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Adult male Forest Red-tailed Black Cockatoo
(left) displaying to female (right) at nest hollow in
Serpentine Hills.

Photo: T. Kirkby.

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THE DISTRIBUTION, STATUS MOVEMENTS AND DIET OF THE FOREST RED-TAILED BLACK COCKATOO IN THE SOUTH-WEST WITH EMPHASIS ON THE GREATER PERTH REGION, WESTERN AUSTRALIA

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ABSTRACT

The Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*) is a large, iconic forest cockatoo endemic to the south-west corner of Western Australia. It is listed as Threatened under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* and Vulnerable under the *Western Australian Wildlife Conservation Act 1950*. It has experienced a severe decline in numbers and range since European colonisation. Over the past 20 years there has been a dynamic change in the foraging ecology of many birds in the northern Darling Range (adjacent to the Perth metropolitan area) driven mainly by their discovery of Cape Lilac as a new food source. Flocks that were once largely sedentary have now developed regular movements onto the Swan Coastal Plain and in some places have established new roost and breeding sites. Furthermore in 2014–2015 there was also a massive flowering and nutting of Marri (the main food throughout its range) in the northern Darling Range and on parts of the Swan Coastal Plain and during late 2015 and throughout 2016 there was a considerable movement of birds from the hills onto the southern Swan Coastal Plain to forage on Marri seed. Despite this abundance of food on the Swan Coastal Plain and in the adjacent hills region, almost no birds were recorded breeding in 2016, perhaps a result of

food quality rather than quantity, or perhaps a result of the energy required with the extensive movements to and from foraging sites. The availability of Jarrah and Marri seed is becoming increasingly scarce in many areas in the face of habitat modification, climate change and fire. The implications are that the Forest Red-tailed Black Cockatoo may become more dependent on some introduced species for food in some areas and this will impact on their breeding biology.

INTRODUCTION

The Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*) is a large, iconic forest cockatoo, endemic to the south-west of Western Australia. This subspecies occurs in the humid and subhumid south-west mainly the hilly interior, north to Gingin (formerly to Dandaragan), Gidgegannup, and east to Mount Helena (formerly Toodyay), Chidlow, Woorlooloo, Wundowie, The Lakes, Christmas Tree Well, near Brookton, Bannister (formerly to Wandering), Mount Saddleback, Kojonup, Rocky Gully, the upper King River, Porongurup Range and Green Range. It was formerly common, but is now rare to uncommon and patchily distributed over most of its range. Its distribution on the northern Swan Coastal Plain was confined largely to the eastern zone north to Gingin and south to the Armadale-Byford and Serpentine-North Dandalup regions, with small breeding populations at Baldivis, Mundijong, Stake Hill, Karnup and more recently in the Perth area at Murdoch and possibly Perry Lakes.

It is listed as Threatened under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* and as Schedule 3 fauna [species that are 'rare or likely to become extinct, as vulnerable fauna, are declared to be fauna that is in need of special protection'] under the Western Australian *Wildlife Conservation Act 1950*. It is currently the subject of a recovery program (Chapman 2008).

This paper provides details of the changing foraging ecology of many birds in the northern Darling Range over the past 20 years. The foraging ecology of some populations in the northern Jarrah-Marri forest in recent times has meant that flocks that were largely sedentary have now developed regular movements onto the Swan Coastal Plain and in some places established new roost sites and breeding sites. This movement has led to an erroneous impression in the Perth region that this subspecies is expanding its range and increasing in abundance.

DISTRIBUTION

The Red-tailed Black Cockatoo

Calyptorhynchus banksii (Latham, 1790) is widely distributed in eastern and northern Australia, and south-western Australia. In Western Australia there are three

subspecies: *C. b. macrorhynchus* occurs in the Kimberley region; *C. b. samueli* in the mid-western region and *C. b. naso* from the far south-west of the State (Figure 1).

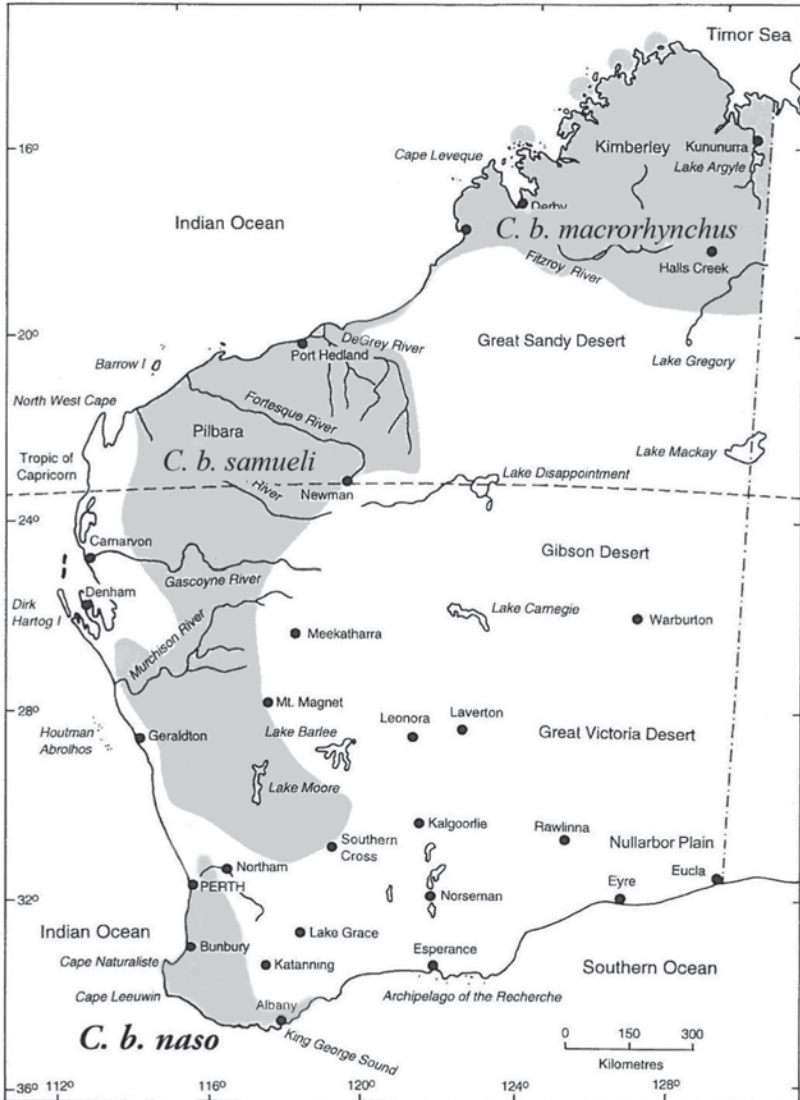


Figure 1. Distribution of Red-tailed Black Cockatoo subspecies in Western Australia.

Forest Red-tailed Black Cockatoo
(*Calyptorhynchus banksii naso*)

This subspecies occurs in the humid and subhumid south-west mainly the hilly interior, north to Gingin (casually e.g. December 1983 and Boonarring November 2012), (formerly to Dandaragan), Guildford (resident here in colonial times now only rare or casual visitor, see below), Bindoon, Gidgegannup, and east to Mount Helena (formerly Toodyay),

Chidlow, Wooroloo, Wundowie, The Lakes, Christmas Tree Well, Westdale, 10 km west of Brookton, North Bannister (formerly to Wandering), Mount Saddleback, Kojonup, Rocky Gully, the upper King River, Porongurup Range and Green Range (Figure 2). Masters and Milhinch (1974) noted it as scarce in the Northam district, only observed west of the Avon River each autumn in Wandoo forest at Glen Avon and west of Clackline in flocks up to

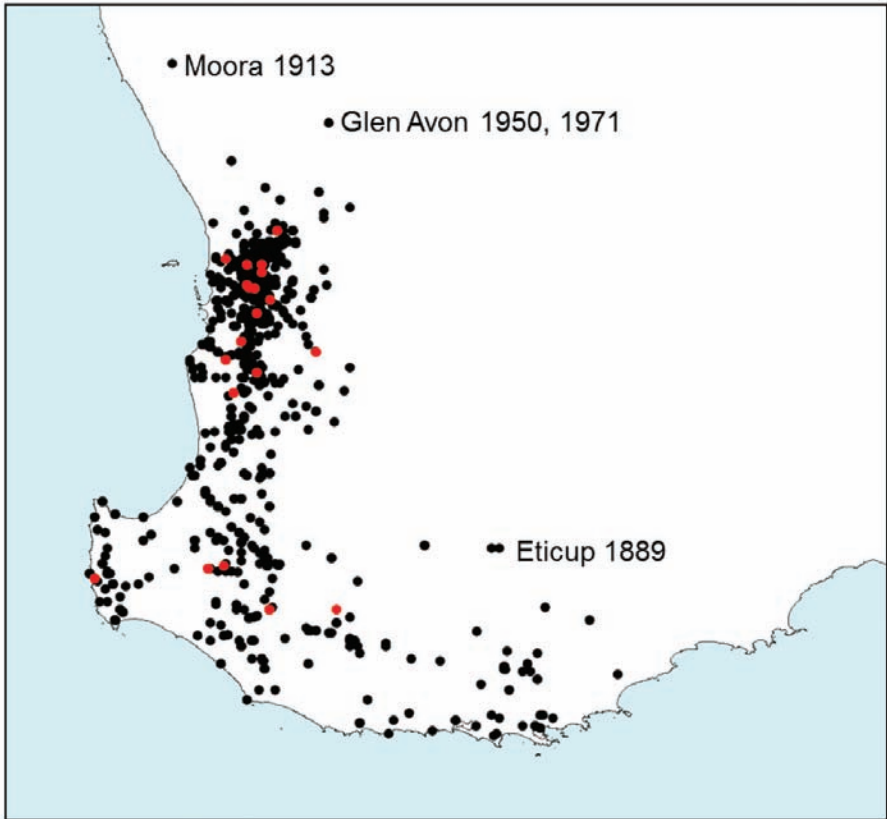


Figure 2. Distribution of Forest Red-tailed Black Cockatoo *C. b. naso* including historical records.

50; suddenly disappeared and last sighting was of five birds north of Clackline in 1971.

On the Swan Coastal Plain its status in historical times is uncertain. G.F. Moore noted a black cockatoo with a red tail about his homestead near Guildford in 1831. It was listed by Gould (1865) as "appears to be most numerous in the colony of the Swan River, where it inhabits all parts of the country". W.B. Alexander (1921) listed it for the Swan River District as "only occasionally seen in the district, being a bird of the inland regions of the State. The reasons for the occasional visits to coastal districts are unknown". Serventy (1948) noted that it was "never reported nowadays from the Swan Coastal Plain". Storr and Johnstone (1988) list it as a rare visitor in flocks up to 30, (November to May) to eastern parts of the Swan Coastal Plain, presumably from the adjacent Darling Range. On the Swan Coastal Plain it is currently rare, but resident at some sites (although patchily distributed) at Mundijong, Baldivis, Karnup, Stakehill, near Lake McLarty, Pinjarra, Coolup, Meelup, Goodale Sanctuary, Lake Clifton area, Dawesville and Wokalup (Storr-Johnstone Bird Data Bank).

Inland Red-tailed Black Cockatoo (*Calyptorhynchus banksii samueli*)

This subspecies occurs in the western arid and semiarid regions of Western Australia, from the De Grey River south to Eneabba,

Bindi Bindi, Wyalkatchem, Merredin, Walgoolan and Koolyanobbing and is a casual visitor further south at Kwolyin and Narembeen.

While the range of *C. b. naso* has contracted over the past 50 years, in comparison the range of *C. b. samueli* has expanded southwards and this may be continuing judging from southern records at Kwolyin, Narembeen and a recent report in September 2015 of a flock of five birds feeding in a paddock on the upper Darkin River (Westdale, Beverley Shire) within the range of *C. b. naso*.

MOVEMENTS AND CHANGES IN STATUS AND ABUNDANCE

The northern subspecies *samueli* is quite dispersive undertaking regular seasonal movements whereas *naso* on the other hand is considered generally very sedentary with strong fidelity to home range territory. In the past there has been some isolated vagrancy of pairs and small flocks onto the Swan Coastal Plain. For example a small flock was observed by A. Chapman at Lake Joondalup on 25 April 1977; two were observed by P. Griffin in Booragoon bushland on 27 May 1978; six observed drinking by J. Stuart at Rosalie Park (near Shenton Park) on 11 March 1981; and three seen by B. Gardiner over Guildford Grammar School in late April 1984.

Banding recoveries of 37 chicks that were banded between 1997

and 2011 with some 35 re-sightings of 11 birds (including fledglings to adults 13 years old) showed that juvenile-immature birds moved on average less than 3 km from their natal tree and older birds were recorded moving up to 19 km. For example a male chick banded at Nest 2 on 23 November 1997 was re-sighted ten times between January 1998 and November 2003 moving only 1–3 km from the nest site over that period and in July 2004 it was observed (with a female and immature) at Kelmscott six and a half years after banding and a distance of 6 km from the nest site. A male chick banded at Nest 18 in Bungendore Park (near Armadale) on 4 January 1998 was observed seven times between 6 April 1998 and 9 March 2003 moving between 0.2 and 3 km from its nest site. Another male chick, banded at Serpentine on 11 July 2000, was observed at Myara on 31 May 2013 and again on 3 July 2014 (13 and 14 years later) some 7 km from its nest site. Noteworthy also is a female banded as a chick in Nest 40 at Bungendore Park on 18 April 2002 that was observed four times in and around Bungendore Park between 2 June 2003 and 13 October 2005 (moving less than 3 km from the nest site) and on 15 July 2010 it was injured (after colliding with a car) at Lynwood a distance of 19 km from its natal area. Also a female banded as a chick in Nest 529 at Bungendore Park on 4 July 2009 was injured, and later died from vehicle strike at Carlisle on 29 January 2017 a

distance of 24 km from its natal area. Another bird of interest is a male chick banded at Nest 47 at 31 Mile Road (Jarrahdale State Forest) in December 2003 was observed at Gleneagle on 29 August 2005 (a distance of 1.3 km) and observed in Bungendore Park on 21 March 2011, a distance of 14 km from its natal area.

Other banding records from Department of Parks and Wildlife include immature birds banded at Kaarakin Conservation Centre in Martin on 9 June 2009 and recovered at Araluen on 15 June 2009 after colliding with a vehicle (a distance of 7.1 km); another on 24 March 2011 and recovered at Manning after colliding with a vehicle on 5 June 2012 (a distance of 18 km); another banded on 27 July 2012 recovered at Wattle Grove after colliding with a vehicle on 2 August 2012 (a distance of 10.8 km).

Records suggest that Forest Red-tailed Black Cockatoos are generally sedentary. This sedentary nature of most flocks in the Perth Hills is backed up not only by banding but also by observations and photographs of a distinctive aberrant female with yellowish patches on nape and throat and two white outer primaries (Figure 3) observed at Cardup in February 2006, on Admiral Road in the Byford hills in August 2007 and near the same site in December 2007, January 2008, February 2008, August 2008, September 2008, November 2008, December 2008,



Figure 3. Aberrant female Red-tailed Black Cockatoo at Admiral Road, Byford.

March 2009, April 2009 and February 2011 and at Waterwheel Ridge estate, Bedforddale in 2015. The overall movement being less than 10 km during the period 2006–2015.

Further south, a Coolup resident, A. Robinson (1970), recorded small flocks leaving the heavily timbered Darling Range in 1970 and moving out onto the more open coastal plain which he noted as unusual.

FORAGING ECOLOGY

There are pronounced differences in the dimensions of the bill and in the food of the Forest Red-tailed Black Cockatoo *C. b. naso* and the more northern inland and mid-western subspecies *C. b. samueli*. The former *naso* has a large bill (and is mainly arboreal and the latter *samueli* has a small bill and feeds mainly on the ground.

Perth Region

Since 1995 there has been a very dynamic change in the foraging ecology of many birds in the northern Darling Range (adjacent to the metropolitan area). This began as a slow expansion of foraging range from the Darling Range, west onto the Swan Coastal Plain (mainly south of Perth) to foothill localities. Prior to this, sightings of banded birds (banded as nestlings) were within three km of banding site (natal tree). In the late 1990s small flocks and family groups began to alter their daily routine from foraging in relatively small home ranges within Jarrah-Marri forest to become at first only casual visitors to the base of the escarpment mainly exploiting fruiting Cape Lilac (*Melia azedarach*) in some of Perth's south-eastern suburbs e.g. Byford, Armadale, Kelmscott and Gosnells. By early 2000 this had extended further north and west as other feeding sites or opportunities were found in other suburbs including Thornlie, Lynwood, Queens Park, Cannington, Kewdale, Bentley, Belmont, Kensington and by 2005 this had extended further west and north to Murdoch and Kardinya, by 2007 north to Nedlands and west to Medina. By 2009 north to City Beach, Woodlands, Hamilton Hill, Mosman Park and Henley Brook, also west to Kwinana and by 2010 further north to Carine, Joondalup and the Upper Swan.

Also by early 2010 some of these flocks had established roost sites

on the coastal plain and up to 30 birds were roosting in Lemon-scented Gum (*Corymbia citriodora*) at Murdoch, and by November numbers had increased to over 60. Small numbers (up to 5) were also roosting in the vicinity of Shenton Park bushland judging from some early morning observations. By 2011 over 100 birds were roosting in tall Lemon-scented Gum at Murdoch campus and up to 80 were roosting nightly in Marri in the western suburbs of Perth, near East Lake, Perry Lakes. During 2011–2012 numbers at the Perry Lakes roost would occasionally fluctuate from 0–80 birds (M. Owen pers. comm.) and at the same time numbers at Murdoch would increase with some counts of up to 200, so there was apparently some movement of birds between these roosts. By 2013 birds were regularly flying out from the scarp and visiting fruiting Cape Lilac trees as far west as Fremantle and Kwinana around 32 km from the Darling Scarp. On evening of 2 January 2017 over 266 birds were recorded in the Perry Lakes-Underwood Avenue area gathering to roost (M. Owen pers. comm.) This is the largest flock ever recorded on the Swan Coastal Plain. Since 2010 there has also been some vagrancy of flocks (probably driven by a lack of surface water in home ranges) east into the wheatbelt to areas where there was previously no historic records of Forest Red-tailed Black

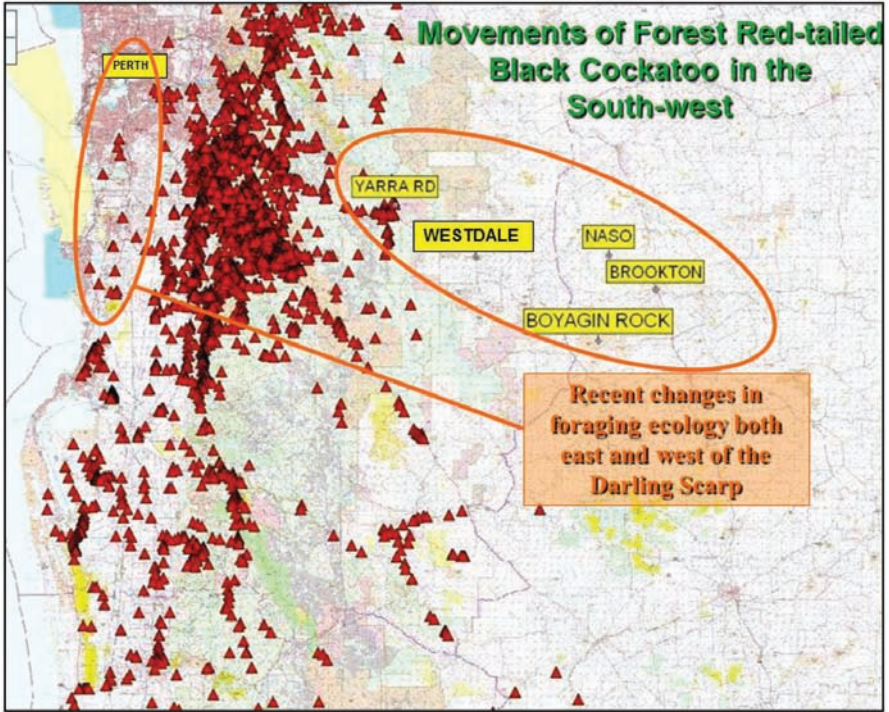


Figure 4. Occasional movements from the Darling Range eastwards into the wheatbelt towards Brookton and westwards onto the Swan Coastal Plain.

Cockatoos e.g. near Brookton and Boyagin Rock, see Figure 4.

Cape Lilac (*Melia azedarach*)

Cape Lilac (White Cedar, Persian Lilac), a native of Indomalaysia and Australasia (variety in northern Australia), is a large, seasonally deciduous tree (generally 10–15 m, but up to 40 m) with a canopy 6–8 m wide. Trees in the south-west of Western Australia appear to be the Persian Lilac introduced from Asia (Mabberley and Pannell 2013). On the Swan Coastal Plain and especially in the Perth metro-

politan area it is a common garden, park and farm tree grown mainly for its shade. It flowers in spring, just as the new leaves emerge, and flowering continues through into summer.

The marble-sized drupes (berry-like fruits) are produced from November to March in branched clusters 10–20 cm long, initially green then turning light yellow in colour at maturity. The leaves turn yellow in late autumn and fall in winter, but fruits remain on the tree all winter and gradually become wrinkled and more whitish. On the Swan



Figure 5. Adult male feeding on Cape Lilac in August at Fremantle.

Coastal Plain some trees with fruits can be seen throughout the year, including trees with both old (yellow) and new (green) fruits. From June to mid-September, most trees have lost their leaves and the yellow berry-like clusters are quite visible, see Figure 5.

The Inland Red-tailed Black Cockatoo *C. b. samueli* has been recorded feeding on the drupes of Cape Lilac at Merredin in the eastern wheatbelt of Western Australia since the mid-1990s (Stranger 1997) and at Dowerin in March 2001.

The first observations of the Forest Red-tailed Black Cockatoo foraging on Cape Lilac were from

Bedfordale in August 1995 when some members of a small flock (nine birds) were seen feeding on ripe fruits. There was no evidence that birds had previously been feeding in these trees (i.e. no old or new debris below the trees) and some birds perched in the trees appeared uninterested in feeding while others began feeding at a rapid pace. Within two weeks most drupe clusters were gone from those trees and small flocks were foraging on nearby trees. These trees were within the home range of a large flock and the Cape Lilac trees were in a house garden at the edge of an orchard not typical habitat for Forest Red-tailed Black Cockatoo.

The movement onto the Swan Coastal Plain was initially very slow. Small flocks and family groups moving in early morning from roost sites near the western side of the Darling Range to areas at the foot of the range where they could forage on Cape Lilac and if the food resources were suitable discovering new sites often close by moving in a mosaic pattern. This opportunistic movement in populations that generally exhibit strong site fidelity was quite exceptional for this subspecies. This could be correlated with the decline in the availability or nature of Jarrah and Marri in the northern forest block or possibly an increase in the number of birds moving west to the edge of the escarpment from the drier eastern parts of the Darling Range. In the long term, however, many of these birds that are on the move could be condemned, through loss or change in their forest habitat, to become nomads and drifters to parts of the Swan Coastal Plain where food resources are also, or will eventually be, greatly limited. Around Perth many shires are removing Cape Lilac trees to control a pest caterpillar species of the White Cedar Moth (*Leptocneria reducta*) that is confined to these trees. Because of the limited amount of foraging habitat and the fact that birds quickly exhaust food supplies, seasonal fluctuations in numbers have been recorded at some roost sites including Murdoch and Perry Lakes.

We have recorded birds feeding on ripe Cape Lilac throughout the year. Trees close to the escarpment are stripped first and the birds generally start feeding in the canopy biting off the spray of fruits and then eating each fruit one at a time whilst holding the rest of the spray, see Figure 5. Experienced birds have been observed taking less than four seconds to remove the seed whilst immatures can take up to fifteen seconds. One banded bird fleshed ten fruits in 35 seconds. Once the canopy fruits are gone, the birds move to the lower branches. By the end of July most of the trees close to the escarpment have been stripped of fruits but many trees further west on the coastal plain (e.g. around Welshpool, Queens Park, Kensington) are still heavily loaded with fruit. At Armadale for example, birds begin visiting trees loaded with fruits in January and February and by the end of June most trees have been stripped of fruits and flocks are moving further north and west onto the coastal plain. Numerous trees with fruits are available on the Swan Coastal Plain throughout the year and birds have learned the location of these trees and return to the same trees year after year.

Noteworthy also is an apparent change in foraging behaviour with many of the birds visiting the Coastal Plain especially those around Murdoch, feeding on the ground (Figure 6), a behaviour that is rarely observed in the forest.



Figure 6. Forest Red-tailed Black Cockatoo feeding on the ground at Murdoch University.

The toxic principles and insecticidal qualities of the seeds, leaves and roots of Cape Lilac are discussed by Mabberley and Pannell (2013) – Cape Lilac fruit is toxic to pigs and humans (6–8 are a fatal dose in children). However, it is unknown what the long-term effects are (if any) of the foraging by Forest Red-tailed Black Cockatoos on Cape Lilac.

On 12 January 2012 a flock of ten birds was observed feeding in the canopy of Cape Lilac trees on Quarry Road in Hamilton Hill and another two were feeding on the ground below the trees.

This was in stark contrast with our observations in the forest where during the past 20 years of our study we have fewer than ten observations of birds feeding

on the ground. This behaviour has also changed dramatically in 2016 with numerous observations of birds feeding on the ground either on fallen Marri seed or on nuts dropped by other species at Christmas Tree Well (Brookton Highway), Willowdale, Harvey, Myara, Mundijong and Serpentine. This is probably the result of a huge nutting cycle of Marri in 2015–16 with a considerable amount of seed falling onto the ground and many species such as Red-capped Parrots clipping nuts from trees that has enabled birds to forage on these unopened nuts.

Slow foraging expansion (Figure 7). Slow vagrancy affords a species a method of discovering new habitat, which, if environ-

mentally suitable, especially food resources, can result in breeding range expansion. It appears important in this case also as a way of perhaps coping with the changing nature or loss of foods in the northern Jarrah-Marri forest, perhaps through the impacts of climate change and in some cases possibly fire. More likely it could be simply a case of opportunism and the fact that once they discovered the extensive Cape Lilac food resource on the plain, early morning movements to and from the Darling Range to isolated trees became frequent and the birds returned each day until the food source was depleted and again each year at fruiting times to the same trees. Once a feeding site had been located, birds flying in were quickly able to sight other neighbouring trees and thus slowly expand their foraging zone. The birds showed persistence in returning to the same food trees every day until the trees were completely depleted of fruits before moving on.

Judging from our observations of flocks foraging daily in the Jarrah-Marri forest of the Perth Hills region, about 50% of birds from the western edge of the escarpment, i.e. from edge to about 3 km east, are involved in this movement onto the coastal plain, but the bulk of birds from areas further east in the Darling Range remain and forage within the Jarrah-Marri forest. A number of birds banded in the Perth Hills have been recorded

moving up to 19 km from their original nest site which confirms their region of origin. For example birds banded as nestlings in Bungendore Park (near Armadale), have been observed at Byford and also at Lynwood and Carlisle.

The daily routine of birds leaving the western edge of the Darling Range at traditional roost sites at or around dawn 06:00–07:00 hrs and flying west, often high up, wheeling around the top of the scarp for a few seconds before flying out over the drop, then descending and levelling out over the tree tops, to suitable feeding sites, often single trees in suburban gardens well out onto the coastal plain. On several occasions small flocks (up to 14) were tracked from a vehicle as they left the edge of the Darling Scarp east of Gosnells at 06:30–07:00 hrs to Welshpool where they began to descend into gardens at Welshpool and Belmont a distance of 16 km. They remained and fed at that site until 16:30–18:30 hrs then flew back towards the Gosnells hills. This behaviour was observed for several weeks in August–September in that area until all green and yellow fruits on the trees were eaten. This daily routine has become commonplace for numbers of birds in the northern forest block and has continued year after year since 2000 and now extending across the entire Perth metropolitan area to forage on fruiting Cape Lilac.

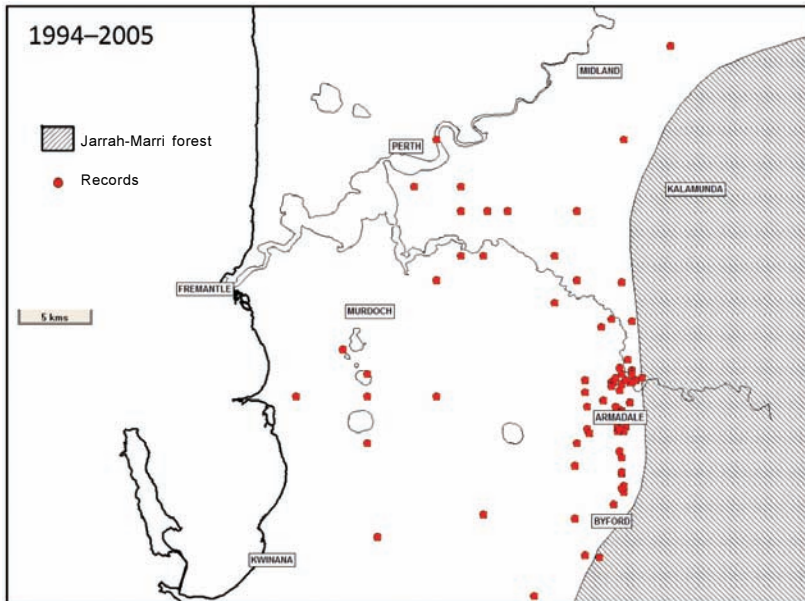
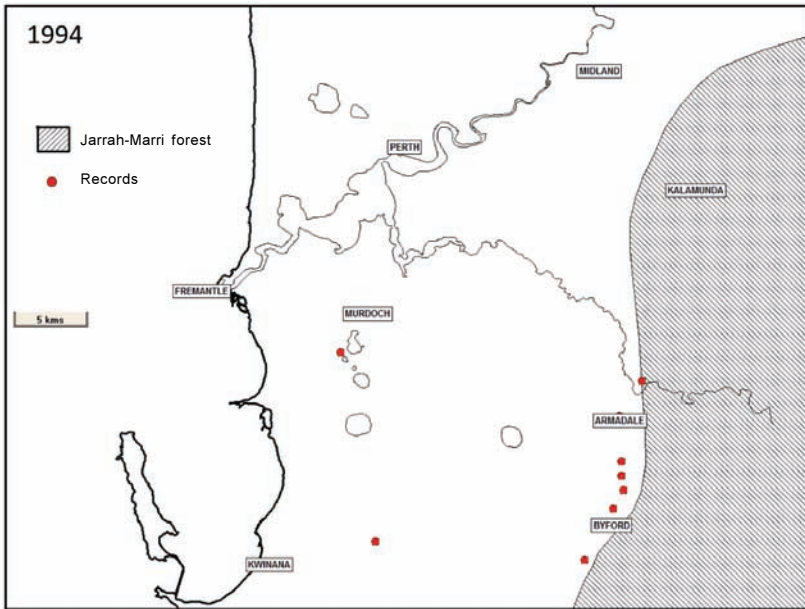


Figure 7. Records indicating slow foraging expansion on to the Swan Coastal Plain in 1994, and from 1994–2005, 1994–2011 and 1994–2016.

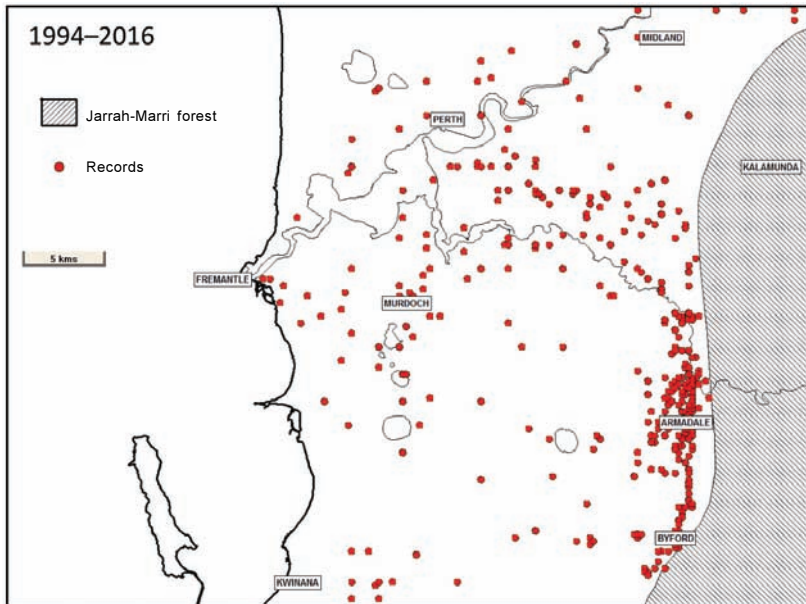
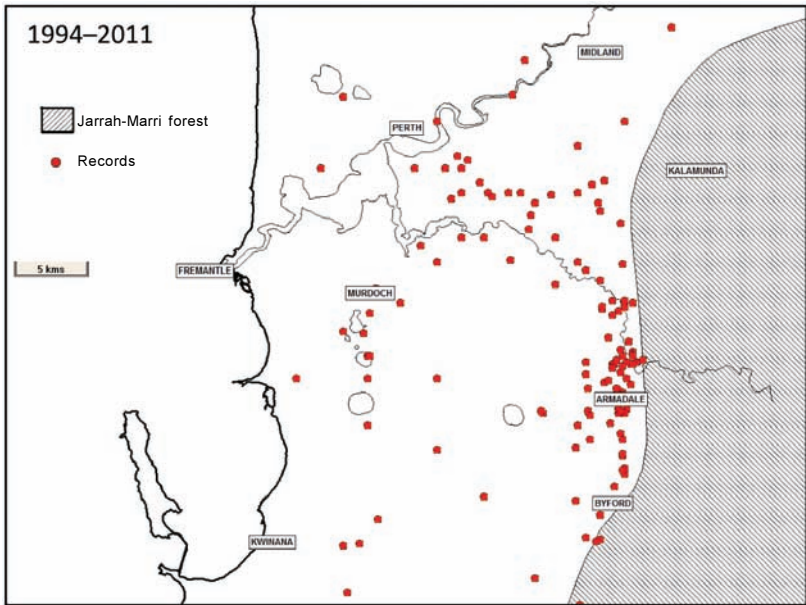


Figure 7 (cont.)

In areas where they found other foods both native and exotic and in some cases suitable roost sites with suitable drinking sites, new roosts were established. In the April 2016 Great Cocky Count for example a total of 771 birds were recorded at 29 roosts on the Swan Coastal Plain. These included counts of 125 at Murdoch, 88 at Byford, 73 at Munster, 57 at Coolbellup, 49 at Floreat, 42 at Kensington, 36 at Morley, 31 at Gosnells, 31 at The Vines, 26 at Darling Downs, 24 at Baldivis and 16 at Parklands. There is considerable variation in numbers at some of these roosts. For example a total of 199 birds was recorded at the Murdoch roost in 2014, 33 in 2015 and 125 in 2016; also 47 at one Yokine roost in 2014, 28 in 2015 and none in 2016. This highlights the fact that there is considerable movement of birds to and from these roosts on the Swan Coastal Plain as well as a movement of flocks each day from the hills region onto the coastal plain.

Following the establishment of roost sites on the coastal plain birds at two sites, Murdoch University and Perry Lakes, began prospecting for breeding hollows and in July 2011 and September 2012 at least two pairs bred successfully in artificial PE tube nest hollows erected at Murdoch (Figure 8). This was extraordinary as a few years previous (2000) there were no birds at all on that part of the Swan Coastal Plain. The fact that these birds bred in an artificial

PE tube erected in an exotic pine tree (*naso* favour Marri as nest trees) in a busy university car-park is remarkable and provides some important insights into conservation management.

Numbers fluctuate at these sites no doubt depending on the availability of food so monitoring breeding times and success would provide valuable information on the viability of this population.

At other sites in the south-west, birds were first recorded feeding on Cape Lilac near Boddington in April 2003, at Serpentine and Mundijong in February 2005 and at Dwellingup and Waroona in March 2006 and a small flock was recorded feeding on Cape



Figure 8. Female at a PE Cockatube® mounted in pine tree, Murdoch University.

Lilac at Harvey in May-June 2016. The April 2003 record from near Boddington is of great interest because it was not until March 2006 that birds began to feed on Cape Lilac at a regular Waroona observation site (58 km to west) and it is 80 km to the nearest northern record at Bedforddale. This suggests that there is some movement of birds through the forest.

There is obviously some interaction and movement of small numbers of birds from the Perth Hills to areas further south as some of the flocks in these more southern areas have discovered and learned to feed on Cape Lilac. The recent records of birds feeding on Cape Lilac from Harvey suggest that there has been some interaction of birds along the escarpment between Waroona and Harvey in recent times. We doubt that this discovery and learnt behaviour would have been done independently but more likely introduced to these southern flocks by contact with birds from further north. Probably because of the overall sedentary nature of these populations the expansion or southward-spread into new territory appears to have been very slow and part of this may be due to the destruction and fragmentation of original habitat on the Swan Coastal Plain.

Certainly south of Harvey, birds still have not yet discovered Cape Lilac as a food source despite large numbers of trees

growing in towns such as Collie, Brunswick Junction, Boyanup, Bunbury, Whicher Range area, Donnybrook and Capel. Extensive groves of Cape Lilac along laneways in the Tutunup area also have no evidence that birds are currently using this food resource.

Southern Region: Byford-Waroona-Harvey

Between May and November 2015 we carried out a series of mostly east-west transects on the southern Swan Coastal Plain between Byford and Harvey to determine habitat use by Forest Red-tailed Black Cockatoos in roadside verges. These targeted surveys were to search for evidence of feeding, both old and recent, to determine if there was a change in the status of birds during different times of the year. There was a very extensive flowering of Marri (*Corymbia calophylla*) in 2014–15 resulting in a massive nut crop on many trees especially those in road verges in this part of the Swan Coastal Plain. Between May and August 2015 there was very little evidence of recent foraging and indeed few sightings of birds within the region. This was in stark contrast to surveys in September–October 2015 where there was extensive evidence of birds foraging within that region (Figure 9). While there were still some birds observed foraging within the adjacent hills Jarrah-Marri forest there was obviously considerable movement of birds

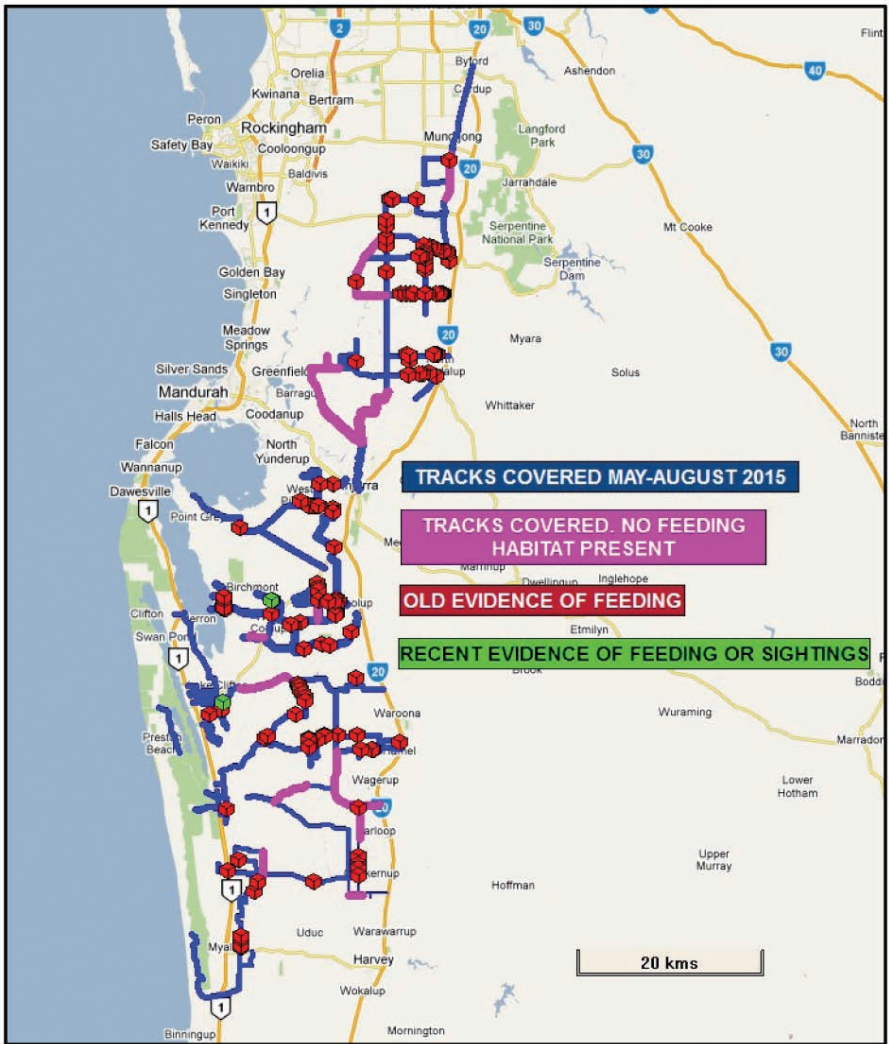


Figure 9. Surveys showing foraging of Marri seed on the Swan Coastal Plain, May–August 2015 (above) and September–October 2015 (facing page).

from the hills onto the coastal plain to take advantage of the extensive nutting of the Marri in these road verges. As with Cape Lilac further north this appears to be a change in the foraging

ecology of some populations. Unfortunately a great deal of road verge habitat was destroyed around Waroona, Yarloop, Harvey and Lake Clifton in the January 2016 wildfire. With a



Figure 9 (cont.)

perimeter of 398 km this fire destroyed a total of 69,000 ha.

MORTALITY

Vehicle Strikes

One of the main mortality factors

for these birds is vehicle strikes. In August-September 2009 a total of 10 birds including adults and immatures were killed at a drinking site in a truck bay at the edge of Albany Highway in Bedforddale (probably more killed

but not found) and this would have had a significant impact on that small local population.

The movement of birds onto the Swan Coastal Plain, especially around Perth, has greatly increased the risk of birds being killed or injured from vehicle strikes. Records from Kaarakin (Black Cockatoo Conservation Centre) for example show that 11 birds were brought in dead or injured in January 2016; four in February; five in March; seven in April; and eleven in May. Also three birds were recorded as being killed or injured after being hit by a train at Serpentine.

Fire

The loss of nest trees through logging, fire (including prescribed burns) and post-fire clean up, and weather is of concern, especially fire. Fire is acknowledged as a significant factor in the fall of hollow trees (Parnaby *et al.* 2010). Many veteran and stag Marri (the favoured nest tree) are particularly susceptible to fire. Most of these trees have only an outer living shell around rotten heartwood. A fire at the base of these trees quickly burns through the outer shell creating a chimney stack that destroys the tree.

The January 2005 Perth Hills fire for example, destroyed four out of five known nest trees with hollows leaving only a burnt stump or the tree completely burnt to ground.

In May 2011 another three out of five known nest trees in the

Wungong catchment were destroyed during a controlled “biodiversity management burn” and it was noteworthy that these trees burnt from the top down indicating a fairly intense fire.

The January 2016 Waroona-Yarloop wildfire had a devastating impact on the flora and fauna of the area. The fire burnt an estimated 69,000 ha including extensive areas of Jarrah-Marri forest and road verges. This fire was extremely intense with the entire canopy, understorey and ground layers being burnt (Figure 10). The loss of about 80–90% of foraging habitat for the small resident flocks in that region means that these birds would have needed to forage well outside their normal home range to survive. The two resources most likely to limit their continual survival in the area are in the short term, the food supply and in the longer term, nest hollows.

Overall this fire was an extremely significant ecological event in that region and we plan to monitor the response of black cockatoos to determine where these populations forage and adapt to change after the burn. Five months after the fire and the widespread presence of basal reshooting and fresh ground growth suggests that some areas of both forest and verge were regenerating rapidly. Nevertheless, there will be a gap in the available food supply chain causing them to forage elsewhere. The loss of many large



Figure 10. Loss of habitat at Lake Clifton January 2016 (top) and Waroona 2016 (bottom) post-wildfire.

veteran Marri that are required for breeding hollows, and which are already scarce in the landscape, is concerning. Moderate fires often help create large hollows suitable for cockatoos in old trees, however, wildfires tend to destroy all old or veteran trees that could provide future hollows.

The same January 2016 Waroona wildfire also swept through the nearby Larego forest block and destroyed a total of 19 of 41 known cockatoo hollows.

Nest Tree loss

During our study we have noticed a fairly high fall rate

(including trees blown over during storms) of veteran and stag Marri (Johnstone *et al.* 2013a) e.g. on 23 November 1999 a nest tree we had been monitoring, in which there was a large chick, blew over in strong easterlies; the chick that was almost ready to fledge was killed (WA Museum specimen A36732).

Feral bees

About 26% of known breeding hollows of Forest Red-tailed Black Cockatoo in our study sites have been taken over by feral European Honey Bees (*Apis mellifera*) and at some sites at the edge of the Darling escarpment (Bedforddale, Serpentine) it is as high as 50%. At one nest hollow in Bedforddale in December 2000, a chick that appeared healthy may have succumbed to swarming bees in the same tree near the hollow entrance.

Ravens

Movement onto the Swan Coastal Plain has also brought these cockatoos into greater contact with Australian Ravens (*Corvus coronoides*) that harass and sometimes kill juveniles and immatures (Figure 11). Attacks and harassment by ravens often leads to the young cockatoos being separated from their adults and being mobbed. Not always do the ravens succeed and, on one occasion, a raven that was attacking and holding tail feathers of a fledgling Red-tailed Black Cockatoo, in a tree, had one of its legs bitten off by an adult male Red-tail Black Cockatoo that was following close behind. Ravens have greatly increased in abundance in the Perth region since the late 1960s and are now common throughout the suburbs and are attracted to road-killed animals, garbage



Figure 11. Red-tailed Black Cockatoo being attacked by an Australian Raven, Bedforddale.



Marri *Corymbia calophylla*



Silver Princess *Eucalyptus caesia*



Illiyarrie *Eucalyptus erythrocorys*



Sheoak *Allocasuarina* sp.



Jarrah *Eucalyptus marginata*



Cape Lilac *Melia azedarach*

Figure 12. Some common foods (native and introduced) on the Swan Coastal Plain.

dumps and spilt food in parks and around food take-away outlets.

DIET

Principal native food species

The principal foods (Figure 12) of the Forest Red-tailed Black Cockatoo in the northern Jarrah-Marri forest and the Perth Region are the seeds of Marri (*Corymbia calophylla*) and Jarrah (*Eucalyptus marginata*) and their method of feeding on these fruits is distinctive (see Johnstone and Kirkby 1999). Other less important foods include Blackbutt (*Eucalyptus patens*), Sheoak (*Allocasuarina fraseriana*), Snottygobble (*Persoonia longifolia*), *Hakea* spp. including *H. petiolaris*, Tuart (*Eucalyptus gomphocephala*) and Red Heart or Moit (*E. decipiens*).

Introduced food species

Some introduced species regularly foraged include the Cape Lilac (*Melia azedarach*); Spotted Gum (*Corymbia maculata*) a native of eastern Australia (Queensland, NSW and Victoria) and commonly grown in the Perth region; Lemon-scented Gum (*C. citriodora*) originally from Queensland, but naturalised in the Darling Range and in suburban Perth; Silver Princess (*Eucalyptus caesia*) endemic to the central wheatbelt region of Western Australia, but common in Perth gardens; Illlyarrie (*Eucalyptus erythrocorys*) endemic to the limestone ridges of the

Dongara region of Western Australia and commonly grown in Perth gardens; Bushy Yate (*Eucalyptus lehmannii*) endemic to the south-west of Western Australia (mainly Albany and Esperance Plain) and used as a street tree in Perth and Kaffir Plum (*Harpephyllum caffrum*) a native of southern Africa and grown in Perth gardens and used as a street tree. Also of interest recently was a flock of 12 birds feeding on olives *Olea europaea* in Shenton Park.

IMPLICATIONS FOR THE FUTURE

The past half century has seen massive environmental change in the south-west of Western Australia. The region is now a severely fragmented landscape and the future loss of habitat, the changing structure of the Jarrah-Marri forest through forestry and fire, the impact of introduced and invasive species and the effects of climate change make the survival of the Forest Red-tailed Black Cockatoo and indeed its forest relative Baudin's Cockatoo (*Calyptrorhynchus baudinii*) of great concern. As Jarrah and Marri availability becomes increasingly threatened in the face of habitat modification, climate change and fire, Forest Red-tailed Black Cockatoos may become more dependent on some introduced species for food in some areas. The change in foraging behaviour by Forest Red-tailed

Black Cockatoos suggests opportunism, but could also be possibly linked or have been evoked by a decline in the availability or nature of Jarrah and Marri as food in some parts of the Darling Range due to declining rainfall. The big downside of this movement of birds onto the Swan Coastal Plain has been the additional impact of mortality with many deaths from collisions with motor vehicles and this loss is not sustainable. Furthermore the altered foraging behaviour has led to local changes in distribution and roosting patterns that will no doubt also influence breeding success. While Forest Red-tailed Black Cockatoos feed their fledglings on Cape Lilac seed, it may not be a suitable food to stimulate and sustain the next breeding cycle. Further studies are required on the availability of different food resources in different years which may help determine what triggers important breeding events.

In 2016, almost no Forest Red-tailed Black Cockatoos were recorded breeding at any of our study sites and no juveniles (birds of the year) were recorded in the northern Jarrah forest or on the Swan Coastal Plain. This indicates that this population may be at greater risk that we originally thought.

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REFERENCES

- ABBOTT, I. and BARRETT, G 2016. Suburban occurrence of birds: A microgeographic perspective based on comparison of two sites in inner suburbs of Perth. *Western Australian Naturalist* 30(3): 152–171.
- ALEXANDER, W.B. 1921. The Birds of the Swan River district, Western Australia. *Emu*, 20: 149–168.
- Cockatoo Care programme. URL: <http://www.cockatoocare.com> [accessed May 2016]. W.A. Museum Perth and formerly Water Corporation of W.A.
- DEC 2008. Forest Black Cockatoo (Baudin's Cockatoo *Calyptorhynchus baudinii* and Forest Red-tailed Black Cockatoo *Calyptorhynchus banksii naso*) recovery plan 2007–2016. Wildlife Management Program No. 42. Department of Conservation and Land Management, Perth.
- GARNETT, S.T. and CROWLEY, G.M. 2000. *The Action Plan for Australian Birds* 2000. Environ-

- ment Australia and Birds Australia, Canberra.
- GOULD, J. 1865. *Handbook to the Birds of Australia*, London.
- JOHNSTONE, R.E. and STORR, G.M. 1998. *Handbook of Western Australian Birds, Volume 1, non-passerines (Emu to Dollarbird)*. Western Australian Museum, Perth.
- JOHNSTONE, R.E. and KIRKBY, T. 1999. Food of the Forest Red-tailed Black Cockatoo *Calyptorhynchus banksii naso* in south-west Western Australia. *Western Australian Naturalist* 22(3): 167–177.
- JOHNSTONE, R.E. and KIRKBY, T. 2005. 'Cockatoo Care' – A Public Programme. *Western Wildlife* Vol. 9. (4).
- JOHNSTONE, R.E. 2006. Going, going, gone! Veteran and stag trees: a valuable resource. *Western Wildlife* Vol. 10. (1).
- JOHNSTONE, R.E. and KIRKBY, T. 2006. Cockatoos in Crisis. *Landscape*, 21 (2).
- JOHNSTONE, R.E. and KIRKBY, T. 2007. Feral European honey bees: a major threat to cockatoos and other tree hollow users. *Western Australian Naturalist* 25(4): 252–254.
- JOHNSTONE, R.E. & C. and KIRKBY, T. 2008. White-tailed Black Cockatoos on the Northern Swan Coastal Plain (Lancelin–Perth) Western Australia. Report June 2008 for DEWHA.
- JOHNSTONE, R.E. and KIRKBY, T. 2009. Birds of the Wungong Dam Catchment, Bedfordale, Western Australia. *Western Australian Naturalist* 26(4): 219–274.
- JOHNSTONE, R.E. and KIRKBY, T. 2009. *Birds of Bungendore Park*, Bungendore Park Management Committee, Armadale.
- JOHNSTONE, R.E., KIRKBY, T. and SARTI, K. 2010. Cockatoos Calling. pp. 3–9 In *Endangered Black Cockatoos in Western Australia: Proceedings of a symposium about their biology, status, threats and efforts to restore their habitat and populations*. Urban Bushland Council WA (Inc.), Perth.
- JOHNSTONE, R.E., KIRKBY, T. and SARTI, K. 2013a. The breeding biology of the Forest Red-tailed Black Cockatoo *Calyptorhynchus banksii naso* Gould in south-western Australia. I. Characteristics of nest trees and nest hollows. *Pacific Conservation Biology* 19(3): 121–142.
- JOHNSTONE, R.E., KIRKBY, T. and SARTI, K. 2013b. The breeding biology of the Forest Red-tailed Black Cockatoo *Calyptorhynchus banksii naso* Gould in south-western Australia. II. Breeding Behaviour and diet. *Pacific Conservation Biology* 19(3): 143–156.
- MABBERLEY, D. J. and PANNELL, C. M. 2013. *Melia*. *Flora of Australia* 26: 11–13. CSIRO Publishing, Melbourne.
- MAWSON, P. and JOHNSTONE, R.E. 1997. Conservation status of parrots and cockatoos in Western Australia. *Eclectus*, 3: 21–23.
- PARNABY, H., LUNNEY, D., SHANNON, I. and FLEMING, M. 2010. Collapse rates of hollow-bearing trees following low intensity prescription burns in the Pilliga forests, New South

Wales. *Pacific Conservation Biology* 16(3): 209–220.

PECK, A., BARRETT, G. and WILLIAMS, M. 2016. The 2016 Great Cockey Count: a community-based survey for Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*) and Forest Red-tailed Black-Cockatoo (*Calyptorhynchus banksii naso*). Birdlife Australia, Floreat, Western Australia.

ROBINSON, A. 1960. The importance of the Marri as a food source to south-western Australian Birds. *Western Australian Naturalist* 7(5): 109–115.

ROBINSON, A. 1970. Department of Fisheries and Fauna. *Fauna Bulletin*. 4(1): 20.

SAUNDERS, D.A., ROWLEY, I. and SMITH, G.T. 1985. The effects of clearing for agriculture on the distribution of cockatoos in the southwest of Western Australia, In *Birds of Eucalypt Forests and Woodlands: Ecology, Conservation, Management*. Eds A. Keast, H.F. Recher, H. Ford, D. Saunders, pp. 309–321. Royal Australasian Ornithologists Union and Surrey Beatty: Sydney.

SERVENTY, D.L. 1948. The birds of the Swan River district, Western Australia. *Emu*, 47: 241–286.

STRANGER, R. 2003. *The Birds of the Mandurah District, Western Australia*. Finline Print.

STORR, G.M. and JOHNSTONE, R.E. 1988. Birds of the Swan Coastal Plain and adjacent seas and islands. *Records of the Western Australian Museum*, Supplement No. 28: 1–76.