

# Arrival dates of migrant bush birds in the Strathalbyn district: a 45 year collaborative study

JOHN ECKERT

## Abstract

*A collaborative community-wide record of arrival times (first seasonal records) of 18 bird species over 45 years in the Strathalbyn district established a pattern indicating migration or partial migration in 12. Such a pattern was not excluded in the others but data were less conclusive, generally being too few. In the Little Button-quail, Cockatiel, Budgerigar, Rainbow Bee-eater, White-winged Triller and Masked and White-browed Woodswallow a regular spring arrival was documented but its timing varied among the species, being least variable in the Rainbow Bee-eater (25 days variation 17 September to 14 October) but ranged through September to November in most others. The Rufous Songlark showed a similar pattern but with occasional arrivals as early as May. The Horsfield's Bronze, Pallid and Fan-tailed Cuckoos arrived earlier during late autumn and early winter (April to June). The Flame Robin proved a regular post-breeding autumn migrant, with most first records occurring between mid April and mid May.*

*Variation in arrival dates reflected seasonal conditions, being later in locally dry years or following wet years inland, but was inconsistent among species. Arrival date was also influenced by species abundance, being detected earlier when a species was more numerous.*

*The Rainbow Bee-eater and White-winged Triller arrived earlier over the study period, possibly influenced by a warming trend in Australia associated with climate change.*

## PREAMBLE

**Andrew Black and Graham Carpenter**

Over a period of forty years John Eckert published notes on birds of the Strathalbyn district in the weekly newspaper Southern Argus under the pen name 'Robin'. Of particular interest were his reports of the first arrivals of migratory birds – a local equivalent of letters to The Times of claims to hearing the first cuckoo in spring. In 2004 he submitted a paper on the records for publication in the South Australian Ornithologist. It was accepted for publication subject to further analysis in order to identify factors that might be responsible for the variation in arrival dates from year to year.

John Eckert died on 21 June 2008 without resubmitting the paper. As its reviewers, we believe that it is a remarkable record that deserves publication. We have therefore provided further analysis and discussion, including the addition of a further four years of data from John's notebooks.

For an obituary and bibliography of John Eckert read Black and Horton (2008).

## INTRODUCTION

While bird migration is a well-understood characteristic of many Northern Hemisphere breeding species, including those waders and terns that visit Australia for the austral summer, it is much less clear-cut for birds that breed in Australia. Here the differences between

nomadism and migration have not always been easily separated. Chan (2000) defined migration as the predictable seasonal movement from a breeding-ground to a distant wintering-ground and back again within a single year and nomadism as the circumstance wherein birds constantly wandered to wherever conditions might be suitable for breeding and foraging. The erratic rainfall and climate of inland Australia doubtless force nomadic movement in many species in order to take advantage of times of abundance fortuitously presented in areas that are normally too harsh for survival or breeding. Wyndham (1982) proposed that the Budgerigar, *Melopsittacus undulatus*, a species known for spectacular nomadic movements, seemed to possess an underlying defined migratory pattern.

In the late 1950s I came to the belief that various bird species such as the White-browed, *Artamus leucorhynchus* and Masked, *A. personatus* Woodswallows, Budgerigars, *Melopsittacus undulatus* and Cockatiel, *Nymphicus hollandicus* were regular spring visitors to the Strathalbyn district. When I mentioned this observation to Professor J.B. Cleland he told me that this was not generally known to be the case, and suggested that I obtain prospective documentary evidence. I here provide data showing that most of the species dealt with have an underlying regular pattern of annual movements.

## METHODS

When the Strathalbyn Naturalists Club was formed in 1962 an opportunity arose to assess local bird movements more comprehensively than a single observer could achieve. The publishing of bird notes in the local paper, the Southern Argus, allowed an even wider group of observers to volunteer information.

I therefore began to document the arrival times (earliest report) for 18 species that I believed moved in and out of the district on a seasonal if not necessarily a regular basis. Care was taken to use only those observations with a high

degree of certainty. Species targeted are listed in Table 1. While others such as Sacred Kingfisher, *Todiramphus sanctus*, Silvereye, *Zosterops lateralis*, Welcome Swallow, *Hirundo neoxena*, Fairy Martin, *Petrochelidon aerial* and Tree Martin, *P. nigricans* also undoubtedly have seasonal movements, some are present all year or absent only for a brief period (Fairy Martin). Thus they were not easy to assess for the first date of returning birds.

The data have been collected since 1963, when a network had been established that offered reasonable monitoring, and were continued until 2007, those for the last four years having been extracted from notebooks by Deb and Rick Eckert. A core of observers supplied most of the records but 103 separate individuals contributed (refer to Acknowledgments). Localities are not named but can be provided.

No attempt was made to record the abundance of each species, although exceptional numbers were noted.

The area covered was modelled on that of the former Strathalbyn District Council of the 1960s, bounded roughly by Finnis, Ashbourne, Flaxley, Chauncey's Line, Wellington and the edge of Lake Alexandrina to Clayton, an area of about 100,000 ha (refer to map in Strathalbyn Naturalists Club 2000). The district receives 400-500 mm annual rainfall. Most of the original eucalypt woodland and mallee has long been cleared for agriculture (cereals and stock grazing) and vineyards.

## RESULTS

First arrival dates in each year for 13 of the 18 seasonal visitors to the Strathalbyn district are graphed in Figures 1-12. Those for the Masked Woodswallow are not shown since they closely followed those of the White-browed Woodswallow with which it formed mixed flocks. Observers' initials are given with each record (refer to names in Acknowledgments).

**Table 1. Eighteen seasonally occurring species in the Strathalbyn district chosen for study.**

Species	% years reported	Earliest	Latest	Mean
Little Buttonquail	93	31 Aug	10 Dec	24 Oct
Red-chested Buttonquail	44	24 Oct	5 Jan	29 Nov
Cockatiel	84	23 Aug	29 Nov	27 Sep
Budgerigar	89	27 Jul	16 Jan	11 Oct
Horsfield's Bronze Cuckoo	71	18 Mar	15 Jun	1 May
Shining Bronze Cuckoo	16	18 Aug	17 Apr	8 Nov
Black-eared Cuckoo	22	17 Apr	2 Feb	8 Nov
Pallid Cuckoo	100	8 Apr	12 Sep	7 Jun
Fan-tailed Cuckoo	96	20 Mar	19 Jun	13 May
Red-backed Kingfisher	33	24 Sep	14 Mar	20 Nov
Rainbow Bee-eater	100	14 Sep	12 Oct	29 Sep
Orange Chat	51	10 Sep	15 Apr	9 Jan
White-winged Triller	96	9 Aug	2 Dec	23 Sep
Black-faced Woodswallow	20	31 May	28 Jul	21 Jun
White-browed Woodswallow	91	15 Sep	26 Dec	12 Oct
Masked Woodswallow	73	23 Sep	19 Nov	18 Oct
Flame Robin	100	2 Apr	18 Jun	28 Apr
Rufous Songlark	73	24 May	10 Oct	22 Aug

A statistically derived 'best fit' trend-line was applied to each graph and is shown where a trend to change in arrival dates has been detected from the data. The earliest and latest recorded arrival dates of all 18 species during the 45 years of the study are shown in Table 1. Arrival dates of the four less commonly recorded species are listed in Table 2.

Climatic factors thought most likely to influence arrival times of seasonally occurring species are local winter rainfall and inland rainfall. Graphs of yearly winter rainfall (April-September at Strathalbyn: data from Bureau of Meteorology) and central Australian rainfall are therefore also provided for comparison (Figures 13 and 14). Central Australian rainfall has been adapted from Bureau of Meteorology Australian rainfall deciles (Bureau of Meteorology website), where 7=record rainfall; 6=much above average; 5=above average 4=average; 3=below average; 2=much below average.

## SPECIES ACCOUNTS

### Little Buttonquail, *Turnix velox*

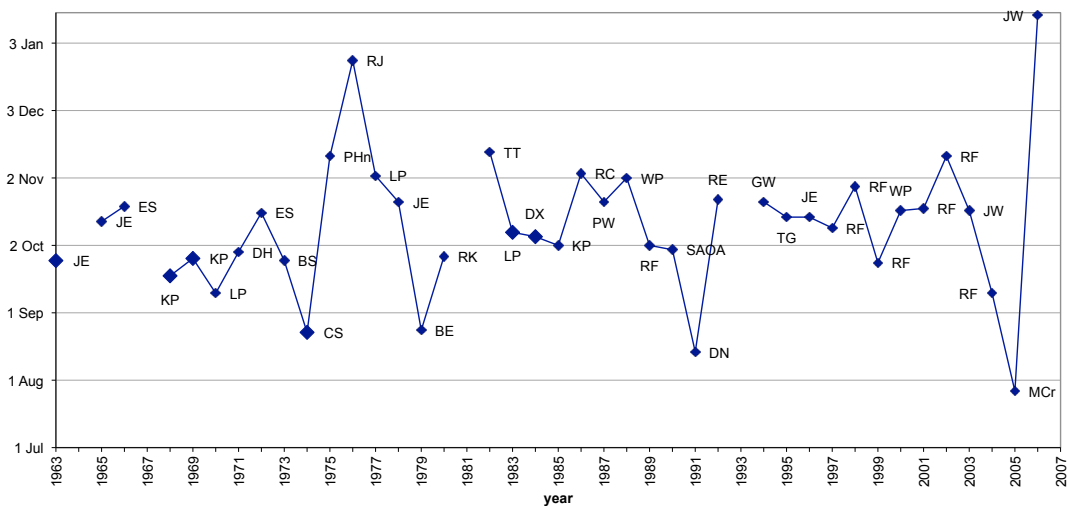
Due to its cryptic habits and preference for either cereal crops or dense grassland, this is a difficult bird to monitor. Arrival dates vary between 31 August and 10 December (mean 24 October) with October – November the usual arrival time recorded. In reality it is more likely that birds begin to arrive in late September – early October in most years, with detection being more dependent on the timing of cereal harvesting than actual arrival dates. Some stayed through winter in 1977 and 1981, and none were reported in 1986, 1998 and 1999. Spring irruptions in southern South Australia occurred in 1963, 1968, 1973, 1983 and 1984 (Jenkin *et al.* 1964, Kraehenbuehl 1970, Eckert 1972, Reid 1976, Carpenter *et al.* 2003).

Arrival dates show no trend over time, although they have become more erratic (Figure 1). Arrival dates also tended to be earlier in irruption years. There is no obvious relationship between local or inland rainfall and arrival dates.

**Table 2. First seasonal records for four less consistently recorded species.**

Year	Shining Bronze Cuckoo	Black-eared Cuckoo	Red-backed Kingfisher	Black-faced Woodswallow
1963		10/10 JE	14/10 LP	
1964				29/6 JE
1965	10/10 JE			7/6 LP
1966	4/9 JEn	17/4 LP		8/6 LP
1967				
1968			29/9 JE	12/6 LP
1969				
1970		15/9 JE		26/6 JE
1971			25/11 ES	
1972				31/5 LP
1973	10/2		20/2 KF	
1974				
1975				
1976				
1977				
1978		2/2 JEn		
1979				
1980				5/7 RCh
1981				
1982			24/9 LP	
1983				
1984			6/1 LW	
1985			26/10 JW <sub>u</sub>	
1986			20/11 JE	28/7 JE
1987				
1988				
1989	17/4 JG			
1990				
1991			21/11 LP	
1992				
1993				
1994			15/10 RE	
1995			14/3 RF	
1996				
1997		27/9 JE		21/6 DM <sub>u</sub>
1998			19/11 EM	
1999			6/10 EM	
2000	24/8 RR	25/4 KP		
2001	18/8 RR	2/9 RE		
2002		24/6 JE		
2003				
2004			4/11 BS	
2005			26/9 RF	
2006				
2007				





**Figure 3. Budgerigar**

flock in excess of 100 is seen, whereas in the 1960s post-breeding flocks of several hundred were sometimes encountered. In some springs that it was not recorded there were observations early in the following year (e.g. five near Hartley on 14 January 1988 – Len Potts pers. comm.). Some were recorded through winter in 1969, 1975, 1984, 2000, 2005 and 2006.

Arrival dates appear to have become later over time (Figure 2) and do not show any obvious relationship with local or inland rainfall.

#### **Budgerigar, *Melopsittacus undulatus***

Budgerigars are an erratic visitor to the district, both in terms of arrival date and numbers. Appearances have been between 17 July and 16 January (mean 11 October) with October the most favoured month. Numbers are often few and duration of stay brief, although in at least half of the years some have stayed to breed. Spring irruptions into southern South Australia have occurred in 1963, 1968-9, 1973-7 and 1983-4 (Higgins 1999, Carpenter *et al.* 2003).

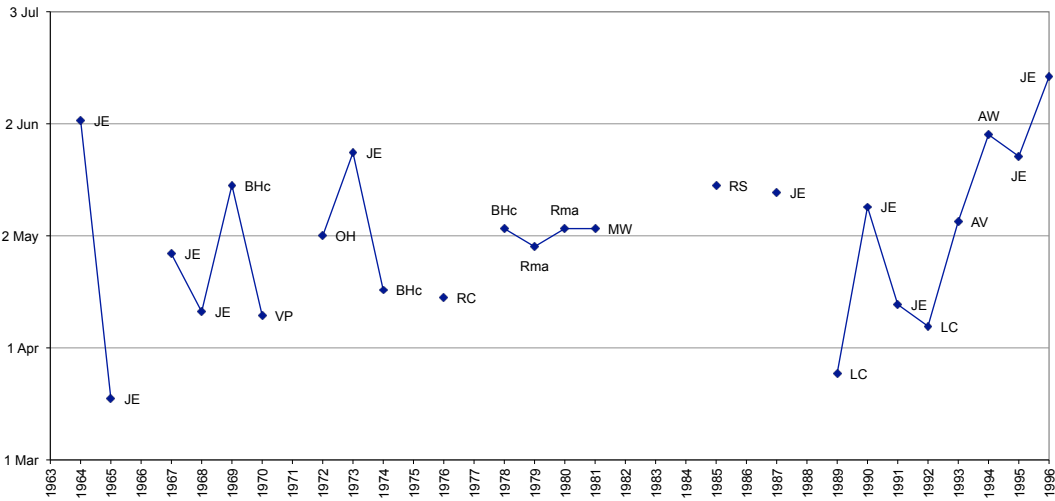
An enormous migration was witnessed on the morning of 7 October 1963. Between 0900 and about 1200, flocks of 10-100 flew continuously over a front of at least 15 km between Belvidere and near Mulgundawa, travelling from north-east to south-west aided by a fairly strong north-

easterly breeze. At least four flocks were visible at any one spot during most of this passage. Late that morning C. Sim (pers. comm.) encountered a similar situation between Strathalbyn and Macclesfield, but with birds flying south to north. Presumably they had been blocked by the sea and the Mount Lofty Ranges and chose to return north along the foothills. It was estimated that a least a million birds passed through the district that day. A similar movement, but with less than 10% of the numbers, occurred on 29 September 1973. A few stayed through winter in 1974, 1983 and 1990. On 13 June 1990 a flock of 200 was seen at Langhorne Creek (R. Lange pers. comm.) but usually in winter flocks of less than 20 are seen. Substantially fewer Budgerigars have visited the district since the 1970s and none were recorded in 2007.

Arrival dates show no trend over time (Figure 3) but are earlier in irruption years, later in locally dry years, and show no obvious relationship with inland rainfall.

#### **Horsfield's Bronze Cuckoo, *Chalcites basalis***

This cuckoo first appears in autumn-early winter in most years, with arrival times from 18 March to 15 June (mean 1 May). However because some juveniles may be present through into autumn, arrival times proved ambiguous. Hence records were not kept after 1996. Arrival times appear to be earlier in locally wet years (Figure 4). The



**Figure 4. Horsfield's Bronze Cuckoo (note arrival dates were not recorded after 1996)**

same ambiguity in arrival times probably also applies to the following two species.

**Shining Bronze Cuckoo, *Chalcites lucidus***

This species is a rare spring visitor to the survey area, recorded as a result of accidental death almost as often as by observation. It prefers high rainfall country and may be more prevalent to the west of Strathalbyn where there were fewer observers.

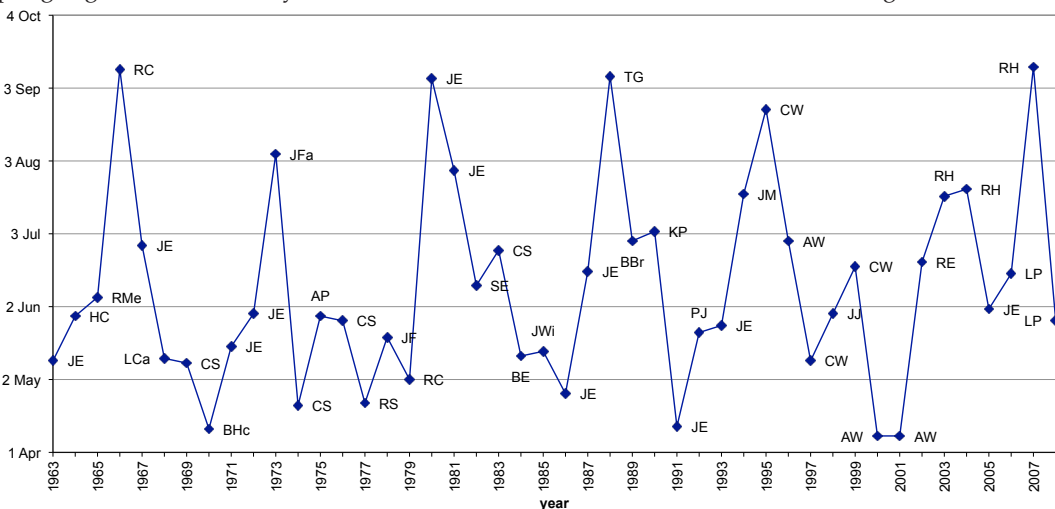
**Black-eared Cuckoo, *Chacites osculans***

For much of the survey area this species is a rare spring vagrant. More recently better attention was

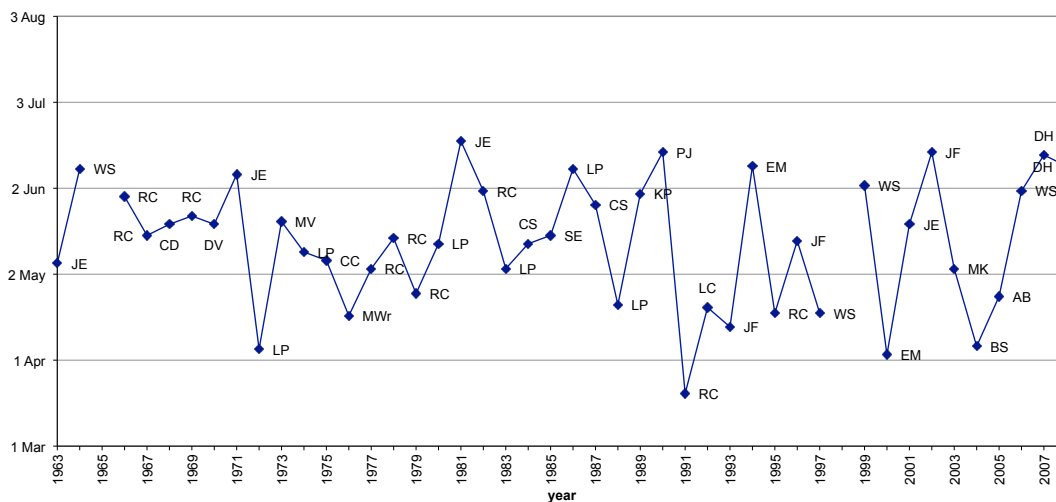
paid to the Chauncey's Line and Ferries McDonald Conservation Park, where closer monitoring might show it to be a more regular visitor.

**Pallid Cuckoo, *Cacomantis pallidus***

The Pallid Cuckoo is a regular visitor to the district, appearing in autumn-early winter but remaining through spring and summer. Arrival dates were from 8 April to 12 September (mean 7 June). An early report observed that it arrived on the Adelaide Plains in the middle of July and at times as early as the middle of June (Anon. 1918). Condon (1968) considered it a spring – summer visitor, with some birds arriving in the first week



**Figure 5. Pallid Cuckoo**



**Figure 6. Fan-tailed Cuckoo**

of June. The Pallid Cuckoo is another species whose numbers have gradually declined, and in some years it is difficult to locate.

Arrival dates show a 7-8 year cyclical pattern with no obvious trend (Figure 5). The pattern shows no obvious relationship with local or inland rainfall.

#### **Fan-tailed Cuckoo, *Cacomantis flabelliformis***

This species is more punctual than the preceding. First dates range from 20 March to 19 June (mean 13 May). It was not recorded in 1965 and 1997. It is a rather furtive species in this district and can easily be overlooked, although it frequently flies into windows. It is considered a regular visitor to the Strathalbyn district, usually departing by November after breeding (Eckert 2000).

Arrival dates show no trend but have become more erratic over time (Figure 6). There is no obvious relationship with rainfall.

#### **Red-backed Kingfisher, *Todiramphus pyrrhopygius***

This species is a rare spring visitor to the southern parts of South Australia including the Strathalbyn district, where the infrequent records obtained suggest that this locality is beyond the normal southerly limit of such movement (Eckert 1989). Despite pairs being present at times no breeding was recorded.

#### **Rainbow Bee-eater, *Merops ornatus***

The Rainbow Bee-eater proved to be the most regular visitor, both in arrival times and numbers. Arrival dates were 14 September to 12 October (mean 29 September) with most in the last week of September or the first week of October. They nested at many places throughout the district and often assembled into sizeable groups before leaving on northward migration in March. Two stayed through winter near Ashbourne in 1967, feeding at times from bees at hives.

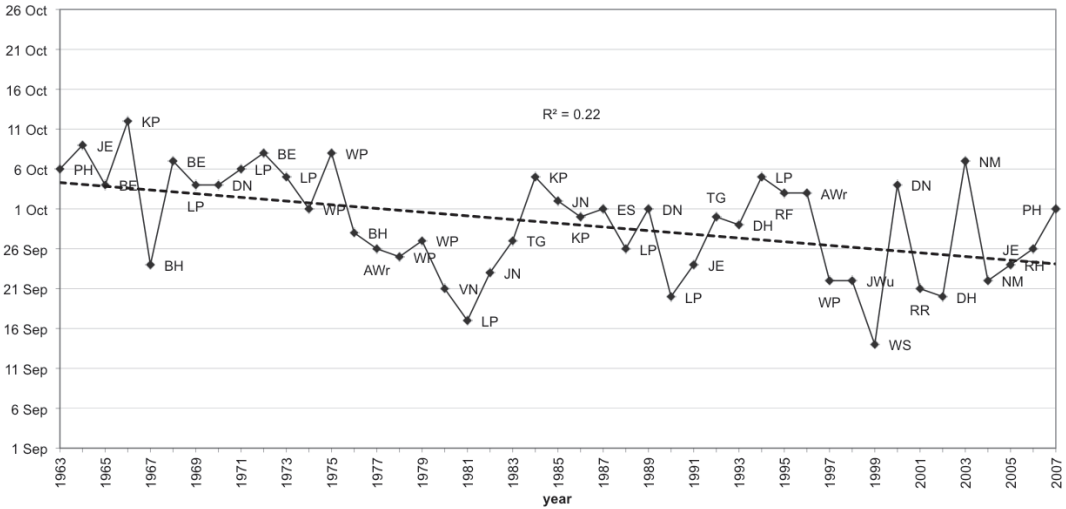
Arrival dates show an earlier trend over time (Figure 7) and are not related to rainfall.

#### **Orange Chat, *Epthianura aurifrons***

This species has been present at some time during half of the survey years but more first reports are in late summer or autumn than spring (Figure 8) and are difficult to interpret, whether early or late. For example, the first record for 1983/4 was 19 January and for 1984/5 it was 10 September.

Thus two first arrival dates may be shown in one year. It has bred on several occasions in both spring and late summer. In three years it stayed until late June and a party of four was seen on 24 August 2002, leaving only July – late August the only period without records. The data suggest that the Orange Chat is at least partly nomadic to the district. Arrival dates show no obvious relationship





**Figure 7. Rainbow Bee-eater**

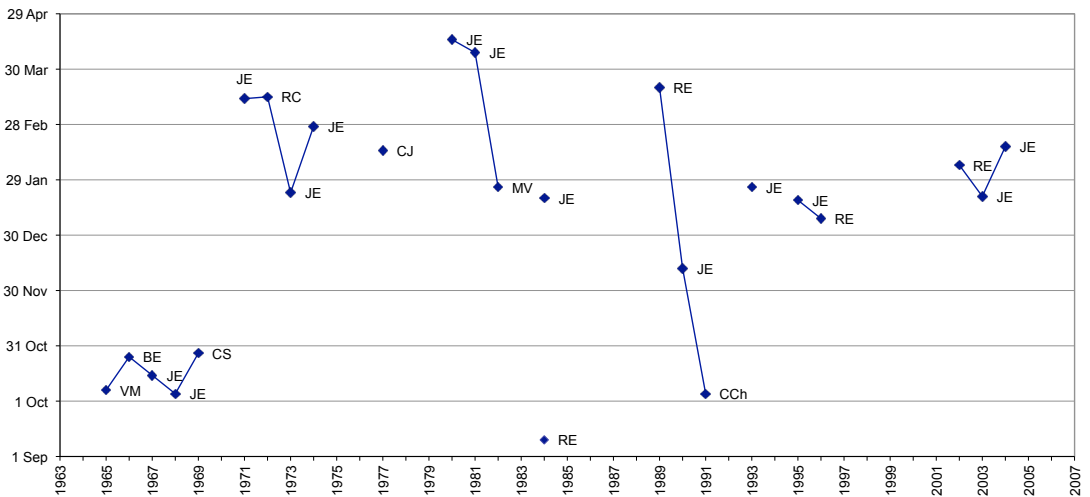
with rainfall, although late summer arrivals may correspond with wet years inland.

birds arrived in spring, the only record for 1975 being of a late-staying bird near Milang in March.

**White-winged Triller, *Lalage sueurii***

This species is a regular spring-summer visitor, usually only in low to moderate numbers. Prior to the 1990s we had never recorded them before early September but since then there have been six years with appearances in August (Eckert 2008). Arrival dates have varied from 9 August to 2 December (mean 23 September). Breeding occurred in about half of the years but often they pass through without staying long. Single birds in female or eclipse plumage stayed through winter on three occasions. In 1975 and 2006 no

The graph (Figure 9) shows a trend towards earlier arrival dates over time although this does not appear to be linear, little change being evident though the 1970s and 1980s, since when arrivals have been earlier on average although more erratic. The apparently abrupt change is not easily explained, e.g. by a change in observer vigilance, and it is possible that some previous ‘early’ claims were discounted because of the species’ otherwise apparent regularity. Later arrivals correspond with wet years inland.



**Figure 8. Orange Chat**

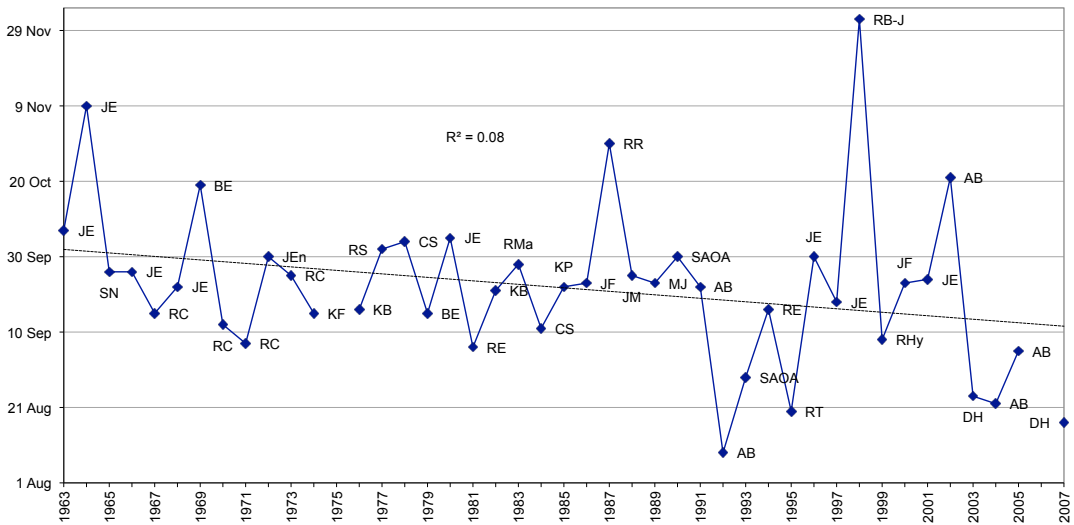


Figure 9. White-winged Triller

**Black-faced Woodswallow, *Artamus cinereus***  
 During the first decade of the study it appeared that this species might be a regular visitor to the Strathalbyn district. Arrival dates are 31 May to 28 July (mean 21 June) with birds staying only for brief period. However there have been only three records in the last 30 years so the species would now be better regarded as an erratic winter visitor.

**White-browed Woodswallow, *Artamus superciliosus***

This and the following species often move into the study area together, the Masked usually in

the minority and, when flocks are passing over at considerable height, are difficult to separate with certainty. Consequently only this species has been graphed (Figure 10). The White-browed occurs in most years, arriving from 15 September to 26 December (mean 12 October). September and October are the usual months of its arrival and it has nested in most years. They usually depart in late January but occasionally some have stayed until March. None have over-wintered.

Arrival dates show no trend over time but are later when wet inland and earlier when wet locally.

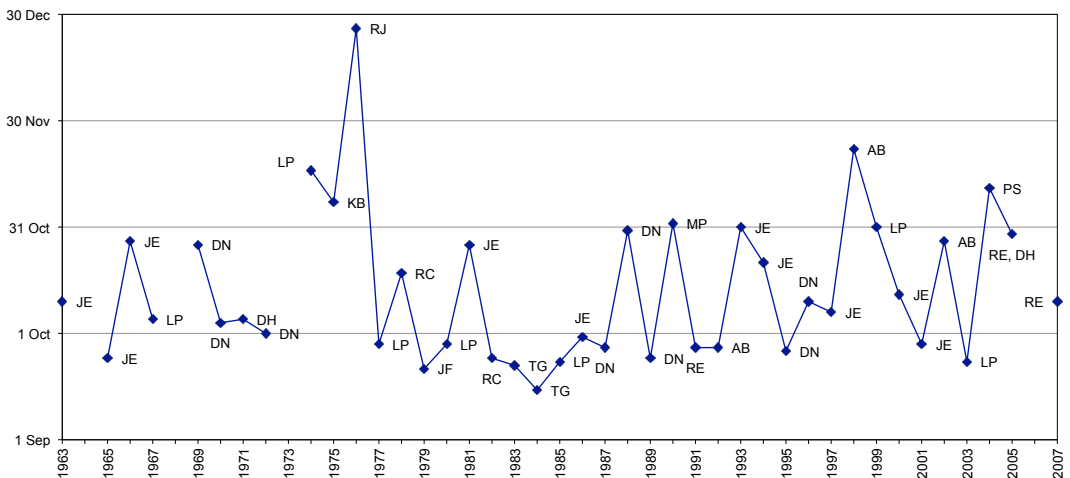


Figure 10. White-browed Woodswallow

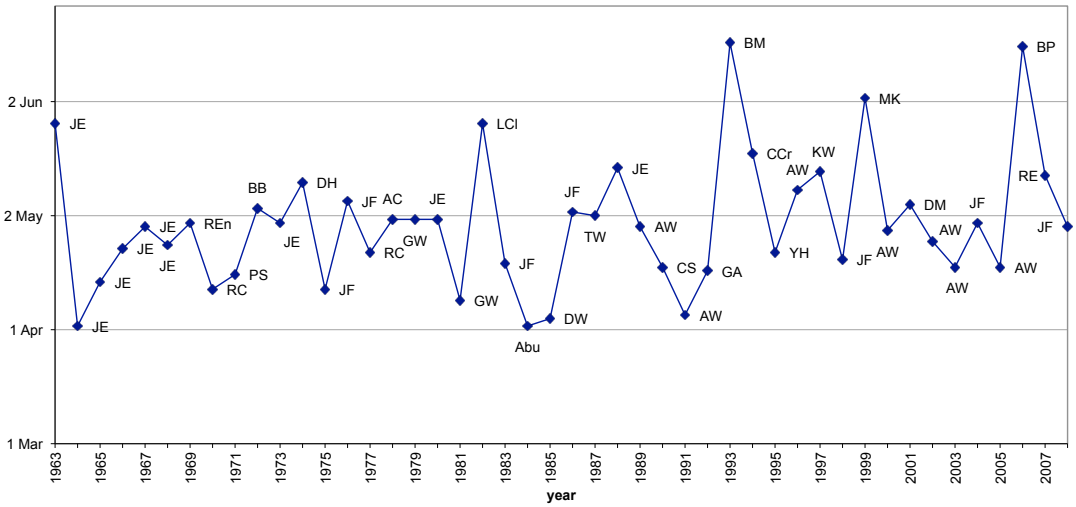


Figure 11. Flame Robin

**Masked Woodswallow, *Artamus personatus***

This species was recorded much less frequently than the preceding in the early years of the study, suggesting that either it was missed among mixed flocks early in the study or its numbers are increasing in proportion. It has not been found nesting as often as the White-browed, but has bred profusely on several occasions.

that only two or three groups visit whereas fifty years ago most parts of the district hosted a group. Arrival dates are 2 April to 18 June (mean 28 April) and birds usually depart by mid August. None have stayed beyond 21 August.

**Flame Robin, *Petroica phoenicea***

An alarming decline has been evident for this non-breeding winter visitor, beginning in the 1950s. While it still occurs each year, it is probable

Arrival dates appear to have become later with time and are more erratic (Figure 11). They are not related to local rainfall.

**Rufous Songlark, *Cincloramphus mathewsi***

A furtive nature combined with plain plumage made this species difficult to monitor. Usually its

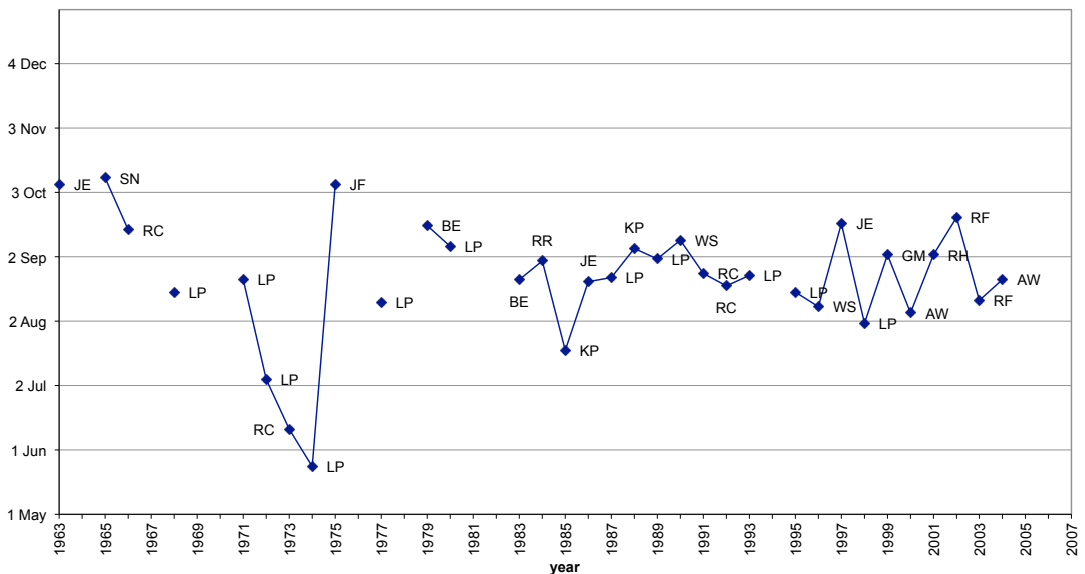
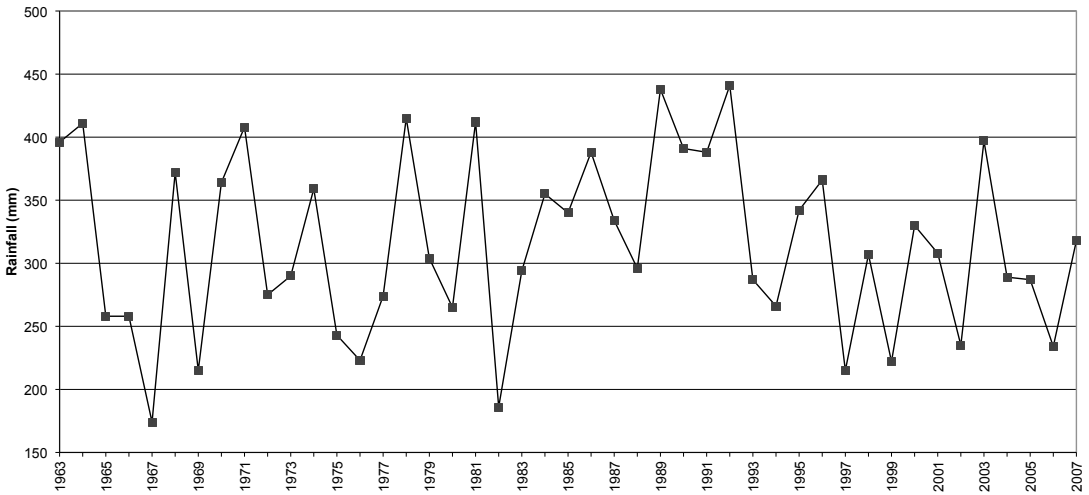


Figure 12. Rufous Songlark

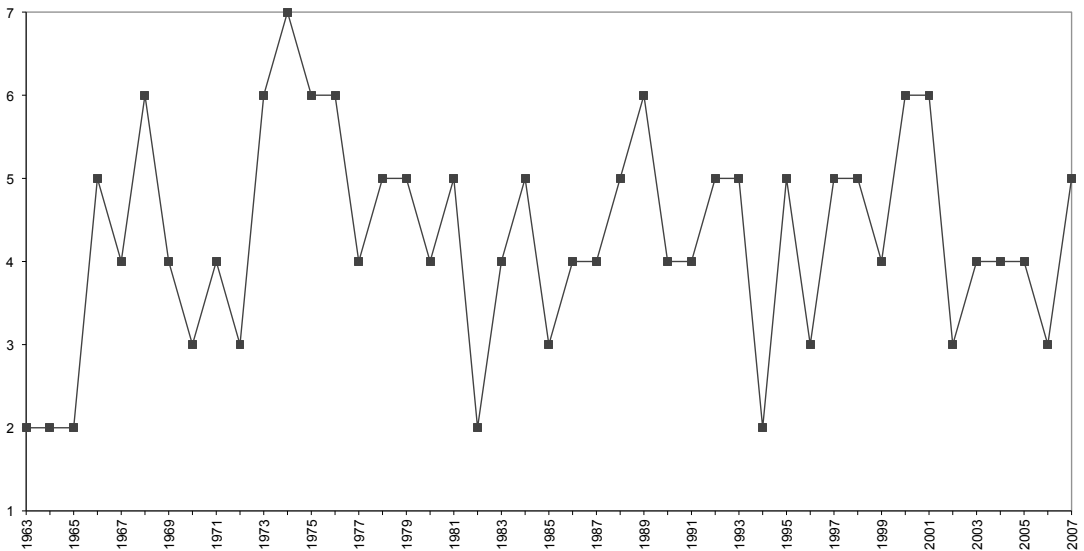


**Figure 13. Combined monthly rainfall for April to September for each year at Strathalbyn (data from Bureau of Meteorology)**

presence was not noticed until it called. This was generally in August or September, but sometimes in June or July (mean 22 August). In 1974 one was heard on 24 May and again on 3 June, suggesting that some birds might arrive well before the date of our first record. It is possible that birds may have been present in more than the 73% of years reported. In most years few birds were recorded, but occasionally they have been quite common with almost every sizeable patch of trees with good grass growth nearby

being occupied by one or more singing males. Breeding is presumed over most of the district at these times.

Arrival dates show no trend with time and have become less erratic (Figure 12). Birds arrived early during a wet period inland (1973-4) and were not recorded in years of low local rainfall.



**Figure 14. Central Australian rainfall based on rainfall deciles (data from Bureau of Meteorology), where 7=record rainfall; 6=much above average; 5=above average 4=average; 3=below average; 2=much below average**

## DISCUSSION

Soon after the commencement of this study Condon (1968) wrote of the Cockatiel, Red-backed Kingfisher and Little Buttonquail as occasional visitors to the southern agricultural districts from the interior and the Budgerigar and Orange Chat as nomadic. The Flame Robin he recognised as a non-breeding winter migrant and the Fan-tailed Cuckoo as resident or partly migratory, the Red-chested Buttonquail being listed only as "rare". He considered the Masked Woodswallow to be either migratory or nomadic and the White-browed Woodswallow to be entirely nomadic. He named only the Pallid Cuckoo and the three smaller cuckoos, Rainbow Bee-eater and White-winged Triller as (regular) spring-summer migrants, the Rufous Songlark an irregular spring migrant.

Whether our findings apply to the southern agricultural regions more broadly, all of the above named 18 species of land-birds are here shown to occur seasonally in the Strathalbyn district. Twelve are considered regular seasonal visitors, occurring in most years. The Little Buttonquail, Cockatiel, Budgerigar, Rainbow Bee-eater, White-winged Triller, White-browed and Masked Woodswallow and Rufous Songlark appear chiefly in spring, while the cuckoos (Horsfield's Bronze, Pallid and Fan-tailed) usually arrive in autumn or early winter. All except the Flame Robin, which arrives in autumn after breeding, have been observed to breed in the district, but the extent varies from year to year with some simply moving through the district. The remaining six species are irregular visitors but show seasonal trends.

In naming the cuckoos as spring-summer migrants to southern districts Condon (1968) noted that some birds arrived earlier. The Fan-tailed Cuckoo he listed as a possible resident based on reports of some birds throughout the year. In the Strathalbyn district this study shows that some at least arrive earlier, but, because abundance was not recorded it is

possible that more birds arrive in spring in support of Condon's (1968) assertion. The Black-faced Woodswallow is generally considered sedentary (Higgins, Peter and Cowling 2006) or partly nomadic (Condon 1968), although early in this study a possible winter migration into the Strathalbyn district seemed evident. The irregular spring and late summer occurrence of the Orange Chat is even more puzzling and monitoring of an expanded area might be necessary to reveal a pattern to its movements.

In order to better quantify the seasonal status of each species it would be necessary to determine departure dates. No attempt was made to do this because, in contrast to arrivals, when a bird is readily detected after being absent and when many species are calling and conspicuous, last recorded dates are often not noted and are therefore easily overlooked. In addition birds are often inconspicuous prior to leaving and, for both these reasons, are more difficult to monitor in a community based survey. The Rainbow Bee-eater is one exception, forming large groups prior to departing. Departures are also complicated by the presence of juveniles, many of which stay on after the adults have left.

The direction of migratory movement is generally assumed to be north-south. Nix (1976) drew attention to the peak productivity of plant growth in spring and early summer in southern temperate areas but in autumn and winter in northern Australia following the tropical wet season. He pointed out that this facilitated a regular south-north movement pattern in some birds which allowed them to take advantage of the food generated by such peaks. Complementary evidence of patterns of north-south movements of many Australian birds was provided by Griffioen and Clarke (2002) who analysed seasonal records from the two Australian Bird Atlases and other large cooperative databases. Their analysis excluded Western Australia, and was most reliable for movements in the four eastern states where cover was most complete. Five basic movement

patterns were recognised, four being pertinent to these records. The Flame Robin was one of the 'Trans Bass Strait' migrants. Fan-tailed and Shining Bronze Cuckoos had a strongly defined 'eastern coastal' migratory pattern. Little Buttonquail (Red-chested not discussed), Red-backed Kingfisher, Rainbow Bee-eater, Cockatiel and Orange Chat showed a 'north-south' inland movement pattern. The remaining seven exhibited 'non-cardinal' (i.e. not strictly north-south) inland movements. Budgerigar, White-winged Triller and Masked Woodswallow moved in a north-westerly direction away from the south-eastern Australian coastline ('slope line') and Pallid and Horsfield's Bronze Cuckoos (Black-eared not discussed), White-browed Woodswallow (Black-faced not discussed) and Rufous Songlark took an 'Inland Circle' route, moving north-east in the autumn, north-west and inland in the winter and south in spring.

With the exception of the Flame Robin a north-south movement pattern is probably true in a broad sense for all of the species discussed, but the direction of travel in birds actually seen during their arrival in the Strathalbyn district is much more often from north-east to south-west. Some species (Budgerigars and woodswallows) seem to be assisted by the wind, particularly bouts of north-easterly and northerly wind preceding changes in weather. Occasionally though, our first woodswallow sightings are of flocks going north, presumably having reached the sea and turned back. There seems to be a scouting element associated with early visits by both these and the Budgerigar, for they seldom settle down and stay on first arrival as most other seasonal species do, possibly because seasonal conditions are not yet suitable for residence. It is often the third or fourth visit before woodswallows stay to nest. It may be that the main migratory stream comes down from Queensland through mid-western and western New South Wales to about northern Victoria and continues into southeastern South Australia through the mallee belt. Southward progress may be in a series of advancements and moves back as it is necessary for country to dry out and mature

so that insects and seeds become more readily available. Some of these species are often recorded at Loxton a week before arriving near Strathalbyn (G.E. Warneke, pers. comm.) and I have recorded Little Buttonquail and migratory woodswallows east of Meningie a week or more before they were detected west of the River Murray.

Other than for the Rainbow Bee-eater and Flame Robin there is great variation in arrival dates, presumably reflecting seasonal conditions in differing parts of Australia. Local rainfall may influence arrival times by affecting the availability of food. In locally wet years there may be a greater cover of grass earlier in the season, providing feeding habitat for quails, parrots and songlarks. There may be a greater abundance of invertebrate prey for woodswallows, cuckoos, trillers and kingfishers. Local rainfall also affects the abundance and timing of breeding for cuckoo hosts. These factors may explain the earlier arrivals of White-browed and Masked Woodswallows and Horsfield's Bronze Cuckoo in locally wet years and later arrivals of Budgerigar, in locally dry years.

Species that migrate through or from more arid central Australia are influenced by rainfall in that region. The combination of water and higher temperatures creates ideal breeding conditions. This may influence arrival times in the study area by delaying or reducing movements, such as is evident in White-winged Triller, Rufous Songlark, White-browed and Masked Woodswallows. Irruptions into coastal areas also occur when the inland dries out. Arrival dates are also likely to change if a species becomes more or less abundant. Arrivals are statistically more likely to be recorded earlier in years when a species is more abundant. This appears to apply to irruptions of Little Buttonquail and Budgerigar. On the other hand, arrival dates are more likely to be recognised only later and more erratically when a species is present in very small numbers. The Flame Robin, Cockatiel, Fan-tailed Cuckoo and possibly Red-chested Buttonquail are examples.

It is likely that a combination of these factors affect the arrival times of seasonal bird species in the Strathalbyn district.

At the global scale, climate change may influence arrival dates. There is evidence for a warming trend in temperatures across much of Australia (Della-Marta, Collins and Braganza 2004). While no clear evidence for changes in migration times has been established in Australia, in the Northern Hemisphere many bird species are arriving earlier and changing breeding seasons (e.g. Sparks and Menzel 2002, Rubolini *et al.* 2007). Species most affected are those that migrate the longest distances.

The 45 years covered by this study provides a unique opportunity to determine whether bird species may be affected by climate change in temperate southern Australia. Any such influence is however difficult to isolate given the extent to which local habitats have been impacted by vegetation clearance, and its associated effect on local climate. Most significant is the trend for earlier arrival in the Rainbow Bee-eater (about 2.5 days per decade), because its abundance in the study area has been similar over the study period and impacts on habitat less evident. A similar trend was found during a 20 year study at Eyre Bird Observatory in south-eastern Western Australia (Chambers 2008), although a stronger trend was found for later departure dates resulting in a longer stay. In a 30 year study near Sydney, Smith and Smith (2012) found 16 locally breeding woodland and forest migrants had significantly earlier arrival times (4.4 days per decade), although the species studied were different from those monitored in the Strathalbyn district.

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**Andrew Black**  
**South Australian Museum,**  
**North Terrace,**  
**Adelaide, South Australia 5000.**  
**Email [abblack@bigpond.com](mailto:abblack@bigpond.com)**

**Graham Carpenter**  
**24 Dryden Road,**  
**Black Forest, South Australia 5035.**