The Minister approved this conservation advice and transferred this species from the Vulnerable to Endangered category, effective from 15/02/2018

Conservation Advice

Calyptorhynchus baudinii

Baudin's cockatoo

Taxonomy

Conventionally accepted as *Calyptorhynchus baudinii* (Lear 1832).

Summary of assessment

Conservation status

Endangered: Criterion 1 A2cde
Vulnerable: Criterion 3 C1+2a(ii)

The highest category for which *Calyptorhynchus baudinii* is eligible to be listed is Endangered.

Species can be listed as threatened under state and territory legislation. For information on the listing status of this species under relevant state or territory legislation, see http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl

Reason for conservation assessment by the Threatened Species Scientific Committee

Baudin's cockatoo was listed as Vulnerable under the predecessor to the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), the *Endangered Species Protection Act 1992* and transferred to the EPBC Act in July 2000.

This advice follows assessment of new information provided to the Threatened Species Scientific Committee (the Committee) to change the listing status of the Baudin's cockatoo to Endangered.

Public consultation

Notice of the proposed amendment and a consultation document was made available for public comment for 30 business days between 4 April and 19 May 2017. Any comments received that were relevant to the survival of the species were considered by the Committee as part of the assessment process.

Species Information

Description

Baudin's cockatoo is a large cockatoo that measures 50–57 cm in length, with a wingspan of approximately 110 cm, and a mass of 560–770 g. It is mostly dull black in colour, with pale whitish margins on the feathers, large, rounded patches (white to yellowish-white in the female and dusky-white to brownish-white in the male) on the ear coverts, and rectangular white panels in the tail. It has a large bill (with a very elongated upper mandible) that is coloured black in the male and whitish-grey with a black tip in the female; a dark brown iris that is surrounded by a reddish-pink eye-ring in the male and a grey eye-ring in the female; a short, rounded, erectile crest; and grey feet (Higgins 1999; Johnstone & Storr 1998).

Juvenile birds are like the adults in appearance, but the bill of the juvenile male is like that of the adult female. The bill of the juvenile male begins to darken after the second year (Johnstone & Storr 1998).

Distribution

Baudin's cockatoo is endemic to south-west Western Australia (Western Australian Museum 2017). The range of the species occurs between Margaret River and Albany, extending northward to Gidgegannup and Mundaring (east of Perth), and inland to the Stirling Range and near Kojonup (BirdLife International 2016; Davies 1966; DSEWPaC 2012; Saunders 1974, 1979; Saunders et al. 1985; Storr 1991).

Breeding occurs in the south-west of the species range, bounded by Leschenault (near Bunbury), Collie (inland east of Bunbury) and Albany (DSEWPaC 2012). Breeding has also been recorded north of this area at Perth Hills, Harvey (BirdLife International 2016), Lowden (Johnstone & Storr 1998), Serpentine (hills area), and to the east at Kojonup (Johnstone & Kirkby 2008).

Relevant Biology/Ecology

Baudin's cockatoo occurs in temperate forest and woodland dominated by *Eucalyptus marginata* (jarrah), *Corymbia calophylla* (marri) and *E. diversicolor* (karri). The species nests in the hollows of mature eucalypts, particularly marri, karri, *E. wandoo* (wandoo), *E. gomphocephala* (tuart) and *E. megacarpa* (bullich) (Johnstone et al. 2010, Western Australian Museum 2017). Suitable hollows form as a result of activity from invertebrates and fungi, followed by fire, when a branch or trunk snaps off or is damaged (Chapman 2008). Analyses show that trees with hollows large enough for use by Baudin's cockatoo may be between 200 and 500 years of age (Johnstone et al. 2002).

The southern and northern limits of the species range, from Albany to Gidgegannup and Mundaring, are for the most part connected by extensive tracts of forest (Saunders 1979). However, nesting and breeding habitat for Baudin's cockatoo is continuing to decline and the current stand structure of remaining jarrah-marri forest is largely uniform and not representative of structural variation in pre-European forest. Old-growth jarrah-marri forest with suitable hollows for Baudin's cockatoo now only occur in unconnected stands. As such, breeding habitat for the species is severely fragmented (R Johnstone, pers. comm. 2017c).

The species mainly feeds on the seeds and flowers of marri, with their long beak making them particularly efficient at extracting the seed (Cooper et al. 2002). The species also takes the seeds of jarrah, cultivated apples and pears, *Banksia* and *Hakea* species, *Erodium botrys* and insect larvae (Long 1985; Halse 1986; Johnstone et al. 2010).

Nesting is typically clustered within the landscape in remaining stands of suitable breeding habitat (R Johnstone, pers. comm. 2017c). The species usually lays one or two eggs between August and December, although only one young is reared (Western Australian Museum 2017). Breeding success is only estimated at 0.6 young per pair (Johnstone & Storr 1998). This rate of recruitment appears below the rate of mortality of mature birds (Garnett 1992).

Baudin's cockatoo is gregarious. The species is usually seen in groups of three (comprising the adult pair and a single dependent young) or in small parties, but will occasionally gather in large flocks of up to 300 birds during the non-breeding season, usually at sites where food is abundant (Higgins 1999; Storr 1991).

A generation time of 19.2 years (Garnett et al. 2011) is derived from an age at first breeding of four years and maximum longevity of 34.4 years, both extrapolated from *C. latirostris* (Carnaby's cockatoo).

Threats

Nest hollow shortage is a principal threat to Baudin's cockatoo. The primary threatening processes resulting in nest hollow shortages are land clearing practices for agriculture, forestry and mining, fire events and competition with invasive and native species. Illegal shooting by orchardists and phytopathogens are also causing declines in breeding and foraging habitat. Climate change poses a significant future threat to Baudin's cockatoo in terms of decline in nesting trees, reduced food availability, increased fire frequency and altered movements (R Johnstone, pers. comm. 2017a, c).

Table 1 – Threats impacting the Baudin's cockatoo in approximate order of severity of risk, based on available evidence.

Threat factor	Threat type and status	Evidence base
Habitat loss, disturbance and modifications		
Land clearing and tree harvesting for agriculture, forestry and mining	known present	Mawson & Johnstone (1997) reported that Baudin's cockatoo no longer occupied up to 25 percent of its former habitat that was historically cleared for agriculture. The clearing of forests in southern Western Australia for agriculture, forestry and mining is ongoing and continues to threaten Baudin's cockatoo (R Johnstone, pers. comm. 2017a). Land clearing associated with bauxite mining is responsible for the removal of over 700 hectares of jarrah-marri forest annually (R Johnstone, pers. comm. 2017c). Suitable hollows are scarce, only forming in trees 130 to 220 years of age, many of which have been preferentially felled (Abbott & Whitford 2002; Chapman 2008). Nest hollows are likely to continue to be lost to vegetation clearance associated with mining (Chapman 2008). The loss of older trees also reduces food availability for the species (DSEWPaC 2011).
Fire		
Destruction of nesting and foraging trees from fire events	known present	Baudin's cockatoo nesting and foraging trees species, including jarrah, marri and wandoo, are threatened by fire (R Johnstone, pers. comm. 2017c) and mismanagement of fire. Marri, the species' preferred forage tree, is particularly susceptible to fire (R Johnstone, pers. comm. 2017c). Wildfires and planned fires have resulted in the loss of nesting and foraging trees for Baudin's cockatoo across the species' distribution. For example, the January 2005 Perth Hills wildfire resulted in the complete loss of four out of five known Baudin's cockatoo research nest trees. A controlled burn in May 2011 in the Wungong Catchment resulted in the complete loss of three out of five known nest trees, and the January 2016 wildfire in the Waroona-Yarloop area destroyed an estimated 69 000 hectares of jarrah-marri forest. This wildfire resulted in a temporary loss of 80-90 percent of foraging habitat and almost half of the known nesting trees for the species in the area (R Johnstone, pers. comm. 2017c, d). Fire control and management activities, including the use of large machinery during post-fire clean-up activities, have contributed to the loss of known nesting trees (R Johnstone, pers. comm. 2017c). The resistance of key breeding and foraging trees to fire may be reduced through the effects of other threatening processes, including phytopathogens and a drying climate. Prescribed fires may also be destroying key breeding and foraging trees that have already been previously weakened by wildfire. It is likely that these threatening processes in

		association with each other have resulted in an accelerated nesting and foraging tree loss for Baudin's cockatoo. The availability of suitable nesting and foraging trees for the species is likely to continue to decline (R Johnstone, pers. comm. 2017a; DSEWPaC 2011), particularly due to an increase in the frequency and intensity of fire events as a result of climate change.
Invasive species		
Loss of hollows from European honey bees (*Apis mellifera*)	known present	European honey bees have been observed competing with Baudin's cockatoo for suitable nest hollows. A study undertaken by the Western Australian Museum in 2007 found that approximately 20 percent of cockatoo breeding hollows surveyed had been invaded by European honey bees. Swarming European honey bees are also known to cause mortality of chicks and nesting females (BirdLife International 2016; R Johnstone, pers. comm. 2017c).
Competition with native species		
Nest hollow shortage due to competition with native bird species	known present	Competition for hollows with other bird species has been observed. Cockatoos, including *C. latirostris* (Carnaby's cockatoo) and *C. galerita* (sulphur-crested cockatoo), as well as *Cacatua rosiecapilla* (galah), *C. tenuirostris* (eastern long billed corella), *C. sanguinea* (little corella), *Chenonetta jubata* (Australian wood duck) and *Polytelis anthropeplus* (regent parrot) have been observed to displace Baudin's cockatoo from nesting hollows (Johnstone & Cassarchis 2004; Johnstone & Kirkby 2007; Chapman 2008; R Johnstone, pers. comm. 2017a).
Illegal killing		
Shooting by orchardists	known present	Baudin's cockatoo is known to damage fruit crops, particularly pears and apples, and there is ongoing evidence that farmers still illegally shoot birds as a method of control (Chapman 2008), despite the species being protected in Western Australia since 1996 (Mawson & Johnstone 1997). Illegal shooting by orchardists is likely to be limiting recovery of the population (Chapman 2008).
Phytopathogens and pests		
Phytopathogens affecting key tree species	known present	Phytopathogens are affecting key tree species used by Baudin's cockatoo, particularly in the northern and eastern areas of the species range. Phytopathogens include *Phytophthora cinnamomi* dieback, *Quambalaria coyrecup* (canker) and *Quambalaria pitereka* (leaf and shoot blight). Canker and leaf and shoot blight are significant factors contributing to the decline of marri (R Johnstone, pers. comm. 2017a, c).
Infestation of bullseye borer (*Phoracantha acanthocera)*	suspected present	Significant attack on jarrah, marri and karri by bullseye borer (a beetle) has been observed and is likely to be contributing to the decline in breeding and foraging habitat for Baudin's cockatoo (R Johnstone, pers. comm. 2017c).

Climate change		
Reduced rainfall and increased temperature	known future	It is projected with high confidence that climate change will result in increased temperatures across all seasons, reduced winter and spring rainfall and a harsher fire weather climate in south-west Western Australia (CSIRO & BoM 2017). A decline in rainfall is likely to have a significant impact on the extent of survival, capacity for regeneration and recruitment of key tree species within the habitat of Baudin's cockatoo across its range. Key eucalypt species require adequate rainfall for successful germination to occur as well as regeneration after fire (DPaW 2013). The effect of reduced rainfall on Baudin's cockatoo habitat is likely to be further exacerbated by an increased frequency and intensity of fires. With reduced rainfall, the Baudin's cockatoo population is expected to contract towards higher rainfall areas in the south-west (R Johnstone, pers. comm. 2017c). The frequency and severity of hot days are also predicted to increase in south-west Western Australia as a result of climate change (CSIRO & BoM 2017). This is likely to threaten Baudin's cockatoo through heat stress associated mortality of individuals on extreme hot days, as observed in Carnaby's black cockatoo (Saunders et al. 2011).

Assessment of available information in relation to the EPBC Act Criteria and Regulations

Criterion 1. Population size reduction (reduction in total numbers)
Population reduction (measured over the longer of 10 years or 3 generations) based on any of A1 to A4

	Critically Endangered Very severe reduction	Endangered Severe reduction	Vulnerable Substantial reduction
A1	**≥ 90%**	**≥ 70%**	**≥ 50%**
A2, A3, A4	**≥ 80%**	**≥ 50%**	**≥ 30%**

A1 Population reduction observed, estimated, inferred or suspected in the past and the causes of the reduction are clearly reversible AND understood AND ceased.

A2 Population reduction observed, estimated, inferred or suspected in the past where the causes of the reduction may not have ceased OR may not be understood OR may not be reversible.

A3 Population reduction, projected or suspected to be met in the future (up to a maximum of 100 years) [*(a) cannot be used for A3*]

A4 An observed, estimated, inferred, projected or suspected population reduction where the time period must include both the past and the future (up to a max. of 100 years in future), and where the causes of reduction may not have ceased OR may not be understood OR may not be reversible.

based on any of the following:

(a) direct observation [*except A3*]

(b) an index of abundance appropriate to the taxon

c) a decline in area of occupancy, extent of occurrence and/or quality of habitat

d) actual or potential levels of exploitation

(e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites

Evidence:

Eligible under Criterion A2cde for listing as Endangered

Baudin's cockatoo has undergone substantial long term decline in population size and range. The principal causes of these declines are historic and ongoing clearing of forests for agriculture, forestry and mining, competition with other species for nest hollows and illegal shooting by orchardists (BirdLife International 2016).

Baudin's cockatoo is continuing to decline. However, the rate of decline is poorly quantified due to a lack of recent quantitative population data (BirdLife International 2016).

Experts agree that the suspected rate of decline for Baudin's cockatoo is more than 50 percent over three generations since the 1960s (Garnett et al. 2011; R Johnstone, pers. comm. 2017b). The expert opinion is supported by the results of annual monitoring of traditional roost sites in northern jarrah-marri forest. This monitoring has been undertaken for over 20 years (R Johnstone, pers. comm. 2017d). The data demonstrate that since 2009, the number of individuals counted at all traditional roosts have declined, with most roosts having declined by 90-100 percent (R Johnstone, pers. comm. 2017c). These traditional roosts make up 90-95 percent of the total Baudin's cockatoo population (R Johnstone, pers. comm. 2017d).

The Committee considers that Baudin's cockatoo has satisfied Criterion 1 A2cde for listing as Endangered based on a suspected severe reduction in population size, observed declines at traditional roosting sites, a decline in the area of occupancy and range of the species, and several threatening processes continuing to cause a reduction in population size.

Criterion 2.	**Geographic distribution as indicators for either extent of occurrence AND/OR area of occupancy**		
	Critically Endangered Very restricted	**Endangered Restricted**	**Vulnerable Limited**
B1. Extent of occurrence (EOO)	**< 100 km2**	**< 5,000 km2**	**< 20,000 km2**
B2. Area of occupancy (AOO)	**< 10 km2**	**< 500 km2**	**< 2,000 km2**
AND at least 2 of the following 3 conditions indicating distribution is precarious for survival:			
(a) Severely fragmented OR Number of locations	**= 1**	**≤ 5**	**≤ 10**
(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			
(c) Extreme fluctuations in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) number of locations or subpopulations;(iv) number of mature individuals			

Evidence:

Not eligible.

The extent of occurrence is estimated at 146 000 km^2 and the area of occupancy is estimated at 4200 km^2. These estimates are based on the mapping of point records from 1997 to 2017, obtained from state governments, museums, CSIRO and Birdlife Australia. The extent of occurrence was calculated using a minimum convex hull, and the area of occupancy calculated using a 2x2 km grid cell method, based on the IUCN Red List Guidelines 2014 (DOEE 2017).

The Committee considers that Baudin's cockatoo does not meet the requirements of Criterion 2 as neither the extent of occurrence or area of occupancy are limited.

Criterion 3. Population size and decline				
		Critically Endangered Very low	**Endangered Low**	**Vulnerable Limited**
Estimated number of mature individuals		**< 250**	**< 2,500**	**< 10,000**
AND either (C1) or (C2) is true				
C1	An observed, estimated or projected continuing decline of at least (up to a max. of 100 years in future)	**Very high rate 25% in 3 years or 1 generation (whichever is longer)**	**High rate 20% in 5 years or 2 generation (whichever is longer)**	**Substantial rate 10% in 10 years or 3 generations (whichever is longer)**
C2	An observed, estimated, projected or inferred continuing decline AND its geographic distribution is precarious for its survival based on at least 1 of the following 3 conditions:			
(a)	(i) Number of mature individuals in each subpopulation	**≤ 50**	**≤ 250**	**≤ 1,000**
	(ii) % of mature individuals in one subpopulation =	**90 – 100%**	**95 – 100%**	**100%**
(b)	Extreme fluctuations in the number of mature individuals			

Evidence:

Eligible under Criterion 3 C1+2a(ii) for listing as Vulnerable

The Western Australia Museum estimates the total Baudin's cockatoo population to contain 5000-8000 birds (R Johnstone, pers. comm. 2017a), of which approximately 2500-4000 are thought to be mature individuals (R Johnstone, pers. comm. 2017b).

Baudin's cockatoo population is continuing to decline (Johnstone & Kirkby 2015, 2016). Experts agree that the suspected rate of decline for Baudin's cockatoo is more than 50 percent over three generations since the 1960s (Garnett et al. 2011; R Johnstone, pers. comm. 2017b). This severe rate of population decline is supported by observed declines of 90-100 percent at traditional Baudin's cockatoos roost sites (R Johnstone, pers. comm. 2017c).

Baudin's cockatoo occurs in a single population (BirdLife International 2016), which is made up of separate groups (R Johnstone, pers. comm. 2017c). The species does not undergo extreme fluctuations in the number of mature individuals (BirdLife International 2016).

The Committee considers that Baudin's cockatoo has satisfied Criterion 3 C1+2a(ii) based on a limited number of mature individuals and continuing population decline of greater than ten percent over three generations.

Criterion 4. Number of mature individuals			
	Critically Endangered Extremely low	**Endangered Very Low**	**Vulnerable Low**
Number of mature individuals	**< 50**	**< 250**	**< 1,000**

Evidence:

Not eligible.

The Western Australia Museum estimates the Baudin's cockatoo population to contain 2500-4000 mature individuals (R Johnstone, pers. comm. 2017b).

The Committee considers that Baudin's cockatoo does not meet the requirements of Criterion 4 as the number of mature individuals is greater than 1000.

Criterion 5. Quantitative Analysis			
	Critically Endangered Immediate future	**Endangered Near future**	**Vulnerable Medium-term future**
Indicating the probability of extinction in the wild to be:	**≥ 50% in 10 years or 3 generations, whichever is longer (100 years max.)**	**≥ 20% in 20 years or 5 generations, whichever is longer (100 years max.)**	**≥ 10% in 100 years**

Evidence:

Insufficient data to determine eligibility.

As a population viability analysis has not been undertaken, there is insufficient data to demonstrate if the species is eligible for listing under this criterion.

Conservation Actions

Recovery Plan

Baudin's cockatoo is included in the Forest Black Cockatoo (Baudin's Cockatoo *Calyptorhynchus baudinii* and Forest Red-tailed Black Cockatoo *Calyptorhynchus banksii naso*) Recovery Plan (Chapman 2008). This recovery plan should be retained until it sunsets in October 2021. A decision about whether there should be a recovery plan for Baudin's cockatoo after the current plan has expired has not yet been determined, and should only be made once the current plan has been reviewed.

Primary Conservation Actions

The primary conservation actions for Baudin's cockatoo are to limit the amount of illegal shooting and to increase the number of nest hollows, mainly through limiting further loss of mature trees.

Conservation and Management Priorities

Habitat loss, disturbance and modifications

- Develop and implement a policy for the identification of old-growth forest areas for retention and protection of existing hollow-bearing trees and future habitat trees that may develop hollows in the next 50-100 years.
- Develop and implement a policy for the retention and mapping of hollow-bearing trees in urban and agricultural areas, and managed forests.

- Ensure land managers are aware of the species' occurrence and provide appropriate mitigation measures against habitat clearing.
- Undertake habitat restoration by revegetating suitable areas with key tree species.

Fire

- Fire management authorities and land management agencies should use suitable maps and install field markers to avoid damage to known Baudin's cockatoo habitat. Physical damage to identified nesting trees must be avoided during and after fire operations.
- Fires must be managed to ensure that prevailing fire regimes do not disrupt the life cycle of Baudin's cockatoo, that they support rather than degrade the species' habitat, and that they do not promote invasion of exotic species.

Invasive species

- Develop and implement a control program for the reduction or eradication of feral European honey bees.

Illegal shooting

- Promote non-lethal means of mitigating fruit damage by Baudin's cockatoo in orchards, including netting.
- Develop and implement guidelines to allow for the use of noise emitting devices in orchards in areas near population centres.
- Develop a targeted education and communication program combined with appropriate enforcement strategies to eliminate illegal shooting.

Phytopathogens

- Implement best practice and adaptive management actions to reduce the spread of phytopathogens, manage and contain infested areas, and protect non-infested areas across the Baudin's cockatoo distribution.

Stakeholder engagement

- Liaise with organisations which are undertaking research and conservation actions for Baudin's cockatoo, including BirdLife International, Western Australia Museum and Murdoch University.
- Continue the 'Cockatoo Care' citizen science program and community education activities, including orchardists and government departments, to encourage conservation of the species and ensure ongoing research of the species' ecology and distribution.

Survey and Monitoring priorities

- Continue to undertake population monitoring of Baudin's cockatoo across its range to more precisely assess population size, distribution, migration and movements, food requirements, breeding range, the timing of nesting events, breeding age, nest tree and hollow characteristics, breeding behaviour, breeding success and nest site fidelity.
- Undertake mapping and monitoring of important breeding, feeding and nesting sites in the south-west of the species' distribution, including Serpentine Hills, Nannup region and Leeuwin-Naturaliste Ridge.

- Monitor and record the impacts of fire events on Baudin's cockatoo habitat, including losses of foraging habitat and nesting trees.
- Monitor and record the location and impacts of European honey bee nest hollow invasions to target management actions for eradication in high priority nesting areas.
- Monitor the progress of conservation actions, including the effectiveness of management actions and adapt them if necessary to contribute to the species' recovery.

Information and Research priorities

- Improve understanding of the dynamics of hollow creation and loss, including the role of fire and the influence of fire regimes.
- Determine effective methods to control and mitigate the threat of phytopathogens in Baudin's cockatoo habitat, including *Phytophthora cinnamomi*, *Quambalaria coyrecup* (canker) and *Quambalaria pitereka* (leaf and shoot blight).
- Determine and implement methods to manage key forest resources for the conservation of Baudin's cockatoo.
- To reduce the effect of competition with other native bird species, continue to undertake research into the design and success of nest tubes and boxes at known nesting sites to increase availability of nest sites to Baudin's cockatoo. Continue to trial prototypes to ensure artificial nest tubes and boxes are used by Baudin's cockatoo.
- Improve understanding of the response of Baudin's cockatoo to climate change, focusing on direct impacts on behaviour, breeding and key tree species.

Recommendations

(i) The Committee recommends that the list referred to in section 178 of the EPBC Act be amended by **transferring** from the Vulnerable category to the Endangered category:

Calyptorhynchus baudinii

(ii) The Committee recommends that the recovery plan decision be maintained.

Threatened Species Scientific Committee

08/06/2017

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