Appendix 47 Fauna Habitat Scoring Tool Report

Report

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Project Name	Pinjarra Alumina Refinery Revised Proposal – Environmental Review Document		
Subject	Threatened fauna habitat scoring tool – explanatory report		

1. Introduction

1.1 Purpose of this report

The purpose of this report is to describe the process and outcomes of the development of fauna habitat quality scoring methods to support the calculation of residual significant impacts[1] to threatened fauna habitat, for presentation in the Pinjarra Alumina Refinery Revised Proposal ('the Proposal') Environmental Review Document (ERD).

2. Scope and limitations

2.1 Scope of work

The scope of the work completed was:

– Develop scoring method for threatened fauna species habitat, for species likely to occur in the Proposal Development Envelope (DE) (Carnaby's, Baudin's and Forest Red-tailed Black Cockatoo, Chuditch, Quokka and Woylie)
– Provide rationale and justification as to the suitability of the scoring methodology with respect to fauna habitats within the Northern Jarrah Forest IBRA (Interim Biogeographic Regionalisation for Australia) sub-region.

2.2 Limitations

This report: has been prepared by GHD for Alcoa of Australia and may only be used and relied on by Alcoa of Australia for the purpose agreed between GHD and Alcoa of Australia as set out in section 1.1 of this report.

GHD otherwise disclaims responsibility to any person other than Alcoa of Australia arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

[1] The Commonwealth use the term residual significant impact, whereas the Western Australian Government use significant residual impact. Within this report, residual significant impact is used to refer to both terms.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report (refer section(s) 2 of this report). GHD disclaims liability arising from any of the assumptions being incorrect.

3. Threatened fauna habitat scoring

3.1 Habitat scoring guidance

The development of threatened fauna habitat scoring for the Proposal ERD has considered guidance on habitat quality in the EPBC Act *How to Use the Offsets Assessment Guide* (undated) and the WA *Environmental offsets metric: Quantifying offsets in Western Australia* (DWER 2021). Table 1 presents a summary of the EPBC Act and WA guidance with respect to threatened species. As presented, the two guidance documents align broadly on three habitat scoring components, being site condition, site context, and species population.

The development of threatened fauna habitat scoring has also considered guidance of habitat requirements and key threats for the six EPBC Act listed fauna species assessed as known or likely to occur in the Proposal DE (the 'subject listed species'), namely:

Known to occur:

– Baudin's Cockatoo (*Zanda baudinii*) (Endangered)
– Carnaby's Cockatoo (*Zanda latirostris*) (Endangered)
– Forest Red-tailed Black-Cockatoo (FRTBC) (*Calyptorhynchus banksii naso*) (Vulnerable)
– Chuditch (*Dasyurus geoffroii*) (Vulnerable)
– Quokka (*Setonix brachyurus*) (Vulnerable)

Likely to occur:

– Woylie (*Bettongia penicillata ogilbyi*) (Endangered)

A summary of the guidance of habitat requirements and key threats is presented in Table 2 for Black Cockatoos and Table 3 for the subject listed species that are critical weight range (CWR) mammals.

3.2 Habitat scoring framework

The overall rationale for the habitat scoring framework is to score habitat quality based on available datasets at the time of preparing the ERD, such as the fauna habitat / vegetation types or vegetation condition mapped over the Proposal DE, or inferred water habitats mapped in proximity to the DE. Accordingly, habitat quality elements that do not have available datasets at the time of preparing the ERD are excluded (e.g. canopy cover, den density, density of prey species, density of feral predators). These habitat quality elements may potentially be introduced into the habitat scoring framework at a later stage (e.g. offset monitoring) if the necessary datasets become available.

The habitat guidance and literature (Table 2, Table 3), baseline survey results (GHD 2024, 2025a, 2025b), and advice by specialists (T. Kirkby, M. Craig, pers. comm.) indicate that the importance of site condition, context and species stocking for Black Cockatoos is substantially different from that of the subject CWR mammals. Accordingly, a separate scoring framework is proposed for each of the two fauna groups.

Black Cockatoos are dependent on foraging resources and habitat features (nest trees, roost trees and drinking water) that vary substantially with fauna habitat / vegetation types. In contrast, the subject CWR mammals can forage across all fauna habitat / vegetation types but are substantially affected by feral predators (in the case of Quokka, restricting the habitat types it would otherwise occupy) and/or habitat fragmentation. The collection of field records for Black Cockatoos and CWR mammals also differs substantially. Black Cockatoos are readily identified during field surveys, with distinctive calls and daytime visibility while roosting, in flight, or by conspicuous foraging residues. The subject CWR mammals are comparatively cryptic, being nocturnal and with relatively small, localised (in the case of Quokka) and/or sparse populations that reduce the recording of individuals or their signs (e.g. scats, diggings).

The habitat scoring framework has adopted three habitat components considering both the EPBC Act and WA guidance, namely:

1. Site / vegetation condition, including:
    - vegetation condition, using the condition scale developed for the Proposal DE (Mattiske 2024)
    - presence of habitat species and features
2. Site context, including:
    - species movement patterns
    - proximity to suitable habitat
    - context of species population
    - presence of threats
3. Species stocking rate / habitat value:
    - species presence and population

The scoring for each habitat component is generally scored out of 3. Site condition is scored out of 4 for Black Cockatoos, reflecting its relative importance for these highly mobile species, whereas site context is scored out of 4 for CWR mammals, reflecting the importance of key threats and connectivity for ground fauna. Scores for each habitat component are then summed to make a score out of 10.

The habitat scoring framework is presented in Table 4 for Black Cockatoos and Table 5 for CWR mammals. Each framework contains supporting notes, where relevant. Table 6 provides supporting definition of habitat / features for input into the scoring framework.

Table 1 Threatened species habitat quality – EPBC Act and WA environmental offsets guidance

EPBC Act offset guide habitat quality component	Description in relation to threatened species	WA offset metric habitat quality component	Description in relation to threatened species
Site condition	Condition of a site in relation to the ecological requirements of a threatened species. Includes considerations such as: – vegetation condition and structure, – the diversity of habitat species present, and – the number of relevant habitat features.	Vegetation condition	Condition of the native vegetation present at a site. Evaluation should include (but not be limited to) consideration of: – forms of disturbance and/or threats: disturbance from land use and management practices, edge effects – number of weeds: disturbance opportunistic, those carried by vectors, persistent perennials, aggressive invaders in the absence of disturbance – soil stability: the presence of stems and other plant bases, surface feeder roots, humus/organic matter, duricrust, cryptograms, lichens, litter and debris – number of native plants: species composition of a particular vegetation type, and a sense of whether there has been a loss of components – number of strata: vegetation structure of a particular vegetation type, and a sense of whether there has been a loss of components – seedlings and sapling presence: regenerative capacity, for resilience – vegetation health: general health of the overstorey and understorey, signs of stress, atypical leaf colouration, leaf/limb or whole plant death. It may be appropriate for the condition to be determined using the Keighery scale in the intensive land use zone.
Site context	The relative importance of a site in terms of its position in the landscape, taking into account the connectivity needs of a threatened species. Includes considerations such as: – movement patterns of the species, – the proximity of the site in relation to other areas of suitable habitat, and – the role of the site in relation to the overall population or extent of a species or community.	Site context	The relative importance of a site in terms of its position in the landscape, taking into account the connectivity needs of the threatened species. Evaluation should include (but not be limited to) consideration of: – movement patterns; that is, where a mobile species – proximity of the site in relation to other areas of suitable habitat, such as size of the site in the context of the surrounding landscape/region, – connectivity with other suitable or known habitat – proximity to water – importance of the site in relation to the overall species population – vegetation extent, such as extent of vegetation type within the bioregion, percentage of vegetation coverage within the local area – the occurrence of threats on or near the site.
Species stocking rate	Usage and/or density of a species at a particular site. The principle acknowledges that a particular site may have a high value for a particular threatened species, despite appearing to have poor condition and/or context. Includes considerations such as: – survey data for a site in regards to a particular species population. – the role of the site population in regards to the overall species population viability.	Habitat value	The ability of a site to support the threatened species. Evaluation should consider whether a particular site may have a high importance for the threatened species, despite, for example, appearing to have low-scoring vegetation condition. The evaluation should include (but not be limited to) consideration of: – the presence of a species on the site (confirmed/modelled through survey data) – the density of a species at the site – the context of a species population at the site in regard to the overall species population – any threats present at the site that may impact the survival of species.

Table 2 Summary of published habitat guidance – Black Cockatoos

Species	Forest Red-tailed Black-Cockatoo (*Calyptorhynchus banksii naso*)	Baudin's Cockatoo (*Zanda baudinii*)	Carnaby's Cockatoo (*Zanda latirostris*)
Habitat description (with relevance to Northern Jarrah Forest habitats)	Referral guidelines (DAWE 2022) Foraging – Primarily seeds of Jarrah and Marri in woodlands and forest, also Allocasuarina cones and fruits of Snottygobble. Less important foods include Blackbutt, Bullich, Sheok, and Hakea spp. Breeding – Generally in woodland or forest, but may also breed in partially cleared woodland or forest, including isolated trees. Nest in hollows in live or dead trees (many eucalypt species may provide suitable hollows), particularly Marri, Wandoo, Bullich, Blackbutt, and Jarrah. Roosting – Any tall trees may provide roosting habitat, but particularly tall Jarrah, Marri, Blackbutt, and introduced eucalypt trees or large trees on the edges of forests.	Referral guidelines (DAWE 2022) Foraging – Primarily seeds of Marri, rarely Jarrah, in woodlands and forest, and seeds of native proteaceous plants (e.g. Banksia, Dryandra and Hakea spp.). Also insects and insect larvae, Kangaroo Paw, tips of Pinus spp. Breeding – Generally in woodland or forest, but may also breed in partially cleared woodland or forest, including isolated trees. Nest in hollows in live or dead trees (many eucalypt species may provide suitable hollows), particularly Marri, Jarrah, Wandoo and Bullich. Roosting – Generally in or near riparian environments or other permanent water sources. Any tall trees may provide roosting habitat, but particularly Jarrah, Flooded Gum, Blackbutt, and introduced eucalypts.	Referral guidelines (DAWE 2022) Foraging – Native shrubland, kwongan heathland and woodland on proteaceous plants (e.g. Banksia, Hakea and Grevillea spp.), as well as Callistemon spp. and Marri. Also seeds of Pinus spp, insects and insect larvae. Breeding – Woodland or forest, but also in partially cleared woodland or forest, including isolated trees. Nest in hollows in live or dead trees (many eucalypt species may provide suitable hollows), particularly Wandoo, Jarrah, Flooded Gum, and Marri. Roosting – Generally in or near riparian environments or natural and artificial permanent water sources. Any tall trees may provide roosting habitat, but particularly Wandoo, Marri, Blackbutt, introduced eucalypts and pines.
Critical habitat	Recovery Plan (DEC 2008): – areas currently occupied by the cockatoos; – natural vegetation in which the cockatoos nest, feed and roost – natural vegetation through which the cockatoos can move from one occupied area to another; and – suitable vegetation within the recorded range in which undiscovered cockatoo populations may exist – Marri, Karri and Jarrah forests, woodlands and remnants in the south-west of Western Australia receiving more than 600 mm of annual average rainfall.	Recovery Plan (DEC 2008): – areas currently occupied by the cockatoos; – natural vegetation in which the cockatoos nest, feed and roost – natural vegetation through which the cockatoos can move from one occupied area to another; and – suitable vegetation within the recorded range in which undiscovered cockatoo populations may exist – Marri, Karri and Jarrah forests, woodlands and remnants in the south-west of Western Australia receiving more than 600 mm of annual average rainfall.	Recovery Plan (DPaW 2013): – The eucalypt woodlands that provide nest hollows used for breeding, together with nearby vegetation that provides feeding, roosting and watering habitat that supports successful breeding; – Woodland sites known to have supported breeding in the past and which could be used in the future, provided adequate nearby food and/or water resources are available or are re-established; – In the non-breeding season, the vegetation that provides food resources as well as the sites for nearby watering and night roosting that enable the cockatoos to effectively utilise the available food resources.
Key threats	Recovery Plan (DEC 2008): – killing by illegal shooting – feral honeybees (sting deaths / nest exclusion) – habitat loss (clearing, harvesting) – nest hollow shortage – nest hollow competition (other birds, feral bees)	Recovery Plan (DEC 2008): – killing by illegal shooting – feral honeybees (sting deaths / nest exclusion) – habitat loss (clearing, harvesting) – nest hollow shortage – nest hollow competition (other birds, feral bees)	Recovery Plan (DPaW 2013): – loss of breeding habitat (hollow bearing trees) Loss of non-breeding foraging and night roosting habitat – tree health (e.g. Phytophthora dieback) – mining and extraction activities – illegal shooting and taking – climate change – collisions with motor vehicles – disease

Table 3 Summary of habitat guidance – critical weight range mammals

Species	Chuditch (*Dasyurus geoffroii*)	Woylie (*Bettongia penicillata ogilbyi*)	Quokka (*Setonix brachyurus*)
Habitat description (with relevance to Northern Jarrah Forest habitats)	Recovery Plan (DEC 2013): The major portion of the remaining natural populations occur in varying densities in jarrah forests and woodlands in the south-west corner of WA, and in woodlands, mallee shrublands and heaths along the south coast, east to the Ravensthorpe area. Chuditch are solitary animals for most of their life. In the absence of foxes, they occupy relatively large home ranges, males ranging over 15 km² and females 3-4 km². Home ranges may overlap; however there tends to be a smaller non-overlapping 'core' area defined by den locations: 4 km² and 0.9 km² for males and females respectively. Both sexes occur at similar densities in the jarrah forest.	Recovery Plan (Yeatman and Groom 2012): Known from a variety of habitats. Current habitat includes tall eucalypt forest and woodland, dense myrtaceous shrubland, kwongan (proteaceous) or mallee heath. Thickets and other suitable habitat types such as heath, provide refuges for woylies against predators. Woylie occupy home ranges, the size of which varies between habitats, sites and according to woylie density. Small home ranges (less than 6 ha) are generally observed at high density occurrences.	Habitat use in the northern jarrah forest is largely restricted to swamps and riparian habitat (Hayward et al 2005, Dundas et al 2017). Within swamps, they are habitat specialists, preferring early seral stages that have been burned within the previous 10 years. This preference derives from a combination of dietary requirements and refuge from predation. As swamps mature they become suboptimal, forcing quokkas to colonize new patches. Since the collapse of the metapopulation following the introduction of the fox, quokkas have been forced to remain at a site because predation inhibits dispersal (Hayward et al 2005). Home-range sizes are estimated at approximately 6-7 ha and core ranges approximately 1.2 ha (Hayward et al 2004). Ranges shift to the edge of swamps in winter, and toward the centre in autumn as the swamps dried.
Critical habitat	Recovery Plan (DEC 2012) – areas currently occupied by chuditch; – areas of natural vegetation in which chuditch breed, forage or use to move from one area to another; – areas of suitable vegetation within the recorded range in which undiscovered populations may exist; – areas not currently occupied due to recent fire but capable of supporting populations when sufficiently recovered – areas previously occupied that provide suitable habitat and into which can be reintroduced Chuditch have historically been present in a large variety of habitats so it is not possible to list a set of characteristic habitats that should be preserved. However, some key aspects are required for chuditch survival in an area. These are: adequate den resources (e.g. hollow logs, burrows or rock crevices), adequate prey resources (particularly large invertebrates) and sizeable areas (> 20 000 ha.).	Recovery Plan (Yeatman and Groom 2012) Although habitat suitable for the woylie varies across its current range, a number of key habitat requirements appear to be essential for the persistence of the species within this range. Woylies may persist in the following habitats where there is adequate introduced predator (fox and cat) control or exclusion: – tall eucalypt forest and woodland; – dense myrtaceous shrubland; and, – kwongan (proteaceous) or mallee heath. All habitat meeting these key requirements within the current range, which is either known to be occupied by woylies or to have the identified potential to be occupied by woylies, is considered habitat critical to the survival of the species.	Recovery Plan (DEC 2013) Habitat critical to the survival of the quokka has been well defined for the northern jarrah forest subpopulation and comprises Taxandria linearifolia swamps. Quokkas are thought to occur as, or previously occurred as, metapopulations dispersing from swamp to swamp over time as vegetation structure changes with time since fire. Habitat critical to survival includes areas of natural vegetation where the understorey is sufficiently thick and complex to provide a predation refuge close to more open, recently burnt vegetation which is used as a food source. Habitat changes seasonally, in wetter months after wetlands become inundated the quokkas core home range shifts toward the periphery of the swamp, leaving the quokka more exposed to predation. When this habitat is altered, and in the presence of feral predators, the carrying capacity of a site may also be reduced.
Key threats	Recovery Plan (DEC 2012) – land clearing, particularly of riparian vegetation, and the removal of suitable den logs and den sites – predation by, and competition from, foxes and feral cats – mortality from poisoning, trapping, illegal shooting, and road kills	Recovery Plan (Yeatman and Groom 2012) – fox predation – cat predation – habitat alteration (clearing, Phytophthora dieback) – native predators – climate change, particularly reduced rainfall and increasing temperatures – disease	Recovery Plan (DEC 2013): – fox predation – cat predation – feral pigs - destruction of habitat – Phytophthora dieback (impact likely to be variable) – clearing of habitat – altered fire regimes – altered hydrological regimes – climate change – disease

Table 4 Scoring framework – black cockatoos

Guidance summary	Site / vegetation condition	Site context	Species stocking rate / habitat value
EPBC Act offset guide	Ecological requirements of a threatened species. – vegetation condition and structure, – the diversity of habitat species present, and – the number of relevant habitat features.	Relative importance in terms of the landscape, taking into account connectivity needs. – movement patterns of the species, – proximity in relation to other areas of suitable habitat, and – role in relation to the overall population or extent of a species or community.	Usage and/or density of a species. – survey data for a site. – the role of the site population in regards to the overall population viability.
WA offset metric	Vegetation condition, as per Keighery in the intensive land use zone	– movement patterns – proximity of the site in relation to other areas of suitable habitat – connectivity with other suitable or known habitat – proximity to water – importance in relation to the overall species population – vegetation extent – occurrence of threats.	– presence of species (confirmed/modelled through survey data) – density of species – context of species population in regard to the overall population – any threats present[2].
Score	**Site / vegetation condition**	**Site context**	**Species stocking rate / habitat value**
4	– vegetation cover is dominated by foraging species, AND – contains potential breeding and/or roosting habitat, AND – vegetation condition is Good or better	n/a (scored out of 3)	n/a (scored out of 3)
3	– vegetation cover is dominated by foraging species, AND – vegetation condition is Good or better OR pine plantation (Carnaby's Cockatoo only)	– within 2 km of perennial water resources, AND – within 6 km of extensive (> 1000 ha) foraging resources	– local resident population in high numbers, including breeding
2	– vegetation cover is dominated by foraging species, AND – vegetation condition is Degraded or worse OR – vegetation has limited foraging species, AND – vegetation condition is Good or better	– between 2-3 km of perennial water resources, AND – within 6 km of extensive (> 1000 ha) foraging resources	– local resident population in small numbers, including breeding, with seasonal use by non-residents (no breeding)
1	– vegetation cover has limited foraging species, AND – vegetation condition is Degraded or worse	– more than 3 km from perennial water resources OR – between 6-12 km of extensive (> 1000 ha) foraging resources	– seasonal or transient use by small numbers (no breeding)
0	– vegetation cover does not contain foraging species	– more than 12 km of extensive (> 1000 ha) foraging resources	– no historic records, or records during baseline surveys
Notes	– The NJF is mapped as predominantly comprising open forest with 30-70% projection foliage cover of tallest stratum (Heddle et al 1980, NVIS[3]). No data on foliage cover is available at the local scale. – Presence and abundance of foraging species, as well as roosting and breeding habitat features, vary considerably across native vegetation types in the Jarrah forest. – While Degraded or Completely Degraded condition vegetation may provide foraging, breeding or roosting habitat (e.g. scattered trees in a parkland cleared context), the degraded vegetation condition may reduce recruitment and replacement of habitat species over the long term. Phytophthora dieback infestation may affect tree health for vulnerable species (e.g. Jarrah, Banksia spp.), noting most key foraging, breeding and roosting species (including Marri, Blackbutt, Bullich and Pinus spp.) are not vulnerable. – Vegetation condition mapping using condition scale developed for the Proposal DE by Mattiske Consulting (2024). – Note: pine plantation provides highly productive foraging resources for Carnaby's Cockatoo that is artificially recruited despite Completely Degraded vegetation condition. – Black Cockatoos favour key foraging species (Marri, Jarrah, Pinus spp.) (T. Kirkby, pers. comm.) that dominate the vegetation cover in their respective vegetation types, foraging on other plant species (and insects) as required.	– Black Cockatoos forage over a wide area, mainly nesting within 12 km of foraging resources and roosting within 2 km of water resources (DAWE 2022). – Craig et al. (2022) found ¾ of known nest hollows used by FRTBC were within 3 km of perennial water bodies. Unpublished data (M. Craig, pers. comm.) found a statistically significant increase in FRTBC foraging residues within 2 km of perennial water bodies compared to further than 2 km from perennial water bodies. – Unpublished observations are that FRTBC will use water sources from rural areas (particularly elevated troughs) and river pools (T. Kirkby, pers. comm.), whereas use of reservoirs occurs in low numbers (M. Craig, pers. comm.). Baudin's and Carnaby's Cockatoo will use water sources from rural areas, river pools, reservoirs, and seasonally from running streams (T. Kirkby, pers. comm.). – Population scored under species stocking rate / habitat value. – Modelled distribution of all three Black Cockatoos covers the Proposal MDE and surrounding land. Not scored. – No spatial data available to score key threats (feral honeybees, nest availability, nest competition, climate change). Phytophthora dieback threat scored as site / vegetation condition.	– Black Cockatoos are conspicuous and readily identified through calls, observation while roosting/flying, and/or foraging residues. – Forest-red Tailed Black Cockatoos occupy the Proposal DE as a resident, breeding population (T. Kirkby, pers. comm.). Baseline surveys (GHD 2024, 2025a, 2025b) recorded numerous observations of the species within the Proposal DE. – Baudin's and Carnaby's Cockatoos primarily occupy the DE on a seasonal basis, foraging during the non-breeding season of autumn-winter and returning to their breeding habitat for the spring-summer. Small, resident breeding populations also occur in proximity to the MDE (T. Kirkby, pers. comm). Baseline surveys (GHD 2024, 2025a, 2025b) recorded sparse observations of both species within the Proposal DE.

[2] Note this is a repeat from site context so is covered by the site context component.
[3] **https://www.agriculture.gov.au/sites/default/files/documents/mvg3-nvis-eucalypt-open-forest.pdf**

Table 5 Scoring framework – critical weight range mammals

Guidance summary	Site condition	Site context	Species stocking rate
EPBC Act offset guide	Ecological requirements of a threatened species. – vegetation condition and structure, – the diversity of habitat species present, and – the number of relevant habitat features.	Relative importance in terms of in the landscape, taking into account connectivity needs. – movement patterns of the species, – proximity in relation to other areas of suitable habitat, and – role in relation to the overall population or extent of a species or community.	Usage and/or density of a species. – survey data for a site. – the role of the site population in regards to the overall population viability.
WA offset metric	Vegetation condition, as per Keighery in the intensive land use zone	– movement patterns – proximity of the site in relation to other areas of suitable habitat – connectivity with other suitable or known habitat – proximity to water – importance in relation to the overall species population – vegetation extent – occurrence of threats.	– presence of species (confirmed/modelled through survey data) – density of species – context of species population in regard to the overall population – any threats present.
Score	**Site condition**	**Site context**	**Species stocking rate**
4	n/a (scored out of 3)	– key threats absent: • all species: feral predators eliminated (e.g. fenced enclosure, intensive control), AND • Quokka: feral pigs eliminated (e.g. fenced enclosure, intensive control), OR • Chuditch: no sealed roads within 2.2 km (male range) AND – high connectivity of habitat: • Chuditch: connected to > 20,000 ha of native vegetation with limited fragmentation	n/a (scored out of 3)
3	– Excellent or Pristine vegetation condition	– key threats reduced: • all species: feral predators suppressed (Western Shield baiting), AND • Chuditch: no sealed roads within 1.1 km (male core area / female range), OR • Quokka, Woylie: dense riparian vegetation that provides refuge from feral predators AND – high connectivity of habitat: • Chuditch: connected to > 20,000 ha of native vegetation with limited fragmentation • Quokka, Woylie: connected to a large riparian corridor > 5 km in length	– resident population in high numbers
2	– Good or Very Good vegetation condition	– key threats reduced: • all species: feral predators suppressed (Western Shield baiting), AND • Chuditch: no sealed roads within 1.1 km (male core area / female range), OR • Quokka, Woylie: dense riparian vegetation that provides refuge from feral predators AND – moderate connectivity of habitat: • Chuditch: connected to 5,000-20,000 ha of native vegetation with limited fragmentation • Quokka, Woylie: connected to a moderate riparian corridor 1-5 km in length	– resident population in small numbers
1	– Degraded vegetation condition	– key threats prevalent: • all species: feral predators suppressed (Western Shield baiting), AND • Chuditch: sealed roads within 1.1 km (male core area / female range), OR • Quokka, Woylie: open upland vegetation that does not provide refuge from feral predators OR – low connectivity of habitat: • Chuditch: connected to <5,000 ha of native vegetation with limited fragmentation • Quokka, Woylie: connected to a small riparian corridor < 1 km in length	– sparse population, transient use
0	– Completely degraded vegetation	– key threats prevalent: • all species: no feral predator suppression (e.g. outside of Western Shield baiting)	– species, if present, is below detectable densities
Notes	– All native vegetation / fauna habitat types within Jarrah forest are expected to	– Chuditch males range over 15 km^2 (2.2 km radius) with a core area of 4 km^2 (1.1 km radius), females range over 3-4 km2 (1.1 km radius) with a core area (0.54 km radius) (DEC 2012).	– No local population estimates are available for Chuditch. The total population of the Jarrah forest (north and south) is estimated at approximately 1,400 to 12,500 adults, however the

Guidance summary	Site condition	Site context	Species stocking rate
	provide foraging and denning resources for CWR mammals. – Degraded condition vegetation (including Phytophthora dieback impact) reduces the diversity and abundance of native flora, reducing the foraging resources for native herbivores, and impacting the food web and thus foraging resources for native carnivores. – No spatial data available to score dens as habitat features, which may occur throughout	– Chuditch require sizable areas (>20,000 ha) to survive. Chuditch need large natural areas because of their large home ranges and resource requirements (DEC 2012). – Limited fragmentation includes scattered forest tracks with infrequent traffic and timber harvesting. High fragmentation includes mining, rural development and sealed roads. – Modelled distribution of all three CWR mammals cover the Proposal MDE and surrounding land. Not scored. – CWR mammals are less reliant on watering habitat for drinking. – Population scored under species stocking rate / habitat value. – No spatial data available to score threats of climate change or fire regime. Phytophthora dieback threat scored as site / vegetation condition.	sparse and dispersed / nomadic nature of the species makes it difficult to accurately estimate abundance and/or density, and to define key populations (DEC 2012). – Woylie populations are estimated to be sparse over the Northern Jarrah Forest, at approximately 400 animals over 7750 km^2 as at 2010 (TSSC 2018) or an average of 1 animal per 19 km^2. The largest natural populations are located in Upper Warren (Perup and Kingston) and Dryandra, with a number of translocated populations in offshore islands and fenced sanctuaries that provide refuge from feral predators (TSSC 2018). – Quokka populations in the Northern Jarrah Forest persist in small, isolated populations around favoured riparian habitat (Dundas et al 2017). Populations recorded in the vicinity of the Huntly Mine are estimated to be small, with approximately 5-25 animals recorded in each swamp (Dundas et al 2017).

Table 6 Supporting definition of fauna habitat / features for input to scoring framework

Fauna habitat types mapped over MDE	Associated vegetation types mapped over MDE	Black Cockatoos – site / vegetation condition – habitat species / habitat features			CWR mammals – site context – vegetation density as a predator refuge
		Forest Red-tailed Black-Cockatoo	Baudin's Cockatoo	Carnaby's Cockatoo	
Blackbutt Forest	AW, C, CW	Foraging, breeding, roosting	Limited foraging, roosting	Limited foraging, roosting	Dense / predator refuge
Bullich Forest	W	Foraging, breeding, roosting	Limited foraging, breeding, roosting	Limited foraging, roosting	Open
Flooded Gum Woodland	AC	Limited foraging, roosting	Limited foraging, roosting	Limited foraging, breeding, roosting	Dense / predator refuge
Granite Outcrop Association	G, G1, G2, R	Limited foraging	Limited foraging	Limited foraging	Open
Jarrah Marri Forest	D, DA, DG, E, P, PG, PS, PT, PW, Q, S, SP, ST, SW, T, TP, TS	Foraging, breeding, roosting	Foraging, breeding, roosting	Foraging, breeding, roosting	Open
Melaleuca Dampland	A	Limited foraging	Limited foraging	Limited foraging	Dense / predator refuge
Wandoo Woodland	Y, YG, AY	Foraging, breeding, roosting	Foraging, breeding, roosting	Foraging, breeding, roosting	Open
Mine rehabilitation		Foraging	Foraging	Foraging	Open
Pine Plantation		None	Foraging	Foraging, roosting	Open
Watering habitat based on available spatial datasets					
Perennial watering habitat		– Rural and urban zoned land – Permanent river pools	– Rural and urban zoned land – Permanent river pools – Drinking water reservoirs	– Rural and urban zoned land – Permanent river pools – Drinking water reservoirs	n/a

4. References

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