



A Biodiversity Planning Assessment for the Northwest Highlands Bioregion

Version 1.1
Expert Panel Report

Prepared by: Biodiversity Assessment, Queensland Herbarium, Science and Technology Division, Department of Environment and Science.

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Cover image: jagged St Ronan metamorphics stradbroke - photo taken and provided by Chris Appelman, Department of Environment and Science.

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Note. This report should be read in conjunction with the accompanying Summary Report - A Biodiversity Planning Assessment for the Northwest Highlands Bioregion: Summary Report. Version 1.1 (DES, 2020).

1 Introduction

The Northwest Highlands bioregion is characterised by a spectacular exposure of ancient rock and supports some of the most unique habitats and native species in the state (Neldner et al. 2019). The bioregion contains the globally important Riversleigh fossil mammal world heritage area and two ecologically unique national parks, Boodjamulla (Lawn Hill) and Camooweal Caves. There are also a number of wetlands of national importance, including the Gregory River, one of the most pristine river ecosystems in the country and the Thorntonia Aggregation which supports the unique springs ecosystems around Lawn Hill and Riversleigh. While less biodiverse than many other Queensland bioregions, the Northwest Highlands is one of the most intact regions in the state, with less than one percent clearing across the bioregion.

This report details the results of expert panels used to produce a Biodiversity Planning Assessment (BPA) for the Northwest Highlands bioregion. To date, BPA results have been used to inform a wide range of assessment, planning and referral activities including:

- regional plans and local planning schemes
- government advice under the *Planning Act 2016*
- State government tenure dealings including identification of protected areas
- habitat mapping for threatened species.

Biodiversity Planning Assessment results have also been used by environmental consultants, environmental non-government organisations and natural resource management groups to:

- identify priorities for protection, regulation or rehabilitation of ecosystems
- contribute to impact assessment of large-scale development
- provide input to socio-economic evaluation and prioritisation processes
- inform natural resource management plans.

The Biodiversity Assessment and Mapping Methodology version 2.2 (BAMM) (EHP, 2014) was developed to provide a consistent approach for assessing biodiversity values at the landscape scale using vegetation mapping data generated or approved by the Queensland Herbarium. The BAMM is being used by the Department of Environment and Science (DES) to generate BPAs for all bioregions across Queensland. The BAMM is continually being refined and is published on the DES website at <https://www.qld.gov.au/environment/plants-animals/biodiversity/planning/>. The methodology was modified from an approach initially developed by Chenoweth EPLA (2000) and the results can be used by DES staff, other government departments, local governments or members of the community to advise on a range of decision-making processes.

The methodology is applied in two stages (Figure 1). The first stage uses existing data to assess seven diagnostic criteria. These account for ecological concepts including rarity, diversity, fragmentation, habitat condition, resilience, threats and ecosystem processes. They are diagnostic in that they are used to filter available data and provide a 'first-cut' determination of significance. This initial assessment is generated on a geographic information system (GIS) and is then refined using a second group of expert panel criteria. These criteria rely more upon expert opinion than on quantitative data and focus on information that may not be available uniformly across the bioregion. A generalised terms of reference for the expert panels is provided in EHP (2014).

This project was led by the Department of Environment and Science with significant contributions from regional stakeholders and experts. This report should be read in conjunction with the accompanying Summary Report (DES, 2020). For convenience, the Northwest Highlands bioregion is hereafter referred to as NWH. [Appendix 1](#) provides details of any other abbreviations included in the report.

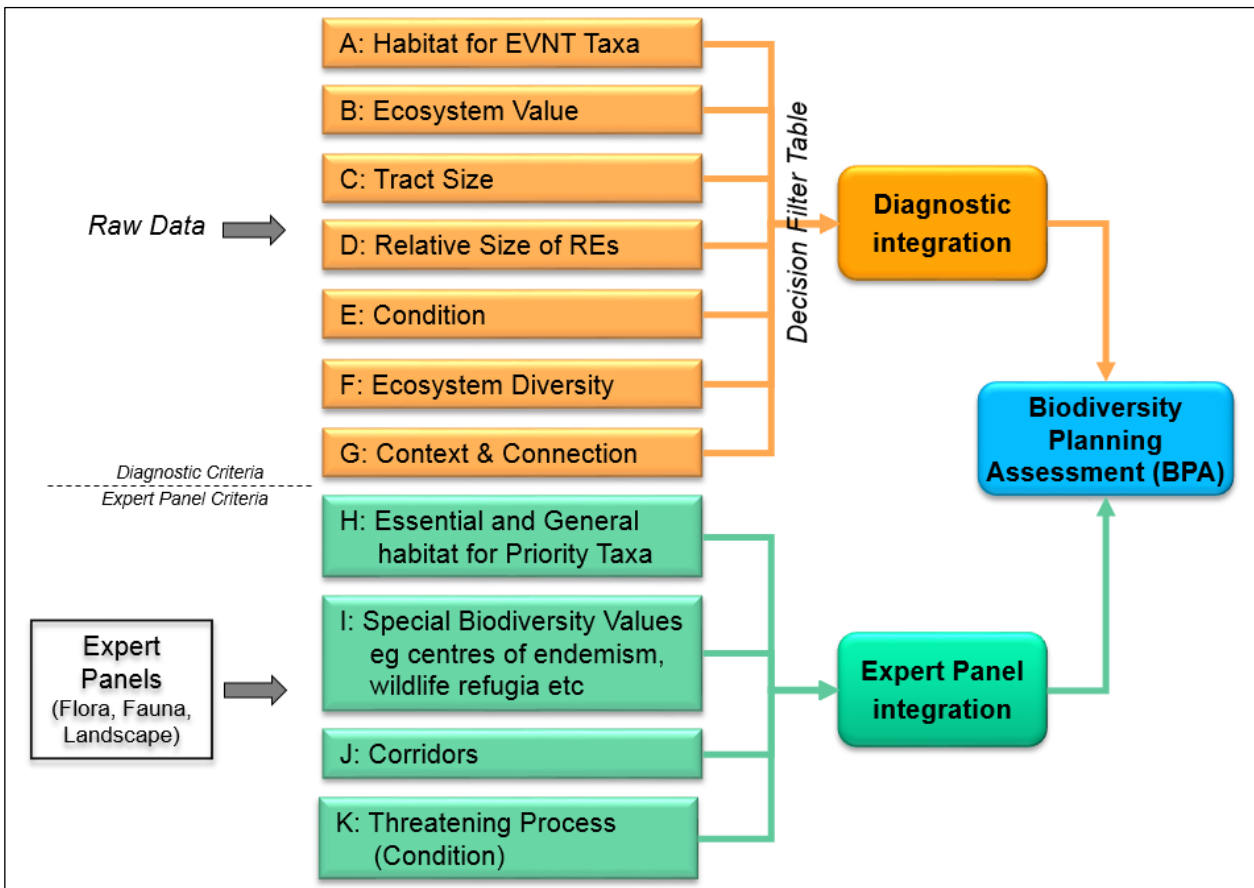


Figure 1. Biodiversity Assessment and Mapping Methodology (BAMM) process

2 Method

2.1 Study area

Covering 7.34 million hectares, the NWH is the eighth largest bioregion in Queensland (Accad et al. 2017), extending for approximately 580km from north of Boulia to north of Doomadgee (Figure 2).

The NWH is a complex landscape, dominated by dissected metamorphic and volcanic rocky hills, eroded sandstone platforms and limestone karst systems. River systems in the bioregion either flow north to the Gulf of Carpentaria, inland to the Barkly Tableland, or south to the Eyre Basin. Soils are mostly shallow to skeletal and are derived from a range of parent materials such as volcanic and calcareous rocks to granitoid rocks and sandstones (Christian et al. 1954; Perry et al. 1964). The climate in the region ranges from semi-arid in the south to dry monsoonal in the north, (Geoscience Australia, 2020). The hot summers occasionally lead to tropical cyclones that can result in significant rainfall events and flooding across the region.

The Northwest Highlands is difficult to summarise from a geological perspective because it is a mix of subregions with vastly different and complex geological histories. The eastern half of the bioregion, the Mount Isa Inlier, is a highly weathered and eroded mix of volcanic and granitoid rocks that have at times been covered by sea and had most of their covering sediment stripped off during the Tertiary period. The western half of the bioregion, made up of three subregions, is a mix of limestone karst systems and formerly swampy plains that have received part of the sediment load from the Mount Isa Inlier during periods of erosion. This area sits on the north-eastern edge of the Great Artesian Basin and many of the springs in the region have this aquifer as their origin. The limestone karst systems house extensive fossil and near-fossil remains and are particularly well known for their mammal fossils from the Riversleigh area.

The complex geological history has given rise to a complex ecological history to the bioregion. While overall biodiversity is low due to the semi-arid nature of much of the region, the northern parts are better described as dry monsoonal. Rain in this region comes mainly from the north and annual rainfall averages change on a north-south gradient, with the southern parts averaging 300–400mm and the northern parts as high as 600–900mm (Geoscience Australia, 2020). This rainfall is highly seasonal, with the majority falling over a three month period in summer.

Land use in the NWH is primarily agriculture, especially pastoral grazing and extractive industry. The major population centres are Mt Isa and Cloncurry. Approximately eight per cent of the bioregion has protected area estate or nature refuge status.

Key threats to biodiversity values within the bioregion include:

- changed fire regimes, particularly through invasion of exotic pasture grasses leading to increases in fire frequency and intensity
- direct habitat loss through extractive industry and indirect habitat loss through intensive grazing leading to loss of habitat condition
- climate change
- invasion by exotic and non-local native plants and animals, both terrestrial and freshwater
- stochastic events, e.g. cyclones.

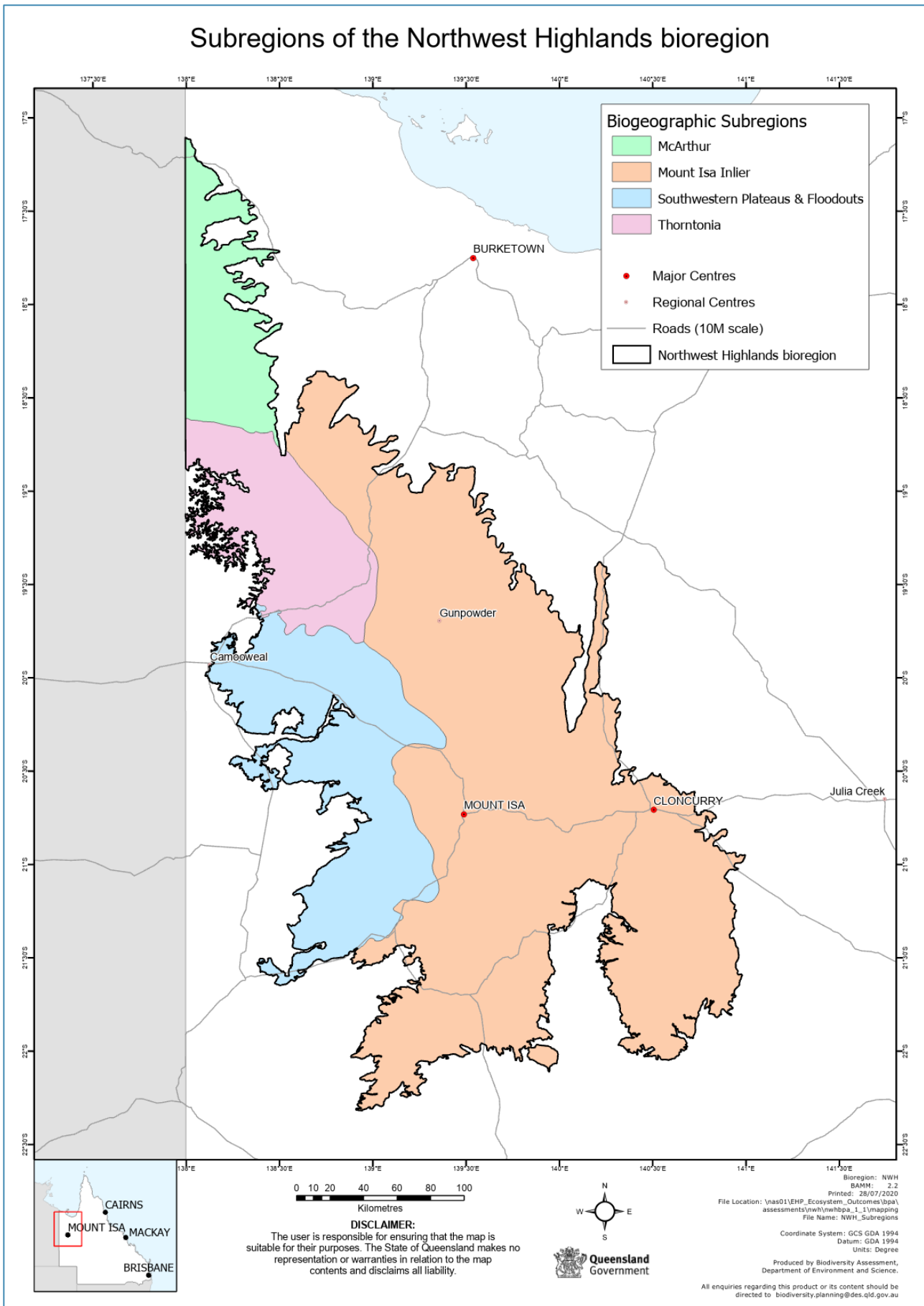


Figure 2. Subregions of the NWH

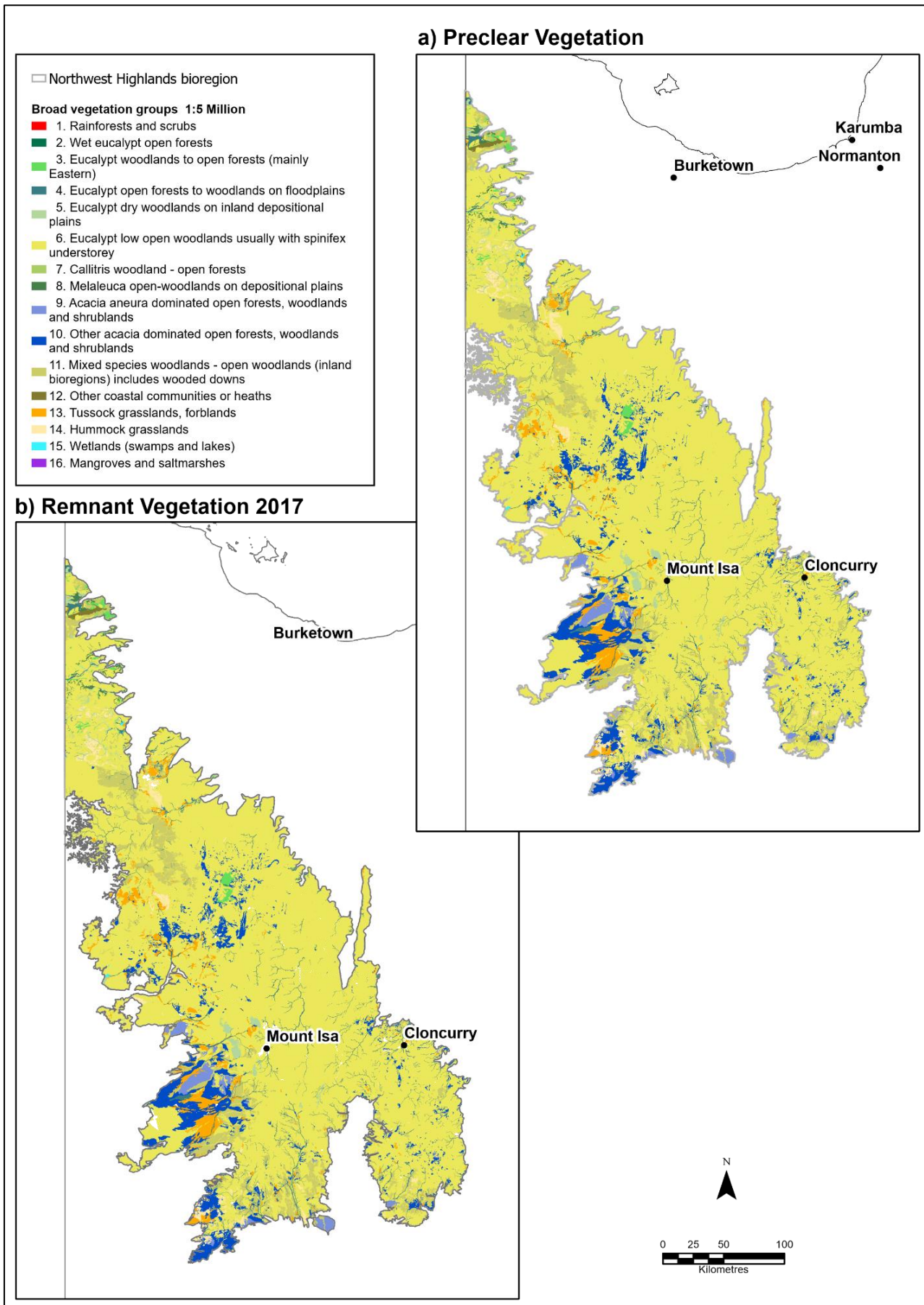


Figure 3. Broad vegetation groups across the NWH

2.2 Expert panel

A series of expert panel workshops were held in Brisbane (QLD Herbarium) from 20 to 22 May 2019. Expert panels play a significant role in the development of a BPA. The aim of the expert panel process is to:

- identify additional information sources including expert knowledge, technical reports and papers
- elicit expert opinion where quantitative data is not available uniformly across the bioregion.

Biodiversity values and issues addressed at the expert panel workshops include:

- evaluating point records and habitat models for endangered (E), vulnerable (V) and near threatened (NT) taxa to improve spatial accuracy and precision
- identifying non-EVNT taxa to be treated as priority species under Criterion H
- capturing any additional records available from expert panel members for use in Criterion A and H
- identifying areas with special biodiversity values (Criterion I)
- identifying terrestrial and riparian landscape connections (Criterion J)
- identifying data gaps.

The NWH expert panels comprised invited persons with knowledge of the biodiversity of the bioregion and a sound understanding of ecological conservation and management principles. As far as possible, the combined expertise of participants covered the whole NWH and a range of key stakeholders (e.g. local government, regional Natural Resource Management (NRM) bodies, state government, educational institutions). The terms of reference for expert panels are provided in EHP (2014). All NWH BPA v1.1 expert panel participants are listed in Table 1.

The output of the panel process aims to be justifiable and transparent. Data that is captured digitally and mapped is a result of consensus within the panel and ratified by the Manager, Biodiversity Assessment, DES.

Significance ratings of State, Regional or Local are attributed to the decisions produced at the expert panels. In general, ratings are only attributed by the panel to areas of remnant vegetation, however, in some instances panel identified special areas have incorporated areas of non-remnant vegetation.

The ratings used by the panel were described as:

State significance - areas assessed as being significant for biodiversity at the bioregional or state scales. Includes areas assessed as being significant at national or international scales.

Regional significance - areas assessed as being significant for biodiversity at the sub-bioregional scale. These areas have lower significance for biodiversity than areas assessed as being of State significance.

Local significance - areas assessed as being significant for biodiversity at a local scale. These areas have lower significance for biodiversity than areas assessed as being of Regional significance.

Table 1. Expert panel participants

Name	Organisation	Panel Attendance
Chris Appelman	Queensland Herbarium (DES)	Attended
Phil Bourke	Queensland Parks and Wildlife Service (DES)	Out of panel advice
Lea Ezzy	Queensland Parks and Wildlife Service (DES)	Attended
Darren Fielder	Consultant, Redleaf Environmental	Attended
Luke Hogan	Queensland Herbarium (DES)	Attended
Katharine Glanville	Queensland Herbarium (DES)	Attended
Dan Kelman	Queensland Herbarium (DES)	Attended
Nick Leseberg	University of Queensland	Attended
Gethin Morgan	Consultant, Previously Department of Env and Heritage	Attended
Kayler Plant	Southern Gulf NRM group	Attended
Mark Sanders	Consultant, EcoSmart Ecology	Attended
Christopher Sanderson	Queensland Herbarium (DES)	Out of panel advice
Brett Taylor	Consultant, CMD Smith	Attended
Bruce Wannan	Environmental Services and Regulation (DES)	Attended
Support staff		
Stephen Trent	Biodiversity Assessment Team, DES	
Mark Kelton	Biodiversity Assessment Team, DES	
Shane Chemello	Biodiversity Assessment Team, DES	
Ofalia Ho	Biodiversity Assessment Team, DES	
Courtney Miles	Biodiversity Assessment Team, DES	
Harriet Preece	Biodiversity Assessment Team, DES	

2.3 Expert panel considerations format

The expert panel workshops used an interactive approach of GIS software, spreadsheets, reports, laptops and data projectors. Prior to the panel being convened, relevant information was collated and disseminated to the workshop participants.

Resources made available to the participants during the workshop proceedings included:

- copy of the BAMB (EHP, 2014)
- information from databases such as Herbreccs, Corveg, Queensland Historical Fauna Database (QHFD) and WildNet
- available regional ecosystem mapping and 1:100,000 topographic maps
- relevant reports and published literature
- ancillary GIS layers provided for local reference including roads and cadastral information, drainage, protected areas including nature refuges and recently captured high resolution imagery.

[Appendix 2](#) provides a full list of the resources made available at the panel workshops.

2.3.1 Taxa (Criteria A and H)

Flora and fauna taxa considered by the expert panel were threatened and near-threatened (EVNT) species (Criterion A) listed under the Queensland *Nature Conservation Act 1992* (NCA) or the Australian Government *Environment Protection and Biodiversity Conservation Act 1999* (EPBC), priority (non-EVNT) taxa (Criterion H) - including those identified through the Back on Track species prioritisation framework and other natural resource assessments focused on the bioregion. Records were compiled using WildNet, Corveg, HerbreCs, QHFD and from project specific data sets obtained from other sources. Other species were nominated, discussed and either added or discarded from the priority taxa list by workshop participants prior to and during the panel workshops. Experts were asked to identify known preferences of species for particular habitat features, e.g. specific regional ecosystems (REs), geology or landscape position.

Selected species records were interactively reviewed using GIS commencing with EVNT species then priority species. Participants were asked to accept, add, shift or exclude records based upon their expert knowledge. Panel participants accepted records located within their known distributions, at known locations or if collected by a reliable source. They identified records that were incorrectly located and added records either during the workshop proceedings or with follow-up consultation.

Records were excluded for the following reasons:

- incorrect coordinates - a mismatch between location description and coordinates
- is a cultivated plant
- duplicate records which had been cited by a number of sources
- records with a precision > 2,000m
- records collected before 1950 (flora) or 1975 (fauna).

For most BPAs, priority taxa are identified for each bioregion on the basis of one or more values and the written opinion of experts. These values include:

1. Taxa at risk - taxa that, from a bioregional perspective, are under threat and consequently have had significant population and/or range declines based on scientific evidence and/or expert opinion.
2. Taxa of scientific interest as relictual (ancient or primitive) - taxon (e.g. species or other lineage) that is the sole surviving representative of a formerly diverse group. Some flora and fauna taxa have been linked with important stages in the Earth's evolutionary history.
3. Endemic taxa - taxa which have at least 75 per cent of their geographical range within one bioregion (Commonwealth of Australia 1995, Queensland CRA/RFA Steering Committee 1998).
4. Significant taxa - these species identified by experts as important from a bioregional perspective as they exhibit characteristics such as: taxa which have limited distribution in Queensland mostly within the bioregion, or with a restricted range bordering two or more bioregions; the species may be found outside the state within Australia and/or overseas; the species in the bioregion exhibits characteristics or traits not evident elsewhere in its range; the bioregion is a stronghold for the species.
5. Taxa important for maintaining genetic diversity such as complex patterns of genetic variation - species that exhibit a recognised variation in genetic composition across the bioregion, or with respect to other bioregions. This could include taxa that appear to comprise several cryptic taxa.
6. Disjunct species populations - populations broken by climatic, topographic or edaphic barriers bridged by long distance dispersal of propagules; or seen as insurmountable barriers to dispersal requiring a geological (historical) rather than a behavioural (ecological) explanation for their presence (Groves, 1981).
7. Taxa functionally important to ecosystem integrity - plant or animal taxa that play a unique and crucial role in the way an ecosystem functions, and whose decline or disappearance would see a dramatic change in the nature of that ecosystem. The contributions of such species are large compared to the species' prevalence in the habitat. They are often, but not always, a predator. A few predators can control the distribution and population of large numbers of prey species.
8. Taxa performing a role as an ecological indicator of ecosystem integrity - can be of many different types. They can be used to reflect a variety of aspects of ecosystems, including biological, chemical and physical integrity. Indicators are used to communicate information about ecosystems and the impact human activity has on ecosystems.
9. Taxa vulnerable to impacts of climate change - species that are considered to be adversely affected by the predicted changes in climate, e.g. increasing temperatures, sea level rise and increasing frequency of extreme weather events (drought, flood and cyclones). Species can only be listed under this reason if there is sufficient knowledge of species' biology and its interaction with climate that would support an assessed impact under climate change scenarios.

The panel also assigns a significance category of "Priority type A", or "Priority type B" for each nominated taxon.

Generally, "Priority A" importance was assigned to those species considered at "High" risk under eligibility criteria 1 or 9, or where in combination with another criteria, i.e. narrow endemic (subset of eligibility criterion 3), and/or relictual (criterion 2) taxa. "Priority B" importance was assigned to the remainder.

Decisions were recorded in the spatial database and minutes, as well as habitat information and the threatening processes identified for each species. Individuals were also consulted following the workshops to clarify some recommendations and to add records.

2.3.2 Special area considerations (Criteria I)

The flora and fauna panels nominated areas of special biodiversity value for inclusion under Criterion I. Panels assigned State, Regional, or in some instances Local Significance to the nominated areas on the basis of presence of at least one of the following elements:

- Criterion Ia - the area supports a number of taxa endemic to the NWH
- Criterion Ib - wildlife refugia, for example, mound springs, caves, wetlands, gorges, mountain ranges and topographic isolates that act as shelters from clearing, stochastic events (fire, flood, drought) and exotic animals
- Criterion Ic - the area supports a number of taxa that are present in other bioregions and have a limited number of occurrences in the NWH bioregion (outliers/disjunct populations)
- Criterion Id - the area supports a number of taxa at or near the limits of their respective geographical ranges
- Criterion Ie - the area supports high species richness
- Criterion If - the area supports concentrations of relictual (ancient and primitive) taxa
- Criterion Ig - the area contains a regional ecosystem or regional ecosystems that exhibit variation in species composition
- Criterion Ih - an artificial waterbody or managed/manipulated wetland of ecological significance
- Criterion Ii - the area contains high relative densities of habitat shelters (i.e. nesting or resting shelters - hollow-bearing trees, caves, rock outcrops etc.) that provide animal habitat
- Criterion Ij - the area is used by significant numbers of individuals for roosting or breeding
- Criterion Ik - climate change refugia.

The biodiversity issues addressed at landscape panel workshops were:

- consideration of new special areas with landscape values - these may include areas that have been identified by both the flora and fauna panels which warrant a landscape scale decision, or areas that have not been previously identified under Criterion I
- review of corridors and linkages based on consideration of the overall configuration of remnant and other vegetation and areas where landscape restoration would be desirable (Criterion J).

The above criteria are focussed on terrestrial values with some consideration of aquatic values. The importance of specific aquatic values such as habitat dependences associated with aquatic species, ecosystem processes and other aquatic criteria are assessed in more detail through application of the Aquatic Biodiversity Assessment and Mapping Methodology (AquaBAMM) (Clayton et al. 2006).

The diagnostic criteria in BAMM use prescribed thresholds for determining the relative importance of individual criteria and standard rules for assigning biodiversity significance based on combinations of values present. However, BAMM (EHP, 2014) deliberately provides non-specific guidance on how expert panels are to assess and assign significance ratings to expert criteria. The NWH expert panels used a consensus approach in assigning overall significance. Where there was uncertainty or further work needed, tasks were assigned for follow-up. In some cases, the areas were specifically identified by RE polygons, whilst in others, a bounding box was drawn to indicate the general location and specific recommendations provided which allow later spatial delineation using a combination of other vegetation, geology or landform mapping. Subsequently, the areas were mapped and distributed to the expert panel for review and then finalised.

2.3.3 Corridors (Criterion J)

Landscape scale corridors have been defined and mapped at a statewide level for most of the state. The network is being expanded as BPAs are completed for additional bioregions. Their broad purpose is to provide for ecological and evolutionary processes by:

- maintaining long term evolutionary/genetic processes that allow the natural change in distributions of species and connectivity between populations over long periods of time
- maintaining landscape/ecosystems processes associated with geological, altitudinal and climatic gradients, to allow for ecological responses to climate change
- maintaining seasonal migrations and movement of fauna

- maximising connectivity between large tracts/patches of remnant vegetation
- identifying key areas for rehabilitation and offsets.

Corridors routes may be selected to reflect:

- major watershed and catchment boundaries
- intact river systems
- major altitudinal/geological/climatic gradients
- connectivity between remnant vegetation in good condition
- linkages between bioregions
- linkages between permanent waterholes.

The methods used to identify bioregional terrestrial and riparian corridors, and gaps and critical weaknesses in terrestrial corridors, are outlined in (Howell et al., 2019). Corridors that form part of the statewide network are assigned State significance. Other corridors providing connectivity at a sub-regional scale are assigned Regional significance.

2.3.4 Threatening processes: condition (Criterion K)

The condition of remnant vegetation is affected by threatening processes such as clearing, weeds, feral animals, grazing and burning regime, selective timber harvesting/removal, salinity, soil erosion and climate change. A consistent assessment of condition for whole bioregions is not yet possible under the diagnostic criteria. In lieu of this, Criterion K can be used to upgrade or downgrade an area's overall biodiversity significance based upon expert judgement of an area's habitat quality.

In selected instances, previous expert panels nominated to upgrade the overall significance of areas which represented outstanding, or comparatively intact examples of specific habitats which, elsewhere, were largely degraded.

3 Results

Outcomes from the flora, fauna and landscape panels are recorded in the following sections.

3.1 Flora taxa (Criteria A and H)

Criteria A and H attribute significance to areas based on the presence of EVNT taxa scheduled under the NCA or the EPBC, or, the presence of priority species. The NWH flora expert panels identified 39 species for inclusion in Criteria A and H. Table 2 summarises the categories of taxa. The standard BAMB record vetting rules were applied (EHP, 2014).

Table 2. Summary of flora taxa identified by the expert panel for Criteria A and H

	Endangered (Criterion A)	Vulnerable (Criterion A)	Near Threatened (Criterion A)	Priority (non-EVNT) taxa (Criterion H)	Total
Number of taxa	1	4	4	30	39

3.1.1 Habitat for endangered, vulnerable and near threatened flora taxa (Criterion A)

The panel identified and selectively reviewed species records to define a list of nine NWH EVNT flora taxa relevant to the NWH (Table 3). For inclusion in the NWH BPA the records were first vetted as described in the section (2.3.1) and subsequently buffered by twice the precision with a minimum of 300m and a maximum of 2km. For four taxa, in conjunction with records, the panel approved the use of expert vetted habitat suitability models developed under the National Environmental Science Program (Pintor et al. 2018) to identify areas of potential habitat.

Table 3. NWH - endangered, vulnerable and near threatened flora taxa (Criterion A)

Scientific Name	Common Name	NCA ¹	EPBC ²	Expert Panel Comments
<i>Cycas brunnea</i>		V		This species is a relict, probably restricted in distribution due to low rainfall. It is threatened by encroachment of Buffel Grass (<i>Cenchrus ciliaris</i>) leading to more frequent and intense fires. The panel agreed to the use of a species habitat suitability model (Pintor et al. 2018) in conjunction with records, to identify areas of habitat likely occupied.
<i>Dichanthium setosum</i>			V	
<i>Eucalyptus nudicaulis</i>		V		Naturally rare species and endemic to the bioregion.
<i>Ipomoea antonschmidii</i>		NT		Endemic to the bioregion, but locally common where it occurs.
<i>Lobelia membranacea</i>		NT		The panel agreed to the use of a species habitat suitability model (Pintor et al. 2018) in conjunction with records, to identify areas of habitat likely occupied.
<i>Ptilotus extenuatus</i>		E		
<i>Ptilotus maconochiei</i>		NT		This species is locally common.
<i>Solanum carduiforme</i>		V		Potentially impacted by climate change (Crowley, 2016). The panel agreed to the use of a species habitat suitability model (Pintor et al. 2018) in conjunction with records, to identify areas of

<i>Scientific Name</i>	<i>Common Name</i>	NCA¹	EPBC²	Expert Panel Comments
				habitat likely occupied.
<i>Trachymene glandulosa</i>		NT		The panel agreed to the use of a species habitat suitability model (Pintor et al. 2018) in conjunction with records, to identify areas of habitat likely occupied.

¹ E = endangered, V = vulnerable, NT = near threatened as per *Nature Conservation Act 1992*

² CE = critically endangered, E = endangered, V = vulnerable as per *Environment Protection and Biodiversity Conservation Act 1999*

3.1.2 Habitat for priority flora taxa (Criterion H)

Priority species (Criterion H) are non-EVNT species that are considered to be of particular conservation significance in the bioregion. The rationale for inclusion is based upon the eligibility criteria described in section 2.3.1. A total of 30 flora taxa were listed for Criterion H (Table 5). The number of species pertaining to each eligibility criteria is summarised in Table 4. Most species listed had more than one eligibility criteria. Two of the species exhibited three or more eligibility criteria.

For inclusion in the NWH BPA, priority species records were first subject to filtering rules as described in the section 2.3.1 and subsequently, buffered by twice the precision (as for Criterion A) with a minimum of 300m, and a maximum of 1km. The decision rules for assigning Criterion H values ratings (Low to Very High) are summarised in Table 6.

Table 4. Number of priority flora taxa listed for each eligibility criterion.

Eligibility value¹	Taxa count
1. Taxa at risk	2
2. Taxa of scientific interest as relictual (ancient or primitive)	0
3. Endemic taxa	14
4. Significant taxa	9
5. Taxa important for maintaining genetic diversity such as complex patterns of genetic variation	0
6. Disjunct species populations	13
7. Taxa functionally important to ecosystem integrity	0
8. Taxa performing a role as an ecological indicator of ecosystem integrity	1
9. Taxa vulnerable to impacts of climate change	2

Table 5. NWH - priority flora taxa (Criterion H)

Scientific Name	Common Name	Significance	Eligibility value no.	Expert panel comments
<i>Acacia malloclada</i>		A	4,6	The NWH records are disjunct from the main range of the species (Northern Territory).
<i>Acalypha pubiflora</i> subsp. <i>australiana</i>		A	6	The NWH occurrence represents a disjunct occurrence with records in Western Australia and Northern Territory also.
<i>Archidium thalliferum</i>		A	1,3	The species is endemic to the bioregion.
<i>Boronia hoipolloi</i>		A	1,3	There are only two records of this species, both within this bioregion, making it endemic to the Northwest Highlands. The species grows on rocks, sheltered in gorges.
<i>Brachychiton collinus</i>		B	4,8,9	Northwest highlands - Queensland stronghold of this species. Indicator of fire refugia where individuals are found in good condition.
<i>Cajanus lanuginosus</i>		A	3	This species occurs mainly in the Northwest Highlands bioregion, with one disjunct record in Western Australia.
<i>Cyperus cunninghamii</i> subsp. <i>cheradicus</i>		B	3	Species grows in sandstone country. Majority of records for this species occur in the Northwest Highlands, though it is likely common across the border. Treated as an endemic species for the purposes of this assessment.
<i>Eucalyptus leucophylla</i>		B	3,6	Disjunct populations in Western Australia and elsewhere in Queensland. Majority in NWH. Medium vulnerability to climate change (Low, 2011).
<i>Eucalyptus melanophloia</i> subsp. <i>nana</i>		A	4,6	The bioregion holds a disjunct population. Records also from the Northern Territory. In Queensland, this taxon occurs only in the NWH.
<i>Eucalyptus whitei</i>	White's ironbark	A	6	The population in this bioregion is highly localised and disjunct and represents a community unique to the region.
<i>Euphorbia operta</i>		A	3	This species is a narrow-range endemic found only in the NWH.
<i>Galactia</i> sp. (Andoom A.Morton 1149)		B	4	There is a single record of this species from the bioregion. It was thought be the same as the species found in Cape York bioregion. The Cape York specimens have now been determined to be <i>Galactia tenuiflora</i> var. <i>latifolia</i> .
<i>Geijera salicifolia</i>	brush wilga	B	6	The disjunct population in this bioregion may in fact represent a phylogenetically distinct taxa and requires further study.
<i>Heliotropium delestangii</i>		A	3	This species is endemic to the bioregion.
<i>Heliotropium frohlichii</i>		A	3	This species is endemic to the bioregion.

Scientific Name	Common Name	Significance	Eligibility value no.	Expert panel comments
<i>Heliotropium lapidicola</i>		A	3	This species is endemic to the bioregion and is known from only one record, southwest of Cloncurry.
<i>Jacksonia lateritica</i>		B	3	This species is largely endemic to the bioregion, with the majority of records occurring in the Northwest Highlands.
<i>Livistona rigida</i>		B	6,9	This species is known to be highly vulnerable to climate change and is killed by both large fires and floods (Low, 2011).
<i>Melaleuca dissitiflora</i>		B	6	In Queensland, this taxon occurs only in the NWH. There are disjunct populations in Northern Territory and South Australia.
<i>Paspalidium johnsonii</i>		A	3	This species is endemic to the bioregion and is currently known from only one record.
<i>Polygala barklyensis</i>		B	3	This species is considered endemic to the bioregion, with the majority of records occurring in the Northwest Highlands.
<i>Scaevola revoluta</i> var. <i>revoluta</i>		B	4	Within Queensland this species only occurs in the Northwest Highlands, however the species also extends into the Northern Territory and Western Australia.
<i>Scaevola</i> sp. (Mt Isa P.L.Harris 699)		B	3	This species is considered to be endemic to the bioregion, with the majority of records occurring in the Northwest Highlands.
<i>Sida</i> sp. (Murray Springs R.W.Johnson+ MRS919)		B	6	The species occurrence in NWH are disjunct to populations also found in Western Australia.
<i>Tephrosia</i> sp. (Adels Grove A.de Lestang 359)		A	4,6	This species is found in Queensland and Western Australia, however, very few known records.
<i>Tephrosia</i> sp. (Barkly Downs S.L.Everist 3384)		B	6	Disjunct species also found in Northern Territory and Western Australia.
<i>Tephrosia</i> sp. (Mt Isa P.L.Harris 277)		A	3	This species is endemic to the bioregion.
<i>Tephrosia</i> sp. (Musselbrook M.B.Thomas+MRS472)		B	4	Only found in NWH in Queensland, but also found in Northern Territory.
<i>Triumfetta mellina</i>		B	4,6	In Queensland found only in NW corner of the state. Disjunct population in Western Australia.
<i>Triumfetta rupestris</i>		B	4,6	In Queensland found predominately in NWH bioregion. Disjunct population in Western Australia.

Table 6. Priority taxa value rating rules

Low	Medium	High	Very High
<p>The remnant has no confirmed records/models or otherwise defined areas of habitat for priority taxa</p>	<p>The area within the remnant unit has a precise record (precision <= 500m), or core habitat for ONE "Priority type A" taxa</p> <p>OR</p> <p>The area within the remnant unit has precise records (precision <= 500m) or core habitat for only ONE or TWO "Priority type B" taxa</p> <p>OR</p> <p>The area within the remnant unit has imprecise records or non-core habitat for "Priority type A or B" taxa</p>	<p>The area within the remnant unit has precise records (precision <= 500m), or core habitat for TWO "Priority type A" taxa</p> <p>OR</p> <p>The area within the remnant unit has precise records (precision <= 500m), or core habitat for THREE "Priority type B" taxa</p> <p>OR</p> <p>The area within the remnant unit has precise records (precision <= 500m), or core habitat for ONE "Priority type A" taxa AND TWO "Priority type B" taxa</p>	<p>The area within the remnant unit has precise records (precision <= 500m), or core habitat for a minimum of THREE "Priority type A" taxa</p> <p>OR</p> <p>The area within the remnant unit has precise records (precision <= 500m), or core habitat for a minimum of FOUR "Priority type B" taxa</p> <p>OR</p> <p>The area within the remnant unit has precise records (precision <= 500m), or core habitat for TWO "Priority type A" AND TWO OR THREE "Priority type B" priority taxa</p>


3.1.3 Special flora area decisions (Criterion I)

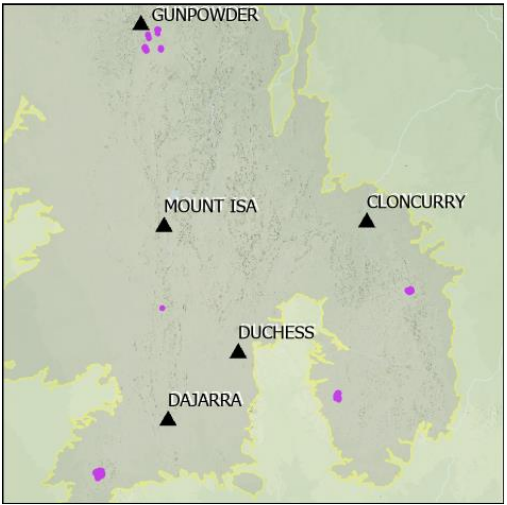
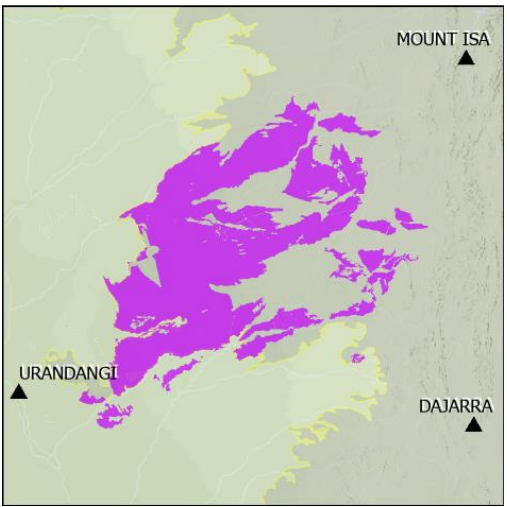
The flora panel was asked to identify areas with special biodiversity values within the NWH under the BMM supplementary Criterion I. Areas with special biodiversity value are important because they can contain multiple taxa in unique ecological and often highly biodiverse environments. Values can include centres of endemism, wildlife refugia, disjunct populations, geographic limits of species distributions, high species richness and relictual populations. The full rationale for inclusion is based on eligibility criteria described in section 2.3.2.

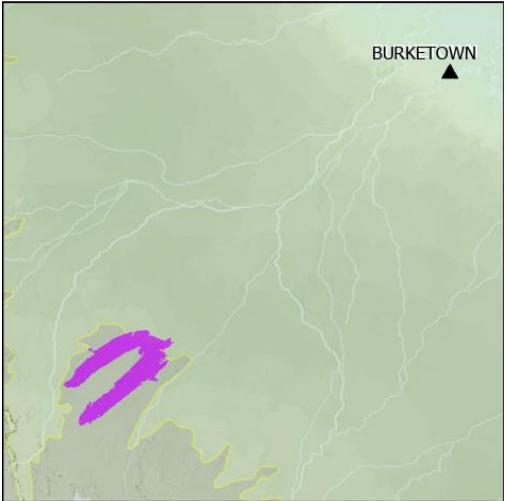
Using expert knowledge and available information (records, maps, GIS derived datasets), panel members discussed nine areas and described their values. Of these areas, seven were implemented as flora decisions. A number of decisions were consolidated with fauna or other values to become landscape decisions. The special areas proposed by the panel are detailed in Table 7. A range of species are listed for most decisions including EVNT and endemics.

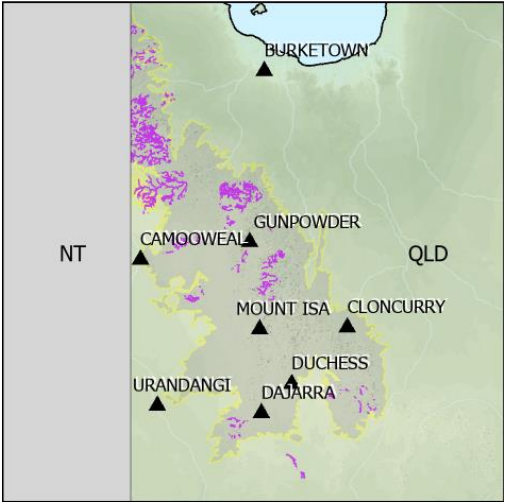
Table 7. Areas of special flora biodiversity value (Criterion I)

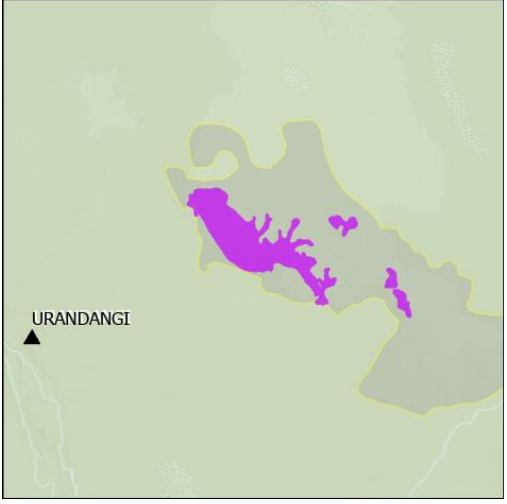
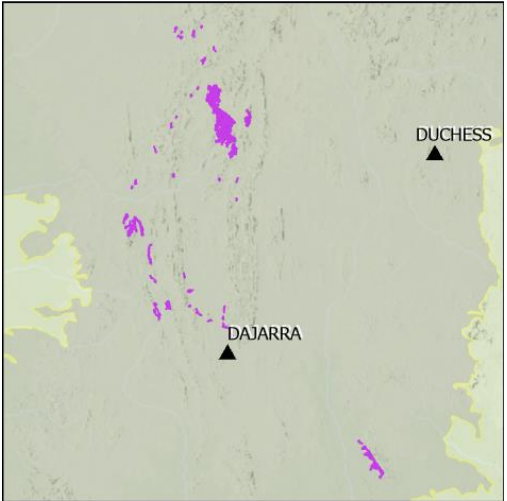
¹ VH = Very High, H = High and M = Medium. For more information on the criteria values, see section 2.3.2.

Decision Number	Description (including spatial extent where implemented)	Significance	Identified Values in BPA	Criteria values ¹
nwh_fl_01	<p>Pilpah and Saint Smith Ranges Ecosystem Complex</p> 	State	<p>An ecosystem complex with unique vegetation communities of <i>Eucalyptus odontocarpa</i>, <i>E. nudicaulis</i> (endangered), <i>Corymbia aparrerinja</i> and <i>C. capricornia</i> in the Pilpah and Saint Smith Ranges. The area contains linear dune systems, relicts from the last ice age made up of deep red sands which were once contiguous with the north eastern margin of the Simpson Desert. The complex depicted incorporates inland dunefields (the only land zone 6 systems present in the NWH), as well as unique sandplains and lowlands on metamorphics (variations of land zones 5 and 11 respectively).</p> <p>On sandplains formed from degraded dune fields, <i>C. aparrerinja</i> and <i>C. capricornia</i> grow to form large trees with hollows. The ecosystem complex is a centre of endemism with several new plant species described from the area. Other flora species include <i>Crotalaria novae-hollandiae</i>, <i>Trianthema pilosa</i>, <i>Corynotheca micrantha</i> var. <i>divaricata</i> and <i>Distimake davenportii</i>. The endangered Carpentarian grasswren (<i>Amytornis dorotheae</i>) and the endemic priority species <i>Tephrosia</i> sp. Barkly Downs S.L. Everist 3384 have been recorded from the area.</p>	<p>la (centre of endemism): VH lc (disjunct populations): VH le (high species richness): H lg (REs with distinct variation in species composition): VH li (habitat shelters): H</p>

<p>nwh_fl_02</p>	<p>Grasslands on Meta Volcanic Landscapes</p> 	<p>State</p>	<p>Small isolated and disjunct <i>Astrelba</i> spp. grasslands occur on black cracking clay soils. The area depicted captures small areas of grasslands (regional ecosystem 1.12.5) south of Gunpowder and several isolated and scattered grasslands south of Mount Isa and Cloncurry (regional ecosystem 1.11.13). Both communities are very similar in soils and floristics and under severe pressure from grazing. Due to the isolated occurrences of these communities, if impediments to recruitment occur, they may be vulnerable in terms of their recovery post impact prolonged grazing.</p> <p>The soils on which the grasslands occur, are derived from ancient metamorphosed, meta-dolerite or meta-basalt and may be of higher fertility than similar communities in the Barkley Tablelands, resulting in unique communities. Considered to be of very high species richness relative to other NWH grasslands, these grasslands were also considered by the panel as likely to contain outlier populations of species from adjacent bioregions.</p>	<p>Ib (wildlife refugia): VH Ic (disjunct populations): H Ie (high species richness): VH Ig (REs with distinct variation in species composition): VH</p>
<p>nwh_fl_03</p>	<p>Oban Sandsheet</p> 	<p>Regional</p>	<p>A now relictual linear dunal landscape, formed in the last 14,000 years. The Oban Sandsheet, named after the station, is a unique sandplain on Land Zone 5 (Tertiary-early Quaternary loamy and sandy plains and plateaus) with species at their range limits forming into communities: <i>Eucalyptus victrix</i> (smooth barked coolibah), <i>Acacia georginae</i> (Poison Gidgee) and <i>Acacia aneura</i> (regional ecosystem 1.5.19). An outlier of the Mitchell Grass Downs and Channel Country bioregions, the full extent of <i>Acacia georginae</i> in the NWH bioregion occurs here.</p>	<p>Id (geographic range limits): H Ie (high species richness): H Ig (REs with distinct variation in species composition): H</p>

04	Fiery Creek Volcanics (not implemented)	N/A	<p>The Fiery Creek volcanics is a unique geological feature with limited grazing and considered likely to be in good condition. The creeks in this area have distinct vegetation communities of <i>Eucalyptus miniata</i> and may house new regional ecosystems types. However, little is known about the area due to it being the most remote part of Northwest Highlands, making access very difficult.</p> <p>n.b. the panel determined the decision should not implemented due to a current lack of information. Area of interest during future reviews.</p>	
nwh_fl_05	<p>Two Fingers</p> 	Regional	<p>The 'Two Fingers' represents an area of unique geology in the Northwest Highlands, consisting of metamorphosed calcareous material including silcrete (resembling piles of bricks). This in turn supports a unique vegetation community dominated by <i>Eucalyptus herbertiana</i> (regional ecosystem 1.11.2j).</p> <p>The threatened species <i>Trachymene glandulosa</i> has been recorded from the area, as well as the endemic priority species <i>Triumfetta rupestris</i>.</p>	<p>Ib (wildlife refugia): H Ig (REs with distinct variation in species composition): VH</p>

<p>nwh_fl_06</p>	<p>Ecosystems with a Biodiversity Status of Endangered or Of Concern in good condition</p> 	<p>State</p>	<p>Areas of naturally restricted and good condition “of-concern” / “endangered” (biodiversity status) non-rocky ecosystems. These ecosystems are very susceptible to degradation through overgrazing and invasion of the groundcover by Cloncurry buffel grass <i>Cenchrus pennisetiformis</i>. The buffel grass can increase carrying capacity up to 10 times.</p> <p>The degraded parts of these ecosystems now have reduced biodiversity values due to the associated changes in species composition and/or soil condition. Remaining areas in relatively good condition are susceptible to what would normally be viewed as local threats or impacts and are therefore vulnerable to rapid loss of natural values. The values of these remaining good condition occurrences relate to their floristic and structural integrity, the retention of fauna susceptible to grazing impacts, and the continuation of ecological processes characteristic of the ecosystem.</p>	<p>Ib (topographic isolate and refuge from clearing): VH K (Condition): State</p>
<p>07</p>	<p>Headwater of Buchanan Creek Plateau gorge complex (not implemented)</p>	<p>N/A</p>	<p>Headwater of Buchanan Creek Plateau gorge complex on Westmoreland Station is a poorly known region which is suspected of containing novel communities because of a sharp rainfall gradient. The area between Hells Gate to Borroloola represents a good example of this area.</p> <p>n.b. the panel determined the decision should not implemented due to a current lack of information. Area of interest during future reviews.</p>	

<p>nwh_fl_08</p>	<p>Urandangi Sand Overlying Limestone</p> 	<p>Regional</p>	<p>A Mitchell Grass Downs regional ecosystem outlier situated inside the margins of the Northwest Highlands bioregion. The low open woodland community (4.5.5b) with an upper stratum consisting of <i>Corymbia aparrerinja</i> and <i>C. terminalis</i>, occurs on eroded sand dunes overlying limestone. The current instance represents an extremely well-developed example of this community. An underlying connection to ground water affords a degree of resilience during periods of drought.</p> <p>n.b. whilst not a Northwest Highlands remnant, the expert panel recommended including for the purpose of completeness and to ensure its inclusion in later Mitchell Grass Downs reviews.</p>	<p>Ig (REs with distinct variation in species composition): VH</p>
<p>nwh_fl_09</p>	<p>South-western Dajarra Mallees</p> 	<p>State</p>	<p>Whilst regional ecosystems 1.5.4c and 1.11.2h have been subject to limited survey effort, the panel noted that instances of these communities which overlay areas of mineralisation, appear to contain unique flora assemblages, host centres of endemism, taxa at their range limit and exhibit high species richness. Regional ecosystem 1.5.4c is suspected of containing a number of locally restricted undescribed species, whilst regional ecosystem 1.11.2h, similarly exhibits interesting species patterns and complexes in such areas.</p> <p>Species at their range limit include <i>Eucalyptus melanophloia nana</i> (the only population known not to occur on granite) and <i>Eucalyptus gamophylla</i>. <i>E. gamophylla</i> usually on sandplains and low-lying areas, occurs in the areas depicted on steep meta-sediments.</p>	<p>Ia (centre of endemism): VH Ic (disjunct populations): VH Id (geographic range limits): VH Ie (high species richness): H Ig (REs with distinct variation in species composition): VH</p>

3.2 Fauna taxa considerations (Criteria A and H)

Criteria A and H attribute significance to areas based on the presence of EVNT taxa scheduled under the NCA or the EPBC, or the presence of priority species. The NWH fauna expert panels identified some 21 taxa for inclusion under Criteria A and 41 taxa for criterion H. Table 8 summarises the number of taxa by status categories. The standard BMM record filtering rules were applied (EHP, 2014).

Table 8. Summary of fauna taxa considered by the expert panel for Criteria A and H

	Endangered	Vulnerable	Near Threatened	Priority (non-EVNT) taxa	Total
Number of taxa listed	10	10	1	41	62

3.2.1 Habitat for endangered, vulnerable and near threatened fauna taxa (Criterion A)

The panel identified and selectively reviewed species records to define a list of 21 NWH EVNT fauna taxa and one presumed extinct taxon (Table 9). A number of threatened taxa were excluded from the table below either because there were no (or too few) reliable records in the NWH or, based upon expert opinion, the taxa was considered not to occur in the bioregion (refer to [Appendix 3](#)). For inclusion in the NWH BPA the records were first subject to vetting rules as described in the preceding section 2.3.1 and subsequently buffered by twice the precision (as for Criterion A) with a minimum of 300m, and a maximum of 2km. For seven taxa, in conjunction with records, the panel approved the use of expert vetted habitat suitability models developed under the National Environmental Science Program (Pintor et al. 2018) to identify areas of potential habitat.

Table 9. NWH - endangered, vulnerable and near threatened fauna taxa (Criterion A)

Scientific name	Common name	NCA ¹	EPBC ²	Mobility ³	Expert panel comments
Reptile					
<i>Acanthophis hawkei</i>	plains death adder	V	V	L	Currently under taxonomic review - genus taxonomically "unstable".
<i>Crocodylus porosus</i>	estuarine crocodile	V		H1	No records for use in NWH measures, but panel notes species is present in the lower Gregory River within the study area.
<i>Eelseya lavarackorum</i>	Gulf snapping turtle	V	E	L	Endemic to NWH, only known from the Nicholson River drainage (Cogger, 2018). Relict species known from the fossil record at Riversleigh (White and Archer, 1994). The panel agreed to the use of a species habitat suitability model (Pintor et al. 2018) in conjunction with records, to identify areas of habitat likely occupied.
<i>Emydura subglobosa worrelli</i>	diamond head turtle	NT		L	At limits of distribution, occurs from West Arnhem Land through to NWH (Cogger, 2018). The panel agreed to the use of a species habitat suitability model (Pintor et al. 2018) in conjunction with records, to identify areas of habitat likely occupied.

Scientific name	Common name	NCA ¹	EPBC ²	Mobility ³	Expert panel comments
Bird					
<i>Amytornis dorotheae</i>	Carpentarian grasswren	E	E	L	Queensland population may be more significant. Northern Territory population declined/potentially extinct. The panel agreed to the use of a species habitat suitability model (Pintor et al. 2018) in conjunction with records, to identify areas of habitat likely occupied.
<i>Calidris ferruginea</i>	curlew sandpiper	E	CE	H1	Inland permanent waterbodies may be important for migration stopovers. The panel agreed to the use of a species habitat suitability model (Pintor et al. 2018) in conjunction with records, to identify areas of habitat likely occupied.
<i>Charadrius mongolus</i>	lesser sand plover	E	E	H1	Has been recorded but generally a coastal species.
<i>Epthianura crocea</i>	yellow chat	V		L	Occasional records in the North West Highlands, likely a vagrant to the bioregion. Species has been sighted around Lake Moondarra and Lake Corella.
<i>Erythrotriorchis radiatus</i>	red goshawk	E	V	H2	Single record from the region.
<i>Erythrura gouldiae</i>	Gouldian finch	E	E	L	Chidna Nature Refuge and surrounds, noted as one of the few breeding populations in Queensland. The panel agreed to the use of a species habitat suitability model (Pintor et al. 2018) in conjunction with records, to identify areas of habitat likely occupied.
<i>Falco hypoleucos</i>	grey falcon	V		H2	Large home range, plains habitat preference. Possible seasonal movement by the species. Species is known to regularly occur at Boodjamulla National Park and is potentially resident there.
<i>Grantiella picta</i>	painted honeyeater	V	V	H1	Reliant on mistletoe species for foraging.
<i>Limosa lapponica baueri</i>	Western Alaskan bar-tailed godwit	V	V	H1	Has been recorded but generally a coastal species.
<i>Malurus coronatus</i>	purple-crowned fairy-wren	V		L	Resident in the Boodjamulla/Lawn Hill National Park and Riversleigh areas. Likely found throughout the riparian vegetation in the Thornton Aggregation, particularly where <i>Pandanus</i> sp. occur. The panel agreed to the use of a species habitat suitability model (Pintor et al. 2018) in conjunction with records,

Scientific name	Common name	NCA ¹	EPBC ²	Mobility ³	Expert panel comments
					to identify areas of habitat likely occupied.
<i>Numenius madagascariensis</i>	eastern curlew	E	CE	H1	Has been recorded but generally a coastal species.
<i>Pezoporus occidentalis</i>	night parrot	E	E	H1	Probable records just inside the southern edge of the bioregion.
<i>Rostratula australis</i>	Australian painted snipe	V	E	H1	Likely to be primarily associated with permanent water in the bioregion, particularly large artificial waterbodies such as Lake Moondarra and Lake Corella, but also potentially farm dams and braided river systems.
Mammal					
<i>Hipposideros stenotis</i>	northern leaf-nosed bat	V		L	This species is known in the region from only a couple of records at the Lady Annie Mine.
<i>Macroderma gigas</i>	ghost bat	E	V	H2	This species is reliant on limestone karst caves and sinkholes, many of which are unmapped due to scale issues.
<i>Notomys longicaudatus</i>	long-tailed hopping-mouse		PE		The only record from the region is a skull retrieved from Kalkadoon Cave, Camooweal. This is highly likely to be a near-fossil midden deposit rather than a recent record.
<i>Petrogale purpureicollis</i>	purple-necked rock-wallaby	V		L	This species is common in and largely endemic to rocky outcrop habitats within the Northwest Highlands region. The panel agreed to the use of a species habitat suitability model (Pintor et al. 2018) in conjunction with records, to identify areas of habitat likely occupied.
<i>Rhinonictes aurantia</i>	orange leaf-nosed bat	V		L	This species is found mainly in limestone sink holes and karsts and sandstone massifs in the northern part of the bioregion, at Boodjamulla/Lawn Hill National Park, Camooweal Caves National Park and Lagoon Creek.

¹ E = endangered, V = vulnerable, NT = near threatened as per *Nature Conservation Act 1992*

² CE = critically endangered, E = endangered, V = vulnerable as per the *Environment Protection and Biodiversity Conservation Act 1999*

³ Mobility rating: H1 = high - use all records, H2 = high - use only known breeding/feeding/roosting records, L= low - use all records

3.2.2 Habitat for priority fauna taxa (Criterion H)

Priority species are non-EVNT species that are considered to be of particular conservation significance. The rationale for inclusion is based upon the eligibility criteria described in section 2.3.1. A total of 41 fauna taxa were listed for inclusion under Criterion H (Table 11). The number of species pertaining to each eligibility criteria is summarised in Table 10. Some species listed had more than one eligibility criteria assigned. Any taxa that were chosen that were at significant risk, or which were narrow endemics, i.e. very small distribution in the NWH, were assigned "Priority type A" taxa, while the remainder were assigned as "Priority type B" taxa.

For inclusion in the NWH BPA priority species records were first subject to filtering rules as described in section 2.3.1 and subsequently, buffered by twice the precision (as for Criterion A) with a minimum of 300m, and a maximum of 1km. The decision rules for assigning Criterion H values (Low to Very high) are summarised in Table 6.

Table 10. Number of priority fauna taxa listed for each eligibility criteria

Eligibility value ¹	Taxa count
1. Taxa at risk	9
2. Taxa of scientific interest as relictual (ancient or primitive)	0
3. Endemic taxa	9
4. Significant taxa	24
5. Taxa important for maintaining genetic diversity such as complex patterns of genetic variation	1
6. Disjunct species populations	8
7. Taxa functionally important to ecosystem integrity	0
8. Taxa performing a role as an ecological indicator of ecosystem integrity	4
9. Taxa vulnerable to impacts of climate change	10

Table 11. NWH - priority fauna taxa (Criterion H)

Scientific Name	Common Name	Significance	Eligibility value no.	Expert panel comments
Invertebrates				
Decapods				
<i>Pycnisia bunyip</i>	A carid shrimp	A	3	This species is known from only a single location, Forbes Inferno Cave, Riversleigh, Lawn Hill National Park. While it is neither listed nor under any known threats, it is potentially highly vulnerable to once-off catastrophic events.
Vertebrates				
Fish				
<i>Ambassis elongatus</i>	elongate glassfish	A	4,5,6	Known only from three river systems in northern Queensland that drain into the Gulf of Carpentaria (Thompson, 2020).
<i>Hephaestus carbo</i>	coal grunter	B	4,6,8	Found in a relatively small number of streams in Queensland and the Northern Territory adjacent to the Gulf of Carpentaria.
<i>Neoarius berneyi</i>	highfin catfish	B	9	This species is potentially vulnerable to climate change through sea-level rise intruding salinity into freshwater habitats (Morrongiello et al. 2011).
<i>Neoarius graeffei</i>	blue catfish	B	9	This species is potentially vulnerable to climate change through sea-level rise intruding salinity into freshwater habitats (Morrongiello et al. 2011).
<i>Neoarius leptaspis</i>	boofhead catfish	B	9	This species is potentially vulnerable to climate change through sea-level rise intruding salinity into freshwater habitats (Morrongiello et al. 2011).
<i>Neoarius midgleyi</i>	silver cobbler	B	9	This species is potentially vulnerable to climate change through sea-level rise intruding salinity into freshwater habitats (Morrongiello et al. 2011).
<i>Neosilurus hyrtlii</i>	Hyrtl's catfish	B	9	This species moves into ephemeral creeks to breed.
<i>Scleropages jardinii</i>	northern saratoga	B	1,4,6,8	
Amphibians				
<i>Litoria coplandi</i>	sandstone frog	B	4	At eastern limit of distribution.
<i>Litoria watjulumensis</i>	giant rocketfrog	B	4	At eastern limit of distribution.
Birds				

Scientific Name	Common Name	Significance	Eligibility value no.	Expert panel comments
<i>Amytornis ballarae</i>	Kalkadoon grasswren	A	3,9	This species is considered a priority due to being endemic to the bioregion, as well as facing considerable threats in the form of fire intensification, buffel grass (<i>Cenchrus ciliaris</i>) encroachment, and potentially mining impacts.
<i>Barnardius zonarius macgillivrayi</i>	Cloncurry parrot	B	3,4	The Cloncurry form of the Australian Ringneck is near endemic to the bioregion, and represents a distinct form found only in the vicinity of the Northwest Highlands.
<i>Heteromunia pectoralis</i>	pictorella mannikin	A	1,9	This species has been previously listed as threatened and is nominated as a priority species for the region due to concerns about declines across Australia. They are threatened by changing fire and grazing regimes that affect seeding native grasses.
<i>Neochmia ruficauda</i>	star finch	A	1,9	The status of star finch in the Mt Isa region is uncertain, with taxonomists being unable to place which subspecies this population belongs to. It is possible the species has been extirpated from the Mt Isa region, or that it was only ever present on a temporary basis.
Mammals				
<i>Lagorchestes conspicillatus</i>	spectacled hare-wallaby	A	1,9	This critical weight range mammal is highly vulnerable to predation by feral predators, as well as changes to habitat through fire and grazing regimes.
<i>Onychogalea unguifera</i>	northern nailtail wallaby	B	1	This species relies on dense vegetation on plains and woodland country and is impacted by grazing and drought. Whilst there is unlikely to be extensive habitat for this species in the bioregion, the panel considered it should still be included as a priority species.
<i>Petrogale wilkinsi</i>	eastern short-eared rock-wallaby	B	4	This species was first recognised as present in the region in 2019. Boodjamulla represents the eastern-most population of the species.
<i>Petropseudes dahli</i>	rock ringtail possum	A	1,4	The Boodjamulla/Lawn Hill National Park region is the eastern limit of the distribution of this species. They are suspected of having undergone significant declines in this bioregion.
<i>Planigale ingrami</i>	long-tailed planigale	B	1,8	There is some taxonomic uncertainty about the status of Planigale species in this region. Due to the documented catastrophic declines in small mammals in the top end of Australia

Scientific Name	Common Name	Significance	Eligibility value no.	Expert panel comments
				(Woinarski et al. 2011), and the potential that it represents a novel taxon, the population in this bioregion should be treated as a priority species.
<i>Planigale tenuirostris</i>	narrow-nosed planigale	B	1,8	There is some taxonomic uncertainty about the status of <i>Planigale</i> species in this region. Due to the documented catastrophic declines in small mammals in the top end of Australia (Woinarski et al. 2011) and the potential that it represents a novel taxon, the population in this bioregion should be treated as a priority species.
<i>Pseudantechinus bilami</i>	sandstone pseudantechinus	B	4	Records of this species in the bioregion represent the extreme limit of the species' distribution.
<i>Pseudantechinus mimulus</i>	Carpentarian pseudantechinus	B	4,6,9	This species was previously listed as vulnerable under the <i>EPBC Act</i> (1999), however was moved to Least Concern due to the discovery of the Queensland population, which appears stable. Within Queensland it is limited to the bioregion and this population may represent the most stable subpopulation of the species. Identified as a priority for climate change (Low, 2011; Crowley, 2016).
Reptiles				
<i>Acanthophis rugosus</i>	Papuan death adder	B	4	Currently under taxonomic review - genus taxonomically "unstable". Only a few records, however, these may be taxonomically confused with the common death adder.
<i>Chelosania brunnea</i>	chameleon dragon	B	4	Records of this species in the bioregion represent the extreme limit of the species' distribution.
<i>Ctenotus alacer</i>	lively ctenotus	B	4,6	A disjunct, rarely encountered, population.
<i>Ctenotus decaneurus</i>	ten-lined ctenotus	B	4,6	There is a disjunct population of this species in the bioregion that exhibits characteristics not found elsewhere in its range.
<i>Ctenotus striaticeps</i>	stripe-headed finesnout ctenotus	B	3	Near-endemic to the bioregion.
<i>Demansia flagellatio</i>	long-tailed whipsnake	A	3	Endemic to the bioregion.

Scientific Name	Common Name	Significance	Eligibility value no.	Expert panel comments
<i>Diplodactylus barraganae</i>	Gulf fat-tailed gecko	B	3	Endemic to the bioregion.
<i>Diporiphora granulifera</i>	granulated two-lined dragon	B	3,4	A newly described species which may be near-endemic and at its distributional limit.
<i>Egernia hosmeri</i>	Hosmer's skink	B	4,6	The Northwest Highlands occurrences of this species represents the limit of the western population that occurs from Borroloola, Northern Territory to Dajarra, Queensland. This population is disjunct from the eastern Queensland population. This species prefers cracks in rocky outcrops as habitat.
<i>Gehyra robusta</i>	robust dtella	B	3	Near-endemic to the bioregion.
<i>Lerista orientalis</i>	north-eastern orange-tailed slider	B	4	Records of this species in the bioregion represent the extreme limit of the species' distribution.
<i>Lerista timida</i>	timid slider	B	4,6	This population is disjunct from the main distribution of the species and may represent an undescribed species.
<i>Oedura bella</i>	Gulf marbled velvet gecko	B	4, 6	At the eastern distributional limit for the species and near-endemic to the bioregion.
<i>Pseudechis pailsi</i>	eastern dwarf mulga snake	B	4	The taxonomic status of this species is highly uncertain, with more samples from across the range of <i>P. weigeli</i> and <i>P. pailsei</i> needed. Only a few records, however, could be taxonomically confused with other <i>Pseudechis</i> species. The holotype of this species is from the Mt Isa region.
<i>Strophurus taeniatus</i>	white-striped gecko	B	4	Near the eastern limit of distribution for the species.
<i>Varanus glebopalma</i>	long-tailed rock monitor	B	4	At the eastern limit of distribution for the species.
<i>Varanus mertensi</i>	Mertens' water monitor	B	1	While there has anecdotally been a recovery of large varanids in the north of Queensland post cane toad invasion, this species has been recently listed as Endangered by the IUCN Red List of Threatened Species due to ongoing declines in the western part of the range and lack of quantitative evidence of recovery (Shea et al. 2018). This species should be treated as a priority species

Scientific Name	Common Name	Significance	Eligibility value no.	Expert panel comments
				given the available evidence.
<i>Varanus mitchelli</i>	Mitchell's water monitor	A	4	At eastern limit of distribution; possible disjunct population.

3.2.3 Special fauna area decisions (Criterion I)

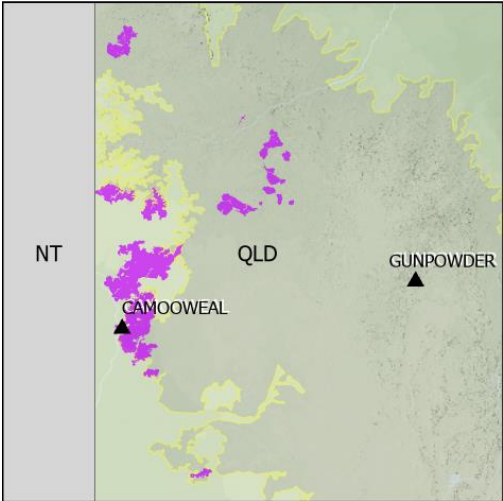
The fauna panel was asked to identify areas with special biodiversity values within the NWH under the BMM supplementary Criterion I. Areas with special biodiversity value are important because they contain multiple taxa in unique ecological and often highly biodiverse environments. Values can include centres of endemism, wildlife refugia, disjunct populations, geographic limits of species distributions, high species richness, relictual populations, high densities of hollow-bearing trees and breeding sites. The full rationale for inclusion is described in section 2.3.2.


Using expert knowledge and available information (records, maps, GIS derived datasets), panel members discussed three areas and described their values, all of which were implemented as fauna decisions. Several other areas discussed which encompassed fauna values, were combined with flora or other values to become landscape decisions. The special areas proposed by the panel are detailed in Table 12. Generally only EVNT and priority species are specified for each decision.

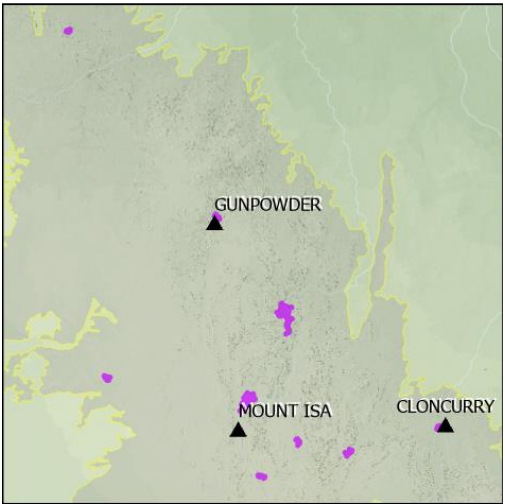
To ensure consistency and provide better integration with BPAs conducted across adjoining bioregions, special areas nominated during the course of non-NWH expert panels, however, which impact NWH remnant units, have been incorporated and are listed at the end of Table 12.

Table 12. Areas of special fauna biodiversity value (Criterion I)

¹ VH = Very High, H = High and M = Medium. For more information on the criteria values, see section 2.3.2.

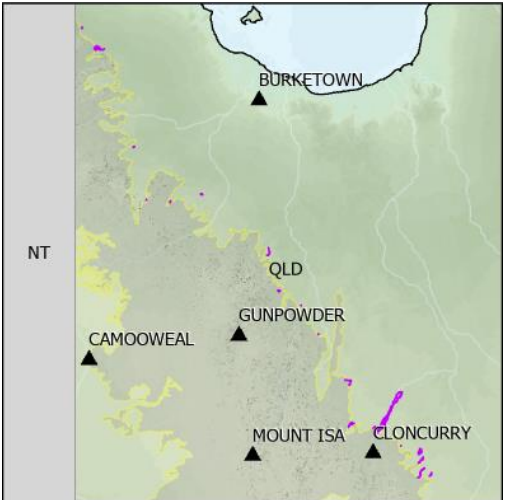
Decision Number	Description (including spatial extent where implemented)	Significance	Identified Values in BPA	Criteria values ¹
nwh_fa_01	<p>Camooweal Limestone Caves</p> 	State	<p>The extensive and elaborate limestone caves and sinkholes in the Camooweal area support a unique system of groundwater dependent ecosystems. The groundwater dependent regional ecosystem 1.9.10 (many occurrences of which are below the scale of current regional ecosystem mapping, i.e. not depicted in the current delineation), encompass sink holes with a surrounding low woodland of <i>Celtis strychnoides</i> and <i>Ficus</i> spp.</p> <p>The Camooweal system makes up a major extent of caves in arid Queensland. Subterranean fauna (stygo fauna and troglotauna species) are present and whilst poorly known, are suspected in many cases to contain isolated and ancient taxa. In addition, the caves and sink holes are considered to provide important roosting and maternity sites for species of bat, including the orange horseshoe bat (<i>Rhinonictes aurantia</i>) and ghost bat (<i>Macroderma gigas</i>), both Vulnerable under the NCA. The threatened purple-necked rock-wallaby (<i>Petrogale purpureicollis</i>) has also been recorded from the general locality of a number of these systems and caves may provide a valuable daytime shelter for this species.</p>	<p>lb (wildlife refugia): VH lc (disjunct populations): VH ld (geographic range limits): VH lf (concentrations of ancient and primitive taxa): VH lj (Breeding/roosting sites used by sig. no. of individuals): VH</p>

<p>nwh_fa_02</p>	<p>Chidna</p> 	<p>State</p>	<p>The Chidna property encompassing unique and spectacular geologic features is an excellent example of the Mount Isa Inlier landscape, poorly represented within Queensland's protected area estate. The northern portion of the property is a declared Nature Refuge. Rugged terrain and deeply dissected gorges provide a refuge from fire, whilst permanent waterholes along Gunpowder Creek in the south, rock holes and springs in the north of Chidna and semi-permanent waterholes along Revolver Creek, provide sources of water.</p> <p>Known to support important habitat for breeding populations of the endangered Gouldian finch (<i>Erythrura gouldiae</i>) and Carpentarian grasswren (<i>Amytornis dorotheae</i>), other threatened taxa recorded from the site and general locality include the purple-necked rock-wallaby (<i>Petrogale purpureicollis</i>) and diamond head turtle (<i>Emydura subglobosa worrelli</i>). The site also supports priority fauna such as the pictorella mannikin (<i>Heteromunia pectoralis</i>) stripe-headed finesnout ctenotus (<i>Ctenotus striaticeps</i>), Hosmer's skink (<i>Egernia hosmeri</i>), robust dtella (<i>Gehyra robusta</i>), sandstone frog (<i>Litoria coplandi</i>), giant rocketfrog (<i>Litoria watjulumensis</i>), gulf marbled velvet gecko (<i>Oedura bella</i>) and Mertens' water monitor (<i>Varanus mertensi</i>), as well as the bioregional endemics the Kalkadoon grasswren (<i>Amytornis ballarae</i>) and long-tailed whipsnake (<i>Demansia flagellatio</i>).</p> <p>The Mount Oxide Mine operating on site intermittently from the late 1920s through to early 1970s, left a remediation legacy inclusive of stockpiles, leach heaps and overburden dumps. Following moderate to heavy wet seasons, the open cut mine pit fills with rainwater which filters through the fractured rock causing discolouration for several kilometres along Mount Oxide Creek (bright blue from the copper precipitate). Despite these impacts, the historic mining shafts and natural rock falls likely provide habitat for microbats.</p> <p>Subject to low intensity grazing in recent years, fencing, partly funded through the Nature refuges program has been undertaken by the landholder around Camel Waterhole and Revolver Creek Gorge to exclude cattle. As a result, creek banks previously impacted, are now recovering.</p>	<p>la (centre of endemism): H lb (wildlife refugia): VH le (high species richness): H li (habitat shelters): H lj (Breeding/roosting sites used by sig. no. of individuals): VH lk (climate refugia): VH</p>
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<p>nwh_fa_03</p>	<p>Large Artificial Waterbodies</p> 	<p>Regional</p>	<p>Several large artificial waterbodies occur in the NWH and have become important drought refugia for aquatic species and waterbirds (i.e. migratory birds, waders, terns). The lakes include Lake Moondarra, Chinaman Creek Dam, Corella Dam, Lake Julius, Lake Mary Kathleen, Waggaboonya Lake and other large unnamed waterbodies. The only large permanent waterbodies in the bioregion, they provide important habitat for water birds in a relatively dry landscape. For example, the highest concentrations of breeding cormorants in the bioregion occur on these lakes. Some of these lakes also contain comparatively high fish diversity (i.e. 17 species).</p> <p>Threatened species recorded on these waterbodies include curlew sandpiper (<i>Calidris ferruginea</i>), yellow chat (<i>Epthianura crocea</i>), Gouldian finch (<i>Erythrura gouldiae</i>), <i>Ipomoea antonschmidii</i> and Australian painted snipe (<i>Rostratula australis</i>). Endemic priority species recorded here include Cloncurry parrot (<i>Barnardius zonarius macgillivrayi</i>) and <i>Tephrosia</i> sp. Mt Isa P.L. Harris 277. Other priority taxa recorded in the locality include the blue catfish (<i>Neoarius graeffei</i>), Hyrtl's catfish (<i>Neosilurus hyrtlil</i>), boofhead catfish (<i>Neoarius leptaspis</i>) and northern saratoga (<i>Scleropages jardinii</i>).</p>	<p>lb (wildlife refugia): VH le (high species richness): H lh (artificial waterbody ecologically significant): H lj (Breeding/roosting sites used by sig. no. of individuals): H</p>
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Adjoining bioregion decisions

n.b. for the following non- NWH BPA decisions, only affected NWH assessment units are depicted in the images below

<p>gup_fa_05</p>	<p>Bauhinia woodlands</p> 	<p>Regional</p>	<p>Seasonally important for nectarivores (honeyeaters, white-browed woodswallows <i>Artamus superciliosus</i>, white-winged trillers <i>Lalage sueurii</i> and varied lorikeets <i>Psitteuteles versicolor</i>) (Richard Johnson in lit). Important for honeyeater diversity given relatively high fertility and productivity with shallow sands over shales.</p> <p>Bauhinia woodland on alluvium may be at risk given possible future development of agriculture in the region (Richard Johnson in lit).</p>	<p>lb (wildlife refugia): H le (high species diversity): H lg (REs with distinct variation in species composition): H</p>
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3.3 Landscape

Specific recommendations from the landscape panel are recorded in several tables in the following sections.

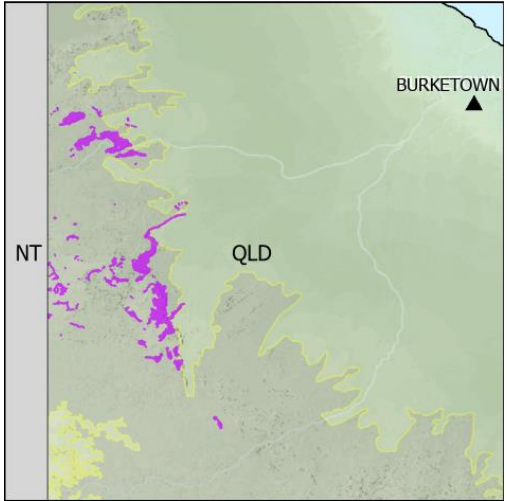
3.3.1 Special landscape decisions (Criterion I)

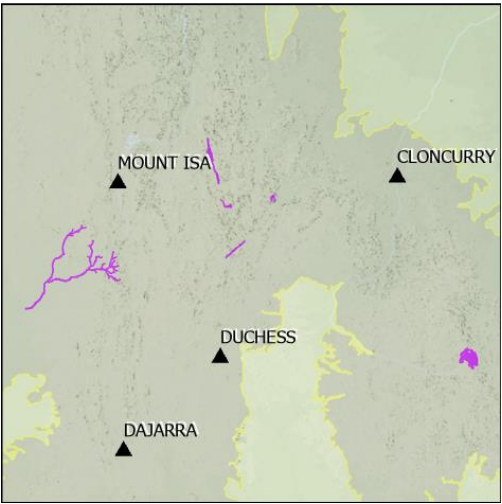
The panel identified new areas which met the eligibility criteria (section 2.3.2). Selected decisions nominated by flora and fauna panels were also reviewed and consolidated into broader landscape decisions. Panel comments and recommendations relating to these landscapes of special biodiversity value are outlined in Table 13. All of the 15 decisions examined were implemented.

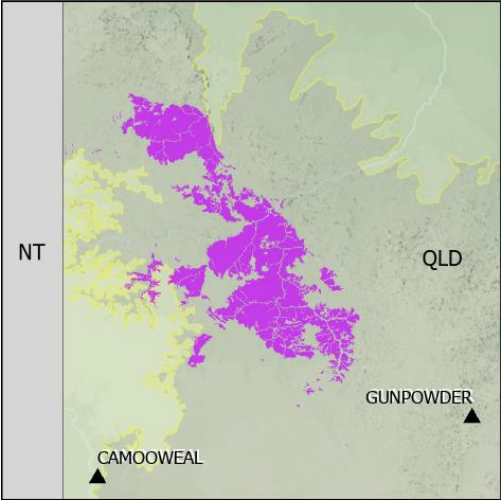
To ensure consistency and provide better integration with BPAs conducted across adjoining bioregions, special areas nominated during the course of non-NWH expert panels and which impact NWH remnant units, have been incorporated and are listed at the end of Table 13.

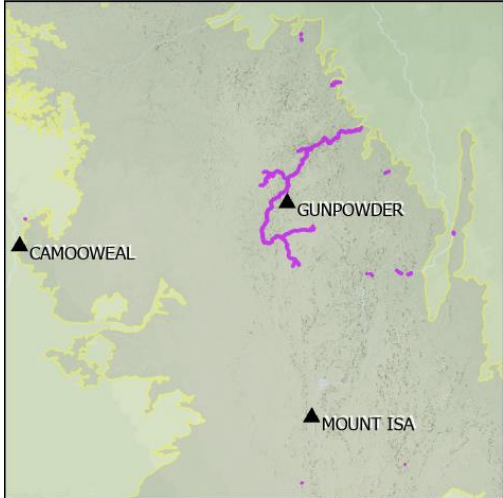
Table 13. Areas of special landscape biodiversity value (Criterion I)

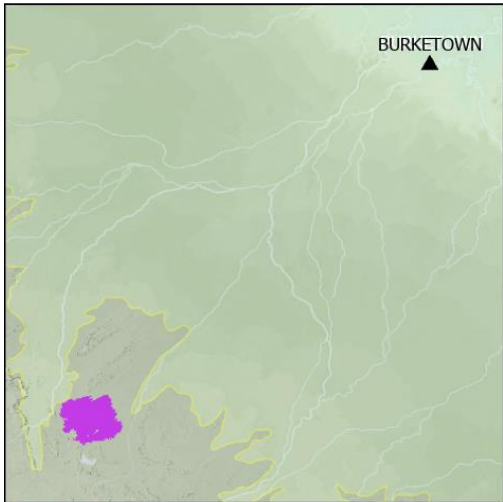
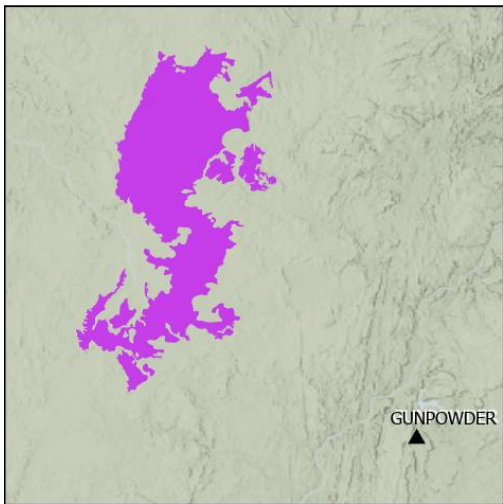
¹ VH = Very High, H = High and M = Medium. For more information on the criteria values, see section 2.3.2.

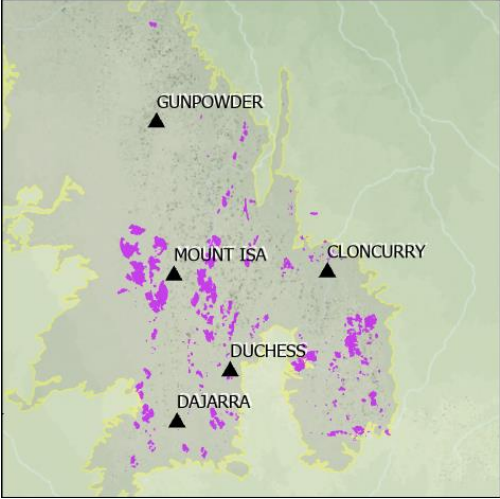
Decision Number	Description (including spatial extent where implemented)	Significance	Identified Values in BPA	Criteria Values ¹
nwh_I_01	<p>McArthur Sandstone Springs</p> 	State	<p>Numerous active sandstone discharge springs found predominantly on Land Zone 10 (regional ecosystem 1.10.6) occur in the McArthur Subregion. These springs act as important refugia from clearing and fire, contain high species richness, support some relictual taxa and several species occur at the limit of their geographic range. With a disproportionately large influence on the surrounding landscape due to the high discharge flow of groundwater, they provide an important ecotone.</p> <p>These springs can support high levels of biodiversity and contain high densities of breeding sites (e.g., hollow bearing trees) in comparison to surrounding ecosystems. Common species occurring in these springs are <i>Corymbia ptychocarpa</i>, <i>Syzygium angophoroides</i>, <i>Grevillea pteridifolia</i>, <i>Melaleuca leucadendra</i>, <i>Limnophila</i> spp., <i>Lindernia</i> spp., <i>Mimulus</i> spp., <i>Melastoma</i> spp., <i>Utricularia</i> spp., <i>Stylidium</i> spp., <i>Drosera</i> spp. and ferns. Turtles inhabit the permanent springs. Springs with figs are habitat for frugivores, nectivorous species and have a high avian richness.</p> <p>Threatened species found at the springs include Gouldian finch (<i>Erythrura gouldiae</i>), purple-crowned fairy-wren (<i>Malurus coronatus</i>), purple-necked rock-wallaby (<i>Petrogale purpureicollis</i>), <i>Ipomoea antonschmidii</i> and <i>Solanum carduiforme</i>. Priority species present include long-tailed whipsnake (<i>Demansia flagellatio</i>), <i>Jacksonia lateritica</i>, pictorella mannikin (<i>Heteromunia pectoralis</i>), giant rocketfrog (<i>Litoria watjulumensis</i>), rock ringtail (<i>Petropseudes dahli</i>), boofhead catfish (<i>Neoarius leptaspis</i>) and <i>Triumfetta rupestris</i>.</p> <p>n.b. For information relating to spring fed riverine systems, refer to nwh_I_14. For information relating to active discharge springs on landzone 11 in the mount Isa inlier subregion, refer to nwh_I_02.</p>	<p>lb (wildlife refugia): VH</p> <p>ld (geographic range limits): VH</p> <p>le (high species richness): VH</p> <p>li (habitat shelters): H</p> <p>lj (Breeding/roosting sites used by sig. no. of individuals): VH (less critical for southern springs on LZ 11 as depicted in nwh_I_02 – breeding season more associated with large wet events)</p> <p>lk (climate change refugia): VH</p>

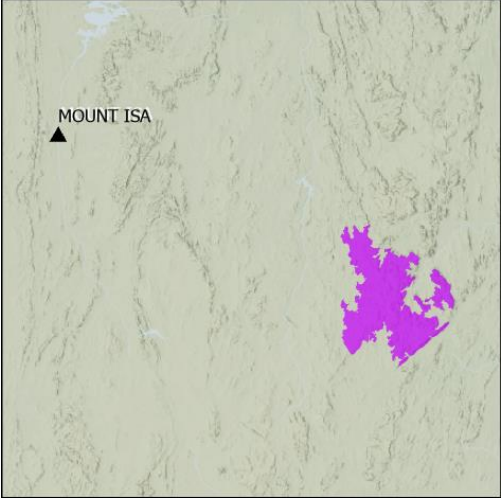
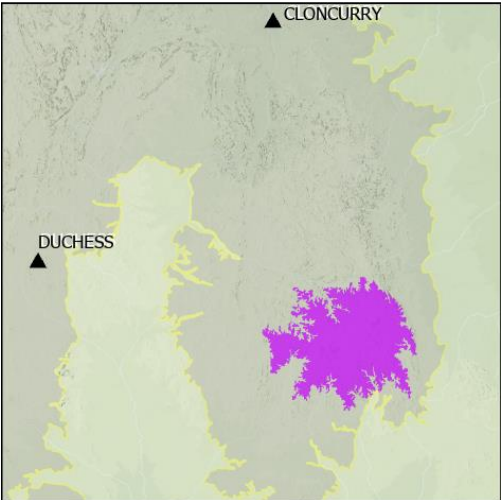
<p>nwh_I_02</p>	<p>Mt Isa Inlier Springs</p> 	<p>State</p>	<p>The Mount Isa Inlier springs are a widespread but localised permanent water source found on Land Zone 11 (1.11.5). They are usually small water filled rock holes in an otherwise dry landscape. Whilst these springs are small in footprint, they are a critical source of water and refugial habitat for a range of species including threatened species purple-necked rock-wallaby (<i>Petrogale purpureicollis</i>) and endemic priority species Kalkadoon grasswren (<i>Amytornis ballarae</i>). There is a probable record of night parrot (<i>Pezoporus occidentalis</i>) in the vicinity of Galah Creek, south of Mt Isa.</p> <p>n.b. For information relating to spring fed riverine systems, refer to nwh_I_14. For information relating to the McArthur sandstone springs, refer to nwh_I_01.</p>	<p>Ib (wildlife refugia): VH Id (geographic range limits): H Ie (high species richness): H (limited sp. richness for flora in springs compared to LZ 10 in preceding decision) Ii (habitat shelters): H (suspected - limited information) Ik climate change refugia: VH</p>
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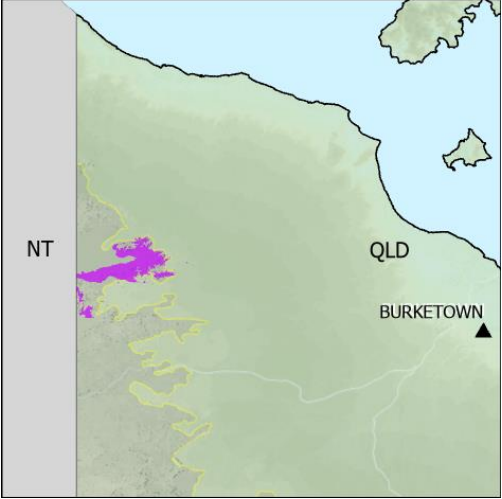
<p>nwh_I_03</p>	<p>Thorntonia Subregion Limestone Karsts</p> 	<p>State</p>	<p>The vast areas of limestone karst (regional ecosystem 1.9.4b) in the Thorntonia subregion are some of the most ancient examples of such systems in the world. The karsts are remote and isolated making surveys difficult and consequently, poorly known. However, they are unusual landscapes in Australia and the systems are considered likely to support high numbers of endemic taxa. Whilst most are limestone karsts, some areas have more recent laterite with underlying limestone.</p> <p>These systems provide important refugia from fire and maintain a microclimate that supports a relatively high floristic species richness in shrubs and mid-storey trees. Fruiting trees (<i>Ficus</i> spp., <i>Celtis strychnoides</i>) are common providing important habitat for frugivorous and bower birds. The limestone karst outcrops and caves maintain populations of the threatened purple-necked rock-wallabies (<i>Petrogale purpureicollis</i>), as well as many species of microbats which use the areas for breeding and maternity sites.</p> <p>NWH endemic taxa recorded within the mapped area include <i>Archidium thaliferum</i>, <i>Eucalyptus leucophylla</i>, rock ringtail (<i>Petropseudes dahli</i>), <i>Pycnisia bunyip</i> and <i>Scaevola</i> sp. Mt Isa P.L. Harris 699.</p> <p>Other threatened taxa supported by the karst systems include the gulf snapping-turtle (<i>Elseya lavarackorum</i>), diamond-head turtle (<i>Emydura subglobosa worrelli</i>), painted honeyeater (<i>Grantiella picta</i>), purple-crowned fairy-wren (<i>Malurus coronatus</i>), orange horseshoe-bat (<i>Rhinonicteris aurantia</i>) and the ghost bat (<i>Macroderma gigas</i>). With respect to the latter, ghost bats appear to have largely disappeared from the system. One possible explanation for the decline, is due to cane toad (<i>Rhinella marina</i>) ingestion (White et al. 2016) - however, contrary to this, breeding colonies are known from other locations where cane toads are abundant.</p> <p>Priority species supported by the karst systems include coal grunter (<i>Hephaestus carbo</i>), giant rocketfrog (<i>Litoria watjulumensis</i>) and Mertens' water monitor (<i>Varanus mertensi</i>).</p>	<p>la (centre of endemism): VH lb (wildlife refugia): VH lc (disjunct populations): H le (high species richness): H lj (Breeding/roosting sites used by sig. no. of individuals): H (suspected - limited information)</p>
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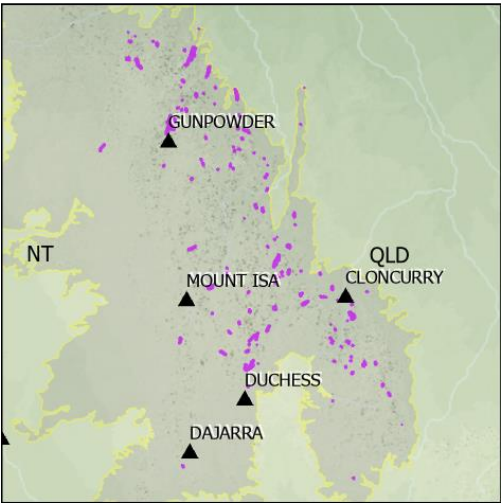
<p>nwh_l_04</p>	<p>Permanent and semi-permanent instream waterholes - drought refugia</p> 	<p>State</p>	<p>Within the Mount Isa and Southwestern Plateaus and Floodouts subregions, permanent waterholes and surrounding riparian vegetation support aquatic and terrestrial flora and fauna in an otherwise arid environment. Systems, such as Gunpowder Creek and its tributary Eastern Creek, retreat to become isolated waterholes which persist during long dry periods and provide drought refugia. The more permanent and deeper waterholes may act as important climate refugia.</p> <p>The waterholes are important for common species within the region and often encompass a high species richness relative to the surrounding landscape. The large deep permanent pools provide habitat for aquatic species like freshwater crocodiles (<i>Crocodylus johnsoni</i>), diamond head turtle (<i>Emydura subglobosa worrelli</i>) and blue catfish (<i>Neoarius graeffei</i>), whilst the adjoining riparian vegetation (1.3.7) provides a diverse habitat structure with numerous hollows and habitat shelters along the terraces and supports species such as <i>Ipomoea antonschmidii</i>, purple-necked rock-wallaby (<i>Petrogale purpureicollis</i>), Cloncurry parrot (<i>Barnardius zonarius macgillivrayi</i>), <i>Brachychiton collinus</i>, <i>Cyperus cunninghamii</i> ssp. <i>cheradicus</i>, <i>Eucalyptus leucophylla</i> and pictorella mannikin (<i>Heteromunia pectoralis</i>). This special area type is a critical dry season refugia for fauna that require regular access to drinking water.</p>	<p>Ib (wildlife refugia): VH Ie (high species richness): VH Ii (habitat shelters): VH Ij (Breeding/roosting sites used by sig. no. of individuals): VH Ik (climate refugia): VH</p>
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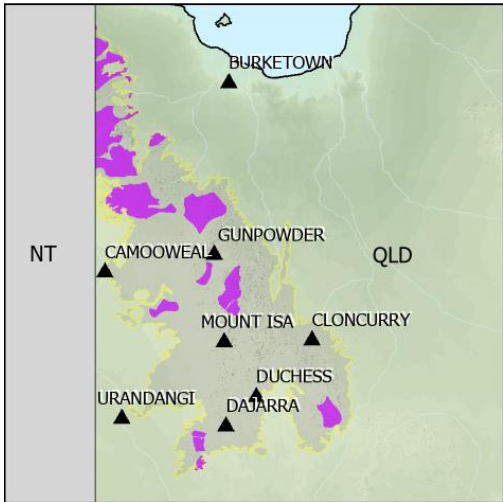
<p>nwh_I_05</p>	<p>Lawn Hill Impact Structure</p> 	<p>Regional</p>	<p>An impact structure of global significance preserved at the surface and readily identifiable 500 million years after its genesis due to the geologic stability of the area. The impact which caused it has been linked to a mid-Cambrian extinction event which played an important part in the evolution of life on earth.</p> <p>The structure is a unique geological feature of the Armravnald Plain and the mixed tussock grassland regional ecosystem community 2.4.1c (Gulf Plains outlier), encompassed by Northwest Highland communities and is endemic to the area.</p> <p>The area hosts a variety of priority species for the region including gulf fat-tailed gecko (<i>Diplodactylus barraganae</i>), Hosmer's skink (<i>Egernia hosmeri</i>), robust dtella (<i>Gehyra robusta</i>), pictorella mannikin (<i>Heteromunia pectoralis</i>), north-eastern orange-tailed slider (<i>Lerista orientalis</i>), timid slider (<i>Lerista timida</i>), gulf marbled velvet gecko (<i>Oedura bella</i>), long-tailed planigale (<i>Planigale ingrami</i>), eastern dwarf mulga snake (<i>Pseudechis pailsi</i>) and the long-tailed rock monitor (<i>Varanus glebopalma</i>).</p>	<p>Ia (centre of endemism): H Ib (wildlife refugia): H Ig (REs with distinct variation in species composition): VH</p>
<p>nwh_I_06</p>	<p>The Desert</p> 	<p>Regional</p>	<p>A remnant of a once more extensive land surface, the Desert is located on an isolated tertiary plateau with no surface waters. However, horizontal bedding in conjunction with an overlaying sand cover facilitates a shallow groundwater system that retains water in the soil profile for long periods of time post rainfall. Although not mapped as such, many of the surface vegetation communities may be groundwater dependent. Due to this unique hydrology, the area may also imbue climate refugial qualities for some species.</p> <p>Whilst the area exhibits low species richness, limited survey effort has occurred and the area may potentially house locally endemic taxa restricted to the remnant land surface. The southern extent of the range for <i>Eucalyptus miniata</i> (outlier population) normally found in the Northern Territory occurs here. Because of the groundwater lens, individuals of the species are substantially taller than the surrounding vegetation and contain numerous hollows.</p>	<p>Ic (disjunct populations): H Ig (REs with distinct variation in species composition): H Ii (habitat shelters): H Ik (climate refugia): H</p>

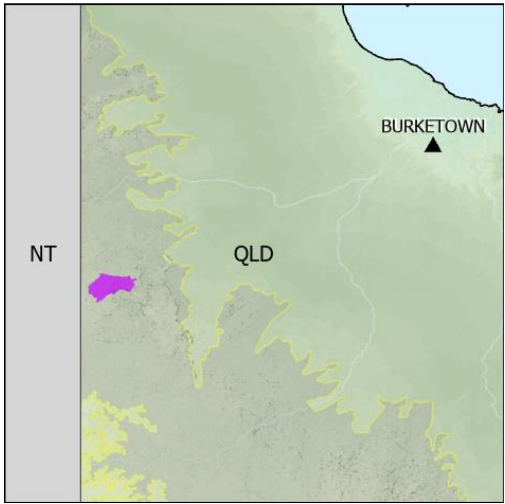
<p>nwh_I_07</p>	<p>Coarse Granites and Tor Fields</p> 	<p>State</p>	<p>Regional ecosystems 1.12.2 and 1.12.7, occur on ancient weathered skeletal and relatively infertile soils. Deeply fractured coarse grained granite tors which house caves and crevices, characterise the landscape. The unique habitat created by the coarse nature of the soils and fractured rock allow water to be absorbed and retained in the soil profile. These unique habitat niches and characteristics support high flora and fauna species richness and provide a fire refugia, however, are potentially at risk from more intense and frequent climate induced fires (Low, 2011).</p> <p>Whilst likely to house a wide range of currently unidentified taxa, notable fauna values include the presence of the purple-necked rock-wallabies (<i>Petrogale purpureicollis</i>), Carpentarian pseudantechinus (<i>Pseudantechinus mimulus</i>) and it's likely that micro bat colonies occupy crevices. Priority taxa such as the Kalkadoon grasswren (<i>Amytornis ballarae</i>), Cloncurry parrot (<i>Barnardius zonarius macgillivrayi</i>), ten-lined ctenotus (<i>Ctenotus decaneurus</i>), stripe-headed finesnout ctenotus (<i>Ctenotus striaticeps</i>), gulf fat-tailed gecko (<i>Diplodactylus barraganae</i>), Hosmer's skink (<i>Egernia hosmeri</i>), robust dtella (<i>Gehyra robusta</i>), spectacled hare-wallaby (<i>Lagorchestes conspicillatus</i>), white-striped gecko (<i>Strophurus taeniatus</i>), <i>Eucalyptus leucophylla</i> and <i>Heliotropium frohlichii</i> have been recorded. There is a probable night parrot (<i>Pezoporus occidentalis</i>) sighting in this habitat from the vicinity of Galah Creek, south of Mt Isa. Also, the western range limit of <i>E. melanophloia</i> ssp. nana</p> <p>n.b. Relates to an adjoining bioregional decision eiu_I_23.</p>	<p>Ia (centre of endemism): VH Ib (wildlife refugia): VH Ic (disjunct populations): VH Id (geographic range limits): H Ie (high species richness): VH Ig (REs with distinct variation in species composition): H Ij (Breeding/roosting sites used by sig. no. of individuals): H</p>
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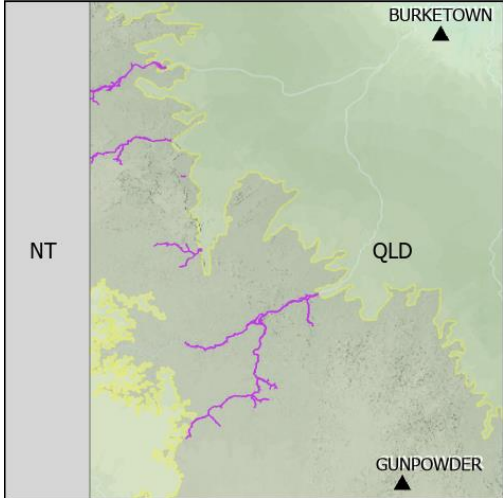
<p>nwh_I_08</p>	<p>Western Ranges of Ballara Nature Refuge</p> 	<p>Regional</p>	<p>This topographic isolate encompasses some of the highest areas in the bioregion. Whilst buffel grass dominates the ground layer along the Cloncurry River, it is largely restricted to the alluvial soils. Due to its elevated altitude (>450m asl in some areas), lack of water and steep terrain, the area depicted is in unusually good condition with little grazing occurring other than on the flats. The western ranges of Ballara Nature Refuge are largely spinifex dominated with kangaroo grass (<i>Themeda triandra</i>) present and have a high floristic diversity in groundcover.</p> <p>The threatened <i>Eucalyptus nudicaulis</i> occurs in this range and the endemic priority species Kalkadoon grasswren (<i>Amytornis ballarae</i>) and <i>Cajanus lanuginosus</i> have also been recorded. Cloncurry parrots (<i>Barnardius zonarius macgillivrayi</i>) have been observed in several locations throughout western Ballara Nature Refuge, whilst ghost bats (<i>Macroderma gigas</i>) have been observed in the old Hightville rail tunnel near the Wee McGregor mine.</p> <p>A permanent waterhole subject to tourism impacts, Fountain Spring, is located at the southern margin of the site.</p>	<p>Ib (wildlife refugia): H Ie (high species richness): H K (threatening processes and condition): Regional</p>
<p>nwh_I_09</p>	<p>Squirrel Hills</p> 	<p>State</p>	<p>Squirrel Hills, a comparatively young Northwest Highlands landscape with highly dissected laterite capped Jurassic sandstone plateaus, exhibits a unique geology and dry climate which has resulted in a distinct composition of flora. Subject to light grazing, the area depicted is considered in good condition.</p> <p>The threatened purple-necked rock-wallaby (<i>Petrogale purpureicollis</i>) and priority species Kalkadoon grasswren (<i>Amytornis ballarae</i>), Cloncurry parrot (<i>Barnardius zonarius macgillivrayi</i>), giant rocketfrog (<i>Litoria watjulumensis</i>), Carpentarian pseudantechinus (<i>Pseudantechinus mimulus</i>) and <i>Heliotropium frohlichii</i> have been recorded from the area. Whilst survey effort has been limited due to the isolated and difficult terrain, at least one (possibly two) endemic spinifex species are known to occur. The panel considered it likely that the area would contain other endemics and numerous taxa at range limits.</p>	<p>Ia (centre of endemism): VH Ib (wildlife refugia): VH Ic (disjunct populations): H Id (geographic range limits): H</p>

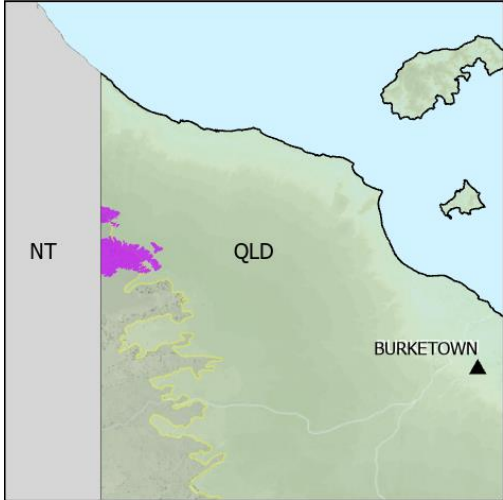
<p>nwh_I_10</p>	<p>Westmoreland Sandstones</p>  <p>The map shows the border between the Northern Territory (NT) and Queensland (QLD). The Westmoreland Sandstones are highlighted in purple and yellow along the coast. Burketown is marked with a black triangle on the QLD side.</p>	<p>State</p>	<p>Westmoreland Sandstones is a geological feature with a limited area in the Northwest Highlands that continues into (and is more extensive) in the Northern Territory. The faulting, fractured and almost horizontal bedded protozoic sandstones house deep cracks and crevices that provide unique habitats for a range of fauna at the edge of their range (e.g., sandstone pseudantechinus (<i>Pseudantechinus bilarni</i>) and chameleon dragon (<i>Chelosania brunnea</i>)).</p> <p>The crevices contain significant long-eared bat roosts (<i>Nyctophilus</i> spp.) and other species at their geographic range extents including the threatened orange leaf-nosed bat (<i>Rhinochiropterus aurantia</i>). The most easterly record of sandstone pseudantechinus (<i>Pseudantechinus bilarni</i>) and chameleon dragon (<i>Chelosania brunnea</i>) occur here – both rarely recorded in Queensland. In addition, the sandstones contain the only population of <i>Eucalyptus whitei</i> (1.5.1x2) in Northwest Highlands (disjunct population). The old, hollow bearing, <i>Eucalyptus miniata</i> trees provide complex habitat and shelter. Threatened species found here include Carpentarian grasswren (<i>Amytornis dorotheae</i>), purple-necked rock-wallaby (<i>Petrogale purpureicollis</i>), orange horseshoe-bat (<i>Rhinochiropterus aurantia</i>) and <i>Trachymene glandulosa</i>. Endemic priority species found here include the stripe-headed finenout ctenotus (<i>Ctenotus striaticeps</i>) and robust dtella (<i>Gehyra robusta</i>). Other priority taxa recorded in the locality include Hosmer's skink (<i>Egernia hosmeri</i>), pictorella mannikin (<i>Heteromunia pectoralis</i>), spectacled hare-wallaby (<i>Lagorchestes conspicillatus</i>), north-eastern orange-tailed slider (<i>Lerista orientalis</i>) and <i>Triumfetta mellina</i>.</p>	<p>Ib (wildlife refugia): VH Ic (disjunct populations): VH Id (geographic range limits): VH Ie (high species richness): VH Ig (REs with distinct variation in species composition): H Ii (habitat shelters): H Ij (Breeding/roosting sites used by sig. no. of individuals): VH</p>
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<p>nwh_I_11</p>	<p>Softwood Thickets on Metamorphic Screens</p> 	<p>State</p>	<p>Regional ecosystem 1.11.8 occurs on rock outcrops on hills and ranges on strongly folded siliceous sedimentary and metamorphic pre-Cambrian rocks (Queensland Herbarium, 2019). Some occurrences of this community are dominated by <i>Terminalia aridicola</i> and <i>Brachychiton collinus</i> softwood thickets.</p> <p>The softwood thickets are characterised by large crown trees with >30% foliage projection cover. The dense canopy and hill shade results in cooler conditions allowing species to survive in an otherwise dry hot environment. Small areas of surface water can be present and along with deeper organic matter accumulation and higher soil moisture, provide a cooler microclimate. In comparison to surrounding ecosystems, the thickets have high species richness and support significant habitat for birds (e.g., bower birds). Due to their topographic position, they represent a refuge from grazing, whilst instances of this community situated on steep rock dominated slopes, also provide a refuge from fire.</p> <p>Threatened species recorded include <i>Eucalyptus nudicaulis</i> and purple-necked rock-wallaby (<i>Petrogale purpureicollis</i>) and priority species Kalkadoon grasswren (<i>Amytornis ballarae</i>), sandstone frog (<i>Litoria coplandi</i>), giant rocketfrog (<i>Litoria watjulumensis</i>) and Carpentarian pseudantechinus (<i>Pseudantechinus mimulus</i>).</p>	<p>Ib (wildlife refugia): VH Ic (disjunct populations): VH Ie (high species richness): VH Ii (habitat shelters): H Ik (Climate refugia): VH</p>
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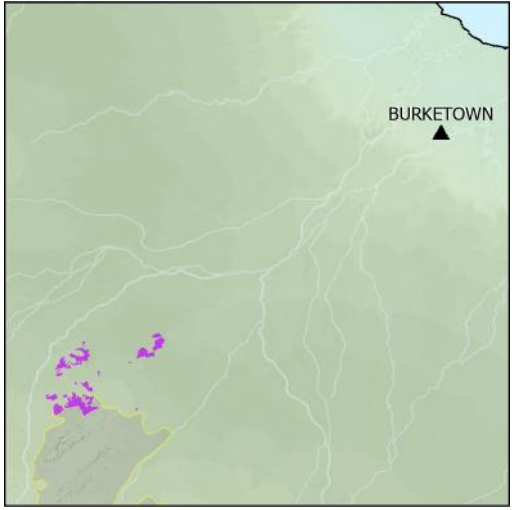
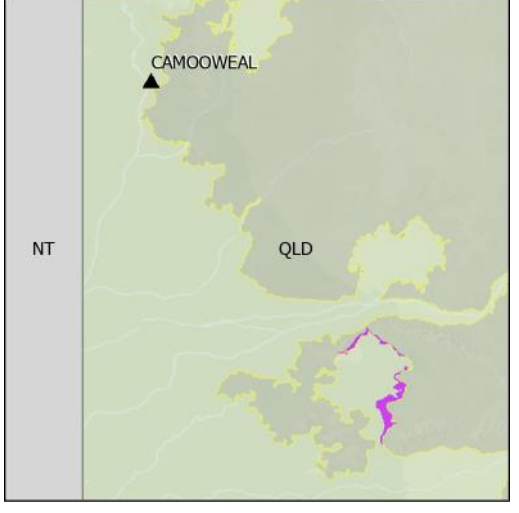
<p>nwh_l_12</p>	<p>Landscapes of least disturbance</p> 	<p>State</p>	<p>Inaccessible natural landscapes in the NWH are some of the least disturbed and most extensive undamaged areas in Queensland (e.g. Westmoreland Sandstones and Thornton Limestones). These remote and natural areas have had little impact from grazing by domestic stock or the associated infrastructure. They are centres of endemism with disjunct populations and are refugia from grazing. These are areas where the landscapes have been little disturbed and the biodiversity values within them have the greatest chance of being maintained in the long term.</p> <p>The major threatening process to these areas is the intensification of grazing through development of infrastructure such as watering points and fencing. The current condition of the ground layer and soil is considered likely to be in very good condition and provide a refuge for sensitive plant and animal species from the impacts of grazing. Any increase in land use intensity in these areas is likely to result in degradation and the consequent loss of biodiversity values.</p>	<p>Ib (topographic isolate and refuge from clearing): VH K: State</p>
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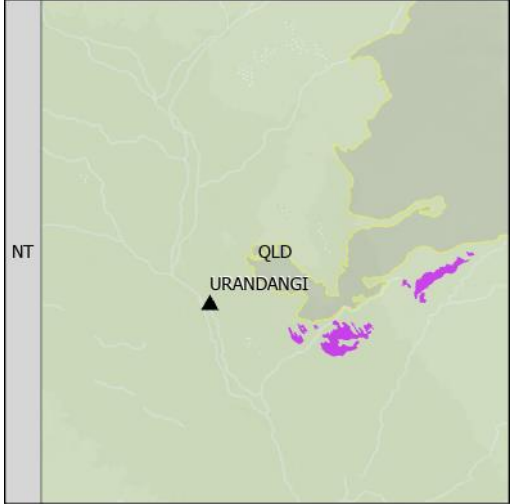
<p>nwh_I_13</p>	<p>Lawn Hill Stockyard Creek Resources Reserve</p> 	<p>State</p>	<p>The amphitheatre in the Lawn Hill Stockyard Creek Resource Reserve contains a diversity of geology types and landforms, inclusive of sandstone ranges, metamorphic hills, ironstone jump ups and deeply eroded lateritic surfaces, now infilled with sand. The rock pavements and escarpments that enclose the area afford topographic protection from late dry season fires.</p> <p>This combination of geological and topographic elements supports comparatively high species diversity and results in unique variation in the vegetation communities present. In some areas, very high vegetation cover is present and dominated by <i>Eucalyptus miniata</i>. Several threatened species have been recorded from the amphitheatre and its immediate surrounds (<i>Boronia hoipolloi</i> and <i>Solanum carduiforme</i>). The entire population of <i>Boronia hoipolloi</i> is known only from this area. Priority flora from the amphitheatre includes <i>Jacksonia lateritica</i> and <i>Paspalidium johnsonii</i>.</p> <p>Additionally, the area also supports threatened fauna such as Carpentarian grasswren (<i>Amytornis dorotheae</i>) and purple-necked rock-wallaby (<i>Petrogale purpureicollis</i>) and priority fauna including pictorella mannikin (<i>Heteromunia pectoralis</i>), sandstone frog (<i>Litoria coplandi</i>), giant rocketfrog (<i>Litoria watjulumensis</i>) and Mertens' water monitor (<i>Varanus mertensi</i>).</p> <p>Whilst, the topography imparts a level of protection, the area was considered by the panel at potential long-term climatic risk from expected changes in fire frequency and intensity.</p>	<p>Ia (centre of endemism): VH Ib (wildlife refugia): VH Id (geographic range limits): H Ie (high species richness): VH Ig (REs with distinct variation in species composition): VH Ii (habitat shelters): VH</p>
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<p>nwh_I_14</p>	<p>Permanent western watercourses and associated riparian areas</p> 	<p>State</p>	<p>The permanent/near permanent western watercourses and their associated riparian areas support the most species rich habitats within the Northwest Highlands bioregion and are critically important in northwest Queensland. The riparian areas delineated extend across four nationally important Directory of Important Wetland Areas (DIWA) sites - Lawn Hill Gorge (pristine wetland with permanent deep water, refuge for diverse and distinctive biota including threatened taxa) and Gregory River (fed by springs in the shallow valleys of the Barkly Tablelands and is the largest perennial river in arid/semi-arid Queensland), the Musselbrook Creek Aggregation (excellent example of a structurally diverse suite of wetlands developed on meadow podosolic soils in back plains within the Doomadgee Plains province) and the Thornton Aggregation (pristine wetland system with permanent deep water in a semi-arid environment).</p> <p>Caves are present throughout the region, whilst the riparian areas support high density of hollow bearing trees. In conjunction with permeant/near permanent sources of water and feeding resources, these areas provide important shelter and habitat for both micro and macro bat species - key feeding sites for little red flying foxes (<i>Pteropus scapulatus</i>). Significant populations of the endangered relict species Gulf snapping turtle (<i>Elseya lavarackorum</i>) (Lawnhill Creek and Gregory River catchments (Freeman, 2010)) occur. The Gregory and Nicholson rivers, including Beames Brook, contain a disjunct population of northern saratoga (<i>Scleropages jardinii</i>) (Hogan and Vallance 2005), supports freshwater sawfish (<i>Pristis pristis</i>), purple-crowned fairy-wrens (<i>Malurus coronatus</i>), buff sided robins (<i>Poecilodryas cerviniventris</i>), pictorella mannikin (<i>Heteromunia pectoralis</i>), crimson finches (<i>Neochmia phaeton</i>), barking owl (<i>Ninox connivens</i>) and red goshawk (<i>Erythrotriorchis radiates</i>) (Macgillivray, 1914; Rowley, 1993; Peverell, 2005). Within the Gregory, saltwater crocodiles (<i>Crocodylus porosus</i>) extend into the bioregion and freshwater crocodiles (<i>Crocodylus johnsoni</i>) are also present. <i>Melaleuca leucadendra</i> and plant species such as <i>Pandanus aquaticus</i>, <i>Ficus racemosa</i> and <i>Nauclea orientalis</i> occur.</p> <p>The permanent water and associated riparian vegetation support a huge diversity of threatened and priority species of flora and fauna beyond those mentioned above. Threatened species include <i>Cycas brunnea</i>, diamond head turtle (<i>Emydura subglobosa worrelli</i>), Gouldian finch (<i>Erythrura gouldiae</i>), painted honeyeater (<i>Grantiella picta</i>) and <i>Lobelia membranacea</i>. Priority species include Cloncurry parrot (<i>Barnardius zonarius macgillivrayi</i>), pictorella mannikin (<i>Heteromunia pectoralis</i>), sandstone frog (<i>Litoria coplandi</i>), giant rocketfrog (<i>Litoria watjulumensis</i>), rock ringtail possum (<i>Petropseudes dahli</i>), coal grunter (<i>Hephaestus carbo</i>), <i>Livistona</i></p>	<p>Ib (topographic isolate and refuge from clearing): H Id (geographic range limits): H Ii (presence of hollow bearing trees): VH Ij: (Breeding/roosting sites used by sig. no. of individuals): VH</p>
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			<p><i>rigida</i>, highfin catfish (<i>Neoarius berneyi</i>), blue catfish (<i>Neoarius graeffei</i>), boofhead catfish (<i>Neoarius leptaspis</i>), Hyrtl's catfish (<i>Neosilurus hyrtlii</i>) and Mertens' water monitor (<i>Varanus mertensi</i>).</p> <p>n.b. This decision represents a continuation of the Gulf Plains Biodiversity Plains Assessment special area decision, gup_fa_08.</p>	
nwh_l_15	<p>Westmoreland area</p>  <p>The map shows the border between the Northern Territory (NT) and Queensland (QLD). A purple shaded area is located in the north-western part of Queensland, near the border with NT. A black triangle marks the location of Burketown in the south-eastern part of the purple shaded area. The map also shows the coastline and some inland features.</p>	State	<p>A landscape characterised by ironstone jump-ups (forming mesa, scarps in the South and weathered rocky lowlands to the North), metamorphic hills and sandstone ranges, dissected by incised gorges and narrow bands of alluvium. The northern extent of the bioregion, which receives comparatively higher rainfall, exhibits high landscape diversity, contains novel vegetation communities, two of which (regional ecosystems 1.12.1x9, 1.12.1x10) only occur in the area depicted.</p> <p>Whilst under surveyed, the panel noted that the area exhibits high levels of species richness, is likely to act as an important refugia and similarly, that numerous flora and fauna are likely to occur at their range limits. The nationally recognised wetland, the Wentworth Aggregation is one of the best examples of the full range of wetland types characteristic of hydrologically related alluvial and estuarine systems, occurring in the Doomadgee and Karumba plain provinces of the Gulf Plains bioregion. It extends into the Northwest Highlands bisecting the two upland areas depicted (refer to the Gulf Plains Biodiversity Planning Assessment landscape decision gup_l_16 for values). Priority species that are known to occur in this area include robust dtella (<i>Gehyra robusta</i>), giant rocketfrog (<i>Litoria watjulumensis</i>), <i>Scaevola revoluta var. revoluta</i>, <i>Tephrosia</i> sp. Barkly Downs S.L.Everist 3384, <i>Tephrosia</i> sp. Mt Isa P.L.Harris 277 and <i>Triumfetta mellina</i>.</p> <p>The area is impacted from inappropriate fire regimes in terms of frequency and intensity. During normal fire conditions, old fire scars and natural breaks are sufficient, however, during intense fires, these become less effective. The crevices are important as they provide refugia particularly from large fires.</p>	<p>la (centre of endemism): H (suspected - limited information)</p> <p>lb (wildlife refugia): VH (tends to be well watered & supports many species)</p> <p>ld (geographic range limits): VH</p> <p>le (high species richness): VH</p> <p>lg (REs with distinct variation in species composition): VH</p> <p>li (habitat shelters): VH</p> <p>lk (climate refugia): VH</p>

<p>nwh_I_16</p>	<p>Terrestrial bioregional corridors (landscape connections) Refer to Figures 4, 5 and 6</p>	<p>State</p>	<p>The broad purpose of landscape-scale connections is to provide for ecological and evolutionary processes at a bioregional scale. Maintaining connectivity across a landscape, either through "continuous linkages" or via "stepping-stones" of remnant vegetation, is important for the long-term conservation of biodiversity.</p> <p>For further information regarding the broad principles and intent, as well as more specific information relating to the Northwest Highlands terrestrial corridor network, refer to Section 3.3.2.1 Terrestrial corridors and Table 14.</p>	<p>Criteria J (landscape connections): State</p>
<p>nwh_I_17 (a & b)</p>	<p>Riparian bioregional corridors (landscape connections) Refer to Figures 4, 5 and 6</p>	<p>State (nwh_I_17a) or Regional (nwh_I_17b)</p>	<p>Riparian corridors encompass some of the most diverse, dynamic and complex habitats incorporating both environmental and topographic gradients. Comparatively, such areas tend to exhibit high species richness with respect to both flora and fauna, provide important resources in terms of water, food, shelter, nesting and nursery sites and act as a refugia during periods of drought, or in response to longer terms impacts associated with climatic change.</p> <p>At the landscape scale, networks of major and minor riparian linkages are a significant element of habitat continuity and provide important migratory and dispersal pathways for a substantial number of species (especially birds, insects and flora, but also for many arboreal mammals and reptiles).</p> <p>Within the NWH, remnant vegetation within 200m and 100m of selected major and minor waterways was designated as being of State and Regional significance respectively. The significance of selected riverine systems was also modified in some instances. For further information regarding the broad principles and intent, as well as more specific information relating to the Northwest Highlands riparian corridor network, refer to Section 3.3.2.2 and Table 15.</p>	<p>Criterion J (riparian corridor): State or Criterion J (riparian corridor): Regional</p>

Adjoining bioregion decisions <i>n.b. for the following non- NWH BPA decisions, only affected NWH assessment units are depicted in the images below</i>				
gup_l_42	Surprise Creek area 	State	Replaces gup_fl_10. Very high flora and landscape significance and diversity. Extremely diverse area on Doomadgee plains outlier, diverse shrub-lands and contains a rare RE that's entire distribution is contained in this area. Northern naitail wallaby <i>Onychogalea unguifera</i> , spectacled hare-wallaby <i>Lagorchestes conspicillatus</i> and purple-crowned fairy-wren <i>Malurus coronatus</i> recorded in the area. Contains only land zone 6 (inland dunes) in Gulf Plains, but mainly land zone 5. Archie creek may receive discharge/overflow from mine – dewatering. Archie Creek is heavily infested with rubber-vine <i>Cryptostegia grandiflora</i> . Southern Gulf NRM trying to control but no interest. Rubber-vine extends into plains. Condition unknown, potential high grazing pressure.	le (high species diversity): VH lg (REs with distinct variation in species composition): VH
mgd_l_10	Barkly Downs Wetlands 	State	Wetland complex, internal drainage basin. Complex of wetland surfaces. Bluebush and other flora species. Important for wetland bird nesting.	lb (wildlife refugia): VH lg (REs with distinct variation in species composition): H lj: (Breeding/roosting sites used by sig. no. of individuals): VH

<p>mgd_l_19</p>	<p>Urandangi confluence</p>  <p>The map shows the border between Northern Territory (NT) and Queensland (QLD). A black triangle marks the location of Urandangi. Purple shaded areas represent specific regions of interest, likely related to the biodiversity assessment.</p>	<p>State</p>	<p>Particularly diverse area. Outwash fan, grasslands, drainage lines. Identified based on Marxan analysis</p>	<p>le (high species diversity): VH</p> <p>Ig (REs with distinct variation in species composition): VH</p>
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3.3.2 Corridors (Criterion J)

3.3.2.1 Terrestrial corridors

The expert panel agreed that the traditional approach to defining corridors of remnant vegetation made little sense in NWH, where the landscape is largely intact. The two terrestrial corridors nominated by the panel focused on a north-south mountain range connection, whilst at the western margin of the bioregion, a dune field and sand plain connection that runs through to the Mitchell Grass Downs bioregion and down into Channel Country and Simpson Desert. The final terrestrial corridor network is summarised in decisions nwh_l_16 in Table 13. Details relevant to each corridor are described in Table 14 and displayed in Figure 4, Figure 5 and Figure 6.

Table 14. Terrestrial bioregional corridors (landscape connections) identified by the landscape expert panel

Corridor Number	Corridor description	Significance (width)
1	<p>Northwest Highlands Corridor</p> <p>Corridor running from the Northern Territory-Queensland border from Lawn Hill National Park southeast through the Waggaboonya Range and Ballara Nature Refuge, between Mount Isa and Cloncurry, through the Selwyn Range to Answer Downs. Encompasses upland ranges mostly in good condition, whilst the intervening valleys are degraded to some extent.</p>	State (10km)
2	<p>Dunefields and Sandplains Terrestrial Corridor</p> <p>Corridor extending from Camooweal Caves National Park southeast through the Pilpah Range, southwest through the Barkly Tableland, southeast past Dajarra and back to the southwest to the Toomba Range, Cravens Peak Nature Refuge, extending to the sand dunes of the Channel Country and Simpson Desert. Follows sand dune and outwash deposits with continuity of ecosystems containing similar soils and plants with variations reflective of climate conditions.</p>	State (10km)

3.3.2.2 Riparian corridors

The panel noted that all riparian areas, inclusive of perennial systems, are important for maintaining connectivity in the NWH. These watercourses are important landscape elements which act as significant migratory and dispersal pathways for many species of fauna and flora and contain important habitat resources (including food, water, sheltering, roosting and nesting sites).

All watercourses with a stream order equal to 4 or 5 (assigned at a scale of 1:100,000) were selected to provide connections to upland/headwater areas and assigned regional significance. Streams orders of 6 or more, were assigned State significance.

Table 15. Riparian bioregional corridors

Watercourses to Include	Significance
Accident Creek	State and Regional
Ada Creek	Regional
Age Creek	Regional
Alexandra River	State
Alison Creek	Regional
Alligator Creek	Regional
Amphitheatre Creek	Regional
Anthony Creek	Regional
Anvil Creek	Regional
Archie River	State and Regional
Argus Creek	Regional
Argylla Creek	Regional
Battle Creek	Regional
Beetle Creek	Regional
Bellbird Creek	Regional
Big Mick Creek	Regional
Big Sandy Creek	Regional
Big Toby Creek	Regional
Big Tots Creek	Regional
Birdnest Creek	Regional
Black Creek	State and Regional
Black Tea Tree Creek	Regional
Blazan Creek	Regional
Bluey Creek	Regional

Bony Creek	Regional
Boomerang Creek	Regional
Boorama Creek	Regional
Border Creek	Regional
Boundary Creek	Regional
Branch Creek	Regional
Breakaway Creek	Regional
Breakfast Creek	Regional
Brenda Creek	Regional
Briar Creek	Regional
Bronzewing Creek	Regional
Broughton Creek	Regional
Brown Gully	Regional
Browns Creek	Regional
Brumby Creek	Regional
Buchanan Creek	State and Regional
Buckley River	State and Regional
Bull Creek	Regional
Burke River	State and Regional
Bustard Creek	Regional
Butcher Creek	Regional
Cabbage Tree Creek	Regional
Cameron Creek	Regional
Cameron River	Regional
Canal Creek	Regional
Carbine Creek	Regional
Carleton Creek	Regional
Caroline Creek	Regional
Carrara Creek	State and Regional
Cartridge Creek	State and Regional
Castle Creek	Regional

Cattle Creek	Regional
Caves Creek	Regional
Central Creek	Regional
Charley Creek	Regional
Chester Creek	Regional
Chinaman Creek	Regional
Chinaman Creek Dam	Regional
Cleanskin Creek	Regional
Clement Creek	Regional
Cliffdale Creek	State and Regional
Cloncurry River	State and Regional
Coglan Creek	Regional
Collins Waterhole	Regional
Cone Creek	Regional
Conglomerate Creek	Regional
Coppermine Creek	State and Regional
Corella Creek	State and Regional
Cordelia Creek	Regional
Corella River	State and Regional
Corella Dam	Regional
Courtenay Creek	State and Regional
Corkwood Creek	Regional
Crawford Dam	State
Crocodile Waterhole	Regional
Cromwell Creek	Regional
Crooked Creek	Regional
Crystal Creek	Regional
Culdara Creek	Regional
Culdara Lagoon	Regional
Dariel Creek	Regional
Dead Horse Gully	Regional

Deep Creek	Regional
Desert Creek	Regional
Dingo Creek	Regional
Don Creek	Regional
Doughboy Creek	Regional
Douglas Creek	Regional
D-Tree Creek	Regional
Duck Creek	Regional
Duffers Creek	Regional
Dugald River	State and Regional
Duncans Creek	Regional
Dynamite Creek	Regional
Eastern Creek	Regional
Eight Mile Creek	State and Regional
Elder Creek	Regional
Elizabeth Creek	State and Regional
Emu Creek	State and Regional
Engine Creek	Regional
Ewen Creek	State and Regional
Farley Creek	Regional
Fiery Creek	State and Regional
Figtree Creek	Regional
Fisher Creek	Regional
Five Mile Waterhole	State
Florence Creek	Regional
Four Mile Creek	State and Regional
Frank Creek	Regional
Fullarton River	State and Regional
Galah Creek	State and Regional
Garden Creek	Regional
George Creek	Regional

Georgina River	State
Gidya Creek	State and Regional
Gin Creek	Regional
Goa Creek	Regional
Goonooma Creek	Regional
Gorge Creek	Regional
Gorge Waterhole	Regional
Granite Creek	Regional
Gregory River	State
Green Creek	Regional
Greens Creek	Regional
Greenstone Creek	Regional
Gulliver Creek	Regional
Gum Creek	Regional
Gum Well Creek	Regional
Gunpowder Creek	State and Regional
Gypsum Creek	Regional
Hamilton River	State
Hann Creek	State
Harris Creek	State and Regional
Harry Creek	Regional
Hedleys Creek	Regional
Hetzer Creek	Regional
Holts Creek	Regional
Horse Creek	Regional
Hut Creek	Regional
Hutchinson Creek	Regional
Ibis Creek	Regional
Ibis Lagoon	Regional
Inca Creek	Regional
Ixion Creek	Regional

Jayah Creek	State and Regional
Jayah Bore Creek	Regional
Jayah Rocky Creek	Regional
Jenny Creek	Regional
Jimmy Creek	Regional
Johnson Creek	Regional
Judenan Creek	Regional
Jump Up Creek	Regional
Kahko Creek	Regional
Kemps Camp Waterhole	Regional
King Ranch Dam	Regional
Kolar Creek	Regional
Lagoon Creek	State and Regional
Lament Creek	Regional
Lake Canellan	State
Lake Francis	State
Lake Julius	State
Lake Mary Kathleen	Regional
Lake Moondarra	State
Lawn Hill Creek	State and Regional
Leichhardt River	State and Regional
Leichhardt River (East Branch)	State and Regional
Letterbox Creek	Regional
Lightning Creek	Regional
Lily Creek	Regional
Lily Hole Creek	Regional
Lily Lagoon	State
Lily Waterhole	Regional
Limestone Creek	Regional
Little Archie Creek	Regional
Little Creek	Regional

Little Galah Creek	Regional
Little Horse Creek	Regional
Little Mick Creek	Regional
Little Mosman Waterhole	State
Little Sandy Creek	Regional
Little Templeton River	Regional
Little Toby Creek	Regional
Little Wooroona Creek	Regional
Louie Creek	State and Regional
Macadam Creek	State
Macnamara Creek	Regional
Maggies Creek	Regional
Maiden Creek	Regional
Mairindi Creek	Regional
Malbon River	State and Regional
Mallee Gap Creek	Regional
Makbat Creek	State and Regional
Maramungee Creek	Regional
Marathon Creek	Regional
Mars Creek	Regional
Martin Creek	Regional
Maxim Creek	Regional
McKinlay River	State and Regional
Mclean Creek	Regional
McPhee Creek	Regional
Mica Creek	Regional
Mickory Waterhole	Regional
Middle Creek	Regional
Mindyalla Creek	State
Mine Creek	Regional
Mingera Creek	State and Regional

Miranda Creek	Regional
Mistake Creek	State and Regional
Mittigudi Creek	State and Regional
Mitton Creek	Regional
Monastery Creek	Regional
Moonah Creek	State and Regional
Moores Creek	Regional
Morris Creek	Regional
Morrison Creek	Regional
Morstone Creek	Regional
Mosquito Creek	State and Regional
Mort River	State and Regional
Mountain Home Creek	Regional
Murrays Creek	Regional
Musselbrook Creek	State and Regional
Myally Creek	State and Regional
Mystery Creek	Regional
Narrowgret Creek	State
Nicholson River	State and Regional
Nine Mile Creek	Regional
Nine Mile Waterhole	State
Ninmaroo Waterhoole	State
Nowranie Creek	Regional
Nowranie Waterhole	Regional
Ogorilla Creek	Regional
Old Man Creek	Regional
Old Man Creek Left Hand Branch	Regional
One Mile Waterhole	Regional
O'Shannassy River	State and Regional
Oxide Creek	Regional
Palm Creek	Regional

Pandanus Creek	Regional
Paradise Creek	Regional
Paroo Creek	State and Regional
Percy Creek	State
Perishing Creek	Regional
Perrys Camp Waterhole	State
Peters Creek	State and Regional
Pilgrim Creek	Regional
Pinnacle Creek	Regional
Plain Creek	Regional
Police Creek	State and Regional
Polygonum Creek	State
Pomegranate Creek	Regional
Pompeii Creek	Regional
Portal Creek	Regional
Prospector Creek	Regional
Pumpkin Gully	Regional
Quartpot Creek	Regional
Quarts Creek	Regional
Quita Creek	Regional
Racecourse Dam	Regional
Rankin Creek	Regional
Redbank Creek	State and Regional
Reedy Creek	Regional
Revolver Creek	Regional
Ribbon Creek	Regional
Rifle Creek	Regional
Roberts Creek	Regional
Rocky Creek	Regional
Rocky Waterhole	Regional
Rufus Creek	Regional

Russell Creek	Regional
Saga Creek	Regional
Saint Paul Creek	Regional
Sally Creek	Regional
Saltamine Creek	Regional
Sandy Creek	State and Regional
Scrubby Creek	Regional
Scrutton Creek	Regional
Settlement Creek	State and Regional
Seymour River	Regional
Sherrin Creek	Regional
Six Mile Creek	Regional
Six Mile Lagoon	Regional
Sixteen Mile Waterhole	State
Slaty Creek	Regional
Slaughter Creek	Regional
Smith Creek	Regional
Smoky Creek	State and Regional
Snake Creek	Regional
Snake Creek (East Branch)	Regional
Snake Creek (West Branch)	Regional
Spear Creek	Regional
Spell Paddock Dam	Regional
Spider Creek	Regional
Split Creek	Regional
Spring Creek	Regional
St Ronans Creek	State and Regional
St Ronans Creek Dry Branch	Regional
St Ronans Creek Wet Branch	Regional
Stockyard Creek	Regional
Stony Creek	Regional

Sugarbag Creek	Regional
Suliman Creek	State and Regional
Suprise Creek	Regional
Surprise Creek	Regional
Sybella Creek	Regional
Templeton River	State and Regional
Thorton River	State and Regional
Tomahawk Creek	Regional
Tommy Creek	Regional
Toole Creek	Regional
Toomoon Creek	Regional
Torpedo Creek	Regional
Trough Creek	Regional
Turpentine Creek	Regional
Two Mile Creek	Regional
Ulupna Creek	Regional
Underilla Creek	Regional
Urquhart Creek	Regional
Verdon Creek	Regional
Victor Creek	Regional
Victory Creek	Regional
Waggaboonya Lake	Regional
Wagunda Creek	Regional
Walford Creek	Regional
Wandolbie Waterhole	Regional
Waverly Creek	State and Regional
Weatherly Creek	Regional
Wellington Creek	Regional
West Thornton Creek	State and Regional
Whistler Creek	Regional
Widdallion Creek	State

Wilfred Creek	Regional
Williams River	State and Regional
Wills Creek	State and Regional
Wonomo Waterhole	State
Wooroona Creek	State and Regional
Yaningerry Creek	State
Yappo Creek	Regional
Yard Creek	Regional
Yaringa Creek	Regional
Yellow Waterhole Creek	Regional
Youl Creek	Regional

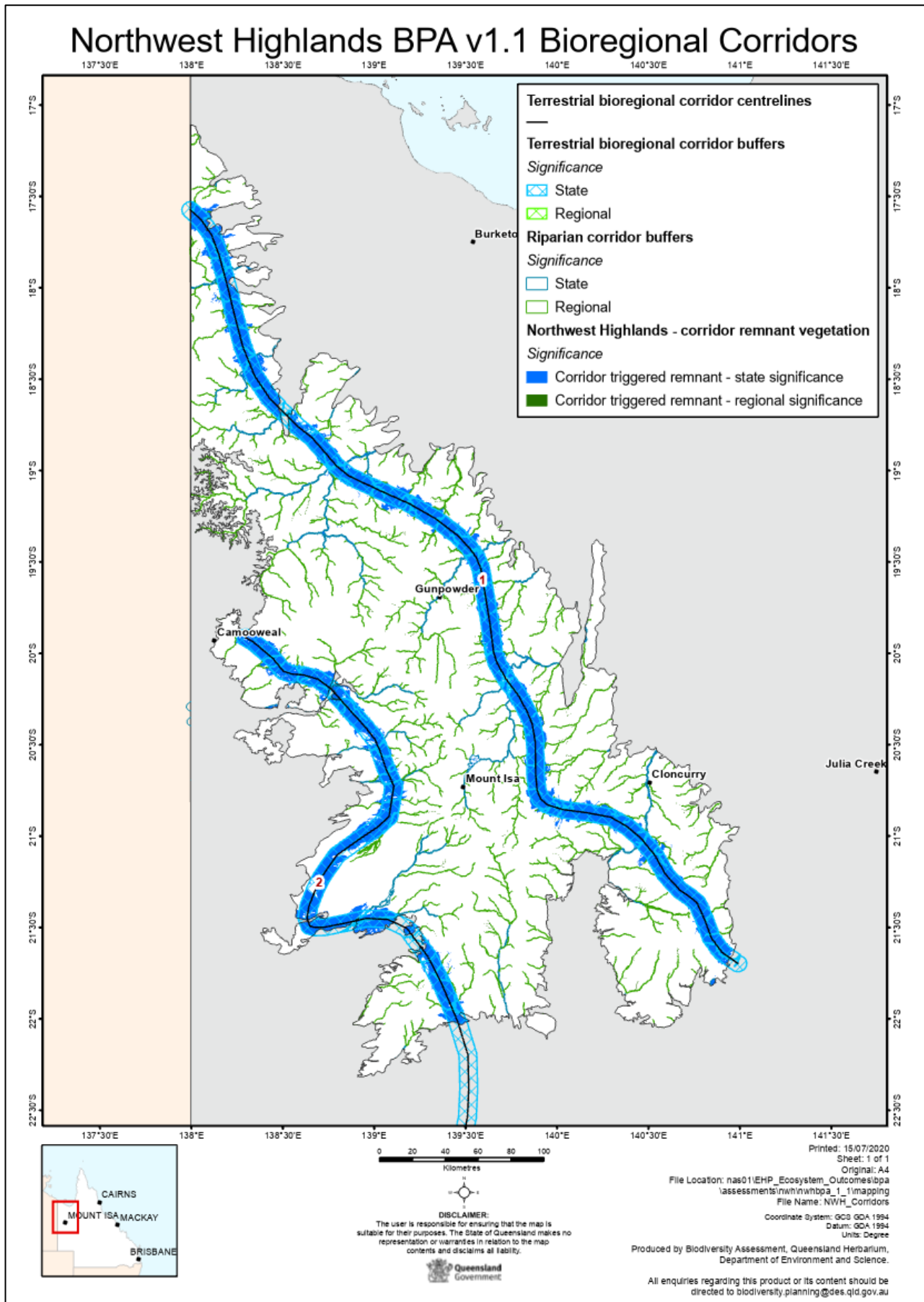


Figure 4. NWH terrestrial and riparian bioregional corridors

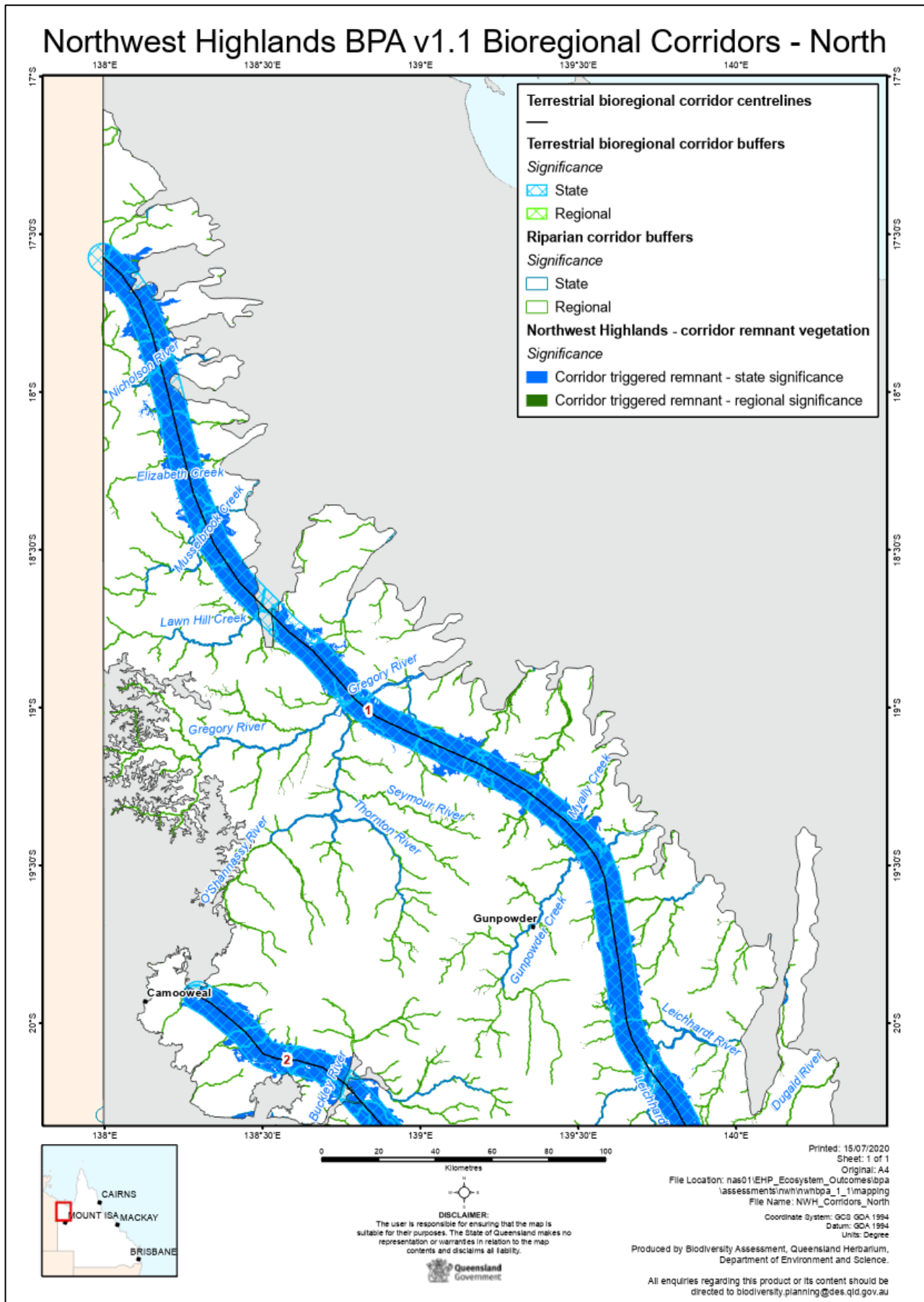


Figure 5. NWH terrestrial and riparian bioregional corridors - North

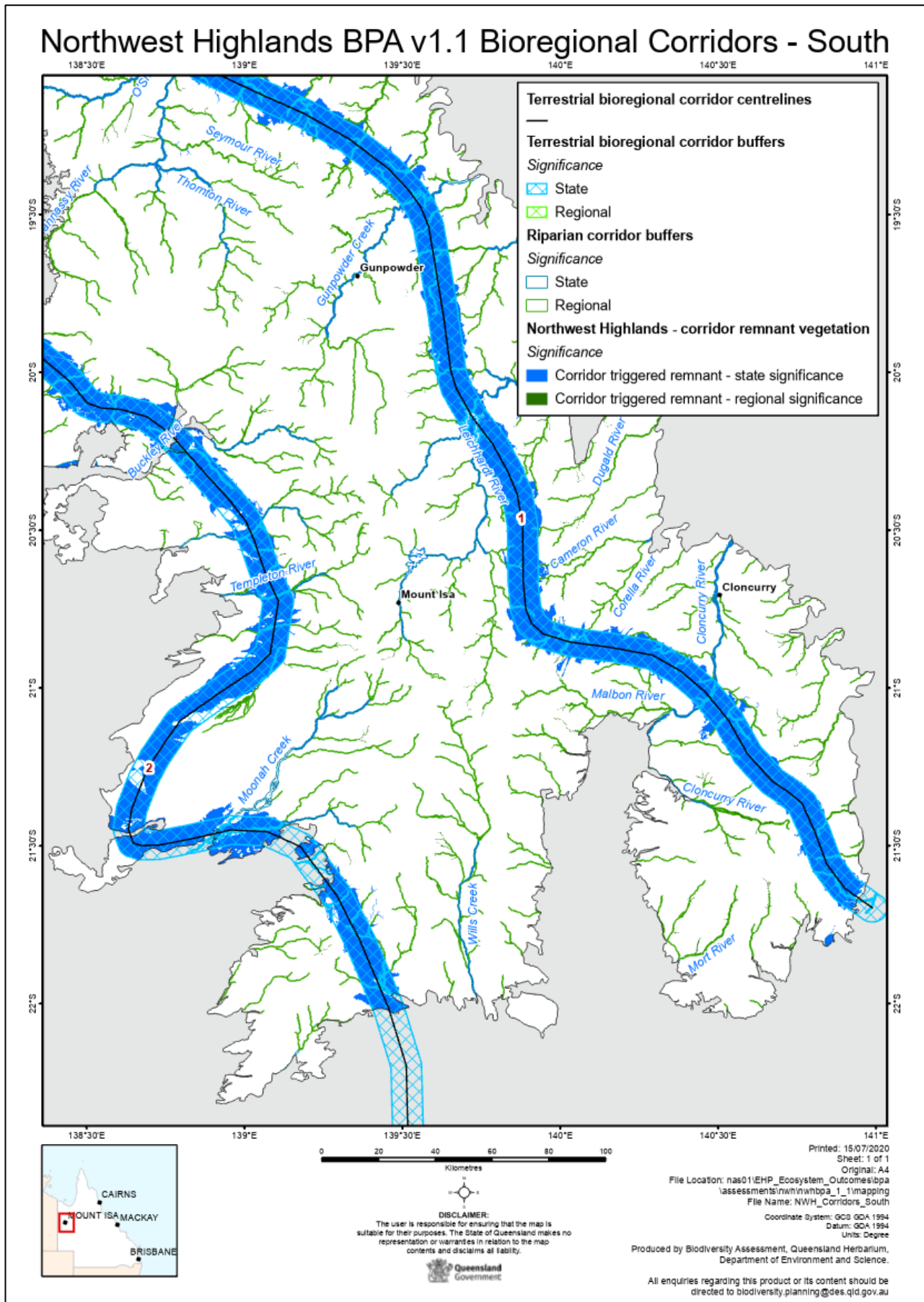


Figure 6. NWH terrestrial and riparian bioregional corridors - South

4 Discussion

4.1 General

There are a number of features that make the NWH bioregion unique. The region is one of the most intact parts of the country, with less than one per cent of the vegetation cleared. Despite the low relief of the landscape, the complex geology and topography has given rise to pockets of endemism and refugia for threatened species, as well as several highly significant wetlands and riverine systems.

The expert panel noted several landscape features of national and international significance. The Riversleigh World Heritage Site and Boodjamulla National Park are internationally significant sites and are both part of the Thornton karst system, itself a nationally important wetland aggregation. Riversleigh is well known as a significant site for fossils, particularly mammal fossils and Boodjamulla hosts a number of threatened species including the relictual Gulf snapping turtle (*Eseya lavarackorum*), a species first identified from fossils in the Riversleigh fossil beds before being discovered alive in nearby waterways (Thomson, White and Georges, 1997). The Thornton Aggregation and the Camooweal Caves limestone karst system both support a significant number of limestone caves, hosting a number of bat colonies including those of threatened ghost bat (*Macroderma gigas*) and orange leaf-nosed bat (*Rhinonicteris aurantia*). There are eight nationally significant wetlands: the Gregory River, one of the most unmodified rivers in the country, Lake Julius, Lake Moondarra, Lawn Hill Gorge, Austral Limestone Aggregation, Musselbrook Creek Aggregation, Thornton Aggregation and Wentworth Aggregation (WetlandInfo, 2020).

The unique geology of the NWH bioregion is a major driver of flora and fauna diversity. The heavily mineralised soils and ruggedness of the southern portion of the Mount Isa Inlier subregion act as a driver of speciation resulting in high floral species diversity manifesting predominantly in the herb and shrub layers. The panel believe that this part of the region may have many species as yet not yet described. There are nine flora species in the bioregion that are listed as threatened or near threatened and a further 30 that were considered by the panel as priority (non-EVNT) taxa. The panel noted that due to under sampling in the region (both temporally and spatially), there is a likelihood that some of these plant species are more abundant than currently believed (Silcock, Healy and Fensham, 2014). Conversely, some of the endemic species in the region are likely far rarer than presumed, which would lead to an increase in their threat status. Further survey work is required in the region to re-evaluate the status of many of the significant plant species mentioned in this report.

There are 21 fauna species in the bioregion that are listed as threatened or near threatened (EVNT) and a further 41 species that were considered priority (non-EVNT) taxa. As with flora, more sampling could change the perceived status of some of these species, but in general fauna species are far better surveyed. The exception to this is invertebrates, which are understudied in general and further work is highly likely to lead to the discovery of new species, including species endemic to the bioregion. The panel noted that while many species of migratory shorebirds are listed as being present in the region, these are likely primarily associated with Lake Moondarra, Lake Julius and other artificial waterbodies such as mining dams. Fauna of particular note include the Gulf snapping turtle (*Eseya lavarackorum*), a relictual species endemic to the bioregion and the Carpentarian grasswren (*Amytornis dorotheae*), which appears to have been extirpated from the Northern Territory and may now be endemic or near-endemic to the bioregion and more threatened than currently recognised.

The expert panel assigned significance to nearly 40% of the remnant vegetation in the bioregion, the majority as being of State significance. Aquifer outflows and other permanent water sources act as stable refugia in an environment with extreme seasonal variation in rainfall. The trend under climate change towards aridification in the region will likely have significant impacts on wetland-adapted flora and fauna beyond changes to fire regime. The panel notes that as the region becomes dryer, species restricted to spring-fed river systems are likely to become priority species, while any form of permanent water will become rarer and more critical to the survival of species in general. The impacts of this are already being seen, with waterholes previously believed to be permanent beginning to dry out during prolonged dry seasons. In particular, amphibians are likely to be disproportionately affected by these changes over time.

Despite the lack of broadscale clearing in the region, the condition of much of the remnant vegetation has been impacted from agriculture, mining, weeds and feral animals lowering the habitat value. The panel considered that changes to the fire regime and grazing are the two main drivers of loss of condition for habitat. Fire in the region is driven by the cycle of intense rainfall during the monsoon, followed by a very dry rest of the year. This wet-dry cycle leads to a build-up of biomass followed by loss of soil moisture and drying vegetation, significantly increasing the intensity and area of fires when they do occur. Changing from an indigenous-driven fire landscape to a grazing-dominated landscape has subverted the natural fire processes, with introduction and spread of invasive grasses leading to increases in fire frequency and severity. Fires are also predicted to increase in frequency and severity even further under climate change, where less rainfall and more intense weather events for the region are predicted.

4.2 Expert panel recommendations

The expert panel raised several issues and made recommendations for future consideration when updating the NWH BPA. The following provides a summary of key comments and recommendations.

Criteria A Threatened species and Criteria H priority species

- The panel recognised there is a paucity of records in the NWH due to a lack of systematic survey effort across the entire bioregion and in addition, that there is a clear bias in survey effort (close to roads, mining regions). Access to areas within the NWH represents a significant impediment. As such, the panel agreed that species habitat models in conjunction with records be used to identify potential hotspots for threatened and priority taxa.
- The panel noted it was difficult to be consistent when applying criteria for priority taxa and suggested that further information or guidance would be useful to better enable a more systematic listing.
- The panel also suggested that future reviews of priority species:
 - consider phylogenetic rarity as a justification for including species - spatial phylogenetic data is becoming more available and should be considered in the future, and
 - that future processes consider species with ranges that have a limited extent within protected areas as a justification for inclusion.
- The NWH bioregion is the Queensland portion of the Mount Isa Inlier IBRA region, with the Queensland border cutting off a portion of the Barkly Tablelands. The panel noted that species that aren't endemic to the Queensland portion may be endemic to the IBRA region as a whole and that this is a limitation of using a political boundary for a biological system.

Criteria I Special Areas

- The panel observed that landscape heterogeneity was not well represented in the special area decisions.
- The panel indicated they would have liked to consider species with ranges that have limited extent within protected areas in determining conservation values of special area decisions.

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6 Appendices

Appendix 1: Acronyms and abbreviations

ALA	Atlas of Living Australia
BAMM	Biodiversity Assessment and Mapping Methodology
BPA	Biodiversity Planning Assessment
CORVEG	The site survey database maintained by the Queensland Herbarium
DCDB	Digital cadastral database – a spatial database of Queensland property boundaries.
DES	Department of Environment and Science
EHP	Department of Environment and Heritage Protection
EVNT	Endangered, vulnerable or near threatened under the Queensland <i>Nature Conservation Act 1992</i> and Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i>
EPBC	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
GIS	Geographic information system
HerbreCs	Specimen based register of plants held by Queensland Herbarium
NCA	<i>Nature Conservation Act 1992</i>
NWH	Northwest Highlands bioregion
QHFD	Queensland Historical Fauna Database
RE	Regional ecosystem
REDD	Regional Ecosystems Description Database
SDRN	State Digital Road Network
SPA	<i>Sustainable Planning Act 2009</i>
WildNet	Department of Environment and Science (DES)'s corporate wildlife application containing records and other information on Queensland flora and fauna

Appendix 2: Datasets/themes available to the expert panel during the workshop

GIS

Geographic data

Catchment boundaries

Contours (10m interval)

Topographic maps (1:100 000)

Cadastral, government and locational data

Cadastral data (DCDB) for NWH study area local government areas

Local government boundaries

Places

Towns

State Digital Road Network (SDRN)

Stock routes

Vegetation

Regional Ecosystem Description Database (REDD)

Pre-clearing (RE11) RE mapping

Remnant (RE11) RE mapping

Species

All fauna species records were obtained from Queensland Historical Fauna database, Wildnet, ALA and panel provided data. Flora species records were obtained from HerbreCs, WildNet and Corveg databases

Wetlands

Queensland Wetland Mapping

Directory of Important Wetlands

Ramsar

Drainage network - rivers

Drainage network - creeks

Biodiversity Planning Assessment data

Queensland bioregion and subregion boundaries

Terrestrial and riparian state bioregional corridors

Protected areas

Protected areas

Nature refuges

Imagery

Landsat mosaic of the NWH bioregion

SPOT imagery (10 metres)

Documents available electronically

EHP 2014, *Biodiversity Assessment and Mapping Methodology. Version 2.2*, Department of Environment and Heritage Protection, Brisbane

Hard copy maps

NWH bioregions and subregions (Queensland)

Broad vegetation groups (1:5M)

Statewide corridors

Appendix 3: Candidate flora and fauna taxa considered but not implemented as NWH threatened species

Taxon Group	Species	Panel reason for not implementing
fauna	<i>Notomys longicaudatus</i>	Retain in report but exclude in records. May be remains from ghost bat feeding ground - unlikely to be live animal in 1980 as the long-tailed hopping mouse is presumed extinct.
fauna	<i>Polytelis alexandrae</i>	One historic record. NWH outside of distribution. Outside of recognised distribution. Possible vagrant/outlier. Include in notes but exclude single record.