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EFFECT OF WILDFIRE ON BIRDS AT WEDDIN MOUNTAIN, NEW SOUTH WALES

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Members of the New South Wales Field Ornithologist's Club counted the number of species and individual birds in Weddin State Forest and Weddin Mountain National Park, parts of which were affected by fire in January 1975. This was the first study of the effects of fire on bird populations in White Cypress Pine habitat. Counts were made eight months after the fire in October 1975 and again eight years later in October 1983, comparing the birds seen in burnt and unburnt bush. At the eight month count, there were 59 species and 400 individuals recorded in the unburnt area, compared with 50 species and 225 individuals in the burnt area. In 1983, however, over the same areas, there were 87 species and 660 individuals in the burnt area and 63 species and 340 individuals in the unburnt area. The increase in the diversity of birds eight years post-fire occurred in the insectivorous ground, shrub and foliage foraging guilds.

INTRODUCTION

Few investigations in Australia have been made on the effect of fire on birds. There have been studies in Western Australia, Victoria and south-eastern New South Wales, but these referred to populations in taller eucalypt forests. Some case histories have been described in Keast *et al.* (1985), but most are from higher rainfall, sclerophyll forests near the coast. Some comparisons on rates of recovery have been made with other studies on bird survival after fire and subsequent recolonization.

This study examined the effect on the bird population at two intervals after a wildfire in a much drier, inland environment. Cypress forests occur over an appreciable area of land on the western fall of the Great Dividing Range, where they are managed to produce a valuable timber. Tree replacement is dependent on natural regeneration, and fire seriously disrupts this process by destroying young trees and damaging or killing seed trees. The native cypress forests are a haven for native birds in a predominantly agricultural landscape.

In January 1975 a wildfire in Weddin State Forest and Weddin Mountain National Park, central western New South Wales, burned parts of the White Cypress Pine/eucalypt forest. Counts of the birds in burnt and unburnt areas were made by members of the New South Wales Field Ornithologist's Club (NSWFOC) eight months and again eight years and eight months after the fire.

The aim of the initial survey, in 1975, was to examine the short-term effect of the wildfire on bird populations by comparing the numbers of species and individuals in the unburnt woodland and forest with numbers in areas burnt eight months previously. The goal of the second survey, in 1983, was to determine any shift in bird populations and to ascertain any long-term effect of the fire.

STUDY SITE

Survey Area

Weddin Mountain is a landmark in the plains between Forbes, Grenfell and West Wyalong (Fig. 1). Much of the mountain is 600 m above sea level, while the surrounding countryside is about 300 m above sea level. There are exposed escarpments to the north and north-west, with the highest part of the plateau being 725 m above sea level. There is a more gradual slope to the south and south-west. This boomerang-shaped range is the basis of Weddin Mountain National Park. On gently sloping land to the west is Bimbi State Forest and to the south is Weddin State Forest. These three areas contain natural vegetation in various states of disturbance, forming a large island of about 15 000 ha of forest, woodland heath and scrub. It is surrounded by land mostly cleared for agriculture, where wheat is the most important cereal crop. The survey was conducted over parts of Weddin State Forest and Weddin Mountain National Park. The geographical co-ordinates 34°S and 148°E meet in Weddin State Forest.

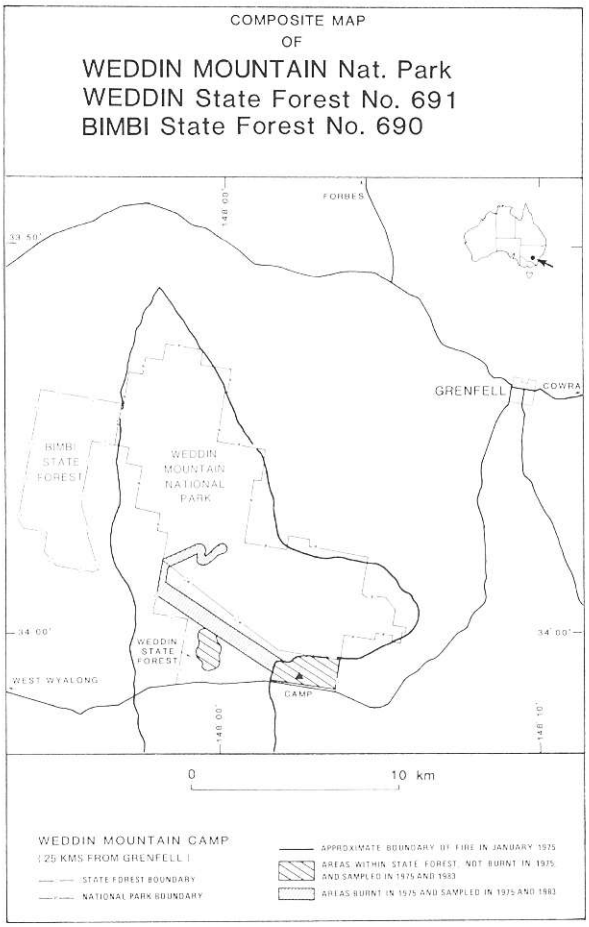

Figure 1. *Weddin Mountain National Park and Weddin and Bimbi State Forests showing areas surveyed in 1975 and 1983 by members of NSWFOC.*

Vegetation

Although forestry management practices favour the growth of one species, White Cypress Pine *Callitris glaucophylla*, within the State Forest, there are natural clearings, roadsides, creek lines, variation in height between regeneration and mature trees, varying densities of eucalypts, together with the edge effect with the adjoining cleared land, which contribute a wide range of possible habitats for birds. Plant species in the two areas were listed in 1977 (Turner and Harden, unpubl. data).

On the flat country below Weddin Mountain there are stands of White Cypress Pine. Much of this forest is a disclimax dating back to regeneration that occurred between 1880 and 1890. Eucalypts are found scattered through the deep sandy soil of the State Forest: Yellow Box *Eucalyptus melliodora*, Grey Box *E. woollsiana*, White Box *E. albens*, Fuzzy Box *E. conica* and Blakely's Red Gum *E. blakelyi*. Further up the slope the soils are shallower with some obvious rock supporting Black Cypress Pine *C. endlicheri*. The eucalypts found on these slopes at the foot of the mountain are Mugga Ironbark *E. sideroxylon* and Dwyer's Mallee Gum *E. dwyeri*. The side slopes have progressively fewer of these species and more Red Stringybark *E. macrorhynchya* and Scribbly Gum *E. rossii*. Along the level ridge tops, in the part of the National Park sampled, there are few eucalypts, no pine, and a greater development of the undershrub species of the lower slopes, including *Casuarina* spp, *Acacia* spp, myrtles and epacrids (R. J. Turner and G. J. Harden, unpub. data).

The Fire

A bushfire started on a property about 16 km north of the sample area, just before 1700 hrs, 24 January 1975, when a transmission pole was blown down (Forestry Commission of NSW 1975). Before 0400 hrs the following morning, the fire had extended 27 km to the south, with a final perimeter of 88 km. The temperature in the afternoon, when two other fires were controlled by local fire brigades, was 37°C, with a relative humidity of 9 per cent and wind speeds up to 100 km per hour, which gave a fire danger rating of 100 per cent, or extreme. Even at midnight, fire was spotting 12 km ahead of the main blaze, which by this time was travelling through the crowns of trees before a northerly wind. The conflagration was so furious that twigs and small branches were distorted and set in a position pointing to the south. Flame height was recorded as 20 m. A total of 16 456 ha were burnt: National Park, 8 296 ha; State Forest, 1 940 ha; other Crown Lands, 200 ha; and private property, 6 040 ha.

Before the fire, the vegetation had been similar either side of a firebreak alongside a surveyed fenceline. At the time of the October 1975 bird count, the difference between burnt and unburnt areas on Weddin State Forest was dramatic. On the unburnt section to the east of the firebreak where the fire was stopped, there was a healthy Cypress Pine forest with much pine regeneration, scattered eucalypts and a few shrubs, with forbs and grasses between the trees in spaces with sufficient light. In the burnt area west of the firebreaks and over the Weddin Range were fire-killed cypress trees, defoliated eucalypts commencing to resprout epicormics along the branches, no young pine, and negligible ground cover.

By 1983 there was considerable recovery in the canopy, especially with the redevelopment of crowns in the eucalypts, eucalypt seedling regrowth, and thickets of shrubs such as wattles. Visibility through the forest had been reduced considerably since 1975. After the fire there had been a flush of growth of weeds such as Paterson's Curse *Echium plantagineum* and Cape Weed *Arctotheca calendula*, which was not as obvious in 1983. There was a lush, prolific spring growth following good rains in both years of counts.

METHODS

Survey Method

Two surveys were carried out by members of the NSWFOC. The first, carried out on 3–5 October 1975, involved ten observers and about 90 observer hours. The second survey, over 1–3 October 1983, involved four of the original ten observers (including the same leader), with an additional six not present in 1975. Eighty-one hours were spent on formal census work in 1983.

The survey covered as much area as possible on both sides of main roads and fire trails along a route considered representative of the range of vegetation types. In the burnt areas, the sample transect followed the main access road leading north-west through the forest, and at its end turned north-east along a fire trail to Weddin Gap. The transect crossed creeks, level ground, side slopes and ridge tops, covering an area between 500 and 600 ha. In the unburnt areas, observations were taken along roads and fire trails in the forest subdivision close to the camp (422 ha) and in an area of about 100 ha on Little Weddin Mountain missed by the main fire; the total unburnt area sampled was about 520 ha.

Counts were made of the numbers of birds of each species observed (excepting waterfowl). These were recorded by observers on a checklist of species likely to be found, prepared from the author's unpublished data for the survey. For the 1983 survey, over 30 species of birds were added to the checklist from unpublished data following further inspections (author's data; J. Brickhill pers. comm.).

Care was taken to allocate equal time to burnt and unburnt areas, providing sufficient consistency in the method to enable meaningful statistical analysis of the results.

Data Analysis

Species and numbers of individuals recorded in the 1975 and 1983 surveys were tabulated. Sightings of each species in the two surveys in burnt and unburnt habitat were used as pairs of observations to calculate the effect of the wildfire using Wilcoxon's Signed Ranks Test (Langley 1979). Birds were also grouped by migration habits and year of observation. Migration categories were adapted from Morris *et al.* (1981), according to author's observations of each species in the area under consideration.

Species were then classified into eight foraging guilds according to the foraging substrates, following the categories of Recher *et al.* (1985) and Ford *et al.* (1986). Twenty-eight species common to these two studies were observed in the Weddin Mountains, and these were directly assigned to an appropriate guild for the current study. Other species were placed into a guild as closely as possible from the local knowledge of the author of their feeding habits. A 2×2 contingency table analysis (Anon. 1987) was applied to the numbers of individuals in each guild to test for differences in the distribution of counts taken in burnt and unburnt areas in 1975 and 1983. Birds observed were also grouped into six categories according to the height above ground where they were likely to be feeding, again using Recher *et al.* (1985) and Ford *et al.* (1986) as a guide. A contingency table analysis was applied to these six groups to test for differences between burnt/unburnt and 1975/1983 surveys.

TABLE 1

Summary of results of bird counts by NSWFOC from Weddin Mountain area 1975 and 1983 surveys.

	1975 Survey		1983 Survey	
	Burnt	Unburnt	Burnt	Unburnt
Observers	10	10	10	10
Hours	9	9	c.8	c.8
Observer hours	90	90	81	81
Number of species	50	59	87	63
Number of individuals	225	400	660	340
Number of species per observer hour	0.55	0.65	1.07	0.78
Number of individuals per observer hour	2.50	4.44	8.15	4.20

RESULTS

A summary of observers' times and sightings is given in Table 1. Appendix 1 lists the species and numbers of individuals sighted in 1975 and 1983. The total numbers of birds seen, number of species seen per observer hour, and number of individuals seen per observer hour are reasonably similar for the 1975 and 1983 counts in the unburnt area. Both the numbers of species and of individuals seen per observer hour were higher in the burnt areas in 1983 than in 1975.

In the 1975 survey there were fewer birds seen in the burnt area than in the unburnt area ($p = 0.02$, Wilcoxon's Signed Ranks Test). Conversely, there were significantly more birds in the regenerating burnt area eight years later in 1983 ($p = 0.02$). Grouping all species into six foraging guilds gave significant differences at similar levels (Turner 1987).

NSWFOC observers recorded 99 of the 129 terrestrial species on the combined checklist. In 1975, there were fewer birds and fewer species in the burnt than unburnt bushland. In 1975, 50 species (39% of the 129 species of the checklist) were observed in the burnt area; 59 species (46%) were seen in the unburnt area. The 1983 survey recorded 87 species (67%) in the burnt area and 63 (49%) in the unburnt.

Groupings of species and numbers of individuals by migration habits and years of observation are given in Table 2. Most species and a majority of the individuals were in the sedentary category. Sedentary, migratory and nomadic species increased in 1983.

The contingency table analysis of the numbers of individuals recorded in the surveys, divided among eight foraging guilds, is shown in Table 3. In five foraging categories (ground foraging, insectivorous foliage, insectivorous aerial, nectarivores, and granivores), the numbers of birds in the burnt area in 1983 were greater than those seen in the same area in 1975 (significant at $p = 0.01$). Another two guilds, tree trunk, bark and branch foragers, and frugivores, showed differences at much lower levels ($p = 0.06$ and 0.05 respectively). The remaining category (vertebrate feeders, raptors, omnivores, etc.) showed no difference in burnt and unburnt areas in the two surveys ($p = 0.63$).

Table 4 shows the number of individual birds observed, classified into five foraging height classes from 0–1 m to over 15 m, plus the same miscellaneous vertebrate feeding group as in Table 3. Contingency table analysis showed that the numbers of birds observed in the height classes were dependent on treatment and time since treatment (fire), significant at $p = 0.01$. In the eight years and eight months following the fire, there was a large increase in the numbers of species and individual birds in the burnt areas compared with the unburnt areas. Also as shown with the foraging guilds, the vertebrate feeding group did not differ between surveys.

TABLE 2

Seasonal movements of 99 species recorded by NSWFOC during surveys on Weddin Mountain. For each category, first number is number of species, number in parentheses is number of individuals.

	1975 survey		1983 survey	
Habit	Burnt	Unburnt	Burnt	Unburnt
Sedentary	36 (152)	38 (261)	54 (355)	37 (233)
Migratory	5 (46)	11 (61)	16 (215)	15 (81)
Nomadic	7 (24)	10 (78)	17 (90)	11 (26)
Vagrant	2 (3)	0 (0)	0 (0)	0 (0)
Totals	50 (225)	59 (400)	87 (660)	63 (340)

TABLE 3

Contingency table analysis of numbers of individual birds in burnt and unburnt areas observed 1975 and 1983 surveys of the Weddin Mountain area classified according to foraging guild. *Low probability (P) values indicate that the numbers of birds observed change between survey dates and/or with different burning history.

Foraging Guilds	No. of Species	1975 Survey		1983 Survey		P*
		Burnt	Unburnt	Burnt	Unburnt	
1. Ground foraging	26	70+	149+	285+	149+	<0.01
2. Tree trunk, bark and branch foragers	5	16	18	28	13	0.06
3. Insectivorous, foliage foragers	28	74+	108+	178+	119+	0.01
4. Insectivorous, aerial foragers	11	20	46	58	14	0.01
5. Nectarivorous	6	2	28	27	6	0.01
6. Granivorous	5	18	17	45	9	0.01
7. Frugivorous	4	8	16	11	6	0.05
8. All others, mainly vertebrate feeders, scavengers, omnivores, raptors and predators	14	17	18	28	24	0.63
Total	99	225	400	660	340	0.01

TABLE 4

Contingency table analysis of numbers of individual birds in burnt and unburnt areas observed during 1975 and 1983 surveys in Weddin Mountain area, classified according to foraging height. *Low probability (P) values indicate that the numbers of birds observed changed between survey dates and/or with different burning history.

Foraging Height	No. of Species	1975 Survey		1983 Survey		P*
		Burnt	Unburnt	Burnt	Unburnt	
1. 0–1 m ground and log foraging (insect and seed)	34	98+	173+	345+	159+	0.01
2. 1–4 m shrub level (mainly insectivorous)	6	8	25	23+	8	0.01
3. 5–9 m tall shrubs, trunk, sub-canopy	23	58	84	133	92	0.01
4. 10–14 m upper branchlets, canopy, foliage	15	42+	73+	108	50	0.01
5. Over 15 m aerial, 6 insectivorous, 1 nectarivorous, tree tops	7	2	27	23	7	0.01
6. All other, mainly vertebrate feeders, scavengers, omnivores, raptors and predators	14	17	18	28	24	0.63
Total	99	225	400	660	340	0.01

DISCUSSION

The increase in species numbers sighted in the burnt forest in 1983 compared with 1975 could be attributed to a better season, or better observers, but these suggestions are insufficient to explain the much greater difference.

There were some notable differences between the 1975 and 1983 surveys. Sixteen species observed in unburnt areas were not found in the burnt area eight months after the fire. Yet in 1983, the burnt area had 24 more species than the unburnt area. The results suggest that 31 of the observed species may prefer regenerating forest eight years after wildfire to the unburnt forest. The most numerous species of bird recorded was the Rufous Songlark, in 1983. Parrots, Black-faced Cuckoo-shrike, Superb Fairy-wren, Grey Fantail, Varied Sittella and Apostlebird had successfully recolonized the burnt zones, and preferred this to unburnt areas.

The high intensity 1975 wildfire considerably reduced the diversity of the vegetation. There was more uniformity, fewer understorey plants and ground cover, which led to reduced opportunities for feeding, less substrate for perching and

increased risk to individuals from predation (Christensen *et al.* 1981). Some species were disadvantaged by the reduced vegetation (Cowley 1971), while others may have preferred the more open situation of a forest partly destroyed by fire, moving in from grasslands, pastures and open country of surrounding farmlands (Bamford 1985).

In 1975 survey, eight months after the fire, there were fewer birds in the burnt area than the unburnt forest. Christensen and Kimber (1975), working in sclerophyll Jarrah forest in Western Australia, reported fewer birds immediately after a prescribed burn and for the following spring. Smith (1989) observed that six species were less abundant after a fire and drought in Mimosa Rocks National Park near Bega, New South Wales; as with the Weddin data, the species most affected were those that frequented the ground and lower shrubs. Bamford (1985) noted fewer birds in one of his observation blocks soon after a fire. Other workers found that many birds survive fire and remain close to the same territory. After a hotter than normal prescribed burn, two-thirds of the birds banded before the burn were still on the area, occupying the same ranges as before (Cowley 1974). Wooller and Brooker (1979) reported that in Western Australia 12 months after a controlled burn, many individuals remained in the area. Rowley and Brooker (1987) could find no evidence of deaths of Splendid Fairy-wren four seasons after a wildfire in heathland near Perth, Western Australia.

The Australian flora has many adaptations that allow recovery. The three main methods of regeneration are epicormic shoots that sprout from trunks and branches after defoliation, redevelopment from underground roots and lignotubers, and reproduction of large quantities of seed that may be opened in the heat of the fire (Gill 1981). Of the plants recovering after the fire, eucalypts may have been the most obvious because of the epicormic shoots appearing along the trunk and crown within a few months of the burn. A range of Australian studies have documented the rapid recovery of vegetation and insects following fire (Cochrane 1963; Kimber 1975; Newsome *et al.* 1975; Rowley and Brooker 1987; Smith 1989). They have shown that within a few weeks or months of the fire, there will be some vegetation providing a substrate for insects and other invertebrates and therefore making available food for insectivorous birds. As the forest recovers and returns to its original structure, animals recolonize each area as each species finds the stage of succession suitable to its needs (Christensen *et al.* 1981).

Christensen *et al.* (1985) reported increases in the bird population six months after a fire in Autumn in Jarrah forest near Manjimup, Western Australia. The numbers of individuals in the burnt forest remained higher than the control for three years after the burn. Christensen *et al.* (1985) stated that recovery of the bird population might be slow following a severe wildfire because it would take longer for vegetation to regrow sufficiently for invertebrates to become established. Meredith (1983) described a rapid rise in numbers and species of birds in Victorian mallee from zero to 15 years after a fire. He listed a few common species present in the early stages of recovery when there was low structural diversity. This seems similar to the Weddin situation, with the increases, in numbers of individuals and species, which occurred in the widespread and sedentary species in the forest. In the Victorian mallee study there was a decline in numbers of birds after a peak in 15 years but an increase in species richness to 60 years. The recovery following the Weddin fire might be closer to this situation than the studies on dry and wet sclerophyll forests closer to the coast.

Braithwaite *et al.* (1984) examined the vertebrate fauna in tall eucalypt forest about to be logged near Eden, south-eastern New South Wales. After their study plot was burnt by wildfire, they recorded a post-fire increase in Flame and Scarlet Robins and Grey Butcherbirds. This is considered equivalent to the increase in Red-capped Robins and Pied Butcherbirds and the presence of Hooded Robins in the recovering burnt areas in the Weddin Mountain area observed in 1983. Whereas the Eden study took place in a large forested area, the Weddin area was surrounded by farmlands, and recruitment or movement into the burnt forest may have been by species accustomed to open country with fewer trees. Bamford (1985) reported on this aspect following fire in Banksia woodland in Western Australia.

There was a significant decrease in the 1975 count in the number of birds foraging on the ground, in tall shrubs and in the canopy. This was similar to the reaction in dry sclerophyll Jarrah forest in Western Australia after an intense prescribed burn (Christensen and Kimber 1975). Birds feeding at upper canopy levels were least affected by fire. In wet sclerophyll Karri forests, Christensen and Kimber (1975) found that counts three years after fire were still higher than those made before the fire.

Newsome *et al.* (1975) compared their results in south-eastern New South Wales with the cycles in North American forests, where, in one case, the diversity of birds and mammals increased for 25 years after a fire and the greatest biomass existed in an area burnt 300 years before. The dominance of eucalypts is relatively unaffected by fire, which may limit the long-term developments of mixed eucalypt/cypress forest. A contrasting situation occurs with conifer forests and some rainforests, where tolerant species form under the canopy and may eventually become the dominant species. The Weddin Mountain fire encouraged regeneration and development of eucalypt at the expense of White Cypress Pine. Any change in forest type or species composition may have an effect on bird populations.

This study, apparently unique for cypress pine forests, indicates the direction that research could be applied in recovery of the Australian environment following fire. Fire is an essential component of the eucalypt forest (Newsome *et al.* 1975; Gill *et al.* 1981), and in the Weddin area a tall eucalypt forest is probably the climax vegetation. The White Cypress Pine forest managed until the 1975 fire was a disclimax depending on control or management of fire (Lacey 1972). The varying nature and sequence of recolonization of birds following fire was studied in heath in Cooloola National Park, Queensland (McFarland 1988). The practice of burning every three years favoured opportunist species such as Richard's Pipit, but resident species such as Ground Parrot and Southern Emu-wren did not become abundant until the recovering habitat was over five years old. The results in this paper suggest that greater diversity in numbers of species and individual birds follow fire in central western New South Wales. This survey and other work indicate that more information is required on the effect of fire on frugivorous and nectarivorous birds.

In this context, it is appropriate to note the practice of burning to encourage populations of two species of vulnerable, rare mammals, the Woylie *Bettongia penicillata* and Tammar Wallaby *Macropus eugenii*, for which fire was applied in a rotation in a fauna conservation area in Perup Forest, Western Australia (Christensen and Maisey 1987).

CONCLUSIONS

This study has indicated that fire could be used selectively to encourage species of birds into forested areas. It has been shown that burning every three years in coastal heath can be used successfully to favour opportunist species, but that a less frequent interval is necessary for resident species. It is reasonable to conclude that a similar pattern of recolonization following controlled fire would apply in these central western forests, although no recommendation can be made on the frequency of burning. Land managers would have to be aware of the possibility of invasions of farmland and open country birds. Since fire will damage commercially valuable timber species such as White Cypress Pine, it would be a more appropriate management tool for manipulating bird populations in areas reserved for nature conservation, such as national parks and nature reserves.

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APPENDIX 1

Numbers of terrestrial birds sighted by NSWFOC during 1975 and 1983 surveys comparing with a list over parts of Weddin State Forest and Weddin Mountain National Park. Years of sighting, fire history, feeding guides and migration habits are shown.

Species	1975 survey		1983 survey		Foraging guilds by substrate[1]	Main foraging height[2]	Migration habitat[3]
	Burnt	Unburnt	Burnt	Unburnt			
Emu *Dromaius novaehollandiae*	4	—	2	—	FE	0–1 m	S
Black-shouldered Kite *Elanus notatus*	—	—	—	1	AO	AO	N
Brown Goshawk *Accipter fasciatus*	—	—	2	—	AO	AO	S
Grey Goshawk *A. novaehollandiae*	2	—	—	—	AO	AO	V
Wedge-tailed Eagle *Aquila audax*	1	1	1	3	AO	AO	S
Little Eagle *Hieraaetus morphnoides*	—	1	1	1	AO	AO	S
Brown Falcon *Falco berigora*	—	1	3	—	AO	AO	S
Painted Button-quail *Turnix varia*	—	2	—	2	GF	0–1 m	S
Peaceful Dove *Geopelia placida*	3	2	7	3	GF	0–1 m	S
Common Bronzewing *Phaps chalcoptera*	2	1	3	2	GF	0–1 m	S
Crested Pigeon *Ocyphaps lophotes*	—	6	10	2	GF	0–1 m	S
Little Lorikeet *Glossopsitta pusilla*	2	6	—	—	NF	0–1 m	N
Galah *Cacatua roseicapilla*	6	6	10	2	SE	0–1 m	S
Cockatiel *Nymphicus hollandicus*	—	—	10	—	SE	0–1 m	N
Eastern Rosella *Platycercus eximius*	4	10	8	5	SE	0–1 m	S
Red-rumped Parrot *Psephotus haematonotus*	4	—	5	1	SE	0–1 m	N
Turquoise Parrot *Neophema pulchella*	4	1	12	1	SE	0–1 m	S
Pallid Cuckoo *Cuculus pallidus*	—	1	3	2	IF	5–9 m	M
Fan-tailed Cuckoo *C. pyrrhophanus*	—	1	3	2	IF	0–1 m	N
Black-eared Cuckoo *Chrysococcyx osculans*	—	1	1	1	IF	5–9 m	M
Shining Bronze-Cuckoo *C. lucidus*	1	—	1	2	IF	5–9 m	M
Horsfield's Bronze-Cuckoo *C. basalis*	—	3	1	1	IF	5–9 m	M
Boobook Owl *Ninox novaeseelandiae*	1	—	1	—	AO	AO	S
Tawny Frogmouth *Podargus strigoides*	1	—	1	—	GF	0–1 m	S
Sacred Kingfisher *Halcyon sancta*	—	—	5	2	AO	AO	M
Red-backed Kingfisher *H. pyrrhopygia*	1	—	—	—	AO	AO	V
Laughing Kookaburra *Dacelo novaeguineae*	3	7	3	3	AO	AO	S
Rainbow Bee-eater *Merops ornatus*	—	6	17	6	IA	>15 m	M
Dollarbird *Eurystomus orientalis*	—	1	—	1	IA	>15 m	M
Welcome Swallow *Hirundo neoxena*	—	—	1	—	IA	>15 m	S
White-backed Swallow *Cheramoeca leucosternum*	—	—	3	—	IA	>15 m	S
Tree Martin *Cecropis nigricans*	—	—	2	—	IA	>15 m	M
Richard's Pipit *Anthus novaeseelandiae*	—	—	1	—	GF	0–1 m	S
Black-faced Cuckoo-shrike *Coracina novaehollandiae*	4	6	16	5	IF	10–14 m	S
White-winged Triller *Lalage sueurii*	3	—	13	5	IF	5–9 m	M
Red-capped Robin *Petroica goodenovii*	8	12	50+	50+	GF	0–1 m	S
Hooded Robin *Melanodryas cucullata*	—	—	4	—	GF	0–1 m	N
Eastern Yellow Robin *Eopsaltria australis*	10	15	4	6	GF	0–1 m	S
Jacky Winter *Microeca leucophaea*	4	4	4	2	IA	5–9 m	S
Shrike-tit *Falcunculus frontatus*	1	1	6	1	TT	5–9 m	N
Gilbert's Whistler *Pachycephala inornata*	—	—	6+	—	IF	1–4 m	S
Golden Whistler *P. pectoralis*	—	—	—	5	IF	5–9 m	M
Rufous Whistler *P. rufiventris*	20+	20+	50+	50+	IF	5–9 m	M
Grey Shrike-thrush *Colluricincla harmonica*	8	8	5	5	GF	0–1 m	S
Leaden Flycatcher *Myiagra rubecula*	—	—	1	—	IA	5–9 m	M
Grey Fantail *Rhipidura fuliginosa*	6	8	10+	2	IA	5–9 m	N
Willie Wagtail *R. leucophrys*	4	10	6	3	IA	1–4 m	S
Restless Flycatcher *Myiagra inquieta*	—	3	1	—	IA	5–9 m	N
Spotted Quail-thrush *Cinclosoma punctatum*	—	—	1	—	GF	0–1 m	S
White-browed Babbler *Pomatostomus superciliosus*	—	12	20	12	GF	0–1 m	S
Rufous Songlark *Cincloramphus mathewsi*	2	4	100+	—	GF	0–1 m	M
Superb Fairy-wren *Malurus cyaneus*	1	10	10	4	GF	0–1 m	S
Speckled Warbler *Sericornis saggitatus*	—	20+	2	7	GF	0–1 m	N
Weebill *Smicrornis brevirostris*	—	2	4	6	IF	10–14 m	S

Appendix 1 — *continued*

Species	1975 survey		1983 survey		Foraging guilds by substrate[1]	Main foraging height[2]	Migration habitat[3]
	Burnt	Unburnt	Burnt	Unburnt			
Western Gerygone *Gerygone fusca*	6	6	13	3	IF	10–14 m	S
White-throated Gerygone *G. olivacea*	—	—	2	1	IF	10–14 m	M
Yellow Thornbill *Acanthiza nana*	4	8	16	12	IF	10–14 m	S
Brown Thornbill *A. pusilla*	—	7	—	—	IF	1–4 m	S
Yellow-rumped Thornbill *A. chrysorrhoa*	2	9	7	7	GF	0–1 m	S
Buff-rumped Thornbill *A. reguloides*	20+	20+	7	10	GF	0–1 m	S
Chestnut-rumped Thornbill *A. uropygialis*	—	—	2	2	GF	1–4 m	S
Inland Thornbill *A. apicalis*	4	4	7	2	IF	1–4 m	S
Southern Whiteface *Aphelocephala leucopsis*	—	—	6	8	GF	0–1 m	S
Varied Sittella *Daphoenositta chrysoptera*	3	—	5	—	TT	0–14 m	S
Brown Treecreeper *Climacteris picumnus*	6	6	12	1	TT	0–1 m	S
White-throated Treecreeper *C. leucophaea*	4	6	5	9	TT	5–9 m	S
Red Wattlebird *Anthochaera carunculata*	—	8+	1	3	NF	5–9 m	N
Little Wattlebird *A. chrysoptera*	—	—	2	—	NF	5–9 m	N
Spiny-cheeked Honeyeater *Acanthagenys rufogularis*	—	—	—	1	FE	5–9 m	S
Striped Honeyeater *Plectorhyncha lanceolata*	—	—	4	—	IF	10–14 m	N
Little Friarbird *Philemon citreogularis*	—	13	3	3	NF	10–14 m	N
Noisy Friarbird *P. corniculatus*	—	1	14	—	NF	10–14 m	N
Noisy Miner *Manorina melanocephala*	2	—	2	1	IF	5–9 m	S
Fuscous Honeyeater *Lichenostomus fuscus*	20+	20+	6	3	IF	10–14 m	M
Yellow-faced Honeyeater *L. chrysops*	—	20+	9	4	IF	5–9 m	N
Grey-fronted Honeyeater *L. plumulus*	—	—	6	—	NF	10–14 m	N
White-plumed Honeyeater *L. penicillatus*	—	5+	6	9	IF	10–14 m	S
White-eared Honeyeater *L. leucotis*	2	5	—	2	TT	5–9 m	S
Brown-headed Honeyeater *Melithreptus brevirostris*	—	—	4	2	IF	10–14 m	N
White-naped Honeyeater *M. lunatus*	6	—	5	—	IF	5–9 m	N
Black-chinned Honeyeater *M. gularis*	—	—	2	1	IF	5–9 m	S
White-fronted Chat *Ephthianura albifrons*	—	—	8	—	GF	0–1 m	M
Mistletoebird *Dicaeum hirundinaceum*	4	12	7	4	FE	10–14 m	S
Spotted Pardalote *Pardalotus punctatus*	3	4	2	—	IF	5–9 m	S
Striated Pardalote *P. striatus*	1	—	2	2	IF	10–14 m	N
Silvereye *Zosterops lateralis*	—	4	2	1	FE	1–4 m	M
Red-browed Firetail *Emblema temporalis*	—	—	1	—	GF	0–1 m	S
Diamond Firetail *E. guttatum*	1	6	2	—	GF	0–1 m	S
Chestnut-breasted Mannikin *Lonchura castaneothorax*	—	12	—	—	GF	0–1 m	S
White-winged Chough *Corcorax melanorhamphos*	8	4	20+	22	GF	0–1 m	S
Apostlebird *Struthidea cinerea*	—	—	3	—	GF	0–1 m	S
Magpielark *Grallina cyanoleuca*	2	2	3	—	AO	AO	S
Dusky Woodswallow *Artamus cyanopterus*	6	—	13	—	IA	5–9 m	S
White-browed Woodswallow *A. superciliosus*	—	14	—	—	IA	> 15 m	N
Australian Magpie *Gymnorhina tibicen*	2	4	8	7	GF	0–1 m	S
Pied Currawong *Strepera graculina*	4	4	7	7	AO	AO	N
Pied Butcherbird *Cracticus nigrogularis*	—	—	2	1	AO	AO	S
Grey Butcherbird *C. torquatus*	1	—	1	—	AO	AO	S
Australian Raven *Corvus coronoides*	4	4	2	7	AO	AO	S
99/129 species on list	225	400	660	340	99	99	

Symbols used in table for foraging guilds, foraging height and main migration habit.

[1]Foraging guilds
GF Ground foraging
TT Tree trunk
IF Insectivorous, foliage
IA Insectivorous, aerial
NF Nectar feeders
SE Seed eaters
FE Frugivorous
AO All others, mainly vertebrate prey

[2]Main foraging height
0–1 m Ground and low vegetation
1–4 m Shrubs
5–9 m Trunk, sub-canopy
10–14 m Canopy foliage
>15 m Aerial, blossom

[3]Migration habit
M Migratory
N Nomadic
S Sedentary
V Vagrant