Report on the distribution, abundance and breeding status of the Superb Parrot (*Polytelis swainsonii*) during the 2009-10 breeding season, Gungahlin, ACT.



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Background

The Superb Parrot (*Polytelis swainsonii*) is a listed threatened species under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* and as such must be considered in any development application. Within the ACT the species is declared vulnerable under the ACT's *Nature Conservation Act 1980* and is regarded as a non-breeding summer migrant restricted to the north western area of the ACT, in particular the area around Mt. Rogers in the suburb of Fraser.

The most significant threat to the Superb Parrot is widespread clearing, degradation and fragmentation of box woodland throughout the species' range, especially breeding and foraging habitats, and corridors of vegetation used for regular movements (Webster 1988). Until recently the nearest known breeding location was from the area of Captains Hill along the Wallaroo Road, NSW (35° 09' 04" S, 149° 01' 30" E), (Davey, 1997).

Martin (1996) produced a survey questionnaire and conducted a road survey within the Wallaroo Road area o the Yarrowlumla Shire, NSW and provided an estimate of the number of potential Superb Parrot nesting trees.

Within the ACT, Davey (2002) reported on bird observations from Mulligan's Flat Nature Reserve between 1995 and 2000 and noted a single observation of a Superb Parrot only and of an individual hollow inspecting nearby the Reserve in 1996-97.

An unprecedented number of Superb Parrots including many dependent young were observed in the northern Belconnen suburbs over the summer of 2005-06 (Lashko 2006). The species was recorded from 10 Belconnen suburbs and was present from early December with small numbers remaining through to February. Records from the Canberra Ornithologists Group's (COG) database indicate that this influx has continued. Associated with this summer influx the birds appear to be arriving earlier and departing later with records in early September to late March and with dependent but begging young now often observed.

With an increase in sightings at Mulligan's Flat / Goorooyarroo Nature Reserves and breeding in trees in the adjacent suburb of Harrison, there is a strong possibility that breeding may now be occurring within the potentially suitable habitat to be found in areas reserved for urban development within the Gungahlin area. It is unknown why there has been a change in the occurrence and distribution of the Superb Parrot within the ACT or whether this change will be temporary or permanent. It cannot be assumed that the influx is due to an increase in their abundance.

The aim of the survey was to document the distribution and breeding status of Superb Parrots during the 2009-10 breeding season within and surrounding the proposed suburbs of Kenny, Throsby, Jacka, Moncrieff and Kinlyside and to determine the condition of the tree-hollow estate within the areas proposed for development (but not including Kinlyside).

Methods

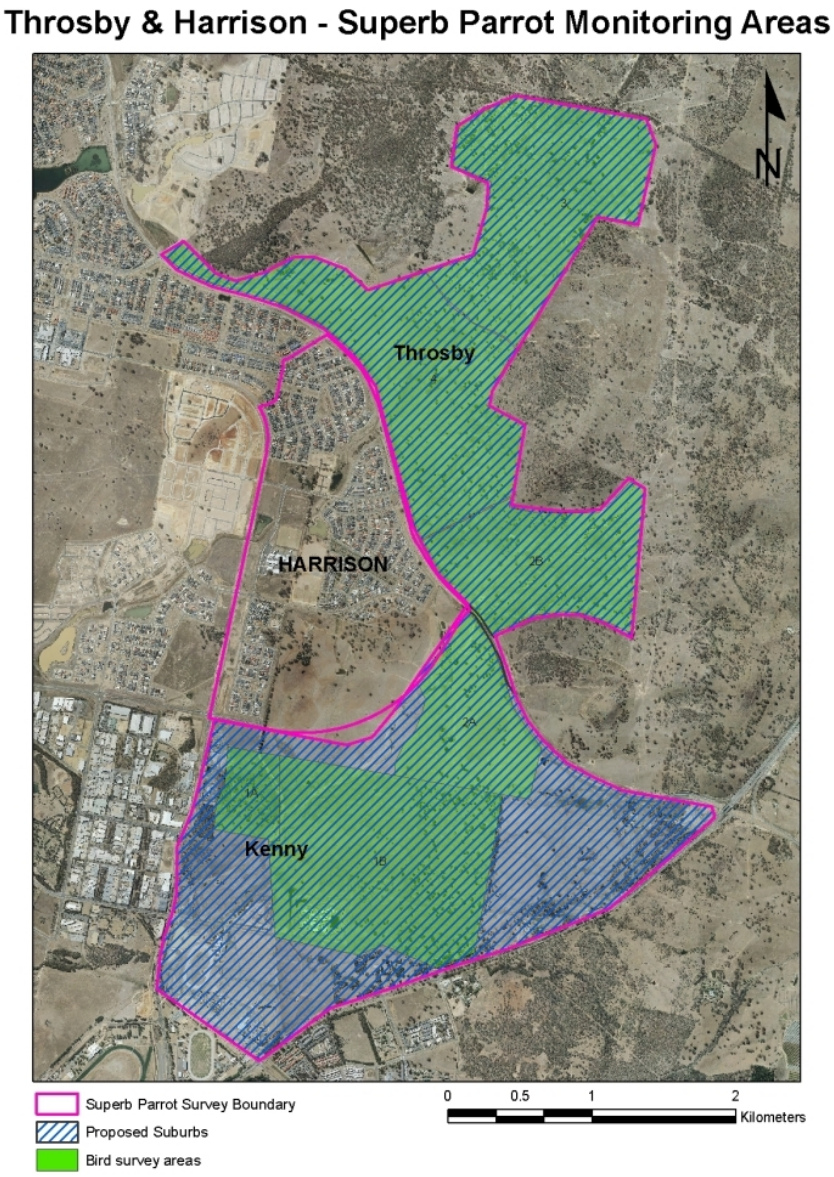
Superb Parrot survey

Members of the Canberra Ornithologists Group (COG) were advised of the survey and were asked to report to the COG Discussion List (Chat-line) any observations on the birds. Although it is recognised that this information is of limited use due to inconsistencies in observations, the lack of nil observations etc, it is possible to gain a general impression of where birds were located over urban Canberra and of their behaviour. Additional information was obtained from the ANU and from ACT Government rangers on sightings from Mulligan's Flat and Goorooyarroo Nature Reserves.

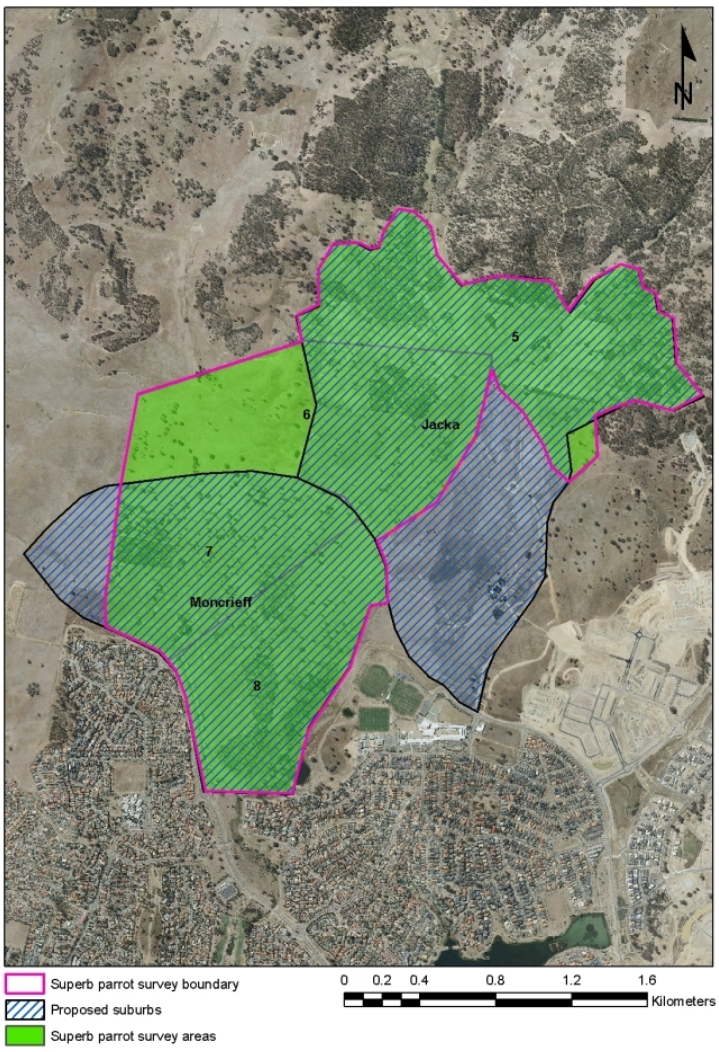
Over the mornings of 12 September, 17 October, 14 November and 12 December survey teams of COG members searched areas covered by the proposed suburbs of Kenny, Throsby, Jacka, Moncrieff and Kinlyside. Surveys started 1 hour after sunrise and continued until the individual teams were satisfied that their designated area had been adequately covered; usually taking 3-4 hours. All team members were familiar with the Superb Parrot and at least one member of each team was familiar with the calls.

For the purpose of the monthly breeding surveys the suburbs were sub-divided to facilitate ease of access and to ensure adequate coverage. Team 1 covered two areas in Kenny (area 1a and 1b) whilst team 2 covered a part of Kenny (area 2a) and part of Throsby (area 2b). Team 3 was assigned to area 3 and team 4 to area 4, both in Throsby. Teams 5 and 6 covered areas 5 and 6 in Jacka whilst Teams 7 and 8 covered areas 7 and 8 in Moncrieff, see Map 1 for details. For each survey observers were assigned to different teams. Finally, a dedicated team with prior knowledge of the area (through COGs regular woodland surveys) was assigned to Kinlyside.

Map 1. Superb Parrot survey areas in the proposed suburbs of Kenny, Throsby, Jacka and Moncrieff.



Jacka & Moncrieff - Superb Parrot Monitoring Areas



All areas were covered on the four occasions except for Throsby (areas 2b, 3 and 4) and a section of Kenny (area 2a) when lambing prevented access for the September survey. On all occasions the locations of any Super Parrots were recorded on an aerial photo of the area and details of behaviour noted. Many observers had trouble identifying specific trees from aerial photographs and just indicated the general area of the observation. It is, therefore, not possible to provide an accurate geo-location for all observations but the coordinates do indicate the general area of interest.

As well as noting the location and behaviour of individual Superb Parrots, observers involved in the monthly surveys also recorded the estimated abundance of all other bird species within the proposed suburbs. All data were recorded on a COG Observation Data Sheet for subsequent transcribing to the COG database.

Due to the preliminary nature of the survey and limited resources it was not possible to determine successful breeding with any accuracy. It was not possible to return to specific areas to confirm observations and no attempt was made to examine in detail any of the possible nesting sites. Rather, the definitions of breeding indicates an intention to breed and includes the following observations; females observed entering or exiting hollows,

copulations, aggressive interactions between pairs with a potential nest hollow near by and a male 'on station' indicated by the presence of a lone male perching quietly in a tree occasionally making a soft call and with a possible nest hollow in the same tree.

In addition, to the four bird surveys, a reconnaissance trip of Throsby area 4 was carried out on 10 October and all sites were covered for the tree survey, see below for details. Apart from the bird surveys all other visits were conducted by Chris Davey.

Tree-hollow survey

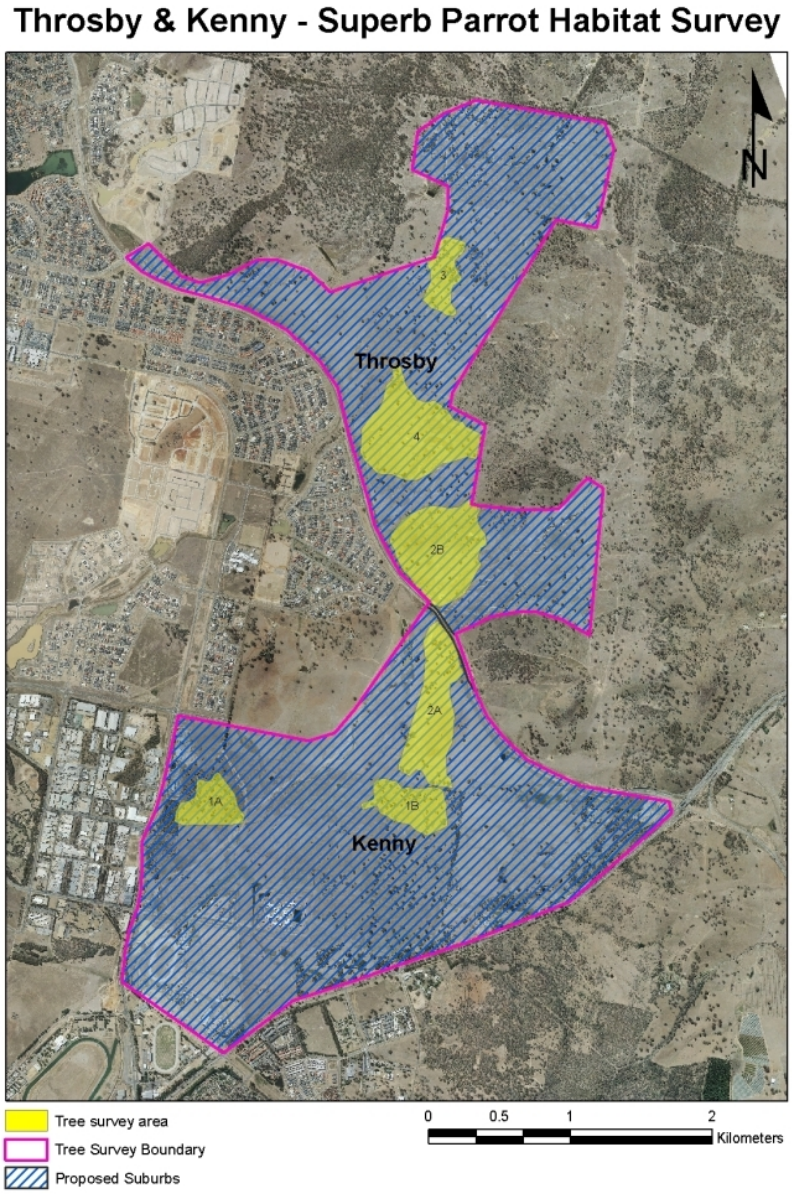
The Superb Parrot, along with most cockatoo and other parrot species, nest in tree hollows. The characteristics of their nesting hollows have been described by Webster (1988) and subsequently by Manning (2004) for his studies on the ecology of the Superb Parrot. Nine sites of trees were selected from aerial photographs to best represent the trees within the proposed suburbs of Kenny (3 sites), Throsby (3 sites), Jacka (1 site) and Moncrieff (2 sites), see Map 2. Each site contained about 75 trees (range 61- 91) with the number of trees and size of site limited by 3-4 hours of survey time for each site. The number of trees surveyed was therefore determined by the distance required to travel between each tree i.e. tree density. Sites were surveyed between 26 October and 19 December 2009.

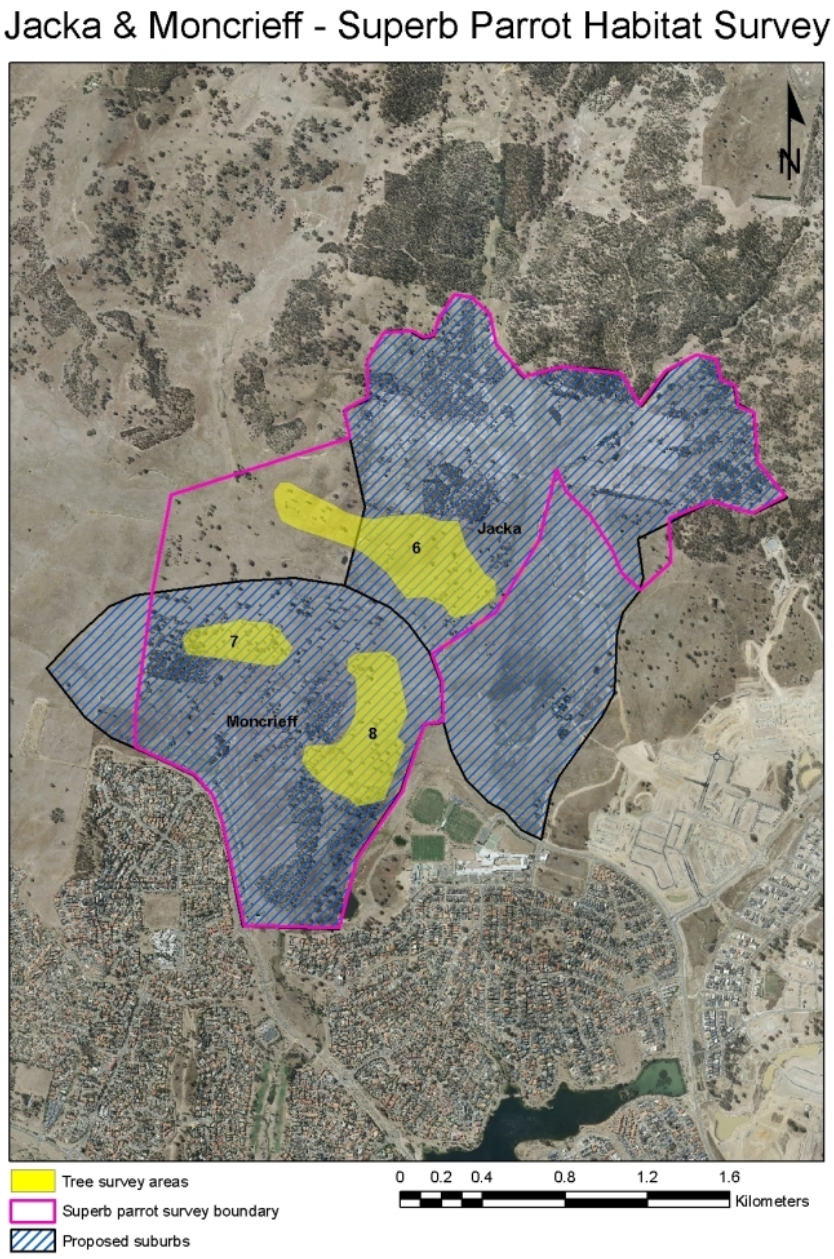
All native hollow-bearing trees with a diameter at breast height (DBH) greater than 0.3 m were assessed then located and uniquely numbered on an aerial photo. The following attributes were recorded for each tree; tree species and DBH, number of hollows in the following size categories- small (up to 5 cm diameter), medium (6-10 cm), large (11 to 15 cm) and very large (greater than 15 cm diameter). The hollow size was estimated by eye and finally an assessment of the height of the tree from ground to the first major branch was noted. All attributes, except for height to start of first major branch follows Manning (2004).

Some trees in the proposed suburbs of Kenny, Jacka and Moncrieff were found to have numbered tags nailed to the trunk. The labelled trees are assumed to be 'Registered Trees' and the tag number was recorded so that an assessment could be made of differences between registered and non-registered trees.

An overall estimation of the number of each hollow size category for each suburb was made by extrapolation. The number of trees in each tree survey site was counted from the aerial photographs and compared with the actual number surveyed and a correction factor calculated. The number of trees in each suburb was then counted from the aerial photographs and the correction factor applied. The ratio of each hollow size category at the tree survey site was then applied to each suburb.

Map 2. Tree survey area in the proposed suburbs of Kenny, Throsby, Jacka and Moncrieff.





Results and Discussion

Superb Parrot survey

From postings to the COG Discussion List, the Superb Parrot returned to the Canberra area in 2009 around early September with the first report at Belconnen Golf Course on 1 September. By mid-September birds had been reported from Mulligan's Flat, Macquarie, flying over William Slim Drive, Harrison and Mt Rogers. With the first survey set for 12 September, the birds had returned approximately two weeks earlier.

Bearing in mind the possibility of double counting when estimating the number of birds as they fly through areas that are being counted simultaneously, the estimated number of Superb Parrots observed in each survey area is shown in Table 1 with the number observed during the tree surveys shown in Table 2.

Table 1. Estimated number of Superb Parrots recorded during bird surveys within proposed suburbs of Gungahlin, ACT.

Suburb	Area	Survey dates			
		12-Sep	17-Oct	14-Nov	12-Dec
Kenny	1a	0	0	0	0
Kenny	1b	0	0	0	1
Kenny	2a	No survey	0	0	0
Throsby	2b	No survey	12+	8	20
Throsby	3	No survey	10	14	19
Throsby	4	No survey	23	8	2
Jacka	5	0	0	0	0
Jacka	6	0	0	0	0
Moncrieff	7	0	0	0	0
Moncrieff	8	0	0	0	0
Kinlyside	9	0	0	0	0

In the proposed suburbs of Jacka, Moncrieff and Kinlyside there were no signs of Superb Parrots during any of the bird surveys, or tree surveys. Apart from a single observation of a single bird flying over the area on 12 December no Superb Parrots were reported from Kenny.

Table 2. Estimated number of Superb Parrots recorded during tree surveys within proposed suburbs of Gungahlin, ACT.

Suburb	Area	Survey date	No. Superb Parrots
Kenny	1a	26-Oct	0
Kenny	1b	27-Oct	0
Kenny	2a	31-Oct	0
Throsby	2b	4 and 9 Nov	12, 13
Throsby	3	2-Nov	7 or 8
Throsby	4	10-Nov	0*
Jacka	6	14-Dec	0
Moncrieff	7	19-Dec	0
Moncrieff	8	24-Nov	0
Kinlyside	9	No survey	

* note: 3 seen on 10 Oct

In Throsby, unfortunately the area in which the birds were most likely to be observed during the September survey could not be assessed. From October onwards Superb Parrots were reported from two distinct locations.

In area 2b (east Throsby) Superb Parrots were recorded on all visits with pairs interacting over tree hollows, and possible nests at three locations (sites 1, 2 and 3), see Table 3. By early November there were indications of breeding at six additional locations (sites 8, 9, 10, 11, 12, 13) and juveniles being observed in mid- December. As with area 3 there was much movement between the area and Harrison.

In area 3 (north Throsby) birds were observed flying back and forth from area 4 (south Throsby) with an increase in numbers due to the presence of juvenile begging birds recorded in mid-December, see Tables 1 and 2. In mid-October, in addition to birds inspecting tree hollows, signs of breeding were observed at sites 5 and 6, see Table 3. On 2 November during the tree survey signs of breeding were observed at sites 5 and 7. In mid-December there was still a nest at site 7 with the female visible and sitting as well as begging young within the area.

In area 4 (south Throsby) during mid-October birds were observed flying to the 'Big Dam' at Mulligan's Flat and back and forth from areas 2b (east Throsby) and area 3 (north Throsby) and from the suburb of Harrison. Signs of a possible breeding event was observed at site 14 with a male observed 'on station' calling softly presumably to a female in the hollow, see Table 3. By November and subsequently December the number of birds recorded flying over area 4 was much reduced, see Tables 1 and 2.

Although difficult to estimate due to the amount of Superb Parrot movement in the area, by mid-October the minimum number of birds using the Throsby area would have been about 20 individuals. By mid-December by which time the birds were more localised and with juveniles there would have been in the order of 40 individuals using the area.

Table 3. Location and date of observations for 16 possible breeding sites within the proposed suburb of Throsby and surrounds, ACT.

Suburb	Site	Date	Latitude	Longitude	Observations
			Deg	Deg	
East Throsby	1	17-Oct-09	35.193969	149.170633	female in and out hollow
East Throsby	2	17-Oct-09	35.195658	149.173159	male on station
East Throsby	3	14-Nov-09	35.194081	149.169883	female enter hollow
East Throsby	4	14-Nov-09	35.194439	149.169283	attempt copulation
East Throsby	8	4-Nov-09	35.197056	149.170220	pair sit quiet next to hollow
East Throsby	9	4-Nov-09	35.195256	149.170620	male on station
East Throsby	10	4-Nov-09	35.195017	149.171568	male on station
East Throsby	11	4-Nov-09	35.195087	149.171225	male on station
East Throsby	12	4-Nov-09	35.194702	149.170949	male on station
East Throsby	13	4-Nov-09	35.196860	149.169085	possible nest
East Throsby		12-Dec-09			adults with begging young, in/out hollows
North Throsby	5	4-Feb-00	35.182229	149.167792	male look in hollow, call to female in hollow
North Throsby	6	17-Oct-09	35.178410	149.169778	male on station
North Throsby	5	2-Nov-09			v likely sp hollow
North Throsby	7	2-Nov-09	35.182219	149.166678	female seen on nest
North Throsby	7	14-Nov-09			female flushed off nest
North Throsby	7	12-Dec-09			flushed from nest site
North Throsby		12-Dec-09			adults with begging young in general area
South Throsby	14	17-Oct-09	35.191164	149.169992	male possibly on station
South Throsby		12-Dec-09			adults with begging young in general area
Mulligan's Flat	15	3-Nov-09	35.176472	149.162028	on station and female into hollow
Mulligan's Flat	16	3-Nov-09	35.176389	149.163333	possibly on station

Harrison	H		35.195537	149.155296	
Harrison School	HS		35.200901	149.153093	
Franklin Woods	FW		35.203436	149.147210	
BL	BL		35.180580	149.164416	

In addition to the surveyed suburbs there are eight other locations of interest.

For many years Mt. Rogers (35° 11' 51.56" S, 149° 03' 17.43" E) has been known as a site where birds are reported first in the ACT and where adults and begging young go to feed post breeding. This pattern was repeated in 2009 with the first report received on 12th September and birds still present up to late November. The greatest number reported was of 50 individuals on 13th September.

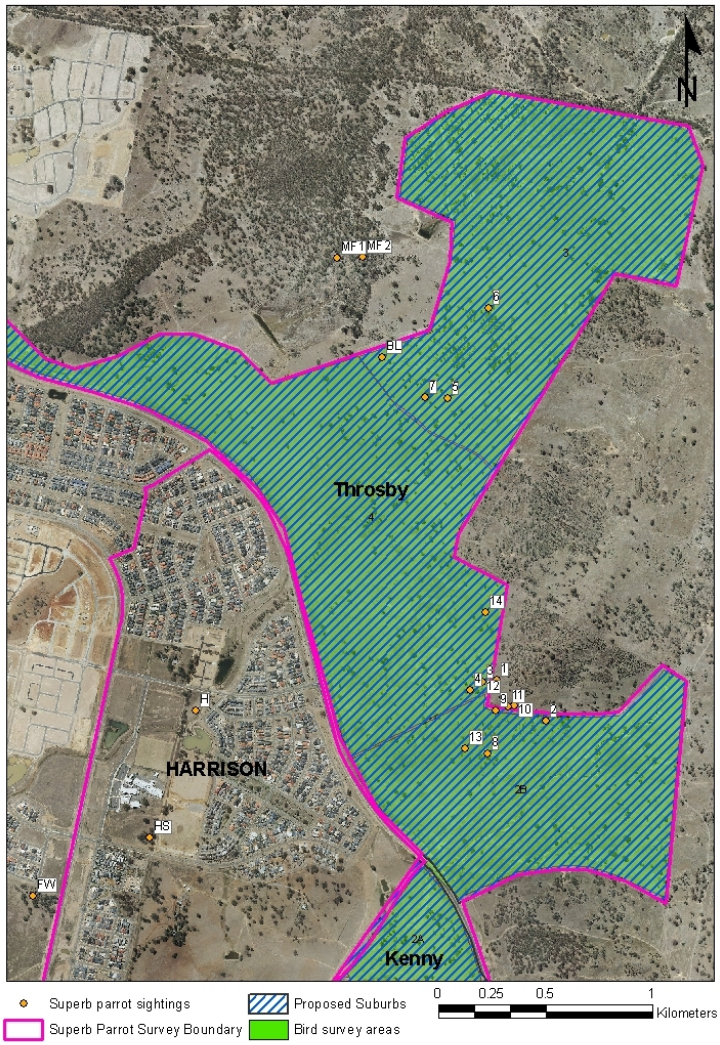
Over the spring and summer months the area between and including the Kama Nature Reserve and north-east to Pine Ridge farm, otherwise known as Central Molonglo (35° 14' 48.94" S, 149° 00' 48.84" E), was regularly visited by Chris Davey for a study on the vulnerable Brown Treecreeper (*Climacteris picumnus*). The Superb Parrot was first recorded in the area on 28 September, from then on until late January birds were found scattered throughput the area. By early October the sex ratio appeared to be 1 female to every 5 males with much hollow inspecting and aggressive interactions. By the end of December flocks including begging juveniles were seen. There is no doubt that the Superb Parrot used the Central Molonglo area for breeding during the 2009-10 season.

The Gungaderra Creek starts near the neck joining Mulligan's Flat and Goorooyarroo Nature Reserves and flows south through the proposed suburb of Throsby, under Horse Park Drive, through the suburb of Harrison, passing north of the Harrison School and Franklin Woods and then continuing through the Gungaderra Grassland Reserve, under the Barton Highway to flow through Kaleen and finally to join the Ginninderra Creek. In previous years, a pair of Superb Parrots had been reported breeding at the Harrison School site (35° 11' 50.77" S, 149° 09' 35.23" E), see Map 3 and observations between mid-September and mid November confirmed that this happened again during 2009-10. The male being frequently observed 'on station' between 6 October and 2 November. Interestingly, the pair would depart the area always flying in a north- easterly direction, not up Gungaderra Creek, possibly to the east Throsby area from which birds had been observed flying in a westerly direction.

During a walk along the Gungaderra Creek from where it travels under Horse Park Drive to where it flows north of the Harrison School on 24 October, at least six males were noticed flying either up or down stream with a male being recorded 'on station' in a Blakely's Red Gum (*E. blakelyi*) in the Harrison Park at 35° 11' 43.93" S, 149° 09' 19.06" E, see Map 3 in an area reserved for 'Future Residential Development- Land Development Agency'. At the same time and in the same area a second male was noted to be 'on station'.

Map 3. Superb Parrot breeding locations.

Throsby & Harrison - Superb Parrot Breeding Locations



On 21 October during a visit to the Franklin Woods (35° 12' 12.37" S, 149° 08' 49.96" E), see Map 3, two females and five to six males were seen. Although no signs of breeding were observed there are appropriate nesting sites in the area. When observing the pair at the Harrison School, on occasions birds were noticed flying in an north-east direction from the area of the Franklin Woods possibly to the east Throsby area and *vice versa*.

Regular observations from CSIRO Sustainable Ecosystems by Chrs Davey (35° 13' 10.83" S, 149° 07' 27.67"E) indicated a daily back and forth north-east/ south-west pattern of movement over the site. Associated observations posted to the COG email Discussion list suggested that the birds were flying to and from the Kaleen district playing fields and ovals. Up to 22 birds were reported, and were regularly observed feeding on the ground suggesting a possible passage of birds to the playing fields from the Throsby, Harrison, Franklin Woods area. Both males and females were first noted flying over the site from early-September in flocks of up to nine birds but from late September onwards the passage consisted of single males until by early November an increase in the number of birds was observed passing through. By mid-December the passage had ceased and on 16 December adults and young were seen feeding in acacias along Bellenden Street.

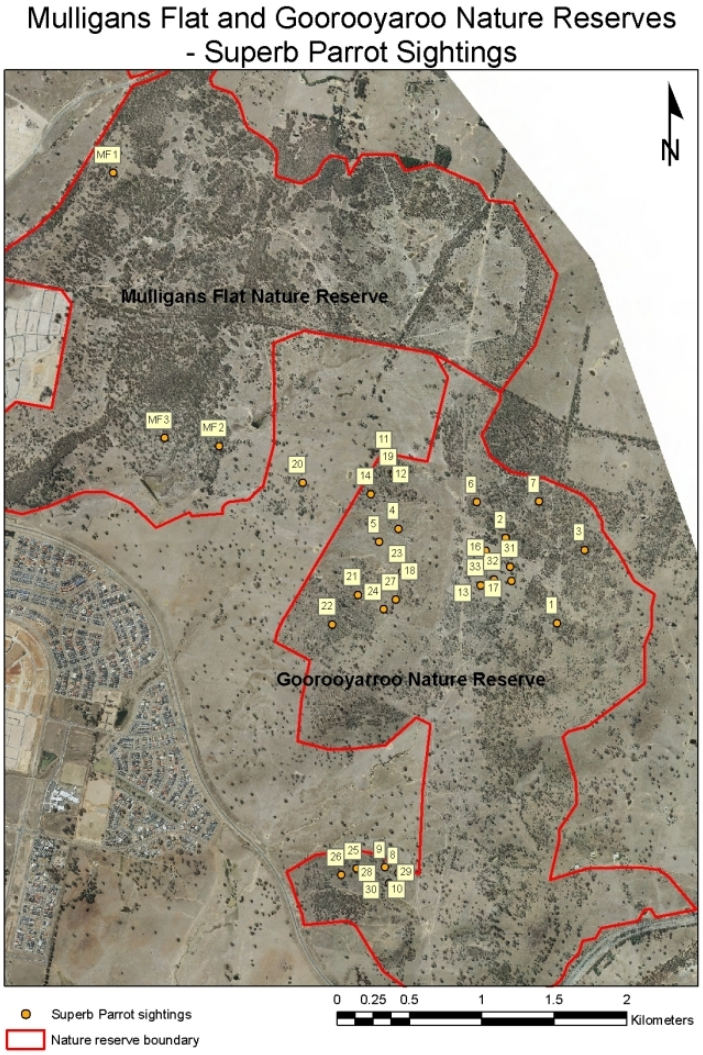
The Gungaderra Creek, therefore, appears to be an important area for the Superb Parrot linking north Throsby to Harrison and Franklin and then via CSIRO to Kaleen. It will be interesting to see how the birds continue to use the area with the continuing development of Harrison and Franklin. In addition, there appears to be traffic from the east Throsby area directly across the suburb of Harrison to the Harrison School area and the Franklin Woods.

Despite a frequent presence of Rangers from Parks and Conservation and frequent trips by COG members, there were few sightings from the Mulligan's Flat Nature Reserve. Birds were reported flying between north Throsby and the 'Big Dam' but the only report of birds breeding from within the Reserve was of a pair interested in a hollow at 35° 10' 35.09" S, 149° 09' 43.09" E, see Map 3, site 15 with on the same day a single male possibly 'on station' at site 16, see Map 3.

At Goorooyarroo Nature Reserve, a couple of years previously, a pair had been observed breeding in a hollow at 35° 11' 59.55" S, 149° 11' 11.70" E (S. Holliday *pers. comm.*) but despite frequent visits has not been seen since.

Over the period 13- 21 October 2009 members from the Fenner School of Environment and Society, Australian National University, with the help of members from the Canberra Ornithologists Group, conducted their annual bird survey of both Mulligan's Flat and Goorooyarroo Nature Reserves. Observations are taken from standard points within the Reserves for 10 minute periods with each point being surveyed twice during the survey. Behaviour was not recorded. There were 39 records of Superb Parrots of which only three were from Mulligan's Flat with the remainder from Goorooyarroo Nature Reserve, see Map 4. Observations appear to suggest that the birds were primarily using two areas within the Reserve, at an area north-east of East Throsby and again in an area south-east of East Throsby

Map 4. ANU Superb Parrot sightings within Mulligan's Flat and Goorooyarroo Nature Reserves, October 2009.



There were nine postings to the COG email Discussion list in September, a similar number in October and November then rising to 28 in December and then 6 in January with a single reported observation in February. These observations emphasise the increase in the number of Superb Parrot after the emergence of young in December. Reports were received from 16 suburbs north of the Molonglo River and two from the south. The most distance posting was of birds reported from Hoskinstown and along the Captains Flat Road during late November/ early December.

Other bird observations.

During the course of the survey there were 106 bird species recorded from the area. Not surprisingly due to differences in tree cover and area size the number of species varied between the different suburbs. Kinlyside had the greatest species richness with 80 species, see Appendix I. Sixteen percent of species were seen in all survey areas whilst 47 percent were seen in three or less of the survey areas. Two species of interest were of breeding

observations on the Banded Lapwing (*Vanellus tricolor*) and the Fairy Martin (*Petrochelidon ariel*).

In early October 2009, a pair of Banded Lapwing was observed just outside the Mulligan's Flat Sanctuary fence on leased land grazed by sheep within the Throsby area, see Map 3, site BL. One was sitting on a nest and subsequent observations confirmed the successful hatching of 3 chicks. At the same time a second pair was observed in the same area but it was not possible to confirm a breeding event. By early November the first pair was still present but with a single chick only. It is unknown whether the chick fledged but subsequent observations confirmed that this pair laid a second clutch and on 20 January two adults and three chicks were observed in the same area as the first nest. These sightings are being prepared for publication in Canberra Bird Notes (C. Boekel *pers. comm*.).

Summary of bird observations

Ad hoc observations on the behaviour of the Superb Parrots, including observations on the sex ratio at various stages of the breeding season, indicate that the birds arrive in the ACT at the start of September, egg laying starts in the third week of September with young appearing approximately 60 days later towards the end of November. The adults and young then spread throughout northern urban Canberra and leave the ACT from the middle of January onwards. This routine is similar to that reported by Davey (1997) from observations of birds around Murrumbateman, NSW.

When possible, and if resources allow, the most appropriate way of using behaviour as a means of assessing breeding is to frequently revisit the area to confirm observations and if possible to record changes in behaviour by the adults as breeding progresses. Infrequent observations can therefore only provide an indication that birds are breeding or intend to breed in an area.

Despite four bird surveys over five areas in Jacka, Moncrieff and Kinlyside and four areas covered in Jacka and Moncrieff tree surveying, no Superb Parrots were found. Attention was paid to an additional three areas in Jacka that had been sown to oats- a favoured food item of the Superb Parrot, but again there were no sightings. At Kenny three areas were searched on three occasions during the bird surveys and three areas were covered for the tree survey but on one occasion only was a single Superb Parrot seen and that was flying over the area towards east Throsby.

Within the proposed suburb of Throsby there appears to be two areas in which breeding was observed. In north Throsby a female was observed sitting on a nest and subsequently flushed from the site on several occasions whilst most of the other breeding observations were of males 'on station'. Gungaderra Creek appears to be an important route for birds to travel from the area into Harrison and beyond, apparently to feed in suburban trees and from the herb layer at various ovals and other open-spaced grassy areas.

The area to the north-east of the breeding sites in east Throsby within the Goorooyarroo Nature Reserve needs to be examined in more detail to determine whether breeding occurs in the area.

The findings from the survey conducted during the 2009-10 breeding season should be regarded as preliminary and should be repeated next year with greater emphasis to confirm

breeding by repeated frequent observations in those areas of Throsby in which there were indications of breeding in 2009.

Including the Superb Parrot, one hundred and six (106) bird species were recorded from the survey area. The Superb Parrot, Varied Sittella (D*aphoenositta chrysoptera*) and the White-winged Triller (L*alage sueurii*) are all ACT listed threatened species whilst the Speckled Warbler (*Chthonicola sagittata*) and Diamond Firetail (*Stagonopleura guttata*) are regarded as species of concern in the ACT and as threatened within New South Wales. The Dusky Woodswallow (A*rtamus cyanopterus*) and the Jacky Winter (*Microeca fascinans*) are also regarded as species of concern within the ACT.

In regard to breeding by two species of interest mentioned earlier, Breeding by the Fairy Martin is now, unfortunately, a rare event in the ACT whilst the Banded Lapwing has not been reported breeding in the ACT since 1982 (Davey 1987). Wilson (1999) rated Banded Lapwings as never having been 'particularly numerous' in the ACT and by 1999 as 'presumed extinct in the ACT'. However, Taylor and Canberra Ornithologists Group (1992) rated Banded Lapwings as a 'rare breeding visitor'. The Canberra Ornithologists Group (COG) Annotated Checklist of the Birds of the Australian Capital Territory (COG web site) has recently been modified to: 'rare breeding vagrant'.

The Throsby area may benefit the Banded Lapwing with the proximity of the 'Big Dam' at Mulligan's Flat Nature Reserve and possibly protection from foxes (*Vulpes vulpes*) due to the baiting activity around the Reserve. For two pairs to be recorded, one of which bred twice, is a significant observation.

The survey has identified two locations within the proposed suburb of Throsby used by the Superb Parrot for nesting during the 2009-10 breeding season. This valuable information will allow appropriate management and suburb design decisions to be made. Superb Parrots were also present and possibly breeding within the Central Molonglo area and so there is every possibility that they could also be present and nesting within East Molonglo. This area also needs to be assessed for the presence of nesting Superb Parrots before further development approval is granted. In the process of surveying for Registered Trees within the East Molonglo area a measure of tree hollow abundance should be included as a part of the assessment process.

Tree survey

Tree species

The tree survey was conducted over nine sites, see Map 2. Within each site the number of trees surveyed varied between 69 and 91.

Three sites covered the proposed suburb of Kenny at which a total of 219 trees were surveyed. One site covered the proposed suburb of Jacka whilst two sites at which 154 trees were surveyed covered Moncrieff. At Throsby there were 253 trees surveyed from three sites.

The area is dominated by Blakelys Red Gum (*Eucalyptus blakelyi*), comprising approximately 44% of the eucalypts present, and Yellow Box *(E. melliodora)* with seven other eucalypt species noted. In addition, 8% of the trees were dead so could not be identified whilst just under 4% could not be identified. The frequency of each species varied with each proposed suburb with proportionally less Blakleys Red Gum in the suburbs of Jacka and Moncrieff, see Table 4.

TABLE 4. Number of tree surveyed within four proposed suburbs, Gungahlin, ACT.

Tree name	Kenny	Throsby	Jacka	Moncrieff
Dead	9	26	17	5
E.blakelyi	113	132	61	5
E.bridgesiana	4	1	1	1
E.dives	1	0	14	0
E.macrorhyncha	0	0	12	11
E.mannifera	0	0	2	15
E.melliodora	68	58	32	22
E.polyanthamos	2	0	0	0
E.rossii	11	13	13	18
E.rubida	7	1	2	0
E.unknown	4	22	0	0

Tree hollows

From the eleven categories of eucalypt species recorded *E. mannifera* followed by *E. rossii* contained the greatest number of tree hollows at 3.0 and 2.7 hollows per tree respectively, see Table 5. The 26 trees that could not be identified (*E. unknown*) were in most cases either *E. mannifera* or *E. rossii* with the difficulty being to identify with confidence the two species from each other. Therefore, of the four eucalypt species that contained the most hollows all were 'gums' and in all cases the most common hollow size was those between 6 and 10 cm diameter.

Of the remainder only *E. blakelyi* was a 'gum' the others being a 'stringybark', three 'box' and one 'peppermint' species and in most cases the most common hollow size was less than 6 cm diameter. Of the two most frequent tree species present for *E. blakelyi* the most common hollow size was in the 6-10 cm category with an average of 1.05 hollows per tree whilst for *E. melliodora* the most common hollow size was less than 6 cm with an average of 0.53 hollows per tree; that is too small for the Superb Parrot to use as a nesting hollow.

Table 5. Number of trees and number of hollows per tree for eucalypt tree species found in four proposed suburbs Gungahlin, ACT.

	No. trees	No. hollows per tree				
		Small	Medium	Large	V. large	Overall
E.mannifera	17	0.94	1.18	0.65	0.29	3.1
E.rossii	55	0.80	1.35	0.45	0.09	2.7
E.unknown	26	0.65	1.15	0.19	0.00	2.0
E.rubida	10	0.50	0.60	0.30	0.00	1.4
Dead	57	0.65	0.53	0.16	0.05	1.4
E.macrorhyncha	23	0.83	0.35	0.00	0.00	1.2
E.blakelyi	311	0.30	0.54	0.19	0.01	1.0
E.polyanthamos	2	0.50	0.50	0.00	0.00	1.0
E.bridgesiana	7	0.14	0.57	0.00	0.00	0.7
E.melliodora	180	0.63	0.61	0.35	0.09	0.5
E.dives	15	0.20	0.00	0.00	0.00	0.2

By extrapolation overall there were approximately 3000 eucalypts within the area surveyed for Superb Parrots with a DBH > 0.3 m. There was an estimated 1,100 small, 1,530 medium, 550 large and 80 very large tree hollows, see Table 6.

Table 6. Estimated total number of trees and tree hollows within four proposed suburbs, Gungahlin, ACT.

	No. native	No. tree hollows*			
	trees	Small	Medium	Large	V. large
Kenny	864	375	469	130	24
Throsby	1030	338	570	142	20
Moncrieff	831	216	297	178	11
Jacka	244	171	200	101	29
Total	2969	1100	1536	552	83

* After Manning et al. 2004. Hollow size: estimated diameter

Registered trees

In four sites (4, 5, 9, 11) certain trees were labelled with an aluminium tag and numbered. It is assumed that the tagged trees had been identified with certain attributes that allow them to be classified as Registered Trees. The attributes chosen are not necessarily those that provide resources for hollow-nesting bird species so analyses comparing small, medium and large tree hollows, DBH and height from ground to the first main branch were compared between labelled and unlabelled trees.

Data from a total of 298 trees were analysed using a Generalised Linear Mixed Model (GLMM) and a Walt Test to assess the significance of the difference between the two types of

trees The only significant difference (p= 0.006) between the two groups was the higher distance from ground to first main branch of the Registered Trees, see Appendix II for analysis).

A GLM was used to determine differences in tree species between the two groups with an analysis of deviance used to assess statistical differences. *E. rubida*, *E. dives* and *E. macrororhyncha* had a low probability of being a Registered Tree whilst *E. melodica* and *E. rossii* had a high probability, see Appendix III for details. *E. unknown*, *Dead*, *E. bridgesiana*, *E. mannifera* and *E. polyanthamos* had insufficient data to be included in the analysis.

Estimate of number of potential Superb Parrot nesting trees

Manning et al. (2004) investigated the nest tree requirements for the Superb Parrot on the south-west slopes NSW. The natural vegetation of the south-west slopes is box-gum woodlands similar to that found in the Gungahlin survey area. After modelling the various measured attributes they concluded that the best predictor for Superb Parrot nest hollows was DBH, Blakleys Red Gum and Dead trees and tree condition, the latter was not assessed in the present survey.

Taking the 25% quartile as 90 cm DBH (see Figure 2, Manning et al., 2004) then 75% of nests were found in trees with a DBH of greater than 90 cm. The diameter of multi-stemmed trees is calculated by adding the diameter of each trunk giving a large diameter yet each trunk is thin and unlikely to develop hollows. Excluding multi-stemmed trees, the 606 trees that had a DBH of greater than 90 cm and with at least one hollow of more than 5 cm diameter was as follows (Table 7):

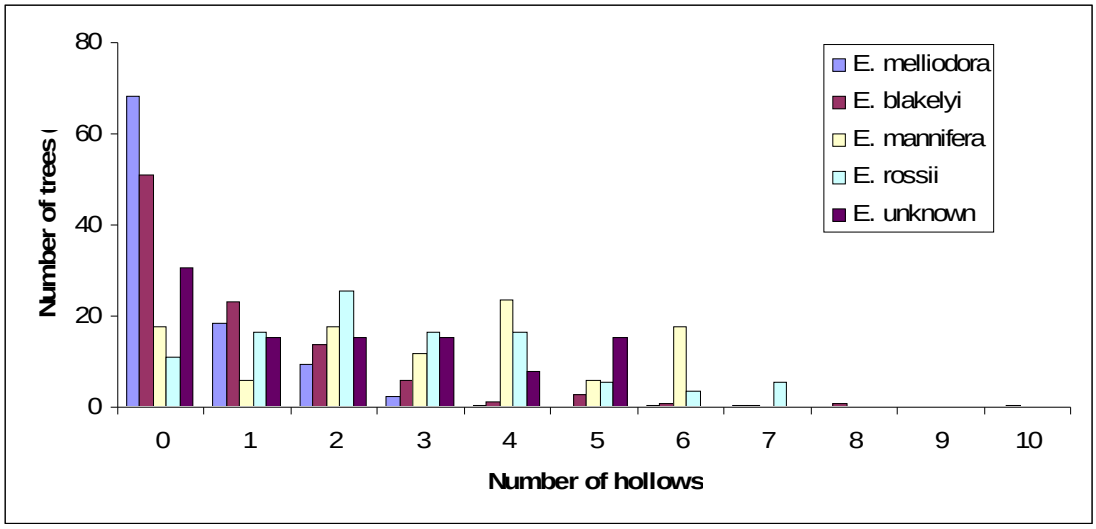
Table 7. Estimated number of suitable Superb Parrot nesting trees.

	Kenny	Throsby	Jacka	Moncrieff	Total	No. trees in sample
Dead	0	4	1	0	5	45
E. blakelyi	17	25	3	7	52	262
E. bridgesiana	2	0	0	0	2	6
E. dives	0	0	0	0	0	11
E. macrorhyncha	0	0	1	0	1	21
E. mannifera	0	0	6	0	6	13
E, melliodora	7	9	4	2	22	161
E. polyanthamos	1	0	0	0	1	2
E. rossii	5	7	6	2	20	51
E. rubida	3	0	0	0	3	10
E. unknown	2	11	0	0	13	24
Total	37	56	21	11	125	

The total number of hollows in a tree has consistently been shown as a variable associated with occupancy (Gibbons and Lindenmayer, 2002) implying that those trees with a greater number of hollows should be retained. In the Gungahlin area very few *E. blakelyi* or *E.mannifera* contained more than 2 hollows with only 9% of tree containing more than two hollows.

There was a tendency for *E. mannifera*, *E. rossii* and E. *unknown* to contain more larger hollows than *E. blakelyi* or *E. melliodora* with 47% of trees containing more than two hollows, see Figure 1.

Figure 1. Distribution of the percentage of hollows for each of five tree species



Summary of tree survey

The area under survey can best be described as structurally altered Yellow Box-Red Gum woodland with a herb layer of introduced grasses. With the two species comprising 70% of the eucalypt species present both are well endowed with tree hollows with a minimum of 14% of Yellow Box and 20% of Blakelys Red Gum containing hollows of a size potentially suitable for the Superb Parrot to nest.

Two other eucalypt species *E. rossii* and *E. mannifera*, remnant trees from cleared dry schlerophyll forest and occupying the dryer ridges, are also well endowed with tree hollows.

Although not measured it is apparent that due to present and past stock grazing regimes, apart from site 1b (Kenny) there is virtually no eucalypt regeneration occurring on any of the sites that could in the future provide additional or replacement hollows.

Gibbons and Lindenmayer (2002) note that the entrance dimensions are not strongly correlated with predicting hollow occupancy and in east Gippsland it was found that only 29% of all hollows between two and five cm contained evidence of prior occupation. For those with an entrance width of six to 10 cm, 44% contained evidence of prior occupancy whilst the occupancy rate increased to 62% for hollows with entrance diameter greater than 10 cm. Overall, only 43% of hollows contained evidence of prior occupancy. Given a similar rate for the Gungahlin area this reduces the number of hollows available to fauna, from 1100 to 330 small hollows from 1536 to 676 medium hollows and from 635 to 393 hollows greater than 10 cm. and the number of potential nest trees for the Superb Parrot from 125 to 54.

Although the Superb Parrot has only recently been recorded as breeding within the ACT, there is every possibility that this has been due to food resources provided by the urban open

spaces. Their successful breeding will depend on the retention of appropriately sized, eucalypt species on rural lands. Although suitable hollows may be present the Superb Parrot is unlikely to breed within the dry sclerophyll forests of the Canberra nature park system preferring instead woodland habitats on high fertility soils. In Canberra, these are the very areas where lowland woodland has been lost to urban development.

Any reduction in the tree hollow estate in rural land surrounding the urban areas of Canberra caused by clearing or lack of regeneration will affect species seen within the Bush Capital. The urban forest provides little in the way of nesting for hollow-dependent bird species and their occurrence within the urban area is largely due to breeding on those rural lands as well as within the Canberra Nature Park.

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Appendix I

The number of surveys recorded for each of 106 bird species.

										Total
Survey area	1a/1b	2a/2b	3	4	5	6	7	8	9	number
Number of surveys	4	3	3	3	4	4	4	4	4	of sites
Stubble Quail	1									1
Australian Wood Duck	3	2	3	3	3	4	2	1	4	9
Grey Teal	2	3				3			2	4
Pacific Black Duck	3	1	2	2	1			2	3	7
Hardhead	1								1	2
Australasian Grebe	2	2				1	1	1	3	6
Rock Dove								2		1
Common Bronzewing	1		1		1				1	4
Crested Pigeon	3	2	2	3	2		3		4	7
Little Pied Cormorant	2	1	1	1						4
White-necked Heron			1					1	1	3
White-faced Heron	1	1	3	3		1	1	1	1	8
Australian White Ibis	2	1						1		3
Straw-necked Ibis			1	1	1	2	1	3		6
Black-shouldered Kite	1							1		2
Brown Goshawk	1	1					1	1	2	5
Collared Sparrowhawk									1	1
Wedge-tailed Eagle	3	1	1							3
Nankeen Kestrel	3	3	2	2	3	1	4	2	2	9
Brown Falcon	1	1	3			3	1	2		6
Australian Hobby	1				1		1			3
Peregrine Falcon									1	1
Black-winged Stilt	1									1
Black-fronted Dotteral						1				1
Banded Lapwing**			3							1
Masked Lapwing	3		2	3				1	1	5
Yellow-tailed Black-Cockatoo			1							1
Galah	4	3	3	3	4	4	4	4	4	9
Little Corella		3		1	1	2	3	2		6
Sulphur-crested Cockatoo	4	3	3	3	4	4	4	4	4	9
Australian King-Parrot	2								1	2
Superb Parrot	2	3	3	2						4
Crimson Rosella	4	3	1	3	4	4	4	4	4	9
Eastern Rosella	4	3	3	3	3	4	4	4	4	9
Red-rumped Parrot	4	3	3	3	2	3	4	4	4	9
Horsfield's Bronze-Cuckoo	1				2	1	1		3	5
Shining Bronze-cuckoo									1	1
Pallid Cuckoo	1	2	2		3	1	2	1	4	8
Fan-tailed Cuckoo					1				1	2
Laughing Kookaburra	1	1			3	1	3	2	4	7
Sacred Kingfisher	1		1						3	3
Dollarbird						1	1		1	3
White-throated					4				4	2

Treecreeper										
Superb Fairy-wren	3	1			3			3	4	5
Speckled Warbler					2				4	2
Weebill	4	2	2		4	1	2	3	4	8
Western Gerygony			2	1	1		2	1	4	6
White-throated Gerygony				1	4	3	1	2	3	6
Striated Thornbill		1		2	2	2		2	3	6
Yellow-rumped Thornbill	3	3	2	3	4	2	3	4	4	9
Buff-rumped Thornbill		1			3		2	2	4	5
Yellow Thornbill	1				1					2
Brown Thornbill					3					1
Southern Whiteface					1	2		1	3	4
Spotted Pardalote	1		1		4	2	1		1	6
Striated Pardalote	4	2	3	3	4	4	4	3	4	9
Eastern Spinebill					1					1
Yellow-faced Honeyeater					4	1	1	1	3	5
White-eared Honeyeater									2	1
White-plumed Honeyeater							1	1	2	3
Noisy Miner	3	3	3	3			4	4	3	7
Red Wattlebird	4	1		1	4	1	2	2	4	8
Brown-headed Honeyeater	1	1					1		3	4
White-naped Honeyeater					1				1	2
Noisy Friarbird	3	3	1	3	2	1	1	4	3	9
Varied Sittella	1	2				1	1		2	5
Black-faced Cuckoo-shrike	4	3	2	2	4	2	2	4	4	9
White-winged Triller	1	1	1	2		2	2	1	2	8
Golden Whistler									3	1
Rufous Whistler		2	2		4	3	1	2	4	7
Grey Shrike-thrush			2		2				4	3
Olive-backed Oriole	1								3	2
Dusky Woodswallow				2		3	2	3	2	5
Pied Butcherbird							1		1	2
Grey Butcherbird	1		2						3	3
Australian Magpie	4	3	3	3	4	4	4	4	4	9
Pied Currawong	3	2		1	3				4	5
Grey Currawong									1	1
Grey Fantail	2	2	1	1	4	3	3	4	4	9
Willie Wagtail	2	2	3	3	2	4	4	4	3	9
Australian Raven	4	3	3	3	4	4	4	4	4	9
Little Raven	1		1		1					3
Leaden Flycatcher					2				3	2
Magpie-lark	3	2	3	3	2	1	4	4	4	9
White-winged Chough	1				4	1	2	1	4	6
Jacky Winter						1				1
Scarlet Robin									4	1
Red-capped Robin					2				1	2
Eurasian Skylark	3							1		2
Australian Reed-Warbler								2		1
Rufous Songlark	1	2			1	2	1	2	2	7
Brown Songlark						1	2			2
Silvereye	1					1			1	3
Welcome Swallow	3	1	1	1	1		1		3	7
Fairy Martin**		1			4				1	3
Tree Martin	4	3	2	3		4	3	4	2	8

Common Blackbird	1								1	2
Common Starling	4	3	3	3	4	4	4	4	4	9
Common Myna	4	3	1	2	3		3	3	1	8
Mistletoebird			1						4	2
Double-barred Finch									2	1
Red-browed Finch	1									1
Diamond Firetail						1			3	2
House Sparrow					1		1			2
Australasian Pipit	4			2	1	4			2	5
Common Goldfinch	1					1				2
Number of species	64	47	45	37	56	48	51	51	80	
Total number of apecies	106									

Appendix II

Analysis of potential differences in tree characteristics with respect to the labelled and the non-labelled trees

Data from a total of 298 trees sampled in two suburbs with four surveys were analysed using a mixed model. The fixed effect was labelled or non-labelled and a random effect, survey number included. This allowed for a potential correlation between trees within each survey to be incorporated into the test.

The mean responses for the dependent variables, number of small, medium and large hollows, diameter at breast height and the height of the main branch are presented in Table 1 for the four surveys.

Table 1. Observed mean values for response variables, number of small hollows, medium hollows and large hollows, diameter at breast height and the height of the main branch, classified by survey number and labelled versus un-labelled trees.

Response variable		Survey			
		11	4	5	9
Small_holes	Label				
	Unlabelled	0.3333	0.2899	0.3793	0.2632
	Labelled	0.2143	0.0000	0.4545	0.1111
Medium_holes	Label				
	Unlabelled	0.3725	0.5942	0.3966	0.3158
	Labelled	0.4286	0.0000	0.2727	0.3333
Large_holes	Label				
	Unlabelled	0.0980	0.1159	0.1207	0.2807
	Labelled	0.2143	0.0000	0.1818	0.3333
DBH	Label				
	Unlabelled	82.80	94.19	102.84	75.93
	Labelled	91.57	114.83	100.91	77.22
Main_branch	Label				
	Unlabelled	3.484	2.685	3.751	3.902
	Labelled	4.261	3.583	4.118	4.617

A Wald test was used to assess the significance of the differences between the labelled and unlabelled trees. Results are presented in Table 2.

Table 2. Wald statistic tests derived from GLMM or REML models fitted to the response variables, number of small, medium and large hollows, diameter at breast height (DBH) and height of main branch. 'n.d.f.' and 'd.d.f.' refer to numerator and denominator degrees of freedom.

Fixed term	Wald statistic	n.d.f.	F statistic	d.d.f.	F pr
Small hollows	1.65	1	1.65	296.0	0.200
Medium hollows	0.74	1	0.74	244.1	0.390
Large hollows	0.96	1	0.96	287.6	0.328
DBH	1.75	1	1.75	295.3	0.187
Main branch	7.66	1	7.66	293.0	0.006

Appendix III

Analysis of potential differences in tree characteristics with respect to the labelled and the non-labelled trees

Relationship between species identity and affiliation with unlabelled or labelled group

Data from a total of 298 trees sampled in two suburbs with four surveys were analysed using a generalized linear model (GLM). The response variable was membership of the labelled group (determined by using the variate Label and performing a logical test to see if the label was greater than zero). The potential predictor or independent variate was the factor 'Tree_name'.

The number of individuals of each species surveyed, number in the labelled group and the observed probability that an individual belonged to the labelled group are presented in Table 1.

Table 1. Number of individuals of each species surveyed, number in the labelled group and the observed probability that an individual belonged to the labelled group, classified by species of tree.

Species	No. of individuals	No. in Labelled group	Probability individual is in Labelled group
Dead	23	2.000	0.0870
E.blakelyi	131	26.000	0.1985
E.bridgesiana	5	0.000	0.0000
E.dives	14	1.000	0.0714
E.macrorhyncha	12	1.000	0.0833
E.mannifera	2	0.000	0.0000
E.melliodora	84	26.000	0.3095
E.polyanthamos	2	2.000	1.0000
E.rossi	13	4.000	0.3077
E.rubida	9	0.000	0.0000
E.unknown	3	1.000	0.3333

Only six species, E.blakelyi, E.dives, E.macrorhyncha, E.melliodora, E.rossi and E.rubida had sufficient individuals sampled to enable realistic estimates of the probability of an individual being in the Labelled group. Restricting the data to these six species and fitting a GLM to the data to test if the species have different probabilities of an individual being in the Labelled group gave a highly significant test (Table 2). The test is based on the change in deviance from a null model (one in which the overall mean is fitted) and the model with the factor Tree_name fitted is assumed to be distributed as a Chi-squared statistic.

Table 2. Analysis of deviance table derived from GLM model fitted to the response variable, individual is a member of the Labelled group, as a function of the identity of the species of the individual. ‘d.f. is the degree of freedom, deviance is a measure of the fit.

Source	d.f.	deviance	mean deviance	deviance ratio	approx chi pr
Regression	5	12.9	2.573	2.57	0.025
Residual	257	264.6	1.030		
Total	262	277.5	1.059		

The fitted probability that a tree will be in the Labelled group together with an estimate of the 95% confidence limits are presented in Table 3 for those species with nine or more individuals samples.

Table 3. The predicted probability of an individual of selected species being a member of the Labelled group and the 95% confidence interval for those predictions.

Species	95% lower	Mean	95% upper
E.blakelyi	0.14	0.20	0.28
E.dives	0.01	0.07	0.38
E.macrorhyncha	0.01	0.08	0.42
E.melliodora	0.22	0.31	0.42
E.rossi	0.12	0.31	0.60
E.rubida	0.00	0.00	1.00

Broadly there are three groups of species, those with a low probability of being the Labelled group, E.rubida, E.dives, and E.macrorhyncha, E.balkelyi with an intermediate level and tow final group, E.mellidora and E.rossii with a higher probability of being in the Labelled group. Note that the very wide confidence limits attached to the estimate for E.ribida is due to the comparatively small sample size and the observed probability of an individual being in the Labelled group being zero.