ARK ENERGY

Attexo

Chalumbin Wind Farm

Potential habitat for Ghost bat

Figure 4.26

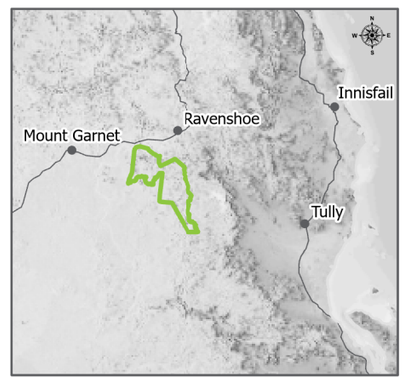
- Project Area Boundary
- Study Area
- Turbine
- Met-mast

Clearance Envelope

- Stage 1
- Stage 2
- Survey Observation
- Harp trap
- Anabat (Dry Season)
- Anabat (Wet Season)
- Areas of Rocky Relief
- Potential Foraging Habitat
- Watercourse
- Lot Boundary
- Easement

Date: 12/10/2022 Author: TOD

Project: EPU-004 Reviewed: NOD



0 5 10 Km

Scale: 1:200,000@A3

Data Source(s):
Digital Cadastral Database - Department of Resources (2022); Regional Ecosystem Mapping, WildNet - Department of Environment and Science (2022); Atlas of Living Australia (2020) Earthstar Geographics, © State of Queensland (Department of Resources) 2022

Path: C:\Users\Tim ODonnell\Attexo Group\Attexo - Documents\Projects\Epuron\EPU-004 - Chalumbin\GIS\4.3 Cartography\11_PER_Submission.aprx

4.7.3 Koala

4.7.3.1 Threat Status, Distribution, Population, Ecology and Habitat Preferences

The koala – combined populations of Queensland, New South Wales and the Australian Capital Territory (*Phascolarctus cinereus*) is listed as Endangered under the EPBC Act; however, as per the PER Guidelines, this species is assessed for the Project as Vulnerable[15]. The koala is listed as Endangered under the NC Act. It is listed globally at the species level as Vulnerable on the IUCN Red List.

The koala is endemic to Australia, with its biological range extending from north-eastern Queensland to the southeast corner of South Australia. The listed species range spans the inland and coastal areas of Queensland north to the Herberton area, extending westwards into hotter and drier semi-arid climates of central Queensland, NSW and the ACT (DAWE 2022a). Koalas are widespread in Queensland, occurring in patchy and often low-density populations across the different bioregions (DAWE 2022a). The Queensland population was estimated to be 79,264 in 2012, with the highest populations reported for the Brigalow Belt North, Mulga Lands and South East Queensland bioregions (DAWE 2022a).

The koala inhabits a range of temperate, sub-tropical and tropical forest, woodland and semi-arid communities dominated by species from the genus *Eucalyptus*. Its diet is restricted mainly to Eucalyptus species, it may also consume *Corymbia* and *Angophora* (TSSC 2012b, DAWE 2022a). Its distribution is determined by specialist food, habitat and environmental requirements; habitat suitability models indicate that koalas are best suited to locations where the mean maximum summer temperatures are 23-26°C and mean annual rainfall ranges from 700-1500 mm (DAWE 2022a). As a species, koalas are reported to utilise more than 400 different tree species for their food and habitat requirements, with different tree species varying by habitat type and location across their range. Primary food species differ across habitats and may be as few as two at a particular location. Koala browsing preferences show regional differences which are influenced by the chemical profiles and water content of different target food leaves (DAWE 2022a).

Koala habitat is broadly defined by the availability and nutritional quality of food trees, presence of suitable resting trees and microclimates, age structure of vegetation, history and impediments to dispersal (DAWE 2022b).

Youngentob et al (2021) divided the koala's distribution into koala management bioregions and identified locally important koala trees for each of these management bioregions. Locally important koala trees are species that are regularly browsed by koalas in a particular area, such that they may be considered a substantial portion of the koala's diet. The combination of koala occurrence and locally important koala trees provides a strong indication that an area is koala habitat. However, the absence of koalas from an area with locally important koala trees does not mean it is not potential koala habitat, particularly as the koala is often a cryptic species for which it is difficult to establish true absence. Ancillary habitat trees have also been identified, which provide important ancillary habitat elements for the koala when they co-occur with locally important koala trees. Youngentob et al (2021) lists locally important koala trees and ancillary habitat trees for the Einasleigh Uplands and Wet Tropics koala management bioregions (see **Section 4.7.3.4**).

Habitat critical to the survival of the species should consider the following factors:

- Whether the habitat is used during periods of stress (e.g. flood, drought or fire);

[15] The koala was declared an endangered species under the EPBC Act on 12 February 2022; however, the PER Guidelines stipulate that any listing events that occur after the controlled action decision (received on 10 August 2021) do not affect the assessment and approval process. Therefore, the koala is assessed under this PER through its former vulnerable listing under the EPBC Act.

- Whether the habitat is used to meet essential life cycle requirements (e.g. foraging, breeding, social behaviour);
- The extent to which the habitat is used by important populations;
- Whether the habitat is necessary to maintain genetic diversity and long-term evolutionary development;
- Whether the habitat is necessary for use as corridors to allow the species to move freely between sites used to meet essential life cycle requirements;
- Whether the habitat is necessary to meet the long-term future of the species through reintroduction or re-colonisation; and
- Any other way in which habitat may be critical to the survival of the species (DAWE 2022a).

The Conservation Advice states that it is currently not practicable to identify by description and to provide spatial information on the habitat critical to the survival of the koala, due to insufficient knowledge (DAWE 2022a).

Important populations are defined as those that are valued for cultural, social and economic reasons, as well as for species conservation. For conservation of the listed koala, it will be imperative to maintain populations that:

- Have the potential to act as source populations to adjacent areas of suitable, or potentially suitable, habitat;
- Exist in areas of climatically suitable refugia during periods of environmental stress, including droughts, heat waves and long-term climate change;
- Are genetically diverse;
- Are disease-free and/or exhibit low rates of infection with important pathogens;
- Contain genes which may confer adaptation to current and future environmental stressors (DAWE 2022 identifies koala subpopulations at the western edges of Queensland and New South Wales distributions as an example of this); and
- Are geographical or environmental outliers within the species range.

Current efforts to assess and identify important populations across the range are hindered by a lack of comprehensive, unbiased data (DAWE 2022a).

A National Recovery Plan for the listed population was published in March 2022 (DAWE 2022b).

4.7.3.2 Known Threats

The Recovery Plan (DAWE 2022b) identifies the following as the main threats to the species:

- Climate change;
- Land use change resulting in habitat loss and fragmentation;
- Forestry;
- Altered fire regimes;
- Mortality from vehicle strike and predation by dogs; and
- Disease – of koala themselves and of koala habitat.

SPRAT 2022 does not list any threat abatement plans as being relevant for this species.

4.7.3.3 Survey Effort

As described in **Section 4.2.2.3**, spotlighting for nocturnal fauna including koala was undertaken for a total of 103 person hours.

4.7.3.4 Project Area Habitat Assessment

There are three previous records for koala within the Study area (ALA), as shown in **Figure 4-27**; however, no evidence of koalas was observed on site within the Project area during field surveys over the past 24 months. Both landholders report never having seen koalas on their properties and its occurrence on the Yourka Nature Reserve, immediately to the south, is rare (the species was recorded there for the first time in a decade in October 2020). The Project area is not a stronghold for any koala population and if koalas are present within the Project area, it is likely to be on a very sporadic basis and/or in low numbers.

The following tree species have been identified as locally important koala trees within the Einasleigh Uplands and/or Wet Tropics koala management bioregions (Youngentob et al 2021) and were recorded within the Project area:

- *Eucalyptus crebra*;
- *Eucalyptus exserta*;
- *Eucalyptus grandis*;
- *Eucalyptus melanophloia*;
- *Eucalyptus resinifera*; and
- *Eucalyptus tereticornis*.

The following tree species have been identified as ancillary habitat trees within the Einasleigh Uplands and/or Wet Tropics koala management bioregions (Youngentob et al 2021) and were recorded within the Project area:

- *Corymbia citriodora*;
- *Corymbia intermedia*;
- *Corymbia tesselaris*;
- *Eucalyptus platyphylla*;
- *Eucalyptus portuensis*; and
- *Lophostemon confertus*.

Koala habitat in the Project area has therefore been mapped in **Figure 4-27** as remnant and regrowth vegetation communities containing these locally important koala tree species or ancillary tree species.

ARK ENERGY

Attexo

Chalumbin Wind Farm

Potential Habitat for Koala

Figure 4.27

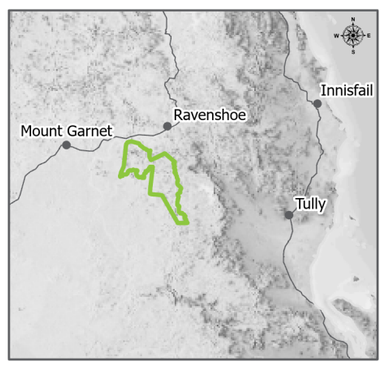
- Project Area Boundary
- Study Area
- Turbine
- Met-mast

Clearance Envelope

- Stage 1
- Stage 2
- Threatened Fauna Record (ALA/WildNet)
- Locally important koala trees
- Ancillary habitat trees
- Watercourse
- Lot Boundary
- Easement

Date: 12/10/2022 Author: TOD

Project: EPU-004 Reviewed: NOD



0 5 10 Km

Scale: 1:200,000@A3

Data Source(s):
Digital Cadastral Database - Department of Resources (2022); Regional Ecosystem Mapping, WildNet - Department of Environment and Science (2022); Atlas of Living Australia (2020) Earthstar Geographics, © State of Queensland (Department of Resources) 2022

Path: C:\Users\Tim ODonnell\Attexo Group\Attexo - Documents\Projects\Epuron\EPU-004 - Chalumbin\GIS\4.3 Cartography\11_PER_Submission\11_PER_Submission.aprx

4.7.4 Large-eared Horseshoe Bat

4.7.4.1 Threat Status, Distribution, Population, Ecology and Habitat Preferences

The large-eared horseshoe bat (*Rhinolophus philippinensis* syn. *Rhinolophus robertsi*) is listed as Vulnerable under the EPBC Act and Endangered under the NC Act. It is listed globally as Least Concern on the IUCN Red List.

It has been recorded from north-eastern Cape York Peninsula in Queensland as well as Indonesia, Malaysia, PNG, the Philippines and Timor-Leste (Armstrong 2021). The distribution of the large-eared horseshoe bat is not well understood but its current known extent of occurrence extends from the Iron Range southwards to Townsville and west to the karst regions of Chillagoe and Mitchell-Palmer (TSSC 2016c, SPRAT 2022).

The current population is unknown but is thought to be decreasing in Australia and possibly also elsewhere within its global range (Armstrong 2021).

It is primarily found in rainforest, as well as riparian forest adjacent to rainforest and *Melaleuca* forest with rainforest understorey. It prefers to forage in relatively dense stands of vegetation, including thicker vegetation in gullies (TSSC 2016c, SPRAT 2022). It roosts in caves, mines and other similar types of habitat (Armstrong 2021) although it is not an obligate cave-dweller and may also roost in tree hollows and dense vegetation (SPRAT 2022).

4.7.4.2 Known Threats

There appear to be no major threats to this species that would cause widespread or imminent decline, mainly due to small colony sizes and its broad distribution. However, it is threatened in Australia by disturbance of roost sites and the collapse or intentional closure of old mines (Armstrong 2021).

4.7.4.3 Survey Effort

Surveys for large-eared horseshoe bat were undertaken in accordance with the Survey Guidelines for Australia's Threatened Bats (DEWHA 2010a) using a combination of anabats and harp traps as described in **Section 4.2.2.3**. The total survey effort comprised 96 detector nights at 48 sites (wet and dry season) and 21 nights of harp trapping at 7 locations across the Project area (dry season only).

4.7.4.4 Project Area Habitat Assessment

There are no historical records of the large-eared horseshoe bat within the Study area and no individuals were recorded within the Project area during field surveys.

Potential habitat was mapped as rainforest, riparian forest and densely vegetation gullies within open eucalypt woodland, see **Figure 4-28**.

ARK ENERGY

Attexo

Chalumbin Wind Farm

Potential Habitat for Large-eared horseshoe bat

Figure 4.28

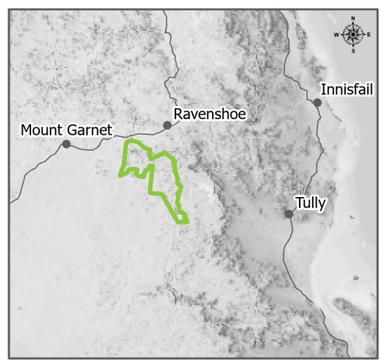
- Project Area Boundary
- Study Area
- Turbine
- Met-mast

Clearance Envelope

- Stage 1
- Stage 2
- Potential habitat
- Watercourse
- Lot Boundary
- Easement

Date: 12/10/2022 Author: TOD

Project: EPU-004 Reviewed: NOD



0 5 10 Km

Scale: 1:200,000@A3

Data Source(s):
Digital Cadastral Database - Department of Resources (2022); Regional Ecosystem Mapping, WildNet - Department of Environment and Science (2022); Atlas of Living Australia (2020) Earthstar Geographics, © State of Queensland (Department of Resources) 2022

Path: C:\Users\Tim ODonnell\Attexo Group\Attexo - Documents\Projects\Epuron\EPU-004 - Chalumbin\GIS\4.3 Cartography\11_PER_Submission\11_PER_Submission.aprx

4.7.5 Mahogany Glider

4.7.5.1 Threat Status, Distribution, Population, Ecology and Habitat Preferences

The mahogany glider (*Petaurus gracilis*) is listed as Endangered under both the EPBC Act and the NC Act. It is listed globally as Endangered on the IUCN Red List.

The mahogany glider is endemic to an area of coastal lowland forest (open wet sclerophyll forest) between Crystal Creek (southeast of Ingham) and the Hull River near Tully (Burnett et al 2016a, Jackson and Diggins 2021). The Project area falls outside the species' known range as presented in Burnett et al 2016a, Jackson and Diggins 2021 and SPRAT 2022, see **Figure 4-29**. The mahogany glider has an upper elevation limit of 120 m whilst the lowest part of the Project area is 670 m.

There is no information available on current population size or trend (Burnett et al 2016a, SPRAT 2022).

The distribution of the mahogany glider appears to be influenced by a blend of woodland vegetation that has historically been shaped and maintained by fire (Jackson and Diggins 2021). Habitat critical to the survival of the species includes any habitat where the species is likely to occur within its known distribution, any newly discovered locations that extend the likely range of the species and areas that support specific subpopulations (Jackson and Diggins 2021).

4.7.5.2 Known Threats

Clearing of forest for agriculture has led to a reduction in the distribution and connectivity of the species; only 20 % of its habitat remains and much of this is severely fragmented. Altered fire regimes, weed invasion and grazing threaten the structure and ecological integrity of these remaining fragments (Burnett et al 2016a).

Jackson and Diggins (2021) identifies the following key threats to the mahogany glider:

- Habitat loss and fragmentation;
- Inappropriate fire regimes leading to habitat degradation;
- Inappropriate grazing management;
- Weed invasion;
- Roads and easement corridors;
- Barbed wire fencing; and
- Increasing frequency of extreme climate events.

SPRAT (2022) lists the following threat abatement plans as being relevant to this species:

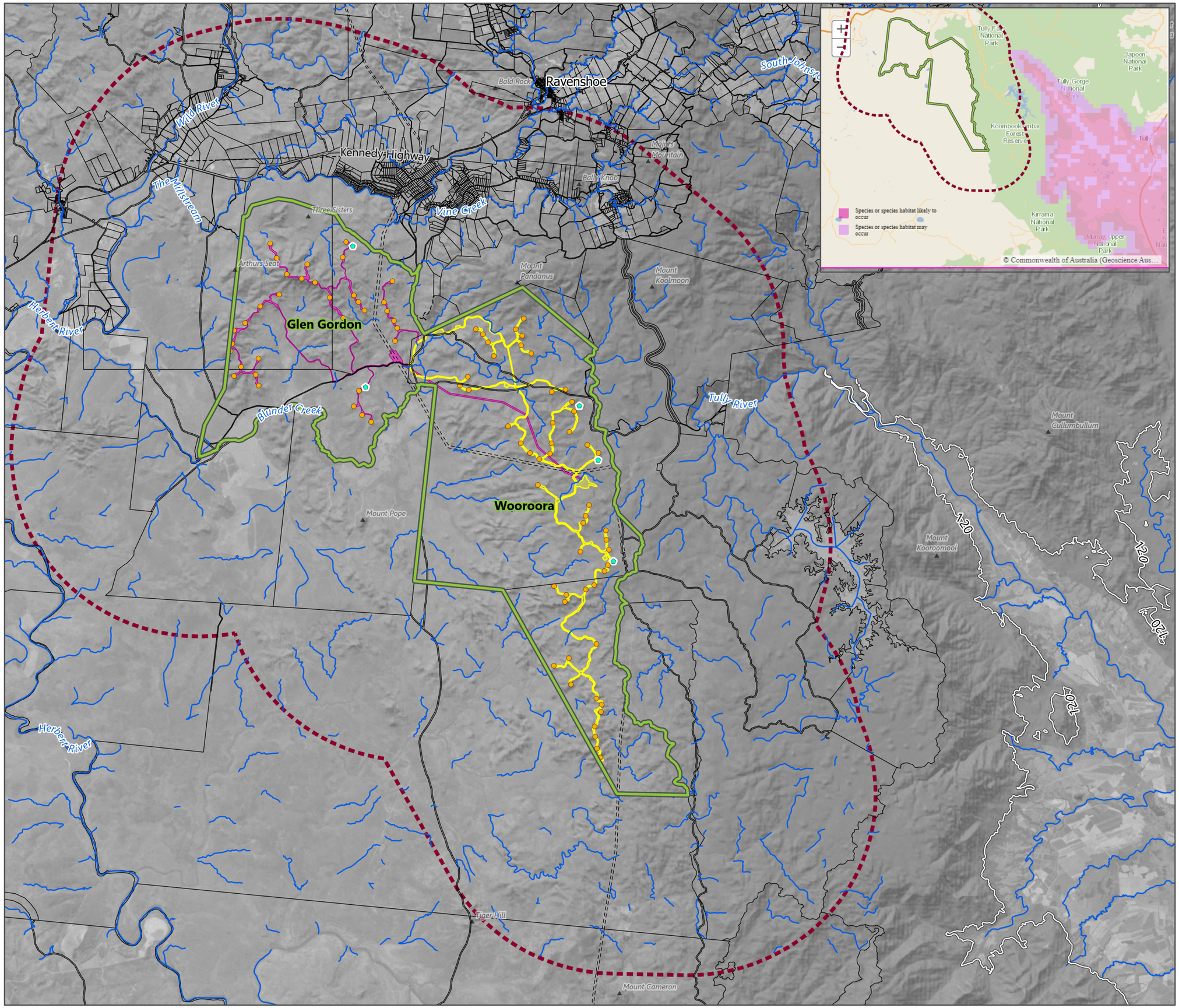
Threat abatement plan for predation by feral cats (DoE 2015).

4.7.5.3 Survey Effort

Specific surveys for mahogany glider were not undertaken due to the Project area being outside the species' published range. Nonetheless, the spotlighting surveys described in **Section 4.2.2.3** meet the survey requirements for this species as outlined in the Survey Guidelines for Australia's Threatened Mammals (DSEWPC 2011a).

4.7.5.4 Project Area Habitat Assessment

The mahogany glider has never been recorded within the Project area or the broader Study area. As illustrated in **Figure 4-29**, the Project area does not overlap with the species' known distribution and is well above the species' published upper elevation limit of 120 m.



ARK ENERGY

Attexo

Chalumbin Wind Farm

Potential Habitat for Mahogany glider

Figure 4.29

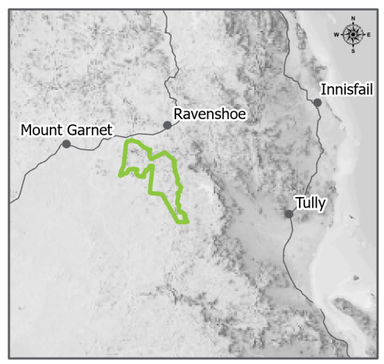
- Project Area Boundary
- Study Area
- Turbine
- Met-mast

Clearance Envelope

- Stage 1
- Stage 2
- 120m Contour
- Watercourse
- Lot Boundary
- Easement

Date: 12/10/2022 Author: TOD

Project: EPU-004 Reviewed: NOD



0 5 10 Km

Scale: 1:200,000@A3

Data Source(s):
Digital Cadastral Database - Department of Resources (2022); Regional Ecosystem Mapping, WildNet - Department of Environment and Science (2022); Atlas of Living Australia (2020) Earthstar Geographics, © State of Queensland (Department of Resources) 2022

Path: C:\Users\Tim ODonnell\Attexo Group\Attexo - Documents\Projects\Epuron\EPU-004 - Chalumbin\GIS\4.3 Cartography\11_PER_Submission.aprx

4.7.6 Northern Bettong

4.7.6.1 Threat Status, Distribution, Population, Ecology and Habitat Preferences

The northern bettong (*Bettongia tropica*) is listed as Endangered under both the EPBC Act and the NC Act. It is listed globally as Endangered on the IUCN Red List.

The species is endemic to north-eastern Queensland, with only three known locations of extant populations: the western side of Lamb Range (including Davies Cree, Emu Creek and Tinaro subpopulations), the western edge of the Mount Carbine Tableland and the Coane Range (Paluma). Mount Windsor Tableland may also have a population, with the last confirmed record dating from 2003. A population in the vicinity of Ravenshoe has not been seen since the 1920s (Dennis 2001, Burbridge and Woinarski 2016, TSSC 2016e).

Northern bettongs are heavily dependent on truffles as a food source during the wetter parts of the year. The subterranean stem bases from cockatoo grass and lilies are also an important part of the species' diet (Dennis 2001, TSSC 2016e). The species distribution appears to be limited by the availability of food resources and vegetation associations which are heavily influenced by fire. Areas that remain unburnt in the tall wet sclerophyll component of northern bettong habitat soon lose some or all of these resources (Dennis 2001, TSSC 2016e).

The population is estimated between 5,000 and 10,000, and declining (Burbridge and Woinarski 2016).

The northern bettong is restricted to a narrow strip of sclerophyll forest along the western margin of rainforest, in the ecotone between rainforest and dry eucalypt forest. It inhabits a range of eucalypt forest types, from tall and wet forest dominated by *Eucalyptus grandis* and tall forest dominated by *E. resinifera* and *Syncarpia glomulifera*, abutting the rainforest. It may also inhabit medium height and drier woodlands dominated by *Corymbia citriodora* and *C. platyphylla* (Burbridge and Woinarski 2016).

The species has a lower elevation limit of 800 m (Burbridge and Woinarski 2016).

4.7.6.2 Known Threats

The main threats to the northern bettong are (Dennis 2001, TSSC 2016e, Burbridge and Woinarski 2016):

- Low fire frequency and intensity affected the vegetation structure of wet sclerophyll forests (conversion to rainforest);
- Predation by feral cats, dogs and potentially foxes;
- Climate change (drought leads to reduced truffle abundance);
- Habitat degradation due to grazing and historical logging; and
- Foraging competition from pigs.

SPRAT 2022 lists the following threat abatement plans as being relevant to this species:

- Threat abatement plan for predation by the European red fox (DEWHA 2008d);
- Threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*) (DoEE 2017); and
- Threat abatement plan for predation by feral cats (DoE 2015).

4.7.6.3 Survey Effort

The Recovery Plan for the northern bettong (Dennis 2001) and the Survey guidelines for Australia's threatened mammals (DSEWPC 2011a) recommend camera trapping as the preferred survey method for the species. As described in **Section 4.2.2.3** an extensive camera trapping program was undertaken across the full extent of the Project area, comprising nearly 6,000 camera trap nights between January and December 2021.

4.7.6.4 Project Area Habitat Assessment

The northern bettong has not been previously recorded within the Project area. There are a number of historical records of the species within the broader Study area, the most recent of which dates from 1988 and was on the road towards Koombooloomba Dam (ALA). This record is described as "a single, unconfirmed sighting by reliable witnesses" in Dennis 2001. A considerable search effort (2120 trap nights) described in Dennis 2001 failed to record the species in the greater Ravenshoe area.

The species was not recorded within the Project area during the 11-month camera trapping campaign.

Potential habitat has been mapped as wet sclerophyll forests and vegetation communities dominated by *Corymbia citriodora* and *C. platyphylla*, see **Figure 4-30**.

ARK ENERGY

Attexo

Chalumbin Wind Farm

Potential Habitat for Northern bettong

Figure 4.30

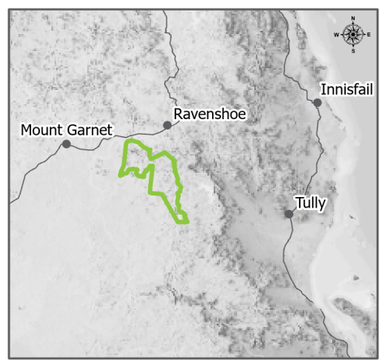
- Project Area Boundary
- Study Area
- Turbine
- Met-mast

Clearance Envelope

- Stage 1
- Stage 2
- Threatened Fauna Record (ALA/WildNet)
- Potential Habitat
- Rainforest
- Contour - 800m
- Watercourse
- Lot Boundary
- Easement

Date: 12/10/2022 Author: TOD

Project: EPU-004 Reviewed: NOD



0 5 10 Km

Scale: 1:200,000@A3

Data Source(s):
Digital Cadastral Database - Department of Resources (2022); Regional Ecosystem Mapping, WildNet - Department of Environment and Science (2022); Atlas of Living Australia (2020) Earthstar Geographics, © State of Queensland (Department of Resources) 2022

Path: C:\Users\Tim ODonnell\Attexo Group\Attexo - Documents\Projects\Epuron\EPU-004 - Chalumbin\GIS\4.3 Cartography\11_PER_Submission.aprx

4.7.7 Northern Greater Glider

4.7.7.1 Threat Status, Distribution, Population, Ecology and Habitat Preferences

The northern greater glider (*Petauroides minor*) was recognised as a species and listed as Vulnerable under the EPBC Act on 5th July 2022. It is also listed as Vulnerable under the NC Act.

The northern greater glider is still considered a subspecies of the greater glider (*Petauroides volans*) on the IUCN Red List, which is listed as Vulnerable and with the population believed to be decreasing.

The northern greater glider occurs in the wet-dry tropical region of north-eastern Australia, including the WTWHA. It is distributed from around Townsville northwards to the Windsor Tablelands, however the distribution is patchy with some isolated subpopulations. The broad extent of occurrence is unlikely to have changed appreciably since European settlement, however the area of occupancy has decreased substantially, mostly due to land clearing. This area is probably continuing to decline due to further clearing, fragmentation, edge effects, bushfire, climate change and some forestry impacts (TSSC 2016b, DCCEEW 2022). The northern greater glider has an elevational range from sea level to 1200 m asl (Burbridge and Woinarski 2020).

There are no robust estimates of population size for the northern greater glider however it is considered unlikely that there are fewer than 10,000 mature individuals (DCCEEW 2022).. It is thought that the population is declining due to loss of habitat and, particularly, loss of appropriate denning habitat. The northern greater glider is largely restricted to eucalypt forests and woodlands. It is typically found in highest abundance on high elevation, wetter sites in open woodland to open forests, containing relatively old trees and abundant hollows (TSSC 2016b, DCCEEW 2022). It is likely that only a proportion of forest in potential habitat areas is suitable for the species, as the structural attributes of the forest overstorey and forage quality it relies on vary considerably across the landscape.

It is primarily folivorous, with a diet mostly comprising eucalypt leaves and occasionally flowers. It feeds from a range of eucalypt species and favours forests with a diversity of eucalypt species due to seasonal variation in its preferred tree species (DCCEEW 2022).

During the day, the northern greater glider shelters in tree hollows with a particular preference for large hollows (> 10 cm diameter) in large, old trees (Gibbons & Lindenmayer 2002; Eyre et al 2010; DCCEEW 2022), at least 8 m above the ground (Maloney 2007). Smith et al 2007 identified that greater gliders require hollow-bearing myrtaceous trees (dead or alive) or non-myrtaceous trees (dead) with a diameter at breast height (DBH) of over 30 cm, and that the species preferentially forages in trees with a DBH greater than 40 cm. A study by Eyre et al (2010) identified that trees with a DBH of at least 60 cm were most likely to contain hollows of a suitable size for greater gliders. Verma et al (2014) developed allometric relationships between tree height (or crown projection area) and DBH for individual and clumped Eucalyptus species; scatter plots for individual trees with a DBH of 60 cm illustrate heights ranging from 10-30 m across the five species surveyed, with the allometric regression curve predicting a tree height of approximately 15 m.

Once habitat trees are lost from the system, the length of time required for the development/recruitment of replacement habitat trees appropriate for the species is prohibitive (TSSC 2016c). Hollows develop very slowly in Australian eucalypts, with minimum times of 150-260 years from germination to the beginning of hollow development (Harris and Maloney 2010).

Home ranges are typically relatively small, and are larger for males (2.5 ha) than for females (1.3 ha). Starr et al 2021 reported home ranges of 1-12 ha for northern greater glider at Bluff State Forest, in proximity to the Project area. Densities were estimated at 0.24 and 0.38 individuals per hectare in wet and dry sclerophyll forest (Starr et al 2021). Typically 4-6 different dens are used by individual animals within their home range per month although this can be as few as 2 dens per hectare in the north of its range (DCCEEW 2022). In the north of its range (including in the vicinity

of the Project area), forest red gum (*Eucalyptus tereticornis*) is favoured for denning and 2 dens per hectare are used (Starr et al 2021). The species has low persistence in small forest fragments, due to low dispersal ability.

Habitat critical to the survival of the northern greater glider may be broadly defined as (DCCEEW 2022):

- Large contiguous area of eucalypt forest which contains mature hollow bearing trees and a diverse range of the species' preferred food species particular to that region;
- Smaller or fragmented habitat patches connected to larger patches of habitat, that can facilitate dispersal of the species and/or that enable recolonisation;
- Cool microclimate forest/woodland areas (e.g. protected gullies, sheltered high elevation areas, coastal lowland areas, southern slopes);
- Areas identified as refuges under future climate change scenarios; and
- Short-term or long-term post-fire refuges (i.e. unburnt habitat within or adjacent to recently burnt landscapes) that allow the species to persist, recover and recolonise burnt areas.

Geographic areas containing habitat critical to survival need to be defined by forest type on a regional basis.

An important population can be defined as one that occurs:

- In a defined geographical area containing critical habitat;
- In areas where the species persists in relatively high density or abundance at a regional level;
- Where its habitat provides refugia in times of stress or in response to threatening processes (particularly where other nearby populations have substantially declined or may be expected to do so in the future); and
- Populations that are isolated or occur at the margins of the species' range, that may be important for maintaining genetic diversity and evolutionary adaptation.

There is no adopted or made Recovery Plan for this species (SPRAT 2022).

4.7.7.2 Known Threats

Key threats to the northern greater glider are climate change, land clearing, timber harvesting, inappropriate fire regimes, entanglement in barbed wire fencing and predation by feral cats. Loss and fragmentation of habitat has already occurred in many parts of the species' range and the impacts of climate change will place increased pressure on its remaining habitat (DCCEEW 2022). A 'stark' and 'dire' decline of habitat suitable for the northern greater glider ('almost complete loss" ~ 90 %) has been predicted if there is a 3°C temperature increase (DCCEEW 2022).

Harris and Maloney (2010) identified owls, the domestic cat, dingo, domestic dog, red fox, wedge-tailed eagle, spotted-tailed quoll and lace monitor as predators of greater gliders.

SPRAT 2022 does not identify any threat abatement plans as being relevant for this species.

4.7.7.3 Survey Effort

As described in **Section 4.2.2.3**, spotlighting for nocturnal fauna including greater glider was undertaken for a total of 103 person hours across wet and dry seasons. Targeted habitat quality assessments for greater glider were also

undertaken in a number of locations to demonstrate how habitat quality changes with elevation across the Project area, due to variability in bio-physical characteristics such as soil depth, soil moisture, aspect, etc.

4.7.7.4 Project Area Habitat Assessment

There are multiple prior records of greater glider within the Study area to the north, east and south of the Project area (ALA), as shown in **Figure 4-31**.

Northern greater gliders were observed on both properties during the nocturnal spotlighting surveys. Across January 2021, March 2021 and June 2021, a total of 64 gliders were observed over a combined duration of 103 person hours. MacHunter et al. 2011 defined a large population as > 10 individuals per km of spotlighting transect or > 2 / ha or > 15 per hour of spotlighting; following this, the population within the Project area (< 1 per hour of spotlighting) would not be considered 'large'. Surveys to date have focussed on lower lying parts of the site as ridgelines were difficult to safely access at night due to the poor condition of access roads across the two properties. These lower lying areas support the tallest trees with the highest abundance of hollows, and would be expected to have the highest abundance of greater gliders.

Habitat for greater glider needs to provide attributes such as live and dead hollow-bearing trees for denning, feed trees, large trees for gliding and habitat connectivity across the landscape. An extensive study led by the Queensland Department of Environment and Science (DES 2022) identified 24 REs within the Wet Tropics Bioregion that are confirmed habitat for northern greater glider and 28 REs within the Einasleigh Uplands bioregion. Appendix B of DES 2022 identifies individual tree species that typically characterise greater glider habitat within the Wet Tropics and Einasleigh Uplands bioregions; those tree species that were recorded during field surveys within the Project area are listed in **Table 4-5**.

Table 4-5 Tree Species Characterising Northern Greater Glider Habitat within the Project area

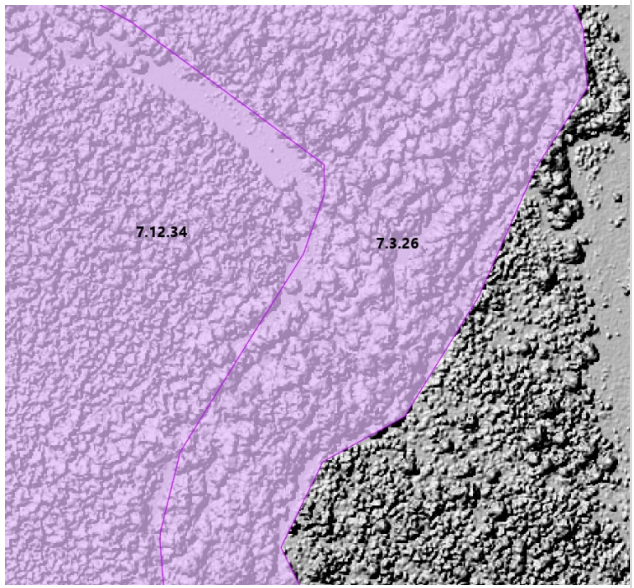
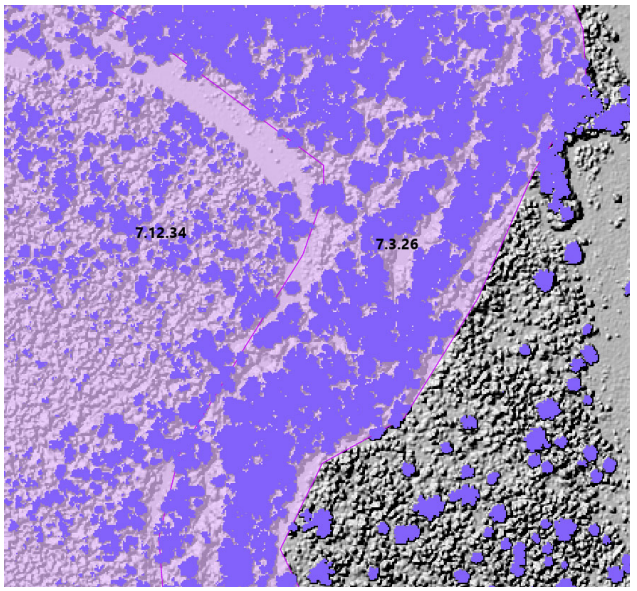
Wet Tropics Bioregion	Einasleigh Uplands Bioregion
Banksia aquilonia	*Corymbia abergiana*
Corymbia abergiana	*Corymbia citriodora*
Corymbia citriodora	*Corymbia clarksoniana*
Corymbia clarksoniana	*Corymbia intermedia*
Corymbia intermedia	*Corymbia tessellaris*
Corymbia tessellaris	*Corymbia trachyphloia*
Eucalyptus grandis	*Eucalyptus crebra*
Eucalyptus granitica	*Eucalyptus exserta*
Eucalyptus lockyeri	*Eucalyptus granitica*
Eucalyptus portuensis	*Eucalyptus melanophloia*
Eucalyptus reducta	*Eucalyptus platyphylla*
Eucalyptus resinifera	*Eucalyptus portuensis*
Eucalyptus shirleyi	*Eucalyptus shirleyi*
Eucalytpus tereticornis	*Eucalyptus tereticornis*
Lophostemon suaveolens	*Grevillea glauca*

Wet Tropics Bioregion	Einasleigh Uplands Bioregion
Melaleuca viminalis	*Lophostemon suaveolens*
Melaleuca viridiflora	*Melaleuca viridiflora*
Syncarpia glomulifera	

The demonstrated correlation between tree diameter at breast height (DBH) and presence of hollows is well established and is increasingly used as an indicator of tree habitat value. The advantage of using tree size (DBH) as an indicator is that is can be directly and precisely measured. DES 2022 therefore recommends that densities of hollow-bearing trees should not be used to define whether or not an area is greater glider habitat, and that instead improved reliability for indicating potential greater glider habitat can be achieved by measuring densities of "large trees". Size thresholds for what constitutes a "large tree" within a particular ecosystem type is guided by the probability of hollow presence in different tree species in different regions, meaning some species may contain hollows at smaller diameters than other species.

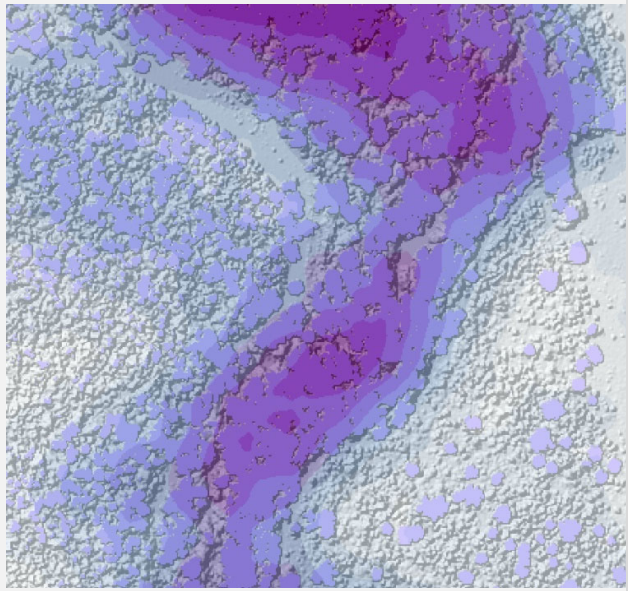
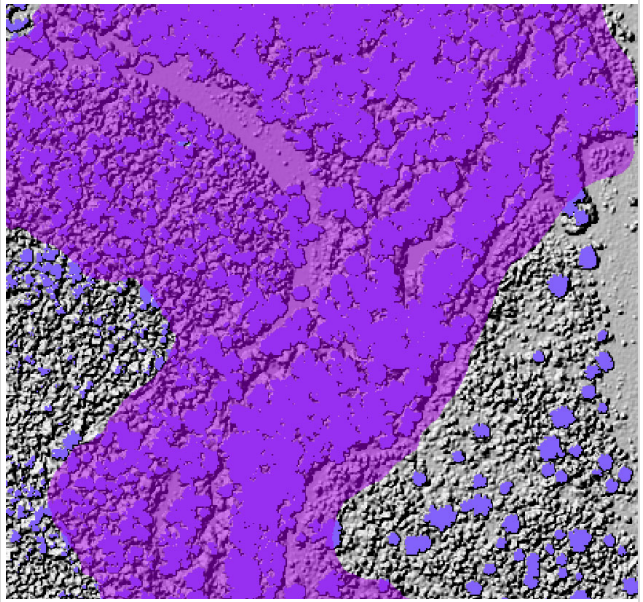
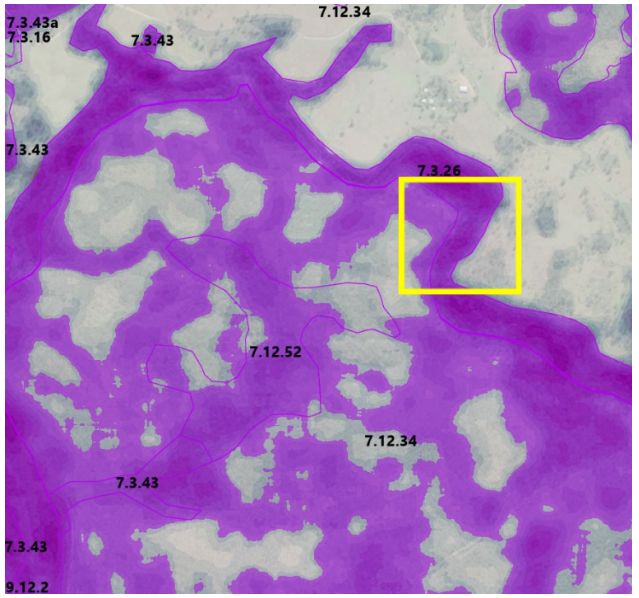
The mapping of 'large trees' across the study area was undertaken through the derivation of allometric relationships between DBH and tree height measurements of habitat trees captured during a greater glider habitat assessment in December 2021 and extrapolated across the entire site using tree height data extracted from LiDAR data. Using the recommended threshold for DBH for "large trees" of 41.2 cm in the Wet Tropics bioregion (as identified in DES 2022), the habitat assessment data was plotted to indicate an allometric relationship on site between DBH and tree height. A conservative intercept of 13 m tree height was selected as a threshold for the height of tall trees when using the mean of all species. Species such as *Eucalyptus tereticornis* and *Corymbia intermedia* were observed to have a taller tree structure, achieving heights closer to 17-20 m at the same DBH. This process is illustrated in **Table 4-6** and **Table 4-7**.

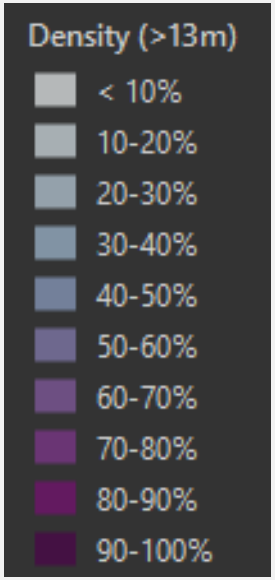
Table 4-6 Identification of Large Habitat Trees for Northern Greater Glider

Aerial image + RE containing habitat tree species	Lidar Tree Height mapping + RE containing feed species	Tree height classified as >13m = 'large tree' + RE containing feed species
		

Once classified, it was possible to observe the crown diameter of individual trees and make an estimate of the width of the canopy of large tree. In more closed woodland areas, the tree crowns are inter-locked which places limitations on the effectiveness of this approach. A conservative estimate of 100 m^2 per large tree (canopy diameter of 11 m) was determined by measuring the width of individual trees in the adjacent non-remnant area and separated trees in the habitat area. On the basis of this threshold, a tree density of 25 large trees per ha would occupy 2,500 m^2 per ha (25%). A density algorithm was run with a 1 ha kernel to determine the number of 'large tree' pixels in the surrounding hectare kernel and plotted as a percentage of large tree cover, then reclassified to the 25 % threshold. This density layer was then intersected with the vegetation community mapping to provide a habitat layer for the greater glider containing the correct species of habitat trees and an adequate density of large trees for denning and gliding.

Table 4-7 Identification of Appropriate Density of Habitat Trees for Northern Greater Glider

Large Tree density + Tree height classified as >13m = 'large tree'	Tree Density of 25% + Tree height classified as >13m = 'large tree'	Habitat = Tree Density layer + Regional Ecosystems (yellow inset is extent of earlier windows)
		

Large Tree density + Tree height classified as >13m = 'large tree'	Tree Density of 25% + Tree height classified as >13m = 'large tree'	Habitat = Tree Density layer + Regional Ecosystems (yellow inset is extent of earlier windows)
		

Following the above process, as per the *Guide to greater glider habitat in Queensland* (DES 2022), northern greater glider habitat within the Project area was mapped as follows (see **Figure 4-31**):

- Denning habitat:
  - Ground-truthed vegetation communities containing tree species characterising greater glider habitat (listed above); AND
  - Containing "large trees" at a density of >25 trees per ha for the Wet Tropics bioregion (lower quartile of 46.5 cm DBH based on LQ = Mean – (0.65 x SD)) and >20 trees per ha for the Einasleigh Uplands bioregion; AND
  - As the Project area is located in a largely intact region, patch size was not considered as a defining attribute.
- Additional foraging habitat was mapped as vegetation communities containing habitat trees species listed above within a buffer area around denning habitat based on a conservative home range size of 12 ha (from Starr et al 2021).

The Project will result in the clearance of 534.0 ha of denning habitat and 368.6 ha of foraging habitat. As the Project area represents a large contiguous area of eucalypt forest which contains mature hollow bearing trees and a diverse range of the species' preferred food species particular to that region, it can be considered as habitat critical to the survival of the northern greater glider.

These habitat mapping rules were tested with a small program of detailed habitat quality assessments along four slope gradients within the Project area (as described in **Section 4.2.2.3** and illustrated in **Figure 4-9**). While the diversity and total number of eucalyptus food trees exceeded the minimum requirement of six foraging trees per hectare across all sites (Woinarski et al. 2014), there was greater density and diversity of Eucalyptus species in the lower slopes. The ecological dominant canopy and sub-canopy layers of the upper and mid-slope sites were of relatively small stature and DBH with little opportunity for large hollows to form and hence a lower density and smaller distribution of hollow-bearing trees with large hollows present on elevated slopes. Hollow-bearing trees inclusive of large hollows with diameters greater than 8 cm at least 8 m from the ground were more prevalent in alluvium associated communities with a considerably taller and more diverse ecological dominant layer, therefore representing higher quality of required habitat features in the lower slope assessment site. The linear assessments present a gradient of declining greater glider habitat (denning and foraging) from upper to lower slope as indicated by the data in **Table 4-8** to **Table 4-11.**

Table 4-8 Linear Northern Greater Glider Habitat Assessment - Site GG1

Site along transect	Gradient	RE	Canopy height	Species richness / recruitment	Tree species richness	Density of potential food trees (20cm+ DBH) per hectare	Hollow density / large trees	Site photo
HA08	Upper slope	9.5.5a (LC): *Eucalyptus portuensis, Corymbia citriodora subsp. citriodora, E. granitica* or *E. crebra, C. intermedia* or *C. clarksoniana* mixed woodland on steep hills and ranges on igneous hills close to Wet Tropics boundary (DES 2021).	Canopy: 14m Sub-canopy: 8m Woody debris: 46m	Trees: 7 Recruitment: 100% Stags: 8 Shrubs: 12 Grass/forbs: 12	*C. Citriodora* *E. crebra* *E. resinifera* *E. tindaliae* *L. confertus*	102/ ha	4 hollows Large trees: 34 per ha	
HA09	Mid-slope	9.5.5a (LC): *Eucalyptus portuensis, Corymbia citriodora subsp. citriodora, E. granitica* or *E. crebra, C. intermedia* or *C. clarksoniana* mixed woodland on steep hills and ranges on igneous hills close to Wet Tropics boundary (DES 2021).	Canopy: 11m Sub-canopy: 4.5m Woody debris: 21m	Trees: 6 Recruitment: 100% Stags: 1 Shrubs: 10 Grass/forbs: 13	*C. intermedia* *E. granitica* *E. resinifera* *E. tindaliae* *L. confertus*	108/ ha	9 hollows Large trees: 46 per ha	

Site along transect	Gradient	RE	Canopy height	Species richness / recruitment	Tree species richness	Density of potential food trees (20cm+ DBH) per hectare	Hollow density / large trees	Site photo
HA10	Lower slope	9.3.15 (LC): *Eucalyptus tereticornis +/- Casuarina cunninghamiana +/- Melaleuca* spp. fringing woodland on channels and levees	Canopy: 18 Sub-canopy: 7m Woody debris: 83m	Trees: 9 Recruitment: 100% Stags: 8 Shrubs: 16 Grass/forbs: -	*A. subvelutina* *C. intermedia* *C. trachyphloia* *E. crebra* *E. resinifera* *E. tereticornis* *E. tindaliae*	92/ ha	11 hollows Large trees: 68 per ha	

Table 4-9 Linear Northern Greater Glider Habitat Assessment - Site GG2

Site along transect	Gradient	RE	Canopy height	Species richness / recruitment	Tree species richness	Density of potential food trees (20cm+ DBH) per hectare	Hollow density / large trees	Site photo
HA14	Upper slope	9.12.2 (LC): *Eucalyptus portuensis, Corymbia citriodora subsp. citriodora, E. granitica* or *E. crebra, C. intermedia* or *C. clarksoniana* mixed woodland on steep hills and ranges on igneous hills close to Wet Tropics boundary	Canopy: 14m Sub-canopy: 6m Woody debris: 108m	Trees: 11 Recruitment: 100% Stags: 11 Shrubs: 18 Grass/forbs: 16	*C. Citriodora* *C. intermedia* *E. crebra* *E. resinifera* *E. melaphloia* *Syncarpia*	50/ ha	0 hollows Large trees: 22 per ha	
HA15	Lower slope	9.12.2 (LC): *Eucalyptus portuensis, Corymbia citriodora subsp. citriodora, E. granitica* or *E. crebra, C. intermedia* or *C. clarksoniana* mixed woodland on steep hills and ranges on igneous hills close to Wet Tropics boundary	Canopy: 19.5m Sub-canopy: 7m Woody debris: 162m	Trees: 6 Recruitment: 100% Stags: 12 Shrubs: 15 Grass/forbs: 21	*A. subvelutina* *C. Citriodora* *C. intermedia* *E. crebra* *E. resinifera* *E. melaphloia* *Syncarpia*	194/ ha	16 hollows Large trees: 90 per ha	

Table 4-10 Linear Northern Greater Glider Habitat Assessment - Site W1

Site along transect	Gradient	RE	Canopy height	Species richness / recruitment	Tree species richness	Density of potential food trees (20cm+ DBH) per hectare	Hollow density / large trees	Site photo
HA07	Upper slope	7.12.27a: *Eucalyptus reducta* medium open forest and woodland. Uplands and highlands on shallow granitic and rhyolitic soils, of the moist rainfall zone. Not a Wetland (BVG1M: 9d).	Canopy: 11m Sub-canopy: 5.5m Woody debris: 89m	Trees: 6 Recruitment: 100% Stags: 3 Shrubs: 19 Grass/forbs: 8	*A. subvelutina* *E. granitica* *E. resinifera* *L. confertus* *S. glomulifera*	68/ ha	0 hollows Large trees >30cm: 26 per ha	
HA06	Mid-slope	7.12.27a: *Eucalyptus reducta* medium open forest and woodland. Uplands and highlands on shallow granitic and rhyolitic soils, of the moist rainfall zone. Not a Wetland (BVG1M: 9d).	Canopy: 12.5 Sub-canopy: 7m Woody debris: 126m	Trees: 6 Recruitment: 100% Stags: 13 Shrubs: 12 Grass/forbs: 10	*A. subvelutina* *C. intermedia* *E. tindaliae* *S. glomulifera*	84/ ha	5 hollows Large trees >30cm: 48 per ha	

Site along transect	Gradient	RE	Canopy height	Species richness / recruitment	Tree species richness	Density of potential food trees (20cm+ DBH) per hectare	Hollow density / large trees	Site photo
HA05	Lower slope	Transition between 7.12.27a (description below) and 7.3.43: *Eucalyptus tereticornis* open forest to woodland on uplands on well-drained alluvium.	Canopy: 15.5m Sub-canopy: 9m Wood debris: 81m	Trees: 7 Recruitment: 100% Stags: 2 Shrubs: 8 Grass/forbs: 9	*C. intermedia* *C. trachyphloia* *E. tereticornis* *E. tindaliae* Ironbark sp. x2	82/ ha	6 hollows Large trees >30cm: 32 per ha	

Table 4-11 Linear Northern Greater Glider Habitat Assessment - Site W2

Site along transect	Gradient	RE	Canopy height	Species richness / recruitment	Tree species richness	Density of potential food trees (20cm+ DBH) per hectare	Hollow density / large trees	Site photo
HA11	Upper slope	7.12.34 (LC): *Eucalyptus portuensis* and/or *E. drepanophylla* +/- *C. intermedia* +/- *C. citriodora*, +/- *E. granitica* open woodland to open forest on uplands on granite.	Canopy: 10.5m Sub-canopy: 6.5m Woody debris: 38m	Trees: 6 Recruitment: 100% Stags: 0 Shrubs: 22 Grass/forbs: 8	*C. citriodora* *C. trachyphloia* *E. melanaphloia* *E. portuensis* *E. tindaliae* *S. glomulifera*	44/ ha	2 hollows Large trees >30cm: 14 per ha	
HA12	Mid-slope	7.12.34 (LC): *Eucalyptus portuensis* and/or *E. drepanophylla* +/- *C. intermedia* +/- *C. citriodora*, +/- *E. granitica* open woodland	Canopy: 15m Sub-canopy: 8m Woody debris: 57m	Trees: 5 Recruitment: 100% Stags: 2 Shrubs: 5 Grass/forbs: 9	*C. citriodora* *C. intermedia* *E. crebra* *E. lockyeri* *E. portuensis*	46/ ha	8 hollows Large trees >30cm: 28 per ha	

Site along transect	Gradient	RE	Canopy height	Species richness / recruitment	Tree species richness	Density of potential food trees (20cm+ DBH) per hectare	Hollow density / large trees	Site photo
		to open forest on uplands on granite.						
HA13	Lower slope	7.12.30a: *Corymbia citriodora, Eucalyptus portuensis, C. intermedia, Syncarpia glomulifera* woodland to low woodland to open forest with *Callitris intratropica, Acacia calyculata* and *Xanthorrhoea johnsonii*. Uplands and highlands, of the moist and dry rainfall zones. Not a	Canopy: 21.5m Sub-canopy: 13m Woody debris: 78m	Trees: 9 Recruitment: 100% Stags: 3 Shrubs: 15 Grass/forbs: 12	*A. subvelutina* *C. citriodora* *C. intermedia* *E. crebra* *E. platyphylla* *E. portuensis* *E. resinifera* *E. tereticornis*	110/ ha	14 hollows Large trees >30cm: 41 per ha	

Site along transect	Gradient	RE	Canopy height	Species richness / recruitment	Tree species richness	Density of potential food trees (20cm+ DBH) per hectare	Hollow density / large trees	Site photo
		Wetland (BVG1M: 10b).						