A SECOND BIRD ATLAS OF THE ADELAIDE REGION. PART 1: CHANGES IN THE DISTRIBUTION OF BIRDS: 1974-75 vs 1984-85

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SUMMARY

The distributions of 259 species of birds in the Adelaide region during 1984-85 were compared with similar data collected in 1974-75 (SAOA 1977). Almost all species showed some minor changes in their recorded distributions. These changes consisted of a species being recorded in some 10 000 × 10 000 yd grid squares in 1974-75 but not in 1984-85 and vice versa. For 101 species the changes only involved a relatively small proportion of the grid squares in which that species was recorded and did not result in any substantial change in distribution. For another 158 species there were often substantial changes in the numbers and locations of grid squares occupied by a species in 1984-85 compared with 1974-75. In some cases more than a third of the grid squares in which the species was formerly recorded had changed. Many of the changes in distribution were not unexpected given the generally drier conditions throughout South Australia in 1984-85 compared with the exceptionally wet years of 1974-75. Three patterns to changes in distribution were prominent: (1) an influx of waterbirds (presumably from inland areas) into the more mesic and coastal areas of the atlas area in 1984-85; (2) a shift of waterbirds away from some of the ephermeral wetlands that were flooded in 1974-75 to more permanent wetlands near the coast; and (3) a greater influx of terrestrial birds from more arid inland habitats into the atlas area in 1984-85. In general, pigeons, parrots, larks, honeyeaters and woodswallows had increased distributions in 1984-85 or showed no change between the two periods, while flycatchers (including robins and whistlers), reed warblers (including grassbirds and cisticola) and finches tended to show declines in distribution. Most of the terrestrial species that had reduced distributions in 1984-85 were woodland species that were largely ground-dwelling, or species that nested and fed on or close to the ground. Amongst these species were the Malleefowl, Painted Button-quail, Hooded Robin, Jacky Winter, Restless Flycatcher, Chestnut-rumped Hylacola, Southern Whiteface, Crested Bellbird and Diamond Firetail, species that have been recorded as declining in other parts of Australia. Detailed ecological studies are urgently needed to establish the reasons for these apparent declines, so that appropriate management strategies can be implemented to arrest further losses. Comparisons between the two atlas periods reveal only broad changes in distribution. Other species may have also declined on a local scale within the Adelaide atlas area but were not detected at the rather coarse scale of grid squares. In future the distributions of many species of birds may need to be recorded at a finer resolution.

INTRODUCTION

In 1974-75 the South Australian Ornithological Association (SAOA) collected information on the distribution of birds in the Adelaide region (SAOA 1977). The area surveyed included all land areas shown on the 1:250 000 R502 maps Adelaide and Barker excluding Kangaroo Island. Printed on these maps was a 10 000 × 10 000 yd grid system, and observers recorded the birds that they saw in each grid square on specially printed cards. Most of the 268 grid squares with land were visited several times during the 21 month survey period in 1974-75 and the distributions of 301 bird species were recorded (SAOA 1977). These records provide a set of baseline data with which to monitor future changes in the distribution of birds within the region. In 1984-85 the SAOA repeated their survey of birds of the Adelaide region to document any changes in distribution since the 1974-75 atlas. This paper summarises and compares the 1984-85 distributions of birds within the Adelaide region with their distributions in 1974-75. Maps showing the distribution of birds in 1984-85 are provided in SAOA (1994).

METHODS

Map units

The original 1974-75 atlas of birds in the Adelaide region was one of several pilot atlases run before the Royal Australasian Ornithologists Union (RAOU) initiated a 5-year Australia-wide atlas from 1977-81 (Blakers *et al.* 1984). The 10 000 yd grid system used in 1974-75 became obsolete during 1974 when Australia switched to a metric scale for distances. Since then latitudes and longitudes have been used to define locations for bird atlases in Australia (e.g. Blakers *et al.* 1984; Emison *et al.* 1987; Ford and McFarland 1991; Taylor and Canberra Ornithologists Group 1992). So that the 1984-85 bird atlas of the Adelaide region could document any changes in distribution, the old 10 000 yd grid squares were used as map units. However, observers had to provide exact location details so that these could also be defined by latitude and longitude. Latitudes and longitudes were given to the nearest minute, except when the observer

roamed over a whole grid square or did not define the location of their observations more accurately than the coordinates of a grid square. Then, the latitude and longitude closest to the centre of the grid square were used. The use of latitude and longitude in addition to grid coordinates makes future comparisons easier and provides the data in units compatible with other databases on bird distributions.

Collection and processing of field data

All observations were recorded on cards (the same as 1974-75) which listed almost all of the bird species likely to be encountered in South Australia. On each card observers gave: their name and address; the exact location of their observations; the 10 000 yd grid coordinates; and the date(s) of observation. They ticked those species seen and entered an H against species only heard. Breeding activity was indicated with a B, though no particular effort was made to locate evidence of breeding. Observers resident in a grid square or frequently visiting the same location provided either a monthly or three-monthly composite list of the birds seen at that location.

Completed cards were sent to one of six regional organisers who initially checked the records and sought additional information on any unusual sightings (e.g. see SAOA Newsletter No. 109, March 1984). Only unusual sightings that could be verified with adequate descriptions were accepted. Regional organisers checked locations, and added latitudes and longitudes. These latitudes and longitudes were subsequently checked again before vetted records were compiled on computer files. All database files were printed and checked for errors against the original cards at least once. The initial dBase II formats of these computer files were subsequently converted to allow retrieval and presentation of data using MapInfo.

Intensity of coverage

To allow sensible comparisons between the 1974-75 and 1984-85 atlas the coverage needs to be similar in the two periods. Given that the primary purpose was to identify species that had declined in distribution since 1974-75 the coverage in 1984-85 needed to be at least as intense as in 1974-75. During 1974-75 grid squares that had been poorly covered were identified as those with low cumulative species totals and observers were urged to visit those grid squares before that atlas period ended. To secure a similar spread and intensity of coverage a similar approach was taken in 1984-85. First, grid squares with low cumulative species totals were identified at regular intervals (SAOA Newsletters Nos 110-115, 1984-85) and observers urged to visit them. Second, distributions of selected species whose distributions had appeared to have changed (based on records to date) were listed and observers asked to search specifically for these species. The following species were identified for special attention: Hooded Plover, Fairy Tern, Peaceful Dove, Blue Bonnet, White's Thrush, White-browed Babbler, Chestnut-rumped Hylacola, Southern Emu-wren, Superb Fairy-wren, Restless Flycatcher, Scarlet Robin, Hooded Robin, Crested Bellbird, Spotted Pardalote, Yellow-rumped Pardalote, Black-eared Miner, Beautiful Firetail, Diamond Firetail, Red-browed Finch and White-winged Chough.

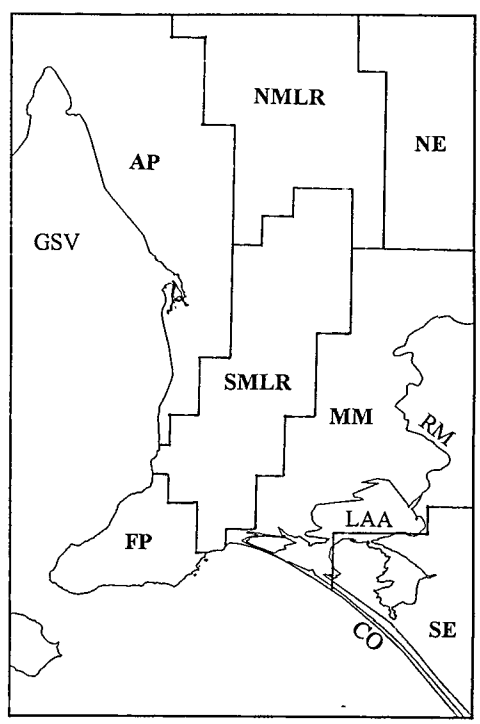


Figure 1. Map of the Adelaide atlas area, showing the seven regions used to describe shifts in distributions of birds: Adelaide Plains (AP); Fleurieu Peninsula (FP); Southern Mt Lofty Ranges (SMLR); Northern Mt Lofty Ranges (NMLR); Murray Mallee (MM); North-east (NE); and South-east (SE). Other areas identified are: Lakes Alexandrina and Albert (LAA); River Murray (RM); Coorong (CO); and Gulf St Vincent (GSV).

Changes in distribution

Changes in distribution were determined by comparing 1984-85 distribution maps based on grid squares with those produced from the 1974-75 data (SAOA 1977). Changes in the numbers of grid squares in which a species was recorded and the position of those changes were used to document changes. To assist in describing the locations of changes the atlas area was divided into seven regions: Adelaide Plains (AP); Fleurieu Peninsula (FP); Southern Mt Lofty Ranges (SMLR); Northern Mt Lofty Ranges (NMLR); Murray Mallee (MM); North-East (NE); and South-East (SE) (Fig. 1). These regions differ in topography, annual rainfall and types of remnant native vegetation (Table 1). Within these regions, or bordering on them were several prominent aquatic habitats, notably the freshwater wetlands fringing Lakes Alexandrina and Albert (LAA) that extended along the River Murray (RM), the estuarine to hyper-marine wetlands of the northern Coorong (CO), and the tidal mudflats and associated mangroves and samphire flats of northern Gulf St Vincent (GSV).

No specific criteria were used to define changes in distribution. Small changes in the numbers and positions of grid squares where a species was recorded, however, were not considered significant. The simple rule of thumb used was that a substantial proportion (>20%) of the grid squares where a species had been seen within a region needed to have changed between the two atlas periods before a

Table 1. Area, topography, rainfall, main types of native vegetation and levels of native habitat remnancy for the seven main regions of the Adelaide atlas area. Levels of remnancy in 1986 calculated from Department of Environment and Planning (1966) and from Harris (1976). Substantial amounts of native vegetation remain in NE but much is heavily grazed by domestic stock. Landscapes in all regions are dominated by agricultural development and consist mainly of introduced grasslands, crops and pasture. Fires in February 1983 burnt approx 330 sq km in the Anstey Hill-Chain of Ponds area, 39 sq km at Mt Osmond, 27 sq km between Bridgewater and Hahndorf, and 169 sq km in the Willunga-Meadows area (S.A. Country Fire Service, unpublished data).

Region	Approx land area (sq km)	Annual rainfall (mm)	Altitude (m)	% native vegetation remaining	Main types of native vegetation (see also SAOA 1977)
AP	4380	400-600	0-150	3.9	Mallee open scrub to low woodland with open understorey; mangroves and samphires along coast.
NMLR	2800	400-500	150-300	1.8	Blue gum and peppermint gum with open understorey on ridges.
SMLR	2630	500-900	150-600	9.7	Stringybark open forest with heathy understorey on ranges, eucalypt woodlands with open understorey along creeks and flats.
FP	1090	600-800	100-500	11.1	Stringybark forest with heathy understorey on ranges, grading to open scrub and heath on steeper slopes; small areas of freshwater swamps.
NE	3660	200-350	75-150	41.6	Mostly mallee open scrub with open understorey, also false sandalwood low woodlands and bluebush shrublands.
MM	5910	250-400	75-150	4.9	Mallee low woodland, open scrub and mallee heath, red gum woodland, native pine low woodland and freshwater wetlands along RM and LAA.
SE	1200	350-500	0-75	5.5	Mostly mallee heath, coastal shrublands and semi-saline wetlands associated with CO, also sheoak, blue gum and pink gum low woodlands.

change in distribution was recorded. To overcome possible biases and inconsistencies two observers (David Paton and Graham Carpenter) assessed the distribution maps independently, and only when both observers agreed were changes in distribution accepted.

RESULTS AND DISCUSSION

Intensity of coverage: 1974-75 versus 1984-85

The intensity of coverage in 1984-85 was greater than in 1974-75. In 1984-85, 117 766 observations were obtained compared with 91 597 in 1974-75. This greater number of observations was reflected in the number of non-incidental bird lists received. Non-incidental bird lists were defined as lists containing 10 or more species. In 1974-75, 2 753 non-incidental lists were received while the number received in 1984-85 was 3 750. The number of incidental bird lists (<10 species recorded) was also higher in 1984-85 than 1974-75 (1 103 versus 482 respectively). These data suggest that observer effort was substantially higher in 1984-85 than 1974-75.

Equally important is the distribution of this effort over the atlas area. Figure 2 shows the numbers of non-incidental bird lists received for each grid square during the two atlas periods. In 1984-85, the mean number of lists received per square was 14.0 ± 20.5 (s.d., range = 1-208; median = 8) while in 1974-75 the mean number received per grid square was 10.3 ± 10.3 (s.d.) with a range of 0-78 and a median of 7. Although the quantity of data collected in 1984-85 was significantly higher than in 1974-75 (t-test, $p<0.01$) much of the increased effort was restricted to a few grid squares. For example, the two grid squares centred around Adelaide (16:67 and 16:68) each received at least 100 more bird lists in 1984-85 than 1974-75, accounting for over 20% of the total increase in effort. This distribution of increased effort largely reflects the distribution of properties owned by observers.

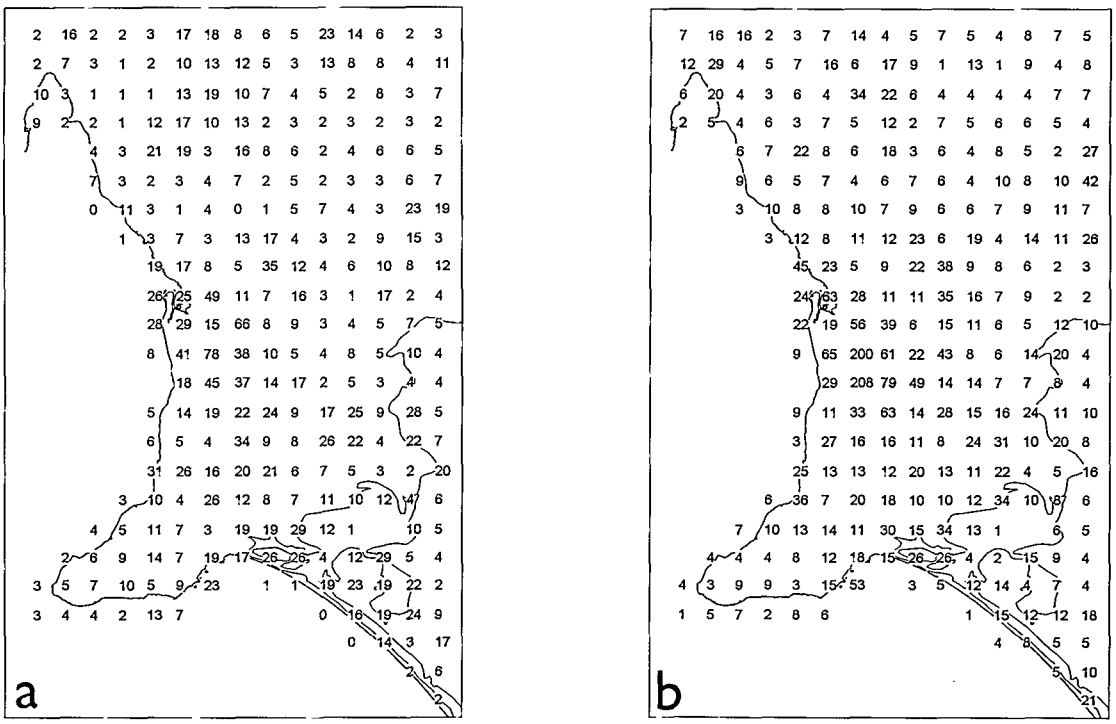


Figure 2. Numbers of non-incidental bird lists (10 species listed) received for each grid square during the 1974-75 (a) atlas and the 1984-85 (b) atlas. Some numbers appear in the sea because they are printed in the centre of their grid square.

For both atlases more than 100 observers of differing skills were involved in collecting information and the amount of time and effort spent by each observer in compiling lists of birds seen in an area was highly variable. As a result the numbers of species recorded on any one list or card was also highly variable, and so the numbers of lists received may not be a good measure of observation effort for each grid square. An alternative method of assessing the similarity in coverage is to compare the numbers of species recorded in each grid square for the two periods.

In 1974-75, bird lists were obtained for 265 grid squares. The number of species recorded in each grid square ranged from 14 to 154 with a mean of 67 ± 29 (s.d.) birds per square. The numbers recorded for each grid square are shown in Figure 3a. In 1984-85, bird lists were obtained for the same 265 grid squares plus three more with small amounts of land not covered in 1974-75. The number of species recorded in each grid square in 1984-85 ranged from 21 to 144 with a mean of 69 ± 25 (s.d.) per square (Fig. 3b). There was no significant difference in numbers of species recorded per square between 1984-85 and 1974-75 (t-test, $P = 0.38$). In 1974-75, more than 100 species of birds were reported from 38 grid squares and 83 squares had 50 or fewer species recorded for them. Although fewer squares (29) had over 100 species recorded for them in 1984-85, there were also fewer squares (73) that had 50 or fewer species. The three additional squares covered in 1984-85 are not included in this comparison. All three had fewer than 50 species recorded for them. Possible distributional changes in the intensity of coverage have been highlighted in Figure 3 by showing those squares that had more species recorded in 1974-75 than 1984-85 (Fig. 3c), and vice versa (Fig. 3d). The only consistent patterns were increased numbers of species reported for grid squares along the coast of AP in 1984-85 and a decrease in numbers of species reported from grid squares in NE during 1984-85. Elsewhere, grid squares showing substantial increases and decreases in the numbers of species reported between 1974-75 and 1984-85 were more or less evenly distributed over the study area (Fig. 3c,d). Although the most likely explanation for many of the differences between the two periods in numbers of species recorded in a grid square are differences in observer effort, the possibility that some of the differences reflect actual changes in the avifauna between the two periods should not be dismissed.

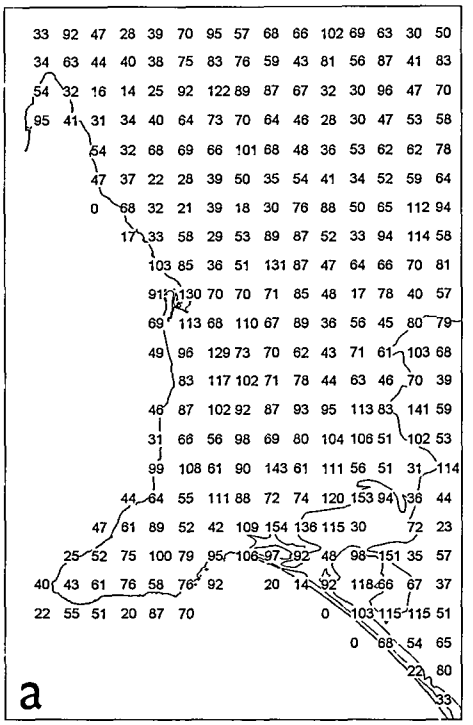
The overall effort to record bird distributions in the Adelaide atlas area during 1984-85 was at least as intense if not more intense than during 1974-75.

Distribution of birds in 1984-85 and comparisons with 1974-75

In the 1974-75 atlas, 301 bird species were recorded in the study area, 220 of these species were reported from 10 or more grid squares and 81 from fewer than 10 grid squares. The tally of species was similar in 1984-85 when 321 species were recorded with 220 being reported from more than 10 grid squares and 101 from 10 or less. Fourteen species were reported in 1974-75 and not 1984-85. These were mainly various seabirds, waterbirds and waders that were reported infrequently in 1974-75 including Northern Giant-Petrel, White-headed Petrel, Southern Fulmar, Fairy Prion, Intermediate Egret, and Broad-billed Sandpiper. The Letter-winged Kite, Grey Goshawk, Red-chested Button-quail, Plains-wanderer, Bush Thick-knee, Regent Parrot, Eastern Yellow Robin, and Black-eared Miner were also recorded infrequently and only from 1-4 grid squares in 1974-75 but not at all in 1984-85. Most of these species maintain populations outside the area surveyed, though the lack of records for both Black-eared Miners and Bush Thick-knees suggests that both may now have been lost from the area. Both species were originally more widespread (Condon 1968; Joseph 1986).

Thirty-four species were recorded in 1984-85 but not in 1974-75. These included ten species that were likely to have escaped from captivity (Muscovy Duck, Domestic Goose, Indian Peafowl, Collared Turtle-Dove, Peach-faced Lovebird, Port Lincoln Ringneck, Scarlet-chested Parrot, Red-whiskered Bulbul, Nutmeg Mannikin, Long-tailed Finch) of which only four (Muscovy Duck, Domestic Goose, Indian Peafowl and Port Lincoln Ringneck) persisted in any area for any length of time. Other species recorded in 1984-85 and not 1974-75 included a variety of seabirds, raptors, waders and flycatchers that were infrequent visitors to the region (Condon 1968; Parker *et al.* 1979). Rufous Bristlebirds were not recorded in 1974-75 possibly because few observations were made on Younghusband Peninsula in the northern Coorong where the species is resident (Condon 1968).

Maps showing the distributions of 248 species of birds in the Adelaide region during 1984-85 are given in SAOA (1994). These maps show the distributions of all species seen in at least four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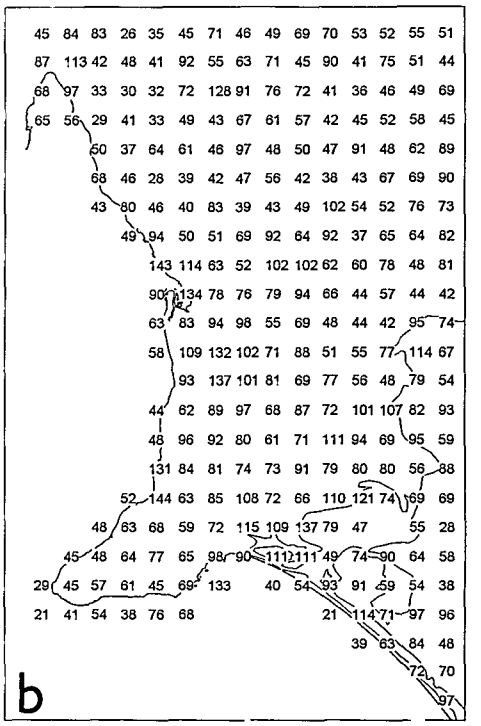
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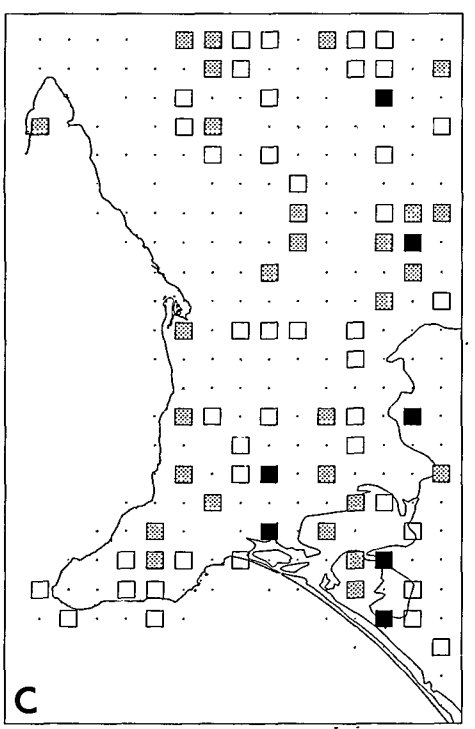
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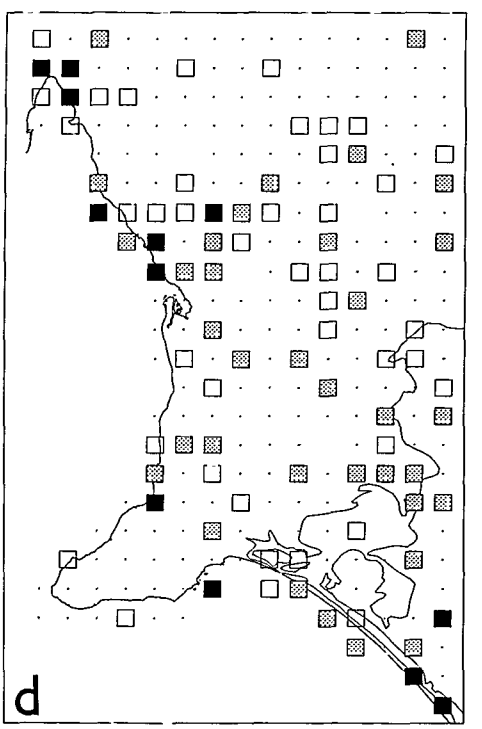
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10 000 yd grid squares and or on at least 10 occasions. Details of the locations and dates of sightings of the remaining 73 species seen less frequently in the atlas area during 1984-85 are also given in SAOA (1994).

Almost all species showed at least some minor changes in their recorded distributions for 1974-75 and 1984-85 (Tables 2 and 3). These changes involved species being recorded in some grid squares in 1974-75 and not in 1984-85, and vice versa (Table 3). For 101 species these changes only involved a relatively small proportion of the grid squares in which the species was previously reported and did not result in any substantial increase or decrease in the species distribution. For another 158 species there were often substantial changes in the numbers of grid squares in which a species was reported in the different regions, and the distributions of these species within the atlas area were deemed to have changed. In some cases more than a third of the grid squares in which a species was formerly recorded had changed. A further 76 species that were only reported infrequently in one or both atlases were not considered. These species included: rare vagrants to the study area that were reported on isolated dates and from widely scattered locations, including various seabirds, waders and flycatchers; escapees from captivity (e.g. Collared Turtle-Dove, Peach-faced Lovebird, Red-whiskered Bulbul, Nutmeg Mannikin); and small isolated feral populations (Indian Peafowl, Domestic Goose, Muscovy Duck) that may not have been included in the first atlas.

Maps showing the changes in distribution for each species are not presented because space is insufficient but summaries of the changes in each region are given for groups of birds and individual species in Tables 2 and 3 respectively. A few maps are given for selected species, however, to illustrate some of the patterns. For other species some comparisons can be made by comparing the grid square maps presented in the first atlas (SAOA 1977) with the 1984-85 distribution maps based on latitude and longitude presented in SAOA (1994).

On a regional basis decreases in distribution were more prominent in NE, SMLR and NMLR. In each of these regions at least 27 species of birds had smaller distributions in 1984-85 than 1974-75 (Table 2). Increases in species distributions were more prominent for AP, NMLR and SMLR. For most regions the numbers of species showing increased distributions were similar to the number of species showing declines, except for four regions. On AP, 64 species were more widely distributed in 1984-85 than 1974-75 and only six species had smaller distributions. A variety of waterbirds, raptors, waders, parrots and honeyeaters all increased in this region (Table 2). For NE, RM and LAA decreases outstripped increases (37 to 22; 12 to 3; and 11 to 5 respectively). Again waterbirds figured prominently in these decreases with 8-10 species being less widely distributed in each of these regions in 1984-85.

While waterbirds largely shifted their distributions within the atlas area, other groups of birds showed more consistent trends throughout the atlas area. In general pigeons, parrots (including cockatoos and lorikeets), larks (including songlarks), honeyeaters and woodswallows had increased distributions in 1984-85 or showed no change between the two periods (Table 2), while flycatchers (including robins and whistlers), reed warblers (including grassbird and cisticola) and finches tended to show declines in distribution. Other groups had mixed responses with some increasing, others decreasing or doing both on a regional scale.

In many cases changes in distribution reflected responses to the generally drier conditions of 1984-85 compared with 1974-75 rather than reflecting long-term increases or decreases. In 1974-75, rainfall both within the atlas area and further inland was above average (e.g. Reid 1976; Chinner 1977; Matheson 1978) and followed above average rainfall in 1973. Although rainfall was limited during the first half of 1975 above average rains fell again during the second half of 1975 in much of South Australia (Reid 1976; Matheson 1978). Most inland wetlands (e.g. Lake Eyre, Lake Callabonna, Lake Frome) held water during 1974-75, and some continued to hold water into 1977-78 despite below average rainfalls in these latter years (Cox and Pedler 1977; Pedler and Ragless 1978; Badman 1979). Plant growth was extensive and exceptional in inland areas during 1973-75 (e.g. Black 1975).

Figure 3. Numbers of species recorded in each grid square in 1974-75 (a) and 1984-85 (b). Those grid squares that had more species recorded in 1974-75 than in 1984-85 are shown in c. and those where more species were recorded in 1984-85 than in 1974-75 are shown in d. 11-20 species more, white square; 21-40, stipple; >40, black. Some numbers appear in the sea because they are printed in the centre of their grid square.

Table 2. Summaries of changes in distribution for various bird groups in each of the regions of the Adelaide atlas area for 1984-85 compared with 1974-75. Seventy-six species were recorded too infrequently to assess changes in distribution and were not considered. Note that many species declined or increased in several regions. NM is used for NMLR and SM is used for SMLR.

Bird Group	spp not used	spp no change	spp with change	Increase									Decrease								
				AP	NM	SM	FP	NE	MM	SE	RM	LAA	AP	NM	SM	FP	NE	MM	SE	RM	LAA
Emu	0	0	1					1													
Seabirds	17	4	0																		
Waterbirds	5	12	30	11	6	6	1	1	2	4	2	1		8	3	1	11	2	1	7	7
Raptors	5	6	9	6		1	1		2	1	1	1		3	3	2	3	3	2	2	1
Quails, land-rails brolga, bustard, malleefowl	4	0	8	2	1			1	1					3		1	3	2	3	1	1
Waders	11	16	17	10						5		2			4	1	1	2	1	1	
Gulls, terns	4	4	5	3			1			4		1	1						1		1
Pigeons, doves	2	2	4	3	2	1	1	3	2	2				1	2				1		
Cockatoos, parrots, lorikeets	7	6	12	11	3	8	4	2	3	1							2	1			
Cuckoos, owls, nightjars, bee-eaters kingfishers	0	4	10			4	1	2	1				1	2	4	1	4	5	2		1
Larks, pipits, songlarks	0	2	3	2	1	1	1	1	2								1				
Swallows, martins, swifts	1	4	2	1						1				2	1		2				
Quail-thrush, babblers, thrushes, scrub-robins, trillers, cuckoo-shrikes	2	5	4		1	1		1	2	2							1	1			
Robins, whistlers, flycatchers	6	5	9	1	1	1			1				2	1	4	2	3	2	5		
Reed-warbler, cisticola, grassbird	0	0	3											1	2		2	1		1	
Fairy-wrens, emu-wrens, grasswrens, scrubwren, hylacolas	2	4	5			1		1	1						2		1	1			
Thornbills, weebills, warblers, whitefaces	2	5	5	1	2	1								2	2		1		2		
Sitella, treecreepers	1	2	1										1	1							
Honeyeaters, chats	1	8	17	9	7	4	2	5	3	1					1	1		1	1		
Mistletoebird, pardalotes, silvereye	0	3	2			2	1							1							
Finches	2	3	4										1	1	2	1	2				
Starlings and allies	2	1	0																		
Magpie-lark, chough, apostlebird	0	1	2					1	1				1								
Woodswallows	0	0	4	3		2	-	2	1					1							
Butcherbirds, ravens, magpie, currawong	2	4	1	1	1			1										1			
TOTALS	76	101	158	64	25	33	13	22	22	21	3	5	7	27	30	10	37	22	19	12	11

Table 3. Changes in the numbers of grid squares in which 335 bird species were recorded in the Adelaide atlas area in 1974-75 and 1984-85. In 1974-75 details of several species (e.g. Indian Peafowl, Domestic Goose) may not have been recorded and this is indicated by nr in the Table. Comments summarise the changes in distribution within regions relative to the 1974-75 atlas results. Comments are only provided for those species that were either permanently or seasonally present in the atlas area. No comments are given for vagrant species reported on isolated dates from scattered localities. Figure 1 shows the locations of different regions and the symbols used to identify these regions.

Bird Species	Number of Grid Squares				Regional Changes in Distribution
	Total 74-75	Total 84-85	Losses	Gains	
Emu	15	23	7	15	Increase NE.
Little Penguin	6	4	4	2	No change.
Great Crested Grebe	13	23	8	18	No change.
Hoary-headed Grebe	59	83	22	46	Increase NMLR and SMLR.
Australasian Grebe	115	91	49	25	Decrease NMLR, NE and MM.
Black-browed Albatross	4	2	3	1	
Yellow-nosed Albatross	4	3	3	2	
Shy Albatross	3	1	2	0	
Southern Giant-Petrel	5	1	4	0	
Northern Giant-Petrel	1	0	1	0	
Cape Petrel	2	1.	2	1	
White-headed Petrel	2	0	2	0	
Kerguelen Petrel	2	1	2	1	
Blue Petrel	0	2	0	2	
Southern Fulmar	2	0	2	0	
Broad-billed Prion	0	1	0	1	
Antarctic Prion	0	1	0	1	
Slender-billed Prion	0	1	0	1	
Fairy Prion	1	0	1	0	
Flesh-footed Shearwater	5	2	5	2	
Short-tailed Shearwater	8	4	7	3	
Fluttering Shearwater	6	3	4	1	
Australian Pelican	71	84	14	27	Increase southern AP.
Australasian Gannet	17	9	11	3	No change.
Black-faced Cormorant	14	15	7	8	No change.
Great Cormorant	66	72	29	35	Decrease NMLR and SMLR, increase AP.
Little Black Cormorant	95	83	41	29	Decrease NMLR.
Pied Cormorant	65	76	20	31	No change.
Little Pied Cormorant	150	158	27	35	No change. Widespread.

Bird Species	Number of Grid Squares				Regional Changes in Distribution
	Total 74-75	Total 84-85	Losses	Gains	
Darter	10	12	6	8	Increase RM and LAA.
Pacific Heron	70	27	55	12	Decrease SMLR, NMLR, NE and MM.
White-faced Heron	210	187	41	18	Decrease NE.
Cattle Egret	12	27	5	20	Increase SMLR, AP and MM.
Great Egret	60	69	20	29	Decrease NE.
Little Egret	25	36	10	21	Increase AP and RM.
Intermediate Egret	3	0	3	0	
Eastern Reef Egret	6	4	5	3	No change.
Rufous Night Heron	16	9	13	6	Decrease RM and LAA.
Australasian Bittern	6	1	5	0	Decrease LAA.
Glossy Ibis	10	13	7	10	No change.
Australian White Ibis	96	107	20	31	No change.
Straw-necked Ibis	92	102	18	28	No change.
Royal Spoonbill	41	48	14	21	Decrease NE, increase AP coast.
Yellow-billed Spoonbill	59	38	34	13	Decrease NE, NMLR, SMLR and FP
Black Swan	84	86	20	22	Decrease NMLR, increase AP coast.
Cape Barren Goose	30	25	12	7	No change.
Plumed Whistling-Duck	0	1	0	1	
Freckled Duck	5	3	5	3	Decrease LAA.
Australian Shelduck	47	47	15	15	Decrease NE.
Pacific Black Duck	142	146	31	35	Decrease NE.
Mallard	28	38	14	24	Increase SMLR, NMLR and AP, decrease RM and LAA.
Grey Teal	101	156	19	74	Increase NMLR, AP, FP and SE.
Chestnut Teal	53	61	20	28	Increase SE, decrease NE and RM.
Australasian Shoveler	24	26	11	13	No change.
Pink-eared Duck	11	37	6	32	Increase AP, NMLR, SMLR, MM and SE.
Hardhead	34	57	15	38	Increase SMLR and AP, decrease RM and LAA.
Maned Duck	109	131	16	38	Increase NE, NMLR and AP, decrease RM and LAA.
Blue-billed Duck	11	14	7	10	No change.

Bird Species	Number of Grid Squares				Regional Changes in Distribution
	Total 74-75	Total 84-85	Losses	Gains	
Musk Duck	57	40	29	12	Decrease NMLR, RM and LAA.
Muscovy Duck	nr	8	nr	8	
Domestic Goose	nr	4	nr	4	
Osprey	1	1	0	0	
Black-shouldered Kite	195	193	35	33	Decrease NE, SMLR and FP, increase AP.
Letter-winged Kite	4	0	4	0	
Black Kite	5	25	4	24	Increase AP, RM and LAA.
Black-breasted Buzzard	0	1	0	1	
Whistling Kite	133	110	50	27	Decrease NE, NMLR, SMLR and FP.
Brown Goshawk	97	97	45	45	No change in overall distribution.
Collared Sparrowhawk	36	39	28	31	Decrease MM and SE, increase AP, SMLR and FP.
Grey Goshawk	2	0	2	0	
White-bellied Sea-Eagle	7	14	5	12	No change.
Wedge-tailed Eagle	142	118	57	33	Decrease NMLR, MM and SE.
Little Eagle	63	66	35	38	Decrease SMLR and NMLR, increase MM and SE.
Spotted Harrier	64	79	29	44	Decrease NE, increase AP and MM.
Swamp Harrier	64	72	17	25	No change.
Black Falcon	43	38	33	28	Decrease RM and LAA, increase AP.
Peregrine Falcon	30	34	19	23	No change.
Australian Hobby	70	57	46	35	Decrease RM and MM, increase AP.
Grey Falcon	0	1	0	1	
Brown Falcon	201	210	26	33	No change. Widespread.
Australian Kestrel	254	250	12	8	No change. Widespread.
Malleefowl	6	3	3	0	Decrease SE.
Stubble Quail	132	101	72	41	Decrease NE, NMLR, MM and FP.
Brown Quail	4	1	4	1	
Painted Button-quail	15	9	12	6	Decrease NMLR and SE.
Little Button-quail	40	30	25	15	Decrease NMLR, NE, MM and SE.

Bird Species	Number of Grid Squares				Regional Changes in Distribution
	Total 74-75	Total 84-85	Losses	Gains	
Red-chested Button-quail	3	0	3	0	
Plains-wanderer	1	0	1	0	
Indian Peafowl	nr	2	nr	2	
Buff-banded Rail	17	10	14	7	Decrease RM and LAA.
Lewin's Rail	3	2	2	1	
Baillon's Crake	3	4	2	3	No change.
Australian Crake	31	28	19	16	Decrease NE.
Spotless Crake	10	8	9	7	Decrease RM and LAA.
Black-tailed Native-hen	129	150	34	55	No change.
Dusky Moorhen	106	78	45	17	Decrease NE, NMLR and SE.
Purple Swamphen	60	52	22	14	No change.
Eurasian Coot	72	94	22	44	Increase NMLR, SMLR and SE.
Brolga	0	3	0	3	Increase AP.
Australian Bustard	0	6	0	6	Increase AP, NMLR, NE and MM.
Bush Thick-knee	2	0	2	0	Decrease NE.
Pied Oystercatcher	16	22	7	13	No change.
Sooty Oystercatcher	14	15	6	7	No change.
Masked Lapwing	186	180	33	27	Decrease NE.
Banded Lapwing	92	91	39	38	Decrease SMLR, MM and SE, increase AP.
Grey Plover	8	13	1	6	No change.
Pacific Golden Plover	4	14	2	12	Increase LAA and coastal AP.
Red-kneed Dotterel	39	55	18	31	Increase AP.
Hooded Plover	8	14	1	7	No change.
Mongolian Plover	3	3	3	3	No change.
Double-banded Plover	12	17	6	11	Increase AP.
Large Sand Plover	0	1	0	1	
Oriental Plover	0	2	0	2	
Red-capped Plover	48	60	11	23	No change.
Black-fronted Plover	89	72	45	28	Decrease SMLR and MM.
Inland Dotterel	4	1	4	1	
Black-winged Stilt	37	67	13	43	Increase AP and SE.
Banded Stilt	13	31	4	22	Increase AP and SE.
Red-necked Avocet	17	38	7	28	Increase AP and SE.

Bird Species	Number of Grid Squares				Regional Changes in Distribution
	Total 74-75	Total 84-85	Losses	Gains	
Ruddy Turnstone	4	16	1	13	Increase AP coast.
Eastern Curlew	15	15	4	4	No change.
Whimbrel	4	7	3	6	No change.
Wood Sandpiper	11	9	7	5	No change.
Grey-tailed Tattler	3	4	3	4	No change.
Common Sandpiper	24	16	17	9	Decrease SMLR.
Greenshank	38	59	8	21	Increase SE.
Redshank	0	1	0	1	
Marsh Sandpiper	9	14	5	10	No change.
Terek Sandpiper	1	5	1	5	No change.
Latham's Snipe	15	6	13	4	Decrease SMLR, FP and RM.
Black-tailed Godwit	6	11	1	6	No change.
Bar-tailed Godwit	7	10	3	6	No change.
Red Knot	5	8	2	5	No change.
Great Knot	3	4	2	3	No change.
Sharp-tailed Sandpiper	29	46	3	20	Increase SE.
Pectoral Sandpiper	1	5	1	5	
Cox's Sandpiper	nr	1	nr	1	
Red-necked Stint	39	46	8	15	Increase LAA.
Long-toed Stint	0	2	0	2	
Curlew Sandpiper	19	35	4	20	Increase SE and AP.
Sanderling	2	1	1	0	
Broad-billed Sandpiper	1	0	1	0	
Ruff	1	3	0	2	
Red-necked Phalarope	0	1	0	1	
Australian Pratincole	6	11	4	9	Increase AP.
Great Skua	5	3	4	2	
Arctic Jaeger	5	2	4	1	
Silver Gull	107	123	10	26	No change.
Pacific Gull	20	14	10	4	Decrease AP and SE.
Kelp Gull	1	2	0	1	
Whiskered Tern	32	67	4	39	Increase AP and SE.
White-winged Tern	6	4	5	3	No change.
Gull-billed Tern	5	6	3	4	No change.
Caspian Tern	52	66	7	21	Increase SE and coastal FP.

Bird Species	Number of Grid Squares				Regional Changes in Distribution
	Total 74-75	Total 84-85	Losses	Gains	
Common Tern	1	7	1	7	Increase LAA, SE and AP coast.
Crested Tern	56	62	10	16	No change.
Little Tern	3	1	3	1	
Fairy Tern	28	34	8	14	Decrease LAA, increase CO and AP coast.
Feral Pigeon	183	194	27	38	No change. Widespread.
Spotted Turtle-Dove	96	118	20	42	Increase AP, NMLR, NE, MM and SE.
Collared Turtle-Dove	0	2	0	2	
Peaceful Dove	34	73	11	50	Increase all regions.
Diamond Dove	3	3	3	3	
Common Bronzewing	113	110	34	31	Decrease SE and SMLR, increase NE.
Brush Bronzewing	34	35	18	19	Decrease NMLR and SMLR, increase AP.
Crested Pigeon	232	246	7	21	No change. Widespread.
Yellow-tailed Black-Cockatoo	34	43	4	13	Increase SMLR.
Galah	251	257	6	12	No change. Widespread.
Long-billed Corella	1	3	1	3	
Little Corella	62	90	29	57	Increase AP, SMLR and FP.
Pink Cockatoo	1	2	1	2	
Sulphur-crested Cockatoo	56	73	17	34	Increase SMLR, NMLR and AP
Rainbow Lorikeet	37	66	4	33	Increase AP, NMLR, SMLR and FP.
Musk Lorikeet	70	92	9	31	Increase AP, SMLR and MM.
Purple-crowned Lorikeet	92	138	17	63	Increase all regions except SE.
Peach-faced Lovebird	0	5	0	5	
Regent Parrot	1	0	1	0	
Cockatiel	73	122	26	75	Increase AP, NE, SMLR, MM and FP.
Budgerigar	90	104	45	59	Decrease NE, increase AP.
Adelaide Rosella	156	164	8	16	Increase AP and SE.
Eastern Rosella	18	17	9	8	No change.
Mallee Ringneck	65	62	16	13	No change.
Port Lincoln Ringneck	0	6	0	6	
Red-rumped Parrot	214	208	20	14	No change. Widespread.

Bird Species	Number of Grid Squares				Regional Changes in Distribution
	Total 74-75	Total 84-85	Losses	Gains	
Mulga Parrot	40	44	5	9	No change.
Blue Bonnet	44	37	26	19	Decrease NE and MM, increase AP.
Blue-winged Parrot	9	11	8	10	No change.
Elegant Parrot	65	88	26	49	Increase SMLR and AP.
Rock Parrot	5	12	4	11	Increase AP coast.
Orange-bellied Parrot	0	1	0	1	
Scarlet-chested Parrot	0	1	0	1	
Pallid Cuckoo	126	118	61	53	Decrease MM and FP, increase NE and SMLR.
Fan-tailed Cuckoo	93	78	46	31	Decrease MM and AP.
Black-eared Cuckoo	15	14	12	11	Increase NE, decrease SMLR and NMLR.
Horsfield's Bronze-Cuckoo	153	140	52	39	No change. Widespread.
Shining Bronze-Cuckoo	19	19	13	13	Decrease MM, increase SMLR.
Southern Boobook	50	56	25	31	No change.
Barn Owl	71	49	50	28	Decrease NE, MM, SE and SMLR.
Tawny Frogmouth	36	30	27	21	Decrease SMLR and SE.
Australian Owlet-nightjar	34	44	22	32	Increase SMLR and FP.
Spotted Nightjar	19	10	15	6	Decrease SMLR and NMLR.
White-rumped Swiftlet	0	3	0	3	
White-throated Needletail	4	7	2	5	No change.
Fork-tailed Swift	19	21	16	18	No change.
Laughing Kookaburra	123	121	17	15	No change.
Red-backed Kingfisher	20	22	13	15	No change.
Sacred Kingfisher	71	53	41	23	Decrease NE, MM, LAA and FP.
Rainbow Bee-eater	94	102	43	51	Decrease NE, increase SMLR and MM.
Singing Bushlark	57	66	26	35	Increase AP.
Skylark	108	170	13	75	Increase AP, NMLR, NE and MM.
White-backed Swallow	35	26	25	16	Decrease NE and NMLR, increase SE.
Welcome Swallow	253	260	4	11	No change. Widespread.
Tree Martin	203	209	31	37	No change. Widespread.
Fairy Martin	110	101	54	45	Decrease NE, NMLR and SMLR, increase AP.

Bird Species	Number of Grid Squares				Regional Changes in Distribution
	Total 74-75	Total 84-85	Losses	Gains	
Richard's Pipit	206	203	29	26	No change. Widespread.
Black-faced Cuckoo-shrike	209	216	27	34	No change. Widespread.
Ground Cuckoo-shrike	10	10	7	7	Decrease MM.
White-winged Triller	49	71	30	52	Decrease NE, increase SMLR, MM and SE.
Red-whiskered Bulbul	0	1	0	1	
White's Thrush	14	19	9	14	No change.
Common Blackbird	116	138	19	41	Increase NMLR, MM and SE.
Southern Scrub-robin	20	18	8	10	No change.
Rose Robin	0	3	0	3	
Pink Robin	0	1	0	1	
Flame Robin	18	3	18	3	Decrease SMLR, MM and SE.
Scarlet Robin	58	57	13	12	No change.
Red-capped Robin	101	139	18	56	Increase AP, NMLR, SMLR and MM.
Hooded Robin	106	88	42	24	Decrease SMLR, FP and SE.
Eastern Yellow Robin	1	0	1	0	
Western Yellow Robin	0	1	0	1	
Jacky Winter	124	108	47	31	Decrease SMLR.
Crested Shrike-tit	48	45	23	20	No change.
Red-lored Whistler	1	4	0	3	
Gilbert's Whistler	21	16	11	6	Decrease NE.
Golden Whistler	97	106	23	32	No change.
Rufous Whistler	130	135	44	49	Decrease SE.
Grey Shrike-Thrush	184	208	17	41	No change. Widespread.
Crested Bellbird	30	21	12	3	Decrease AP and SE.
Leaden Flycatcher	0	1	0	1	
Restless Flycatcher	86	61	51	26	Decrease all regions.
Grey Fantail	167	164	50	47	Decrease NE.
Willie Wagtail	259	261	5	7	No change. Widespread.
Chestnut Quail-thrush	13	14	3	4	No change.
White-browed Babbler	115	126	23	34	Increase NE.
Chestnut-crowned Babbler	24	20	7	3	No change.
Clamorous Reed-warbler	92	82	37	27	Decrease NE and SMLR.

Bird Species	Number of Grid Squares				Regional Changes in Distribution
	Total 74-75	Total 84-85	Losses	Gains	
Little Grassbird	80	50	42	12	Decrease NE, NMLR, SMLR and MM.
Golden-headed Cisticola	28	21	14	7	Decrease RM.
Rufous Songlark	80	77	41	38	Decrease NE, increase SMLR, MM and FP.
Brown Songlark	192	174	42	24	No change. Widespread.
Superb Fairy-wren	142	143	22	23	No change.
Splendid Fairy-wren	10	16	1	7	Increase NE and MM.
Variegated Fairy-wren	59	57	16	14	No change.
White-winged Fairy-wren	26	30	7	11	No change.
Southern Emu-wren	7	3	5	1	Decrease SMLR.
Striated Grasswren	2	1	1	0	
Rufous Bristlebird	0	2	0	2	
White-browed Scrubwren	61	74	12	25	Increase northern parts SMLR.
Chestnut-rumped Hylacola	13	7	9	3	Decrease SMLR and FP.
Shy Hylacola	14	12	8	6	No change.
Redthroat	8	5	4	1	Decrease NE.
Calamanthus	1	2	1	2	
Weebill	96	126	24	54	Increase AP, NMLR and SMLR.
Western Gerygone	1	1	1	1	
White-throated Gerygone	1	3	1	3	
Brown Thornbill	54	54	9	9	No change.
Inland Thornbill	37	34	17	14	No change.
Chestnut-rumped Thornbill	48	48	16	16	Decrease NE and SE, increase NMLR.
Buff-rumped Thornbill	51	54	13	16	Decrease SE.
Slender-billed Thornbill	8	12	1	5	No change.
Yellow-rumped Thornbill	227	232	15	20	No change. Widespread.
Yellow Thornbill	86	78	43	35	Decrease NMLR and SMLR.
Striated Thornbill	64	71	7	14	No change.
Southern Whiteface	96	86	21	11	Decrease NMLR and SMLR.
Varied Sitella	102	100	42	40	No change.
White-throated Treecreeper	43	40	9	6	No change.
White-browed Treecreeper	1	1	1	1	

Bird Species	Number of Grid Squares				Regional Changes in Distribution
	Total 74-75	Total 84-85	Losses	Gains	
Brown Treecreeper	102	96	24	18	Decrease SMLR and AP.
Red Wattlebird	148	188	13	53	Increase AP, NMLR, NE and FP.
Little Wattlebird	36	48	10	22	Increase southern AP and FP.
Spiny-cheeked Honeyeater	102	125	13	36	Increase NMLR and AP.
Striped Honeyeater	19	23	10	14	Decrease SE, increase AP and NE.
Noisy Miner	135	143	22	30	Increase NMLR and NE, decrease FP.
Yellow-throated Miner	80	94	13	27	Increase AP.
Black-eared Miner	4	0	4	0	
Yellow-faced Honeyeater	59	63	9	13	No change.
Singing Honeyeater	167	197	7	37	Increase on foothills of NMLR and SMLR.
White-eared Honeyeater	28	28	8	8	No change.
Purple-gaped Honeyeater	12	16	8	12	No change.
Yellow-plumed Honeyeater	38	61	6	29	Increase NMLR, SMLR, NE and MM.
Fuscous Honeyeater	0	1	0	1	
White-plumed Honeyeater	178	194	14	30	Increase AP and MM.
Black-chinned Honeyeater	10	9	6	5	No change.
Brown-headed Honeyeater	118	128	40	50	Increase SE.
White-naped Honeyeater	54	48	15	9	No change.
Crescent Honeyeater	52	52	7	7	No change.
New Holland Honeyeater	111	127	7	23	Increase AP.
White-fronted Honeyeater	13	26	5	18	Increase NMLR and SMLR.
Tawny-crowned Honeyeater	24	21	12	9	Decrease SMLR.
Eastern Spinebill	50	55	7	5	No change.
Black Honeyeater	11	13	7	9	Increase NMLR and SMLR.
Crimson Chat	2	8	2	8	Increase AP and NE.
Orange Chat	1	7	0	6	Increase AP and MM.
White-fronted Chat	191	188	36	33	No change. Widespread.
Mistletoebird	79	78	34	33	No change.
Spotted Pardalote	17	27	7	17	Increase SMLR and FP.
Yellow-rumped Pardalote	68	64	32	28	Decrease NMLR, increase SMLR.
Striated Pardalote	179	200	12	33	No change. Widespread.

Bird Species	Number of Grid Squares				Regional Changes in Distribution
	Total 74-75	Total 84-85	Losses	Gains	
Silvereye	155	163	32	40	No change.
European Goldfinch	131	127	26	22	Decrease NMLR and NE.
European Greenfinch	32	35	12	15	No change.
House Sparrow	242	248	8	14	No change. Widespread.
Red-browed Finch	60	63	5	8	No change.
Beautiful Firetail	13	8	8	3	Decrease SMLR and FP.
Diamond Firetail	65	60	26	22	Decrease SMLR.
Zebra Finch	82	63	42	23	Decrease NE and AP.
Long-tailed Finch	0	1	0	1	
Nutmeg Mannikin	0	1	0	1	
Common Starling	252	263	3	14	No change. Widespread.
Common Mynah	2	1	2	1	
Olive-backed Oriole	2	3	2	3	
White-winged Chough	66	79	9	22	Increase NE and MM.
Apostlebird	3	2	3	2	Decrease on AP.
Australian Magpie-lark	239	245	6	12	No change. Widespread.
Masked Woodswallow	31	43	17	29	Increase AP, NE and SMLR.
White-browed Woodswallow	62	73	26	37	Increase AP and SMLR.
Black-faced Woodswallow	10	14	6	10	Decrease NMLR, increase MM and NE.
Dusky Woodswallow	129	146	33	50	Increase AP.
Grey Butcherbird	70	77	22	29	Decrease MM, increase AP coast, NMLR and NE.
Pied Butcherbird	1	2	1	2	
Australian Magpie	259	263	1	5	No change. Widespread.
Grey Currawong	84	84	22	22	No change.
Australian Raven	41	48	20	27	No change.
Little Raven	259	263	4	8	No change. Widespread.
Little Crow	1	1	0	0	

Extensive areas of surface water were also widespread throughout the atlas region including the generally dry NE region during 1974-75. The River Murray flooded during 1974 and high flows later in 1975 flooded numerous wetlands along the river (e.g. Geddes and Butler 1984). These wetter conditions provided extensive and diverse areas of wetlands for different waterbirds and lusher conditions for many terrestrial species, both inland and in the atlas area. In particular, inland areas supported large numbers of waterbirds and other species in 1974-75 but numbers declined in these areas as water levels dropped and conditions deteriorated during 1976-78 (e.g. Black 1975; Chinner 1977; Cox and Pedler 1977; Pedler and Ragless 1978; Badman 1979).

In comparison 1984-85 was relatively dry and followed several years of drier than average conditions over much of southern Australia (e.g. Robinson 1993). River Murray flows were generally low (e.g. Geddes 1987) and areas of surface water were greatly reduced. Given these conditions, three patterns to changes in distributions could be expected during 1984-85 relative to 1974-75: (1) an influx of waterbirds from inland wetlands into the more mesic and coastal areas of the atlas area; (2) a shift of waterbirds away from some of the ephemeral wetlands that were flooded in the atlas area in 1974-75 but dry in 1984-85 to more permanent wetlands near the coast; and (3) a greater influx of terrestrial birds from more arid inland habitats into the atlas area. Most of the changes in distribution that were detected could be explained by one or more of these general patterns but the extent to which species showed these responses often differed. Some species showed opposite responses, and the declines of a variety of woodland species are not easily explained by differences in the prevailing conditions during the two atlases. Shifts in the distributions of all species are summarised in Table 3 and are discussed in the following sections.

Emus

Emus were reported widely from the NE and SE regions of the atlas area in 1984-85. Increases in reports in the NE in 1984-85 are probably because non-breeding birds moved into the atlas area from drought affected areas further to the northeast. Isolated records in the SMLR are from re-introductions in several reserves (Ford and Paton 1976; Parker *et al.* 1979; Baxter 1980).

Seabirds: penguins, albatrosses, petrels, prions, shearwaters and gannets

The atlases of the Adelaide region were designed to record the distribution of terrestrial species and observations on seabirds were mostly incidental and insufficient to document distributions. In 1984-85, fifteen species of seabirds were reported from the atlas area (see SAOA 1994 for specific details). The Broad-billed Prion, Antarctic Prion, Slender-billed Prion, Blue Petrel, Kerguelen Petrel and Cape Petrel were only recorded as beach-washed specimens. Black-browed Albatrosses, Yellow-nosed Albatrosses, Shy Albatrosses, Southern Giant-Petrels and Flesh-footed Shearwaters were observed off the southern coast, while Short-tailed and Fluttering shearwaters were reported off the southern coast and in gulf waters. Little Penguins were the only seabirds recorded breeding within the atlas area. These penguins bred on Granite, Wright and West Islands near Victor Harbor during 1984-85. The Australasian Gannet was the most widely reported seabird with reports from coastal areas around the gulf and off the southern coast.

Grebes and pelicans

The distributions of grebes in 1974-75 and 1984-85 provide an interesting contrast. The Australasian Grebe was reported from fewer squares in 1984-85 compared with 1974-75, while both the Hoary-headed and Great-crested grebes were distributed more widely in 1984-85. These patterns are consistent with the drier conditions of 1984-85. Australasian Grebes use freshwater pools, drains, dams, reservoirs, lakes and swamps and rarely use saltwater or brackish habitats (Parker *et al.* 1979; Blakers *et al.* 1984). In 1974-75 freshwater habitats were widespread throughout the atlas area, but in the drier conditions of 1984-85 such habitats were restricted to the more mesic areas of the Mt Lofty Ranges. Similarly during drier periods Hoary-headed Grebes and Great-crested Grebes might be expected to congregate on both fresh and saline areas on and around the coast, since many inland areas would have been dry during those periods. A similar response would have been expected and was detected for Australian Pelicans.

Of the grebes only the Australasian Grebe was recorded breeding with widespread reports from the SMLR and NMLR in 1984-85.

Cormorants and darters

Great, Little Black, Pied and Little Pied cormorants were distributed primarily around the coast, RM and LAA. The Little Pied Cormorant was also widespread in the SMLR and NMLR (including several reports of breeding). Reports from these regions for the other three species were much less frequent and less widespread in 1984-85 than 1974-75 consistent with drier conditions and less surface water in 1984-85.

The Black-faced Cormorant is a marine species and was only reported around the more rocky coasts from a little north of Adelaide to near the Murray Mouth during 1984-85. There were no reports from coastal areas of northern GSV, consistent with Parker *et al.* (1979) who stated that the species was only occasionally reported in this region.

The Darter was reported primarily from the RM and LAA regions in both 1974-75 and 1984-85, but the species was more widespread in these regions in 1984-85. Darters were widely reported from inland wetlands during the mid 1970s following above average rainfall (e.g. Chinner 1977; Cox and Pedler 1977; Badman 1979). In the drier conditions of 1984-85 inland wetlands were less extensive and many Darters may have been forced to retract to permanent areas of open water like those of the RM and LAA regions.

Herons, egrets, ibis and spoonbills

Pacific Herons were reported from far fewer squares in 1984-85 than 1974-75 throughout the atlas area (Fig. 4a). Parker *et al.* (1979) suggested that Pacific Herons were autumn-winter non-breeding visitors to the atlas area, but in 1984-85 observations were made throughout the year with most records in spring. The wider distribution of Pacific Herons in 1974-75 may reflect the wetter conditions in those years. Rufous Night Herons were also less frequently reported in 1984-85 than 1974-75, particularly in the RM and LAA regions. Australasian Bitterns may have also declined since 1974-75 being reported from only one location around the shore of Lake Alexandrina in 1984-85, though the species is cryptic and difficult to detect. White-faced Herons remained widespread in both periods but were reported from fewer squares in the NE in 1984-85 consistent with drier conditions. A variety of other waterbirds had also declined in the NE in 1984-85. For example, Great Egrets, Yellow-billed Spoonbills and Royal Spoonbills were all recorded for the NE in 1974-75 but not in 1984-85.

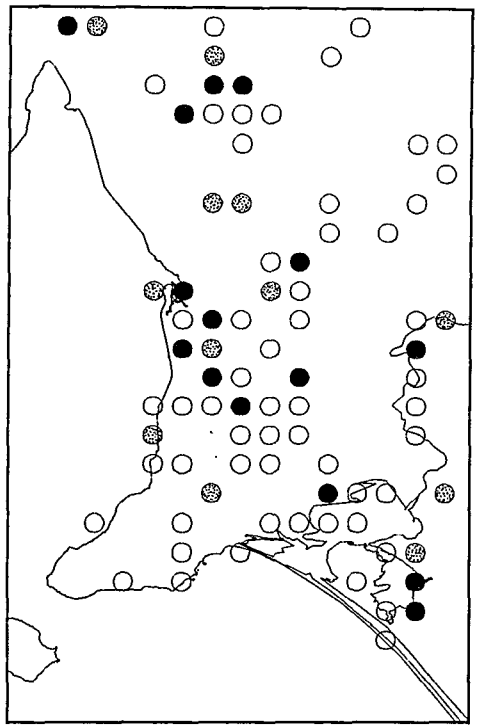
In contrast Cattle Egrets were more widespread in 1984-85 than 1974-75 with more records from SMLR and AP (Fig. 4b). All observations were made between April and November suggesting a regular seasonal influx of birds into the region during the non-breeding season. Cattle Egrets have been recorded in these areas since 1948 and more often since 1972 (Parker *et al.* 1979) and would appear to be expanding their non-breeding distribution.

Little Egrets were also reported from more squares in 1984-85 primarily around the north-eastern coasts of GSV. Although this area was surveyed more intensively in 1984-85, egrets are conspicuous species and are unlikely to have been missed by observers in 1974-75. This species was first reported in South Australia in 1952 and the first report of breeding was in 1967 from LAA (Parker *et al.* 1979). Breeding has subsequently been detected at several locations in mangroves fringing GSV (Treloar *et al.* 1986; Vincent and Paton 1986).

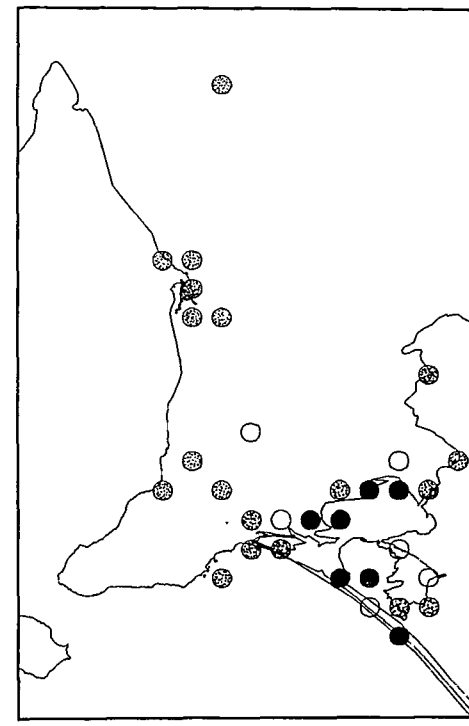
The three species of ibis showed no substantial changes in distribution between 1974-75 and 1984-85. Straw-necked and Australian White Ibis were widely distributed over the southern and south-eastern parts of the atlas area and presumably were not greatly influenced by the drier conditions elsewhere. Similarly for Glossy Ibis which were even more restricted to southern or coastal areas around LAA, near Victor Harbor and around St Kilda and Buckland Park on AP.

Royal Spoonbills also showed little net change in distribution, although in 1984-85 the species was reported from more areas along AP coast and fewer areas in the NE than in 1974-75 consistent with the drier conditions. Yellow-billed Spoonbills, however, showed a dramatic reduction in reports throughout much of the atlas area in 1984-85.

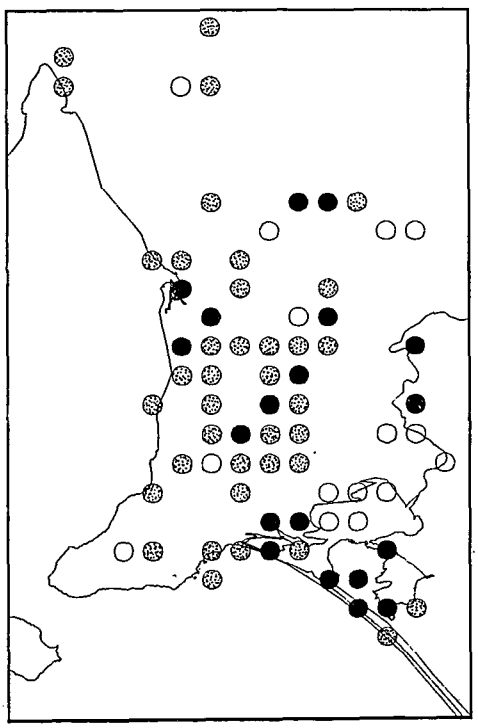
Only four observations of Eastern Reef Egrets were made in 1984-85 and these were from widely scattered locations around the rocky coasts of FP and associated offshore islands (e.g. West Island). Parker *et al.* (1979) state that nearly all observations of Eastern Reef Egrets from FP are in the non-breeding season. However, three of the four observations made in 1984-85 were during the breeding season (Oct.-Jan.; see SAOA 1994 for details), suggesting that the species may breed locally.



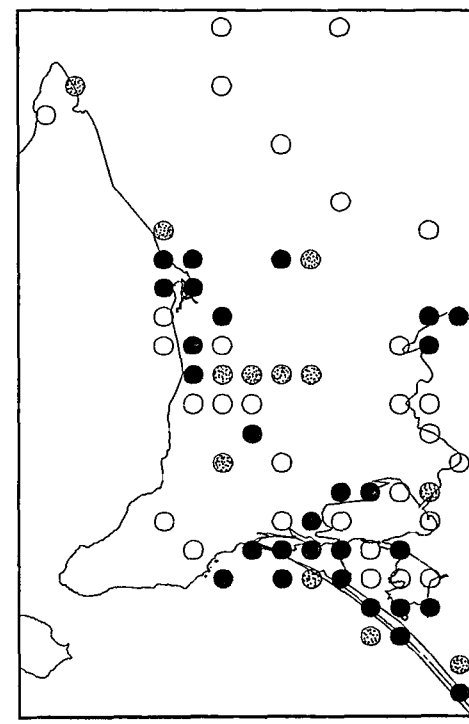
Pacific Heron



Cattle Egret



Hardhead



Musk Duck

Waterfowl: ducks, swans and geese

Despite the generally drier conditions of 1984-85 most species of duck were reported from more squares than in 1974-75. These increases were largely confined to SMLR, NMLR and AP with most ducks and swans being reported less widely from the NE in 1984-85. Grey Teal, Pink-eared Duck and Hardhead, in particular, showed marked increases consistent with an influx of birds from inland areas during the drier 1984-85 period (e.g. Fig. 4c). Parker *et al.* (1985) describe these waterfowl as being nomadic in South Australia, with large irregular influxes in (inland) areas after rains or floods. They presumably retract to permanent wetlands and coastal areas at other times. The single record of Plumed Whistling-Duck (Buckland Park Lake) is also consistent with an influx of inland waterfowl into southern areas during 1984-85.

Maned Duck showed a response opposite to the general decline of waterbirds in the NE. Instead Maned Duck were reported from more areas in the NE as well as NMLR and AP in 1984-85 than in 1974-75. The breeding distribution of this species in South Australia is increasing wherever farm dams are present (Parker *et al.* 1985). Mallards also showed a general increase in distribution, being reported from more locations in SMLR, NMLR and AP (see Paton *et al.* 1992 for more recent information). They were less widely reported from the lower RM and LAA during 1984-85.

Musk Duck was the only species of duck showing an apparent decline, being reported from fewer areas throughout the atlas area but particularly from RM, LAA and NMLR (Fig. 4d). The decline of this species along the RM and LAA regions since 1974-75 may be correlated with the increase in European Carp *Cyprinus carpio*. Musk Duck were considered common until the early 1970s in the region, but have declined since, apparently as a result of destruction of waterweed and its insect life by European Carp (Parker *et al.* 1985). Black Swans also may have suffered (Parker *et al.* 1985). Musk Duck were also frequently caught in fish nets in the lower RM and LAA, shortly after carp became popular as a crayfish bait 10-15 years ago (P.Macrow pers. comm.). Blue-billed Ducks were also occasionally caught in nets.

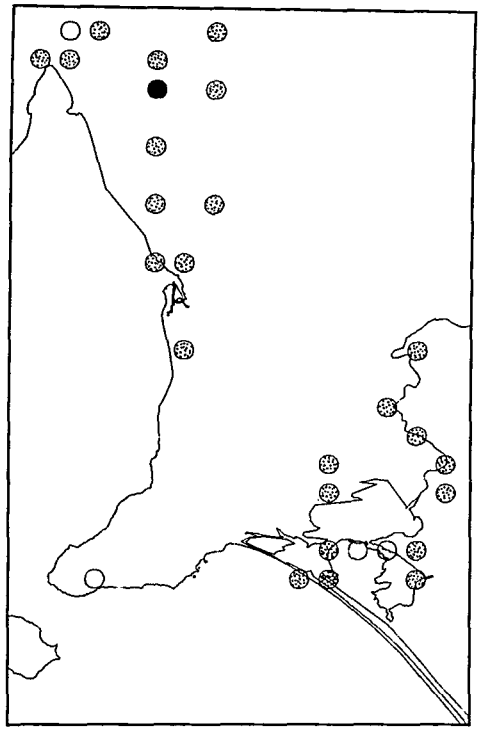
Records for Blue-billed Ducks and Australasian Shovellers were concentrated mainly around LAA with a few widely spaced records from SMLR, FP, NMLR and AP (SAOA 1977, 1994). Cape Barren Geese were also distributed mainly around LAA with only scattered reports of a few birds from the AP. No significant changes in distribution were detected for these species.

Raptors: eagles, kites, harriers and falcons

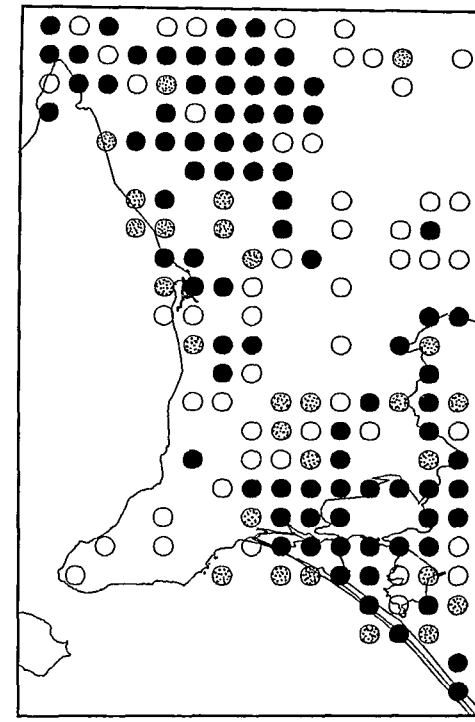
Most raptors were reported from similar numbers of grid squares in both atlases. Six species showed no change in distribution, six decreased in some regions but these declines were balanced by increases in other regions (particularly AP), while three others showed a substantial change in overall distribution (i.e. a net change of at least 20 grid squares; Table 3). These latter three species were the Black Kite, Whistling Kite and Wedge-tailed Eagle. Black Kites showed a dramatic increase being reported widely from AP, along the RM and around LAA in 1984-85, in stark contrast to 1974-75 when they were reported from only 5 grid squares (Fig. 5a). The other two species declined. Wedge-tailed Eagles were reported from fewer areas of NMLR, MM and SE in 1984-85 and continued to be rarely reported from the southern AP. Reports of Whistling Kites also declined in NE, NMLR, SMLR and FP, but the species was still widely reported from AP (e.g. Fig. 5b). Several other species also declined over parts of FP, SMLR, NMLR and NE or were largely absent from these regions during both atlases including the Black-shouldered Kite, Little Eagle, Spotted Harrier, Swamp Harrier, Black Kite and Black Falcon. Several of these species were reported more widely in other areas including AP, MM and SE (Table 3).

Black Falcons and Australian Hobbies were less frequently recorded along RM, LAA and/or MM in 1984-85, but both were reported from more grid squares on AP. Other falcons showed no change in distribution. Peregrine Falcons were patchily distributed throughout the atlas area, while Brown Falcons and Australian Kestrels were amongst the most widely reported species, being recorded from

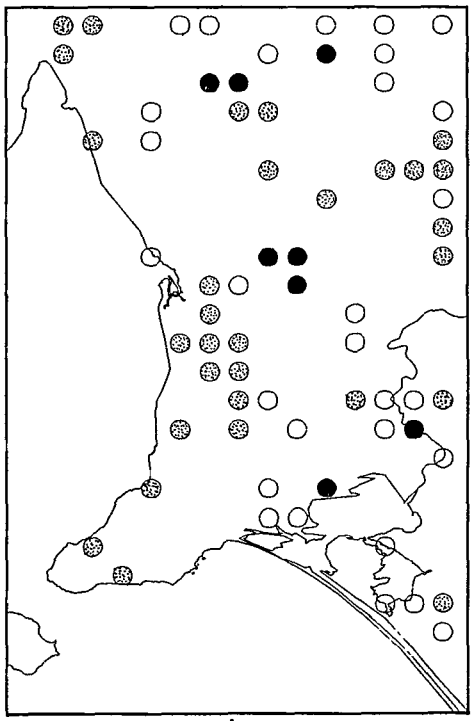
Figure 4. Comparisons of the distributions of Pacific Herons, Cattle Egrets, Hardheads and Musk Ducks in the Adelaide atlas area in 1974-75 and 1984-85. The figures show the grid squares where each species was seen in 1974-75 only (white), 1984-85 only (stipple), or in both (black). Some dots appear in the sea because they are printed in the centre of their grid square.



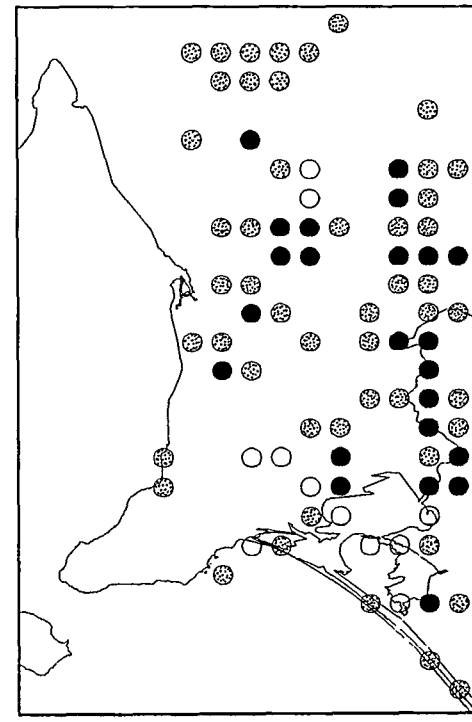
Black Kite



Whistling Kite



Collared Sparrowhawk



Peaceful Dove

210 and 250 grid squares respectively in 1984-85. In contrast White-bellied Sea-Eagles were patchily distributed around the coast.

Only one species of raptor, the Collared Sparrowhawk, increased its distribution in the SMLR and FP. Collared Sparrowhawks were also reported more widely from AP, but less widely from MM and SE during 1984-85 (Fig. 5c). In comparison the overall distribution of Brown Goshawks did not change, being reported from 97 grid squares in both atlases. However, 45 of these grid squares were different in 1984-85 suggesting that Goshawks may regularly shift locations. A similar high turnover of grid squares also occurred for Collared Sparrowhawks. In 1984-85, Collared Sparrowhawks were reported from only 8 of the 36 grid squares in which the species was seen in 1974-75 and 31 different grid squares (Table 3, Fig. 5c).

These changes in distribution for raptors between the two atlas periods probably reflect differences in the abundance of prey, especially in areas used extensively for cropping and pasture. During drier conditions grasses and herbage are less luxuriant and associated prey are less abundant, particularly in regions receiving the lowest rainfall (i.e. NE and MM – see Table 1). Many raptors, therefore, may have vacated these drier regions between the two atlas periods, shifting to higher rainfall areas where prey are consistently available (i.e. AP). Given the mobility of many species of raptor (Blakers *et al.* 1984) regional shifts in distribution of individuals in response to changes in prey abundance could be expected.

Single records of Black-breasted Buzzard, Osprey and Grey Falcon within the atlas area in 1984-85 further illustrate the mobility of some birds of prey.

Malleefowl, quails, button-quails and cranes

Malleefowl have a restricted and patchy distribution within the atlas area and the lack of reports in 1984-85 from the areas east of Meningie where the species was reported in 1974-75 is of concern. Extensive clearance of native vegetation in the SE region that commenced in the 1940s (Eckert 1977) and continued into the early 1980s (Harris 1976; Department of Environment and Planning 1986) may have been responsible for this decline.

Stubble Quails and Little Button-quails generally use grasslands and pastures within the Adelaide atlas region and both were reported from fewer areas in 1984-85 than 1974-75 consistent with the drier conditions. Most of the reductions were limited to NMLR, NE and MM, the regions likely to be most affected during dry conditions. Stubble Quails were also reported less frequently from FP in 1984-85 but maintained a wide distribution over AP. The abundance of these quails fluctuates with seasonal conditions, with both species being more abundant in good years than poor years and vacating areas when food is scarce (e.g. Eckert 1972; Pedler and Ragless 1978; Blakers *et al.* 1984). Painted Button-quails were reported less frequently than the other two species and remained very patchily distributed mainly over SMLR and NMLR. This patchy distribution may reflect the patchiness of suitable habitat and the difficulty in detecting the species. However, Condon (1968) commented that the species was fairly common in open forest and heathland within the Adelaide atlas area, and so the current patchy distribution suggests the species has declined. Like the previous two species, Painted Button-quails were reported less frequently during 1984-85 than 1974-75, particularly in the NMLR and SE regions. The only record for Brown Quail was of a bird that escaped from capitivity. This species appears to have disappeared from SMLR, FP and AP, areas where the species previously occurred and bred albeit in small numbers (Condon 1968). There were no records for Plains-wanderers or Red-chested Button-quails in 1984-85 but Australian Bustards and Brolgas were both reported from several locations within the atlas area during 1984-85, their presence reflecting the dry inland conditions.

Rails, crakes, moorhens and allies

Distributions for several species in this group differed between the two atlas periods. Australian Crakes, Spotless Crakes and Dusky Moorhens had reduced distributions consistent with a reduction of ephemeral wetlands in the NE, NMLR, RM, LAA and SE regions during 1984-85. Eurasian Coots, however, were more widely distributed over NMLR,

Figure 5. Comparisons of the distributions of Black Kites, Whistling Kites, Collared Sparrowhawks and Peaceful Doves in the Adelaide atlas area in 1974-75 and 1984-85. The figures show the grid squares where each species was seen in 1974-75 only (white), 1984-85 only (stipple), or in both cases (black). Some dots appear in the sea because they are printed in the centre of their grid square.

SMLR and SE in 1984-85 than 1974-75 suggesting an influx of birds from outside the atlas area. Surprisingly few reports of Eurasian Coots were from AP in either period except from urban wetlands near Adelaide.

Distributions for Purple Swamphens and Black-tailed Native Hens were similar during both atlases. As in 1974-75, Black-tailed Native Hens were widely reported from most regions in 1984-85. Lewin's Rail, however, was only reported from two locations in 1984-85 during the summer months (SAOA 1994) supporting Parker's (1985) contention that this rail was a spring-autumn visitor to southern South Australia. Spotless Crakes, Baillon's Crakes and Buff-banded Rails are also assumed to be spring-autumn breeding visitors to southern Australia (Condon 1968; Blakers *et al.* 1984; Emison *et al.* 1987). These three species were reported infrequently and often from widely scattered locations from the atlas area in 1984-85.

The general lack of observations of Baillon's Crake during both atlases is incongruous with Condon (1968) who stated that Baillon's Crake was common around margins of rivers and swamps in coastal districts east of Adelaide. Such a difference suggests the species may have declined in abundance since the 1960s.

Waders

Most species of wader showed no changes in distribution. Records for most species were concentrated in two areas: LAA and northern CO in the SE; and around the St Kilda saltfields and northwards around the coast of GSV on the AP. All of the rarely recorded waders (e.g. Oriental Plover, Terek Sandpiper, Red-necked Phalarope and Redshank; SAOA 1994) were reported from one or other of these regions.

Pacific Golden Plovers, Red-kneed Dotterels, Double-banded Plovers, Ruddy Turnstones, Greenshanks, Curlew Sandpipers, Red-necked Stints, Sharp-tailed Sandpipers, Black-winged Stilts, Banded Stilts and Red-necked Avocets were all reported from more areas around LAA and northern CO and/or around the north-eastern shores of GSV in 1984-85. The general increase in the number of reports for each of these species within the atlas area is consistent with the drier conditions of 1984-85 forcing more birds to congregate at permanent wetlands near the coast. However increased reports around the north-eastern coast of GSV may also reflect increased observer efforts in those areas.

Australian Pratincoles were reported from more areas in 1984-85 but surprisingly there were few reports of Inland Dotterels in 1984-85 despite the dry conditions inland that might have been expected to force this species to shift to coastal areas.

Masked Lapwings were still widely distributed but were reported from fewer areas in the NE. Banded Lapwings were also widely distributed in 1984-85 but their distribution had decreased in SE, MM and SMLR. The general lack of records for this species from FP and SMLR during both atlases (SAOA 1977, 1994) suggest that these regions are largely avoided by Banded Lapwings.

Of the waders, Latham's Snipe showed the greatest decline, with no records for this species from SMLR, FP and RM in 1984-85. The species was formerly considered to be moderately common in favoured spots in the Mt Lofty Ranges, on AP and along RM (Condon 1968). The fewer reports during 1984-85 compared with 1974-75 suggest the species continues to decline in this region. Bush Thick-knees were reported from at least two locations in 1974-75 (SAOA 1977) but no reports were received in 1984-85, so this species, once more widely distributed through the atlas area (Condon 1968), may have disappeared completely now.

Two other species showed apparent declines. Common Sandpipers were reported from fewer locations in SMLR and unlike 1974-75 there were no records from inland locations except near RM, perhaps reflecting the drier conditions of 1984-85. Black-fronted Plovers were also reported from fewer areas in SMLR and MM in 1984-85.

The distributions of Sooty Oystercatchers, Pied Oystercatchers and Hooded Plovers were similar in 1974-75 and 1984-85. All three have coastal distributions. Sooty Oystercatchers were patchily distributed in small numbers around the coastline. Pied Oystercatchers were extensively reported but only from coastal areas north of Adelaide and east of Victor Harbor. Hooded Plovers remained patchily distributed around the southern coasts of FP and the northern CO. Conditions in these coastal areas are not as variable as inland areas and shifts in distribution were not expected for these species. The small numbers of birds involved, their patchy distribution and limited breeding (e.g. see SAOA 1994) along coasts used extensively for human recreation make these populations vulnerable (e.g. Buick and Paton 1989).

Gulls and terns

Gulls and terns were largely distributed around the coast with most species being recorded in marine habitats and/or using adjacent protected wetlands, including LAA and RM. Of the gulls, Silver Gulls were the most widespread, with birds breeding off Outer Harbor and on islands near Victor Harbor. Pacific Gulls were reported fairly regularly in GSV and around the southern coast although reports were less frequent in 1984-85 than 1974-75. This species was regarded as rare in GSV up until the 1960s (Condon 1968). Kelp Gulls were first reported in South Australia in 1968 (Condon 1968), and records for this species remain infrequent. Vincent (1988), however, has since reported several unsuccessful nesting attempts by Kelp Gulls at Outer Harbor in 1986 and 1987.

Caspian and Crested Terns were the most frequently reported terns around the coastline including the coasts of FP. Both were reported breeding but no other terns were reported breeding in the area in 1984-85. Both Whiskered and Caspian Terns use inland wetlands as well as coastal areas (e.g. Condon 1968). More widespread reports of both species around the coasts in 1984-85 are consistent with these terns shifting from inland areas to coastal areas in dry years. Fairy Terns were also reported widely from coastal regions but, along with Whiskered Terns, were rarely seen around the rocky coasts of Fleurieu Peninsula. Although Fairy Terns decreased around LAA in 1984-85, they were reported more widely along the CO and AP coast, and their overall distribution remained little changed. Five other species of tern were reported from scattered locations that usually included sites along the northern CO, around LAA or near the St Kilda saltfields on AP (Table 3).

Pigeons and doves

Eight species of pigeon were recorded in the atlas area in 1984-85. Crested Pigeons and Domestic Pigeons were widespread in all regions. Brush Bronzewings were mainly reported from SMLR, FP and SE while Common Bronzewings were recorded from these regions as well as the drier mallee habitats of MM and NE. Both Common and Brush Bronzewings were each reported from similar numbers of grid squares in 1984-85 and 1974-75 (Table 3) but their distributions had shifted slightly. Common Bronzewings were reported more widely from the NE and less widely from SE and SMLR in 1984-85. Reports of Brush Bronzewings also declined for SMLR and NMLR but there were more reports of this species from AP. These shifts in distribution are not easily explained.

Both Peaceful Doves and Spotted Turtle-Doves were reported more widely in 1984-85 than 1974-75 (Table 3). This increase in distribution was dramatic for Peaceful Doves (Fig. 5d). Peaceful Doves were once widespread throughout the atlas area, but became rare in closely settled areas near Adelaide and in the Mt Lofty Ranges some time after the 1930s (Condon 1968). The expansion of Peaceful Doves into areas like the NMLR, SMLR and suburbs of Adelaide during 1984-85 largely reclaimed areas they formerly occupied. The trigger for the expansion into these areas is not known, but could be an influx of birds into these areas from the dry conditions inland. Whether this increased distribution can be maintained is still to be established.

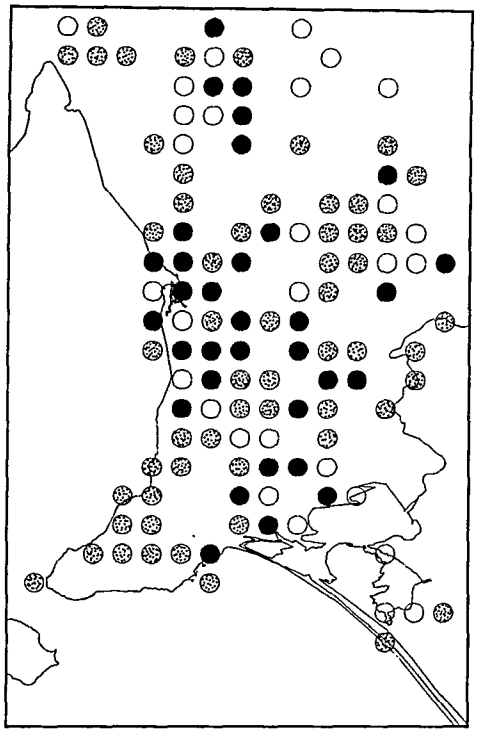
Spotted Turtle-Doves also increased their distribution particularly in NMLR, northern AP, NE, MM and SE regions suggesting the species was still expanding and consolidating in the drier habitats of the atlas area.

Condon (1968) suggested that the virtual disappearance of Peaceful Doves from around Adelaide was linked to the accidental release of Spotted Turtle-Doves. Spotted Turtle-Doves established a feral population about Adelaide in the 1930s following accidental release of turtle-doves from the Adelaide Zoo and the species has since spread widely. That Peaceful Doves have expanded into areas occupied by Spotted Turtle-Doves without any reciprocal reduction in Spotted Turtle-Doves suggests factors other than interactions between the two taxa may have contributed to the earlier decline of Peaceful Doves in the Adelaide area.

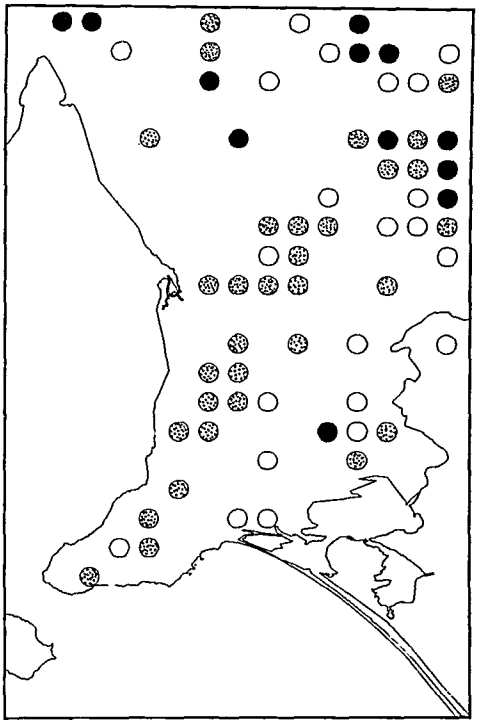
Diamond Doves and Collared Turtle-Doves were reported rarely, and the Collared Turtle-Doves, at least, involved birds escaping from captivity.

Cockatoos, parrots and lorikeets

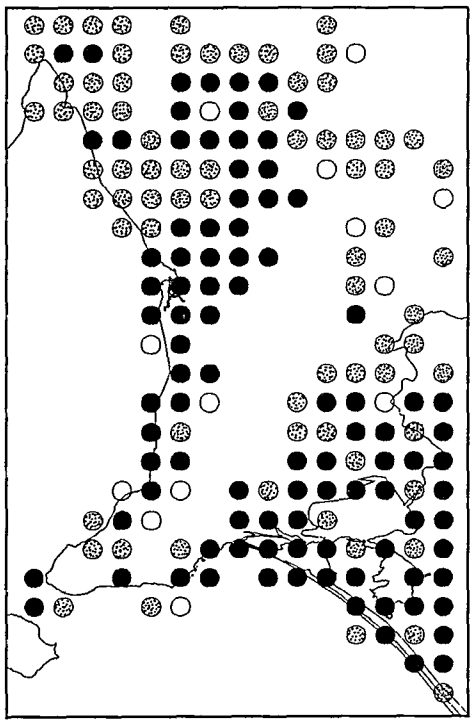
Of the four cockatoos regularly reported from the atlas area, three showed increased distributions during 1984-85. Yellow-tailed Black-Cockatoos were reported from the SMLR, FP and SE, and in 1984-85 were recorded more widely from the SMLR than in 1974-75. Little Corellas and Sulphur-crested Cockatoos were both more widely reported from the AP and SMLR during 1984-85. Sulphur-crested Cockatoos were also reported more widely from NMLR while Little Corellas had expanded over FP,



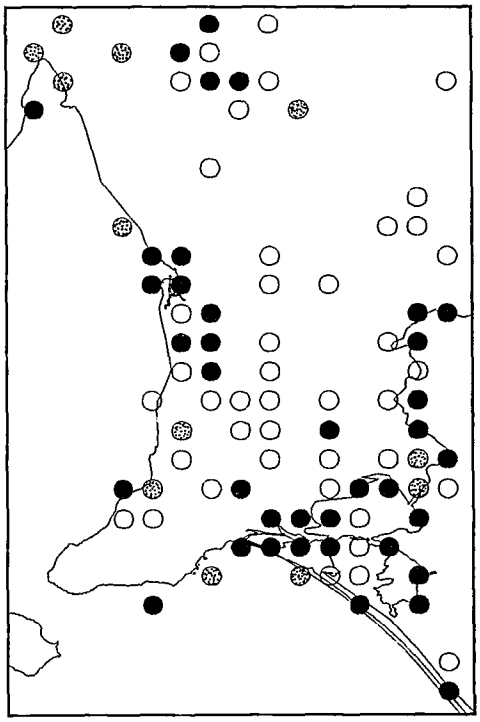
Little Corella



Australian Owlet-nightjar



Skylark



Little Grassbird

an area that they hardly occupied in 1974-75 (Fig. 6a). This expansion probably took place in the late 1970s since inspection of the RAOU atlas data collected from 1977-1981 shows Little Corellas being widespread over FP.

Both Galahs and Little Corellas have benefited from clearance of native vegetation for agriculture and the provision of suitable food and water, and both have expanded into southern areas (Blakers *et al.* 1984; Rowley 1990). This expansion has long been complete for the Galah in the Adelaide region where Galahs were recorded from more than 250 grid squares during both atlases. Little Corellas, however, still appear to be expanding in the region and in other parts of South Australia (e.g. Beardsell and Emison 1985; B. St John pers. comm.).

The few scattered records of Pink Cockatoos and Long-billed Corellas in the atlas area are probably of birds that had escaped from captivity.

In general the distributions of Rainbow, Musk and Purple-crowned lorikeets in the atlas area reflected the distributions of the types of eucalypts they tend to use. Rainbow Lorikeets had the most restricted distribution of the three lorikeets being largely limited to the taller eucalypt forests and woodlands of the SMLR and FP, with only a few scattered reports from the NMLR. Musk Lorikeets were largely restricted to similar areas over SMLR and NMLR and western parts of the MM while Purple-crowned Lorikeets were reported from all regions. Surprisingly Musk Lorikeets were absent from most of the FP where stringy-barked eucalypts predominate, suggesting this species rarely uses these types of eucalpyts. All three species of lorikeet were reported from more grid squares within their respective ranges during 1984-85 than 1974-75. This general increase may reflect more widespread flowering of eucalpyts in 1984-85 than 1974-75 but unfortunately no quantitive data on flowering are available for these periods. Increases for Musk and Rainbow lorikeets on the AP, however, were limited to urban areas to the north-east, west and south of Adelaide, while Purple-crowned Lorikeets increased generally over the AP. This difference probably reflects the more frequent use of mallee eucalypts by Purple-crowned Lorikeets compared to the other two species. The larger species appear to prefer the larger gums, many of which have been planted in urban areas and now flower regularly (e.g. Winslet and Winslet 1987).

Cockatiels and Budgerigars regularly shift into the atlas area during spring and summer and both were more widespread during 1984-85 than 1974-75, consistent with the drier conditions in 1984-85. Budgerigars, however, were reported less frequently from the NE in 1984-85 suggesting that this area was less suitable for them in dry years.

Rosellas and ringnecks showed little change in distributions between 1974-75 and 1984-85. Adelaide Rosellas remained widespread throughout FP, SMLR, NMLR and adjacent parts of MM and NE in 1984-85. Small expansions occurred on the southern AP and in the SE. Mallee Ringnecks were widespread over MM and NE regions with a few scattered reports from NMLR and AP. Eastern Rosellas were reported only from a few grids on the southern AP and adjacent SMLR in 1984-85, similar to their distribution in 1974-75. Scattered reports of Port Lincoln and Mallee Ringnecks from near Adelaide were probably cage birds that had escaped but the record of Port Lincoln Ringnecks west of Nantawarra is consistent with records in the RAOU atlas where the species was also reported breeding. According to Taylor (1987), Port Lincoln Ringnecks were first recorded in the area in 1968 and he suspects that a small feral population may have established. Records in the area are isolated from the main distribution of the species which is Eyre Peninsula and westwards (Condon 1968).

Peach-faced Lovebirds also escaped from aviaries during 1984-85 and were reported on five occasions (SAOA 1994). No lovebirds persisted in any area for any length of time as attempts were usually made to recapture the birds (e.g. Paton and Pollard 1985).

Red-rumped Parrots were widespread throughout the atlas area being reported from 208 grid squares, while Mulga Parrots were widespread over MM and NE only. Both species had similar distributions during both atlases. Reports of Mulga Parrots from the northern AP are part of a small and probably isolated remnant population that extends northwards towards Crystal Brook (based on records held in RAOU atlas). Blue Bonnets were patchily distributed

Figure 6. Comparisons of the distributions of Little Corellas, Australian Owlet-nightjars, Skylarks and Little Grassbirds in the Adelaide atlas area in 1974-75 and 1984-85. The figures show the grid squares where each species was seen in 1974-75 only (white), 1984-85 only (stipple) or in both (black). Some dots appear in the sea because they are printed in the centre of their grid square.

over the northern and eastern parts of the atlas area. They were reported less widely from MM and NE regions in 1984-85. However, countering these declines was an apparent increase on AP during this period.

Four species of *Neophema* were recorded in 1984-85. Elegant Parrots were the most widespread with breeding being reported from FP, SMLR and MM. Reports of Rock Parrots were along the north-eastern coast of GSV with a few widely scattered reports around the south coast. Both Rock Parrots and Elegant Parrots were more widely reported in 1984-85 than 1974-75. For Elegant Parrots these increases were mainly over SMLR and AP, and for Rock Parrots along the GSV coast on AP. Orange-bellied Parrots were reported from one location near LAA feeding on sunflower seeds with Elegant and Blue-winged parrots (Ragless 1987). Reports of Blue-winged Parrots were infrequent and widely scattered over the atlas area.

Cuckoos

Pallid Cuckoos, Fan-tailed Cuckoos and Horsfield's Bronze-Cuckoos were widely distributed being reported throughout the atlas area, though Fan-tailed Cuckoos were less frequently recorded from the drier districts (MM, NE and AP) than the other two species. Reports of Shining Bronze-Cuckoos during 1984-85 were largely restricted to SMLR and NMLR while Black-eared Cuckoos were recorded mainly from the NE with occasional reports from other regions. All five species of cuckoo were primarily winter-spring visitors to the atlas area and showed numerous local shifts in distribution between 1974-75 and 1984-85 (Table 3) suggesting that cuckoos may not return to the same locations each year. Variations in these movements could account for most of the regional differences in distribution found between the two atlases. Alternatively some of the apparent shifts in distribution may reflect local shifts in observer effort between the two atlases (Fig. 3).

Owls and nightjars

Barn Owls, Southern Boobooks, Tawny Frogmouths and Australian Owlet-nightjars were widely, though patchily, distributed in the atlas area. All showed numerous local differences in distribution suggesting that none of these species remained permanently at any one location for long periods of time. Records of Southern Boobooks were more frequent for SMLR and NMLR, while Barn Owls were rarely reported from SMLR, being more widespread over more open habitats on AP and MM. Barn Owls were less widely reported in 1984-85 than 1974-75 consistent with the generally drier conditions during the second atlas. Continued good conditions during 1974-75 resulted in large numbers of Barn Owls being reported in many parts of South Australia during 1975 (Reid 1976). The species is well known to respond to increases in prey including introduced house mice *Mus musculus* (e.g. Parker 1977; Blakers *et al.* 1984) and presumably prey was more abundant in 1974-75 than 1984-85. Southern Boobooks showed no change in distribution during the two atlas periods.

Tawny Frogmouths, Spotted Nightjars and Australian Owlet-nightjars also showed changes in distribution between the two atlas periods. Australian Owlet-nightjars were widely distributed over the SMLR and FP in 1984-85 in stark contrast to 1974-75 (Fig. 6b). This species was either consistently missed from these regions in the first atlas, or there has been a marked increase in the numbers since 1974-75. One possible explanation is that dry conditions in adjacent mallee areas forced some owlet-nightjars to shift into the SMLR region.

Spotted Nightjars were infrequently reported from drier areas in both atlases. However, in 1974-75 there were four isolated reports from SMLR but none in 1984-85. Before this period there had been only two isolated records of the species from the SMLR (McGilp 1964; Rix 1976). The reason for the influx of Spotted Nightjars into the SMLR in 1974-75 is not known.

Kingfishers and bee-eaters

Laughing Kookaburras had a wide distribution throughout the taller woodland and forested areas of FP, SMLR, NMLR and adjacent parts of MM but were largely absent from the NE, SE and northern AP in both atlases. Sacred Kingfishers and Red-backed Kingfishers were mainly reported during spring and summer. Sacred Kingfishers were mainly reported from SMLR, NMLR, RM and coastal AP in 1984-85, while Red-backed Kingfishers were more prominent in drier habitats (NE, MM and AP). Sacred Kingfishers were reported less frequently from NE, FP, MM and LAA regions in 1984-85 compared with 1974-75. Rainbow Bee-eaters were also spring-summer visitors to the atlas area and were reported less widely from the NE and more widely from SMLR and MM in 1984-85 consistent with the drier conditions during that period.

Swallows, martins and swifts

Welcome Swallows, Tree Martins and Fairy Martins were widely distributed throughout the atlas area. Of the three, Welcome Swallows were the most widely distributed being recorded from 260 grid squares in 1984-85. Tree Martins were also reported from over 200 grid squares but there were few reports from the northern AP where little native vegetation remains (i.e. in the Mallala-Dublin-Pt Wakefield-Balaklava region). Unlike the other two species, Fairy Martins showed many localised shifts in distribution, suggesting that their seasonal movements into and out of the atlas area during spring to summer respectively were not consistent from one period to the next. They were reported less widely from NE, NMLR and SMLR but more widely over AP in 1984-85.

White-backed Swallows remained patchily distributed in drier areas but also showed a high turnover in locations where birds were seen. There were fewer reports from areas in the NE and more reports in the CO region in 1984-85 compared with 1974-75. These shifts may have been associated with the drier conditions of 1984-85. Sightings of Fork-tailed Swifts and White-throated Needletails were made mainly during late summer and autumn, with Fork-tailed Swifts being reported from a variety of coastal and inland locations while needletails were only reported from several locations in SMLR. A small group of White-rumped Swiftlets were also observed near Mannum in March 1985 (SAOA 1994). This species usually occurs in north-eastern Queensland but vagrants are sometimes reported south of their normal range (Blakers *et al.* 1984).

Bushlarks, skylarks and pipits

Skylarks, Singing Bushlarks and Richard's Pipits had similar distributions within the atlas region with all three species being distributed broadly over AP, NMLR, MM and SE. All three species largely avoided the SMLR and FP, and only Richard's Pipit was widespread in the NE. Both Skylarks and Singing Bushlarks were reported from more grid squares in 1984-85 than 1974-75. Singing Bushlarks were more widespread over AP while Skylarks had increased their distribution over AP, NMLR, NE and MM (Fig. 6c) in spite of the drier conditions.

Cuckoo-shrikes, triller and bulbul

Black-faced Cuckoo-shrikes were widespread in both 1974-75 and 1984-85 but Ground Cuckoo-shrikes were restricted to the NE in 1984-85. Unlike 1974-75 there were no records from MM, suggesting that the species has declined there. White-winged Trillers were more widely distributed across southern areas in 1984-85 being reported more widely over MM, SMLR (including breeding) and SE but not FP. They were also reported less frequently from the NE. These changes in distribution between the two atlases are consistent with birds shifting further south during drier conditions further north.

The single record of a Red-whiskered Bulbul was probably an escaped cage bird. Red-whiskered Bulbuls have been recorded occasionally in the Adelaide region in the past and all have probably involved escaped cage birds (Condon 1968; Paton 1985; Barrington 1985). Where possible the birds have been trapped and destroyed so the species has failed to establish. There have been no reports of bulbuls since 1985.

Blackbird, thrush and scrub-robin

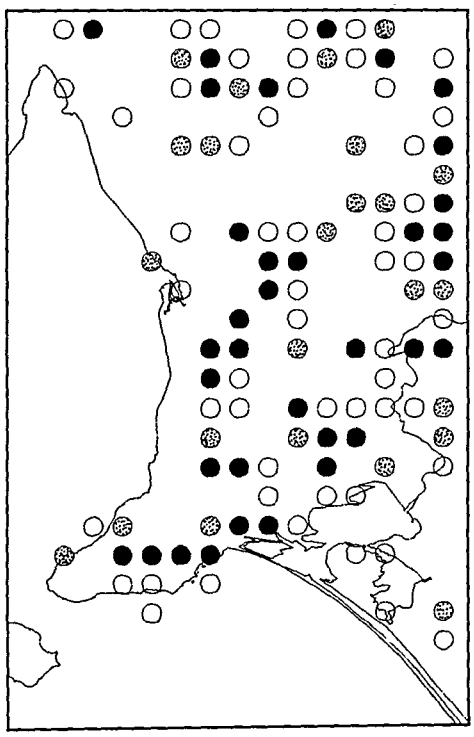
White's Thrush was restricted to SMLR and FP in 1984-85 with scattered reports along the spine of the ranges and Southern Scrub-robins were restricted to mallee areas in NE, MM and SE within the atlas area. Both species had similar distributions in 1974-75 and 1984-85. Common Blackbirds on the other hand were widely distributed over FP and SMLR and had increased their distribution in NMLR, MM and SE, suggesting the species had expanded since 1974-75 despite generally drier conditions.

Robins and flycatchers

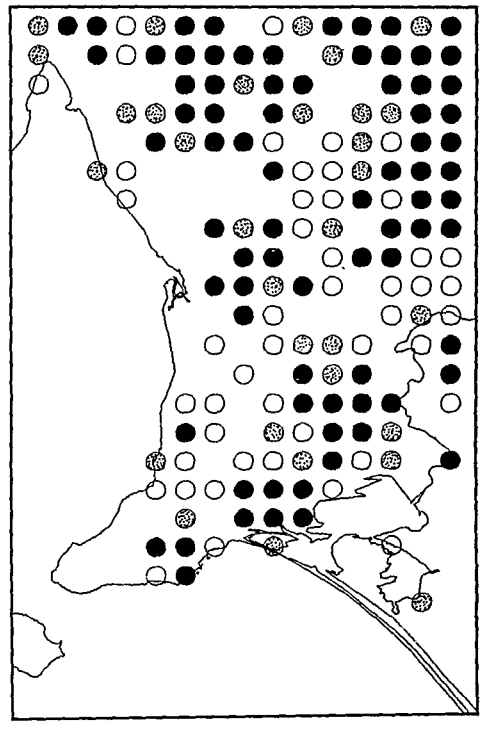
Of the flycatchers and robins, only the Red-capped Robin increased its distribution in 1984-85 relative to 1974-75. Distributions for Willie Wagtails and Scarlet Robins changed little, while those of Flame Robins, Hooded Robins, Jacky Winters, Grey Fantails and Restless Flycatchers declined.

Willie Wagtails were the most widely distributed flycatchers being recorded from 261 grid squares. Records of breeding were also widespread, coming from 51 grid squares. Grey Fantails were widespread throughout SMLR and FP and all reports of breeding by this species were contained within this region. Outside this area Grey Fantails were still widespread but were more patchily distributed. They were reported less often from the NE in 1984-85, consistent with drier conditions.

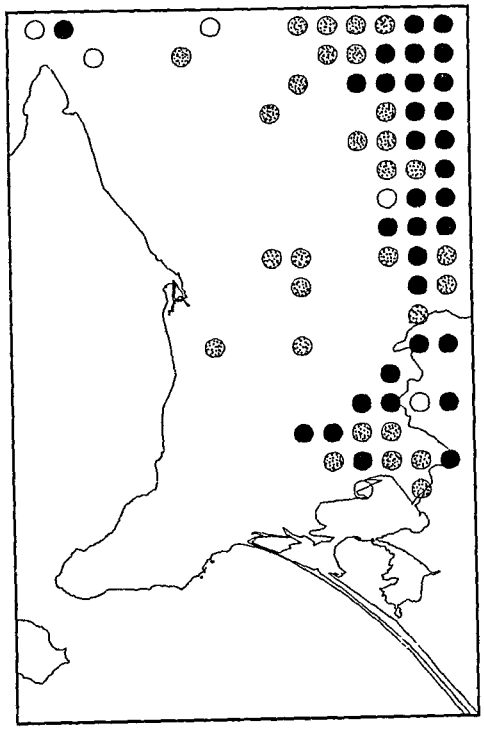
Scarlet Robins were largely restricted to SMLR and FP. The occasional observations of Scarlet



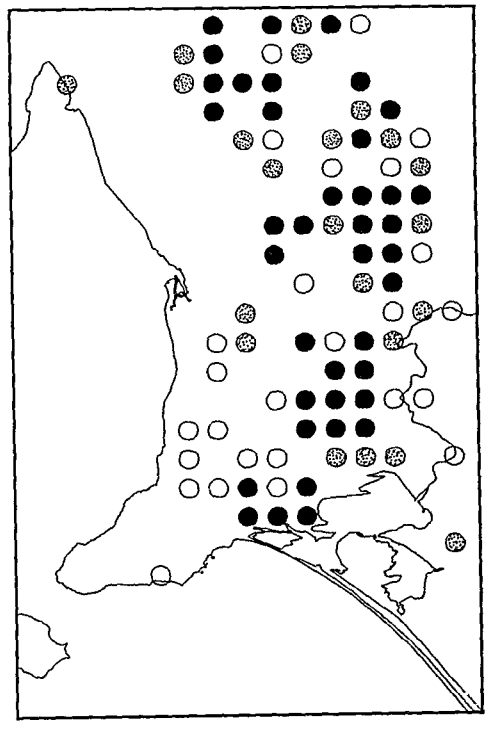
Restless Flycatcher



Jacky Winter



Yellow-plumed Honeyeater



Diamond Firetail

Robins outside this region in NMLR and MM were all between April and August, the non-breeding season, suggesting that Scarlet Robins, like many other species of *Petroica*, disperse widely during the non-breeding season. Red-capped Robins were widespread over the northern half of the atlas area with occasional records from SMLR. In 1984-85, Red-capped Robins were more widespread on AP, NMLR, SMLR and MM than in 1974-75, consistent with birds shifting further south in response to drier conditions. Most (77% of 462) observations of Red-capped Robins in the atlas area were made between April and September, suggesting that these robins move seasonally into the atlas area from areas further inland during winter.

Hooded Robins, Jacky Winters and Restless Flycatchers had similar widespread but patchy distributions. All three species were reported from fewer grid squares in SMLR during 1984-85 than 1974-75 suggesting a general decline for all three in this region (e.g. Fig. 7a,b). Hooded Robins also declined from the SE and FP, while Restless Flycatchers were less widespread in all areas. The reasons for these declines are unclear. They could be related to dry conditions reducing their food supply or to the accumulating deleterious effects of extensive clearance of native vegetation throughout the region. Ford and Howe (1980) predicted that even without further vegetation clearance as many as 35-50 species of birds might be lost in the future from the Mt Lofty Ranges. The already extensive vegetation clearance has meant reductions in population sizes for many species. However they did not list Hooded Robins, Restless Flycatchers or Jacky Winters as species most likely to disappear because of their extensive distributions in adjacent areas. All three species largely forage on or near the ground and so could be more prone to predation from introduced and native predators than other more arboreal species, or their food sources are perhaps more sensitive to perturbations like grazing.

Other ground-frequenting species (e.g. Southern Whiteface) have also declined within the atlas area. Whatever the reasons, ground-frequenting species including Hooded Robins and Jacky Winters have declined in other areas of Australia (e.g. Reid and Fleming 1992; Robinson 1993) and detailed ecological studies on these species are needed.

Rose, Pink and Flame robins were rare winter (Apr.-Aug.) visitors to the atlas area in 1984-85 (SAOA 1994) consistent with previous observations (e.g. Condon 1968; Reid *et al.* 1984). Flame Robins, however, were rarely reported in 1984-85 compared with 1974-75. As McGlip (1964) noted that Flame Robins were numerous at times in the Mt Lofty Ranges, these changes suggest that the population of Flame Robins that moves into the Adelaide atlas area for winter may have declined. Single individuals of two other species of flycatcher were recorded as summer vagrants to the atlas area during 1984-85: the Leaden Flycatcher and Western Yellow Robin (Ashton 1986; SAOA 1994).

Whistlers, shrike-thrush, shrike-tit and bellbird

The distributions for Rufous and Golden whistlers and Grey Shrike-thrushes were similar in 1974-75 and 1984-85, though Rufous Whistlers decreased in the SE. All three species were widespread but Golden Whistlers were only consistently reported throughout SMLR and FP and more patchily reported outside this area. All but five of the 59 observations of Golden Whistlers from AP, NMLR and NE were made between late March and September suggesting that Golden Whistlers dispersed into these regions during the non-breeding season. The exceptions were two reports of Golden Whistlers in the Buckland Park-St Kilda area on AP in February and three reports in the vicinity of Sedan (one in October and two in December). Parker (1984) has previously suggested that some Golden Whistlers disperse widely after the breeding season. Rufous Whistlers also moved seasonally but the movements were more complex and may not involve all birds. In southern areas (including most of SMLR, MM, SE and FP) 68% of 362 observations were during spring and summer (Oct.-Mar.), while in northern areas (most of AP, NMLR and NE) Rufous Whistlers were reported more frequently during autumn and winter with 64% of 211 observations being made between April and September (inclusive). Observations over longer periods at various sites spread over SMLR also show a strong seasonal influx of Rufous Whistlers during spring and summer (e.g. Ford and Paton 1976; Rix 1976; Paton and Paton 1980; Baxter 1980; Ashton 1985; Laybourne-Smith 1989).

Figure 7. Comparisons of the distributions of Restless Flycatchers, Jacky Winters, Yellow-plumed Honeyeaters and Diamond Firetails in the Adelaide atlas area in 1974-75 and 1984-85. The figures show the grid squares where each species was seen in 1974-75 only (white), 1984-85 only (stipple), or in both (black). Some dots appear in the sea because they are printed in the centre of their grid square.

Gilbert's Whistlers were reported mainly from the NE and MM and appear to have declined in the NE. The reports of Gilbert's Whistlers from isolated locations in NMLR and SMLR may involve birds dispersing in the non-breeding season (Joseph and Kernot 1982). Observations of Gilbert's Whistlers on the coast of AP, continue a series of observations in this region dating back to the 1930s and suggests that a small population may still remain on AP (Joseph and Kernot 1982). Red-lored Whistlers were only reported on four occasions from the NE and MM between March and August in 1984-85. These reports presumably involve post-breeding dispersal from areas further east of the atlas area as proposed by Parker (1984).

Crested Shrike-tits had similar distributions during both atlases. They were largely restricted to the woodland and forested areas of FP, SMLR and NMLR with a few reports from MM and near RM. Although the spread of records did not change greatly, Crested Shrike-tits were reported from many different grid squares during the two atlas periods, suggesting some local shifts in distribution had occurred since 1974-75. Crested Bellbirds, however, declined in both the SE and AP. No reports of Crested Bellbirds were received from AP during 1984-85 and the species may now be extinct in that region. Taylor (1987) notes that Crested Bellbirds were moderately common in mallee at South Hummocks, north of Pt Wakefield on AP, before 1975 and that he last recorded the species in this area in winter 1978. The cause of the decline was unknown. In the SE region where Crested Bellbirds have also declined since 1974-75, factors like continued habitat clearance may have been involved (Harris 1976; Department of Environment and Planning 1986). Rufous Whistlers had also declined in this region since 1974-75.

Quail-thrush and babblers

Chestnut-crowned Babblers were restricted to the NE and Chestnut Quail-thrushes to the NE and MM regions of the atlas area. Both maintained similar distributions during both atlas periods. In contrast White-browed Babblers were widespread over the NE, MM and SE regions and were reported more widely from the NE during 1984-85. Elsewhere, over FP, SMLR, NMLR and AP, they were more patchily distributed, suggesting that many groups may be isolated from other groups in these regions.

Grassbird, reed warbler, cisticola and songlarks

Both Little Grassbirds and Clamorous Reed-warblers were reported less widely from the NE and SMLR in 1984-85 with Little Grassbirds also being less widespread in MM and NMLR during this period (Fig. 6d). In 1974-75 many ephemeral wetlands throughout the atlas area were flooded and would have enabled these species to expand during that period. Few ephemeral wetlands contained water consistently in 1984-85 and distributions of grassbirds and reed-warblers were expected to retract in 1984-85. Golden-headed Cisticolas were reported largely around LAA, and from a few scattered locations along RM, southern AP and SMLR. They were also less widely reported in 1984-85 than 1974-75, particularly along RM.

Brown Songlarks and Rufous Songlarks both maintained broad distributions over the atlas area during 1974-75 and 1984-85, except both species tended to avoid SMLR and FP. The distributions of Brown Songlarks did not change, but Rufous Songlarks decreased in the NE and increased over MM, SMLR and even the FP, indicative of the species shifting to wetter areas in drier years.

Fairy-wrens, emu-wrens and grasswrens

The four fairy-wrens recorded in the atlas area had markedly different distributions. Superb Fairy-wrens were widely distributed throughout the southern half of the atlas area (FP, SMLR, MM and SE), NMLR and coastal areas of AP. Variegated Fairy-wrens were widely distributed in the eastern parts of the atlas area including NE, MM and SE with several isolated reports from AP, while both Splendid and White-winged Fairy-wrens had more restricted distributions within the atlas area. White-winged Fairy-wrens were reported from two separate regions: NE and around the coast of GSV north of Adelaide. Splendid Fairy-wrens, however, were restricted to the NE and northern parts of MM and were the only fairy-wrens to show a slight increase in distribution between the two atlases.

Records for Striated Grasswrens were restricted to one location east of Murray Bridge where they were recorded in the previous atlas. Data collected for the RAOU atlas show that this is a small and isolated population of Striated Grasswrens. Southern Emu-wrens also consisted of several isolated populations: one near Deep Creek Conservation Park, another associated with the Finniss River and a third population in the SE along the Coorong.

Fewer reports of Southern Emu-wrens in 1984-85 compared with 1974-75 may reflect the bushfires that burnt parts of its range in 1983 or the difficulty in detecting these species.

Scrub-wren, hylacolas, redthroat and bristlebird

Chestnut-rumped Hylacolas were only observed at a few widely separated locations on FP and SMLR. Relative to 1974-75, Chestnut-rumped Hylacolas were reported less widely in 1984-85. Some of the areas where they were present in 1974-75 but absent in 1984-85 (e.g. Cox's Scrub Conservation Park) were burnt by extensive bushfires in 1983. Some of these areas have since been re-colonised. Shy Hylacolas were reported from NE, MM and SE and were also patchily distributed.

Redthroats were reported less frequently from the NE in 1984-85 perhaps as a result of the drier conditions. Calamanthus were restricted to the SE as were Rufous Bristlebirds. In contrast White-browed Scrub-wrens were widely distributed throughout FP and SMLR and along the coasts of AP and SE, having expanded their distribution further north within the SMLR since 1974-75. The reasons for this apparent expansion require further study.

Weebill, thornbills, whiteface and gerygones

Southern Whitefaces were recorded largely in the north-eastern third of the atlas area with populations in NMLR and SMLR being less widespread in 1984-85 than 1974-75, continuing a declining trend noted by Condon (1968). During the same period Weebills showed a substantial increase in their distribution particularly over AP, SMLR and NMLR. These increases suggest Weebills may be able to shift into more mesic areas during drier conditions.

Generally the distributions of thornbills were little changed. Yellow-rumped Thornbills were widespread in all areas but Striated Thornbills were restricted to SMLR, FP and coastal areas in the SE. Buff-rumped Thornbills were also restricted to SMLR and FP with a separate population in northern woodland areas of NMLR. Slender-billed Thornbills were restricted to coastal samphire areas around the north-eastern shores of GSV, and Chestnut-rumped Thornbills to the NE, MM and eastern parts of the NMLR. Several isolated populations of Chestnut-rumped Thornbills were reported from northern parts of SMLR and NMLR. The record of Chestnut-rumped Thornbills at Aldinga Scrub on the AP involved a single bird(s) seen infrequently in the area since 1980 (Ashton 1985).

Yellow Thornbills showed many local shifts in distribution suggesting that they were mobile. During 1984-85 they were reported less frequently from SMLR and NMLR than in 1974-75 and may be declining in these regions. Other species to show shifts in distribution were the Chestnut-rumped and Buff-rumped Thornbills, two ground-frequenting thornbills. Chestnut-rumped Thornbills were less widespread in the NE but more widespread in NMLR in 1984-85, perhaps expected in drier conditions. Both Chestnut-rumped and Buff-rumped thornbills were reported from several locations in the SE in 1974-75 but neither were reported from this region in 1984-85, their loss perhaps related to further clearance of native vegetation in the SE region between the two atlases (Harris 1976; Department of Environment and Planning 1986).

Brown Thornbills were primarily recorded from SMLR and FP while Inland Thornbills were primarily reported from two separate areas: the coastal samphire areas around GSV north of Adelaide; and from the NE, MM and SE. In the first atlas no attempt was made to differentiate between Brown and Inland thornbills since many observers were not aware of the diagnostic but subtle features that separate these two species. Similar problems of identification existed in 1984-85 and in many instances specific identities were assigned by the location of the observation.

Western and White-throated gerygones were recorded from one or two locations only in 1984-85 and 1974-75. All observations were during spring and summer (SAOA 1994), consistent with most of the previous records for these species in the Adelaide area where both species are rare spring-summer vagrants (Condon 1968; McNamara and McNamara 1975; Smyth 1976; Ashton and Ashton 1982).

Sitellas and treecreepers

Varied Sitellas were widely, though patchily, distributed throughout the atlas area. Although the distributions were similar in 1974-75 and 1984-85, sitellas were not reported consistently from the same grid squares during the two atlases, suggesting some local shifts in distribution. Treecreepers were not as widely distributed as sitellas, with White-throated Treecreepers being restricted to SMLR and FP, and Brown Treecreepers broadly distributed over SMLR, NMLR, NE and MM with a few reports from northern and eastern parts of the AP. Brown Treecreepers were patchily distributed in southern areas of SMLR and FP, and the few remaining

populations within these areas appear more or less isolated now. Fewer reports of Brown Treecreepers were received from AP and SMLR during 1984-85 suggesting that these populations are declining. The third treecreeper, the White-browed, was reported from only one NE location with Black Oak *Casuarina cristata* woodland. This species is more widespread further north and east of the Adelaide atlas region (Condon 1968; Blakers *et al.* 1984).

Honeyeaters

Twenty-two species of honeyeater were recorded in the atlas area during 1984-85 and more than half of these were reported more widely in 1984-85 than in 1974-75. Those species that increased were generally the large honeyeaters (wattlebirds, miners), widespread species or species normally found in mallee and arid shrublands. Most of the remaining species showed little change in distribution between the two atlases.

Eastern Spinebills, Yellow-faced, White-naped, Black-chinned and Crescent honeyeaters were largely restricted to SMLR and FP, and their distributions were similar in both atlases. These species were extensively reported throughout these wetter, forested regions, except the Black-chinned Honeyeater which was reported from only a few isolated locations. The Black-chinned Honeyeater was previously more widespread and had disappeared from many locations before the 1974-75 atlas (e.g. Whatmough 1978; Baxter 1980). The species was listed as one likely to decline further, given its patchy distribution and isolation (SAOA 1977; Ford and Howe 1980). However, no further decline was detected in its distribution in 1984-85.

New Holland Honeyeaters, Tawny-crowned Honeyeaters and Little Wattlebirds were mainly reported from SMLR, southern parts of MM, and the SE. Tawny-crowned Honeyeaters were patchily distributed within these areas, and were reported less widely from the southern parts of SMLR in 1984-85. Both New Holland Honeyeaters and Little Wattlebirds, however, were more widespread on AP in 1984-85. For Little Wattlebirds this increase was limited to areas in the vicinity of Adelaide suggesting that suburban habitats are becoming more suitable for them.

Red Wattlebirds, Noisy Miners, White-plumed and Brown-headed honeyeaters were the most widespread honeyeaters in the atlas area being reported from most regions. All four species were more widely reported in 1984-85. Red Wattlebirds had increased in FP, NMLR, NE and AP (particularly in the vicinity of Adelaide), White-plumed Honeyeaters in AP and MM, Brown-headed Honeyeaters in the SE, and Noisy Miners in the NMLR and NE regions. The absence of Noisy Miners and Little Wattlebirds from FP is probably due to the lack of suitable woodland habitats.

Yellow-plumed, White-eared, White-fronted and Striped honeyeaters were mainly reported from the NE and MM regions during the 1974-75 atlas. In 1984-85 distributions of three of these species had expanded. Yellow-plumed Honeyeaters were more widespread in the NE and MM in 1984-85, and both Yellow-plumed and White-fronted honeyeaters invaded NMLR and SMLR during the second atlas (e.g. Fig. 7c), suggesting that these honeyeaters disperse to more mesic southern habitats in dry years. All records for White-fronted Honeyeaters in NMLR and SMLR were in 1985 and most of these were during spring (Oct.-Dec.) with a few observations in winter. Yellow-plumed Honeyeaters were detected in the ranges in both years but more so in 1985, with most being seen between autumn and late winter. Striped Honeyeaters also increased in the NE and were reported from several locations on AP. However, they were not seen in the SE, unlike 1974-75. The reports of a Striped Honeyeater at Sandy Creek Conservation Park in the SMLR were of a vagrant. Rix (1976) visited the park regularly from 1962 to 1972 and did not record the species.

Another predominantly mallee honeyeater, the Purple-gaped Honeyeater, was reported from the MM with scattered observations from the NE and SE and showed no obvious increase in distribution in 1984-85.

Spiny-cheeked Honeyeaters, Yellow-throated Miners and Singing Honeyeaters were reported from more squares in 1984-85 than 1974-75. These species were widespread in NE, MM and AP. Singing and Spiny-cheeked honeyeaters were also widespread in the SE, and Singing Honeyeaters were also distributed in a narrow band around the coast of FP. All three species largely avoided NMLR, SMLR and FP, but in 1984-85 Singing Honeyeaters expanded their distribution into the foothills of NMLR and SMLR, Spiny-cheeked Honeyeaters increased in NMLR and AP, and Yellow-throated Miners increased on AP. Again these increases may be from birds shifting towards more mesic habitats in drier periods. Interestingly, Noisy Miners had also increased their distribution since 1974-75 being reported more extensively from the NE and NMLR of the Mt Lofty Ranges despite the drier conditions of 1984-85.

The Black Honeyeater is an inland species that visits the Adelaide atlas area irregularly during spring and summer, often breeding while there (Ford 1978). In 1984-85, Black Honeyeaters were seen at scattered locations in the atlas area during spring and summer. In 1984, observations were all from MM and NE, while in 1985 observations were from NMLR and SMLR with no reports from MM and NE. Black Honeyeaters were also found breeding near Naracoorte in the lower South East of South Australia and near Port Neill on Eyre Peninsula in spring of 1985 (Cox 1987; Bourne 1987). It is tempting to suggest that Black Honeyeaters moved south because of dry inland conditions, but the last time Black Honeyeaters were reported from southern latitudes was in 1975 and 1976, when conditions were good inland. Ford (1978) concluded that southern influxes were not drought related but were caused possibly by a general increase in population size that pushed some birds further south. That the birds were seen over two consecutive years, a pattern that often occurs (e.g. see Ford 1978; Carpenter 1985a), coupled with Ian May's report of large numbers in the northern Flinders Ranges in spring of 1984 (Carpenter 1985b) adds support to this explanation. The differences in the distributions of Black Honeyeaters in 1984 and 1985 may, however, reflect prevailing conditions. In general mallee eucalypts flowered more extensively in the spring of 1984 than 1985 and this may have led to the lack of reports in MM and NE during 1985. White-fronted Honeyeaters also invaded the Mt Lofty Ranges in 1985 and not 1984, but were present in MM and NE in both years.

Although many of the shifts in distributions of honeyeaters between 1974-75 and 1984-85 can be linked to the different prevailing conditions during the two atlases some at least are probably induced by changes in flowering intensities of plants, particularly eucalypts. Flowering intensities of many eucalypts vary dramatically from one year to the next, and this variability may be linked to previous weather conditions rather than the prevailing conditions. For example, many eucalypts and other nectar-producting shrubs initiate bud production up to 12 months before flowering and thus flowering intensities should lag weather conditions by 1-2 years. Apparent increases in the distributions of many honeyeaters during 1984-85 compared with 1974-75 may be because several eucalypts flowered more widely and profusely. Certainly increased numbers of various honeyeaters and lorikeets around suburban Adelaide and adjacent parts of AP are likely to be caused by extensive plantings of eucalypts in these urban areas since the 1970s (e.g. Winslet and Winslet 1987).

No Black-eared Miners were reported in 1984-85 within the atlas area, suggesting that this species is now locally extinct. Joseph (1986) attributes the decline of this species to clearing of extensive areas of dense mallee favoured by Black-eared Miners and extensive hybridization with Yellow-throated Miners which favour more open habitats. The Fuscous Honeyeater (one seen at Sandy Creek Conservation Park) is a vagrant to South Australia (e.g. Condon 1968; Templeton 1975).

Chats

White-fronted Chats were widely distributed over the atlas area except SMLR and FP, with little change in distribution between the two atlases. Both Crimson and Orange chats, however, were recorded infrequently from widely scattered locations in 1984-85, but more frequently than in 1974-75, consistent with drier conditions forcing these birds to travel further south. These small influxes of chats into the atlas area in 1984-85 were nowhere near as extensive as those of 1968 and 1969 (Glover 1969, 1971; Taylor 1987).

Pardalotes, mistletoebird and silvereye

Striated Pardalotes were the most widespread (in 200 grid squares) of the three pardalotes, while Spotted and Yellow-rumped pardalotes (combined) were reported from fewer than 100 squares. Spotted and Yellow-rumped pardalotes were not always differentiated by observers because the diagnostic colours of the rump were not seen. Differentiation was further hampered by the presence of individuals with intermediate colours (orange-yellow) on the rump and such birds were recorded as hybrids. In general, Spotted Pardalotes were seen in SMLR and FP, while Yellow-rumped Pardalotes were widespread in the NE and MM with a few scattered reports for AP, SMLR and NMLR. Birds with intermediate rump colours and unspecified spotted/yellow-rumped type pardalotes primarily came from SMLR and FP, reflecting the difficulty of identifying these pardalotes in the taller forests and woodlands of these regions, compared to mallee habitats. Both Yellow-rumped and Spotted pardalotes had increased their distributions in SMLR in 1984-85. Spotted Pardalotes had also increased over FP but Yellow-rumped Pardalotes declined in NMLR. No simple explanation exists for these shifts in distribution.

Silvereyes and Mistletoebirds were also widely distributed though Silvereyes were not as widespread or as evenly distributed over the northern half of the atlas area compared with the southern half. Distributions of both species were similar in the two atlases.

Finches

Beautiful Firetails, Diamond Firetails and Zebra Finches had smaller distributions in the Adelaide atlas area in 1984-85 than 1974-75 and the only native finch to maintain a distribution similar to that recorded in 1974-75 was the Red-browed Finch. Red-browed Finches were reported throughout SMLR and FP with only a few scattered records outside this region. Beautiful Firetails were patchily distributed along the southern reaches of FP and in isolated locations in the southern SMLR. Records for this firetail in SMLR may have been reduced in 1984-85 as a result of the 1983 fires, though Cox's Scrub Conservation Park (near Ashbourne) was completely burnt in these fires and was recolonised by Beautiful Firetails within two years. Most records of Beautiful Firetails in SMLR are during autumn and winter and possibly involve dispersal of immature birds into this region (see also Ashton 1985). The single record of a Red-browed Firetail near Caloote in MM was also in autumn.

Diamond Firetails and Zebra Finches were reported mainly from drier regions (NMLR, NE and MM) with Zebra Finches also prominent on the southern AP. Both species were recorded infrequently in SMLR during 1984-85 and Diamond Firetails, in particular, appear to have declined dramatically over FP and southern parts of SMLR since 1974-75 (Fig. 7d). Zebra Finches had also declined in NE and on AP, possibly because less surface water was available in both areas in 1984-85 compared with 1974-75.

Three introduced species of finch were prominent. House Sparrows were found in almost all areas, while European Goldfinches and European Greenfinches were restricted to wetter areas like SMLR, with greenfinches being more restricted in distribution than goldfinches. Only the European Goldfinch has declined in distribution since 1974-75 being less widespread over NMLR and NE regions probably because of the drier conditions in 1984-85.

Single observations of a Nutmeg Mannikin and Long-tailed Finch (SAOA 1994) were likely to be of escaped cage birds, since neither species occurs naturally in South Australia (Condon 1968; Blakers *et al.* 1984).

Starlings and oriole

Common Starlings were one of the most ubiquitous species in the atlas area with reports from 263 squares in 1984-85. A single Common Mynah was reported in suburbs of Adelaide in 1984-85 and this was almost certainly a bird that had escaped from captivity. No further reports of this species have been received since 1985. The small colony established in the Kilburn area had at least 86 birds in April 1964 but eventually died out in the early 1980s. The last record from this area was of 1 or 2 birds in May 1981, with none being seen in subsequent years (R. Brown pers. comm.).

Olive-backed Orioles are only rare vagrants to the atlas area (Condon 1968). Three reports were received in 1984-85, all of single birds between June and November (SAOA 1994).

Chough, magpie-lark and apostlebird

Australian Magpie-larks were widespread throughout the atlas area, but White-winged Choughs were only widespread in the drier mallee and woodland areas of the NE, MM and NMLR. White-winged Choughs were also reported from SMLR in woodlands and adjacent pine plantations in the Birdwood-Williamstown-Lyndoch area with another isolated population near Meadows. The species was formerly more widespread and Condon (1968) attributed the decline to the loss of eucalypt woodlands. The two atlases show that there has been no further decline between the mid-1970s and mid-1980s and even a slight increase in distribution in the NE.

Apostlebirds were rarely reported from north-eastern parts of the atlas area, perhaps shifting into these areas because of dry conditions. The small colony that had established in south-eastern suburbs of Adelaide (near the Waite Arboretum) was recorded during 1974-75 but was not seen after then (Saunders 1983).

Woodswallows

Four species of woodswallows increased their distributions in one or more regions of the atlas area in 1984-85. Dusky Woodswallows were the most widespread being reported throughout the atlas area and more widely from AP during 1984-85. Drier conditions inland probably accounted for the increase in reports for Masked and White-browed Woodswallows including records from SMLR and AP. Similarly the range of the Black-faced Woodswallow increased in MM in 1984-85, though they were not seen in NMLR in 1984-85, unlike 1974-75.

Magpie, butcherbirds, ravens and currawong

Distributions for Australian Magpies, Grey Currawongs and the two species of raven were similar in 1974-75 and 1984-85. Australian Magpies and Little Ravens were recorded in almost all grid squares, while Australian Ravens were mainly seen in eastern districts (NE, MM and SE) with a few widely scattered reports from other northern parts of the atlas area. Grey Butcherbirds were also frequently recorded in these areas and around the northern coasts of AP with a few widely scattered reports from SMLR. In 1984-85 Grey Butcherbirds were recorded more widely along the AP coast, NMLR and NE, and less widely from the MM. Grey Currawongs were widely reported from SMLR and FP with reports more scattered for the NE, MM and SE. They were largely absent from NMLR and AP. Pied Butcherbirds and Little Crows were rarely reported from one or two NE locations.

The limitations of bird atlases for detecting changes in distributions of birds

Bird atlases are often promoted as providing baseline data from which changes in bird distributions can be monitored in the future. The second bird atlas of the Adelaide region was conducted to compare distributions measured in 1984-85 with those recorded 10 years earlier. Comparisons revealed that the recorded distributions of many species were different for the two periods. These changes in distribution and the lack of them for other species need to be interpreted cautiously. Depending on the species, substantial changes in distribution do not necessarily reflect permanent changes in distribution and abundance, since many waterbirds and some inland passerines regularly expand and contract their distribution depending on seasonal conditions. Likewise, little or no change in the distribution of a species does not necessarily mean that population densities and distributions for those species have remained unchanged within each grid square.

To a large extent the ability of an atlas to detect changes in distribution depends on the temporal and spatial resolution of data collection and presentation, and on the quantity of data collected. Most bird atlases in Australia have relatively crude spatial and temporal scales with distributions being plotted at resolutions of 3, 10 or 60 minutes of latitude and longitude with data being pooled for 2-5 year periods (e.g. Aston and Balmford 1978; Blakers *et al.* 1984; Emison *et al.* 1987; Ford and McFarland 1991; Taylor and Canberra Ornithologists Group 1992). Even the 10 000 yd grid squares used in the 1974-75 bird atlas of the Adelaide region (SAOA 1977) only have a resolution of approximately 3 minutes of latitude and longitude. As a result many of the finer patterns to the distribution of birds are lost and some misconceptions about the distributions of some species may result. For example, distribution maps at a scale of 10 000 yd for species like the Scarlet Robin, Striated Thornbill, White-throated Treecreeper, Crescent Honeyeater and Eastern Spinebill shown in SAOA (1977) give the impression that these species were evenly and consistently distributed over the SMLR and FP, and evenly distributed over each grid square within this area. Such a pattern has not been established. In reality these species may be limited to just those areas of a grid square that still have suitable remnant native vegetation, and at a finer scale than 10 000 yd the species may be patchily distributed. Knowledge of this patchiness is important for the management and future monitoring of populations of birds. This is highlighted even more so for remnant and isolated populations of Black-chinned Honeyeaters, Southern Emu-wrens, Beautiful Firetails and Chestnut-rumped Hylacolas. These species are shown as occurring in 7-13 grid squares in 1974-75 (3-9 in 1984-85) and potentially using areas of 500 to 1 000 km^2, while in reality their habitat is confined to much smaller areas within these grid squares.

To highlight this potential patchiness, and the patchiness of data collection, all of the distribution maps of birds for the Adelaide region in 1984-85 are given at a scale of one minute of latitude and longitude (SAOA 1994). This resolution has several advantages. First, most observations were collected at this scale and not over a larger area and so such a scale is representative of the scale at which data were collected. Second, by presenting data at the finest resolution, distribution maps using coarser scales can still be constructed. The reverse, however, is not possible without access to the original data. Third, the atlas area of the Adelaide region consists of a diverse array of habitats (e.g. Table 1) that range from exposed coastal marine habitats, tidal mudflats, mangroves, samphire flats, freshwater lakes, swamps and riparian wetlands to various types of eucalypt forests, woodlands, mallee, mallee-heath, horticultural plantations, urban environments and agricultural areas that are either cropped or grazed. These often change within a few kilometres (i.e. within a 10 000 yd grid square), so precise knowledge of where observations were made is important for assessing future changes in bird distributions. By plotting distributions at a resolution of one minute, more precise patterns to

distribution associated with particular habitats can also be displayed. Such precision will also aid future documentation of changes in distribution, in that the same locations can be re-examined in subsequent years. When exact locations of observations are not known (as happens when larger scales are used) then differences in bird distributions from one time period to the next may reflect small differences in the locations and hence habitats examined between two periods.

Temporal scales are also important. For the two atlases of the Adelaide region a positive record of a species in a grid square simply means that the species was recorded at least once in that square during a two-year period, without any information on the degree of residency (or status) of the species in that area. Other atlases have provided some information on the frequency of records for a species in an area by calculating reporting rates for that species over a 3-5 year period (e.g. Blakers *et al.* 1984; Emison *et al.* 1987; Taylor and Canberra Ornithologists Group 1992). These rates are usually expressed as the percentage of data sheets on which that species was recorded. A similar approach is also used to document either seasonal patterns to reporting rates (Blakers *et al.* 1984) or seasonal changes in the area (number of grid squares) occupied by a species (Emison *et al.* 1987; Taylor and Canberra Ornithologists Group 1992). These types of analyses have not been attempted for the atlases of the Adelaide region for two reasons. First, despite mobilising over 100 observers for both atlases, most of the 268 grid squares were visited fewer than 10 times over the 21 and 24 month atlas periods. Such a frequency of visits is insufficient to allow statistical comparisons of reporting rates for each grid square during the two periods. Second, the sizes of the grid squares (ca. 80 km^2) are such that they support a diversity of habitat types. Without knowledge of the exact locations and hence habitats examined by an observer during each visit to a grid square, differences in reporting rate from one period to the next might simply reflect differences in the locations and hence the habitats searched within a grid square. Third, by pooling data collected over several years potential differences between years may be lost (e.g. the distribution of Black Honeyeaters in the Adelaide atlas area was different in 1984 compared with 1985).

Another component that is poorly documented is breeding activity. For the purposes of managing remnant populations, knowledge of where various species breed is paramount. During the 1984-85 bird atlas of the Adelaide region 179 species were recorded breeding but evidence of breeding was only reported on 2 798 occasions, about 2.4% of all records. The areas with the highest numbers of breeding species, however, were usually those where the observer was a resident and regular contributor. Short visits to locations appear to miss some of the breeding activity that takes place in those areas. The distribution of breeding records during 1984-85 is given for 248 species in SAOA (1994).

These criticisms of atlas data are not easily overcome. All atlases suffer from insufficient information to properly document the distributions of many species at appropriate temporal and spatial scales. The limitations are largely set by the numbers of observers able to contribute. Given this, future studies may need to consider a different approach – concentrating on key species in a smaller area and collecting detailed and repeated information from specific locations within that area.

Implications for conservation and management of bird populations in the Adelaide region

Despite the obvious limitations of atlas data, there are patterns to the changes in recorded distributions that may have important implications for conservation and management. First, some terrestrial species (e.g. Collared Sparrowhawk, Brown Goshawk, Southern Boobook, Singing Bushlark, Crested Shrike-tit, Yellow Thornbill, Varied Sitella) showed extensive shifts in local distribution between 1974-75 and 1984-85 (Table 3). This suggests that these species may not occupy a particular area for a long time. If this is the case their conservation and management will be complex, requiring a network of suitable habitats on both reserves and private land, perhaps even linked by corridors of native vegetation that allow the birds to move around. Second, comparisons between the two atlases highlight possible changes in distribution that might otherwise be difficult to detect and so help to identify populations of birds that may be increasing or decreasing.

Of particular concern to conservationists are those species that appear to be declining. If declines can be detected early enough, appropriate action can be taken to arrest further declines. In the Adelaide atlas area a variety of species appear to have declined where the declines are not easily explained by differences in the prevailing conditions during the two atlases. Amongst the species are the Musk Duck, Yellow-billed Spoonbill, Whistling Kite, Wedge-tailed Eagle, Malleefowl, Painted Button-quail, Buff-banded

Rail, Sacred Kingfisher, Flame Robin, Hooded Robin, Jacky Winter, Gilbert's Whistler, Crested Bellbird, Restless Flycatcher, Southern Emu-wren, Chestnut-rumped Hylacola, Redthroat, Yellow Thornbill, Southern Whiteface, Brown Treecreeper, Tawny-crowned Honeyeater, Beautiful Firetail, Diamond Firetail and Zebra Finch (Table 3). In addition, a range of other species have also largely disappeared or declined dramatically from the Adelaide region (and Mt Lofty Ranges in particular) this century, including Latham's Snipe, Bush Thick-knee, King Quail, Brown Quail, Azure Kingfisher, Spotted Quail-thrush, Regent Honeyeater, and Black-chinned Honeyeater. Some of these species have continued to decline (e.g. Latham's Snipe, Bush Thick-knee, Brown Quail) (Table 3). Of the species that have declined many are woodland species that dwell or feed on or close to the ground and have been recorded as declining in other parts of Australia (e.g. Reid and Fleming 1992; Robinson 1993). This suggests that woodland habitats have been worst affected by selective land clearance and that the ground and shrublayers, in particular, are more easily changed by fires, weeds and grazing by domestic stock. These changes, coupled with possible increased risks of predation from introduced cats and foxes may account for many of the declines.

The decline and loss of native species from an area is usually attributed to the clearance and fragmentation of native vegetation (e.g. Ford and Howe 1980; Saunders 1989; Recher and Serventy 1991; Robinson 1993). Within the Adelaide region much of the native vegetation has been cleared (e.g. Table 1) and in most areas only small isolated remnants of native vegetation remain. At best these only support small local populations of birds which are more or less isolated from other similar populations. Small isolated populations are vulnerable to perturbations like drought, fire and predation. When these secondary perturbations take effect, the isolation of remnants impedes re-colonisation and gradually populations of certain species dependent on natural vegetation decline within the region as a whole. Although the Ash Wednesday fires of February 1983 burnt about 33 000 ha in four locations in the Mt Lofty Ranges (Table 1), those particular fires have had no long term impact on remnant bird populations. So far only Southern Emu-wrens have failed to recolonise areas that they occupied before the fires (i.e. Cox's Scrub Conservation Park) and populations of this species have been recently reported in adjacent areas (J. Cutten pers. comm.) suggesting that they will eventually recolonise. These recoveries, however, may not always occur.

Although further habitat clearance has ceased since the mid-1980s in the Adelaide region, many populations of birds will continue to decline. Ford and Howe (1980) established a relationship between the number of species of birds that could be supported by different areas of native vegetation in southern Australia. They estimated that with the current area of native vegetation remaining in the Mt Lofty Ranges between 35 and 50 species of birds would eventually disappear from the region. For many, the decline would be gradual and already there are a number of studies that document the decline and disappearance of birds from local areas gradually over the last 40-50 years (e.g. Ford and Paton 1976; Paton 1976; Rix 1976; Whatmough 1978; Baxter 1980; Ashton 1985; Taylor 1987; Winslet and Winslet 1987; Laybourne-Smith 1989). Amongst the species listed in these studies were the Scarlet Robin, Dusky Woodswallow, White-browed Babbler, Richard's Pipit, Yellow-rumped Thornbill, Grey Fantail, Rufous Whistler, White-browed Scrubwren, Superb Fairy-wren and Variegated Fairy-wren, species that were not detected by the second atlas as having declined at the coarse scale of grid squares between 1974-75 and 1984-85 (Table 3).

If the loss of species from a region consists of a series of local extinctions followed by failure to re-establish then clearly these vulnerable bird populations need to be monitored and managed at those local scales to minimise further declines. The long-term solution to counter further declines is extensive revegetation but such a solution is far from being embraced. One short-term management option to counter declines could be to re-introduce populations of birds to areas where they formerly lived, and to follow the fate of those birds through time. The benefit of this is that successful re-establishment in areas provides additional security for extant populations by providing a further source of birds for re-colonisation if populations in neighbouring areas crash. However, before any introductions could be considered seriously, detailed information on the population dynamics, life histories, ecological requirements and limiting factors of the birds would be needed. Future studies should aim at documenting local patterns to the distribution and survival of many of the birds listed above and start collecting the biological and ecological data that will be needed in the future for effective management.

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