

2005

A Study of the Abundance, Distribution and Daily Activities of the Australian Raven (*Corvus Coronoides*) in Urban Wetland Parks

Desiree L. Moon
Edith Cowan University

Follow this and additional works at: https://ro.ecu.edu.au/theses_hons



Part of the [Ornithology Commons](#)

Recommended Citation

Moon, D. L. (2005). *A Study of the Abundance, Distribution and Daily Activities of the Australian Raven (Corvus Coronoides) in Urban Wetland Parks*. https://ro.ecu.edu.au/theses_hons/967

This Thesis is posted at Research Online.
https://ro.ecu.edu.au/theses_hons/967

Edith Cowan University

Copyright Warning

You may print or download ONE copy of this document for the purpose of your own research or study.

The University does not authorize you to copy, communicate or otherwise make available electronically to any other person any copyright material contained on this site.

You are reminded of the following:

- Copyright owners are entitled to take legal action against persons who infringe their copyright.
- A reproduction of material that is protected by copyright may be a copyright infringement.
- A court may impose penalties and award damages in relation to offences and infringements relating to copyright material. Higher penalties may apply, and higher damages may be awarded, for offences and infringements involving the conversion of material into digital or electronic form.

**A STUDY OF THE ABUNDANCE, DISTRIBUTION AND DAILY
ACTIVITIES OF THE AUSTRALIAN RAVEN
(*Corvus coronoides*)
IN URBAN WETLAND PARKS**

DESIRÉE L MOON

A Thesis Submitted in fulfilment of the Requirements for the Award of
Bachelor of Arts (Geography) Honours for the Faculty of Community
Services, Education & Social Sciences, Edith Cowan University,
Mt Lawley, Western Australia

6 JANUARY, 2005

Abstract

Habitat destruction as a result of urbanisation has resulted in the population decline of some bird species. However, the Australian Raven (*Corvus coronoides*), has adapted well to the urban environment and is thriving. Although naturally occurring seasonal food sources are at times restricted in an urban setting, this adaptive species finds alternative food sources. As carrion-eaters this includes road-kill, as well as refuse discarded on the ground and into bins. Coupled with few natural predators, the species enjoys optimal conditions for breeding and survival.

This biogeographical study investigated whether seasonal-influxes of populations of ravens cause problems at three urban wetland parks in the City of Gosnells, Western Australia. Past complaints included reports of damaging property, stealing food, attacks on pets and other birds and wildlife, notably their young.

This multi-faceted investigation of the Australian Raven explores the impacts of the species on other birds and wildlife, as well as people. It also investigates contemporary beliefs and attitudes to the species. It examines seasonal fluctuations in population densities and distribution of the species at the sites and identifies their main daily activities and interactions with other birds and animals. Finally, it explores the level of community support for population control of the species.

Interestingly, the final results do not support commonly held beliefs that ravens are vicious predators. Their main daily activities are identified as perching in trees, picking at bark and leaves, foraging on the ground for food and to a lesser extent, drinking, bathing and preening. Although acts of predation of other birds, egg stealing and food stealing were witnessed during the study, they were few and no attacks on domestic animals, or acts of property damage were recorded for the study.

The research concluded that there are populations of Australian Ravens present at all sites that fluctuate seasonally. It also identified the biggest problem associated with the Australian Raven is a poor image problem. They are unpopular, considered a sign of a bad omen, both their song and plumage considered unpleasant. But in spite of these negative perceptions the majority of people using the sites do not support population control as a means of managing the abundance of the species.

Declaration

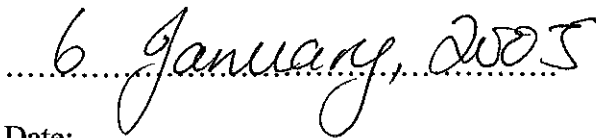
I certify that this thesis does not, to the best of my knowledge and belief:

- I. incorporate without acknowledgement any material previously submitted for a degree or diploma in any institution of higher education;
- II. contain any material previously published or written by another person except where due reference is made in the text; or
- III. contain any defamatory material

Signature:

A handwritten signature in black ink, appearing to read "Desiree L Moon", is written over a horizontal dotted line. A vertical line is drawn through the signature, extending upwards and downwards.

Desiree L Moon

A handwritten date "6 January, 2005" is written in black ink over a horizontal dotted line.

Date:

USE OF THESIS

The Use of Thesis statement is not included in this version of the thesis.

Acknowledgments

There are a number of people I would like to thank. Most importantly, my daughters Beth and Caitce Moon, for their selfless forfeiture of time and steadfast love and support throughout my studies. My sisters, most especially Steph and her husband Mario Andacich, for help with children, computers and a myriad of other things. Friends Fiona Struthers, Sharon Russell and Elaine van Halen for time-out, as well as other practical help and emotional support. Robyn Robson, Paulette Mountford, Wendy Lovell, and Michelle Jennings for all the before and after-school pickups and after-school plays. Also, to Alta Winmar for her charcoal sketch of Australian Raven. As well, other members of the Walliston Primary School community, without whom I would not have been able to complete this challenge. To Dr Hugo Bekle (Supervisor), for offering the challenge and helping me endure. Wayne van Leiven and Alice McClelland (City of Gosnells) for helping me develop a useful research topic. Members of Birds Australia (WA Inc.) and Dr Stephen Davies for ornithological advice. Special thanks to Matthew Williams (Conservation and Land Management Science Research Division) for assistance with the analysis of biological population data. To Edith Cowan University employees for the provision of research advice, information technology expertise and document delivery services. To all those who offered support and assistance, you have my enduring gratitude. Thank you.

Table of Contents

ABSTRACT	2
DECLARATION	3
USE OF THESIS	4
ACKNOWLEDGEMENTS	5
TABLE OF CONTENTS	6
1. INTRODUCTION	
1.1 Justification for the Study	10
1.2 Relevant Literature	11
1.3 The Present Study	15
2. METHODOLOGY	
2.1. Site Survey	17
2.2. Abundance and Distribution	18
2.3. Daily Activities and Interactions	22
2.4. Community Attitudes Survey	23
2.5. Species Lists	23
3. THE AUSTRALIAN RAVEN	
3.1. Nomenclature and Recognition of Species	24
3.2. Description of Type	25
3.3. Distribution and Abundance in Australia	27
3.4. Behaviour and Breeding Habits	30
3.5. Habitat selection and Food	38
4. STUDY SITES	
4.1. Site Selection	44
4.2. Common Site Characteristics	44
4.2.1. Landforms	45
4.2.2. Climate and Weather	45
4.2.3. Vegetation	47
4.2.4. Fauna	47
4.2.5. Public Use Areas	48
4.3. Specific Site Descriptions	49
4.3.1. Mary Carroll Park	51
4.3.2. Pioneer Park	55
4.3.3. Southernwood Park	59

5. COMMUNITY ATTITUDES TO THE AUSTRALIAN RAVEN AT THE STUDY SITES	
5.1. Introduction	63
5.1.1. Folklore and History	63
5.1.2. Contemporary Portrayals	65
5.2. Community Attitudes Survey	67
5.2.1. Revision of methods	67
5.3. Data Analysis	68
5.4. Results and Discussion	68
5.5. Conclusion	73
6. ABUNDANCE AND DISTRIBUTION OF THE AUSTRALIAN RAVEN AT THE STUDY SITES	
6.1. Background	74
6.2. Data Analysis	75
6.2.1. Abundance	75
6.2.2. Distribution	79
6.3. Results and Discussion	79
6.3.1. Abundance	80
6.3.2. Distribution	85
6.4. Conclusion	92
7. DAILY ACTIVITIES AND INTERACTIONS OF THE AUSTRALIAN RAVEN AT THE STUDY SITES	
7.1. Background	93
7.2. Data Analysis	94
7.2.1. Daily Activities	95
7.2.2. Interactions	95
7.2.3. Flight Entry and Exit Patterns	95
7.3. Results and Discussion	96
7.3.1. Daily Activities	96
7.3.2. Interactions	104
7.3.3. Flight Entry and Exit Patterns to and from Sites	107
7.4. Conclusion	108
8. DISCUSSION OF OUTCOMES	
8.1. Review of Hypothesis and Research Questions	109
8.2. Concluding Statements	112
8.3. Guiding Principles	116
BIBLIOGRAPHY	119

LIST OF TABLES:

4.1	Estimated coverage of five habitat types present at each site	50
6.1	Comparison of Detection Function Models	76
6.2	Detection Function / Chi-square Goodness of Fit Test	78
6.3	Comparison of Distance Analysis and actual counts estimates	81
6.4	Estimated extent of vegetation types present at each site	85
6.5	Extent of vegetation in transects preferred by ravens	91
7.1	Daily Activity Budget: Site and seasonal summary	102
7.2	Frequency of Interactions between ravens and other birds	104

LIST OF FIGURES:

2.1	Transect methodology diagram	20
3.1	Frequency of Australian Raven observations in Perth	29
5.1	Community Attitudes Survey: Extent of site usage	70
5.2	Community Attitudes Survey: Views on abundance	70
5.3	Community Attitudes Survey; Ravens threat to other birds	71
5.4	Community Attitudes Survey: Ravens threat to other wildlife	71
5.5	Community Attitudes Survey: Ravens nuisance when using site	72
5.6	Community Attitudes Survey: Views on population control	72
6.1	Initial plot of population data (and probability of detection)	77
6.2	Subsequent plot incorporating adjustment for evasive movement	77
6.3	Graph depicting statistically significant differences	80
6.4	Mary Carroll Park: Population distributions, January-May	86
6.5	Mary Carroll Park: Population distributions, June-October	86
6.6	Pioneer Park: Population distributions, January-May	87
6.7	Pioneer Park: Population distributions, June-October	87
6.8	Southernwood Park: Population distributions, January-May	88
6.9	Southernwood Park: Population distributions, June –October	88
6.10	Mary Carroll Park: Population distributions, entire study	89
6.11	Pioneer Park: Population distributions, entire study	89
6.12	Southernwood Park: Population distributions, entire study	90
7.1	Activity Budget Summary, Mary Carrroll Park: January to May	97
7.2	Activity Budget Summary, Mary Carrroll Park: June to October	97
7.3	Activity Budget Summary, Pioneer Park: January to May	98
7.4	Activity Budget Summary, Pioneer Park: June to October	98
7.5	Activity Budget Summary, Southernwood Park: January to May	99
7.6	Activity Budget Summary, Southernwood Park: June to October	99
7.7	Activity Budget Summary, Mary Carrroll Park: January to Oct.	100
7.8	Activity Budget Summary, Pioneer Park: January to Oct.	100
7.9	Activity Budget Summary, Southernwood Park: January to Oct	101
7.10	Activity Budget Summary, all sites: January to October	103
7.11	Interactions Summary: List of species involved	105

MAPS:

1.1	Location of study sites within the City of Gosnells	16
2.1	Mary Carroll Park, Transect Boundaries	21
2.2	Pioneer Park, Transect Boundaries	21
2.3	Southernwood Park, Transect Boundaries	21
3.1	Abundance Distribution of Australian Raven in Australia	27
4.1	Aerial photograph of Mary Carroll Park	52
4.2	Aerial photograph of Pioneer Park	56
4.3	Aerial photograph of Southernwood Park	60
7.1	Flight Entry and Exit Patterns: All sites	107

PLATES:

3.1	Mature Raven	26
3.2	Immature Australian Raven, aggressive calling stance	26
3.3	Australian Ravens, pair, allo-preening	35
3.4	Flight: group of Australian Ravens leaving roosting place	35
3.5	Nest tree, Australian Raven, Transect 8, Southernwood Park	37
3.6	Nest tree, Australian Raven, Transect 11: Southernwood Park	37
3.7	Caterpillars in Eucalypt used by the Australian Raven	41
3.8	Caterpillars in Eucalypt used by the Australian Raven	41
3.9	The Australian Raven ground feeding, Pioneer Park	41
3.10	Preferred transect showing vegetation, Mary Carroll Park	42
3.11	Preferred transect, showing vegetation, Pioneer Park	42
3.12	Preferred transect, showing vegetation Southernwood Park	43
3.13	Type of vegetation complexes avoided, Southernwood Park	43
4.1	Effects extreme hydrology regime, Mary Carroll Park	46
4.2	Algal blooms and Pioneer Park and Southernwood Park	46
4.3	Playground and picnic area, Mary Carroll Park	54
4.4	Amphitheatre and picnic area, Pioneer Park	58
4.5	Playground, picnic area and tennis courts, Southernwood Park	62
5.1	Cartoon depicting some <i>crows</i> , in <i>The West Australian</i>	69
5.2	Charcoal sketch of the Australian Raven	73
7.1	Red Wattle Bird chasing Australian Raven, Pioneer Park	106

APPENDICES

A	Fieldwork Roster	130
B	Fieldwork Record: Population Data	131
C	Fieldwork Record: Activity Budget	132
D	Fieldwork Record: Interactions/Entry & Exit/Species List	133
E	Community Attitudes Survey: Questionnaire	134
F	Community Attitudes Survey: Consent Form	135
G	Species List: All Sites	136

CHAPTER ONE: INTRODUCTION

1.1 Justification for the Study

The genus *Corvus* has been listed as one of the major avian pests of the world (Mawson, 1995). This world-view is equally relevant in Perth, Western Australia as there are many incidents reported concerning the native Australian Raven (*Corvus coronoides*). The species has increased in abundance in the area; a fact supported by both Atlas and Perth Metropolitan Bird Survey data. This increased abundance has raised concerns within the community, as they are considered predatory toward smaller birds and steal eggs (Cayley, 1970; Hill, 1970; Saunders & Ingram, 1995; Schodde and Mason, 1999; Stewart, 1997).

Discussion with the Department of Conservation and Land Management (CALM), Birds Australia (BA) and several local councils confirmed that all of these organisations received complaints about Australian Ravens. In particular, the Environmental Officer at City of Gosnells was concerned about reports of ravens attacking other birds and raiding nests at local wetland parks. Three sites were mentioned: Mary Carroll, Pioneer and Southernwood Parks (see page 16). Although quite small, each serves as a wildlife corridor. Such urban parks support remnant bush and riparian vegetation unique to the area and help maintain local bio-diversity.

However, many callers complained the presence of the Australian Raven detracted from the aesthetics of these parkland areas and suggested population control of the species may be necessary (Alice McLelland, pers. comm., October 13, 2003). Culling of problem species, such as the Australian Raven, represents an extreme response to a problem that warrants further investigation.

Essentially this study is a *biogeographical* study of the Australian Raven. It explores the birds' behaviours and movements over time and space. It attempts to identify spatial variability in seasonal abundance and distribution of the species, as well as examine their activities and interactions within this framework. Further, the study considers human attitudes toward the species, as well as how the presence of ravens at the sites impacts on site use.

This study, unlike others previously conducted, is unique as it uses Distance Sampling Methodology to estimate Abundance of the species at each specific site. Previous studies have been less rigorous in their methodology. For example, abundance data used by Stewart (1997) is calculated on the Australian Bird Count (1989-1995) and the Perth Metropolitan Bird Survey (1996) data. Similarly, Suzanne Cumming (n.d., unpublished Doctoral Thesis) relied on data collected in these generalised surveys. Another aspect that sets this study apart from these others is its setting, in parklands. Areas supporting limited natural habitat, confined by larger areas significantly modified for human use. Previous studies were conducted in different settings, such as in Kings Park, a larger park that supports substantial remnant vegetation (Stewart, 1997), or on streetscapes (Cumming, n.d., unpublished Doctoral Thesis).

1.2 Literature Review

There were several aspects to acquiring the relevant literature for this study. The first: how to study and identify the birds of Perth. The preferred field-guide chosen for the study is Pizzey and Knight (1997), although others were consulted occasionally (Bell, 1969; Cayley, 1970; Slater, 1975; Serventy and Whittell, 1976; Pizzey, 1980 and 1997; Beruldsen, 1980). General books on the bird-life of Perth were also reviewed (Balmford, 1980; van Delft, 1997), as were several university dissertations (Mawson, 1995; Mansell, 1997; Stewart, 1997). Other references were obtained to develop a general understanding of corvine behaviour and how it related to their survival (Hill, 1970; Goodwin, 1977; Curry 1978; Debus, 1995; Strahan, 1996; Moss, 1996; Forshaw, 1998 and Schodde and Mason, 1999). Articles and books specifically on the Australian Raven were consulted (Blakers, Davies and Reilly, 1984; Saunders and Ingram, 1995 and Debus, 1996) giving useful insights into all aspects of the species. Detailed studies of the Australian Raven by Rowley were reviewed (1967*a* 1967*b*; 1970; 1973 and 1974), as well as another co-written article, Rowley and Vestjens (1973). These are not recent, but have not been surpassed by any more recent studies. More recently Barker and Vestjens (1990) examined the food of the Australian Raven.

Significant texts dealing with bird behaviours and displays included Armstrong (1947, 1975); Brooke and Birkhead (1991), and Barber, (1993). Studies on predation were also reviewed (eg Andren, 1992; Bayley and Blumstein, 2001; Berry, 2002; Luck, Possingham and Paton, 1999; Matthews, Dickman and Major, 1999; Thorington and Bowman, 2003; and Weidinger, 2002). Of the numerous nest predation studies identifying the Australian Raven as nest predators, the majority were conducted with artificial nests (eg Andren, 1992; Major, Gowing and Kendal, 1996; Major and Kendall, 1996; Fulton and Ford 2001; and Berry, 2002).

Analysis of artificial nest experiments has found higher predation rates for artificial nests than natural ones (Berry and Lill, 2003), with the accuracy of results being questioned by some authors (eg Luck, Possingham and Paton, 1999; Bayley and Blumstein, 2001; and Pärt and Wretenberg, 2002). Predation by non-avian species such as cats, rats and possums was also considered (eg Major *et al.*, 1996; Luck *et al.*, 1999; Mathews, Dickman and Major, 1999; Weidinger, 2002; Berry and Lill, 2003; and Thorington and Bowman, 2003).

Studies on human-induced habitat were reviewed and show that these areas favoured large, aggressive birds, and over abundance of a species is likely to be the result of habitat change (Emlen, 1974; Cambell and Dagg, 1976; Lancaster and Rees, 1979 and Edgar and Kershaw, 1994). Another study emphasised that over-abundant species are usually non-native (Marzluff, Gehlback and Manuwal, 1998). The factors resulting in over abundance in bird species are complex and continue to challenge researchers (Recher, 1972; Green, Catterall and Jones; 1989, Paton, 1990; Catterall, Green and Jones, 1991; Hoskin, Hindwood and McGill 1991).

Several texts on fauna survey techniques were also consulted to assess the technique best suited to this study, including Davies (1984); Bibby, Burgess and Hill (1992); Sutherland (1996); and Bibby, Jones and Marsden, (1998). Ultimately, Line Transect Methodology was the approach chosen as the most appropriate for this study. Other literature dealt with seasonal change and time of day on animal survey data (Armstrong, 1963 and Best, 1981), as “the timing of the counts is an essential factor that influences accuracy and comparability” (Skirvin, 1981, p.271).

The method, in use for over 50 years, was re-worked and presented by Emlen (1971) incorporating concepts put forward in earlier studies (Leopold, 1933; Kelker, 1945 and Gates, 1969). This method used variable-strip widths to collect survey data, with the basic assumption that all objects of interest in the area surveyed were seen. The data analysis used a 'Co-efficient of Detection' function to calculate overall abundance. The concept was later modified to improve estimator efficiency (Ramsey and Scott, 1981), and introduced a 'Cumulative Detection Curve'.

In spite of modifications it was labeled *ad hoc* (Franzreb, 1981, p144). In response to weaknesses, model robustness and estimator efficiency improved, resulting in the evolution of Distance Estimation. The new approach, pioneered in a paper by Gates, Marshall and Olsen (1968) gained the attention of researchers and was further developed by Anderson, Burnham and Crain (1978*a*, 1979*b* and 1980*c*), re-worked in a paper by Burnham, Anderson and Laake (1980) and improved by Buckland (1987). It was then presented again by Buckland, Anderson, Burnham and Laake (1993) resulting in a definitive text that is still in use. This burgeoning methodology was assisted by computer software programs to aid data analysis. The first, TRANSECT (Laake, Burnham and Anderson (1979), followed by LINETRAN, (Gates, 1980) and finally, DISTANCE, by Laake *et al.* (1993). The software and manual are free at: <http://www.ruwpa.st-and.ac.uk/distance/>.

The methodology attracted favourable peer review (Bell and Ferrier, 1984; Shields and Recher, 1984; Cassagrande and Beissinger, 1997; Wilson, Twedt and Elliott, 2000 and Pollock, Nichols, Simons, Farnsworth, Baily and Sauer, 2002). However, the approach did not avoid some criticism (Watson, 2003 and Franzreb, 1981), with critics saying the technique tended to under-estimate abundance compared with other methods (Hilden, 1981, Tilghman and Rusch, 1981). Others though found no major differences (Burnham, 1981 and Edwards, Dorsey and Crawford, 1981).

An extension of planning the *methodology* was planning the *analysis*. An introductory text on parametric and non-parametric procedures was first consulted (Sheskin, 2000); an article by Hone (1991) summarised the most popular analyses used in animal surveys. These were investigated in Dytham (2003) who presented data analyses in the context of computer software programs in use in the social sciences.

The Community Attitudes Survey (CAS) was developed after reviewing several books and articles (Oppenheim, 1966; Moser and Kalton, 1971; Harris, 1995). Historical and contemporary portrayals of the species were also reviewed (Armstrong, 1975; Torres, 1987; Mansell, 1997; Stewart, 1997; Carson and Sams, 1999).

The remainder of the literature review relates to site information. Beard (1990) provided a useful overview of the area's climate and landscape. Several State and Local government reports were available on Mary Carroll Park (Semeniuk, 1988; Hill, Semeniuk, Semeniuk and Del Marco, 1996; Lund, 1998 and Greenskills, 2004). A thesis on the wetland (Pedersen, 1995) gave accurate descriptions of the sites. Vegetation at the other sites was investigated in Powell (1990) in his text on the trees and shrubs of Perth and in Hussey, Keighery, Cousens, Dodd and Lloyd (1997), an extensive guide to the weeds of Western Australia. Other site information came from the Internet on the Waters and Rivers Commission (WRC) web-site that overviewed the precincts identified in *Bushplan* (incorporating the *Urban Bushland Strategy* (1995); the Perth Environment Project; System Six Report (1983) and Update program; as well as various reports by CALM and the WRC). Fortunately Pioneer Park (Precinct 19) and Southernwood Park (Precinct 23) were included.

This concludes the review of literature consulted in preparation for the planning and execution of this study. The Internet was also used extensively with all sites accessed listed throughout the text and included in the end text references.

As a result of this extensive background reading it was hoped a meaningful study would develop. A study likely to produce reliable outcomes, due to the application of sound methodologies: each designed to investigate specific aspects of the research.

1.3 The Present Study

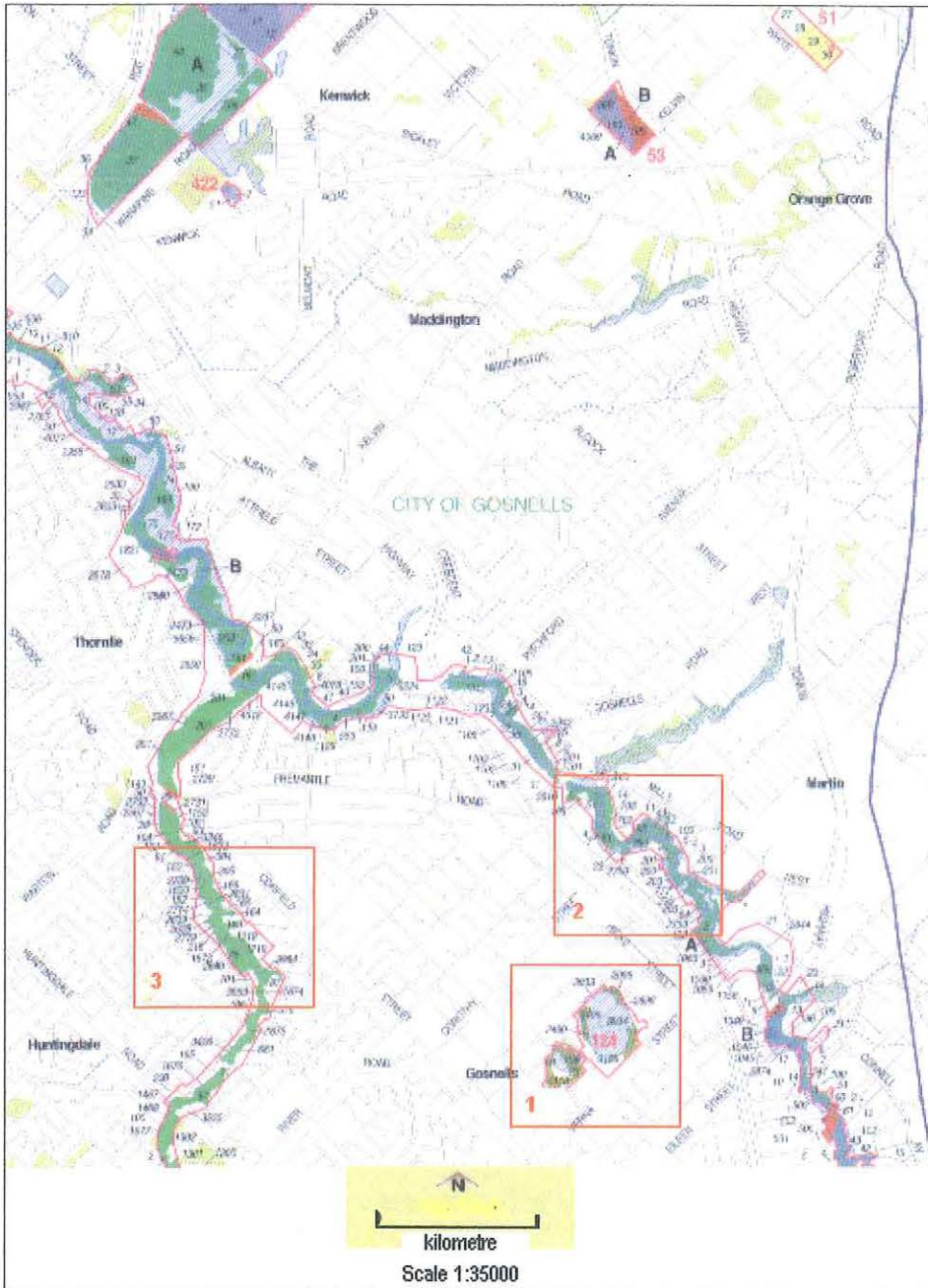
The first and second research questions aim to estimate the abundance and distribution of the Australian Raven in the three defined study areas, Mary Carrell Park, Pioneer Park and Southernwood Park, all located in the City of Gosnells (refer Map 1.1 Map Sheet No. 55, *Bush Forever Report*). The third research question seeks to identify the types and frequencies of the main daily activities of ravens and their interactions with other species of birds and wildlife at each site. The fourth question investigates community attitudes towards ravens at the study sites, whilst the fifth, and final question attempts to identify and record as many of the other bird and wildlife species present at each site. Whilst not central to the research, it seemed prudent to recognise the other species found at the sites. Overall, the study design is intended to collect data to either sufficiently prove or disprove the hypothesis that:

Seasonal increases in the abundance of Australian Ravens at the study sites diminishes each areas aesthetic and recreational values, and threatens other wildlife to such an extent the community supports population control (culling) of the species.

To fully investigate the hypothesis, four questions were formulated:

1. What are the estimated seasonal abundances of the Australian Raven at the study sites?
2. What seasonal differences are there in the distribution of Australian Ravens at the study sites?
3. What are the main daily activities and interactions between Australian Ravens and other species at the study sites?
4. What are the views of held by those using the sites for recreation toward the presence of the Australian Raven at each of the study sites?
5. What are the other birds and wildlife are present in each of the study sites?

The following chapter outlines the various methods used to obtain the data collected in relation to each of these research objectives.



Map 1.1 Map showing regional location of study sites in the City of Gosnells. Site 1: Mary Carroll Park; Site 2: Pioneer Park and Site 3: Southernwood Park (Adapted from *Bush Forever*, 2000, Map Sheet No. 55).

CHAPTER TWO: METHODOLOGY

2.1 Site Survey

This population survey and behavioural study of the Australian Raven was conducted with the approval of the Animal Ethics Committee, Edith Cowan University, in accordance with recommended guidelines. The survey design allowed for forty, ninety-minute surveys to be conducted at each site, equally in the summer/autumn period as in the winter/spring period and were conducted fortnightly, on one week and one weekend day (rotating) (Refer Appendix A, Fieldwork Schedule).

Survey times were staggered with each site receiving a minimum of thirteen visits conducted at one of three different time intervals: AM sessions (starting no later than one hour following sunrise), MIDDAY sessions (starting one hour either side of the zenith), and PM sessions (commencing no more than hour before sunset). A table of perpetual sunrise-sunset times, based on local time, was consulted prior to each survey (<http://www.southcom.com.au/~cengiata/au-locat.htm>).

Fieldwork data sheets were filled in at the start of each survey and included day, date and time of visit, (as well as time of corresponding sunrise, zenith or sunset), and weather and wind conditions. The first survey at each site commenced at Transect 1 and finished at Transect 13, with subsequent visits commencing at opposite ends. All line transects were walked at a moderate pace, to cover all the pre-determined distance intervals. Population data were collected during the initial sweep of the site only. On the return sweep, a fifteen-minute activity budget was recorded.

Other data recorded for the duration of the survey included interactions with other species and flight of ravens entering and exiting sites. Other birds and animal species present at the sites were also recorded. A short Community Attitudes' Survey was also conducted. The methods for all will be explained more fully later in the chapter.

Equipment required (other than for record keeping) included binoculars (8x30 magnification); field guide (Pizzey and Knight, 1997); prismatic compass, 35mm camera, and a small tape recorder for taking site notes while walking.

2.2 Abundance and Distribution

Primarily the focus of the study is to ascertain the Abundance where random plots are defined in an area (A) and counts taken (N), so effectively density (D) is measured as $D = N/A$. Distance sampling, an extension of this, uses three main survey designs: strip, line and point transects. Line Transect Methodology was chosen as it is well-reviewed (Casagrande and Beissinger, 1997; Wilson, Twedt, Elliot, 2000) and suited the purposes of the study (Refer Appendix B, Fieldwork Record: Population Data). The principles of data collection are shown in Figure 2.1.

The method is based on several critical assumptions, listed in order of importance below (Anderson *et al.*, 1979):

1. Objects directly on the line will never be missed i.e. $g(0) = 1$;
2. Points are fixed at the initial sighting position, no movement before or after;
3. Distance and angles are measured accurately; and
4. Sightings are independent events.

These assumptions must be met or model robustness is undermined. They are best met by following set fieldwork procedures, listed below in order of importance:

1. The centre-line of the transect must be well marked;
2. Observer, at all times, must strictly adhere to the centre-line of the transect (so objects are seen with probability equal to 1);
3. Treat width of transect as unbounded (discard unnecessary outlier data);
4. All measurements and distances must be accurate (poor measurements and rounding errors lead to unreliable estimates);
5. All necessary measurements should be taken;
6. Measurements to be recorded separately for each segment (of the total transect length);
7. As a practical minimum survey design should assure at least 40 objects ($n > 40$) are seen, with enough length to allow up to 60-80 objects ($n > 60-80$);
8. A pre-survey to aid survey design (to assess basic biological information about the animal and its habits and habitat);
9. Assure the population sampled is not correlated with the sample line transects (avoid transects on roads and streams); and
10. The survey to be conducted using competent, interested observers (based on Anderson *et al.*, 1979).

Every effort was made to meet the criteria fully, but some of the above assumptions were compromised:

- Assumption 4: Only the perpendicular distance was recorded as the method stood up to robust analysis without the other measurements;
- Assumption 7: The minimum objects detected in individual surveys at times fell below the expected minimum, but combined reached the 40 objects ($n > 40$ minimum) and ($> 60-80$ best);
- Assumption 9: The population survey was correlated along the sample line transects at some points as the centre-line for the transect followed paths and watercourses in the survey area; and
- Assumption 10: The final weakness lay in the observer, who although competent and interested, was without experience.

Despite some minor breaches of the ten assumptions, the robustness of the data collection was verified by a bio-statistician for the Department of Conservation and Land Management, Matthew Williams, and ornithologist, Dr Stephen Davies.

Each site was allocated thirteen, one hundred and fifty metre (m) line transects (a total of 1950m), covering the entire site. During the pilot surveys conducted in early January transects were defined using a 'measuring wheel' and marked with a surveyors' tape, with both transect route and boundaries identified (Refer Maps 2.1, 2.2 and 2.3).

The only exception is Southernwood Park, where four sections were not surveyed. The first was an area between Jenkinson Street and Baron Way (separating Transects 6 and 7) that included the buildings, grounds and carpark of the Richard Rushton Community Centre that cut into the site. The other was an area, between Dobell and Balfour Streets (separating Transects 10 and 11) that contained a private residence; and had been subjected to a fire (the Fire & Emergency Services Authority WA confirmed they attended a substantial fire at the site on 27 December 2003). Also this site was slightly larger than the other sites, so omitting these areas made the total areas surveyed at each site close to equal in size.

Running parallel to each of the line transects were nine fixed-width distance zones, assigned to record the distance of the 'object of interest' from the observer (0-5m, 5-10m, 10-15m, 15-20m, 20-25m, 25-30m, 30-50m, 50-100m, 100m+). As accuracy was essential each of these zones were also measured and identified with markers during the pilot study.

Figure 2.1 Transect Methodology Diagram

L = transect line

Z = position of observer

X = position of object

W = strip width (1/2)

r_i = sighting distance (flushing distance)

θ_i = (theta) = sighting angle

y_i = perpendicular distance (note: $y_i = r_i \sin \theta_i$)

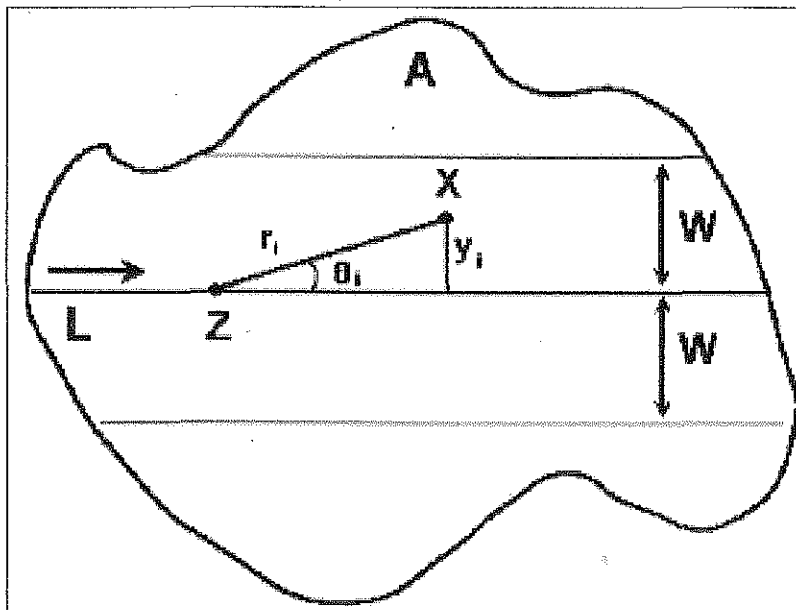
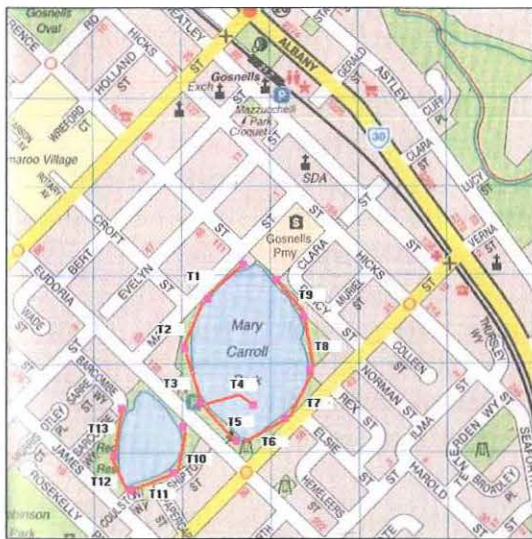


Figure 2.1 Transect Methodology Diagram

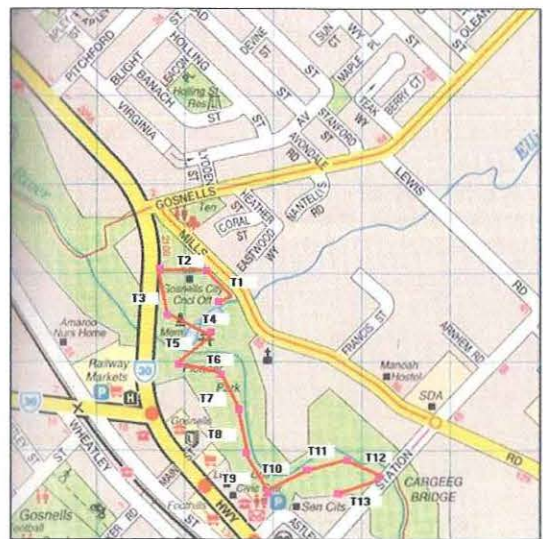
For this study the observer walked closely along the centre of the transect line and recorded the perpendicular distance at which the 'objects of interest', the Australian Raven, were located. Each detection was not measured individually, rather each was assigned to one of nine distance zones, from 0-5m, 5-10m, 10-15m, 15-20m, 20-25m, 25-30m, 30-50m, 50-100m, 100m+. The total detections were then graphed to commence Distance Estimation analysis. (from Fish & Wildlife Population Ecology at <http://www.cnr.uidaho.edu/wlf448/lab5line.htm>).

The other way in which population data were recorded was in relation to age (ie mature ravens have white eyes, immature ravens have dark eye colour). This was to show if ravens present were likely resident breeding birds, or nomadic juveniles. Care was taken to avoid counting birds more than once and birds in flight were not recorded unless a take-off point perpendicular to a transect was recorded.

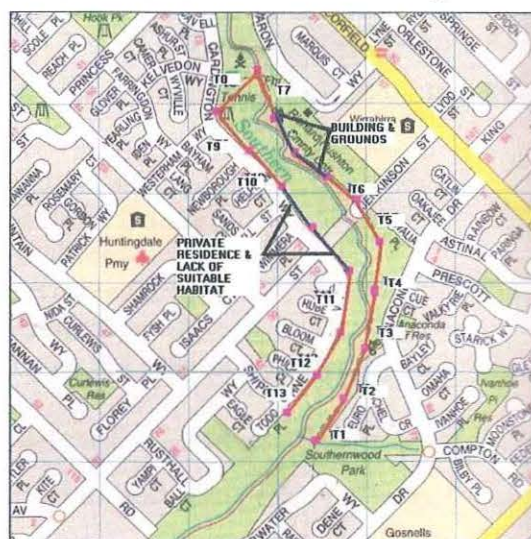
Each transect was traversed strictly down the centre line to ensure the *detection function* ($g(y)$), the probability of detecting an object given its distance (y) from the random line or point (or $\text{Probability} = \{\text{detection} / \text{distance } y\}$) was not compromised. The method assumes detection decreases with increasing distance, $0 \leq g(y) \leq 1$ always, so objects on the line are seen with certainty, a probability of 1.



Map 2.1 Mary Carroll Park



Map 2.2 Pioneer Park



Map 2.3 Southernwood Park

(All transect maps adapted by Desiree Moon from Perth UBD, 45th Edition, 2003)

2.2 Daily Activities and Interactions

The methodologies for this part of the study were not replicated from a particular template, but evolved from a process. In order to record times spent in particular daily activities by the Australian Raven, firstly, likely daily activities to occur were listed and set to a 15 minute timetable, in one-minute increments. On the return sweep of the survey, the first ravens encountered were observed and each incident of an activity scored as it occurred, multiplied by the number of ravens conducting the activity, then tallied to reach a total count (Refer Appendix C, Fieldwork Record: Activity Budget). Ten main categories of activities were listed:

- (i) foraging on ground;
- (ii) perching in tree or shrub;
- (iii) flying;
- (iv) plant and tree destruction;
- (v) property damage;
- (vi) scavenging at bin;
- (vii) scavenging at litter on ground;
- (viii) stealing food;
- (ix) raiding nests and egg stealing; and
- (x) Other – not previously listed.

The methodology for recording interactions between the Australian Raven and other species was developed using a similar process. A list of anticipated interactions was compiled and set against a scoring system. As interactions occurred they were scored according to who initiated the action. Possible interactions were:

- (i) initiate attack;
- (ii) victim of chase;
- (i) victim of attack;
- (ii) raven cause death;
- (iii) death of raven;
- (iv) Other not previously listed.

The final aspect of daily activities investigated were flight patterns of the Australian Ravens coming into and going from the sites. Data collection was based on taking the directional bearing from which ravens either entered or exited the site, as well as the numbers travelling (Refer Appendix D Fieldwork Record: Interactions/Entry and Exit Points/Species List).

2.4 Community Attitudes Survey

This aspect of the study served to identify the community's views on the Australian Raven at the study sites. The format selected for the questionnaire was a five point Likert Scale (Refer Appendix E, Community Attitudes Survey: Questionnaire). Such questionnaire design measures responses according to a "ordinal and an interval scale"(Harris, 1995, p.16), on a scale ranging from strongly agree to strongly disagree (p.16). The final questionnaire consisted of eight questions and covered site use, recognition of species, participants' views on abundance, perceived level of threat by the Australian Raven toward other birds and wildlife at the sites, and participants' views on population control. It also asked participants to share anecdotes of any encounters they may have experienced with the Australian Raven at the site, or any other location.

The Community Attitudes Survey commenced in February, 2004 after first obtaining ethical approval from the Faculty of Community Services, Education and Social Sciences Ethics Committee, Edith Cowan University, with approval subject to the observance of certain ethical procedures. The main consideration was that all participants were to be provided with a covering letter (Appendix F, Consent Form) including information about the research project and advice on how the results were to be used and stored. The letter was to also clearly state the terms of participation: voluntary participation, assurance of confidentiality, and anonymity, as well as list the names of the Researcher, Principal Supervisor and Programme Director (including contact telephone numbers so queries could be dealt with). No incentives, financial or otherwise were offered to participants, all of whom were selected from people present at each of the study sites at the time population surveys of the Australian Raven were being conducted.

2.5 Species Lists

Species present at each site were recorded under their common name for the duration of each visit. All interim lists were then compiled into final comprehensive lists for each site, stating the species' common and scientific names (Refer Appendix G, Avian Species List: All sites).

CHAPTER THREE: DESCRIPTION OF TYPE

3.1 Nomenclature and Recognition of Species

The Australian Raven *Corvus coronoides* was first named by Vigors and Horsfield (1827). Then Sharpe (1877) separated two forms, interpreting the *coronoides* specimen as having a white feather base, calling it *crow*, and the other, *Corone australis*, became *raven*, but this altered when included in Mathews' (1912*a* and *b*) listing of Australian *Corvus* species. At the same time Ogilvie-Grant (1912) re-examined a specimen at the British Museum and realised an error had been made, and it was in fact *coronoides*, the *raven* that had the grey feather bases. Stresemann (1916) amalgamated many Australian corvids and others into *Corvus coronoides*, with Meinertzhagen (1926) recognising only two subspecies, *coronoides* amongst them. Further investigations were carried out for the next few decades (Hartert, 1929; Stresemann, 1943; Dorst, 1947 and Vaurie, 1958). It was Vaurie, as editor of a *Checklist of birds of the world* (1962) that included *Corvus coronoides*, the Australian Raven and began circulating the name by which it is currently known. Future updates by Rowley (1967*a*, 1967*b*, 1970) were substantiated by Goodwin (1977) and Christidis and Boles (1994) and gained further acceptance later in Schodde and Mason (1999).

In Western Australia the species was subject to further classification challenges, with the species split into *Corvus coronoides perplexus* by Mathews (1912*a* and *b*); Stresemann (1943); Vaurie (1962) and Rowley (1970) (Schodde and Mason, 1999). The most significant difference according to Mathews (1912*a*) is "its much smaller size" compared to other *C.c. coronoides* (p.442). Its song is also deeper, more guttural (Debus, 1995).

The species has also attracted several native names: Warrdong, Kwaggum, Queg-gum, Par-dang, Wur-dang, Woordang, Warrdong (Serventy and Whittell, 1976). But to most local people, the large, loud, native black birds are simply *crows*.

3.2 Description of Type

The Australian Raven is a large, distinctive bird, well known for its maudlin plumage. They are not simply *black*, but several shades of it (Rowley, 1967a, p.193-p.196). The *blackness* of their plumage seems suited to the “terminal, long drawn-out gargle” (p.197) they blast out. Lasting about four seconds, it is a “loud, wailing aah-aah-aah-aaaaaaaahh, drawn out, descending” (Pizzey and Knight, 1997, p.470).

Yet at times its harshness seems incongruous against the gentle chuckling, a “baby-like wavering wail” (p.470) often shared between peers, and partners. During aggressive calling the long hackles and gular pouch, situated under the lower mandible, distends and raises, causing the hackles to fan, giving the species “a most characteristic profile” (Rowley, 1967a, p.199). This distinctive call accompanied by a lowering of the head, to a point “that the head, body and tail are nearly horizontal... and the long pointed ‘hackles’ are conspicuous on the bulging throat” (Cayley, 1987, p. 146).

The species shares another unusual feature with other members of the genus *Corvus* in Australia, “a distinctively white iris with blue inner ring in adults” (Schodde, 1999, p.605). This noticeable feature is not acquired until the bird is mature, ready to breed, at about three years. The eye colour of juveniles changes each year as they develop.

As nestling they begin life with deep-blue eyes, changing to brown in the non-breeding first year, into a lighter hazel by non-breeding second or third year, changing to white when mature (Rowley, 1970, p.33). Juveniles also lack the “ornamental plumes” (p.39) that fan out when the bird is calling. The mean length of the feathers of the throat hackles grow to about 50mm males, 47mm females; the primary and secondary feathers of the wing, 373mm males, 359mm females, and the tail feathers 240mm male, 220mm female (p. 47). The mean weight of the species: Males 675g and females 615g. The bill is proportionate to the bird, both long and solid (mean males 56mm and females 53mm). The feet, like the feathers, are black (Rowley, 1970, p.47).



Plate 3.1 A Mature Australian Raven

Note the white eye colour of breeding birds aged over 3 years, and the distinctive throat hackle feathers covering the gular pouch under the chin (Photograph G. Chapman, in Strahan, 1996).

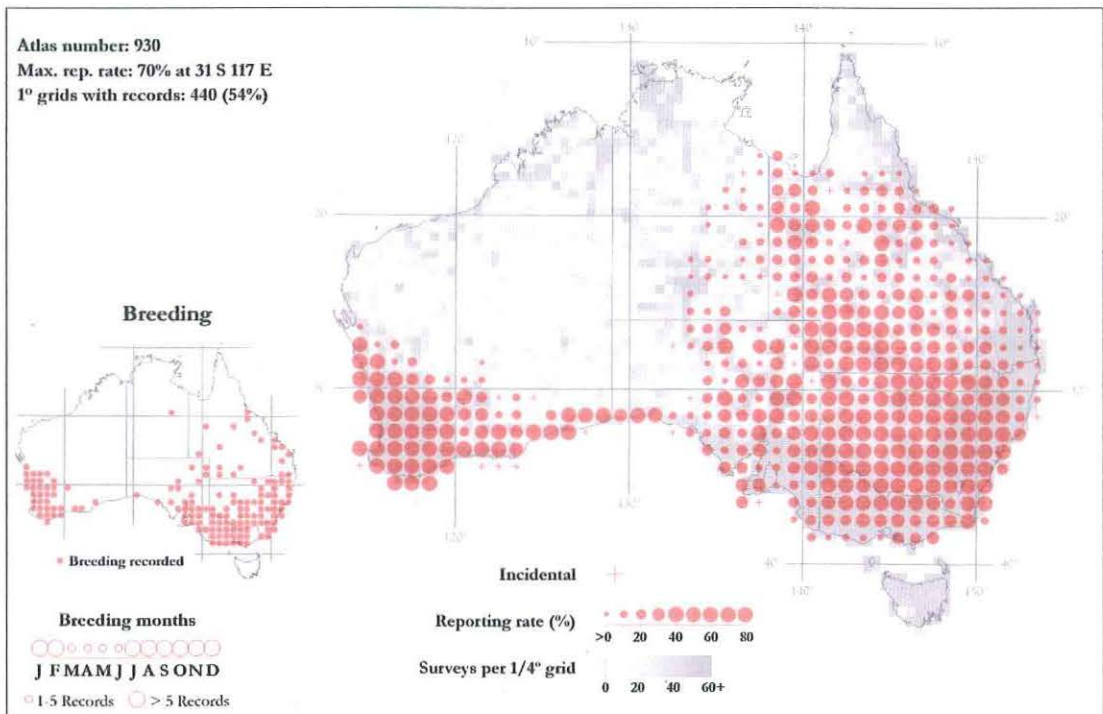


Plate 3.2 An Immature Australian Raven: Aggressive Calling Stance.

Aggressive, territorial calls consist of long drawn-out *rah-rah-raaaa-aaaahhk* sounds lasting about 4 seconds. When calling, the long throat-hackle feathers fan out from under the chin, and the tail drops until almost horizontal, giving the species a most distinctive profile. Note the dark eye colour of juvenile birds' aged less than 3 years (Photograph by A. Henley in Strahan, 1996).

3.3 Distribution and Abundance in Australia

The Australian Raven is considered common in Perth and Sydney. Within Australia it extends from the coastal regions of the Eastern States, both New South Wales and Victoria. It spreads from the southern regions of South Australia, along the Great Australian Bight into south-west Western Australia, inland to Menzies and up the coast to Shark Bay. It is largely absent from Cape York Peninsula, and occurs in sparse populations in Queensland. In Eastern Australia the distribution has been found to parallel that of sheep. This is likely related to the availability of carrion and because short-grass pasture provided for the sheep, is “very attractive to ravens hunting insects and lizards” (Rowley, 1970, p 48) (refer Map 3.1).



Map 3.1 Map indicating abundance and distribution of the Australian Raven. This excerpt from *The New Atlas of Australian Birds* (Barrett *et al.*, 2003), shows the species is most heavily distributed across the Eastern States, into the Great Australian Bight and the south-west of Western Australia. It is absent from the Kimberley region of Western Australia, Cape York Peninsula, Northern Territory, and in some areas of Far North Queensland. In the southern areas of Queensland and Northern Territory, there are only limited populations present. The species is considered ‘common’ to Perth and Sydney.

In Western Australia *C. coronoides* does not follow sheep farming to the same degree, and are not recorded inland in drier areas, as are the sheep. The populations of the south-west are older stock that “lack the colonizing vigor so often typical of the species” (p. 48). Although found throughout Australia, there are differences between the Australian Raven found in the eastern states to that found in the west. The western sub-species, *C.c. coronoides perplexus* (Rowley, 1970) is generally smaller, with shorter throat hackles, they expose less *gular* skin and have a finer bill (Schodde, 1999, p.612). It is without doubt, that there is “a cline of decreasing size from north to south in eastern Australia, and from eastern Australia across the continent to the west (p.48). They are said to be “somewhat intermediate in character” (p. 613) to their eastern counterparts. They also sound closer to *C. mellori*, suggestive that *coronoides* invaded the range of *mellori* secondarily (Debus, 1995).

Often throughout Australia two species occur together, such as the Australian Raven, *C. coronoides* and Little Raven *C. mellori*; or Little Crow *C. bennetti*. In both cases, one species is a large resident, occurring in pairs and occupying a large permanent territory, and nesting solitarily in tall trees; whilst the other is a small nomad, nesting semi-colonially in small trees (Strahan, 1996). There are also differences in diet. Whilst it is highly unlikely Little Raven, *C. mellori* would occur here, Little Crow *C. bennetti* might. This could cause problems in identification, as both are similar in appearance. Further investigations found Little Crow is usually restricted to the interior regions, rather than coastal regions (Cayley, 1970, 63), and prefer arid scrub areas (Beruldsen, 1980) and are not classified common to Perth.

A further check (on the Australian Bird Count) for the Perth region (up to 3 July 2002), listed 241 species for the region, but did not list Little Crow among them (<http://www2.abc.net.au/birds/AtlasServer/cgiAtlas>). Nor did a Birds Australia (WA Inc) site, (<http://birdswa.iinet.net.au>), current to August 2004, and dating back to March 2002. It is therefore reasonable to assume the identification of the Australian Raven throughout this study is correct.

A previous study on the Australian Raven in the Perth metropolitan area (Stewart, 1997) used data from the Atlas database (*circa* 1984) and the Perth Metropolitan Bird Survey to estimate abundance of the species in the region (Refer Figure 3.1). The results show gradual increases each year since 1977 (except in 1980), annual estimated increases of 7%. Total abundance of the species has increased 27% since the databases commenced in 1977. Population densities for the species were found to be the highest in suburbs to the south-east of the city (Stewart, 1997, p.17).

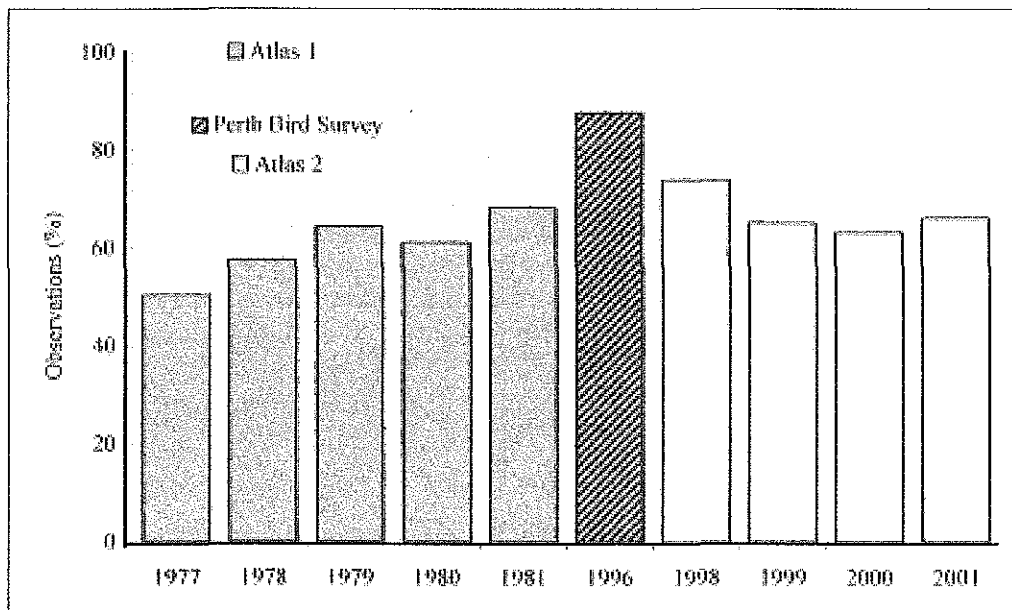


Figure 3.1 Abundance of the Australian Raven in Perth

This graph on the abundance of the Australian Raven in Perth is based on data obtained from the Atlas of Australian Birds (1998- current) and the Perth Metropolitan Bird Survey. Note the steady, gradual increases in abundance for each year, other than 1980, when there was a slight decrease overall. No further decreases were recorded with abundance peaking in 1996. (As per the methods of Stewart, 1997).

3.4 Behaviour and Breeding Habits

The species is described as usually “solitary, seldom in large flocks” (Cayley, 1987, p. 146), a particularly wary bird. “difficult to approach, except in suburban areas, where it is often bold”(p.146). They have been known to use tools (Armstrong, 1975, Goodwin, 1977). Food storing is a trait of the Australian Raven, using methods “essentially similar to, or identical with, those used when feeding the young (Goodwin, 1977, p. 21), by pushing the food into the throat, regurgitating it later”.

Whilst the actual act of hiding food by the Australian Raven was not seen, the retrieval of food was, at Mary Carroll Park, Transect 7:

A mature Australian Raven flew into Transect 7 from Transect 4 near the end of the causeway, calling out loudly and looking around intently. Keeping a wary eye, it went to a fallen branch and dislodged a twig of a few brown leaves, purposefully flicking it away with its bill from an object placed there, a small light coloured egg, slightly smaller, but of a similar appearance to a chicken egg. It took the egg in its mouth and flew directly back to its original perch in Transect 4, where it perched and ate it. It coveted the egg for itself, a number of times preventing another Australian Raven from sharing it by swiping with its bill and partially-opening its wings. The morsel quickly devoured

(Fieldwork Notes: Friday, 13 August 2004).

The species drinks regularly in the usual passerine manner, by dipping and then lifting the head (Goodwin, p25). But apart from drinking, they are not fond of the water, bathing infrequently, and seldom wading (Rowley, 1973). Bathing takes place standing in shallow water, ducking the head into the water, followed by vigorous head shaking and upward wing-flicking, with the tail lowered into the water, causing it to shower upwards, over the entire body. They also clean their bill regularly by “stopping them vigorously against their perch” (Goodwin, p.26). Observations of these activities throughout the study closely followed these descriptions. Incidents of drinking or bathing were only ever recorded at morning and evening sessions, never midday sessions and were not recorded at each visit. Bill cleaning occurred most days but incidents were not scored as a daily activity as it was often difficult to differentiate at some distance through binoculars, this action from where the birds were simply picking at the bark or leaves of a tree.

Another unusual aspect of raven behaviour is that they have been recorded playing (Hill, 1970; Moss, 1996). For example they have been seen sliding down frozen slopes, riding warm thermal gusts, as well as skipping and hopping up and down stairways. Such claims are difficult to dismiss when occurrences of play were recorded for this study. The first was at Mary Carroll Park:

On this hot summer morning (the temperature peaked at 39C) a mature pair of Australian Raven were seen taking consecutive turns at flying through the sprinkler mist in Transect 6, a grassed area of the park near the playground. Each time they flew through the mist, they called out in short, loud, bursts to each other. They landed with a series of three-four, short, two-legged jumps, in an animated dance prior to turning, flying up and commencing the nest sweep. The activity continued until someone walked by with a dog, causing them both to take the tall trees nearby.

(Fieldwork Notes: Friday, 26 March 2004).

Another similar occurrence between an immature pair was recorded at Pioneer Park in Transect 8 during a midday survey, when:

Two immature Australian Ravens on the lawn under a shady tree are flicking a piece of bark to each other. Each flicks the bark and then jumps away, with a funny two-legged jump action, turns around, quickly turns and flies back for another pass. Occasionally calling out loudly, a much quieter discourse of gurgles and chuckles is taking place. It seems personal, not for the other immature ravens foraging in the grass nearby. The activity carries on for several minutes until disturbed by a mature bird, flying straight into one of them, chasing it from that space, closely followed by its buddy into a nearby tree. The mature bird makes several sharp, loud calls, the young birds' silent on their perch. It was obvious the bark was not ever intended as food, it was for the purpose of playing.

(Fieldwork Notes: Saturday, 11 September 2004).

Whilst it is known that corvids held in captivity create and maintain a social hierarchy (Goodwin, 1977, p.34) little is known about them in the wild. They are not generally known for showing "fear or aggression when near each other", but do maintain exclusive zones of *individual distance*. It was not clear why the older raven interrupted play, but the obvious retreat by the younger raven, hinted at some kind of social hierarchy. Other similar displays intimating seniority were recorded in the study, but did not happen frequently enough to be treated to particular discussion.

Maintaining individual distance is paramount to the species and is so innate that even when allo-preening (grooming each other) individuals reach “forward or to one side to preen...instead of perching in bodily contact as other birds would do” (Goodwin, 1977, p.33). Allo-preening can be initiated by either of the pair, usually sharing the same branch. One moves sideways towards its mate, lowering its head to expose the base of the feathers at the nape. Occasionally the position of the head is changed to allow for other areas to be preened. Only rarely does reciprocal allo-preening occur (Rowley, 1973). Other than at times of body maintenance, individual distance is strictly maintained, perhaps to ensure each bird can secure and eat food without being robbed of it, and take to flight unhindered (Goodwin, 1977, p.34).

Flight or locomotion serves several functions in the life of the Australian Raven, for “travelling, searching, fighting and display” (Rowley, 1973, p. 28). Travelling flight is usually >35m above the ground, “the course characteristically straight and the wing-beats regular, deep, and unhurried” (p.28), that can reach speeds of up to 40km/hour. Sometimes when returning home, usually after an intruder has been evicted from inside territory boundaries, the species adopts a “reduced amplitude flight” (p.29) whilst calling loudly; this trait is peculiar to the Australian Raven.

The only other times individual distances were not so rigidly maintained was when sharing a communal roost. Those most likely to roost are sexually immature birds that do not hold territory (Goodwin, 1977). New communal roosts are formed often with little known as to how or why a particular roost is selected, though it is likely “young or insecure individuals follow those older or more decisive in manner” (p.33). Communal Roosting was witnessed several times at Mary Carroll Park throughout the summer period, during morning and evening surveys. The first time was during a morning survey, close to daybreak (sunrise 5.30am, survey 5.41am):

Large numbers of Australian Ravens are emerging from three Eucalyptus trees, situated in a close proximity of each other in Transects 7 and 8. The cacophony of sound is intense, as they all seem to be calling out, *ra-a-a-k, ra-a-a-k, ra-a-a-k*, an extended song, as they exit the roosts, dividing into small groups and dispersing over the site and beyond its boundaries
(Fieldwork Notes: Sunday, 18 January 2004).

It was interesting to witness the presence of such a large group of Australian Ravens at the site. For they are known to form flocks, usually in a group no larger than 30 birds and rarely greater than 50 birds (Rowley, 1970, 1973). This group fit that description well, as it easily numbered 30 birds. Also the species are known for selecting a communal roost adjacent to a food source, and arriving and departing in small groups, of less than 10 individuals (1970, 1973), which was also observed. A week later a similar event was recorded during an evening survey:

At sunset, just prior to dusk, over a fifteen - twenty minute period individuals and small groups of (2 or 3) Australian Ravens flew in from all directions to roost in two particularly densely canopied Eucalypts occurring in Transects 8 and 9. They took time to settle in, some drinking and bathing before flying up to roost. There they jostled amongst themselves for prime position, further inside the canopy. Several times, Little Pied Cormorants were chased from their space, the raven returning to the recently vacated space (Fieldwork Notes: Monday, 26 January 2004).

A similar scene was witnessed on Sunday, 15 February, when the ravens already present gathered at the lakes' edge (at the border of Transect 7 and 8) while others were arriving. It was a hot day (max temperature 37.1) accompanied by a hot easterly breeze. As individuals and small groups of ravens entered the site, close to the previous roost, many stopped to drink and bathe at the small pool in the Northern Lake. At this time, however, it was not such a cacophony of sound as before (like in the mornings), but a quieter, chuckling discourse within the group. This chatter was accompanied by great deal of vigorous splashing and wing flicking, followed by a quick drink before roosting. Once in the roost, they were seen to settle, first moving about, then becoming still as night approached. They appeared to sleep the same way as other birds, with their heads tucked under their wings and turned around "so that it rests on the back with the bill tucked into the scapulars or between folded wing and body" (Goodwin, 1977, p. 29).

It was not unlikely they had traveled in the hotter, drier months to extend their search for food and water. Retreating when confrontations intensified from resident, mature pairs, re-establishing territory, thus forcing others to return to unclaimed, less fiercely protected sites in other areas. This too, explains and supports the notion that there are seasonal influxes in populations of the Australian Raven at this site, at least.

It was noted during the study that various calls were used by Australian Ravens in different situations, and at different times of the day. The calls ranged from a quiet, rumbling 'low murmur call' (as identified by Rowley, 1973, p.32) to a loud, territorial call. The quiet calling often occurred in the mornings and evenings, during feeding times, between individuals and others in the group. The loud calls were issued during the middle of the day, and obviously belonged to the 'territorial advertisement type' described by Rowley (p.33). The species is said to communicate with a series of 'contact calls' (p.33). Members of the species meet the dawn with a chorus of 'mild calls', that later develop in tempo to 'call and answer' sequences; and then, if necessary, into 'strong calls' to drive intruders out of territory (p.33). Sometimes a pair of ravens confronted by an intruder will engage in 'antiphonal pair challenging' (p.34), whereby the chorus is delivered close-by, in unison by both members of a pair, that may lead to physical contact (p.34). The long, drawn out song synonymous with the species is likely 'returning home calling' (p.34) which is performed by the pair after successfully defending their territory.

The maintenance of a permanent territory by mature, breeding pairs of Australian Ravens is inextricably linked to success in breeding. The territory must supply all dietary and nesting requirements for both adults and offspring. The average territory size is 112 ha (Rowley, 1973, p 48) but may be smaller if food supply can be met from a reduced area. The pair bond is strong, with partnerships lasting until death. If a partner is lost, another mate is soon selected (Rowley, 1973). During breeding time (July-October) is the only time there are obvious differences in the male and female of the species, with the female displaying an "extensive brood patch" (Rowley, 1970, p.52). No specific "conspicuous courtship display flight" has been identified for the species. Occasionally "brief 'follow-my-leader' or close-chase flights" (Rowley, 1973, p.38) have been observed (p.112). The only other sign of elementary courtship is an increase in allo-preening (grooming) between pairs involving "the heaking of feathers in the most vulnerable portions of the partner's body" (Rowley, 1973, p.38), occurring toward the end of the moult. Other ravens present may be considered potential competitors and subjected to threat displays. These consist of loud calls accompanied by an aggressive wing flip, with the head, body and tail parallel to the ground, and two or three rapid vertical flips of the closed wings made as it calls" (Rowley, 1967a, p.200).



Plate 3.3 Pair of Australian Ravens ‘allo-preening’

The raven to the right of the picture is in the process of being preened by the raven on the left. The head is lowered to expose the base of the feathers and then moved around to allow other areas around the head and face to be preened. Note the individual distance maintained even during preening, which is unlike other birds (Photograph by Desiree Moon, September 2004).



Plate 3.4 A group of Australian Ravens leaving the roost.

This photograph was taken at Mary Carroll Park just after dawn (Sunday, 18 January 2004). A large group of Australian Ravens had roosted in tall unidentified eucalyptus trees in transects 7 and 8. As they emerged from the roost they dispersed in small groups around the area. Travelling flight is usually over 35m, and can reach 40km/hour. (Photograph by Desiree Moon, January 2004)

After courtship, when pairing is established a nest site is selected. Ravens are branch nesters (Goodwin, 1977, p.45), choose a site “where there is a fork, preferably multiple in character, that they can crouch in; a firm support underneath (p.45). The nest consists “of a base or platform and outer shell of sticks or large stems and an inner lining of softer substances, cup shaped and open at the top” (p.45). They are usually substantial, rarely positioned lower than 13 metres above the ground, and usually placed in a secondary or (rarely) primary fork of tall trees (Rowley, 1970, p.44) (in treeless areas, power-poles may suffice). This description applied to all the nest trees found at, or near, all sites during the population surveys. However the only nest trees found inside site boundaries were at Southernwood Park.

One nest was located in a tall Marri tree (*Eucalyptus calophylla*) in Transect 8, near Cardington Way, close to the tennis courts and playground. It was one of the tallest trees around (>13m) and was also close to a water-source (<50m). The tree was likely chosen as it supported a suitable arrangement of branches for nesting, and harbored plentiful food. Marri trees produce both a flower and fruit, and support a range of micro-fauna, including bees, wasps, ants, larvae and long-horned beetles (Powell, 1990, p98-99) that both live and breed in the bark.

The other nest tree, located in Transect 11, opposite Hube Court, was also in a gum tree (unidentified Eucalypt). It too was one of the tallest trees in the area (>13m), supported multi-forks and was situated close (<50m) from the water course. Both nests were not located until after the eggs had hatched and the nestlings fully fledged. They were observed close to the nest, begging for food and being fed by one of the parents, the other sitting nearby.

The eggs of the Australian Raven have been described as pale blue, with bold markings, dark, olive-brown, with freckles, blotches and spots” (Serventy and Whittell, 1967); 45x30mm in size, they incubate for around twenty days (Rowley, 1967a, p.201), with a clutch size of four, sometimes, five eggs. Care of the young is carried out by only its own parents (Goodwin, 1977), with the male defending the territory and the female caring for the young. The fledglings are slow to leave the nest, and parental care extends for up to about four months (Rowley, 1967a).



Plate 3.5 Nest tree located at Southernwood Park, transect 8.

The tree is a Marri (*Eucalyptus calophylla*), with a suitable, forked-branch structure for nesting. The tree also provides food from nuts and flowers, as well as insects in its bark and foliage. It is less than 50m from the river. (Photograph by Desiree Moon, September 2004)



Plate 3.6 Nest tree located at Southernwood Park, transect 11.

The tree is an unidentified gum-tree (Euclalypt). It too has a suitable, forked-branch structure for nesting. It is the tallest tree in the area and is located less than 50m from the Southern River tributary that winds through the park. (Photograph by Desiree Moon, September 2004).

3.5 Habitat Selection and Food of the Australian Raven

Habitat selection is tied to food availability, as food is “the fuel that enables a bird to survive in a given environment” (Rowley and Vestjens, 1973, p.131). Large urban expanses provide the perfect foraging grounds for this omnivorous, species, re-known “ for eating carrion, stealing eggs, and killing small defenceless young of other animals, for which they come under continual persecution from man”. (Schodde, 1999, p.604). But, due to their “intelligence, suspicion and learning ability” (Goodwin, 1977, p.65), ravens have thrived in spite of it.

Usually solitary or colonial ground-feeders, they use their substantial bill to probe and grasp food. Generally food is not lifted by the feet, but carried in the bill (Rowley, 1973, p.29). Observations from the study supported this behaviour.

By autumn the amount of food consisting of vegetable origin increases. The amount of carrion eaten by the species altered according to the availability of other food sources, and carrion (Rowley and Vestjens, 1973, p.135).

It is in winter that carrion is most important, as insects are scarce and most of the seed eaten (p.135). They are known for attacking other species for food, witnessed attacking young galahs, even killing one. They have also been seen attacking Starlings and Mynas (family Sturnidae) (Rowley & Vestjens, 1973, Lepschi, 1994, Reif, 1998 and Rogers & Rogers, 1999).

A comprehensive study that analysed the gut content of many Australian birds, included the Australian Raven (Barker and Vestjens, 1990). The results showed the range of diet enjoyed by the species. This included over one hundred species of plant material (some 20 types of seed, berries, and fruit, with five species of Eucalypt identified); fifty species of invertebrates (including, centipedes, roaches, grasshoppers, cicadas, leaf beetles, caterpillars, and spiders); and lizards and skinks (Scincidae) and dragons (Agamidae) (Rowley and Vestjens, 1973, p.370-375). Traces of several species of bird eggs were also found (Cormorant, Ibis, Spoonbill and Galah). Evidence of carrion was also found, along with rabbit-kitten and lamb (p.375).

An incident of egg stealing by the Australian Raven was seen at Pioneer Park during a morning survey:

A pair of Western Ringneck Parrots has nested in a hollow of a Eucalypt in Transect 8. Previously one of the pair has been seen searching for food some distance from the nest, but the other has remained behind. Today however both of the pair left the nest unattended, a moment not missed by the Australian Raven. With both birds absent, the raven flew to the hollow, attached itself to the side of the trunk with its feet and stuck its head inside. At this point the pair of ringnecks returned to thwart the theft, flying at the raven from behind, beating it with their wings and screeching loudly. The raven, seemingly unfazed, grasped an egg in its bill so tightly it exploded, spraying out as it beat a hasty retreat from the angry parents (Fieldwork Notes: Saturday, 9 October 2004).

The species are extremely efficient nest-finders and devote considerable time to this in the spring, on the lookout for nestlings, quickly devoured once removed from the nest (p.139). Evidence of this was also witnessed at Pioneer Park during a midday survey when an Australian Raven attacked a Red Wattlebird (*Anthochaera chrysoptera*) nest situated in a Swamp Peppermint (*Agonis linearifolia*) tree, Transect 9:

While in transect 8, standing atop the ramp and looking toward the river, an Australian Raven was seen sitting high in a tall Eucalypt. First once, then a second time, a Red Wattlebird flew directly at the raven, almost unseating it from its perch, the raven aggressively swinging its beak at the attacking bird. After the wattlebird retreats, it first returns to its nearby nest, then ventures a little way to obtain food for its nestlings which are calling out. It is then that the raven launches itself into a powerful flight, straight at the nest. It perches on the side, reaches in and plucks out one of the nestlings. It grabs it with its bill, tightly in the middle, the nestling's head and legs' protruding from each side of the bill. The wattlebird, realising what has occurred, flies after the raven, chittering loudly, but is quickly left behind. The raven retreats to the other side of the river, away from any other of its kind, to eat the tasty morsel unimpeded. The wattlebird returns to guard its nest. (Fieldwork Notes: Saturday, 11 September)

Surprisingly earthworms (Lumbricidae) made-up very little of the diet, given the species propensity to ground-foraging, and the efficiency of the bill for digging (p.136). The insects most preferred for eating are those found in open pasture, from just below the ground, up to about 30-40cm above it (Rowley and Vestjens, 1973, p.138). The main exceptions being certain beetles usually found in Eucalypts (p.138).

For they are also prolific leaf foragers. Often seen landing in the canopy of Eucalypts, grasping the foliage, clinging on and searching for beetles (p.138). Both aspects of these feeding habits were noted throughout the study. An investigation of leaves obtained and the discarded by a raven showed the presence of *sugar lerps*, starchy deposits left by insects on the underside of leaves. It may have been these they were eating, or insects, or caterpillars hidden in the foliage.

In spring at Pioneer Park (Transect 8), ravens were observed feeding around the base of Eucalyptus trees, their constant digging and scratching for insects resulting in cup-size holes around the base of the trees. Another time, at the same site, a group of about one dozen ravens flew into transect 2, singularly, and pairs. They were gathered around the same spot, between the larger artificial lake and the municipality building. Prior to this time they had been indifferent to this area, rarely venturing into it for feeding. Further investigation showed the patch of lawn at the time was inundated with ladybird bugs, and the ravens were enjoying a feast.

It is evident that the type of habitat chosen by the Australian Raven must meet all needs in terms of feeding and breeding, and have a reliable water supply. Their preferred habitat includes areas of pasture (grass or lawn) that also support suitable tall trees for nesting. All of the sites support these types of habitat, areas of lawn with intermittent tall trees and permanent water supplies. All areas of public open space, used for recreation, that have food-stuffs either left or discarded. The site that recorded the lowest populations of the species, Southernwood Park, differed from the others sites, as it had a much greater amount of mid-storey foliage than the other sites. It is apparent they prefer open areas that support considerable expanses of lawn, but still have tall trees (within or on the perimeter), with sparse ground cover.

This concludes the overview of the species; the following chapters examine the sites in more detail, providing information on landforms, climate, vegetation and fauna. They also provide detailed descriptions of the features and vegetation types particular to each site.



Plate 3.7 & Plate 3.8: Larvae in trees used by the Australian Raven.

The Australian Raven is a prolific 'leaf-forager', often seen dwelling in trees, usually gum trees (Eucalypts), picking at either the bark or leaves. Each tree supports a range of beetles, insects and larvae, all valuable food sources for the species, especially at breeding time. (Photographs by Desiree Moon, taken at Mary Carroll Park, August and September, 2004)



Plate 3.9 The Australian Raven ground foraging at Pioneer Park.

Although avid tree-dwellers and leaf-foragers, ravens also acquire food from ground foraging, which is often conducted as a group activity or in pairs (photograph by Desiree Moon, August 2004).



Plate 3.10 Preferred transect, Mary Carroll Park

Transect 6 was used throughout summer and winter, but attracted higher winter populations of Australian Ravens. It is likely the area that supports both lawn and tall trees, mainly Eucalypts, and is located close to the edge of Northern Lake, best meets all the birds needs. (Photograph by Desiree Moon, September 2004).



Plate 3.11 Preferred transect, Pioneer Park

Transect 9 attracted the highest population densities of ravens during both summer and winter surveys. This area also supports mainly lawn with intermittent tall-trees (Eucalypts). It seems areas with open-vegetation, such as this, most suit the species. (Photograph by Desiree Moon, September 2004).



Plate 3.12 Preferred transect, Southernwood Park

Transect 8 also supports extensive lawn areas, with intermittent tall trees growing around its borders, mainly Eucalypts. It is also located close to the river, and seems to meet all feeding and nesting requirements of ravens present at the site. (Photograph by Desiree Moon, September 2004).



Plate 3.13 Type of vegetation complexes avoided, Southernwood Park.

Southernwood Park recorded the lowest population density figures for Australian Ravens during the entire study. This may be a result of the site supporting more extensive areas of mid-storey vegetation complexes, such as this thicket in transect 10. Such areas are not favoured by ravens, likely because the shrubs present an impenetrable vegetation strata that prevents effective ground-foraging and fails to meet nesting requirements. (Photograph by Desiree Moon, October 2004)

CHAPTER FOUR: STUDY SITES

4.1 Site Selection

Although several study sites in a number of localities were considered, three sites were finally chosen; all located within the City of Gosnells. The sites of interest were Mary Carroll, Pioneer and Southernwood Parks. They were chosen because each had been the subject of complaints about the Australian Raven; and all shared environmental characteristics. They all fall in the same geomorphic unit and vegetation zone; have a permanent water source; are conservation areas used for recreation; have similar public amenities such as pathways, lawn, a playground, and rubbish bins (both open and closed types).

The parks are all classified as a Category 'O' areas, a *multi-use* classification allowing for recreation to be conducted in conservation areas (Environmental Protection Authority, Bulletin 686, 1993). Such wetlands even with only moderate degrees of naturalness, "are considered to play important roles in their urban and/or rural settings" (*ibid*). Therefore recreation is permitted but "maintaining and enhancing the existing natural attributes" (*ibid*) is a management priority, including their avifauna.

It was reasoned that by studying three sites in one locality, all similar in size and habitat type, valid comparisons could be made between them. Also logistically, it made the project considerably more manageable for a single observer.

4.2 Common Site Characteristics

The three selected sites are in close proximity, within 5km of each other. The boundaries at each site were set to cover a mean area of 19.5 ha. Due to the close proximity, all share several common environmental characteristics: They are all wetlands occurring in the same geomorphic unit that share the same vegetation types and associations, as well as support similar species of native flora and fauna.

4.2.1 Landforms

The sites all occur on the eastern fringes of the geomorphic unit known as the Bassendean Dune System, a belt approximately 15 km wide made up of aeolian soils, the oldest, most infertile sands of the Swan Coastal Plain (Seddon, 1972). They appear yellow at some depth and are bleached pale grey at the surface (Powell, 1990). The area, of low hills of leached quartz sands, form wetlands in slight depressions, consisting of layers of organic material over regional sands (McArthur and Bettenay, 1960), has poor drainage due to the permeable soils (Semunui, 1988). During winter the water table increases and fills swamps and wetlands in the area.

4.2.2 Climate and Weather

All experience a warm Mediterranean climate with winter precipitation and is dry for five to six months each. It experiences distinct seasons: A hot dry summer, and a cooler winter (May – October), during which 80 per cent of rainfall occurs. The area receiving between 900-1000mm year (Beard, 1990). Winter rains provide the main groundwater recharge (Sharma and Hughes, 1985).

Weather is an important aspect of the study, as it can significantly impact on data collected. During the study the weather was monitored using data included on Australian Bureau of Meteorology web-site (<http://www.bom.gov.au/index.shtml>). Previous climate data for the area was compared to the conditions experienced during this study, with no significant differences noted. It is reasonable to assume that the prevailing weather conditions had not significantly impaired or altered the data collected. The study was conducted during the period mid-January to mid-October, 2004. The temperature range for the Gosnells area over the study period was: maximum 39°C (Friday, March 26) to minimum 3.2°C (Saturday, September 11). The average daily temperature exceeded 20°C for the period January-March, with the average daily temperature June-August below 10°C. Rainfall for the period mid-January to mid-May was low, 0.4mm. However, substantial rains in the final week of May boosted rainfall by 17mm, a welcome replenishment for all sites.

By the close of March the lakes at Mary Carroll Park were close to completely dry, and the other sites were suffering from severe algal blooms and greatly reduced water quality.

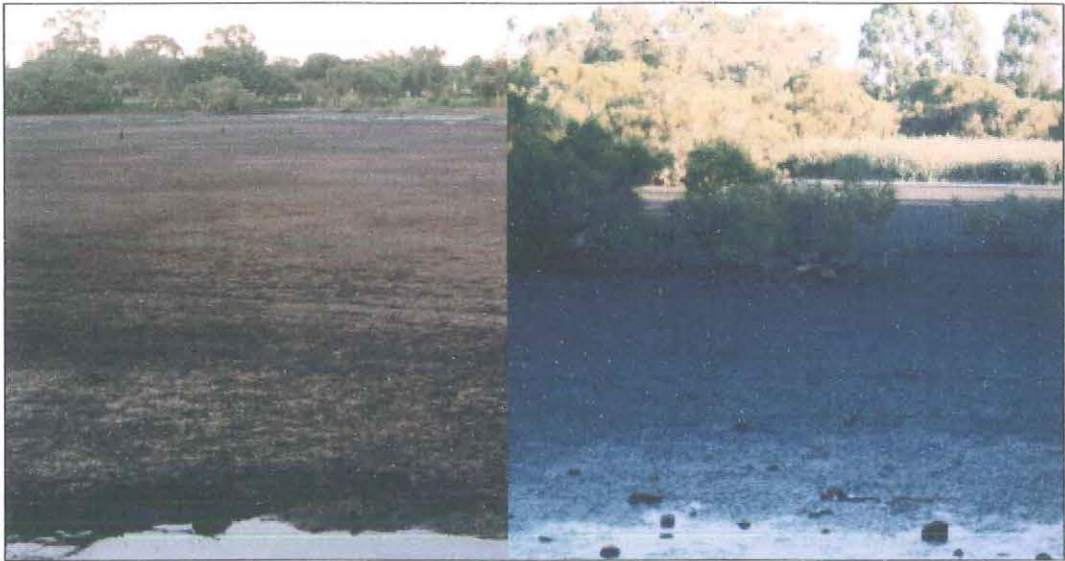


Plate 4.1: Dry lakes, Northern Lake (left) and Southern Swamp (right) at Mary Carroll Park: These photographs show how the extreme summer hydrology regime affects the site. By the end of summer, water in the Northern Lake was restricted to a large puddle between the island, transect 4 and the shore, transect 8. The impact on the Southern Swamp was more severe, retaining only patches of dampness near transect 12. (Photograph by Desiree Moon, March 2004).



Plate 4.2: Poor water quality resulting in algal blooms, Pioneer Park (left) and Southernwood Park (right): The artificial lake in transect 1, Pioneer Park, is surrounded by lawn regularly fertilised and watered that may result in some run-off that adversely effects water quality. A more serious problem for the lake is the constant feeding of birds by visitors, resulting in excessive defecation and water soiling by birds. The algal bloom present at Southernwood Park, located between transects 4 and 11, may be due to reduced water-flow at the site during summer.

4.2.3 Vegetation

All sites fall within the Drummond Botanical sub-division (Beard, 1990) and support remnant vegetation typical of the Southern River association. The main vegetation types for that region listed in an extensive vegetation survey by (Beard & Sprenger (1984) listed coverage in the division as mainly Banksia and Jarrah low woodland (5414km²); lesser Marri and Wandoo woodland (3042 km²); heathland (1334 km²) and scrub-heath (1295 km²). Sparse areas of Tuart/Jarrah woodland are also found (1039 km²) along with Sedgeland (Cyperaceae) (39 km²) in wetland areas.

All study sites shared similarities in vegetation, with the same types of trees and shrubs present. They also all contained the same five habitat types. It was important to consider habitat types in relation to both the abundance and distribution of the Australian Raven at the sites: What habitat characteristics, including non-native tree, shrub and grass species, appear as the most and least appealing to the Australian Raven at, and between sites? What are their differences? Greater insights into factors influencing habitat selection should aid the development of more enlightened management strategies for the species.

4.2.4 Fauna

During the course of the study many species of birds were sighted and recorded. These interim lists were then compiled into more comprehensive species lists for each site (Refer Appendix G, Avian Species List: All Sites). The site that recorded the most types of birds present was Mary Carroll Park with 53 listed species. Pioneer Park recorded 43 species and Southernwood Park 34 species (all include 5 non-native species). The greater numbers of species present at Mary Carroll Park were likely due to more water birds being present (total 21 species).

Several small mammals were also recorded, but as the sightings were often quite brief, identification was difficult. A text on Australian mammals was reviewed (Strahan & Cayley, 1987) but only common names are given in the descriptions below to depict a general animal. At Pioneer Park a possum was sighted (Transect 9) and at Southernwood Park, a pair of bandicoots (Transect 7).

Large rodents were seen at Mary Carroll Park, concealed in the long grasses near the Northern Lake (Transect 3) and at Pioneer Park, near the Station Street bridge (Transect 12). Cats were seen at all sites, but were not identified as being either domestic or feral. Each time they were seen, they were crouching in areas of undergrowth. A fox (or very large red cat) was also recorded for Mary Carroll Park.

A number of other creatures were also seen including goannas, skinks and the Western Spiny-Tailed Gecko (*Diplodactylus spinigerus*). All sites recorded assorted insects, bugs, beetles and butterflies which were less prolific during mid-winter and at the close of summer when the landscape is parched.

4.2.5 Public Use Areas

Each site had paths used for walking and cycling and either children's playground equipment, or a public entertainment area, as well as park furniture. Each had rubbish bins, open and closed types. The placement and types of rubbish bins at the sites was of particular interest, as many complaints received about ravens were that they scavenged and spread rubbish from bins. It was also important to appraise the extent to which rubbish bins provided an alternate food source for ravens.

There were several negative aspects to public use of the study sites. Firstly, a number of domestic ducks and geese are now resident at Mary Carroll and Pioneer Parks. They are now breeding with native duck species, and producing hybrids.

Also on several occasions at all sites, children and young people were witnessed chasing and scaring birds. Several times they were seen throwing sticks and rocks, as well as yelling and being frightening. Targets at Mary Carroll Park included a Willie Wag Tail (*Rhipidura leucophrys*) and Eurasian Coot (*Fulica atra*) that were nesting (Wednesday, 22 September, Saturday, 9 October respectively). Another incident recorded at Pioneer Park (Saturday, 24 April) recalls a man setting his dog on to water-birds on and near to the artificial lake in transect 1. The man, when asked to halt the activity, was hostile and allowed the dog to continue. On another occasion at the same park, a group of youths threatened other visitors, including myself. Incidents such as these greatly undermine the appeal of the area.

However, the biggest problem confronting all sites is the feeding of birds by visitors. Feeding occurs at all sites, at all times throughout the day, often by a succession of visitors. The foodstuffs offered are often bread products. These foods are not well digested by the birds, resulting in excessive defecation into the water. This can produce botulism in the water and cause outbreaks of avian botulism, bringing the threat of sickness and death for many wetland birds. (Lund, Ryder and Ogden, 1998). It also causes birds to defecate over pathways and lawn areas, which at times makes them unpleasant and dangerous to walk on.

These negative aspects of site usage have the potential to undermine the integrity of each of these wetland environments. It is imperative each site is managed to maintain and protect the intrinsic conservation value inherent in each of them.

4.3 Specific Site Characteristics

Although the sites shared some similar characteristics, each also had its own uniqueness. However, similarities in vegetation meant that five distinct habitat types were represented to a varying extent at each site. They were defined using categories assigned by Bibby, Jones and Marsden (1998) and include:

- Type 1: Over-storey: Tall trees (>25m), ample canopy; mainly Euclaypts;
- Type 2: Native and exotic trees and shrubs (>10m to <25m);
- Type 3: Native and exotic shrubs (<10m);
- Type 4: Grassed: Cultivated areas of grass; and
- Type 5: Moist: Shore of lake or river

The percentage of coverage of each type of habitat type was estimated for all transects, at all sites. Results showed that similar vegetation complexes are found at each, but the extent of coverage differs between sites. (Table 4.1). The assessment revealed that Mary Carroll Park and Pioneer Parks have a greater extent of Habitat Types 1, 4 and 5: Whereas Southernwood Park has a more Habitat Types 2 and 3.

Observations suggested that the Australian Raven preferred open parkland: areas supporting cultivated grasses, tall trees and a reliable water-source. This combination provides all the necessary feeding and breeding requirements for the species. Southernwood Park however, has more shrubs and small trees, and a less reliable water source. The more impenetrable foliage inhibits ground foraging and does not provide adequate nesting sites. Water quality within the wetland habitat is also poor during the summer months.

Overall, it seems the greater the level of disturbance and modification to the natural vegetation complexes of each site, the greater the number of ravens likely to be frequenting the area. They are a highly intelligent, adaptive species, which have learned to thrive in environments impacted by human settlement.

HABITAT ZONES-ALL SITES					
Site	type1	type2	type3	type4	type5
	Trees >25m	Shrubs 10-25m	Shrubs <10m	Cultivated grass	River or Lake Shoreline
MaryCarroll Park	59%	45%	49%	54%	43%
Pioneer Park	68%	44%	41%	68%	42%
Southernwood Park	49%	64%	62%	36%	39%

Table 4.1 Comparison of estimated coverage of the five habitat types present.

Each site was visually assessed to estimate coverage for each vegetation type present. At Mary Carroll and Pioneer Parks there were more tall trees and cultivated grasses (lawn) present, than mid-storey shrubs and small trees. The vegetation complexes at Southernwood Park however, had greater mid-storey coverage from (<10 –25m). The vegetation did not provide the preferred habitat type for the Australian Raven.

4.3.1 Mary Carroll Park


Mary Carroll Park is located 18km south-east of Perth, and sits between two tributaries: 1km west of the Canning River and 2.5km from Southern River, approximately 3km from their junction (refer map 4.1 aerial photograph of site). The park contains two lakes, the only ones found in Gosnells (Payne, 1993), the two separate water-bodies, bisected by Eudoria Street, are connected by a drain underneath the road. This flows all year as topographically the smaller lake is 16cm higher than the larger lake (Coote, 1992). The parkland around the lakes is almost 19ha, with a relatively small catchment (68ha) that has experienced some environmental problems (Lund *et al*, 1998). Previous studies refer to the larger lake as 'Northern Lake', and the smaller as 'Southern Swamp' (Bekle, 1999; Lund, Ryder & Ogden, 1998); these names also applying for this study (Refer Map 4.1, aerial photograph showing location).

The Northern Lake provides (relatively) permanent water; whilst the Southern Swamp is an ephemeral wetland (it seasonally dries out). Internal migration of bird-life occurs daily between the two for feeding, roosting, and at times, breeding (Bekle, 1999). The only dwellings near the park are adjacent to the north-east boundary of Northern Lake (Pedersen, 1995).

The area depends on winter rainfalls for groundwater re-charge. Evaporation is extreme and usually exceeds rainfall between August and May (Bekle, 1999). It is the most important climatic factor influencing the wetlands. By summer end both lakes are shallow pools, but rarely dry out entirely (Pedersen: 1995). This year Northern Lake retained a small puddle adjacent to Transect 8, whilst Southern Swamp barely showed patches of dampness, and did not retain even a shallow pool of water.

Attempts to rectify problems of insufficient water-depth resulted in major earthworks in the 1980's to deepen the Northern Lake. These works also added a causeway and an island (Pedersen, 1995). Later the eastern margins (Transects 7,8 & 9) were fenced as a bird sanctuary (Bekle 1995). All observations in these sectors were made through binoculars only, as it was decided that walking would cause too much of a disturbance to the wildlife of the area.



Scale = 1:4000	Mary Carroll Park Gosnells	City of Gosnells Tuesday 7 December 2004	 N
----------------	-------------------------------	--	--

Map 4.1: Aerial photograph showing Mary Carroll Park, Gosnells.

Note the predominant vegetation of the parkland, compared to the patch-effect of vegetation supported by the surrounding urban settlement, as well as the substantial coverage of the lakes, a dominant feature of this wetland park.

The water quality of both lakes has in the past has been severely affected by botulism, causing the death of over two thousand water birds (Rodda and Deely, 1992, p.2). Botulism may result from low water levels, high levels of nutrients and deteriorating water quality in summer. The situation is also worsened by visitors over-feeding birds (often bread products, not tolerated by their digestive system), resulting in increased levels of defecation which is discharged into the lakes. Feeding of parkland birds by visitors was witnessed during the majority of site surveys.

The parklands supports two main species of tall trees (<12m). Jarrah (*Eucalyptus marginata*) and Marri (*E. calophylla*) are present on the fringes adjacent to the Northern Lake (along Eudoria and Verna Streets) and on the causeway and island of the lake. At the western end of each lake are various banksias (*Banksia attenuata*, *B. grandis*, *B. littoralis*) interspersed with other trees. The lakes are fringed with Flooded Gums (*E. rudis*) and Freshwater Paper barks (*Melaleuca raphiophylla* and *M. teretifolia*). Jointed-twig Rush (*Baumea articulata*) and other sedges also occur in the wetlands. Heath-land is the dominant plant community, with the herbaceous monocotyledons well. The under-storey is spectacular in the spring, with Smokebush (*Conospermum*), Yellow Morrison (*Verticordia nitens*), Blue Leschenaultia (*Leschenaultia biloba*) and Kangaroo Paws in bloom. (Pedersen, 1995). Both the sections have grassed areas, the largest in the southern corner of Northern Lake along Eudoria and Verna Streets and at Barcombe Way and Eurdoria Streets in the Southern Swamp section (Waters and Rivers Commission, 2004).

The playground includes a barbecue, tables and chairs (Transects 5 & 6). It has a bin with a closed lid, along with four others of the same type in (Transects 1 & 4). There are also three open bins at the park (Transects 2, 4 & 13), but none seemed to figure significantly as a food source with only one incidence of scavenging food from a bin recorded for the study. This incident occurred toward the end of winter (Sunday, August 29) at a closed bin over-flowing with food scraps (Transect 4). At this time, naturally occurring foods (insects, seeds and flowers) are in short supply, so acquiring food in this manner seemed merely opportunistic, and resourceful.

The native vegetation has been invaded by a variety of exotic plant species. Japanese Pepper trees (*Shinus terebinthifolius*), Pampas grass (*Cortaderia sellona*) and Giant Reeds, or Bamboo (*Arundo donax*) the most conspicuous. The Southern Swamp is degraded, with *Shinus* all around the lake, interspersed with large stands of *Cortaderia* and *Arundo*. Also, Bulrushes (*Typha*) and long grasses are present.

The site is a refuge for trans-equatorial migratory birds, with Greenshank and Red-necked stints (family Scolopacidae) recorded at the site Keeling (1991) and Storey, Vervest, Pearson and Halse (1993). During this study Nankeen Night Heron (*Nycticorax caledonicus*) and Jacky Winter (*Microeca fascinans*) were recorded at the site, both species which have experienced a national population decline since the last atlas (Barrett *et al*, 2003). Also Swamp Harrier (*Circus approximans*), Laughing Kookaburra (*Dacelo novaeguinea*) and Southern Boobook Owls (*Ninox novaeseelandiae*) were recorded for the site, so consequently ravens were not the only predatory species present. A real problem are the numerous domestic ducks and geese that have appeared at the wetland. It appears some domestic ducks are even forming hybrid breeds with native Wood Duck (*Chenonetta jubata*) and Pacific Black Ducks (*Anas superciliosa*).

Overall the environmental quality of the site seems sound and the wetlands and surrounding parkland well managed. It appears attention is given by the City of Gosnells to protect both the conservation and recreation values of the site.



Plate 4.3: Playground and picnic area, Mary Carroll Park.

This area was popular with both visitors, and the Australian Raven, often seen foraging on the ground, or picking at the bark and leaves of trees. At times it appeared ravens were waiting for any discarded, or unguarded food.

4.3.2 Pioneer Park

Pioneer Park is located on the Canning River, approximately 2.5 km south of Mary Carroll Park (refer map 4.2 aerial photograph of site). The boundaries defined by City of Gosnells Municipal Building at Mills Road and Albany Highway, to Astley and Station Streets, and the Canning River to the east (only one side of the river was surveyed, as the other side backs onto private land). The river runs the entire length of the site, from Mills Road to Station Street. A total area of 19ha was surveyed. The area is identified as Precint 19 in Waters and Rivers Commission report, *Bushplan*, available online (which provided most information on the site).


The river at the site meanders upstream from the Southern River confluence, which has split into two channels forming flat alluvial islands. The channel is narrow and shallow and at times appears as a creek, especially in times of low rainfall. It has several tributaries, with Ellis Brook the main one. The southern bank of the Canning River becomes increasingly incised into the landscape as the river takes a lower route.

The stretch of river that winds through the study site flows all year, guaranteeing a constant, clean water supply. The artificial lakes however, in summer are affected by algal-blooms that form a green, floating slick over them. The water runs through a water-feature that aerates the water and produces a cooling mist.

The water quality of the lakes is largely affected by the amount of fecal matter discharged into the water by the resident ducks and other water birds. This is a problem encountered at the previous site and other similar wetland areas. The birds also soil the pathways, making unpleasant walking conditions for visitors.

There are City of Gosnells buildings along the edge of the northwest corner. The complex was built in the 1980s, and the gardens comprise a mix of non-native trees, as well as Eucalypts and other endemic species, flower-beds, and lawn. Buildings have been built over time in different materials and styles. The latest, a library and civic offices on Albany Highway (backing onto Transect 9) were under construction throughout the study.



Scale = 1:4000	Pioneer Park Gosnells	City of Gosnells Tuesday 7 December 2004	 N
----------------	--------------------------	--	--

Map 4.2: Aerial photograph showing Pioneer Park, Gosnells.

The (riparian) vegetation of the park clearly meanders in unison with the Canning River as it winds through the entire site. It is interesting to note the retail complexes adjacent to the site, some of which sell take-away foods and fresh produce. The refuse from these sources likely providing a steady, alternative food source for Australian Ravens in the area.

The lawns are maintained and the park well facilitated with barbecues, seats, tables, toilets, Amphitheatre, and a sundial garden with local native and non-endemic native species, including some spectacular ground covering Grevilleas. Other features of the park are the War Memorial, as well as various artworks scattered throughout the park to reflect the area's local history, flora and fauna. Indigenous cultural values associated with the area are recognised, with Aboriginal Totem Poles erected near the Amphitheatre in Transect 9.

The natural Amphitheatre has tile mosaics around the stage. It is popular venue for live music shows provided by the City of Gosnells during the summer months. The area support stands of Flooded gums (*E. rudis*) and Freshwater Paperbark (*M. raphiophylla*), growing adjacent to a mowed plain, bordered by a steep embankment of trees, and forms a perfect natural enclosure.

The riparian vegetation at the study consists mainly of Freshwater Paperbarks (*M. raphiophylla*) and Flooded Gums (*E. rudis*) overhanging the river, forming an over-storey that is home to many birds. The marvelous view marred only by the severe infestation of exotics in the corresponding under-storey. Some native species are present but limited in extent. Project works by the City of Gosnells started this year to clear the riverbanks of exotics, and re-surface the riverbed to improve flow. The west bank re-planted with various shrubs and small trees (Transects 4- 11). The banks on the eastern side are infested with Arum Lilly (*Zantedeschia aethiopica*), African Cornflag (*Chasmanthe floribunda*), Watsonia (*Watsonia. bulbifera*), Three-Cornered Garlic (*Allium triquetrum*) and Bridal Creeper (*Asparagus asparagoides*).

Areas close to the river at times become inundated, especially in winter, along the flat, downstream section. In Transects 12 & 13 this produced an oasis, the area benefiting from a previous planting of native species (including Eucalypts, Acacias and Sedges). Whilst the ravens did not appear to be particularly interested in the area (even when frogs were present), Laughing Kookaburras were often seen perched silently in the area.

The park also has two orchards containing some citrus and stone fruits (Transects 6 & 12). These areas were most popular when fruiting, with birds and people vying for the spoils. Australian Ravens were only ever observed on the ground within these areas, not eating fruit, but most likely picking for insects.

However, another factor that may have influenced the distribution of the Australian Raven in the park was the presence of construction workers in the first part of the year, constructing new civic buildings at the rear of Transects 8 and 9. Workers often discarded scraps in a bid to entice a bird closer. No incidents were recorded of ravens stealing food, but they ate food scraps discarded in the area.

The park supports diverse population of birds, with a total of 40 native bird species recorded for the study. This site also recorded Nankeen Night Heron and Jacky Winter, both species that have experienced population decline in Australia (Barrett *et al*, 2003). Birds of prey were also listed for the site, with Brown Goshawk (*Accipiter fasciatus*) and Swamp Harrier (*C. approximans*) recorded during surveys.

Generally the park appears to be environmentally healthy, with dual problems of water quality and weeds being addressed. Recently, shrubs and small trees have been planted to restore mid-storey vegetation at the park, with re-planting carried out by volunteers coordinated by the City of Gosnells, in conjunction with *Green Corps*. There is no management plan, but river restoration works have begun (involving the City of Gosnells, Armadale-Gosnells Landcare Group and Department of Environment), following recommendations of the Pioneer Park River Restoration Plan (Pers. Comm., Wayne van Lieven, City of Gosnells, 14 December 2004).



Plate 4.4: Amphitheatre and picnic area, Pioneer Park.

This area attracted visitors throughout the entire study, summer and winter, at most times of the day. Often foods bought at nearby take-away food outlets were bought to the site and consumed, and scraps discarded. This constant food source may influence the distribution of Australian Ravens at the site.

4.3.3 Southernwood Park


Southernwood Park is located approximately 3km west of Mary Carroll Park, about 20km from Perth (refer map 4.3 aerial photograph of site). The site boundaries for this study incorporate Anaconda Drive (near Dene Court & Shearwater Way), along Shipbourne Way and Cardington Streets to the west and Anaconda Drive and the Richard Rushton Community Centre to the east. Pedestrian crossings over the river are located near Todd Street and the Richard Rushton Community Centre. As previously explained two sections were missed, due to lack of suitable habitat in those sectors, and to reduce the site to an equal survey size.

At the confluence of the Southern River and the Canning River, the Swan Soil Association occurs, with its red, alluvial soils. The rest of the river falls within the Southern River Soil Association, characterised by grey sand dunes with intervening clayey swamps. The surface is gently undulating into flats with intermittent damplands, wetlands and areas of seasonal inundation. Much of the sediment has been reworked with sand dunes moving and creating new dunes.

The river channel is less than one metre in depth as it meanders downstream towards its confluence with the Canning River. The surrounding embankments range from very flat to between 1-2 metres deep. It is entirely fluvial, with several small drainage lines entering the main water channel. Much of the surrounding land is poorly drained and water is retained in wetlands away from the Southern River. The river has a broad flood plain due to the low lying surrounding topography, the land adjacent to the river often damp and inundated in winter months. Away from the river, wetlands drain into larger lakes in the area.

At the confluence of the Canning and Southern Rivers the Swan Complex is the dominant vegetation type consisting of woodlands of Flooded Gum (*E. rudis*) and Freshwater Paperbark (*M. raphiophylla*), occasional Swamp Sheoak (*Casuarina obesa*), Shore Rush (*Juncus kraussii*) and Lake Club Rush (*Schoenoplectus validus*).



Scale = 1:4000	Southern River and Southernwood Park, Gosnells	City of Gosnells Tuesday 7 December 2004	 N
----------------	--	---	--

Map 4.3: Aerial photograph showing Southernwood Park, Gosnells.

Note that four, 150 metre sections within the site boundaries defined for this study, were not surveyed as they included buildings, or burned bush, so as to reduce the total area surveyed and make it the same as the other two sites.

In the wetter parts of this community the Bracken Fern (*Pteridium esculentum*) can be abundant, while the drier areas support Green Stinkwood (*Jacksonia sternbergiana*).

The complex also supports open woodland of Jarrah (*E. marginata*), Marri (*E. calophylla*) and various banksia species. Along the river and creek banks the Flooded Gum (*E. rudis*) and Freshwater Paperbark (*M. raphiophylla*) are found along with occasional Moonah (*M. pressiana*). A mix of banksias, sheoak and Coastal Swan River Blackbutt (*E. patens*) front Jenkinson Street, with Firewood Banksia (*B. menziesii*), Holly Leafed Banksia (*B. ilicifolia*), and Woody Pear (*Xylomelum occidentale*) also present. Heathland is the dominant plant community with the lower storey supporting Grass Trees (*Xanthorrhoea preissii*) and Zamia Palms (*Macrozamia riedlei*).

Several exotic flora species have invaded the woodlands, among them Castor Oil Bush (*Ricinis communis*), Pampas Grass (*Cortaderia selloana*), Bulrush (*Typha orientalis*), Weeping Willow (*Salix* sp), Japanese pepper (*Shinus terebinthifolius*), Giant Reed (*Arundo donax*) Victorian Tea Tree (*Leptospermum laevigatum*), Canna Lily (*Cannax orchiodes*) and Blackberry (*Rudus* sp). Close to Jenkinson Street, there is a large stand of Bullrush (*T. orientalis*) adjacent to areas of low, open banksia woodland. Near Jenkinson Street Lupins (*Lupinus cosentinii*) and Veldt grass (*Ehrharta* sp) are present.

The land adjacent to the Southern River in this precinct is mainly used for urban purposes. Other land uses include the growing and distribution of plants for metropolitan nurseries. Many of these nurseries have diverted water from the Southern River and the used water, often rich in nutrients, is returned to the river through a series of drains.

Cardington Way Reserve is situated on the banks of the Southern River in Huntingdale and has two tennis courts and a barbecue area, with five open bins. This area recorded the highest population densities of the Australian Raven for the site, for both summer and winter surveys. Another playground is located at the opposite end, between Anaconda and Shearwater Drives (Transect 1). It also has open bins.

A total of 36 bird species were recorded for the site, slightly less than the other sites. However some birds may stay in the habitat closest to the river, which is surrounded by dense weeds and bracken, and was quite inaccessible to the observer. While fewer species were recorded, numbers of individual birds were higher than at the other sites.

The site is very open and popular with walkers and cyclists, presenting a natural vista, less ornamental than the other two sites. It displays the courser texture of local native vegetation, interspersed with areas of sparse, coarse grass (the lawns at the other sites appear much softer in texture and deeper in colour).

It appears well managed, with evidence of weed control and re-planting in some sectors. The site supports much more mid-story vegetation, especially close to the edge of the river. This mid-storey vegetation seemed to attract the smaller bush-birds, but did not appeal to the Australian Raven who stayed in areas of cultivated grasses, with intermittent tall (Eucalypt) trees providing both food, and a view.



Plate 4.5: Playground, picnic area and tennis courts, Southernwood Park

This area at the site attracted many visitors participating in various recreational pursuits. As it is located next to a footbridge crossing the Southern River, pedestrian traffic is quite high. Other people came to the area to visit the playground or play tennis. The highest population densities of Australian Ravens were recorded in this sector of the study site, which could be linked to increased food availability from discarded food scraps.

CHAPTER FIVE: COMMUNITY ATTITUDES SURVEY

5.1 Introduction

Throughout time ravens and crows have been the subjects of stories and omens, often with evil associations. It is important to consider how these negative historical portrayals may have influenced current community attitudes.

5.1.1 Folklore and History

Stories of the raven date back to biblical times and when “Noah released the raven...acting just as Babylonian mariners did” (Armstrong, 1975, p. 65) using land seeking birds to guide them. Vikings credited with the re-discovery of Iceland supposedly did the same and Alexander the Great was said to have been guided “across the desert to the oasis of Ammon by two ravens sent from heaven” (p66). In *Wicca*, the ancient study of witchcraft, ravens and crows are identified with ‘shape-shifting’, said to be ‘familiars’: witches that have taken the form of a beast. The raven and crow are chosen for their intelligence and strength. They are seen as beasts capable of magic, ever watchful, and existing from past-lives (Vera, 1992; Farrar, 1996; Crowley, 2000 and Buckland, 2002). Even the colour of their plumage, *black*, is symbolic of “retribution and communicating with the dead” (Pulford, 1998).

These concepts are often reflected in verse, a good example being *The Lady of the Crow - Sorceress of Ravens* (Anon., circa 1700):

The tale begins of...witch named Raven.
Stripped of everything and tied onto a cross...
Suspicious of her witchcraft...
They finally took her from her home and hung her...
But she was not evil...
She stayed there, rotting away.
Many crows flew the skies, watching her...
Temptation of death sweeping over her,
She called out to her god “My lord! I call to you!
Let me come back as what stands by me!”
She could not say any thing more and she took one last breath...
Now she lets her crows soar the sky, watching out.

Another fine example is reflected in the poem *The Death Raven* by Adam Gottlieb Oehlenschläger, a famous Danish poet and playwright (Circa 1750):

The wild Death-raven, perch'd upon the mast,
Scream'd 'mid the tumult, and awoke the blast.
Dame Sigrid saw the demon bird on high,
And teardrops started in her beauteous eye;
Her cheeks, which late like blushing roses bloom'd,
had now the pallid hue of fear assum'd...
He was a kind of God, in former days.
Kings worshipp'd him, and minstrels sang his praise;
But when Christ's doctrine through the dark North flam'd,
His, and all evil spirits' might was tam'd.
He now is but a raven; yet is still
Full strong enough to work on thee his will:
Lost is the wretch who in his power falls –
Vainly he shrieks, in vain for mercy calls."

A final example of how ravens are portrayed in literature is the gothic verse, *The Raven*, by poet Edgar Allan Poe, which depicts the vileness felt for the species (circa 1845):

"Prophet!" said I, "thing of evil! – Prophet, still bird of devil!
Whether Tempter sent, or whatever tempest tossed thee ashore,
Desolate yet all undaunted, on this desert land enchanted –
On this home by Horror haunted -- tell me truly, I implore...
... "Be that word our sign of parting, bird or fiend!" I shrieked, upstarting --
"Get thee back into the tempest and the Night's Plutonian shore!
Leave no black plume as a token of that lie thy soul hath spoken!
... Take thy beak from out my heart, and take thy form from off my door!
... And the Raven, never flitting, still is sitting, still is sitting
On the pallid bust of Pallas just above my chamber door,
And his eyes have all the seeming of a demon that is dreaming,
And the lamp light o'er him streaming throws his shadow on the floor.
And my soul from out that shadow that lies floating on the floor,
Shall be lifted -- nevermore!

However, in Native American legends the raven is portrayed as a life creator, that coloured the other birds first, leaving only black for itself (Moss, 1996). The colour black said to possess "an iridescence that speaks of the magic of darkness, and a changeability of form and shape" (Sams and Carson, 1999, p.101). Others are less flattering, and say the raven was burned trying to steal the sun (Moss, 1996).

Another story from the Nyul-Nyul people of the north-west region of Western Australia, says the crow is black because he stole the eagle's wife. The eagle exacted revenge by dropping a hot coal into his mouth, the burning ember said to have caused his raspy voice and blackened plumage (Torres, 1987).

Generally throughout history praise of the species has been scarce, with emphasis on their innate *evilness*, and ties to black magic. This poor view is clearly evident in the collective nouns ascribed them: a *murder* of crows, and an *unkindness* of ravens (Ross, 2000). The species have earned an undesirable reputation connected to death, doom and destruction. Such views were prevalent amongst respondents in the Community Attitudes Survey, with few making nice comments about the species.

5.1.2 Contemporary Portrayals:

A previous study by Mansell (1997) found 66% of its respondents thought Australian Raven the least desirable species in Perth parkland (p.93). Respondents complained that they "are noisy, aggressive and messy" (p.99). They were disliked because they ate carrion and are closely linked to tales of "death and disaster" (p.99).

This view seems worldwide, with a recent article reporting on an injured mountain climber, who escaped death by sawing off his arm which was trapped beneath a rock. The article reports that he first, "prayed to God for help. And then he prayed to the devil, as a raven circled overhead" (p.5), reflecting that the historical stereotype still exists in these contemporary times.

Ravens are also perceived as a form of public nuisance, with reports of property damage making Perth's daily paper, *The West Australian*. The 'Inside Cover' section ran a series of articles on ravens (referred to as *crows*) causing "a rubbery problem" (Adshead, 2004a, p.2) in the south-eastern suburbs. They were blamed for stripping car-wiper blades of their rubbers. The next column offers some solutions, most dire for the birds. One suggests "shoot one bird and leave it on the car bonnet as a signal to the other birds, the crows would get the message and stay away"; another, "stone the crows"! (2004b, p.2). By day three we're told they're "young birds that have found a fun toy, so just best to move the car" (2004c, p.2).

A previous study by Stewart (1997) that investigated community views on the species in Perth, found the species were located in all areas, with the most problems reported from Windthrop (south of Perth) and Wilson (to the south-east). From the 1500 respondents, 40% did not like them, with some suggesting culling as a solution for the metropolitan area” (p.43). The biggest problems related to noise, with 33% of respondents saying they disturbed sleep, disrupted school classes and drowned out “more desirable songbirds” (p.44). Only 1% said they liked the calls of Australian Ravens, and “their calls were part of the Australian bush” (p.44). Almost 20% said they had witnessed attacks by the Australian Raven on other birds, compared to 6% that said they had seen the species attacked by other birds, mainly smaller species. Close to 5% said they had seen them attack domestic fowl, mainly chicks, and steal eggs. A few said they saw them kill and eat tortoises, frogs, possums, lizards and fish (p.45). Only 3% of respondents expressed concerns that the species scavenged rubbish and spread it around, whilst almost 5% considered them “a bonus in an urban environment as they cleaned up unwanted refuse and rubbish” (p.45). Other significant problems people had with the Australian Raven was that they created a health hazard “by defecating in playgrounds and schools” (p.45), and caused damage to property (to such items as windscreen wipers, window fly-wires and television antennas to list a few). Less common complaints related to them stealing food from park tables, or perching nearby and loudly calling out, and being a nuisance (p.49).

Another study of the urban ecology of the Australian Raven also investigated community attitudes to the species. The survey (176 responses) was conducted with readers of ‘Eureka’ in *The West Australian* (16 October 2000). Although final results are not yet available, talks with the researcher suggested most problems reported related to the ravens’ habits of killing other wildlife and destroying eggs, as well as an apparent increase in abundance. Most thought ravens stole other birds’ eggs and killed their young, especially those of honey-eaters and wattle-birds. They were seen as a threat to goannas and turtles also. Yet, field observations taken for the same study clearly show, during both breeding and non-breeding times of the year, the majority of aggressive, chase/swoop /attack interactions were actually instigated by the smaller bird species. Although it is clear some sections of the community condemn them as nuisances, this study also indicated that overall, less than 20% of respondents supported culling (pers. comm. Suzanne Cumming, 15 November 2003).

These examples clearly show the contemporary views held of the species: as harbingers of doom, and bad omens, or just plain noisy, ugly, naughty birds. Such views have long existed, and seem to remain, with little else in their favour. This survey was not as extensive as some others, with all respondents chosen from people that used the study sites for recreational purposes. This survey was more an examination of whether the Australian Raven suffers as much a persecution problem as it causes a predation problem. Primarily the survey investigates whether Australian Ravens are considered too abundant at the study sites and if people consider them such a nuisance and threat to other wildlife present, that they support population control (culling) of the species. Responses will be discussed below.

5.2 Community Attitudes Survey

A survey was conducted to test the hypothesis that seasonal increases in abundance of Australian Ravens at the study sites diminish their aesthetic values to such an extent the public supported population control (culling) measures. The results largely confirm findings by Stewart (1997) and Mansell (1997) that the species are not a popular parkland bird. It is disliked because of its mournful song and black, sinister, plumage. They are also blamed for acts of predation and property damage. Respondents were first asked to share their views on the species at the study sites, followed by a request for anecdotes of any personal experiences shared with the Australian Raven, either at the site or another location.

5.2.1 Revision of Methods

A questionnaire, consisting of eight questions was presented as an informal interview to park visitors (age and sex of respondents were not recorded). All interviews were carried out when population surveys were being conducted (from February 2004). Most required responses to pre-determined categories, with one open-ended question asking participants for their comments about the species.

5.3 Data Analysis

The results (108 responses) were tallied and then converted to percentages that were displayed in a series of bar graphs, which allowed for comparisons and similarities to be identified. The presentation of the data in this format made it possible to ascertain if the views expressed fell into the majority, or minority of those expressed; especially for question seven (population control), to see if this strategy is supported by the community.

5.4 Results and Discussion

The first two questions examined the extent of park usage by participants to ascertain their familiarity with the site, and whether they had seen the Australian Raven. The results showed regular attendance by the majority of respondents with 14% using the sites less than once weekly, 23% attending twice weekly, 33% more than twice weekly, and 29% using them daily (Figure 5.1) All respondents were able to identify The Australian Ravens at the sites. Respondents were then asked if they thought there were too many of ravens at the study sites of which 20% agreed, whilst 54% felt neutral, 22% disagreed, and 4% strongly disagreed (Figure 5.2).

Participants were then asked if they considered the Australian Raven a threat to other birds species at the sites; only 1% strongly agreed, whilst 25% agreed, 51% were neutral, 21% disagreed, and 2% strongly disagreed (Figure 5.3). This question was then framed in terms of ravens being a threat to other animals and wildlife (other than birds) present at the sites: no respondents strongly agreed, 7% agreed, a majority 68% were neutral, 22% disagreed and 3% strongly disagreed (Figure 5.4).

The next question asked whether the Australian Ravens' were a nuisance for people using the parks for recreation. No respondents strongly agreed, only 10% agreed, the majority 66% were neutral about this, and less, 21% agreed they were a nuisance, and very few, 3% felt strongly about this notion (Figure 5.5).

The following question asked respondents if they considered Australian Ravens such a nuisance at the sites that they supported population control (culling) of the species. No respondents strongly agreed with this suggestion and only 4% agreed. The majority of 44% were neutral, 42% disagreed with the idea, and 10% strongly disagreed with it (Figure 5.6).

The final question required participants to share any personal experiences of the Australian Raven, either at the study site or another location. Only 15% had witnessed Australian Ravens attack any other birds or wildlife (12% at the sites, 3% at another location - mainly domestic chickens). Only 6% of participants complained of them damaging trees or plants at the sites (none at any other location), slightly less, 5%, complained of property damage (all at other locations). A small number of participants, 2%, reported egg stealing at the sites, and 5% reported similar incidents in other locations (theft of chicken eggs). Other complains related to noise, 22%, problems associated with defecation, 19%, food stealing, 5% and swooping 2%.

Many comments made about the Australian Ravens were in relation to their 'awful, raucous song', and 'ugly, demonic appearance'. Comments made by one respondent aptly reflected the opinions of many when she replied about the birds: "Australian Ravens? Ah! Yes! The noisy, ugly black birds that poo [sic] a lot!" Yet in spite of all the negative commentary, it seems ravens are actually tolerated by most people using the study sites for recreation.

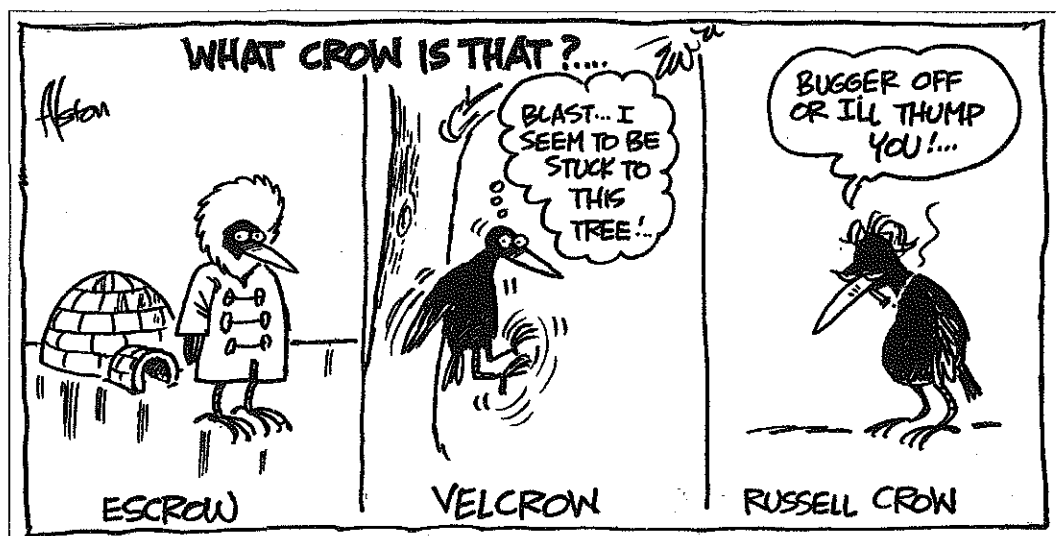


Plate 5.1: Cartoon depicting some crows, accompanying 'Inside Cover' article. This cartoon by Dean Alston, ran in *The West Australian* newspaper (24 March, p.2.), along with the article by Gary Adshead. The article sought to light problems some readers were experiencing with 'crows' (Australian Ravens) in Perth's south-eastern suburbs (reprinted with artists' permission).

COMMUNITY ATTITUDES SURVEY

RESPONSES TO QUESTIONS AT ALL STUDY SITES

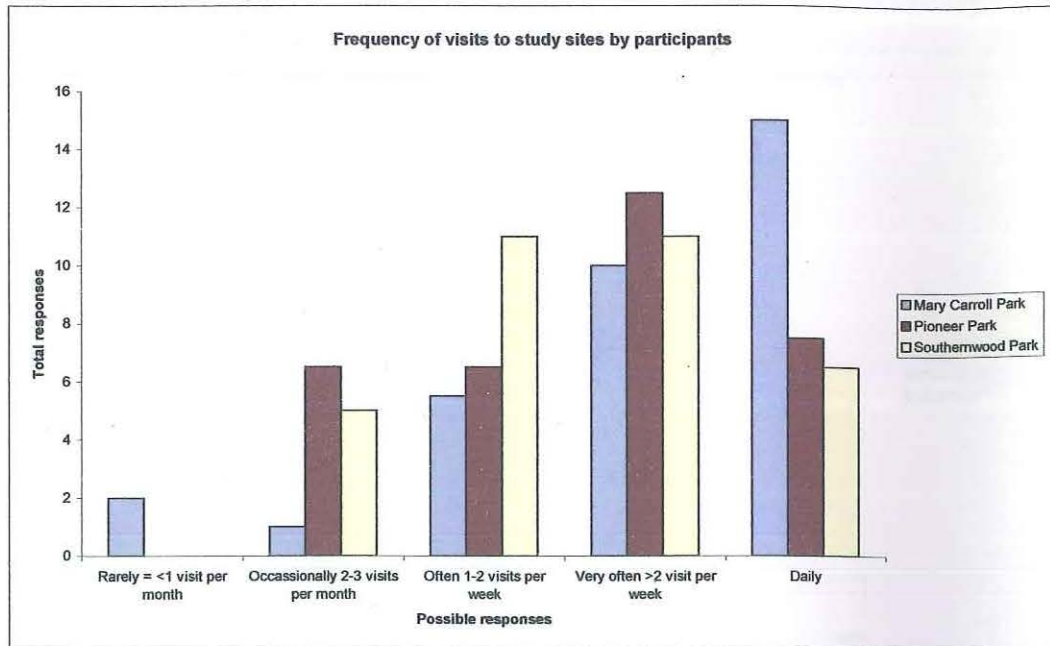


FIGURE 5.1: Extent of park usage by survey participants.

This shows fewer than 15% visited less than once weekly, 23% visited twice weekly, 33.5% visited more than twice weekly and 29% visited daily, with all respondents able to identify the Australian Raven at the study sites.

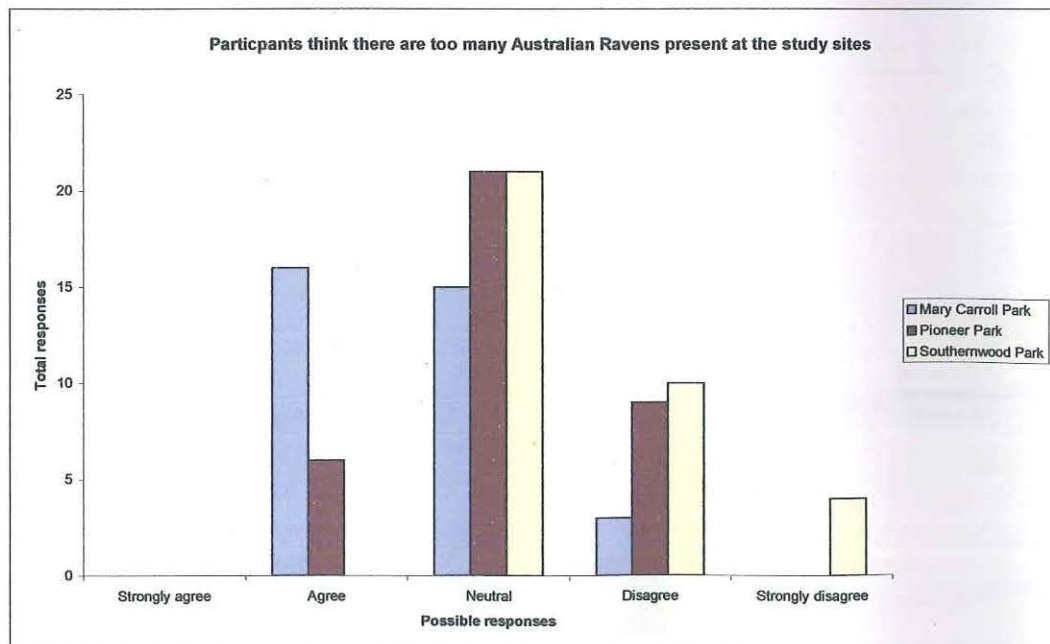


FIGURE 5.2: Views on abundance of Australian Ravens at the study site

This shows respondents views on whether the abundance of Australian Ravens is too great at each site: 20% agreed there were, 54% felt neutral, 22% disagreed, and 4% strongly disagreed.

COMMUNITY ATTITUDES SURVEY

RESPONSES TO QUESTIONS AT ALL STUDY SITES

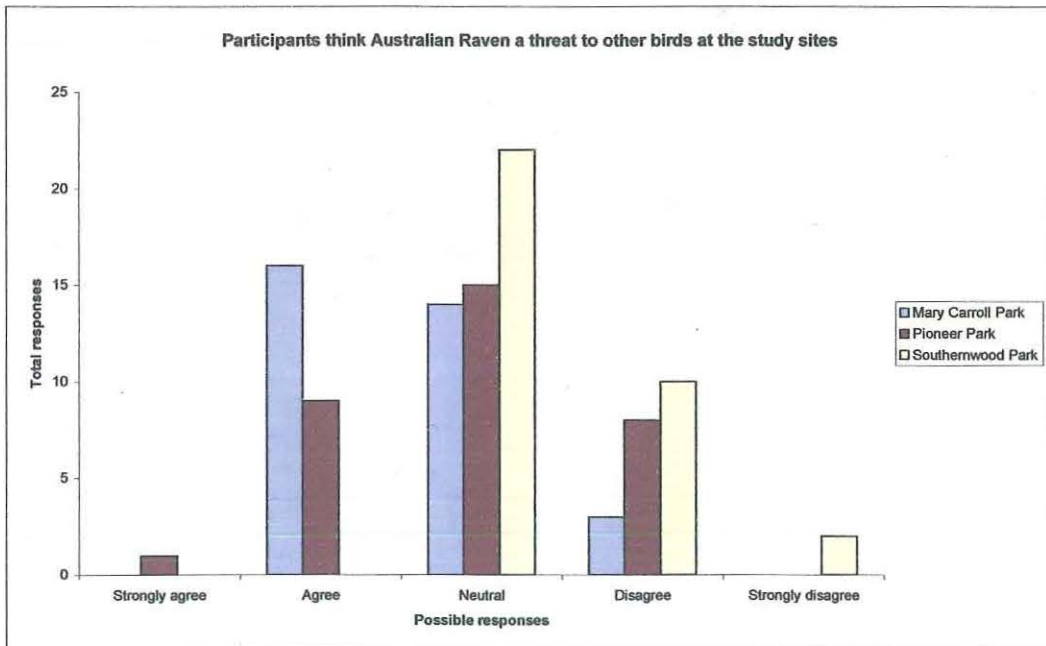


FIGURE 5.3: Views on Australian Ravens as a threat to other birds at the site

This indicates participants views on whether Australian Ravens are threatening to other birds present at the sites: only 1% strongly agreed, 25% agreed, 51% felt neutral, 21% disagreed and 2% strongly disagreed

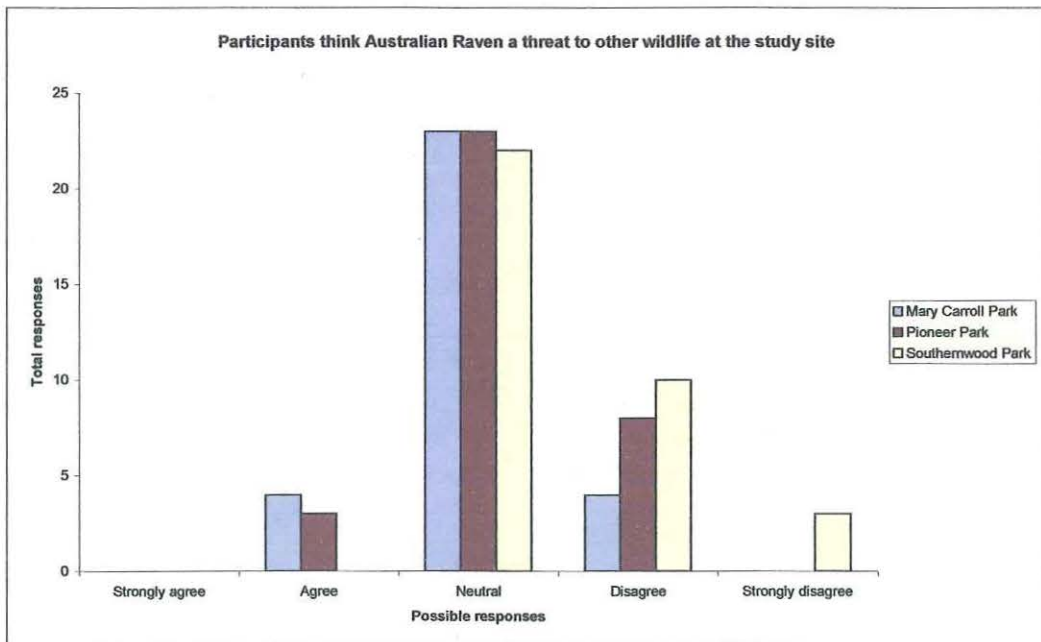


FIGURE 5.4: Views on Australian Ravens as a threat to other wildlife

This indicates that few participants consider Australian Raven a threat to animals, other than birds at the sites: no respondents strongly agreed, 7% agreed, the majority 68% were neutral, 22% disagreed and 3% strongly disagreed

COMMUNITY ATTITUDES SURVEY

RESPONSES TO QUESTIONS AT ALL STUDY SITES

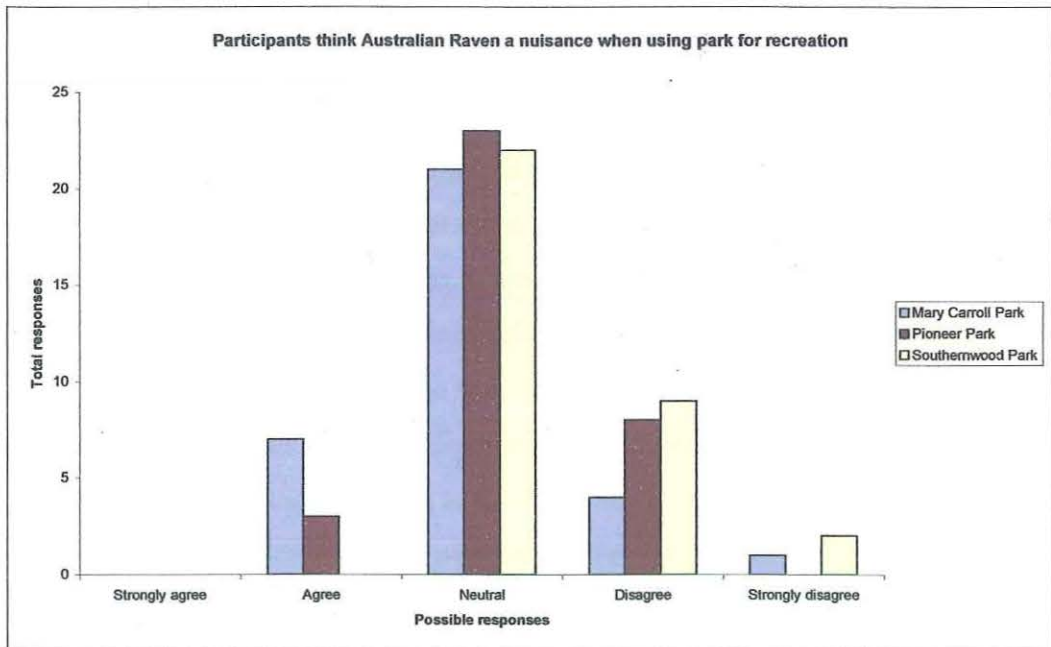


FIGURE 5.5: Views on whether Australian Ravens are a nuisance at the sites. This indicates whether participants thought Australian Ravens a nuisance when using the parks for recreation: no respondents strongly agreed, 10% agreed, the majority 66% were neutral, whilst 21% agreed they were a nuisance, 3% strongly disagreed.

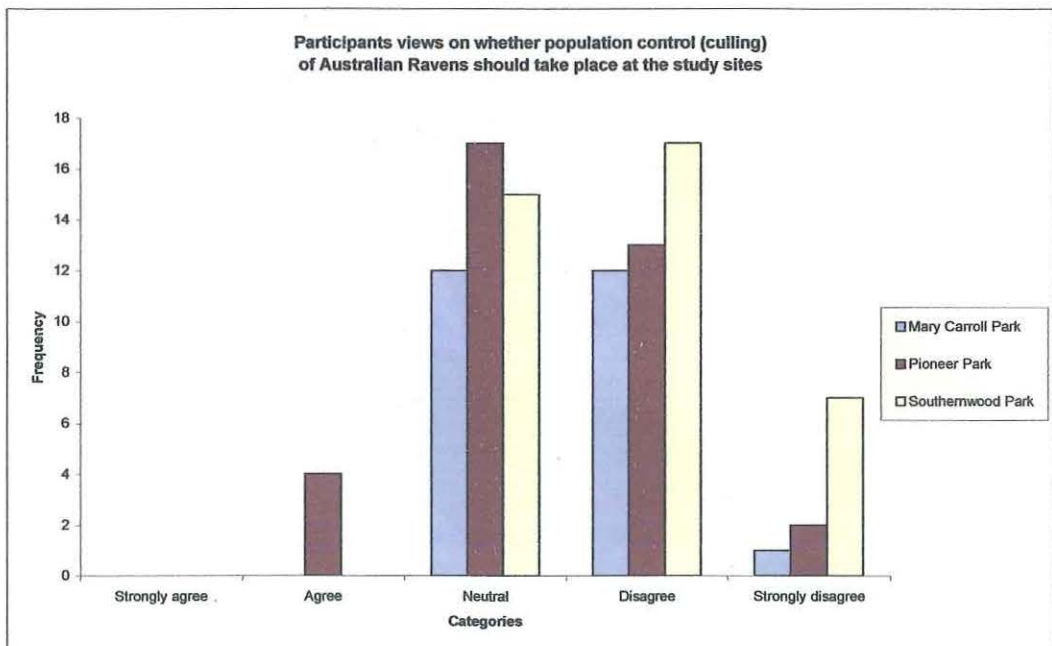


FIGURE 5.6: Views to using population control (culling) to manage abundance This shows attitudes toward using population control to manage over-abundant populations of ravens at the sites. None strongly agreed with the suggestion, only 4% agreed, the majority 44% felt neutral, whilst 42% disagreed with the idea, and 10% strongly disagreed with the suggestion.

5.5 Conclusion

The results show that the majority of respondents in the survey were regular park users, all of whom could identify the Australian Raven at the study sites. Most felt neutral or disagreed with the suggestion that ravens presented an overt threat to other species of birds and wildlife at the sites. Most respondents also felt neutral or disagreed that Australian Raven was a nuisance when using the sites for recreation. Most importantly, the majority of respondents felt neutral or disagreed with the suggestion population control of the species should take place at the sites. Almost one-third of respondents strongly disagreed with the notion. Most regular park users do not feel ravens are too abundant at the sites, and do not perceive them as a major threat to other species of birds and wildlife present, or consider them a nuisance when using the parks for recreation. Most participants felt neutral or outright disagreed with using population control to manage over-abundance of the species at the sites. Consequently all these views challenge the research hypothesis in its current formulation.

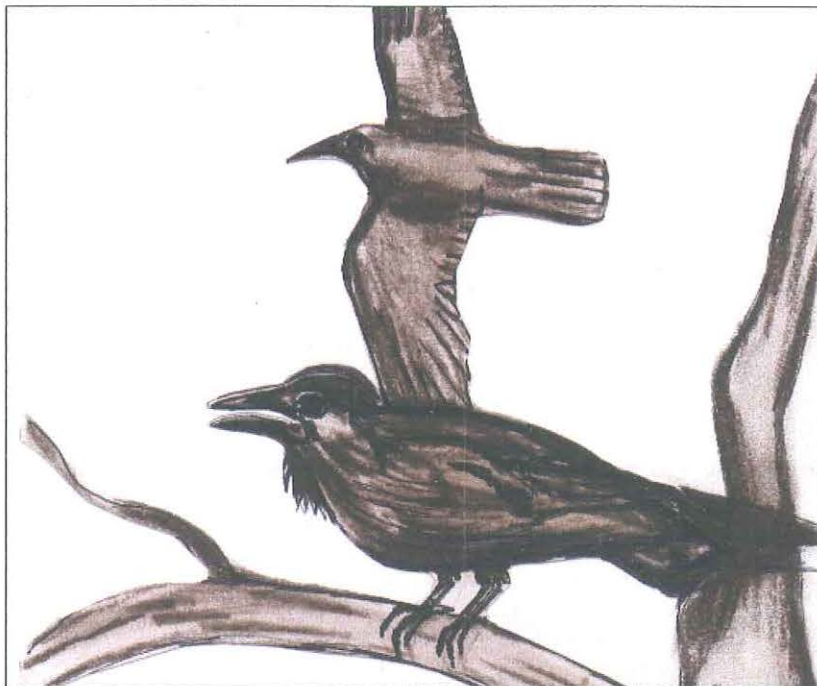


Plate 5.2: The Australian Raven, (*Corvus coronoides*)
(Charcoal sketch, by Alta Winmar, 2004)

CHAPTER SIX: ABUNDANCE AND DISTRIBUTION OF AUSTRALIAN RAVEN AT STUDY SITES

6.1 Background

Before examining the results for this aspect of the study it is important to understand the key concepts and terms. The two terms, Abundance and Distribution are often used synonymously but represent two vastly different aspects of animal population data. The paradigms ascribed to the key terms are outlined below, to ensure a clearer understanding of the results and discussion that follow.

The Abundance figures were obtained using Distance analyses and the figures reflect an *estimate* of abundance, (population density), of the species: i.e. the number of Australian Ravens found per hectare for each site. These are derived from actual counts taken during surveys of each site. The accuracy of estimates obtained using Distance Analysis is strongly correlated with the estimates obtained from the actual counts taken for each site. Figures arrived at using actual and estimated counts are presented as a comparison.

When reference is made to the Distribution of ravens at the study sites, it is in terms of their seasonal spatial location within the sites. It is clear that certain sectors of the sites were preferred, while others were rarely visited. By examining differences in habitat values between these areas, strategies may be developed to lessen the appeal of sites to Australian Ravens, whilst still maintaining and enhancing the conservation and recreation values of each.

A brief revision of the main methods of data collection is also appropriate. Firstly, each site was visited at least six times at different times of the day (AM, Midday, and PM visits). Each site was surveyed forty times during January to October. Each site was allocated thirteen (150m) transects covering the entire site, with nine corresponding distance zones (0-5m - 100m+). The target species were recorded as mature, immature or unknown, to try and determine if those present were likely to be resident, mature birds, or young nomads, visiting the area. (Refer Appendix B, Fieldwork Record: Population Data).

6.2 Data Analysis

The final analysis of survey population data was subjected to an established technique, a Fourier Series Analysis (Buckland *et al*, 1993) in order to extract unbiased, accurate results. Extracting abundance (population density) and distribution data required separate analyses and are explained below.

6.2.1 Abundance

Although detections were initially classified as mature, immature or unknown, the distinctions between the categories were too insignificant to be applied in the analysis, so no distinction was made between mature (resident) and immature (nomad) birds in the analysis.

Line transect methodology “embodies the explicit recognition of the fact that the probability of detecting birds decreases with increasing distance from the transect line (Burnham, Anderson and Laake, 1981, p.466). Accurate measurements of the perpendicular distance from the observer to the bird are detected and recorded and the data used to correct the sample size for the detectability of birds”. (p.466).

The analysis of line transect data was carried out using Distance 4.1 Release 2 (Thomas, Laake, Strindberg, Marques, Buckland, Borchers, Anderson, Burnham, Hedley, Pollard, and Bishop, 2003). Initially the analysis was attempted without assistance, but was finalised with assistance from Matthew Williams, a bio-statistician with the Department of Conservation and Land Management.

Initially, Australian Ravens were recorded in bands of width 5m, 20m or 50m, up to a perpendicular distance of 100m (unbounded) from the observer. It was apparent from the distribution of these initial counts that ravens exhibit a strong behavioural response, i.e. some ravens within 15m of the observer are moving away, and into the 15 to 30m distance classes (refer Figure 6.1). The subsequent analysis corrects this behavioural response, and allows for the fact that some ravens will remain unseen (the red line in Figure 6.1 indicates the estimated proportion of ravens seen, and the blue bars indicate the actual number of ravens seen in each band). Also note the very low detection rate >30m from the observer, especially compared with the 25 to 30m category.

Consequently, the count data was modified by incorporating an adjustment of 15m to balance the skew in the data caused by the behavioural response (refer Figure 6.2). The adjusted data were then subjected to a Distance Analysis, to calculate an appropriate Detection Function. Maximum likelihood was used to ascertain the best detection function, selecting the model giving the lowest Akaike Information Criterion (AIC). The concept put forward by Akaike (1973), provides “a quantitative method for model selection” (Buckland *et al*, 1993, p.75). Overall, the model with the lowest AIC was the half-normal detection function with cosine adjustment: It was this model that was then used to compute the estimates of abundance and population density of Australian Raven at each study site (refer Table 6.1)

TABLE OF POSSIBLE DETECTION FUNCTION MODELS		
FUNCTION	ADJUSTMENTS	AIC
Uniform	cosine	2162.42
half-normal	cosine	2158.56
hazard	cosine	2161.21
exponential		2167.4

Table 6. 1: Comparison of all four possible detection function models.
The function with the lowest AIC provides the best fit to the data and was used to calculate Australian Raven population estimates.

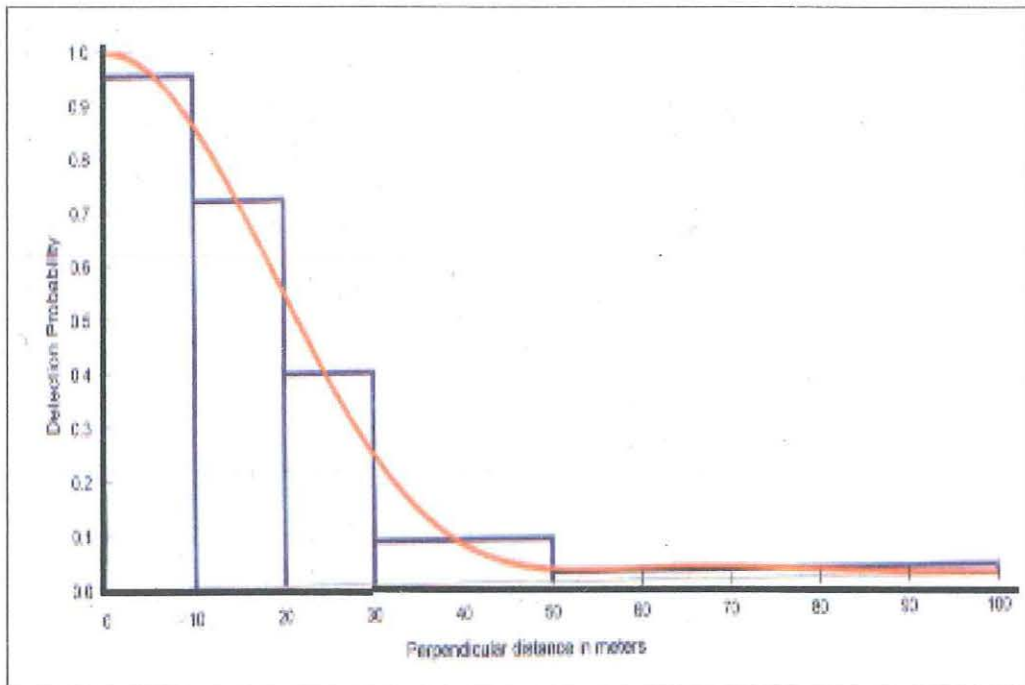


Figure 6.1: Initial plot depicting counts of Australian Raven in bands of varying width, at increasing intervals of perpendicular distances from the observer.

This histogram shows the total counts of ravens in each band; the fitted line is the initial estimate of the probability of detection, which seeks to calculate the decreasing detectability of ravens at increasing distance away from the observer.

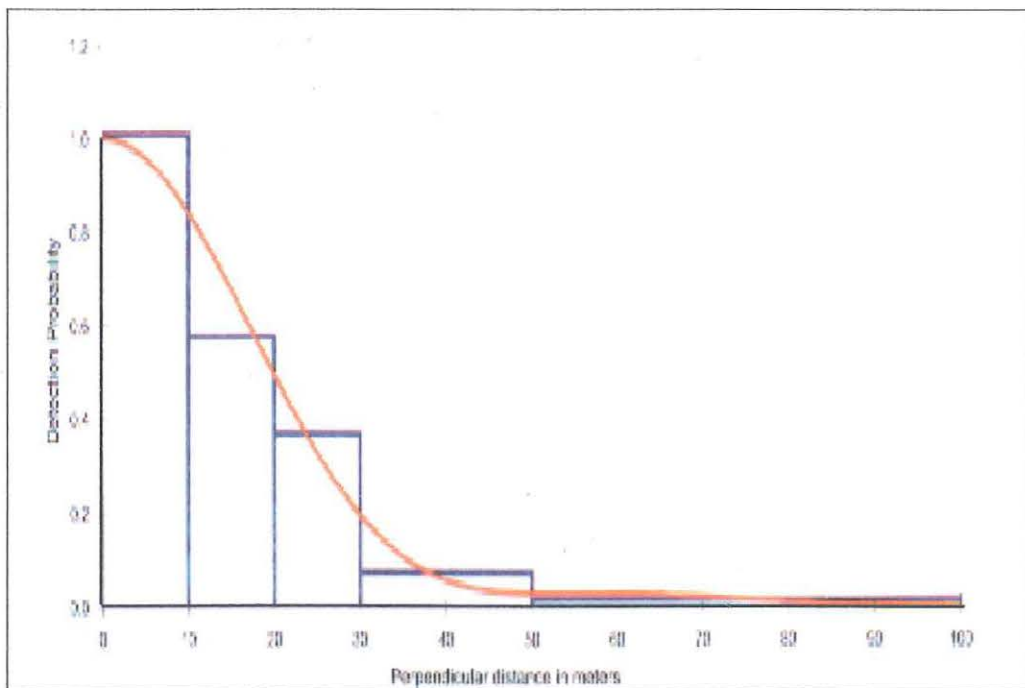


Figure 6.2: Graph depicting adjustments for behavioural response

Estimated counts of Australian Raven in five perpendicular distance bands from the transect line (bars) and estimated probability of detecting ravens (fitted line), after adjusting the initial data of Figure 6.1 for the behavioural response.

As part of the analysis, it was necessary to combine some of the initial eight distance bands into only five, in order to get a better fit of the model to the data (refer Table 6.2). Once the value of the detection function has been ascertained, and a suitable model identified to apply to the calculations, the analysis proceeds. The results are presented together with the actual counts from the survey, as a comparison to the estimated population densities for each site.

PERPENDICULAR DISTANCE IN METRES DETECTION FUNCTION / GLOBAL / CHI-SQ GOODNESS OF FIT TEST					
CELL	CUT POINT		OBSERVED VALUES	EXPECTED VALUES	CHI- SQUARE VALUES
1	0.0	10.0	376	352.54	1.561
2	10.0	20.0	215	251.01	5.165
3	20.0	30.0	138	124.39	1.490
4	30.0	50.0	55	56.23	0.027
5	50.0	100.0	31	30.84	0.001
Total Chi-square value = 8.2438			Degrees of Freedom = 1.0		
Probability of a greater chi-square value, P = 0.00409					

Table 6.2: Detection Function/Global/Chi-square/Goodness of Fit Test.

This includes perpendicular distance classes and observed and expected numbers of Australian Ravens seen for the half-normal, Detection Function. The Chi-square Goodness of Fit Test indicates a lower than expected number of ravens observed in Cell 2

6.2.2 Distribution

The analysis of data to identify predominant patterns of distribution of Australian Raven in the study sites first involved creating tables of the counts. This included all raw data collected, without any regard to a detection function: All data from the seasonal counts (January – May / June – October) and total counts (January – October) were tabulated for each transect, and for each site. From this series of tables, data were transferred into bar graphs to create pictorial interpretations of the distribution patterns for the sites. Both seasonal and total counts for the study were graphed, in order to ascertain if the seasonal distribution patterns differed, or remained similar. Also the extent of coverage for each vegetation type present in the preferred transects at each site were estimated and tabled to enable comparisons and similarities in habitat selection to be identified and discussed.

6.3 Results and Discussion

The following results and discussion of the abundance and distribution of Australian Ravens at the study sites contain both seasonal comparisons for each site, and comparisons between each site. It also presents population densities modeled on estimated and actual counts. Finally distribution patterns of the Australian Raven at each site, for each season, and the entire duration of the study will also be presented.

6.3.1 Abundance

The figures presented here show the estimated seasonal abundance of Australian Ravens for each site (number of ravens per hectare), ascertained using Distance 4.1. Others, for the purposes of comparison, are results extrapolated from actual counts. To ascertain differences between sites it is necessary to compare the estimated population densities for each. By tabulating figures for each season, each site along with (95%) confidence limits (both upper and lower) the data converts to a vertical line graph. Presentation of the data in this way made it simpler to identify *statistically significant differences* between them (refer Figure 6.3). Differences are identified when the number for *estimated density* (yellow tab) of a site falls outside associated *95% confidence limits* (upper, red tab) or (lower, blue tab) of another site. Several *statistically significant differences* are apparent in the graph: In summer (January-May) densities of ravens at Pioneer and Mary Carroll Parks exceeds Southernwood Park by almost 50%. In winter (June-October) populations of ravens at Pioneer Park exceeded Mary Carroll and Southernwood Parks, by almost 50%. Overall Southernwood Park recorded the lowest population densities of all.

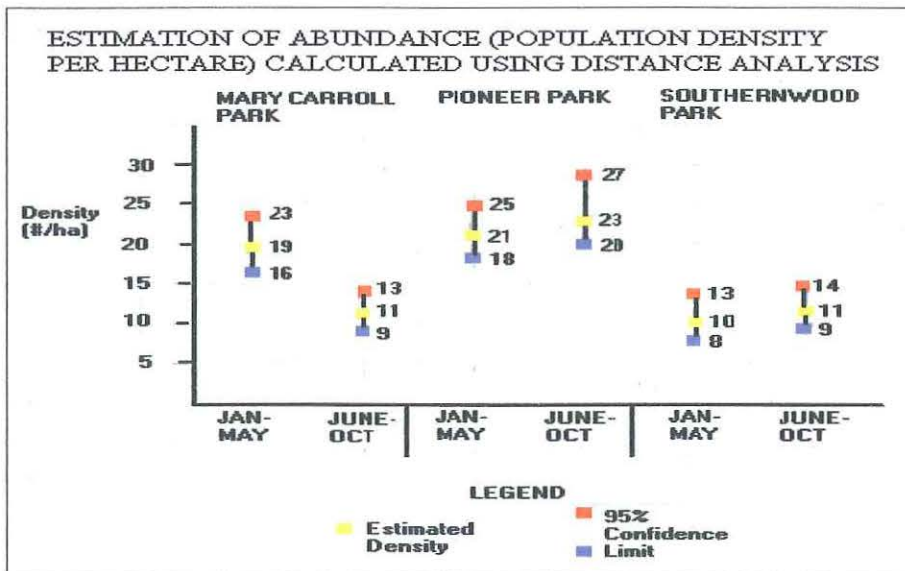


Figure 6.3: Abundance and Population Density Estimates Summary

When estimated density (yellow-tab) of a site falls outside the confidence limits (red and blue tabs) of another, the difference is statistically significant. Pioneer Park recorded the highest populations for the study; Southernwood Park, the lowest densities; and the site showing the greatest seasonal variation in population densities is Mary Carroll Park.

Before discussing these *estimated* differences it is worth examining the data from the *actual* counts, as they appear closely correlated with those estimated by Distance Analysis. The density (number of ravens per hectare) figures were ascertained from the counts (surveys conducted) by dividing total detections (of seasonal surveys), by the total area surveyed ($20 \times 1950 = 39,000\text{m}$), multiplied by 10,000 (to arrive at a number per hectare figure).

It is interesting to note that in this instance, as critics suggest, the density figures arrived at using Distance analysis are lower than those arrived at using an alternative method, in this case, the raw data (refer Table 6.3). The differences may actually be greater as the results are based on detections of up to only 30m from the raw survey data. This is because observations past this point failed to meet the critical assumption $g(0) = 1$ and were not considered reliable. It is therefore reasonable to assume actual differences between them may be greater than shown.

A quick comparison shows that Mary Carroll and Pioneer Parks attracted similar population densities for the summer period. Whereas winter figures for Mary Carroll Park were much lower and more closely aligned with the considerably lower density estimated for Southernwood Park.

COMPARISON SUMMARY - DISTANCE ESTIMATION DENSITY DERIVED FROM ACTUAL COUNTS								
SITE NAME	JANUARY - MAY				JUNE - OCTOBER			
	95% CONFIDENCE LIMIT		ESTIMATED DENSITY	DENSITY FROM ACTUAL COUNTS	95% CONFIDENCE LIMIT		ESTIMATED DENSITY	DENSITY FROM ACTUAL COUNTS
	Upper	Lower			Upper	Lower		
MARY CARROLL	16	23	19	30	9	13	11	16
PIONEER PARK	18	25	21	30	20	27	23	30
SOUTHERN WOOD PARK	8	13	10	16	9	14	11	13

Table 6.3: Comparisons of estimated abundance calculated using Distance 4.1, compared with population density estimates derived from the actual counts. It shows that figures arrived at using Distance analyses are generally lower than those calculated from the raw survey data. Differences could actually be greater, as detections $> 30\text{m}$ were not counted as they could not meet the assumption $g(0) = 1$ so were not considered reliable enough for use in analysis.

This is most likely due to the roosting phenomenon that occurred at Mary Carroll Park in the first weeks of the study. These incidents greatly inflated the counts for that period, and it is likely that the lower winter densities more accurately reflect population levels at the site for most times of the year. Another important aspect of the Mary Carroll Wetland is its status as a summer refuge, providing water, shade, food and shelter in landscape severely impacted by urbanisation. It is reasonable to assume that Australian Ravens attracted to the site initially come to drink, and is especially attractive because of the tall Eucalypts in the vegetation.

The population densities of Australian Raven were highest at Pioneer Park for both the summer and winter periods, with the site recording the highest estimate for the study in the winter period. It is likely Mary Carroll Park loses appeal in winter as insect populations decline and fewer people use the site for recreation, leaving fewer foodstuffs to be scavenged. A similar scenario is expected for Southernwood Park, with less winter usage producing less organic refuse.

It is unlikely usage at Pioneer Park declines to the same extent in at the other sites in the winter period. Firstly, the site backs onto shops, including a take-away chicken shop, supermarket and other specialty shops, some which trade all week. This busy retail area is in close proximity to the park and often foodstuffs purchased in the complex are bought into the park.

Nor is this the only retail area close-by, as the site is adjacent to the Gosnells Hotel (and restaurant) and Gosnells Railways Markets (selling fresh produce). Whilst the majority of waste is discarded into rubbish bins and large industrial bins on the complex, some still finds its way to the ground providing opportunities for these efficient scavengers.

It is reasonable to assume that population densities of Australian Raven at this site remain constant all year due to constant food availability. In summer it has plentiful naturally occurring foods and organic refuse, as well as water, shade and shelter: In winter, the site retains these features, with the sparse winter diet of naturally occurring food sufficiently supplemented with organic waste (discarded by people using the site and nearby retail complexes).

It is worth noting that the population densities for Southernwood Park both summer and winter, were (almost 50%) less than that of the other sites. This is likely tied to the extreme *hydrology* of the site, as the water supply and quality are both severely affected in summer, suffering algal blooms in some areas, and drying out completely in other parts.

While hydrology is an important factor, it is worth noting that this site supports more native vegetation species that provide greater *mid-storey* structure. The site has a *thicker, more impenetrable* habitat than the open vegetation shared by Mary Carroll and Pioneer Parks. Although the vista of native vegetation may not be as aesthetically pleasing to the eye (compared to a typical English park), there are practical benefits. The results substantiate the claim that the greater the degree of modification to an area of natural landscape, the higher the abundance of large, aggressive birds (Emlen, 1974; Cambell and Dagg, 1976; Lancaster and Rees, 1979 and Edgar and Kershaw, 1994), in this instance, Australian Raven.

Summer densities surpassed (or equaled) winter densities at all sites. This trend could be due to the highly mobile populations of immature, nomad ravens being present at the sites in non-breeding times. Most likely immature birds are tolerated until season change, when territories are aggressively maintained by the resident, breeding pairs. It is reasonable to assume that the immature birds will then leave summer drought refuges and seek out unclaimed, less fiercely protected areas, as their own.

It is clearly apparent that there are variations in population densities of Australian Raven between sites, and seasons. These differences are likely a response to water and food availability and habitat features (vegetation types). The most important point to consider in relation to the abundance figures arrived at for the study, is that they reflect population density estimates for *weiland parks*. In areas such as these all the requirements of the species are concentrated there (eg food, water, nesting and roosting trees, and company). As well as naturally occurring foods, the sites also provide additional foods from refuse and hand feeding of birds by visitors. They should not be extrapolated to reflect the abundance of the species in the surrounding urban landscape, for Gosnells, or any other suburban region.

The Distance Analysis also provided pooled estimates for the sites, combining the survey results for each site, to estimate overall abundance of the species in this area: the final estimated abundance of Australian Ravens 15.9 per hectare. This is a very high number in comparison with the accepted standard for breeding pairs of Australian ravens, which states that a territory of 110 ha is required (Rowley, 1973). However, in the next chapter, discussion in relation to linked site usage by ravens is presented. It appears that the species is concentrated in wetland parks, due to the consistency of food and water supplies, and availability of roosting and nesting sites, but actually disperse over a much larger area, effectively reducing this figure.

Three obvious conclusions can be drawn from these results for similar habitats: Firstly, a greater extent of naturally occurring, (especially) mid-storey vegetation appears to deter Australian Ravens from selecting a site for foraging. Secondly, actual survey data are very closely correlated with the estimated abundance arrived at using Distance Analysis. This is important when planning future surveys, as Distance Analysis was very time consuming and added significantly to the effort required to conduct animal population survey. An equally accurate picture may be could be obtained within the context of space and time, without enduring the lengthy analysis. Finally on first consideration, it seems that population densities of the Australian Raven at these urban parkland sites are very high, especially compared to the expected densities related to the territory sizes of mature, breeding pairs in rural areas. It is possible that the foraging/feeding range of Australian Ravens is greater in rural areas. Differences in territory sizes between urban and rural populations of Australian Ravens may be a response to sufficient food being found in smaller areas in an urban environment; and to restricted areas of suitable habitat being available. This is an aspect of the urban ecology of Australian Ravens that warrants further investigation. Such a study would require more sophisticated methodologies to track the movements of the species across the urban landscape.

6.3.2 Distribution

There are distinct similarities in the distribution of the birds at the sites in relation to habitat choice. Investigating the underlying reasons for these similarities may provide information for management of these parkland areas. Data collected in the population surveys of Australian Raven at the sites were compiled into tables, and then converted to a series of bar graphs. Presentation of the data this way provides a snapshot of the way ravens were distributed at each site (refer Figures 6.4 to 6.12).

As previously discussed (in chapter four) all sites were assessed to estimate the coverage of each habitat type present (shown as %) (refer Table 6.4). The purpose was to eventually identify the main types of vegetation cover present in transects which recorded the highest seasonal populations, and for the entire study.

ESTIMATED EXTENT OF VEGETATION COVERAGE FOR ALL SITES (SHOWN AS PER CENTAGE)					
Site	type 1	type 2	type 3	type 4	type 5
	Trees >25m	Shrubs 10-25m	Shrubs <10m	Cultivated grass	River or Lake Shoreline
Mary Carroll Park	28%	17%	17%	23%	15%
Pioneer Park	27%	16%	16%	26%	15%
Southernwood Park	17%	26%	26%	16%	15%

Table 6.4: Summary of estimates of vegetation types present at each site.

This table shows there are differences in the extent of coverage of the different vegetation types at each site. The sites that recorded the highest population densities for the study, Mary Carroll and Pioneer Parks, support more extensive areas of cultivated grasses (lawn) and tall trees (>25m). Southernwood Park, which recorded the lowest abundance figures overall, supports more mid-storey vegetation (<25m)

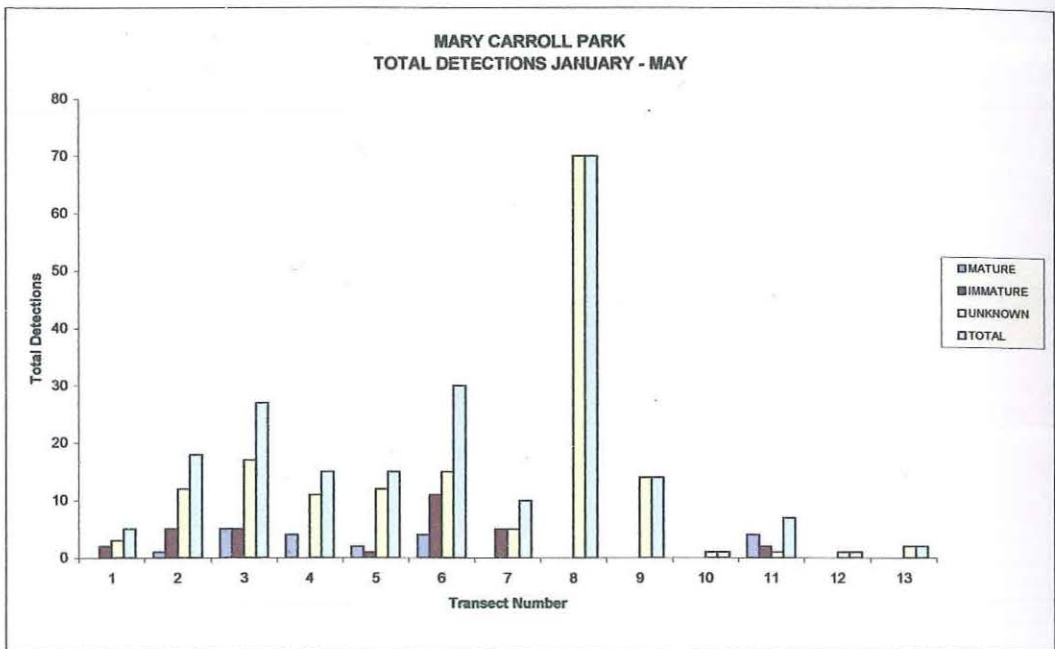


Figure 6.4: Graph depicting distribution of Australian Ravens at Mary Carroll Park for the period January to May: Note the highest population densities recorded are in the mid-sectors, most especially, transects 6 and 8

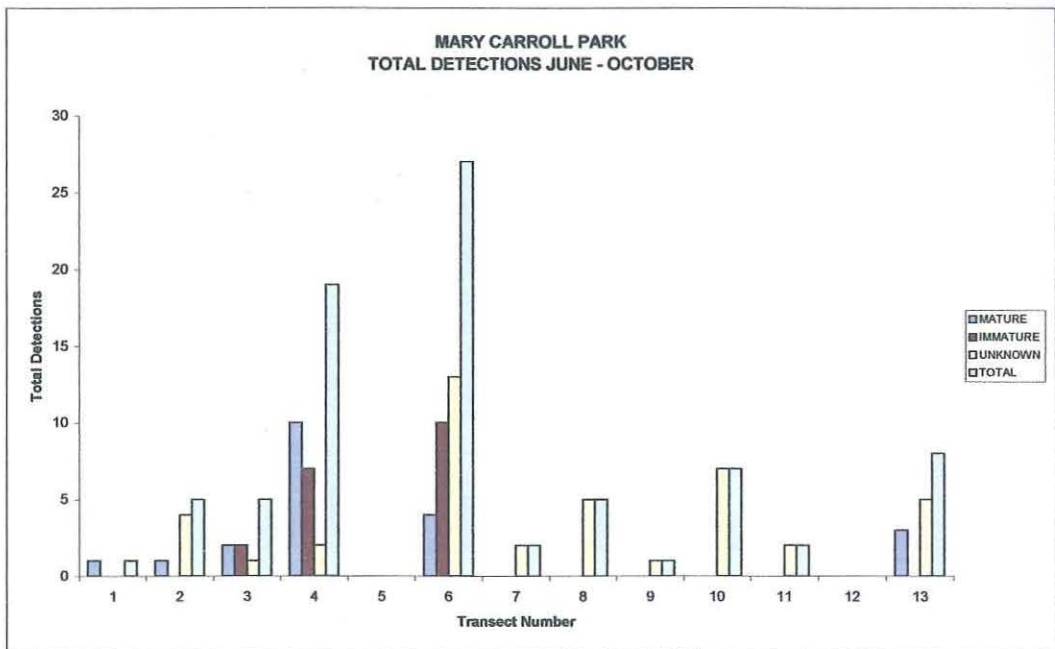


Figure 6.5: Graph depicting distribution of Australian Ravens at Mary Carroll Park for the period June to October: Note the highest population densities recorded for this period are in mid-sector locations, most especially transects 4 and 6.

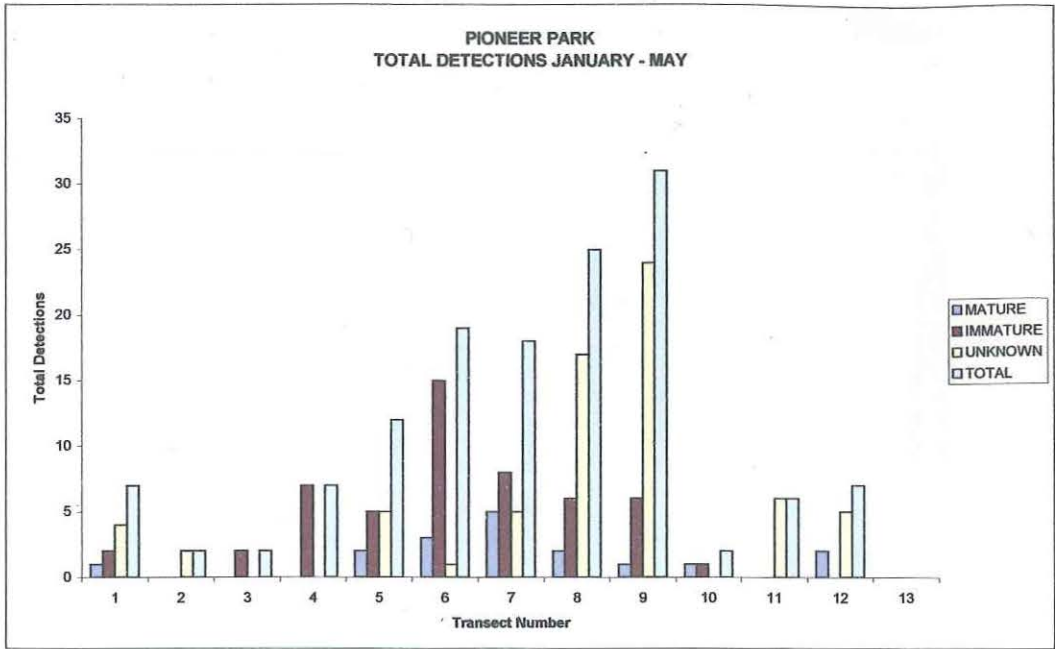


Figure 6.6: Graph showing distribution of Australian Ravens at Pioneer Park for the period January to May. Again, the mid-sector transects have recorded the most detections, especially transects 5,6, 7,8 and 9.

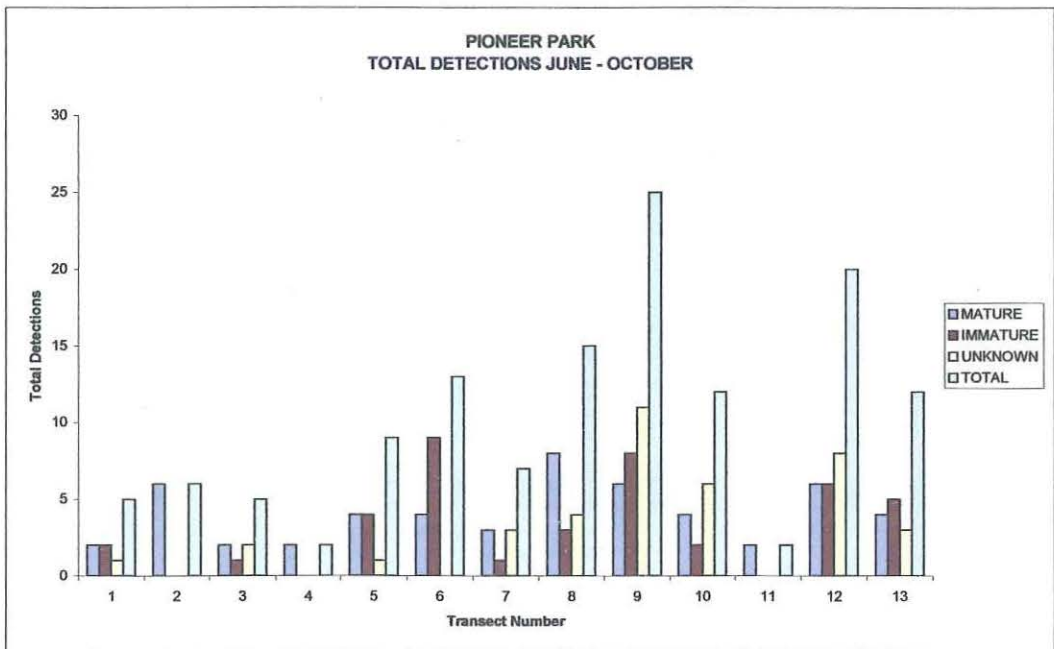


Figure 6.7: Graph depicting distribution of Australian Ravens at Pioneer Park for the period June to October. Again, the sectors that record the highest populations are the midsections of the sites, especially transects 6, 7, 8, 9 and 10.

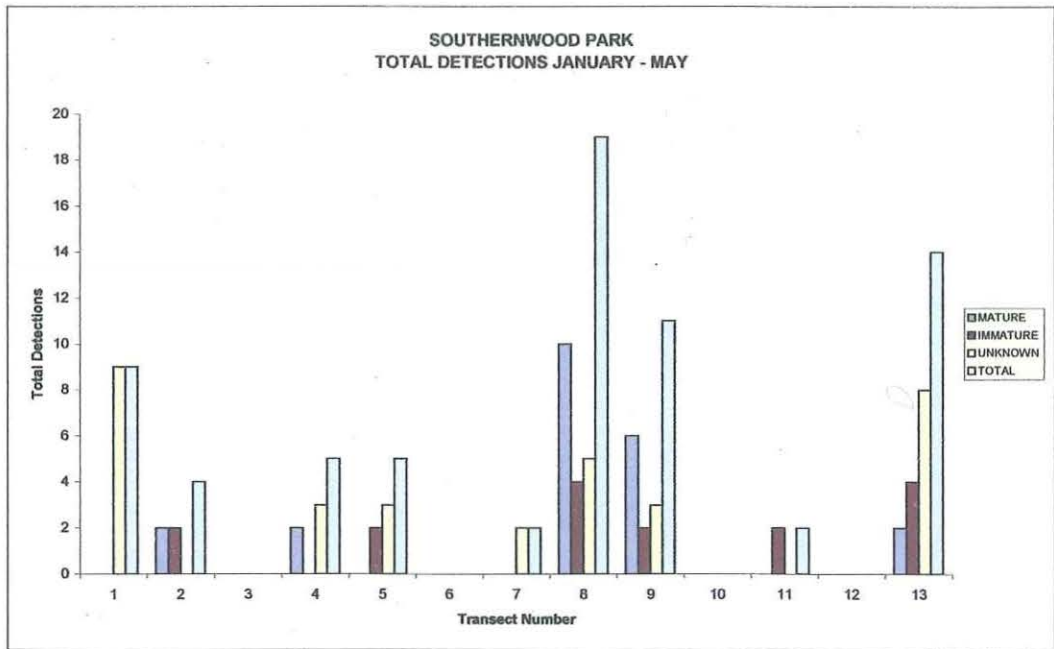


Figure 6.8: Graph depicting distribution of Australian Ravens at Southernwood Park for the period January to May: Note the highest populations were again recorded in the mid-sector transects, although higher populations were recorded in the outer sections (transects 1 and 13), probably in search of food and water

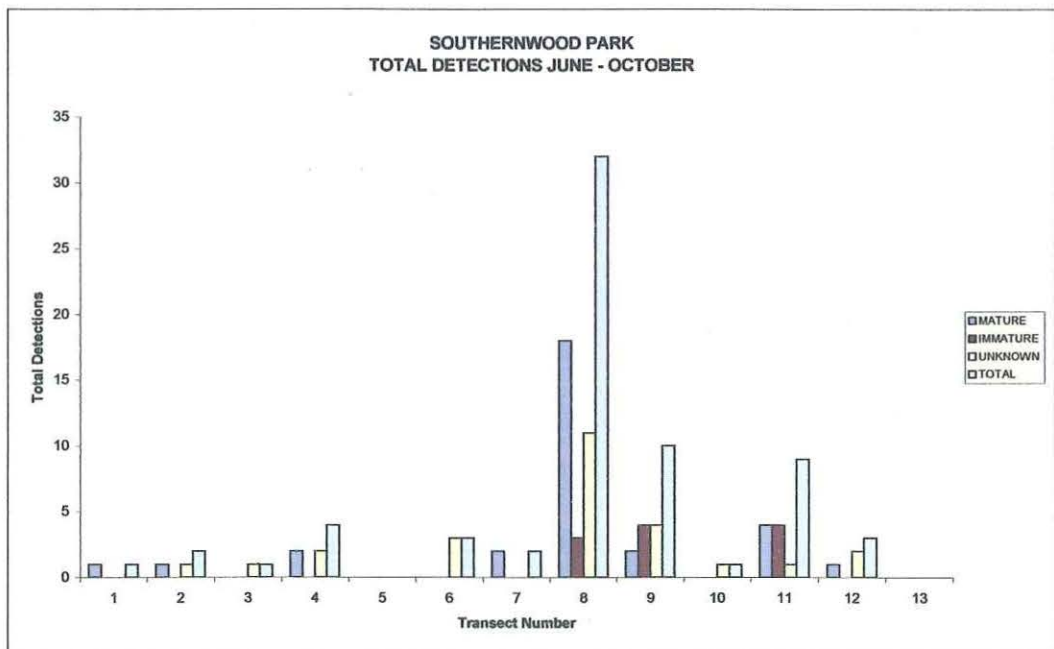


Figure 6.9: Graph depicting distribution of Australian Ravens at Southernwood Park for the period June to October: Note the highest populations were again located in the mid-sector transects, especially transects 8, 9 and 11

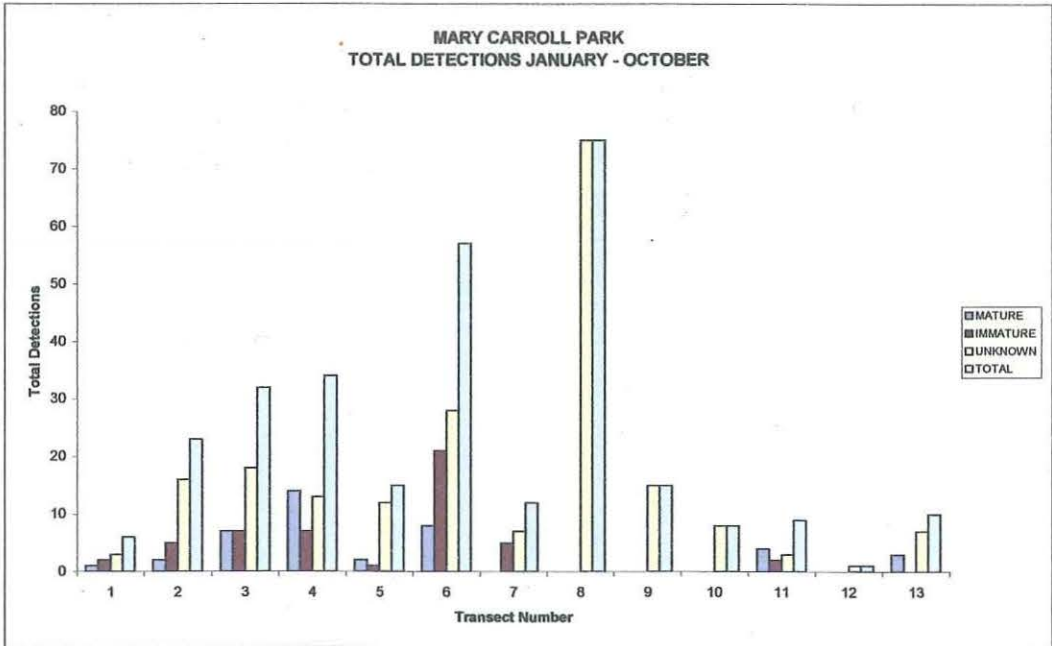


Figure 6.10: Graph depicting distribution of Australian Ravens at Mary Carroll Park for the duration of the study, January to October 2004. Note that the highest densities were recorded for the mid-sector transects. Forays into the outer-sectors most likely to find food and a water supply.

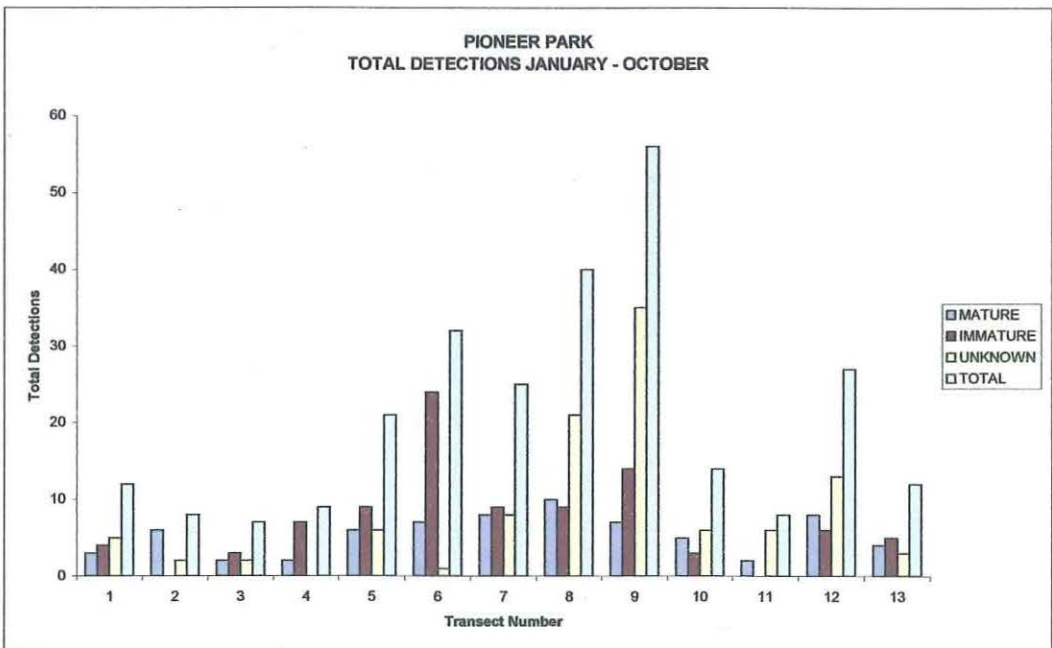


Figure 6.11: Graph depicting distribution of Australian Ravens at Pioneer Park for the duration of the study, January to October 2004. Note that again the highest populations are recorded in the mid-sector transects, 5,6,7,8 and 9

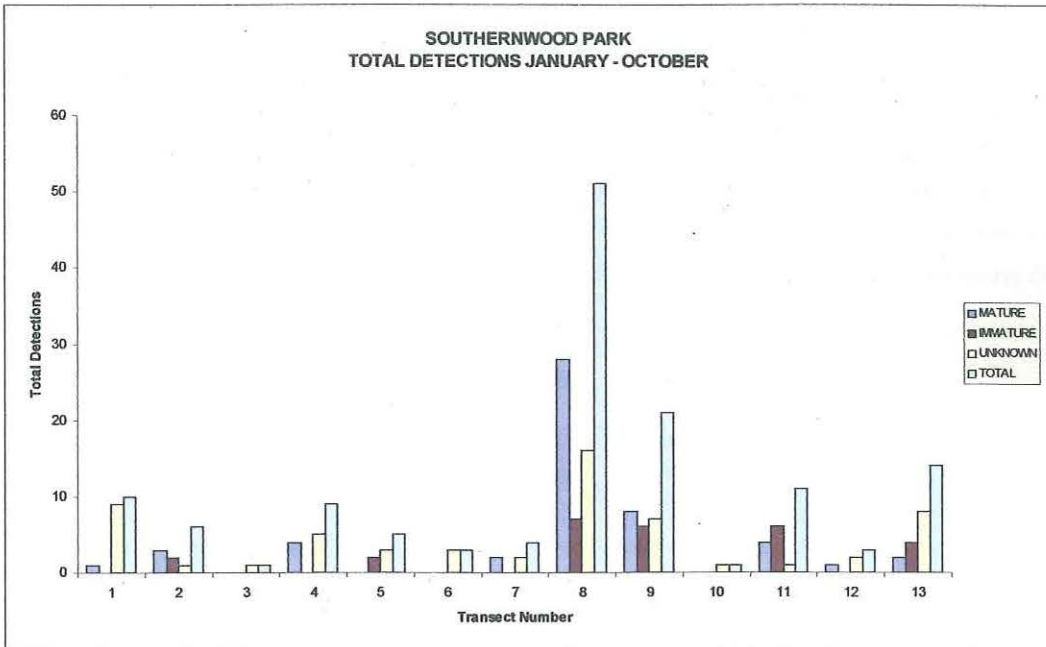


Figure 6.12: Graph depicting distribution of Australian Ravens at Southernwood Park for the duration of the study, January to October 2004. Note that the mid-sectors of the site recorded the highest population densities. This suggests that the Australian Raven preferred areas that provide a barrier (in the form of vegetation cover) from the surrounding urban landscape, perhaps in order to avoid the hazards inherent in this type of environment. Such hazards may be domestic pets, vehicular and pedestrian traffic (consisting of people that do not like them and may act in a hostile or frightening manner toward them).

From the Australian Raven population survey data the two transects recording the highest population densities (each site, each season, and for the year) were tabled with corresponding estimates of the main habitat types (refer Table 6.5).

It appears that Australian Ravens mostly frequented the middle sections of the sites, only ventured to the outer transects when targeting a food-source (such as food-scrap, or seasonal infestations of insects into a particular area). This intelligent bird seems to instinctively compensate for problems associated with edge effect (e.g. reduced food availability, increased rates of nest predation, interference by humans, as well as other birds and animals). It seems they prefer areas that offer a buffer of vegetation, or space, away from the modified (urban) landscape surrounding them.

The summary identifies several important factors: Firstly, each preferred transect had access to water; and supported two main types of habitat: Type 1, tall trees >25m; and Type 4, cultivated grasses (these were often in combination).

The placement and number of rubbish bins in each transect was not a major factor in habitat selection. They are more likely to scavenge food-scrap already on the ground rather than take them from a rubbish bin. The main factors influencing site selection appears to be the extent of naturally occurring foods available, and the presence of a reliable water source.

SUMMARY OF ESTIMATED EXTENT OF VEGETATION COVERAGE IN TRANSECTS PREFERRED BY AUSTRALIAN RAVENS AT THE SITES (FOR THE ENTIRE STUDY)				
TYPES REPRESENTED		SITE		
		MARY CARROLL PARK	PIONEER PARK	SOUTHERNWOOD PARK
TYPE 1	Trees >25m	27%	26%	19%
TYPE 2	Shrubs 10-25m	17%	17%	25%
TYPE 3	Shrubs <10m	17%	16%	22%
TYPE 4	Cultivated grass	24%	26%	19%

Table 6.5: Summary of main vegetation types found in preferred transects.

It is evident that the preferred areas have higher representations of tall trees (>25m), and cultivated grasses, each also contains a reliable water supply.

6.4 Conclusion

The results showed there were several statistically significant differences in the abundance and distribution of Australian Ravens between seasons and sites. Mary Carroll Park attracted much higher summer populations (probably due to a *roosting* phenomenon in January-February). Pioneer Park recorded the highest densities for each season (probably due to constant food availability). Southernwood Park recorded the lowest densities all year (probably due to more mid-storey vegetation that reduced foraging, and is not suitable for breeding). It seems densities are highest at the sites that have more greatly modified native vegetation structures. Hydrology is important, as sites with the lower densities (Mary Carroll and Southernwood Parks) are more affected by evaporation and algal blooms, whereas Pioneer Park, on the larger tributary, has better water flow, and the lakes aerated by pumps during summer which improves water quality. The Australian Raven shows a distinct preference for the middle transects at the sites, that support tall trees (>25m) and cultivated grasses, often in combination.

It appears that the estimated abundance of Australian Raven at the study sites is high, especially when these densities are compared to the numbers that maintain large territories in rural areas. There is some seasonal fluctuation at Mary Carroll Park (due to roosting), but this is not so at the other sites.

In regard to the distribution of the species, ravens prefer habitats combining tall trees, preferably Eucalypts and cultivated grasses and avoid areas with thick mid-storey vegetation. There are a number of factors to consider in relation to planning to manage problems associated with Australian Raven in suburban parklands: namely the vegetation present, water quality, and refuse management.

CHAPTER SEVEN: DAILY ACTIVITIES AND INTERACTIONS OF THE AUSTRALIAN RAVEN AT STUDY SITES

7.1 Background

Observations were recorded as Daily Activities, Interactions, or Flight Entry and Exit Pattern. All are behavioural aspects offering insights into the urban ecology of the Australian Raven. Again it is necessary to define the key terms and concepts: daily activities, interactions and flight patterns.

The main daily activities investigated were how food was obtained. Categories included foraging on ground, scavenging at a bin, scavenging litter on the ground, stealing food from park visitors, raiding nests and stealing eggs. Other instinctive activities were also examined such as perching in tree or shrub, plant or tree destruction and flying. Anti-social aspects such as property damage were originally investigated but removed from the analysis as no incidents were recorded.

Interactions were noted in relation to how the Australian Raven acted toward other birds present at the sites; and how they in turn, behave toward ravens. Observations were tallied according to which species initiated either a chase or attack action, including those between Australian Ravens. The other species involved in the interaction were also identified to portray the dynamics that existed in the parklands.

Flight entry and exit patterns to and from the sites were also considered. These aspects of raven behaviour were recorded during population surveys, particularly the directions in ravens were headed, into and out of each site. This served the purpose of identifying dominant directional patterns, to and from each site. This data was then transposed onto a map covering all three sites, to suggest any possible links between site usage.

In revising the main methods for this part of the study, it should be acknowledged that these techniques were not based on a particular template but evolved from a process. Initially, relevant categories of behaviour were identified, then formatted for data collection in such a way records could be analysed.

Firstly, the main daily activities likely to occur were listed, then set to a fifteen minute timetable, in one-minute increments (Refer Appendix C, Fieldwork Record: Activity Budget). On the return sweep of survey, the first ravens encountered to be observed and each incident of an activity (total ten categories) scored as it occurs, multiplied by the number of ravens conducting the activity, then tallied to reach a total count (Refer Appendix C, Fieldwork Record: Activity Budget).

The methodology for recording interactions between Australian Ravens and other species was developed using a similar process. First, anticipated interactions were compiled as a list and set against a scoring system. As interactions occurred they were scored according to who initiates the action (total six categories); the Australian Raven or the other species, which were also identified (Refer Appendix D, Fieldwork Record: Interactions/Entry and Exit Points/Species List).

The final aspect of daily activity observed was flight. Data collection was based on taking the directional bearing from which Australian Ravens were travelling to (using a prismatic compass). Each scored as Entering or Exiting, as well as the numbers travelling (Refer Appendix D, Fieldwork Record: Interactions/Entry and Exit Points/Species List). Any strong patterns to and from each sites were applied to a map covering all sites to establish any links between them. Mobility across the wider landscape suggests that the species engaged in optimal foraging strategies, scouring for food, water and shelter.

7.2 Data Analysis

These observations were not subjected to a rigid analysis, based on any specialised model. Instead the data for each category are shown as a percentage and are presented in tables and graphs, to enable comparisons between seasons and sites.

7.2.1 Daily Activity Budget

Initially ten categories were used to score the activities of the Australian Raven. These were later either amalgamated or omitted due to lack of data to six categories. Final tallies were then presented as percentages, and displayed as pie-graphs, to show total times spent in each activity for each site, and season. Site tallies for the entire study were then amalgamated and tabulated to enable comparisons to be made.

7.2.2 Interactions

Initially six categories were used to score the interactions of the target species, these were either amalgamated, or omitted due to a lack of data, to three final categories. Final tallies were then presented as percentages to identify the main types of interactions taking place and the main species involved in them. The figures were tabulated and presented as bar graphs.

7.2.3 Flight Entry and Exit Patterns

Total tallies for directions of flight were formatted into a table to ascertain the predominant routes taken. The final figures were transposed on a map showing all sites to establish if any predominant flight patterns between sites were evident.

7.3 Results and Discussion

A number of interesting observations emerged from records of the daily activities and interactions by the Australian Raven. Mainly, the few incidents of anti-social behaviour: such as scavenging, damaging property, and attacking other animals. Ravens seem most intent on finding food, protecting territory and avoiding unpleasant weather conditions (extreme heat and cold, and heavy, unrelenting rain). Throughout the study only a few acts of predation were witnessed: with one raven seen taking a nestling, one, egg stealing and another, caching a stolen egg, however such incidents were too few to be presented as percentages in the final results.

7.3.1 Daily Activity Budget

Data collected regarding the daily activities of Australian Raven, recorded for each site, each season, are displayed in a series of pie-graphs (Figures 7.1 to 7.9). The graphs clearly show that most time spent in daily activities by Australian Ravens relate to the categories ‘perching in tree/shrub’, and ‘foraging on ground’, with some time in trees including acts of ‘plant/tree destruction’, in a search for food in the bark and leaves. The category ‘flying’ scored moderately, which suggests the species is mobile over the area. Incidents of drinking, bathing and preening were not recorded for each survey, and did not score highly overall. Other aspects of daily activities that scored poorly related to incidents of scavenging food from rubbish bins and on the ground. This is surprising, considering the complaints made about the species to various agencies, as well as comments made in the Community Attitudes Survey.

The only pattern suggestive that more time was spent engaging in particular activities at certain times of year (summer/autumn, non-breeding times and winter/spring breeding times), relates to ‘perching in tree/shrub’, which scores more highly through the winter/spring period at all sites. It is at this time of year that many species of birds are breeding, and corresponds with less time spent ‘picking at tree/shrub’. It appears that Australian Ravens scout trees in the area, methodically investigating the leafy canopies.

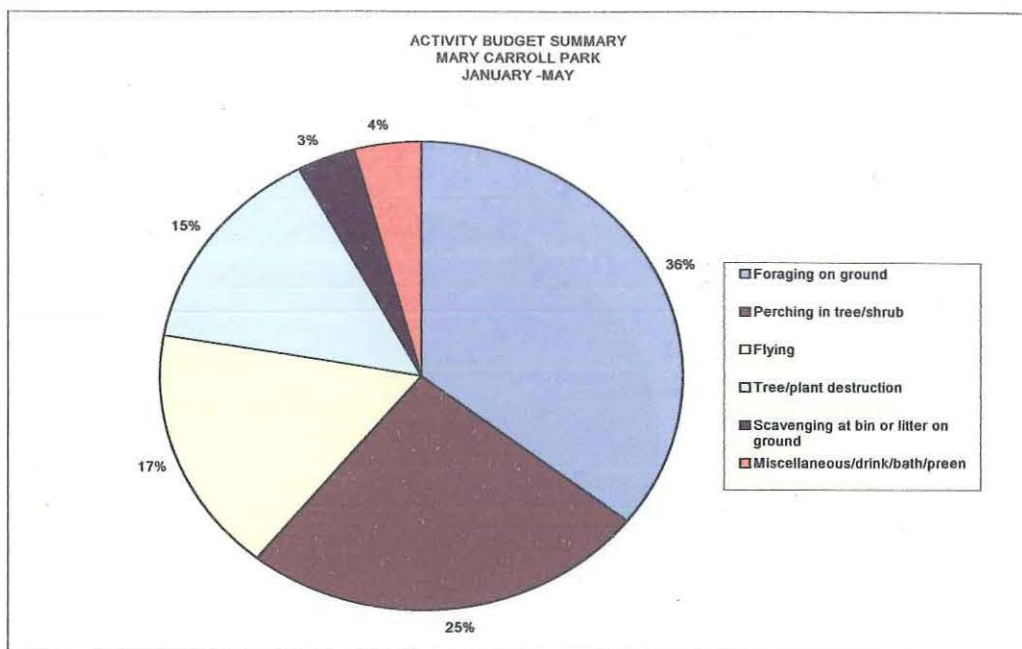


Figure 7.1: Activity Budget Summary for Mary Carroll Park, January to May. At this time of year ‘ground foraging’ is the most prevalent activity, then ‘perching in tree/shrub’. An almost equal portion of time is spent ‘picking at tree/shrubs’ (for food, tools, or nesting materials), and flying, showing the species to be quite mobile. Only a small amount of time is spent drinking/bathing. Interestingly, even less time is taken up with scavenging from bins, or at rubbish on the ground.

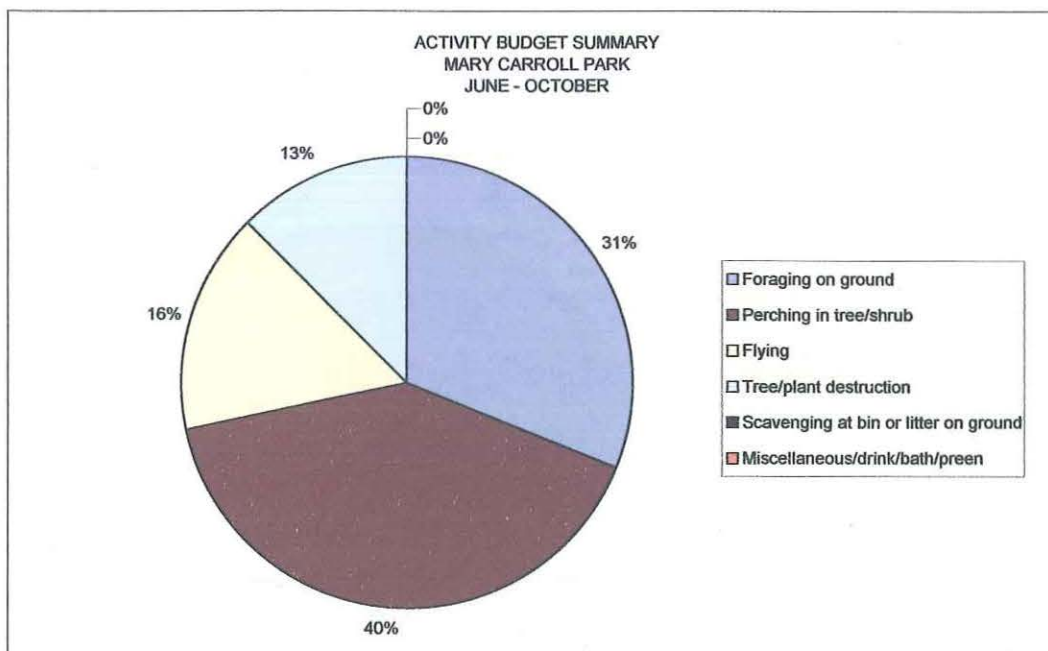


Figure 7.2: Activity Budget Summary for Mary Carroll Park, June to October. At this time of year ‘perching in tree/shrub’ is the main daily activity, with only slightly less time spent ‘ground foraging’. Time spent flying is about half spent in these activities. It is unusual that incidents of drinking/bathing/preening, as well as scavenging rubbish, were so minimal they did not feature in the analysis.

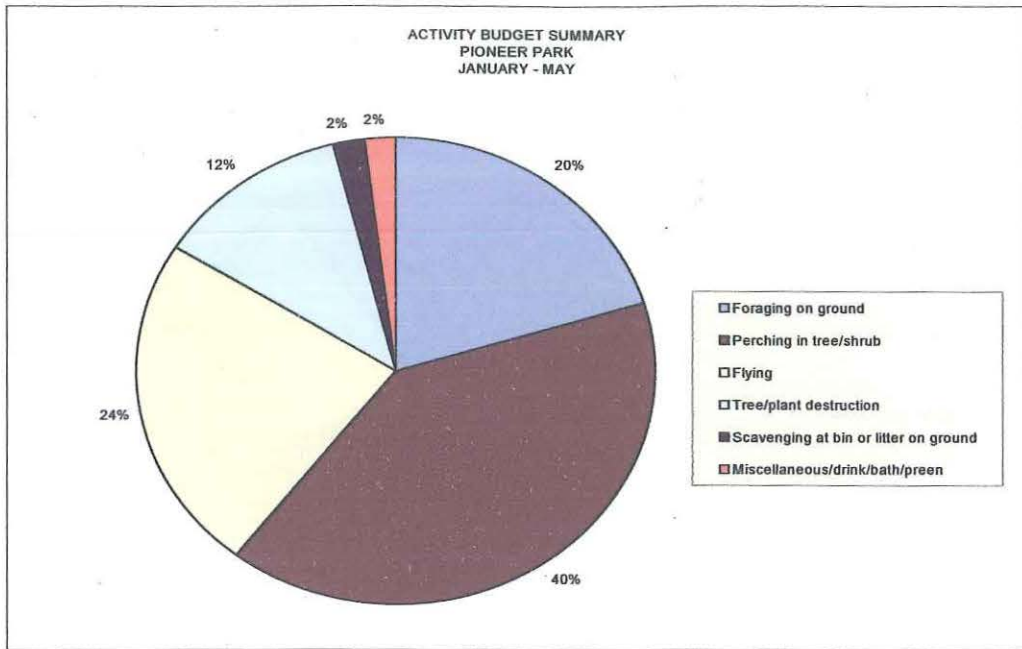


Figure 7.3: Activity Budget Summary for Pioneer Park, January to May. Similarly, most time is spent ‘perching in tree/shrub’, compared to ‘ground foraging’ at this site. Less time is spent in ‘tree/plant’ destruction, which suggests food may be found from alternative sources. Flight was frequent, however incidents of scavenging litter were not frequently recorded during surveys, with drinking and body care also scoring low.

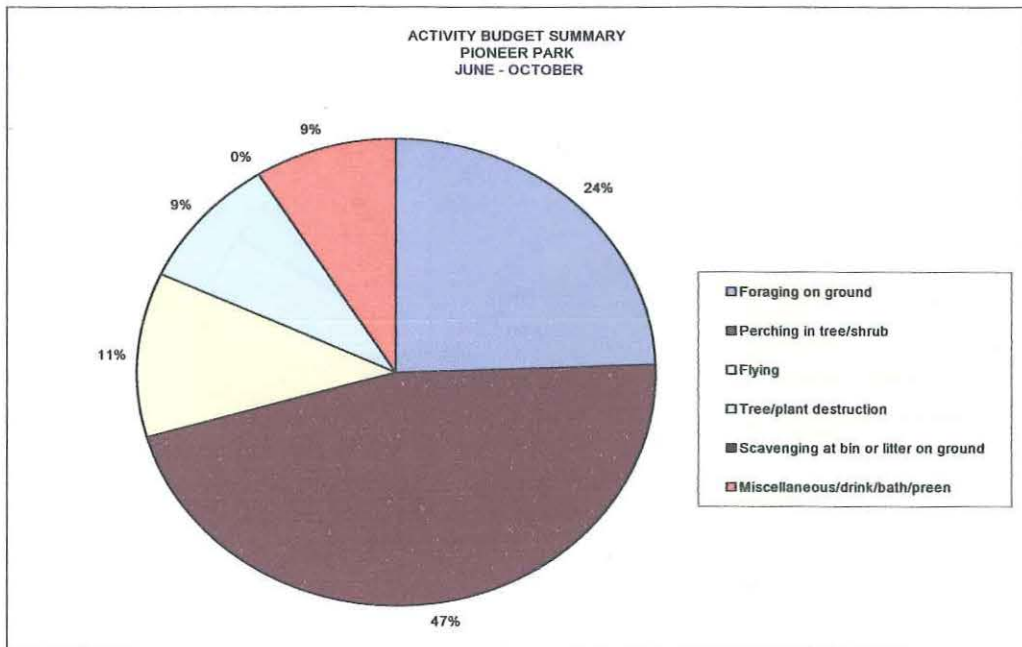


Figure 7.4 Activity Budget Summary for Pioneer Park, June to October. At this site again ‘perching in tree/shrub’ recorded the highest score, with slightly less time spent ‘ground foraging’. Less time was spent in flight. Considerably more incidents of drinking/bathing/preening were recorded for this period at this site.

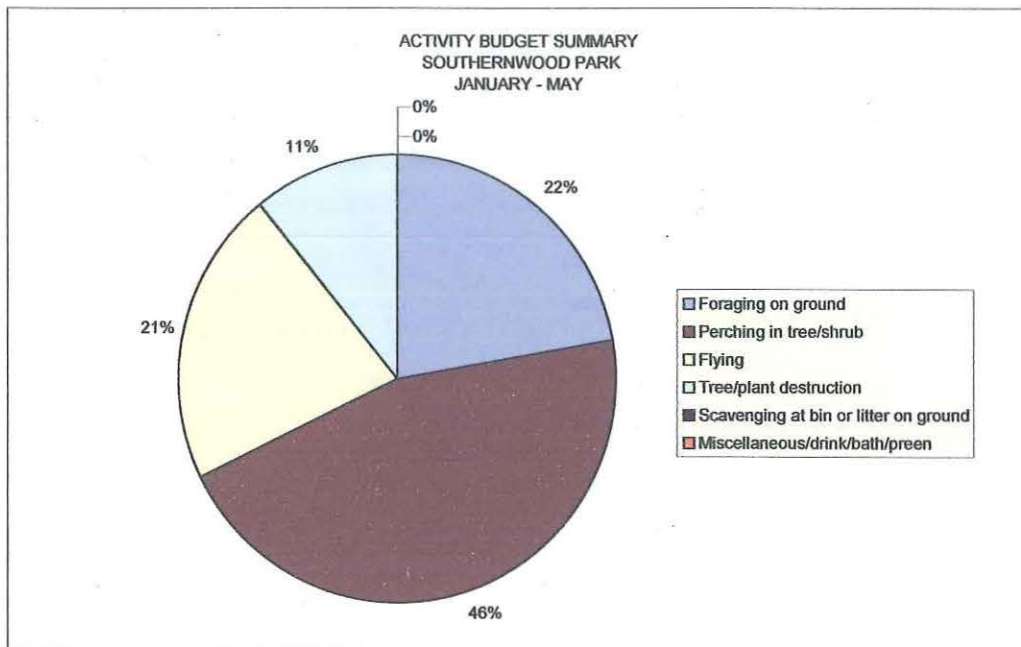


Figure 7.5: Activity Budget Summary for Southernwood Park, January to May. Considerably more time is spent ‘perching in tree/shrub’ at this site, than is spent ‘ground foraging’. The species is quite mobile in the area, with ‘flying’ scoring similarly as a daily activity. Again, too few incidents of ‘drinking/bathing/preening’ and ‘scavenging at bin or on ground’ were recorded to feature in the analysis.

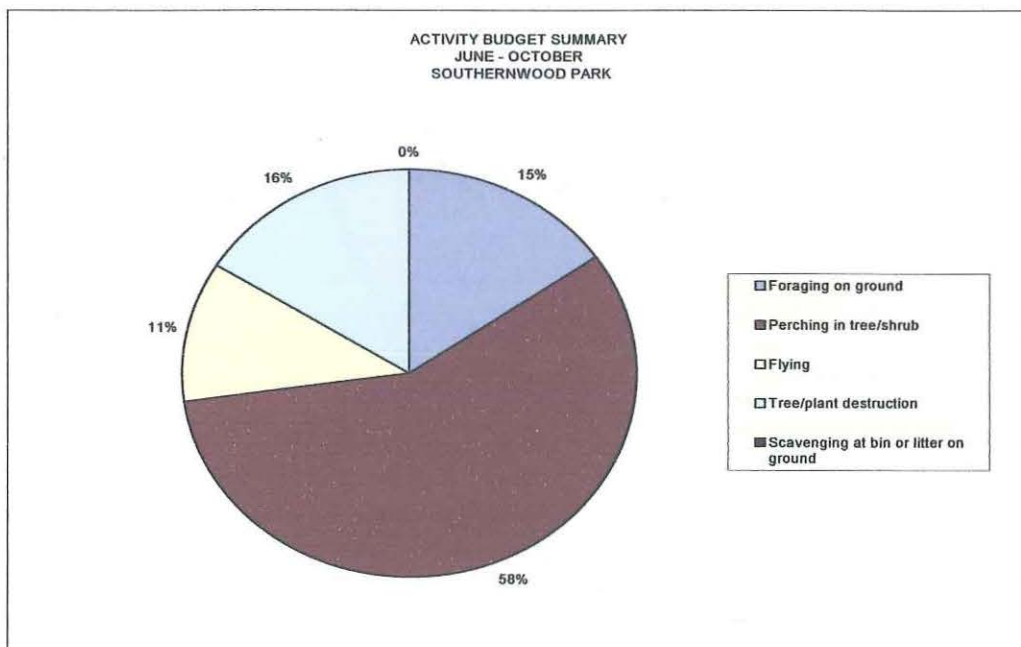


Figure 7.6: Activity Budget Summary for Southernwood Park, June to October. The majority of time is once again spent ‘perching in tree/shrub’ at this site, almost four times greater amount than ‘ground foraging’. Flight is also minimal, less than time spent in tree/plant destruction record. The species is quite mobile in the area, with ‘flying’ scoring similarly as a daily activity. Again, too few incidents of drinking, and body care were recorded to feature in the analysis.

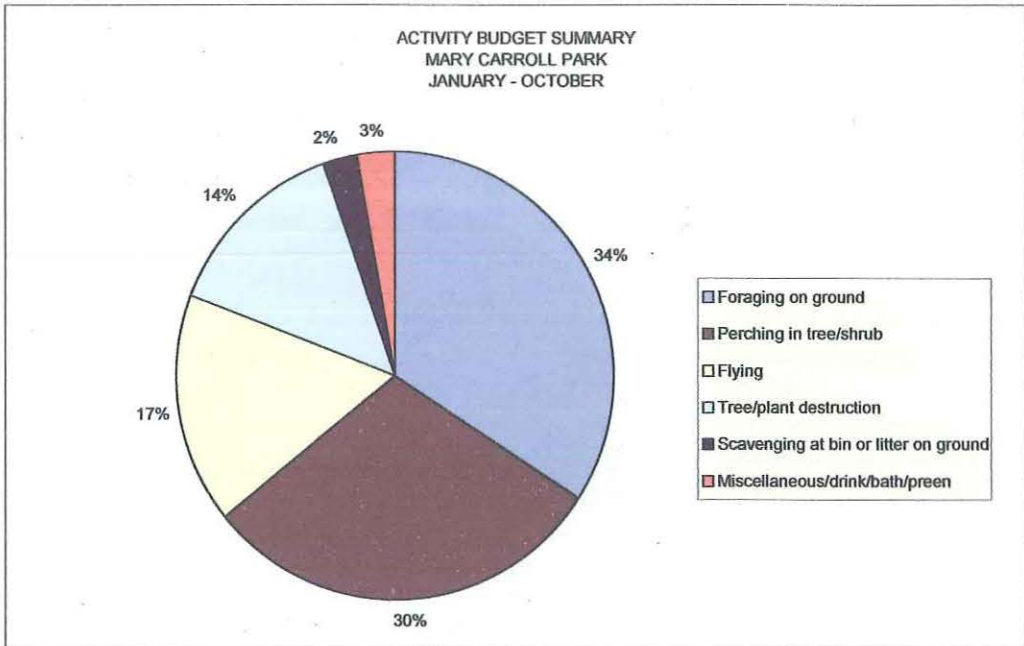


Figure 7.7: Activity Budget Summary for Mary Carroll Park, January to October. Results show that overall for the site, almost equal amounts of time were spent ‘foraging on ground’, as ‘perching in tree/shrub’, with almost half that amount of time spent in ‘tree/plant destruction’. Flight was consistent throughout the year. Incidents of drinking/bathing/preening, and ‘scavenging at bin or litter on ground’ combined, accounted for only five percent of daily activities.

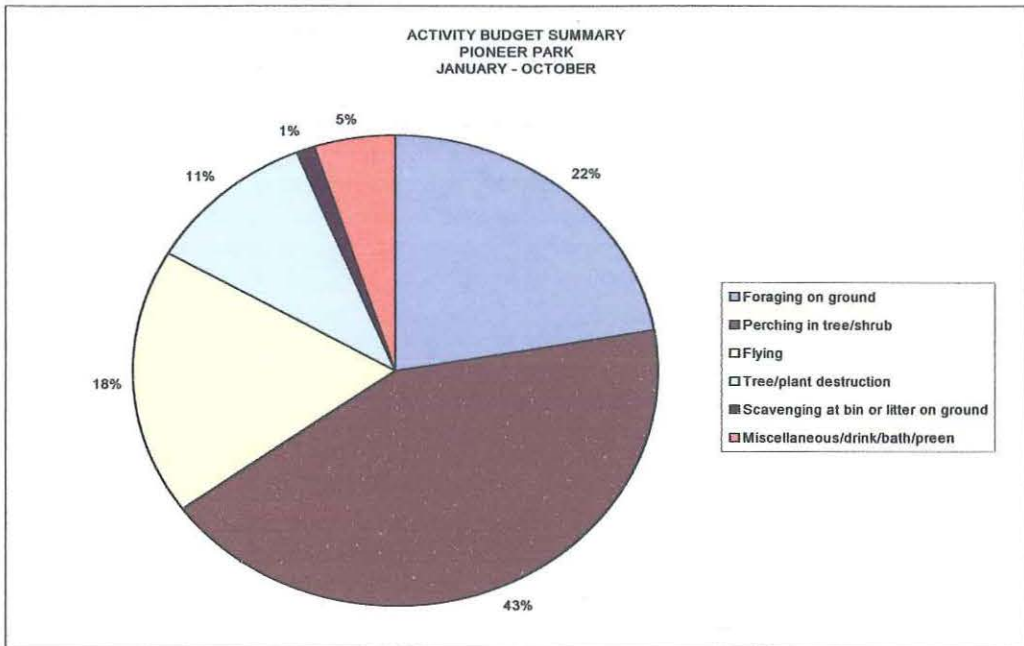


Figure 7.8: Activity Budget Summary for Pioneer Park, January to October. Results show that overall at this site the main daily activity is ‘perching in tree/shrub’, with considerably less time dedicated to ‘ground foraging’. Fairly consistent times spent in ‘tree/plant destruction’ and ‘flying’. Again, incidents of drinking/bathing/preening’ and ‘scavenging at bin or litter on ground’ did not attract high scores.

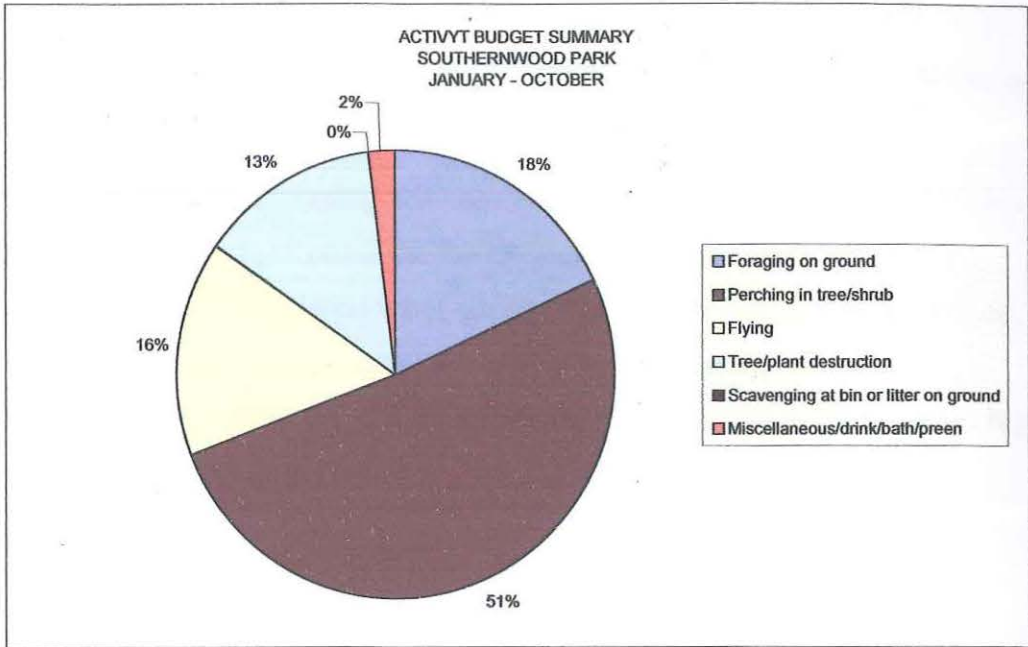


Figure 7.9: Activity Budget Summary for Southernwood Park, January to October. Results show that overall at this site, almost half the time dedicated to daily activities involved ‘perching in tree/shrub’. Considerably less was spent ‘ground foraging at this site (which has less cultivated grasses and more mid-storey cover)’. Flight remained consistent throughout the year. Drinking and body-care were not recorded for each survey, which shows in the analysis. Again, note the low score for ‘scavenging at bin or litter on ground’. This is interesting considering the nature of complaints, and views people have of the species. That these types of incidents did not score significantly enough to show in the analysis in several instances for this study, it appears that ideas about such ‘problem behaviour’ outweigh examples of it.

The allocation of time to daily activities of Australian Ravens at each of the sites appeared to vary little over seasons and between sites, with all recording similar scores for each season, and for the duration of the study refer Table 7.1).

Less bathing and preening activities were recorded for Southernwood Park, possibly because the site recorded the lowest seasonal population densities and experienced the most diminished water quality. The highest total recorded for these activities was at Mary Carroll Park. This was likely due in part to roosting populations that visited the site in summer. Before retiring in the evening, and at first light, groups would drink and bath at the edge of Northern Lake (Transect 7).

ACTIVITY BUDGET SUMMARY: SEASONAL COMPARISON OF PERCENTAGE OF TIME SPENT ENGAGING IN ACTIVITIES						
Activity	MARY CARROLL PARK		PIONEER PARK		SOUTHERNWOOD PARK	
	Summer	Winter	Summer	Winter	Summer	Winter
Foraging on ground	23	19	24	24	17	20
Perching in tree or shrub	37	55	44	44	59	53
Flying	21	12	18	11	18	13
Tree/plant destruction	7	11	9	9	5	13
Scavenging at bin or litter on ground	2	2	2	4		
Miscellaneous/drink/bath/preen	10	1	3	8	1	1

Table 7.1: Summary of Daily Activities, all sites: Time spent in each activity (shown as %). It seems that the time spent in activities does not vary significantly between seasons, or between sites. This is suggestive that all daily activities are executed similarly throughout the year at all sites. The increased rate of drinking/ bathing/ preening at Mary Carroll Park is likely due to the high number of transient ravens that roosted at the site during January and February, and then departed. Of particular interest is the very low allocation of time spent in scavenging food from rubbish bins, or the ground. Other anti-social behavioural aspects did not score significantly and were not included in the analysis.

Calculated annually, (refer Figure 7.10) the main daily activities of Australian Ravens were dominated by perching in a tree/shrub (45%) and (8%) of time spent was spent engaging in tree/plant destruction (searching for food contained in the bark and leaves). Another aspect of this activity is that Australian Ravens spent time perched in trees to avoid inclement weather. At other times ravens appeared to be scouting the area, patrolling territorial boundaries. Food was also obtained by ground foraging (22%). Another popular activity was *flying* (17%). They often flew higher-up-and-further-into the same tree in which they were perching. It seemed at times that ravens were conducting a grid search of the canopy, not leaving until sure there were either no unwelcome visitors to their territory, or no new opportunities for obtaining food. Utilising foods scavenged from the bin or the ground accounted for only 1% of daily activities. This was mostly from litter discarded on the ground, with only one incident of scavenging at a bin recorded for the entire study. Other activities including drinking, bathing and preening accounted for 7% of daily activities. Most related to drinking, less to bathing (the species is not fond of the water). Only occasional acts of allo-preening, during late winter, early spring, were witnessed.

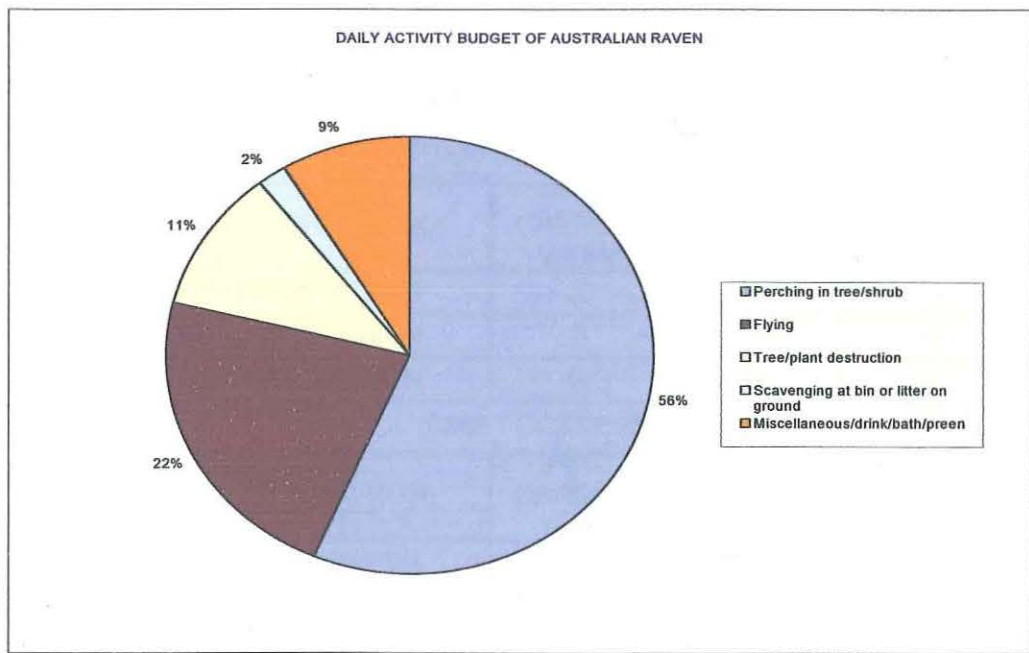


Figure 7.10: Summary of time spent in activities, all sites, January to October. Note that the main activity overall is 'perching in tree/shrub', followed by 'foraging on ground'. The extent of 'flying' shows the Australian Raven is quite mobile over the area. Drinking and body care did not score significantly, with drinking accounting for most of the score. As previously identified, incidents of scavenging were very low, which underrates the validity of complaints about this to some extent.

7.3.2 Interactions

In the final analysis three categories were identified describing the main interactions involving the Australian Raven (refer Table 7.2). There were some seasonal differences in frequencies but they did not follow any noticeable pattern. The highest (summer) frequency for *raven chase other* was recorded at Pioneer Park (this park recorded the highest population densities). In contrast, this type of interaction was more predominant in winter at Southernwood Park. In terms of *other chase raven* interactions, high frequencies were recorded for both summer and winter. In summer, at Pioneer Park this type of interaction accounted for almost two-thirds of the total interactions recorded. In winter, only a slightly smaller percentage was recorded for Mary Carroll Park. Southernwood Park records the lowest frequencies for this type of interaction (but has the lowest population densities). Not surprisingly the highest frequency recorded for this *other chase raven* type of interaction was over winter at Pioneer Park, the breeding time for most birds and when territories are more fiercely protected from intruders.

SUMMARY OF INTERSPECIFIC INTERACTIONS: SEASONAL COMPARISON (SHOWN AS PERCENTAGE)			
JANUARY - MAY			
TYPE OF INTERACTION	MARY CARROLL PARK	PIONEER PARK	SOUTHERN WOOD PARK
RAVEN CHASE OTHER	28	53	19
OTHER CHASE RAVEN	8	79	13
RAVEN CHASE RAVEN	49	42	9
JUNE - OCTOBER			
TYPE OF INTERACTION	MARY CARROLL PARK	PIONEER PARK	SOUTHERN WOOD PARK
RAVEN CHASE OTHER	16	26	58
OTHER CHASE RAVEN	64	21	15
RAVEN CHASE RAVEN	31	63	6

Table 7.2: Frequency of interactions between the Australian Raven and other birds: No obvious patterns in the interactions of ravens and other species appeared evident after the analysis of data collected during population surveys. Interactions occurred regularly between Australian Ravens, and with other species.

Interactions occurred with a total of fifteen other bird species, the majority with Red Wattlebird (*Anthochaera carunculata*), and Willie Wag Tail (*Rhipidura leucophrys*)(Refer figure 7.11). In both instances these species were the main instigators of chases, initiating almost 75% of interactions between them. This is suggestive that these smaller birds greatly fear the Australian Raven as a predator, endeavoring to keep them out of their territory and away from their nests. Such a constant offence by these smaller birds is not surprising after witnessing the efficiency of raids by the Australian Raven on the nests (eggs), and young of other birds. These much smaller species often fended ravens off in unison with others of the same species. At times the assaults were almost simultaneous: an unrelenting outburst of wing-beats and pecking, accompanied by a chorus of aggressive chatter. However interactions between Little Black Cormorant (*Phalacrocorax sulcirostris*) and Australian White Ibis (*Threskiornis molucca*) were mostly initiated by Australian Ravens. Several instances were recorded of ravens chasing Cormorants from roosting positions at Mary Carroll Park, and food-scrap were taken from Ibis at both other sites.

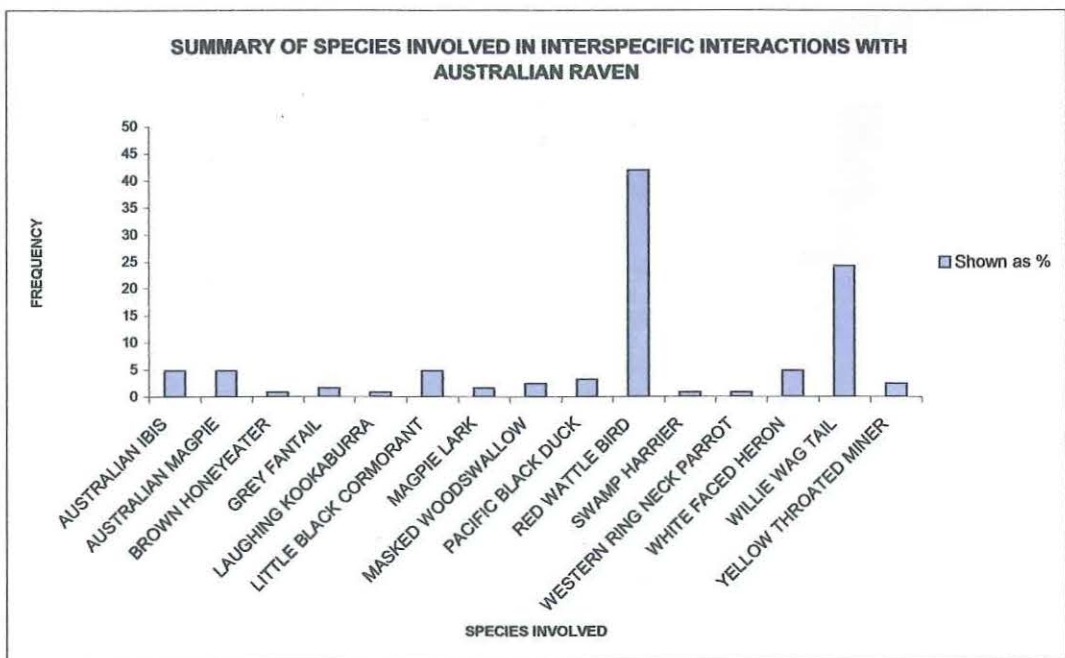


Figure 7.11: Summary of interactions between Australian Raven and other parkland birds: Most interactions occurred between Red Wattlebird (*Anthochaera carunculata*), and Willie Wag Tail (*Rhipidura leucophrys*), with the smaller birds initiating 75% of interactions (chases). Other species such as Little Black Cormorant (*Phalacrocorax sulcirostris*) were chased from roosting sites, and Australian White Ibis (*Threskiornis molucca*) had food taken by Australian Ravens.

This type of co-operation between individuals of the same species did not seem as apparent in ravens after witnessing an incident at Mary Carroll Park:

An immature Australian Raven present earlier in Transect 6 had moved on after raising the ire of park visitors by attempting to liberate food from their picnic spread. It entered a tall Eucalypt in Transect 4, flying between this and another tall Eucalypt in Transect 5 for about ten minutes. Then it launched itself out of the tree in Transect 5 over toward the island. First it flew up high, fast and powerful. It then quickly descended, honing in on a family of Pacific Black Ducks and ducklings. When the ducks became aware one of their kind was about to be preyed upon, they called out and other ducks flew from around to harass the raven. Four ducks wing-beat and pecked the raven into the water, nearly drowning it. They only relented when they thought it posed no further threat. The raven barely made it to shore, then hid in the undergrowth (it was not seen emerging before the survey finished). A number of other ravens were present to witness the assault, but not one came to the rescue, all rigidly maintained distance from the victim.

(Fieldwork Notes: Friday 13 August).

It appears that the Australian Raven is essentially a solitary bird. Although it may seek company for the purpose of roosting or foraging, it otherwise maintains a rigid individual space: staying out the way if trouble arrives for another of their kind.



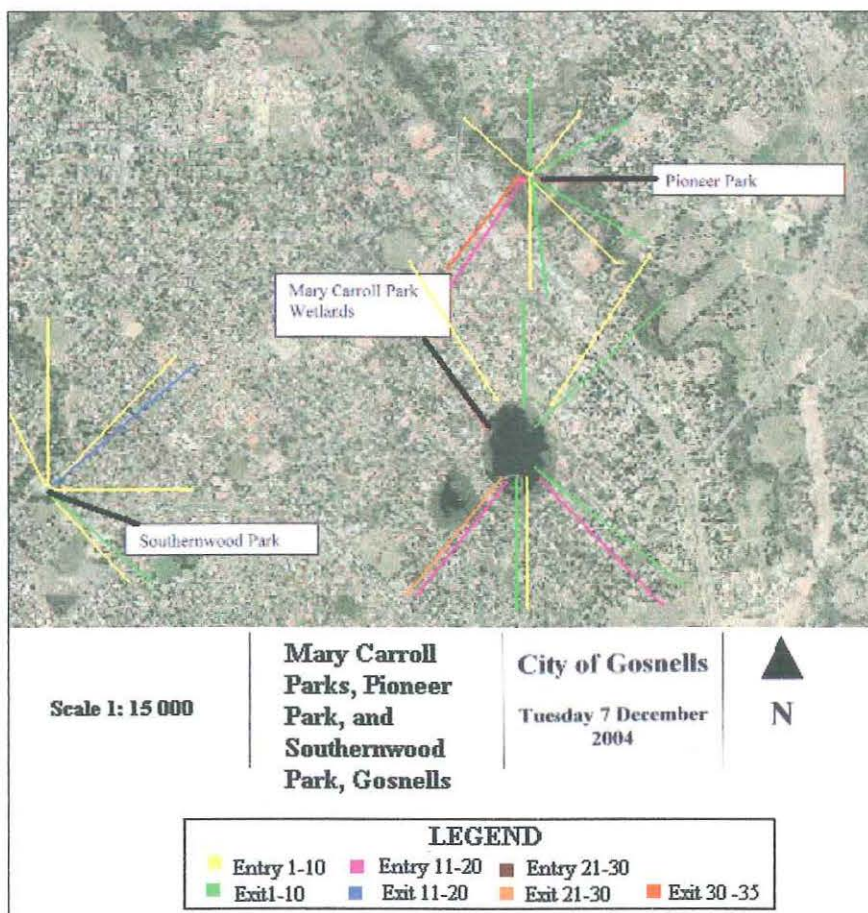
Plate 7.1: Australian Raven being chased by Red Wattlebird.

This incident occurred at Pioneer Park during a morning survey. Observations involving Australian Ravens interacting with Red Wattlebirds (*Anthochaera carunculata*) were made for almost 15 minutes before this photograph was taken. Such offences by smaller bird species are not surprising considering the efficiency of raids executed by Australian Raven on nests for eggs, and for juveniles. (Photograph by Desiree Moon, Wednesday, 22 September, 2004).

7.3.3 Flight Entry and Exit Patterns to and from Sites

It seems a definite pattern of flight exists between the three sites: the strongest pattern exists between Mary Carroll Park and Pioneer Park, which are close together. Although the pattern of flights in and out of Southernwood Park to the east, north-east and south-east are also towards the other sites, this is not as pronounced (refer Map 7.1).

From Mary Carroll Park some birds travel further south, but most head north, toward Pioneer Park, with an equally strong pattern of return flight. It is interesting to note that predominant flight patterns out of Pioneer Park are to the south-west, a direction that takes Australian Ravens out of the park boundaries to the retail centres (take-away food shop), market and hotel (other sources of food).



Map 7.1: Map of depicting patterns of Entry and Exit Flights to and from sites. It suggests there is a likely interchange of Australian Raven between all sites; however the link between Mary Carroll and Pioneer Parks is more distinct, which may be due to the closer proximity of the sites, compared to Southernwood Park. (Adapted from City of Gosnells Map, 2004, by Desiree Moon).

7.4 Conclusion

The main activities of Australian Ravens involved dwelling in trees, with about one-third of that time spent in their destruction in search of food, nesting and other requirements. They are a highly mobile species with flight used to carry them into other areas, and sometimes take them higher up and further into the same tree, perhaps to scout for intruders or food. Contrary to the nature of complaints received about the species, they will consume food scraps discarded on the ground, but rarely scavenge directly from rubbish bins.

There are no distinct seasonal patterns of interactions between species. The main species Australian Ravens interacted with at the sites were Red Wattle Bird (*Anthochaera carunculata*) and Willie Wag Tails (*Rhipidura leucophrys*), which initiated 75% of all interactions that occurred (chase).

Individual ravens were witnessed engaging in acts of predation, but were not offered protection by others of their kind if threatened by another species. It appears the species rigidly maintains a zone of individual distance between each other, only relaxing it for allo-preening and body care. The only other time this is relaxed is when large groups of ravens share a communal roost, or sometimes when foraging for food.

Australian Ravens are generally feared by species of smaller size, likely worried about possible acts of predation by them. Seemingly though, Australian Ravens are responsible for procuring their own food. All predatory acts witnessed during the study were executed by individual Australian Ravens. At no time were incidents of a dualistic, or group-attack by ravens witnessed. Generally it seemed Australian Ravens preferred to keep to themselves: with time mostly spent foraging for naturally occurring food sources, protecting territory and singing loud, discordant songs, rather than making mischief for park visitors and being a general nuisance.

CHAPTER EIGHT: DISCUSSION OF OUTCOMES

8.1 Review of Hypothesis

This purpose of this study was to investigate the urban ecology of the Australian Raven, in order to gain greater insight into the abundance, distribution, activities and interactions of the species in selected study sites in the City of Gosnells. The sites selected were chosen in response to complaints made about Australian Ravens (to various agencies) relating to the abundance and activities of the species at these and other locations. These particular sites were chosen as they were close to each other, which made the logistics involved in conducting surveys manageable. They were also chosen as they shared several common geographical characteristics: all are wetland parks, have similar landscapes, and supported the same vegetation complexes and habitat types. The selection of similar sites allowed variables to remain constant in relation to the data analysis for each site, and for valid comparisons apply. The basis of the study was to investigate the hypothesis that:

Seasonal increases in the abundance of Australian Ravens at the study sites diminishes each area's aesthetic and recreational values, and threatens other wildlife to such an extent the community supports population control (culling) of the species.

To investigate the hypothesis fully, five research questions were formulated. These queries defined the scope of the research, and were fundamental to the survey design. By examining the biogeographical data collected from the scheduled surveys it was hoped sufficient evidence would emerge to either support or nullify the statement. Following the analysis of the results, certain outcomes were clear.

Whilst there were no similar studies using the same data collection techniques or analysis to compare population data against, other studies by Stewart (1997) and Mansell (1997) both investigated community attitudes to the Australian Raven in Perth's parklands.

Each study concluded that the Australian Raven is among the least popular parkland birds in the region. Many people expressed opinions that they considered the species far too abundant, both in parks and the surrounding metropolitan area. They also believed them ugly, noisy and aggressive birds (mainly towards other smaller species and their young). Other problems were reported about excessive defecation by ravens at parks (on paths, furniture, playground equipment and other infrastructure), as well as incidents of food-stealing from park visitors, and scavenging at rubbish bins (and school bags). Importantly, the studies also found that whilst some people supported population control (culling) the species to manage their apparent over-abundance, the idea did not have the approval of the majority of respondents. The study by Stewart (1997) also investigated various ecological aspects of the species, examining dietary and other survival requirements, none of which differ significantly from those reported in this study.

Similar results also appeared to be emerging from a later study that is not yet complete (Suzanne Cumming, unpublished Doctoral Thesis). This study of the Australian Raven (also based in Gosnells, but conducted on streetscapes in the area), focused on the urban ecology of the species and did not calculate the population densities of the species for the area. It was mainly concerned with examining food foraging techniques and other survival aspects of the species. Although it was primarily an ecological study, it also examined community attitudes to ravens. Once again the majority of respondents held poor views of the birds. The complaints received about ravens in this study are of a similar nature to the previous studies (eg concerns about abundance and anti-social behaviour toward people and animals). Many also thought ravens looked and sounded unpleasant. Interestingly, whilst the majority of respondents expressed concerns about the abundance, and aggressive traits of the species in the Perth region, population control (culling) ravens as a means of managing the problem did not have strong community support. Similarities were found in this study, and will be discussed further on.

Before considering the results of the study, it is necessary to first acknowledge that whilst every effort was made to ensure a rigorous methodology and analysis under-pinned the study, it still suffered some limitations in its execution.

The first relates to the inexperience of the observer in conducting ornithological research. It may have been beneficial to work with other more experienced persons. The survey design however was praised by an esteemed ornithologist (Dr Stephen Davies) and wildlife researcher (Matthew Williams) so did not fail altogether in meeting acceptable standards of fieldwork practices.

Also, not all recommended measurements for Line Transect Methodology were taken during population surveys of ravens as they were difficult to prescribe and seemed superfluous to the analysis. At times sample sizes fell short of the suggested minimum when not grouped with other data.

Another important distinction is that all survey data are *observational*, which does not produce data as reliable as that obtained using alternative methods, such as bird banding or radio-tracking to monitor animal populations and movements over the landscape, and over time. The study was also unsuccessful in clarifying the age of the species present (mature, immature or unknown), to try and ascertain if ravens observed were resident mature birds, or immature nomads (due to the high number of unknown classifications, this criterion did not feature in the final analysis). This investigation could succeed if bird-banding or radio-tracking techniques were used.

Also, this study was restricted to observations of *daily* activities and interactions of the Australian Raven at the study sites, whereas it would have been useful to gain insights into the nocturnal activities of the species.

As previously mentioned, the study was limited to areas of *urban wetland parks*, and it is imperative that the results are not taken out of this context, and applied to the broader landscape surrounding the sites, or the Perth region.

The final shortfall of the study is that it had to fit an academic timetable, and was scheduled from January to October, 2004: an incomplete year and seasonal cycle, which may have influenced the results.

In spite of these shortfalls, the study was completed using the planned survey techniques, and the data collected during surveys subjected to robust analyses to produce meaningful results for interpretation and discussion.

8.2 Concluding Statements

Keeping these limitations in mind, results gleaned from the study succeeded in answering the hypothetical challenge around which it was based. The first research question, which investigated estimated seasonal abundance of the Australian Raven at the study sites, was addressed by developing a population survey of the species based on Line Transect Methodology techniques, and subjected to a Distance Analysis. The final results showed that the seasonal abundance of ravens did vary to some extent at each site and between each site. These figures (arrived at using a Distance Analysis) closely correlated with estimates calculated from the actual counts (using detections up to 30m), which suggests the outcomes are reliable indicators of the abundance of ravens at the study sites. The highest densities were recorded at Pioneer Park, the lowest densities recorded at Southernwood Park, and the most significant seasonal fluctuations were evident at Mary Carroll Park.

The second research question examined seasonal differences in the distribution of ravens at the study sites. The two sites that recorded the highest population densities, Mary Carroll Park and Pioneer Park, were both highly modified from their natural state and supported more tall trees (>25m), mainly Eucalypts, and larger areas of cultivated grasses. The site that recorded the lowest population densities, Southernwood Park, retained more natural riparian vegetation and had more mid-storey vegetation (<25m). The results showed the distribution of Australian Ravens at the study sites was most strongly influenced by the main types of vegetation present as the species was most heavily distributed in areas supporting predominantly tall trees (mainly Eucalypts), and substantial areas of cultivated grass. These types of vegetation complexes seem to best meet all dietary, nesting, roosting and other requirements of the species. It was evident that ravens avoided areas of extensive mid-storey vegetation (likely as it prohibited ground foraging and failed to meet nesting and roosting needs). Each highly populated transect also had access to a reliable water source, which makes it seem that wetland parks in particular appeal to the species. It also appeared that populations were concentrated in the mid-sector transects of each site, suggestive that they try to avoid dangers present on the edge of these wetland habitats, that are surrounded by intensive urban areas.

The presence of rubbish bins in the highly populated transects did not seem to influence habitat selection, with incidents of scavenging food (from bins, or on the ground) occurring so infrequently they did not feature significantly in the final analysis of daily activities for each site. This is an important distinction, as many complaints about ravens related to them scavenging, especially from rubbish bins. It seems this activity is more prevalent in the minds of critics, than in reality, at these sites at least. Overall though, the seasonal distribution of ravens at the study sites remained fairly constant, and did not indicate any major seasonal relocation of the Australian Raven at the sites for the duration of the study.

The third research question investigated daily activities and interactions of the Australian Raven at the study sites. Final results showed that the most time was spent 'perching in a tree/shrub', often engaged in the destruction of its bark and leaves (likely searching for food), with only half as much time spent searching for food by 'foraging on ground'. The species is mobile, with time allocated to 'flying' remaining constant throughout the study. Flight appeared to have several purposes, to move to different perching positions, move around the site, and travel between sites. Distinct patterns of flights between sites emerged, with most travel occurring between the two sites in closest proximity, Mary Carroll and Pioneer Parks. Flight patterns for Southernwood Park suggested that ravens from this site travel to the other sites, but less frequently.

Time spent allocated to miscellaneous activities such as drinking and body care accounted for less than ten percent of total daily activities overall, with drinking accounting for the majority of time. This outcome substantiates the view that ravens do not like the water, and keep away from it except for the purpose of hydration, (mainly over the summer period), and to maintain cleanliness and assist in grooming.

The third question also investigated the main interactions occurring between ravens and other species (birds and other animals) at each study site. No distinct seasonal variations in the frequencies or types of interactions involving Australian Raven at the study sites were identified. In the final analysis only three (from six) categories of interactions were classified. Most interactions were with smaller birds that were also the main instigators of interactions (mainly chases). This behaviour is likely a response to a threat of predation by Australian Raven. During the study two acts of predation (killing a juvenile bird, and eating eggs from a nest) and one act of caching a stolen egg were witnessed. However, such incidents were infrequent and did not score significantly, so were not featured in the final analysis of these behavioural aspects of the study. This result is surprising given the nature and number of complaints made about ravens to the various agencies responsible for parkland, and wildlife management.

The fourth question examined the views of ravens held by people using the study sites for recreational purposes by means of an informal survey on community attitudes to the species. Whilst the validity of complaints made about Australian Ravens to the various authorities is not questioned, the results of the survey indicated that in fact the species is reasonably well tolerated by most people, at the study sites at least. The survey results concluded that most respondents regularly used the sites, (and all of them identified the Australian Raven at them). However, most did not feel strongly that the species were overly abundant at the study sites. An exception was Mary Carroll Park, where most respondents thought there were too many in the park.

Although quite obvious concerns were expressed regarding an apparent increase in abundance of ravens at the study sites, most respondents did not consider them a threat to other birds and wildlife present, or regard them as a nuisance when visiting sites. Most importantly, a clear majority of respondents were neutral, or disagreed with the suggestion to use population control (culling) to control the abundance of Australian Ravens at the sites. Many asked that other options be considered before such a drastic course action is taken, and were repulsed by the idea the birds may be killed. Commentary from respondents suggested that an over-abundance of ravens (or any other species) in a particular location, is a result of other management challenges which needed addressing by the relevant agencies.

The fifth and final question, whilst not central to the study, investigates and acknowledges the other birds and wildlife present at the study sites. Whilst other species of birds present were recorded during raven population surveys, and interim lists compiled into comprehensive species lists, they were not counted to establish an index of abundance at the sites. Other animals and reptiles present were also noted during surveys but as sightings were brief, and identification was difficult and unreliable, they were not compiled into lists for each site. There were sightings of various native mammals (possums, bandicoots and rodents), as well as domestic pets (cats and dogs). Also foxes were seen and some of the cats present were large enough that they may have been feral beasts and not domestic pets (however due to difficulties in differentiating them, no distinction was made between them). A number of reptiles were also seen (small skinks, lizards and goannas). Many insects were also recorded, and appeared far less prolific at the end of summer and in mid-winter, which may influence the types of foods eaten by ravens at the sites during these times. This concludes the revision of the hypothesis and concluding remarks in relation to the research questions.

Considered in terms of the hypothesis, the results derived from the study presented outcomes that failed to substantiate it, effectively nullifying the statement. For whilst it was evident there were some seasonal fluctuations in the seasonal abundance of the Australian Raven at the study sites, changes in seasonal distribution of the species suggested the variances were insignificant. Also, it was ascertained that the Australian Ravens allocated very little time to 'anti-social' activities (such as preying on other birds, scavenging and being a nuisance for visitors). They also mainly kept to themselves, and kept interactions with other birds and wildlife present to a minimum. Also, the majority of people that used the sites for recreation did not rate the species as an overt threat to other birds and wildlife present at the sites, or as a particular nuisance for them when at the park. Most importantly, the study clearly showed that the use of population control to manage problems of abundance of the Australian Raven at the study sites clearly did not have the support of the majority.

As a result of conducting the study, several other aspects of parkland management, other than in relation to the Australian Raven, were identified for each site. These presented challenges to the integrity of these wetland areas and must be incorporated into the guiding principles of future management plans for these areas.

8.3 Guiding Principles for Future Management

Although this examination of the Australian Raven in urban wetland parks developed as a response to complaints received by various agencies of 'anti-social' behaviour of the species in these areas, by the completion of the study it was apparent that the poorest standards of behaviour actually belonged to park visitors. During surveys some visitors were witnessed loitering and harassing other people (including cadging money and cigarettes). One such incident resulted in the attempted theft of equipment, and mild assault of the researcher (which was duly reported to police). Others were witnessed chasing and frightening birds, and many litter the grounds, even though bins were within easy walking distance.

But the most common activity, and one that constitutes a major problem at the sites, is the feeding of birds at the sites by park visitors (contrary to signage prohibiting the activity). The feeding occurs at all sites, at all times of the day and often in succession, or conjunction with others. Most visitors feed the birds bread products, which are not tolerated by the birds' digestive system. This causes increased defecation into rivers and lakes, effectively reducing water quality and potentially allowing the introduction of botulism bacteria into the water, that could result in the sickness and death of birds and other wildlife at the sites. Pathways and lawn areas are also soiled to such an extent that walking on them is unpleasant, as the muck transfers to shoes, blankets and food containers. An incident at Pioneer Park saw a wedding party become extremely distressed when the hemline of the bride's dress was covered in feces during a photographic session prior to the ceremony. The increased defecation onto pathways and lawn however, also present safety concerns as it makes them slippery and dangerous for walking.

Whilst these aspects are not so common that they significantly detract from the aesthetics of these wetland parks, they could perhaps be reduced by more proactive management. During times when poor standards of behaviour by park visitors were witnessed, there were no ranger patrols or police in the immediate vicinity, so most complaints were not reported to any local authorities and went unchecked. Problems such as these, and other challenges for management may benefit if the following guiding principles are considered in the development of future strategies.

- The science of geographical ecology now places strong emphasis on an *eco-system approach*. This approach treats organisms, such as the Australian Raven, as individual components of a complex interplay of relationships, including vegetation, other forms of animal life, hydrology and climate. All of the sites should be managed bearing this approach in mind.
- An *ecosystem*, such as an urban wetland park, is a *dynamic* system, with many of its variables (such as wetland water depth) altering markedly in relation to seasonal and other long-term fluctuations in weather and climate, and outcomes for management apply within this context.
- The movements of the Australian Raven over *space* and *time*, and fluctuations in their populations over time (within urban wetland parks) occur as a response to the availability of food, hydrology and climate. It is important that such biogeographical aspects are interpreted and managed from paradigms established from scientific research, not from generalised assumptions about the species.
- Diversifying the vegetation types present at those sites that attracted the highest population densities of Australian Raven, to include greater extents of mid-storey vegetation complexes may deter the species from using the site. It seems the abundance of ravens increased with the degree of modification of the landscape from its natural form. Therefore, returning the sites to a state that more closely resembles the natural vegetation cover for the area may reduce raven populations.
- Managing refuse efficiently at the sites is another step toward limiting food availability for the species. Although scavenging is not central to their survival, they are ever opportunists and utilise discarded food and other organic matter (carrion) as food sources. Rubbish bins at the sites may provide fewer pickings if all were closed bins. It is important bins at the sites are emptied regularly and quickly following weekends due to the greater volume of refuse left by visitors.

- Another additional food source utilised by Australian Raven comes from food fed by park visitors to birds (mainly ducks). It is imperative a more pro-active stance is made by authorities against these activities. Most people are unaware of the detrimental impacts of their actions: with education the key to enlightenment. Such strategies as increased signage (more signs and larger, bolder signs), provision of information sessions (by local councils), increased editorial in local papers (such as *Comment News*). If this aspect continues in spite of these attempts, it may be necessary to consider a punitive response in the future, such as an on the spot fine, as issued for littering.
- Another problem at some of the sites are the various exotic species present (domestic ducks and geese). These non-native species have started to breed with native duck species, creating hybrids species. It is essential they are removed immediately, and the prevention of leaving exotic species in these urban wetlands made a management priority (this may also need to attract a punitive response).
- Predatory mammals (namely cats and foxes) were other exotic species recorded at all sites. Similarly, creatures such as these must also be removed from the sites, to protect native wildlife populations present.
- Another problem at these sites is anti-social behaviour by visitors, both toward the wildlife present, and other park users. Again, increased ranger or security patrols may reduce the likelihood such incidents will occur.

As this study concluded, a report appeared in the local newspaper, *Comment News* (Tuesday 30 November, 2004) expressing the views of some Gosnells City Councillors, that Australian Ravens were a problem in local parklands because of their predatory behaviour. One in particular, Cr Dave Griffiths, wanted the concerns to become a matter of public record, and to let his constituents know that he had “gone on record with his concerns about crows (actually Australian Ravens) (p.2). The report confirms that the species are a problem in the area, and reaffirms that the debate on how to fix the problems must be based on scientific scrutiny, rather than emotive responses. It is hoped that this study will help foster such an outlook, and contribute to the development of effective management policies for these and other urban wetland parks.

BIBLIOGRAPHY

- Abensperg-Traun, M. (1986) *The Distribution and Ecology of Red-Capped Plover on a Western Australian Salt Lake*. Published Dissertation for Bachelor of Science with Honours. University of Western Australia.
- Adshead, G. (2004a) "Inside Cover". *The West Australian*. Monday March 22, 2004.
- Adshead, G. (2004b) "Inside Cover". *The West Australian*. Tuesday March 23, 2004.
- Adshead, G. (2004c) "Inside Cover". *The West Australian*. Wednesday March 24, 2004. (Including cartoon by Dean Alston).
- Aikike, H. (1973) "Information theory and an extension of the maximum likelihood principle, in *International Symposium on Information Theory*. 2nd edn (Eds) B.N. Petran and F. Csaaki). Akademiai Kiado, Budapest. 267-281. (Not read).
- Anderson, D.R., Burnham, K.P. and Crain, B.R. (1978) "A log-linear model approach to estimation of population size using the line-transect sampling method". *Ecology* 59. 190-193.
- Anderson, D.R., Laake, J.L., Crain, B.R. and Burnham, K.P. (1979) "Guidelines for transect sampling of biological populations." *Journal of Wildlife Management*. 43. 70-78.
- Andren, H. (1992) "Corvid Density and Nest Predation in Relation to Forest Fragmentation: A Landscape Perspective". *Ecology* 73(3) 794-804.
- Anon. (circa 1700). "The Lady of the Crow - Sorceress of Ravens" on Internet at <http://communities.ninemsn.com.au/HomeofDrizzDoUrden/ladyofthecrow.msnw>
- Argyrous, G. (1996). *Statistics for Social Research*. (1st printed 1963) MacMillan Education Australia P/L. South Melbourne.
- Armstrong, E.A. (1947) *Bird Display and Behaviour: An Introduction to the Study of Bird Psychology*. Lindsay Drummond Ltd. London.
- Armstrong, E.A. (1975) *The Life and Lore of the Bird in Nature, Art, Myth & Literature*. Crown Publishers Inc. New York.
- Balmford, R. (1980) *Learning about Australian Birds*. Drawings by Rhyllis Plant. Collins. Sydney.
- Barber, T.X. (Ph.D.) *The Human Nature of Birds: A scientific discovery with startling implications*. Bookman Press. Melbourne.

- Barrett, G., Silcocks, A., Barry, S., Cunningham, R. & Poulter, R. (2003) *The New Atlas of Australian Birds*. Birds Australia & Royal Australasian Ornithologists Union. Shannon Books. Victoria.
- Barker, R.D. & Vestjens, W.J.M. (1990) *The Food of Australian Birds*. CSIRO Publishing. ACT. Australia.
- Bayly, K.L. & Blumstein, D.T. (2001) "Pied Currawongs and the Decline of Native Birds." *Emu*, **101**: 199-204.
- Beard, J.S. & Sprenger, B.S. (1984) *Geographical Data from the Vegetation Survey of Western Australia*. Occasional Paper No2. Vegemap Publications. Applecross. Western Australia.
- Beard, J.S. (1990) *Plant Life of Western Australia*. Kenthurst, Kangaroo Press.
- Bell, A & S. (1969) (2nd Ed) *Common Australian Birds*. Oxford University Press. London
- Beli, H.L. and Ferrier, S. (1984) "The Reliability of Estimates of Density from Transect Counts". *Corella* **9**. 3-13.
- Bekle, H. (1999) *Monitoring of Waterbird Habitat Usage in the Mary Carroll Park Wetlands*. City of Gosnells.
- Berry, L. (2002) "Identifying Nest-Predator Species in a Southern Victorian Woodland Using Remotely Triggered Cameras at Artificial Nests". *Corella* **26**(1). 24-26.
- Berry, L. & Lill, A. (2003) "Do predation rates on artificial nests accurately predict predation rates on natural nests?" The effects of nest type, egg type and nest-site characteristics. *Emu*. **103**: 207-214.
- Beruldsen, G. (1980) *A Field Guide to Nests and Eggs of Australian Birds*. Rigby. Australia.
- Bibby, C.J., Burgess, N.D. and Hill, D.A. (1992) *Bird Census Techniques*. Royal Society for the Protection of Birds. British Trust for Ornithology. Academic Press. London.
- Bibby, C.J. & Jones, M. & Marsden, S. (1998) *Expedition Field Techniques: Bird Surveys*. Expedition Advisory Centre. Royal Geographical Society. London.
- Birds Australia: <http://www.abc.net.au/birds/>. A co-production between Birds Australia, AcroMap Pty Ltd and ABC Science Online.
- Birds Australia (WA Inc): <http://birdswa.iinet.net.au>. *Unusual Sightings*. The Western Australian group was formed in 1943 and was incorporated in 2001.
- Blakers, M., Davies, S.J.J.F. & Reilly, P.N. (1984) *The Atlas of Australian Birds*. Royal Ornithologists Union. Melbourne University Press. Victoria.

- Brooke, M., & Birkhead, T. (1991) *The Cambridge Encyclopedia of Ornithology*. Royal Society for Protection of Birds. University of Cambridge Press. Melbourne.
- Buckland, R. (2002) *Buckland's Complete Book of Witchcraft*. Llewellyn Publications. USA.
- Buckland, S.T. (1987) "On the variable circular plot method of estimating animal density". *Biometrics*. 43. 363-384.
- Buckland, S.T., Anderson, D.R., Burnham, K.P. and Laake, J.L. (1993) *Distance Sampling: Estimating abundance of biological populations*. Chapman & Hall Australia, Thomas Nelson Australia. South Melbourne. Victoria.
- Bureau of Meteorology <http://www.bom.gov.au/index.shtml>
- Burnham, K.P. (1981) Summarizing Remarks: environmental influences, in *Estimating Numbers of Terrestrial Birds: Studies in Avian Biology No. 6* (Eds C.J. Ralph and J.M. Scott, Cooper Ornithological Society, 324-325.
- Burnham, K.P., Anderson, D.R. and Laake, J.L. (1980) "Estimation of density from line transect sampling of biological populations. *Wildlife Monogram*. 72
- Burnham, K.P., Anderson, D.R. and Laake, J.L. (1981) "Line Transect Estimation of bird population density using a Fourier Series". In *Estimating Numbers of Terrestrial Birds: Studies in Avian Biology No. 6* (Eds C.J. Ralph and J.M. Scott, Cooper Ornithological Society. 466-482.
- Campbell, B & Lack, E. (1985) (Eds) *A Dictionary of Birds*. British Ornithologists Union. Staffordshire. England.
- Campbell, C.A. and Dagg, A.I. (1976) "Bird Populations in downtown and suburban Kitchener-Waterloo, Ontario. *Ontario Field Biologist*. 30. 1-22.
- Carson, D. and Sams, J.(1999) *Medicine Cards*. Revised Expanded Edition. St. Martins Press. New York.
- Casagrande, D.G. & Beissinger, S.R. (1997) "Evaluation of four methods for estimating parrot population size." *Condor*. 99. 2. 445-457
- Catterall, C.P., Green, R.J. and Jones, D.N. (1991) "Habitat use by birds across a forest-suburb interface in Brisbane: implications for corridors". *Nature Conservation 2: The Role of Corridors*. (Eds D.A. Saunders and R.J. Hobbs). 247-258. Surrey Beatty and Sons P/L. Chipping Norton, NSW
- Cayley, N.W. (1970) (First published 1931) *What Bird Is That?* Angus & Robertson. Sydney.
- Cayley, N.W. (1987) (First published 1931) *Neville Cayley's, What Bird Is That?* (Revised by T. Lindsay). Angus & Robertson. Australia

- Chalfoun, A., Thompson III, F.R. & Ratnaswamy, M.J. (2002) "Nest Predators and Fragmentation: a Review and Meta-Analysis." *Conservation Biology*. Vol 16: 306.
- Cochran, W.G. (1977) *Sampling Techniques*. 3rd Edition. Wiley. New York.
- Coote, M. (1992) *The Role of Groundwater in the nutrient enrichment of Mary Carroll Park Wetlands*. A report prepared for the City of Gosnells. City of Gosnells.
- Coulson, G. (1998) "Management of overabundant macropods -- are there conservation benefits?" Proceedings of a Symposium held at the Society for Conservation Biology Conference. July 1998. Sydney. Australia.
- Crowley, V. (2000) *Wicca*. Harper Collins. Sydney. Australia.
- Cumming, S. (2003) *The Urban Ecology of Australian Raven*. (Unpublished Doctoral Dissertation). Edith Cowan University.
- Cunningham, R. B., D. B. Lindenmayer, H. A. Nix, and B.D. Lindenmayer. (1999) "Quantifying observer heterogeneity in bird counts." *Australian Journal of Ecology* in press.
- Curry, P.J. (1978) "On the field characters of Little and Torresian Crows in Central Western Australia." *Australian Bird Watcher*. December. 265-269.
- Davies, S.J.J.F. (1984) *Methods of Censusing Birds in Australia*. Royal Australasian Ornithologists Union. Department of Conservation and Environment. Perth. Western Australia.
- Debus, S.J.S. (1982) "Sympatry in Australian Corvids". *Australian Bird Watcher*. 9. (5) 147-153
- Debus, S.J.S. (1995) "Crows and Ravens." *Wingspan*. Vol 5: 38-43.
- Debus, S.J.S. (1996) *Finches, Bowerbirds & Other Passerines of Australia*. (Edited by R. Strahan). Angus & Robertson. Australia.
- Dytham, C. (2003) (2nd Ed) *Choosing and Using Statistics: A Biologists Guide*. Blackwell Publishing. Melbourne. Victoria.
- Edgar, D.R. and Kershaw, G.P. (1994) "The density and diversity of the bird populations in three residential communities in Edmonton, Alberta." *Canadian Field-Naturalist*. 108. 156-161.
- Edwards, D.K., Dorsey, G.L. and Crawford, J.A. (1981) "A comparison of three avian census methods". In *Estimating Numbers of Terrestrial Birds: Studies in Avian Biology No. 6* (Eds C.J. Ralph and J.M. Scott, Cooper Ornithological Society. 170-176.
- Emlen, J.T. (1971) "Population densities of birds derived from transect counts." *Auk*. 88. 323-342.

- Emlen, J.T. (1974) "An urban bird community in Tuscon, Arizona: derivation, structure, regulation." *Condor*. 76. 184-197.
- Environmental Protection Authority. (1993) "A Guide to Wetland Management in the Perth and Near Perth Swan Coastal Plain Area." *Bulletin 686* (Update to EPA Bulletin 374). 9 July. Perth. Western Australia.
- Farrar J. (1996) *A Witches' Bible: The Complete Witches Handbook*. Wiccanway Publishing. California. USA.
- Ford, H.A. (1999) "Nest sites and breeding success in large Australian honeyeaters: are there benefits from being different?" *Emu*. 99, 91-99
- Forshaw, J. (1998) *Encyclopedia of Birds*. Illustrated by David Kirshner. Academic Press. San Diego. USA.
- Franzreb, K.E. (1981) "The Determination of Avian Densities Using the Variable-Strip and Fixed-Width Transect Surveying Methods". In *Estimating Numbers of Terrestrial Birds: Studies in Avian Biology No. 6* (Eds C.J. Ralph and J.M. Scott, Cooper Ornithological Society. 139-145.
- Freudenberger, D (Dr) (1996) "Density of Eastern Grey Kangaroos on Rural Leases and Nature Reserves in the ACT during November 1995". A report prepared for the ACT Kangaroo Advisory Committee. In conjunction with Wildlife Research Unit, Conservation of Wildlife Section, ACT Parks and Conservation Service and CSIRO Division of Wildlife and Ecology.
- Fulton, G.R. and Ford, H.A. (2001) "The Pied Currawong's role in avian nest predation: a predator removal experiment". *Pacific Conservation Biology*. Vol 7: 154-160. Surrey Beatty & Sons, Sydney
- Freudenberger, D. (1995) *Density of Eastern Grey Kangaroos on Rural Leases and Nature Reserves in the ACT During November 1995*. A report prepared for the ACT Kangaroo Advisory Committee with Wildlife Research Unit, Conservation of Wildlife Section. ACT Parks & Wildlife. CSIRO Division of Wildlife and Ecology. Lyneham. Australian Capital Territory.
- Gates, C.E. (1969) "Simulation study Estimators for the line transect sampling method." *Biometrics*. 25. 317-328.
- Gates, C.E. (1980) LINETRAN, a general computer program for analyzing line transect data. *Journal of Wildlife Management*. 44. 658-661.
- Gates, C.E., Marshall, W.H. and Olson, D.P. (1968) "Line transect method of estimating grouse population densities." *Biometrics*. 24. 134-145.
- Goodwin, D. (1977) *Crows of the World*. University of Queensland Press. Australia.
- Green, R.J., Catterall, C.P. and Jones, D.N. (1989) "Foraging and other behaviour of birds in subtropical and temperate suburban habitats. *Emu*. 89, 216-222

- Green Skills (2004) *Mapping and Identification of Weeds in the City of Gosnells: A Perth Biodiversity Project Initiative*. Report Produced for Green Skills Inc. Environmental Training Project Management and Employment Services. January.
- Haggett, P. (1973) *Geography: A Modern Synthesis*. Unwin and Allen. London.
- Harris, M.B. (1995) *Basic Statistics for Behavioural Science Research*. Allyn & Bacon. Boston.
- Hartley, M. & Hunter Jr, M.L. (1998) "A Meta-Analysis of Forest Cover, Edge Effects, and Artificial Nest Predation Rates." *Conservation Biology*. 12: 465
- Hayne, D.W. (1949) "An examination of the strip census method for estimating animal populations." *Journal of Wildlife Management*. 13. 145-157.
- Hilden, O. (1981) "Sources of Error Involved in the Finnish Line Transect Method. In *Estimating Numbers of Terrestrial Birds: Studies in Avian Biology No. 6* (Eds C.J. Ralph and J.M. Scott, Cooper Ornithological Society. 152-159.
- Hill, R. (1970) *Popular Edition of Australian Birds*. Thomas Nelson. Australia.
- Hill, A. Semeniuk, C.A., Semeniuk, V. and Del Marco, A. (1996) *Wetlands of the Swan Coastal Plain*. (2 vols). Perth: Waters and Rivers Commission and [W.A.] Department of Environmental Protection.
- Hone, J. (1991) "Analysis of Animal Survey Data". *Nature Conservation: Cost Effective Biological Surveys and Data Analysis*. 42-46
- Hoskin, E.S., Hindwood, K.A. and McGill, A.R. (1991) *Birds of Sydney*. (2nd Ed). Surrey Beatty & sons P/L, Chipping Norton. NSW
- Hussey, B.M.J., Keighery, G.J., Cousens, R.D., Dodd, J. & Lloyd, S.G. (1997) *Western Weeds: A guide to the weeds of Western Australia*. Plant Protection Society. Victoria Park. Western Australia
- Kavanagh, R. and H. F. Recher. (1983) "Effects of observer variability on the census of birds." *Corella* 7:93-100.
- Kelker, G.H. (1945) *Measurement and interpretation of force that determine populations of managed deer*. PhD Dissertation, University of Michigan, Ann Arbor, MI, USA
- Laake, J.L., Burnham, K.P. and Anderson, D.R. (1979) *User's Manual for the Program TRANSECT*. Utah State University Press. Logan. UT. USA
- Laake, J.L., Buckland, S.T., Anderson, D.R. and Burnham, K.P. (1993) *DISTANCE User's Guide*. Colorado Cooperative Fish and Wildlife Research Unit. Colorado State University, Fort Collins, CO. USA
- Lancaster, R.K. and Rees, W.E. (1979) "Bird communities and the structure of urban habitats. *Canadian Journal of Zoology*. 57. 2358-2368.

- Leopold, A. (1933) *Game Management*. Charles Scribner's Sons. New York
- Lepschi, B.J. (1994) "Australian Raven Predation on Common Starling". *The Australian bird-watcher*. 15, Issue 5. March. p. 211
- Link, W. A., and J. R. Saur. (1997). "New approaches to the analysis of population trends in land birds: comment." *Ecology* 78: 632-34.
- Low, T. (2001) "To Catch a Lizard." *Nature Australia*. Spring. Vol 27. No 2. Australian Museum Trust. Sydney. NSW. 24-25
- Luck, G.W., Possingham, H.P. and Paton, D.C. (1999) "Bird responses at inherent and induced edges in the Murray Mallee, South Australia". 2. "Nest predation as an edge effect." *Emu*. 99, Part 3. September. 170-175.
- Lund, M., Ryder, D. & Ogden, G. (1998) *Biomonitoring of the Mary Carroll Park Wetlands to assess their biological health*. A report funded by and prepared for the City of Gosnells.
- Lund, M. (Dr), Brown, S. & Lee, G. (2000) *Midge Sampling of the Northern Mary Carroll Park wetland*. A report funded by and prepared for the City of Gosnells. March. City of Gosnells.
- Major, R.E. and Kendal, C.E. (1996) "The contributions of artificial nest experiments to our understanding of avian reproductive success: a review of methods and conclusions. *Ibis*. 138. 298-307.
- Major, R.E., Gowing, G. & Kendal, C.E. (1996) "Nest Predation in Australian urban environments and the role of the pied currawong, *Strepera graculina*." *Australian Journal of Ecology*, Vol 21: 399-409.
- Mansell, J. (1997) *The Birds of Perth's Urban Parks; Factors Influencing Their Distribution and Community Attitudes Towards Them*. Honours Thesis Bachelor of Science in Environmental Management. Edith Cowan University.
- Marzluff, J.M., Gehlbach, F.R. and Manuwal, D.A. (1998) "Urban environments: influences on avifauna and challenges for the avian conservationist." In *Avian Conservation: research and management*. 283-296. Island Press. Washington D.C., USA.
- Mathews, A., Dickman, C.R. and Major, R.E. (1999) "The influence of fragment size and edge on nest predation in urban bushland". *Ecography*. 22. 349-356.
- Mawson, P.R. (1995) *The Red-capped Parrot (Purpureicephalus spurius): A Pest by Nature or Necessity?* Doctoral Dissertation. University of Western Australia.
- McArthur W.M. and Bettenay, E. (1960). *The development and distribution of soils on the Swan Coastal Plain, Western Australia*. CSIRO Soil Publication No 16, Melbourne.

- McArthur W.M. and Bettenay, E. (1974). *The development and distribution of soils on the Swan Coastal Plain, Western Australia*. CSIRO Soil Publication No 16, Melbourne 2nd Edition
- McDonald, G. (1938) *The Gosnells Story*. City of Gosnells. Western Australia.
- Melies, S., Glenn, S. and Martin, K. (2003) "Urban Bird Diversity and Landscape Complexity: Species-environment Associations Along a Multi-scale Habitat Gradient". *Conservation Ecology*. 7(1):5 found at: <http://www.consecol.org/vol7/iss1/art5>.
- Moser, C.A. and Kalton, G. (1971) *Survey Methods in Social Investigation*. (2nd Ed) Heinemann. London.
- Moss, M.B. (1996) "Cunning Corvids". *Backpacker*. 24, Issue 8, pages 16-18
- Oehlenschläger A. G. (1779-1850) *The Death Raven* found on Internet at <http://mirror.aarnet.edu.au/pub/pg/etext00/rmbdd10.txt>
- Oppenheim, A.N. (1966) *Questionnaire Design and Attitude Measurement*. Heinemann. London.
- Pärt, T. & Wretenberg, J. (2002) "Do artificial nests reveal relative nest predation risk for real nests?" *Journal of Avian Biology*, Vol 33: 39.
- Pank, L.F. (1981) Summarizing Remarks: Estimating Birds Per Unit Area. In *Estimating Numbers of Terrestrial Birds: Avian Biology No 6*. (Eds C.J. Ralph and J.M. Scott, Cooper Ornithological Society. 152-159.
- Paton, D.C. (1990) "Domestic cats and wildlife". *Bird Observer*. 696, 34-35
- Pedersen, B. (1995) *Progress in the Remedial Management of Mary Carroll Park, Western Australia*. Thesis prepared for Degree of Master of Science. Department of Geography. University of Western Australia.
- Pizzey, G. (1980) *A Field Guide to the birds of Australia*. Collins & Co Ltd. London.
- Pizzey, G & Knight, F. (1997) *Field Guide to the Birds of Australia*. Angus & Robertson, Australia: Harper Collins.
- Poe, Edgar Allan, (1809-1849) *Title The complete poetical works and essays on poetry of Edgar Allan Poe* (together with his Narrative of Arthur Gordon Pym / edited annotated and arranged with memoir by John H. Ingram). Publisher London : Frederick Warne, [1888?]
- Poilock, K.H., Nichols, J.D., Simons, T.R., Farnsworth, G.L. Bailey, L.L. and Sauer, J. (2002) "Large Scale Wildlife Monitoring studies: statistical methods for design and analysis". *Environmetrics* 13. 105-119.
- Pople, T. & Grigg, G. (1999) *Commercial harvesting of Kangaroos in Australia*. Department of Zoology. The University of Queensland (for Environment Australia).

- Powell, R. (1990) *Leaf and Branch: Tress and Tall Shrubs of Perth*. Department of Conservation and Land Management. Como. Western Australia
- Ralph, C.J. and Scott, J.M. (1981) (Eds) *Estimating Numbers of Terrestrial Birds: Studies of Avian Biology 6*. Proceedings of an International Symposium held at Asilomar, California. Oct 26-31, 1980. Cooper Ornithological Society.
- Ralston, A. (2004) "Climber filmed farewells before cutting off arm." *The West Australian*. Friday August 13, 2004.
- Ramsey, F.L. and Scott, M.J. (1981) Analysis of Bird Survey Data Using a Modification of Emlen's Method. *Studies in Avian Biology* 6. 483-487.
- Recher, H. (1972) "The vertebrate fauna of Sydney". *Protection of Ecology Society Australia*. 7, 79-87.
- Recher, H. (1999) "The state of Australia's avifauna: a personal opinion and prediction for the new millennium." *Australian Zoology*. Vol 31: p. 11-27
- Reif, B. (1998) "More on the Australian Raven". *Western Australian Bird Notes*. 88.
- Rodda, J. & Deeley, D. (1990) *Nutrient pollution of Mary Carroll Park wetlands, Gosnells*. A report prepared for the City of Gosnells. Perth. City of Gosnells.
- Rogers, K.G. and Rogers, A. (1999) "Australian Ravens preying on a Banded Stilt." *The Australian bird-watcher*. 18, Issue 3. September. 128-129
- Rowley, I. (1967a) "A Fourth Species of Australian Corvid". *The Emu*. 66:3. February. 191-210
- Rowley, I. (1967b) "Sympatry in Australian Raven". *Proceedings of the Ecological Society of Australia*. Vol/Chapter 2
- Rowley, I., (1970) "The genus *Corvus* (Aves: Corvidae) in Australia". *C.S.I.R.O. wildlife research*. 15. 27-71
- Rowley, I. (1973) "The comparative ecology of Australian Corvids". *C.S.I.R.O. wildlife research*. 18. 25-130
- Rowley, I.. (1974) "The Australian Raven *Corvus coronoides*". *Bird Life*. 80-88
- Rowley, I.. (1975) *Bird Life*. William Collins. Sydney. The Australian Naturalist Library.
- Rowley, I and Vestjens, W.J.M (1973) "The comparative ecology of Australian corvids. *C.S.I.R.O. wildlife research*. 18. 131-155
- Saunders, D.A. & Ingram, J.A. (1995) *Birds of Southwestern Australia: An Atlas of Changes in the Distribution and Abundance of the Wheatbelt Avifauna*. Surry Beatty & Sons with Western Australian Laboratory CSIRO Division of Wildlife & Ecology.

- Schodde, R. (1999) *The Directory of Australian Birds: Passerines*. The Australian Biological Resources Study & The Australian Bird Environment Fund of the Bird Observers Club of Australia. CSIRO Publishing. Victoria. Australia.
- Schwarz, C.J. & Seber, A.F. (1999) "Estimating Animal Abundance: Review III." *Statistical Science*. Vol 14. No 4: 427-436.
- Seddon, G. (1972) *A Sense of Place: a response to an environment, the Swan coastal plain Western Australia*. University of Western Australia Press, Nedlands.
- Semenuik, D.A. (1988) "Consanguineous Wetlands and their Distribution in the Darling System." *Journal of the Royal Society of the Western Australia*. 70: 69-87.
- Serventy, D.L., & Whittell, H.M. (1976) *Birds of Western Australia*. University of Western Australia Press. Perth. Western Australia.
- Sheskin, D.J. (2000) (2nd Ed) *Handbook of Parametric and Non-Parametric Statistical Procedures*. Chapman and Hall. London and New York.
- Shields, J.M. and Recher, H. (1984) "Breeding bird censuses: an evaluation of four methods for use in sclerophyll forest". *Corella*. 8. 29-41.
- Simpson, K., Day, N. and Trusler, P. (1996) (5th Ed) *A Field Guide to the Birds of Australia*. Viking. Penguin Books Australia Ltd. Ringwood. Victoria.
- Slater, P. (1974) *A field guide to Australian Birds: passerines*. Rigby. Adelaide
- Strahan, R. (Ed) (1996) *Finches, Bowerbirds and Other Passerines of Australia*. Angus and Robertson/Harper Collins. Sydney
- Strahan, R. & Cayley, N.W. (1987) *What Mammal Is That?* Angus & Robertson. Australia
- Stewart, P.J. (1997) *Some Aspects of the Ecology of an Urban Corvid: The Australian raven (Corvus coronoides) in Metropolitan Perth*. Honours Thesis. Department of Environmental Management. ECU. Perth.
- Sutherland, W.J. (1996) *Ecological Census Techniques: A Handbook*. Cambridge University Press. Cambridge. United Kingdom.
- Thomas, L., Laake, J.L., Strindberg, S., Marques, F.F.C., Buckland, S.T., Borchers, D.L., Anderson, D.R., Burnham, K.P., Hedley, S.L., Pollard, J.H. and Bishop, R.R.B. (2003) Distance 4.1 Release 2. Research Unit for Wildlife Population Assessment. University of St Andrews. UK.
(<http://www.ruwpa.st-and.ac.uk/distance/>)
- Thorington, K.K. and Bowman, R. (2003). "Predation rate on artificial nests increases with human housing density in suburban habitats. *Ecography*. 26:2. 188-203.

- Tilghman, N.G. and Rusch, D.H. (1981) "Comparison of line-transect methods for estimating breeding bird densities in deciduous woodlots." In *Estimating Numbers of Terrestrial Birds: Studies in Avian Biology No 6*. (Eds C.J. Ralph and J.M. Scott, Cooper Ornithological Society. 202-208.
- Torres, P. (1987) *The Story of Crow*. Nyul Nyul Language Text by Magdalene Williams. Gunada Productions. Broome. Western Australia.
- Turner, G.W. (1984) (Ed.) *The Australian Pocket Oxford Dictionary*. Based on The Pocket Oxford Dictionary of Current English. Oxford University Press. Melbourne.
- UBD (2003) Perth Street Directory (45th Ed.) Universal Press. New South Wales, Victoria, Queensland, South Australia. With thanks to Main Road Western Australia.
- van Delft, R. (1997) (2nd Ed) *Birding Sights Around Perth*. University of Western Australia Press. Nedlands. Western Australia
- van Ripper, C. (III) (1981) Summarizing Remarks in *Estimating Numbers of Terrestrial Birds: Avian Biology No 6*. (Eds C.J. Ralph and J.M. Scott, Cooper Ornithological Society. 152-159.
- Vera, D. (1992) (Ed.) "Satanism and the History of Wicca". in *Temple of the Dark Moon*. Harper Collins. Sydney. Australia.
- Waters and Rivers Commission. Precinct 19 Report. Internet site:
<http://www.wrc.wa.gov.au/srt/publications/landscape/precincts/precinct19/index.html>
- Waters and Rivers Commission. Precinct 23 Report. Internet site:
<http://www.wrc.wa.gov.au/srt/publications/landscape/precincts/precinct23/index.html>
- Watson, D.M. (2003) "The 'Standardized search': An improved way to conduct bird surveys". *Austral Ecology* 28 515-525. Applied Ornithology Group, The Johnstone Centre, Charles Sturt University, Albury, New South Wales.
- Weidinger, K. (2002) "Interactive effects of concealment, parental behaviour and predators on the survival of open passerine nests." In *Journal of Animal Ecology*. Vol 71: 424.
- Wilson, R.R., Twedt, D.J. & Elliott, A.B. (2000) "Comparison of Line Transects and Point Counts for Monitoring Spring Migration in Forested Wetlands." *Journal of Field Ornithology*. 71. 2. 345-355.

• DENOTES PILOT STUDY

LEGEND: M – MARY CARROLL PARK

S – SOUTHERNWOOD PARK

P-PIONEER PARK

SEASON	SUMMER SURVEYS					WINTER SURVEYS				
	January	February	March	April	May	June	July	August	Sept	Oct
Saturday					1.					
Sunday		1.			2.			1. SPM		
Monday		2.	1.		3.			2.		
Tuesday		3.	2.		4.	1.		3.		
Wednesday		4.	3.		5. MSP	2.		4.	1.	
Thursday	1. MSP *	5.	4.	1.	6.	3.	1.	5.	2.	
Friday	2.	6.	5.	2.	7.	4. SPM	2.	6.	3.	1.
Saturday	3. SPM *	7.	6.	3.	8.	5.	3.	7.	4.	2.
Sunday	4.	8.	7.	4.	9. SPM	6. PMS	4. MSP	8.	5.	3.
Monday	5.	9.	8.	5. PMS	10.	7.	5.	9.	6.	4.
Tuesday	6.	10. MSP	9.	6.	11.	8.	6.	10.	7. MSP	5.
Wednesday	7.	11.	10.	7.	12.	9.	7.	11.	8.	6.
Thursday	8.	12.	11. SPM	8.	13.	10.	8.	12.	9.	7. SPM
Friday	9.	13.	12.	9.	14.	11.	9.	13. PMS	10.	8.
Saturday	10.	14.	13.	10.	15.	12.	10.	14. MSP	11. SPM	9. PMS
Sunday	11.	15. SPM	14. PMS	11. MSP	16.	13.	11.	15.	12.	10.
Monday	12.	16.	15.	12.	17.	14. MSP	12.	16.	13.	11.
Tuesday	13.	17.	16.	13.	18.	15.	13.	17.	14.	12.
Wednesday	14.	18.	17.	14.	19.	16.	14. SPM	18.	15.	13.
Thursday	15.	19.	18.	15.	20. PMS	17.	15.	19.	16.	14.
Friday	16. PMS	20.	19.	16.	21.	18.	16.	20.	17.	15.
Saturday	17.	21.	20.	17.	22. MSP	19. SPM	17. PMS	21.	18.	16.
Sunday	18. MSP	22.	21.	18.	23.	20.	18.	22.	19.	17.
Monday	19.	23.	22.	19.	24.	21.	19.	23. SPM	20.	18.
Tuesday	20.	24.	23.	20. SPM	25.	22.	20.	24.	21.	19.
Wednesday	21.	25. PMS	24.	21.	26.	23.	21.	25.	22. PMS	20.
Thursday	22.	26.	25.	22.	27.	24.	22.	26.	23.	21.
Friday	23.	27.	26. MSP	23.	28.	25.	23.	27.	24.	22.
Saturday	24.	28. MSP	27. SPM	24. PMS	29.	26.	24.	28.	25.	23.
Sunday	25.	29.	28.	25.	30.	27.	25.	29. PMS	26. MSP	24.
Monday	26. SPM		29.	26.	31.	28.	26.	30.	27.	25.
Tuesday	27.		30.	27.		29. PMS	27.	31.	28.	26.
Wednesday	28.		31.	28.		30.	28.		29.	27.
Thursday	29.			29.			29. MSP		30.	28.
Friday	30.			30.			30.			29.
Saturday	31. PMS						31.			30.

SITE: MARY CARROLL PIONEER SOUTHERNWOOD

DATE: ___ / ___ / ___ DAY: _____ SESSION TIME: _____ START TRANS _____

WEATHER: _____ WIND _____ SALAT TIME _____ END TRANS _____

TRANSECT #	AGE			PERPENDICULAR DISTANCE FROM OBSERVER									TOTAL
	MATURE	IMM	UNKNOWN	0-5M	5-10M	10-15M	15-20M	20-25M	25-30M	30-50M	50-100M	100M+	
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													
13													
14													
15													
TOTALS													

(FOR 15 MINUTE WINDOW)

SITE: MARY CARROLL PIONEER SOUTHERNWOOD
 DATE: ____/____/____ DAY: _____ SESSION TIME: _____
 WEATHER: _____ WIND _____ SALAT TIME _____

ACTIVITY	TOTAL	MIN 01	MIN 02	MIN 03	MIN 04	MIN 05	MIN 06	MIN 07	MIN 08	MIN 09	MIN 10	MIN 11	MIN 12	MIN 13	MIN 14	MIN 15
Foraging on ground																
Perching in tree/shrub																
Flying																
Plant/tree destruction																
Property damage																
Scavenging at bin																
Scavenging litter on ground																
Stealing food (park visitors)																
Raiding nests/stealing eggs																
Other (describe)																

DESCRIPTION OF 'OTHER' IF REQUIRED: _____

ADDITIONAL COMMENTS: _____

SITE: MARY CARROLL

PIONEER

SOUTHERNWOOD

DATE: ____/____/____

DAY: _____

SESSION TIME: _____

WEATHER: _____

WIND _____

SALAT TIME _____

INTERACTIONS BETWEEN RAVENS AND OTHER BIRDS AND WILDLIFE

ACTION	FREQUENCY WITH	FREQUENCY WITH	SPECIES
INITIATE CHASE			
INITIATE ATTACK			
VICTIM OF CHASE			
VICTIM OF ATTACK			
RAVEN CAUSE DEATH			
DEATH OF RAVEN			
OTHER - NOT LISTED			

DIRECTIONAL BEARING OF RAVENS ENTERING AND EXITING SITES

ENTERING SITE			EXITING SITE		
SIGHTING #	# RAVENS	BEARING	SIGHTING #	# RAVENS	BEARING
Sighting 1			Sighting 1		
Sighting 2			Sighting 2		
Sighting 3			Sighting 3		

COMMON NAME OF OTHER CONSPICUOUS SPECIES OF BIRDS/ANIMALS/WILDLIFE PRESENT AT SITE

APPENDIX D: FIELDWORK RECORD: INTERACTIONS / ENTRY & EXIT / SPECIES LIST

APPENDIX E

COMMUNITY ATTITUDES SURVEY: QUESTIONNAIRE

MARY CARROLL PIONEER SOUTHERNWOOD

1. How frequently do you visit this park?

- Rarely (less than once per month) Occassionally (several times per month) Often (once per week) Very often (more than once per week) Daily

Other (please specify) _____



2. Have you seen Australian Ravens in this park?

- Yes No Unsure

3. Are there are too many Australian Ravens in this park?

- Strongly Agree Agree Neutral Disagree Strongly disagree

4. Australian Ravens are a threat to other birds in this park?

- Strongly Agree Agree Neutral Disagree Strongly disagree

5. Australian Ravens are a threat to other wildlife in this park?

- Strongly Agree Agree Neutral Disagree Strongly disagree

6. Australian Ravens are nuisances when using park for recreation?

- Strongly Agree Agree Neutral Disagree Strongly disagree

6. Population Control (culling) Australian Ravens at this park should take place?

- Strongly Agree Agree Neutral Disagree Strongly disagree

8. Do you have other comments to add about Australian Raven?

- Yes (record overleaf) No

APPENDIX F

COMMUNITY ATTITUDES SURVEY: QUESTIONNAIRE

INFORMATION & CONSENT FORM

“Population Dynamics & Interspecific Interactions of the Australian Raven (*Corvus coronoides*) in Suburban Parklands”.

My name is Desiree Moon. I am a student at Edith Cowan University, Mt Lawley Campus. I am undertaking a Bachelor of Arts – Honours – Geography course. My Academic Supervisor is Dr Hugo Bekle and I have full faculty approval from the Faculty of CSESS Ethics Committee for my study.

The study is designed to record the abundance and distribution of Australian Ravens at three sites: Mary Carroll, Pioneer and Southernwood parks, in Gosnells. The study is an attempt to identify the main activities of ravens and the types and frequencies of their interactions with other birds/wildlife in the study areas. The final aspect of the study is to investigate the attitudes of park users towards the presence and behaviour of ravens, and their views on population control (culling) of them at these sites.

The terms of participation are voluntary and participants can withdraw from the survey at any time. Anonymity is assured, as the survey does not request any personal details. All information is confidential and all documents and computer records will be stored in a locked cabinet in a locked store at the University (room 17.124).

If you have queries regarding the study or your participation in the survey please do not hesitate to contact any one of the following persons:

Desiree Moon
Student
Student # 0863392

Dr Hugo Bekle
Supervisor
Senior Lecturer -
Geography

Dr Jill Durey
Independent Advisor
Programme Director
Community Services,
Education and Social
Sciences, International,
Cultural and Community
Studies, Mt Lawley

Ph: 0413 929 367

Ph: 9370 6148

Ph: 9370 6308

APPENDIX G

AVIAN SPECIES LIST MARY CARROLL, PIONEER & SOUTHERNWOOD PARKS GOSNELLS, WESTERNS AUSTRALIA

Identification and classification from
'The Field Guide to the Birds of Australia' (Pizzey, 1997)
Based on 'The Taxonomy and Species of birds of Australia and its Territories'
(RAOU Monograph 2, Melbourne, 1994)

All sightings confirmed against the *Checklist of the Birds of Western Australia*.
A list maintained by Ron Johnstone at the Western Australian Museum
& Alan Burbidge 1996, 1997, 1998, 1999, 2000, 201, 2002, 2003).
Nomenclature follows Christidis and Boles (1994)
'The Taxonomy and Species of Birds of Australia and its Territories'
(RAOU Monograph 2, Melbourne, 1994)

√ - INDICATES SPECIES RECORDED AT SITE
MCP = MARY CARROLL PARK
PP = PIONEER PARK
SP = SOUTHERNWOOD PARK

• DENOTES INTRODUCED SPECIES

		Species present at:		
		MCP	PP	SP
FAMILY ANATIDAE				
Australian Shelduck	<i>Tadorna tadornoides</i>	√	√	
Australian Wood Duck	<i>Chenonetta jubata</i>	√	√	√
Black Swan	<i>Cygnus atratus</i>	√		
Grey Teal	<i>Anas gracilis</i>	√	√	√
Blue-billed Duck	<i>Oxyura australis</i>	√		
Mallard*	<i>Anas platyrhynchos</i>	√		
Musk Duck	<i>Biziura lobata</i>	√		
Pacific Black Duck	<i>Anas superciliosa</i>	√	√	√
Domestic Goose*	<i>Anser anser</i>	√	√	
FAMILY PODICIPEDIDAE				
Australasian Grebe	<i>Tachybaptus novaehollandiae</i>	√	√	
FAMILY ANHINGIDAE				
Darter	<i>Anhinga melanogaster</i>	√	√	

Species present at:
MCP PP SP

FAMILY PHALACROCORACIDAE

Great Cormorant	<i>Phalacrocorax carbo</i>	✓		
Little Black Cormorant	<i>Phalacrocorax sulcirostris</i>	✓	✓	
Little Pied Cormorant	<i>Phalacrocorax melanoleucos</i>	✓		

FAMILY PELECANIDAE

Australian Pelican	<i>Pelecanus conspicillatus</i>	✓	✓	
--------------------	---------------------------------	---	---	--

FAMILY ARDEIDAE

Great Egret	<i>Ardea alba</i>	✓		
Little Egret	<i>Egretta garzetta</i>	✓		
Nankeen Night Heron	<i>Nycticorax caledonicus</i>	✓	✓	
White-faced Heron	<i>Egretta novaehollandiae</i>	✓	✓	✓

FAMILY THRESKIORNITHIDAE

Australian White Ibis	<i>Threskiornis molucca</i>	✓	✓	✓
Yellow Billed Spoonbill	<i>Platalea flavipes</i>	✓	✓	✓

FAMILY ACCIPITRIDAE

Brown Goshawk	<i>Accipiter fasciatus</i>		✓	✓
Swamp Harrier	<i>Circus approximans</i>	✓	✓	

FAMILY RALLIDAE

Dusky Moorhen	<i>Gallinula tenebrosa</i>	✓		
Purple Swamphen	<i>Porphyrio porphyrio</i>	✓		
Eurasian Coot	<i>Fulica atra</i>	✓	✓	

FAMILY RECURVIROSTRIDAE

Black-winged Stilt	<i>Himantopus himantopus</i>	✓		
--------------------	------------------------------	---	--	--

		Species present at:		
		MCP	PP	SP
FAMILY COLUMBIDAE				
Laughing Turtle Dove*	<i>Streptopelia senegalensis</i>	√	√	√
Spotted Turtle Dove*	<i>Streptopelia chinensis</i>	√	√	√
Rock Dove*	<i>Columba livia</i>	√	√	√
Common Bronzewing	<i>Phaps chalcoptera</i>		√	√
FAMILY CACATUIDAE				
Galah	<i>Cacatua roseicapilla</i>	√	√	√
Sulphur Crested Cockatoo*	<i>Cacatua galerita</i>	√		
FAMILY PSITTACIDAE				
Elegant Parrot	<i>Nephema elegans</i>	√		
Rainbow Lorikeet*	<i>Trichoglossus haematodus</i>	√	√	√
Red-capped Parrot	<i>Purpureicephalus spurius</i>		√	
Western Ringneck	<i>Barnardius zonarius</i>	√	√	√
FAMILY STRIGIGIDAE				
Southern Boobook	<i>Ninox novaeseelandiae</i>	√	√	
FAMILIES ALCEDINIDAE & HALCYONIDAE				
Laughing Kookaburra*	<i>Dacelo novaguineae</i>	√	√	√
Sacred Kingfisher	<i>Todiramphus sanctus</i>			√
FAMILY PARDOLOTIDAE				
Western Gerygone	<i>Gerygone fusca</i>	√	√	√
Yellow-rumped Thornbill	<i>Acanthiza chrysorrhoa</i>		√	√
Weebill	<i>Smicrornis brevirostris</i>	√	√	√
FAMILY MELIPHAGIDAE				
Little Wattlebird	<i>Anthochaera chrysoptera</i>			√
Red Wattlebird	<i>Anthochaera carunculata</i>	√	√	√
Singing Honeyeater	<i>Lichenostomus virescens</i>	√	√	√
New Holland Honeyeater	<i>Phylidonyris novaehollandiae</i>	√		
Brown Honeyeater	<i>Lichmera indistincta</i>	√	√	√

Species present at:
MCP PP SP

FAMILY PACHYCEPHALIDAE

Rufous Whistler	<i>Pachycephala rufiventris</i>	√	√	√
Grey Shrike-thrush	<i>Colluricincla harmonica</i>	√	√	√

FAMILY DICRURIDAE

Willie Wagtail	<i>Rhipidura leucophrys</i>	√	√	√
Grey Fantail	<i>Rhipidura fuliginosa</i>	√	√	√

FAMILY CAMAPEPHAGIDAE

Black-faced Cuckoo Shrike	<i>Coracina novahollandiae</i>	√	√	√
White-winged Triller	<i>Lalage sueurii</i>	√	√	√

FAMILY ARTAMIDAE

Black-faced Woodswallow	<i>Artamus personatus</i>	√	√	√
Magpie Lark	<i>Grallina cyanoleuca</i>	√	√	√
Australian Magpie	<i>Gymnorhina tibicen</i>	√	√	√

FAMILY HIRUNDINIDAE

Welcome Swallow	<i>Hirundo neoxena</i>	√	√	√
-----------------	------------------------	---	---	---

FAMILY ZOSTEROPIDAE

Silvereye	<i>Zosterops lateralis</i>	√	√	√
-----------	----------------------------	---	---	---

TOTAL SPECIES DETECTED		53	43	34
-------------------------------	--	-----------	-----------	-----------