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**The Fire Patchiness Paradigm:  
A Case Study in Northwest Queensland**

**Thesis submitted by  
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in April 2007**



**for the degree of  
Doctor of Philosophy  
in Environmental Science  
School of Earth and Environmental Sciences  
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Information derived from published or unpublished work of others has been acknowledged in the text and a list of references is given.

.....

**Leasie Felderhof**

## **STATEMENT OF CONTRIBUTION OF OTHERS**

### **Ergon Energy**

- Operating Expenses (\$80,000).

### **Tropical Savannas Management CRC:**

- Post-Graduate Research Scholarship.

### **James Cook University:**

- Library access,
- General student support and supervision,
- Conference attendance.

### **CSIRO (Atherton)**

- Library access and use of drying ovens.

### **QPWS**

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## **DEDICATION**

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# ABSTRACT

## The Fire Patchiness Paradigm

Research into fire ecology has culminated in ‘the patchiness paradigm’. This is the view that numerous small fires, with variety in fire timing, frequency and intensity, will lead to habitat diversity across the landscape, thereby benefiting species conservation. The paradigm recognises that fire is instrumental in shaping the Australian environment, and that no single fire regime will suit all species. As a result, land holders wanting to adopt ecologically sustainable fire management practices are advised to develop and maintain fine-grained landscape patchiness using fire. However, there is no guidance on optimal fire size, level of internal fire patchiness or desirable fire frequency. Having ill-defined objectives is incompatible with ‘adaptive management’, the approach espoused for managing in the face of inadequate information and uncertainty. Adaptive management, or learning by doing, requires clear management objectives and careful monitoring. When, how often, and how much should manager’s burn, and how should they evaluate success? Although adaptive management accommodates uncertainty, the scale and internal patchiness of proposed fire operations need to be articulated in order to commence the cycle with a ‘best guess’ management target. Addressing this issue and bridging the gap between ecological understanding and applied land management is the critical next step in fire ecology. This thesis focuses on this concern.

The case study area was the Mount Isa Inlier, a semi-arid bioregion in northwest Queensland, Australia. The study concentrated on the fire ecology of spinifex/snappy gum woodlands, the dominant vegetation type in the bioregion. Remote sensing technology was used to examine landscape fire patterns and to identify key drivers of these patterns. Field surveys were undertaken to determine

regenerative responses of the vegetation and to investigate spatial variability between and within fires. To investigate the potential effects on fauna, a fauna fire-response database was compiled using expert opinion. Species were then classified according to their fire sensitivity based on species' refugium requirements during a fire and vegetation maturation stage requirements after a fire. The predicted response of fauna was tested in the field using birds as a sub-group. The results were interpreted in terms of setting objectives for adaptive management, with recommendations on a target fire size and associated monitoring.

The Mount Isa Inlier was found to have greater affinity with arid Australian landscapes than mesic savannas. Fire scars mapped over a six-year period (1998-2003) showed that the total area burnt per year was related to the strength of the preceding wet season. Post-fire changes in the vegetation were highly predictable. There was a flush of annual and ephemeral species after the first rain. The abundance of these species decreased over time, while the cover of perennial species increased. There was insufficient fuel for fire to spread for at least three years from the previous fire. By then, most ephemeral species have set seed, and perennial species have started to produce seeds. Resilience to fire was enhanced by the inherent variability within burnt areas. Vegetation at early recovery stages co-existed with patches of vegetation at later recovery stages. Mature plants in unburnt patches provide reproductive material that ensures individual species remain in the system. Collectively, these data provided an understanding of fire-mediated vegetation dynamics in spinifex/snappy gum communities.

When the fire-sensitivity of fauna species was tested, birds relying on long-unburnt spinifex during and after fire were more vulnerable than generalist species. Additional field studies were undertaken to investigate the internal fire-patchiness requirements of fire-sensitive species. The ideal characteristics for unburnt patches within fire scars could not be defined. Nonetheless the approach provided sufficient insight for a target fire size to be proposed. Restricting fire size to around 100 ha

was considered acceptable to conserve birds in the bioregion. It is recommended that a suite of fire-sensitive species be used for ecological monitoring, based on the objective process used in this study.

Fine-scale satellite imagery (IKONOS, 1-m<sup>2</sup> – 4-m<sup>2</sup> pixel resolution) was investigated as a tool for quantifying fire patchiness. If fuel load or fire severity could be mapped, this would provide the initial step. Mapping fuel loads at this scale would also give accurate and spatially explicit fire histories for different areas. This would benefit researchers interested in characterising fire regimes as it would allow for successive monitoring. Field data on fuel load and fire severity were compared to reflectance values recorded by the IKONOS satellite. A fuel load map was produced, but the inherent uncertainty in remote sensing processes meant that results were generalised to areas with high, medium or low fuel load. Although this can assist managers to identify areas of high fire hazard, its day-to-day use for monitoring fire patchiness is questionable. Mapping fire severity was not successful and remains the key fire regime variable not yet captured by remote sensing. The fine-scale mapping components of this study supported the notion that restricting fire size should be emphasised as a management goal in northwest Queensland. Internal fire-patchiness was inherent and difficult to specifically plan for. Fire size can be readily monitored using existing remote sensing techniques.

The major contribution of this work is that it provides a way to mesh the patchiness paradigm with practical land management. By tailoring fire size to the needs of the most fire sensitive species, the remainder are likely to be catered for, by default. Fire-sensitive species can be identified by classifying species according to their requirements during, and immediately after, fire. The method tested here proved to be useful and can be applied in different environments and at different scales.

This is one of the few studies that endeavours to quantify the level of patchiness to which managers might aspire. It demonstrates a strategic approach that

integrates well with adaptive management. Thus, the findings provide a way to progress from setting management goals based on ecological principles, such as 'a fine scale mosaic', to setting more specific targets based on ecological understanding and a coherent process. Further, the thesis provides important information on the fire ecology of spinifex/snappy gum woodlands in the Mount Isa Inlier. Fire-related research is scant for this area, so this information provides a starting point for ecological fire management in the region.

# TABLE OF CONTENTS

Statement of Access .....	ii
Statement on Sources Declaration .....	iii
Statement of Contribution of Others .....	iv
Acknowledgements .....	v
Dedication .....	vii
Abstract .....	viii
List of Tables .....	xviii
List of Figures .....	xx
CHAPTER 1 INTRODUCTION.....	1
1.1 Ecological Fire Management .....	2
1.2 Determinants of Landscape Fire Patterns .....	4
1.3 The Fire Patchiness Paradigm .....	8
1.4 Adaptive Management and Fire Planning .....	12
1.5 Subject Matter .....	16
1.6 Aims and Significance of the Research.....	17
1.7 Research Strategy and Thesis Structure.....	19
CHAPTER 2 BROAD SCALE FIRE PATTERNS.....	22
2.1 Introduction.....	22
2.2 Methods .....	24
2.2.1 The Study Area .....	24
2.2.2 Mapping Techniques and Analysis.....	30
Fire scar mapping .....	30
Data verification .....	32
Data analysis .....	33

2.3	Results .....	34
	2.3.1 Data Verification.....	34
	2.3.2 Area Burnt and Seasonal Patterns .....	35
	2.3.3 Fire Frequency and Time Since Fire .....	38
2.4	Discussion .....	41
	2.4.1 Mapping Accuracy .....	41
	2.4.2 Regional Fire Patterns .....	43
	2.4.3 Implications for Research and Management .....	46
2.5	Conclusion.....	47
CHAPTER 3 VEGETATION DYNAMICS WITHIN FIRE SCARS.....		49
3.1	Introduction.....	49
3.2	Methods.....	55
	3.2.1 Vegetation Recovery After Fire .....	55
	Site stratification and sampling .....	55
	Data analysis .....	59
	3.2.2 Fuel Load Accumulation over Time.....	62
	Calibrating the 'disc-dropper' .....	62
	3.2.3 Variation in Fire Severity .....	64
	Variation in fire severity between fire scars.....	64
	Variation in fire severity within a single fire scar.....	68
	Data analysis.....	68
3.3	Results .....	72
	3.3.1 Vegetation Recovery After Fire .....	72
	Species diversity and dominance .....	72
	Age classes and reproductive status .....	77
	Regenerative responses of the dominant species .....	82

3.3.2	Synthesis: Vegetation Dynamics in Spinifex/Snappy Gum Communities .....	85
3.3.3	Fuel Load Accumulation Over Time .....	86
	Disc-drop calibration .....	86
	Changes in fuel load over time .....	87
3.3.4	Variation in Fire Severity .....	88
	Fire severity indicators .....	88
	Fire severity and patchiness indices .....	88
	Variation in fire severity between and within fire scars .....	89
3.4	Discussion .....	92
	3.4.1 Vegetation Recovery After Fire .....	92
	3.4.2 Fuel Load Accumulation Over Time .....	95
	3.4.3 Variation in Fire Severity.....	97
	3.4.4 Vegetation Dynamics in Spinifex/Snappy Gum Communities .	100
	3.4.5 Implications for Management and Research.....	101
3.5	Conclusion.....	103

## CHAPTER 4 UNDERSTANDING PATTERNS: MAPPING FUEL LOAD AND FIRE

	SEVERITY .....	105
4.1	Introduction.....	105
4.2	Methods .....	110
	4.2.1 The Study Area .....	110
	4.2.2 Satellite Imagery .....	112
	Image pre-processing .....	112
	4.2.3 Fuel Load Mapping .....	116
	Fuel load measures in the field .....	116
	The cover of trees and shrubs .....	118
	Data analysis.....	119

	Fuel map compilation .....	128
4.2.4	Fire Severity Mapping .....	129
	Field measures of fire severity .....	129
	Data analysis.....	130
4.3	Results and Interpretations .....	131
4.3.1	The Pre-Fire Landscape .....	131
	Fuel load, fire age and reflectance .....	131
	Landscape position and fuel load .....	134
	Canopy dimensions of <i>Acacia chisholmii</i> .....	136
	<i>Acacia</i> dimensions, fuel load relationships and reflectance .....	137
	The tree layer, fuel load relationships and reflectance ...	141
	Models to predict fuel load .....	141
	The <i>Acacia</i> constant.....	144
	Fuel map compilation and model predictions .....	146
4.3.2	The Post-Fire Landscape .....	153
	Fire severity indicators and reflectance values .....	153
	NDVI differencing and fire severity indicators .....	154
4.4	Discussion .....	155
4.4.1	Fuel Load Map .....	155
	Fire severity mapping.....	158
	Implications for research and management .....	160
4.5	Conclusion.....	162
CHAPTER 5 MANAGING FIRE TO CONSERVE VERTEBRATE FAUNA.....		163
5.1	Introduction.....	163
5.2	Methods.....	165
5.2.1	Predicted Fauna Responses to Fire .....	165

5.2.2	Field Evaluation of Predicted Fire Response: Birds .....	173
5.2.3	Determining Fire Patchiness Requirements for Target Species .....	176
5.3	Results.....	179
5.3.1	Fauna Database Analyses .....	179
5.3.2	Predicted Versus Actual Bird Responses .....	181
5.3.3	Patchiness Requirements of Indicator Species.....	189
5.4	Discussion .....	191
5.4.1	The Fauna Fire-Response Database .....	191
5.4.2	The Application of Functional Groups .....	193
5.4.3	Fire Sensitive Species: Predicted Versus Actual .....	194
5.4.4	Determining Patchiness Requirements .....	197
5.4.5	Management Implications .....	199
5.4.6	Implications for Research .....	199
5.5	Conclusion .....	201
CHAPTER 6 SUMMARY, FUTURE RESEARCH AND CONCLUSIONS .....		203
6.1	Thesis Objectives.....	203
6.2	General Approach .....	204
6.3	Summary of Results.....	206
6.3.1	Bioregional Patterns.....	206
6.3.2	Vegetation Dynamics.....	207
6.3.3	Variation in Fire Severity.....	208
6.3.4	The Response of Fauna .....	209
6.3.5	Options for Monitoring.....	211
6.4	The Patchiness Paradigm.....	212
6.5	Improving Fire Management.....	214
6.6	Recommendations for Ecological Fire Management .....	215

6.6.1 What Should Fire Managers Aim For? .....	216
Fire size .....	216
Fire frequency .....	217
Fire intensity .....	217
Fire season.....	218
The landscape context .....	218
Monitoring outcomes.....	218
6.7 Recommendations for Further Research .....	219
6.7.1 Implementing the Mosaic.....	219
The distribution of patches in the landscape .....	219
Fire behaviour .....	220
Meteorological studies .....	221
Operational adaptive management .....	221
Social and economic research.....	222
6.7.2 Species' Fire Responses .....	223
6.7.3 Cross-Scale, Cross-Discipline Studies.....	224
6.8 Conclusion.....	224
References .....	226
Appendix 1 Papers Produced During the Course of This Work.....	240
Appendix 2 Species Longevity and Fire Response List.....	282
Appendix 3 Image Pre-Processing flow charts.....	285
Appendix 4 Fauna Database .....	288

## LIST OF TABLES

<b>Table 3.1</b> Data on plant maturity, reproductive status, regenerative traits and longevity were recorded for every plant intercepted by the wheel-point apparatus. In later analysis, some categories were grouped (grey shading). .....	61
<b>Table 3.2</b> Fire severity scores were determined for each transect by assessing transect values against severity classes assigned to 5 different variables. The final severity score was the median of the five scores. ....	70
<b>Table 3.3</b> Fire patchiness scores were determined for each transect by assessing transect values against classes assigned to 7 different variables. The final patchiness score was the median of the seven scores .....	70
<b>Table 3.4</b> Plant species recorded at sites of different fire age. Lists are from pooled data for 75 sites across the Mount Isa Inlier bioregion. ....	73
<b>Table 3.5.</b> Tree and shrub variables measured as indicators of fire severity were positively correlated with one another (values are Spearman's Rank correlation coefficients, $p < 0.001$ ). ....	88
<b>Table 3.6</b> Average tree char heights were significantly different from one another at the fire scar level ( $F = 31.4$ , $p < 0.001$ , $df = 18$ , $n = 1391$ ), although some fire scars could not be differentiated (Tukey's HSD test). Mean char heights grouped into homogeneous subsets allowed fire scars to be plotted along a continuum of fire severity .....	89
<b>Table 3.7</b> Transect pairs had significantly different fire severity scores at almost half the sites ( $p < 0.05$ ). ....	91
<b>Table 4.1</b> Attributes of the pre- and post-fire IKONOS images used to investigate the mapping of fuel loads and fire severity in the Mount Isa area. ....	112
<b>Table 4.2</b> Correlations between fuel load, bands and vegetation indices. Numbers in bold show correlations that are significant at the 0.01 level or better (2-tailed) .....	125
<b>Table 4.3</b> Summary of 5 model options for predicting $\text{Log}_{10}$ Fuel Load. For model 5, $F = 57.4$ , $p < 0.001$ , $df = 793$ .....	127
<b>Table 4.4</b> Fuel load was weakly but significantly correlated with all bands and indices except PVI.....	134
<b>Table 4.5</b> The height of <i>Acacia</i> was correlated to reflectance on the red band as well as EVI, NDVI, PVI2, and $\text{log}_{10} B4/B3$ . ....	139
<b>Table 4.6</b> The canopy area of <i>Acacia</i> was negatively correlated to reflectance on the green, red and NIR bands. ....	140
<b>Table 4.7</b> Tree cover was weakly correlated with some bands of reflectance; however, there were no significant correlations when 'Snappy Gum' and 'Other tree species' were considered separately.....	143
<b>Table 4.8</b> The mean reflectance of sites stratified for ' <i>Acacia</i> ', 'other shrub species' or 'no shrubs' was significantly different on all bands and for all indices. The strongest difference was detected on the green band (ANOVA $F = 54.747$ , $p < 0.001$ , $n = 499$ ). ....	145
<b>Table 5.1</b> The data fields and categories used to collate information on the likely response of vertebrate species to fire, and potential response options .....	166

<b>Table 5.2</b> Names and affiliation of people who contributed their expertise to the fauna fire-response database.....	171
<b>Table 5.3</b> Using the ‘Bradstock’ classification, 15 terrestrial bird species and 4 mammal species were predicted to be more sensitive to fire than others in their class. ....	180
<b>Table 5.4</b> Fewer than half of the bird species predicted to be fire sensitive were sighted. The three species seen in sufficient number for statistical analysis (asterisk) were all associated with unburnt spinifex .....	188
<b>Table 5.5</b> Indicator species analysis was used to identify species with a strong association with either unburnt (grey shading) or burnt (no shading) vegetation. Species are ranked according to their calculated indicator value (IV).....	189
<b>Table 6.1</b> Integrating fire-related information across scales and deciding which factors operate predictably assists in formulating fire plans. ....	215

## LIST OF FIGURES

<b>Figure 1.1</b>	Landscape pattern is determined by different factors acting on a series of templates. The existing pattern or mosaic reflects the underlying templates and forces, as well as the recent history of a location, with natural and anthropogenic disturbances operating in a repeating pattern-process sequence.....	5
<b>Figure 1.2</b>	The Adaptive Management Cycle. Plans for achieving management objectives are developed using current knowledge and monitoring is undertaken to determine the outcome of management actions (based on Holling 1978). .....	13
<b>Figure.1.3</b>	Adaptive management requires information at a number of levels. Information on the regional setting, the predicted and potential responses of flora and fauna to different fire regimes, and information on how fire behaves under different environmental conditions is required for effective planning. ....	16
<b>Figure 1.4</b>	Location of the study area. The Mount Isa Inlier bioregion (dark grey) lies within Australia's tropical savannas (light grey). ....	19
<b>Figure 1.5</b>	Model of the adaptive management cycle showing information requirements that will be addressed by this thesis.....	20
<b>Figure 2.1</b>	The regional setting needs to be considered when planning the use of fire. Such information enables fire management to be in context with contemporary fire patterns, allows areas to be identified where wildfire would be unacceptable, and is used to determine areas for fire ignition and containment .....	22
<b>Figure 2.2</b>	Average annual rainfall for the Mount Isa Inlier. Map based on Bioclim data (EPA 2003); bar graphs based on Clewett <i>et al.</i> (2003). ....	26
<b>Figure 2.3</b>	Annual temperature range (difference between the summer maximum and winter minimum) and the average annual temperatures in the Mount Isa Inlier. Map based on Bioclim data (EPA 2003); line graphs based on Clewett <i>et al.</i> (2003). ....	27
<b>Figure 2.4</b>	Typical landscape within the Mount Isa Inlier. The predominant vegetation is low open woodland with <i>Eucalyptus</i> spp., <i>Acacia</i> spp. and an understorey of <i>Triodia</i> spp. Other grasses occur in areas of higher fertility. ....	28
<b>Figure 2.5</b>	This study focussed on low open woodland of <i>Eucalyptus leucophloia</i> (snappy gum) with an understorey of <i>Triodia</i> spp. (spinifex) in various stages of recovery post-fire. Plate (A) long-unburnt vegetation; plate (B) vegetation at three different fire-ages .....	29
<b>Figure.2.6</b>	Fire scars appear as dark, black or purple areas on Landsat 'quicklooks'. 'Hot spot' data from the NOAA-AVHRR satellite sensors (shown here in orange) help to confirm that these areas were burnt.....	31
<b>Figure 2.7</b>	The relationship between the areas of individual fire scars mapped from Quicklooks (QL) compared with the corresponding fire scars mapped from actual Landsat imagery (LS). $Y = 0.92$ , $R^2 = 0.95$ , $n = 29$ , $p \leq 0.0001$ . ....	35
<b>Figure 2.8</b>	Variation in the area burnt per annum 1998-2003, as total number of hectares burnt (bars) and as a percentage of the study area (circles). ....	36
<b>Figure 2.9</b>	Relationship between the average area burnt per month (bars) and average monthly rainfall (lines), 1998-2003. ....	36
<b>Figure 2.10</b>	The area burnt per month (bars) and rainfall (lines) for the Mount Isa Inlier, 1998-2003. ....	37

<b>Figure 2.11</b>	There was a strong relationship between the area burnt per year and rainfall in the preceding 12 months (solid line, $R^2 = 0.84$ , $n = 6$ , $p \leq 0.01$ ) but no relationship between area burnt and rainfall during the year of burning (dashed line, $R^2 = 0.068$ , $p \leq 0.1$ ).	37
<b>Figure 2.12</b>	There was a stronger relationship between the area burnt per year and pasture growth (triangles and dashed line, $R^2 = 0.94$ , $n = 6$ , $p \leq 0.01$ ) than between the area burnt and rainfall in the preceding 12 months (circles and solid line, $R^2 = 0.84$ , $n = 6$ , $p \leq 0.01$ ).	38
<b>Figure 2.13</b>	The 'age' of the landscape with respect to time since fire by the end of 2003. Wildfires in 2001 resulted in a large area of similar fire age.	39
<b>Figure 2.14</b>	The time lag between an area burning and recovering sufficiently to support a subsequent fire resulted in a patchy landscape. Fire reliably abutted areas burnt in the previous few years (see inset).	40
<b>Figure 3.1</b>	Information on the response of vegetation to fire is required so managers can define their desired result and evaluate the outcome of management actions.	49
<b>Figure 3.2</b>	A generalised diagram showing the relationship between fire and vegetation. Aspects covered in this chapter are shaded grey	52
<b>Figure 3.3</b>	Vegetation was sampled at 75 sites across the bioregion. Sites were stratified with respect to 'time since fire'; 5 fire-age classes were represented	56
<b>Figure 3.4</b>	The wheel-point apparatus was used to sample plants in the ground, shrub and tree layers	58
<b>Figure 3.5</b>	The 'disc-dropper' was calibrated by relating the average depth of fuel (based on 3 measures) to the dry weight of fuel collected within a 1.5 m x 0.5 m quadrat.	64
<b>Figure 3.6</b>	Sites (black triangles) where indicators of fire severity were recorded. Sites were located in areas that had burnt within the previous 6 months, although not all fire scars were mapped	66
<b>Figure 3.7</b>	The wandering quarter method for plotless sampling of vegetation (Mueller-Dombois & Ellenberg 1974). Open circles represent trees.	67
<b>Figure 3.8</b>	Species diversity declined over time ( $F = 4.44$ , $p < 0.003$ , $n = 75$ ), driven by the difference in diversity in the first two years post fire (Tukey HSD, $p < 0.03$ ). (Bars are 95% confidence intervals).	75
<b>Figure 3.9</b>	The diversity of ground cover species declined over time (Spearman's $R = 0.361$ , $p < 0.001$ , $n = 75$ ). (Bars are 95% confidence intervals)	76
<b>Figure 3.10</b>	Rank cover curves (Gill 1999) for species in the ground layer showed that species richness decreased and species dominance increased in the years after fire.	77
<b>Figure 3.11</b>	The percentage of ground cover plants that were seedlings or juveniles (dark bars) decreased with time since fire, with a concomitant increase in the percentage that were adult or old (pale grey bars). The percentage of dead plants (white bars) increased after fire-age four.	78
<b>Figure 3.12</b>	The proportion of shrubs at the seedling stage (black bars) or dead (white bars) decreased with time since fire, while the percentage of adult and old shrubs (pale grey) increased. The proportion of juvenile shrubs (dark grey) appeared to change non-linearly, but means were not significantly different at the $p < 0.05$ level	79

<b>Figure 3.13</b>	The percentage of ground layer species that were annual or ephemeral (dark bars) decreased over time. b) The relationship was similar when percentage cover was considered. Light bars represent perennial species.....	80
<b>Figure 3.14</b>	a) The percentage of ground layer species that were obligate seeders (dark bars) decreased over time, while representation of resprouting species (light bars) increased. b) The relationship was similar when percentage cover was considered .....	81
<b>Figure 3.15</b>	The percentage of spinifex that was at the seedling or juvenile phase (dark bars) decreased over time post fire, while the percentage that was adult or old (pale bars) increased. (Data for hard and soft species are combined).....	83
<b>Figure 3.16</b>	The percentage of <i>Acacia chisholmii</i> at seedling and juvenile stages (dark bars) decreased with time post fire, while the proportion of mature and old specimens (pale bars) increased.....	83
<b>Figure 3.17</b>	For <i>Acacia chisholmii</i> , reproduction commences around three years post fire. Pale bars represent the proportion of plants where buds, flowers or seed pods were present. Dark bars represent samples without reproductive material....	84
<b>Figure 3.18</b>	The percentage of <i>Eucalyptus leucophloia</i> that was reproductive (pale bars) increased with time since fire. Dark bars represent samples where reproductive material was not present.....	84
<b>Figure 3.19</b>	Fire completely removes most of the cover in spinifex/snappy gum communities, but the vegetation is restored over time as species resprout or are recruited from the soil seed bank. There can be sufficient fuel to sustain fire after three years, but fire intervals are usually longer. ....	85
<b>Figure 3.20</b>	The relationship between disc-drop height and total fuel load was used to calibrate the disc-dropper ( $R^2 = 0.80$ , $p < 0.05$ , $n = 106$ ).....	87
<b>Figure 3.21</b>	.....Fuel load increased with time since fire. Error bars show standard error ( $n = 75$ ). ....	87
<b>Figure 4.1</b>	Fire planning objectives related to landscape patchiness can be evaluated by monitoring broad scale fire patterns. Such patterns also aid understanding of pattern/process interactions. ....	105
<b>Figure 4.2</b>	Location of the study area in the Mount Isa Inlier, Queensland, Australia. IKONOS imagery was used for mapping fuel load (horizontal shading) and fire intensity (right inset, vertical shading). ....	111
<b>Figure 4.3</b>	Summary of image processing steps undertaken to reduce errors related to geo-referencing, topography and atmospheric scattering .....	115
<b>Figure 4.4</b>	Fuel load estimates were made at 20 different locations across the study areas. Data were recorded for two to four transects at each location, with 20 data points per transect (see inset). ....	117
<b>Figure 4.5</b>	9 disc-drop measures were made at each transect point (dark circle) to provide a fuel load estimate for a 3 x 3 pixel grid.....	118
<b>Figure 4.6</b>	The mean NDVI for spinifex ( $n = 744$ ) was significantly different to the mean NDVI of other grass, ( $n = 406$ ), but not spinifex/other grass ( $n = 49$ ). The mid-point value 0.264 was used to differentiate between 'spinifex' and 'other grass' .....	126
<b>Figure 4.7</b>	Ten locations (numbered), each with two transects where fire severity data were collected for relating to reflectance values on satellite imagery (area of interest is shown by rectangle). The powerline and road access tracks are also shown .....	131

<b>Figure 4.8</b>	Fuel load increased with time since fire, but levelled off after three years. Error bars show 95% confidence intervals. ....	132
<b>Figure 4.9</b>	Mean reflectance was low after fire, increased in the immediate post-fire years, then dropped to a moderate level. This general pattern was apparent on all bands .....	133
<b>Figure 4.10</b>	Fuel load was highest at sites with both spinifex and other grass, and lowest at sites with species other than spinifex ( $F = 49.6$ , $p < 0.001$ , $df = 2$ ). ....	133
<b>Figure 4.11</b>	Mean fuel load varied with landscape position. Most fuel occurred on mid-slopes, whereas gullies, flats and footslopes had similar amounts of fuel. ....	135
<b>Figure 4.12</b>	Mean fuel load was significantly different between some landscape positions, however, each category had a wide spread of values. Numbered points represent site IDs of outlying values.....	136
<b>Figure 4.13</b>	The canopy area of <i>Acacia chishomii</i> increased with <i>Acacia</i> height ( $y = 56.73 \ln(x) + 152.2$ ; $R^2 = 0.8006$ , $p < 0.001$ , $n=98$ )......	137
<b>Figure 4.14</b>	The average height of <i>Acacia chisholmii</i> increased with time since fire. ( <i>Acacia</i> height was measured in cm). ....	138
<b>Figure 4.15</b>	Although mean reflectance was significantly different between shrub species, there was considerable overlap in values. Numbered points represent IDs of outlying values .....	146
<b>Figure 4.16</b>	Fuel load map for the Calton Hills study area. ....	147
<b>Figure 4.17</b>	Fuel load map for the 'Gunpowder' section of the Calton Hills study area. ....	148
<b>Figure 4.18</b>	a) The regression model over-predicted the minimum fuel load at each fire age. (Grey bars = predicted minimum, white bars = actual minimum, error bars = standard error). b) The model under-predicted the maximum fuel load at each fire age. (Grey bars = predicted maximum, white bars = actual maximum, error bars = standard error).....	149
<b>Figure 4.19</b>	On average, the regression model over-predicted fuel load by 0.7 to 1.5 t/ha across all fire ages. (Grey bars = predicted average, white bars = actual average, error bars = standard error). ....	150
<b>Figure 4.20</b>	Comparing NDVI and fuel load at each point helped to explain model bias: points with old, grey spinifex had high fuel load but low reflectance; bare ground had high reflectance but very low fuel.....	151
<b>Figure 4.21</b>	The correlation between actual and predicted fuel loads for each point was around 20% ( $R^2 = 0.2023$ , $p < 0.05$ , $n = 794$ )......	152
<b>Figure 4.22</b>	Fuel load at each sampling point was based on the average of 9 disc-drop measures. Fuel load varied considerably at each fire age .....	152
<b>Figure 4.23</b>	Bare ground was present at all fire ages .....	153
<b>Figure 5.1</b>	Ecological fire management requires consideration of the fauna present and the likely effects of fire. A decision framework to use when species have conflicting requirements would also assist. ....	163
<b>Figure 5.2</b>	Map showing the six sites (black dots) where bird surveys were undertaken inside and outside fire scars (grey). (Dashed line is powerline access track; Fire scar boundary was not available for Roxmere).....	175

<b>Figure 5.3</b>	Eleven sites (dots) within the Mt. Isa Inlier where surveys were undertaken to investigate the internal fire-patchiness requirements of fire sensitive bird species. All sites had burnt within the previous 12 months .....	178
<b>Figure 5.4</b>	Number of bird species predicted to persist (black bars), decline (grey bars), or exist at optimal levels (white bars) given different fire return intervals.....	181
<b>Figure 5.5</b>	Ordination based on the bird species sighted revealed slight clustering at the property level but not between burnt and unburnt sites. ....	182
<b>Figure 5.6</b>	Based on the bird species present, burnt and unburnt sites at Roxmere could be discriminated from one another. However, the two unburnt sites were also different from one another.....	183
<b>Figure 5.7</b>	Based on the bird species present, most burnt and unburnt sites at Bushy Park could be discriminated from one another.....	184
<b>Figure 5.8</b>	There was no clear distinction between the bird species recorded on burnt and unburnt sites at Calton Hills.....	185
<b>Figure 5.9</b>	There were differences in bird abundance in burnt and unburnt vegetation when data from all fire scars were combined .....	186
<b>Figure 5.10</b>	Indicator species were sighted more frequently during surveys of unburnt habitat (grey bars) than within fire scars (white bars).....	190
<b>Figure 5.11</b>	The distribution of patch sizes of unburnt spinifex within fire scars where the playback technique was used to survey target bird species.....	191