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THE ECOLOGY OF TROPICAL LOWLAND
PLANT COMMUNITIES WITH PARTICULAR REFERENCE TO
HABITAT FRAGMENTATION
AND
MELALEUCA VIRIDIFLORA SOL. EX GAERTN.
DOMINATED WOODLANDS

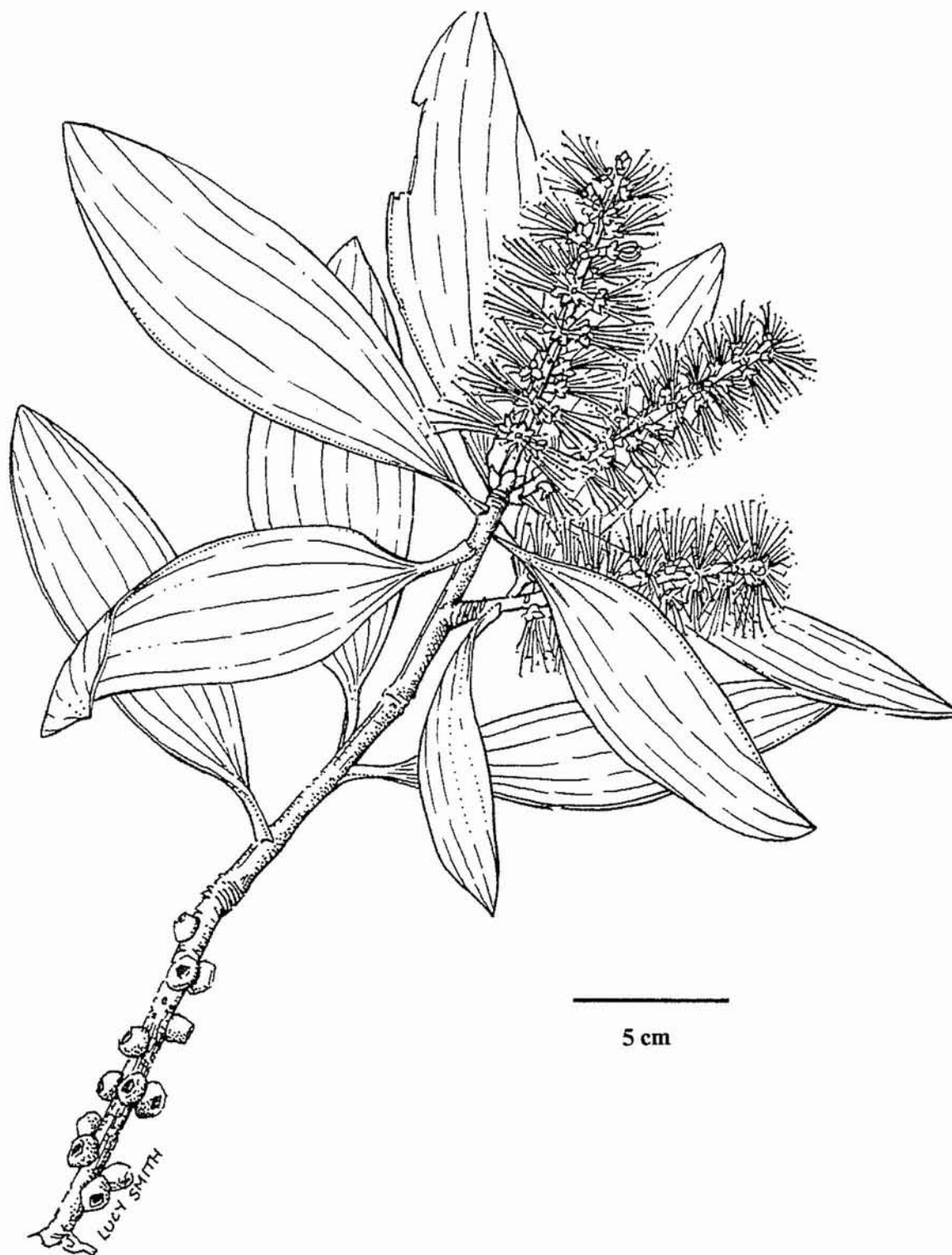
Dissertation submitted by

Stephen David Skull BSc JCUNQ

1st June 1998

for the degree of Doctor of Philosophy
in the Department of Tropical Plant Sciences at the
James Cook University of North Queensland.

Frontispiece The Broad-leaved tea-tree: *Melaleuca viridiflora* (Myrtaceae). Drawing by Lucy Smith taken from Skull (1995).



DEDICATION

I dedicate this thesis to my late grandfather, Mr William H. Cleverly,
a noted goldfield geologist and naturalist who,
even from the red bull dust streets of Kalgoorlie,
encouraged the completion of this project in a remarkable manner.

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STATEMENT OF SOURCES

I declare that this thesis is my own work, and has not been submitted in any other form for another degree or diploma at any other university or tertiary institution. Information derived from the published and unpublished work of others has been acknowledged in the text, and a list of references is given.

S.D. Skull

1st June 1998

ABSTRACT

Tropical lowland plant communities in north-eastern Queensland are under enormous pressure from continuing clearing, fragmentation, exotic species invasion, inappropriate fire regimes, and altered hydrological patterns. Few accurate figures with respect to past clearing patterns exist, and comparatively little scientific research has been conducted on the highly diverse and ecologically significant range of remnant vegetation types. Additionally, most plant communities remain very poorly represented in the existing conservation reserve system. The initial focus of this thesis was, therefore, to provide the first detailed assessment of clearing and fragmentation for an area of the tropical lowland environment (between Townsville and Cairns) widely recognised for its ecological significance.

In the area examined, approximately 140 ha yr⁻¹ of remnant vegetation has been cleared over a 50 year period (1942-1992). This is more than double the rate recorded by any other study in the wet-tropics, but well below clearing rates calculated for more populated regions of the state. Dramatic changes in the size class (area) distribution of remnants were recorded for all vegetation types, particularly in the smaller size classes. A range of landscape indices were used to assess patterns of habitat fragmentation. Remnant shape, perimeter length and dispersion across the landscape all varied significantly for certain vegetation types, and the management implications associated with these changes are considered. The need for a "fine-scale" approach to landscape analysis in conservation planning exercises is discussed, with three vegetation types utilised as case studies.

Melaleuca viridiflora open woodlands were selected for further investigation, based on their relatively simple structure, the fact that opportunities arose to assess prescribed burns conducted by management agencies, and the large extent to which they have been affected by past clearing patterns. Their current conservation status as described within the literature was also reviewed. To assess this status fully, a detailed analysis of community structure and composition was conducted at 24 sites throughout the wet-tropics coastal region between Townsville and Cooktown. A high diversity of structural and floristic types was recorded. Many of these types are not adequately included (some not at all) in the existing conservation reserve system. A synthesis of previous research highlighted the significant level of biodiversity associated with these woodlands, adding weight to the argument for increased levels of protection in reserves.

A total of 127 species were recorded from the 24 sites, with classification analyses of species presence/absence data separating seven or eight main groups of sites, essentially related to a gradient of latitude and (predicted) rainfall. The groups were not well explained by either species richness, past fire frequencies or soil types. Structural classification analyses based upon DBH data identified six or seven main groups, the singularly most striking of which was sites with annual fire histories. Ordinations based on both the DBH and species presence/absence data produced groupings that supported those detected by the classification techniques. In a closer examination of sites with similar fire histories, soil moisture and soil type were both found to have significant effects on community structure and composition.

The effects of single prescribed burns were examined at several sites. Moderately intense fire dramatically affected individuals in the understorey and intermediate size classes, with reductions in the latter of up to 58%. The effects of repeated fires (i.e. an annual fire regime) on these size classes were also examined and suggest that two consecutive fires are sufficient to exhaust the regenerative ability of *M. viridiflora* saplings, even though the species is widely considered to be adapted to fire. The simplification of community structure (fewer strata with insufficient recruitment to maturity) as a result of subsequent high frequency fires is considered likely, and recommendations (adopted by management agencies) for longer fire-free intervals than those currently prescribed are proposed. The effects of fires on the fine fuel loads of these communities were also examined, with an average loss of 97% of fine fuel in moderate intensity fires. Even two to three years after fire, fuel loads remained well below pre-fire levels.

The spatial pattern of Caribbean pine (*Pinus caribaea* var. *hondurensis* Barrett & Golfari (Pch)) invasion (from plantations adjacent to high conservation value remnants) into *M. viridiflora* woodlands was also documented. Pines dispersed more than 400 m, with densities ranging widely between the remnants studied. At a site examined in detail, the distribution of pines was poorly correlated with that of the dominant native species in the community. Growth rates of the exotic pine were, at times, more than twenty-fold those of *M. viridiflora*, whilst mortality was substantially lower. Differences in the germination responses of the two species to varying temperature and soil moisture treatments were also examined, with *M. viridiflora* germinating more readily at higher temperatures and elevated soil moisture levels. A relatively intense prescribed fire was used to assess its effectiveness as a management tool for the control of exotic pines. Although successful in controlling juveniles (less than 1.5

m tall), little effect was observed on larger trees. Other potential management techniques (hand removal, localised chemical treatment and the development of sterile plantation species) are considered essential for a successful integrated control program that minimises the potential for invasion into other significant remnant *M. viridiflora* habitats.

Finally, the results of this study are assessed within the context of the sustainable management and development of these woodland communities at the landscape level. The opportunities for future research relevant to each section of the thesis are also outlined.

ACKNOWLEDGMENTS

A lot of water has flowed under the bridge (although not much of it in Townsville) since I first had the notion of tackling a PhD. A great many people have helped me hobble over the finishing line and a brief mention is made of some of these below.

Financial support for this thesis was initially supplied by the then Queensland Department of Environment and Heritage, as part of a broad project that assessed the effects of fire on a range of lowland vegetation types on Hinchinbrook Island National Park. The Wet Tropics Management Authority and the World Wide Fund for Nature allocated funding through their Competitive Research Grants Programs. The Thorsborne Trust also provided funding, as did the Ecological Society of Australia through a Travel Support Scheme for post-graduate students. I sincerely thank all these organisations and agencies for their support.

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TABLE OF CONTENTS

Dedication	i
Statements of access and sources	ii
Abstract	iii
Acknowledgments	vi
Table of contents	vii
Glossary of abbreviations and acronyms	xi
List of plates	xii
List of figures	xiii
List of tables	xvi
List of appendices	xix
1. General introduction	1
1.1 Introduction and background	1
1.2 Scope of thesis	3
1.3 Project objectives and structure of the thesis	3
2. An assessment of habitat fragmentation: The north-eastern Queensland tropical lowlands - A case study	6
2.1 Introduction	6
2.1.1 Habitat fragmentation and its ecological effects	6
2.1.2 Australian lowlands and those of the north-eastern Queensland tropics	11
2.1.3 Indices of landscape pattern	14
2.1.4 Aims of this investigation	16
2.2 Methods	17
2.2.1 Study area	17
2.2.2 Vegetation mapping	17
2.2.3 Digitising	18
2.2.4 Data analysis	19
2.3 Results	20
2.3.1 General	20
2.3.2 Total areas of vegetation types	27

TABLE OF CONTENTS (cont.)

2.3.3	Total number of patches of vegetation types	30
2.3.4	Patch size class distributions of selected vegetation types	33
2.3.5	Vegetation types and patch areas	38
2.3.6	Vegetation types and patch perimeter lengths	42
2.3.7	Vegetation types and patch shape index	47
2.3.8	Vegetation types and the fragmentation index	50
2.3.9	Vegetation types and the dispersion index	50
2.4	Discussion	55
2.4.1	The broad picture	55
2.4.2	The landscape indices	56
2.4.3	Specific vegetation types of interest	58
2.4.4	Management implications for fragmented landscapes	60
3.	<i>Melaleuca viridiflora</i> Sol. ex Gaertn open woodlands of the wet tropics: Their distribution, structure and conservation status	63
3.1	Introduction	63
3.1.1	General distribution and physiognomy	63
3.1.2	Ecological significance and conservation status of the woodlands	68
3.1.3	Review of previous research	73
3.1.4	Aims of this investigation	78
3.2	Methods	81
3.2.1	Site selection	81
3.2.2	Plot data collection	92
3.2.3	Data analyses	93
3.3	Results	97
3.3.1	General characteristics of the sites	97
3.3.2	Relationships between tree DBH and tree height	104
3.3.3	Community analyses of study sites	108
3.3.4	Variation in community parameters among classification/ordination groups	120
3.4	Discussion	126

TABLE OF CONTENTS (cont.)

4.	The effects of soil type and soil moisture on the structure of <i>Melaleuca viridiflora</i> open woodlands	131
4.1	Introduction	131
4.1.1	General	131
4.1.2	Aims of this investigation	132
4.2	Methods	133
4.2.1	Data collection	133
4.2.2	Data analysis	136
4.3	Results	137
4.4	Discussion	145
5.	The effect of fire on the structure and fuel loads of <i>Melaleuca viridiflora</i> open woodlands	149
5.1	Introduction	149
5.1.1	Fire and ecosystem disturbance	149
5.1.2	Fuel load accumulation	157
5.1.3	Fire temperature determination	162
5.1.4	Aims of this investigation	163
5.2	Methods	163
5.2.1	Fire temperature determination	163
5.2.2	Structural changes following fire	164
5.2.3	Simulated fire experiment	165
5.2.4	Fuel load accumulation	166
5.3	Results	167
5.3.1	Fire temperature determination	167
5.3.2	Structural changes following fire	168
5.3.3	Simulated fire experiment	174
5.3.4	Fuel load accumulation	182
5.4	Discussion	189

TABLE OF CONTENTS (cont.)

6.	Exotic species invasion into <i>Melaleuca viridiflora</i> open woodlands: <i>Pinus caribaea</i> var. <i>hondurensis</i> - A case study	199
6.1	Introduction	199
6.1.1	Pine invasion	199
6.1.2	Germination experiments	204
6.1.3	Aims of this investigation	205
6.2	Methods	205
6.2.1	Pine invasion	205
6.2.2	Germination experiments	209
6.2.3	Data analysis	210
6.3	Results	211
6.3.1	Pine invasion	211
6.3.2	Germination experiments	231
6.4	Discussion	234
7.	Conclusions, implications and future research opportunities	238
8.	References	245
9.	Appendices	280

GLOSSARY OF ABBREVIATIONS AND ACRONYMS

ACF	Australian Conservation Foundation
ACG	Australian Commonwealth Government
AMG	Australian Metric Grid
ANCA	Australian Nature Conservation Agency
ANCOVA	Analysis of Co-variance
ANOVA	Analysis of Variance
AUSLIG	Australian Survey and Land Information Group
BIOCLIM	Bioclimatic Prediction System (Software program)
CSIRO	Commonwealth Scientific Industry Research Organisation
DBH	Diameter at Breast Height
DEST	Department of Environment, Sport and Territories
DNR	Department of Natural Resources
FI	Fragmentation Index
GIS	Geographic Information System
GPS	Geographic Positioning System
HSD	Honestly Significant Difference
HINP	Hinchinbrook Island National Park
PATN	Pattern Analysis (Software program)
QDE	Queensland Department of Environment
QDEH	Queensland Department of Environment and Heritage
QDPI	Queensland Department of Primary Industries
QSFS	Queensland State Forest Service
QNPWS	Queensland National Parks and Wildlife Service
RAKES	Rapid Selection and Appraisal of Key and Endangered Sites
SAS	Statistical Analysis System (Software program)
SI	Shape Index
SIIP	Sugar Industry Infrastructure Package
SPSS	Statistical Package Trade Name (Software program)
SSH	Semi-strong Hybrid Multi-dimensional Scaling
TWINSpan	Two-Way Species Indicator Analysis (Software program)
UPGMA	Unweighted Pair Group Arithmetic Averaging
WTBR	Wet Tropics Biogeographic Region
WTMA	Wet Tropics Management Authority
WTWHA	Wet Tropics World Heritage Area

LIST OF PLATES

Frontispiece	The Broad-leaved tea-tree: <i>Melaleuca viridiflora</i> (Myrtaceae).	
Plate 1	Typical <i>M. viridiflora</i> -dominated open woodland habitat65
Plate 2	Time series of photographs showing the effects of, and recovery from, a prescribed fire at Site 5169
Plate 3	Pine (<i>P. caribaea</i> var. <i>hondurensis</i>) invasion into <i>M. viridiflora</i> open woodland habitat (Site 14)213

LIST OF FIGURES

Figure 2.1	Vegetation map of the entire study area from aerial photographs taken in 1942.	22
Figure 2.2	Vegetation map of the entire study area from aerial photographs taken in 1992.	24
Figure 2.3	Patch area size class distribution results for all remnant vegetation types	26
Figure 2.4	Total area (ha) of each vegetation type in 1942 and 1992.	29
Figure 2.5	Total number of patches of each vegetation type in 1942 and 1992.	32
Figure 2.6	Patch size class distributions for mid-high <i>Melaleuca</i> open woodlands (MOW) in 1942 and 1992.	35
Figure 2.7	Patch size class distributions for three vegetation types within the entire study area in 1942 and 1992.	37
Figure 2.8	Mean patch area (ha) for each vegetation type in 1942 and 1992.	40
Figure 2.9	Mean perimeter length (km) for each vegetation type in 1942 and 1992.	44
Figure 2.10	Mean shape index for each vegetation type in 1942 and 1992.	49
Figure 2.11	Mean fragmentation index for each vegetation type in 1942 and 1992.	52
Figure 2.12	Mean dispersion index for each vegetation type in 1942 and 1992.	54
Figure 3.1	Climate data for locations studied either during this investigation (Townsville, Cardwell & Cooktown) or for previous research conducted on <i>M. viridiflora</i> woodlands (Coen & Jabiru)	80
Figure 3.2	Location of study sites within the Wet Tropics Biogeographic Region	83
Figure 3.3	<i>M. viridiflora</i> size class data across all study sites	95
Figure 3.4	<i>M. viridiflora</i> tree height (m) and DBH (cm) data for all study sites	106
Figure 3.5	Classifications of the species presence/absence data matrix	110
Figure 3.6	Ordination of presence/absence data by SSH, Vector 2 vs. Vector 1 (S = site)	114
Figure 3.7	Classifications of the <i>M. viridiflora</i> DBH size class data	118
Figure 3.8	Ordination of the <i>M. viridiflora</i> DBH size class data by SSH, Vector 2 vs. Vector 1 (S = site)	122

LIST OF FIGURES (cont.)

Figure 4.1	Transect showing relative tree heights and position of study sites along a perceived environmental gradient	135
Figure 4.2	Mean percentage soil moisture (%) and rainfall (mm) at the three study sites over a 20 month period	141
Figure 5.1	Density of <i>M. viridiflora</i> shoots (500 m ²) in the understorey of Sites 5, 6 (Hinchinbrook Island National park) and 19 (mainland) prior to and following fire	171
Figure 5.2	Density and the percentage reduction (%) of individuals in the 1.5 to 3.0 m height category at Sites 5, 6 (Hinchinbrook Island National Park) and 19 (mainland) prior to and following fire	173
Figure 5.3	Density of <i>X. johnsonii</i> (500 m ²) in the understorey of Sites 5, 6 (Hinchinbrook Island National Park) and 19 (mainland) prior to and following fire	176
Figure 5.4	Pattern of <i>M. viridiflora</i> seedling survival (mean density of seedlings 0.25 m ²) in the understorey of Sites 5 and 10 (Hinchinbrook Island National Park)	178
Figure 5.5	Growth responses of <i>M. viridiflora</i> midstorey (1.5 to 3.0 m) individuals to single (September 1992) and repeated (2) fires (September 1992 and October 1993) at Site 5 on Hinchinbrook Island National Park	180
Figure 5.6	Pattern of fuel load accumulation (t ha ⁻¹) following fire (September 1992) in a <i>M. viridiflora</i> woodland at Site 5 on Hinchinbrook Island National Park	184
Figure 5.7	Pattern of fuel load accumulation (t ha ⁻¹) following fire (October 1993) in a <i>M. viridiflora</i> woodland at Site 6 on Hinchinbrook Island National Park	186
Figure 5.8	Pattern of fuel load accumulation (t ha ⁻¹) following fire (November 1993) in a <i>E. cloeziana</i> forest at Site E on Hinchinbrook Island National Park	188

LIST OF FIGURES (cont.)

Figure 5.9	Exponential curve $\{f(x) = ae^{-bx} + ce^{-dx}\}$ fitted to empirical total fuel load accumulation ($t\ ha^{-1}$) data at three sites (Sites 5, 6 and E) on Hinchinbrook Island National Park	191
Figure 6.1	Map showing location of <i>P. caribaea</i> var. <i>hondurensis</i> invasion study sites	207
Figure 6.2	Distribution of <i>M. viridiflora</i> densities ($100\ m^{-2}$) on each of the three transects at Site 3	216
Figure 6.3	Distribution of <i>P. caribaea</i> var. <i>hondurensis</i> densities ($100\ m^{-2}$) on each of the three transects at Site 3	218
Figure 6.4	Distribution of <i>A. mangium</i> densities ($100\ m^{-2}$) on each of the three transects at Site 3	220
Figure 6.5	Growth measurements of <i>P. caribaea</i> var. <i>hondurensis</i> taken along Transect 2 at Site 3	222
Figure 6.6	Mean height (cm) and DBH (mm) increases for <i>M. viridiflora</i> and <i>P. caribaea</i> var. <i>hondurensis</i> at Site 3	226
Figure 6.7	The effect of fire on the density ($100\ m^{-2}$) of eight species in two size classes ($>1.5\ m$ and $<1.5\ m$) at Site 3	230
Figure 6.8	Mean number of seedlings of <i>M. viridiflora</i> and <i>P. caribaea</i> var. <i>hondurensis</i> following 28 days of different temperature and moisture treatments	233

LIST OF TABLES

Table 2.1	Vegetation clearance (%) figures determined by three previous studies .12	
Table 2.2	Extent of the three areas examined and the associated level of landscape disturbance.	19
Table 2.3	Mapping units (vegetation types) recognised by this investigation. . . .	27
Table 2.4	Results of variables describing remnant vegetation for the entire study area	30
Table 2.5	Results of chi-squared (χ^2) analyses for different vegetation types in the study areas.	38
Table 2.6	Results of unbalanced 3-way ANOVAs of each landscape variable and area, vegetation type and time period.	41
Table 2.7	Results of one-way ANOVAs of each landscape variable and vegetation type	42
Table 2.8	Results of the t-tests conducted on individual vegetation types within the study area at the two times examined	45
Table 3.1	The seven themes of <i>M. viridiflora</i> woodlands identified by Stanton and Godwin (1989)	67
Table 3.2	Summary of the conservation status of <i>M. viridiflora</i> (\pm eucalypt species) open woodlands in Australia (Specht <i>et al.</i> 1995)	70
Table 3.3	Synopsis of research relevant to <i>M. viridiflora</i> -dominated woodlands .	75
Table 3.4(a)	Summary of site data (position, altitude, rainfall, theme, soil type, fire history, species richness and sampling effort)	99
Table 3.4(b)	Summary of site data (structural data)	102
Table 3.5	Linear regression and Pearson correlation coefficient results for tree height and tree DBH at each site	107
Table 3.6	Analysis of co-variance (ANCOVA) results for the regression equations	108
Table 3.7	Results of one-way ANOVAs of Bray-Curtis classification groupings with species richness and predicted total annual rainfall	125

LIST OF TABLES (cont.)

Table 3.8	Results of a Tukey-HSD multiple comparison test for the Bray-Curtis species presence/absence classification groups and predicted total annual rainfall	125
Table 3.9	Results of one-way ANOVAs of Bray-Curtis classification groupings with site DBH data and predicted total annual rainfall	126
Table 3.10	Results of a Tukey-HSD multiple comparison test for Bray-Curtis classification groupings and site DBH data	126
Table 4.1	Soil moisture contents (%), water table depths (cm) and approximate annual rainfall (mm) for <i>M. viridiflora</i> sites investigated by Twedell (1982)	133
Table 4.2	Morphological descriptions of the soil profile from auger borings at each of the three study sites	138
Table 4.3	Summary of the community data collected at each of the three sites	139
Table 4.4	Results of repeated measures ANOVA for soil moisture	143
Table 4.5	Size class structural data, regression and correlation coefficient (height = a + b DBH) for each site from Chapter 3	144
Table 5.1	Fire-driven mechanisms of plant population decline and extinction potentially most relevant to <i>M. viridiflora</i> communities in this study (after Keith 1996)	155
Table 5.2	Area of study for 80 fuel dynamics research papers published in Australia	158
Table 5.3	Some sampling strategies within the literature for quantitative (harvest) fuel load estimations	160
Table 5.4	Temperatures (°C) recorded during a small-scale fire in a <i>M. viridiflora</i> woodland (Site 5)	168
Table 5.5	Results from the repeated measures ANOVA of the number of coppice shoots in the two treatments (single burn vs. repeated burns) over the duration of the experiment	181

LIST OF TABLES (cont.)

Table 5.6	Results from the repeated measures ANOVA of the length of coppice shoots in the two treatments (single burn vs. repeated burns) over the duration of the experiment	181
Table 5.7	Fine fuel load accumulation and general fire data	182
Table 6.1	Density and size of <i>P. caribaea</i> var. <i>hondurensis</i> (P.c.) in eight <i>M. viridiflora</i> (M.v.) woodland communities	212
Table 6.2	Multiple linear regression and ANOVA results for pooled pine distribution data (i.e. total pine density = $a + b \times (\text{total density of other species})$, where b = slope and a = intercept of the regression line)	223
Table 6.3	Multiple linear regression and ANOVA results for the distribution of pines >1.5 m (i.e. pine density >1.5 m = $a + b \times (\text{total density of other species})$, where b = slope and a = intercept of the regression line)	223
Table 6.4	Multiple linear regression and ANOVA results for the distribution of pines >1.5 m (i.e. pine density <1.5 m = $a + b \times (\text{total density of other species})$, where b = slope and a = intercept of the regression line)	224
Table 6.5	Results from the repeated measures ANOVA of the height data for both species over the duration of the study, showing F ratios and their significance	227
Table 6.6	Results from the repeated measures ANOVA of the DBH data for both species over the duration of the study, showing F ratios and their significance	227
Table 6.7	Uni-variate ANOVA results for the effects of the prescribed fire on total species density, showing F ratios and their significance	228
Table 6.8	Results of two-way ANOVAs of temperature and moisture, showing F ratios and their significance	234

LIST OF APPENDICES

Appendix A	Comparison of vegetation types within different time periods and areas - Results of Tukey's-HSD one-way ANOVA post-hoc multiple comparison test	281
Appendix B	Species presence/absence data matrix for all study sites	287
Appendix C	Tree DBH (cm) and tree height (m) (TH) size class data matrix for all study sites	289
Appendix D	Results of uni-variate tests for soil moisture and community composition attributes, and chi-squared results of DBH size class comparisons . .	290
Appendix E	Fire information relevant to investigations carried out in Chapters 5 and 6	293