebrate species known or expected to damage plantation eucalypts in Queensland. Five of these were recorded in *E. cloeziana* plantations surveyed in this study; these being the swamp wallaby (*Wallabia bicolor)*, the red-necked wallaby (*Macropus rufogriseus)*, the brush-tail possum (*Trichosurus vulpecula)*, the introduced European hare (*Lepus capensis)* and the yellow-tailed black cockatoo (*Calyptorhynchus funereus*). Two other bird species recorded in the *E. cloeziana* plantations can cause problems in tree plantations. The sulphur-crested cockatoo (*Cacatua galerita*) can damage plantation hoop pines (G. Smith, pers. comm.). The noisy miner (*Manorima melanocephala*), through strong territorial behaviour can decrease bird diversity and abundance, thus reducing the number of insect feeding birds within their territories (Grey *et al.*, 1997).

4.2.6 Rare and threatened vertebrates

The four rare or threatened vertebrate species recorded in the *E. cloeziana* plantations represents only about 7% of the rare and threatened terestrial, forest/woodland vertebrate species listed by McFarland (1998) for the six Southeast Queensland Bioregion provinces in which the survey sites occur. None of the 22 rare and threatened birds listed by McFarland (1998) for these provinces were recorded in the plantations.

The use of plantations by rare and threatened vertebrates should not be discouraged. The four rare and threatened species recorded in the *E. cloeziana* plantations are not considered pest species either in or outside the plantation. Their presence should also not be used as a reason to not allow harvesting. Such a prohibition would be a disincentive to tree planting and to undertaking management practices that increase biodiversity values within plantations. Where rare or threatened species occur in a plantation, there is no reason why the impact of timber harvesting and other management activities can't be ameliorated through a co-operative and voluntary program with growers. For instance, where a rare or threatened bird is nesting in a plantation tree ready for harvest, consideration could be given to delaying harvest of the tree until nesting is complete.

5. Implications

Some of the trends in the vertebrate diversity data, which were not statistically significant, would almost certainly have benefited from more replicates per vegetation type and more surveys per site. However, resource constraints precluded this. Any future funding should ensure resources are adequate for a minimum of 5 replicates per treatment and a minimum of three surveys per annum per site. Regardless of the need for more surveys and replicates, the results of this study still show *E. cloeziana* plantations are habitat for the full range of vertebrate types found in native forest. Though birds were the dominant species group in the plantations, 75 non-bird species were also recorded. Therefore plantation management to enhance vertebrate diversity should not ignore non-bird species. For instance, if arboreal insect feeding mammals are to be encouraged and connectivity to native forest with hollows is poor, the installation of suitable nest boxes (Smith and Agnew, in press) is worth consideration.

The results of this study show vertebrate diversity is low on cleared improved pasture and that single species eucalypt plantations of 10 hectares or less with connectivity to natural habitat, even without special management to enhance biodiversity, will support more vertebrate species. Plantations are also better than cleared improved grazing land for bird abundance and abundance of the few other vertebrate species where enough data was gathered to compare abundance. If current government supported initiatives that encourage the planting of eucalypt plantations on cleared land continue, this study indicates a significant medium term restoration of vertebrate diversity will occur across south east Queensland as a result of farm forestry. It also has implications for vertebrate diversity restoration elsewhere, as hardwood plantation establishment on private land continues to increase in Australia (Wood *et al.*, 2001). However, if plantations are harvested, not replanted and the land allowed to revert to cleared farmland such as pasture, the vertebrate diversity gained will be lost. Farm forestry will only contribute long term to restoring a significant amount of vertebrate diversity to farmland if the plantation cycle is one of continuing harvest and replanting. What the impact of harvesting and replanting is on vertebrate diversity is unknown. Should it be similar to the vertebrate diversity increase following initial establishment of a plantation, then recovery from harvesting should be evident within two years of replanting. Factors affecting vertebrate diversity in a replanting will include continuing connectivity to either native forest or other habitat in which vertebrate fauna resides, length of the logging cycle and the degree of harvesting disturbance. Length of the logging cycle may be critical to the establishment of a complex shrubby understorey within a plantation.

This investigation found no correlation between plantation area and vertebrate diversity within the range of 1.5 to 10.5 ha. Fauna survey results and habitat measurements indicate plantings to about 10 ha in size could make a significant contribution to vertebrate diversity if well sited and appropriately managed. It is expected most private tree growers in south east Queensland under Government initiative schemes will continue to establish plantation blocks of 10 or less hectares (N. Halpin, DPI, pers. comm.). Whether planting substantially larger blocks of eucalypts in south east Queensland will result in a significant increase in vertebrate diversity is unknown. There is also no information on vertebrate diversity in mixed eucalypt plantations.

This current study was limited by the lack of *E. cloeziana* plantations in south east Queensland between 4 to 30 years of age. The exceptions were the two 15 to 16.5 year old plantations surveyed in this study. Consequently, there is a significant knowledge gap on what happens to vertebrate diversity in this plantation age period. The impact of cattle is also unknown in this age period. The belief is that the Government joint-venture plantations surveyed in this study will change in groundcover structure and possibly plant species composition after four years of age, due in part to the impact of cattle and canopy closure. It is suspected such changes to habitat may initially reduce vertebrate species richness and abundance at ground level.

Some vertebrate species using *E. cloeziana* plantations can be potential pests in or outside of the plantation. Tree growers need to be aware of pest species and their potential for damage, where possible adopting appropriate proactive management strategies. These strategies might include establishing a plantation some distance from a potentially threatened crop or habitat manipulation within an existing plantation. For instance, to reduce house mouse (*M. musculus*) numbers in a plantation when an adjoining grain crop is threatened, may require suppressing the tall, thick grassy ground cover that the house mice prefers (Caughley, 1999). This could be achieved through regular slashing, grazing or establishment of a shrubby understorey. Practices to mitigate the impact of pest species may not always be optimal for maintaining maximum vertebrate species richness. While this study found plantations with a well structured shrubby understorey had the highest vertebrate diversity, a shrubby understorey may not be appropriate for the management of some pests. For example, the black rat (*Rattus rattus*), which is a major macadamia orchard pest, will use structurally complex vegetation adjacent to an orchard as refuge habitat (White *et al.*, 1997). In this study *R. rattus* were caught in a 15-16.5 year old plantation adjacent to a macadamia orchard. The pest management action for this plantation would be to regularly slash to maintain a short ground cover that is unsuitable for the rat (Hoskins *et al.*, 1998; White *et al.*, 1998). While such management would reduce rat numbers it would probably also reduce ground vertebrate diversity.

The finding from this study that plantations with a structurally complex understorey support more vertebrate species may have economic significance. Shade tolerant, native, understorey species that can be harvested for foliage, flowers, oil, etc could be established in a plantation. This may provide the understorey complexity to enhance vertebrate diversity, while providing income from the site prior to timber harvesting. To allow access for maintenance and harvesting, every second row could be planted with commercial understorey species.

6. Recommendations

The *E. cloeziana* plantations were used by a significant number of vertebrate fauna species. How these plantations are managed, their connectivity/distance to other habitats in which wildlife resides, and the ability of wildlife to move into these plantations from nearby habitat will have a bearing on species richness and abundance. Vertebrate fauna diversity was highest in the 38 to 40.5 year old plantations, and was not significantly different from the selectively logged eucalypt forest sites that were surveyed. The 38 to 40.5 year old plantations not only had more vertebrate species than the younger, grassy plantations, but also had a different species compliment. These particular 38 to 40.5 year old plantations had received minimal management after planting and initial thinning and tending, had stumps and logs on the ground left during plantation establishment, good connectivity to native forest, no grazing and no evidence of hot fires. How much each of these attributes contributed to the high vertebrate diversity in these plantations is unknown, but it is suspected each has played a role. If one of the reasons to establish a farm forestry plantation is to maximize vertebrate diversity values without significantly compromising plantation maintenance and productivity, then the recommendations from this study are:

1. Do not clear native forest to establish eucalypt plantations, plant instead on previously cleared land such as pasture;
2. Establish eucalypt plantations on sites with connectivity to native forest, especially forest with hollows if hollow-using arboreal mammals are to be attracted to plantations;
3. Where more than one eucalypt plantation is planned, establish adjacent to each other, staggering harvest times by at least four years;
4. Maximize time between planting and harvest (*e.g.* plant for pole timbers rather than for wood chip);
5. Push all logs into every second planting row, in these rows retaining stumps and establishing a well structured shrubby understorey;
6. Exclude grazing, except when grazing is used as a short term pest management tool to speed the suppression of grass species; and
7. Avoid hot burns and establish firebreaks to exclude unplanned fires.

By setting up a structured shrubby understorey in every second planting row, access for tree maintenance and harvesting is not unduly impeded. Where pest species occurring or expected to occur in a plantation pose an economic threat, either manage or site plantations to minimize pest impact. Consult appropriate authorities for advice on pest management.

Recommendations for further research are:

1. Within eucalypt plantations, measure the biodiversity benefits of establishing shade-tolerant, native species that can be regularly harvested for foliage, flowers, oil, etc, while still providing a structurally complex habitat beneath plantation trees for wildlife;
2. Until harvest, continue regular measurement of vertebrate diversity on Government joint-venture, *E. cloeziana* plantations in south east Queensland;
3. Measure vertebrate diversity on Government joint-venture *E. cloeziana* plantations following timber harvesting and replanting;
4. Measure the impact of grazing on biodiversity in a plantation;
5. Measure the biodiversity benefits of mixed species eucalypt plantations in south east Queensland; and
6. Measure the impact of short logging cycles on vertebrate diversity.

7. Appendices

Appendix 1: Vertebrate fauna species recorded on the 18 survey sites. ∗ = introduced species

TAXA	COMMON NAME	CG1	CG2	CG3	P(0.3-1.8)1	P(0.3-1.8)2	P(0.3-1.8)3	P(2.1-3.8)1	P(2.1-3.8)2	P(2.1-3.8)3	P(15-16.5)1	P(15-16.5)2	P(38-40.5)1	P(38-40.5)2	P(38-40.5)3	NF1	NF2	NF3	NF4
AMPHIBIANS																			
Adelotus brevis	tusked frog											X			X				
Bufo marinus∗	cane toad	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Crinia parinsignifera	beeping froglet			X															
Crinia signifera	clicking froglet		X									X							
Crinia tinnula	wallum froglet												X						
Limnodynastes ornatus	ornate burrowing-frog						X			X	X								
Limnodynastes peronii	striped marshfrog	X		X	X	X	X	X	X	X	X	X			X				
Limnodynastes tasmaniensis	spotted marshfrog									X	X								
Limnodynastes terraereginae	scarlet-sided pobblebonk						X			X	X								
Litoria brevipalmata	green-thighed frog												X						
Litoria caerulea	green treefrog						X												
Litoria dentata	bleating treefrog						X												
Litoria fallax	eastern sedgefrog											X			X		X		
Litoria gracilenta	graceful treefrog						X		X					X	X	X	X	X	
Litoria latopalmata	broad-palmed rocketfrog		X		X	X	X												
Litoria lesueuri	stony-creek frog				X			X				X							
Litoria nasuta	striped rocketfrog				X		X												
Litoria peronii	emerald-spotted treefrog									X				X		X		X	
Litoria rubella	naked treefrog		X				X					X							
Litoria sp. (not *peronii* or *gracilenta)*	Frog																	X	
Litoria verreauxii	whistling treefrog		X																
Mixophyes fasciolatus	great barred-frog												X		X	X			
Pseudophryne coriacea	red-backed broodfrog		X																
Pseudophryne sp.	Frog									X									
Uperoleia fusca	sandy gungan									X						X			

TAXA	COMMON NAME	CG1	CG2	CG3	P(0.3-1.8)1	P(0.3-1.8)2	P(0.3-1.8)3	P(2.1-3.8)1	P(2.1-3.8)2	P(2.1-3.8)3	P(15-16.5)1	P(15-16.5)2	P(38-40.5)1	P(38-40.5)2	P(38-40.5)3	NF1	NF2	NF3	NF4
REPTILES																			
Cacophis krefftii	dwarf crowned snake																X		
Calyptotis scutirostrum	skink, no common name						X												
Carlia pectoralis	skink, no common name										X				X				
Carlia vivax	lively skink		X				X			X	X								
Cryptoblepharus virgatus	wall skink					X			X		X					X			X
Ctenotus robustus	eastern striped skink				X			X											
Delma plebeia	common delma						X												
Dendrelaphis punctulata	common tree snake									X					X				
Eroticoscincus graciloides	elf skink													X			X	X	X
Eulamprus tenuis	skink, no common name														X		X		
*Hemidactylus frenatus**	house gecko												X						
Hemisphaeriodon gerrardii	pink-tongued skink												X						
Lampropholis amicula	friendly skink					X	X			X		X				X			
Lampropholis couperi	skink, no common name											X							
Lampropholis delicata	eastern grass skink		X		X	X	X	X	X	X		X		X	X	X	X	X	X
Lygisaurus foliorum	Burnett's skink										X								
Oedura sp.	gekko, no common name																		X
Pogona barbata	Bearded dragon					X				X	X								
Ramphotyphlops silvia	blindsnake, no common name														X				
Ramphotyphlops sp.(not *weidii*)	blindsnake, no common name					X													
Ramphotyphlops weidii	blindsnake, no common name					X													
Rhinoplocephalus nigrescens	eastern small-eyed snake															X	X		
Saiphos equalis	skink, no common name															X			
Varanus varius	lace monitor												X		X				
Vermicella annulata	bandy-bandy														X				
BIRDS																			
Acanthiza lineata	striated thornbill												X	X	X	X	X	X	
Acanthiza pusilla	brown thornbill							X		X			X		X	X	X	X	X
Acanthiza reguloides	buff-rumped thornbill																	X	
Acanthorhynchus tenuirostris	eastern spinebill														X	X			
Aegotheles cristatus	Australian owlet-nightjar										X				X	X	X	X	X
Alectura lathami	Australian brush-turkey											X			X				

TAXA	COMMON NAME	CG1	CG2	CG3	P(0.3-1.8)1	P(0.3-1.8)2	P(0.3-1.8)3	P(2.1-3.8)1	P(2.1-3.8)2	P(2.1-3.8)3	P(15-16.5)1	P(15-16.5)2	P(38-40.5)1	P(38-40.5)2	P(38-40.5)3	NF1	NF2	NF3	NF4
BIRDS (continued)																			
Alisterus scapularis	Australian king-parrot											X				X	X	X	X
Anas superciliosa	Pacific black duck		X	X															
Anthus novaeseelandiae	Richard's pipit	X																	
Aquila audax	wedge-tailed eagle					X					X								
Ardea ibis	cattle egret		X						X										
Artamus leucorynchus	white-breasted woodswallow	X																	
Aviceda subcristata	Pacific baza												X						
Cacatua galerita	sulphur-crested cockatoo	X													X	X			
Cacomantis flabelliformis	fan-tailed cuckoo								X		X	X	X	X		X			
Cacomantis variolosus	brush cuckoo							X								X			
Calyptorhynchus funereus	yellow-tailed black-cockatoo												X				X		X
Calyptorhynchus lathami	glossy black-cockatoo																	X	
Centropus phasianinus	pheasant coucal		X		X	X	X	X	X	X					X	X			
Chalcophaps indica	emerald dove																X		X
Chenonetta jubata	Australian wood duck		X	X															
Chrysococcyx basalis	Horsfield's bronze-cuckoo									X									
Chrysococcyx lucidus	shining bronze-cuckoo								X	X				X	X	X	X	X	X
Chrysococcyx minutillus	little bronze-cuckoo															X			
Cisticola exilis	golden-headed cisticola			X	X	X	X	X	X										
Colluricincla harmonica	grey shrike-thrush							X	X	X	X			X	X	X	X	X	X
Colluricincla megarhyncha	little shrike-thrush													X		X	X		
Columba leucomela	white-headed pigeon											X				X		X	X
Coracina novaehollandiae	black-faced cuckoo-shrike				X	X	X	X	X	X	X	X	X	X		X	X		
Coracina papuensis	white-bellied cuckoo-shrike										X					X			
Coracina tenuirostris	Cicadabird											X			X	X	X	X	X
Cormobates leucophaeus	white-throated treecreeper											X	X	X	X	X	X	X	X
Corvus orru	Torresian crow	X	X	X	X	X		X	X	X	X	X	X		X	X	X	X	X
Coturnix chinensis	king quail				X														
Coturnix ypsilophora	brown quail			X	X	X	X	X	X	X	X								
Cracticus nigrogularis	pied butcherbird	X	X	X	X	X		X	X		X					X			X
Cracticus torquatus	grey butcherbird								X		X	X	X			X		X	X
Dacelo novaeguineae	laughing kookaburra	X		X	X			X	X		X	X	X	X	X	X	X	X	X

TAXA	COMMON NAME	CG1	CG2	CG3	P(0.3-1.8)1	P(0.3-1.8)2	P(0.3-1.8)3	P(2.1-3.8)1	P(2.1-3.8)2	P(2.1-3.8)3	P(15-16.5)1	P(15-16.5)2	P(38-40.5)1	P(38-40.5)2	P(38-40.5)3	NF1	NF2	NF3	NF4
BIRDS (continued)																			
Daphoenositta chrysoptera	varied sittella												X	X					
Dendrocygna arcuata	wandering whistling-duck			X															
Dicaeum hirundinaceum	Mistletoebird					X	X					X			X	X	X	X	X
Dicrurus bracteatus	spangled drongo							X	X		X	X	X	X	X	X	X	X	X
Egretta novaehollandiae	white-faced heron		X																
Entomyzon cyanotis	blue-faced honeyeater											X							
Eopsaltria australis	eastern yellow robin											X	X	X	X	X	X	X	X
Eudynamys scolopacea	common koel							X			X		X		X	X	X	X	X
Eurostopodus mystacalis	white-throated nightjar							X	X				X				X	X	
Eurystomus orientalis	dollarbird																	X	
Falco berigora	brown falcon				X	X													
Gallirallus philippensis	buff-banded rail					X													
Geopelia humeralis	bar-shouldered dove					X			X							X			X
Geopelia striata	peaceful dove														X	X			
Gerygone mouki	brown gerygone							X				X	X	X	X	X	X	X	
Gerygone olivacea	white-throated gerygone				X			X	X	X		X	X		X	X			
Glossopsitta pusilla	little lorikeet															X			
Grallina cyanoleuca	magpie lark	X	X	X			X												
Gymnorhina tibicen dorsalis	Australian magpie	X	X	X	X	X	X	X	X		X	X		X		X	X	X	X
Haliastur sphenurus	whistling kite															X			
Hirundapus caudacutus	white-throated needletail		X		X					X			X			X		X	X
Hirundo ariel	fairy martin								X										
Hirundo neoxena	welcome swallow	X	X	X	X	X	X	X	X	X									
Hirundo nigricans	tree martin		X																
Lichenostomus chrysops	yellow-faced honeyeater													X	X	X	X	X	X
Lichenostomus fuscus	fuscous honeyeater							X	X										
Lichmera indistincta	brown honeyeater								X	X					X				
Lonchura castaneothorax	chestnut-breasted mannikin						X												
Macropygia amboinensis	brown cuckoo-dove							X	X			X	X	X	X	X	X	X	X
Malurus cyaneus	superb fairy-wren							X						X					
Malurus lamberti	variegated fairy-wren							X						X	X	X	X		X
Malurus melanocephalus	red-backed fairy-wren			X	X	X	X	X	X	X				X	X				

TAXA	COMMON NAME	CG1	CG2	CG3	P(0.3-1.8)1	P(0.3-1.8)2	P(0.3-1.8)3	P(2.1-3.8)1	P(2.1-3.8)2	P(2.1-3.8)3	P(15-16.5)1	P(15-16.5)2	P(38-40.5)1	P(38-40.5)2	P(38-40.5)3	NF1	NF2	NF3	NF4
BIRDS (continued)																			
Manorina melanocephala	noisy miner					X		X	X		X	X				X			
Manorina melanophrys	bell miner															X			
Megalurus timoriensis	tawny grassbird			X	X	X	X	X	X										
Meliphaga lewinii	Lewin's honeyeater				X			X	X	X		X	X	X	X	X	X	X	X
Melithreptus albogularis	white-throated honeyeater								X		X			X	X	X	X	X	X
Melithreptus lunatus	white-naped honeyeater												X			X			
Merops ornatus	rainbow bee-eater					X	X		X	X				X		X	X		X
Microeca fascinans	jacky winter								X										
Monarcha leucotis	white-eared monarch																X		
Monarcha trivirgatus	spectacled monarch												X	X	X	X	X	X	
Myiagra rubecula	leaden flycatcher														X	X	X	X	
Myzomela sanguinolenta	scarlet honeyeater								X		X	X	X	X	X	X	X	X	X
Neochmia temporalis	red-browed finch				X	X	X		X	X			X	X		X	X		X
Ninox novaeseelandiae	southern boobook															X	X	X	
Ocyphaps lophotes	crested pigeon			X		X													
Oriolus sagittatus	olive-backed oriole					X					X	X			X	X	X	X	X
Pachycephala pectoralis	golden whistler							X	X			X	X	X	X	X	X	X	X
Pachycephala rufiventris	rufous whistler				X			X	X		X	X		X	X	X	X	X	X
Pardalotus punctatus	spotted pardalote				X			X			X			X		X	X		X
Pardalotus striatus	striated pardalote		X			X			X	X	X	X		X	X	X	X	X	
Petroica rosea	rose robin														X	X			
Philemon citreogularis	little friarbird											X							
Philemon corniculatus	noisy friarbird							X	X		X	X	X	X	X	X		X	
Phylidonyris nigra	white-cheeked honeyeater													X					
Pitta versicolor	noisy pitta													X					
Platycercus adscitus	pale-headed rosella		X				X	X	X			X	X	X	X	X		X	X
Podargus strigoides	tawny frogmouth										X	X			X				
Psophodes olivaceus	eastern whipbird						X	X				X	X	X	X	X	X	X	X
Ptilinopus regina	rose-crowned fruit-dove																X	X	
Ptilonorhynchus violaceus	satin bowerbird															X			
Rhipidura fuliginosa	grey fantail			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Rhipidura leucophrys	willie wagtail	X	X	X	X		X		X	X									

TAXA	COMMON NAME	CG1	CG2	CG3	P(0.3-1.8)1	P(0.3-1.8)2	P(0.3-1.8)3	P(2.1-3.8)1	P(2.1-3.8)2	P(2.1-3.8)3	P(15-16.5)1	P(15-16.5)2	P(38-40.5)1	P(38-40.5)2	P(38-40.5)3	NF1	NF2	NF3	NF4
BIRDS (continued)																			
Rhipidura rufifrons	rufous fantail												X	X	X				
Scythrops novaehollandiae	channel-billed cuckoo														X	X		X	X
Sericornis citreogularis	yellow-throated scrubwren												X				X		
Sericornis frontalis	white-browed scrubwren							X		X			X	X	X	X	X	X	X
Sericornis magnirostris	large-billed scrubwren												X	X					
Sericulus chrysocephalus	regent bowerbird														X				
Sphecotheres viridis	figbird					X		X	X			X			X				
Strepera graculina	pied currawong			X					X				X	X	X	X	X	X	X
Threskiornis spinicollis	straw-necked Ibis	X		X															
Todiramphus macleayii	forest kingfisher								X							X		X	X
Todiramphus sanctus	sacred kingfisher										X	X			X				
Trichoglossus chlorolepidotus	scaly-breasted lorikeet					X						X	X	X	X	X	X	X	X
Trichoglossus haematodus	rainbow lorikeet									X	X	X	X	X	X	X	X	X	X
Tyto alba	barn owl						X												
Tyto novaehollandiae	masked owl														X		X	X	X
Vanellus miles	masked lapwing	X	X	X							X								
Zoothera heinei	russet-tailed thrush														X				
Zosterops lateralis	silvereye				X	X	X	X	X	X	X	X	X	X	X	X	X	X	
BATS																			
Chalinolobus gouldii	Gould's wattled bat	X	X								X	X				X	X	X	
Chalinolobus nigrogriseus	hoary wattled bat										X								
Microbat (species unknown, not *Nyctophilus*)	microbat (species unknown)							X											
Microbat (species unknown, not *Vespadelus*)	microbat (species unknown)				X														
Microbat (unknown, not other spp on site 14)	microbat (species unknown)														X				
Microbat (unknown, not other spp on site 8)	microbat (species unknown)								X										
Miniopterus australis	little bent-wing bat	X	X			X			X	X		X				X	X	X	X
Miniopterus schreibersii	common bent-wing bat	X							X			X							
Mormopterus beccarii	Beccari's freetail bat	X	X							X		X							
Mormopterus sp (sp. 2 or sp. 3)	free-tail bat (sp. unknown)					X	X												
Mormopterus sp.	free-tail bat (sp. unknown)													X					
Mormopterus sp. 2.	free-tail bat	X							X		X	X					X		

TAXA	COMMON NAME	CG1	CG2	CG3	P(0.3-1.8)1	P(0.3-1.8)2	P(0.3-1.8)3	P(2.1-3.8)1	P(2.1-3.8)2	P(2.1-3.8)3	P(15-16.5)1	P(15-16.5)2	P(38-40.5)1	P(38-40.5)2	P(38-40.5)3	NF1	NF2	NF3	NF4
BATS (continued)																			
Nyctophilus bifax	eastern long-eared bat													X	X				X
Nyctophilus gouldi	Gould's long-eared bat									X			X			X		X	
Nyctophilus sp.	long-eared bat (sp. unknown)							X											
Pteropus poliocephalus	grey-headed flying-fox												X						
Saccolaimus flaviventris	yellow-bellied sheathtail-bat	X					X				X	X							
Scotorepens balstoni	inland broad-nosed bat								X			X							
Scotorepens sp.	broad-nosed bat (sp. unknown)		X								X						X		
Tadarida australis	white-striped freetail bat	X		X															
Vespadelus pumilus	eastern forest bat														X	X			
Vespadelus sp.	microbat	X			X							X							
ARBOREAL MAMMALS																			
Acrobates pygmaeus	feathertail glider										X								
Petaurus breviceps	sugar glider															X	X	X	
Petaurus norfolcensis	squirrel glider										X		X						
Petaurus sp.	glider (species unknown)													X	X				
Phascolarctos cinereus	koala															X	X	X	X
Trichosurus vulpecula	common brushtail possum									X	X					X	X		
GROUND MAMMALS																			
Aepyprymnus rufescens	rufous bettong										X								
Antechinus flavipes	yellow-footed antechinus							X	X		X		X	X	X	X	X	X	X
Isoodon macrourus	northern brown bandicoot					X		X	X	X				X	X	X			
*Lepus capensis**	brown hare	X	X			X				X		X							
Macropus giganteus	eastern grey kangaroo	X							X		X	X		X					
Macropus parryi	whiptail wallaby				X														
Macropus rufogriseus	red-necked wallaby		X	X	X	X	X	X		X	X			X		X			
Melomys burtoni	grassland melomys				X	X	X	X	X					X				X	
Melomys cervinipes	fawn-footed melomys												X	X	X	X	X	X	X
Perameles nasuta	Long-nosed bandicoot							X											
Pseudomys gracilicaudatus	eastern chestnut mouse					X	X	X		X									
*Mus musculus**	house mouse	X	X	X	X	X	X	X	X	X	X	X	X						X
Planigale maculata	common planigale					X		X	X	X				X		X			

TAXA	COMMON NAME	CG1	CG2	CG3	P(0.3-1.8)1	P(0.3-1.8)2	P(0.3-1.8)3	P(2.1-3.8)1	P(2.1-3.8)2	P(2.1-3.8)3	P(15-16.5)1	P(15-16.5)2	P(38-40.5)1	P(38-40.5)2	P(38-40.5)3	NF1	NF2	NF3	NF4
GROUND MAMMALS (contin.)																			
Rattus fuscipes	bush rat												X	X	X	X	X	X	X
Rattus lutreolus	swamp rat						X	X	X	X				X		X			
*Rattus rattus**	black rat								X			X	X						
Rattus tunneyi	pale field-rat							X			X								
Sminthopsis murina	common dunnart												X	X	X		X		X
Thylogale thetis	red-necked pademelon															X			
*Vulpes vulpes**	fox		X		X					X									
Wallabia bicolor	swamp wallaby											X	X	X	X	X			

Appendix 2: Flora species recorded on the 18 survey sites.
= introduced species

TAXA	COMMON NAME	CG1	CG2	CG3	P(0.3-1.8)1	P(0.3-1.8)2	P(0.3-1.8)3	P(2.1-3.8)1	P(2.1-3.8)2	P(2.1-3.8)3	P(15-16.5)1	P(15-16.5)2	P(38-40.5)1	P(38-40.5)2	P(38-40.5)3	NF1	NF2	NF3	NF4
FERNS																			
Blechnum cartilagineum	gristle fern														X		X		
Cheilanthes distans	bristly cloak fern		X																
Cheilanthes sieberi subsp. *sieberi*	mulga fern		X							X	X								
Cheilanthes tenuifolia	rock fern																	X	
Doodia aspera	prickly rasp fern															X	X	X	X
Hypolepis muelleri	Harsh ground fern													X					
Lastreopsis microsora subsp. *microsora*	creeping shield fern																X		
Platycerium bifurcatum	an elkhorn fern															X			
Pteridium esculentum	common bracken	X		X	X	X	X	X	X	X		X		X	X	X			X
Pteris tremula	tender bracken											X		X	X		X		X
GRASSES																			
Agrostis avenacea var. *avenacea*	blowngrass									X									
Alloteropsis semialata	cockatoo grass		X								X								
Aristia jerichoensis var. jerichoensis	Jericho wiregrass		X																
Aristida echinata			X																
Aristida queenslandica var. *queenslandica*										X	X								
Aristida ramosa	purple wiregrass			X							X								
Aristida vagans	threeawn speargrass										X								
Arundinella nepalensis	reed grass									X									X
*Axonopus fissifolius**	narrow leaved carpet grass	X	X	X	X	X		X	X	X		X							
Bothriochloa decipiens var. *decipiens*	pitted bluegrass	X	X				X				X								
*Brachiaria decumbens**	signal grass					X	X												

TAXA	COMMON NAME	CG1	CG2	CG3	P(0.3-1.8)1	P(0.3-1.8)2	P(0.3-1.8)3	P(2.1-3.8)1	P(2.1-3.8)2	P(2.1-3.8)3	P(15-16.5)1	P(15-16.5)2	P(38-40.5)1	P(38-40.5)2	P(38-40.5)3	NF1	NF2	NF3	NF4
GRASSES (contin.)																			
Capillipedium parviflorum	scented top				X			X											
Capillipedium spicigerum	scented top				X			X											
*Cenchrus caliculatus**	hillside burrgrass			X															
*Cenchrus ciliaris**	buffel grass							X											
*Chloris gayana**	rhodes grass	X	X	X	X	X	X	X		X	X	X				X			
Chrysopogon fallax	golden beardgrass			X	X		X	X			X								
Cymbopogon refractus	barb wire grass		X	X	X	X		X		X	X					X		X	
Cynodon dactylon var. *dactylon*	couch grass	X	X	X	X	X		X	X	X		X							
Digitaria breviglumis																X			
*Digitaria ciliaris**	summer grass	X	X	X	X	X		X	X	X	X	X				X			
*Digitaria didactyla**	Queensland blue couch					X													
Digitaria longiflora					X														
Digitaria parviflora	smallflower fingergrass				X						X	X		X	X	X	X	X	X
Digitaria sp.										X									
*Echinochloa crus-galli**	barnyard grass									X									
Echinopogon caespitosus var. *caespitosus*						X													
Echinopogon nutans var. *nutans*	nodding hedgehog grass									X									
Entolasia stricta	wiry panic							X			X		X	X	X	X	X	X	X
Eragrostis brownii											X								
Eragrostis elongata											X								
*Eragrostis pilosa**	soft lovegrass				X														
Eragrostis sororia			X	X	X		X	X		X	X					X			
Eragrostis sp.					X														
*Eragrostis tenuifolia**	elastic grass		X		X			X	X	X									
Eremochloa bimaculata	poverty grass		X																

TAXA	COMMON NAME	CG1	CG2	CG3	P(0.3-1.8)1	P(0.3-1.8)2	P(0.3-1.8)3	P(2.1-3.8)1	P(2.1-3.8)2	P(2.1-3.8)3	P(15-16.5)1	P(15-16.5)2	P(38-40.5)1	P(38-40.5)2	P(38-40.5)3	NF1	NF2	NF3	NF4
GRASSES (contin.)																			
Heteropogon contortus	bunch speargrass										X								
Imperata cylindrica	blady grass	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Juncus usitatus	common rush	X	X	X		X		X	X	X									
Lepidosperma laterale var. *laterale*	variable swordsedge												X		X		X		X
*Melinis minutiflora**	molasses grass						X		X										X
*Melinis repens**	red natal grass		X	X	X		X	X			X	X							X
Microlaena stipoides var. *stipoides*	weeping grass		X					X		X		X							
Oplismenus aemulus								X				X		X		X			
Oplismenus hirtellus subsp. *Imbecillis*												X						X	
Ottochloa gracillima												X	X	X	X	X	X	X	X
Panicum effusum var. *effusum*					X			X		X	X						X	X	
Panicum maximum var. *maximum**	guinea grass			X	X	X	X	X	X	X	X	X							
Paspalidium distans								X											
*Paspalum dilatatum**	paspalum	X	X	X	X	X		X		X		X							
*Paspalum notatum**	ditch millet or Bahia grass				X			X	X	X		X							
Paspalum scrobiculatum	ditch millet		X	X	X	X	X	X			X					X			
*Paspalum urvillei**	vasey grass	X		X	X														
*Pennisetum setaceum**	fountain grass							X											
*Poa annua**	Winter grass								X										
Poa labillardieri var. *labillardieri*	tussock grass															X			
Sacciolepis indica	Indian cupscale grass							X											
Setaria phacelate var. *sericea**	South African pigeon grass			X	X	X	X		X			X				X			
Setaria phacelate var. *splendida**	South African pigeon grass								X										

TAXA	COMMON NAME	CG1	CG2	CG3	P(0.3-1.8)1	P(0.3-1.8)2	P(0.3-1.8)3	P(2.1-3.8)1	P(2.1-3.8)2	P(2.1-3.8)3	P(15-16.5)1	P(15-16.5)2	P(38-40.5)1	P(38-40.5)2	P(38-40.5)3	NF1	NF2	NF3	NF4
GRASSES (contin.)																			
Setaria surgens		X	X	X	X	X	X					X							
Sorghum plumosum var. *plumosum*											X								
Sporobolus elongatus	slender rat's tail grass	X	X	X	X	X	X	X	X	X	X					X			
*Sporobolus fertilus**										X									
Themeda triandra	kangaroo grass		X						X		X					X		X	
HERBS																			
*Acetosella vulgaris**	sorrel				X			X											
*Ageratina adenophora**	crofton weed							X		X									
Ageratum conyzoides subsp. *conyzoides**	billygoat weed					X			X										
*Ageratum houstonianum**	blue billygoat weed			X	X	X	X	X	X	X	X	X		X					X
Ajuga australis	Australian bugle										X								
*Amaranthus spinosus**	needle burr				X	X													
*Anagallis arvensis**	scarlet pimpernel		X	X	X		X	X	X	X									
Argemone ochroleuca subsp. *ochroleuca**	prickly poppy or Mexican poppy					X	X												
*Asclepias curassavica**	red head cotton bush			X			X												
*Asparagus plumosus**	asparagus fern											X							
*Bidens pilosa**	cobbler's pegs				X	X	X	X	X	X	X	X				X			
Blumea saxatilis					X			X											
Bracteantha bracteata	golden everlasting				X			X											
Brunoniella australis											X							X	
*Carthamus lanatus**	saffron thistle						X												
*Centaurium erythraea**	common centaury			X	X	X	X												
Centella asiatica	pennywort	X	X	X	X	X	X	X	X	X	X	X				X			

TAXA	COMMON NAME	CG1	CG2	CG3	P(0.3-1.8)1	P(0.3-1.8)2	P(0.3-1.8)3	P(2.1-3.8)1	P(2.1-3.8)2	P(2.1-3.8)3	P(15-16.5)1	P(15-16.5)2	P(38-40.5)1	P(38-40.5)2	P(38-40.5)3	NF1	NF2	NF3	NF4
HERBS (contin.)																			
*Cerastium glomeratum**	mouse-ear chickweed					X				X									
Chamaecrista nomame var. *nomame*							X	X		X		X							
*Chamaesyce hirta**	asthma plant	X			X		X		X	X		X							
Chrysocephalum apiculatum	yellow buttons		X	X	X					X	X					X			
*Cyclospermum leptophyllum**	slender celery or wild carrot	X		X	X	X	X	X		X		X							
*Cirsium vulgare**	spear thistle	X			X	X	X	X	X	X	X	X							
Commelina diffusa	wandering jew				X	X		X		X	X	X				X			
*Conyza bonariensis**	flaxleaf fleabane				X			X											
Conyza canadensis var. *pusilla**	Canadian fleabane	X	X	X	X	X	X	X	X	X	X	X				X			
*Conyza primulifolia**					X			X											
*Coronopus didymus**	lesser swine-cress									X									
*Crassocephalum crepidioides**	thickhead				X	X		X	X	X		X				X			
Crotalaria lanceolata subsp. *Lanceolata**					X		X	X			X					X			
Cyanthillium cinereum	vernonia	X			X	X			X		X	X	X	X	X	X	X	X	X
Cynoglossum australe var. *australe*								X											
Desmodium gunnii				X		X						X				X		X	
Desmodium heterocarpon var. *heterocarpon*											X								
Desmodium sp.																X			
*Desmodium triflorum**	creeping tick-trefoil	X	X	X	X		X	X	X	X		X							
Dianella caerulea	blue flax lily				X					X	X	X			X	X			
Dianella caerulea var. *vannata*	blue flax lily												X				X	X	X
Dianella rara			X																

TAXA	COMMON NAME	CG1	CG2	CG3	P(0.3-1.8)1	P(0.3-1.8)2	P(0.3-1.8)3	P(2.1-3.8)1	P(2.1-3.8)2	P(2.1-3.8)3	P(15-16.5)1	P(15-16.5)2	P(38-40.5)1	P(38-40.5)2	P(38-40.5)3	NF1	NF2	NF3	NF4
HERBS (contin.)																			
Dianella revoluta var. revolute											X								
Drymaria cordata subsp. *cordata*	tropical chickweed			X		X			X	X		X				X			
Eclipta prostrata	white eclipta											X							
Einadia trigonos subsp. *stellulata*	fishweed									X									
Emilia sonchifolia var. *javanica**	emilia	X			X	X	X		X	X									
Epaltes australis	spreading nut-heads										X								
Epilobium billardierianum subsp. *cinereum*					X			X											
Erechtites valerianifolia forma *valerianifolia**	Brazilan fireweed							X											
Galium migrans								X											
*Gamochaeta pensylvanica**	cudweed			X	X	X		X	X	X		X							
Geranium solanderi var. *solanderi*	native geranium		X	X	X	X	X	X		X						X			
Glossocardia bidens	native cobbler's pegs										X								
Gonocarpus chinensis subsp. *verrucosus*					X			X											
Gonocarpus oreophilus					X														
Gonocarpus tetragynus					X			X											
Goodenia rotundifolia											X				X		X	X	X
Gymnostachys anceps	settler's flax															X	X	X	X
Hybanthus stellarioides	spade flower								X		X						X	X	
Hydrocotyle actutiloba	pennywort					X	X	X		X									
Hydrocotyle laxiflora	stinking pennywort		X	X	X	X	X	X		X		X							
Hydrocotyle peduncularis			X	X	X					X									
Hypericum gramineum	small St. John's wort				X	X		X									X		
*Hypochaeris radicata**	flatweed	X		X	X	X		X	X	X		X							

TAXA	COMMON NAME	CG1	CG2	CG3	P(0.3-1.8)1	P(0.3-1.8)2	P(0.3-1.8)3	P(2.1-3.8)1	P(2.1-3.8)2	P(2.1-3.8)3	P(15-16.5)1	P(15-16.5)2	P(38-40.5)1	P(38-40.5)2	P(38-40.5)3	NF1	NF2	NF3	NF4
HERBS (contin.)																			
Indigofera trifoliata									X										
*Kummerowia striata**	Japanese lespedeza		X																
*Lepidium africanum**	peppercress		X							X									
*Lepidium bonariense**	peppercress				X	X	X	X	X										
*Lepidium virginicum**	Virginian peppercress								X										
Lobelia purpurascens	white root	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X
Lomandra confertifolia subsp. *pallida*					X						X		X	X	X	X	X	X	X
Lomandra filiformis subsp. *filiformis*					X						X				X			X	
Lomandra longifolia	spinyhead matrush							X					X	X	X	X	X	X	X
Lomandra multiflora subsp. *multiflora*	many flowered matrush		X		X						X				X	X	X	X	
Lotus cruentus	red-flowered lotus											X							
Ludwigia octovalvis	willow primrose		X		X														
*Malva parviflora**	small flowered mallow				X	X													
*Mecardonia procumbens**											X								
*Medicago lupulina**	black medic		X																
*Medicago polymorpha**	burr medic			X		X	X		X										
Murdannia graminea	grass lily										X								
*Nicandra physalodes**	apple-of-Peru						X												
*Oenothera affinis**	long flower evening primrose									X									
Opercularia diphylla											X								
Oxalis corniculata var. *corniculata**	creeping oxalis	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

TAXA	COMMON NAME	CG1	CG2	CG3	P(0.3-1.8)1	P(0.3-1.8)2	P(0.3-1.8)3	P(2.1-3.8)1	P(2.1-3.8)2	P(2.1-3.8)3	P(15-16.5)1	P(15-16.5)2	P(38-40.5)1	P(38-40.5)2	P(38-40.5)3	NF1	NF2	NF3	NF4
HERBS (contin.)																			
Oxalis rubens			X							X									
*Paronychia brasiliana**			X																
Phyllanthus sp.					X														
Phyllanthus virgatus		X	X		X		X			X	X	X					X	X	
Physalis minima	wild gooseberry				X			X											
*Physalis peruviana**	Cape gooseberry					X	X			X									
*Phytolacca octandra**	ink weed					X		X	X	X		X							
Pimelea linifolia subsp. *linifolia*	queen of the bush		X																X
*Plantago lanceolata**	plantain or rib grass		X			X													
Plectranthus parviflorus																X			
Poranthera microphylla									X										
Portulaca oleracea	pigweed						X			X									
Pseuderanthemum variabile	pastel flower											X			X			X	X
Pterocaulon sphacelatum	applebush										X								
Pycnospora lutescens									X										
Ranunculus sessiliflorus var. *sessiliflorus*				X	X	X				X		X				X			
*Richardia brasiliensis**	white eye		X		X	X	X	X	X							X			
Rotala tripartita			X																
Rumex brownii	swamp dock		X			X	X	X											
*Rumex crispus**	curled dock					X													
Sauropus hirtellus									X		X								
Senecio amygdalifolius			X							X									
*Senecio madagascariensis**	fireweed									X									
Sisyrinchium sp. (Peregian P.R.Sharpe 4970) *					X														

TAXA	COMMON NAME	CG1	CG2	CG3	P(0.3-1.8)1	P(0.3-1.8)2	P(0.3-1.8)3	P(2.1-3.8)1	P(2.1-3.8)2	P(2.1-3.8)3	P(15-16.5)1	P(15-16.5)2	P(38-40.5)1	P(38-40.5)2	P(38-40.5)3	NF1	NF2	NF3	NF4
HERBS (contin.)																			
*Sigesbekia orientalis**	Indian weed		X			X	X			X		X				X			
Solanum americanum	blackberry nightshades				X	X	X	X	X	X		X				X			
*Soliva sessilisa**	bindy-eye or jo-jo weed									X									
Sonchus asper subsp. *glaucescens**	prickly sowthistle							X											
*Sonchus oleraceus**	common sowthistle or milk thistle					X	X	X		X									
*Stellaria media**	chickweed									X				X					
Stylosanthes guianensis var. *guianensis**	stylo				X	X	X	X											
*Tagetes minuta**	stinking roger				X		X			X									
*Taraxacum officinale**	dandelion				X	X													
Teucrium argutum var. *argutum*	native germander				X			X											
*Tithonia diversifolia**	Japanese sunflower							X											
*Trifolium dubium**	yellow suckling clover	X																	
Trifolium repens var. *repens**	white clover	X	X	X	X	X	X	X		X		X							
Urtica incisa	stinging nettle		X																
*Urtica urens**	stinging nettle									X									
*Verbena bonariensis**	purple top			X	X	X	X	X	X	X									
*Verbena litoralis**									X	X		X							
*Verbena officinalis**	common verbana				X		X	X				X							
*Verbena rigida**	veined verbena	X	X		X	X		X		X		X				X			
*Veronica persica**	creeping speedwell									X									
Veronica plebeia	trailing speedwell		X					X		X		X				X			
Viola betonicifolia subsp. *betonicifolia*	purple violet				X			X											

TAXA	COMMON NAME	CG1	CG2	CG3	P(0.3-1.8)1	P(0.3-1.8)2	P(0.3-1.8)3	P(2.1-3.8)1	P(2.1-3.8)2	P(2.1-3.8)3	P(15-16.5)1	P(15-16.5)2	P(38-40.5)1	P(38-40.5)2	P(38-40.5)3	NF1	NF2	NF3	NF4
MISTLETOES																			
Wahlenbergia graniticola					X	X			X		X					X			
Zornia dyctiocarpa var. *dyctiocarpa*			X		X			X			X								
Amyema conspicuum subsp. *conspicuum*														X					X
ORCHIDS																			
Acianthus amplexicaulis																X			
Caladenia carnea var. *carnea*	pink fingers														X				X
Calanthe triplicata	Christmas orchid															X		X	X
Cheirostylis ovata																X			
Chiloglottis sylvestris															X				X
Cymbidium madidum	native cymbidium																	X	
PALMS																			
Livistona australis	cabbage palm													X	X				
SEDGES																			
Carex appressa				X		X													
Carex horsfieldii																	X		
*Cyperus aggregatus**			X		X				X			X							
*Cyperus brevifolius**	mullumbimby couch	X	X	X	X	X	X	X	X	X		X							
Cyperus cyperoides								X			X								
Cyperus enervis								X											
Cyperus fulvus											X								
Cyperus gracilis							X			X	X	X							
*Cyperus haspan*subsp. *haspan*									X										
Cyperus laevis					X			X	X	X	X	X							
Cyperus pilosus			X																
Cyperus polystachyos	bunchy sedge							X											
Cyperus polystachyos var. *polystachyos*	bunchy sedge	X	X	X	X	X	X		X	X		X							
*Cyperus rotundus**	nut grass			X															
Cyperus sculptus					X	X	X												

TAXA	COMMON NAME	CG1	CG2	CG3	P(0.3-1.8)1	P(0.3-1.8)2	P(0.3-1.8)3	P(2.1-3.8)1	P(2.1-3.8)2	P(2.1-3.8)3	P(15-16.5)1	P(15-16.5)2	P(38-40.5)1	P(38-40.5)2	P(38-40.5)3	NF1	NF2	NF3	NF4
SEDGES (contin.)																			
Cyperus sesquiflorus *	Kyllinga weed		X		X			X	X	X									
Cyperus sphaeroideus							X		X										
Cyperus tenuiculmis								X											
Cyperus tetraphyllus					X	X													
Fimbristylis dichotoma	common fringerush	X	X	X	X	X	X	X	X	X	X	X				X			
Fimbristylis tristachya											X								
Gahnia aspera								X		X			X	X	X		X	X	X
Scleria sphacelata														X			X		X
SHRUBS																			
Acronychia imperforata	beach acronychia																	X	
Acronychia laevis	glossy acronychia												X	X	X		X	X	X
Acronychia oblongifolia	common acronychia																X	X	
Acrotriche aggregata	tall groundberry													X	X		X	X	X
Alchornea ilicifolia	native holly									X		X							
Alyxia magnifolia													X	X				X	
Astrotricha latifolia														X	X			X	
Babingtonia bidwillii														X	X				X
Baccharis halimifolia *	groundsel bush	X		X	X	X	X	X	X	X		X							
Breynia oblongifolia	coffee bush				X			X		X	X	X	X	X	X	X	X	X	X
Bridelia exaltata	scrub ironbark															X			
Caesalpinia decapetala *	thorny poinciana											X							
Canthium coprosmoides	coast canthium												X	X		X	X	X	X
Capparis arborea	brush caper berry													X					
Carissa ovata	carissa									X			X		X		X	X	X
Chamaecrista rotundifolia var. *rotundifolia* *							X												

TAXA	COMMON NAME	CG1	CG2	CG3	P(0.3-1.8)1	P(0.3-1.8)2	P(0.3-1.8)3	P(2.1-3.8)1	P(2.1-3.8)2	P(2.1-3.8)3	P(15-16.5)1	P(15-16.5)2	P(38-40.5)1	P(38-40.5)2	P(38-40.5)3	NF1	NF2	NF3	NF4
SHRUBS (contin.)																			
Clerodendrum floribundum	lolly bush							X		X				X	X	X	X		X
Clerodendrum tomentosum	hairy clerodendrum				X														
Commersonia bartramia	brown kurrajong			X								X						X	
Cordyline rubra	red-fruited palm lily													X	X		X	X	X
Crotalaria montana									X							X			
Crotalaria pallida var. *obovata**	streaked rattlepod								X	X									
Croton insularis	silver croton											X							
Croton phebalioides	narrow-leaved croton																		X
Decaspermum humile	silky myrtle													X			X		
*Desmanthus virgatus**	dwarf koa													X					
*Desmodium intortum**	green-leaved desmodium											X							
Desmodium nemorosum					X													X	
Dodonaea triquetra								X					X		X	X	X	X	X
Elaeodendron australe var. *australe*	red olive plum									X						X			
Eremophila debilis	winter apple										X								
Philotheca myoporoides subsp. *queenslandica*																			X
Eupomatia bennettii	small bolwarra																		X
Everistia vacciniifolia forma *vacciniifolia*	small-leaved canthium												X						
Everistia vacciniifolia var. *nervosa*	small-leaved canthium												X						
*Gomphocarpus physocarpus**	balloon cotton bush	X	X	X	X	X	X	X	X	X	X	X						X	
Grewia latifolia	dog's balls							X				X							
Hakea florulenta																X			
Hibbertia aspera														X	X				
Hibiscus splendens	pink hibiscus							X						X			X		X

TAXA	COMMON NAME	CG1	CG2	CG3	P(0.3-1.8)1	P(0.3-1.8)2	P(0.3-1.8)3	P(2.1-3.8)1	P(2.1-3.8)2	P(2.1-3.8)3	P(15-16.5)1	P(15-16.5)2	P(38-40.5)1	P(38-40.5)2	P(38-40.5)3	NF1	NF2	NF3	NF4
SHRUBS (contin.)																			
Hovea linearis	common hovea							X	X				X	X	X	X	X	X	X
Indigofera australis	Australian indigo																	X	
Jacksonia scoparia	dogwood																	X	
Lantana camara var. *camara* *	lantana			X		X	X	X	X	X	X	X	X	X	X	X	X	X	X
Lantana montevidensis *	lantana		X							X						X			
Lespedeza juncea subsp. *sericea*	perennial lespedeza				X			X											
Leucopogon juniperinus	prickly heath									X				X		X		X	
Leucopogon margarodes													X						
Logania albiflora												X	X	X			X	X	X
Lomatia silaifolia	fern leaved lomatia															X			
Lycopersicon esculentum *	cherry tomato									X									
Maclura cochinchinensis	cockspur thorn							X		X		X				X			
Malvastrum coromandelianum *	prickly malvastrum									X									
Maytenus silvestris	narrow-leaved orange bark															X			
Notelaea johnsonsii	veinless mock-olive															X			
Notelaea longifolia forma *glabra*	large mock-olive					X				X			X		X		X	X	X
Ochna serrulata *	ochna								X			X				X			
Oxylobium robustum	native holly													X	X				
Persoonia sericea																		X	
Persoonia stradbrokensis															X		X		
Persoonia virgata													X						
Petalostigma triloculare													X				X		X
Phebalium squamulosum subsp. *squamulosum*	scaly phebalium												X	X			X		X

TAXA	COMMON NAME	CG1	CG2	CG3	P(0.3-1.8)1	P(0.3-1.8)2	P(0.3-1.8)3	P(2.1-3.8)1	P(2.1-3.8)2	P(2.1-3.8)3	P(15-16.5)1	P(15-16.5)2	P(38-40.5)1	P(38-40.5)2	P(38-40.5)3	NF1	NF2	NF3	NF4
SHRUBS (contin.)																			
Pilidiostigma rhytispermum	small-leaved plum myrtle							X					X	X	X		X	X	
Pimelea latifolia subsp. *altior*					X			X		X				X					X
Pittosporum revolutum	hairy pittosporum									X			X	X	X		X		X
Pittosporum spinescens	orange thorn												X			X	X		
Pittosporum undulatum	sweet pittosporum															X			
Pomax umbellata																	X		
Psychotria daphnoides	smooth psychotria					X													
Psychotria loniceroides	hairy psychotria												X					X	X
Pultenaea petiolaris																		X	
Rapanea variabilis	muttonwood									X		X	X		X				
Rhodomyrtus psidioides	native guava													X	X				
Ricinocarpos speciosus													X						
Senna pendula var. *glabrata**	winter senna or Easter cassia															X			
*Sennax septemtrionalis**	smooth senna											X							
Sida cordifolia	flannel weed						X									X			
*Sida rhombifolia**	common sida	X	X	X		X	X	X	X	X		X				X			X
*Solanum capsicoides**	devil's apple	X						X	X			X							
*Solanum erianthum**	flannel bush							X											
Solanum furfuraceum	variable nightshade											X							
Solanum gympiense																		X	
Solanum hispidum	giant devil's fig								X	X									
*Solanum mauritianum**	wild tobacco tree				X	X	X	X	X	X		X							
*Solanum seaforthianum**						X				X		X							
Solanum stelligerum	star nightshade											X			X	X			

TAXA	COMMON NAME	CG1	CG2	CG3	P(0.3-1.8)1	P(0.3-1.8)2	P(0.3-1.8)3	P(2.1-3.8)1	P(2.1-3.8)2	P(2.1-3.8)3	P(15-16.5)1	P(15-16.5)2	P(38-40.5)1	P(38-40.5)2	P(38-40.5)3	NF1	NF2	NF3	NF4
SHRUBS (contin.)																			
*Solanum torvum**	devil's fig				X														
Tabernaemontana pandacaqui	banana bush												X	X	X		X		X
Trema tomentosa	poison peach				X			X		X		X				X	X	X	X
Wikstroemia indica	tie bush													X					
Xanthorrhoea johnsonii	forest grasstree																		X
Xanthorrhoea latifolia subsp. *latifolia*															X		X	X	
Zieria furfuracea													X	X	X		X	X	X
Zieria smithii													X	X	X			X	X
TREES																			
Acacia disparrima subsp. *disparrima*	hickory wattle		X			X			X	X	X	X	X	X	X	X	X	X	X
Acacia falcata								X			X							X	
Acacia irrorata subsp. *irrorata*	green wattle															X			
Acacia leiocalyx subsp. *leiocalyx*	black wattle										X							X	
Acacia maidenii	Maiden's wattle					X		X	X	X	X	X	X	X	X	X		X	X
Acacia melanoxylon	blackwood				X			X		X				X			X		
Acacia oshanesii													X	X	X		X	X	X
Acacia penninervis	mountain hickory																		X
Acronychia pauciflora	soft acronychia													X					
Allocasuarina littoralis	black she-oak																X	X	X
Allocasuarina torulosa	forest she-oak															X		X	
Alphitonia excelsa	red ash or soap tree				X	X		X			X	X	X	X	X	X	X	X	X
Alphitonia petriei	white ash													X	X		X		X
Angophora leiocarpa	smoothbark apple or rusty gum																	X	
Araucaria cunninghamii var. *cunninghamii*	hoop pine									X						X			
Austromyrtus hillii	scaly myrtle												X						

TAXA	COMMON NAME	CG1	CG2	CG3	P(0.3-1.8)1	P(0.3-1.8)2	P(0.3-1.8)3	P(2.1-3.8)1	P(2.1-3.8)2	P(2.1-3.8)3	P(15-16.5)1	P(15-16.5)2	P(38-40.5)1	P(38-40.5)2	P(38-40.5)3	NF1	NF2	NF3	NF4
TREES (contin.)																			
Austromyrtus bidwillii	python tree													X					
Beilschmiedia elliptica	grey walnut													X					
Beilschmiedia obtusifolia	blush walnut												X	X					
Brachychiton populneus subsp. *populneus*	kurrajong											X							
Callistemon salignus var. *salignus*	willow bottlebrush							X	X	X			X		X	X		X	X
Cassia sp.*																X			
*Celtis sinensis**	Chinese celtis															X			
*Cinnamomum camphora**	camphor laurel							X	X			X		X	X				X
Citrus australis	native lime												X						
Corymbia citriodora subsp. *variegata*	spotted gum										X								
Corymbia intermedia	pink bloodwood		X					X		X				X	X	X	X	X	X
*Corymbia torelliana**	cadaghi															X			
Cryptocarya glaucescens	Jackwood																X		
Cryptocarya macdonaldii														X	X				
Cryptocarya microneura	murrogun													X		X	X		X
Cupaniopsis anacardioides	tuckeroo															X			
Cupaniopsis parvifolia	small-leaved tuckeroo					X							X	X		X			
Cupaniopsis serrata	smooth tuckeroo													X			X		X
Denhamia celastroides	denhamia									X				X	X		X		X
Drypetes deplanchei	yellow tulip													X					X
Elaeocarpus obovatus	hard quandong						X					X		X			X		
Elaeocarpus reticulatus	blueberry ash									X									
Elattostachys xylocarpa	white tamarind														X				
Eucalyptus acmenoides	white mahogany							X								X	X		

TAXA	COMMON NAME	CG1	CG2	CG3	P(0.3-1.8)1	P(0.3-1.8)2	P(0.3-1.8)3	P(2.1-3.8)1	P(2.1-3.8)2	P(2.1-3.8)3	P(15-16.5)1	P(15-16.5)2	P(38-40.5)1	P(38-40.5)2	P(38-40.5)3	NF1	NF2	NF3	NF4
TREES (contin.)																			
Eucalyptus biturbinata	an ironbark															X			
Eucalyptus cloeziana	Gympie messmate				X	X	X	X	X	X	X	X	X	X	X		X	X	X
Eucalyptus crebra	narrow leaved ironbark										X							X	
Eucalyptus fibrosa subsp. *fibrosa*	broad leaved ironbark										X								
Eucalyptus grandis	rose gum or flooded gum												X	X	X			X	X
Eucalyptus microcorys	tallowwood															X	X		X
Eucalyptus pilularis	blackbutt																X		
Eucalyptus propinqua	grey gum															X	X	X	X
Eucalyptus resinifera	red mahogany																		X
Eucalyptus siderophloia	grey ironbark							X								X			
Eucalyptus sideroxylon	red ironbark									X									
Eucalyptus tereticornis subsp. *tereticornis*	forest red gum															X			
Euroschinus falcatus var. *falcatus*	ribbonwood													X	X				
Ficus coronata	creek sandpaper fig										X								
Ficus fraseri	sandpaper fig											X							
Flindersia australis	teak or crow's ash					X				X				X					
Flindersia bennettiana	Bennet's ash											X	X	X			X		
Glochidion ferdinandi var. *ferdinandi*	cheese tree							X				X	X	X	X		X	X	X
Glochidion sumatranum	umbrella cheese tree												X						
Grevillea robusta	silky oak		X							X		X							
Guioa acutifolia	northern guioa												X		X		X		
Guioa semiglauca	guioa											X				X			
Homalanthus nutans	bleeding heart											X							
Jagera pseudorhus forma *pseudorhus*	foam bark tree											X		X	X	X	X	X	X
Litsea leefeana	brown bolly gum											X							
Lophostemon confertus	brush box							X	X						X	X	X	X	X
Lophostemon suaveolens	swamp mahogany														X	X		X	

TAXA	COMMON NAME	CG1	CG2	CG3	P(0.3-1.8)1	P(0.3-1.8)2	P(0.3-1.8)3	P(2.1-3.8)1	P(2.1-3.8)2	P(2.1-3.8)3	P(15-16.5)1	P(15-16.5)2	P(38-40.5)1	P(38-40.5)2	P(38-40.5)3	NF1	NF2	NF3	NF4
TREES (contin.)																			
Macaranga tanarius								X											
Mallotus discolor	white kamala															X			
Mallotus philippensis	red kamala															X			
Melaleuca quinquenervia	paper barked tea tree													X					
Melia azedarach	white cedar															X			
Melicope micrococca	white euodia											X				X			
Mischocarpus pyriformis subsp. *pyriformis*	yellow pear-fruit														X				
Neolitsea dealbata	white bolly gum													X	X				
*Pinus elliottii**	slash pine				X			X							X				
Podocarpus el atus	plum pine													X					X
Polyalthia nitidissima														X					
Polyscias elegans	celery wood												X	X	X	X	X	X	X
Rhodamnia acuminata	Cooloola ironwood													X					
Rhodamnia rubescens	scrub turpentine													X			X		X
Rhodosphaera rhodanthema	deep yellow-wood														X	X	X		X
*Schinus terebinthifolius**	broadleaf pepper tree		X																
Scolopia braunii	flintwood																X		
Siphonodon australis	ivorywood									X									
Streblus brunonianus	whalebone tree											X							
Syncarpia glomulifera subsp. *glomulifera*	turpentine													X		X	X	X	X
Synoum glandulosum subsp. *glandulosum*	scentless rosewood														X				
Syzygium francisii	giant water gum																		X
Syzygium luehmannii	riberry									X									
Trochocarpa laurina	tree-heath															X			
Waterhousea floribunda	weeping lilly pilly												X	X	X				
Xanthostemon oppositifolius	southern penda													X					

TAXA	COMMON NAME	CG1	CG2	CG3	P(0.3-1.8)1	P(0.3-1.8)2	P(0.3-1.8)3	P(2.1-3.8)1	P(2.1-3.8)2	P(2.1-3.8)3	P(15-16.5)1	P(15-16.5)2	P(38-40.5)1	P(38-40.5)2	P(38-40.5)3	NF1	NF2	NF3	NF4
VINES/CREEPERS																			
*Araujia sericifera**							X	X				X							
Berberidopsis beckleri	mountain redberry vine													X					
Billardiera scandens var. *scandens*	common apple-berry												X	X	X	X	X	X	X
Calamus muelleri	lawyer vine																X		
Calystegia marginata											X								
Cassytha filiformis	dodder laurels															X			
Cassytha pubescens	dodder laurels														X				X
Cayratia clematidea	slender grape									X		X				X			
Cissus antarctica	water vine															X			
Cissus hypoglauca	five-leaf water vine											X	X	X	X	X	X		X
Cissus opaca	small-leaf water vine									X	X			X		X	X		X
Convolvulus erubescens	Australian bindweed															X			
*Cuscuta campestris**	dodder					X				X									
Derris involuta	native derris							X											
Desmodium rhytidophyllum					X						X					X		X	X
*Desmodium uncinatum**	silverleaf desmodium				X				X										
Desmodium varians	slender tick trefoil		X		X			X		X	X								
Dichondra repens	kidney weed			X	X			X	X	X									
Dioscorea transversa	native yam													X			X		X
Embelia australiana	embelia				X					X			X	X	X		X	X	X
Eustrephus latifolius	wombat berry				X			X			X				X	X	X	X	X
Flagellaria indica	flagellaria												X	X	X		X	X	
Flemingia parviflora											X								
Galactia tenuiflora			X								X								
Geitonoplesium cymosum	scrambling lily									X		X	X	X	X	X	X	X	X
Glycine clandestina var. *clandestina*			X	X	X		X	X		X	X				X				

TAXA	COMMON NAME	CG1	CG2	CG3	P(0.3-1.8)1	P(0.3-1.8)2	P(0.3-1.8)3	P(2.1-3.8)1	P(2.1-3.8)2	P(2.1-3.8)3	P(15-16.5)1	P(15-16.5)2	P(38-40.5)1	P(38-40.5)2	P(38-40.5)3	NF1	NF2	NF3	NF4
VINES/CREEPERS (continued)																			
Glycine clandestina var. *sericea*	twining glycine									X									
Glycine tabacina	glycine pea		X	X	X	X	X	X		X	X	X				X		X	X
Glycine tomentella	woolly glycine or rusty glycine				X					X									
Hardenbergia violacea	native sarsaparilla										X							X	
Hibbertia dentata											X			X	X		X		
Hibbertia scandens	twining Guinea flower										X								
Hypserpa decumbens													X						
Jasminum simplicifolium subsp. *australiense*	stiff jasmine									X									
Kennedia rubicunda	red Kennedy pea						X	X	X							X			
*Lotononis bainesii**	lotononis								X										
*Macroptilium atropurpureum**	Siratro				X		X	X	X	X									
Macrotyloma axillare var. *axillare**								X	X										
Macrotyloma uniflorum var. *uniflorum**	horse pram	X					X												
Marsdenia lloydii	corky marsdenia														X				X
Melodinus australis	southern melodinus												X	X					
Melodorum leichhardtii													X						
Morinda canthoides	veiny morinda									X									
Morinda jasminoides	morinda											X	X	X	X	X	X		
Neonotonia wightii var. *wightii**	glycine						X												
Pandorea pandorana	wonga vine		X									X							
Parsonsia straminea	common silkpod									X		X	X	X					
Passiflora aurantia var. *aurantia*	blunt-leaved passionfruit											X							

TAXA	COMMON NAME	CG1	CG2	CG3	P(0.3-1.8)1	P(0.3-1.8)2	P(0.3-1.8)3	P(2.1-3.8)1	P(2.1-3.8)2	P(2.1-3.8)3	P(15-16.5)1	P(15-16.5)2	P(38-40.5)1	P(38-40.5)2	P(38-40.5)3	NF1	NF2	NF3	NF4
VINES/CREEPERS (continued)																			
*Passiflora edulis**	passionfruit											X							
Passiflora foetida var. *foetida**	foetid passionfruit						X				X								
*Passiflora suberosa**	corky passionfruit								X		X	X							
*Passiflora subpeltata**	white passionflower															X			
Pleogyne australis														X					
Polymeria calycina							X		X		X								
Ripogonum brevifolium	small-leaved supplejack													X					
*Rubus ellipticus**	yellow raspberry							X											
Rubus moluccanus var. *trilobus*	molucca bramble									X									
Rubus parvifolius	Japanese raspberry				X														
Rubus rosifolius var. *rosifolius*	rose-leaf bramble									X		X							
Sarcopetalum harveyanum	pearl vine													X			X		X
Smilax australis	Austral sarsaparilla							X		X		X		X	X	X	X	X	X
Smilax glyciphylla	sweet sarsaparilla														X		X		
Stephania japonica var. *discolor*	snake vine									X		X	X			X			
Tragia novae-hollandiae	stinging vine																	X	X
Trophis scandens subsp. *scandens*	burny vine												X		X				

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