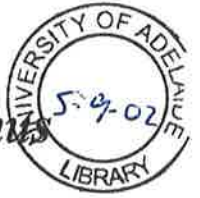


An Ecological Study of Bush Stone-curlews *Burhinus*
grallarius on Kangaroo Island, South Australia



Master of Science Degree
Department of Environmental Biology
Adelaide University

Jody A. Gates
2001


Preface

This thesis has been prepared in order to fulfil the requirements of the Degree of Master of Science by research, with the Department of Environmental Biology, at Adelaide University.

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university or tertiary institution, and to the best of my knowledge and belief, the thesis contains no material previously published or written by another person, except where due reference is made in the text of the thesis.

I give consent to this copy of my thesis, when deposited in the University Library, being available for loan and photocopying.

Signed:



Jody A. Gates

25-6-02
Date

Acknowledgments

The majority of the field research for this project was undertaken whilst I was working full-time as a Senior Ranger at Flinders Chase National Park on Kangaroo Island, between 1995 and 1998. This put considerable time constraints on fieldwork timetables, however, National Parks and Wildlife, South Australia were supportive of the project and provided study leave to assist with undertaking fieldwork. The thesis was subsequently prepared between 1998 and 2001, when I was also predominantly employed full-time on various contracts with National Parks and Wildlife SA.

The project was essentially self-funded, however, the generous support of my supervisor Dr David C. Paton is gratefully acknowledged. The NPWSA Wildlife Conservation Fund also provided a grant to cover some expenses associated with the radio-tracking component of the study.

As indicated the project was supervised by Dr. David Paton. Throughout the extended period over which this project was completed David's assistance, encouragement and critical comments were of great value. Thanks Dave!

I would especially like to thank two people for their considerable assistance during the fieldwork component of this project – Ange Paltridge and Lynn Pedler. Ange assisted with the distribution survey, nest searches, catching and radio-tracking of the birds, and her company and support was greatly appreciated. Lynn was invaluable in assisting with catching the birds and radio-tracking several birds on occasions. His experience with handling birds and general knowledge on ornithology ensured that our catching trips were successful and enjoyable.

The following landholders allowed regular access to their properties (at all hours of the day and night!) for fieldwork: Joe Riggs (lessee of KB Downs), and the following two managers of what is now Hanson Bay Sanctuary, Snow Dennis and Peter Davis.

Gavin Burgess, alias Kevin Bargass, provided guidance and instruction with GIS, and helped me become proficient enough to eventually produce the maps/figures.

Keith Walker and Graeme Moss assisted me with the data analysis, particularly in Chapters 4 and 5.

Helen Richards is thanked for distributing questionnaires through the Landcare Newsletter that she produces for Kangaroo Island.

Wendy and Bob Furner and Fiona Gill provided great hospitality during the latter stages of fieldwork when I no longer lived on the island.

Kirrily Blaylock was kind enough to assist with identifying the fragments of invertebrates in the faeces of bush stone-curlews.

Kylie Moritz and Steve Gates assisted with the task of proof-reading the final drafts of the thesis.

Finally, a special thanks to Mum and Dad whose love of the outdoors led to the development of my interest in birds at a very young age, and led me to pursue a career in natural resource management. Now I get paid to do the things I've always loved – thanks guys.

Abstract

Bush stone-curlews *Burhinus grallarius* forage, roost and nest on the ground, making them particularly vulnerable to decline. Although once common and widespread throughout southern, eastern and northern Australia, only sporadic records occur across much of their former range in southern and eastern Australia following a major contraction in range (Marchant and Higgins 1993). Two main factors have been implicated in the decline of this species in southern and eastern Australia – predation by foxes and habitat clearance and modification (Marchant and Higgins 1993, Johnson and Baker-Gabb 1994, Saunders and Ingram 1995, Robinson and Traill 1996). Bush stone-curlews have recently been listed as near threatened at the national level (Garnett and Crowley 2000) but have been down-graded from endangered to vulnerable in South Australia, primarily as a result of the findings in this study.

In contrast to the mainland, bush stone-curlews were apparently common on Kangaroo Island, providing an opportunity to study their ecology in a temperate environment. The studies were undertaken at two major study sites in the south-west of the island: Flinders Chase National Park Headquarters (FCHQ) and an agricultural property, 'KB Downs'. The objectives of the study were:

1. To document the historical distribution, and subsequent decline, of bush stone-curlews in South Australia.
2. To determine the current distribution and status of bush stone-curlews on Kangaroo Island.
3. To determine the home range sizes and movements of bush stone-curlews on Kangaroo Island.
4. To determine the characteristics of foraging habitat, day roost areas and nest sites, and the availability of this habitat across Kangaroo Island.
5. To determine the diet and food resources of the bush stone-curlews on Kangaroo Island.
6. To determine potential threats to the population and to make management recommendations aimed at ameliorating these threats.

A total of 414 records of bush stone-curlews were obtained for South Australia from the late 1880s through to 1995. Early records were widespread across the State. However, by 1940 a major decline was evident. By 1980 most records came from Kangaroo Island, with relatively few from the Riverland, South-east, Lower Lakes and Southern Eyre Peninsula.

Call-playback surveys were undertaken across Kangaroo Island in 1995/96 to determine the current distribution of the birds. Surveys and questionnaires were undertaken by landholders to compliment the call-playback surveys. The birds were recorded at 109 of 147 (74%) call play-back survey sites. Of the 38 sites where the birds were absent only seven sites (5% of the total) were within agricultural areas, and the remaining 31 sites (21% of the total) occurred within large continuous areas of vegetation, such as Flinders Chase National Park. Combined with the results of questionnaires and

landholder surveys the call-playback surveys showed that the birds were widespread and common across Kangaroo Island, and showed a strong preference for the agricultural areas. This confirmed that Kangaroo Island was the major stronghold for these birds in southern and eastern Australia.

Fifteen bush stone-curlews were fitted with radio-transmitters between July 1996 and June 1998. Adult birds were preferentially selected, although one juvenile was also radio-tagged. Based on home range sizes and use, three groups of birds were identified: (1) resident breeding birds; (2) mobile breeding and non-breeding birds and (3) first year juveniles. Six birds belonged to group (1) and home range estimates for four of these ranged between 26 ha and 64 ha. These birds regularly used the same sites for roosting, were always observed roosting with another bird, and were recorded breeding within the vicinity of their regular roost sites. Nine birds belonged to the second group, and these birds ranged widely and regularly made long distance movements, which accounted for larger home range sizes of between 120 ha and 877 ha. Five of these birds were recorded using a communal roost with up to 15+ other birds during the non-breeding season, and four of these birds subsequently disappeared from the study site. Fortunately one of these birds was subsequently rediscovered eight kilometres away from the study site, suggesting that the birds may have dispersed. The radio-tagged juvenile was placed within a separate group of birds. This bird remained within the home range of its parents until at least the beginning of the following breeding season. Unfortunately the transmitter either failed or the bird dispersed at this time.

Characteristics of roost, nest and foraging locations were investigated. Roost and nest sites were located through radio-tracking and intensive searching, and foraging locations were obtained from radio-tracking alone. Within three broad habitat types (A- natural vegetation; B- semi-cleared/regrowth vegetation; and C- cleared areas) roost sites (n=47) were predominantly located within vegetation (60% in A, 30% in B, 10% in C). Nest sites (n=27) however, were found in cleared land more often (41% in A, 15% in B, 44% in C), and foraging locations (n=819) were primarily in cleared areas (21% in A, 12% in B, 67% in C). The small percentage of records of foraging in natural vegetation, and roosting in cleared areas, were primarily related to nest or chick attendance by the birds. Specific data on vegetation and other habitat variables were collected for all roost and nest sites and associated random sites. Multi-dimensional scaling and ordination plots showed that there were no differences between the sites used by the birds and the random sites. These results suggest that suitable habitat was abundant on Kangaroo Island, and that land clearance has benefited these birds by opening up otherwise unsuitable habitat.

Faecal analysis and micro-pitfall traps were used to investigate diet and food resources. Faeces (n=416) were collected opportunistically from roost sites at the two major study sites (FCHQ and 'KB Downs') and one other property ('Brookland Park') between 1995 and 1998. A total of eight micro-pitfall trap sites (each with nine pitfalls) was established at the major study sites. Beetles were the

most commonly recorded food item (in 90% of all faeces) followed by spiders, larvae/caterpillars and ants. Earwigs, centipedes/millipedes, moths, snails and vertebrates were also important food items, but occurred in less than 25% of faeces. Over 20,000 macro-invertebrates were captured in the micro-pitfall traps, and remains of all major groups captured were present in faeces, except for worms. At both of the major study sites beetles and ants accounted for the majority of the captures in the pitfall traps. Seasonal variation in diet was evident, and based on the captures in pitfall traps, primarily reflected changes in the abundance/activity of prey groups. The results demonstrated that the birds were opportunistic foragers with a generalist diet, consuming what was most readily available, with no major preferences observed. All food items had been recorded in other studies. This study suggests that food resources were not likely to be limiting. However, potential changes to the agricultural landscape may have both long and short-term impacts on prey resources, either directly or as a result of changes to foraging habitat.

This study has provided a basis for management and research recommendations for bush stone-curlews to ensure that Kangaroo Island remains a stronghold for the species. The major threats to the birds, habitat clearance and modification, and predation by foxes, are both absent on Kangaroo Island. The initial clearance of native vegetation for agriculture on the Island has actually provided more suitable habitat, as large areas of natural vegetation of minimal value to the birds were cleared and replaced with pasture. However, ongoing changes across the agricultural landscape may be detrimental to the birds, particularly as large areas of potential foraging habitat are being converted to agro-forestry.

TABLE OF CONTENTS

Preface	ii
Acknowledgements	iii
Abstract	v
List of Figures	xii
List of Tables	xiv
CHAPTER 1	
INTRODUCTION AND BACKGROUND INFORMATION	1
1.0 Introduction.....	1
1.1 Background Information.....	3
1.1.1 Description	3
1.1.2 Distribution	4
1.1.3 Habitat	4
1.1.4 Social Organisation	5
1.1.5 Diet.....	7
1.1.6 Vocalisations	7
1.1.7 Breeding biology	8
1.1.8 The decline of woodland birds on the mainland	8
1.2 Aims and Objectives of the Study	9
1.3 The Study Sites	9
1.3.1 Kangaroo Island - A General Overview.....	9
1.3.2 Flinders Chase National Park Headquarters.....	11
1.3.3 KB Downs.....	14
1.4 Structure of the Thesis	16
CHAPTER 2	
THE HISTORICAL AND CURRENT DISTRIBUTION OF BUSH STONE-CURLEWS, <i>BURHINUS GRALLARIUS</i> , IN SOUTH AUSTRALIA AND ON KANGAROO ISLAND.	17
2.0 Introduction.....	17
2.1 Methods	18
2.1.1 Historical and current distribution across South Australia.....	18
2.1.2 The Kangaroo Island survey	19
2.1.3 Data storage and analysis	22
2.2 Results	22
2.2.1 Historical and recent records for South Australia	22
2.2.2 The Kangaroo Island survey	22
2.3 Discussion.....	30
2.3.1 Effectiveness of survey methodology	30
2.3.2 Historical perspective.....	31

2.3.3	Distribution on Kangaroo Island and broad habitat preferences	31
2.3.4	Conclusions	33

CHAPTER 3

SIZE OF HOME RANGES AND MOVEMENTS OF BUSH STONE-CURLEWS <i>BURHINUS GRALLARIUS</i> ON KANGAROO ISLAND		34
3.0	Introduction.....	34
3.1	Background Information.....	35
3.1.1	Definition of home range	35
3.1.2	Analysis of home range sizes	36
3.1.3	Study sites	38
3.2	Methods	40
3.2.1	Capturing the birds	40
3.2.2	Radio-transmitter attachment and banding	40
3.2.3	Radio-tracking procedure	42
3.2.4	Calculation of home range sizes and quantifying movements	43
3.3	Results	44
3.3.1	Details of the radio-tracked birds	44
3.3.2	Timing and duration of radio-tracking	46
3.3.3	Comparisons between home range analysis techniques	49
3.3.4	Home range sizes and use of home ranges by individual bush stone-curlews	52
3.3.6	The movements of the five birds for which home range estimates could not be determined	67
3.3.7	Summary of patterns of home range size and home range use by the birds	70
3.4	Discussion.....	72
3.4.1	Home range sizes and patterns of movements of the birds	75
3.4.1	Summary and conclusions.....	80

CHAPTER 4

CHARACTERISTICS OF ROOST, NEST AND FORAGING SITES SELECTED BY BUSH STONE-CURLEWS <i>BURHINUS GRALLARIUS</i> ON KANGAROO ISLAND.		83
4.0	Introduction.....	83
4.1	Background information on habitat use by bush stone-curlews	84
4.2	Methods	85
4.2.1	Locating sites used by the birds	85
4.2.2	Describing macro- and micro-habitats	86
4.2.3	Statistical analysis of nest and roost site data	93
4.3	Results	94
4.3.1	Macro-habitat preferences.....	94
4.3.2	Micro-habitat selection.....	96
4.4	Discussion.....	101
4.4.1	Nest Sites.....	102

4.4.1	Characteristics of roost sites.....	103
4.4.3	Foraging (nocturnal) site selection.....	105
4.4.5	Conclusions	105
CHAPTER 5		
DIET AND FOOD RESOURCES		107
5.0	Introduction.....	107
5.1.1	Other studies on the diet of bush stone-curlews.....	108
5.1.2	Techniques for determining the diet of birds	108
5.1.3	The use of micro-pitfalls to assess abundance and diversity of ground-dwelling invertebrates	111
5.2	Methods	112
5.2.1	Collection and analysis of faeces	112
5.2.2	Sampling of invertebrates within areas used for foraging by bush stone-curlews.....	114
5.2.3	Data analysis	117
5.3	Results	118
5.3.1	Prey items recorded within faeces.....	118
5.3.2	Potential prey items collected in micro-pitfall traps	124
5.3.3	Comparisons between food groups recorded in faeces and captured in micro-pitfall traps.....	130
5.4	Discussion	132
5.4.1	Determination of diet using faecal analysis	132
5.4.2	Use of micro-pitfall traps to determine potential prey resources	133
5.4.3	The composition of the diet.....	134
5.4.4	Potential prey availability compared with diet.....	135
5.4.5	Conclusions	138
CHAPTER 6		
MANAGEMENT OF BUSH STONE-CURLEWS ON KANGAROO ISLAND AND THE MAINLAND OF SOUTH AUSTRALIA		139
6.1	Introduction.....	139
6.2	Status of bush stone-curlews.....	139
6.3	Threats to bush stone-curlews.....	140
6.3.1	The role of predation by foxes and habitat modification	140
6.3.2	Ongoing changes to preferred habitat in Kangaroo Island.....	142
6.3.3	Other threats	142
6.3	Recommendations for further research and management.....	145
6.3.1	Recommendations for Kangaroo Island	146
6.3.2	Recommendations for the South Australian mainland.....	147
6.4	Conclusions.....	148
7.0	REFERENCES	150

Appendix 1. Past Records of Bush Stone-curlews in South Australia..... 162
Appendix 2. Summary of Community Questionnaire Results..... 172

LIST OF FIGURES

CHAPTER 1

- Figure 1.1. The location of Kangaroo Island, South Australia 2
- Figure 1.2. Long-term mean annual rainfall (mm) isohyets for Kangaroo Island. 12
- Figure 1.3. Location of the study sites on Kangaroo Island 13

CHAPTER 2

- Figure 2.1. Historical and current distribution of bush stone-curlews *Burhinus*
grallarius in South Australia. 24
- Figure 2.2. Distribution of bush stone-curlews *Burhinus grallarius* on Kangaroo
Island, determined during surveys in 1995 and 1996. 25
- Figure 2.3. Frequency of response times to call playback surveys by bush stone-
curlews *Burhinus grallarius* on Kangaroo Island. 29

CHAPTER 3

- Figure 3.1. Locations of study sites for home range and movements study on bush
stone-curlews *Burhinus grallarius*. 39
- Figure 3.2. The harness design and attachment of radio-transmitters on bush stone-
curlews *Burhinus grallarius*. 41
- Figure 3.3. The timing and length of radio-tracking periods for each bush stone-
curlew *Burhinus grallarius* that was radio-tracked. 47
- Figure 3.4a. The home range boundaries and sizes (ha) estimated by the kernel (K,
solid lines), harmonic mean (HM, dashed lines) and minimum convex
polygon (MCP, dotted lines) analysis techniques for six breeding bush
stone-curlews *Burhinus grallarius* on Kangaroo Island. 50
- Figure 3.4b. The home range boundaries and sizes (ha) estimated by the kernel (K,
solid lines), harmonic mean (HM, dashed lines) and minimum convex
polygon (MCP, dotted lines) analysis techniques for four non-breeding
bush stone-curlews *Burhinus grallarius* on Kangaroo Island. 51
- Figure 3.5. Radio-tracking fixes and home range boundaries for three bush stone-
curlews *Burhinus grallarius* (FC1, FC2 and FC3) at Flinders Chase
National Park Headquarters, south-western Kangaroo Island, 1996 -
1998. 55
- Figure 3.6a. Frequency of 'foraging distances' for six breeding bush stone-curlews
Burhinus grallarius on south-western Kangaroo Island between 1996
and 1999. 56
- Figure 3.6b. Temporal patterns in 'foraging distances' for six breeding bush stone-
curlews *Burhinus grallarius* on south-western Kangaroo Island
between 1996 and 1999. 57
- Figure 3.7. Radio-tracking fixes and home range boundaries for three bush stone-
curlews *Burhinus grallarius* (KB4, KB7 and KB8) at 'KB Downs',
south-western Kangaroo Island, 1997 - 1999. 60
- Figure 3.8. Radio-tracking fixes and home range boundaries for two bush stone-
curlews *Burhinus grallarius* (KB9 and KB10) at 'KB Downs', south-
western Kangaroo Island, 1998 - 1999. 62

Figure 3.9.	Radio-tracking fixes and home range boundaries for two bush stone-curlews <i>Burhinus grallarius</i> (KB5 and KB11) at 'KB Downs', south-western Kangaroo Island, 1997 – 1998.	64
Figure 3.10a.	Frequency of 'foraging distances' for four non-breeding bush stone-curlews <i>Burhinus grallarius</i> on south-western Kangaroo Island between 1996 and 1999.	65
Figure 3.10b.	Temporal patterns in 'foraging distances' for four non-breeding bush stone-curlews <i>Burhinus grallarius</i> on south-western Kangaroo Island between 1996 and 1999.	66
Figure 3.11.	Radio-tracking fixes for five bush stone-curlews <i>Burhinus grallarius</i> (KB1, KB2, KB3, KB6, and KB12) at 'KB Downs', south-western Kangaroo Island, 1996 - 1998.	68

CHAPTER 4

Figure 4.1.	Location of study sites for investigation of the habitats used for nesting, roosting and foraging by bush stone-curlews <i>Burhinus grallarius</i> on Kangaroo Island.	87
Figure 4.2.	Configuration of sampling area for each bush stone-curlew <i>Burhinus grallarius</i> nest site and associated random sites.	89
Figure 4.3.	The layout of the grid that was 'overlayed' at nest and roost areas to select random sites for sampling.	92
Figure 4.4.	Relative frequency of use of three broad habitat types by bush stone-curlews <i>Burhinus grallarius</i> for nesting, roosting and foraging.	95
Figure 4.5.	The similarities between bush stone-curlew <i>Burhinus grallarius</i> nest sites and random sites on Kangaroo Island as determined by multi-dimensional scaling (a) without site labels and (b) with sites labels.	97
Figure 4.6.	The similarities between bush stone-curlew <i>Burhinus grallarius</i> roost sites and random sites on Kangaroo Island as determined by multi-dimensional scaling: (a) complete data-set and (b) with the 7 outliers removed.	100

CHAPTER 5

Figure 5.1.	Locations of the study sites for the study of the diet of bush stone-curlews <i>Burhinus grallarius</i>	113
Figure 5.2.	Locations of micro-pitfall trapping sites at Flinders Chase Park Headquarters and 'KB Downs'.	115
Figure 5.3.	Configuration of micro-pitfall trap sites.	116
Figure 5.4.	Percentage of bush stone-curlew <i>Burhinus grallarius</i> faeces containing the remains of different prey groups at Flinders Chase Park Headquarters (n = 191), 'KB Downs' (n = 157) and 'Brookland Park' (n = 68), on western Kangaroo Island.	120
Figure 5.5.	Percentage frequency of total numbers of prey groups recorded within individual bush stone-curlew <i>Burhinus grallarius</i> faeces collected for three sites on western Kangaroo Island during 1995-1998.	121
Figure 5.6.	Seasonal variation in the percentage frequency of prey items recorded within bush stone-curlew <i>Burhinus grallarius</i> faeces at (a) Flinders Chase Park Headquarters and (b) 'KB Downs'.	123

Figure 5.7.	Average number of captures per trap-night for each micro-pitfall trap site at Flinders Chase Park Headquarters and 'KB Downs' between June 1997 and July 1998.	127
Figure 5.8.	Bray-Curtis similarity dendogram for all micro-pitfall trap sites.....	128
Figure 5.9.	The captures per trap-night of all prey groups for the micro-pitfall trap sites at Flinders Chase Park Headquarters and 'KB Downs'.....	129
Figure 5.10.	Seasonal changes in capture rates for each prey group at Flinders Chase Park headquarters and 'KB Downs'.....	131
 CHAPTER 6		
Figure 6.1.	Trends in crop production on Kangaroo Island, 1987/88 – 2000/01.....	143
Figure 6.2.	The current and proposed extent of agro-forestry plantations on Kangaroo Island, 2001.	144

LIST OF TABLES

CHAPTER 1

Table 1.1.	Long-term mean maximum and minimum temperatures for four weather stations on Kangaroo Island.	12
------------	--	----

CHAPTER 2

Table 2.1.	Source of historical (pre-1980) and current (1980 – 1995) records of bush stone-curlews <i>Burhinus grallarius</i> for South Australia.....	23
Table 2.2.	Source of current records of bush stone-curlews, <i>Burhinus grallarius</i> , on Kangaroo Island.	26
Table 2.3.	Summary of call-playback survey results for bush stone-curlews <i>Burhinus grallarius</i> along 13 survey transects.....	28

CHAPTER 3

Table 3.1.	The weights and age-groups of the bush stone-curlews <i>Burhinus grallarius</i> that were radio-tracked.....	45
Table 3.2.	Radio-tracking effort and number of locations obtained for each bush stone-curlew <i>Burhinus grallarius</i>	48
Table 3.3.	Estimates of home range area for ten bush stone-curlews <i>Burhinus grallarius</i> using the south-western area of Kangaroo Island.	54
Table 3.4.	Fidelity to roost sites for ten bush stone-curlews <i>Burhinus grallarius</i>	58

CHAPTER 4

Table 4.1.	The three broad habitat categories into which all nocturnal and diurnal locations of bush stone-curlews <i>Burhinus grallarius</i> obtained from radio-tracking were allocated.	88
Table 4.2.	Edaphic and vegetative variables measured at each bush stone-curlew <i>Burhinus grallarius</i> nest site and associated random sites on Kangaroo Island.	88
Table 4.3.	Habitat variables measured for each bush stone-curlew <i>Burhinus grallarius</i> roost sites and associated random sites.	91
Table 4.4.	The frequency of records of types of ground cover at bush stone-curlew <i>Burhinus grallarius</i> nest sites (n = 27) on Kangaroo Island.	99
Table 4.5.	Features of roost sites of bush stone-curlews <i>Burhinus grallarius</i> on Kangaroo Island.	99

CHAPTER 5

Table 5.1.	List of food items recorded for bush stone-curlews <i>Burhinus grallarius</i> from published literature	109
Table 5.2.	Numbers of bush stone-curlew faeces collected from three locations on Kangaroo Island between 1995 and 1998 in each month of the year.	119
Table 5.3.	The results of a comparison between the diets of bush stone-curlews <i>Burhinus grallarius</i> at the three main study sites using the Bray-Curtis test of similarity and an analysis of similarity (ANOSIM).	125

Table 5.4. Total trap effort for each micro-pitfall trap site (trap-nights) at Flinders Chase Headquarters and 'KB Downs' between June 1997 and July 1998..... 125