

NSW Threatened Species Scientific Committee

Conservation Advice: Black-eared Cuckoo *Chalcites osculans* Gould 1847 Cuculidae

Ben Hope¹, Anne Kerle², Veronica Doer²

¹NSW Threatened Species Scientific Committee Project Officer,

²NSW Threatened Species Scientific Committee member

July 2020

Current EPBC Act status: Not listed

Proposed EPBC Act status: Not eligible for listing (data deficient)

Summary of Conservation Assessment

Chalcites osculans (Black-eared Cuckoo) was found to be data deficient nationally and hence ineligible for listing on the *Environment Protection and Biodiversity Conservation Act 1999*. There is evidence that this species is of conservation concern due to inferred decline and threats, although insufficient evidence to warrant listing. Decline of the Black-eared Cuckoo has been inferred based on the ecological traits of this species (and its hosts), land use patterns and threats, however the rate of decline was not able to be quantified (data deficient, IUCN Criterion A).

The Black-eared Cuckoo was originally publicly nominated for listing as a Vulnerable species in NSW under the *Threatened Species Conservation Act 1995*, which has now been replaced with the *Biodiversity Conservation Act 2016*. A national scale assessment has been undertaken to facilitate alignment with the *Environment Protection and Biodiversity Conservation Act 1999*. Representatives from the Queensland (Qld), South Australian (SA), West Australian (WA), Australian Capital Territory (ACT) and Northern Territory (NT) Threatened Species Scientific committees provided feedback on a draft of this report and the information received indicated that a data deficient outcome nationally is appropriate as there is a genuine lack of data on this species.

Description and Taxonomy

Black-eared Cuckoo was described by Gould 1847. Occasionally placed in monospecific genus *Misocalius*; some authors include this species in *Chrysococcyx*. Listed as *Chalcites osculans* on the Birdlife Australia working list of Australian birds V2, the Australian Faunal Directory (2018) and by Payne (2017).

“Medium small bronze cuckoo noticeably bigger than other bronze cuckoos. Readily distinguished from other bronze-cuckoos by diagnostic combination of rather dull brown-grey upperparts with contrasting paler rump, unbarred buff underbody, dark tail with prominent white tip, and distinctive head-pattern of prominent broad white supercilium and bold dark eye –stripe. Sexes alike.” (Higgins 1999). The call, a descending low whistle, is distinctive. However, as they call less often than other cuckoos and mostly call during the breeding season, they are cryptic much of the year (Higgins 1999, Todd *in litt.* 29 March 2017; Payne 2017).

Distribution

Widely distributed on the Australian mainland, listed as a vagrant in Tasmania in some sources (probably erroneously, A. Crane *in litt.* 7 July 2017), and an occasional visitor to Papua New Guinea (Higgins 1999). Breeding records are concentrated in the southern half of inland mainland Australia (mainly south of the Tropic of Capricorn) (Beruldsen 1980; Cooper *et al.* 2016; Payne 2017). Breeding records are from NSW, SA, Vic, WA (ABBBS unpublished data). Breeding distribution is uncertain, however records of one host in particular, *Pyrrholaemus brunneus* (Redthroat) are likely incomplete as it occurs in remote locations. Further surveys could increase the known range for both the Black-eared Cuckoo and the Redthroat. The Black-eared Cuckoo is highly mobile and travels large distances to find suitable nesting areas with high densities of suitable hosts, although there are reports that the Black-eared Cuckoo can be sedentary (Higgins 1999). The mobility of this species is responsible for the widespread distribution outside the breeding season.

NSW Threatened Species Scientific Committee

The Black-eared Cuckoo is rare in NSW where it is found west of the Great Dividing Range (Cooper et al. 2016). In the ACT it is described as a “rare non-breeding vagrant” and there are only two recorded breeding events of the host species *Chthonicola sagittata* (Speckled Warbler) in the ACT by COG (2017). However, Gardner (2002) studied the breeding of the Speckled Warbler in the ACT and found they may breed more frequently than COG records indicate, although it is not known if these populations are used by Black-eared Cuckoos. Another host, the Redthroat, is uncommon and restricted in NSW, although more widely distributed in other areas (e.g. Western Australia). In Western Australia it is estimated that the Redthroat breeds across its entire range and that this is considered the likely breeding range of the Black-eared Cuckoo in western Australia and contiguous areas. This is broadly supported by the overlap of observation data (A. Mutton *in litt* 10 May 2018). Contemporary breeding records of the Black-eared Cuckoo in NSW appear to be on the drier western margin of the distribution of the Speckled Warbler and within the (arid) core distribution of the Redthroat (although the low detection rate of nests is a limitation in defining the breeding area of this species). In arid areas the host species breed in response to rain so the timing and location of breeding is linked to climatic conditions in these areas (Cooper *et al.* 2016). For this reason, breeding locations are widely but patchily distributed and the locations of suitable breeding sites probably vary as a result of climatic patterns and disturbance (e.g. fire). Additionally, birds may lay (dump) eggs in nests of hosts that are not ideal if suitable nests are not located. These nests are highly likely to fail and may account for some of the reported host species and breeding records (N. Langmore *in litt.* 22 June 2017). Further study of nesting success in this species is required in order to determine the nesting success in a variety of hosts and any geographic variation.

Ecology

Habitat

Found mainly in open vegetation types, in particular open woodlands and open shrublands, often with a *Eucalyptus* canopy (Higgins 1999). Also found in open woodlands including mallee, large wattles (e.g., Mulga and Nelia), Cypress Pine, Belah, Buloke, Leopardwood, open riverine forests (e.g. Black Box and Coolabah), shrub lands (Eremophila, Saltbush and Bluebush) (Higgins 1999; Recher and Davis 2010; Cooper *et al.* 2016). Occasionally recorded from grazing lands and urban areas, willows or other introduced vegetation (Cooper *et al.* 2016). Barrett *et al.* (2007) also indicated that this species is likely to be associated with patches of woodland or open forest in the temperate or arid regions. Suitable habitat for this brood parasite depends critically on the presence of host species during the breeding season – primarily Speckled Warbler and Redthroat (and possibly other hosts). The Speckled Warbler is woodland dependent and prone to local extinction in small patches of vegetation (Gardner and Heinsohn 2007). There are a number of records from the early 1900s of the black-eared cuckoo breeding in the Sydney basin in areas where no suitable habitat remains today and where the hosts are now locally extinct. Redthroats also prefer larger habitat patches (Frost et al. 1999; Brooker 2002; Chambers 2008; InSight Ecology 2009), for instance in the Buntine-Marchagee Catchment, WA they are only found in patches larger than 30 ha (InSight Ecology 2009).

Diet

Predominantly insectivorous but poorly known, mainly forages on the ground and sally pounces from shrubs (Higgins 1999).

Breeding / Hosts

The Black-eared Cuckoo and its hosts breed in response to rains and mainly south of the tropic of Capricorn (Beruldsen 1980; Payne 2017). Usually seen singly or in pairs, although groups of birds have been seen interacting at the start of the breeding season (Higgins 1999). As a parasitic cuckoo it is unable to rear its own young and instead lays its eggs in the nest of a host species which raises the cuckoo young until they are fledged. The most common host species recorded are the Speckled Warbler and Redthroat, although more than 24 species have been recorded as host species (Cooper *et al.* 2016). However, the presence of eggs in a host’s nest alone does not indicate successful breeding as egg and chick rejection by the hosts and nest predation by large birds all significantly impact breeding success. Australian cuckoos avoid egg and chick rejection primarily only in nests in which cuckoo egg colour, nestling skin colour, nestling mouth colour and begging calls all mimic those of the host and the nest morphology is compatible with development of a larger cuckoo chick (N. Langmore *in litt.* 22 June 2017).

NSW Threatened Species Scientific Committee

Individual cuckoos generally parasitise the same host species (Johnsgard 1997), although this behaviour has not been confirmed in this species. Some cuckoo species are divided into host-specific races (gentes), where the eggs and young closely mimic that of the host (Gibbs *et al.* 2000). Gentes are not confirmed for the Black-eared Cuckoo, however, if present this species might be assessed separately as Speckled Warbler gens and Redthroat gens. The geographic distribution of the Speckled Warbler has a “low” geographic range overlap between the parasitic breeding range and the host breeding range, whilst the Redthroat has an “intermediate” overlap (Johnsgard 1997). Cooper *et al.* (2016) note that in NSW many breeding records are outside the range of both the Redthroat and Speckled Warbler, but nesting success is unknown with any other host species. Speckled Warblers are used as hosts in the woodlands of south-east NSW and Victoria and the Redthroat in shrublands of western NSW, SA and WA. Both of these species are listed as Vulnerable species in NSW (Todd *in litt.* 29 March 2017, NSWSC 2001).

The Black-eared Cuckoo lays dark eggs in dome shaped nests. Given this colour, it is likely that these eggs are not readily detected by the host, a strategy also used by some other Australian bronze-cuckoo species (*Chalcites spp.*) to avoid egg rejection (Langmore *et al.* 2009). The Speckled Warbler and the Redthroat, are the only acanthizids to have plain chocolate-brown eggs (Higgins 1999; Gardner *et al.* 2010), similar in colour to those of the Black-eared Cuckoo (Johnsgard 1997) (see Table 1). Successful breeding in *Calamanthus spp.* nests therefore would rely on the dark coloured cuckoo eggs remaining cryptic in the host nest. Chicks of the Black-eared Cuckoo, described as coal black, also closely mimic the colouration of Speckled Warbler and the Redthroat chicks (see Gardner *et al.* 2010). Breeding might be viable in the nest of *Calamanthus spp.* (Heathwren and Fieldwrens), as the nest morphology is apparently suitable, and *Calamanthus spp.* are closely related to Speckled Warbler and Redthroat. *Calamanthus spp.* are relatively uncommon and the breeding success of the Black-eared Cuckoo with these hosts is not known. The Shy Heathwren (*Calamanthus cautus*) (potential host), Striated Fieldwren *Calamanthus fuliginosus* (coastal species and suspected to be a host) and Rufous Fieldwren (*Calamanthus campestris*; western NSW, potential host) are threatened species in NSW. The Chestnut-rumped Heathwren (*Calamanthus pyrrhopygius*; present on western slopes of GDR and potential host) is not listed as a threatened species in NSW.

NSW Threatened Species Scientific Committee

Table 1 Characteristics of potential host species

Host	Egg colour	Nest type	Chick colour	Distribution and notes	Source
Speckled Warbler <i>Chthonicola sagittata</i>	Ground colour, light or dull cochineal red, bright chocolate red, brownish terracotta or chocolate brown	Well concealed nest on ground in slight depression	Covered with fine grey down	Coast to western slopes of the east coast NSW, VIC and QLD	Higgins and Peter (2002), listed as host for Black-eared Cuckoo
Redthroat <i>Pyrrholaemus brunneus</i>	Olive-brown, stone brown dark brown, purplish buff nearly black, similar to those of the Black-eared Cuckoo	Domed globular or spherical	Nestlings have soft brown skin	Arid zone south of the Tropic of Capricorn	Higgins and Peter (2002), listed as host for Black-eared Cuckoo
Shy Heathwren <i>Calamanthus cautus</i>	Similar to Redthroat but larger, chocolate to purplish brown	Compact and domed with side access, nest near ground	Naked hatchlings	Scattered distribution in Great Australian Bight and adjacent areas of Aust. mainland in VIC, SA and WA, in NSW south west slopes, central west plains and lower western regions. Has declined due to clearing of Mallee and other threats such as feral cats.	Higgins and Peter (2002), listed as host for Black-eared Cuckoo
Striated Fieldwren <i>Calamanthus fuliginosus</i>	Light chocolate, acorn, vinaceous buff, pale or purplish brown with purplish brown spots or speckles	Domed or oval	?	Coastal and adjacent areas of NSW, VIC (and near the SA/VIC border in SA) and TAS. Loss of habitat from clearing.	Higgins and Peter (2002), listed as host for Black-eared Cuckoo.

NSW Threatened Species Scientific Committee

Rufous Fieldwren <i>Calamanthus campestris</i>	Pale chocolate, rich or dark vinaceous buff	Globular, near ground	Naked, neutral coloured down, gape yellow	Southern and south-western Australia, large decline reported in wheatbelt, remnants degraded by stock and weeds, not present in overgrazed areas, isolated populations vulnerable to fire	Higgins and Peter (2002), listed as host for Black-eared Cuckoo.
Chestnut-rumped Heathwren <i>Calamanthus pyrrhopygius</i>	Warm pinkish white, pinkish buff, with fine light chocolate brown spots.	Compact and domed with side access, nest near ground.	Sparse grey down on head, otherwise no information.	Similar to Speckled Warbler. Has likely declined on western slopes of the Great Dividing Range in NSW and also in coastal SA and NSW.	Higgins and Peter (2002), not listed as host for Black-eared Cuckoo

Breeding timing

Black-eared Cuckoo: Breeds Jun–Oct in the west (when rainfall is adequate) and, Aug–Dec in the east to coincide with hosts (Payne 2017).

Redthroat: Breeds between Mar–Dec, although mostly between Jul–Dec (Gregory 2017a); breeding more common after rain, the timing of which is variable; sometimes double-brooded (Gregory 2017a).

Speckled Warbler: Breeding peaks in Sept–Nov; up to three broods per season, breeding recorded in all months except May (Gregory 2017b). Early breeding by hosts may be an attempt to minimise parasitism by cuckoos, however the trade-off is that insect food is less available in the cooler months (Rose 1982).

Population size

Unknown. Incomplete survey coverage, natural rarity and low detectability of the species prevent population estimation. Inference can be made drawing on the population sizes of the primary host species and their distribution. Del Hoyo *et al.* (2007) estimated the total population of the Redthroat as up to 3,000,000 and the population of the Speckled Warbler as up to 400,000. Assuming that a pair of cuckoos requires 10 breeding host pairs to successfully breed (Langmore *et al.* 2007) and perhaps 10% of the breeding pairs are parasitized, the population of the Black-eared Cuckoo is estimated (with a low level of confidence) to be 34,000 globally. The use of other hosts is possible and may increase this estimate, but evidence of reproductive success using other hosts is required before including these in the estimates. The size of the suppressed population (i.e. individuals capable of breeding but competitively excluded) is also unknown and may also increase this estimate. Justification for this indirect estimate derives from the fact that for the breeding system of cuckoo and host to be functional, the abundance of the host species needs to be well above that of the cuckoo. Cuckoos require large numbers of contiguous host territories to breed successfully. For example, pairs of Horsfield's Bronze-cuckoos defend a territory comprising an average of 10 contiguous fairy-wren territories (Langmore *et al.* 2007). This number of host territories is necessary because the cuckoo must time its egg laying for the laying period of the host, giving it only a few days in which to deposit its egg in a particular host nest (N Langmore *in litt.* 22 June 2017). The female cuckoo lays her next egg two days later and must find another host individual with a nest in the egg laying period. Thus, the cuckoo pair has to defend multiple host territories in order to have enough host nests at the right stage for parasitism. This means that small patches of

NSW Threatened Species Scientific Committee

remnant habitat containing few host territories, or widely dispersed host territories, may not support even a single pair of cuckoos (Brooker & Brooker 2003).

Generation length:

Unknown, with little direct data available. Over most of the range of this species the main host is the Redthroat, whose reporting rate fluctuates (Birdlife Australia 2015a) and breeding success is likely linked to rainfall. In the absence of other information it may therefore be reasonable to infer that the generation length for the Black-eared Cuckoo in the core of its range is constrained by the length of the boom and bust cycles in arid Australia. These patterns are variable, although historical (1900-2013) drought maps indicate that the period between suitable rainfall years ranges between 4 and 12 years (Liddy *et al.* 2014). The likely generation length may be therefore between 4 and 12 years, and the average value of 8 years has been used for this assessment (although it may be shorter in areas with higher rainfall). It is reasonable to assume that the longevity of a bird species that relies on unpredictable and widespread resources would need to exceed the period in which conditions are unsuitable or marginal in order to persist. It is also plausible that even in drought years, geographic variation in rainfall patterns may result in small areas which are not drought affected and highly mobile birds may find these refuges and successfully breed in drought years. While birds are probably able to breed after one year, if the conditions are not suitable the first successful breeding may not occur until later in life. *Chalcites crassirostris* (Pied Bronze-cuckoo) (from the from the Moluccas, Tanimbar Islands and The Lesser Sundas Islands) was estimated by IUCN to have a generation length of 4.2 years, the much longer estimate for the Black-eared Cuckoo presented here reflects the more unpredictable climatic conditions found in Australia. The Speckled Warbler (a host species) has an estimated maximum reproductive age of 15 years and starts breeding at year two (Gardner and Heinsohn 2007). Garnett *et al.* 2011 estimate 3 generations to be 17 years for the Speckled Warbler.

Band resightings (often used as maximum longevity indicators) are rare for Australian Bronze Cuckoos due to the mobility (and inferred lack of site fidelity) of this species, and are not informative for this assessment due to a low sample size. *Cacomantis (Vidgenia) flabelliformis* (Fan-tailed Cuckoo) has a maximum period between a band being fitted and its next record as almost 6 years, *Chalcites basalis* (Horsfield Bronze-Cuckoo) is 3 years and *Chalcites lucidus* (Shining Bronze-Cuckoo) is 2 years 2 months (Source ABBBS database 28/6/2017). Birds probably breed in the first year of life and breeding success probably increases as birds gain experience finding hosts.

Threats (general)

Threats for the Black-eared Cuckoo and both the main hosts (small ground, or near ground nesting birds) include:

- trampling of nests and removal of cover by introduced herbivores (e.g. rabbits, deer, pigs, goats, cattle and sheep)
- exclusion by noisy miners and other aggressive birds (Maron *et al.* 2013)
- predation by foxes, cats or pigs (and other introduced and native predators) of nests, nestlings or adults tending nests (exacerbated by removal of cover)
- In central Australia densities of feral predators peak after large rainfall and breeding events of prey species, however their densities remain high after the 'boom' phase and are likely to heavily impact on a wide range of vertebrates including Black-eared Cuckoo and its hosts (A Stewart *in litt.* 15 May 2018).
- increases in nest predation by currawongs and other species that have been favoured by anthropogenic habitat supplementation (Remeš *et al.* 2012).
- processes that reduce insect availability (e.g. pesticide use)
- egg collection (Higgins 1999)
- habitat fragmentation and decreasing patch sizes
- anthropogenic climate change, which is expected to continue to increase drought periods and lead to less frequent 'boom' years (Eldridge and Beecham 2018). Predicted decreased rainfall and reduced ground-storey plant cover (Eldridge and Beecham 2018) are expected to negatively impact this species and its hosts.

NSW Threatened Species Scientific Committee

- habitat degradation and loss in central Australia related to invasive buffel grass (*Cenchrus ciliaris*) which has the potential to increase fire damage through higher fire intensity and shorter inter-fire period (A. Stewart *in litt.* 15 May 2018; Smyth *et al.* 2009).

Declines – general information

The Black-eared Cuckoo (along with its main host species in NSW, the Speckled Warbler) has apparently declined in south-eastern Australia (Cooper *et al.* 2016) between 1986 and 2006. Ford (2001) (citing Robinson, 1993; Keast, 1995) also noted that the black-eared cuckoo has apparently declined in southern Australia, concurrently with declines of its main hosts, Speckled Warblers and Redthroats (Reid, 1999). Available information on reporting rates of the Black-eared Cuckoo and Speckled Warbler is from too short a period (compared with environmental variability) to reliably quantify the rates of decline. The population trends across the range of the Redthroat are less certain, although declines have been noted (Reid and Fleming 1992; Cooper and McAllan 1995; Garnett and Crowley 2000; Higgins and Peter 2002; del Hoyo *et al.* 2007; Cooper *et al.* 2016), however this species is closely related to the Speckled Warbler and has similar nesting behaviour so is also likely to be in decline (or at lower abundance than prior to the introduction of foxes and cats).

The two main hosts (Speckled Warbler and Redthroat) that this species relies on for breeding are exposed to a range of threats. They have declined historically and are both threatened species in NSW (although more recent monitoring has indicated that the decline of the Speckled Warbler has not been as severe as earlier predicted (Garnett *et al.* 2011)). Both hosts have patchy distributions in NSW. Based on reported host declines, it is therefore inferred that the Black-eared Cuckoo is also in decline. Reporting rates for the Black-eared Cuckoo are too low and the areas this species inhabits are incompletely surveyed so the rate of decline cannot be quantified. Environmental variability may also mask or give a false impression of decline over the assessment period of 3 generations. It is inferred that in NSW this species is declining based on a predicted decreasing host availability and declining habitat quality. It is unclear whether this rate of decline exceeds 30% over a 3 generation (24 year) period. For the purpose of this assessment, based on plausible threats, it is assumed there is a continuing decline, although quantitative data are lacking.

In general, nesting success of many Australian woodland birds has declined over the last four decades due to increased predation (Remeš *et al.* 2012). This has been exacerbated by clearing (Ford *et al.* 2001; Ford 2011). Increased densities of large and/or aggressive birds such as currawongs and noisy miners have also been implicated in these declines (Clarke and Oldland 2007). Land clearing and other habitat modification (e.g. excessive grazing and browsing) and the associated impacts that occur in smaller remnants (higher abundances of aggressive birds and increased nest predation) within suitable breeding habitat are likely to cause decline of Black-eared Cuckoo as host species populations decline. Most species of cuckoo are more common in larger patches of habitat than smaller patches (Ford *et al.* 2001) as they require numerous contiguous host nests in order to successfully time egg deposition and breed (N. Langmore *in litt.* 22 June 2017). The impacts of aggressive birds and nest predators are also generally lower in larger habitat patches (Major *et al.* 2001; Clarke and Oldland 2007) - although they may still be significant. Gardner (2002) reports high levels (up to 80 % in one year) of Speckled Warbler nest failures, mainly due to predation, in a large (1000 ha) vegetation remnant in the ACT (where Black-eared Cuckoo are not confirmed to have bred). During this study the Speckled Warbler had a low reproductive success (one fledgling per female per season) (Gardner 2002), indicative of a slow recovery from decline (Cooper *et al.* 2016). Other more common cuckoos (Fan-tailed Cuckoo, Shining Bronze Cuckoo and Horsfield's Bronze Cuckoo) also parasitise Speckled Warblers, potentially competing for this resource.

No detailed studies of the Black-eared Cuckoo has been conducted, however the Black-eared Cuckoo is insectivorous and both hosts also consume insects as part of their diet, and all three species are ground feeding and nesting birds. Insectivorous ground feeding birds are typically prone to decline following land-use intensification and habitat loss (Reid 1999; Ford *et al.* 2001; Watson 2015). Reid (1999, citing Robinson 1991; Garnett 1992, 1993; Smith and Smith 1994) noted that ground nesting birds in mallee, woodland and open (dry) forest were more at risk than those of wet forests and heaths and that ground feeding birds are at higher risk of extinction. These risks apply to the Black-eared

NSW Threatened Species Scientific Committee

Cuckoo and all its host species. Sedentary birds are more likely to be in decline than migratory birds (there are reports of Black-eared Cuckoo being both sedentary and migratory) and both main host species appear to be sedentary (Reid 1999). Both the Speckled Warbler and the Redthroat nest on or very close to the ground, which make the nest accessible to a range of predators including cats, foxes, currawongs and monitors. Ground nesting exposes them to a similar suite of threats (predation, trampling, loss of cover) as small terrestrial mammals, many of which have declined dramatically in the arid zone (Reid and Fleming 1992; Smith et al. 1994; Short and Smith 1994; Short 2004). Birdlife Australia (2015a) report that in the arid zone, a composite index which includes 19 ground nesting arid zone birds is below the baseline level and in decline, with 8 of the 19 species included in the index in decline in the period 1998-2013. Patterns for species in this group were complex and as a result confidence in this index is reduced, particularly towards the end of the reporting period.

Black-eared Cuckoo - Reporting rates (changes in an index of abundance over time)

The monthly reporting rate (the number of times a bird was seen in standardised surveys divided by the number of surveys performed, expressed as a percentage) for the Black-eared Cuckoo in the period 1986-2006 in NSW peaks in October at 1.4%. Annual reporting rates fluctuate and no decline was evident between 1986 and 2006. However, the reporting rate was low and the sample size limited throughout this period making the detection of change more difficult (Cooper *et al.* 2016). Assessing change in reporting rates over relatively short periods has limitations, due to the shifting baselines syndrome (Pauly 1995), however long-term data with consistent methods is lacking for this species. Cooper *et al.* (2016) identified that this species is likely to be in decline in NSW following declines in Speckled Warbler abundance. Reporting rates for the Black-eared Cuckoo in Barrett *et al.* (2007) were 2.8% in Atlas 1 (1977-1981) and 3.3% in Atlas 2 (1998-2001) an increase of 13.5%, although the authors include this species in the group that had no significant change in reporting rates between periods. The methods used by Cooper *et al.* (2016) and Atlas 1 and Atlas 2, while similar, all differ so are not directly comparable. The Australian Birds Index (ABI) project (Birdlife Australia 2015ab) expanded the analysis performed by Barrett *et al.* (2007) of the Birdlife Australia Atlas 2 and reports a statistically significant decline of the Black-eared Cuckoo in the period 1998- 2013, however this decline may also be interpreted as a fluctuation (see **Error! Reference source not found.****Error! Reference source not found.**). In this period a high reporting rate in 2001 of ~20% (when it was wetter than average) was followed by a drought. This high reporting rate may also be an artefact as survey effort was low. The higher reported abundance in 2001 also explains the apparent increase from Atlas 1 to Atlas 2 as reported by Barrett *et al.* (2007). In the same period (1998 - 2013), other species recovered after the drought (e.g., Rufous Song Lark, Brown Quail, Budgerigar) and increased in reporting rate after the drought in 2011/2012. This post-drought increase was not evident in the Black-eared Cuckoo (Birdlife Australia 2015a). It may be that recovery of the Black-eared Cuckoo reporting rates lags behind other birds as it is linked to host abundance, but the period of time covered by the ABI project is insufficient to reliably determine whether this species is declining or fluctuating (or irruptive when conditions are good). In the arid zone, the Redthroat (a host species) was also unusual, peaking around 2006 (see Figure 3) (Birdlife Australia 2015a). As the Redthroat requires older woody vegetation, fire or land use patterns may also explain the pattern in reporting rate observed in the Redthroat. Redthroats can be cryptic and reporting rates from community surveys probably underestimate presence. Around 2006, when Redthroat reporting rate peaked, there were some areas in the arid zone which received better than average rain, despite this period being in the middle of the millennium drought (Liddy *et al.* 2014). In one West Australian study the abundance of the Black-eared Cuckoo (and other cuckoos) followed the abundance of the host (Redthroat), both of which declined with increasing drought (Recher and Davis 2014), but the duration of the study was too short to determine whether populations recovered following drought.

341

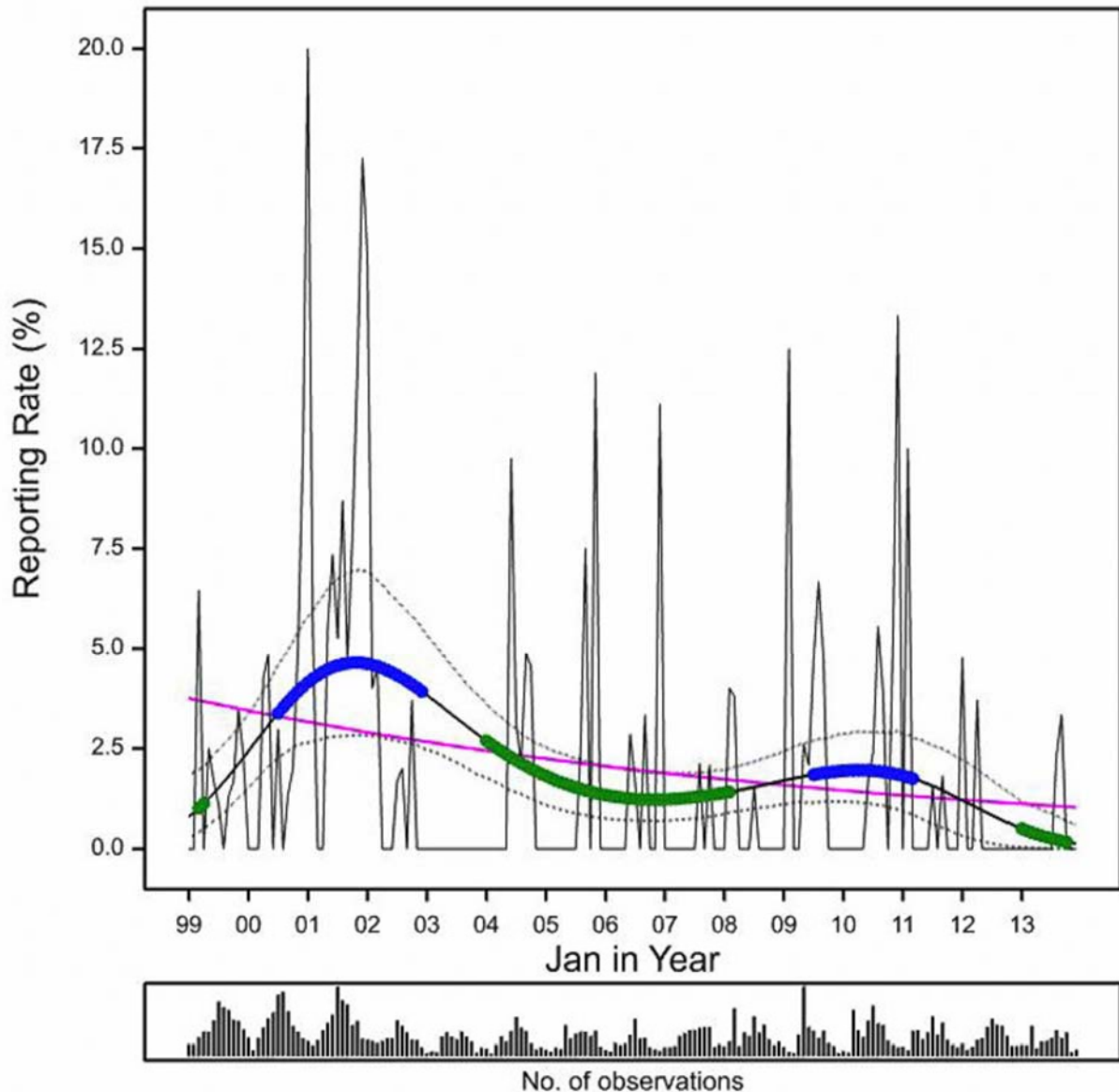


Figure 1 Trends in reporting rate for Black-eared Cuckoo in the arid zone (500m² area search method) (Birdlife Australia 2015a). The decline is statistically significant, however the period of time (1998-2013) is insufficient to determine if this is a declining or irruptive species. The high reporting rate in 2001 and 2002 coincided with above average rainfall which was followed by the millennium drought (2010 and 2011 also had widespread above average rainfall and corresponding peaks). Relatively high reporting rates in drought years 2004, 2005 and 2006 might indicate birds are selecting areas with higher rainfall closer to the coast and human population centres or may be birds searching for suitable breeding sites. The bar graph below indicates survey effort. See figure 1a for an explanation of the Birdlife Australia reporting rate trend graphs. Generation length, while unknown has been assumed to be 8 years which put the assessment period over three generations at 24 years. While the average reporting rate (based on a linear trend) halves over the period that data is available this species is unlikely to decline in a linear fashion and multiple wet and dry periods are required to make an accurate assessment of decline. Reporting rate data is not directly related to abundance and declines in abundance may not be apparent over short periods of time in this analysis.

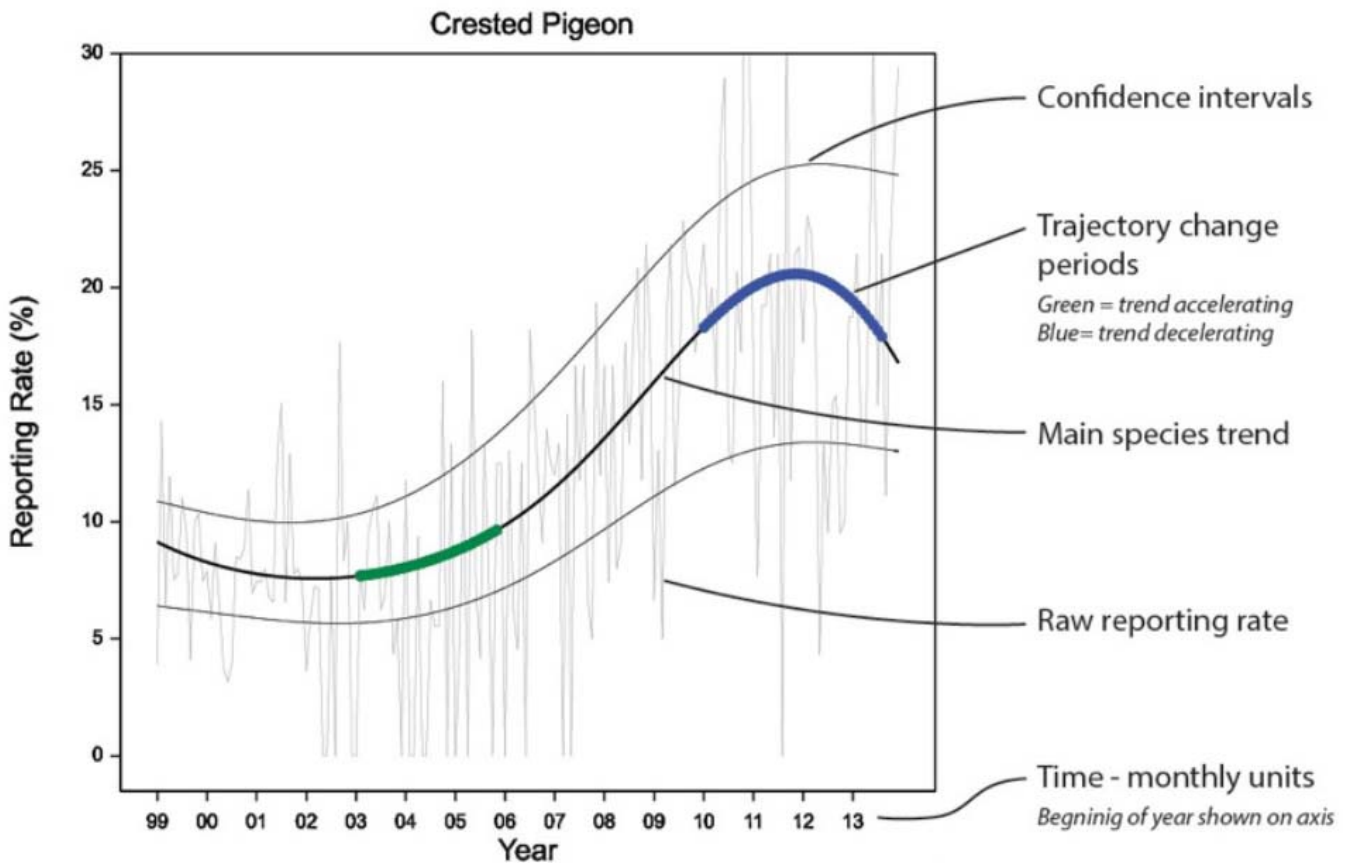


Figure 2a An annotated example (Crested Pigeon) of the reporting rate graphs used in Birdlife Australia (2015ab) (source: Birdlife Australia 2015c).

Declines - Speckled Warbler

Speckled Warblers inhabit woodlands with a grassy understorey, often on ridges or gullies. The species is sedentary and forages on the ground and in the understorey for arthropods and seeds (Ford *et al.* 1986). The Speckled Warbler had declined or was predicted to decline in numbers from large parts of its range (Hoskin 1991; Keast 1995; Egan *et al.* 1997; Barrett *et al.* 1994; NSWSC 2001; Fisher 1997; Reid 1999; NSW SC 2001) leading to the listing of this species as Vulnerable in NSW in 2001. The Speckled Warbler is threatened by clearing and fragmentation of habitat including removal of dead timber. Barrett *et al.* (1994) found that the species decreased in abundance as woodland area decreased and it appears to be extinct in districts where no fragments larger than 100ha remain. Isolation of Speckled Warbler populations in small remnants increases their vulnerability to local extinction as a result of stochastic events and decreases their genetic viability in the long term. Low population densities and relatively large home range requirements also would exacerbate their vulnerability to habitat loss. Gardner and Heinsohn (2007) showed that Speckled Warblers were often unable to produce enough young to replace adult females and extinction occurred during drought years in smaller remnants.

The preferred foraging habitat of Speckled Warbler is a combination of open grassy patches, leaf litter and shrub cover. This habitat is susceptible to degradation by stock and weed invasion. Nesting on the ground also makes them vulnerable to predation from exotic mammalian predators such as foxes and cats. Cooper *et al.* (2016) found that the Speckled Warbler has declined significantly in NSW from 1986 to 2006 (from a reporting rate of ~6% to about 3.5%), attributing the declines to clearing, overgrazing, weed invasion and increased nest predation (e.g. from currawongs). Cooper *et al.* (2016) note that much of the decline has been in the regions from the western slopes eastwards (e.g., around Sydney). Cooper *et al.* (2016) identify over-clearing and fragmentation, interacting with

NSW Threatened Species Scientific Committee

drought as the likely cause of decline of the Speckled Warbler in NSW, which they note is slow to recover from declines. The trends apparent in NSW are likely to be indicative of trends in Victoria and Queensland for this period. Garnett *et al* (2011) identified the Speckled Warbler as Near Threatened nationally, noting that it has been more resilient in patches than previously recognised and it is declining but at a rate below 30% over three generations. In the Cowra region, systematic bird surveys have demonstrated that the Speckled Warbler was apparently stable in the 2001-2015 period (J Reid *in litt.* 27 Nov 2017). These Cowra surveys only rarely detected Black-eared Cuckoos and there are no breeding records in this area. For the Warrumbungles area Stevens and Watson (2013), on the basis of low reporting rates, list the Speckled Warbler as ecologically extinct, however more recent survey following drought have detected this species in higher abundance (M Ellis *pers. comm.*) indicative of a recovery.

In southeast mainland area (an area defined by Birdlife Australia 2015b which consist of agro-climatically similar areas of NSW, VIC and SA) the reporting rate for the Speckled Warbler exhibited a similar pattern to most arid zone species (see figure 2 and Birdlife Australia 2015a) with peak reporting rates in the wetter periods 2001 and 2011/12. It is not known if individual Black-eared Cuckoos can use multiple hosts species successfully or if they are specialised into gentes that exclusively use one host species.

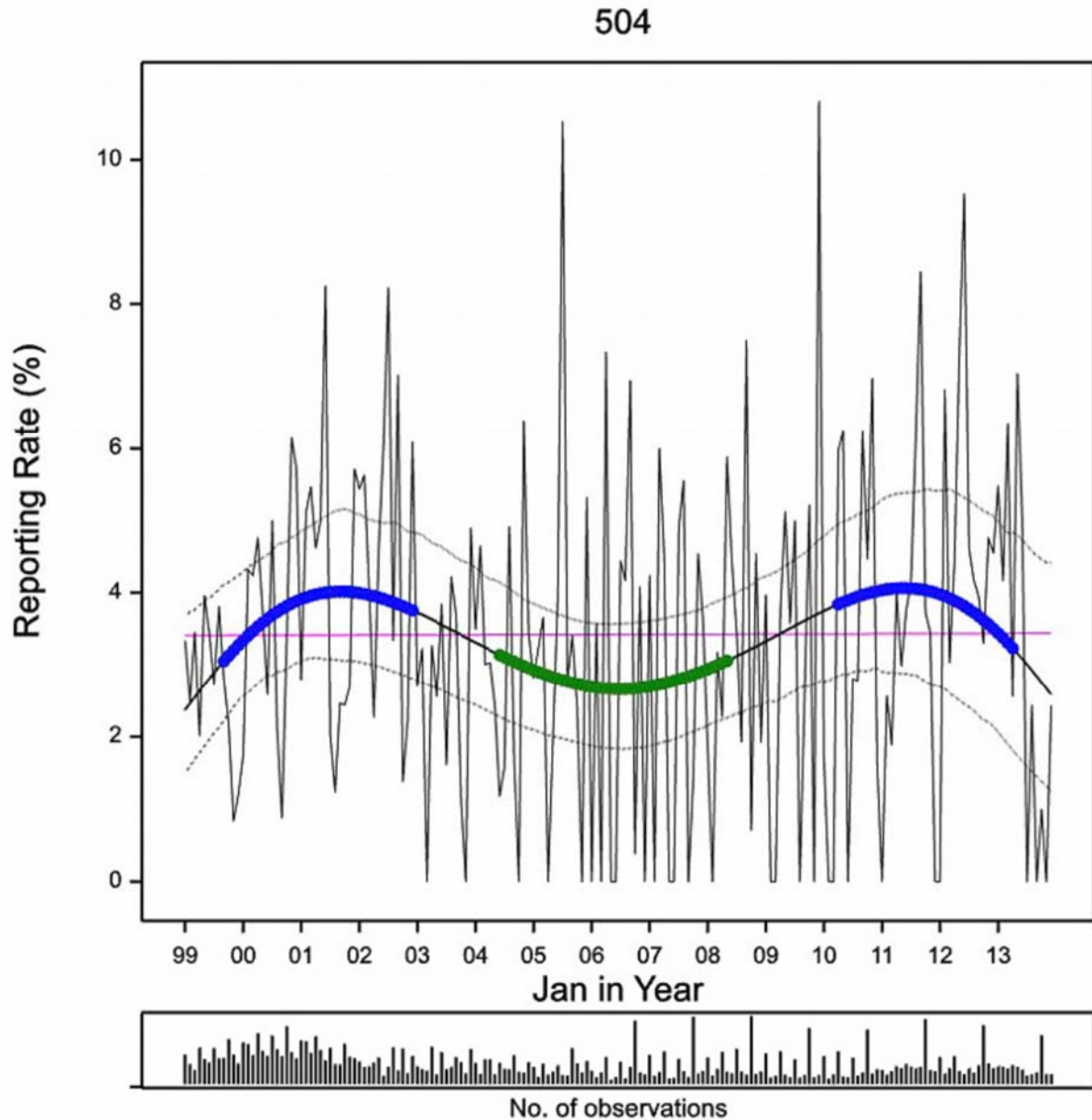


Figure 3 Speckled Warbler (southeast mainland region) exhibited a similar reporting rate pattern to most arid zone species (see Birdlife Australia 2015a) with peak reporting rates in the wetter periods, 2001 and 2011/12, and no decline over the study period (from Birdlife Australia 2015b). See figure 1a for an explanation of the Birdlife Australia reporting rate trend graphs.

Declines - Redthroat

The Redthroat is found in older patches of arid and semi-arid chenopod dominated shrublands (including Old Man Saltbush, Black Bluebush and Dillon Bush shrublands) (OEH 2014). It is mostly a ground dwelling, insectivorous species nesting on or near the ground (Beruldsen 1980). Around Broken Hill it appears to be associated with the denser vegetation, particularly Acacias, found in drainage lines that run from the rocky hills (OEH 2014). In other locations it is known from canegrass and lignum swamps and depressions, particularly on floodplains but they also occur in other habitats in other parts of their range (OEH 2014), most notably in Western Australia. The Redthroat

NSW Threatened Species Scientific Committee

has been adversely affected across its range by clearing, habitat loss, feral predators and overgrazing by rabbits, goats and introduced stock and both the range and population density have declined in many areas (Reid and Fleming 1992; Cooper and McAllan 1995; Garnett and Crowley 2000; Higgins and Peter 2002; del Hoyo *et al.* 2007; Cooper *et al.* 2016). By comparison in WA the Redthroat is more widespread (Higgins and Peter 2002) but at risk of future decline (Saunders and Ingram 1995; Johnstone and Storr 1998) and it is listed as Rare in SA (State conservation rating under *National Parks and Wildlife Act 1972*). Reporting rates in the Arid zone show no evidence of decline in the period 1999 to 2013 (Birdlife Australia 2015a and figure 3). The population density has declined along the wetter fringes of its range, particularly in eastern Australia, the Nullabor Plain, and the wheatbelt of south-west Western Australia, while in Victoria a few fragmented populations remain (Insight Ecology 2009; Birdlife International 2016a). Redthroats have not been recorded on the Nullabor Plain since 1932, although they may have only occurred on the edges of the plain (Higgins and Peter 2002) and the species is extinct on lower reaches of Cooper Creek SA where it was once plentiful (Higgins and Peter 2002). Redthroats prefer long unburnt mulga habitat (Leavesley *et al.* 2010) and around Broken Hill they appear to be associated with denser vegetation (OEH 2014). Fire and other processes that reduce shrub cover (e.g. grazing) are likely to reduce the abundance of this species. Redthroats also prefer larger habitat patches (Frost *et al.* 1999; Brooker 2002; Chambers 2008; InSight Ecology 2009), so land clearing is therefore a threat. The distribution of the Redthroat has contracted in NSW, it was once found as far east as Cobar (145.8° longitude) and Ivanhoe (145.0° longitude), but there have been no records in these areas for more than a century (Cooper *et al.* 2016). The contemporary distribution in NSW consists of isolated populations west of 144° E longitude (Cooper *et al.* 2016).

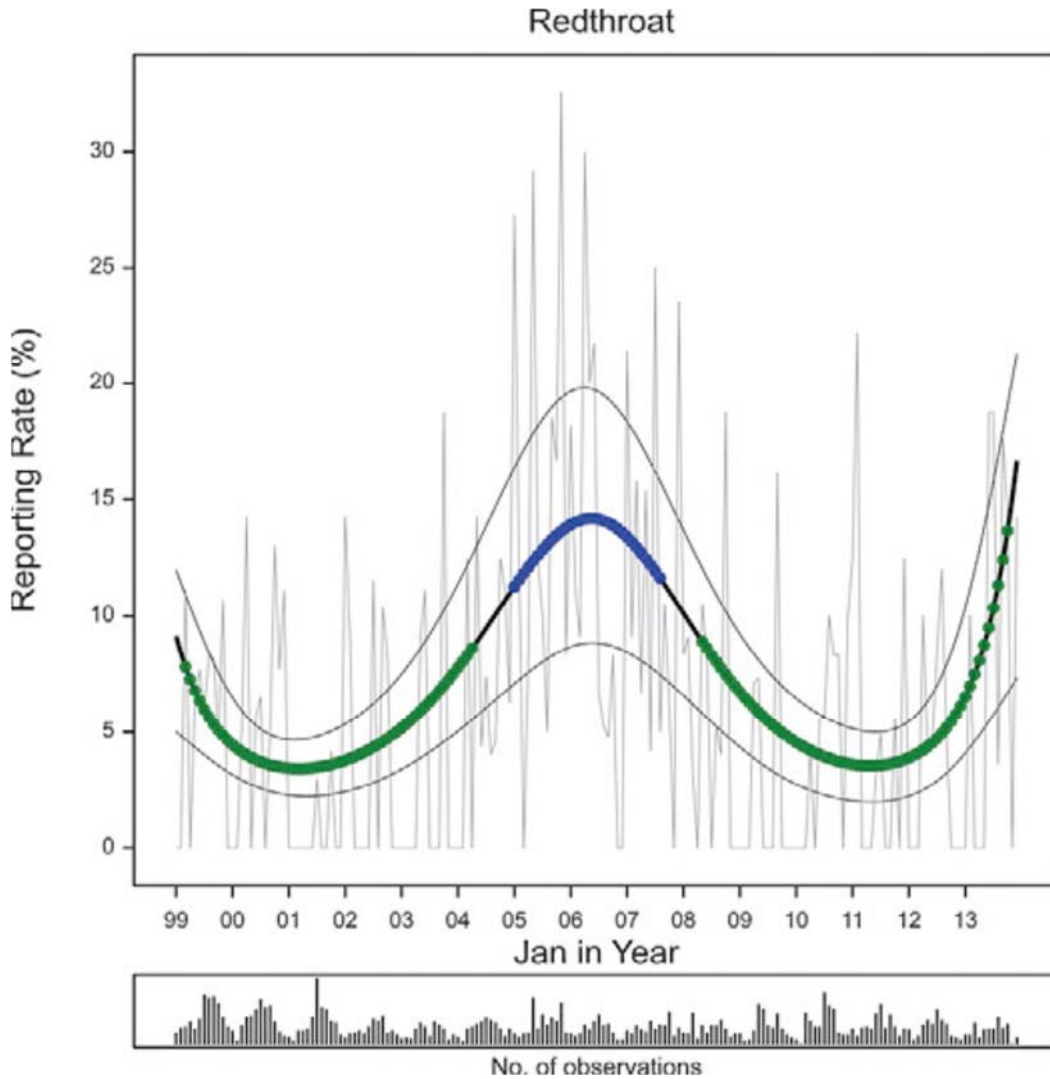


Figure 4 Trends in reporting rate in the arid zone for the Redthroat between 1998 and 2013; no decline was detected over the survey period (from Birdlife Australia 2015a). See figure 1a for an explanation of the Birdlife Australia reporting rate trend graphs.

Conservation and Management Actions

As the Black-eared Cuckoo is not currently listed there is no targeted National Recovery Plan and no NSW Saving our Species program. Management actions targeted towards the key host species (Speckled Warbler and Redthroat) may benefit this species. The following is derived from the threat information.

Habitat loss, disturbance and modification

- Prevent further habitat loss and maintain large patches of host habitat
- Control feral and native grazers and browsers where grazing pressure is impacting this species

Invasive species

- Landscape scale fox and cat control in key breeding areas (where technologically possible)
- Reduce grazing and browsing pressure through removing feral herbivores (cattle, sheep, camels, goats, rabbits etc.) from larger remnants

NSW Threatened Species Scientific Committee

Ex situ conservation

- Low priority for this species.

Stakeholder Management

- Inform land owners and managers of sites where this species and its host breed and consult with these groups regarding options for conservation management and protection of the species.

Survey and Monitoring priorities

- Monitoring for increased habitat degradation
- Regular surveys to determine whether there is a decline in the population
- Monitoring of breeding success and host use
- Research into flexibility of birds to utilise alternate host species and whether separate genets are present
- Research into population trends of host species

Information and Research priorities

- Determine the factors influencing nesting success with the different hosts and habitat types.

NSW Threatened Species Scientific Committee

Assessment against IUCN Red List criteria

For this assessment it is considered that the survey of Black-eared Cuckoo *Chalcites osculans* has been inadequate and there is insufficient scientific evidence, as such this species is considered to be data deficient. Assessment outcomes follow IUCN conventions, Data Deficient is not an available category under the *EPBC Act 1999* and as such this species is ineligible for listing.

Criterion A Population Size reduction

Assessment Outcome: data deficient

Justification:

Likely to be declining but at an unknown rate, the generation length is also uncertain but likely to be about 8 years (although possibly as short as 4 years). Available reporting rate data from the 1999-2013 periods (Birdlife Australia 2015a) is too short in duration to measure decline between similar climatic periods and the reporting rate is very low which lengthens the period required to detect change. There is evidence for habitat degradation due to clearing, grazing, burning and fragmentation of habitat in the breeding range of this species and its two main hosts (Speckled Warbler and Redthroat). Cuckoos require many contiguous host territories for successful breeding (Langmore *et al.* 2007) and are therefore likely to be more sensitive to fragmentation and clearing than their hosts. In the eastern states of Australia the Speckled Warbler is the most important host for this species with the Redthroat occupying a much smaller patchy distribution. Australia-wide the Redthroat has a much larger distribution than the Speckled Warbler and is more abundant so the status of this species is of greater importance when considering Black-eared Cuckoo at the national scale. The Speckled Warbler is a declining species (NSW SC 2001; Cooper *et al.* 2016), it is listed as a threatened species in NSW (NSW SC 2001), it is sensitive to small patch size and land clearing (Barret *et al.* 1994; NSW SC 2001; Gardner and Heinsohn 2007). The Speckled Warbler is listed as "Least Concern" by Birdlife International (2016b) with decline occurring at a rate below 30% over 3 generations.

There is no data indicating that the Redthroat is currently in decline (or otherwise), however it has not been studied intensively over a sufficiently long period of time and historical range contractions (Reid and Fleming 1992) indicate past decline. Ecological attributes (partly insectivorous diet, ground or near ground nesting) and a historical contraction of range, indicate that ongoing decline is likely. In NSW and SA the occurrence of this species is patchy. The ecology of the Redthroat is not as well known as for the Speckled Warbler, but it is closely related to the Speckled Warbler, is a similar size, nests on or near the ground and there are some more general reports that the species is in decline (Higgins and Peter 2002). The Redthroat is Vulnerable in NSW (Lunney *et al.* 2000), and least concern (but declining) nationally (Birdlife international 2016a).

Both foxes and cats have had and continue to have major impacts on small ground dwelling fauna, in particular in the arid zone (Ford *et al.* 2001; Woinarski *et al.* 2014). Broad-scale fox control programs such as "Western Shield" have mitigated fox impacts in WA to some extent (Woinarski *et al.* 2014), however, with a few exceptions (e.g. Flinders Ranges Fox and Cat control program) these programs have not been possible in areas outside of WA where native species are sensitive to 1080. Broad-scale cat control in arid areas is more challenging than controlling canids. It is currently not possible to reduce cat densities sufficiently to allow the re-introductions of some small mammals (Moseby *et al.* 2011) and cats are likely to continue to be significant predators of ground nesting/ feeding birds until control technologies are improved. Woinarski *et al.* (2014) map impacts of habitat degradation and resource depletion due to livestock and feral herbivores. These impacts are most intense in the arid zone in an area surrounding the NT, QLD, NSW and SA borders, and extend into WA but at a lower intensity, indicating the distribution of these threats is not uniform. Multiple studies indicate that land-clearing and grazing are degrading the habitat elements required by this species and its hosts (Harrington *et al.* 1979; Yates *et al.* 1994, 2000; Hodgkinson and Grice 1996; Friedel 1997; James 2003). Grazing has been linked to shrub encroachment which may have resulted in the expansion of arid woodlands, although these areas of shrub encroachment also tend to be heavily grazed and degraded (Eldridge *et al.* 2013) and are likely of low habitat value for this species or its hosts. Farm abandonment and the resulting shrubby regrowth has also been shown to be of value for some woodland birds including the Speckled Warbler (Smallbone *et al.* 2014). In small remnants, recruitment of trees and shrubs is often suppressed and

NSW Threatened Species Scientific Committee

other threats (e.g. weeds) are increasingly prevalent which means the habitat values of these remnants are likely to continue to deteriorate (Yates *et al.* 1994, 2000, Smyth *et al.* 2009). The Black-eared Cuckoo may have been negatively impacted by egg collectors (Higgins 1999) although the current extent of this practice is unclear.

Criterion B Geographic range

Assessment Outcome: Least Concern

Justification: All AOO and EOO metrics follow the IUCN (2017) recommendations and the AOO is calculated with a 2x2 km grid. Breeding records (used to calculate AOO and EOO) of this species supplied by ABBBS, although low in number are widespread so the breeding EOO (4,638,780 km²) is larger than the thresholds. The AOO (breeding) is 288 km² based on known nests sites. At face value, this in part qualifies for Endangered if other criteria are met. However, this species breeds in areas that are inaccessible, are distant from large human population centres and nests are cryptic so breeding records are incomplete. When the national AOO is calculated using breeding records from the Black-eared Cuckoo and host species (*Calamanthus campestris* Rufous Fieldwren, Redthroat, Speckled Warbler) the National AOO is 764 km² and EOO 4,535,942 km². The nesting records of host species are also likely to be incomplete and not all host nests are parasitized by Black-eared Cuckoos. The above estimates include older historical records in areas that are no longer suitable habitat for the Black-eared Cuckoo or its hosts (e.g. cleared areas in the Sydney basin). Accounting for incomplete detection, habitat loss, climatic variability and other ecological factors the AOO is estimated to exceed 2000 km². When suitable habitat and all occurrence records is considered the AOO may be as large as ~8,500 km². As severe fragmentation or extreme fluctuations are not thought to occur this species is not eligible under this clause.

In addition to these thresholds, at least two of three other conditions must be met. These conditions are:

- a) The population or habitat is observed or inferred to be severely fragmented or there is 1 (CR), ≤5 (EN) or ≤10 (VU) locations.

Assessment Outcome: not severely fragmented, number of locations >10

Justification:

The Black-eared Cuckoo is known from multiple locations and is highly mobile, which offsets the impact of fragmentation to some extent (although its hosts are sedentary). Some Black-eared Cuckoos appear to be sedentary and may therefore be more vulnerable to fragmentation. Fragmentation is occurring at different spatial scales: 1) at the site scale and 2) at the scale of distribution of host species. At the site scale the risk of fragmentation is that localised extinction of the host might occur or that not enough hosts remain to allow successful breeding for the cuckoo. At the scale of distribution of host species, the distance between host species (in particular Speckled Warbler and Redthroat) populations is increasing which has left a large area unsuitable for breeding between the two hosts, which may increase pressure on cuckoos to specialise on only one host (with unknown impacts).

The Speckled Warbler (and probably other host species) are negatively impacted by (site scale) fragmentation and small patch size. Grazing and clearing have resulted in a large reduction in available habitat and have reduced habitat patch size as well as distance and connectivity between patches (which increase extinction risk in patches). Within western NSW (and elsewhere in the arid zone) grazing and browsing has removed suitable habitat from large areas, leaving isolated pockets suitable for the Redthroat. The Redthroat has undergone extensive range contractions particularly in chenopod shrub-steppe environments across the southern arid zone although many mulga habitats remain suitable for this species (Reid and Fleming 1992). The distribution of the Redthroat in NSW is now limited and patchy. Historically the ranges of the Speckled Warbler and the Redthroat were parapatric, however the westward retreat of the Redthroat distribution now means there is a gap between these two hosts. Since breeding cuckoos need a number of contiguous territories to successfully breed in an area, this species may be more susceptible to fragmentation than its hosts. Analysis of the AOO of speckled warbler found that ~27% (n=1839, grid size 2km) of the AOO of the speckled warbler distribution can be considered non-viable in NSW (and by inference in Vic and Qld). Speckled Warbler records within NSW from the last 10 years were analysed and each 2x2km AOO square was coded as viable when the record

NSW Threatened Species Scientific Committee

was in or near a remnant larger than 400ha (the size of a 2x2 km grid square and the minimum area specified by Gardner and Heinsohn 2007) or when multiple smaller connected remnants exceeded 400ha in close proximity to records (see appendix 1). The pattern of geographic decline that was evident from historic records was also used to inform coding, as were published descriptions of home range, density and movements. The few isolated coastal records of Speckled Warblers were also coded as unviable (as they are unlikely to be parasitised). An outcome of "Severe fragmentation" requires that 50% of the AOO must be considered to be non-viable (IUCN 2017) and the assessment does not support this categorisation. For the Speckled Warbler there has been an apparent contraction of the AOO by about 28.5% in the last 30 years based on records (without correction for survey effort).

- b) Continuing decline observed, estimated, inferred or projected in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) area, extent and/or quality of habitat; (iv) number of locations or subpopulations; (v) number of mature individuals

Assessment Outcome: area, extent and quality of habitat (iii) are in decline

Justification:

Habitat quality is declining due to declining nesting resources (decline in abundance of host species). The nesting success of the Black-eared Cuckoo and host species is likely to be reduced due to nest predation, land clearing and grazing. These declines are largely driven by introduced species and inappropriate land management.

- c) Extreme fluctuations.

Assessment Outcome: Extreme fluctuations are **not** known to occur

Justification:

Reporting rates, while low, appear to fluctuate, and at the site scale fluctuations occur. As an annual migratory species there is also seasonal fluctuation resulting from birds migrating (this in itself does not elevate extinction risk). Although site scale fluctuation occurs it is not clear how total abundance changes year to year as birds may be moving around in response to climatic conditions or the observed fluctuations may be survey artefacts. The number of birds breeding each year is likely to vary with the climate but is unlikely to result in extreme fluctuations.

Criterion C Small population size and decline

Assessment Outcome: Least Concern (estimated population is ~34,000)

Justification:

Del Hoyo *et al.* (2007) estimated the total population of the Redthroat as up to 3,000,000 and the population of the Speckled Warbler as up to 400,000. Assuming that a pair of cuckoos requires 10 breeding host pairs to successfully breed and only 10% of the breeding pairs are parasitized, the population of the Black-eared Cuckoo is estimated to be 34,000 globally. The use of other hosts is possible and may increase this estimate, however evidence of frequent reproductive success with other hosts would be required before including these in the estimates. **The confidence in this estimate is low.**

At least one of two additional conditions must be met. These are:

- C1. An observed, estimated or projected continuing decline of at least: 25% in 3 years or 1 generation (whichever is longer) (CR); 20% in 5 years or 2 generations (whichever is longer) (EN); or 10% in 10 years or 3 generations (whichever is longer) (VU).

Assessment Outcome: projected continuing decline

Justification:

NSW Threatened Species Scientific Committee

Decline due to decline in host availability and ongoing habitat degradation and loss is predicted. See Clause A above. While exact rate of decline unknown continuing decline is inferred.

C2. An observed, estimated, projected or inferred continuing decline in number of mature individuals.

Assessment Outcome: Continuing decline likely

Justification:

See A and C1 above

In addition, at least 1 of the following 3 conditions:

a (i). Number of mature individuals in each subpopulation ≤ 50 (CR); ≤ 250 (EN) or ≤ 1000 (VU).

Assessment Outcome: Not applicable

Justification:

likely to be >1000 birds within each gens (assuming gentes are present)

a (ii). % of mature individuals in one subpopulation is 90-100% (CR); 95-100% (EN) or 100% (VU)

Assessment Outcome: data efficient

Justification:

It is possible that this species population is structured by the host species, where there are two gentes that each specialise on Redthroats or Speckled Warblers. Alternatively, as these birds are highly mobile the entire species may effectively be a single population.

b. Extreme fluctuations in the number of mature individuals

Assessment Outcome: No evidence

Justification:

Reporting rates, while low, appear to fluctuate, and at the site scale fluctuations occur. As an annual migratory species there is also seasonal fluctuation resulting from birds migrating (this in itself does not elevate extinction risk). Although site scale fluctuation occurs it is not clear how total abundance changes year to year as birds may be moving around in response to climatic conditions. The number of birds breeding each year varies with the climate.

Criterion D Very small or restricted population

Assessment Outcome: Least Concern (not threatened)

Justification: Population exceeds 1000 mature individuals, number of locations >5 , AOO larger than 20 km²

To be listed as Vulnerable under D, a species must meet at least one of the two following conditions:

D1. Population size estimated to number fewer than 1,000 mature individuals

Assessment Outcome: Least concern (not threatened)

Justification:

Population unknown but likely to exceed 1,000 individuals.

D2. Restricted area of occupancy (typically <20 km²) or number of locations (typically <5) with a plausible future threat that could drive the taxon to CR or EX in a very short time.

NSW Threatened Species Scientific Committee

Assessment Outcome: _Least concern

Justification: Area of occupancy much larger than 20 km² and number of locations exceeds 5.

Criterion E Quantitative Analysis

Assessment Outcome: Data Deficient

Justification:

Parameters required for quantitative analysis are not known as many aspects of this species ecology remain unstudied.

Approved for public exhibition

Dr Anne Kerle
Chairperson
NSW Threatened Species Scientific Committee

References

- Barrett GW, Silcocks AF, Cunningham R, Oliver DLL, Weston MAA, Baker J (2007) Comparison of atlas data to determine the conservation status of bird species in New South Wales, with an emphasis on woodland-dependent species. *Australian Zoologist* **34**, 37–77.
- Barrett GW, Ford HA, Recher HF.(1994) Conservation of woodland birds in a fragmented rural landscape. *Pacific Conservation Biology* **1**, 245–256.
- Beruldsen G (1980) 'A field guide to nests and eggs of Australian birds.' (Rigby: Sydney)
- Birdlife Australia (2015a) Arid Zone terrestrial species ABIs and species trends in detail. <http://www.birdlife.org.au/images/uploads/e-news/soab/indices/Arid-Zone.pdf> (accessed 25Jan2018)
- Birdlife Australia (2015b) South-east Mainland terrestrial species ABIs and species trends in detail. <http://www.birdlife.org.au/images/uploads/e-news/soab/indices/South-eastern.pdf> (accessed 25Jan2018)
- Birdlife Australia (2015c) Measuring the state of Australia 's terrestrial birds Composite indices (ABIs) <http://birdlife.org.au/images/uploads/e-news/soab/indices/ABI-methods.pdf> (accessed 25Jan2018)
- BirdLife International. (2016a). *Pyrrholaemus brunneus*. The IUCN Red List of Threatened Species 2016: e.T22704593A93976763. <http://dx.doi.org/10.2305/IUCN.UK.2016-3.RLTS.T22704593A93976763.en>. Downloaded on 06 July 2017.
- BirdLife International. (2016b). *Pyrrholaemus sagittatus*. The IUCN Red List of Threatened Species 2016: e.T22728490A94988404. <http://dx.doi.org/10.2305/IUCN.UK.2016-3.RLTS.T22728490A94988404.en>. Downloaded on 06 July 2017.
- Brooker MG, Brooker LC (2003) Brood parasitism by Horsfield' s Bronze-Cuckoo in a fragmented agricultural landscape in Western Australia. *Emu* **103**, 357–361.
- Brooker L (2002) The application of focal species knowledge to landscape design in agricultural lands using the ecological neighbourhood as a template. *Landscape and Urban Planning* **60**, 185–210.
- Chambers SA (2008) Birds as Environmental Indicators. Review of Literature. Parks Victoria technical series. Number 55 https://parkweb.vic.gov.au/__data/assets/pdf_file/0018/314523/19_2346.pdf (accessed 1 Aug 2017)

NSW Threatened Species Scientific Committee

- Clarke MF, Oldland JM (2007) Penetration of remnant edges by noisy miners (*Manorina melanocephala*) and implications for habitat restoration. *Wildlife Research* **34**, 253–261. doi:10.1071/WR06134.
- Canberra Ornithologists Group (COG) 2017 <http://canberrabirds.org.au/> (accessed 23Jan2018)
- Cooper R, McAllan I, Brandis C, Curtis B (2016) 'An Atlas of the Birds of NSW and the ACT. Volume 2: Comb-crested Jacana to Striated Pardalote.' (CSIRO Publishing, Melbourne.)
- Cooper RP, McAllan IAW (1995) 'The Birds of Western New South Wales. A Preliminary Atlas.' (Albury NSW: NSW BIRD Atlassers)
- del Hoyo J, Elliott A, Christie D (2007) Handbook of the Birds of the World, vol. 12: Picathartes to Tits and Chickadees. (Lynx Edicions, Barcelona, Spain)
- Egan K, Farrell J, Pepper-Edward D (1997) Historical and seasonal changes in the community of forest birds at Longneck Lagoon Nature Reserve, Scheyville, New South Wales. *Corella* **21**, 1–16.
- Eldridge DJ, Beecham G (2018) The Impact of Climate Variability on Land Use and Livelihoods in Australia's Rangelands. In: Gaur M., Squires V. (eds) Climate Variability Impacts on Land Use and Livelihoods in Drylands. Springer, Cham.
- Eldridge DJ, Soliveres S, Bowker MA, Val J (2013) Grazing dampens the positive effects of shrub encroachment on ecosystem functions in a semi-arid woodland. *Journal of Applied Ecology* **50**, 1028–1038.
- Fisher A M (1997). The distribution and abundance of avifauna in the Bathurst landscape: Implications for conservation and land management. PhD thesis, Charles Sturt University, Bathurst.
- Ford HA, Noske S, Bridges L (1986) Foraging of birds in eucalypt woodlands in north-eastern New South Wales. *Emu* **86**, 168–179.
- Ford H, Barrett G, Saunders D, Recher H (2001) Why have birds in the woodlands of Southern Australia declined? *Biological Conservation* **97**, 71–88.
- Ford HA (2011) The causes of decline of birds of eucalypt woodlands: Advances in our knowledge over the last 10 years. *Emu* **111**, 1–9.
- Friedel MH (1997) Discontinuous change in arid woodland and grassland. *Journal of Arid Environments* **37**, 145–164.
- Frost F, Lambeck RJ, Dymond W, Rowley T, Gowdie T (1999) Living Landscapes Final Report. A report commissioned by the Natural Heritage Trust. (Greening Australia (WA) and Alcoa World Alumina Australia, Perth)
- Gardner JL (2002) Breeding biology of the speckled warbler, *Chthonicola sagittata*. *Australian Journal of Zoology* **50**, 169–181.
- Gardner JL, Heinsohn RG (2007). Probable consequences of high female mortality for Speckled Warblers living in habitat remnants. *Biological Conservation* **135**, 473–483.
- Gardner JL, Trueman JWH, Ebert D, Joseph L, Magrath RD (2010) Phylogeny and evolution of the Meliphagoidea, the largest radiation of Australasian songbirds. *Molecular Phylogenetics and Evolution* **55**, 1087–1102. doi:10.1016/j.ympev.2010.02.005.
- Garnett ST, Szabo JK, Dutson G (2011) 'The action plan for Australian birds 2010.' (CSIRO Publishing: Melbourne)
- Garnett ST (1992) 'An Action Plan for Australian Birds'. (Australian National Parks and Wildlife Service, Canberra)
- Garnett ST (1993) 'Threatened and Extinct Birds of Australia. RAOU Report 82' (Royal Australasian Ornithologists Union and Australian National Parks and Wildlife Service, Melbourne)

NSW Threatened Species Scientific Committee

- Garnett ST, Crowley GM (2000) 'The Action Plan for Australian Birds' (Environment Australia, Canberra)
- Gibbs HL, Sorenson MD, Marchetti K, Brooke MD, Davies NB, Nakamura H (2000) Genetic evidence for female host-specific races of the common cuckoo. *Nature* **407**, 183–186.
- Gregory, P (2017a) Redthroat (*Pyrrholaemus brunneus*). In: del Hoyo, J., Elliott, A., Sargatal, J., Christie, D.A. & de Juana, E. (eds.). *Handbook of the Birds of the World Alive*. Lynx Edicions, Barcelona. (retrieved from <http://www.hbw.com/node/59806> on 27 June 2017).
- Gregory P (2017b) Speckled Warbler (*Pyrrholaemus sagittatus*). In: del Hoyo, J., Elliott, A., Sargatal, J., Christie, D.A. & de Juana, E. (eds.). *Handbook of the Birds of the World Alive*. Lynx Edicions, Barcelona. (retrieved from <http://www.hbw.com/node/59807> on 27 June 2017).
- Harrington GN, Oxley RE, Tongway DJ (1979) The effects of European settlement and domestic livestock on the biological system in poplar box (*Eucalyptus populnea*) lands. *The Rangeland Journal* **1**, 271–9.
- Higgins PJ, Peter JM eds (2002) 'Handbook of Australian, New Zealand and Antarctic birds. Volume 6: Pardalotes to shrike-thrushes.' (Oxford University Press, Melbourne)
- Higgins PJ ed (1999) 'Handbook of Australian, New Zealand and Antarctic Birds. Volume 4: Parrots to Dollarbird' (Oxford University Press, Melbourne)
- Hodgkinson KC, Grice AC (1996) The Influence of Recent Grazing Pressure and Landscape Position on Grass Recruitment in a Semi-Arid Woodland of Eastern Australia. *The Rangelands Journal*. **18**, 3–9.
- Hoskin E (1991) 'Birds of Sydney 1770-1989'. (Surrey Beatty and Sons: Sydney)
- Insight Ecology (2009) Report on Baseline Bird Surveys in Buntine-Marchagee Natural Diversity Recovery Catchment, 2006-2008 https://www.dpaw.wa.gov.au/images/documents/conservation-management/wetlands/recovery_catchments/13_Report_on_Baseline_Bird_Surveys_in_BMNDRC_2006_-_2008_.pdf (accessed 1 Aug 2017)
- IUCN Standards and Petitions Subcommittee (2017) Guidelines for Using the IUCN Red List Categories and Criteria. Version 13. Prepared by the Standards and Petitions Subcommittee. <http://www.iucnredlist.org/documents/RedListGuidelines.pdf>.
- James CD (2003) Response of vertebrates to fence-line contrasts in grazing intensity in semi-arid woodlands of eastern Australia. *Austral Ecology* **28**, 137–151.
- Johnsgard PA (1997) 'The Avian Brood Parasites: Deception at the Nest' (Oxford University Press, Oxford).
- Johnstone RE, Storr, GM (1998) 'Handbook of Western Australian Birds: Volume 1 – Non-Passerines (Emu to Dollarbird)' (Western Australian Museum, Perth, WA.)
- Keast A (1995) Habitat loss and species loss: the birds of Sydney 50 years ago and now. *Australian Zoologist* **30**, 3-25.
- Langmore NE, Adcock GJ, Kilner RM (2007) The spatial organization and mating system of Horsfield's bronze-cuckoos, *Chalcites basalis*. *Animal Behaviour* **74**, 403–412.
- Langmore NE, Sevens M, Maurer G, Kilner RM (2009) Are dark cuckoo eggs cryptic in host nests? *Animal Behaviour* **78**, 461–468.

NSW Threatened Species Scientific Committee

- Leavesley AJ, Cary GJ, Edwards GP, Gill AM (2010) The effect of fire on birds of mulga woodland in arid central Australia. *International Journal of Wildland Fire* **19**, 949–960.
- Liddy M, Elvery, S, Spraggon B (2014) Interactive: 100 years of drought in Australia. ABC News, Sydney <http://www.abc.net.au/news/2014-02-26/100-years-of-drought/5282030> (accessed 25/08/2017)
- Lunney D, Curtin AL, Ayers D, Cogger HG, Dickman CR, Maitz W, Law B, Fisher D. (2000) The threatened and non-threatened native vertebrate fauna of New South Wales: status and ecological attributes. Environmental and Heritage Monograph Series No. 4. Pp. 1-132. (NSW) National Parks and Wildlife Service, Hurstville.
- Major RE, Christie FJ, Gowing G (2001) Influence of remnant and landscape attributes on Australian woodland bird communities. *Biological Conservation* **102**, 47–66.
- Maron M, Grey MJ, Catterall CP, Major RE, Oliver DL, Clarke MF, Loyn RH, Mac Nally R, Davidson I, Thomson JR (2013) Avifaunal disarray due to a single despotic species. *Diversity and Distributions* **19**, 1468–1479.
- Moseby KE, Read JL, Paton DC, Copley P, Hill BM, Crisp HA (2011) Predation determines the outcome of 10 reintroduction attempts in arid South Australia. *Biological Conservation* **144**, 2863–2872.
- NSW Scientific Committee (NSW SC) (2001) NSW Scientific Committee - final determination: Speckled Warbler. <http://www.environment.nsw.gov.au/determinations/SpeckledWarblerVulSpListing.htm> (accessed 25 Aug 2017).
- OEH (2014) Redthroat Profile. <http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10721> (accessed 25 Aug 2017).
- Pauly D (1995) Anecdotes and the shifting baseline syndrome of fisheries. *Trends in Ecology and Evolution*, **10**, 430.
- Payne R (2017) Black-eared Cuckoo (*Chalcites osculans*). In: del Hoyo, J., Elliott, A., Sargatal, J., Christie, D.A. & de Juana, E. (eds.). *Handbook of the Birds of the World Alive*. Lynx Edicions, Barcelona. (retrieved from <http://www.hbw.com/node/54815> on 21 June 2017).
- Recher HF, Davis WE (2010) The foraging behaviour of woodland birds along the mulga-eucalypt line on Mt. Gibson Station, Western Australia during late winter and spring. *Western Australian Journal of Ornithology* **2**, 29–41.
- Recher HF, Davis WE (2014) Response of birds to episodic summer rainfall in the Great Western Woodlands, Western Australia. *Australian Zoologist* **37**, 206–224.
- Reid J, Fleming M (1992) The conservation status of birds in arid Australia. *The Rangeland Journal* **14**, 65.
- Reid J (1999) Threatened and declining birds in the New South Wales sheep–wheat belt. Unpublished report for NSW National Parks and Wildlife Service.
- Remeš V, Matysioková B, Cockburn A, Reme V, Matysiokov B, Cockburn A (2012) Long-term and large-scale analyses of nest predation patterns in Australian songbirds and a global comparison of nest predation rates. *Journal of Avian Biology* **43**, 435–444. doi:10.1111/j.1600-048X.2012.05599.x.
- Robinson D. (1991) Threatened birds in Victoria: their distributions, ecology and future. *The Victorian Naturalist* **3**, 67-77.
- Robinson D (1993) Vale Toolern Vale: the loss of our woodland birds. *Wingspan*, 9(1–3), 20-21.
- Rose LN (1982) Breeding ecology of British pipits and their Cuckoo parasite. *Bird Study* **29**, 27-40.
- Saunders DA, Ingram JA (1995) 'Birds of Southwestern Australia' (Surrey Beatty & Sons, Sydney)

NSW Threatened Species Scientific Committee

- Short J (2004) Conservation of the Malleefowl: are there lessons from the successful conservation of native mammals by intensive fox control? Proceedings of the National Malleefowl Forum 2004.
- Short J, Smith A. (1994) Mammal decline and recovery in Australia. *Journal of Mammalogy* **75**, 288-297.
- Smallbone LT, Matthews A, Lunt ID (2014) Regrowth provides complementary habitat for woodland birds of conservation concern in a regenerating agricultural landscape. *Landscape and Urban Planning* **124**, 43–52.
- Smith P, Smith J (1994) Historical change in the bird fauna of western New South Wales: ecological patterns and conservation implications. Pp. 123-147 In D. Lunney, S. Hand, P. Reed and D. Butcher (eds). Future of the Fauna of Western New South Wales. Royal Zoological Society of NSW, Mosman.
- Smith PJ, Pressey RL, Smith JE (1994) Birds of particular conservation concern in the Western Division of New South Wales. *Biological Conservation* **69**, 315-338.
- Smyth, A., Friedel, M. and O'Malley, C.O. (2009) The influence of buffel grass (*Cenchrus ciliaris*) on biodiversity in an arid Australian landscape. *The Rangeland Journal*, **31**, 307-320.
- Stevens HC, Watson DM (2013) Reduced rainfall explains avian declines in an unfragmented landscape: Incremental steps toward an empty forest? *Emu* **113**, 112–121.
- Watson DM (2015) Disproportionate declines in ground-foraging insectivorous birds after mistletoe removal. *PLoS ONE* **10**, 1–12. doi:10.1371/journal.pone.0142992.
- Woinarski J, Burbidge A, Harrison P (2014) 'The Action Plan for Australian Mammals 2012' (CSIRO publishing, Melbourne)
- Yates CJ, Hobbs RJ, Bell RW (1994) Factors Limiting the Recruitment of *Eucalyptus salmonophloia* in Remnant Woodlands. I. Pattern of Flowering, Seed Production and Seed Fall. *Australian Journal of Botany* **42**, 531–542.
- Yates CJ, Norton DA, Hobbs RJ (2000) Grazing effects on plant cover, soil and microclimate in fragmented woodlands in south-western Australia: Implications for restoration. *Austral Ecology* **25**, 36–47.

Expert Communications

Belinda Cale Australian Landscape Trust

Daisy Englert Duursma, Macquarie University

Murray Ellis Office of Environment and Heritage, NSW

Naomi Langmore, Professor, ANU College of Science

Michael Todd Office of Environment and Heritage, NSW

Dr Julian Reid, Honorary Lecturer, Fenner School of Environment and Society, Australian National University, and Management Committee member of the Cowra Woodland Birds Program, BLA.

Ken Atkins, Manager, Species and Communities Program, Department of Biodiversity, Conservation and Attractions, Western Australia.

Andrew Crane, Manager, Policy and Conservation Advice Branch, Department of Primary Industries, Parks, Water and Environment, Tasmania.

NSW Threatened Species Scientific Committee

Angela Duffy Senior Policy Officer, Threatened Species and Ecological Communities, Department for Environment and Water, South Australia.

Alistair Stewart Department of Environment and Natural Resources, Northern Territory Government

Kathryn Tracy Manager Natural Environment, Environment and Planning, ACT Government

Mike Mathieson Queensland Government Department of Environment and Science

Amy Mutton Zoologist / Executive Officer Fauna - WA Threatened Species Scientific Committee. Department of Biodiversity, Conservation and Attractions, Western Australia.

NSW Threatened Species Scientific Committee

Appendix 1 Speckled warbler records from 2007 to 2017 (Source Bionet 7/6/2018) coded as viable or non-viable, this was used to determine the nature of fragmentation

