

Appendix D

Habitat Descriptions for 12 Threatened Species Specific to Central Queensland Central Queensland Threatened Species Habitat Descriptions

Citation

This report should be cited as Kerswell A, Kaveney T, Evans C and Appleby L. (2020) *Habitat descriptions* for 12 threatened species, specific to central Queensland. Report commissioned by BHP.

Acknowledgements

This document has been prepared with support from BHP, Steve Wilson, Brad Dreis (E2M), Lindsay Agnew (Austecology), Penn Llyod (BAAM), Greg Ford, Berlinda Ezzy & Andy Jensen (EMM), Craig Eddie (Boobook) and Liz Fisher (AECOM).

Version

v3, prepared 21 August 2020

Contents

1. Introduction	
2. Methodology	
2.1 Desktop assessment and literature review	
2.1.1 Spatial analysis	
2.2 Development of draft definitions	
2.3 Habitat categories	
2.4 Expert elicitation and review	
2.5 Definition refinement and finalisation	14
3. Koala (Phascolarctos cinereus)	15
3.1 Legal status	
3.2 Ecology and distribution	15
3.2.1 Known distribution	
3.2.2 Biology and reproduction	
3.3 General habitat requirements	
3.4 Central Queensland habitat definition	
3.5 Habitat identification guidance	
3.6 References	
4. Greater glider (Petauroides volans)	21
4.1 Legal status	21
4.2 Ecology and distribution	21
4.2.1 Known distribution	
4.2.2 Biology and reproduction	
4.3 General habitat requirements	22
4.4 Central Queensland habitat definition	23
4.5 Habitat identification guidance	24
4.6 References	25
5. Squatter pigeon (southern; Geophaps scripta scripta)	27
5.1 Legal status	27
5.2 Ecology and distribution	27
5.2.1 Known distribution	
5.2.2 Biology and reproduction	
5.3 General habitat requirements	
5.4 Central Queensland habitat definition	29
5.5 Habitat identification guidance	
5.6 References	

6. Painted honeyeater (Grantiella picta)	
6.1 Legal status	
6.2 Ecology and distribution	
6.2.1 Known distribution	
6.2.2 Biology and reproduction	
6.3 General habitat requirements	
6.4 Central Queensland habitat definition	35
6.5 Habitat identification guidance	35
6.6 References	
7. Australian painted snipe (Rostratula australis)	
7.1 Legal status	
7.2 Ecology and distribution	
7.2.1 Known distribution	
7.2.2 Biology and reproduction	
7.3 General habitat requirements	
7.4 Central Queensland habitat definition	40
7.5 Habitat identification guidance	40
7.6 References	42
8. Ornamental snake (Denisonia maculata)	43
8.1 Legal status	43
8.2 Ecology and distribution	43
8.2.1 Known distribution	
8.2.2 Biology and reproduction	
8.3 General habitat requirements	44
8.4 Central Queensland habitat definition	45
8.5 Habitat identification guidance	46
8.6 References	47
9. Yakka skink (Egernia rugosa)	49
9 1 Legal status	49
9.2 Ecology and distribution	
9.2.1 Known distribution	49
9.2.2 Biology and reproduction	
9.3 General habitat requirements	
9.4 Central Queensland habitat definition	
9.5 Habitat identification guidance	51
9.6 References	53
10. Collared delma (Delma torquata)	54

10.1 Legal status	54
10.2 Ecology and distribution	54
10.2.1 Known distribution	54
10.2.2 Biology and reproduction	
10.3 General habitat requirements	55
10.4 Central Queensland habitat definition	56
10.5 Habitat identification guidance	56
10.6 References	57
11. Large-eared wattled bat (Chalinolobus dwyeri)	59
11.1 Legal status	
11.2 Ecology and distribution	59
11.2.1 Known distribution	59
11.2.2 Biology and reproduction	
11.3 General habitat requirements	61
11.4 Central Oueensland habitat definition	
11.5 Habitat identification guidance	62
11.6 References	63
12. Corben's (south-eastern) long-eared bat (Nyctophilus corbeni)	65
12.1 Legal status	65
12.2 Ecology and distribution	65
12.2.1 Known distribution	
12.2.2 Biology and reproduction	
12.3 General habitat requirements	67
12.4 Central Queensland habitat definition	67
12.5 Habitat identification guidance	68
12.6 References	69
13. Ghost bat (Macroderma gigas)	71
13.1 Legal status	71
13.2 Ecology and distribution	71
13.2.1 Known distribution	71
13.2.2 Biology and reproduction	
13.3 General habitat requirements	73
13.4 Central Queensland habitat definition	73
13.5 Habitat identification guidance	74
13.6 References	75
14. Grey-headed flying-fox (Pteropus poliocephalus)	77
14.1 Legal status	77

14.2 Ecology and distribution	77
14.2.1 Known distribution	77
14.2.2 Biology and reproduction	
14.3 General habitat requirements	79
14.4 Central Queensland habitat definition	79
14.5 Habitat identification guidance	80
14.6 References	81
Appendix A: outcomes of expert elicitation and review	82

List of Figures

Figure 3-1: Koala (Phascolarctos cinereus) (Steve Wilson 2020)	15
Figure 3-2: Distribution range of the koala (ALA 2020; DoE 2020)	16
Figure 4-1: Greater glider (Petauroides volans) (Steve Wilson 2019)	21
Figure 4-2: Distribution range of the greater glider (ALA 2020; DoE 2020)	22
Figure 5-1: Squatter pigeon (Geophaps scripta scripta) (Loren Appleby 2020)	27
Figure 5-2: Distribution range of the squatter pigeon (ALA 2020; DoE 2020)	28
Figure 6-1: Painted honeyeater (Grantiella picta) (Tomas Kelly 2019)	33
Figure 6-2: Distribution range of the painted honeyeater (ALA 2020; DoE 2020)	34
Figure 7-1: Australian painted snipe (Rostratula australis) (birdlife Australia 2020)	38
Figure 7-2: Distribution range of the Australian painted snipe (ALA 2020; DoE 2020)	39
Figure 8-1: Ornamental snake (Denisonia maculata) (MacDonald 2017)	43
Figure 8-2: Distribution range of the ornamental snake (ALA 2020; DoE 2020)	44
Figure 9-1: Yakka skink (<i>Egernia rugosa</i>) (Bookbook n.d.)	49
Figure 9-2: Distribution range of the yakka skink (ALA 2020; DoE 2020)	50
Figure 10-1: Collared delma (Delma torquata) (Steve Wilson 2019)	54
Figure 10-2: Distribution range of the collared delma (ALA 2020; DoE 2020)	55
Figure 11-1: Large-eared wattled bat (Chalinolobus dwyeri) (T. Reardon n.d)	59
Figure 11-2: Distribution range of the large-eared wattled bat (ALA 2020; DoE 2020)	60
Figure 12-1: Corben's long-eared bat (Nyctophilus corbeni) (T. Reardon n.d)	65
Figure 12-2: Distribution range of Corben's long-eared bat (ALA 2020; DoE 2020)	66
Figure 13-1: Ghost bat (<i>Macroderma gigas</i>) (Duncan Mackenzie 2014)	71
Figure 13-2: Distribution range of the ghost bat (ALA 2020; DoE 2020)	72
Figure 14-1: Grey-headed flying-fox (Pteropus poliocephalus) (NSW National Parks and Wildlife Serv	ice
2020)	77
Figure 14-2: Distribution range of the grey-headed flying-fox (ALA 2020; DoE 2020)	78

List of Tables

Table 1: Overview of lines of evidence used to develop habitat descriptions	10
Table 2: Professional ecologists involved in expert elicitation and review process	13
Table 3: Koala habitat identification	18
Table 4: Greater glider habitat identification	24
Table 5: Squatter pigeon habitat identification	30
Table 6: Painted honeyeater habitat identification	35
Table 7: Australian painted snipe habitat identification	41
Table 8: Ornamental snake habitat identification	46
Table 9: Yakka skink habitat identification	51
Table 10: Collared delma habitat identification	56
Table 11: Large-eared wattled bat habitat identification	62
Table 12: Corben's long-eared bat habitat identification	68
Table 13: Ghost bat habitat identification	74
Table 14: Grey-headed flying-fox habitat identification	80
Table 15: Expert reviewer's credentials	83
Table 16: Summary of expert reviews for Koala	87
Table 17 Summary of expert reviews for Greater Glider	93
Table 18 Summary of expert reviews for Squatter Pigeon	98
Table 19 Summary of expert reviews for Painted Honeyeater	107
Table 20 Summary of expert reviews for Australian Painted Snipe	114
Table 21 Summary of expert reviews for Ornamental Snake	118
Table 22 Summary of expert reviews for Yakka Skink	124
Table 23 Summary of expert reviews for Collared Delma	129
Table 24 Summary of expert reviews for Large-eared Wattled bat	132
Table 25 Summary of expert reviews for Corben's long-eared bat	136
Table 26 Summary of expert reviews for Ghost bat	140
Table 27 Expert reviews for Grey-headed Flying-fox	143

Abbreviations

Abbreviation	Description
ALA	Atlas of Living Australia
DAWE	Department of Agriculture, Water and the Environment
DERM	Department of Environment and Resource Management
DEWHA	Department of Environment, Water, Heritage and the Arts
DoE	Department of Environment
DoEE	Department of Environment and Energy
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
LZ	Land zone
NC Act	Nature Conservation Act 1992
TSSC	Threatened Species Scientific Committee

1. Introduction

BHP have a number of coal operations across Central Queensland within the Bowen Basin. In the course of undertaking works at these operations, BHP commonly encounters a number of fauna species that are protected as Matters of National Environmental Significance (MNES) under the *Environment Protection and Biodiversity Conservation Act 1999*. These species are common and indicative of environments within Central Queensland and include:

- koala (Phascolarctos cinereus)
- greater glider (*Petauroides volans*)
- squatter pigeon (Geophaps scripta scripta)
- painted honeyeater (Grantiella picta)
- Australian painted snipe (Rostratula australis)
- ornamental snake (Denisonia maculata)
- yakka skink (Egernia rugosa)
- collared delma (Delma torquata)
- large-eared wattled bat (Chalinolobus dwyeri)
- south-eastern/Corben's long-eared bat (Nyctophilius corbeni)
- ghost bat (Macroderma gigas)
- grey-headed flying fox (*Pteropus poliocephalus*)

Ecological investigations and environmental impact assessments necessary to facilitate coal operations generally involve survey for and description of these species and their associated habitats.

A wide range of literature is available on the majority of the species, including description provided in conservation guidelines and the Species Profile and Threats Database (SPRAT). However as none of these are unique to Central Queensland, the description of habitats does not necessarily capture the ecological factors and habitat variances in Central Queensland environments that allow these species to persist there.

BHP has worked with a number of professional ecologists to undertake a review of the information available for these species and refine these descriptions in a way that is tailored to the specific ecology of the central Queensland region. For the purposes of this assessment central Queensland is broadly defined to include the Briglow Belt north and south bioregions, within the state of Queensland. The majority of observational and site-specific data has been sourced from areas within the Bowen Basin region (Figure 1).

The specific aims of this work are to:

- Develop agreed detailed habitat descriptions for a suite of EPBC Act-listed species in central Queensland
- Use the best available regional information to update & refine SPRAT definitions

- Provide a suite of habitat definitions that can be used consistently to support ecological investigations and environmental impact assessments, thereby ensuring assessment material is standardised, consistent and scientifically robust
- Ensure habitat definitions are well supported by scientific evidence, or where this is not available, consensus opinion from species experts, thereby removing individual interpretation, opinion and inconsistency.

The following sections of this report outline the methodology undertaken to collated and refine the descriptions and profiles for each of the species assessed. The refined habitat definitions provided below include a detailed description of each species' habitat that accounts for the niche requirements of species based on the actual climatic, vegetation, hydrological and topographical features of central Queensland. The descriptions are focuses at two levels:

- Factors that influence species' utilisation and life cycle behaviours within and across the range of habitats in which a species may be encountered e.g. breeding, roosting/resting, foraging and dispersal; and
- Determining which factors are crucial for a species' to persist in an area compared to those that are less key in facilitating a species' presence at that particular site.

2. Methodology

2.1 Desktop assessment and literature review

A desktop assessment and literature review of a variety of information sources / lines of evidence was undertaken to identify species habitat requirements and attributes. The best available data was utilised, with a priority placed on scientific publications. The range of different information sources reviewed are detailed in Table X below and included:

- Commonwealth and State government policy guidance
- Published literature
- BHP terrestrial ecology reports
- BHP terrestrial ecology geodatabase
- Publicly available ecology survey results from other Bowen Basin projects

The nature of ecological research is such that there are gaps in knowledge for some species, especially in a central Queensland specific setting. To provide a rigorous approach to addressing these gaps, a number of assessment techniques were used including:

- Review of 'grey literature' including unpublished research studies, monitoring studies and environmental impact statements
- High level spatial analysis of BHP's ecology geodatabase and State published vegetation and habitat layers
- Expert elicitation with a number of ecologists who have significant experience with these species in Central Queensland.

Line of evidence	Relevance to habitat definitions	Examples	Limitations of dataset
Commonwealth and State government policy guidance	Provides guidance on broad habitat requirement across species geographic range Framework that regulators use in assessments	SPRAT Conservation advice, recovery plans, referral guidelines Recent advice from QLD North Assessment Team	Data may not be specific or relevant to central QLD context Data are sometimes quite dated Some information is incomplete or inconsistent
Published literature	Provides peer reviewed scientific evidence	Ellis et al. (2002) Tree use, diet and home range of the koala (<i>Phascolarctos cinereus</i>) at Blair Athol, central Queensland. Wildlife Research 29, 303-311.	May be very site specific Limited number of publications for some species and central QLD in general
BHP terrestrial ecology reports	Habitat definitions will be provided in ecology reports Specific to central QLD context	Reports from numerous project assessments, usually provided to support impact assessments	Regulators have not accepted some of these definition in previous assessments

Table 1: Overview of lines of evidence used to develop habitat descriptions

Central Queensland Threatened Species Habitat Descriptions

Line of evidence	Relevance to habitat definitions	Examples	Limitations of dataset
	Using both impact and offset site data can provide a range of habitat condition settings		Inconsistencies in definitions between report authors
Publicly available ecology survey results from other Bowen Basin projects	Provides central QLD specific data supplementary to that held by BHP	Olive Downs Project Isaac Downs Project Fairhill Coal Project Meadowbrook Project	Regulators may have required updates to definitions during EIA process
BHP terrestrial ecology geodatabase and ALA records	Spatial analysis to inform mapped habitat areas and also analysis of location of species records	NA	Statistical analysis may not be possible depending on size of datasets, but trends should be evident
Expert elicitation from other senior consulting ecologists	Environmental scientists most frequently working in the Bowen Basin to provide expert review of draft habitat definitions	See Section 2.3 for participants	Risk that consensus cannot be reached Experts may not hold enough data to provide confident inputs
	as a robust method of filling data gaps, especially where consensus can be reached		

The review of information sources was used to identify and record habitat requirements and attributes for each species. These requirements and attributes included:

- Vegetation composition, structure, Regional Ecosystems (REs)
- Food resources
- Land forms/land zones
- Soils
- Water/hydrology needs
- Patch size
- Connectivity
- Shelter including denning or roosting resources
- Micro habitat features (fallen woody debris, leaf litter, rocky outcrops)
- Breeding resources
- Habitat condition requirements

Across all data sources, uncertainties, inconsistencies and gaps were also be noted as appropriate.

2.1.1 Spatial analysis

A high-level spatial analysis was undertaken to support the development of habitat definitions. This included:

• Reviewing species records within areas of ground-truthed species habitat to gain additional understanding as to the habitat features that are present.

- Undertaking correlative assessment to inform which land zones or vegetation community types appear to be most commonly recorded as providing habitat for threatened species.
- Determining REs that may provide habitat within the central Queensland region. In this instance, REs considered in the habitat identification guides are those within the Brigalow Belt Bioregion (north and south) that intersect the Bowen Basin.

It is important to note that these spatial data were not relied upon heavily in determining the overall habitat definitions for species, as there is inherent uncertainty in the quality and accuracy of the data, as well as potential bias in survey effort. Rather the data contributed to the overall understanding of habitat requirements for each species.

2.2 Development of draft definitions

Information gathered via the above methods was collated into a master information spreadsheet for each species, with information recorded against each of the key attributes listed above (where available). This allowed an initial assessment of common themes for species-specific requirements across data resources, highlighted any inconsistencies and identify and prioritise information relevant to central Queensland. The information was used as a holistic based of evidence upon which to build the species habitat definitions.

Using the collated information and expert opinion, ecologists experienced in undertaking assessments in central Queensland prepared draft habitat definitions for each species. These were developed according to a suite of habitat categories, as described below.

2.3 Habitat categories

Three habitat categories were used to provide a consistent framework for identifying, describing and defining species' habitats within inland areas of Central Queensland – preferred, suitable and marginal habitat. These categories have been applied to each species, noting that not all species have habitat diverse enough the warrant a split across all three categories.

Preferred habitats are those that are most important to the species and contain the features that are crucial for the species' persistence in an area. It includes habitats in which key activities are undertaken e.g. breeding, roosting and/or where high quality/species limiting foraging resources are found. If the species is present in a region, individuals will usually be found in preferred habitat.

Suitable habitat provides resources for the species but is not crucial for its persistence in an area. Individuals may be found in suitable habitat but are not likely to be undertaking key activities such as breeding or roosting. Foraging resources may be lower quality or used opportunistically (rather than being depended upon). If the species is present in a region, individuals may be found in suitable habitat but this habitat type may also remain unoccupied.

Marginal habitat provides limited resources for the species and is not crucial for its persistence in an area. Individuals may be occasionally found in marginal habitat but will not be undertaking key activities such as breeding, roosting or extensive foraging. If the species present in a region, individuals would be found in marginal habitat only rarely and this habitat type is likely to be unoccupied most of the time.

Preferred habitat is defined for all species. For some species, only suitable or marginal habitat is defined (i.e. only two habitat categories preferred and suitable or preferred and marginal). For species with definitions preferred and suitable habitat, those areas categorised as suitable comprise a range of resources and may vary in quality and usage across a region. Areas that do not meet the definition of preferred or suitable would not be used by the species and therefore 'marginal habitat' is not considered to be a relevant habitat category. For species with definitions preferred and marginal habitat, those areas categorised as preferred comprise the majority of habitat for the species and are crucial for persistence. There may be areas that are used on rare occasions but only contain limited resources and these are considered marginal. There are unlikely to be areas that are provide suitable habitat resources that are not considered crucial and therefore 'suitable habitat' is not considered to be a relevant habitat category.

2.4 Expert elicitation and review

To provide scientific rigour and a level of robustness to the habitat descriptions, draft species-specific definitions were reviewed and refined in collaboration with key personnel with significant experience in collecting data, analysing and reporting on these species (see Table 2).

Emphasis was placed on senior/principal consulting ecologists who regularly work within central Queensland, as they possess detailed working knowledge of these species. The process for expert elicitation included providing species profiles to experts for review and seeking their input across the following questions:

- What information in the draft definition (preferred/suitable/marginal) do you support and why?
- What information in the draft definition (preferred/suitable/marginal) do you not support and why?
- Do you have additional suggestion to improve the draft definition?
- For species where only two habitats types are defined (e.g. preferred and suitable or marginal), do you think the third habitat type should be included? If not, why? If so, why and please provide a suggested definition.
- Are there other resources, particularly published literature or outcomes of research, relevant to this species in central Queensland that are not referenced in the current work?

Given the importance of this step, the full results of the reviews along with details of each reviewer's credentials has been provided in Appendix A.

Name	Current position	Years' experience in central QLD	Species definitions reviewed
Steve Wilson	Fauna Consultant; Information Officer at the Queensland Museum	35 years	Ornamental snake, Collared delma, Yakka Skink
Dr Penn Lloyd	Principal Ecologist, Biodiversity Assessment & Management Pty Ltd (BAAM)	27 years	Squatter pigeon, Ornamental snake, Australasian painted snipe
Lindsay Agnew	Principal Biologist and Director, Austecology	Over 24 years of field experience within central Queensland	Koala, Greater glider, Squatter pigeon, Ornamental snake, Australasian painted snipe

Table 2: Professional ecologists involved in expert elicitation and review process

Central Queensland Threatened Species Habitat Descriptions

Name	Current position	Years' experience in central QLD	Species definitions reviewed
Craig Eddie	Principal Ecologist, BOOBOOK Ecological Consulting	25+ years	Koala, Greater glider, Squatter pigeon, Ornamental snake, Yakka skink, Australian painted snipe, Painted honeyeater, Collared delma, Large- eared Wattled bat, Corben's (south- eastern) long-eared bat
Greg Ford	Principal Ecologist, Balance! Environmental	20+ years	Large-eared Wattled bat, Corben's (south-eastern) long-eared bat, Ghost bat, Grey-headed Flying-fox
Brad Dreis	Principal Ecologist, E2M	18 years	Koala, Greater glider, Squatter pigeon Ornamental snake, Australasian painted snipe, Painted honeyeater
Liz Fisher	Principal Ecologist / Ecology Team Lead, AECOM	12 years	Koala, Greater glider, Squatter pigeon, Ornamental snake, Yakka skink, Painted honeyeater
Berlinda Ezzy & Andrew Jensen	Associate Ecologist, EMM Consulting	10+ years	Painted honeyeater, Grey-headed Flying-fox
Loren Appleby	Senior Ecologist, Eco Logical Australia	7 years	All species

2.5 Definition refinement and finalisation

Following the results of expert elicitation and review from professional ecologists, the habitat definitions were refined where necessary and based on the consensus view of relevant reviewers. These are the definitions presented in the species profile sections below¹.

¹ Initial draft definitions that were reviewed by species experts listed in Table 2 are provided in Appendix A, as part of the expert elicitation and review results.

3. Koala (Phascolarctos cinereus)

3.1 Legal status

Environment Protection and Biodiversity Conservation Act 1999: Vulnerable (as the combined populations of Queensland, New South Wales and the Australian Capital Territory)

Nature Conservation Act 1992: Vulnerable

3.2 Ecology and distribution

The koala (*Phascolarctos cinereus*) is an arboreal marsupial, with a stocky body, large rounded ears, sharp claws and variable but predominantly grey-coloured fur (see Figure 3-1). In the north of their distribution, koalas tend to have shorter, silver-grey fur, whereas those in the south have longer, thicker, brown-grey fur.²

Koalas display sexual dimorphism (males generally are larger than females), with male koalas weighing approximately 6.5 kg.³ There is a gradient in body weight, with larger individuals in the southern states and smaller individuals in the north of their range within northern Queensland.



Figure 3-1: Koala (Phascolarctos cinereus) (Steve Wilson 2020)

3.2.1 Known distribution

The koala is distributed along the east coast of Australia extending from Queensland to NSW (see Figure 3-2). In Queensland, the koala's distribution extends across several bioregions, encompassing a great diversity of habitats with the greatest concentration in southeast Queensland.

² Martin & Handasyde 1999

³ DoE 2020

In Queensland, koalas have been recorded in many biogeographic regions including the Einasleigh Uplands, Wet Tropics, Desert Uplands, Central Mackay Coast, Mitchell Grass Downs, Mulga Lands, Brigalow Belt, South Eastern Queensland and Channel Country.³ They generally occupy wet forests along the coast, sub-humid woodlands in southern and central regions, and eucalypt woodlands along watercourses in semi-arid environments of western regions.⁴



Figure 3-2: Distribution range of the koala (ALA 2020; DoE 2020)

3.2.2 Biology and reproduction

The koala is a leaf-eating specialist feeding primarily during dawn, dusk or during the night. Its diet is restricted mainly to foliage of *Eucalyptus* spp.; however, it may also consume foliage of related genera, including *Corymbia* spp., *Angophora* spp. and *Lophostemon* spp. The koala may, at times, supplement its diet with other species, including *Leptospermum* spp. and *Melaleuca* spp.^{5,6,2}

Female koalas can potentially produce one offspring each year with births occurring between October and May. Offspring stay in the pouch for 6 to 8 months and remain dependent on the mother, riding on its back, until 12 months of age. The generation length of koalas is estimated to be between 6 to 8 years.³ Adult females may live for more than 15 years and adult males for more than 12 years.²

3.3 General habitat requirements

Across their entire geographic range, koalas inhabit a range of temperate, sub-tropical and tropical forest, woodland and semi-arid communities dominated by species from the genus *Eucalyptus*.² The distribution of koalas is also affected by altitude (limited to <800 m ASL), temperature, leaf moisture in the drier areas of their range and proximity to watercourses (DAWE 2020; Melzer et al. 2000).^{3,4}

⁴ Melzer et al. 2014

⁵ Crowther et al. 2013

⁶ Moore and Foley 2000

Koala habitat consists of woodland and open forests that contain suitable food trees – these are predominantly Eucalypt species.³ Koala habitat for the inland populations (< 800 mm of rainfall) is typically comprised of the following⁷:

- Woodlands/forests with koala food trees that have reliable access to soil moisture.
- Remnant or regrowth Box/Red Gum woodlands formed on heavier soils, particularly on riparian areas.
- Fragmented and sparsely distributed woodlands, shrublands and forests in modified agricultural-grazing landscapes or in the vicinity of rural towns although, there are some larger patches of habitat as well.

3.4 Central Queensland habitat definition

Preferred koala habitat in Central Queensland is defined as:

- Contiguous remnant eucalyptus open forest to woodlands near a permanent or ephemeral water source⁸, and
- Where primary or secondary food trees⁹ are *dominant* in the canopy. Primary food trees across the entire Central Queensland region include *Eucalyptus camaldulensis* and *E. tereticornis.*

Suitable koala habitat that provides food resources or aids to movement for the species in Central Queensland is defined as:

• Remnant and regrowth eucalyptus open forest to woodlands where primary or secondary food trees are *present* (but not necessarily dominant) in the canopy and that have connectivity to other areas of suitable or preferred habitat.

Marginal koala habitat in Central Queensland is defined as:

• All other fragmented and sparsely distributed woodlands and open woodlands, shrub lands and forests in modified agricultural-grazing landscapes that may provide food resources or aids to movement.

3.5 Habitat identification guidance

Table 3 provides specific information about key attributes of koala habitat requirements, and where these data can be obtained. Collectively these data enable koala habitat to be classified as preferred, suitable or marginal as described above.

⁷ TSSC 2012

⁸ Permanent and ephemeral water may originate from a variety of sources e.g. groundwater aquifers, nearby wetlands/watercourses, rainfall seepage/runoff. In central Queensland, it is known that riparian vegetation is highly utilised.

⁹ Primary food and secondary food trees vary on the location within Central Queensland. Refer to <u>https://www.savethekoala.com/sites/savethekoala.com/files/uploads/20150212</u> AKF National Koala Tree Planting List.pd <u>f</u> for guidance

Table 3: Koala habitat identification

Attribute	Description	Verification area
Vegetation composition	High abundance eucalypt trees present in vegetation patch (food resource abundance); community may not be diverse	Desktop and field
Vegetation structure	Open forests, woodlands, open woodlands" including remnant and regrowth	Field
Regional ecosystem associations that may comprise preferred, suitable and/or marginal habitat	Preferred: 11.3.2, 11.3.2a, 11.3.2b, 11.3.4, 11.3.4a, 11.3.25, 11.3.27 Suitable: 11.3.3, 11.3.6, 11.3.7, 11.3.9, 11.3.10, 11.3.14, 11.3.15, 11.3.17, 11.3.18, 11.3.26, 11.3.28, 11.3.29, 11.3.30, 11.3.35, 11.3.36, 11.3.37, 11.3.39, 11.4.2, 11.4.7, 11.4.10, 11.4.12, 11.4.13, 11.5.1, 11.5.1a, 11.5.2, 11.5.3, 11.5.3b, 11.5.5, 11.5.5a, 11.5.5c, 11.5.7, 11.5.8, 11.5.9, 11.5.9b, 11.5.9c, 11.5.9d, 11.5.12, 11.5.13, 11.5.17, 11.5.20, 11.7.1, 11.7.4, 11.7.6, 11.7.7, 11.8.1, 11.8.2, 11.8.4, 11.8.5, 11.8.5a, 11.9.1, 11.9.2, 11.9.7, 11.9.7a, 11.9.9, 11.9.10, 11.9.13, 11.10.1, 11.10.1a, 11.10.1d, 11.10.2, 11.10.2a, 11.10.4, 11.10.5, 11.10.7, 11.10.7a, 11.10.11, 11.10.1a, 11.10.1a, 11.10.1a, 11.10.1a, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.10, 11.11.20, 11.11.20, 11.12.2, 11.12.3, 11.12.5, 11.12.6, 11.12.7, 11.23, 11.12.5, 11.12.6, 11.10.2, 11.10.2, 11.11.2, 11.11.20, 11.10.2, 11.10.2, 11.10.2, 11.10.2, 11.10.2, 11.10.2, 11.10.2, 11.10.2, 11.10.2, 11.10.2, 11.10.2, 11.10.2, 11.10.2, 11.10.2, 11.10.2, 11.10.2,	Desktop and field
Food resources	Known food trees in CQ include (but are not limited to): <i>E. camaldulensis</i> , <i>E. tereticornis</i> , <i>E. populnea</i> , <i>E. orgadophila</i> , <i>E. melanophloia</i> , <i>E. crebra</i> , <i>E. moluccana</i> , <i>E. woolsiana</i> , <i>E. microcarpa</i> , <i>E. coolabah</i> , <i>E. brownii</i> , <i>E. cambageana</i> , <i>E. thozetiana</i> , <i>E. exserta</i> , <i>E. chloroclada</i> , <i>E. major</i> , <i>E. grisea</i> , <i>E. longirostrata</i> , <i>E. melliodora</i> , <i>Corymbia citriodora</i> , <i>C. tessellaris</i> .	Field
Landforms/land zones	Found across multiple landforms and land zones ¹⁰ .	Desktop
Soils	Prefers trees with access to soils with higher fertility and moisture holding capacity e.g. heavier clay soils ^{11,12}	Desktop
Water (for drinking)	Distribution associated with water availability; activity based around steam fringing communities in drier areas.	Desktop and field

¹⁰ Melzer et al. 2014

¹¹ TSSC 2012

¹³ Melzer et al. 2014

¹² Commonwealth of Australia 2014.

Central Queensland Threatened Species Habitat Descriptions

Attribute	Description	Verification area
Hydrological needs	Relationship between leaf water concentration and occurrence of koala ¹⁴ . Densities found along creek lines where food trees have reliable access to soil moisture. ¹⁵	Desktop and field
Patch size	Preferred habitat patches should be larger than 50-100 ha in size unless they are part of a cluster of highly connected patches. ¹⁶	Desktop
Connectivity	Clusters of patches should be separated by less than 100-200 m.	Desktop
Shelter/denning/roosting	Shelter trees are likely to be selected based on height, canopy cover and elevation. There is no identified sub-set of forest and woodland trees known to be shelter trees. ¹⁷	Field
Micro habitat features	N/A	N/A
Breeding resources	It is not possible to separate foraging and breeding habitat requirements with current available information and they are likely to share the same characteristics.	Field
Habitat condition	Assessment of habitat quality for koalas is usually based on the identification of local preferences for food tree species and quantification of the availability of those species. This includes an assessment of canopy connectivity.	Field

3.6 References

Adams-Hosking, C., McAlpine, C., Rhodes, J. R., Grantham, H. S., & Moss, P. T. 2012. Modelling changes in the distribution of the critical food resources of a specialist folivore in response to climate change. Diversity and Distributions, 18(9), 847–860

ALA 2020. *Phascolarctos cinereus: Koala* in Atlas of Living Australia. Available from: <u>https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:e9d6fbbd-1505-4073-990a-dc66c930dad6</u>

Commonwealth of Australia 2014. EPBC Act Referral Guidelines for the vulnerable koala (combined populations of Queensland, New South Wales and the Australian Capital Territory.

Crowther, M., D. Lunney, J. Lemon, E. Stalenberg, R. Wheeler, G. Madani, K. Ross & M. Ellis 2013. *Climate-mediated habitat selection in an arboreal folivore*. Ecography. 36:001-008.

¹⁴ Adams-Hosking et al. 2012

¹⁵ Melzer et al. 2014

¹⁶ McAlpine et al. 2007

¹⁷ Crowther et al. 2013

Department of the Environment (DoE) 2020. *Phascolarctos cinereus (combined populations of Qld, NSW and the ACT)* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

Martin, R.W., Handasyde, K.A. and Krockenberger, A. 2008. Koala. In: Van Dyck, S. and Strahan, R. (eds) The Mammals of Australia. Third Edition. Reed New Holland, Sydney. Pp. 198-201.

McAlpine, C.A., Rhodes, J. R, Peterson, A., Possingham, H., Callaghan, J and Lunney, D. 2007. *Planning Guidelines for Koala conservation and Recovery: A guide to best planning practice.* University of Queensland, Brisbane

Melzer, A, Cristescu, R, Ellis, W, Fitzgibbon, S and Manno, G. 2014. *The habitat and diet of Koalas (Phascolarctos cinereus) in Queensland*. Australian Mammalogy 36(2): 189-199.

Moore, B.D. & Foley, W.J. 2000. *A review of feeding and diet selection in koalas* (Phascolarctos cinereus). Australian Journal of Zoology. 48:317-333.

Phillips, S.S. 2000. *Population trends and the koala conservation debate*. Conservation Biology. 14:650-659.

Threatened Species Scientific Committee (TSSC) 2012. Listing advice for Phascolarctos cinereus (Koala).

4. Greater glider (Petauroides volans)

4.1 Legal status

Environment Protection and Biodiversity Conservation Act 1999: Vulnerable

Nature Conservation Act 1992: Vulnerable

4.2 Ecology and distribution

The greater glider has a head and body length of 35 - 46 cm and a tail ranging from 45 - 60 cm in length, making it the largest gliding possum in Australia. The greater glider has a short snout and large fury ears. Their fur is thick, being white or cream below and dusky brown or dark grey to mottled grey and cream above (see Figure 4-1).¹⁸



Figure 4-1: Greater glider (Petauroides volans) (Steve Wilson 2019)

4.2.1 Known distribution

The greater glider has a restricted distribution within eastern Australia from the Windsor Tableland in north Queensland to central Victoria (Wombat State Forest) (see Figure 4-2). Two isolated populations also occur within Gregory Range west of Townsville and in the Einasleigh Uplands. Their distribution covers an elevational range from sea level to 1200 m above sea level.¹⁸

Although the extent of the species occurrence has unlikely changed significantly since European settlement, their area of occupancy has decreased considerably; predominantly as a result of land clearing. They are largely restricted to eucalypt forests and woodlands where their distribution is often patchy.¹⁸

¹⁸ TSSC 2016



Figure 4-2: Distribution range of the greater glider (ALA 2020; DoE 2020)

4.2.2 Biology and reproduction

The greater glider is primarily a folivore, consuming eucalypt leaves and occasionally flowers.¹⁸ The species typically selects younger leaves within larger trees for feeding, favouring species that have higher levels of nutrients.^{19,20} Key eucalypt species that are used across the species' geographic range from Victoria to Queensland include: *Eucalyptus radiata, E. viminalis, E. acmenoides, E. fastigata, E. globoidea, E. moluccana, E. regnans,* and *E. tereticornis*. The greater glider has also been observed consuming non-eucalypt species on rare occasions including *Acacia* and *Amyemai* species.²¹

Females reach sexual maturity at age 2 and give birth to a single young between March and June. The generation length of the greater glider is estimated to be between 7 to 8 years and longevity is around 15 years.¹⁸

4.3 General habitat requirements

Greater gliders inhabit eucalypt forests and woodlands; typically, moist, montane eucalypt forests that contain taller, older trees with abundant hollows.¹⁸ Their habitat consists of a range of eucalypt species with these varying throughout their range.

In a study conducted in a large tract of forest in the dry inland of southern Queensland the species was commonly foraging on *Eucalyptus moluccana, E. fibrosa* and *Corymbia citriodora,* preferring trees in 30-70 cm dbh classes and as mature and over mature according to growth-stage charateristics.^{19,20}

¹⁹ Smith et al. 2007

²⁰ Smith & Smith 2018

²¹ Harris & Maloney 2010

Occupancy modelling has indicated that the degree of site occupancy is associated with vegetation lushness and terrain wetness.²² This is likely due to their water intake being primarily sourced from the foliage that they consume and explains their preference for moist forests.²⁰

Greater gliders shelter within tree hollows during the day and due to their size, larger tree hollows are required (80 mm, with internal hollow measurements reaching 250 x 250 mm).²³ In one southern Queensland study, large (dbh >50 cm) were primarily used as den trees ¹⁹. In Queensland, the species prefers to den within living or dead *Corymbia citriodora, Eucalyptus moluccana, E. fibrosa Eucalyptus tereticornis* ¹⁹. It has been observed that in southern Queensland, greater gliders require at least 2–4 live den trees for every 2 ha of suitable forest habitat or 4-20 den trees in areas of lower productivity ¹⁹. The requirement for tree hollows limits the distance the species can travel and as a result, greater gliders have small home ranges; typically, between 1-4 ha, but can be larger (up to 16 ha) in lower productivity forest and open woodland (Smith et al. 2007; TSSC 2016).^{18,19}

The species is sensitive to fragmentation and does not disperse easily across non-native vegetation.¹⁸ To maintain viable populations, they appear to require large areas of continuous habitat (estimated in one study to be at least 160 km² in Queensland).²³

4.4 Central Queensland habitat definition

Preferred greater glider habitat in Central Queensland is defined as:

- Remnant, connected eucalypt woodlands containing more than 2 hollow bearing trees/ha, with hollows medium-large in size (>10 cm entrance).
- In Central Queensland, preferred foraging and den trees include *E. camaldulensis, E. tereticornis, E. fibrosa* and *Corymbia citriodora*. The species has also been observed in *Angophora floribunda, Eucalyptus cambageana, E. coolabah, E. crebra, E. laevopinea, E. moluccana, E. orgadophila, E. populnea, E. melanophloia* and *C. tessellaris* in which it may use for foraging and/or denning.

Suitable greater glider habitat in Central Queensland is defined as:

• Remnant eucalypt woodlands connected to areas of roosting habitat that does not contain more than 2 hollow bearing trees/ha, medium-large in size (>10 cm entrance). Home range of the species estimated at 120 m of breeding / denning habitat

Marginal greater glider habitat in Central Queensland is defined as:

²² Lumsden et al. 2013

²³ Eyre 2006

 Remnant or high value regrowth vegetation²⁴ adjacent to preferred greater glider habitat where hollows are smaller and/or less frequent. Isolated patches of marginal habitat >100 m from adjacent habitat do not provide habitat for the species due to gliding capabilities.

4.5 Habitat identification guidance

Table 4 provides specific information about key attributes of greater glider habitat requirements, and where these data can be obtained. Collectively these data enable greater glider habitat to be classified as preferred or marginal as described above.

Attribute	Description	Verification area
Vegetation composition	Forests and woodlands dominated by Eucalyptus species.	Desktop and field
Vegetation structure	Eucalypt forests and woodlands, highly associated with tall (min 16 m), old-growth hollow-bearing trees. ²⁵ In drier climates, a home ranges are larger and hollows for dens are required throughout this area.	Field
Regional ecosystem associations that may comprise preferred or marginal habitat	Eucalypt and/or <i>Corymbia citriodora</i> dominant forest and woodland REs that have potential to form hollows of sufficient size and abundance, including the following REs: 11.3.2, 11.3.2b, 11.3.3, 11.3.4, 11.3.6, 11.3.9, 11.3.10, 11.3.14, 11.3.15, 11.3.17, 11.3.18, 11.3.25, 11.3.26, 11.3.29, 11.3.30, 11.3.35, 11.3.36, 11.3.37, 11.3.39, 11.4.2, 11.4.7, 11.4.10, 11.4.12, 11.4.13, 11.5.1, 11.5.1a, 11.5.2, 11.5.3, 11.5.3b, 11.5.4, 11.5.4a, 11.5.5, 11.5.5a, 11.5.5c, 11.5.7, 11.5.9, 11.5.9b, 11.5.9c, 11.5.9d, 11.5.13, 11.5.17, 11.5.20, 11.7.6, 11.7.7, 11.8.1, 11.8.2, 11.9.1, 11.9.2, 11.9.7, 11.9.7a, 11.9.9, 11.9.10, 11.9.13, 11.10.1, 11.10.1d, 11.10.2, 11.10.2a, 11.10.7, 11.10.1a, 11.11.1, 11.11.3, 11.11.3c, 11.11.10, 11.11.10a, 11.11.5, 11.11.15a, 11.11.6, 11.11.9, 11.12.1, 11.12.1a, 11.12.2, 11.12.3, 11.12.6 and 11.12.7 With the following likely to be considered preferred in CQ: REs 11.3.4, 11.3.4, 11.3.25, 11.8.1, 11.8.2, 11.10.1, 11.10.2, 11.10.5, 11.11.1 & 11.13.	Desktop and field
Food resources	Primarily eucalypt leaves and occasionally flowers. Selects younger leaves within larger trees, with key species including <i>E. moluccana</i> , <i>E. acmenoides E. tereticornis. E. fibrosa</i> and <i>C. citriodora</i> ²⁶ and <i>Angophora floribunda</i> , <i>Eucalyptus coolabah</i> , <i>E. laevopinea</i> , and <i>E. crebra</i> (C. Eddie pers comm.)	Field

Table 1.	Graatar	alidor	hahitat	identification
	Uleater	giluci	παριται	uchuncation

²⁵ TSSC 2016

²⁶ Smith et al. 2007

²⁴ For high value regrowth to be considered marginal habitat, it needs to include scattered large Eucalypt trees as Smith et al. (2007) did not observe any gliders foraging in non-myrtaceous species or myrtaceous trees <20 cm dbh

Attribute	Description	Verification area
Landforms/land zones	N/A	N/A
Soils	Low soil moisture impacts food quality (species water intake reliant on that contained in foliage). ²⁷ High soil moisture includes heavier clays.	Desktop
Water (for drinking)	Species water intake reliant on that contained in foliage.	Desktop
Hydrological needs	Landscape position where trees have access to groundwater or surface water. Degree of site occupancy can be associated with vegetation lushness and terrain wetness. ²⁸	Desktop and field
Patch size	Require tracts of contiguous habitat with surveys in south- east Queensland identifying 160 km ² as the smallest forested patch the species has been observed in. ²⁹ Within Central Queensland, the species has been recorded in smaller patches.	Desktop
Connectivity	Can glide approximately 100 m and disperse poorly across vegetation that is non-native or low vegetation. ³⁰	Desktop
Shelter/denning/roosting	Require at least 2–4 live den trees for every 2 ha of suitable forest habitat ³¹ or utilises 4-20 live den trees across their home range in dry inland environments. Large (dbh >50 cm) and old living trees primarily used as den trees. ³²	Field
Micro habitat features	Hollow entrance of a minimum of 80 mm, with internal hollow measurements reaching 250 x 250 mm. ³³	Field
Breeding resources	Associated with shelter resources and micro habitat features.	Field
Habitat condition	N/A	N/A

4.6 References

ALA 2020. *Petauroides Volans: Greater glider* in Atlas of Living Australia. Available from: <u>https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:7e891f26-c72e-4b29-98db-1cd10c4eaa6d</u>

- ²⁹ Eyre 2006
- ³⁰ Smith et al. 2007
- ³¹ Eyre 2002

³² Smith et al. 2007

³³ Smith et al. 2007

²⁷ Smith & Smith 2018

²⁸ Lumsden et al. 2013

Department of the Environment 2020. *Petauroides volans* in Species Profile and Threats Database, Department of the Environment, Canberra.

Eyre, T. J. 2002. *Habitat preferences and management of large gliding possums in southern Queensland*. Ph.D. thesis, Southern Cross University, Lismore.

Eyre, T. J. 2006. *Regional habitat selection of large gliding possums at forest stand and landscape scales in southern Queensland, Australia I. Greater Glider (Petauroides volans)*. Forest Ecology and Management 235(1):270-282

Harris, J. M., & Maloney, K. S. 2010. *Petauroides volans (Diprotodontia: Pseudocheiridae)*. Mammalian Species, 42(1), 207–219.

Lumsden, L.F., Nelson, J.L., Todd, C.R., Scroggie, M.P., McNabb, E.G., Raadik, T.A., Smith, S.J., Acevedo, S., Cheers, G., Jemison, M.L. & Nicol, M.D. 2013. *A New Strategic Approach to Biodiversity Management* – *Research Component*. Arthur Rylah Institute for Environmental Research. Unpublished Client Report for the Department of Environment and Primary Industries, Heidelberg, Victoria.

Threatened Species Scientific Committee (TSSC) 2016. *Conservation Advice Petauroides volans greater glider*. Canberra: Department of the Environment.

Smith, G.C, Mathieson, M., and Hogan, L. 2007. *Home range and habitat use of a low-density population of greater gliders, Petauroides volans (Pseudocheiridae: Marsupialia), in a hollow-limiting environment*. Wildlife Research, 2007, 34, 472–483

Smith, P., & Smith, J. (2018). *Decline of the greater glider* (Petauroides volans) *in the lower Blue Mountains, New South Wales*. Australian Journal of Zoology, 66(2), 103–114.

5. Squatter pigeon (southern; Geophaps scripta scripta)

5.1 Legal status

Environment Protection and Biodiversity Conservation Act 1999: Vulnerable

Nature Conservation Act 1992: Vulnerable

5.2 Ecology and distribution

The squatter pigeon (southern) (*Geophaps scripta scripta*) is a medium-sized ground-dwelling bird that is approximately 30 cm in length and weighs 190 - 250 g. It is predominantly grey-brown grading to blue-grey on the lower breast and belly; with bold black and white stripes around the face and throat. It has a black bill and faded purple legs and feet (see Figure 5-1). Juveniles have duller colouring and less distinctive black and white facial stripes. The southern species is slightly larger than the northern species and has blue-grey skin around the eyes instead of yellowy-orange to orange-red skin.³⁴



Figure 5-1: Squatter pigeon (Geophaps scripta scripta) (Loren Appleby 2020)

5.2.1 Known distribution

The squatter pigeon is distributed along the inland slopes of the Great Dividing Range; extending from the Burdekin-Lynd Divide in central Queensland to the south in New South Wales (north of 29° S) (see Figure 5-2). This distribution has reduced significantly since the 1870's, with the species historically being abundant and widespread within NSW. The squatter pigeon is now rarely sighted in NSW.^{34,35}

Large areas of squatter pigeon's original habitat in Queensland has been replaced by improved pasture for cattle-grazing; reducing the abundance of food and native plants. Within their current range, they

³⁴ Higgins & Davies 1996

³⁵ Cooper et al. 2014

occupy open-forests, open-woodlands and scrub including sparse regrowth and partly modified vegetation.³⁶



Figure 5-2: Distribution range of the squatter pigeon (ALA 2020; DoE 2020)

5.2.2 Biology and reproduction

The squatter pigeon primarily forages on seeds which have fallen to the ground from nearby vegetation including grasses, herbs and shrubs. It is also observed foraging around stockyards consuming seeds and ticks from livestock droppings. The species requires access to waterbodies for drinking and these can be natural or artificial as long as there is bare ground at the water's edge. The squatter pigeon will access suitable waterbodies on a daily basis. Squatter pigeons can be found in pairs or in groups that can contain greater than 20 individuals.^{36, 37}

The life cycle of the squatter pigeon is poorly understood but they have been observed breeding from one year of age. The generation length is estimated to be 5 years and breeding typically coincides with optimal conditions (food availability), although can occur throughout the year. In Queensland, peak breeding season most likely occurs during the dry season (April to October) when seeds on the ground are abundant. They breed in solitary pairs and can produce two broods of young per season.³⁷

Squatter pigeons scrapes a depression into the ground beneath tussock grass, a bush or a fallen log to create a nest. Females typically lay two eggs which are incubated for 17 days and once hatched, chicks remain within the nest for 2-3 weeks and continue to be dependent upon their parents for around 4 weeks once leaving the nest.^{37,38}

³⁶ TSSC 2015

³⁷ DoE 2020

³⁸ EPA 2006

5.3 General habitat requirements

Squatter pigeons generally inhabit the grassy understory of eucalypt woodland and can be found on tropical savanna and in open grassy areas including regrowth and modified areas such as paddocks and other non-native grasslands.^{36,39} Their habitat is typically:³⁷

- Comprised of an overstorey dominated by Eucalyptus, Corymbia, Acacia or Callitris species;
- Within 3 km of a waterbody;
- On low, gently sloping, flat to undulating plains and foothills; and
- On well-draining, gravelly, sandy or loamy soils.

An overstorey is required within squatter pigeon habitat as they roost in low trees overnight and prefer to undertake daytime behaviours (foraging, dust bathing, breeding) under a canopy of trees.³⁷ However, they are also observed foraging in more modified landscapes including burnt areas, roadsides, stockyards and around rural homes.^{36,39}

5.4 Central Queensland habitat definition

All squatter pigeon habitat is located on low, gently sloping, flat to undulating plains, foothills and plateaus.

Preferred squatter pigeon habitat in Central Queensland is defined as:

- Remnant or regrowth grassy open forest to woodland dominated by *Eucalyptus, Corymbia, Callitris* or *Acacia* with patchy, relatively sparse ground cover vegetation (33%) and sparse shrub layer on well-draining sandy, loamy or gravelly soils within 1 km of a suitable permanent⁴⁰ waterbody.
- Preferred habitat may be located on land zones 3, 5, 7, 8, 9 and 10.

Preferred habitat does not include areas dominated by introduced pasture grasses, in particular *Cenchrus ciliaris*, nor heavily grazed areas⁴¹ but these areas may be included in suitable and marginal habitat as defined below.

Suitable squatter pigeon habitat in Central Queensland is defined as:

- Remnant or regrowth grassy open forest to woodland dominated by *Eucalyptus, Corymbia, Callitris* or *Acacia* with patchy, relatively sparse ground cover vegetation (<33 %) on well-draining sandy, loamy or gravelly soils between 1 and 3 km of a suitable permanent or seasonal⁴² waterbody; and
- Non-remnant areas within 100 m of preferred habitat.

³⁹ Campbell & Woods 2013

⁴⁰ Includes mapped wetlands and $\geq 3^{rd}$ order streams.

⁴¹ Reis 2012

⁴² Includes 1st and 2nd order streams.

• Suitable habitat may be located on land zones 3, 5, 7, 8, 9 and 10.

Marginal squatter pigeon habitat in Central Queensland is defined as:

Non-remnant areas, regrowth and remnant woodland or forest areas more than 3 km from a
permanent or seasonal waterbody that facilities the movement of the species between patches
of preferred or suitable habitat.

5.5 Habitat identification guidance

Table 5 provides specific information about key attributes of squatter pigeon habitat requirements, and where these data can be obtained. Collectively these data enable squatter pigeon habitat to be classified as preferred, suitable or marginal as described above

Attribute	Description	Verification area
Vegetation composition	Mostly dominated in the overstorey by Eucalyptus, Corymbia, Acacia or Callitris species. ⁴³	Desktop and field
Vegetation structure	Open forests to sparse, open woodlands, woodlands and $\ensuremath{scrub^{43}}$	Field
	Open and short grass cover. Less commonly found in dense grass cover. ⁴³	
	Ground cover rarely exceeds 33%.43	
Regional ecosystem associations that may comprise preferred, suitable or marginal habitat	11.3.10, 11.3.14, 11.3.17, 11.3.18, 11.3.2, 11.3.2a, 11.3.2b, 11.3.2c, 11.3.25, 11.3.26, 11.3.27, 11.3.29, 11.3.3, 11.3.30, 11.3.35, 11.3.36, 11.3.37, 11.3.38, 11.3.39, 11.3.4, 11.3.4a, 11.3.6, 11.3.7, 11.3.9, 11.5.1, 11.5.1a, 11.5.11, 11.5.12, 11.5.13, 11.5.17, 11.5.2, 11.5.20, 11.5.3, 11.5.4, 11.5.5, 11.5.8, 11.5.9, 11.7.2, 11.7.3, 11.7.4, 11.7.5, 11.7.6, 11.7.7, 11.9.10, 11.9.7, 11.10.1, 11.10.13, 11.10.4, 11.10.6, 11.10.7, 11.10.9, 11.3.19, 11.3.22, 11.4.2, 11.4.12, 11.8.2, 11.8.4, 11.8.5, 11.9.2, 11.9.9, 11.10.3, 11.10.13, 11.10.14 & 11.11.1	Desktop and field
Food resources	Predominantly seeds of legumes in the family Fabaceae (45% of food volume) including those of exotic pasture plants such as <i>Stylosanthes</i> spp., and native grasses in the family Poaceae ⁴⁴	Field
Landforms/land zones	Predominantly land zones 3, 5, 7, 8, 9 and 10.	Desktop
Soils	Well-draining, gravelly, sandy, loamy, clay and clay-loam soils. ⁴⁵	Desktop

Table 5: Squatter pigeon habitat identification

43 TSSC 2015.

⁴⁴ Higgins and Davies 1996

⁴⁵ Squatter Pigeon Workshop 2011.

Central Queensland Threatened Species Habitat Descriptions

Attribute	Description	Verification area
Water (for drinking)	Drinks water daily. Permanent or seasonal rivers, creeks, lakes, ponds and waterholes, and artificial dams where there is gently sloping, bare ground on which to approach and stand at the water's edge. ⁴⁵	Desktop and field
	Known to utilise stock yard troughs as a drinking resource	
Hydrological needs	Nearly always found within 3 km of water bodies such as rivers, creeks and waterholes. ⁴³	Desktop and field
Patch size	N/A	N/A
Connectivity	N/A	N/A
Shelter/denning/roosting	Not applicable as habitat is identified as breeding or foraging.	N/A
Micro habitat features	Prefers to forage and dust-bathe on bare ground under an open canopy of trees. ⁴⁵	Field
	Favour ground surface consisting of bare patches of gravelly or dusty soil and areas lightly covered in leaf litter and coarse, woody debris. ⁴⁵	
	Commonly forage along the sides of roads or along dusty tracks. The subspecies is also commonly seen foraging in and around stockyards. ⁴³	
Breeding resources	Nests in shallow depressions in the ground and requires well-draining soils. ⁴⁵	Field
	There are gaps in the knowledge of the characteristics of breeding habitat and nesting has been recorded in a variety of habitat and across land zones (see specific information provided in Appendix A). There is general consensus that nesting occurs close to water (within 1 km).	
Habitat condition	Remnant, regrowth or partly modified vegetation communities. Also found on tracks and roadsides. 43	Field

5.6 References

ALA 2020. *Geophaps scripta scripta: Squatter pigeon* in Atlas of Living Australia. Available from: <u>https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:76f9c0ac-bec9-4846-8a63-bc2c92495907</u>

Campbell, I. & Woods, S. 2013. Wildlife of Australia. Princeton: Princeton University Press, Project MUSE.

Cooper, R.M., McAllan, I.A.W. & Curtis, B.R. 2014. *The Atlas of the Birds of NSW and the ACT*. Mini-Publishing, Gordon, New South Wales.

Department of the Environment (DoE) 2020. *Geophaps scripta scripta* in Species Profile and Threats Database, Department of the Environment, Canberra.

Environmental Protection Agency (EPA) 2006. *EPA 2006 Database*. Environmental Protection Agency, Brisbane. www.epa.qld.gov.au.

Higgins, P.J. & Davies, S.J.J.F. 1996. *Handbook of Australian, New Zealand, and Antarctic Birds*. Vol. 3. Snipe to Pigeons. Oxford University Press, Melbourne.

Reis, T. 2012. *Squatter Pigeon (Southern Subspecies)*. Pp. 254-255 *in* Curtis, L.K., Dennis, A.J., McDonald, K.R., Kyne, P.M. and Debus, S.J.S. eds. *Queensland's Threatened Animals*. Collingwood, Victoria: CSIRO Publishing.

Threatened Species Scientific Committee (TSSC) 2015. *Conservation Advice Geophaps scripta scripta squatter pigeon (southern)*. Canberra: Department of the Environment.

6. Painted honeyeater (Grantiella picta)

6.1 Legal status

Environment Protection and Biodiversity Conservation Act 1999: Vulnerable

Nature Conservation Act 1992: Vulnerable

6.2 Ecology and distribution

The painted honeyeater has white underparts, black upperparts and black spots on its flanks. It has yellow edges on its flight and tail feathers, black legs and a deep pink bill (see Figure 6-1). Females are browner on their back, have fewer sots and are smaller than males. Compared to other honeyeaters, this species is the only yellow-winged species with entirely white underparts.⁴⁶



Figure 6-1: Painted honeyeater (Grantiella picta) (Tomas Kelly 2019)

6.2.1 Known distribution

The painted honeyeater has a sparse distribution from south-eastern Australia to north-western Queensland and eastern Northern Territory (Figure 6-2). The species is most prevalent on the inland slopes of the Great Dividing Range between the Grampians, Victoria and Roma, Queensland.⁴⁶ The species migrates between the north and south of its distribution to coincide with the fruiting of mistletoe and breeding. During non-breeding season, the painted honeyeater often moves to semi-arid regions including central and western Queensland, and north-eastern South Australia.⁴⁷

The population of painted honeyeaters is currently declining; largely a result of land clearing and degradation. Much of the current habitat only occurs on private land and is either being cleared or degraded by cattle grazing. Grazing causes uneven age structure of mistletoe trees, leading to future collapses of mistletoe resources; which the species relies upon for food. Breeding within southern and

⁴⁶ Higgins et al. 2001

⁴⁷ DoE 2015



central Queensland is minimal and the species is rarely seen in north-west Queensland. It is predicted that the species will likely become extinct from the northern reaches of its distribution.⁴⁷

Figure 6-2: Distribution range of the painted honeyeater (ALA 2020; DoE 2020)

6.2.2 Biology and reproduction

The painted honeyeater has a specialised diet consisting mainly of mistletoe fruits and nectar. They also consume nectar from other plants (eucalypts and possibly banksias) and arthropods. Arthropods are a significant food source for nestlings and also for adults during non-breeding season when flowering mistletoe is less prevalent.^{46,47}

Painted honeyeaters usually occur as individuals or in pairs, but rarely flocks. They breed between October and March when mistletoe fruits are most abundant. Cup nests are built within the outer foliage of trees between 3 and 20 m above the ground. Nest sites are most commonly in habitats with abundant mistletoe and high parasitism. Nests are built using spiders' webs, rootlets and other plant fibres. The species typically lays 2-3 eggs and both the male and female share incubation, brooding and feeding responsibilities. The success rate of nesting is relatively low, at approximately 43%.⁴⁷

The species can live up to 10 years and has an estimated generation length of 5.8 years.⁴⁸

6.3 General habitat requirements

The painted honeyeater inhabits mistletoe species occuring within eucalypt forests and woodlands, riparian woodlands (*Eucalyptus* spp. such as river red gum *E. camaldulensis*), box-ironbark-yellow gum woodlands, acacia-dominated woodlands (brigalow *A. harpophylla*, weeping myall *A. pendula*, and mulga *A. aneura*), paperbarks, casuarinas and callitris, as well as trees within modified landscapes such as farmland and gardens. The Weeping Myall Woodlands threatened ecological community (TEC)

⁴⁸ Garnett et al. 2011
provides important habitat for the species. Woodlands with more abundant mature trees contain greater levels of mistletoe and hence the painted honeyeater prefers these habitats.^{47,49}

The species occurs more frequently within large patches of remnant vegetation that have been subject to less fragmentation and have a higher percentage of canopy cover.⁵⁰ However, they are also observed within narrow strips of vegetation; in which it also breeds if there is adequate mistletoe.⁴⁷

6.4 Central Queensland habitat definition

Breeding within southern and central Queensland is minimal and therefore habitat descriptions are focused on foraging and dispersal habitat requirements.

Preferred painted honeyeater habitat in Central Queensland is defined as:

• Remnant or regrowth forest/woodlands dominated by mistletoe host trees⁵¹, with a moderate to high abundance of mistletoe (preferably *Amyema* genus).

It is important to note that preferred habitat is not limited by minimum patch size or width i.e. in the Brigalow Belt south bioregion, Painted Honeyeater is frequently observed in narrow (<30 m wide) shade lines, roadside strips and other corridors with high densities of mistletoe as well as in small remnants/regrowth patches even if <0.5 ha. Landscape configuration of vegetation appears to be important (C. Eddie, pers comm) e.g. a highly cleared landscape can still provide habitat for the species providing there is a network of vegetated corridors and small patches of vegetation which support high densities of mistletoe

Marginal painted honeyeater habitat in Central Queensland is defined as:

• Remnant and regrowth forest/woodlands with a low to infrequent mistletoe.

6.5 Habitat identification guidance

Table 6 provides specific information about key attributes of painted honeyeater habitat requirements, and where these data can be obtained. Collectively these data enable painted honeyeater habitat to be classified as preferred or marginal as described above.

Attribute	Description	Verification area
Vegetation composition	Eucalypt and Acacia forests/woodlands with mistletoe host trees containing mistletoe. ⁵²	Desktop and field

Table 6: Painted honeyeater habitat identification

⁴⁹ Rowland 2012

⁵⁰ Oliver et al. 2003

⁵¹ Host trees will vary based on the site by may include *Acacia pendula* (weeping myall), *A. aneura* (mulga), *A. cambagei*, *A. omalophylla*, *A. melvillei*, *A. decora*, *A. stenophylla*, *Eucalyptus camaldulensis* (river red gum), *E. tereticornis* (forest blue gum), *Casuarina cunninghamiana* (river oak), *C. cristata* (belah), *Allocasuarina luehmannii* (bulloak), *Eucalyptus coolabah* (coolibah) and *Acacia harpophylla* (brigalow)

Attribute	Description	Verification area
Vegetation structure	Open forests to woodlands, open woodlands and shrublands. In central QLD, the species is often observed in shade- lines, roadside corridors, remnant edges and regrowth patches, which tend to host a higher density of mistletoes often than found within large remnants. Abundance of suitable mistletoes is considered likely the most important aspect of vegetation structure.	Field
Regional ecosystem associations that may comprise preferred or marginal habitat	11.3.1, 11.3.1b, 11.3.2b, 11.3.3, 11.3.4, 11.3.5, 11.3.16, 11.3.25, 11.3.25b, 11.3.25c, 11.3.25e, 11.3.27i, 11.3.28, 11.4.3, 11.4.7, 11.4.8, 11.4.9, 11.4.10, 11.4.12, 11.5.1, 11.9.5.	Desktop and field
	11.4.6, 11.7.1, 11.9.1, 11.9.10	
Food resources	Almost exclusively on mistletoe fruits. Grey mistletoe <i>Amyema quandang</i> and needle-leafed mistletoe <i>A. cambagei</i> are heavily relied on in the breeding season. <i>A. maidenii</i> Maiden's mistletoe is another preferred food species. During periods of food shortage and in the non-breeding season, nectar (from flowering mistletoe, eucalypts and possibly banksias) and arthropods may be consumed.	Field
	Amyema congener is a frequently utilised food source in parts of BBS.	
	Arthropods are an important dietary item provided to nestlings and for adults during the breeding season. ⁵²	
Land forms/land zones	N/A	N/A
Soils	N/A	N/A
Water (for drinking)	N/A	N/A
Hydrological needs	N/A	N/A
Patch size	Most common in wider blocks of remnant woodland than in narrower strips, although it will utilise narrow roadside strips and small patches of vegetation if ample mistletoe fruit is available. ⁵²	Desktop
Connectivity	N/A	N/A
Shelter/denning/roosting	Roosts in outer foliage of trees anywhere from 3 m to 20 m above the ground	Field
Micro habitat features	A high abundance of mistletoe.	Field
Breeding resources	The species is unlikely to breed in central Queensland.	Field
Habitat condition	Requires habitat in condition that supports a high abundance of mistletoe.	Field

⁵² DoE 2015

6.6 References

ALA 2020. Grantiella picta: Painted honeyeater in Atlas of Living Australia. Available from: https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:ffca4ed4-42c1-44a8-b499-7f0930275040

Department of the Environment 2015. Conservation Advice Grantiella picta painted honeyeater.Canberra:DepartmentoftheEnvironment.Availablefrom:http://www.environment.gov.au/biodiversity/threatened/species/pubs/470-conservation-advice.pdf.

Department of the Environment 2020. *Grantiella picta* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: <u>http://www.environment.gov.au/sprat</u>.

Department of the Environment, Water, Heritage and the Arts DEWHA 2009. *EPBC Policy Statement 3.17* – *Weeping Myall Woodlands*, Commonwealth of Australia, Canberra.

Garnett ST, Szabo JK and Dutson G 2011. *The Action Plan for Australian Birds 2010*. Birds Australia, CSIRO Publishing, Melbourne.

Higgins PJ, Peter JM, Steele WK, eds. 2001 *Handbook of Australian, New Zealand and Antarctic Birds*. Volume 5: Tyrant-flycatchers to Chats. Oxford University Press, Melbourne.

Oliver, D. L., Chambers, M. A., Parker, D. G. 2003. *Habitat and resource selection of the Painted Honeyeater (Grantiella picta) on the northern floodplains regions of New South Wales*. Emu, 103, 171-176.

Rowland, J. 2012. *Painted honeyeater,* Grantiella picta. *Targeted species survey guidelines*. Queensland Herbarium, Department of Environment and Science, Brisbane.

7. Australian painted snipe (Rostratula australis)

7.1 Legal status

Environment Protection and Biodiversity Conservation Act 1999: Endangered

Nature Conservation Act 1992: Vulnerable

7.2 Ecology and distribution

The Australian painted snipe (*Rostratula australis*) is a stocky wading bird that weighs 125-130 g and is approximately 240-300 mm in length with a wingspan of 500-540 mm. Adult females have metallic green wings and back, barred with chestnut and black. Their heads are chestnut coloured with a white crown stripe and white around the eye (see Figure 7-1). Adult males have duller colouring, lacking chestnut colouring on the head, nape and throat. Males are also smaller than females.⁵³



Figure 7-1: Australian painted snipe (Rostratula australis) (Birdlife Australia 2020)

7.2.1 Known distribution

The Australian painted snipe is most common in eastern Australia, although it has been recorded in wetland habitats of all Australian states. It has a scattered distribution throughout Queensland, NSW, Victoria and south-eastern South Australia; and it most commonly recorded in the Murry-Darling region (see Figure 7-2). The extent of occurrence is not suspected to have changed; however, the area of occupancy has declined significantly and continues to decline as a result of wetland modification and clearance since European settlement (50% of wetlands have been lost). Due the species scattered occurrence, absence from current wetland sites is hard to determine. The current population size is predicted to be in decline and the most recent estimate of population size was 2500 mature individuals in 2012.^{53,54}.

⁵³ DoE 2020

⁵⁴ DSEWPaC 2013



Figure 7-2: Distribution range of the Australian painted snipe (ALA 2020; DoE 2020)

7.2.2 Biology and reproduction

The Australian painted snipe feeds on vegetation, seeds, insects, worms and molluscs and crustaceans within dense wetland vegetation; however, it may forage on nearby mudflats and grassland.⁵⁵ It has a bill adapted to probe within soft mud and predominantly feeds in shallow water and along the water's edge of suitable habitats.^{56,57} The species is crepuscular, loafing and resting within grass or reeds during the day.⁵⁵

The species breeds in response to wetland conditions and hence timing varies across its range. In Queensland, breeding is typically between December and May and occurs on ephemeral wetlands. They require continuous reed beds or stands of reed-like vegetation with surrounding cover to breed.^{53,57} Nesting has been recorded in and near swamps, cane grass fields, flooded areas including grazing land and among tussock grasses, couch grasses and samphires (*Tecticornia* spp.)⁵⁸ Within these habitats they build nests on raised mound or thick vegetation surrounded by shallow water. The males are responsible for building the nest, incubating the eggs and rearing the young. Generally, there are four eggs which hatch after 19-20 days.⁵⁵ Once eggs are laid, the female will search for other males to mate with.⁵⁷

Australian painted snipes breed from one year of age and can live up to 16.2 years, with an estimated generation length of 8.6 years.⁵⁷

7.3 General habitat requirements

Australian painted snipes occur within shallow freshwater wetland habitats and occasionally brackish wetlands. These wetlands can be either ephemeral or permanent and include swamps, claypans, lakes,

⁵⁵ Marchant & Higgins 1993

⁵⁶ Ecological Associates 2010

⁵⁷ TSSC 2013

⁵⁸ DoEE 2019

dams, inundated grassland, saltmarsh, rice crops, bore drains and even sewage farms. They select habitats which have substantial cover of grasses, scrub, reeds and *Duma* spp. (lignum).⁵⁴ Although the species can utilise modified habitats for foraging, they do not breed within areas that lack suitable cover. During the day, Australian painted snipes will loaf and rest under clumps of lignum, tea-tree or similar dense bushes.⁵⁵

The species requires highly productive wetland habitats to supply an adequate amount of benthic organisms for food. Optimum habitat conditions are typically temporary wetlands which are drying out due to the high productivity and accessibility of food sources. These areas are often very dry during drought but are subject to rapid inundation following rainfall events.⁵⁹ Migration patterns for the species is poorly understood but movement to and from flooded areas has been frequently observed within Queensland. ^{53,59}

7.4 Central Queensland habitat definition

Preferred Australian painted snipe habitat in Central Queensland is defined as:

• Shallow, permanent or ephemeral, freshwater wetlands which provide areas of bare, exposed wet mud and a mosaic of ground cover⁶⁰ (tufted grasses, sedges, small woody plants).

It should be noted that the presence and/or extent of preferred habitat will be influenced by seasonal conditions (expansion of permanent wetlands, or creation of ephemeral wetland habitat)

Suitable Australia painted snipe habitat in Central Queensland is defined as:

• Shallow permanent or ephemeral freshwater or brackish wetlands and other inundated/waterlogged areas⁶¹ with a variable ground cover (e.g. grasses, shrubs and rushes).

Habitat for this species does not include tall, dense reedbeds associated with stabilized water levels, wetlands that are cropped, and areas of low water quality due to nutrient run-off, agricultural chemicals and turbidity⁶².

7.5 Habitat identification guidance

Table 7 provides specific information about key attributes of Australian painted snipe habitat requirements, and where these data can be obtained. Collectively, these data enable Australian painted snipe habitat as preferred and suitable described above.

⁵⁹ Black et al. 2010

⁶⁰ May include rushes and sedges up to 1 m in height

⁶¹ Can include gilgais lakes, springs, swamps, claypans, inundated or waterlogged grassland/saltmarsh, dams, rice fields, sewage farms and bore drains

⁶² Tzaros et al. 2012

Table 7: Australian painted snipe habitat identification

Attribute	Description	Verification area
Vegetation composition	Permanent or ephemeral shallow freshwater wetlands, gilgais lakes, swamps, claypans, inundated or waterlogged grassland/saltmarsh, dams, rice fields, sewage farms and bore drains with fringing vegetation and grass / reed cover ⁶³	Desktop and field
Vegetation structure	Suitable wetlands usually support a mosaic of low, patchy vegetation, as well as lignum and cane grass. Breeding habitat requirements may include shallow wetlands with areas of bare wet mud and shrub / tree canopy nearby.	Field
Regional ecosystem associations that may comprise preferred/suitable habitat	All lacustrine, palustrine, riverine, estuarine and marine REs within Central Queensland. Also non-remnant areas when gilgai formations occur. Non-exhaustive list includes wetland REs such as 11.3.27 and wetlands (including gilgais) embedded within 11.3.2, 11.3.3, 11.3.25, 11.3.3, 11.4.3, 11.4.7 and 11.9.5.	Desktop and field
Food resources	The aquatic composition of this species' food resources, are a critical component of its habitat needs. It should include small crustacea, molluscs and aquatic worms (not necessarily earthworms) found in shallow water and wet mud. ⁶³	Field
Land forms/land zones	Primarily LZ 3 (wetlands) and LZ 4 and 9 (clay pans and gilgai formations)	N/A
Soils	Associated with clay substrates ⁶⁴	Desktop
Water (for drinking)	N/A	N/A
Hydrological needs	Requires permanent or ephemeral freshwater habitat for breeding and foraging	Desktop and field
Patch size	N/A	N/A
Connectivity	N/A	N/A
Shelter/denning/roosting	Shelters under grass or reeds and can often be difficult to detect as it uses low vegetation of small depressions in the ground as cover. ⁶³	Field
Micro habitat features	Microhabitat consists of a good cover of grasses, rushes and low scrub, <i>Duma</i> spp. (lignum), open timber or samphire. ⁴⁸	Field
Breeding resources	Nesting typically occurs in ephemeral wetlands drying out after an influx of fresh water, provided they have complex shorelines (nests are almost invariably placed on small islands) and a combination of very shallow water, exposed	Field

⁶³ Higgins et al. 1996

⁶⁴ DoE 2019

Attribute	Description	Verification area
	mud, dense low cover and (sometimes) some tall dense cover.63	
Habitat condition	Prefers intact freshwater wetlands that are unaffected by fragmentation or degradation due to cattle overgrazing or other agricultural activities (e.g. water diversion, chemical runoff).	Field

7.6 References

ALA 2020. *Rostratula australis: Australian painted snipe* in Atlas of Living Australia. Available from: https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:008f9f9d-9a91-4c34-9a2bfd82c5a43e13

Black, R., Houston, W and Jaensch, R. 2010. *Evidence of regular seasonal migration by Australian painted snipe* Rostratula australis *to the Queensland tropics in autumn and winter*. Stilt, Vol. 58, pp. 1-9.

Ecological Associates 2010. *Literature review of the ecology of birds of The Coorong, Lakes Alexandrina and Albert Ramsar wetlands*. Ecological Associates report CC-014-1-D prepared for Department for Environment and Heritage, Adelaide

Department of Environment and Energy (DoEE) 2019. *Draft National Recovery Plan for the Australian Painted Snipe* (Rostratula australis). Australian Government.

Department of the Environment (DoE) 2020. *Rostratula australis* in Species Profile and Threats Database, Department of the Environment, Canberra.

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) 2013. *Approved Conservation Advice for* Rostratula australis (*Australian painted snipe*). Canberra: Department of Sustainability, Environment, Water, Population and Communities.

Higgins, P.J. & S.J.J.F. Davies (eds) 1996. Handbook of Australian, New Zealand and Antarctic Birds. Volume 3: Snipe to Pigeons. Oxford University Press, Melbourne.

Rogers, D., Hance, I., Paton, S., Tzaros, C., Griffioen, P., Herring, M., ... & Weston, M. (2005). The breeding bottleneck: Breeding habitat and population decline in the Australian Painted Snipe. In Status and conservation of shorebirds in the East Asian–Australasian Flyway: Proceedings of the Australasian Shorebirds Conference (pp. 15-23).

Threatened Species Scientific Committee (TSSC) 2013. *Commonwealth Listing Advice on* Rostratula australis (*Australian Painted Snipe*). Department of Sustainability, Environment, Water, Population and Communities.

Tzaros, C., Ingwersen, D. and Rogers, D. 2012. *Australian Painted Snipe*. Pp. 274-275 *in* Curtis, L.K., Dennis, A.J., McDonald, K.R., Kyne, P.M. and Debus, S.J.S. eds. *Queensland's Threatened Animals*. Collingwood, Victoria: CSIRO Publishing.

8. Ornamental snake (Denisonia maculata)

8.1 Legal status

Environment Protection and Biodiversity Conservation Act 1999: Vulnerable

Nature Conservation Act 1992: Vulnerable

8.2 Ecology and distribution

The ornamental snake (*Denisonia maculata*) varies in colouration from brown to grey-brown and black (see Figure 8-1). The body scales are often lighter with dark streaks or flecks, the head is usually darker, and the belly is white/cream with dark spots or flecks. The species has distinctly barred lips.⁶⁵



Figure 8-1: Ornamental snake (Denisonia maculata) (MacDonald 2017)

8.2.1 Known distribution

The ornamental snake has a restricted distribution with the Brigalow Belt North and Brigalow Belt South regions (see Figure 8-2). Within its range, it is sparsely distributed.

⁶⁵ Cogger 2000



Figure 8-2: Distribution range of the ornamental snake (ALA 2020; DoE 2020)

8.2.2 Biology and reproduction

The ornamental snake feeds almost exclusively of frogs (approximately 95% of its diet) and is most frequently observed where frogs are observed.^{66,67} A number of different frog species occur throughout the ornamental snake's range and they have been observed consuming a variety of species.⁶⁶

The life cycle of ornamental snakes is poorly understood. However, it is known that they reach sexual maturity at a minimum length of 24.7 cm for females and 23.0 cm for males. The species is viviparous with a litter size of between 3-11 snakelets.⁶⁷

8.3 General habitat requirements

Ornamental snakes occur within woodland and open forest habitats in moist areas such as; floodplains, undulating clay pans, near waterbodies (swamps and lakes) and along watercourses. It prefers these moist areas due to its diet of mostly frogs. Its preferred habitat is woodland or open forest associated with gilgai mounds and depressions in Queensland Regional Ecosystem Land Zone 4. These areas provide suitable microhabitat features for the species including deep cracking clay soils in which the snake shelters. The species also shelters under logs and vegetation debris/litter where it can remain inactive for many months during dry periods. Ornamental snakes are often associated with Brigalow dominated communities including endangered TEC Brigalow (*Acacia harpophylla* dominant and co-dominant) and occur within a variety of region ecosystems (11.4.3, 11.4.6, 11.4.8, 11.4.9, 11.3.3 and 11.5.16).^{66,68}

⁶⁶ DoE 2020

⁶⁷ Shine 1983

⁶⁸ DoE 2014

Remnant vegetation is not required for the species to occur, as gilgai formations can be retained in cleared / non-remnant environments.⁶⁹ Ornamental snakes have been observed within cleared areas where there is adequate ground cover to provide shelter (logs, rocks and artificial debris).⁷⁰ These areas include cleared non-remnant paddocks and woodland regrowth.⁷¹ It is suggested that ornamental snakes typically occur as dense populations within limited, sharply delineated areas of suitable habitat.⁷² This habitat has the following characteristics:^{66,72}

- Low areas of the catchment that are subject to flooding and frequent inundation.
- Gilgai of varying size and depth.
- Soils with high clay as theses have higher water retention capabilities and are subject to cracking when dry.
- Logs or other ground debris to provide shelter.
- Abundant seasonal frog populations.
- Patches of habitat typically larger than 10 ha that are connected to (or within) large areas of remnant vegetation.

8.4 Central Queensland habitat definition

Preferred ornamental snake habitat in Central Queensland is defined as:

 Gilgai depressions (with or without the presence of brigalow or other canopy vegetation⁷³), mounds and wetlands on cracking clays (predominantly land zone 4) where essential microhabitat features are present including an abundance of deep soil cracks and fallen woody debris. Seasonal flooding of habitat areas is a requirement.

Suitable ornamental snake habitat in Central Queensland is defined as:

• Dispersal areas within 1 km of preferred habitat currently or previously dominated by brigalow or coolibah communities where gilgais or soil cracks are infrequent or are shallow or non-remnant areas.

Marginal ornamental snake habitat in Central Queensland is defined as:

• Areas currently or previously dominated by brigalow or coolibah communities where gilgais or soil cracks are infrequent or are shallow or non-remnant areas where threats are high (high abundance of weed incursion and cattle compacting soils) but the species still have potential to occur, especially in times where water is present and prey abundance (frogs) is high.

⁶⁹ DSEWPaC 2011

⁷⁰ WWF 2008

⁷¹ Curtis 2010

⁷² Wilson & Swan 2014

⁷³ I.e. including remnant, regrowth and non-remnant areas as identified in the QLD vegetation mapping framework

8.5 Habitat identification guidance

Table 8 provides specific information about key attributes of ornamental snake habitat requirements, and where these data can be obtained. Collectively these data enable ornamental snake habitat to be classified as preferred or marginal as described above.

Attribute	Description	Verification area
Vegetation composition	Brigalow or coolibah (currently or previously present).74	Desktop and field
Vegetation structure	The presence of remnant vegetation is not required for the species to occur. ⁷⁵	Field
Regional ecosystem associations that may comprise preferred and/or marginal habitat	11.3.1, 11.3.1a, 11.3.1b, 11.3.1d, 11.3.3, 11.3.3a, , 11.3.3c, 11.3.3x1, 11.4.3, 11.4.10, 11.4.6, 11.4.7, 11.4.8, 11.4.8a, 11.4.9, 11.4.9a, 11.4.9b, 11.5.16, 11.5.16a, 11.9.1, 11.9.5, 11.9.5a 11.3.17, 11.3.27, 11.3.37, 11.4.5, 11.4.10	Desktop and field
Food resources	Frogs make up 95% of their diet. ⁷⁶	Field
Landforms/land zones	Predominantly land zone 4, but also LZ 3 and 9. Also found in lake margins and wetlands. ⁷⁷	Desktop and field
Soils	Flood-prone cracking clay soils that support or have supported Brigalow or Coolibah. ⁷⁸	Desktop and field
	Cracking clay soils that are formed by shrinking and swelling, as cracking occurred deeper, more frequently and persisted for longer periods on gilgai mounds compared. ⁷⁹	
Water (for drinking)	N/A	N/A
Hydrological needs	Prefers moist, seasonally flooded areas (see landforms above). Requires water for prey (frogs) and thus can become inactive during dry periods.	Desktop and field
Patch size	Habitat patches are typically greater than 10 ha in area and are within, nearby, or connected to larger areas of remnant vegetation. ⁷⁷	Desktop
Connectivity	Habitat connectivity between gilgais and other suitable habitats is important. ⁷⁴	Desktop

74 DSEWPaC 2011a

75 DSEWPaC 2011b

⁷⁶ Shine, R. 1983

⁷⁷ DAWE 2020.

⁷⁸ Wilson & Swan 2014

79 Veary et al. 2011

Central Queensland Threatened Species Habitat Descriptions

Attribute	Description	Verification area
Shelter/denning/roosting	Shelters during the day under fallen timber, rocks, bark and in deep soil cracks. ⁷⁵ During dry periods it can remain inactive in its shelter for months. ⁷⁵	Field
Micro habitat features	Woody debris, rocks, bark and in deep soil cracks. 75	Field
Breeding resources	Unknown. It is not possible to separate foraging and breeding habitat requirements with current available information and they are likely to share the same characteristics.	Field
Habitat condition	Ornamental snakes have also been found in cleared woodlands that contain adequate ground cover and shelter sites, such as logs and deep soil cracks. ⁸⁰	Field

8.6 References

ALA 2020. *Denisonia maculata: Ornamental snake* in Atlas of Living Australia. Available from: <u>https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:d1c8c742-e7dd-415e-b4f5-a6f3c05123db</u>

Cogger, H.G. 2000. Reptiles and Amphibians of Australia - 6th edition. Sydney, NSW: Reed New Holland.

Curtis, L.K. 2010. *Queensland's Threatened Animals* (eds A.J. Dennis, K.R. McDonald, P.M. Kyne, & S.J.S. Debus). CSIRO Publishing, Collingwood.

Department of the Environment 2014. Approved Conservation Advice for Denisonia Canberra: of Available maculata (Ornamental Snake). Department the Environment. from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/1193-conservationadvice.pdf.

Department of the Environment (DoE) 2020. *Denisonia maculata* in Species Profile and Threats Database, Department of the Environment, Canberra.

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC). 2011a. *Draft Referral guidelines for the nationally listed Brigalow Belt reptiles*. Commonwealth of Australia.

DSEWPC 2011b. Survey guidelines for Australia's threatened reptiles. Commonwealth of Australia.

Shine, R. 1983. *Food habits and reproductive biology of Australian elapid snakes of the genus Denisonia*. Journal of Herpetology 17: 171-175.

Veary, A.T, Veary, E. L, Burgess, J and Fell, D. 2011. Assessment of Habitat Characteristics as Predictors of Habitat Suitability for the threatened Ornamental Snake. Report/research on behalf of the Australian Coal Association Research Program, Research Project C15044

⁸⁰ WWF Australia 2008

Wilson, S & Swan, G 2014. The ornamental snake (Denisonia maculata): notes on the habitat and population density of a vulnerable elapid snake. Herpetofauna 44 (1 & 2).

WWF Australia (2008). *Brigalow Belt bioregion – a biodiversity jewel.* World Wildlife Fund Australia.

9. Yakka skink (Egernia rugosa)

9.1 Legal status

Environment Protection and Biodiversity Conservation Act 1999: Vulnerable

Nature Conservation Act 1992: Vulnerable

9.2 Ecology and distribution

The yakka skink is a large, robust skink that has a thick tail and short legs. It is one of the largest species of skink within its region and can grow up to 40 cm in length; roughly the same size as a blue tongue lizard (*Tiliqua scincoides*). It is a pale fawn colour, with a broad dark brown stripe along its back, from the nape to tail. This stripe is bordered on each side by a pale fan stripe. The flank scales are pale brown to reddish brown in colour and from a variegated pattern. It has a yellow/cream throat with black spots/ flecks and a yellow-orange chest and abdomen (see Figure 9-1).



Figure 9-1: Yakka skink (Egernia rugosa) (Bookbook n.d.)

9.2.1 Known distribution

The yakka skink has a patchy, fragmented distribution extending from south-east and central Queensland to tropical north Queensland (see Figure 9-2). The preferred habitat for the species occurs within Brigalow Belt South Bioregions; specifically, the Mulga Lands. Other populations occur throughout the Brigalow Belt North, Einasleigh Uplands, south-east Queensland, wet tropics and Cape York Peninsula. The distribution is highly fragmented due to the clearance of large amounts of potential habitat for the species for agriculture, urban development and mining.^{81,82} The species exhibits high site fidelity and has limited dispersal capabilities.

⁸¹ DoE 2014

⁸² DoE 2020



Figure 9-2: Distribution range of the yakka skink (ALA 2020; DoE 2020)

9.2.2 Biology and reproduction

The yakka skink is an omnivore; consuming predominantly fruits, plant material and invertebrates (beetles, spiders and grasshoppers). The skink burrows into the ground or beneath roots/logs, preying upon invertebrates that travel close to the burrow.⁸²

The yakka skink is a gregarious species, occurring as colonies or aggregations of varying age and size within suitable habitat.⁸³ The species is viviparous and produces approximately six young per littler.⁸²

9.3 General habitat requirements

The yakka skink occurs in open dry sclerophyll forest, woodland or scrub within Queensland Regional Ecosystem Land Zones (LZ) 3, 4, 5, 7, 9 and 10, primarily within the Mulga Lands and Brigalow Belt South Bioregions. Vegetation types vary, but typically include:

- Brigalow (Acacia harpophylla);
- Mulga (A. aneura);
- Bendee (A. catenulata);
- Lancewood (A. shirleyi);
- Belah (Casuarina cristata);
- Poplar Box (*Eucalyptus populnea*);
- Ironbark (Eucalyptus spp.); and
- White Cypress Pine (Callitris glaucophylla).

The species is known to occur within two TEC listed under the EPBC Act; Brigalow (*Acacia harpophylla* dominant and co-dominant) and Weeping Myall Woodlands.⁸²

⁸³ Chapple 2003

The yakka skink requires microhabitat in which it can shelter/burrow. This includes cavities between ground level rocks, logs, roots and abandoned animal burrows. The species can also burrow via excavation within dense ground vegetation; creating deep burrow systems. The yakka skink has been observed in cleared habitat as long as there are adequate shelter sites such as logs, eroded tunnels/holes or rabbit warrens. Structures such as sheds can also be occupied by the species.⁸² The species are not known to travel far from shelter sites and will quickly retreat to the site if disturbed.⁸⁴

9.4 Central Queensland habitat definition

Preferred yakka skink habitat in Central Queensland is defined as:

Areas of remnant and regrowth woodlands and open woodlands, as well as non-remnant vegetation, with suitable light clay loam, loam and sandy loam substrates on land zones 3, 5, 7, 9 and 10 supporting microhabitat features including large hollow logs, cavities or burrows under large fallen trees and/or tree stumps, log piles, large rocks and rock piles, deep rock crevices, deeply eroded gullies or sinkholes/areas of tunnel erosion.

Preferred habitat may also be further constrained to areas within 10 km of a known occurrence (noting this may not be appropriate in regions where survey effort is poor).

Marginal yakka skink habitat in Central Queensland is defined as:

Areas of remnant and regrowth woodlands and open woodlands, as well as non-remnant vegetation, with suitable light clay loam, loam and sandy loam substrates on land zones 3, 5, 7, 9 and 10 with only rare occurrences of microhabitat features.

9.5 Habitat identification guidance

Table 9 provides specific information about key attributes of yakka skink habitat requirements, and where these data can be obtained. Collectively these data enable yakka skink habitat to be classified as suitable as described above. The species must be recorded for habitat to be classified as preferred.

Attribute	Description	Verification area
Vegetation composition	Dry scleorphyll woodland, open woodland and scrub, where suitable microhabitat features remain ⁸⁵	Desktop and field
Vegetation structure	Dominance of vegetation communities by a range of dry sclerophyll species such as <i>Eucalyptus populnea</i> , <i>E.</i> <i>fibrosa</i> , <i>E. crebra</i> , <i>E. orgadophila</i> , <i>E. melanophloia</i> , <i>Acacia</i> <i>shirleyi</i> , <i>A. catenulata</i> , <i>A. aneura</i> , <i>A. microsperma</i> , <i>Allocasuarina luehmannii</i> , <i>Casuarina cristata</i> and <i>Callitris</i> <i>glaucophylla</i> ⁸⁶	Field

Table 9: Yakka skink habitat identification

84 Wilson 2003

⁸⁵ Ferguson & Mathieson 2014

⁸⁶ C. Eddie pers comm (see Appendix A)

Attribute	Description	Verification area
Regional ecosystem associations that may comprise preferred or suitable habitat	REs that may provide habitat include: 11.3.2, 11.3.6, 11.3.14, 11.3.17, 11.3.18, 11.3.19, 11.3.29, 11.3.30, 11.3.36, 11.3.39, 11.5.1, 11.5.1a, 11.5.4, 11.5.4a, 11.5.2, 11.5.3, 11.5.5, 11.5.5a, 11.5.5b, 11.5.5c, 11.5.9, 11.5.9a, 11.5.9b, 11.5.9c, 11.5.13, 11.5.20, 11.7.1, 11.7.2, 11.7.4, 11.7.6, 11.7.7, 11.9.2, 11.9.7, 11.9.9, 11.9.10, 11.10.7, 11.10.7a, 11.10.9, 11.10.11	Desktop and field
Food resources	Omnivorous - eats plants, fruits and invertebrates (e.g. beetles, grasshoppers, spiders).	Field
Landforms/land zones	LZ 3, 5, 7, 9 and 10.	Desktop and Field
	May also occur on LZ 4 & 8, although this does not represent preferred habitat. ⁸⁷	
Soils	Firm but friable loamy and sandy soils, suitable for burrowing. ⁸⁵	Desktop and Field
	Can include light clay and clay loams but avoids heavy ${\rm clays}^{\rm 86}$	
Water (for drinking)	N/A	N/A
Hydrological needs	N/A	N/A
	However, areas on landzone 3 that is subject to flooding (i.e. every few years) would unlikely be inhabited by the species, as flooded burrows would not be tolerated.	
Patch size	Unknown, however they exhibit high site fidelity and are not considered strong dispersers. ⁸⁷	Desktop
Connectivity	Extensive fragmentation is a key threat to this species as it is unable to disperse far from its colony. ⁸⁸	Desktop
Shelter/denning/roosting	See microhabitat features below	Field
Micro habitat features	Burrows (including abandoned burrows of other species e.g. rabbits ⁸⁷), large logs, log piles, tree stumps, grass tussocks and cavities between and underneath large rocks. ⁸⁵	Field
Breeding resources	It is not possible to separate foraging and breeding habitat requirements with current available information and they are likely to share the same characteristics.	Field
Habitat condition	Will persist in disturbed and cleared habitat provided microhabitat features remain. ⁸⁸	Field

⁸⁷ DAWE 2020

⁸⁸ Hobson et al. .2018

9.6 References

ALA 2020. *Egernia rugosa: Yakka skink* in Atlas of Living Australia. Available from: <u>https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:33916d2f-0d12-4dce-bd45-</u>73ce89a7cdb6.

Chapple, D.G. 2003. Ecology, Life-History, and Behaviour in the Australian Scincid Genus Egernia, with Comments on the Evolution of Complex Sociality in Lizards. Herptological Monographs. 17:145-180

Cogger, H.G. 200. Reptiles and Amphibians of Australia - 6th edition. Sydney, NSW: Reed New Holland.

Department of the Environment 2020. *Egernia rugosa* in Species Profile and Threats Database, Department of the Environment, Canberra.

Department of the Environment 2014. *Approved Conservation Advice for* Egernia rugosa (*Yakka Skink*). Canberra: Department of the Environment.

Eddie, C. 2012. *Yakka Skink*. Pp.224-225 *in* Curtis, L.K., Dennis, A.J., McDonald, K.R., Kyne, P.M. and Debus, S.J.S. eds. *Queensland's Threatened Animals*. Collingwood, Victoria: CSIRO Publishing.

Ferguson, D. and Mathieson, M. 2014. *Yakka skink, Egernia rugosa. Targeted species survey guidelines*. Queensland Herbarium, Department of Environment and Science, Brisbane.

Hobson, R., Venz, M., Wilson, S., Vanderduys, E., Sanderson, C., Cogger, H. & Shea, G. 2018. *Egernia rugosa*. The IUCN Red List of Threatened Species 2018

Peck, S., Gardner, M. Seddon, J. and Baxter, G. (2017) Life-history characteristics of the yakka skink, *Egernia rugosa*, indicate long-term social structure. *Australian Journal of Zoology* **64**(5): *xx* – *xx*.

Wilson S. 2003. Reptiles of the Southern Brigalow Belt. WWF-Australia.

10. Collared delma (Delma torquata)

10.1 Legal status

Environment Protection and Biodiversity Conservation Act 1999: Vulnerable

Nature Conservation Act 1992: Vulnerable

10.2 Ecology and distribution

The collared delma is one of the smallest legless lizards (family Pygopodidae) with a maximum total length of approximately 19 cm and maximum snout-vent length of 7 cm. The scales are brown to reddish brown in colour, becoming paler on the belly. The species has a dark brown banded head and neck with cream-yellow stripes and a blunt and short snout (see Figure 10-1).⁸⁹



Figure 10-1: Collared delma (Delma torquata) (Steve Wilson 2019)

10.2.1 Known distribution

The collared delma has a known distribution limited to a number of sites within Queensland (see Figure 10-2). A large number of records are from the western suburbs of Brisbane as well as the following sites within south east and central Queensland: ^{89,90}

- Bunya Mountains;
- Blackdown Tablelands National Park;
- Expedition National Park;
- Western Creek, near Millmerran; and
- Toowoomba Range.

⁸⁹ Peck & Hobson 2007

⁹⁰ Davidson 1993

The home range and movement patterns of the species is poorly understood; although it is suggested that their home range is likely small.^{91,92}



Figure 10-2: Distribution range of the collared delma (ALA 2020; DoE 2020)

10.2.2 Biology and reproduction

The collared delma feeds on a variety of insects and spiders, with cockroaches appearing to be the most common food source. The species has also been observed within subterranean termite colonies.^{91,92}

The life cycle of the collared delma is poorly understood. The species is known to lay two white eggs in December which then hatch between February and March.⁸⁹

10.3 General habitat requirements

The collared delma occurs within eucalypt woodland and open forest comprised of a variety of canopy species depending on the location and with ground cover of predominantly native grasses including kangaroo grass (*Themeda triandra*), barbed-wire grass (*Cymbopogon refractus*), wiregrass (*Aristida* sp.) and lomandra (*Lomandra* sp.). The species has specific microhabitat requirements, whereby adequate ground cover is required via the presence of logs, park, rocks, vegetation debris and leaf litter.^{91,93} It has been suggested that the species is not able to dig and burrow underground, therefore explaining its requirement for microhabitat which it can shelter beneath.⁹² The collared delma is often associated with rocks (both large and small); however, the presence of rocks is not considered to be essential. The species does not appear to have a preference for a specific soil type and has been observed on a variety of soils including sandy loams, grey and black cracking clays, stony lithosols and basalt derived Podzolics. Generally, the species occurs in Queensland Ecosystem land zones (LZ) 3, 9 and 10 in a number of regional ecosystems (11.3.2, 11.9.10, 11.10.1 and 11.10.4).⁹¹

⁹¹ DoE 2020

⁹² Porter 1998

⁹³ DEWHA 2008

10.4 Central Queensland habitat definition

Based on guidance from species experts, only one habitat definition for this species is provided and includes the categories of both preferred and suitable as per section 2.3 above.

Preferred and suitable collared delma habitat in Central Queensland is defined as:

- Any contiguous patch of habitat containing crucial required features, occurring within the species' known distribution. Crucial features include:
 - o Eucalypt communities on well-drained slopes
 - o Intact, undisturbed leaf litter
 - Scattered undisturbed surface stones, typically 15-30 cm.

10.5 Habitat identification guidance

Table 10 provides specific information about key attributes of collared delma habitat requirements, and where these data can be obtained. Collectively these data enable collared habitat to be classified as suitable as described above. The species must be recorded for habitat to be classified as preferred.

Attribute	Description	Verification area
Vegetation composition	Found in v vegetation communities dominated by various <i>Eucalyptus</i> spp ⁹⁴ . Ground cover is usually dominated by native grasses, such as kangaroo grass, barbed-wire grass, wiregrass and lomandra ⁹⁵	Desktop and field
Vegetation structure	Open forests to open woodlands, with a native grassy understorey.	Field
Regional ecosystem associations that may comprise suitable habitat	11.3.2, 11.3.25, 11.3.29, 11.3.30, 11.3.36, 11.9.9, 11.9.9b, 11.9.10, 11.10.1, 11.10.1d, 11.10.4, 11.10.7, 11.10.11 11.3.1, 11.3.4, 11.3.6, 11.3.7, 11.3.14, 11.3.17, 11.3.18, 11.3.19, 11.3.39, 11.4.3, 11.4.7, 11.4.8, 11.4.10, 11.4.12, 11.5.1, 11.5.2, 11.5.3, 11.5.4, 11.5.5, 11.5.9, 11.7.1, 11.7.2, 11.7.4, 11.7.4c, 11.7.6, 11.7.7, 11.8.2, 11.8.4, 11.8.5, 11.9.1, 11.9.2, 11.9.5, 11.9.7, 11.10.2, 11.10.6, 11.10.3, 11.10.9, 11.10.13, 11.11.1, 11.11.2, 11.11.3, 11.11.4, 11.11.1, 11.12.1, 11.12.2, 11.2.3	Desktop and field
Food resources	Insects and spiders	Field
Land forms/land zones	LZ associations poorly known and may occur within all but LZ 1 & 2.	Desktop
Soils	Has been recorded in a range of soil types, however, must contain the presence of essential microhabitat features	Desktop

Table 10: Collared delma habitat identification

⁹⁴ DoE 2020

95 DEWHA 2008

Central Queensland Threatened Species Habitat Descriptions

Attribute	Description	Verification area
Water (for drinking)	N/A	N/A
Hydrological needs	N/A	N/A
Patch size	Very little is known about movements, although it is likely to be very small based on previous studies (18 m movement over 2 years) ⁹⁶ .	Desktop
Connectivity	Habitat fragmentation is known to degrade habitat.	Desktop
Shelter/denning/roosting	See microhabitat features below.	Field
Micro habitat features	Native grasses, surface rocks, logs, bark, coarse woody debris and thick mats of leaf litter (typically 30-100 mm thick).	Field
Breeding resources	The life cycle of the collared delma is poorly understood and breeding resources are not well known with current information.	N/A
Habitat condition	Requires the essential microhabitat features listed above. Invasion of weeds, particularly Dwarf Lantana also impact condition.	Field

10.6 References

ALA 2020. *Delma torquate: Collared delma* in Atlas of Living Australia. Available from: <u>https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:92ec5b2c-1f8f-4d29-b088-</u> <u>77bacaeeb99f</u>

Cogger, H.G. 2000. Reptiles and Amphibians of Australia - 6th edition. Sydney, NSW: Reed New Holland.

Davidson, C. 1993. *Recovery Plan for the Collared Legless Lizard* (Delma torquata). Page(s) 1-10. Brisbane, Queensland: Department of Environment and Heritage

Department of the Environment 2020. *Delma torquata* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: <u>http://www.environment.gov.au/sprat</u>.

Department of the Environment, Water, Heritage and the Arts 2008. Approved Conservation Advice for Delma torquata (Collared Delma). Canberra: Department of the Environment, Water, Heritage and the Arts. Available from: <u>http://www.environment.gov.au/biodiversity/threatened/species/pubs/1656-conservation-advice.pdf</u>

Peck, S. & R. Hobson 2007. Survey results and management options for the Collared Delma (Delma torquata) along the proposed Toowoomba Bypass, Toowoomba Range, South-east Queensland, November 2006. Queensland Parks and Wildlife Service.

⁹⁶ Porter 1998

Porter, R. 1998. *A preliminary field investigation of the collared delma* Delma torquata (*Reptilia: Pygopodidae*). Queensland: Lone Pine Koala Sanctuary.

Wilson, S. 2015. A Field Guide to reptiles of Queensland. 2nd edition. New Holland Publishers

11. Large-eared wattled bat⁹⁷ (*Chalinolobus dwyeri*)

11.1 Legal status

Environment Protection and Biodiversity Conservation Act 1999: Vulnerable

Nature Conservation Act 1992: Vulnerable

11.2 Ecology and distribution

The large-ear wattled bat is a medium-sized bat with short, broad wings. These wings suggest that the bat has a high amount of manoeuvrability and flies slowly. The bat is approximately 100 mm long and weighs 7-12 grams. Its fur is shiny and black with a white stripe on the torso (ventral side) where it connects to the wings and tail. As the name suggests, it has large ears. Lobes of skin also occur near the lower lip; between the mouth and ear (see Figure 11-1).^{98,99}



Figure 11-1: Large-eared wattled bat (Chalinolobus dwyeri) (T. Reardon n.d)

11.2.1 Known distribution

The distribution of the large-ear wattled bat is poorly understood as it is a relatively newly described species, is nocturnal, unobtrusive and appropriate targeted survey techniques have only been available since the 1990s.^{99,100} There are records of the species ranging from north of Rockhampton in Queensland, to Ulladulla in the south of NSW (Figure 11-2).⁹⁹ Throughout this range it is suggested to occur as restricted, patchy populations, rarely containing more than 50 individuals.⁹⁸

⁹⁹ Hoye 2005

¹⁰⁰ Ryan 1966

⁹⁷ Large-eared Wattled Bat is the new common name for this species (formerly large-eared pied-bat). This name was adopted by Jackson & Groves (2015) in Taxonomy of the Mammals of Australia and will be the name used in the forthcoming 4th Edition of The Mammals of Australia (eds. Baker & Gynther; formerly van Dyck & Strahan, 3rd Edition)

⁹⁸ DoE 2020

In Queensland, the species has been recorded in the Carnarvon, Expedition Ranges and Blackdown Tablelands. Within these areas the species is restricted to sites in the vicinity of sandstone escarpments. These known populations likely make up a large proportion of the entire population in Queensland; however, exact population numbers and health are not known. Smaller populations are known to occur within limestone caves and mines in south-eastern Queensland and Shoalwater Bay.⁹⁹

Only four maternity roost sites have been recorded, all of which occur within NSW. The species has very specific roosting habitat requirements (see below) and potential roost sites are not distributed evenly throughout its range. Populations are likely to be isolated and have limited interaction with each other.⁹⁹



Figure 11-2: Distribution range of the large-eared wattled bat (ALA 2020; DoE 2020)

11.2.2 Biology and reproduction

The diet of the large-ear wattled bat is not well understood however their morphology (slow flying, highly manoeuvrable) suggests that they forage below the canopy and likely consume insects.^{98,99}

Information regarding their life cycle predominantly comes from an early study of a colony in NSW.¹⁰¹ The species reaches sexual maturity at one year of age and mating occurs in early winter. Females were observed to have given birth to 1-2 young by early December and were seen lactating. Nursery colonies were typically established by adult males and females in September, with males leaving in summer once the young were born. Juveniles remained in the roost for 2-3 months before leaving, followed shortly by the adult females; resulting in an abandoned roost over winter.¹⁰¹ Similar life cycle observations have been recorded for other colonies with slight differences likely attributed to the varying thermal properties of the roosting sites.¹⁰²

¹⁰¹ Dwyer 1966

¹⁰² Pennay 2008

11.3 General habitat requirements

The habitat for the large-ear wattled bat is dependent upon available roosting sites which have specific requirements and limit the species distribution throughout its range. They require sandstone cliff/escarpment that is adjacent or close to high productivity sites such as woodland or rainforest which the species uses for foraging. Records of the species have predominantly occurred within close proximity to cliffs or rocky terrain. Roosting has been recorded in caves, old mine shafts, overhangs and disused Fairy Martin (*Hirundo ariel*) nests.^{98,103} Recently it was discovered that suitable roosting sites can also be less complex than large cliffs or caves, such sites include:¹⁰⁴

- Dark zones amongst boulders or collapsed cliff line;
- The roof of hollowed out boulders (not big enough to show up on topographic mapping);
- Small honeycombed holes in sandstone; and
- Long slits in exfoliating sheets of sandstone.

Suitable roosting sites can also be more isolated than first thought as the species is able to traverse open areas to access foraging habitat.¹⁰⁴

The nursery roosts require a more specific structure. They need to be deep enough to enable juvenile bats to practice flying safely inside and also need to have indentations in the roof where heat can be captured. Arch caves with dome roofs are one example that fits these characteristics; however, suitable sites are very rare within the landscape, especially within proximity to fertile foraging habitats. Thus, retaining connectivity between remnant vegetation and potential nursery roost sites is considered to be important for the species long term survival.¹⁰³

The species forages in a variety of vegetation types including dry and wet sclerophyll forest, grassy woodland, *Callitris* dominated forest, tall open eucalypt forest with a rainforest sub-canopy, sub-alpine woodland and sandstone outcrop country.¹⁰⁵ A number of TEC listed under the EPBC Act also provide suitable foraging habitat throughout the species' geographic range, including:⁹⁸

- Brigalow (*Acacia harpophylla* dominant and co-dominant) (QLD and NSW)
- Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (NSW)
- Grey Box (*Eucalyptus microcarpa*) Grassy Woodlands and Derived Native Grasslands of Southeastern Australia (NSW)
- New England Peppermint (*Eucalyptus nova-anglica*) Grassy Woodlands (NSW)
- Temperate Highland Peat Swamps on Sandstone (NSW)
- Weeping Myall Coobah Scrub Wilga Shrubland of the Hunter Valley (NSW)
- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (QLD and NSW).

¹⁰³ TSSC 2012

¹⁰⁴ Lothian 2019

¹⁰⁵ DERM 2012

11.4 Central Queensland habitat definition

Separate definitions are provided for preferred & suitable roosting versus foraging habitat on the recommendation of species experts.

Preferred large-eared wattled bat habitat in Central Queensland is defined as:

- Roosting sandstone cliff-lines (land zone 10), with a north-westerly to south-westerly aspect, containing small caves and fissures. Sheltered caves of several metres depth may be critical maternity sites.
- Foraging open forests and woodlands including riparian zones, foot-slopes and valley floors, within 2.5 km of preferred roosting habitat. Foraging activity appears to be concentrated particularly along ecotones between moist and dry vegetation types and abrupt edges between woodland and pasture.

Marginal large-eared wattled bat habitat in Central Queensland is defined as:

- Roosting larger scarps in land zone 7 (i.e. ironstone jump-ups) and volcanic plugs in land zone 8; abandoned mine adits.
- Foraging woodland and forest associated with marginal roosting habitat.

11.5 Habitat identification guidance

Table 11 provides specific information about key attributes of large-eared wattled bat habitat requirements, and where these data can be obtained. Collectively these data enable large-eared wattled bat habitat to be classified as preferred or suitable as described above.

Attribute	Description	Verification area
Vegetation composition	Relevant to foraging only – particularly box gum woodlands or other riparian vegetation types. ¹⁰⁶	Desktop and field
Vegetation structure	Open forests and woodlands including riparian zones, foot-slopes and valley floors ¹⁰⁷	Field
Regional ecosystem associations	Relevant to foraging primarily – 11.3.1, 11.3.6, 11.3.7, 11.3.10, 11.3.11, 11.3.12, 11.3.14, 11.3.17, 11.3.18, 11.3.19, 11.3.27, 11.4.1, 11.4.3, 11.4.8, 11.4.9, 11.4.10, 11.4.12, 11.9.1, 11.9.2, 11.9.4, 11.9.5, 11.9.7, 11.9.10, 11.10.6, 11.10.8, 11.10.9, 11.10.11, 11.10.13	Desktop and field
Food resources	Diet unknown. Foraging likely occurs along watercourses and in fertile valleys and plains within several kilometres of its roosting habitat.	Field

	Table 11: Large-eared	wattled bat	habitat i	dentificatior
--	-----------------------	-------------	-----------	---------------

¹⁰⁶ TSSC 2012

¹⁰⁷ DERM 2011

Central Queensland Threatened Species Habitat Descriptions

Attribute	Description	Verification area
Land forms/land zones	Predominately roosts in caves and overhangs in sandstone cliffs, equivalent to land zone 10 ¹⁰⁸ . May utilise LZ 7 and 8.	Desktop
	Foraging often associated with LZ3	
Soils	N/A	N/A
Water (for drinking)	Presence of a waterbody within 3 km of roost	N/A
Hydrological needs	N/A	N/A
Patch size	Unknown	N/A
Connectivity	Retaining connectivity between remnant vegetation and nursery roosts is likely to be important. ¹⁰⁶	Desktop
Shelter/denning/roosting	Caves, overhangs, abandoned mine tunnels and disused fairy martin nests.	Field
Micro habitat features	As described above.	Field
Breeding resources	As described above.	Field
Habitat condition	The majority of records are from canopied habitat, although narrow connecting riparian strips in otherwise cleared habitat are sometimes quite heavily used. ¹⁰⁷	Field

11.6 References

ALA 2020. *Chalinolobus dwyeri: Large-eared wattled bat* in Atlas of Living Australia. Available from: https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:4ce623b3-da72-4548-8b99a5894df28779

Department of the Environment 2020. *Chalinolobus dwyeri* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: <u>http://www.environment.gov.au/sprat</u>.

Department of Environment and Resource Management 2011. *National recovery plan for the largeeared wattled bat* Chalinolobus dwyeri. Report to the Department of Sustainability, Environment, Water, Population and Communities, Canberra. Available from: <u>http://www.environment.gov.au/biodiversity/threatened/recovery-plans/national-recovery-planlarge-eared-pied-bat-chalinolobus-dwyeri</u>.

Dwyer, P.D. 1966. *Observations on* Chalinolobus dwyeri *(Chiroptera: Vespertilionidae) Australia*. Journal of Mammalogy. 47:716-718.

Hoye, G.A. 2005. *Recovery plan for the large-eared wattled bat Chalinolobus dwyeri*. Fly By Night Bat Surveys Pty Ltd. Brisbane: Queensland Parks and Wildlife Service.

¹⁰⁸ DERM 2011

Lothian, Andrew (2019. *Large-eared wattled bat activity and buffer zones & large-eared wattled bat roost locations*. Consulting Ecology (Journal of the Ecological Consultants Association of NSW). Vol 43.

Pennay, M. 2008. A maternity roost of the Large-eared Wattled bat Chalinolobus dwyeri (Ryan) (Microchiroptera: Vespertilionidae) in central New South Wales Australia. Australian Zoologist. 34:564-569.

Threatened Species Scientific Committee (TSSC) 2012. *Commonwealth Listing Advice on* Chalinolobus dwyeri *(Large-eared Wattled bat)*. Department of Sustainability, Environment, Water, Population and Communities. Canberra, ACT.

Ryan, R.M. 1966. A new and imperfectly known Australian Chalinolobus and the taxonomic status of African Glauconycteris. Journal of Mammalogy. 47:86-91.

12. Corben's (south-eastern) long-eared bat (Nyctophilus corbeni)

12.1 Legal status

Environment Protection and Biodiversity Conservation Act 1999: Vulnerable

Nature Conservation Act 1992: Vulnerable

12.2 Ecology and distribution

Corben's long-eared bat (*Nyctophilus corbeni*), also known as the south-eastern long-eared bat, was originally classified as the greater long-eared bat (*Nyctophilus timoriensis*) until recently when it was officially described as a separate species.¹⁰⁹ It is a relatively large species of microbat with a head a body length of 50-75 mm and a tail length of 35-50 mm. Females are typically larger than males, weighing between 14-21 g; compared to 11-15 g for males. The species has a broad head and long erect ears (approximately 30 mm in length) that fold back when resting. It has light brown to dark grey-brown fur (see Figure 12-1).¹¹⁰



Figure 12-1: Corben's long-eared bat (Nyctophilus corbeni) (T. Reardon n.d)

12.2.1 Known distribution

As Corben's long-eared bat was only recently descried as a separate species, its past distribution is not well defined. It is known to occur in southern central Queensland, central western NSW, north-western Victoria and eastern South Australia (see Figure 12-2). It appears to be most abundant inland of the Great Dividing Range and a number of records for the species are from the Nandewar and Brigalow Belt South bioregions in New South Wales and Queensland. It is considered uncommon throughout its range, rarely being recorded.¹¹⁰

¹⁰⁹ Parnaby 2009

¹¹⁰ TSSC 2015

There is minimal information regarding the species population; and it is not known whether their numbers are declining. However, habitat loss and fragmentation are likely impacting suitable habitat for the species and reducing their area of occupancy.^{110,111}



Figure 12-2: Distribution range of Corben's long-eared bat (ALA 2020; DoE 2020)

12.2.2 Biology and reproduction

Corben's long eared bat is insectivorous and forages on a range of insects both in flight and on the ground. Whilst in the air, it consumes insects (including caterpillars) via foliage-gleaning or catches flying insects such as moths and beetles. Ground level prey include grasshoppers sand beetles. Foraging typically occurs around patches of trees and many individuals can share the same foraging area.^{110,112,113}

The species roosts solitarily within suitable habitat (see below) during the day and travels significant distances over night between foraging and roosting areas; changing roosting location frequently.^{110,114} On average they travel 2 km each night but have been observed travelling up to 7 km.¹¹⁵ The species has also been recorded roosting in groups to form maternity colonies of 10-20 individuals.¹¹⁴ The reproductive biology of Corben's long-eared bat is poorly understood; however, pregnant and lactating females have been observed during November in Queensland and NSW, and breeding is likely to be seasonal.¹¹¹

- ¹¹³ Lumsden & Bennett 2006
- ¹¹⁴ Lumsden et al. 2008
- ¹¹⁵ NGH Environmental 2013

¹¹¹ Schulz & Lumsden 2010

¹¹² Law et al. 2016

12.3 General habitat requirements

Corben's long-eared bat usually roosts within tree hollows, cervices or under bark in a variety of vegetation types that contain suitable foraging and roosting habitat, these include:^{110,111,116}

- Box/ironbark/cypress pine woodlands;
- Bulloak woodlands;
- Brigalow woodland;
- Belah woodland;
- Smooth-barked apple woodland;
- River red gum forest;
- Black box woodland; and
- Mallee shrublands.

In Queensland and NSW, the species is most abundant within box/ironbark/cypress-pine vegetation which occurs as a north-south belt along the western slopes and plains of New South Wales and southern Queensland.¹¹⁰

The species is typically more abundant in habitats with the following characteristics: ^{110,112}

- Large areas of vegetation rather than smaller patches likely due to the large home range of the species.
- Old-growth vegetation likely due to the species roosting requirements, particularly tree hollows.
- Vegetation with a district canopy and well-developed understorey.
- Areas with high stem density and a large proportion of dead trees (especially dead *Allocasuarina luehmannii*).

12.4 Central Queensland habitat definition

Preferred Corben's long-eared bat habitat in Central Queensland is defined as areas that comprise the following features in combination:

- Woodland or open forest with a complex understorey, typically on land zones 5 and 7; occasionally land zones 3 and 10 and characterised by the following floristic associations:
 - Canopy layer of *Eucalyptus fibrosa* subsp. *nubilus* and/or *E.* crebra and/or *E. populnea* and/or *E. microcarpa/E. moluccana*, often with *Angophora leiocarpa* and/or *Corymbia* spp., over a low tree layer of *Callitris* spp. and/or *Allocasuarina luehmannii*.
- Centred around three key groups of regional ecosystems, including:
 - o 11.5.1 / 11.5.4 cypress/bulloak/eucalypt on sandy or duplex soils; undulating plains
 - o 11.7.4 / 11.7.7 cypress/bulloak/eucalypt on shallow soils; low hills
 - o 11.3.18 / 11.3.2 poplar box/cypress/bulloak on sands and duplex soils; alluvial plains

¹¹⁶ DoE 2020

- Large tract size i.e. greater than ~500 ha¹¹⁷
- High stem-density of the low tree layer
- High density of dead trees especially Bulloak, cypress and eucalypts, which are critical for providing abundant roost microhabitat
- High abundance of hollows (especially in small diameter dead trees) is particularly important as they are used to a greater extent than fissures & loose bark.

Suitable Corben's long-eared bat habitat in Central Queensland is defined as:

• Areas adjacent and connected to areas of preferred habitat (noting particularly the requirement for large tract size), where vegetation is structurally and floristically similar to that of preferred habitat (see footnote for examples¹¹⁸).

12.5 Habitat identification guidance

Table 12 provides specific information about key attributes of Corben's long-eared bat habitat requirements, and where these data can be obtained. Collectively these data enable Corben's long-eared bat to be classified as suitable as described above. Given that the species utilises a wide range of inland woodland types, the species must be recorded for habitat to be classified as preferred.

Attribute	Description	Verification area
Vegetation composition	Bulloak, cypress and eucalypt communities	Desktop and field
Vegetation structure	Woodland or open forest with a complex understorey and high stem density of low tree layer	Field
Regional ecosystem associations that may constitute suitable habitat	As noted above in habitat descriptions	Desktop and field
Food resources	Consumes beetles, bugs and moths, with foraging concentrated around patches of trees in the landscape.	Field
Land forms/land zones	Typically on land zones 5 and 7; occasionally land zones 3 and 10	Desktop
Soils	N/A	N/A
Water (for drinking)	Requires free standing water for drinking.	N/A
Hydrological needs	N/A	N/A
Patch size	Large tract size is important i.e. >500 ha	Desktop
Connectivity	Large tract size is important i.e. >500 ha	Desktop

Table 12: Corben's long-eared bat habitat identification

117 Law et al. 2018

¹¹⁸ RE11.3.2, where there is a complex low-tree/understorey layer, especially with cypress; RE11.3.1 where dense low tree/shrub layer is present and extensive; waterholes in RE11.3.25 when that constitutes a narrow riparian strip through more extensive RE11.5.1; RE11.7.5 "heathland" where it is surrounded by or is part of a mixed RE with 11.7.4 and/or 11.7.7

Central Queensland Threatened Species Habitat Descriptions

Attribute	Description	Verification area
Shelter/denning/roosting	Roosts in tree hollows, crevices and under loose bark ¹¹⁹	Field
Micro habitat features	The availability of suitable roosting habitats is essential for the conservation of the species.	Field
Breeding resources	Maternity colonies roosting in dead trees including ironbarks, cypress and bulloak.	Field
Habitat condition	Given the species' requirements for large areas of land, smaller fragments may not provide viable habitat for the species. ¹⁰⁷	Field

12.6 References

ALA 2020. Nyctophilus corben: Corben's long-eared bat in Atlas of Living Australia. Available from: https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:23686af5-4d75-40f9-b29a-4d6d316b47fd#overview

Bradley Law, Leroy Gonsalves, Mark Chidel, Traecey Brassil 2016. *Subtle use of a disturbance mosaic by the south-eastern long-eared bat (Nyctophilus corbeni): an extinction-prone, narrow-space bat,* Wildlife Research 43(2), 153-168.

Department of the Environment 2020. *Nyctophilus corbeni* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: <u>http://www.environment.gov.au/sprat</u>.

Law, B., Gonsalves, L., Brassil, T. & Hill, D. (2018). Does thinning homogenous and dense regrowth benefit bats? Radio-tracking, ultrasonic detection and trapping. *Diversity* **2018**, *10*(*2*), 45; <u>https://doi.org/10.3390/d10020045</u>

Lumsden, L.F. & A.F. Bennett 2006. *Flexibility and specificity in the roosting ecology of the Lesser Longeared Bat* Nyctophilus geoffroyi: *A common and widespread Australian species*. Pp. 290-307. **In:** Akbar, Z., G.F. McCracken, and T.H. Kunz. (eds.). Functional and Evolutionary Ecology of Bats. New York: Oxford University Press.

Lumsden L, Nelson J, Lindeman M 2008. *Ecological research on the Eastern Long-eared Bat Nyctophilus timoriensis (south-eastern form). A report to the Mallee Catchment Management Authority.* Arthur Rylah Institute for Environmental Research, Department of Sustainability and Environment. Melbourne, Australia.

NGH Environmental 2013. *Biodiversity Assessment - Liverpool Range Wind Farm - Transmission Line Study Area*. Prepared for Epuron.

¹¹⁹ Department of the Environment (2020). Nyctophilus corbeni in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

Parnaby, H 2009. A taxonomic review of Australian greater long-eared bats previously known as Nyctophilus timoriensis (*Chiroptera: Vespertilionidae*) and some associated taxa. Australian Zoologist. 35:39-81.

Schulz M and Lumsden L 2010. *Draft national recovery plan for the south-eastern long-eared bat* Nyctophilus corbeni. Victorian Government Department of Sustainability and Environment. Melbourne, Australia.

Threatened Species Scientific Committee (TSSC) 2015. *Conservation Advice* Nyctophilus corbeni *southeastern long-eared bat*. Canberra: Department of the Environment. Available from: <u>http://www.environment.gov.au/biodiversity/threatened/species/pubs/83395-</u> <u>conservation_advice-01102015.pdf</u>.
13. Ghost bat (Macroderma gigas)

13.1 Legal status

Environment Protection and Biodiversity Conservation Act 1999: Vulnerable

Nature Conservation Act 1992: Endangered

13.2 Ecology and distribution

The ghost bat is largest microbat in Australia, weighing up to 150 g. It has a head and body length of 10-13 mm, forearm length of 10-11 cm and a wingspan of 60 cm; it does not have a tail. The species has a nose-leaf, long interjoined ears and large eyes (Figure 13-1).



Figure 13-1: Ghost bat (Macroderma gigas) (Duncan Mackenzie 2014)

13.2.1 Known distribution

The ghost bat once had a wide-ranging distribution across most of Australia, contracting northwards during times of increased aridity (preceding the last glacial maximum). Prior to European settlement, restricted subpopulations still occurred throughout the arid zone where suitable microclimates were available within caves. Most of these subpopulations have since disappeared with the species contracting further northward.¹²⁰ The last record of the species within the arid zone was in 1961.¹²¹

The ghost bat has a patchy distribution across northern Australia with colonies occurring in the Pilbara, Kimberley, northern Northern Territory, the Gulf of Carpentaria, western Queensland and coastal to near coastal eastern Queensland from Cape York to Rockhampton (see Figure 13-2).¹²⁰ Individual populations (colonies) are genetically distinct from each other (regionally and locally) and are highly structured; suggesting that individuals do not move between different sites. Females are also highly philopatric to their natal roost sites, with males contributing to gene flow between breeding

¹²⁰ TSSC 2016

¹²¹ Butler 1962



sites.^{120,122,123} Populations are likely to be declining and are at significant risk of further declines due to habitat loss and human disturbance; particularly habitat containing breeding sites.¹²⁰

Figure 13-2: Distribution range of the ghost bat (ALA 2020; DoE 2020)

13.2.2 Biology and reproduction

The ghost bat is Australia's only carnivorous bat, consuming small mammals (bats, rats, mice), small birds, reptiles, frogs and large insects. Their prey varies depending upon availability and they require a relatively consistent supply of food throughout the year.^{120,124} It forages by either ambushing prey from a perched location or gleaning surfaces (including the ground) while flying. Foraging typically occurs within around 2 km from the daytime roost site, covering an average area of 61 ha. Foraging locations can be shared with a number of individual bats and their vantage points change frequently while hunting (around every 15 minutes).¹²⁰

Female ghost bats begin breeding between 2-3 years of ages and typically give birth to a single young in late spring (commencing October). Females have been observed forming maternity roosts in warm caves to give birth, with some females moving to different caves with their young if disturbed or conditions become unfavourable (e.g. as summer progresses). Juvenile ghost bats begin flying at around 7 weeks of age.¹²⁰ Generation length is estimated to be approximately 8 years and the species has been recorded living up to 22.6 years in captivity (wild ghost bat longevity is unknown).¹²⁵

¹²² Worthington Wilmer et al. 1994

¹²³ Worthington Wilmer et al. 1999

¹²⁴ Hourigan 2011

¹²⁵ Woinarski et al. 2014

Ghost bats move between multiple different caves depending upon the season and weather conditions. They congregate in a small number of roost sites to breed, many of which have not been identified, and disperse up to 150 km from breeding areas during winter.^{120,124,126}

13.3 General habitat requirements

Ghost bats occupy a variety of habitats throughout their distribution including rainforest, tropical savanna, monsoon and vine scrub, open woodlands and arid areas. Within these areas they require suitable daytime roost sites and breeding roost sites. Roost sites include caves, rock crevices and old mines. As discussed, the species frequently changes roost location; however, there are some permanent roost sites across its range. The species is easily disturbed while roosting and may permanently abandon a roost site if disturbed.^{120,124}

For the ghost bat to persist in an area, populations require multiple caves/shelters that provide daytime roost sites within the vicinity (typically less than 5 km) of a gully or gorge system that opens onto a plain or riparian vegetation; providing adequate foraging habitat.¹²⁰ Roost site characteristics that enable regular or permanent occupancy are described below.^{120,127}

Nocturnal roost/foraging sites:

- Shallow caves/shelters
- Well-lit during the day
- Often poorly insulated from the elements
- Usually in high locations

Diurnal roost sites:

- Deeper, more complex caves or mines with multiple chambers
- Dome ceilings, fissures and/or passages
- Relatively stable microclimate (temperature between 23-28°C and levels of humidity between 50 and 100%)
- Roof height of at least 2-3 m

Maternal roost sites:

- Similar to diurnal sites but are large enough to support a growing population and have more stable conditions
- Multiple entranced caves are preferred

13.4 Central Queensland habitat definition

Separate definitions are provided for preferred & suitable roosting versus foraging habitat on the recommendation of species experts. The definition is also restricted to suitable habitat, as the species

¹²⁶ Richards et al. 2008

¹²⁷ Astron 2017

is restricted to only two breeding sites in Queensland (Mt Etna and Cape Hillsborough), from which is disperses outside of breeding season.

Suitable ghost bat habitat in Central Queensland is defined as:

- Roosting any disused mine tunnels or escarpments with caves and crevices within ~200 km of the breeding roosts at Mt Etna and Cape Hillsborough. Roost sites are likely to be restricted to deeper caves and abandoned tunnels in the Central Qld region, where cool winter nights would make more exposed, shallow overhangs unsuitable for at least the early part of the day.
- Foraging woodland, forest, wetland and cleared agricultural/pastoral land within ~3 km of daytime roosts.

13.5 Habitat identification guidance

Table 13 provides specific information about key attributes of ghost bat habitat requirements, and where these data can be obtained. Collectively these data enable preferred habitat to be classified as suitable as described above. The species must be recorded for habitat to be classified as preferred.

Attribute	Description	Verification area
Vegetation composition	A wide range of habitats from rainforest, monsoon and vine scrub in the tropics to open woodlands and arid areas. ¹²⁸	Desktop and field
Vegetation structure	Inhabits various vegetation communities including woodlands and open and closed forests.	Field
Regional ecosystem associations	REs occurring where caves, rock shelters, overhangs and vertical rock cracks have potential to be developed such as on LZs 8, 10, 11 and 12.	Desktop and field
Food resources	Small mammals (including other bats), birds, reptiles, frogs and large insects. ¹²⁹	Field
Land forms/land zones	Geology that forms caves, rock shelters, overhangs and vertical rock cracks.	Desktop
	To persist in an area, small colonies require a group of caves/shelters that provide alternative day and night roost sites, and a gully or gorge system that opens onto a plain or riparian line that provides good foraging opportunities, typically less than 5 km from the diurnal roost site. ¹²⁹	
Soils	N/A	Desktop
Water (for drinking)	Requires free standing water.	Desktop and field

Table 13: Ghost bat habitat identification

¹²⁸ Hourigan, C. 2011

129 TSSC 2016

Attribute	Description	Verification area
Hydrological needs	N/A	Desktop and field
Patch size	Unknown. However, the species can forage up to 150 km from maternity roosts during the non-breeding season. Known maternity roosts are genetically distinct throughout the species range.	Desktop
Connectivity	Importance unknown. However, geographically disjunct colonies occur throughout the species range.	Desktop
Shelter/denning/roosting	Diurnal roosts include caves, rock crevices and old mines. Roost sites used permanently are generally deep natural caves or disused mines with a relatively stable temperature of 23°–28°C and a moderate to high relative humidity of 50–100 percent. ¹²⁹	Field
Micro habitat features	Caves, rock shelters, overhangs, vertical cracks, and mines during the year as day roosts. ¹²⁸	Field
Breeding resources	Ghost bats concentrate in relatively few roost sites when breeding. Few of these sites are known. Known populations in central Queensland include Cape Hillsborough near Mackay and Mt Etna near Rockhampton. ¹²⁹	Field
Habitat condition	Ghost bats are easily disturbed when roosting. Remnant, and protected roosting sites may be important.	Field

13.6 References

ALA 2020. *Macroderma gigas: Ghost bat* in Atlas of Living Australia. Available from: <u>https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:63bc796a-5a85-45bc-b4bc-edecc931cc50</u>

Astron 2017. *Mesa H Ghost Bat, Macroderma gigas - Contextual Study*. Prepared for Robe River Mining Co. Pty Ltd.

Butler, W. H. 1962. *Occurrence of the Ghost Bat,* Macroderma gigas, *in the Great Victoria Desert, W.A.* The Western Australian Naturalist 8, 42-43.

Department of the Environment 2020. *Macroderma gigas* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: <u>http://www.environment.gov.au/sprat</u>.

Hourigan, C. 2011. *Ghost bat,* Macroderma gigas. *Targeted species survey guidelines*. Queensland Herbarium, Department of Environment and Science, Brisbane.

Richards, G. C., Hand, S., Armstrong, K. A., & Hall, L. S. 2008. *Ghost Bat* Macroderma gigas. In The Mammals of Australia. Third Edition. (Eds S. Van Dyck & R. Strahan), pp. 449-450. Reed New Holland, Chatswood.

Threatened Species Scientific Committee 2016. *Conservation Advice* Macroderma gigas *ghost bat*. Canberra: Department of the Environment.

Woinarski, J. C. Z., Burbidge, A. A., & Harrison, P. L. 2014. *The Action Plan for Australian Mammals 2012*. CSIRO Publishing, Collingwood.

Worthington Wilmer, J., Moritz, C., Hall, L., & Toop, J. 1994. *Extreme population structuring in the threatened ghost bat,* Macroderma gigas: *evidence from mitochondrial DNA*. Proceedings of the Royal Society of London B Biological Sciences 257, 193-198.

Worthington Wilmer, J., Hall, L., Barratt, E., & Moritz, C. 1999. *Genetic structure and male-mediated gene flow in the Ghost Bat* (Macroderma gigas). Evolution 53, 1582-1591.

14. Grey-headed flying-fox (Pteropus poliocephalus)

14.1 Legal status

Environment Protection and Biodiversity Conservation Act 1999: Vulnerable

Nature Conservation Act 1992: Least Concern

14.2 Ecology and distribution

The grey-headed flying-fox weights between 600-1000 g and has a head-body length of 230-289 mm; making it one of the largest bats in the world. It is distinguished from other flying-fox species by its collar of orange-brown fur around its neck and thick leg fur that extends to the ankle (not to the knee like other species). Its head is light grey, as is the belly fur; often with flecks/spots of white and ginger (see Figure 14-1). The species has back fur of varying colour; typically, being either dark grey or frosted silver. Their fur is darker in winter, prior to a moult which occurs in June, revealing lighter fur.¹³⁰



Figure 14-1: Grey-headed flying-fox (Pteropus poliocephalus) (NSW National Parks and Wildlife Service 2020)

14.2.1 Known distribution

The grey-headed flying-fox has a distribution spanning across the eastern and south-eastern coast of Australia; from Rockhampton in Queensland to Melbourne in Victoria (see Figure 14-2). It occurs at different locations throughout its distribution depending upon food availability; therefore, patterns of occurrence and abundance vary largely between seasons and years. There are regional trends in distribution and migration patterns for the species due the timing of flower and fruit production of native plant species. Their distribution is generally more widespread in summer and more restricted in autumn and winter. There are also a number of locations were the species is permanently present including Brisbane, Newcastle, Sydney and Melbourne.¹³⁰ In 2010, a permanent population of greyheaded flying-fox was also established in Adelaide.¹³¹

¹³⁰ DoE 2020

¹³¹ Natural Resources 2013

The population of grey-headed flying-fox is considered to be one single interbreeding population due to their wide movement patterns. The abundance of this population throughout its distribution is thought to be decreasing due to the loss and modification of suitable habitat, particularly roosting habitat. ^{130,132}



Figure 14-2: Distribution range of the grey-headed flying-fox (ALA 2020; DoE 2020)

14.2.2 Biology and reproduction

The grey-headed flying-fox is a canopy-feeding frugivore and nectivore that feeds on a variety of plant species; selectively foraging where food is available. Their primary food source is nectar and pollen from eucalyptus flowers (*Eucalyptus, Corymbia* and *Angophora*), melaleucas and banksias. Eucalypt species flower at varying times during the year and many do not flower every year, this contributes to the grey-headed flying-fox's breeding and migration patterns. The species also feeds on rainforest fruits, cultivated fruit crops and modified vegetation within urban environments. They typically travel within 15 km of their daytime roost site when foraging but can travel up to 50 km to find food if necessary.¹³⁰

Female grey-headed flying-foxes typically reach sexual maturity at 3 years of age and produce one young annually. The species has a slow population growth rate as females will abort or abandon their young in unfavourable conditions (food shortage, high temperatures). Breeding camps form in late spring to early summer when food resources are abundant, with mating occurring in early autumn. After mating the camps begin to break up as males and females segregate in October when females give birth. Females carry their young with them while feeding for 4-5 weeks until the young are furred; at which point they are left in maternal camps to be nursed. Lactation occurs for three to four months after birth until the young are independent at around 12 weeks of age.¹³⁰

The species has an average longevity of 7.1 years and a generation length of 7.4 years.¹³³ Their life expectancy is highly variable and dependent upon environmental conditions. Heat-related deaths are very common, with mass mortalities often occurring during heatwaves.^{133,134}

¹³² TSSC 2011

¹³³ Tidemann & Nelson 2011

¹³⁴ Eby et al. 2004

14.3 General habitat requirements

The grey-headed flying-fox occupies a variety of habitats throughout its large distribution including rainforests, open forests, *Melaleuca* swamps, closed and open woodlands (particularly *Banksia* woodlands) and modified vegetation within urban environments (including non-native species). As discussed, the species migrates between areas based upon food availability and can therefore utilise highly fragmented and patchy vegetation. The species roosts on exposed branches in tress of various size and species, located close to water. ^{130,135} Camps (both temporary and permanent) are typically established in areas with the following characteristics:¹³⁵

- closed canopy with continuous coverage of > 1 ha;
- canopy height of \geq 8 m;
- level topography;
- within 50 km of the coast;
- within 500 m of a waterway/waterbody; and
- within 20 km of foraging areas.

A number of permanent camp sites have been established within or in close proximity to urban areas due to the continual supply of food resources and roosting habitat.¹³⁰

14.4 Central Queensland habitat definition

Separate definitions are provided for preferred & suitable roosting versus foraging habitat on the recommendation of species experts.

Preferred grey-headed flying-fox habitat in Central Queensland is defined as:

- Roosting known grey-headed flying-fox camps.
- Foraging all *Eucalyptus, Corymbia, Melaleuca, Angophora* or fruiting rainforest vegetation communities that have potential to provide food resources¹³⁶ for the species occurring within 50 km of preferred roosting habitat.

Suitable grey-headed flying-fox habitat in Central Queensland is defined as:

- Roosting any known camps of other flying-fox species (e.g. black and little red flying-foxes).
- Foraging all *Eucalyptus, Corymbia, Melaleuca, Angophora* or fruiting rainforest vegetation communities that have potential to provide food resources¹³⁷ for the species occurring within 50 km of suitable roosting habitat.

¹³⁵ EGSC 2015

¹³⁶ Eby and Law 2008 provides additional guidance as to significant blossom and fruit dietary components

¹³⁷ Eby and Law 2008 provides additional guidance as to significant blossom and fruit dietary components

14.5 Habitat identification guidance

Table 14 provides specific information about key attributes of grey-headed flying-fox habitat requirements, and where these data can be obtained. Collectively these data enable preferred habitat to be classified as preferred and suitable as described above.

Attribute	Description	Verification area
Vegetation composition	Foraging – Eucalyptus, Corymbia, Melaleuca, Angophora or fruiting rainforest vegetation	Desktop and field
Vegetation structure	Roost sites – closed canopy with continuous coverage of > 1 ha and canopy height of $\ge 8 \text{ m.}^{135}$	Field
Regional ecosystem associations that may comprise preferred and suitable habitat	Wide range of REs will be used	Desktop and field
Food resources	Myrtaceae dominant. Nectar and pollen from the flowers of eucalypts (genera <i>Eucalyptus, Corymbia</i> and <i>Angophora</i>), melaleucas and banksias are the primary food for the species, but in some areas it also utilises a wide range of rainforest fruits and introduced urban fruits. ¹³⁵	Field
	Species commutes daily to foraging areas, usually within 15 km of the day roost site. Are capable of nightly flights of up to 50 km from their roost to different feeding areas as food resources change. ¹³⁸	
Land forms/land zones	N/A	N/A
Soils	N/A	N/A
Water	Roost sites are typically located near water, such as lakes, rivers or the coast. ¹³⁸	Desktop and field
Hydrological needs	N/A	N/A
Patch size	N/A	N/A
Connectivity	Configuration of foraging areas in proximity of camps/roosts is important. ¹³⁸	Desktop
Shelter/denning/roosting	 Camp sites across their distribution typically include some of the following attributes Closed canopy; Continuous canopy area > 1 ha; Within 50 km of the coast and at less than 65 msl; Close proximity to waterways (< 500m); Level topography; 	Field

¹³⁸ DoE 2020

Attribute	Description	Verification area
	 Canopy height 8m and above; and Positioned with a nightly commuting distance of generally less than 20km of sufficient food resources.¹³⁵ 	
	The above are typical attributes but the changing nature of foraging resources has led to more establishment in urban environments in recent years.	
Micro habitat features	Camps are formed in response to the location and timing of local flowering and fruiting events. An area will be occupied for a few weeks to several months until the food resource is exhausted. ¹³⁵	Field
Breeding resources	Camps are commonly located in closed forest, Melaleuca swamps or stands of Casuarina and are generally found near rivers or creeks. The species display a degree of flexibility in their choice of camp vegetation and location and may include urban areas.	Field
Habitat condition	A number of 'urban' roost sites that are occupied year- round have become established due to consistently available food resources and suitable roosting habitat. ¹³⁵ Remnant woodlands and open forests are more likely to host an abundance for food resources.	Field

14.6 References

ALA 2020. *Pteropus poliocephalus: Grey-headed flying-fox* in Atlas of Living Australia. Available from: https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:7065d246-3017-4768-9c8f-8c58c0e538c1

Department of the Environment 2020. *Pteropus poliocephalus* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: <u>http://www.environment.gov.au/sprat</u>.

East Gippsland Shire Council (EGSC) 2015. *Mitchell River Revegetation Program - Bairnsdale Greyheaded Flying Fox Roost Site Strategic Management and Action Plan.*

Eby, P. 2004. *National Count of Grey-headed Flying-foxes April 3 and 4, 2004*. A report to the Department of the Environment and Heritage, Queensland Parks and Wildlife Service, NSW Department of Environment and Conservation, Victorian Department of Sustainability and Environment.

Natural Resources 2019. *Grey-headed Flying-foxes in South Australia*. Department for Environment and Water SA.

Threatened Species Scientific Committee 2001. *Commonwealth Listing Advice on* Pteropus poliocephalus (*Grey-headed Flying-fox*).

Tidemann, C.R. & J.E. Nelson 2011. *Life expectancy, causes of death and movements of the grey-headed flying-fox (Pteropus poliocephalus) inferred from banding*. Acta Chiropterologica. 13(2):419-429.

Appendix A: outcomes of expert elicitation and review

The following section provides full details of the expert reviewers' professional credentials as well as the outcomes of their reviews.

Table 15: Expert reviewer's credentials

Name	Current position	Years' experience in central QLD	Short professional biography	Relevant literature you have published in peer reviewed publications	Species definitions reviewed
Steve Wilson	Fauna Consultant; Information Officer at the Queensland Museum	35 years	Author of 12 books on Australian herpetology including the standard field guides in use across Australia; 'A Complete Guide to Reptiles of Australia' editions 1-5, 'A Field Guide to Reptiles of Queensland' editions 1-2, 'Australian Lizards - A Natural History' and 'Reptiles of the Southern Brigalow Belt', among others. Extensive field work through inland Queensland, in private capacity and as a consultant. Employed as an Information Officer at Queensland Museum since 1986, identifying specimens and providing information to the public about Queensland ecology and taxonomy.	Books to the left are peer reviewed. Wilson, S. & Swan, G. The Ornamental Snake (Denisonia maculate): notes on habitat and population density of a vulnerable elapid snake. Herpetofauna 44; 1-2. Pp 8-14 Couper, P., Covacevich, J. & Wilson, S. Two New Species of <i>Ramphotyphlops</i> (Squamata: Typhlopidae) from Queensland'. Memoirs of the Queensland Museum (1998) 42(2): pp 459 - 464. Wilson, S. New Information on <i>Pseudechis papuanus</i> (the Papuan Black Snake)'. Memoirs of the Queensland Museum, 42 (1): p 232. Wilson, S. & Couper, P. A New <i>Ctenotus</i> (Reptilia:Scincidae) from the Mitchell Grass Plains of Central Queensland Museum, 1995, 38(2): 687-690.	Ornamental snake Collared delma Yakka Skink
Dr Penn Lloyd	Principal Ecologist, Biodiversity Assessment & Management Pty Ltd (BAAM)	27 years	Penn leads the ecology team at BAAM and has over 27 years of field experience as a terrestrial ecologist. Having authored 230 consultancy reports over the past 10 years as a consultant based in Queensland, he has extensive experience with a wide variety of fauna and flora survey techniques, habitat mapping methodologies, impact assessment and	63 peer reviewed publications in ecology, including 22 in the past 10 years. One publication included Australian Painted Snipe as a study species.	Squatter pigeon Ornamental snake Australasian painted snipe

Name	Current position	Years' experience in central QLD	Short professional biography	Relevant literature you have published in peer reviewed publications	Species definitions reviewed
			reporting to ensure best practice ecological assessment to meet regulatory guidelines.		
Lindsay Agnew	Principal Biologist and Director, Austecology	Over 24 years of field experience within central Queensland	Lindsay has a specialist capacity in terrestrial vertebrate zoology which has been developed with over 30 years of experience as a practising ecologist in Eastern and Northern Australia. Lindsay has widespread experience with Central Queensland, including surveys across leases of over 24 major mining sites, and a principal investigator / author for several industry funded research projects based within central Queensland. Lindsay has been the contributing author in regard to waterbirds, migratory shorebirds, and threatened fauna for a variety of Commonwealth, State and Territory Government reports, including those for Ramsar Wetlands of International Significance. Lindsay has been a member of advice panels to the Australian Government on MNES as listed under the EPBC Act, e.g. threatened bats, reptiles, birds, and Koala.	None relevant to geographic area.	Koala Greater glider Squatter pigeon Ornamental snake Australasian painted snipe
Brad Dreis	Principal Ecologist, E2M	18 years	Brad is a Principal Ecologist with experience throughout Queensland, including over 15 years of experience undertaking flora and fauna surveys in Central Queensland. He is highly experienced in undertaking terrestrial flora and fauna surveys in the region including targeted surveys for the threatened species for which he has reviewed.	Schmidt-Lebuhn AN, Marshall DJ, Dreis B, Young AG. Genetic rescue in a plant polyploid complex: Case study on the importance of genetic and trait data for conservation management. Ecol Evol. 2018;8:5153–5163.	Koala Greater glider Squatter pigeon Ornamental snake Australasian painted snipe Painted honeyeater
Greg Ford	Principal Ecologist, Balance! Environmental	20+ years	Greg is a terrestrial ecologist with more than 30 years' experience gained through government, community/NGO, university, and private sector projects throughout eastern and northern Australia. He is a nationally recognised expert on Australian bats, with highly specialised skills in echolocation call analysis for microbat identification. Through his business, <i>Balance! Environmental</i> , Greg is the primary supplier of bat-call analysis services and threatened species ecological advice for consultants to the mining and CSG industries throughout the Bowen, Surat and Galilee Basins	NA	Large-eared Wattled bat Corben's (south- eastern) long- eared bat Ghost bat

Name	Current position	Years' experience in central QLD	Short professional biography	Relevant literature you have published in peer reviewed publications	Species definitions reviewed
			of Central Queensland. He has an extensive knowledge of bat ecology, bat survey design and analysis, and bat roost management. A Life Member of the Australasian Bat Society (ABS), Greg is currently working with other ABS member scientists on a major revision of bat distribution mapping for all extant Australian species.		Grey-headed Flying-fox
Craig Eddie	Principal Ecologist, BOOBOOK Ecological Consulting	25+ years	Craig is a respected ecologist based at Roma in the Brigalow Belt of Queensland. He has undertaken biological surveys and ecological impact assessments for the past 25 years, both for the Queensland Parks and Wildlife Service and as an environmental consultant, working throughout the Surat and Bowen Basins. He is recognised as a local expert on southern Brigalow Belt fauna and flora with specialist knowledge of threatened Brigalow Belt reptiles and land snails, as well an extensive knowledge of Brigalow Belt ecology. He has contributed to state government threatened species conservation programs and federal government threatened species listings, as well as conducting numerous third party technical reviews concerning threatened fauna and their habitat associations.	Eddie, C. 2012. Yakka Skink. Pp.224-225 in Curtis, L.K., Dennis, A.J., McDonald, K.R., Kyne, P.M. and Debus, S.J.S. eds. <i>Queensland's</i> <i>Threatened Animals</i> . Collingwood, Victoria: CSIRO Publishing.	Koala Greater glider Squatter pigeon Ornamental snake Yakka skink Australian painted snipe Painted honeyeater Collared delma Large-eared Wattled bat Corben's (south- eastern) long- eared bat
Liz Fisher	Principal Ecologist / Ecology Team Lead, AECOM	12 years	Liz is a principal ecologist and has been working in the consultancy sector for over 12 years. During this time her role has involved undertaking large scale field investigations, interpreting ecological data within a policy and legislative context, spatially representing ecological values through vegetation and habitat mapping as well as preparing impact assessment documentation. Her experience in Central Queensland ecology, including the region's flora, fauna, vegetation communities and habitat types is extensive. Specifically, she has undertaken a substantial number of	NA	Koala Greater glider Squatter pigeon Ornamental snake Yakka skink Painted honeyeater

Name	Current position	Years' experience in central QLD	Short professional biography	Relevant literature you have published in peer reviewed publications	Species definitions reviewed
			targeted surveys for threatened species known to occur within the Bowen Basin, including koala, squatter pigeon, ornamental snake, yakka skink and greater glider.		
Berlinda Ezzy	Associate Ecologist, EMM	10+ years	Berlinda is an Associate Ecologist with 20 years of professional experience. She has worked for local and state government, as well as the private sector, across a range of environmental disciplines. Berlinda's areas of expertise include environmental planning and approvals, threatened species management, coordinating delivery of field ecology surveys and reporting, environmental impact assessments and biodiversity offsets. Berlinda has a comprehensive understanding of the Brigalow Belt ecosystems and species they support. Berlinda has designed and managed a number of terrestrial ecology surveys in central Qld, including targeted threatened flora and fauna surveys and habitat assessments. Berlinda has prepared threatened species habitat mapping and threatened species management plans.	NA	Painted honeyeater Grey-headed Flying-fox
Andrew Jensen	Associate Ecologist, EMM	5-10 years	Andrew has fifteen years professional consulting experience across a range of environmental disciplines, in particular terrestrial ecology. Key aspects of his work have included project management, client liaison, preparation of environmental impact statements, preparation of management plans, ecological reporting and surveying, ecological offset plans, management of subcontractors and health and safety processes. Andrew routinely reviews environmental technical studies and has developed environmental management plans and negotiated environmental approval conditions for clients. Andrew has also been responsible for conducting several species impact significance assessments at both Commonwealth and state level and is familiar with the requirements of this process. Andrew has also been responsible for managing, coordinating and undertaking fieldwork campaigns across Queensland.	NA	Painted honeyeater Grey-headed Flying-fox

Table 16: Summary of expert reviews for Koala

Review question	Responses			
Draft definitions reviewed by experts:				
Preferred koala habitat in Central Queensland is defined as:				
 Contiguous patches of woodland and forest occurring within areas with reliable access to soil moisture¹³⁹, and Where primary or secondary food trees¹⁴⁰ are <i>dominant</i> in the canopy. Primary food trees across the entire Central Queensland region include <i>Eucalyptus camaldulensis</i> ar <i>E. tereticornis.</i> 				
Suitable koala habitat that provides food resources or aids to	o movement for the species in Central Queensland is defined as:			
Remnant and regrowth dry eucalyptus open forest	to woodlands where primary or secondary food trees are <i>present</i> in the canopy.			
Marginal koala habitat in Central Queensland is defined as:				
All other fragmented and sparsely distributed woo resources or aids to movement.	• All other fragmented and sparsely distributed woodlands and open woodlands, shrub lands and forests in modified agricultural-grazing landscapes that may provide food resources or aids to movement.			
Expert reviews undertaken: 4 reviews – Brad Dreis,, Lindsay Agnew, Craig Eddie and Liz Fisher				
Preferred habitat – review comments				
Q1: What information in the draft definition of preferred habitat do you support and why? Please provide specific evidence, where possible	BD – Agree with the first requirement that koalas require 'contiguous patches of woodland and forest occurring within areas with reliable access to soil moisture (although would suggest a rewording to 'contiguous remnant woodland and open-forest near a permanent or ephemeral water source'). Also agree that primary food trees should be dominant in the canopy.			
	LA – I think the reference to 'occurring within areas with reliable access to soil moisture' has merit, though research has demonstrated that in some parts of Central Queensland, habitats which do not occur within such areas are indeed seasonally important.			
	CE – The description is a reasonable statement based on current knowledge but needs further refinement – see further comments below.			

¹⁴⁰ Primary food and secondary food trees vary on the location within Central Queensland. Refer to

https://www.savethekoala.com/sites/savethekoala.com/files/uploads/20150212 AKF National Koala Tree Planting List.pdf for guidance

¹³⁹ Soil moisture is defined as moisture stored in the pore spaces between and within soil that is affected by a range of factors including precipitation, temperature and soil structure. Soil moisture may originate from a variety of sources e.g. groundwater aquifers, nearby wetlands/watercourses, rainfall seepage/runoff.

Review question	Responses
	LF – I agree with the definition in the fact that it aligns well with the EPBC Act guideline for Koala in relation to habitat critical to the survival of the species. From my experience in the field, Koala's are predominantly recorded within riparian zones in Central Queensland in Eucalyptus tereticornis or Eucalyptus camaldulensis canopy trees
Q2: What information in the draft definition of preferred habitat do you <u>not</u> support and why? Please provide specific evidence, where possible	BD – Agree with the first requirement that koala's require 'contiguous patches of woodland and forest occurring within areas with reliable access to soil moisture (although would suggest a rewording to 'contiguous remnant woodland and open-forest near a permanent or ephemeral water source'). Also agree that primary food trees should be dominant in the canopy.
	LA – Broadly defined as any woodland or forest which is consistent with a Regional Ecosystem and where primary koala food tree species are dominant in the canopy. Primary food tree species are limited to the Eucalyptus and Corymbia genera. Preferred food tree species may vary seasonally and / or between geographically with Central Queensland.
	CE – Suggest re-word "with reliable access to soil moisture". Soil moisture is defined but I am not sure what is meant by reliable access to this. At a minimum I would suggest incorporating riparian and floodplain REs as preferred habitat and then provide other examples as necessary of additional 'moist' habitats being referred to.
	LF – I don't think there is data and evidence to support that breeding exclusively occurs in the described preferred habitat for Koala. The definition of preferred habitat only covers off on the definition for habitat critical for the survival of the species but not the full definition and understanding of breeding habitat for Koala. The definition for suitable habitat provides a more accurate description of potential breeding habitat as well as foraging habitat for the species.
Q3: Do you have additional suggestion to improve the draft definition of preferred habitat ?	BD – Our experience and analysis of koala records in the Moranbah area (see below) indicate a strong preference for riparian areas in central Queensland with 72% of 95 records within riparian REs.
	Our field experience indicates tree density or canopy cover is an important factor for koalas and maybe this could be captured in the habitat definition.
	LA – There may be merit in highlighting riparian habitat and that associated with adjacent surrounds of wetlands (seasonal or permanent) to augment preferred habitat, though these areas would need spatial definition – e.g. within XXm of a mapped watercourse or wetland.
	CE – See above
	LF – This is an example of how combining quality / importance as well as habitat utilisation can be problematic when defining habitat categories for some species. I would recommend using the definition of preferred habitat as separate standalone criteria to assess when breeding and foraging habitat is habitat critical to the survival of the species. A broader and more encompassing and therefore technically accurate definition for breeding and foraging habitat should be developed i.e. the definition that is used for suitable habitat.
	Parameters should be provided around 'contiguous patches' (i.e. amount of hectares) and 'dominant' (i.e. > 50%).

Review question	Responses
	A common observation in koala occurrence in Central Queensland is the preference of vegetated ridgelines, particularly dominated by ironbark species and riparian zones. High density of individuals have been recorded in areas of contiguous vegetation supporting these habitat types e.g. vegetated ranges to the west of the Saraji and Peak Downs mine sites.
General and/or marginal habitat – review comments	
Q4: What information in the draft definition of suitable and/or marginal habitat do you support and why? Please	BD – I generally agree with the description for suitable habitat. I also agree that fragmented vegetation may provide food resources or aids to movement and therefore constitutes marginal habitat.
provide specific evidence, where possible.	LA – (Marginal) seems to be a warranted / workable description. (Suitable) no comment provided.
	CE – Concept is supported but needs slight rewording.
	LF – I agree with the definition for suitable habitat in the fact that it aligns well with the foraging and dispersal habitat guidance provided in the EPBC Act guideline for Koala. From my experience in undertaking field surveys in Central Queensland koalas are record in this habitat type; however it is less common. In these circumstances, suitable habitat is usually connected or adjacent to preferable habitat.
	I agree with the definition of marginal habitat in the fact that it would provide limited resources for Koalas due to the lack of connectivity and density of foraging / sheltering resources. The species has been rarely recorded in this habitat in Central Queensland
Q5: What information in the draft definition of suitable	BD – I do not agree that shrublands should be included in marginal habitat.
and/or marginal habitat do you <u>not</u> support and why? Please provide specific evidence, where possible.	LA – See below
	CE – See below
	LF – I do not support that suitable habitat would only be utilised by Koala for foraging purposes. It would also provide breeding habitat for Koala. I also do not think remnant areas that contain koala food trees would be considered lower quality foraging habitat and only used opportunistically. Suitable habitat could be occupied and utilised more than 'opportunistically' during non-drought conditions and in fragmented landscapes.
	I have never recorded koala in purely regrowth habitats. Presence of emergent trees has been a requirement.
Q6: Do you have additional suggestion to improve the draft definition of suitable and/or marginal habitat ?	BD – For marginal habitat I recommend replacing 'food resources or aids to movement' with 'scattered primary and secondary food trees and movement corridors'.
	 LA – (Suitable) remnant or regrowth woodland or open forest where food trees are present, though do not dominate the canopy. Food tree species are limited to Eucalyptus, Corymbia, Angophora, Lophostemon and Melaleuca genera. This habitat may provide food resources and / or aid movement between areas of preferred habitat.
	CE – Suggest rewording the definition of "suitable habitat" to more clearly distinguish between preferred habitat such as:

Review question	Responses	
	• "Remnant eucalypt open forests to woodlands where primary or secondary food trees are present but not dominant in the canopy and that have some degree of connectivity"	
	"Regrowth of eucalypt-dominated vegetation containing primary or secondary food trees"	
	For marginal habitat, the current definition could include almost any vegetation type – the definition at the minimum needs to include a reference to eucalypt or Myrtaceae-dominated vegetation that contains at least one species of potential food tree.	
	Marginal habitat can occur in large forested tracts not just in agricultural-grazing landscapes. For example, we have found koalas or evidence thereof in large patches of <i>Callitris glaucophylla</i> -dominated forest. We believe these are individuals moving through the forest (most likely to areas which could be considered as preferred or suitable habitat) as there are usually insufficient food resources to support koalas in this habitat for any length of time.	
	LF – I would recommend removing the 'quality' component associated with the habitat categories and keeping it based on utilisation.	
	For the modified habitat definition I would recommend including 'shrublands with emergent trees' to provide more clarification on what habitat could be used by Koalas.	
	Suitable habitat category definition states that this can be considered habitat critical to the survival of the species if connected. Clarification should be provided if this is the case for this species. I would recommend having standalone criteria to specifically determine this.	
Q7: For species where only two habitats types are defined	BD – NA	
(e.g. preferred and suitable or marginal), do you think the	LA – NA	
third habitat type should be included? If not, why? If so, why and please provide a suggested definition	CE – NA	
	LF – NA	
Other review comments		
Q8: Do you have other comments or information?	BD – I would suggest that preferred habitat should be remnant patches that are dominated by primary food trees and suitable habitat be remnant patches that are dominated by secondary food trees with primary food trees present.	
	Define how big a contiguous patch is (minimum of 50 ha as per Table 2-1?).	
	Ensure consistent use of vegetation structural categories where relevant. For example, preferred and marginal habitat currently refers to woodland and open-forest.	
	I don't believe that Eucalypt species diversity is particularly important for koala habitat utilisation. Our experience is that an abundance of one or two primary food species is just as good / better. This is often the case in riparian areas where koalas are most encountered in central Queensland.	

Review question	Responses
	Koalas rarely drink water save for drought/habitat loss (e.g. bushfire) affected areas. Therefore I would suggest that access to koala drinking water is not a strong contributing factor to habitat suitability.
	We recently did some analysis of koala records in the Moranbah area which identified that RE's 11.3.25 (38% of 95 records), 11.5.3 (19%). 11.3.2 (13%), 11.3.27 (7%) and 11.3.1 (6%) are the most important REs in this area. Note that this is based off RE mapping where the RE was not ground-truthed.
	LA – None.
	CE – Table 2-1.
	Vegetation Composition: the veg composition need not contain a high diversity of eucalyptus species. Several of the preferred REs (e.g. 11.3.4 and 11.3.25) are frequently dominated by a single eucalypt species. This would better be represented by including at least some of the more commonly utilised species in central qld – there are plenty of egs in the available literature.
	Vegetation structure: remove the "associated with composition" as this is currently meaningless unless the veg composition definition is modified. This could simply refer to "open forests, woodlands, open woodlands" including remnant and regrowth
	RE Associations: This would be far more useful if divided into preferred, suitable and marginal but habitat preferences (and therefore RE associations) vary depending on the area in CQ being referred to. However, there seem to be several REs that consistently produce multiple records of koalas whereas they are rarely recorded in others. Following is a suggested list but this would be subject to further modification based on experience of other reviewers in various parts of CQ:
	Preferred: 11.3.2, 11.3.2a, 11.3.2b, 11.3.4, 11.3.4a, 11.3.25, 11.3.27
	Suitable: 11.3.3, 11.3.6, 11.3.7, 11.3.9, 11.3.10, 11.3.14, 11.3.15, 11.3.17, 11.3.18, 11.3.26, 11.3.28, 11.3.29, 11.3.30, 11.3.35, 11.3.36, 11.3.37, 11.3.39, 11.4.2, 11.4.7, 11.4.10, 11.4.12, 11.4.13, 11.5.1, 11.5.1a, 11.5.2, 11.5.3, 11.5.3b, 11.5.5, 11.5.5c, 11.5.7, 11.5.8, 11.5.9, 11.5.9b, 11.5.9c, 11.5.9d, 11.5.12, 11.5.13, 11.5.17, 11.5.20, 11.7.1, 11.7.4, 11.7.6, 11.7.7, 11.8.1, 11.8.2, 11.8.4, 11.8.5, 11.8.5a, 11.9.1, 11.9.2, 11.9.7, 11.9.7a, 11.9.9, 11.9.10, 11.9.13, 11.10.1, 11.10.1a, 11.10.1d, 11.10.2, 11.10.2a, 11.10.4, 11.10.5, 11.10.7, 11.10.7a, 11.10.11, 11.10.11a, 11.10.12, 11.10.13a, 11.11.1, 11.11.3, 11.11.3c, 11.11.6, 11.11.9, 11.11.0, 11.11.10a, 11.11.1, 11.11.5, 11.11.15a, 11.11.16, 11.11.9, 11.12.1, 11.12.1b, 11.12.2, 11.12.3, 11.12.5, 11.12.6 and 11.12.7
	Marginal: 11.3.19, 11.5.4, 11.5.4a, 11.7.2, 11.7.3, 11.7.5, 11.10.3, 11.10.6, 11.10.9, 11.10.13, 11.11.2
	Food resources: A list of commonly utilised food trees would be of use here (i.e. provide some more specific information to CQ) and divide into primary and secondary where known. Known food trees in CQ include (but are not limited to): <i>E. camaldulensis, E. tereticornis, E. populnea, E. orgadophila, E. melanophloia, E. crebra, E. moluccana, E. woolsiana, E.</i>

Review question	Responses
	microcarpa, E. coolabah, E. brownii, E. cambageana, E. thozetiana, E. exserta, E. chloroclada, E. major, E. grisea, E. longirostrata, E. melliodora, Corymbia citriodora, C. tessellaris.
	Landforms/land zones: provide specific land zones i.e. 3,4,5,7,8,9,10,11,12
	LF – None
Q9: Are there other resources, particularly published literature or outcomes of research, relevant to this species in central Queensland that are not referenced in the current work? If so, please provide details and a link (if possible).	 BD – Melzer, A., Santamaria, F., and Allen, S. (2018) The koalas, koala habitat and conservation management in the Clarke-Connors Ranges and associated landscapes. A report to the Queensland Department of Transport and Main Roads. Koala Research CQ, School of Medical and Applied Sciences, CQUniversity, Rockhampton. LA – None. CE – None.
	LF – From memory there is a report that was prepared by Footprints that looked at Koala utilisation across the Peak Downs mine. The study analysed scat samples and leaf content to draw conclusions on which Eucalypt species were foraged more heavily / often.

Table 17 Summary of expert reviews for Greater Glider

Review question	Responses	
Draft definitions reviewed by experts:		
Preferred greater glider habitat in Central Queensland is defined as:		
 Remnant, highly connected eucalypt woodlands containing more than 4 hollow bearing trees/ha, with hollows medium-large in size (>10 cm entrance). In Central Queensland, preferred foraging and den trees include E. camaldulensis, E. tereticornis, E. fibrosa and Corymbia citriodora. The species has also been observed in Eucalyptus cambageana, , E. orgadophila, E. populnea, E. melanophloia and C. tessellaris in which it may use for foraging and/or denning. 		
Marginal greater glider habitat in Central Queensland is defined as:		
• Remnant or high value regrowth vegetation adjacent to preferred greater glider habitat where hollows are smaller and/or less frequent. Isolated patches of marginal habitat >100 m from adjacent habitat do not provide habitat for the species due to gliding capabilities.		
Expert reviews undertaken: 4 reviews – Brad Dreis, Lindsay Agnew Craig Eddie and Liz Fisher		
Preferred habitat – review comments		
Q1: What information in the draft definition of preferred habitat do you support and why? Please provide specific evidence, where possible	 BD – I support the requirement for at least 4 hollow bearing trees / ha and medium-large hollows (>10 cm entrance) based on observations undertaken in central Queensland. LA – Not provided. CE – The description is a reasonable statement based on current knowledge. LF – I agree with all aspects of the definition as it aligns well with the known information on the species as well as my experience in the field with regards to the species requirements for breeding and foraging and what habitat would be considered critical for the species survival. This includes surveys where greater than 20 individuals have been recorded along 2km stretch of creekline containing habitat features as described in the preferred habitat definition. Recorded individuals have also been restricted to these habitat and rarely seen past these areas in adjacent habitats. The described preferred habitat can also only be a tree width wide (very narrow linear strips) and still support these species if sufficient canopy connectivity and tree hollows are present. 	
Q2: What information in the draft definition of preferred habitat do you <u>not</u> support and why? Please provide specific evidence, where possible	BD – NA LA – See below CE – NA LF – None	
Q3: Do you have additional suggestion to improve the draft definition of preferred habitat ?	BD – We have recorded numerous greater glider in habitat dominated by <i>Eucalyptus coolabah</i> , as well as foraging on this species, in the Moranbah and Dysart areas over the past few years. Therefore, I would suggest that <i>Eucalyptus</i>	

Review question	Responses
	<i>coolabah</i> is added to the description for preferred habitat based on these observations as well as the fact that species is one of the better hollow forming species in the region.
	I would also suggest that a minimum patch size of 100 ha (at least) is included in the definition for preferred habitat. Although the studies were not undertaken in central Queensland, Eyre (2006) and Possingham et al (1994) found that greater glider are likely to require large patches (>100 ha) in studies in southern areas and its reasonable to assume the central Queensland populations would have a similar patch size requirement.
	LA – On habitat connectivity, greater gliders are regarded as poor dispersers across open ground. Given the average canopy height of the REs listed, the assumed 400 glide angle, and on level terrain, I suspect that they might achieve a glide of about 24 to 36m at most (given a launch height of 20-30m). Your glide distance of 100m is likely to be well out of reach on level terrain in Central Queensland.
	CE – I have also observed foraging in Angophora floribunda, Eucalyptus coolabah, E. laevopinea, E. moluccana and E. crebra.
	Note in Table 2.1 under microhabitat features the minimum hollow entrance size is given as 80mm whereas the preferred habitat description is >10cm – need to be consistent in application of sizes.
	LF – Whilst for this species the current habitat categorisation works, it does not for all species (e.g. Koala, Ornamental Snake, Squatter Pigeon). Therefore, for the sake of consistency I would still recommend changing the categories based on utilisation and then have standalone criteria to determine what aspects or what utilisation categories would be considered habitat critical to the survival of the species.
	For example, preferred habitat would be 'breeding, foraging and dispersal' and marginal habitat would be 'foraging and dispersal only'. Criteria for habitat critical to the survival of the species would be habitats that provide for all species requirements i.e. breeding, foraging and dispersal. Some other criteria to consider include areas that provide key linkages given that the species is so susceptible to fragmentation. For example, a riparian corridor may not provide breeding resourcing but could be a critical link between two large tracts of vegetation that support the species.
	There have also been a number of surveys in which the 'preferred habitat' resources have been present (connectivity and tree hollows); however greater gliders were absent or in very low numbers. This has occurred where there has been greater presence of other hollow-dependent species such as possums or sulphur crested cockatoos. Some of these species may be more aggressive and out-compete greater gliders. This may need consideration in the definition.
General and/or marginal habitat – review comments	
Q4: What information in the draft definition of suitable and/or marginal habitat do you support and why? Please provide specific evidence, where possible.	BD – I support the inclusion of connected regrowth vegetation as it provides potential foraging resources. I also support the inclusion of remnant habitat with fewer suitable hollows as these areas may present future 'preferred habitat' through further hollow development.

Review question	Responses
	LA – Not provided.
	CE – Not provided.
	LF – I agree with all aspects of the definition that are in reference to remnant vegetation as it aligns well with the known information on the species as well as my experience in the field with regards to areas that the species can utilise opportunistically. However, records are within habitat directly adjacent and connected to preferred habitat and are generally within a few hundred meters of preferred habitat
Q5: What information in the draft definition of suitable	BD – NA
<i>and/or marginal habitat</i> do you <u>not</u> support and why? Please provide specific evidence, where possible.	LA – My main concern here is that there will be habitat that adjoins 'preferred habitat' which will not support the metric for tree hollows BUT will likely be important as feeding habitat. I am not sure this will fit into the 'suitable habitat' category definition because it may well be 'crucial to the persistence of the species in the area' (also 'marginal habitat' may not be useful either). It may well be that such habitat, providing it is contiguous, needs to be included within the 'preferred habitat' description.
	CE – It may be possible to divide the RE list into suitable and marginal habitat as there appears to be some REs that are used more than others. There is a lot of habitat that is ok for foraging where it adjoins preferred habitat but it is not suitable for roosting due to lack of suitable hollows.
	If hollows are <10 cm dia then this habitat is unlikely to be occupied at all. It is probably the lower abundance of large hollows that makes this habitat marginal. Note that marginal habitat could be ok for foraging but not necessarily roosting if within 100m of preferred habitat.
	LF – From my experience, I have never recorded greater glider in regrowth vegetation
Q6: Do you have additional suggestion to improve the draft definition of suitable and/or marginal habitat ?	BD – For high value regrowth to be considered marginal habitat, it needs to include scattered large Eucalypt trees as Smith et al (2007) did not observe any gliders foraging in non-myrtaceous species or myrtaceous trees <20 cm dbh.
	LA – See above
	CE – See above
	LF – Whilst for this species the current habitat categorisation works, it does not for all species (e.g. Koala, Ornamental Snake, Squatter Pigeon, Yakka Skink). Therefore, for the sake of consistency I would still recommend changing the categories based on utilisation and then have standalone criteria to determine what aspects or what utilisation categories would be considered habitat critical to the survival of the species.
	For example, preferred habitat would be 'breeding, foraging and dispersal' and marginal habitat would be 'foraging and dispersal only'. Criteria for habitat critical to the survival of the species would be habitats that provide for all species requirements i.e. breeding, foraging and dispersal. Some other criteria to consider include areas that provide key

Review question	Responses
	linkages given that the species is so susceptible to fragmentation. For example, a riparian corridor may not provide breeding resourcing but could be a critical link between two large tracts of vegetation that support the species.
Q7: For species where only two habitats types are defined (e.g. preferred and suitable or marginal), do you think the third habitat type should be included? If not, why? If so, why and please provide a suggested definition	 BD – No. Greater glider appear to have a very specific habitat requirement for large patches of old growth forests with high density of large hollows. All of these features are critical for their survival in an area. LA – No guidance provided. CE – NA LF – As previously discussed, I would revise the categories as: Breeding, foraging and dispersal
	Foraging and dispersal only
Other review comments	
Q8: Do you have other comments or information?	BD – Add 11.3.3c into the list of associated RE's.
	LA – None
	CE – Table 2.1
	Vegetation composition: don't agree with this statement. I have observed this species numerous times in eucalypt forests/woodlands which are dominated by only one eucalypt species. This section could be improved by listing some of the species known to be utilised e.g. see description of preferred habitat.
	Vegetation Structure: fix typo + define "tall" for CQ (I would suggest a minimum of 16m) and reassess inclusion of 'moist' – not sure that the term moist is applicable for many CQ habitats.
	RE Associations: There could be some attempt to split into preferred and marginal. If this is the consensus among other reviewers than I would suggest at a minimum that REs 11.3.4, 11.3.4, 11.3.25, 11.8.1, 11.8.2, 11.10.1, 11.10.2, 11.10.4, 11.10.5, 11.11.1 & 11.11.3 are preferred REs in CQ and most of the remainder would be either suitable or marginal.
	I have records from many of the other REs but only where they adjoin areas of preferred REs. Eg the only times I have recorded GG in 11.3.2 and 11.3.3 is where these REs immediately adjoin preferred habitat (e.g. 11.3.4 or 11.3.25) unless the patch contains a higher than normal number of tall trees with large hollows. Delete 11.3.28 – occurrence in CQ?
	Add 11.3.7, 11.3.27d, 11.4.8, 11.5.12, 11.7.4, 11.10.5, 11.11.6
	Food Resources: this list presented is too short. See additional spp in preferred habitat description + my additional food records listed above
	LF - NOTE

Review question	Responses
Q9: Are there other resources, particularly published	BD – No
literature or outcomes of research, relevant to this species in	LA – None
central Queensland that are not referenced in the current	CE – None
work? If so, please provide details and a link (if possible).	LF – None

Table 18 Summary of expert reviews for Squatter Pigeon

Review question	Responses	
Draft definitions reviewed by experts:		
Preferred squatter pigeon habitat in Central Queenslar	nd is defined as:	
 remnant or regrowth open forest to woodland dominated by <i>Eucalyptus, Corymbia</i> or <i>Acacia</i> with patchy, relatively sparse ground cover (<33 %) on well-draining, sandy or gravel soils (land zones 3, 5, 7, 10) within 1 km of a suitable permanent¹⁴¹ waterbody AND any other area in which the species is observed to be breeding i.e. active nests are present. 		
Suitable squatter pigeon habitat in Central Queensland is defined as:		
 remnant or regrowth open forest to woodland dominated by <i>Eucalyptus, Corymbia</i> or <i>Acacia</i> with patchy, relatively sparse ground cover (<33 %) on well-draining, sandy or gravell soils (land zones 3, 5, 7, 10) within 3 km of a suitable permanent or seasonal¹⁴² waterbody AND any other area of remnant or regrowth vegetation in which the species is observed that is not preferred habitat. 		
Marginal squatter pigeon habitat in Central Queenslan	d is defined as:	
 non-remnant areas, regrowth and remnant woodland or forest areas more than 3 km from a permanent or seasonal waterbody that facilities the movement of the species between patches of foraging or breeding habitat. 		
Expert reviews undertaken: 5 reviews –Brad Dreis, Lind	say Agnew, Penn Lloyd Craig Eddie and Liz Fisher	
Preferred habitat – review comments		
Q1: What information in the draft definition of preferred habitat do you support and why? Please provide specific evidence, where possible	 BD – I generally support the habitat definition as its pretty consistent with my field observations over the years. However, I think the list of LZ's may not be inclusive of all LZ's where the species has been recorded. LA – Not provided. 	
	PL - I support most of the information in the draft definition, which is consistent with the sources referenced in support of the information, with the exception of the statements outlined in the next section.	
	CE – Proximity to water sources, sparse ground cover and well drained soils are typical characteristics of sites where the species is regularly observed (Reis 2012).	
	Description needs to include open woodlands and <i>Callitris</i> communities in addition to <i>Eucalyptus, Corymbia</i> & Acacia-dominated communities.	
	LF - I agree with the definition as it aligns well with the SPRAT information on breeding and foraging habitat. In my experience in undertaking surveys across the Central Queensland region, large aggregations of Squatter Pigeon have been detected in areas	

¹⁴¹ Includes mapped wetlands and $\geq 3^{rd}$ order streams.

 $^{^{\}rm 142}$ Includes $1^{\rm st}$ and $2^{\rm nd}$ order streams.

Review question	Responses
	containing extensive remnant or regrowth areas of Landzone 5 and 7 not heavily invaded by Buffel Grass and also contain farm dams or are bisected by larger watercourses (ephemeral but can hold small pools of water).
	The species appears to migrate across the region and therefore the lack of presence at the time of a survey does not indicate the lack of habitat.
Q2: What information in the draft definition of	BD – NA
preferred habitat do you <u>not</u> support and why?	LA – See below.
Please provide specific evidence, where possible	LF – If landzone 3 and 10 are included in the preferred habitat definition then landzone 4 would need to be included for consistency. The SPRAT definition only mentions these landzones as suitable when landzone 5 and 7 are also present.
	PL - I do not support the restriction of preferred habitat to within 1km of suitable permanent waterbodies. Firstly, the 1km restriction is attributed to nest sites (in the SPRAT profile for the species), but there is no evidence to support that nesting birds would not feed at distances greater than 1km from permanent water during the nesting season. Second, this statement implies that preferred habitat is restricted to nesting habitat. Preferred habitat in the non-breeding season should also be included. Instead, preferred habitat should be restricted to within 3km of permanent water sources. Squatter Pigeon Workshop (2011 – Squatter Pigeon workshop outcomes summary, QPWS Toowoomba, 14-15 December 2011) identified important habitat as within approximately 3km of water. Incidentally, I have not managed to find the original reference source for the 1km for nest sites – it is referenced to the Squatter Pigeon Workshop (2011) in the SPRAT profile, but that document makes no mention of a 1km restriction. Nonetheless, it is universally accepted that they nest close to water.
	I do not support the breeding habitat description in Table 2.1 i.e. the statement "Breeding habitat occurs on stony rises occurring on sandy or gravelly soils (Squatter Pigeon Workshop 2011)". This statement is accurately sourced from the SPRAT profile, which attributes the information to the Squatter Pigeon Workshop (2011). However, Squatter Pigeon Workshop (2011) makes no such assertion; instead, Squatter Pigeon Workshop (2011) identified that there is a significant knowledge gap with regards to characteristics of breeding habitats and where to find them. Figure 1 below summarises the land zone associations of high precision Squatter Pigeon (southern) nest records (n = 30 nests) supplied by a variety of field ecologists (Chris Hansen, Craig Eddie, Grant Paterson, Lindsay Agnew, Rod Hobson, Penn Lloyd). These confirm that breeding habitat is not restricted to stony rises based on the land zone associations.





Review question	Responses
	Nest with 2 eggs, in loamy/sandy soil in the bed of a seasonal minor creek close to junction with a river, LZ 3, 100 m from water. Remnant riparian woodland with Melaleuca leucadendra present.
	CE – NA
Q3: Do you have additional suggestion to improve the draft definition of preferred habitat ?	BD – As well as a relatively sparse ground cover, squatter pigeon also appear to favour areas with a relatively sparse shrub layer. Also, I would suggest that LZ 8 & 9 is added. I don't have any specific data to support this but LZ 9 and 10 are both sandstone with the only difference being the grain size of the sediments. Penn Lloyd did some analysis last year on some Squatter Pigeon records which I believe was on behalf of BHP, so I assume he is included in this review. That analysis identified Squatter Pigeon nest records on LZ 3, 5, 8, 9 and 10.
	LA – Squatter Pigeons prefer long sight lines to assess potential threats. Thus, I think there is a strong case to include a descriptor that a sparse understorey is important, especially when considering open forest. Further consideration needs to be given / acknowledged that there is some evidence to indicate a comparatively wider variety of Land Zones may be used more frequently within the northern parts of the Brigalow Belt Bioregion in comparison to southern parts (preliminary results from assessment of three sets of data – Agnew (2006) in the north, and BAAM in the south – summarised by BAAM for BMA Poitrel). For some habitats, history of grazing is important – maintaining preferred structure though lower grazing pressure, whilst release of grazing pressure can render totally unsuitable ground cover (dense sward) conditions (and in the absence of fire).
	PL - The meaning of 'regrowth' needs to be defined. Does it mean High Value Regrowth (i.e. Category C vegetation that that has not been cleared in the last 15 years, as regulated under the Vegetation Management Act 1999) or regrowth tree saplings of any height or age following clearing?

Review question	Responses
	Habitat should be identified as 'grassy' i.e. "Remnant or regrowth grassy open forest to woodland". The association of the species with grassy habitats where ground cover is dominated by native perennial tussock grasses is identified in Squatter Pigeon Workshop (2011).
	The description should make it clear that the patchy ground cover should include patchy areas with sparse (<33%) vegetation cover. This does not mean that average ground vegetation cover over the whole area should be <33%, just that there should be adequate patches with <33% ground vegetation cover. Specify "ground vegetation cover" so there is no confusion that ground cover <33% includes e.g. leaf litter and woody debris cover.
	The soil types associated with habitat should include loamy soils i.e. "well-draining sandy, loamy and gravelly soils". Loamy soils are identified as a habitat characteristic in the SPRAT profile and I have observations of birds and nests on loamy soils.
	The land zone associations should also include LZ 8 and 9, given the observations of Squatter Pigeon nests on these land zones (see Figure 1).
	The habitat description should include that habitat occurs on "low, gently sloping, flat to undulating plains, foothills and plateaus". This description can be attributed to Squatter Pigeon Workshop (2011) and the SPRAT profile.
	The food resources section in Table 2.1 provides a description of typical foraging habitat, but not what the diet is, and in this respect, it differs from the approach adopted for Ornamental Snake and Australian Painted Snipe, where the diet is described. Squatter Pigeon feed mostly on the seeds of legumes in the family Fabaceae (45% of food volume) including those of exotic pasture plants such as <i>Stylosanthes</i> spp., and native grasses in the family Poaceae (Crome 1976; Higgins and Davies 1996).
	CE – Areas dominated by introduced pasture grasses, in particular <i>Cenchrus ciliaris</i> , and heavily grazed areas should be excluded from preferred habitat (Reis 2012). These areas may be considered as suitable or marginal habitat.
	LF – I would recommend removing the component relating to habitat critical to the survival of the species from the definition of preferred habitat and re-naming to breeding, foraging habitat and dispersal habitat (suitable habitat would be foraging only and marginal would be dispersal only). The breeding/foraging/dispersal habitat category can be considered to be habitat critical to the survival of the species as it provides for all three uses and not just foraging and not just dispersal.
	This categorisation approach also removes issues with associating dispersal habitat as 'marginal' and connotations of lower quality (see marginal habitat section below).
General and/or marginal habitat – review comments	
Q4: What information in the draft definition of suitable and/or marginal habitat do you support and	BD – As above, I generally support the habitat definition but I think the list of LZ's may not be inclusive of all LZ's where the species has been recorded.
why? Please provide specific evidence, where possible.	LA – (Suitable) taking into account the above for revision. I think you if you adjust the suite of land zones you can dispense the second dot point. (Marginal) seems to be a warranted / workable description.
	PL – I support the information in draft definition, which is consistent with the sources referenced in support of the information.

Review question	Responses
	CE – See below
	LF – I agree with the definition as it aligns well with the SPRAT information on habitat that only provides foraging and dispersal resources for the species.
Q5: What information in the draft definition of suitable and/or marginal habitat do you <u>not</u> support and why? Please provide specific evidence, where possible.	BD – I don't necessarily agree with the notion that anywhere a Squatter Pigeon is recorded that is not preferred habitat is suitable habitat. My reason for this is because species will occur in marginal habitat and just because a Squatter Pigeon may be recorded at that moment does not necessarily mean that area is 'suitable'. Maybe this could be amended to anywhere a species is recorded within 3km of water?
	Because the species is often observed foraging in non-remnant areas in proximity to 'preferred habitat', I would consider including non-remnant areas in this category where it occurs with 500m to 1km of 'preferred habitat' AND within 3km of water.
	LA – NA
	PL – None
	CE – See below. The description of suitable habitat needs to be further refined i.e. suitable habitat would be within >1-3km of a suitable permanent waterbody otherwise there is overlap between preferred and suitable habitat. Needs also to include Callitris-dominated communities.
	LF – Based on the definitions, presence alone can change habitat from marginal to suitable for remnant and regrowth areas, which can easily be influenced by survey effort and therefore may not be an appropriate indicator to use to change quality and use of habitat.
	Marginal habitat definition also includes non-remnant areas; however, the SPRAT states that there is evidence to suggest the species does not move further than 100m away from remnant, regrowth or scattered vegetation when foraging or dispersing. The species can occur in non-remnant but only when vegetation is within 100m. Further clarification of this in the definition should be provided to avoid large areas of non-remnant being mapped as potential habitat for the species.
	Associating dispersal habitat as marginal habitat may be problematic due to its connotations of being of lower quality. It may be hard to support this line of argument when the concept of dispersal and genetic flow is important in maintaining populations.
	Marginal habitat also refers to areas that are rarely inhabited but some of the largest flocks of Squatter Pigeon have been found in cattle yards, which would be classed as marginal habitat. Again, keeping habitat categories based on utilisation rather than including quality parameters would provide a better approach, especially for species that tend to adapt very well to disturbed environments.
Q6: Do you have additional suggestion to improve the draft definition of suitable and/or marginal habitat ?	BD – As above I would recommend that LZ 8 & 9 are added to the suitable habitat description.
	LA – None.
	PL – See comments under preferred habitat relating to habitat descriptions. Suitable habitat could also include non-remnant areas within 100 m of preferred habitat, given the extensive evidence that Squatter Pigeon will both forage and nest in non-remnant

Review question	Responses	
	areas close to remnant/regrowth vegetation if these areas have the preferred groundcover characteristics. The SPRAT profile can be referenced in support of the 100 m distance threshold.	
	CE – The species is regularly observed in non-remnant areas with sparse ground cover (Reis 2012; pers. obs.), particularly in areas of sandy soils dominated by native grasses, with some trees and nearby water sources. Often these are at or close to an artificial but effectively a permanent water source such as a dam or trough. These areas could be considered as Suitable habitat.	
	The description of marginal habitat is non-specific and would be difficult to delineate. It encompasses all areas that are not Preferred or Suitable habitat. Perhaps this category could be better defined as a buffer distance from preferred habitat or suitable habitat patches or is removed altogether if there is no evidence for use of habitat >3km from a water source.	
	LF – I would recommend removing the 'quality' component associated with the habitat categories and keeping it based on utilisation.	
	Suitable habitat category definition states that this can be considered habitat critical to the survival of the species if connected. Clarification should be provided if this is the case for this species i.e. if foraging habitat is connected to breeding habitat, is the entire area considered habitat critical to the survival of the species? My recommendation is that 'preferred habitat' provides breeding, foraging and dispersal opportunities whereas the other categories only provide for one or two, which do not include breeding. Therefore 'preferred habitat' should only be considered as habitat critical to the survival of the species.	
Q7: For species where only two habitats types are defined (e.g. preferred and suitable or marginal), do you think the third habitat type should be included? If not, why? If so, why and please provide a suggested definition	BD – None	
	LA – No guidance provided.	
	PL – NA	
	CE – NA	
	LF – None	
Other review comments		
Q8: Do you have other comments or information?	BD – Update landforms/landzones in Table 2-1 to be consistent with preferred and suitable habitat. Add water troughs to water (for drinking) description.	
	LA – None.	
	PL – The Regional Ecosystem associations in Table 2.1 are restricted to the Brigalow Belt bioregion. Unless there is a reason for this defined elsewhere, the RE associations for central Queensland should be expanded to the other bioregions that fall within central Queensland and the range of the Squatter Pigeon (southern). It would also be useful to include an explanation, perhaps in a footnote, of what method or decision process was used to identify the REs that may comprise preferred, suitable and marginal habitat.	
	CE – Table 2.1	

Review question	Responses
	Vegetation Composition: "open forests to sparse, open woodlands and scrub" needs to be moved to the vegetation structure row and needs to include woodlands in the description
	Vegetation Structure: see above
	Additional REs: Add 11.3.19, 11.3.22, 11.4.2, 11.4.12, 11.8.2, 11.8.4, 11.8.5, 11.9.2, 11.9.9, 11.10.3, 11.10.13, 11.10.14 & 11.11.1.
	Delete 11.3.16, 11.3.28 & 11.5.21– not in CQ?
	Food Resources: The current description is not a description of food resources, rather it describes the vegetation composition – this information should be shifted to that row and replaced with a more refined description of what the bird eats – see HANZAB.
	Landforms/land zones: need to include land zone 10. This species is locally common on this LZ in the southern Central Highlands (e.g. Carnarvon/Expedition Range). There would also be some records from land zone 4, 8, 9 and 11 but these are used to a lesser extent than the other LZs
	Soils: also occurs on clay and clay loams (e.g. on land zone 3)
	Water (for drinking): include troughs – the species is frequently seen around stock yards or other grazing areas with troughs
	Patch Size/Connectivity: the current distribution of this species is to some extent corelated with areas of large vegetated tracts
	(e.g. Carnarvon, Expedition Range and numerous state forest areas) + major watercourses.
	Micro Habitat Features: what does dusty soil refer to? Can this be better defined?
	Habitat Condition: sightings of the bird occur in areas that have significantly modified vegetation as well as "partly modified"
	Other general comments: The title should be altered to "Southern Squatter Pigeon" or "Squatter Pigeon (southern subspecies)", as the northern subspecies occurs in the areas immediately to the north and is not currently threatened.
	LF – None.
Q9: Are there other resources, particularly published literature or outcomes of research, relevant to this species in central Queensland that are not referenced in the current work? If so, please provide details and a link (if possible).	BD – BAAM review of Squatter Pigeon habitat. I don't have a copy of the final deliverable or know where this ended up but it would be a very useful resource.
	PI – None that I am aware of
	CE – Reis, T. 2012. <i>Squatter Pigeon (Southern Subspecies)</i> . Pp. 254-255 <i>in</i> Curtis, L.K., Dennis, A.J., McDonald, K.R., Kyne, P.M. and Debus, S.J.S. eds. <i>Queensland's Threatened Animals</i> . Collingwood, Victoria: CSIRO Publishing.
	How relevant are the "Campbell & Woods" and "Cooper et al" references?
	LF – None
Table 19 Summary of expert reviews for Painted Honeyeater

Review question	Responses
Draft definitions reviewed by experts:	
Preferred painted honeyeater habitat in Central Queensland	is defined as:
Remnant or regrowth forest/woodlands dominated	by mistletoe host trees ¹⁴³ , with a moderate to high abundance of mistletoe (preferably Amyema genus).
Marginal painted honeyeater habitat in Central Queensland	is defined as:
Remnant and regrowth forest/woodlands with a low to infrequent mistletoe.	
Expert reviews undertaken: 4 reviews –Brad Dreis, EMM Craig Eddie and Liz Fischer	
Preferred habitat – review comments	
Q1: What information in the draft definition of preferred	BD – I generally agree with the habitat definition.
habitat do you support and why? Please provide specific evidence, where possible	EMM – EMM support retention of remnant or regrowth forest/woodlands. Regrowth vegetation can support mistletoe and Painted honeyeater has been recorded in regrowth vegetation. Regrowth vegetation can also be important habitat for the species where there is little remnant vegetation remaining.
	EMM agrees the presence of mistletoe is a critical factor in habitat being 'preferred habitat'. See later comments regarding setting some quantitative levels regarding mistletoe abundance.
	CE – The description is a reasonable statement based on current knowledge except that the following should be included:
	• Other vegetation structural types (as per Walker & Hopkins Australian Soil & Land survey Field Handbook definition) are frequently used in the Brigalow Belt South (BBS) such as open woodland and tall shrubland (pers obs).
	• The definition should note that the species can utilise habitats with mistletoe irrespective of patch size or width i.e. in the BBS it is frequently observed in narrow (<30 m wide) shade lines, roadside strips and other corridors with high densities of mistletoe as well as small remnants/regrowth patches even if <0.5 ha. Landscape configuration of vegetation appears to be important (pers obs) e.g. a highly cleared landscape can still provide habitat for the species providing there is a network of vegetated corridors and small patches of vegetation which support high densities of mistletoe.

¹⁴³ Host trees will vary based on the site by may include Acacia pendula (weeping myall), A. aneura (mulga), Eucalyptus camaldulensis (river red gum), E. tereticornis (forest blue gum), Casuarina cunninghamiana (river oak), C. cristata (belah), Allocasuarina luehmannii (bulloak), Eucalyptus coolabah (coolibah) and Acacia harpophylla (brigalow)

Review question	Responses
	LF – I agree with the definition as it aligns with the known information on the species with regards to the species requirements for foraging (noting that the breeding component of the preferred habitat description does not apply as Central Queensland is too far north for species breeding).
Q2: What information in the draft definition of preferred	BD – NA
habitat do you not support and why? Please provide specific	EMM – NA
evidence, where possible	CE – Nil
	LF – None
Q3: Do you have additional suggestion to improve the draft definition of preferred habitat ?	BD – Moderate and high abundance might be interpreted differently by individuals. It would be ideal to have some quantitative measures for moderate to high abundance if possible.
	EMM – No breeding habitat for Painted honeyeater would be present in the Central Qld study areas. There should be some background context for the species which outlines that the species does not breed in central Qld and that all 'preferred habitat' will be foraging habitat only.
	There should also be some discussion in the preferred habitat definition around the distribution of the species - likely time of year the species may be present in the study areas (e.g. winter - nonbreeding season), nomadic nature of the species in response to food resources etc.
	CE – The list of important mistletoe host trees should include "other Acacia species" to capture the importance of this genus and the wide variety of species that host <i>Amyema quandang</i> and/or <i>A. maidenii</i> (including <i>A. cambagei, A. omalophylla, A. melvillei, A. decora, A. stenophylla</i>).
	The species could also use Acacia argyrodendron communities in central Qld but there is currently a lack of publicly accessible records to support the use of this habitat.
	LF – Whilst for this species the current habitat categorisation works, it does not for all species (e.g. Koala, Ornamental Snake, Squatter Pigeon, Yakka Skink). Therefore, for the sake of consistency I would still recommend changing the categories based on utilisation and then have standalone criteria to determine what aspects or what utilisation categories would be considered habitat critical to the survival of the species.
	To simplify the habitat definition, foraging and dispersal habitat could be defined as <i>Remnant or regrowth forest/woodlands dominated by mistletoe host trees, with presence of mistletoe (preferably Amyema genus).</i> Criteria for habitat critical to the survival of the species would be habitats that provide for a high abundance of foraging resources.
	Terms such as 'moderate or high abundance' should be defined as best as possible.
General and/or marginal habitat – review comments	

Review question	Responses
Q4: What information in the draft definition of suitable and/or marginal habitat do you support and why? Please	LF – I agree with the definition as it aligns with the known information on the species with regards to areas that the species can and have been recorded to utilise.
provide specific evidence, where possible.	BD – I agree with the habitat definition.
	EMM – EMM support retention of remnant or regrowth forest/woodlands. Regrowth vegetation can support mistletoe and Painted honeyeater has been recorded in regrowth vegetation. Regrowth vegetation can also be important habitat for the species where there is little remnant vegetation remaining.
	EMM agrees the presence of mistletoe is a critical factor in determining 'marginal habitat'. See later comments regarding setting some quantitative levels regarding mistletoe abundance.
	CE – The description is a reasonable statement based on current knowledge however the same comments applicable to preferred habitat (i.e. vegetation structure and patch size/width) are relevant to marginal habitat.
	LF – I agree with the definition as it aligns with the known information on the species with regards to areas that the species can and have been recorded to utilise.
Q5: What information in the draft definition of suitable	BD – NA
and/or marginal habitat do you not support and why?	EMM – NA
Please provide specific evidence, where possible.	CE – Nil
	LF – None
Q6: Do you have additional suggestion to improve the draft definition of suitable and/or marginal habitat ?	BD – As above, it would be ideal to have some criteria to consistently distinguish low abundance from moderate / high if possible.
	EMM – Setting a prescribed level for moderate to high, and low to infrequent.
	A thought for preferred habitat is to look at setting a minimum patch size. Are two paddock trees with abundant mistletoe preferred habitat, or would it be larger patches with abundant mistletoe that are preferred/primary foraging habitat for the species. Recognising they can use roadside reserves a minimum patch size could be around 1-2ha as it could include linear patches. There is a reference that "studies have been conducted which suggest that habitat areas which have undergone less fragmentation and land clearing may see a greater number of painted honeyeaters present. They have also been found to be more abundant in locations where there are a large number of trees present and a high percentage of canopy cover". Oliver, D. L., Chambers, M. A., Parker, D. G. (2003). Habitat and resource selection of the Painted Honeyeater (<i>Grantiella picta</i>) on the northern floodplains regions of New South Wales. Emu, 103, 171-176.
	Using regional ecosystems at a desktop level to help define preferred and marginal habitat is supported. Ground- truthing to confirm presence and abundance of mistletoe is needed.

Review question	Responses
	CE – See above
	LF – Whilst for this species the current habitat categorisation works, it does not for all species (e.g. Koala, Ornamental Snake, Squatter Pigeon, Yakka Skink). Therefore, for the sake of consistency I would still recommend changing the categories based on utilisation and then have standalone criteria to determine what aspects or what utilisation categories would be considered habitat critical to the survival of the species.
	To simplify the habitat definition, foraging and dispersal habitat could be defined as <i>Remnant or regrowth forest/woodlands dominated by mistletoe host trees, with presence of mistletoe (preferably Amyema genus)</i> . Criteria for habitat critical to the survival of the species would be habitats that provide for a high abundance of foraging resources.
	For species where only two habitats types are defined (e.g. preferred and suitable or marginal), do you think the third habitat type should be included? If not, why? If so, why and please provide a suggested definition.
	As previously discussed, I would revise the categories as foraging and dispersal
Q7: For species where only two habitats types are defined (e.g. preferred and suitable or marginal), do you think the	BD – No. Painted Honeyeater are strongly associated with and reliant on mistletoe and I don't think that a third category could be practically differentiated from the other categories.
third habitat type should be included? If not, why? If so, why and please provide a suggested definition	EMM – For Painted honeyeater the use of two habitat definitions is fine. There is no breeding habitat, so it is defining preferred and marginal foraging habitat. Although given the likely occurrence of the species in the study areas will be limited to dispersing/nomadic individuals from breeding areas, perhaps suitable habitat should replace preferred? Noting the definition for suitable habitat includes "If the species is present in a region, individuals may be found in suitable habitat, but this habitat type may also remain unoccupied", suitable would seem more appropriate to use than preferred.
	CE – No
	LF – None
Other review comments	
Q8: Do you have other comments or information?	BD – The list of REs that could potentially provide preferred or marginal habitat could potentially be expanded to include more REs where common host species for Amyema spp. are dominant or common.
	EMM –
	 Vegetation composition description - this species also favours Acacia woodland. Suggest Acacia/Eucalypt woodland.
	 Vegetation structure - roadside reserves should be added here. Preferred habitat definition above contains regrowth yet this section focuses on remnant woodlands with mature trees. Agreed that mature woodlands more likely to host more mistletoes but regrowth is important in parts of species distribution particularly in largely cleared landscapes.

Review question	Responses
	 Regional ecosystem associations that may comprise preferred or marginal habitat description -EMM agree with approach. How were these RE's chosen? Are they dominated by canopy trees more likely to support mistletoe? Need justification to be provided Patch size description – 'Most common in wider blocks of remnant woodland than in narrower strips' add text stating "due to increased likelihood of mature woodlands to host more mistletoes". Patch size verification – a small patch size does not need to be a limiting factor outside breeding season which is what is relevant to BHP study areas. For example, they could occur in thin roadside strips of <i>Acacia</i> containing mistletoe. Also, paddock trees in cleared landscapes can be used for foraging but these may not be the 'preferred' areas for them rather 'marginal' habitat. Think this paragraph needs some more discussion of the above in Central Qld context. Shelter/denning/roosting description – potentially leave as N/A as it does not assist in defining habitat much. Micro habitat features description – quantitative measures need to be set. Set some criteria both around species diversity (although difficult to ascertain <i>Mistletoe spp</i> high in the canopy) and more importantly, abundance of mistletoe in the area. Perhaps use number of clumps in 100m transect or 50x20m plot, based around BioCondition plot. Low to infrequent mistletoe is <40% of canopy trees noted as hosting live mistletoe in BioCondition plot. Breeding resources description - note here that breeding is almost exclusively south of BHP study areas in central Qld so relevance is limited. Breeding occurs from October to March when mistletoe fruits are most available. Therefore the species is not likely to be present in BHP study area during the breeding season which occurs further south. Habitat condition description – text is valid for breeding but not for foraging - contradicts earlier statements regarding roadside st
	 CE – Note 1 - Add cumbris globcophylla to this list. CE – Note there is a paucity of records of this species in central Queensland therefore conclusions about habitat preferences are difficult to justify and are largely based on either personal observations from the southern Brigalow Belt and/or research from southern Australia (see references). Across inland Queensland the species varies from a summer breeding migrant to spring passage migrant or nomadic flocks, and a sparse winter non-breeding vagrant. Although mistletoe remains key to the species habitat needs, non-breeding birds in Central Queensland could potentially use a wider variety of habitat and food resources especially eucalypt blossom and nectar. The preference for mature woodlands is not clear in inland Queensland. The species is regularly observed in shade-lines, roadside corridors, remnant edges and regrowth patches, which tend to host a higher density of mistletoes than found within large remnants. Abundance of suitable mistletoes is likely the most important aspect of vegetation structure.

Review question	Responses
	Table 2.1
	Vegetation composition – the lack of Acacia dominatyed communities is an oversight - this needs to include Acacia forests/woodlands/shrublands
	Vegetation structure – needs to include open woodlands and shrublands. Also the statement referring to the preference for mature trees is not supported though personal observations in the Brigalow Belt. The species can be locally abundant in patches of regrowth (pers obs) which certainly do not contain high numbers of mature trees.
	Additional REs include 11.3.2, 11.3.8, 11.3.15, 11.3.17, 11.3.37, 11.4.3a, 11.4.5. 11.4.6, 11.7.1, 11.9.1, 11.9.10
	Land Forms/Land Zones – the majority of records seem to be associated with LZ 3 and 4 and to a lesser extent 5 and 9.
	Food resources – Amyema congener is a frequently utilised food source in parts of BBS
	Habitat Condition – suggest replace "woodlands" with "habitats". The comment "requires woodlands that are largely intact" understates the importance of regrowth habitats to this species.
	LF – None
Q9: Are there other resources, particularly published	BD – No
literature or outcomes of research, relevant to this species in central Queensland that are not referenced in the current work? If so, please provide details and a link (if possible).	EMM – Their migration south-north is believed to be as a result of mistletoe berry availability at certain times of the year. Keast, A. (1968). Seasonal movements in the Australian honeyeaters (Meliphagidae) and their ecological significance. <i>Emu</i> , <i>67</i> , 159-209.
	Studies have been conducted which suggest that habitat areas which have undergone less fragmentation and land clearing may see a greater number of painted honeyeaters present. They have also been found to be more abundant in locations where there are a large number of trees present and a high percentage of canopy cover. Oliver, D. L., Chambers, M. A., Parker, D. G. (2003). Habitat and resource selection of the Painted Honeyeater (Grantiella picta) on the northern floodplains regions of New South Wales. Emu, 103, 171-176.
	CE – Bowen, M.E., McAlpine, C.A., House, A.P.N., Smith, G.C., 2009. Agricultural landscape modification increases the abundance of an important food resource: Mistletoes, birds and brigalow. <i>Biological Conservation</i> 142 : 122–133.
	Watson, D.M. 2012. Australian Painted Snipe. Pp. 322-323 in Curtis, L.K., Dennis, A.J., McDonald, K.R., Kyne, P.M. and Debus, S.J.S. eds. Queensland's Threatened Animals. Collingwood, Victoria: CSIRO Publishing.
	Additional habitat information is contained within the following however is based on studies in NSW:
	Barea, L.P. 2012. Habitat influences on nest site selection by the Painted Honeyeater (<i>Grantiella picta</i>): Do food resources matter? <i>Emu</i> 112 : 39-45.
	Barea, L.P. 2008. Nest site selection in the Painted Honeyeater (<i>Grantiella picta</i>), a mistletoe specialist. <i>Emu</i> 108 : 213-220.

Review question	Responses
	Barea, L.P. and Watson, D.M. 2007. Temporal variation in food resources determines the onset of breeding in an Australian mistletoe specialist. <i>Emu</i> 107 : 203-209.
	LF – None

Table 20 Summary of expert reviews for Australian Painted Snipe

Review question	Responses
Draft definitions reviewed by experts:	
Preferred Australian painted snipe habitat in Central Queer	nsland is defined as:
Shallow ephemeral freshwater wetlands with area	s of bare, exposed mud and dense low ground cover.
Suitable Australia painted snipe habitat in Central Queensla	and is defined as:
Shallow permanent or ephemeral freshwater or bit	rackish wetlands and other inundated/waterlogged areas ¹⁴⁴ with a variable ground cover (e.g. grasses, shrubs and rushes).
Expert reviews undertaken: 5 reviews –Lindsay Agnew, Brad	Dreis, Penn Lloyd Craig Eddie and Liz Fischer
Preferred habitat – review comments	
Q1: What information in the draft definition of preferred habitat do you support and why? Please provide specific evidence, where possible	 LA – Freshwater wetlands with surrounds which provide areas of bare, exposed wet mud and a mosaic of low ground cover (tufted grasses, sedges, small woody plants). Together, these attributes provide the required combination of foraging and shelter requirements. Presence and /or extent of preferred habitat will be influenced by seasonal conditions (expansion of permanent wetlands, or creation of ephemeral wetland habitat). BD – I generally support the habitat definition, however I recommend that permanent wetlands are included. PL – I support the information, which is supported by the information in the cited references. CE – The description is a reasonable reflection of the current state of knowledge. LF – I agree with the definition as it aligns with the known information on the species with regards to the species requirements for breeding.
Q2: What information in the draft definition of preferred habitat do you <u>not</u> support and why? Please provide specific evidence, where possible	 LA – Not provided. BD – I don't agree with the 'dense low ground cover' statement as areas of habitat that I am familiar with have included what I would consider tall ground cover such as sedges and rushes approximately 1m in height. The literature seems to be a bit inconsistent with reference to groundcover vegetation height with some stating that tall groundcover is avoided and other references including tall groundcover in the description. There doesn't appear to be a conclusive agreement on what groundcover height is or isn't suitable and for this reason, I would simply refer to a complex of exposed mud, dense vegetation and shallow water. PL – There is no information that I do not support. CE – Nil

¹⁴⁴ Can include gilgais lakes, swamps, claypans, inundated or waterlogged grassland/saltmarsh, dams, rice fields, sewage farms and bore drains

Review question	Responses
	LF – Specific reference is given to ephemeral wetlands in the definition, but it can include permanent wetlands. Most literature also refers to the presence of small islands within wetlands that are utilised for nesting.
Q3: Do you have additional suggestion to improve the draft	LA – If you are including coastal central Queensland, then reference is to include brackish wetlands.
definition of preferred habitat ?	BD – As above. I would also refer to proximity to canopy vegetation similar to what is described in Table 2-1
	PL – The breeding habitat description should refer to the observation that nests are nearly always placed on small islands in shallow wetlands. The specific statement from Rogers et al. (2005) is "Nesting typically occurs in ephemeral wetlands drying out after an influx of fresh water, provided they have complex shorelines (nests are almost invariably placed on small islands) and a combination of very shallow water, exposed mud, dense low cover and (sometimes) some tall dense cover". The words "and shrub/tree canopy nearby" should be deleted from the Breeding habitat requirements description in Table 4.1.
	References to the vegetation cover in Table 4.1 should include sedges as a type of ground cover the species is associated with i.e. "grass, sedge, reed cover".
	CE – Areas with extensive invasive weed growth, heavy dry season grazing and trampling by stock reduce habitat quality (Garnett et al. 2011). Tzaros et al. 2012 suggest that the species avoids tall, dense reedbeds associated with stabilization of water levels, wetlands that are cropped, and areas of low water quality due to nutrient run-off, agricultural chemicals and turbidity. Wetlands dominated by these factors could be excluded from preferred habitat.
	LF – Whilst for this species the current habitat categorisation works, it does not for all species (e.g. Koala, Ornamental Snake, Squatter Pigeon, Yakka Skink). Therefore, for the sake of consistency I would still recommend changing the categories based on utilisation and then have standalone criteria to determine what aspects or what utilisation categories would be considered habitat critical to the survival of the species.
	For example, preferred habitat would be 'breeding, foraging and dispersal' and suitable habitat would be 'foraging and dispersal only'. Criteria for habitat critical to the survival of the species would be habitats that provide for all species requirements i.e. breeding, foraging and dispersal. Some other criteria to consider may include permanency of water, extent of wetland, condition and lack of threatening processes.
General and/or marginal habitat – review comments	
Q4: What information in the draft definition of suitable and/or marginal habitat do you support and why? Please provide specific evidence, where possible.	 LA – Shallow permanent or ephemeral freshwater or brackish wetlands and other inundated/waterlogged areas¹ with bare or a sparse ground cover (e.g. grasses, shrubs and rushes). Often, habitats may exhibit high levels of disturbance / degradation as a result of cattle presence. BD – I generally support the habitat definition.
	PL – I support the information, which is supported by the information in the cited references.
	CE – Not provided

Review question	Responses
	LF – I agree with the definition as it aligns with the known information on the species with regards to areas that the species can utilise opportunistically.
Q5:	LA – Not provided
What information in the draft definition of suitable and/or	BD – NA
marginal habitat do you not support and why? Please	PL – There is no information that I do not support.
provide specific evidence, where possible.	CE – Nil, however the definition of suitable habitat is only slightly different to preferred habitat.
	LF – None
Q6:	LA – None
Do you have additional suggestion to improve the draft definition of suitable and/or marginal habitat ?	BD – I recommend that floodplains are included in this description as APS has been recorded in flooded 'paddocks' under suitable conditions.
	PL – None
	CE – Suggest including the list of habitats/wetland types in the footnote within the actual description of suitable habitat to more clearly differentiate the difference between preferred and suitable habitat (e.g. dams, rice fields, gilgais sewage farms, bore drains etc probably fit in this category). Also suggest inclusion of springs as these may provide ephemeral or permanent habitat suitable for the species in CQ.
	LF – Whilst for this species the current habitat categorisation works, it does not for all species (e.g. Koala, Ornamental Snake, Squatter Pigeon, Yakka Skink). Therefore, for the sake of consistency I would still recommend changing the categories based on utilisation and then have standalone criteria to determine what aspects or what utilisation categories would be considered habitat critical to the survival of the species.
	For example, preferred habitat would be 'breeding, foraging and dispersal' and suitable habitat would be 'foraging and dispersal only'. Criteria for habitat critical to the survival of the species would be habitats that provide for all species requirements i.e. breeding, foraging and dispersal. Some other criteria to consider may include permanency of water, extent of wetland, condition and lack of threatening processes.
Q7: For species where only two habitats types are defined	LA – No guidance provided.
(e.g. preferred and suitable or marginal), do you think the third habitat type should be included? If not, why? If so, why and please provide a suggested definition	BD – No. APS appear to have a very specific habitat requirement and I don't think that a third category could be practically differentiated from the other categories.
	PL – NA
	CE – No. Current information clearly distinguishes regularly used habitat from other areas that are used occasionally. There is no clear division of the latter.
	LF – As previously discussed, I would revise the categories as:

Review question	Responses
	Breeding, foraging and dispersal
	Foraging and dispersal only
Other review comments	
Q8: Do you have other comments or information?	LA – None
	BD – No
	PL – None
	CE – Table 2.1:
	Regional Ecosystem associations - at least some key regional ecosystems could be provided – this need not necessarily be exhaustive (as numerous REs may contain wetland components) but at a minimum this could include wetland REs such as 11.3.27 and wetlands (including gilgais) embedded within 11.3.2, 11.3.3, 11.3.25, 11.3.3, 11.4.3, 11.4.7 and 11.9.5 (note this list is not comprehensive)
	Food Resources undervalues the aquatic composition of this species food resources, which are a critical component of its habitat needs. It should include small crustacea, molluscs and aquatic worms (not necessarily earthworms) found in shallow water and wet mud. A more appropriate/reputable reference to diet should be included rather than TSSC 2013 such as HANZAB
	Landforms/land zones – suggest including land zone 9 as this frequently supports shallow ephemeral wetlands in particular gilgais
	LF – None
Q9: Are there other resources, particularly published	LA – None
literature or outcomes of research, relevant to this species	BD – No
in central Queensland that are not referenced in the current work? If so, please provide details and a link (if possible).	PL – Rogers, D., Hance, I., Paton, S., Tzaros, C., Griffioen, P., Herring, M., & Weston, M. (2005). The breeding bottleneck: Breeding habitat and population decline in the Australian Painted Snipe. In Status and conservation of shorebirds in the East Asian–Australasian Flyway: Proceedings of the Australasian Shorebirds Conference (pp. 15-23).
	CE – Garnett, S.T., Szabo, J.K. and Dutson, G. 2011. <i>The action plan for Australian birds 2010</i> . Pp. 176-177, Australian Painted Snipe. Collingwood, Victoria: CSIRO Publishing.
	Geering, A., Agnew, L. and Harding, S. 2007. Shorebirds of Australia. CSIRO, Victoria.
	Pringle, J.D. 1987. The shorebirds of Australia. Angus & Robertson, Sydney.
	Tzaros, C., Ingwersen, D. and Rogers, D. 2012. Australian Painted Snipe. Pp. 274-275 in Curtis, L.K., Dennis, A.J., McDonald, K.R., Kyne, P.M. and Debus, S.J.S. eds. Queensland's Threatened Animals. Collingwood, Victoria: CSIRO Publishing
	LF – None

Table 21 Summary of expert reviews for Ornamental Snake

Review question	Responses	
Draft definitions reviewed by experts:		
Preferred ornamental snake habitat in Central Queensland is defined as:		
• Gilgai depressions (with or without the presence of brigalow), mounds and wetlands on cracking clays (predominantly land zone 4) where essential microhabitat features are present including an abundance of deep soil cracks and fallen woody debris.		
Marginal ornamental snake habitat in Central Queensland is	defined as:	
• Areas currently or previously dominated by brigalow coolibah communities where gilgais or soil cracks are infrequent or are shallow or non-remnant areas where threats an high (high abundance of weed incursion and cattle compacting soils) but the species still have potential to occur, especially in times where water is present and pre abundance (frogs) is high.		
Expert reviews undertaken: 6 reviews –Steve Wilson, Penn Ll	oyd, Brad Dreis, Lindsay Agnew Craig Eddie and Liz Fischer	
Preferred habitat – review comments		
Q1: What information in the draft definition of preferred habitat do you support and why? Please provide specific evidence, where possible	SW – I support the definition as written. In the case of Ornamental Snake crucial habitat features are readily identifiable so preferred habitat is relatively easy to define. It is reasonable to assume that if core habitat elements including soil type, hydrology and vegetation are appropriate, Ornamental Snakes are likely to be present and potentially in high densities. See Wilson and Swan, 2014	
	PL – Generally support the information in the draft definition but see comment below for improvement.	
	BD – I generally agree with this description and particularly the cracking clay soils, land zone 4 and an abundance of deep soil cracks and fallen woody debris.	
	LA – It is unclear to me why we are trying to create an alternative to the DAWE Preferred Habitat which I think is sound.	
	CE – The definition reflects the current state of knowledge & is supported.	
	LF – I agree that gilgai depressions (with or without the presence of brigalow) and wetlands are important microfeatures for the species as they support the dominant prey type. Deep soil cracks and fallen woody debris are also important microfeatures that allow the species to shelter, retreat from predators, etc. Field surveys in areas where the species has been detected have contained at least one microfeature to support foraging and one microfeature to support sheltering. These areas would be utilised for breeding and foraging and are therefore important to the persistence of the species. The species can also be detected in high numbers in non-remnant and regrowth conditions. This is demonstrated by surveys that were conducted on BHP's Croydon offset property.	

Review question	Responses
Q2: What information in the draft definition of preferred	SW – NA
habitat do you not support and why? Please provide specific	PL – None but see comment below.
evidence, where possible	BD – With or without the presence of brigalow could probably be expanded to include other canopy vegetation that also occur on cracking clays where ornamental snake occurs. For example, we have recorded ornamental snake is 11.3.3c which contains a canopy of <i>Eucalyptus coolabah</i> . Other gilgai habitat may be dominated by <i>Eucalyptus cambageana</i> , <i>Acacia cambagei</i> and /or <i>A. argyrodendron</i> .
	LA – See below
	CE – NA
	LF – Context is important and is not mentioned in the preferred habitat description. The importance of context is supported by the Draft Referral guidelines for nationally listed Brigalow Belt reptiles. Large extents of gilgai (some areas gilgai could be infrequent) within the floodplain of major rivers would be important areas for the species. In some locations areas of lower quality / marginal habitat that are connected to more permanent alternate foraging sources or high quality habitat may be able to support a viable population. This entire area including the connecting dispersal habitat would play a critical role for the persistence of the species.
	Terminology of some of the words used such as 'abundance' may be too subjective. I also don't think there is enough data to provide a threshold of when breeding would or would not occur for individuals of the species based on soil crack abundance. Individuals may still breed in areas with lower crack abundance it may just mean fewer individuals are present.
Q3: Do you have additional suggestion to improve the draft definition of preferred habitat ?	SW – Preferred habitat is well summarised in the species habitat description, though 'Seasonally flooded' should be included as a significant feature. 'Past or present occurrence of brigalow' should also be included. 'Adjacent areas of clay and sandy loams' should be included.
	PL – The draft definition is focussed on gilgai depressions and wetlands on cracking clays, but does not adequately describe the habitats that these features occur in. The habitat definition should really be a bit broader than this e.g. Low-lying areas with deep-cracking clay soils (predominantly land zone 4), and particularly gilgai landscapes, that are subject to seasonal flooding in woodlands and shrublands dominated by Brigalow (<i>Acacia harpophylla</i>), Gidgee (<i>Acacia cambagei</i>), Blackwood (<i>Acacia argyrodendron</i>) or Coolibah (<i>Eucalyptus coolabah</i>), as well as grassland in areas previously cleared of trees wherever flood-prone, cracking clay soils occur. Essential microhabitat features include an abundance of deep soil cracks and/or fallen logs (Wilson and Swan 2014; Commonwealth of Australia 2020).
	It would be useful to include an explanation, perhaps in a footnote, of what method or decision process was used to identify the Regional ecosystem associations that may comprise preferred and/or marginal habitat. One could also make a distinction between the REs that the species is most commonly associated with and the other REs in the list. DSEWPaC

Review question	Responses
	(2011a) identifies that Ornamental Snake is commonly associated with REs 11.4.3, 11.4.6, 11.4.8, 11.4.9, less commonly recorded in REs 11.3.3 (adjacent to an ephemeral wetland) and 11.5.16 (associated with gilgais).
	BD – Marginal habitat refers to infrequent gilgai however there is no mention of gilgai 'density' here. I would recommend adding something along these lines.
	LA – The Ornamental Snake's preferred habitat is within, or close to, habitat that is favoured by its prey - frogs. Principally, this is gilgai depression and mound landform developed on deep cracking clays (typically Land Zone 4), within woodland or open forest (with or without the presence of brigalow), where essential microhabitat features are present, being an abundance of deep soil cracks and coarse woody debris (typically hollow fallen timber and / or weathered coarse woody debris, especially where piles may occur adjacent to / nearby gilgais). Also, shallow vegetated margins of seasonal wetlands within woodland or open forest (with or without the presence of brigalow), where essential microhabitat features are present (an abundance of deep soil cracks and coarse woody debris). Higher abundance of Ornamental Snakes within such habitat has been associated with the lowest part of the catchment, and with soils which have a high fraction of fine clay particles.
	CE – Depending on the definition of central Qld there may need to be some reference to presence/absence in certain drainage systems (e.g. is not known to occur in upper Dawson River catchment in lower CQ)
	LF – I would recommend removing the component relating to important habitat / habitat critical to the survival of the species from the definition of preferred habitat and re-naming to breeding and foraging habitat. Also include a third category for dispersal habitat.
	These categories can be considered to be important habitat / habitat critical to the survival of the species if the following criteria are met:
	• Quality of breeding and foraging habitat can support a population that will allow for the long-term persistence of the species; OR
	• Dispersal habitat provides an important role of the species by connecting areas of habitat to important foraging areas; OR
	Occur within a larger highly connective floodplain of gilgai
General and/or marginal habitat – review comments	
Q4: What information in the draft definition of suitable	SW – Marginal habitat is well summarised
provide specific evidence, where possible.	PL – I support the definition the first part of the definition. The species is known to be associated with the types of habitat referred to where these occur in conjunction with gilgai and deep cracking clays, so habitats where cracking clays and gilgai are infrequent or rare can be considered marginal.

Review question	Responses
	BD – I generally agree with this description and particularly the reference to less frequent and shallow gilgai and soil cracks.
	LA – I have difficulty with this modified habitat definition.
	CE – The definition reflects the current state of knowledge & is supported.
	LF – I agree with the concept that the reduced extent of microhabitat features would reduce the ability of the area to support numerous individuals. As such it may not be considered important habitat.
Q5: What information in the draft definition of suitable	SW – 'Marginal habitat is defined as the habitat that provides limited resources for a species and may be used rarely'.
and/or marginal habitat do you <u>not</u> support and why? Please provide specific evidence, where possible.	If marginal habitat is adjacent (literally, marginal) to preferred habitat it may represent an important buffer and source of food for the snakes' prey. Disturbance of areas immediately adjacent to preferred habitat may be considered potentially significant.
	'Suitable and/or marginal habitat is not defined for all species, as both of these habitat types may not be applicable'
	Suitable and marginal habitats, while sub-optimal for breeding, feeding and habitation, may remain important for dispersal and connectivity between populations. In the case of Ornamental Snakes, preferred habitat can have extremely high population densities, but often with an abrupt cut-off as soon as the soil and hydrology changes. This cut-off represents the shift from preferred to suitable/marginal habitats. Suitable/marginal habitats may have important roles as buffers and potential dispersal routes between populations in preferred habitats.
	PL – I support the definition the second part of the definition referring to threats mentioned unless the supporting evidence can be referenced.
	BD – I'm not sure whether the inclusion of weeds is appropriate as we have recorded the ornamental snake in areas with high incursions of Parthenium and other weeds.
	LA – See below
	CE – NA
	LF – The reduced frequency of soil cracks may not necessarily equate to no breeding individuals. As previously mentioned, I don't think there is enough data to provide a threshold of when breeding would or would not occur for individuals of the species based on soil crack abundance. Individuals may still breed in areas with lower crack abundance it may just mean fewer individuals are present. This may mean the species is harder to detect and therefore more rarely identified to be present in this habitat.
	An example of this is at Daunia Mine, where habitat would match the description of suitable habitat – very shallow gilgai and infrequent soil cracks. However numerous records of Ornamental Snake occur in this area. In surveys I have conducted in this area, an individual was recorded in 'suitable habitat'. It could not be concluded that this individual would be only foraging in this habitat type and not breeding as well.

Review question	Responses
	The definition of marginal habitat for Ornamental Snake is slightly contradictory in that it states that the species may be present "especially in times where water is present and prey abundance (frogs) is high". This suggests that foraging resources are highly available rather than limited as the marginal definition would imply.
Q6: Do you have additional suggestion to improve the draft definition of suitable and/or marginal habitat ?	SW – Sites adjacent to or between preferred habitats, whether defined as suitable or marginal, should be viewed as potentially important dispersal routes and assessed in terms of structural integrity; presence of fallen timber, ground cover, soil cracks/cavities.
	PL – No
	BD – No
	LA – Ornamental Snakes are unlikely to travel great distances; thus, they occur in marginal habitat or not (cf. used rarely). What may assist in the definition is reference to abundance, i.e. marginal habitat may only support very low abundance of animals. Where such habitat is not within close proximity to preferred habitat (with suitable opportunities for small populations to connect with others in better / more sustainable habitat), population viability within marginal habitat may be low over time. Also, I think determining whether soil cracks are 'shallow' may be problematic.
	CE – NA
	LF – This category may be difficult to apply to a highly cryptic species and there may not be enough data to support some of the conclusions drawn between quality and utilisation. I would recommend removing the 'quality' component associated with the habitat categories and keeping it based on utilisation. Concepts of quality can be included in separate criteria when defining important habitat / habitat critical to the survival of the species.
Q7: For species where only two habitats types are defined	SW – I think suitable habitat should be included, to cover areas of potential dispersal value.
(e.g. preferred and suitable or marginal), do you think the third habitat type should be included? If not, why? If so, why and please provide a suggested definition	Suitable: Areas near or between preferred habitats, currently or previously dominated by brigalow coolibah communities where woody debris, and/or gilgai, soil cracks and cavities are present and the species still have potential to disperse between preferred sites, especially in times where water is present and prey abundance (frogs) is high.
	PL – I support two habitat types so long as both remnant and non-remnant vegetation is identified as preferred habitat - Wilson & Swan (2014) document the conditions under which Ornamental Snake can be abundant in non-remnant cleared areas so long as the preferred cracking clay soils are present. It is not entirely clear that the draft preferred habitat definition includes both remnant and non-remnant areas.
	BD – No. Ornamental snake have a very specific habitat requirement and I don't think that a third category could be practically differentiated from the other categories.
	LA – No guidance provided.
	CE – NA

Review question	Responses
	LF – There is no inclusion or mention of dispersal habitat. Ornamental Snake is known to move through different habitat
	types in search for foraging resources, especially when water is scarce. I would recommend including three categories but based on utilisation i.e. breeding, foraging and dispersal.
Other review comments	
Q8: Do you have other comments or information?	SW – None
	PL – None
	BD – No
	LA – None
	CE – Table 2-1
	Vegetation composition: the current definition is largely related to veg structure rather than composition
	Vegetation structure: add information related to veg structure to this section.
	Additional REs: 11.3.17, 11.3.27, 11.3.37, 11.4.5, 11.4.10
	Possibly also on 11.3.4 and 11.3.25 where substrate is clay or where adjoining preferred REs
	Delete 11.9.6, 11.9.6a – not in CQ?
	Landforms/land zones: also on land zone 3 & 9
	Patch size: the species occurs in non-remnant areas so not sure of the justification for habitat patches being typically >10 ha
	Habitat Connectivity: the distribution of this species is probably naturally patchy due to the patchiness of preferred substrate. Not sure that connectivity is therefore highly relevant to this species.
	LF – None
Q9: Are there other resources, particularly published	SW – None
literature or outcomes of research, relevant to this species	PL – None
in central Queensland that are not referenced in the current work? If so, please provide details and a link (if possible).	BD – No
	LA – None
	CE – Melzer, A. 2012. Ornamental Snake. Pp.241-242 in Curtis, L.K., Dennis, A.J., McDonald, K.R., Kyne, P.M. and Debus,
	S.J.S. eds. Queensland's Threatened Animals. Collingwood, Victoria: CSIRO Publishing.
	LF – None

Table 22 Summary of expert reviews for Yakka Skink

Review question	Responses	
Draft definitions reviewed by experts:		
Preferred yakka skink habitat in Central Queensland is defined as:		
Any contiguous patch of suitable habitat where a colony is known or identified.		
Suitable yakka skink habitat in Central Queensland is defined as:		
• Areas of non-remnant, regrowth and remnant woodlands or open forests with suitable loam/sandy substrate (land zones 3, 5, 7, 9 and 10) with a high density of microhabitat features. ¹⁴⁵		
Expert reviews undertaken: 3 reviews – Steve Wilson Craig Eddie and Liz Fisher		
Preferred habitat – review comments		
Q1: What information in the draft definition of preferred habitat do you support and why? Please provide specific evidence, where possible	SW – Broad outline of habitat type, including disturbed areas, and structural features including hollow logs, other animal burrows etc are in accord with my experience.	
	CE – Nil – habitat preferences should not be based on known colonies alone as some of these may be in marginal habitat	
	LF – I agree with the following components of the definition as it aligns with the criteria for important habitat for yakka skink in the Draft Referral Guidelines for nationally listed Brigalow Belt reptiles:	
	Known or identified colonyContiguous habitat	
Q2: What information in the draft definition of preferred habitat do you <u>not</u> support and why? Please provide specific evidence, where possible	SW – Any contiguous patch of suitable habitat where a colony is known or identified. I have a problem with the requirement that positive record (sighting or scats) is necessary to define Preferred Habitat.	
	Extensive survey effort is sometimes necessary to confirm Yakka Skink presence. If this is time/cost prohibitive the species may be overlooked, negating Preferred Habitat status	
	CE – All	

¹⁴⁵ Includes large hollow logs, cavities or burrows under large fallen trees, tree stumps, logs, stick-racked piles, large rocks and rock piles, dense ground-covering vegetation, dense leaf litter and fallen bark, deeply eroded gullies, tunnels and sinkholes.

Review question	Responses
	LF – The exclusion of habitat containing microhabitat features that are likely to support the species from the definition of preferred habitat. This could support breeding individuals. This is also noted to be important habitat for the species in the Draft Referral Guidelines for nationally listed Brigalow Belt reptiles.
	I don't think the presence of a colony alone is a suitable determining factor for breeding habitat for the species. I also do not see the link between species presence and the level of quality of foraging resources.
Q3: Do you have additional suggestion to improve the draft definition of preferred habitat ?	SW – Any contiguous patch of habitat containing crucial required features, occurring within the species' known distribution, and within 10 kilometres (*) of known occurrence.
	(*) Open for discussion, and a more loose term of 'adjacent to area of known occurrence' but the issue is whether the habitat is structurally suitable and the species is known from the area. It removes the requirement to provide positive record in order to deem habitat as preferred.
	CE – Replace the description with a revised version of the suitable habitat description.
	LF – I would recommend developing a broader and more encompassing and therefore technically accurate definition for breeding and foraging habitat, and using utilisation only as the habitat categories. Standalone criteria could then be used to assess when breeding and foraging habitat is important habitat. E.g. contiguous habitat AND high density of microhabitat features likely to support the species, OR presence of colony.
	Reserving 'important habitat' determinations for areas where the species has been identified may change regulator expectations around meeting survey guideline requirements for survey effort, which are substantial for Yakka Skink. Previously, regulators have been flexible around the survey guidelines particularly for large sites due to the approach of mapping habitat based on presence of suitable habitat features (inferring potential presence). If habitat determination and determinations of important habitat are purely based on presence, regulator expectations for survey effort may increase, which could result in more substantial survey time on projects. This may require consideration in either finalising habitat definitions or how these definitions are discussed with the regulator.
General and/or marginal habitat – review comments	
Q4: What information in the draft definition of suitable and/or marginal habitat do you support and why? Please provide specific evidence, where possible.	 SW – I agree with the definition of Suitable Habitat CE – See below LF – I agree that the described habitat is habitat for the species. The species can persist in non-remnant and regrowth areas if a high density of microhabitat features such as logs are present. Sandy/loamy soils are required to allow for the construction of burrows as well as for burrows to hold structural integrity
Q5: What information in the draft definition of suitable and/or marginal habitat do you <u>not</u> support and why? Please provide specific evidence, where possible.	SW – NA CE – See below

Review question	Responses
	LF – The description of suitable habitat for the species does not match the definition of this category. Remnant, regrowth or non-remnant habitat with a high density of microhabitat features is the ideal habitat for this species (particularly remnant areas) and is habitat that could support a colony. It therefore cannot be considered habitat that would be used opportunistically and contain only low quality foraging resources. It also lists habitat features that the species would use for breeding, therefore it cannot be stated that breeding would not occur in a habitat with these resources. It also reflects some aspects listed in the definition of important habitat in the Draft Referral Guidelines for nationally listed Brigalow Belt reptiles.
Q6: Do you have additional suggestion to improve the draft	SW – I would add: 'occurring within the species' known distribution'.
definition of suitable and/or marginal habitat ?	CE – Suggest move the current description of suitable habitat to preferred habitat with some minor modifications to read:
	Areas of remnant and regrowth woodlands and open woodlands, as well as non-remnant vegetation, with suitable light
	large hollow logs, cavities or burrows under large fallen trees and/or tree stumps, log piles, large rocks and rock piles,
	deep rock crevices, deeply eroded gullies or sinkholes/areas of tunnel erosion.
	There is then no need for a suitable habitat but a marginal habitat category could apply to those areas on suitable land zone, with loam/sandy substrate and vegetation associations but rare occurrences of suitable microhabitat features.
	LF – I would recommend developing a broader and more encompassing and therefore technically accurate definition for breeding and foraging habitat, and using utilisation only as the habitat categories. Standalone criteria could then be used to assess when breeding and foraging habitat is important habitat.
Q7: For species where only two habitats types are defined	SW – NA
(e.g. preferred and suitable or marginal), do you think the third habitat type should be included? If not why? If so	CE – See above
why and please provide a suggested definition	LF – Considering this species has high site fidelity, I would revise and include just one category – breeding and foraging. Specific and standalone criteria for important habitat should be developed.
Other review comments	
Q8: Do you have other comments or information?	LF – In the 'habitat identification guidance' section under hydrological needs, consideration should be given to noting that suitable or preferable habitat on land zone 3 that would be subject to flooding (i.e. every few years) would unlikely be inhabited by the species. Burrow systems that are flooded regularly would not be utilised by the species.
	SW – For Yakka Skink and Collared Delma, the species or signs of the species must be identified on-site to deem it as preferred habitat, but for Ornamental Snake, structural elements within known distribution are sufficient. I think Yakka Skink and Collared Delma should be brought into line with this.

Review question	Responses
	By the definitions I have suggested, Preferred Habitat does not require on-site positive records but the species must be known to occur in the vicinity. My definition of 'within 10 km' is a loose one, but I am trying to generate Preferred habitat as being structurally suitable with known populations in the vicinity.
	Suitable Habitat does not require known adjacent populations/records, but requires the site to be within known distribution.
	CE – Note that the ecology, distribution and habitat preferences of this species in central Qld are very poorly known – far less documented than in Brigalow Belt south and Mulga Lands. Information herein is derived from BBS habitat and microhabitat associations. Note that in the Mulga Lands habitat associations are different than in the Brigalow Belt hence information is not directly transferable between bioregions.
	Table 2.1
	Vegetation Composition: the current description relates mainly to structure. A better description would incorporate dominance of vegetation communities by a range of dry sclerophyll species such as <i>Eucalyptus populnea</i> , <i>E. fibrosa</i> , <i>E. crebra</i> , <i>E. orgadophila</i> , <i>E. melanophloia</i> , <i>Acacia shirleyi</i> , <i>A. catenulata</i> , <i>A. aneura</i> , <i>A. microsperma</i> , <i>Allocasuarina luehmannii</i> , <i>Casuarina cristata</i> and <i>Callitris glaucophylla</i> .
	Vegetation structure: incorporate description from Veg composition i.e. dry scleorphyll woodland, open woodland and scrub.
	Microhabitat features are dealt with elsewhere.
	RE associations include:
	add 11.5.1a, 11.5.4, 11.5.4a, 11.7.2, 11.7.6, 11.9.7, 11.10.9, 11.10.11
	delete: 11.3.1, 11.3.4, 11.4.2, 11.4.7, 11.4.8, 11.4.9, 11.4.9a, 11.4.12, 11.5.14a, 11.5.16, 11.9.1, 11.9.11, 11.9.12, 11.9.14, 11.10.1d, 11.10.4a, 11.10.4b, 11.10.4c, 11.10.6 unless there are confirmed local records supporting use of these REs
	Land Zones: predominantly LZs 3,5,7, 9 & 10. It may use LZ4 & LZ8 but this requires confirmation.
	Soils: can include light clay and clay loams but avoids heavy clays
	LF – In the 'habitat identification guidance' section under hydrological needs, consideration should be given to noting that suitable or preferrable habitat on landzone 3 that would be subject to flooding (i.e. every few years) would unlikely be inhabited by the species. Burrow systems that are flooded regularly would not be utilised by the species.
Q9: Are there other resources, particularly published literature or outcomes of research, relevant to this species in central Queensland that are not referenced in the current work? If so, please provide details and a link (if possible).	SW – None CE – Eddie, C. 2012. Yakka Skink. Pp.224-225 in Curtis, L.K., Dennis, A.J., McDonald, K.R., Kyne, P.M. and Debus, S.J.S. eds. Queensland's Threatened Animals. Collingwood, Victoria: CSIRO Publishing.

Review question	Responses
	Peck, S., Gardner, M. Seddon, J. and Baxter, G. (2017) Life-history characteristics of the yakka skink, <i>Egernia rugosa</i> , indicate long-term social structure. <i>Australian Journal of Zoology</i> 64 (5): <i>xx</i> – <i>xx</i> .
	LF – None

Table 23 Summary of expert reviews for Collared Delma

Review question	Responses
Draft definitions reviewed by experts:	
Preferred collared delma habitat in Central Queensland is defined as:	
Any contiguous patch of suitable habitat where an i	ndividual is known or identified.
Suitable collared delma habitat in Central Queensland is defined as:	
• Areas of remnant eucalypt woodlands or open forests on land zones 3, 9 and 10 with a high density of essential microhabitat features. Areas dominated by exotic grasse and regrowth or recently burnt areas are not included as suitable habitat.	
Expert reviews undertaken: 2 reviews – Steve Wilson and Cra	ig Eddie
Preferred habitat – review comments	
Q1: What information in the draft definition of preferred	SW – Any contiguous patch of suitable habitat where an individual is known or identified.
habitat do you support and why? Please provide specific evidence, where possible	CE – Nil. With so few records it is difficult to ascertain what preferred habitat is for this species in CQ. A record of this species does not mean that it was found in preferred habitat – it may have been found in marginal habitat.
Q2: What information in the draft definition of preferred habitat do you <u>not</u> support and why? Please provide specific evidence, where possible	SW – Information is correct but too brief. It infers a specimen (or slough) must be positively recorded before a habitat is deemed suitable
	CE – It is unlikely that a meaningful description of preferred habitat could be derived for this species in CQ based on the lack of records.
Q3: Do you have additional suggestion to improve the draft definition of preferred habitat ?	SW – Any contiguous patch of habitat containing crucial required features, occurring within the species' known distribution. There is no mention of structural elements in the preferred habitat description, though they appear below in the habitat guidance:
	Intact, undisturbed leaf litter
	Eucalypt communities on well-drained slopes
	Scattered undisturbed surface stones, typically 15-30 cm
	CE – Do not have a preferred habitat category until further knowledge is available.
General and/or marginal habitat – review comments	
Q4: What information in the draft definition of suitable	SW – I agree with the references to exotic grasses as inhabiting factors
and/or marginal habitat do you support and why? Please provide specific evidence, where possible.	CE – The description partly reflects current knowledge but needs some refinement – see below.

Review question	Responses
Q5: What information in the draft definition of suitable and/or marginal habitat do you <u>not</u> support and why?	SW – I disagree that recent burn is a disqualifying factor. Most preferred habitat is fire-prone (e.g. dry eucalypt forests with leaf litter).
Please provide specific evidence, where possible.	Recent burn as a disqualifying factor overlooks likely use of other refugia (beneath rock, in soil cavities, invertebrate holes etc) during and following these events.
	Recent burn as a disqualifying factor assumes the occurrence of a natural fire event eliminates the species from a habitat.
	CE – The occurrence of this species is poorly known and it is very difficult to detect. Populations may also occur on other land zones such as 4, 5, 7, 8, 11 & 12. Essential microhabitat features should be defined e.g. dense leaf litter, abundance of small rocks or woody debris).
	Regrowth could not be excluded as potential habitat if essential microhabitat features are present.
	Fire would be a natural part of the ecology of the habitats in which this species lives. Habitat should not be excluded if it has been recently burnt. A wildfire may certainly be destructive however patchy burns are unlikely to significantly impact upon this species and certainly wouldn't render the habitat unsuitable.
Q6: Do you have additional suggestion to improve the draft definition of suitable and/or marginal habitat ?	 SW – Any contiguous patch of suitable habitat within the species' known range, featuring dry eucalypt forest on well-drained slopes, with native grasses and/or leaf litter and scattered undisturbed surface stones, typically 15-30 cm. CE – See above
Q7: For species where only two habitats types are defined (e.g. preferred and suitable or marginal), do you think the third habitat type should be included? If not, why? If so,	 SW – The two habitat definitions, rather than three, should be sufficient, but for reasons outlined signs of recent burns should not preclude an area from consideration. CE – Not provided
why and please provide a suggested definition	
Other review comments	
Q8: Do you have other comments or information?	SW – For Collared Delma and Yakka Skink, the species or signs of the species must be identified on-site to deem it as preferred habitat, but for Ornamental Snake, structural elements within known distribution are sufficient. I think Collared Delma and Yakka Skink should be brought into line with this.
	Fire as a disqualifying factor should be excluded. There is some evidence of prior burns in many areas I have found <i>Delma torquata</i> so clearly they have persisted. In fact most areas I have found them could be considered to be fire- prone. Intense destructive fires are another matter, but unless defined as such, sign of recent burn should not exclude designation as preferred habitat
	CE – Table 2.1

Review question	Responses
	Additional REs: In addition to those listed, the species may also occur in the following REs: 11.3.1, 11.3.4, 11.3.6, 11.3.7, 11.3.14, 11.3.17, 11.3.18, 11.3.19, 11.3.39, 11.4.3, 11.4.7, 11.4.8, 11.4.10, 11.4.12, 11.5.1, 11.5.2, 11.5.3, 11.5.4, 11.5.5, 11.5.9, 11.7.1, 11.7.2, 11.7.4, 11.7.4c, 11.7.6, 11.7.7, 11.8.2, 11.8.4, 11.8.5, 11.9.1, 11.9.2, 11.9.5, 11.9.7, 11.10.2, 11.10.6, 11.10.3, 11.10.9, 11.10.13, 11.11.1, 11.11.2, 11.11.3, 11.11.4, 11.11.1, 11.12.1, 11.12.2, 11.12.3 Habitat condition: revise statement re fire – it does not always destroy microhabitat. Hot fires are certainly undesirable but low intensity fires are unlikely to destroy all microhabitat such as small stones.
Q9: Are there other resources, particularly published literature or outcomes of research, relevant to this species in central Queensland that are not referenced in the current work? If so, please provide details and a link (if possible).	 SW – Wilson, S. 2015. A Field Guide to reptiles of Queensland. 2nd edition. New Holland Publishers CE – Hines, B.M., Hannah, D. Venz, M. and Eyre, T. 2000. New distribution and habitat data for the vulnerable Pygopodid, Delma torquata (Kluge, 1974). Memoirs of the Queensland Museum 45, 393-393.

Table 24 Summary of expert reviews for Large-eared Wattled bat

Review question	Responses	
Preferred large-eared wattled bat habitat in Central Queensland is defined as:		
• Suitable roosting habitat (including caves, rock overhangs and cliff lines in sandstone outcrops and gorges) in close proximity to fertile ¹⁴⁶ wooded valleys.		
Suitable large-eared wattled bat habitat in Central Queensla	nd is defined as:	
Woodlands and open forests occurring within 3 km of preferred habitat.		
Expert reviews undertaken: 2 reviews – Greg Ford and Craig Eddie		
Preferred habitat – review comments		
Q1: What information in the draft definition of preferred	GF – Describes preferred roosting habitat in broad terms but would benefit from more detail.	
habitat do you support and why? Please provide specific evidence, where possible	CE – Agree with the concept of roosting habitat.	
Q2: What information in the draft definition of preferred habitat do you <u>not</u> support and why? Please provide specific evidence, where possible	GF – Uses the term "suitable" under the "preferred" category, which makes the description ambiguous. Refer to my comments on the Corben's Long-eared Bat profile for a more complete critique of the concepts.	
	Requires more detail (although this is covered partly in the Table), e.g. relating to preferred foraging habitat and, perhaps, some more detail on roosts (e.g. general comment on roost structure – does it need deep caves or just shallow overhangs? Does it roost in narrow rock fissures?)	
	CE – The term "fertile" wooded valleys is often mentioned in the literature however we have also captured this species in valleys and other areas away from roost sites that could not be described as fertile e.g. sand plains and broad valleys on land zone 10. In some areas e.g. Carnarvon Range the areas surrounding roost habitat are not necessarily "fertile" but given that we have captured individuals there we assume they are either foraging in them or moving through to forage in more productive habitat.	
Q3: Do you have additional suggestion to improve the draft definition of preferred habitat ?	 GF – I think you need to have some fairly precise descriptions of both "preferred" and "suitable" rather than just listing a bunch of stuff in the Table; primarily because it is unclear in the Table whether the attributes relate to preferred or suitable habitat categories. If you want to use the table as a convenient way of summarising key habitat components, then you should either have one table in each category or have it split into preferred and suitable sections. Williams & Thomson (2019) radio-tracked several males and females in the Blue Mtns region and found the following: 	

¹⁴⁶ In particular box gum woodlands or river/rainforest corridors

Review question	Responses
	 Both sexes roosted in west-facing cliffs without large caves – available roost sites were primarily small (<30cm high) fissures
	 Preferred foraging areas included: a sharp grassland-forest border in a west-facing valley; a creek or moist drainage line with wet vegetation types and <u>day roosts within 700m</u> (maximum distance recorded between roost and foraging area was 2.5km)
	Suggested wording might be along the lines of
	Preferred <u>roosting</u> habitat for Large-eared Wattled Bat is sandstone cliff-lines (Land Zone 10), with a north-westerly to south-westerly aspect, where it roosts in small caves and fissures. Sheltered caves of several metres depth may be critical maternity sites.
	Preferred <u>foraging</u> habitat for Large-eared Wattled Bat is on fertile foot-slopes and valley floors, within 0.5-2.5 km of preferred roosting habitat. Foraging activity appears to be concentrated particularly along ecotones between moist and dry vegetation types and abrupt edges between woodland and pasture.
	CE – Foraging habitat needs to be clearly distinguished from roosting habitat i.e. incorporate the term foraging habitat or similar. Delete the word "fertile" from foraging habitat and replace with something like "open forests and woodlands including riparian vegetation within XX km of roosting habitat" (refer to Greg Ford's suggested distances).
General and/or marginal habitat – review comments	
Q4: What information in the draft definition of suitable and/or marginal habitat do you support and why? Please	GF – The statement more-or-less covers what might be considered "suitable" habitat but needs some more detailed explanation (some of which could be dragged out of the table)
provide specific evidence, where possible.	CE – This is a general reflection of available information in the literature. In the absence of any studies in the northern part of its range the 3 km distance from roost sites is a conservative estimate until local studies are completed. Although the studies of foraging distances completed in the Blue Mountains suggest smaller foraging distances we don't currently know that this distance is directly transferable to the northern populations.
	Agree with Greg Ford that elevated areas of land zone 7 and 8 with potentially suitable roost sites could support the species (there is been little targeted survey work for this species in some of these areas) and may represent either suitable (LZ8) or marginal (LZ7) habitat
Q5: What information in the draft definition of suitable and/or marginal habitat do you <u>not</u> support and why? Please provide specific evidence, where possible.	 GF – It's too generic; and may need to revise the distance reference of 3km – it's probably OK but Williams & Thomson (2019) found a much shorter foraging range (~700m from roosts) in the Blue Mountains CE – Nil
Q6: Do you have additional suggestion to improve the draft definition of suitable and/or marginal habitat ?	GF – Suitable <u>roosting</u> habitat as per "preferred roosting habitat", but potentially also includes larger scarps in Land Zone 7 ("ironstone jump-ups") and volcanic plugs in Land Zone 8. Known also to roost in abandoned mine adits.

Review question	Responses
	Suitable <u>foraging</u> habitat includes woodland and forest associated with suitable roosting habitat. Ecotones and edges (e.g. between vine-thicket and woodland or between riparian woodland and pasture) appear to be important foraging areas. Bats may forage several kilometres away from roost sites, following riparian corridors that traverse otherwise cleared pastureland.
	CE – See above
Q7: For species where only two habitats types are defined (e.g. preferred and suitable or marginal), do you think the third habitat type should be included? If not, why? If so, why and please provide a suggested definition	GF – It may be more appropriate to describe the potential alternative roosting habitats shown above in the "suitable" category as "marginal" habitat – especially the Land Zone 7 jump-ups as they seldom appear to have extensive enough scarps with enough suitable fissures or overhangs to provide for the daily roost changes that the species seems to undertake (Williams & Thomson 2019).
	CE – Agree with Greg Ford – elevated areas of land zone with potential roosting habitat could be described as marginal habitat.
Other review comments	
Q8: Do you have other comments or information?	GF –
	 Please note new common name for this species is <u>Large-eared Wattled Bat</u> This name was adopted by Jackson & Groves (2015) in <i>Taxonomy of the Mammals of Australia</i> and will be the name used in the forthcoming 4th Edition of <i>The Mammals of Australia</i> (eds. Baker & Gynther; formerly van Dyck & Strahan, 3rd Edition)
	CE – Table 2.1
	Vegetation Composition & Vegetation Structure: there seems to be overlap between these two categories – either combine and refine or define composition and structure more clearly. Need also to differentiate between foraging and roost habitat (microhabitat is more important for roost habitat than the veg type/composition/structure)
	RE Associations: Roosting - add 11.10.6 & 11.10.13 to roost habitat as these can support isolated sandstone mesas & outcrops with suitable roost sites e.g in Carnarvon/Expedition Range. 11.10.8 can also support the same microhabitat features (e.g rock fissure/crevices/large boulder piles etc).
	Potentially could also include 11.8.1 & 11.8.2 where there are suitable shelter sites (e.g. Consuelo Tableland) and possibly 11.8.3, 11.7.2 & 11.7.4
	Foraging – we have captured this species in 11.10.9 and 11.9.5 within a kilometre or two of potential roost sites. Almost any RE within the nominated distance of a roost could be potential foraging habitat but at a minimum some key additions would include: 11.3.1, 11.3.6, 11.3.7, 11.3.10, 11.3.11, 11.3.12, 11.3.14, 11.3.17, 11.3.18, 11.3.19, 11.3.27, 11.4.1, 11.4.3, 11.4.8, 11.4.9, 11.4.10, 11.4.12, 11.9.1, 11.9.2, 11.9.4, 11.9.5, 11.9.7, 11.9.10, 11.10.6, 11.10.8, 11.10.9, 11.10.11, 11.10.13

Review question	Responses
	Land Forms/Zones: see above for additional foraging LZ's. Could potentially utilise LZ8 & 7 for roosts. Habitat condition: Suggest revise current statement. I'm not sure that it can be demonstrated that there is a sensitivity to clearing from available records. Roost sites could be obliterated by a mine but otherwise would not generally be impacted by clearing. It has been demonstrated that the species forages along clearing/wooded interfaces so it must be tolerant to some degree of cleared habitat?
Q9: Are there other resources, particularly published literature or outcomes of research, relevant to this species in central Queensland that are not referenced in the current work? If so, please provide details and a link (if possible).	 GF – Williams, E.R. & Thomson, B. (2019). Aspects of the foraging and roosting ecology of the large-eared wattled bat (<i>Chalinolobus dwyeri</i>) in the western Blue Mountains, with implications for conservation. <i>Australian Mammalogy</i> 41(2). 212-219. <u>https://doi.org/10.1071/AM17064</u> CE – Dennis, A.J. 2012. <i>Large-eared Wattled bat</i>. Pp.374-375 <i>in</i> Curtis, L.K., Dennis, A.J., McDonald, K.R., Kyne, P.M. and Debus, S.J.S. eds. <i>Queensland's Threatened Animals</i>. Collingwood, Victoria: CSIRO Publishing.

Table 25 Summary of expert reviews for Corben's long-eared bat

Review question	Responses	
Draft definitions reviewed by experts:		
Preferred Corben's long-eared bat habitat in Central Queens	Preferred Corben's long-eared bat habitat in Central Queensland is defined as:	
Any contiguous patch of suitable habitat where an i	ndividual is known or identified.	
Suitable Corben's long-eared bat habitat in Central Queensland is defined as:		
• Large tracts (>500 ha) of remnant, open forest to woodland (particularly cypress pine, box, ironbark and brigalow/belah communities) with a distinct tree canopy, a dense cluttered understorey and a high abundance of roosting microhabitat. ¹⁴⁷		
Expert reviews undertaken: 2 reviews – Greg Ford and Craig Eddie		
Preferred habitat – review comments		
Q1: What information in the draft definition of preferred habitat do you support and why? Please provide specific evidence, where possible.	 GF – Not supported. Nothing – it's an ambiguous sentence (see response to next question); and I don't think you should be relying on a record of the species (because there aren't any in the CQ region) to determine what "preferred" habitat is. There is enough evidence from published research (e.g. Law et al 2016, Lumsden et al 2008, 2011) and known records in south-central Qld, upon which to base a description of "preferred habitat" (i.e. "in which key activities are undertaken e.g. breeding, roosting"). CE – Nil. Uncertain whether this species is in CQ unless a clear definition of central Qld is provided. Our capture records are slightly further to the north than publicly accessible records at Carnarvon NP and Theodore area. I'm not aware of any records further north than that but consultant records are not always accessible. If CQ incorporates these areas, then a description of habitat based on vegetation type and structure should be provided based on what is available in the literature (our capture records are in similar habitat to more southerly records). 	
Q2: What information in the draft definition of preferred habitat do you <u>not</u> support and why? Please provide specific evidence, where possible	GF – Description of "preferred" uses the term "suitable", which is another habitat category and therefore brings ambiguity to the description. According to the "Habitat categories" description on Page 1, "Preferred habitats are those that are … crucial for the species' persistence", whereas "Suitable habitat … is not crucial for its persistence". How, therefore, can "suitable" (not crucial) be "preferred" (crucial)? The statement also implies that a habitat tract can be determined as "preferred habitat" <u>only</u> if "an individual is known or identified" (i.e. has been reliably recorded) within it. Since it is currently impossible to reliably identify the species from echolocation call detection and given its rarity in the landscape and difficulty of capture without significantly more	

¹⁴⁷ Includes fissures, loose bark and hollows

Review question	Responses
	trapping effort than has historically occurred in the CQ region, there are very few records upon which to base such a judgement.
	CE – See above
Q3: Do you have additional suggestion to improve the draft definition of preferred habitat ?	 GF – Key features of preferred habitat are: 1. Woodland or open forest with a complex understorey, characterised especially by the following floristic associations
	a. Canopy layer of E. fibrosa subsp. nubilus and/or Eucalyptus crebra and/or E. populnea and/or E. microcarpa/E. moluccana, often with Angophora leiocarpa and/or Corymbia spp., over a low tree layer of Callitris spp. and/or Allocasuarina luehmannii. Typically on Land Zones 5 and 7; occasionally Land Zones 3 & 10.
	2. Based on confirmed <i>N. corbeni</i> records in south-central Queensland (mostly in the Brigalow Belt South biogeographic region), "preferred habitat" is centred around three key groups of regional Ecosystems (RE). These include:
	 a. 11.5.1 / 11.5.4 – cypress/bulloak/eucalypt on sandy or duplex soils; undulating plains b. 11.7.4 / 11.7.7 – cypress/bulloak/eucalypt on shallow soils; low hills c. 11.3.18 / 11.3.2 – poplar box/cypress/bulloak on sands and duplex soils; alluvial plains
	 Large tract size (i.e. >~500 Ha) – home range appears to be several hundred hectares (Law et al 2016) with foraging largely restricted to areas within woodland/forest. High stem-density of the low tree layer.
	 High density of dead trees (esp. Bulloak, cypress and eucalypts) – critical for providing abundant roost microhabitat High abundance of hollows (esp. in small diameter dead trees) is particularly important as they are used to a greater extent than fissures & loose bark (Law et al 2016).
	Some other key points:
	• ~2/3 of CLEB records in QLD are in RE with cypress and/or bulloak, but
	RE with cypress/bulloak make up only ~50% of all the RE that have CLEB records
	• One or more other LZ3 REs (e.g. 11.3.14) could be added to the key group listed at point 2c
	• While brigalow/belah/eucalypt on clay soil plains (e.g. RE 11.4.3 & 11.4.10) is often touted as important habitat type, there are only 2 published records in these REs – this suggests that the brigalow/belah complex veg types should be in the "suitable habitat" category rather than "preferred"
	CE – Greg Ford has adequately addressed this and I concur with his excellent descriptions. My only additional information is that we have records from 11.3.4 and 11.3.39 that included patches of white cypress pine and bulloak.

Review question	Responses
General and/or marginal habitat – review comments	
Q4: What information in the draft definition of suitable and/or marginal habitat do you support and why? Please provide specific evidence, where possible.	 GF – The description of "suitable habitat" provides a good overview of veg structural types that may be suitable, but some of the more specific statements (e.g. ">500 ha" and "cypress pineetc") are leaning toward a description of "preferred" habitat. CE – Refer to Greg Ford's comments which adequately address this question.
Q5: What information in the draft definition of suitable and/or marginal habitat do you <u>not</u> support and why? Please provide specific evidence, where possible.	 GF – Assuming the above information will be incorporated into a detailed description of "preferred habitat", a more generalised description of "suitable" habitat types is needed here. CE – Refer to Greg Ford's comments which adequately address this question.
Q6: Do you have additional suggestion to improve the draft definition of suitable and/or marginal habitat?	 GF – Suitable habitat description should aim to achieve three things: Highlight the possibility that vegetation with structural (and floristic?) similarities to "preferred" habitat may be occupied by CLEB e.g. RE11.3.2, where there is a complex low-tree/understorey layer, especially with cypress; e.g. RE11.3.1 where dense low tree/shrub layer is present and extensive Highlight that overall tract size of e.g. >500 ha is a key determinant, particularly if constituted largely of vegetation with suitable structural characteristics; and Highlight the probability that CLEB may utilise habitat types adjacent to/contiguous with "preferred" habitat patches for foraging and drinking e.g. it is relatively easily trapped at waterholes in RE11.3.25 when that constitutes a narrow riparian strip through more extensive RE11.5.1 e.g. there are several confirmed records in RE11.7.5 "heathland" where it is surrounded by or is part of a mixed RE with 11.7.4 and/or 11.7.7
Q7: For species where only two habitats types are defined (e.g. preferred and suitable or marginal), do you think the third habitat type should be included? If not, why? If so, why and please provide a suggested definition	 GF – Realistically, anything that is not "preferred" or "suitable" would be considered "marginal" or even unsuitable. However, since CLEB appears to be restricted to larger tracts of suitable/preferred habitat, perhaps the marginal category is required. As an example, a 20 ha, isolated, narrow, linear patch of remnant RE11.4.3 (e.g. on a roadside surrounded by buffel grass pasture) would constitute "marginal" (if not "unsuitable") habitat for the species even if it was in perfect remnant condition with abundant hollows, complex understorey, etc. CE – Refer to Greg Ford's comments which adequately address this question
Other review comments	

Review question	Responses
Q8: Do you have other comments or information?	GF – No
	CE – Vegetation composition/structure – refer to Greg Ford's comments
	RE Associations: Would be more useful to split into preferred vs suitable based on what is known from capture records. Greg Ford has listed most of these plus refer to comments above regarding 11.3.4 and 11.3.39 in which we have captured individuals. The RE only provides an indication of where it might be found e.g. a patch of 11.3.2 without a complex understorey or without patches of pine/bulloak is unlikely to support the species.
	Land forms/zones: Predominantly occurs on LZ 3 & 5 – check records for the rest of the LZs
	Patch Size/Connectivity: most of our records are from areas with large wooded tracts however I have a record from Alton NP which is only just around 500 ha and is quite isolated in the surroudnig landscape although it does have broad connectivity with larger state forests to the east via the Moonie River. Care needs to be taken ruling out patches that are slightly <500 ha if they have connectivity with other wooded tracts in the landscape.
Q9: Are there other resources, particularly published literature or outcomes of research, relevant to this species	GF – Law, B., Gonsalves, L., Brassil, T. & Hill, D. (2018). Does thinning homogenous and dense regrowth benefit bats? Radio-tracking, ultrasonic detection and trapping. <i>Diversity</i> 2018 , <i>10(2)</i> , 45; <u>https://doi.org/10.3390/d10020045</u>
in central Queensland that are not referenced in the current work? If so, please provide details and a link (if possible).	Lumsden, L.F., Bennet, A.F. & Silins, J.E. (2002). Selection of roost sites by the lesser long-eared bat (<i>Nyctophilus geoffroyi</i>) and Gould's wattled bat (<i>Chalinolobus gouldii</i>) in south-eastern Australia. <i>Journal of Zoology</i> 257 , 207-218. <u>https://doi.org/10.1017/S095283690200081X</u>
	Lumsden, L.F., Bennett, A.F. & Silins, J.E. (2002). Location of roosts of the lesser long-eared bat Nyctophilus geoffroyi and Gould's wattled bat Chalinolobus gouldii in a fragmented landscape in south-eastern Australia. Biological Conservation 106, 237–249. https://doi.org/10.1016/S0006-3207(01)00250-6
	Turbill, C. & Ellis, M. (2006). Distribution and abundance of the south-eastern form of the greater long-eared bat <i>Nyctophilus timoriensis</i> . <i>Australian Mammalogy</i> 28 (1), 1-6. <u>https://doi.org/10.1071/AM06001</u>
	Turbill, C., Lumsden, L. & Ford, G. (2008). South-eastern & Tasmanian Long-eared Bats <i>Nyctophilus</i> spp.; Pp. 527-528 in <i>The Mammals of Australia 3rd Edition</i> (S. van Dyck & R. Strahan, eds.); Reed New Holland, Sydney.
	CE – Reardon, T. 2012. <i>South-eastern Long-eared Bat</i> . Pp.386-387 <i>in</i> Curtis, L.K., Dennis, A.J., McDonald, K.R., Kyne, P.M. and Debus, S.J.S. eds. <i>Queensland's Threatened Animals</i> . Collingwood, Victoria: CSIRO Publishing.

Table 26 Summary of expert reviews for Ghost bat

Review question	Responses
Draft definitions reviewed by experts:	
Preferred ghost bat habitat in Central Queensland is defined as:	
• Suitable roosting habitat (including complex cave systems i.e. multiple entranced caves, disused mine systems and rock crevices) in close proximity to a gully or gorge system	
Suitable ghost bat habitat in Central Queensland is defined as:	
All vegetation communities within 2 km from daytime roost.	
Expert reviews undertaken: 1 review – Greg Ford	
Preferred habitat – review comments	
Q1: What information in the draft definition of preferred	GF – Reasonable general description of roost requirements but could be expanded
habitat do you support and why? Please provide specific	Again, the use of "suitable" in the description makes the chosen habitat terminology ambiguous
evidence, where possible	
Q2: What information in the draft definition of preferred	GF – I'm not sure where "proximity to gorge or gully system" came from and I don't believe it's entirely accurate. E.g.
habitat do you not support and why? Please provide specific evidence, where possible	the maternity colony at Mt Etna, north of Rockhampton, is in a limestone hill surrounded by gently sloping to fairly flat and substantially cleared landscape
Q3: Do you have additional suggestion to improve the draft definition of preferred habitat ?	GF – Preferred <u>roosting</u> habitat of the ghost bat includes limestone cave systems, boulder piles, cliff-lines with deep caves and crevices, and disused mine tunnels. Breeding roosts are generally restricted to deep, complex natural cave
	systems with multiple entrances, or deep abandoned mine adits.
	Preferred <u>foraging</u> habitat is limited by proximity to preferred roosting habitat, as the ghost bat forages in a wide variety of habitats but usually only within about 2km of daytime roost sites.
	BUT
	Taking a literal interpretation of the definition of "preferred habitat" as providing resources that are "crucial to the
	persistence of the species", it could be said that "preferred habitat" is restricted to the two known breeding sites in
	Central Qld (i.e. Mt Etna and Cape Hillsborough, north of Mackay).
General and/or marginal habitat – review comments	
Q4: What information in the draft definition of suitable	GF – It's a correct statement, but see comment below
and/or marginal habitat do you support and why? Please provide specific evidence, where possible.	

Review question	Responses
Q5: What information in the draft definition of suitable and/or marginal habitat do you <u>not</u> support and why? Please provide specific evidence, where possible.	 GF – The statement here really refers to "preferred" foraging habitat As with the other microbat accounts, there seems to be some confusion over the use of the chosen terms of "suitable" and "preferred"
Q6: Do you have additional suggestion to improve the draft definition of suitable and/or marginal habitat ?	 GF – The two known breeding roosts in Central Queensland (i.e. at Mt Etna and Cape Hillsborough) are approximately 300km apart. Wide dispersal from breeding roosts in the non-breeding season is reported (e.g. see Worthington Wilmer 2012);
	however, genetic research (Worthington Wilmer et al 1994, 1999; Augusteyn 2017) shows the Cape Hillsborough and Mt Etna populations are genetically distinct, which implies limited (if any at all) movement of bats between the two Central Qld breeding populations.
	Taken at face-value, the above two key points lead to a conclusion that dispersal from breeding roosts in the non- breeding season is probably no more than 150 km.
	Based on the above assumption, <u>suitable roosting habitat</u> for the ghost bat may include any disused mine tunnels or escarpments with caves and crevices within about 200km of the breeding roosts at Mt Etna and Cape Hillsborough. While the ghost bat is reported to roost in "shallow escarpment overhangs" (Churchill 2008), it cannot enter torpor so depends on roosts with temperature above 23°C to conserve energy (Augusteyn 2017, citing Geiser 2006 & Toop 1985). Such roost sites are likely to be restricted to deeper caves and abandoned tunnels in the Central Qld region, where cool winter nights would make more exposed, shallow overhangs unsuitable for at least the early part of the day.
	<u>Suitable foraging habitat</u> for the ghost bat may include woodland, forest, wetland and cleared agricultural/pastoral land within a few kilometres of daytime roosts. A recent tracking study of ghost bats at the Mt Etna colony (Augusteyn et al 2017) found that lactating females foraged mainly over farmland within 3km of the roost, while a male foraged up to 11.8km from the roost, with activity concentrated on the edge of small remnant woodland patches, particularly those associated with an ephemeral watercourse.
Q7: For species where only two habitats types are defined (e.g. preferred and suitable or marginal), do you think the third habitat type should be included? If not, why? If so, why and please provide a suggested definition	GF – Marginal habitat is probably not needed for ghost bat.
Other review comments	
Q8: Do you have other comments or information?	GF – None

Review question	Responses
Q9: Are there other resources, particularly published literature or outcomes of research, relevant to this species in central Queensland that are not referenced in the current work? If so, please provide details and a link (if possible).	 GF – Augusteyn, J., Hughes, J., Armstrong, G., Real, K. & Pacioni, C. (2017). Tracking and tracing central Queensland's <i>Macroderma</i> – determining the size of the Mount Etna ghost bat population and potential threats. <i>Australian Mammalogy</i> 40(2), 243-253. <u>https://doi.org/10.1071/AM16010</u> Geiser, F. (2006). Energetics, thermal biology, and torpor in Australian bats. Pp. 5–22 in <i>Functional and Evolutionary Ecology of Bats</i>; (Eds A. Zubaid, G. F. McCracken and T. H. Kunz.); Oxford University Press, New York. Toop, J. (1985). Habitat requirements, survival strategies and ecology of the ghost bat <i>Macroderma gigas</i> Dobson (Microchiroptera, Megadermatidae) in central coastal Queensland. <i>Macroderma</i> 1, 37–41. Worthington Wilmer, J. (2012). Ghost Bat <i>Macroderma gigas</i>. Pp. 382-383 in <i>Queensland's Threatened Animals</i>; Curtis, L.K., Dennis, A.J., McDonald, K.R., Kyne, P.M. & Debus, S.J.S. (Ed's); CSIRO Publishing, Collingwood.
Table 27 Expert reviews for Grey-headed Flying-fox

Preferred grey-headed flying-fox habitat in Central Queensland is defined as:			
Suitable grey-headed flying-fox habitat in Central Queensland is defined as:			
• All Eucalyptus, Corymbia, Melaleuca, or Angophora vegetation communities that have potential to provide food resources for the species occurring within 50 km to a camp.			
Expert reviews undertaken: 2 reviews – Greg Ford & EMM			
Preferred habitat – review comments			
Known camps certainly constitute preferred habitat, especially those that are occupied regularly by GHFF.			
1 – NA			
The term "suspected" should be avoided, especially in the context of "preferred habitat". There is no indication of			
t constitutes preferred <u>foraging</u> nabitat.			
η – Preferred habitat has been chosen to be limited to roosting habitat. For this species there will be roosting tat (i.e. permanent and temporary camps) and foraging habitat. For aging habitat is seasonally dependent has don			
t is flowering or fruiting at that time and some areas can become particularly important in drought conditions. EMM			
d consider for this species having 'Roosting habitat' and 'Foraging habitat'.			
The description of foraging habitat provided under the "suitable" category could be elevated to the "preferred"			
gory, since myrtaceous forest and woodland is a <u>critical</u> resource (at least when in flower). The use of the qualifying ement "within 50km of a camp" also infers preferred/critical resource classification.			
forest fruits also make up part of the "preferred" foraging resource, so this needs to be incorporated into the erred foraging habitat description.			
ficant food plants in the GHFF blossom diet are discussed by Eby and Law (2008) and species listed in their Table			
p. 26), and which are known to occur in central Qld woodland/forest communities could be included in the			
ription of preferred habitat. Similarly, species in the fruit diet of GHFF are listed in Table 4.2 (Eby and Law 2008; 18-29), with the authors giving highest rank to vegetation types that contained >10 fruit-diet plants			
finat K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K I K K K K K K K K K K K K K			

¹⁴⁸ <u>https://environment.des.qld.gov.au/wildlife/animals/living-with/bats/flying-foxes/roost-locations</u>

Review question	Responses
	The project reported by Eby and Law (2008) focussed on the bulk of the known range of GHFF, which extended only as far north as about Bundaberg in Qld; however, the methods they developed for the assessment of food resources for GHFF could be adapted and applied to the central Qld region to identify potentially significant ("preferred") foraging habitat resources.
	Perhaps list/map known GHFF camps in the CQ region. This would help guide the identification of areas that may/should be considered preferred foraging habitat (i.e. myrtaceous woodland/forest within 50km of a known camp).
	Camps (in the CQ region) that are counted as part of the national FF monitoring program, and which have contained GHFF in at least one season since 2012 include:
	 Finch Hatton Gorge – all counts <500 individuals - Feb 2013, Feb 2015, May 2015, Aug 2016, Feb 2017, Aug 2017, May 2018, Aug 2018, May 2019 Calliope - <500 individuals Nov 2015, 500-2500 individuals Aug 2019 Mackay (4 camps) - <500 individuals Nov 2016 Kohra (W of Baskbarnatar) - <500 individuals Aug 2017
	 Kabra (W of Rockhampton) - <500 individuals Aug 2017 Emu Park - <500 individuals Aug 2019 Koppel Sands - <500 individuals Aug 2019
	 Wowan - <500 individuals Aug 2019 Tannum Sands (4 camps) - <500 individuals Aug 2019
	EMM – Suggest that the 'preferred or roosting habitat' capture intermittent camps also. Particularly as this species is more likely to occur towards the coast where its core distribution is. So camps may not be relevant to all study areas in central Qld for BHP apart from temporary camps during winter months or drought when species may disperse to forage more widely. A key message is the species is unlikely to have permanent camps in these areas as well as foraging numbers would be limited as it is predominantly known to occur in the coastal lowlands and slopes of southeastern Australia from Bundaberg to Geelong and are usually found at altitudes < 200m.
	It is worth noting that foraging habitat has not been captured under this definition due to the ephemeral nature of this resource.
General and/or marginal habitat – review comments	
Q4: What information in the draft definition of suitable and/or marginal habitat do you support and why? Please provide specific evidence, where possible.	GF – Good general description, but should be moved to "preferred" as these are crucial resources for GHFF EMM – NA

Review question	Responses
Q5: What information in the draft definition of suitable and/or marginal habitat do you <u>not</u> support and why? Please provide specific evidence, where possible.	 GF – None EMM – Definition doesn't specify if it can be remnant or regrowth. We think this should be specified.
Q6: Do you have additional suggestion to improve the draft definition of suitable and/or marginal habitat ?	GF – Describe what constitutes a suitable roost site – based on the information provided in the table. The Wowan camp is the inland-most central Qld roost where GHFF have been encountered in the national FF monitoring program, although the species probably also turns up at multiple other locations that are not monitored. The Wowan camp had been occupied only by Black and Little Red FF prior to January 2017 when the Banana Shire Flying-fox Management Plan was produced (Balance Environmental 2017). This supports the concept that <u>suitable roosting habitat</u> may include any known roosts of other flying-fox species (especially Black FF) in the CQ region. The occasional appearance of GHFF in other far-inland camps (e.g. Allora & Warwick on the Darling Downs (Nov 2018); and Yetman (Aug 2017) and Inverell (Aug 2013) on the NW slopes of NSW) further supports the likelihood that GHFF may be found at suitable roost sites well inland from the coast in central Qld. Based on the above information, it may be pertinent to include maps of known FF camps (especially those where BFF
	 have been recorded – use the national FF monitoring viewer) – or, at least, refer to the availability of the national dataset that can be used to make relevant determinations on a project-by-project basis EMM – The definition is fine, although the difficulty of identifying camps should be acknowledged given the temporary nature of some camps, and camps may be off the project site. Due to the dispersal and nomadic nature of this species, any habitat providing food resources is potential foraging habitat.
Q7: For species where only two habitats types are defined (e.g. preferred and suitable or marginal), do you think the third habitat type should be included? If not, why? If so, why and please provide a suggested definition	 GF – No need for a marginal category for GHFF EMM – As preferred habitat is limited to roosting habitat is it better to use that as the definition, so it is much clearer that is what it is limited to. An argument could be made that suitable and marginal habitat (ie foraging habitat) is interchangeable.
Other review comments	
Q8: Do you have other comments or information?	 GF - None EMM - As a general comment on Table 2-1, the criteria/attributes will not really narrow down potential habitat for this species much - at least in terms of foraging. Most remnant vegetation would have the potential to be foraging habitat at some stage. There needs to be some refinement by proximity to known camps (be it permanent - which
	shouldn't be relevant to BHP study areas) or temporary camps in winter months as species disperses (this

Review question	Responses
	 information may be held by local councils, DES, vet surgeries, wildlife carers etc) and should include research around historic camps which may be used intermittently. Table 2-1 needs to specify whether it applies to preferred (roosting) or suitable (foraging) habitat - in some cases this is done but not all. For example, the vegetation composition description applies to foraging habitat. Vegetation composition description - banksias are also favoured. Orchards as well although limited applicability to study areas. All foraging habitat has the potential to be productive during general food shortages and to therefore provide a resource critical to their survival. The majority of animals feed on nectar and pollen from eucalypts (genera Eucalyptus, Corymbia and Angophora), melaleucas and banksias. Regional ecosystem associations that may comprise preferred and suitable habitat - this is more just suitable habitat; these are vegetation associations for foraging. Roost sites can be broader. Water (for drinking) - remove "for drinking" or possibly move the description down to hydrological needs. Patch size description – you could capture minimum patch size of roost sites here. Connectivity description - define if the camp site attributes provided are for permanent or temporary camps. Grey-headed Flying-foxes display a degree of flexibility in their choice of camp vegetation (Tidemann 1999, Peacock 2004, Roberts 2005). Camps are commonly located in closed forest, Melaleuca swamps or stands of Casuarina and are generally found near rivers or creeks (Ratcliffe 1932, Hall and Richards 2000) Shelter/denning/roosting description – seems to be from Victorian literature. In the Qld context, there are camps in urban areas, parklands etc that wouldn't meet these criteria. Instead, state that these are typical attributes but the changing nature of foraging resources has led to more establishment in urban environments in recent years. Micro habitat
Q9: Are there other resources, particularly published literature or outcomes of research, relevant to this species in central Queensland that are not referenced in the current work? If so, please provide details and a link (if possible).	 GF – Eby, P. and Law, B. (2008). Ranking the feeding habitats of Grey-headed flying foxes for conservation management. Report for The Department of Environment and Climate Change (NSW) & The Department of Environment, Water, Heritage and the Arts; October 2008. National Flying-fox monitoring viewer <u>http://www.environment.gov.au/webgis-framework/apps/ffc-wide/ffc-wide.jsf</u>) Balance Environmental (2017) <i>Banana Shire Flying-fox Management Plan</i>. Report prepared for Banana Shire Council, 30 January 2017. EMM – The majority of animals feed on nectar and pollen from eucalypts (genera Eucalyptus, Corymbia and Angophora), melaleucas and banksias. Grey-headed Flying-foxes forage over extensive areas. One-way commutes of approximately

Review question	Responses
	50 km have been recorded between camps and foraging areas (Eby 1991), although commuting distances are more often < 20 km (Tidemann 1999).
	In order to survive, Grey-headed Flying-foxes require a continuous sequence of productive foraging habitats, the migration corridors or stopover habitats that link them, and suitable roosting habitat within nightly commuting distance of foraging areas (Fleming and Eby 2003).
	Eby, P. 1991. Seasonal movements of Grey-headed Flying-foxes, Pteropus poliocephalus (Chiroptera: Pteropodidae), from two maternity camps in northern New South Wales. Wildlife Research 18: 547–559.
	Tidemann, C.R. 1999. Biology and management of the Grey-headed Flying-fox, Pteropus poliocephalus. Acta Chiropterologica 1: 151–164.
	Fleming, T.H. and Eby, P. 2003. Ecology of bat migration. pp. 156–208 in Ecology of Bats. edited by T.H. Kunz and M.B. Fenton. University of Chicago Press, Chicago USA.
	Ratcliffe, F.N. 1932. Notes on the fruit bats (Pteropus spp.) of Australia. Journal of Animal Ecology 1: 32–57