SPECIES RICHNESS AND ABUNDANCE OF BIRDS IN MT LOFTY RANGES STRINGYBARK HABITAT: YEAR 2000 SURVEY

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ABSTRACT

Following the bird survey of stringybark woodland in the Mt Lofty Ranges in 1999–2000 (Possingham, Field and Possingham 2004), 37 patches of the same habitat were surveyed during the spring–summer of 2000. Each patch contained one or more 2 ha sites that were visited for three 1 h periods on different days. Each visit was divided into three consecutive 20 minute sampling periods providing a total of nine samples for each site. Overall, we visited 48 sites, 33 of which are common to both surveys. This report places the data in the public forum by publishing bird species lists and some simple analysis and discussion.

Two lists summarise the data; one categorises the records by species and the other by site. We calculate two measures of abundance for each species, i.e. probability of recording and density. The main differences in species counts between the two surveys are an increase in total species from 69 to 72 and on-site species from 55 to 62. The common species decreased from six to five, uncommon species remained at 17 and rare species increased from 27 to 32. We combine the records from the 1999–2000 and Year 2000 surveys to define 25 core species for this habitat, as determined by a probability of recording greater than 0.13. Comparing the probability of recording these core species, 18 showed no significant change, five a significant decrease (Brown Thornbill *Acanthiza pusilla*, New Holland Honeyeater *Phylidonyris novaehollandiae*, Black-faced Cuckoo-shrike *Coracina novaehollandiae*, Grey Currawong *Strepera versicolor* and Common Blackbird *Turdus merula*), and two a significant increase (Galah *Cacatua roseicapilla* and Crimson Rosella *Platycercus elegans*). Changes in the abundance of these core species are discussed.

We discuss various estimates of species richness for this habitat; the final one based on accumulation plots as described in the previous report. Applying this method to the records from three independent 20 minute, 2 ha samples of 48 sites, the estimated species richness is 65, as it was in the previous survey. Using three 1 h samples from this survey increases this figure to 83 that is more consistent with other data on birds in the Mt Lofty Ranges. Observer, wind and site all had statistically significant effects on the number of species recorded.

Apart from these simple comparisons, there has been no attempt to determine trends in bird abundance; this will be done using additional data from subsequent surveys.

The basic data and this report are available from the downloads section of <www.ecology.uq.edu.au> and the authors.

INTRODUCTION

During spring–summer 2000, the second year of the long-term survey of the Mt Lofty Ranges, we surveyed stringybark and gum woodland habitats. This paper reports the results from the stringybark habitat; it follows on from the Year 1999 stringybark survey, named the SB99–00 survey and reported in Possingham, Field and Possingham (2004). The survey reported here is referred to as the SB00–01 survey. The results from a concurrent similar survey of gum woodland will be reported later.

The results from this survey extend the baseline data for stringybark woodland, and include:

(i) bird lists, categorised by species and site giving the numbers of birds recorded, times a species is sighted and species recorded from nine samples;
(ii) a comparison of the records from this survey and the SB99–00 survey;
(iii) a continued investigation of species accumulation plots across sites and visits as a means of estimating species richness, and comparison with the SB99–00 survey;
(iv) for selected species, two estimates of bird abundance, i.e. the probability of recording a species and bird density in birds per hectare; and
(v) comments on the effect of survey design on the number of species recorded.

It is important to note that the data presented in this paper refer to a specific set of conditions, i.e. stringybark woodland in late spring and early summer, particular observers and time-of-day; see Possingham and Possingham (1997) for discussion of these and other factors that affect bird observations.

METHODS

From early November 2000 to mid-December 2000, eight observers visited 48 sites in 37 patches of stringybark woodland. The 2 ha sites are based on the 38 used for the previous SB99–00 survey and are shown in Figure 1. Overall, 33 sites were common to both surveys. Birds were recorded for three 1 h periods with each period consisting of three consecutive 20 minute samples. The 1 h visits to each site are termed Sessions; with each Session divided into three consecutive 20 minute visits, termed samples.

The eight observers made the required 144 visits of 1 h, using an unstructured plan. How-

ever, the three consecutive 20 minute samples from each site, that comprised each 1 h sample, were by the same observer. The 1 h visits to each site were by different observers on different days. See the report on the SB99–00 survey for the definitions of patch and site and the techniques required to record the on-site, off-site and overhead transient observations. The Record Sheets and recording procedure were the same as used for the SB99–00 survey.

Note that each entry in the Record Sheet is the estimated total number of birds of a species sighted during a sample, which often includes several observations of individual birds or groups of birds.

The recording method allows both the occurrence of a sighting during a sample and the number of birds in that sighting to be easily extracted for subsequent analysis, but the grouping or flocking of birds is lost. Sightings are the more meaningful measure of the avifauna than bird numbers because of the difficulty of preventing multiple recordings of a bird or group of birds. Observers, however, try not to re-count birds. Note also that the observers do not record the number of distinct occurrences, there is only one number on the Record Sheet, i.e. the number of birds observed during a sample. This information constitutes one sighting of the species and provides the number of birds recorded. The use of small sampling periods, i.e. 20 minutes, rather than 1 h, will reduce multiple recordings during a sample and hence improve any analysis based on the number of birds.

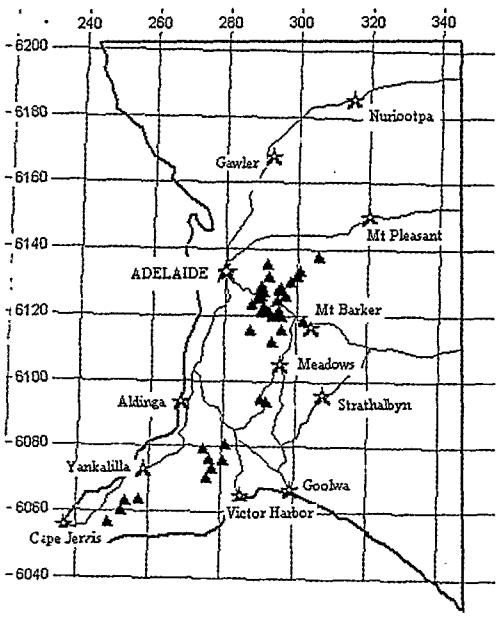

Figure 1. Stringybark sites for the Year 2000 survey (Datum AGD 66).

RESULTS AND ANALYSIS

The eight observers completed 432 Record Sheets and contributed 144 hours observation time plus much more travelling time. The observations resulted in 4,058 on-site, 2,346 off-site and 460 overhead transient Record Sheet entries. All the analyses, except simple lists, ignore overhead transient and off-site records. Most of the analysis uses presence-absence data, rather than the number of birds observed during a sample.

The number of birds of each species observed during each sample and other survey parameters were entered into a *Microsoft Access 97* database for analysis. Copies of this database and report are available from the authors and the downloads section of <www.ecology.uq.edu.au>.

Species lists

Table 1 summarises the records for all species from the nine samples of the 48 sites; scientific bird names may be obtained from Christidis and Boles (1994) or SAOA (1996). The table shows:

(i) the total number of birds for each species recorded on-site, off-site and as overhead transients;

(ii) the number of birds for each of the nine samples;

(iii) the total number of sightings for each Session and all three Sessions combined; and

(iv) the probability of recording each species. The probability of recording a species from the SB99–00 survey is included for comparison.

Note that, in this table, the Total Sightings for each Session is the sum over the three samples. So, for each Session, a species could be sighted a maximum of 144 times (48 sites x 3 samples) and for all three Sessions, 432 times (48 sites x 9 samples).

Compared with the SB99–00 survey, more species were recorded overall (72 versus 69), on-site (62 versus 55) and overhead transient (31

Table 1. All birds recorded for all samples of all stringybark sites: Year 2000 survey. The data given are for on-site records, except where denoted as overhead transients or off-site. Note one sighting means that one or more single birds or several groups of birds were recorded during one single 20 minute sample of a 2 ha site. The probability of recording a species P_{re} for the SB00–01 survey is the total on-site sightings for the three independent samples (Sessions 1, 2 and 3, Sample 1) divided by the number of samples (i.e. 48 x 3 = 144). The total on-site sightings for these three visits is not given in this table, but can be obtained from 144 x P_{re}. The species marked #, ## and ### are commonly, uncommonly and rarely recorded, respectively; values of P_{re} equal to 0.60 and 0.13 are used for these divisions. Species marked #### were not recorded from the three samples (Sessions 1, 2, and 3, Sample 1), so P_{re} was not computed. Of the 10 species recorded not occupying a site, two (marked +) are waterbirds, two (++) could be classed as not bush birds, and three (+++) are bush birds that could have been recorded on-site. The remaining two species (++++) could be considered as vagrant in this habitat. The values of P_{re} for the SB99–00 survey are based on Session 1 to 4, Pass 1, i.e. 4 x 38 = 152 samples. Note that the three additional species recorded on-site only during the SB99–00 survey (Southern Boobook *Ninox novaeseelandiae*, Australian Owlet-nightjar *Aegotheles cristatus* and Yellow Thornbill *Acanthiza nana*) are listed here only with their P_{re} value of 0.007.

		Session 1				Session 2				Session 3				Totals for all samples				Probability of recording	
Common name		Total sightings	Sample 1 birds	Sample 2 birds	Sample 3 birds	Total sightings	Sample 1 birds	Sample 2 birds	Sample 3 birds	Total sightings	Sample 1 birds	Sample 2 birds	Sample 3 birds	On-site sightings	On-site birds	Overhead birds	Off-site birds	SB00–01 survey	SB99–00 survey
Australian Wood Duck	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	8	–	–
Pacific Black Duck	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	24	–	–
Little Pied Cormorant	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–
Whistling Kite	++	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–
Brown Goshawk	####	–	–	–	–	1	–	–	2	–	–	–	–	1	2	2	–	–	–
Collared Sparrowhawk	###	–	–	–	–	1	1	–	–	–	–	–	–	1	1	–	–	0.007	–
Wedge-tailed Eagle	###	–	–	–	–	–	–	–	–	2	2	1	–	2	3	1	–	0.007	–
Nankeen Kestrel	++	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–
Painted Button-quail	###	1	1	–	–	–	–	–	–	–	–	–	–	1	1	–	–	0.007	–
Common Bronzewing	###	15	6	6	9	18	7	11	5	8	5	2	5	41	56	7	41	0.097	0.066
Brush Bronzewing	###	–	–	–	–	1	–	2	–	1	1	–	–	2	3	–	7	0.007	0.033
Yellow-tailed Black-Cockatoo	##	24	19	22	17	24	19	25	20	29	19	34	24	77	199	128	149	0.167	0.171
Galah	##	22	20	16	22	18	18	15	9	22	25	19	15	62	159	115	123	0.153	0.099
Sulphur-crested Cockatoo	##	7	9	2	2	14	30	17	6	14	17	9	8	35	100	56	124	0.125	0.059
Rainbow Lorikeet	##	11	8	13	12	18	14	12	12	25	30	23	21	54	145	201	109	0.132	0.099
Musk Lorikeet	###	1	3	–	–	1	–	–	3	3	2	2	2	5	12	12	6	0.014	0.013
Purple-crowned Lorikeet	+++	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4	–	–	0.020
Crimson Rosella	#	119	147	153	166	115	152	144	163	108	135	137	123	342	1320	123	359	0.813	0.671
Eastern Rosella	####	1	–	–	2	–	–	–	–	–	–	–	–	1	2	–	–	–	–
Red-rumped Parrot	###	–	–	–	–	–	–	–	–	1	2	–	–	1	2	2	1	0.007	0.007
Elegant Parrot	###	2	1	2	–	1	–	–	1	1	–	–	1	4	5	30	12	0.007	–
Pallid Cuckoo	+++	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–
Fan-tailed Cuckoo	###	7	3	1	3	–	–	–	–	6	2	2	2	13	13	1	26	0.035	0.059
Horsfield's Bronze-Cuckoo	###	1	–	–	1	1	1	–	–	–	–	–	–	2	2	–	5	0.007	0.020
Shining Bronze-Cuckoo	###	5	2	2	2	2	2	–	–	3	1	2	–	10	11	–	33	0.035	0.020
(Southern Boobook)																			(0.007)
(Australian Owlet-nightjar)																			(0.007)
Tawny Frogmouth	####	–	–	–	–	–	–	–	–	3	–	3	4	3	7	–	–	–	–

Laughing Kookaburra	###	8	4	–	6	8	3	2	3	12	10	6	4	28	38	–	73	0.090	0.086
Sacred Kingfisher	###	9	4	6	4	10	5	4	4	12	1	6	7	31	41	1	50	0.063	0.059
White-throated Treecreeper	#	94	47	39	45	92	47	53	41	92	46	44	54	278	416	1	271	0.646	0.678
Superb Fairy-wren	#	104	144	141	118	100	150	135	165	87	125	149	133	291	1260	–	220	0.688	0.783
Spotted Pardalote	###	17	6	8	8	10	4	5	3	11	4	7	4	38	49	–	23	0.063	0.007
Striated Pardalote	##	94	55	70	63	78	56	64	62	80	60	58	63	252	551	–	161	0.576	0.487
White-browed Scrubwren	##	73	80	71	80	57	72	75	80	59	79	73	87	189	697	–	50	0.438	0.355
Chestnut-rumped Heathwren	###	1	–	1	–	–	–	–	–	3	1	2	2	4	6	–	–	0.007	0.013
Brown Thornbill	##	71	64	58	64	66	72	69	73	75	52	65	79	212	596	–	22	0.451	0.605
Buff-rumped Thornbill (Yellow Thornbill)	###	22	31	32	26	12	15	21	15	11	7	11	15	45	173	–	5	0.097	0.072 (0.007)
Striated Thornbill	#	108	189	193	164	83	147	118	124	79	105	129	135	270	1304	–	80	0.667	0.678
Red Wattlebird	##	36	23	39	24	33	30	22	36	55	44	51	53	124	322	36	111	0.278	0.197
Little Wattlebird	####	–	–	–	–	–	–	–	–	1	–	–	1	1	1	–	–	–	–
Yellow-faced Honeyeater	##	49	38	28	42	63	42	52	55	69	47	44	53	181	401	26	178	0.451	0.414
White-plumed Honeyeater	####	–	–	–	–	–	–	–	–	1	–	–	2	1	2	–	–	–	–
Brown-headed Honeyeater	###	6	3	2	3	–	–	–	–	1	1	–	–	7	9	1	18	0.014	0.013
White-naped Honeyeater	###	10	4	6	9	15	9	7	12	11	6	10	13	36	76	15	61	0.056	0.145
Crescent Honeyeater	##	49	21	28	31	40	24	17	23	64	33	34	42	153	253	–	40	0.333	0.375
New Holland Honeyeater	###	11	5	11	9	2	1	2		4	3		2	17	33	–	11	0.042	0.125
Eastern Spinebill	##	29	18	15	13	22	11	6	13	21	2	15	10	72	103	–	49	0.146	0.211
Scarlet Robin	##	39	22	17	16	26	10	11	16	24	12	11	10	89	125	–	44	0.215	0.178
Varied Sittella	###	11	12	13	13	8	7	15	5	3	3	1	2	22	71	–	3	0.049	0.033
Crested Shrike-tit	####	2	–	1	1	–	–	–	–	–	–	–	–	2	2	–	5	–	0.007
Golden Whistler	##	45	21	21	14	39	23	12	21	37	17	12	15	121	156	–	115	0.313	0.276
Rufous Whistler	###	8	5	3	3	3		2	1	7	3	1	6	18	24	–	24	0.035	0.013
Grey Shrike-thrush	##	46	11	19	20	48	20	19	23	45	16	19	20	139	167	–	196	0.299	0.441
Restless Flycatcher	+++	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–
Magpie-lark	###	1	3	–	–	–	–	–	–	1	–	2	–	2	5	–	12	0.007	–
Grey Fantail	#	91	58	63	69	103	59	60	74	87	49	52	53	281	537	1	210	0.667	0.849
Willie Wagtail	###	2	2	1	–	2	2	2	–	–	–	–	–	4	7	–	1	0.014	–
Black-faced Cuckoo-shrike	###	9	6	2	3	8	2	4	7	11	–	8	6	28	38	16	21	0.049	0.178
Dusky Woodswallow	###	1	1	–	–	–	–	–	–	2	2	–	1	3	4	–	–	0.014	0.007
White-backed Magpie	###	13	9	10	5	13	19	8	5	8	8	7	3	34	74	9	140	0.118	0.066
Grey Currawong	##	30	15	15	13	23	13	17	7	29	16	16	12	82	124	10	102	0.194	0.230
Little Raven	###	7	1	6	7	4	5	2	1	3	2	1	2	14	27	34	88	0.028	0.059
White-winged Chough	++++	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–
Skylark	++++	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	–	–
Red-browed Finch	###	10	11	8	13	9	2	4	11	13	18	11	15	32	93	–	21	0.069	0.079
European Goldfinch	###	–	–	–	–	2	–	2	1	9	11	20	10	11	44	30	26	0.014	0.072
Mistletoebird	####	–	–	–	–	2	–	–	2	–	–	–	–	2	2	–	1	–	0.020
Welcome Swallow	####	1	–	2	–	1	–	2	–	–	–	–	–	2	4	–	3	–	0.007
Tree Martin	###	5	2	6	3	–	–	–	–	–	–	–	–	5	11	17	–	0.007	0.020
Silvereye	##	46	30	35	40	35	33	22	27	49	31	40	41	130	299	19	46	0.333	0.263
Bassian Thrush	###	–	–	–	–	3	1	1	1	–	–	–	–	3	3	–	–	0.007	–
Common Blackbird	##	43	25	24	18	39	24	21	21	40	21	16	21	122	191	6	148	0.285	0.513
Common Starling	###	13	9	5	5	7	5	2	2	6	3	5	2	26	38	3	32	0.083	0.026
Species counts	72	51	46	44	43	48	40	41	42	51	45	43	45	62	–	31	57	54	54

versus 27), but fewer species off-site (57 versus 62). However, the same number of species (54) was recorded for a 1 h effort using three independent 20 minute samples from the two surveys (Sessions 1, 2, 3, Sample 1, from the SB00–01 survey and Session 1, Samples 1, 2 and 3, from the SB99–00 survey). As for the SB99–00 survey, this species count of 54 for the SB00–01 survey is consistently greater than for any of the 1 h samples, i.e. 51, 48 and 51. For the 33 sites common to both surveys, 61 species were recorded from all nine on-site samples for the SB00–01 survey and 55 for the SB99–00 survey. Some of these differences might be explained by the different survey effort used, 144 person-hours overall for SB00–01 compared with 114 for SB99–00.

Of the 72 species recorded overall, 62 were on-site species. Of the 10 species recorded as not occupying a site, three (marked + in Table 1) were obviously associated with a nearby wetland, two (marked ++) could be classed as not being bush-birds and three (marked +++) are bush-birds that could have been recorded as on-site, i.e. using a 2 ha site of stringybark habitat. The remaining two species (marked ++++) were recorded at very low frequency and could be considered as vagrant in this habitat. As for the SB99–00 survey, three introduced species, European Goldfinch *Carduelis carduelis*, Common Blackbird *Turdus merula* and Common Starling *Sturnus vulgaris*, were recorded.

The probability of recording a species in a 2 ha site during a 20 minute sample, P_{re} (second last column of Table 1) has been computed directly from the number of sightings for each of the 54 on-site species. The data for this calculation were the sum of the sightings from the three independent time-separated 20 minute samples, Sessions 1, 2 and 3, Sample 1, divided by the total number of visits, i.e. 144. See the SB99–00 survey report for a discussion of the precision of P_{re}. Note that the three 1 h samples have an on-site species count of eight more, i.e. 62.

On the basis of P_{re}, we divided these 54 species into four groups: commonly recorded, uncommonly recorded, rarely recorded, and P_{re} not computed (see below). The five species marked with # in Table 1, were commonly recorded, P_{re} >0.60; and were sighted >86 times during the 144 independent visits. Seventeen species marked with ## were uncommonly recorded, P_{re} 0.13–0.60; and were sighted 19–86 times. Thirty-two species marked with ### were rarely recorded, P_{re} <0.13; and were sighted <19 times. Note that eight on-site species with very low abundance were not recorded in all three independent samples (Sessions 1, 2 and 3, Sample 1) and P_{re} was not computed; and are marked with ####.

The 40 species marked ### or #### in Table 1 and four marked '?' from SB99–00 are present in small numbers and are rarely seen or vagrant in the stringybark habitat. These are species with very low abundance and are discussed later.

Core species

We have chosen the common and uncommon species (# and ## in Table 1) as core species for this habitat; they total 22 from the 62 on-site species. Combining the records from the two surveys increases the number to 25, see Table 2. The criterion of # and ## is based on a P_{re} value greater than 0.13, which will slightly differ from the values in Table 2 which are based on the 33 sites common to both surveys. Nineteen of these 25 species are common to both surveys. The other six: White-naped Honeyeater *Melithreptus lunatus*, New Holland Honeyeater *Phylidonyris novaehollandiae* and Black-faced Cuckoo-shrike *Coracina novaehollandiae*, from the SB99–00 survey and Galah *Cacatua roseicapilla*, Rainbow Lorikeet *Trichoglossus haematodus* and Sulphur-crested Cockatoo *Cacatua galerita* from the SB00–01 survey are marginal members of the core species group.

The comparison of the relative abundance of these core species between the two surveys was determined using 90% Confidence Intervals (CI). The exact comparison of probabilities is beyond the level of this paper so a relativity simple method is used; i.e. a change in P_{re} is considered significant if either of the two values of P_{re} falls outside the 90% CI interval of the other. The Appendix gives the 90% significant difference expressed as a percentage of P_{re} that can be detected from two surveys of the same 33 sites. Using these data, 18 of the core species showed no significant change (N in Table 2), two, Galah and Crimson Rosella increased (I) and five, Brown Thornbill *Acanthiza pusilla*, New Holland Honeyeater, Black-faced Cuckoo-shrike, Grey Currawong *Strepera versicolor* and Common Blackbird, decreased (D).

It is considered unlikely that the abundance of these seven species has changed over the year

Table 2. The probability of recording and density of the core species for 48 stringybark sites, SB00–01 survey and a comparison with the SB99–00 survey based on the 33 sites common to both surveys. The species in this table are the core species marked # and ## in Table 1 from either survey.
Species' change in abundance from the SB99–00 survey to the SB00–01 survey: N = No change, I = Increase, and D = Decrease. This decision is based on the CIs of P_{re} from 33 sites common to both surveys. Note P_{re} values for 33 sites will differ slightly from those in Table 1 for both surveys.
The P_{re} values in brackets indicate non-core species for one of the surveys, i.e. marginal members of the core species group.

		SB00–01 (48 sites)			SB00–01 (33 sites)	SB99–00 (33 sites)
Common name	**Change in abundance**	**Number of visits when sighted**	**Average number of birds per visit when sighted**	**Density (birds/ha)**	**Probability of recording**	
Yellow-tailed Black Cockatoo	N	24	2.4	0.20	0.16	0.17
Galah	I	22	2.9	0.22	0.22	(0.09)
Sulphur-crested Cockatoo	N	18	3.1	0.19	0.11	(0.07)
Crimson Rosella	I	117	3.7	1.51	0.86	0.69
Rainbow Lorikeet	N	19	2.7	0.18	0.11	(0.11)
White-throated Treecreeper	N	93	1.5	0.49	0.64	0.67
Superb Fairy-wren	N	99	4.2	1.45	0.73	0.78
Striated Pardalote	N	83	2.1	0.59	0.51	0.54
White-browed Scrubwren	N	63	3.7	0.80	0.38	0.34
Brown Thornbill	D	65	2.9	0.65	0.37	0.58
Striated Thornbill	N	96	4.6	1.53	0.68	0.67
Red Wattlebird	N	40	2.4	0.33	0.30	0.21
Yellow-faced Honeyeater	N	65	2.0	0.44	0.35	0.43
White-naped Honeyeater	N	–	–	–	(0.06)	0.15
Crescent Honeyeater	N	48	1.6	0.27	0.26	0.39
New Holland Honeyeater	D	–	–	–	(0.03)	0.14
Eastern Spinebill	N	21	1.5	0.11	0.15	0.21
Scarlet Robin	N	31	1.4	0.15	0.17	0.18
Golden Whistler	N	45	1.4	0.21	0.34	0.27
Grey Shrike-thrush	N	43	1.1	0.16	0.34	0.44
Grey Fantail	N	96	1.7	0.58	0.74	0.83
Black-faced Cuckoo-shrike	D	–	–	–	(0.05)	0.17
Grey Currawong	D	28	1.6	0.15	0.15	0.26
Silvereye	N	48	2.0	0.33	0.33	0.27
Common Blackbird	D	41	1.7	0.24	0.38	0.52

separating the two surveys. These results probably indicate that one or several of the following has affected the consistency of the results:

(i) survey design, e.g. magnitude, structure, different observers;
(ii) changed seasonal conditions that have benefited some species and disadvantaged others;
(iii) some other factor has caused a natural fluctuation in certain species, e.g. disease.

Species rarely recorded

Most, if not all, of the 40 species mentioned above as being rare in the Mt Lofty Ranges stringybark habitat are wide-ranging and not endangered in Australia or South Australia. See New (2000) for a discussion of how factors such as geographic restriction, ecological specialisation and abundance over normal range need to be considered in assessing rarity for conservation purposes. Their low abundance in the Mt Lofty Ranges stringybark woodland is of little national concern, but we consider that 19 of these species may be of local conservation interest in this habitat. They are listed in Table 3 and the monitoring of any change may be justified; see

Table 3. Species with P_{re} <0.1 in the SB00–01 survey of possible interest in Mt Lofty Ranges stringybark habitat. On-site sightings of these birds from all samples are given (the maximum possible is 432).

Common name	On-site sightings
Painted Button-quail	1
Common Bronzewing	41
Brush Bronzewing	2
Elegant Parrot	4
Fan-tailed Cuckoo	13
Horsfield's Bronze-Cuckoo	2
Shining Bronze-Cuckoo	10
Sacred Kingfisher	31
Spotted Pardalote	38
Chestnut-rumped Heathwren	4
Buff-rumped Thornbill	45
Brown-headed Honeyeater	7
White-naped Honeyeater	36
Varied Sittella	22
Rufous Whistler	18
Black-faced Cuckoo-shrike	28
Dusky Woodswallow	3
Red-browed Finch	32
Bassian Thrush	3

later for a comparison with the SB99–00 records.

Crested Shrike-tit *Falcunculus frontatus* and Mistletoebird from the 1999–2000 survey meet this criterion and would bring this total to 21. The more interesting and less abundant of these species were recorded in the following sites: Painted Button-quail, *Turnix varia,* Site 1310 (Morialta Conservation Park), Chestnut-rumped Heathwren *Hylacola pyrrhopygia,* sites 11301, 11305, 11311 (Cleland Conservation Park), Crested Shrike-tit, site 98401 (Lenswood Recreation Park), Bassian Thrush *Zoothera lunulata*, site 99501 (Stock Rd, Longwood).

Comparing the 19 non-core species where P_{re} values are available from both surveys, four species, the Common Bronzewing *Phaps chalcoptera*, Sacred Kingfisher *Todiramphus sanctus*, Buff-rumped Thornbill *Acanthiza reguloides* and Red-browed Finch *Neochmia temporalis* showed no significant change, while the Common Starling increased. Any change in the remaining 14 species could not be determined because their low values of P_{re}, i.e. 0.007–0.06, made the method described in the Appendix difficult to apply. The Appendix shows that, for 33 sites and a P_{re} of 0.1, P_{re} needs to change by 105% or 70% for a change up or down to be detected with 90% confidence. An increase to 200 samples decreases these percentages to about 30%.

Table 4. On-site species not recorded on both the SB99–00 and SB00–01 surveys. The numbers listed are the on-site sightings from all nine samples. All these species were recorded with a low abundance, i.e. four or fewer recordings, P_{re} of the order of 0.01, except the Purple-crowned Lorikeet *Glossopsitta porphyrocephala* with eight. The SB99–00 records result from nine visits to 38 sites and SB00–01 from nine visits to 48 sites.

	Records	
Common name	SB99–00	SB00–01
Brown Goshawk	–	1
Collared Sparrowhawk	–	1
Wedge-tailed Eagle	–	2
Painted Button-quail	–	1
Purple-crowned Lorikeet	8	–
Eastern Rosella	–	1
Elegant Parrot	–	4
Southern Boobook	1	–
Tawny Frogmouth	–	3
Australian Owlet-nightjar	1	–
Yellow Thornbill	4	–
Little Wattlebird	–	1
White-plumed Honeyeater	–	1
Willie Wagtail	–	4
Bassian Thrush	–	3

We believe that the stringybark habitat is unsuitable for these non-core species and they will always be rare or vagrant in that habitat. Because they are likely to be more abundant in other habitats, we consider that pursuing any measure of change in their abundance in stringybark is not justified.

Of the 66 species recorded on-site from both surveys, 51 were common to both. The remaining 15 species (all recorded at low abundance) comprise four from the SB99–00 survey and 11 from the SB00–01 survey (Table 4). (Reducing the comparison to the 33 common sites only alters the situation in that the Chestnut-rumped Heathwren is added to the species for the SB99–00 survey list, increasing the non-common species to 16.)

One might attribute the difference of 15 species to the additional 10 sites used for the SB00–01

Table 6. Average species count from 48 visits to single 2 ha stringybark sites using various visit formats. Figures in brackets are from the SB99–00 survey of 38 sites.

Source of data	Average species count	90% CI of species count
Three independent single 20 minute samples:	9.53 (10.0)	±5.0 (±5.6)
Three independent 1 h samples:	13.8 (14.0[1])	±6.0 (±6.0[1])
Accumulated species count over three single 20 minute samples:	21.3 (17.2)	±7.3 (±6.4)
Accumulated species count over six samples:	(17.3)	(±6.4)
Accumulated species count over nine 20 minute samples:	21.4	±7.1

[1] From a single 1 h sample averaged over 38 sites from the SB99–00 survey.

survey or to the different survey methods. However it is more likely that because of the small chance of recording rare or vagrant species, i.e. those with $P_{re} = 0.01$, there is only a 3% probability of them being recorded from 342 (38 x 9) visits to a site. Because of this low probability of recording such species, we expect the on-site species lists from these surveys of specific habitats to be highly variable also (see the section on species richness bellow).

Site lists

Table 5 (overleaf) shows how the number of species recorded in a sample varies in space and time. It seems that, as for the SB99–00 survey, the Lenswood Recreation Park and Waterfall Creek sites have a high species count (using all nine samples). For this SB00–01 survey, Hender Reserve, Norris Hill and Filsell Hill are equally high. Willis Rd again has a low species count as has the SB00–01 survey of Deep Creek Conservation Park. Second Valley Forest, with a low species count for the SB99–00 survey, was not surveyed during SB00–01.

Species richness

'Species richness' is a theoretical property of a particular habitat, e.g. a single 2 ha stringybark site or all the stringybark in the Mt Lofty Ranges. A 'species count' obtained from a survey such as described in this document is an estimate of species richness. A species count must always be associated with a particular survey format, i.e. from 20 minute samples of one or more 2 ha sites of stringybark woodland from a particular region in a particular season by one or more observers.

As in the previous survey, a single 20 minute sample of a ***single*** 2 ha site shows considerable variation in species count (e.g. 0 from Cleland Conservation Park Site 10, Session 1, Sample 2 to 19 from Cleland Conservation Park Site 3, Session 3, Sample 1). These figures are not suitable estimates of species richness. Better estimates of a single sample of a 2 ha stringybark site are obtained from the average species counts over the 48 sites surveyed given in Table 5. Table 6 summarises these figures and shows how estimates of the single-site species richness increase from about 10 to 20 as the sampling effort increases. Averaging over the 48 sites is necessary as site has a significant effect on species count (see the Section 'The effect of survey design factors on species count').

Better estimates of species richness are available by accumulating the records from many single-site visits, e.g. the 48 sites surveyed. For example, 14 of the species counts at the base of Table 1, ranging from 40 to 62, are all an accumulated species count and are thus estimates of species richness of the stringybark habitat. They differ because they are based on different specific collection conditions, i.e.:

(i) single samples of 20 minutes (40 to 46 species);
(ii) single samples of 1 h (48 to 51 species);
(iii) three independent 1 h samples combined (62 species);
(iv) three independent 20 minute samples (over 38 or 48 sites) combined (54 species).

Note that the estimate from three independent 20 minute samples (54) is about in the middle of the above range of 40 to 62.

Possingham *et al.* (2004) discuss how fitting the Clench equation to accumulation plots may be used to estimate species richness for the SB99–00 survey. The same method is used for this SB00–01 survey, making changes appropriate to the changed survey design, i.e. three independ-

Table 5. Species counts for all samples of all stringybark sites: Year 2000 survey. OHT = Overhead Transient. CP = Conservation Park, RP = Recreation Park. NA = Not available.

Patch data			Site coordinates AGD66		Session 1				Session 2				Session 3				All Sample 1 (3)		All nine Samples			
Number	and name	Area (ha)	North	East	Total	Sample 1	2	3	Total	Sample 1	2	3	Total	Sample 1	2	3	Average	Total	Average on-site	Total On-site	OHT	Off-site
701	Deep Creek CP	1154.62	605681	24889	11	5	10	8	12	9	8	8	10	4	5	7	6	10	7.1	18	6	15
6902	Hindmarsh Falls	11.33	607521	28061	13	9	10	8	10	6	5	7	10	6	6	5	7	11	6.9	17	5	19
7101	Hazkett Rd	85.86	608083	28100	13	9	9	8	11	8	9	7	14	11	7	10	9.3	15	8.7	19	11	20
9801	Belair RP	825.58	612335	28780	9	5	5	9	13	9	7	9	14	9	12	7	7.7	11	8	21	7	17
11301	Cleland CP Site 1	1355.48	612864	29058	15	9	11	11	11	8	9	7	14	9	7	12	8.7	14	9.2	21	5	19
11302	Cleland CP Site 2	1355.48	612847	29040	14	10	9	9	14	8	10	10	10	9	4	6	9	14	8.3	18	3	18
11303	Cleland CP Site 3	1355.48	612833	29068	20	14	17	14	20	19	15	9	18	13	14	13	15.3	24	14.2	26	6	21
11304	Cleland CP Site 4	1355.48	612722	29095	20	15	13	15	19	13	16	14	14	11	8	12	13	22	13	26	8	30
11305	Cleland CP Site 5	1355.48	612785	29035	16	13	8	10	10	8	3	7	15	11	7	10	10.7	19	8.6	23	8	22
11306	Cleland CP Site 6	1355.48	612792	29014	18	12	10	11	17	9	11	12	15	11	13	11	10.7	16	11.1	23	7	22
11307	Cleland CP Site 7	1355.48	612727	29036	9	7	7	7	13	11	6	7	16	11	9	11	9.7	15	8.4	19	5	12
11308	Cleland CP Site 8	1355.48	612746	29019	12	7	8	9	12	10	6	9	10	8	9	9	8.3	13	8.3	16	6	19
11309	Cleland CP Site 9	1355.48	612695	28998	12	5	6	4	10	9	7	8	8	2	4	6	5.3	12	5.7	17	5	12
11310	Cleland CP Site 10	1355.48	612598	29012	5	4	0	3	8	4	7	7	11	9	9	9	5.7	12	5.8	14	4	13
11311	Cleland CP Site 11	1355.48	612581	29018	15	9	8	11	11	7	6	9	17	11	8	7	9	15	8.4	22	5	9
11312	Cleland CP Site 12	1355.48	612579	28991	18	10	11	7	11	7	11	7	17	13	12	12	10	18	10	22	4	15
11601	Morialta CP	1686.46	613531	29197	17	12	9	9	7	3	5	5	11	9	7	5	8	18	7.1	21	8	17
12001	Loftia RP, Site 1	466.36	612092	29059	11	9	8	8	16	12	8	13	12	8	8	8	9.7	17	9.1	21	3	20
12801	Horsnell's Gully CP	534.72	613169	29259	13	11	11	9	14	10	9	9	14	13	12	13	11.3	15	10.8	19	5	18
13002	North Mt Magnificent CP, Site 2	100.36	609384	29219	15	8	12	7	14	8	8	10	13	8	11	6	8	16	8.7	23	6	20
13501	Stone Reserve, Heathfield	11.80	612096	29266	18	13	12	11	14	10	11	9	17	13	13	9	12	22	11.2	26	6	13
13615	Mt Bold Reservoir Site 15	NA	611192	29382	15	11	11	11	17	12	10	11	14	10	8	9	11	20	10.3	23	3	25
16001	Rangeview Rd, Carey Gully	3.80	612769	29519	14	13	14	12	8	6	5	6	12	10	7	7	9.7	17	8.9	17	4	13
16202	Norris Hill, Aldgate, Site 2	148.56	612150	29541	15	10	13	10	19	12	14	17	14	8	8	9	10	18	11.2	28	8	16
16501	1282 Greenhill Rd, Carey Gully	6.40	612838	29582	15	12	11	14	11	9	8	9	12	7	9	9	9.3	16	9.8	20	6	22
16801	Chapel Hill Diggings, Echunga	44.55	611551	29627	20	14	13	14	13	9	9	7	14	8	10	13	10.3	17	10.9	24	7	21
17004	Mylor CP, Site 4	66.52	611996	29630	14	10	9	14	15	7	11	9	15	8	9	11	8.3	16	9.8	24	5	25
17603	Wotton Scrub, Site 3	153.55	612587	29704	17	14	14	13	14	11	13	11	19	13	8	12	12.7	22	12.1	25	6	24
18203	Filsell Hill, Deviation Rd, Forest Ra.	555.78	613011	29871	21	13	10	15	15	10	11	7	20	12	11	10	11.7	23	11	30	4	20
19101	Wicks Reserve, Forest Range	51.34	613193	30032	11	7	5	9	12	8	8	9	18	8	15	12	7.7	14	9	23	6	21
21101	Willis Rd, Flaxley	24.17	610926	30327	10	5	7	10	7	6	6	6	7	6	6	6	5.7	10	6.4	12	6	21
97101	Mangiri Park	NA	612490	28908	8	5	5	4	10	6	7	7	10	9	7	7	6.7	12	6.3	17	6	18
97201	Bushland Park	NA	613762	30654	14	9	8	10	13	9	10	12	15	12	12	10	10	16	10.2	20	6	25
97301	Waterfall Creek	25.09	606351	25739	21	12	14	12	16	12	13	6	14	9	11	12	11	19	11.2	27	6	25
97401	Springs Rd	50.57	606286	25376	16	9	13	13	11	9	7	9	13	5	7	9	7.7	12	9	21	9	12
97501	Range Rd	79.63	605998	25279	9	5	6	4	8	7	6	5	13	9	10	11	7	12	7	17	5	9
97801	Mylor Parklands	94.3	612010	29535	10	7	8	5	14	12	8	9	16	10	10	9	9.7	16	8.7	21	9	21
97901	Hender Reserve	29.86	612249	29120	16	12	12	12	21	15	7	12	20	10	9	12	12.3	22	11.3	29	6	23
98001	Kanangra	4.85	607310	27769	13	11	11	13	14	10	10	9	16	9	12	13	10	16	10.9	22	7	18
98101	Scott Creek CP	143.84	611532	28745	13	7	7	7	13	8	10	10	12	5	6	9	6.67	13	7.7	21	8	19
98201	Totness RP	42.53	611815	30221	10	10	5	5	9	8	7	8	11	3	6	8	7	12	6.7	16	3	20
98301	Mt George CP	125.00	612474	29497	19	15	15	12	18	14	10	12	14	9	7	12	12.7	23	11.8	25	6	28
98401	Lenswood RP	20.44	613366	30132	24	17	13	16	13	12	5	6	24	17	14	18	15.3	25	13.1	31	4	17
99001	Twin Oaks	7.05	607614	27660	18	16	16	16	15	10	12	11	18	12	13	11	12.7	21	13	23	5	18
99501	Stock Rd, Longwood	14.78	611976	29334	15	10	9	10	14	13	13	13	20	13	12	14	12	20	11.9	26	3	28
99601	Heysen Trail, Myponga Rd	25.64	607930	27500	10	9	9	8	11	11	6	9	13	8	11	10	9.3	12	9	14	9	19
99801	Kyeema CP	250.00	609450	29060	14	8	8	10	5	4	1	3	6	4	5	5	5.3	11	5.3	16	4	23
99901	Spring Mount CP East	121.37	607406	27632	18	14	12	9	13	10	4	8	14	9	11	11	11	19	9.8	25	9	21
	Average species count				**14.46**	**10.02**	**9.83**	**9.92**	**12.83**	**9.33**	**8.5**	**8.83**	**14.04**	**9.21**	**9.15**	**9.73**	**9.53**	**21.29**	**9.39**	**21.42**	**5.9**	**19.23**
	SD of species count				**3.96**	**3.28**	**3.31**	**3.27**	**3.49**	**2.94**	**3.12**	**2.60**	**3.57**	**2.95**	**2.79**	**2.73**	**3.06**	**4.43**	**3.00**	**4.34**	**1.86**	**4.73**

Table 7. Comparison of species richness estimates from the SB99–00 and SB00–01 stringybark surveys.

	SB99–00 survey 20 minute samples, 38 sites, 54 species		SB00–01 survey 20 minute samples, 48 sites, 54 species		SB00–01 survey 1 h samples, 48 sites, 62 species	
	Mean	90% CI	Mean	90% CI	Mean	90% CI
S_m	65	±4.2	65	±6.8	83	±8.5
M	5.6	±0.8	4.8	±1.2	4.4	±0.47
j	0.68	±0.1	0.64	±0.07	0.52	±0.03
k	0.63	±0.1	0.45	±0.08	0.42	±0.07
k/j	0.92	±0.1	0.71	±0.1	0.82	±0.08

ent samples versus four for the SB99–00 survey. Records from the three time-independent 20 minute samples of the 48 sites, i.e. Sessions 1, 2 and 3, Sample 1, were used as the data source. Two different time sequences combined with eight different site sequences gave eight sets of the four parameters: S_m, M, j and k. The results for this survey are compared with those for the SB99–00 survey in Table 7.

The parameters of the accumulation plots for the 20 minute samples from the two surveys are in good agreement, i.e. the estimated species richness of 65, except for the value of k. This is the effect of time visits on the accumulation of species relative to the effect of site visits.

The survey design also allows accumulation plots to be derived for the 1 h samples using the three time-independent 1 h samples of the 48 sites, i.e. Samples 1, 2 and 3 accumulated for the three sessions (resulting in a species count of 62). These plots were made from three different time sequences combined with twelve different site sequences with the results shown in Table 7. The interesting change is that compared with 20 minute samples, the 1 h samples show that, based on the two CIs, there is a significant increase in estimated species richness, i.e. from 65±4.2 to 83±8.5, that is greater than the increase in the sample size from 54 to 62

Possingham *et al.* (2004) use the data in SAOA (1985), to estimate that 85 species are likely to be recorded in the Mt Lofty Ranges, increasing to 93 if summer visitors are included. Compared with these data, the estimate of 65 for species richness from the 20 minute samples is low whereas the estimate of 83 from the 1 h samples shows better agreement. The following Table 8 lists 24 species in the SAOA Field List (omitting raptors) that were not in the data used to produce any of the three accumulation plots. These species are classed as Common or Moderately Common in the Mt Lofty Ranges as defined by the region categories of Mt Lofty Ranges, Southern Regions or Widespread in SAOA (1985); although our data indicate that they rarely use the stringybark habitat. One might be inclined to conclude that these 24 species are those 'missing' from the 62 used to estimate a species richness of 83. However, if these 24 were recorded during the survey and used in an accumulation process, then the estimate would probably be higher.

Survey efficiency

Following the method used for the SB99–00 survey, the efficiency of the various survey designs is obtained by introducing the survey effort into the comparisons shown in Table 9.

As before in the SB99–00 survey, using species per hour as the criterion, single 20 minute surveys are the optimum for both single and 48

Table 8. Species in the SAOA Field List (SAOA 1985) for the Mt Lofty Ranges (including summer visitors and omitting raptors) not represented in the accumulation analysis for species richness.

Emu	Noisy Miner
Little Button-quail	Singing Honeyeater
Rock Dove	Jacky Winter
Spotted Turtle-Dove	Hooded Robin
Crested Pigeon	White-browed Babbler
Peaceful Dove	Restless Flycatcher
Long-billed Corella	White-winged Triller
Little Corella	Grey Butcherbird
Rainbow Bee-eater	Australian Raven
Brown Treecreeper	House Sparrow
Weebill	Diamond Firetail
Southern Whiteface	European Greenfinch

Table 9. Species per hour compared with effort surveying 48 sites for five survey designs, Year 2000 survey.

	Effort			Totals for 48 sites		Average for a single site	
Survey design (total period in brackets)	Hours per sample	Number of samples	Total hours	Species count	Species per hour	Species count	Species per hour
1 Single 20 minute samples (20 minutes):	1.14	48	54.7	43	0.78	9.5	0.17
2 Three independent 20 minute samples combined (1 h):	1.14	48 x 3	164	53.2	0.32	21.3	0.13
3 One 1 h sample (1 h):	1.85	48	88.8	49.7	0.56	13.8	0.16
4 Two independent 1 h samples combined (2 h):	2.9	48 x 2	278	57.3	0.21	18.6	0.067
5 Three independent 1 h samples combined (3 h):	3.9	48 x 3	561	61	0.11	21.4	0.034

sites with single one hour surveys very close for the single site case. Spending time on two and three hour surveys is very inefficient. However, other surveys with different objectives may require a large number of visits and travel time between sites may be a more important factor than for the survey reported here.

Bird density and probability of recording

Using the methods described in the SB99–00 report, the average number of birds of each species recorded for the three independent 20 minute samples of the 48 sites has been used to determine density and probability of recording. The results given in Table 2 from the SB00–01 survey are for the 22 species with more than 18 records, i.e. 0.13. Figure 2 shows the relationship between density D, in birds per hectare, and the value of P_{re}. An exponential fit:

$$D = -\frac{\log(1 - P_{re})}{1.1}$$

to the data is also shown on the figure. For densities less than 0.5 a linear relationship would be satisfactory. Note that the fit parameter has changed slightly to 1.1 compared with the 1.2 for the SB99–00 survey.

There are five species with P_{re} >0.60, indicating that they will be the species most likely to be recorded (see Table 1 or 5). Three of these have a density >1.0 birds/hectare indicating that they will be recorded in relatively high numbers as indicated by the average number of birds per sighting being between 3.7 and 4.6 and a high value of P_{re} between 0.67 and 0 0.81. Two of these, Superb Fairy-wren *Malurus cyaneus* and Striated Thornbill *Acanthiza lineata* are usually observed in groups as indicated by their position above the average fit in Figure 2. In contrast, White-throated Treecreeper *Cormobates leucophaeus* and Grey Fantail *Rhipidura fuliginosa* are often alone and, although with a high P_{re} have low densities.

The effect of survey design factors on species count

Using the methods described in the SB99–00 report, the effect of survey design factors on species count was analysed. Tables 10, 11, and 12 give the average and standard deviation of the species count for the three time-separated 20 minute samples of 48 sites over the range of observers, wind strengths and visit time after sunrise. Regression analysis of the effect that these three factors as well as site had on species count, shows that the observer has a significant effect, P <= 0.05[1]. An inspection of Table 3 indicates that site has a large effect on species count and this is borne out by the regression analysis that gave P <0.001. The regression indicates a change in species count of about eight over the 48 sites.

[1] If it is assumed that there is no effect of this factor, then the P-value is the probability of the differences in average species count being due to random variation. A P-value less than 0.05 is usually considered to indicate a significant factor and less than 0.01, a highly significant factor.

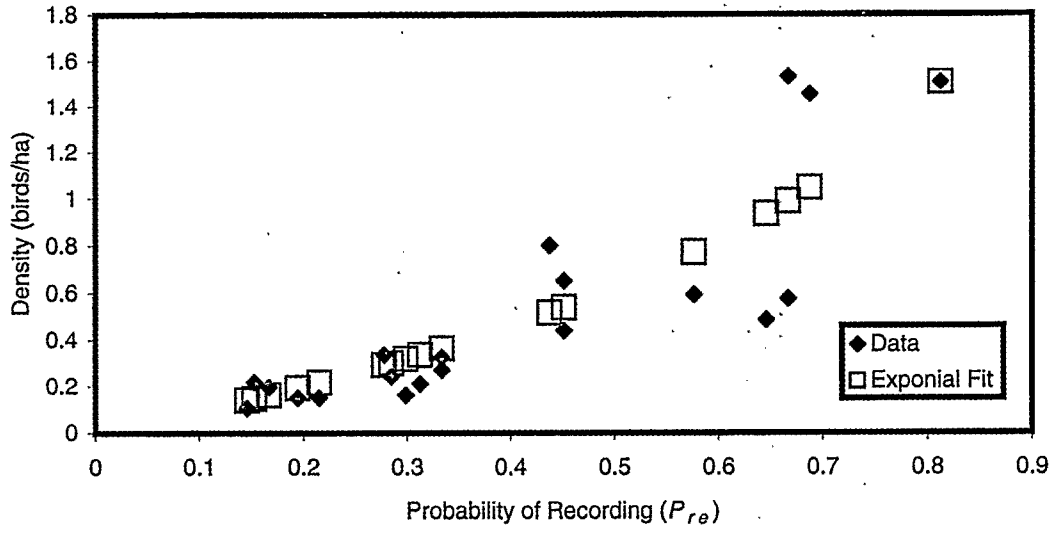

Figure 2. Density versus probability of recording for the stringybark Year 2000 survey.

Table 10. The effect of observer on species count over three 20-minute visits to 42 stringybark sites, Year 2000 survey. P = 0.007[1].

	Observer code							
Analysis of species count	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Number of visits	8	22	40	10	21	11	9	5
Average	12.15	10.09	9.55	9.3	9.24	8.55	8.11	8.0
SD	3.35	3.07	2.99	2.75	3.1	2.98	2.67	3.67

Table 11. The effect of wind on species count over three 20-minute visits to 42 stringybark sites, Year 2000 survey. P = 0.08[1]

	Wind strength			
Analysis of species count	**Calm**	**Light**	**Medium**	**Strong**
Number of visits	48	42	33	3
Average	10.12	9.57	8.76	6
SD	2.91	3.29	2.68	4.58

Table 12. The effects of visit time on species count over three 20-minute visits to 42 stringybark sites, Year 2000 survey. P = 0.11[1]

	Visit starting times after sunrise in 1 h periods				
Analysis of species count	**0**	**1**	**2**	**3**	**4**
Number of visits	10	39	36	19	22
Average	9.40	9.08	9.50	10.68	9.18
SD	3.37	2.82	3.22	3.15	3.13

DISCUSSION

The results of the SB99–00 and SB00–01 surveys showed some similarities and differences. The basic bird lists in the Section 'Species Lists' are generally larger for the SB00–01 survey. Four of the lists show an increase from four to 11 species but the off-site species show a decrease of five. This comparison is not exact because of the differences in the survey plan, observers and sites visited. The most exact, but not perfect, comparison is the on-site species list from all nine samples from the 33 sites common to both surveys where the SB00–01 survey returned 61 species compared with 55 species from the SB99–00 survey.

Both surveys made equal additional contributions of three species to the 25 core species selected from these two surveys. All of these were at the low end of the criterion for core species, i.e. P_{re} >0.13.

The SB00–01 survey contributed 11 additional species different from those recorded during the SB99–00 survey compared with four vice versa. As one would expect, the differences in these bird lists from the two surveys are due to rare or possibly declining species

The above differences in the species recorded in these two surveys illustrate the difficulties in obtaining significant statistical information on rare or declining/increasing species from two surveys of this design and magnitude. Seven of the core species showed an increase or decrease using data from the two surveys. This unlikely result for these relatively common species indicates that both a more sophisticated method and surveys over many more years are needed.

The results of this survey also illustrate how direct estimates of species richness, based on simple species counts, vary widely (40 to 62) depending on the survey conditions used. Accumulation plots showed good agreement between the two surveys, but data based on 1 h samples gave better agreement with other data in SAOA (1985) on the birds of the Mt Lofty Ranges.

This paper provides survey designers/managers concerned with bird species abundance and richness the means of relating the objectives of the survey to the effort required. It also provides some statistical analysis that they might find useful.

Thus we believe that a continuation of this survey of the Mt Lofty Ranges will result in the development a survey format and analysis technique that will identify declining or increasing bird species and conservation locations that ensure viable populations of all bird species endemic to central-southern Australia.

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APPENDIX

Significant differences in probability of recording

When comparing two values of probability of recording P1 and P2, we are 90% confident that P1 is greater than P2 if:

(i) either P1 is greater than the upper 90% confidence limit of P2,

(ii) or P2 is less than the lower 90% confidence limit of P1,

whichever is the least. The same criterion is used to decide if P1 is less than P3. Because of the non-symmetric characteristics of the distribution of P (the mean of a binomial distribution), equal values of the differences P1 – P2 and P3 – P1 have different probabilities.

In order to compare two values of P_{re}, we have, for P_{re} equal to 0.05, 0.1, 0.2, 0.3...0.9, calculated the value of P_{re} that meets the above criteria and expressed the difference from P_{re} as a percentage of the P_{re} base values 0.05 to 0.9. These percentages are given in Table A1 and represent the significant detectable percentage difference, at a 90% confidence limit.

Table A1. Significant changes of P_{re} as a percentage of P_{re} based on 90% confidence interval for 33 sites. The percentages in parenthesis refer to data for 200 sites. The accuracy of the percentages for low values of P_{re} (<0.2) particularly for 33 sites, is low because of the difficulty of computing the confidence limits for these conditions.

Probability of recording, P_{re}	Significant increase as a percentage of P_{re}	Significant decrease as a percentage of P_{re}
0.9	8	12
0.8	13	17
0.7	18	21
0.6	24	27
0.5	31	31
0.4	39	36
0.3	51	42
0.2	68 (23)	50 (20)
0.1	105 (34)	70 (30)
0.05	160 (52)	82 (38)