Department of Environment and Science

A Biodiversity Planning Assessment for the Wet Tropics Bioregion

Version 1.1
Summary Report

Queensland Government

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Cover image: Crawfords Lookout, Palmerston Highway - taken and provided by Lorraine Briggs, Department of Environment and Science

August 2019.

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Nb. This report should be read in conjunction with the accompanying Expert Panel Report - A Biodiversity Planning Assessment for the Wet Tropics Bioregion: Expert Panel. Version 1.1 (DES 2019).

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Acronyms and abbreviations

ACA	Aquatic Conservation Assessment
BAMM	Biodiversity Assessment and Mapping Methodology
BPA	Biodiversity Planning Assessment
BRB	Brigalow Belt bioregion
CORVEG	The site survey database maintained by the Queensland Herbarium
DES	Department of Environment and Science
EHP	Department of Environment and Heritage Protection
EVNT	Endangered, vulnerable or near threatened under the Queensland *Nature Conservation Act 1992* and Commonwealth *Environment Protection and Biodiversity Conservation Act 1999.*
EPBC	*Environment Protection and Biodiversity Conservation Act 1999*
GIS	Geographic information system
HERBRECS	Specimen based register of plants held by Queensland Herbarium
RE	Regional ecosystem
SEQ	South East Queensland bioregion
WILDNET	Department of Environment and Science corporate wildlife application containing records and other information on Queensland flora and fauna
WET	Wet Tropics bioregion
WTMA	Wet Tropics Management Authority

1 Introduction

Long recognised as one of Australia's iconic regions, the Wet Tropics bioregion is a significant biodiversity hotspot. The Wet Tropics World Heritage Area (WTWHA) alone houses more than 2,800 vascular plant species, of which more than 700 are endemic, approximately 670 vertebrate animal species and the richest invertebrate fauna in Australia (WTMA 2019; WTMA 2017). The natural values of the area are one of the cornerstones that underpin the World Heritage status for much of the bioregion.

This report summarises the results of a Biodiversity Planning Assessment (BPA) for the Wet Tropics bioregion. BPAs provide a consistent approach for assessing biodiversity values at the landscape scale. Specifically, this BPA will be an important information layer for the review of the Wet Tropics Management Plan, to support future conservation planning and as an input into the mapping of those ecological Outstanding Universal Values (OUV) that support the World Heritage listing.

This project was led by the Department of Environment and Science (DES) with significant contributions from regional stakeholders, experts and the Wet Tropics Management Authority (WTMA). This report should be read in conjunction with the accompanying Expert Panel Report (DES 2019). For convenience, the Wet Tropics bioregion is hereafter referred to as WET.

1.1 Biodiversity Planning Assessments

The Biodiversity Assessment and Mapping Methodology (BAMM, version 2.2) (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 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 state departments, local governments or members of the community to advise on a range of decision-making processes.

The methodology is applied in two stages. 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.

BPAs have now been completed for twelve bioregions within Queensland. They provide a comprehensive source of baseline conservation and ecological information to support natural resource management and planning processes. They can be used as an independent product or as an important foundation for adding and considering a variety of additional environmental and socio-economic elements (i.e. an early input to broader ‘triple-bottom-line’ decision-making processes). BPAs are periodically updated as new information becomes available, underlying data layers change and resources permit.

BPAs provide a powerful decision support tool that can be interrogated through a GIS platform to support a range of decision making processes. For example, to date BPA results have been used to inform a wide range of assessment, planning and referral activities including:

- regional plans and local government planning schemes
- Queensland Parks and Wildlife Service park management plans
- government advice under the *Environmental Protection Act 1994 and Planning Act 2016*
- State government tenure dealings including identification of new protected areas
- habitat mapping for threatened species.

BPA 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.

While the BAMM incorporates aquatic biodiversity values, DES undertakes more detailed Aquatic Conservation Assessments (ACA) using the Aquatic Biodiversity Assessment and Mapping Methodology (AquaBAMM, Clayton et al. 2006).

1.2 Wet Tropics study area

Covering 1.99 million hectares, the WET is the second smallest bioregion in Queensland (Accad et al. 2017), extending for approximately 415km from north of Townsville to just south of Cooktown, including some offshore islands and a prominent outlier at Mt Elliot further south. The bioregion is comprised of nine subregions (refer to Table 1 and Figure 1~~Figure 1~~).

Table 1. Subregions of the Wet Tropics bioregion

Subregion	Preclear area (ha)	Area (ha) remnant remaining (as of 2015)	Percentage remnant remaining (as of 2015)
Herbert	218,747	104,640	47.8%
Tully	135,320	62,412	46.1%
Innisfail	191,925	79,056	41.2%
Atherton	176,570	87,062	49.3%
Paluma - Seaview	232,199	228,692	98.5%
Kirrama - Hinchinbrook	282,874	276,983	97.9%
Bellenden Ker - Lamb	270,868	250,439	92.5%
Macalister	112,558	91,711	81.5%
Daintree - Bloomfield	354,165	333,838	94.3%

The WET landscape is dominated by a series of coastal and sub-coastal granite and basalt ranges and plateaus. This includes Mt Bartle Frere, which at 1,622m, is the highest mountain in Queensland. These uplands are cut by several major eastward flowing rivers (e.g. Herbert, Johnstone, Tully and Mulgrave-Russell rivers) whose alluvial valleys and intervening coastlines form the only lowland parts of the region. Soils are mostly deep and derived from the underlying granite, metamorphic, volcanic and sedimentary rocks (Stanton et al. 2014). Rainforest occurs on highly weathered soils with high organic matter content (Spain 1991). The WET is a region of contrasting climates with cool mountain summits and plateaus (minimums down to 5^{o}C) and warm humid lowlands (maximums up to 35^{o}C). While the mean average rainfall is around 1,300mm, it can reach 12,000mm on Mt Bellenden Ker (Nix & Switzer 1991; WTMA 2016). The hot wet summers also regularly experience tropical cyclones resulting in significant rainfall events across the region.

During the Early Tertiary period, much of Australia was covered by rainforest, but changing climate saw major contraction to just 1 per cent of land surface in late Pliocene-early Pleistocene (White 1986). The WET represents the largest remnant of Australia's last major greening with biotic elements that can be traced back to Gondwanan origins. Climatic oscillations during the Quaternary has seen expansion and contraction in the extent, as well as changes in composition, of the wet forest of the WET (Barlow & Hyland 1988). In addition, increasing proximity to Asia has led to the inclusion of genera from this region. Patches of closed forest, especially on certain mountain ranges but also in some lowland river valleys that have remained relatively stable over geological time (Hilbert 2008; VanDerWal et al. 2009), have acted as refugia for relictual taxa as well as foci for speciation and endemism. Of the estimated 4,374 terrestrial vascular plant species in WET, 745 (17 per cent) are restricted/largely restricted to the bioregion and 322 (7.5 per cent) are listed as threatened (critically endangered, endangered, vulnerable or near threatened) under State or Commonwealth legislation (DES 2018).

High topographical, edaphic and climatic gradients have resulted in a high diversity of vegetation types. In terms of numbers of regional ecosystems per unit area, with 185 regional ecosystems (RE) the WET is the richest bioregion in Queensland (Neldner et al. 2017). Lowland vegetation types range from mangroves, beach scrub and palm forest to mesophyll rainforest, melaleuca swamp/woodland and eucalypt woodland (Goosem et al. 1999). In the upland areas various forms of rainforest (simple to complex notophyll/microphyll/mesophyll) and wet sclerophyll forest dominate with some eucalypt forest along the drier western margins. Communities such as cloud forest (simple notophyll vine-forest and simple microphyll vine-fern thicket) are restricted to the highest elevations above 1,200m (Goosem et al. 1999). Another distinct habitat comprises boulder fields and rock pavements that are inhabited by a number of endemic plants and animals.

The most dramatic changes in WET vegetation have been associated with European settlement. In the past 200 years there has been extensive clearing of the lowlands and the Atherton Tableland for agriculture. Currently, the amount of native vegetation remaining in these sub-regions is 41–49 per cent, compared to 81–98 per cent in the sub-regions dominated by mountains (Accad et al. 2017) - see Table 1. While only littoral rainforest and broad-leaved tea-tree swamps are currently protected under the EPBC, remnant coastal lowland rainforest in WET have been assessed as endangered (Metcalfe & Lawson 2015), particularly those on alluvial soils.

Rainforest refugia of upland areas in eastern Queensland from Windsor Tableland in the WET to the MacPherson Range on NSW border, form the mesotherm archipelago which enable temperate adapted taxa, either as distinct species or subspecies, to exist in subtropical and tropical regions (Nix 1993). These topographical isolates combined with habitat stability in the WET have led to remarkable level of endemism with taxa being restricted to the bioregion or even individual peaks within the region. For example, 34 per cent of frog species in the bioregion are restricted to the WET (WTMA 2016). Many of the endemic vertebrate taxa are currently listed as threatened. Endemic invertebrates (e.g. beetles and spiders) can also have highly localised attitudinal distributions within the WET, while several taxa exhibit Gondwanan origins being found elsewhere in distant locations in southern Australia, New Zealand, South America and New Caledonia (Monteith & Davies 1991). Nearly 45 per cent of Australia's vertebrate taxa have been recorded in the WET with large tracts identified as significant biodiversity hotspots (e.g. Birdlife Australia 2018).

Land use in the WET is primarily agriculture, especially sugar cane and tourism. The major population centres are situated either on, or near the coast, e.g. Cairns, Tully, Ingham, Innisfail, or, on the tablelands, e.g. Atherton. Approximately 48 per cent of the bioregion is within protected areas (national parks, conservation parks and resource reserves), most of which lie within the Wet Tropics World Heritage area that covers 45 per cent of the bioregion.

Key threats to biodiversity values within the bioregion include:

- habitat loss and hydrological changes due to clearing for agriculture and urbanisation (Laurance & Goosem 2008; WTMA 2013)
- climate change (Balston 2008; Williams et al. 2008)
- invasion by exotic and non-local native plants and animals, both terrestrial and freshwater (Goosem 2008; Congdon & Harrison 2008; WTMA 2013)
- changed fire regimes, e.g. loss of sclerophyll forest/woodland due to invasion by rainforest (Hilbert 2008; Stanton et al. 2014)
- disease, e.g. impact of chytrid fungus leading to the extinction of four species and decline in upland populations of three others (WTMA 2013)
- stochastic events, e.g. cyclones (Turton 2008 and references therein). Post-cyclone fires in disturbed forests (Unwin et al 1988) result in ongoing degradation with a repeated cycle of invasion by flammable grasses and more intense fires.

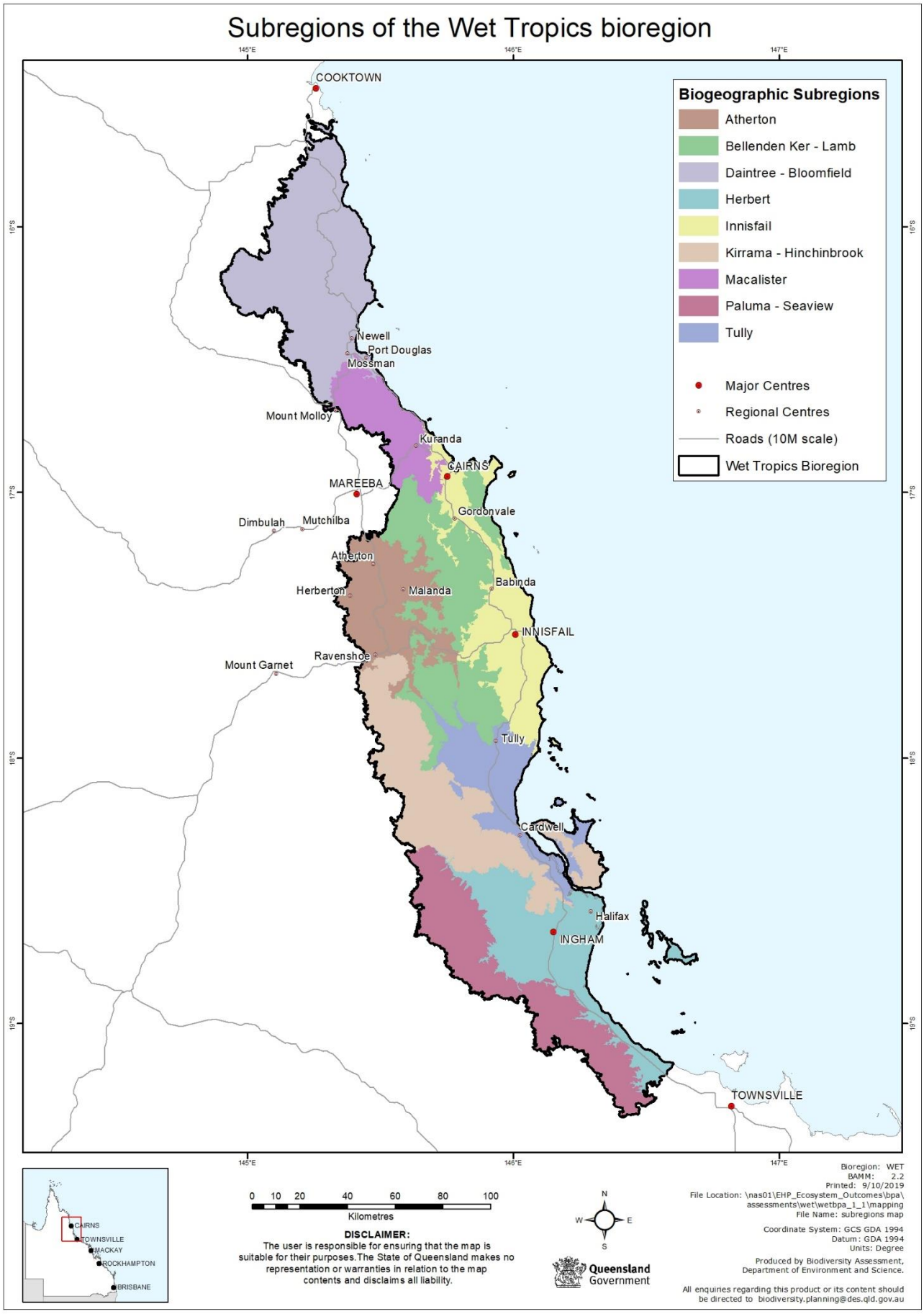

Figure 1. Subregions of the Wet Tropics bioregion

2 Methods and implementation

2.1 BAMM

The WET BPA was undertaken using BAMM version 2.2 (EHP 2014). Many factors contribute to the assessment of biodiversity values. The methodology focuses on consistent and reliable criteria that are transparent, objective and scientifically defensible. The criteria are in two groups (Table 2). The diagnostic criteria, based on existing data with bioregional coverage, are combined with expert panel criteria (expert elicited information) to produce the final BPA product (Figure 2~~Figure 2~~).

Table 2. BAMM criteria

Diagnostic criteria	**Expert panel criteria**
For analysis of uniformly available data	Assessed by expert panel using non-uniform data
A: Habitat for EVNT taxa **B**: Ecosystem value: at two scales: B1: State B2: Regional B3: Local **C**: Tract size **D**: Relative size of regional ecosystem: at two scales: D1: State D2: Regional **E**: Condition **F**: Ecosystem diversity **G**: Context and connection (relationship to water, endangered ecosystems and physical connection between contiguous remnant units)	**H**: Habitat for priority taxa **I**: Special biodiversity values **J**: Corridors **K**: Threatening process (condition)

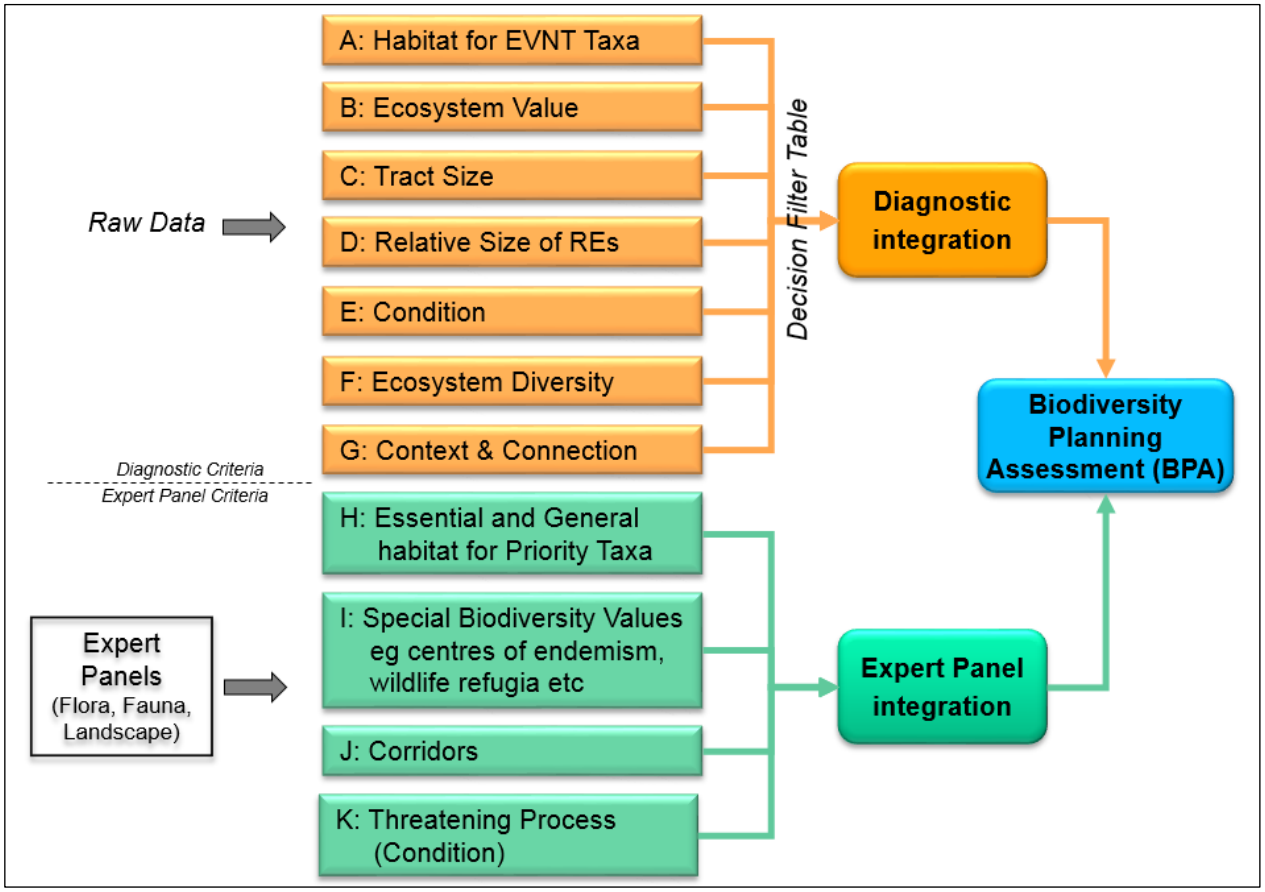

Figure 2. Biodiversity Assessment and Mapping Methodology (BAMM) process

The seven diagnostic criteria in Table 2 use largely uniformly available information that can be queried to automatically generate significance classes based on individual or combinations of biodiversity values. While species data are included in the diagnostic criteria, it is acknowledged that fauna and flora surveys are far from complete in Queensland and that existing data do not provide a uniform coverage across any bioregion.

A filtering process is used to assess remnant units using criteria A to G (refer to Appendix 1). Although the various data layers are integrated in a BPA, each layer can be interrogated separately to ensure transparency and allow for any combination of criteria to be used in isolation from others in decision making.

Data for the expert panel criteria (H to K, Table 2) are primarily derived through elicitation of accumulated knowledge held by persons considered familiar with the biodiversity values of the bioregion. Such information may not be quantitative in nature nor widely available, e.g. in published reports. The expert's role is to propose additional features not identified through the diagnostic criteria. For inclusion in the BPA, the experts must describe the values, significance, and spatial extent of the proposed features.

2.2 Datasets

Typically, a BPA draws on a wide range of datasets with a wide range of formats. This will generally include published scientific documents, unpublished data (grey literature) and officially collated data from various Queensland Government sources including data from the Queensland Museum, Queensland Herbarium, and WildNet. A list of datasets used in the WET BPA is included in Appendix 2.

2.3 Expert panels

Three expert panels were held in Cairns in April 2018 to identify flora, fauna and landscape ecological values. The findings from the WET BPA expert panel process are reported in the accompanying expert panel report (DES 2019).

2.4 Implementation

The BAMM version 2.2 (EHP 2014) was followed in this assessment. Custom python scripts and ArcGIS ModelBuilder toolboxes were used to apply BAMM and create the BPA. Previous methodological updates applied during the review of the Brigalow Belt (BRB) BPA version 2.1 and Southeast Queensland (SEQ) BPA version 4.1 were also implemented in the WET BPA and will form the basis for updating BAMM to version 3. The methodological changes since v2.2 are summarised in Table 3.

Table 3 BAMM method changes implemented in the Wet Tropics BPA version 1.1

Criterion	Change in BRB BPA Version 2.1 and SEQ BPA Version 4.1
A	Inclusion of non 1-to-1 habitat models - i.e. the inclusion of habitat models that do not necessarily spatially align/coincide with the boundary of remnant units
B	1. For the purpose of depicting B1 "Very High" significant wetlands, the base spatial unit was derived from the Queensland Wetland Program mapping product. "Significant wetlands" included those relatively natural wetlands which overlapped with Ramsar, Directory of Important Wetlands, Fish Habitat Areas, and/or State Marine Parks (exclusive of General Use zones) 2. EPBC listed threatened ecological communities were incorporated in Criterion B1 and assigned a significance rating of "Very high"
C	The method of tract delineation was reviewed and altered to account for pinch-points, edge effects and small gaps in tracts. Thresholds used to assign "Low", "Medium", "High" and "Very high" Criterion C significant ratings were calculated at the subregion level
H	1. Revised the justifications for nomination of priority species. 2. New category was incorporated - "Taxa particularly vulnerable to climate change" 3. Altered the spatial implementation to be more consistent with Criterion A and reduced the disproportionate impact of priority species records on the overall biodiversity significance value
I	Addition of a new Sub-criterion, Ik: Climate change refugia

2.5 Assessment parameters

The tools used to produce a BPA calculate a number of criteria parameters based on the size distribution of remnant vegetation polygons. As a result, these will vary between bioregions/subregions and versions of a BPA. Refer to the BAMM version 2.2 (EHP 2014) for further information with respect to specific criteria, methods and associated assessment parameters.

See Appendix 3 for the Criterion C subregion thresholds implemented in WET BPA.

For Criterion F (ecosystem diversity), the calculated buffer distance was 114.4 metres.

2.6 Transparency of results

After running the BAMM tool, BPA results are available at a range of levels, despite its initial presentation as a single score of biodiversity significance. The results are also available through application of user-defined queries that may interrogate one or more levels within the assessment in any number of possible combinations. This transparency provides the BPA end user (e.g. scientists, resource managers and conservation organisations) with a unique level of flexibility for BPA interrogation, interpretation and presentation. Links between the BPA results and a GIS environment facilitate this interrogation and provide a means of visualising the BPA results (Figure 3).

This data access and interrogation flexibility enables investigation of how different data contribute to the overall conservation value, investigation of missing data and an ability to tailor the BPA output for a particular purpose.

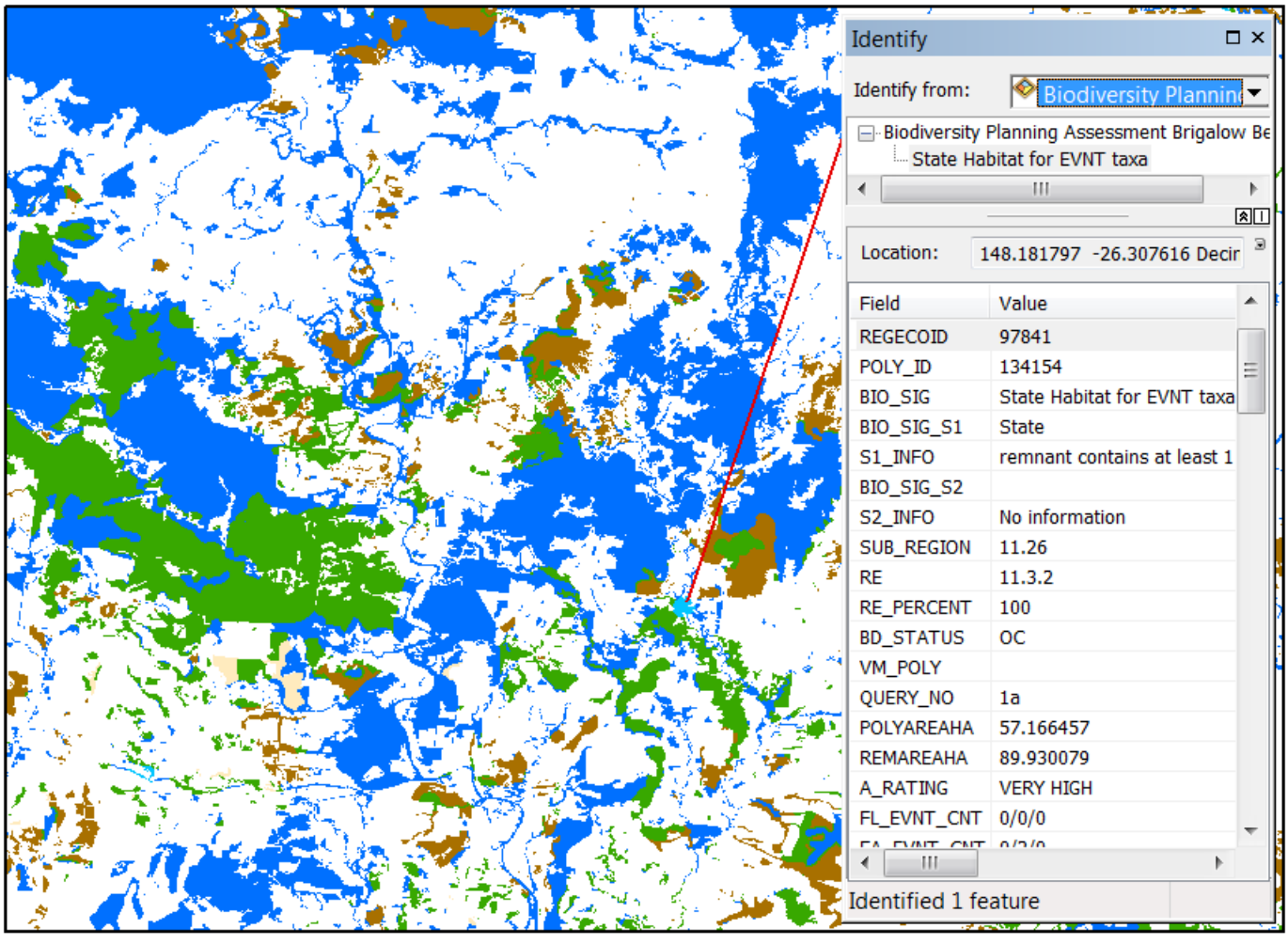

Figure 3. Interrogating the BPA results for a spatial unit in the GIS environment

2.7 Filter table

A single diagnostic biodiversity significance score is derived for each assessment unit by combining all of the diagnostic criteria ratings. This diagnostic significance is then combined with the expert panel significance and the maximum value assigned as the overall biodiversity significance score. This significance will be one of three levels: State, Regional, or Local.

To calculate the diagnostic biodiversity significance, BAMM uses a combination rating table (or filtering decision table), that provides an ordered series of decisions that are tested against the final diagnostic criteria ratings for each spatial unit. Each decision is a unique combination of criteria ratings that is associated with a final conservation significance category. The decisions are effectively a number of 'if-then' statements and are tested in sequence for each spatial unit. A score is assigned immediately when a match is achieved between the criteria rating combination of the decision and that of the assessment unit.

The filter table used to evaluate the diagnostic criteria and assign a biodiversity significance is contained in Appendix 1.

3 Results

3.1 Conservation value categories

The conservation value results are relative within each bioregion, but each value category has characteristics in common. The BAMM uses combinations of criteria level scores to determine the final biodiversity significance. Based on these combinations, the following descriptions can be used to provide context for each level of biodiversity significance.

State significance—Areas assessed as being significant for biodiversity at the bioregional or state scales. They also include 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 and or other values—Areas assessed as not being significant for biodiversity at State or Regional scales.

Non bioregional ecosystem—A regional ecosystem outlier from an adjacent bioregion.

3.2 Positional accuracy

The positional accuracy of the BPA results is dependent on the accuracy of the input data and primarily the Herbarium's regional ecosystem (RE) mapping version 10.0 (December 2016), which is primarily at a scale of 1:50,000 for the Wet Tropics. For 1:50,000 mapping the RE data has a minimum remnant polygon area of one hectare or minimum remnant width of 50 metres. The precision of polygon boundaries or positional accuracy of line-work is 50 metres.

Positional accuracies of other datasets are unknown, but at 1:100,000 scale, at least 100 metres should be assumed.

3.3 Wet Tropics BPA overall results

A summary of the WET BPA results is provided below. Overall, 93 per cent[1] (1.5 million ha) of remnant vegetation in the WET was found to have biodiversity values of State significance of which 65 per cent (1 million ha) is State Habitat for EVNT taxa. Regional significance was attributed to 7 per cent (114,455 ha), with the remaining 0.04 per cent of remnant vegetation being assigned Local or Other Values (Figure 4 and Figure 5).

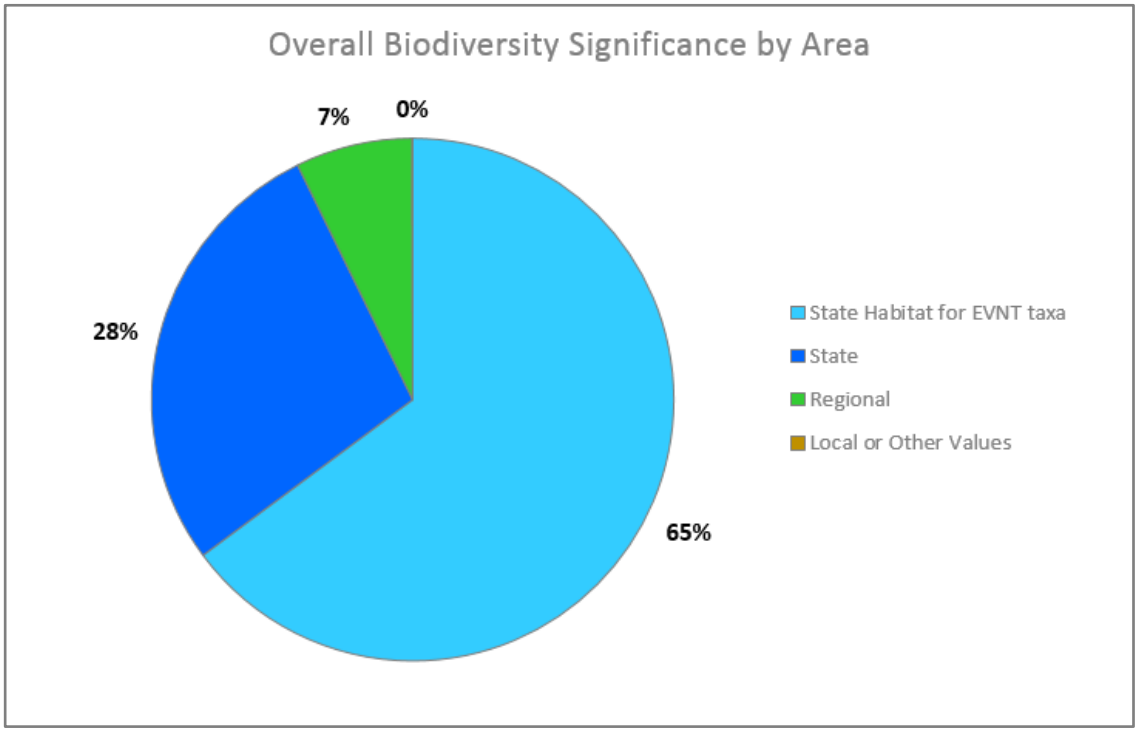

Figure 4. Summary of overall biodiversity significance as a proportion of Wet Tropics bioregion remnant vegetation

[1] Note that percentage area and area calculations mentioned throughout this report relate only to areas of WET remnant vegetation. Non-remnant areas (e.g. some significant wetlands types, threatened species habitat, panel identified special areas etc.) have been excluded for the purposes of the report.

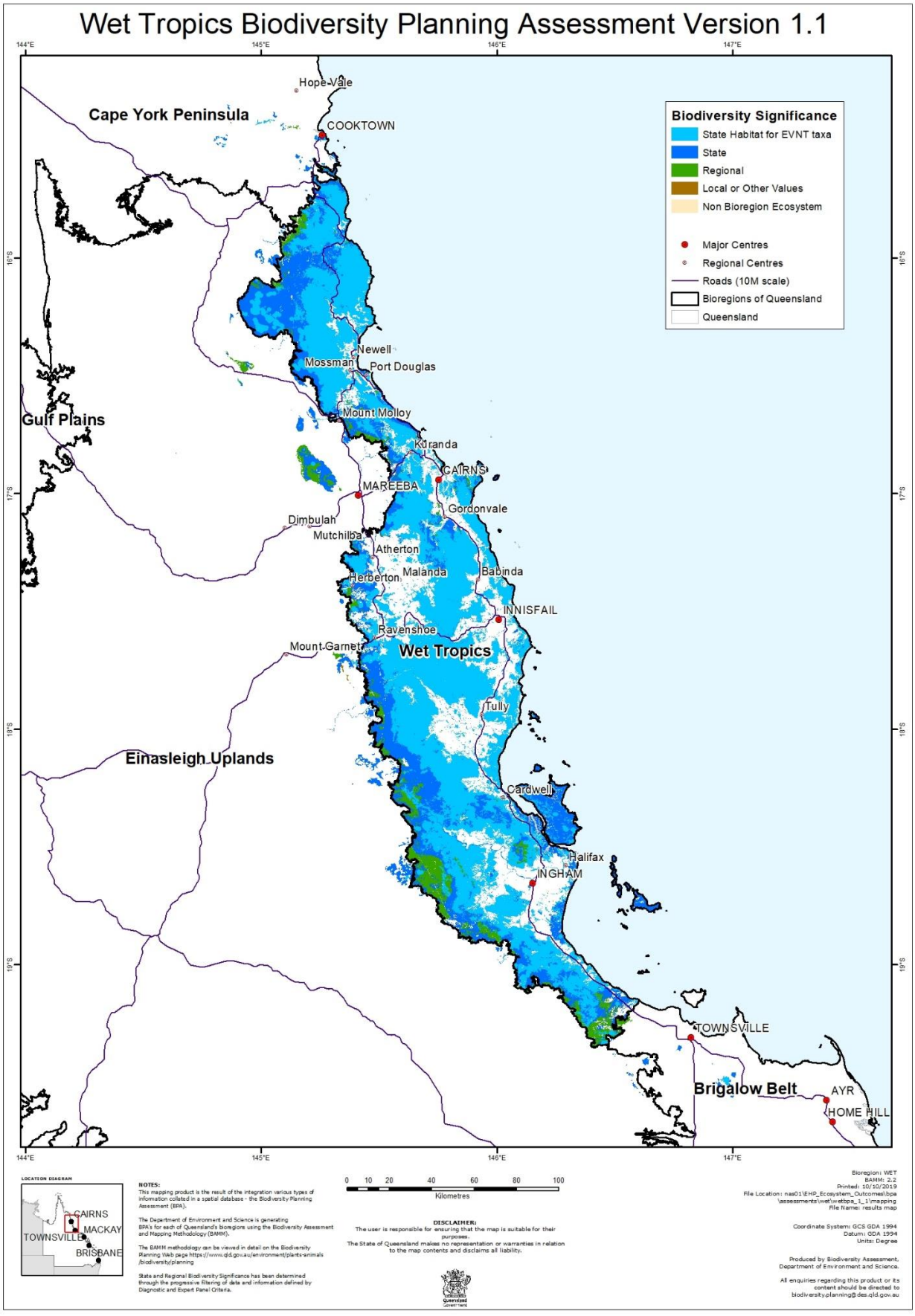

Figure 5. Overall biodiversity significance

As outlined in Table 2, the overall biodiversity significance is the result of a number of criteria that are assessed individually. Criteria A - G ratings are combined, via a filter table, to provide a diagnostic biodiversity significance, whilst Criteria H - K ratings, are combined to provide the expert panel biodiversity significance. Figure 6 shows the results for both the individual diagnostic and expert panel criteria.

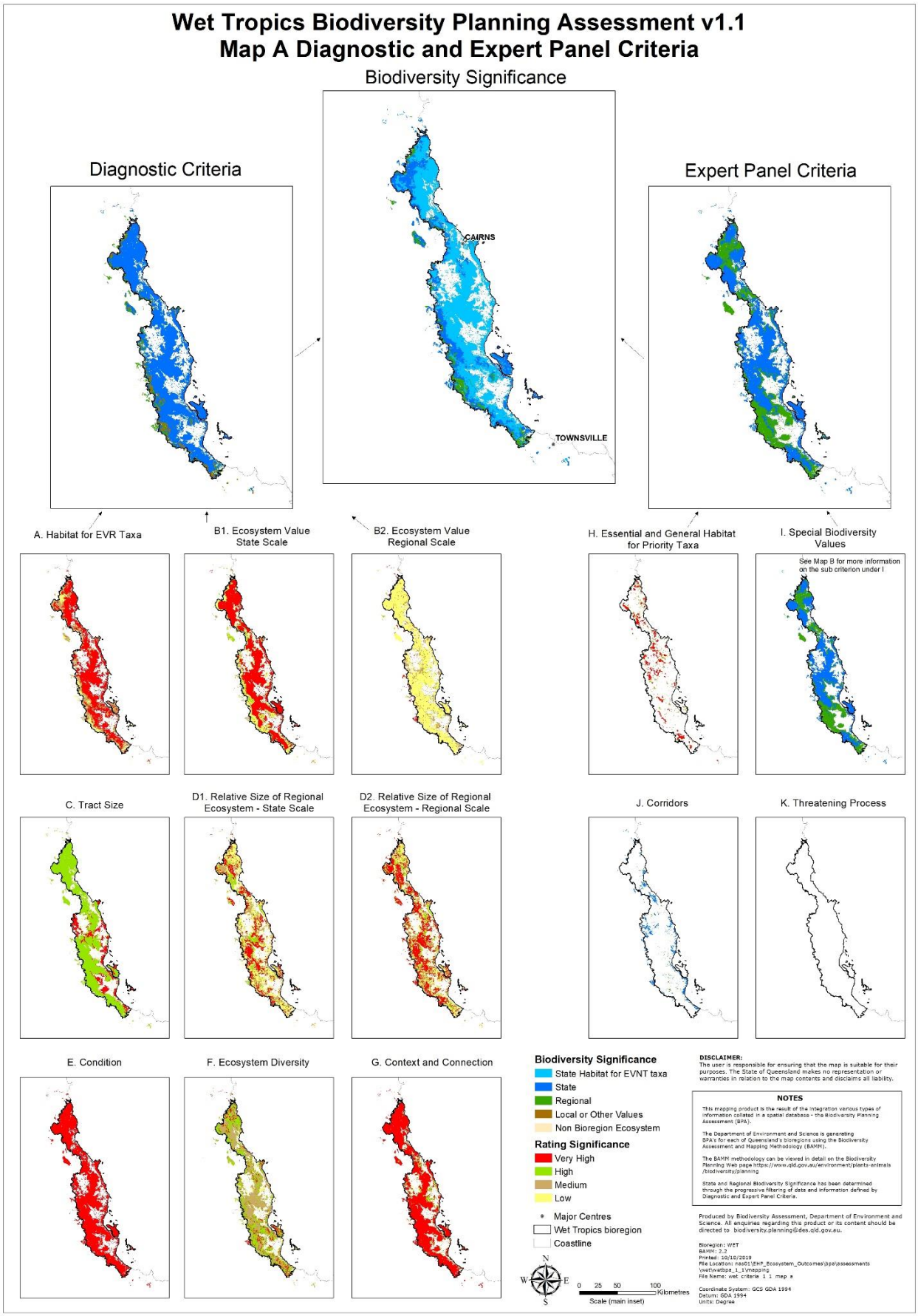

Figure 6. Diagnostic and expert panel criteria results

3.4 Diagnostic results

3.4.1 Overall diagnostic criteria results

From the diagnostic criteria, 87 per cent of the WET remnant vegetation (1.4 million ha) was found to have biodiversity values that are of State significance. Regional significance was attributed to 8 per cent (122,941 ha), and Local or Other Values attributed to 5 per cent (86,236 ha) of the WET remnant vegetation (Figure 7 and Figure 8).

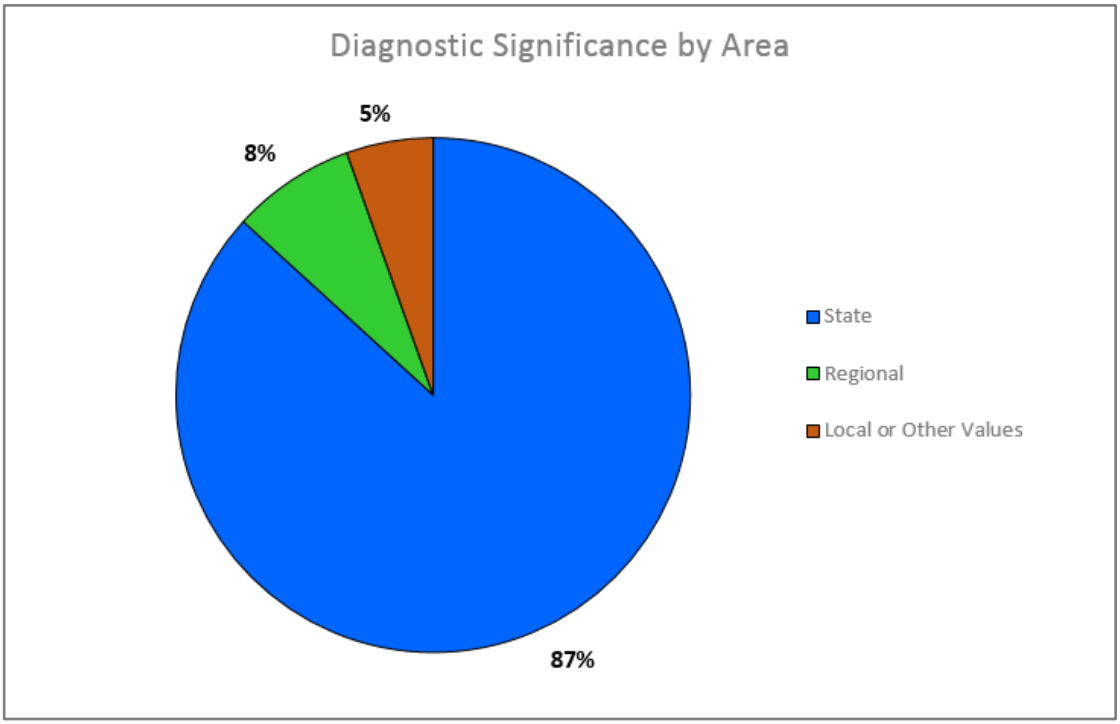

Figure 7. Summary of biodiversity assessment diagnostic criteria results as a proportion of remnant vegetation

The contribution of each diagnostic criterion to the diagnostic significance rating is summarised in Table 4 below.

Table 4 Diagnostic criteria ratings expressed as percentage of remnant vegetation cover only.

Diagnostic criterion rating	Very High % of remnant	High % of remnant	Medium % of remnant	Low % of remnant
A: Habitat for EVNT taxa	64.8%	1.0%	25.4%	8.8%
B1: Ecosystem value (Bioregion)	68.7%	10.5%	1.8%	19.0%
B2: Ecosystem Value (Subregion)	5.7%	2.4%	10.3%	81.6%
C: Tract	17.0%	79.6%	0.4%	3.0%
D1: Relative RE Size				

Diagnostic criterion rating	Very High % of remnant	High % of remnant	Medium % of remnant	Low % of remnant
(Bioregion)	26.6%	11.3%	17.5%	44.6%
D2: Relative RE Size (Subregion)	44.0%	10.9%	13.1%	32.0%
F: Ecosystem Diversity	14.4%	45.5%	36.9%	3.2%
G: Context and Connection	87.6%	6.6%	5.1%	0.7%

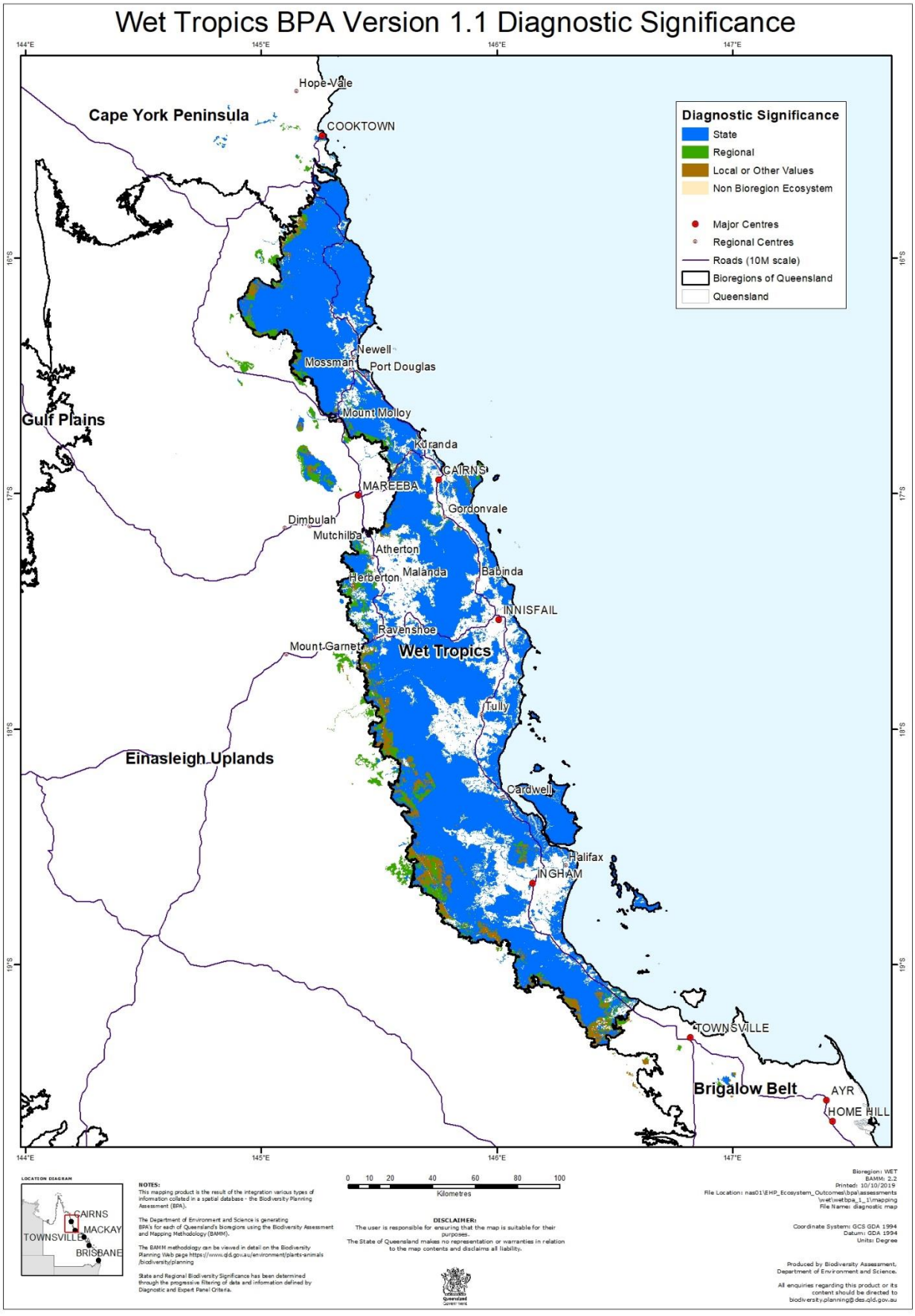

Figure 8. Diagnostic criteria biodiversity significance

3.4.2 Hit analysis

A 'hit analysis' was performed to assess the influence of each diagnostic criterion to the assignment of State or Regional biodiversity significance. For this analysis, hits equate to a polygon assigned significance due to individual or combinations of criteria as defined in the queries table (see Appendix 1). The results of the hit analysis for the diagnostic criteria are presented in Table 5 below.

Table 5. Diagnostic criteria hit analysis results. (Query number as per Appendix 1)

Query No.[1]	Area (ha)	Significance	Percentage of total area of remnant vegetation	Percentage of total query no. frequency
1a	1,025,804	State	64.8%	67.8%
1b	243,982	State	15.4%	20.0%
2a	37,277	State	2.4%	0.6%
3a	1,496	State	<0.1%	<0.1%
3b	12,733	State	0.8%	0.2%
4a	1,402	State	<0.1%	<0.1%
5a	156	State	<0.1%	<0.1%
5b	49,976	State	3.2%	0.4%
6a	5,447	Regional	0.3%	0.5%
6b	57,623	Regional	3.6%	5.2%
7a	18,390	Regional	1.2%	0.3%
8b	1,633	Regional	0.1%	<0.1%
9a	4,749	Regional	0.3%	0.2%
10a	1,445	Regional	<0.1%	0.2%
10b	4,348	Regional	0.3%	0.4%
11b	500	Regional	<0.1%	<0.1%
11f	4	Regional	<0.1%	<0.1%
11g	1,254	Regional	<0.1%	<0.1%
11i	15,399	Regional	1.0%	0.2%
12c	67	Regional	<0.1%	<0.1%
12d	12,082	Regional	0.8%	0.2%
13-19	86,236	Local	5.5%	3.6%

[1] The variations (a - i) of the queries refer to specific combinations of the criteria within the query.

The results of the hit analysis reveal that the most widespread (by area) combination to trigger 'State significance' is query 1a (64.8 per cent of remnant vegetation). This query reflects Very high ratings for Criterion A, which are determined by the extensive presence of threatened species habitat.

The most widespread (by area) combination to trigger Regional biodiversity significance is query 6b, with 3.6 per cent of remnant vegetation triggered. This query is due to a High rating for Criterion B1 (high conservation RE), indicating that the remnant unit contains an 'of concern' regional ecosystem.

3.5 Expert panel results

3.5.1 Overall expert panel results

Overall, 97 per cent of the WET remnant vegetation was assigned a significance rating by the expert panel. The expert panel attributed 63 per cent (999,186ha) of the WET with biodiversity values of State significance. Regional significance was attributed to 34 per cent (538,440ha) (Figure 9 and Figure 10), whilst 0.2 per cent (3,187 ha) attributed as being of Local significance. While there is a high level of confidence that the most important areas of the WET were identified by consulting experts and using existing data, it is possible that not all areas were identified.

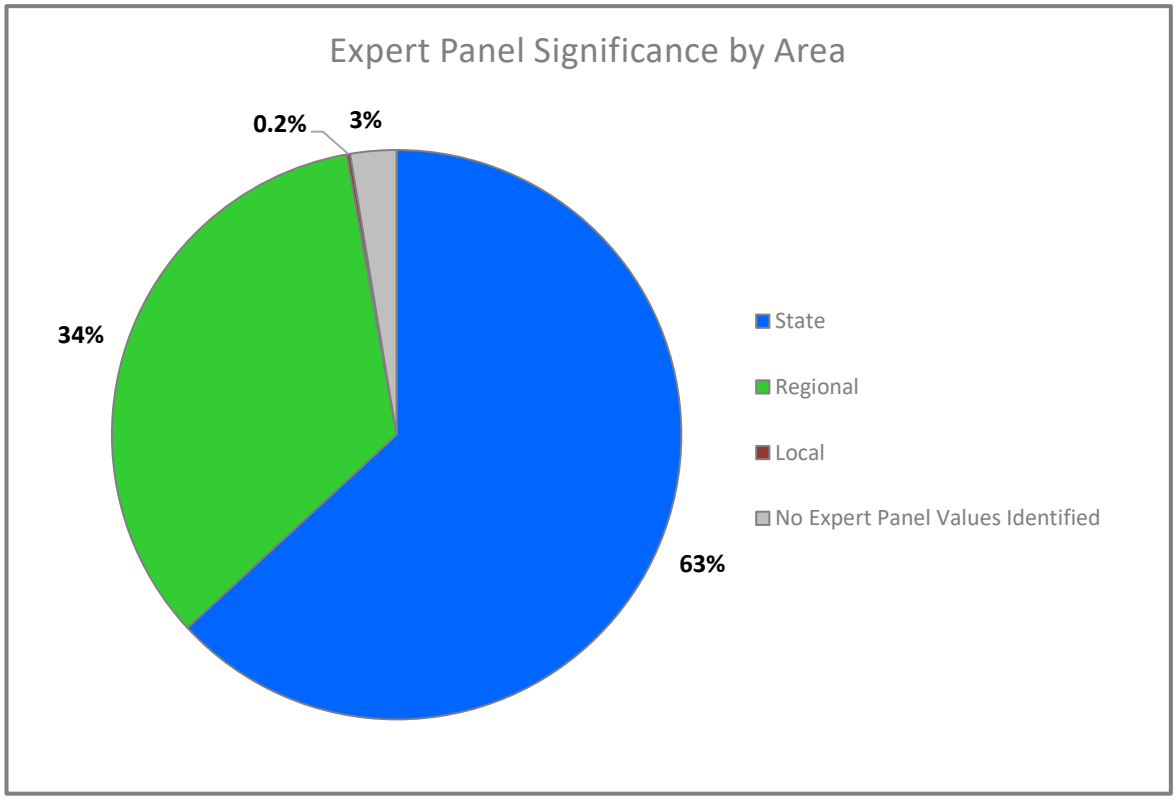

Figure 9. Summary of biodiversity assessment expert panel criteria results

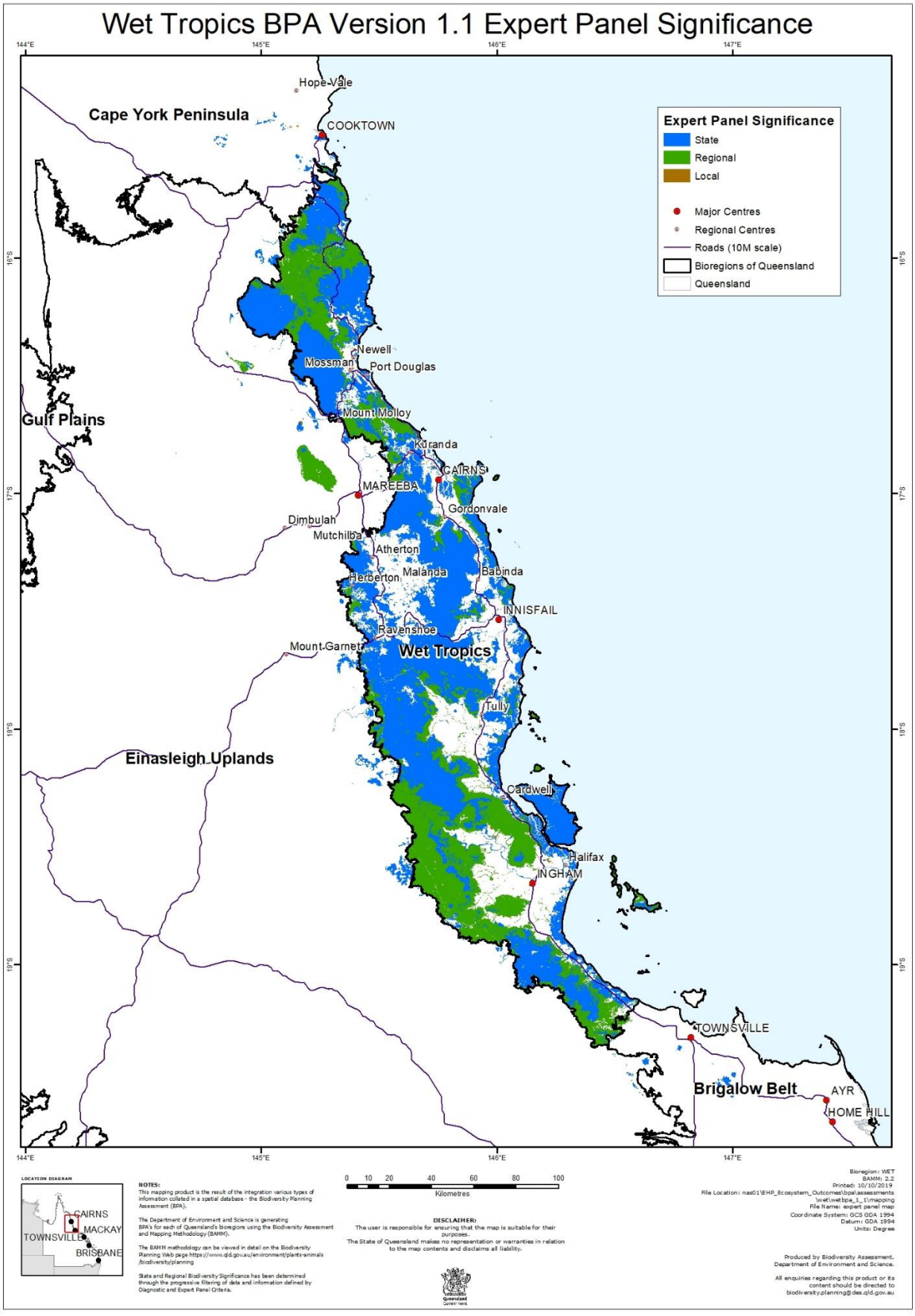

Figure 10. Expert panel criteria biodiversity significance

3.5.2 Criterion H (priority taxa habitat) results

Priority species are those not listed as endangered, vulnerable or near threatened, however, are considered to be of particular conservation significance by the flora and fauna expert panels (DES 2019). There were 226 priority species identified in the WET (78 flora, 148 fauna), and 16,645 total records for these species. Survey effort across the bioregion is variable. Some areas are very difficult to access while others have had comparatively high sampling effort. Approximately, 9.7 per cent of WET (153,081 ha) achieved a value of Very High for Criterion H, and 17,264 ha (1.1 per cent) was determined to be High for this criterion (Table 6).

Table 6. Criterion H (Priority taxa habitat) results as percentage of remnant vegetation

Criterion rating	Very High	High	Medium
H rating	9.7%	1.1%	8.5%

3.5.3 Other expert panel criteria

Criterion I (special areas) and Criterion J (corridors) were identified by the expert panel members. Approximately 94 per cent of the total remnant vegetation area has been identified as having Criterion I special biodiversity values (State, Regional or Local). Figure 11 illustrates the special areas and their biodiversity rating.

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 at a landscape scale. Corridors considered of the greatest importance at the bioregional scale or above were assigned State significance. This mapped network (State and Regional terrestrial corridors) comprises approximately 11 per cent of the WET remnant vegetation (Table 7).

Table 7. Criteria I, J, K biodiversity significance results as percentage of remnant vegetation

Criterion rating	State	Regional	Local
I rating (Special Areas)	58.2%	35.9%	<0.1%
J rating (Corridors)	9.7%	1%	<0.1%
K rating (Threatening Process - Condition)	0%	0%	0%

3.5.4 Criterion I sub-criteria results

Areas exhibiting special biodiversity values are identified by flora, fauna and landscape expert panel members based on their own knowledge and experience. Expert panel members were tasked with identifying what they considered to be the most important areas in the bioregion. For the most part, only Very High and High category values were identified, with Medium values identified less frequently. These identified areas are determined by selection and assignment of specific sub-criteria I values as defined in Table 8. Areas identified as important for wildlife refugia (Ib rating) accounted for - 90 per cent, 1.4 million ha of remnant vegetation. Areas identified as exhibiting Very High species richness (Ie rating), accounted for - 51 per cent, (805,440 ha) of remnant vegetation and areas identified as having Very High levels of species endemism (Ia rating) accounted for 35 per cent of remnant vegetation.

Approximately 94 per cent of remnant vegetation was identified by the expert panel as exhibiting Very High' sub-criteria values for special features (Criteria I). The expert panel report (DES 2019) has detailed information relating to these areas. Most areas exhibited more than one sub-criteria value, with many exhibiting up to five sub-criteria values. Each of the sub-criteria were assessed and valued separately by the expert panel and the results are shown in Table 8 and Figure 11.

Table 8. Criterion I sub-criteria results as percentage of remnant vegetation

Criterion I sub-rating	Very High	High	Medium
Ia rating (centre of endemism)	35.1%	6.7%	1.3%
Ib rating (wildlife refugia)	34.5%	55.9%	<0.1%
Ic rating (disjunct populations)	26.9%	6.7%	3.7%
Id rating (species at geographic range limit)	25.1%	1.7%	5.3%
Ie rating (high species richness)	50.9%	8.7%	<0.1%
If rating (areas with concentrations of relictual populations - ancient and primitive taxa)	21%	1.4%	5.7%
Ig rating (REs show distinct variation in species composition)	14.1%	10%	<0.1%
Ih rating (artificial waterbody or managed/manipulated wetland of ecological significance)	-	<0.1%	-
Ii rating (high relative densities of habitat shelters)	15.7%	1.5%	-
Ij rating (significant breeding or roosting sites)	17.9%	5.9%	-
Ik rating (climate change refugia)	13.8%	13.4%	3.8%

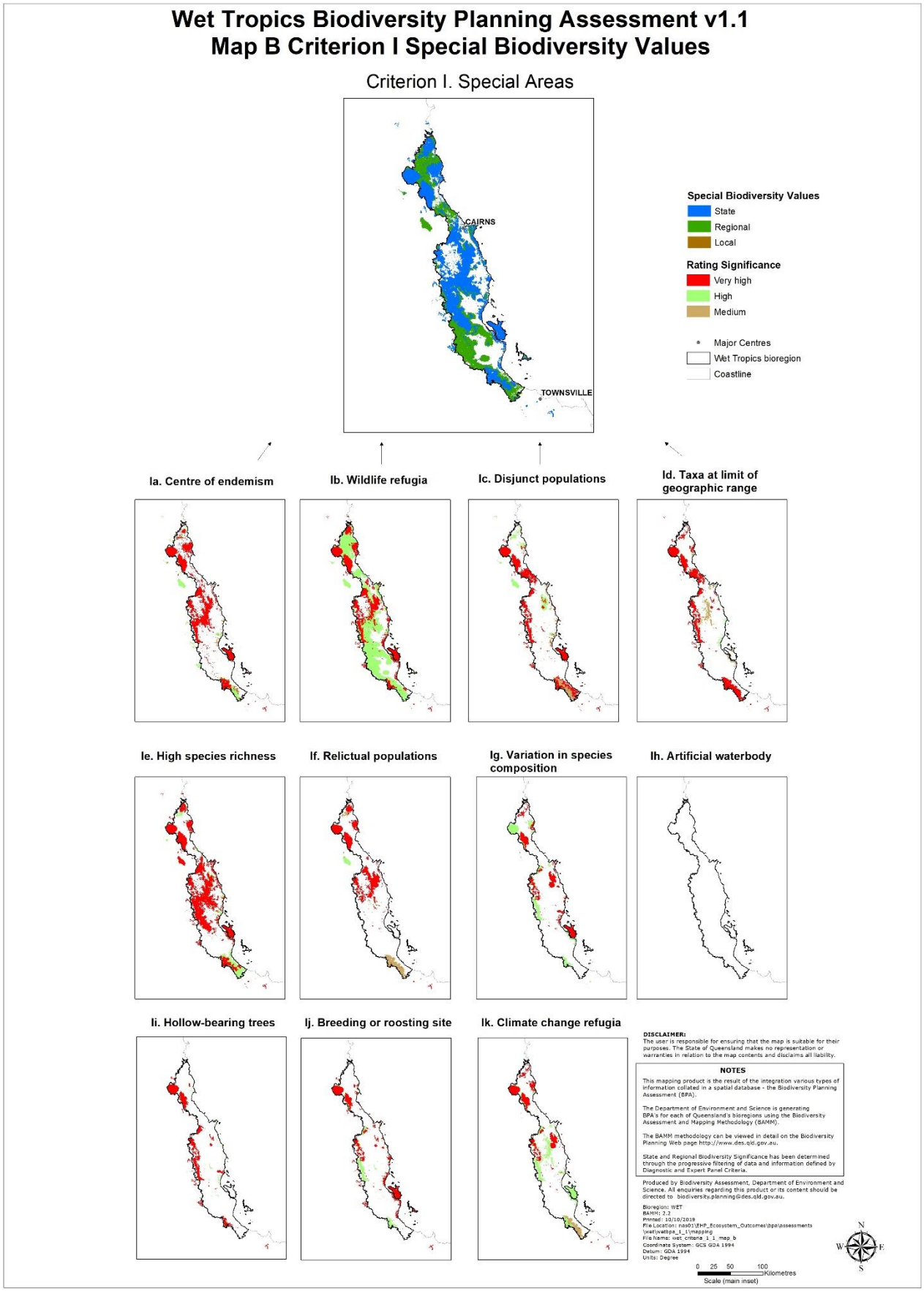

Figure 11. Criterion I special biodiversity values

3.6 Assessment caveats and limitations

It should be emphasised that the overall biodiversity significance rating attributed to each spatial unit is an initial flag to identify known areas of high biodiversity value. Individual criterion ratings should be used to address specific questions depending upon the exercise at hand.

Within a BPA, whilst some criteria ratings are calculated in a deterministic manner (for example high confidence of the presence of an endangered species results in a locality being assigned as Very High under Criterion A), the majority of criteria ratings are calculated relevant to the values present in a bioregion. This provides representation at a bioregion scale and a Very High score in one bioregion is the same as a Very High score in another with respect to the range of values within each. However, direct comparison of criterion results across bioregions is not appropriate. For example, areas containing 30 vertebrate species can be given a species richness (i.e. ~~ie~~ rating) rating of Very High in one bioregion, whilst only Medium in another.

The accuracy and representativeness of the BAMM criteria is largely reliant upon available information. Even within bioregions with comparatively high levels of survey effort, significant knowledge gaps can be present resulting in data layers that are not spatially uniform across the bioregion. For example, areas close to populated centres, roads and accessible areas of public land (i.e. national parks) are generally subject to greater levels of species survey effort, whilst ranges, escarpments and vegetated tracts on private land are often under-represented. The BAMM expert panel process is used, in part, to moderate and fill such knowledge gaps, however the outcomes from the expert panel process are only as comprehensive as the range of experts who contribute and the extent of their knowledge of the bioregion. The increasing availability of predictive habitat suitability models will reduce reliance on sightings records for identifying conservation significant habitat and taxa hot spots.

Whenever lines are drawn on a map, e.g. from the expert panels or extracted from datasets produced as part of other assessments, there is a risk that the boundary may be approximate at the scale of the individual spatial unit. For such decisions, the boundary should always be considered at the appropriate scale. For the majority of diagnostic criteria, and many of the special areas identified by the expert panel, the fundamental spatial input is the Queensland regional ecosystem mapping. The WET remnant vegetation cover mapping is at 1:50 000 scale and delineates a minimum area for remnant vegetation of 0.5 ha with a 20 m width limit for linear features.

4 Summary

Approximately 93 per cent of the remnant vegetation of the WET was assessed as being of State biodiversity significance. This high proportion is not a surprise given a large portion of the bioregion is a World Heritage Area of global significance. The WET contains ecosystems recognised for their importance at a national and international scale, a relatively high number of threatened species, relictual and evolutionary important taxa. Additionally, comparative to other bioregions, a high proportion of the species present are also bioregional endemics.

The diagnostic criteria accounted for 87 per cent of the remnant vegetation mapped as being designated State biodiversity significance. The major contributing factors for this was the presence of threatened species habitat (Criterion A), which accounted for approximately 65 per cent of the total area of mapped remnant vegetation, and Areas with Very High ecosystem value (Criterion B1), which was attributed to 69 per cent of remnant vegetation. The World Heritage Area alone overlays approximately 59 per cent of WET remnant vegetation.

The expert panel criteria identified 97 per cent of remnant vegetation within the WET as having biodiversity values of State or Regional significance. This was largely due to Criterion I special biodiversity values. For example, approximately 58 per cent of the bioregion was identified as having State significant biodiversity values for special features (Criterion I). Please refer to the accompanying expert panel report for more detailed information on the special features identified during the WET BPA expert panel process.

The results of a BPA can be used in a number of ways and for a number of purposes. For example, well-founded ecological or conservation values assessments are a useful input to natural resource management decision making processes, regional planning, development assessment, tenure negotiations or protected area estate review. The criterion and sub-criterion ratings from each assessment can be used for management and planning purposes. An example of this is the spatial prioritising of natural resource management actions within a bioregion including ecological surveys, changes in land management practices, rehabilitation and weed eradication.

The biodiversity of the WET is facing several threats including habitat loss and hydrological changes due to clearing for agriculture and urbanisation (Laurance & Goosem 2008; WTMA 2013). Over coming decades, the impacts associated with these threats may also be exacerbated by climate change. Maintaining ecosystem resilience through landscape connectivity and topographic variation will be key to mitigating the effects of climate change. More information is needed to quantify what impacts these threats are having and are likely to have on the biodiversity values of the bioregion.

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6 Appendices

Appendix 1: Filter table used to evaluate the diagnostic criteria and assign a "BIO_SIG_1" significance

Biodiversity significance of remnant units	Query No.	A: Essential habitat for EVNT spp.		B: Ecosystem value		C: Tract size		D: Relative size of ecosystem		E: Condition		F: Ecosystem diversity		G: Context & connection
S: State	**1**	A: very high	or	B1: very high		n/r		n/r		n/r		n/r		n/r
Or	**2**	n/r		B1: high		n/r	&	D1: very high		n/r		n/r		n/r
Or	**3**	n/r		B1: high	&	C: high	&	D1: high	&	E: very high[1]	or	F: very high[1]	or	G: very high[1]
Or	**4**	n/r		n/r		C: very high	&	D1: very high	&	E: very high		n/r		n/r
Or	**5**	n/r		n/r		n/r		D1: very high	&	E: very high[1]	or	F: very high[1]	or	G: very high[1]
R: Regional	**6**	A: high	or	B1: high		n/r		n/r		n/r		n/r		n/r
Or	**7**	n/r		B2: very high		n/r		n/r		n/r		n/r		n/r
Or	**8**	n/r		B2: high	&	C: very high	or	D2: very high		n/r		n/r		n/r
Or	**9**	n/r		n/r		C: very high	&	D2: very high	&	E: very high		n/r		n/r
Or	**10**	n/r		n/r		C: very high		n/r	&	E: very high	&	F: very high	or	G: very high
Or	**11**	n/r		B2: high	&	C: high	&	D2: high[2]	or	E: very high or high[2]	or	F: very high or high[2]	or	G: very high or high[2]

Biodiversity significance of remnant units	Query No.	A: Essential habitat for EVNT spp.		B: Ecosystem value		C: Tract size		D: Relative size of ecosystem		E: Condition		F: Ecosystem diversity		G: Context & connection
Or	**12**	n/r		n/r		n/r		D2: very high	&	E: very high or high[2]	or	F: very high or high[2]	or	G: very high or high[2]
L: Local	**13**	n/r		B2: high		n/r		n/r		n/r		n/r		n/r
Or	**14**	n/r		B3: very high		n/r		n/r		n/r		n/r		n/r
Or	**15**	n/r		B3: high	&	C: very high	or	D3: very high		n/r		n/r		n/r
Or	**16**	n/r		n/r		C: very high	&	D3: very high	&	E: very high		n/r		n/r
Or	**17**	n/r		n/r		C: very high		n/r	&	E: very high or high[2]	or	F: very high or high[2]	or	G: very high or high[2]
Or	**18**	A: medium	or	B3: high	or	C: high	&	D3: high[2]	or	E: very high or high[2]	or	F: very high or high[2]	or	G: very high or high[2]
Or	**19**	n/r		n/r		n/r		D3: very high	&	E: very high or high[2]	or	F: very high or high[2]	or	G: very high or high[2]

Notes:

The assessment is progressive, i.e. a query is 'triggered' only if the preceding set has not been satisfied.

Criteria B & D vary according to the scale (State, Regional, Local)—all other criteria are independent of scale.

N/R: Not relevant.

VH: Very high

Very High[1]: A single 'Very High' score is not sufficient—at least two of the criteria marked as Very High[1] must be rated as Very High to qualify as significant.

High[2]: A single 'High' score is not sufficient— at least two of the criteria marked as High[2] must be rated as 'High' to qualify as significant.

'or': Options which apply only to the query immediately preceding the 'or' (i.e. A & B or C or D means A+B or A+C or A+D; A or B & C means A+C or B+C; A or B & C or D means A+C or A+D or B+C or B+D)

Appendix 2: List of datasets used in Wet Tropics BPA v1.1

Dataset	Version	Release date	Custodian
Directory of important wetlands		Published 01/01/2005	DES
Ecological communities of national significance database		Published 15/11/2016	Australian Government Department of Environment and Energy
Fish habitat areas		Published 17/03/2017	DES
Nature refuges - Queensland		Published 28/07/2017	DES
Protected areas of Queensland		Published 13/09/2017	DES
Queensland wetland data – wetland Areas	Version 4.0	Published September 2015	DES
Ramsar		Published 22/11/2002	DES
Remnant and preclearing regional ecosystem mapping	10.0	Published December 2016	DES—Queensland Herbarium
Species records - Australian Tropical Herbarium database		Extracted 02/05/2018	Australian Tropical Herbarium
Species records - CORVEG		Extracted 06/03/2018	DES—Queensland Herbarium
Species records - HERBRECS		Extracted 28/05/2018	DES—Queensland Herbarium
Species records – Queensland historical fauna database (QHFD)		Extracted 7/08/2018	DES—Biodiversity Assessment
Species records – USQ selected fauna records		Provided by Jesse Rowland and Scott Burnett on the 7/11/2018	University of Sunshine Coast
Species records - WildNet		Extracted 09/02/2018 for flora, 07/11/2018 for fauna	DES
State marine parks		Revised 19/06/2014	DES
WET rainforest fauna density mapping		Provided by Steven Williams, 23 April 2018	James Cook University
World heritage areas		Published 23/03/2017	Australian Government Department of the Environment and Energy

Appendix 3: Criterion C subregion thresholds implemented in Wet Tropics BPA v1.1

Subregion	Low	Medium	High	Very High
3.2	<118.1	<231.6	<1516.9	NA
3.5	<41954.4	<83908.8	<125863.3	NA
7.1	<206.8	<375.0	<1846.1	54503.2
7.2	<270.4	<508.5	<2772.1	14851.3
7.3	<290.1	<578.9	<3798.1	18450.9
7.4	<144.6	<219.2	<636.8	70147.1
7.5	<19205.8	<38411.5	<57617.3	NA
7.6	<361.7	<1348.6	<85177.2	NA
7.7	<419.1	<904.1	<7470.2	NA
7.8	<204.4	<351.3	<1466.8	NA
7.9	<226.4	<412.8	<2060.1	NA
9.2	<248.4	<523.6	<4146.9	NA
9.3	<120.3	<185.5	<569.0	NA
9.4	<116.8	<192.8	<727.9	NA
9.6	<205.3	<355.1	<1511.9	NA
11.1	<348.7	<677.7	<4048.6	NA