Aquatic Conservation Assessment using AquaBAMM for the riverine and non-riverine wetlands of the Eastern Gulf of Carpentaria

Summary Report

Version 1.1

Queensland Government

Prepared by: Biodiversity Assessment, Conservation and Biodiversity Strategy, Department of Environment and Science

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Cover photo: Mitchell river approximately 18km upstream of its confluence with the Walsh river. (S. Chemello, Dept. Environment and Science 2017)

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Contents

Tables

Figures

Plates

NB. This report should be read in conjunction with the accompanying Expert Panel Report – An Aquatic Conservation Assessment for the riverine and non-riverine wetlands of the Eastern Gulf of Carpentaria: Flora, Fauna and Ecology Expert Panel Report, Version 1.1 (DES 2018).

Acronyms and abbreviations

ACA	Aquatic Conservation Assessment
AquaBAMM	Aquatic Biodiversity Assessment and Mapping Methodology
ASL	Above Sea Level
BAMM	Biodiversity Assessment and Mapping Methodology
BPA	Biodiversity Planning Assessment
CAMBA	China–Australia Migratory Bird Agreement
CIM	Criteria, indicators and measures (used in AquaBAMM)
CYP	Cape York Peninsula bioregion
DAF	Department of Agriculture and Forestry
DIWA	Directory of Important Wetlands in Australia
DERM	Department of Environment and Heritage Protection
DES	Department of Environment and Science
EGoC	Eastern Gulf of Carpentaria
EIU	Einasleigh Uplands bioregion
EPBC	*Environment Protection and Biodiversity Conservation Act 1999*
GUP	Gulf Plains bioregion
IBRA	Interim Biogeographic Regionalisation for Australia
JAMBA	Japan–Australia Migratory Bird Agreement
MDIA	Mareeba-Dimbulah Irrigation Area
MGD	Mitchell Grass Downs
NCA	*Nature Conservation Act 1992*
NP	National Park
QHFD	Queensland Historical Fauna Database
QLUMP	Queensland Landuse Mapping Program
QWS	Queensland Wetland System
Ramsar	Ramsar Convention on Wetlands
RE	Regional Ecosystem
REDD	Regional Ecosystem Description Database
ROKAMBA	Republic of Korea–Australia Migratory Bird Agreement
SOR	State of the Rivers
WET	Wet Tropics bioregion

1 Introduction

Australia's tropical north has a long and chequered history of initiatives aimed at intensified agricultural and pastoral production. While broad analyses have identified areas with the land and water resources capable of supporting intensified production (Petheram et al. 2013), variable rainfall patterns, high potential evapotranspiration rates, and seasonally dynamic hydrological regimes linked to critical ecological processes combine to create complex ecological settings which needs to be considered for resource allocation to occur in a sustainable way (CSIRO 2009). Careful planning and adaptive management regimes supported by accurate and up-to-date information is key to dealing with this complexity.

The Aquatic Biodiversity Assessment and Mapping Methodology (AquaBAMM) was developed in 2006 to provide a robust and repeatable method for assessing the biodiversity values of Queensland's wetlands (Clayton et al. 2006). The method uses a comprehensive set of criteria founded upon a large body of national and international literature. The criteria are combined to assign an overall biodiversity value (AquaScore) to each wetland or spatial unit. The criteria, each of which have a variable numbers of indicators and measures, include Naturalness Aquatic, Naturalness Catchment, Diversity and Richness, Threatened Species and Ecosystems, Priority Species and Ecosystems, Special and Unique Features, Connectivity and Representativeness. The product of applying the AquaBAMM is an Aquatic Conservation Assessment (ACA) for a particular study area (usually a catchment).

Aquatic conservation assessments are non-social, non-economic and tenure neutral. Assessment results include a comprehensive set of baseline ecological information, in addition to the AquaScore, at the individual wetland scale. Assessment measures are populated with data from a range of sources including expert opinion elicited during a series of structured expert panel workshops. Aquatic conservation assessment provide a powerful decision support tool that can be easily interrogated through a geographic information system (GIS) to support natural resource management decisions, policy or regulatory development and implementation. For example, ACA results can have application in:

- Determining priorities for protection, regulation or rehabilitation of wetlands and other aquatic ecosystems.
- On-ground investment in wetlands and other aquatic ecosystems.
- Contributing to impact assessment of large-scale development (e.g. dams).
- Water resource and strategic regional planning processes.
- Providing input to broader social and economic evaluation and prioritisation processes.

This report summarises the methods and results for the Aquatic Conservation Assessments completed for the Flinders, Norman, Gilbert, Staaten and Mitchell River Catchments (Table 1). The process included: a revision, using updated Queensland Wetland Mapping data (version 4.0), species sighting records and statuses, of the draft results completed for the Flinders, Norman and Gilbert River catchments in 2010 (Rollason & Howell, 2010); completely new assessments for the Staaten and Mitchell catchments (an ACA was completed for the northern section of the Mitchell catchment as part of a Cape York Aquatic Conservation Assessment, EHP 2012a, b). The overall study area is referred to in this report as the Eastern Gulf of Carpentaria (EGoC).

The assessment of the five catchments was restricted to the freshwater riverine and non-riverine systems. An assessment of estuarine systems was not undertaken due to difficulties with habitat differentiation that inhibited development of suitable spatial units that would be appropriate for the implementation of measures. Work is being undertaken on this concept to enable inclusion in future assessments.

This report should be read in conjunction with the accompanying Expert Panel Report – An Aquatic Conservation Assessment for the riverine and non-riverine wetlands of the Eastern Gulf of Carpentaria: Flora, fauna and Ecology Expert Panel Report, Version 1.1 (DES 2018).

Table 1. Catchments of the Eastern Gulf of Carpentaria Aquatic Conservation Assessment project

ACA study areas or catchments	Study area code	Catchment area (ha)	Number of riverine spatial units	Number of non-riverine wetlands	Area of non-riverine wetlands (ha)
Flinders	fl	10,862,569	405	3,009	34,965
Norman	nn	5,099,988	195	8,558	87,974
Gilbert	gi	4,593,137	191	2,712	46,581
Staaten	sn	2,599,319	100	3,388	30,633

ACA study areas or catchments	Study area code	Catchment area (ha)	Number of riverine spatial units	Number of non-riverine wetlands	Area of non-riverine wetlands (ha)
Mitchell	ml	7,141,076	256	8,983	88,199
	TOTAL	30,296,090	1,147	26,650	288,352

1.1 Eastern Gulf of Carpentaria study region

1.1.1 General region

The Eastern Gulf of Carpentaria region comprises five study areas – Flinders, Norman, Gilbert, Staaten and Mitchell River basins (Figure 1). Combined they cover the eastern two thirds of the Gulf Plains Bioregion and the western two thirds of the Einasleigh Uplands Bioregion (Sattler & Williams 1999). The headwaters of southern and northern areas are spread among the adjoining bioregions (Flinders River - Northwest Highlands, Mitchell Grass Downs and Desert Uplands; Mitchell River - Cape York Peninsula and Wet Tropics) (Sattler & Williams 1999; Tait et al. 2015). While extending over a significant latitudinal range, the various study areas exhibit a number of similarities.

The region experiences a semi-arid/wet-dry monsoonal climate characterised by a long, hot, dry spring preceding a hot, humid summer. Winters are short but cooler and dry (DERM 2010). Inter-year variation in rainfall is high but seasonally predictable with most falling during the wet season (December-March) and a spatial pattern of highest precipitation in the north and along the coast declining as one moves inland and to the south (Tait et al. 2015). Because of high levels of evaporation most of the study areas have a mean annual rainfall deficit (Waltham et al. 2013). The high rainfall events associated with cyclones or storms result in extensive flooding across the plains (Faggotter et al. 2011, Hogan & Vallance 2012), often resulting in widespread inter-connectedness between adjoining catchments. At such times catchment boundaries can effectively disappear and even during the dry their locations can be ill-defined.

All the region’s major rivers enter the Gulf of Carpentaria after passing through the Karumba Plains subregion. This coastal belt contains of mudflats and saline plains, mangrove-lined estuaries and dune systems. Blackman et al. (1999) recognised the significance of extensive saltwater and freshwater wetlands with all of the area being listed as important wetlands (Southern Gulf Aggregation – Flinders and Norman; and Southeast Karumba Plain Aggregation – Gilbert, Staaten and Mitchell). Much of the region’s shoreline and immediate hinterland covered by these wetland aggregations is recognised as a significant location for migratory waders and waterbirds – the Gulf Plain Important Bird Area (Bamford et al. 2008; Dutson et al. 2009; Jaensch & Richardson 2013).

While the vegetation of the region has been mapped comprehensively (see study area descriptions below), the fauna is relatively unknown. Historically most activities have focussed on migratory waders and waterbirds (Garnett & Taplin 1990, Blackman et al. 1999; Driscoll 2001). Only in the last decade has there been a more concerted effort to survey the terrestrial and freshwater fauna of the region (e.g. Hogan & Vallance 2005; Burrows & Perna 2006; Ecowise Environmental 2007; Hogan et al. 2008; Preece 2009; Smith et al. 2011; Vanderduys & Kutt 2011; Leigh 2013; Preece & Franklin 2013; Waltham et al. 2013). Among the threatened wetland-dependent animals, most are either frogs from the Wet Tropics rainforest in the upper Mitchell, or waders from coastal/sub-coastal areas and some finch species that frequent riparian habitats. The few endemic taxa include a number of freshwater fish, e.g. *Pingalla gilberti, Ambassis elongatus* and undescribed *Porochilus* species and possibly several frogs.

The dominant terrestrial land use across the region is pastoralism with cattle over most and sheep in the far south. Agriculture at present is confined to several small areas, particularly in the upper reaches of the Mitchell (Mareeba-Dimbulah Irrigation Area - MDIA). Mining activity is restricted to the upland parts of the Gilbert, Mitchell and southwestern Flinders catchments. Commercial fishing, e.g. barramundi, mud crab and prawns, occurs in the estuarine sections of the rivers and offshore in the Gulf of Carpentaria. Concern has been raised about the potential decline in fisheries productivity, e.g. changes in nutrient and sediment loads, due to changes in water flows following any expanded irrigation development (Halliday et al. 2012; Bayliss et al. 2014). Similar adverse impacts, as well as reduced water quality, aquifer recharge and seasonal persistence, have also been posed for freshwater systems including waterholes in the region (Waltham et al. 2013). Large areas suitable for irrigated agriculture have been identified in the Flinders, Gilbert and Mitchell catchments (Petheram et al. 2013, CSIRO 2016).

Natural resource management activities in the region are supported by two groups – Southern Gulf Resource Management Group (Flinders) and Northern Gulf Resource Management Group (Norman, Gilbert, Staaten and Mitchell). These are involved in assessing the natural values of the study areas and developing strategies and actions that promote sustainable land use practices. Landscape environmental outcomes are also provided through the Land and Sea Ranger program that delivers care for the biological and cultural values of country.

1.1.2 Flinders River study area

Covering an area of approximately 109,400 km^2, the Flinders basin contains several major watercourses apart from the Flinders River including the Saxby, Cloncurry, Dugald, Corella, Gilliat, Woolgar and Dutton rivers. The lower section of the Flinders basin also includes the Bynoe River.

The rivers of the study area originate in several bioregions adjacent to the Gulf Plains. In the south-west, the Cloncurry-Dugald system drain the low open eucalypt woodlands of pre-Cambrian ranges of the Northwest Highlands bioregion. To the south-east and south, the Flinders-Saxby Rivers form in the ironbark and *Eucalyptus microneura* woodlands of the dissected scarp and plateau landscapes associated with the Gilberton Plateau (Gulf Plains) and the Broken River and Undara-Toomba Basalts subregions (Einasleigh Uplands) and the *Astrebla* dominated tussock grasslands on cracking clay soils of the Northern Downs (Mitchell Grass Downs) respectively (Sattler & Williams 1999). All the rivers then traverse the Woondoola Plains subregion comprising alluvial plains with predominately *Dichanthium* tussock grasslands, with open woodlands of *E. microtheca* and *Lysiphyllum cunninghamii*. Finally the merged rivers pass through the Karumba Plain to the gulf.

In terms of protected estate, the Flinders study area is poorly represented. Two national parks, Porcupine Gorge and White Mountains, cover small parts of the Flinders headwaters. Similarly, despite the presence of extensive wetlands in the form of deep water channels, floodplain lagoons, temporary wetlands/flooded pastures and riparian eucalypt habitat, the only areas listed on the Directory of Important Wetlands of Australia (DIWA) are part of the Southern Gulf Aggregation and the two relatively small Lignum Swamp and Stranded Fish Lake (Blackman et al. 1999). In the upper eastern catchment, springs and spring-fed wetlands occur but are little known. Ground water systems include the Woodoola Beds aquifers below the Flinders floodplain which are brackish and not considered productive or well-connected to watercourses. The river itself is underlain by the Flinders River alluvium aquifer that is better connected and has good water quality (Faggotter et al. 2011).

The overall hydrology of the study area is largely unmodified with the few water storages limited to the upper catchment, usually associated with urban centres (DERM 2010). A population about 6,000 people reside mostly in area’s major towns (Hughenden, Richmond, Julia Creek and Cloncurry) (Waltham et al. 2013).

1.1.3 Norman River study area

The Norman River study area covers 50,300 km^2. Lying almost wholly within the Gulf Plains bioregion the Norman is joined by a number of major tributaries including the Clara and Yappar rivers and Spear Creek (Tait et al. 2015).

The upper reaches of the river occur in the dissected sandstone uplands of the Gilberton Plateau dominated by woodlands of bloodwoods and ironbarks along with acacia and melaleuca communities. Falling to the relatively uniform landscape of the Claraville Plains, the low gradient river passes through low woodlands of *Melaleuca* spp., *L. cunninghamii*, *Atalaya hemiglauca* and *Acacia excelsa* on extensive fans of coarse sands and loams (Sattler and Williams 1999). Further north the landscape changes to large grasslands and low open grassy woodlands on the black clay soils of the Woondoola Plains before the main watercourse moves through the Karumba Plains to the Gulf of Carpentaria.

The only protected area in the study area is the Mutton Hole Wetlands Conservation Park which occurs next to the only DIWA listed wetland – a section of the Southern Gulf Aggregation (Blackman et al. 1999; DERM 2010). Outside of these locations, the Karumba and Woondoola Plains subregions have numerous seasonal and permanent freshwater wetlands on the watercourses and adjacent floodplains. Springs and their associated streams of the Gilberton Plateau subregion feed into the upper Norman River (Sattler & Williams 1999).

No major water resource infrastructure is present in the study area apart from the Glenore Weir on the lower Norman and the Belmore Creek Dam near Croydon. The Glenore weir has been identified as a fish passage barrier, greatly limiting upstream movement of fishes from the river’s lower reach (DERM 2010). Normanton, Karumba and Croydon are the main towns and the area’s population is about 2,500.

1.1.4 Gilbert River study area

Extending over 46,700 km^2 the Gilbert River study area includes the Gilbert River and its major tributaries of the Einasleigh, Etheridge, Copperfield and Robertson rivers and Elizabeth Creek (Waltham et al. 2013).

Headwaters of the rivers are largely within the gorges, hills and ranges of various subregions in the Einasleigh Uplands bioregion. These areas are mostly covered with low *E. microneura* woodland on shallow soils or ironbark communities on red or black soils (Sattler & Williams 1999). Other parts of the upper catchment are in the dissected plateau surfaces of the Holroyd Plain-Red Plateau subregion of the Gulf Plains, vegetated primarily with *E. tetrodonta* and *A. shirleyi* woodlands. Downstream of here, near the Gilbert-Einasleigh River confluence, the basin narrows to a point only six kilometres wide (DERM 2010). After this restriction the system expands across the

Mitchell-Gilbert Fan with extensive overlapping alluvial fans and sandy levees of current and past channels. The diversity of wetlands including braided channels and anabranches, waterholes and floodplain lagoons occur throughout the *Corymbia polycarpa*, *E. leptophleba* and *Melaleuca viridiflora* woodlands (Sattler & Williams 1999; DERM 2010). As with the other gulf rivers the Gilbert ends its journey after passing through the coastal environments of the Karumba Plain.

As in the Flinders study area, protected lands in the Gilbert are confined to the elevated headwaters and comprise four national parks (Littleton, Rungulla, Blackbraes and Undara Volcanic) and one resources reserve (Canyon). Major wetlands in the study area are the Southeast Karumba Plain Aggregation along the coast and the Smithburne-Gilbert Fan Aggregation that extends over much of the lower reaches (Blackman et al. 1999). Several other smaller listed areas include Spring Tower Complex and Undara Lava Tubes in the Einasleigh Uplands, and Macaroni Swamp which actually lies within the Southeast Karumba Plain Aggregation. Numerous springs are present in the upper drainages, especially along the Etheridge and Einasleigh rivers (Smith et al. 2011; Negus et al. 2013).

Gilbert River study area has a small population of approximately 1,200 with a single urban centre at Georgetown (Waltham et al. 2013). Four significant dams are in the area including the Kidston and Copperfield River Gorge dams. Plans for expanding irrigation would see an increase in in-stream infrastructure.

1.1.5 **Staaten River study area**

The smallest of the study areas at 25,700km^2, the Staaten River catchment is confined to the Gulf Plains bioregion and mostly within the Mitchell-Gilbert Fan subregion (Tait et al. 2015). Consequently the landscape is similar to the lower Gilbert with extensive overlapping alluvial fans and sandy levees along channels. The eucalypt and melaleuca woodlands are interspersed with a variety of wetlands including braided channels and anabranches, waterholes and floodplain lagoons (Sattler & Williams 1999; DERM 2010).

Nearly 20% of the catchment lies in national park, covering a considerable area of central river system (Staaten River NP) and part of upper reaches (western part of Bulleringa NP). Staaten River NP is considered an Important Bird Area (Dutson et al. 2009) due to the large population of endangered golden-shouldered parrots *Psephotus chrysopterygius.* DIWA wetlands in the study area are the Southeast Karumba Plain Aggregation and Dorunda Lakes Area (Blackman et al. 1999)

The undeveloped and little disturbed nature of the Staaten River is reflected in the very small population and the absence of any townships. While no water infrastructure is present, the area is exposed to threats from adjoining catchments. During flood periods, overflows from the Gilbert and Walsh-Lynd basins enter the Staaten occasionally leaving large parts of the lower catchment inundated (Hogan et al. 2008). Hydrological and water quality changes in the surrounding rivers may have adverse impacts on the Staaten.

1.1.6 **Mitchell River study area**

The Mitchell River study area covers 75,400km^2 and encompasses the Mitchell, Alice, Nassau, Palmer, Walsh and Lynd river sub-catchments (Tait et al. 2015). Apart from the Nassau which could be viewed as a distributary system within the expansive Mitchell River delta, the headwaters of the remaining rivers lie in the surrounding bioregions.

In the north, the Alice drains the dry woodlands of *E. cullenii* and *E. crebra* on metamorphic rock (Coen-Yambo Inlier – CYP bioregion) and the *E. tetrodonta-M. viridiflora* woodlands on the ridges and watercourses of the dissected sandsheets of the Northern Holroyd Plain (CYP). Most of the Palmer River starts in the Hodgkinson Basin subregion (EIU) where loamy lithosols are dominated by *E. cullenii* low woodlands and scattered limestone outcrops have pockets of dry rainforest surrounded by *E. leptophleba* grassy woodlands. Similarly much of the Mitchell River origins lie in the Hodgkinson Basin except at the eastern most margin where the headwaters flow from the microphyll rainforests along the western slopes of granite massifs (Carbine-Mount Windsor Tablelands) in the Daintree-Bloomfield subregion (WET bioregion) (Sattler & Williams 1999).

The southern rivers of the Walsh and Lynd rise in the high elevation *E. crebra* open forest, grassy eucalypt woodland and grassland communities of the Kidston, Herberton-Wairuna and Undara-Toomba Basalts subregions (EIU) formed of mixed pre-Cambrian and Palaeozoic rocks with patches of sandstone and basaltic flows (Sattler & Williams 1999). After passing through the Holroyd Plain-Red Plateau, all the rivers combine in the Mitchell-Gilbert Fan before crossing the Karumba Plain to the Gulf of Carpentaria.

Similar to the other study areas, protected estate in the Mitchell is restricted to upper reaches of the river systems. Apart from seven national parks (Errk Oykangand, Chillagoe-Mungana Caves, Hann Tableland, Mount Windsor, Mount Lewis, the eastern section of Bulleringa and western part of Forty Mile Scrub) there are also two resource reserves (Olkola (Kurrumbilla) and Palmer Goldfield) in the study area. Significant wetlands include the Southeast Karumba Plain Aggregation and the Mitchell River Fan Aggregation on the lowlands, and Undara Lava Tubes and Spring Tower Complex associated with springs in the uplands (Blackman et al, 1999).

Most of the towns are relatively small and situated in along in upper Walsh River catchment, e.g. Chillagoe, Dimbulah and Petford. The study area population is less than 6,000. Apart from the Lake Mitchell dam on the upper Mitchell River, nearly all the current dams and weirs are situated in the Walsh River associated with the Mareeba-Dimbulah Irrigation Area (CSIRO 2016).

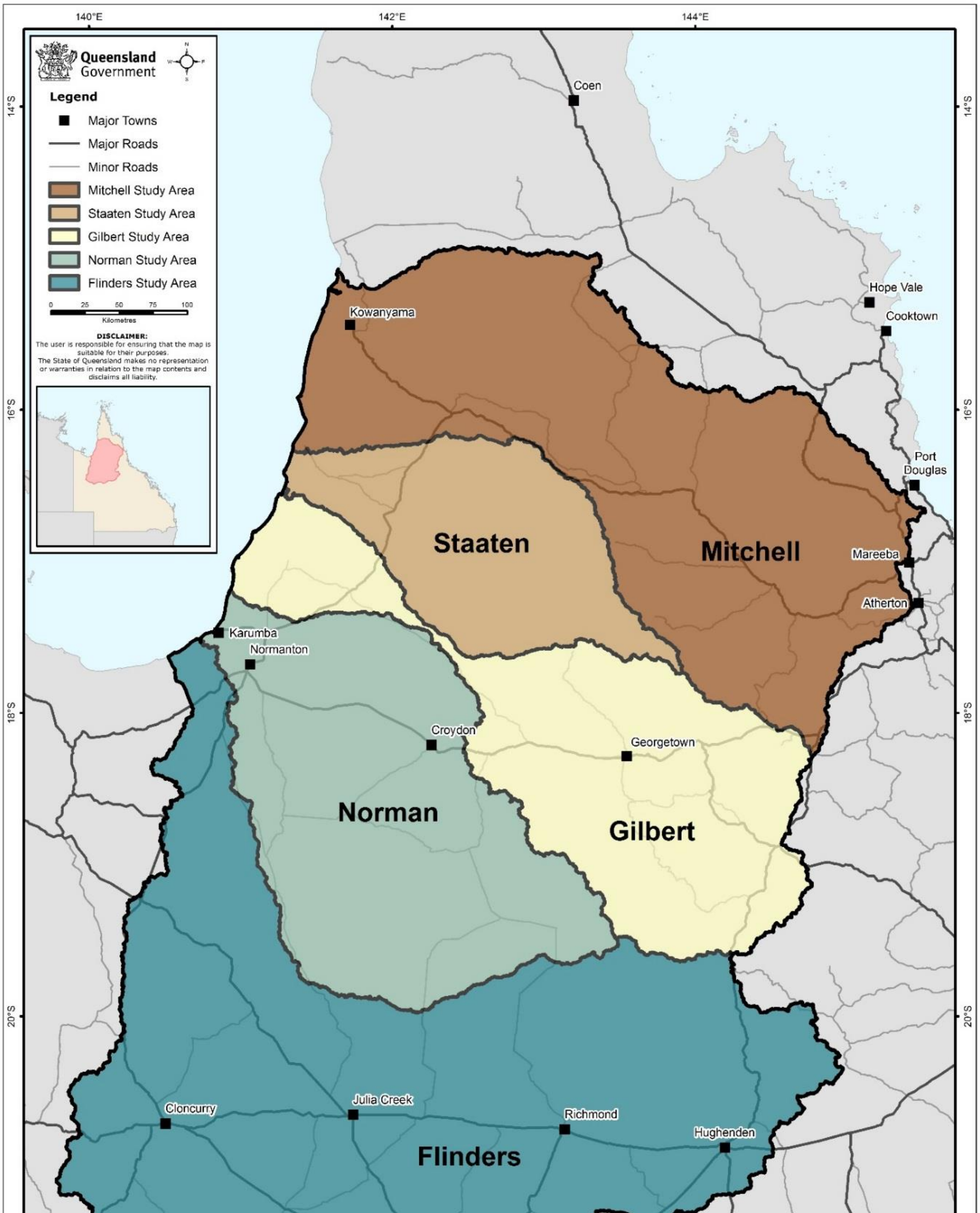


Figure 1. Study areas of the EGoC Aquatic Conservation Assessment project

2 Methods and implementation

2.1 AquaBAMM

The EGoC Aquatic Conservation Assessments were undertaken using AquaBAMM (Clayton et al 2006). The method has been updated since its development and minor changes have been made to the AquaBAMM tool, including revisions to the filter table.

2.2 Spatial Units

In implementing an ACA, subsections or spatial units need to be defined in order to attribute and calculate conservation/ecological values of riverine and non-riverine wetlands. This section describes the spatial units used for each riverine and non-riverine assessment.

2.2.1 Riverine Spatial Units

The spatial units were mapped using a SRTM derived DEM-H Version 1.0, which is a gridded digital elevation model (DEM) that has been hydrologically conditioned and drainage enforced with spatial resolution of 1 arc second (~30 m). Firstly, the DEM-H was corrected to remove small imperfections in the data, where sinks were filled and abrupt peaks were excluded. Secondly, the direction of flow from every cell in the raster was determined, following the eight-direction model (D8), which classifies cells into eight valid output directions relating to the eight adjacent cells into which flow could travel. Thirdly, the accumulated flow was determined, which is a surface with the number of cells drained upslope every cell. Then, the accumulated flow was reclassified to generate a gridded stream network with drainage area greater than 150 km^2 (i.e. number of cells to define a stream = 166,667). This ensured that every stream starts with the same drainage area or number of drained cells. Afterwards, each stream junction (node) was considered as a spatial unit outlet (pour point). Finally, the upstream drainage area of each junction has been mapped to compose the riverine spatial units of the EGoC region.

In order to map the sub-sections, which are larger hydrological units composed of few spatial units, the accumulated flow reclassification threshold has been changed to 1000 km^2 (instead of 150 km^2). Then the same sequence of procedures was used to map these larger hydrological units. The approach was based on the Arc Hydro Tools available for ArcGIS 10.4. Lastly, the sub-sections have been dissolved to create the sub-catchments and study areas based on selection by locations of pre-existing official layers.

The EGoC riverine assessments included 1,147 spatial units derived from method described above. The minimum, maximum and mean riverine spatial unit size was 106 ha, 129,962 ha and 26,413 ha respectively.

2.2.2 Non-Riverine Spatial Units

In Queensland the Queensland Herbarium uses the Wetland Mapping and Classification Methodology (EPA 2005) to map the location, extent and attributes of wetlands across the state. Spatial units for the non-riverine assessments were drawn from this data Queensland Wetland Mapping data (Version 4.0). Natural (H1), slightly modified (H2M2, H2M2p, H2M3, H2M8) and highly modified wetlands (H2M1, H2M3p, H2M5, H2M6, H2M7, H3C1, H3C2, H3C3) were included. Refer to the Wetland Mapping and Classification Methodology (EPA 2005) for more information on hydrological modifiers.

The assessments used Queensland Wetland Mapping data (EPA 2005). Linework and attribute descriptions for this mapping is based in part on the regional ecosystem mapping (Nelder et al. 2017). The current assessments used Version 4.0 Queensland Wetland Mapping data which is based on Version 9.0 regional ecosystem mapping. In 2017 the Queensland Herbarium released Version 10.0 regional ecosystem mapping which included significant updates to the Gulf of Carpentaria regional ecosystems. Updated linework and attributes from Version 10.0 regional ecosystem mapping will be included in Version 5.0 Queensland Wetland mapping data.

The EGoC non-riverine assessments included 26,650 spatial units derived from the palustrine and lacustrine wetland regional ecosystems or waterbodies present in the Queensland Wetland Mapping data. The minimum, maximum and mean non-riverine spatial unit size was 0.5 ha, 3,266 ha and 11 ha respectively.

2.2.3 Springs

A distinct hydrological component of the study areas are the deep artesian groundwater systems operating almost entirely independent of shallower surface water alluvial aquifers. Artesian water emanating from these result in numerous spring systems displaying unique geomorphic appearances and specialised habitats of high intrinsic conservation value (Fensham & Fairfax 2003; Fensham et al. 2007).

Springs wetlands were not assessed as a separate entity as part of the Eastern Gulf of Carpentaria assessments.

They were used, however, as a component of assigning values for special features. The expert panel highlighted the critical need for information on the conservation values of EGoC springs for water and land use planning. In the absence of a separate Aquatic Conservation Assessments for spring wetlands, the reader is referred to the Queensland spring database published by the Queensland Herbarium (https://data.qld.gov.au/dataset/queensland-spring-database). This database provides comprehensive data on the condition, threats and biodiversity values associated with springs within the database. The database also includes a conservation priority rating for springs within the Great Artesian Basin. These ratings were developed by Fensham and Fairfax (2005) and are based on the following criteria:

a. Category 1a: These spring wetlands provide habitat for biota endemic to one spring complex.
b. Category 1b: These spring wetlands provide habitat for biota endemic to more than one spring complex.
c. Category 1c: These spring wetlands provide habitat for species listed under State or Commonwealth legislation (except *Callistemon* sp. Boulia (L. Pedley 5297) which is listed as vulnerable under the EPBC and has since been identified as the common species *C. viminalis*).
d. Category 2: These spring wetlands provide habitat for some isolated populations of plant species, or are outstanding examples of their type.
e. Category 3: Any spring of lower value than above that is relatively intact.
f. Category 4: Severely degraded by any threatening processes.

The EGoC assessments used the conservation priority ratings from the Queensland spring database to assign value to any non-riverine spatial units containing springs. This was implemented utilising criterion 6 (special features). See the accompanying expert panel report for more details.

2.2.4 **Highly Modified Wetlands**

Highly modified wetlands have the following hydrological modification codes - H2M1, H2M6, H2M7, H3C1, H3C2, H3C3. H2 wetlands are modified waterbodies such as dams or weirs and contained in a riverine channel. H3 wetlands are totally artificial and not on, or in, a natural water body.

The basis of an ACA is to provide an inventory and prioritisation of ecological values. Artificial wetlands, especially relatively large ones are considered to potentially hold some ecological value for example species habitat. Expert panels in a very small number of instances, may consider artificial wetlands as playing a role in a special feature.

Highly modified wetlands are included in this ACA for the purpose of ecological comprehensiveness. The values assigned to highly modified wetlands are meant to serve primarily as an ecological inventory. **Their inclusion is not meant to imply any policy, protective or legislative requirements.**

2.3 Assessment parameters

The CIM implemented for each EGoC ACA are outlined in Table 2. A different CIM list was used for the riverine and non-riverine assessments.

This list was developed from the default list of criteria, indicators and measures provided by Clayton et al. (2006). The default CIM list is not mandatory and instead provides a ‘starter set’ for consideration when setting up the assessment parameters for a new ACA.

Table 2. Criterion, indicator, measure list used for the EGoC Aquatic Conservation Assessments

Criteria and Indicators	Measures		Riverine	Non-riverine
1 Naturalness aquatic				
1.1 Exotic flora/fauna	1.1.1	Presence of ‘alien' fish species within the wetland	Y	Y
	1.1.2	Presence of exotic aquatic and semi-aquatic plants within the wetland	Y	Y
	1.1.3	Presence of exotic invertebrate fauna within the wetland	Y	Y
	1.1.4	Presence of feral/exotic vertebrate fauna (other than fish) within the wetland	Y	Y

Criteria and Indicators	Measures		Riverine	Non-riverine
1.3 Habitat features modification	1.3.4	Presence/absence of dams/weirs within the wetland	Y	
	1.3.5	Inundation by dams/weirs (% of waterway length within the wetland)	Y	
	1.3.7	% area of remnant wetland relative to preclear extent for each spatial unit	Y	Y
1.4 Hydrological modification	1.4.5	Hydrological disturbance/modification of the wetland (e.g. as determined through DES wetland mapping and classification)		Y
2 Naturalness catchment				
2.1 Exotic flora/fauna	2.1.1	Presence of exotic terrestrial plants in the assessment unit	Y	Y
2.2 Riparian disturbance	2.2.1	% area remnant vegetation relative to preclear extent within buffered riverine wetland or watercourses	Y	
	2.2.2	Total number of REs relative to preclear number of REs within buffered riverine wetland or watercourses	Y	
	2.2.5	% area of remnant vegetation relative to pre-clear extent within buffered non-riverine wetland: 500m buffer for wetlands >= 8Ha, 200m buffer for smaller wetlands		Y
2.3 Catchment disturbance	2.3.1	% "agricultural" land-use area (i.e. cropping and horticulture)	Y	Y
	2.3.2	% "grazing" land-use area	Y	Y
	2.3.3	% "vegetation" land-use area (i.e. native veg + regrowth)	Y	Y
	2.3.4	% "settlement" land-use area (i.e. towns, cities, etc)	Y	Y
2.4 Flow Modifications	2.4.1	Farm storage (overland flow harvesting, floodplain ring tanks, gully dams) calculated by surface area	Y	
3 Diversity and richness				
3.1 Species	3.1.1	Richness of native amphibians (riverine wetland breeders)	Y	
	3.1.2	Richness of native fish	Y	Y
	3.1.3	Richness of native aquatic dependent reptiles	Y	Y
	3.1.4	Richness of native waterbirds	Y	Y
	3.1.5	Richness of native aquatic plants	Y	Y
	3.1.6	Richness of native amphibians (non-riverine		Y

Criteria and Indicators	Measures		Riverine	Non-riverine
		wetland breeders)		
	3.1.7	Richness of native aquatic dependent mammals	Y	Y
3.2 Communities/ assemblages	3.2.1	Richness of macroinvertebrate taxa	Y	
	3.2.2	Richness of REs along riverine wetlands or watercourses within a specified buffer distance	Y	
3.3 Habitat	3.3.2	Richness of wetland types within the local catchment (e.g. SOR sub-section)	Y	Y
	3.3.3	Richness of wetland types within the sub-catchment	Y	Y
4 Threatened species and ecosystems				
4.1 Species	4.1.1	Presence of rare or threatened aquatic ecosystem dependent fauna species – NCAct, EPBCAct	Y	Y
	4.1.2	Presence of rare or threatened aquatic ecosystem dependent flora species - NCAct, EPBCAct	Y	Y
4.2 Communities/ assemblages	4.2.1	Conservation status of wetland Regional Ecosystems – Herbarium biodiversity status, NCAct, EPBCAct	Y	Y
5 Priority species and ecosystems				
5.1 Species	5.1.1	Presence of aquatic ecosystem dependent 'priority' fauna species (expert panel list/discussion or other lists such as ASFB, WWF, etc)	Y	Y
	5.1.2	Presence of aquatic ecosystem dependent 'priority' flora species	Y	Y
	5.1.3	Habitat for, or presence of, migratory species (expert panel list/discussion and/or JAMBA / CAMBA agreement lists and/or Bonn Convention)	Y	Y
	5.1.4	Habitat for significant numbers of waterbirds	Y	Y
5.2 Ecosystems	5.2.1	Presence of 'priority' aquatic ecosystem	Y	Y
6 Special features				
6.1 Geomorphic features	6.1.1	Presence of distinct, unique or special geomorphic features	Y	Y
6.2 Ecological processes	6.2.1	Presence of (or requirement for) distinct, unique or special ecological processes	Y	Y
6.3 Habitat	6.3.1	Presence of distinct, unique or special habitat (including habitat that functions as refugia or other critical purpose)	Y	Y
	6.3.2	Significant wetlands identified by an accepted method such as Ramsar, Australian Directory of Important Wetlands, Regional Coastal Management Planning, World Heritage Areas, etc.	Y	Y

Criteria and Indicators	Measures		Riverine	Non-riverine
	6.3.3	Ecologically significant wetlands identified through expert opinion and/or documented study	Y	Y
	6.3.4	Areas important as refugia from the predicted effects of climate change (e.g. source of species re-population)	Y	Y
6.4 Hydrological	6.4.1	Presence of distinct, unique or special hydrological regimes (eg. Spring fed stream, ephemeral stream, boggomoss)	Y	Y
7 Connectivity				
7.1 Significant species or populations	7.1.2	Migratory or routine 'passage' of fish and other fully aquatic species (upstream, lateral or downstream movement) within the spatial unit	Y	Y
7.2 Groundwater dependent ecosystems	7.2.1	The contribution (upstream or downstream) of the spatial unit to the maintenance of groundwater ecosystems with significant biodiversity values, including those features identified through criteria 5 and/or 6 (e.g. karsts, cave streams, artesian springs)	Y	Y
7.5 Estuarine and marine ecosystems	7.5.1	The contribution of the spatial unit to the maintenance of estuarine and marine ecosystems with significant biodiversity values, including those features identified through criteria 5 and/or 6	Y	Y
8 Representativeness				
8.1 Wetland protection	8.1.1	The percent area of each wetland type within Protected Areas.		Y
8.2 Wetland uniqueness	8.2.1	The relative abundance of the wetland management group to which the wetland type belongs within the catchment or study area (management groups ranked least common to most common)		Y
	8.2.2	The relative abundance of the wetland management group to which the wetland type belongs within the sub-catchment or estuarine/marine zone (management groups ranked least common to most common)		Y
	8.2.3	The size of each wetland type relative to others of its management group within the catchment or study area		Y
	8.2.4	The size of each wetland type relative to others of its type within a sub-catchment (or estuarine zone)		Y
	8.2.5	Wetland type representative of the study area – identified by expert opinion		Y
	8.2.6	The size of each wetland type relative to others of its type within the catchment or study area		Y

SOR—State of the Rivers

[2] NCA—Nature Conservation Act 1992 (Queensland)

[3] EPBC—Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth)

[4] ASFB—Australian Society for Fish Biology

[5] JAMBA—Japan–Australia Migratory Bird Agreement

[6] CAMBA—China–Australia Migratory Bird Agreement

[7] ROKAMBA—Republic of Korea–Australia Migratory Bird Agreement

2.4 Stratification

Stratification mitigates the effects of data averaging across large study areas, and is particularly important where ecological diversity is high. An example where stratification may be appropriate is fish diversity where fewer species inhabit the upland zone compared to lowland floodplains. For measure datasets where there is an equal probability of scoring across a range of values throughout the study area, stratification is unwarranted

Study area stratification for application to relevant measures of AquaBAMM is a user decision and is not mandatory for a successful assessment. However, AquaBAMM makes provision for data to be stratified in any user-defined manner that is determined to be ecologically appropriate. To date, the use of strata in completed ACAs has been based on elevation (e.g. 150m ASL for coastal catchments and 400 m ASL for catchments west of the Great Dividing Range in the Murray-Darling Basin) or bioregional boundaries.

The EGoC assessment expert panels recommended stratification based on elevation resulting in the segmentation of study areas (catchments) into upland and lowland areas. A delineation between 150 - 200 m ASL was recommended. For implementation 175m ASL was chosen. If a riverine subsection was intersected by this contour, then the entire subsection was placed in either the upland or lowland category, depending on which strata most (>50%) of the subsection area was contained in. This reduces unnecessary complexity in implementation.

2.5 Datasets

Typically, an ACA using AquaBAMM draws on a range of datasets with varying formats and data types. Data sources generally include published scientific documents and unpublished data (grey literature) such as data collected by various Queensland Government departments (e.g. Queensland Museum, Queensland Herbarium, etc.). In addition, data derived from one or more expert panel workshops is incorporated into every ACA. Expert knowledge is used to inform a range of measures within criteria 5, 6, 7 and 8, and to assign relative ranks and weights to individual AquaBAMM indicators and measures (Clayton et al. 2006).

Three expert panel workshops (flora, fauna, and ecology) were held in Cairns during April 2017 as part of the EGoC assessments. The panels were comprised of individuals with expertise in local aquatic and riparian flora, aquatic fauna and/or wetland ecology. Findings from the EGoC expert panel processes are reported in the accompanying expert panel report (DES 2018).

2.6 ACA wetland management groups

The Queensland Wetlands Program (see http://wetlandinfo.ehp.qld.gov.au/wetlands) identifies attributes addressing characteristics of lacustrine and palustrine wetlands at increasingly specific scales (continental, ecosystem, landscape, and local). These attributes can be used to develop wetland typologies aimed at classifying wetlands into types or groups useful for wetland management, monitoring and regulation.

Through expert consultation, and an iterative process of reality checking with the mapping, a series of wetland habitat types has been developed that are broad enough to cover Queensland, while allowing the identification and grouping of key wetland ecological and physical processes across the broad climatic zones of Queensland (EHP 2016c). As wetlands are spatially and temporally diverse, this typology also allows for combining wetland habitat types which may be found within an individual wetland (e.g. a lacustrine waterbody may have a palustrine fringe). Wetland habitat types are subsequently called wetland management groups for the purposes of an ACA.

2.7 Measure Implementation

Each ACA may have a different combination of assessment parameters (refer to section 2.3) based on a different combination of source datasets. Implementation of these measures can be complex therefore comprehensive implementation tables are maintained throughout the assessment.

A description of how each measure was implemented for both the riverine and non-riverine assessment is outlined in the tables below.

There are varying scoring and threshold types used on the raw data. The following explanation for the measure scores will aid in interpretation.

- 0 - refers to a spatial unit being assessed (e.g. percent of agriculture land use) to have 0 value for that measure. The measure will be included in the dependability score.
- -999 - refers to a spatial unit being assessed (e.g. for special features) to have no value for the measure. The value of -999 will ensure the measure is included in the dependability score.
- No data - indicates there is no available data to evaluate the measure for the particular spatial unit. The measure is not part of the assessment for this spatial unit and is reflected in the dependability score.

The Implementation tables are contained in Appendices I and II

2.8 Weighting of measures

Measures were weighted according to their importance to an indicator based on the following rules:

- At least one measure within each indicator must be weighted 10 which is the highest weighting.
- Other measures within each indicator were weighted compared to the weighting of 10 assigned in the first step.
- It was okay to have different measures with the same weight (i.e. all measures could be weighted 10).
- Some indicators only had one measure and had already been given a weighting of 10.
- Measures shouldn't be weighted down because of the quality or lack of data for that measure.

Expert panel members and project officers are asked to weight the measures within each indicator. Weights from all respondents are then averaged and reviewed with particular attention to averages having a high variance.

The measure weights used for the EGoC assessments were based on the weights derived during the expert panel workshops held for the Flinders, Norman and Gilbert River catchments in 2010. A decision was made to use measure weights averaged across all study areas to improve statistical reliability.

The riverine measure weights are contained in Appendix V and the non-riverine measure weights are outlined in Appendix VI.

2.9 Ranking of indicators

ACA Indicators are ranked according to their importance in contribution to a criterion with a rank of 1 signifying the most important contribution. Indicator ranks are based on the following rules:

- At least one indicator within each criterion must be ranked one which is the highest ranking.
- The other indicators are ranked (within each criterion) relative to the ranking of one assigned in the first step.
- It is possible to have different indicators with the same ranking (i.e. all indicators may be ranked one).
- An Indicator should not be ranked down because of the quality or lack of data for that indicator.

Expert panel members and project officers are asked to rank the indicators within each criterion. Ranks from all respondents are then averaged and reviewed with particular attention to averages having a high variance.

The indicator ranks used for the EGoC assessments were based on the ranks derived during the expert panel workshops held for the Flinders, Norman and Gilbert River catchments in 2010. A decision was made to use indicator ranks averaged across all study areas to improve statistical reliability. Small adjustments were then made based on feedback from EGoC expert panel workshops e.g. pest species measures and their relative Indicators were downgraded.

Appendix VII and Appendix VIII list the ranks for all AquaBAMM indicators for riverine and non-riverine assessments respectively.

2.10 Biodiversity / Conservation value categories

The AquaBAMM calculates an overall aquatic conservation score, called an AquaScore, for each spatial unit within a study area. The AquaScore ratings include Very High, High, Medium, Low and Very Low, and are relative within a study area.

The following descriptions provide a summary of the general characteristics of each AquaScore.

Very High

Wetlands given an AquaScore of Very High generally have very high biodiversity values across all criteria (aquatic naturalness, catchment naturalness, diversity and richness, threatened species, special features, connectivity, representativeness), or Very High representativeness values in combination with Very High aquatic naturalness, catchment naturalness or threatened species values. They may also be wetlands nominated by an expert panel as containing very important special or unique features from a flora, fauna and/or ecological perspective regardless of the values across the other criterion.

High

Wetlands given an AquaScore of High are mainly those that have very high aquatic naturalness or representativeness values in combination with High or Very High values for rare and threatened species or diversity and richness. Combinations of Very High or High values among most criteria may also result in a High AquaScore. They may also be wetlands nominated by an expert panel as containing important special or unique features from a flora, fauna and/or ecological perspective regardless of the values across the other criterion.

Medium

Wetlands given an AquaScore of Medium generally have varied combinations of High and Medium criteria.

Low

Wetlands given an AquaScore of Low generally have limited aquatic and catchment naturalness values and generally varied combinations of Medium and Low values among all criteria. These wetlands do not contain special or unique features.

Very Low

Wetlands given an AquaScore of Low generally have Low naturalness (i.e. criterion 1 and 2) and lack any other known significant values. They may also be wetlands that are largely data deficient across the AquaBAMM measures. These wetlands do not contain special or unique features.

2.11 Filter tables

A series of arithmetic techniques are used to bring data from their raw form through to scores for each criterion. However, arithmetic techniques were considered to mask a number of important effects (as perceived by expert opinion) or to insufficiently discriminate between spatial units when used to create an overall AquaScore. Other authors (e.g. Chessman 2002) also discuss this issue.

Rather than a final arithmetic combination, AquaBAMM uses a criterion rating combination table (or filtering decision table) that provides an ordered series of decisions that are tested against the final criterion ratings for each spatial unit (See Appendix III and Appendix IV for riverine and non-riverine filter tables). Each decision is a unique combination of criterion ratings that is associated with a final AquaScore category. The decisions are effectively a number of 'if-then' statements and are tested in sequence for each spatial unit. An AquaScore is assigned immediately when a match is achieved between the criterion rating combination of the decision and that of the spatial unit. This filtering table technique has previously been used successfully in EPA's terrestrial BAMM (EPA 2002).

It is important to note that, unlike previous steps through the AquaBAMM tool, the AquaScore may be one of five categories (i.e. Very High, High, Medium, Low and Very Low). This increased level of discrimination at the AquaScore level provides for a more useful conservation assessment tool and enables more informed management decisions.

2.12 Dependability and data richness

The AquaBAMM uses a dependability score to provide information about the richness of data for each spatial unit within a study area. Dependability scores are calculated at the criterion and AquaScore level.

All criterion ratings and AquaScores should be interpreted in conjunction with the corresponding dependability scores as these provide an overall indication of the amount of data available for each spatial unit. For example, dependability can be used to indicate the potential for and AquaScore to change (upgrade or downgrade) with the addition of new data. For example, spatial units with low dependability and a Very Low AquaScore should be used with caution as the result may be due to a lack of data rather than a lack of values. Dependability scores can also provide an indication of where additional survey work may be required and which, once completed, may or may not change an AquaScore.

Dependability scores range from 0 to 1 and are calculated as a fraction representing the number of measures with data for a particular spatial unit out of the total number of measures used in the assessment. Dependability is calculated as follows:

$$\text{Dependability} = \frac{\text{No. of measures with data (count)}}{\text{Total no. of measures (count)}}$$

2.13 Transparency of results

Despite presentation as a single AquaScore, ACAs produce results at a number of levels. For example, after running the AquaBAMM tool ACA results are available at the AquaScore, criterion, indicator, measure and raw data levels. All results are available to the user through the use of user-defined queries inside a GIS (Figure 2) or other database application (i.e. Microsoft Excel). Results may be interrogated at one or more levels in an almost infinite number of combinations. This transparency of results provides the ACA end user (e.g. scientists, resource managers and conservation organisations) with a unique level of flexibility for ACA interrogation, interpretation and presentation. This data access and interrogation flexibility is important as it enables investigation of different data contributions to the overall conservation value, investigation of missing data, and an ability for users to tailor the ACA output for a particular purpose. The intent of an ACA is not only to evaluate aquatic ecological and conservation values, but just as importantly, to identify variability in these values. Links between the ACA results and GIS facilitate this and constitute the complete ACA results release package.

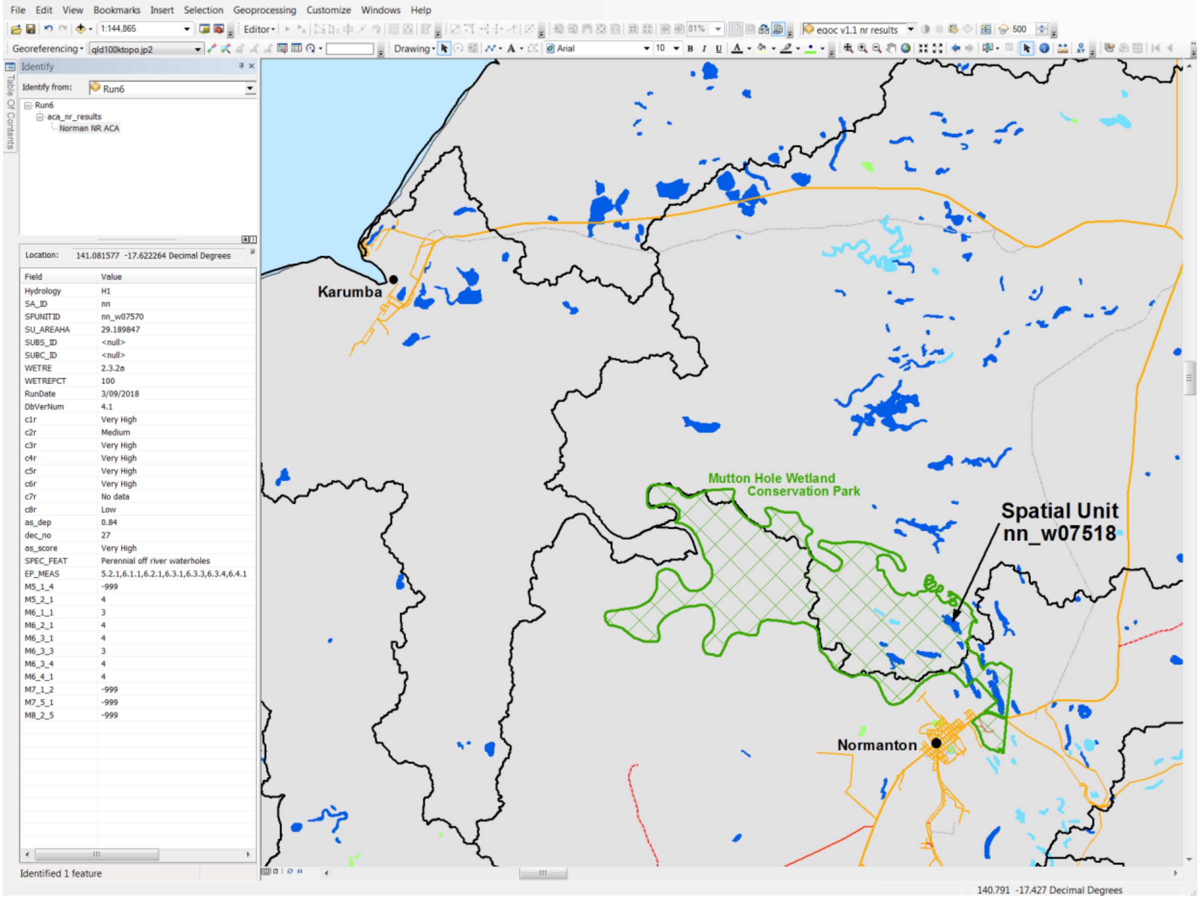


Figure 2. Interrogating the results for non-riverine spatial unit "nn_w07518" in ArcMap.

3 Results

3.1 Accuracy and dependability

The Queensland Wetland Mapping data is the core dataset that these ACAs are built upon. This dataset is mapped at a scale of 1:100,000 with a positional accuracy of ±100 metres, except for areas along the east coast that may be mapped at a scale of 1:50,000 with a positional accuracy of ±50 metres. Wetlands smaller than 1 hectare are not delineated in the wetland data.

The dependability score is a percentage of how many measures, out of those calculated, have data. The dependability does not influence or change the final AquaScore. The ACA results should be interpreted in conjunction with the dependability score.

3.2 Riverine results

Aquatic Conservation Assessments were conducted for the riverine wetlands within each study area. Figure 3 and Figure 4 contain maps of the riverine AquaScores, AquaScore dependability scores and Criterion ratings for each spatial unit within each study area. Table 3 summarises riverine AquaScores and AquaScore dependability ratings by study area.

Approximately 81% of all riverine spatial units received an AquaScore of Very High or High. All catchments, with the exception of the Flinders, had at least 85% of their spatial units assigned a Very High or High Aquascore. This is primarily driven by High or Very High ratings for Criterion 6 (special features), Criterion 3 (diversity and richness) and Criterion 4 (threatened species and ecosystems). Criterion 6 has a major influence with approximately 36% of all riverine spatial units receiving a Very High AquaScore due to Very High ratings for Criterion 6 (filter table decision 4). A further 24.1% of spatial units received an AquaScore of High due to high of Very High scores for Criterion 1 (naturalness aquatic), Criterion 3 (diversity and richness) and Criterion 4 (threatened species and ecosystems) (filter table decision 23).

Overall 15.5% of riverine spatial units received an AquaScore of Medium. These spatial units were concentrated in the Flinders catchment with 64.4% of the riverine spatial units receiving an AquaScore of Medium occurred in this catchment. The Staaten and Norman catchments had the lowest number of riverine spatial units with a Medium AquaScore. In the Norman catchment less than 7% of spatial units received an AquaScore of Medium, and in the Staaten catchment less than 3% of spatial units received an AquaScore of Medium.

Only 4% of riverine spatial units received an AquaScore of Very Low. These spatial units were concentrated in the Flinders catchment, south of Julia Creek and Richmond, and appear to be in part due to low criterion ratings for Criterion 3 (diversity and richness) relative to other riverine spatial units within the Flinders catchment.

Filter table decisions 4 (AquaScore = Very High) and 23 (AquaScore = High) were the most frequently triggered decisions accounting for approximately 60% of all spatial units. Filter table decisions 12 (AquaScore = High) and 24 (AquaScore = Medium) accounted for 12.4% and 11.4% of riverine spatial units respectively. Together, these four decision accounted for 83.9% of all riverine spatial units.ependability scores were relatively high across all study areas. This result was due, in part, to recent changes to how dependability is calculated i.e. -999 is now used to represent data where a value has been assessed and it is not present (i.e. true absence). True absence is now considered as data for a measure when calculating dependability.

Whilst no spatial units had 100% of the measures with data, all spatial units had a dependability score >=50% and 77.6% had a dependability score >= 70%. Only five spatial units (0.4%) had a dependability score >=90%.

More than 90% of spatial units in the Gilbert and Mitchell catchment had dependability scores >70%. For the Norman and Staaten catchments, 76% and 80% of spatial unis respectively had dependability scores >70%. The Flinders catchment had the lowest dependability scores with 63% of spatial units receiving an AquaScore dependability score >70%.

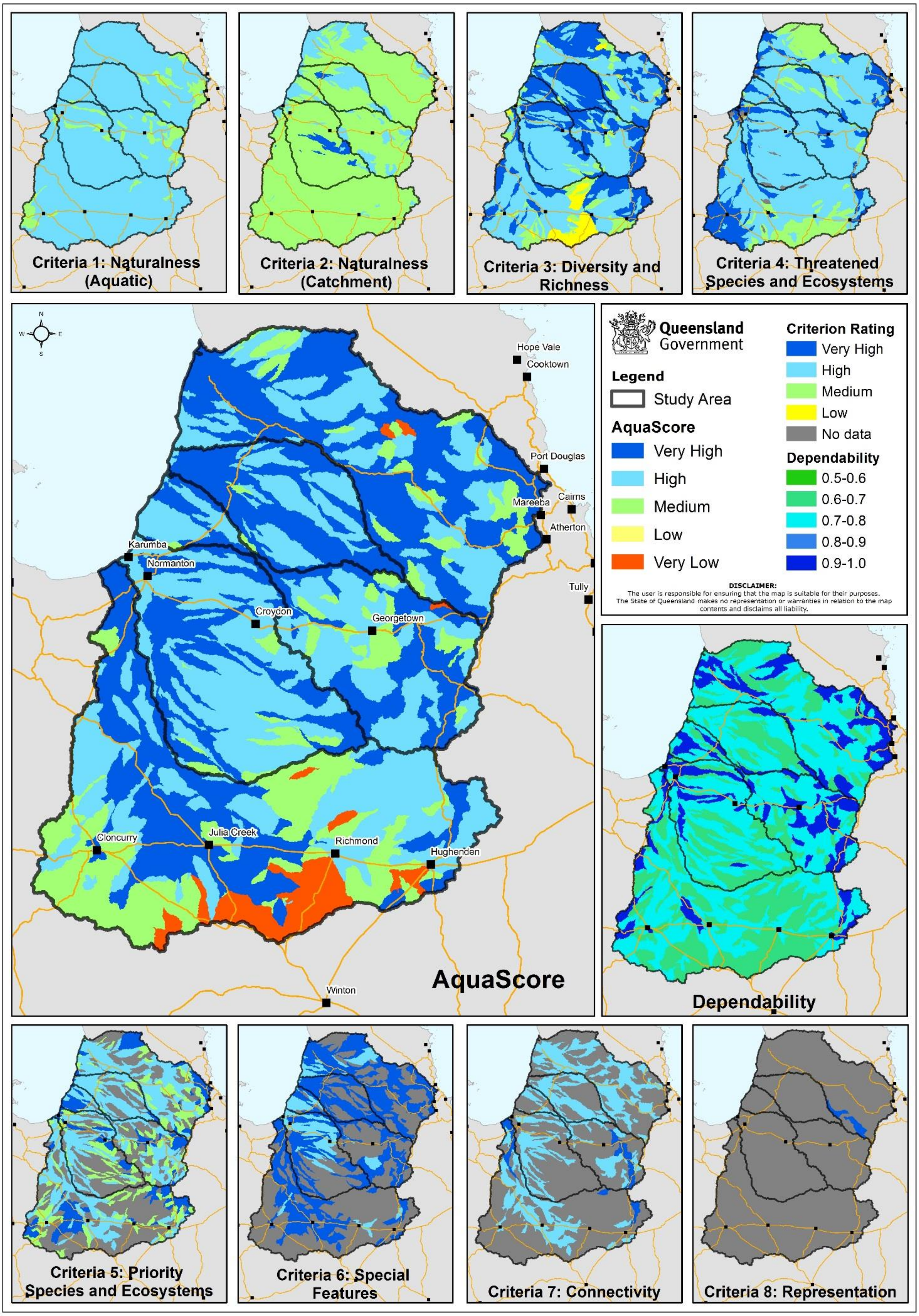


Figure 3. AquaScore, dependability and Criterion rating by riverine spatial unit.

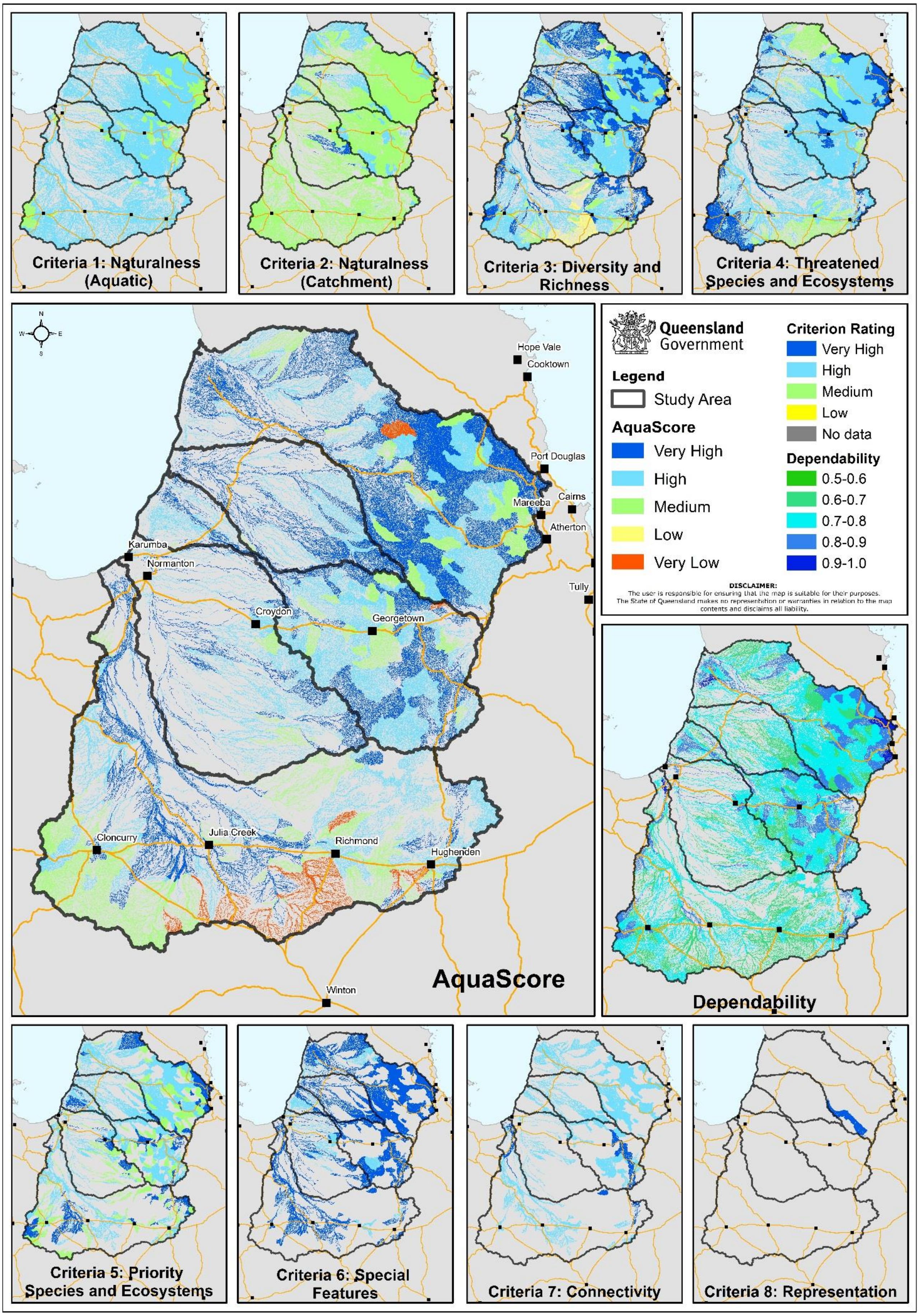
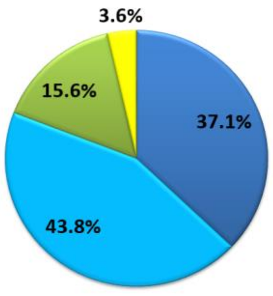
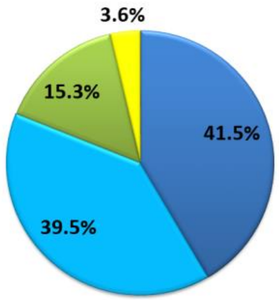
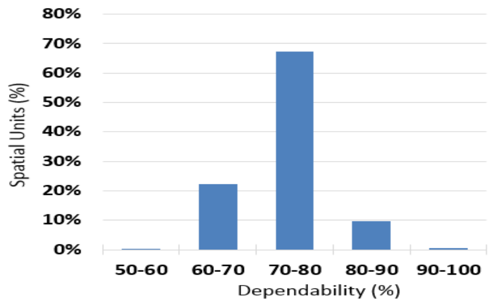
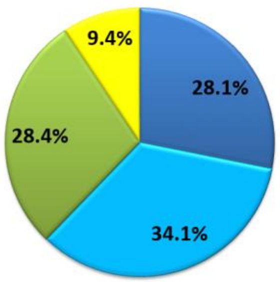
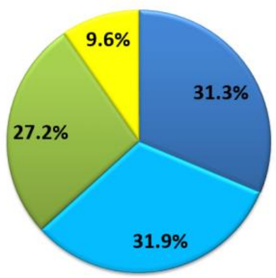
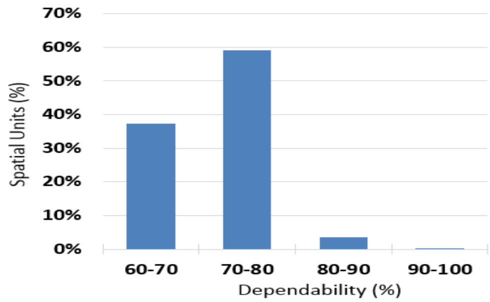
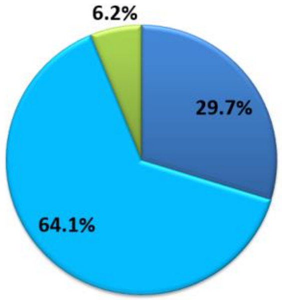
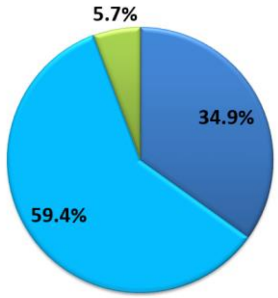
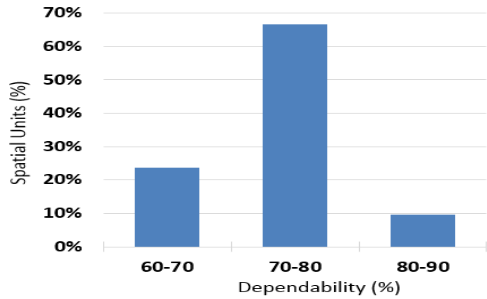
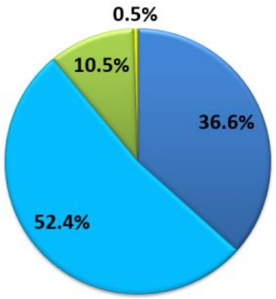
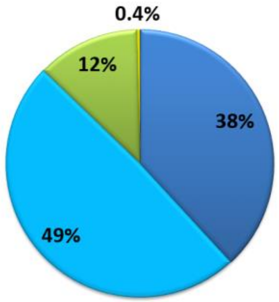
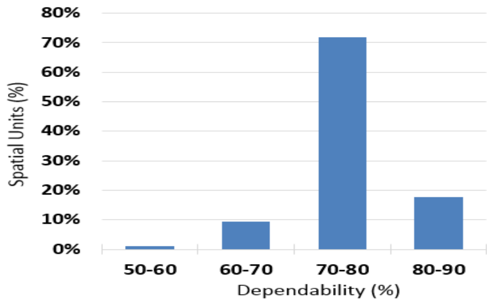
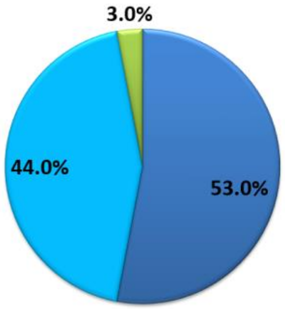
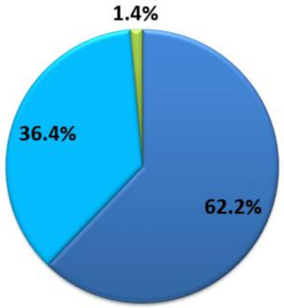
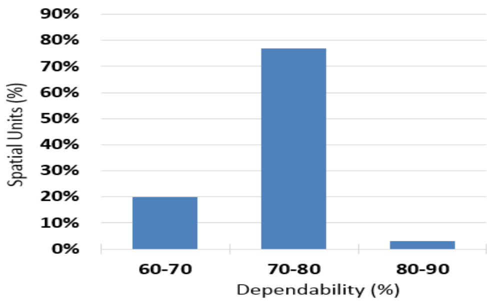


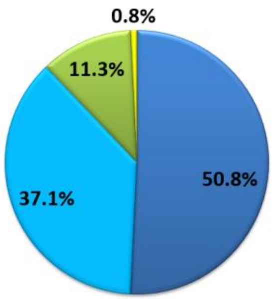
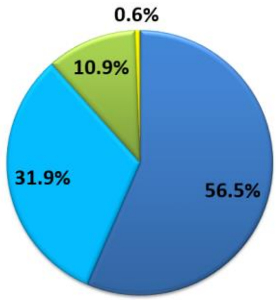
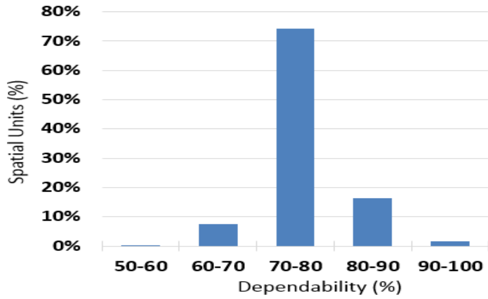
Figure 4. AquaScore, dependability and Criterion rating by riverine drainage lines.

3.2.1 **Riverine AquaScores**

Table 3. Riverine AquaScore and dependability summary statistics by study area.

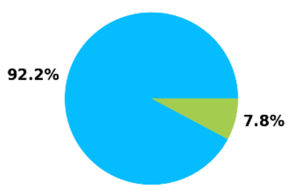
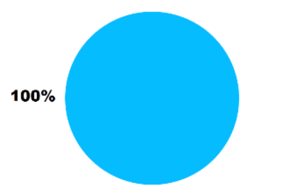
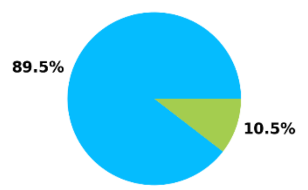
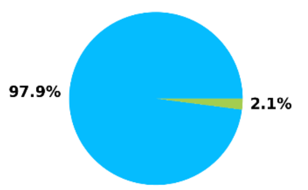
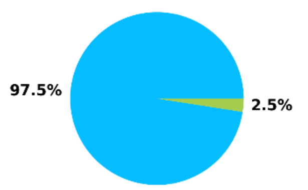
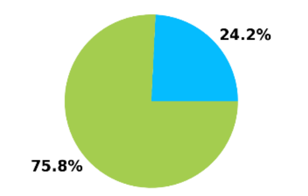
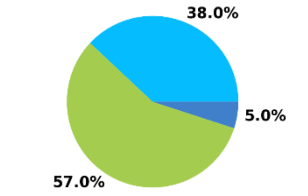
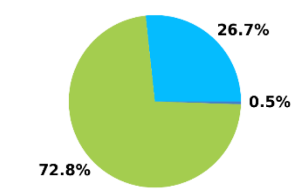
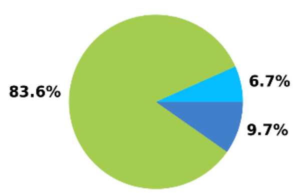
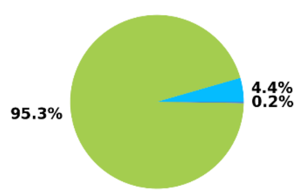
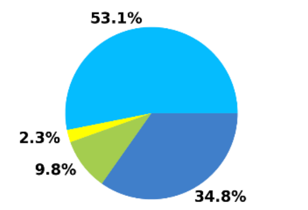
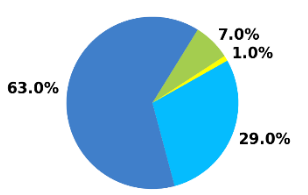
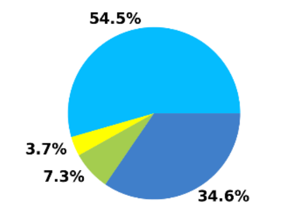
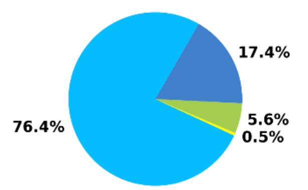
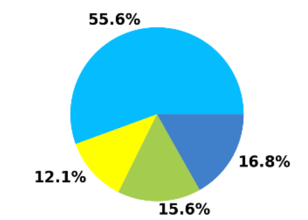
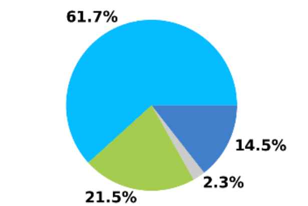
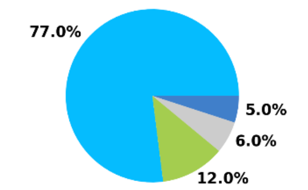
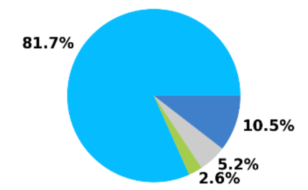
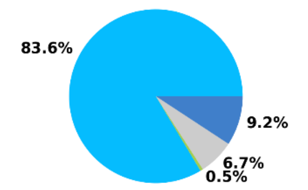
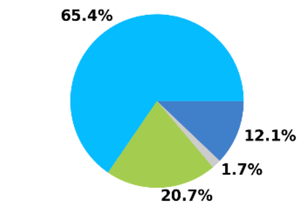
<table>
<tr><th>Catchment</th><th>AquaScore by % of spatial units</th><th>AquaScore by % of total area of spatial units</th><th>AquaScore dependability</th></tr>
<tr><td>All
Very High
High
Medium
Low
Very Low</td><td>
</td><td>
</td><td>
</td></tr>
<tr><td>Flinders
Very High
High
Medium
Low
Very Low</td><td>
</td><td>
</td><td>
</td></tr>
</table>

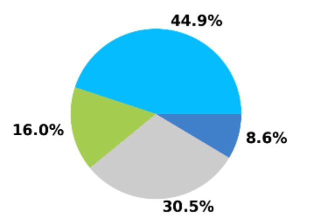
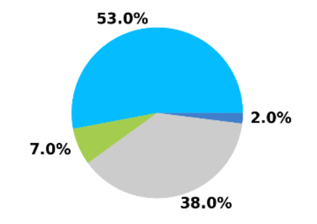
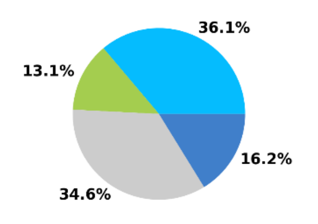
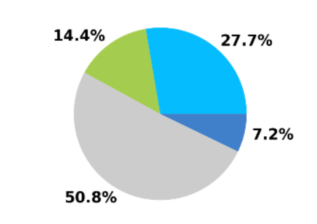
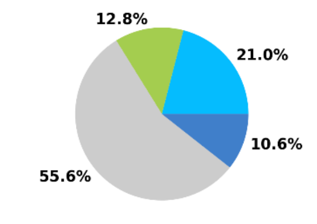
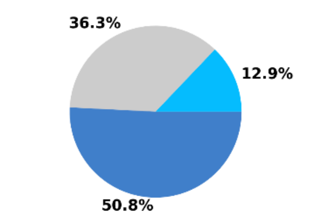
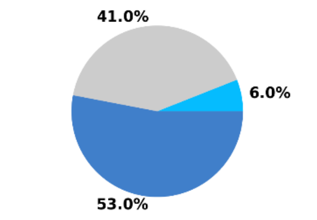
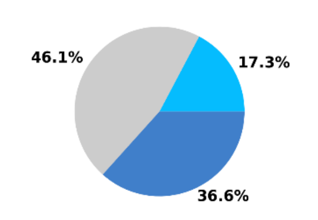
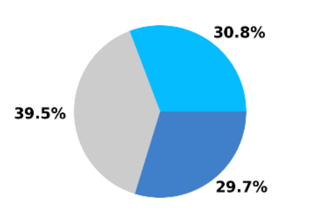
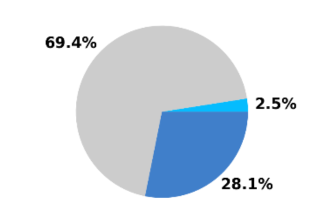
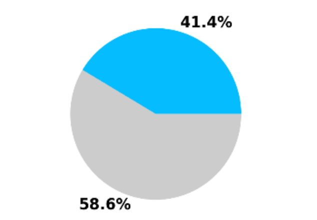
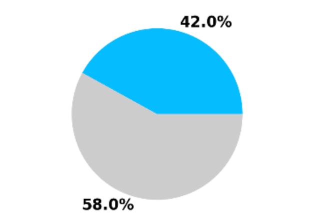
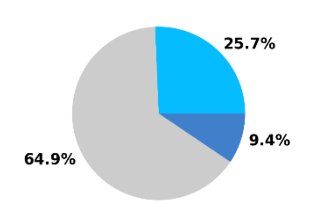
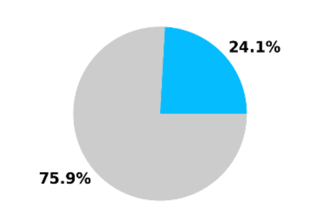
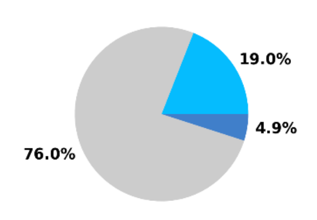
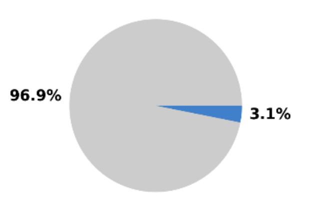
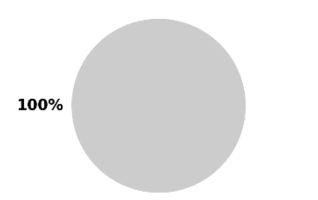
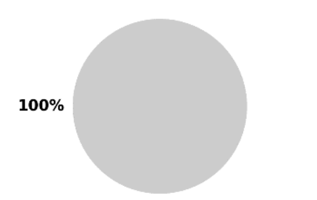
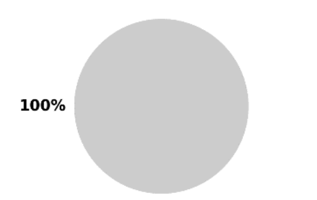
Catchment	AquaScore by % of spatial units	AquaScore by % of total area of spatial units	AquaScore dependability
Norman Very High High Medium Low Very Low			
Gilbert Very High High Medium Low Very Low			
Staaten Very High High Medium Low Very Low			

Catchment	AquaScore by % of spatial units	AquaScore by % of total area of spatial units	AquaScore dependability
Mitchell Very High High Medium Low Very Low			

3.2.2 Riverine Criteria scores

Table 4. Riverine AquaScore percentages by criterion and study area and by number of spatial units

Criteria	Mitchell	Staaten	Gilbert	Norman	Flinders
Criterion 1 Very High High Medium Low No data					
Criterion 2 Very High High Medium Low No data					
Criterion 3 Very High High Medium Low No data					
Criterion 4 Very High High Medium Low No data					

Criteria	Mitchell	Staaten	Gilbert	Norman	Flinders
Criterion 5 Very High High Medium Low No data					
Criterion 6 Very High High Medium Low No data					
Criterion 7 Very High High Medium Low No data					
Criterion 8 Very High High Medium Low No data					

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3.3 Non-riverine results

Aquatic Conservation Assessments were conducted on the non-riverine wetlands for each of the five catchments. Table 5 and Table 6 provide an overview of the AquaScore results in addition to individual criterion results for each catchment. There were 26,650 wetlands assessed. General observations and trends depicted by the results are outlined here.

Just under two thirds (64.8%) of spatial units in all catchments received and AquaScore of 'Very High' or 'High'. Approximately 42.8% of all spatial units received and AquaScore of 'Very High'. This result was driven, for 31.6% of wetlands, by their inclusion in special features as nominated and described by expert panel members.

The Mitchell catchment contained the highest number of wetlands with a 'Very High' or 'High' AquaScore rating (88.2%). This was followed by the Staaten (83.4%), Gilbert (72.3%), Norman (60.7%) and Flinders (34.7%). The filter table decisions that were the main drivers of these results were:

- Decn. no. 27: If C1=H or VH & number of criteria with VH >= 4 then AquaScore = Very High.
- Decn. no. 15a: If C6 = H then AquaScore = High

The most triggered filter table decision number was decn. 27 indicating that many wetlands with a 'Very High' AquaScore had multiple values i.e. at least 4 criteria which had a 'Very High' rating. Special features (criterion 6) was the criterion with the most influence in the two filter table decisions described above.

The top 3 filter table decisions triggered were:

- 27: C1=H, or VH & VH>=4 THEN AquaScore = VH
- 19: C4=VH or H THEN AquaScore = M
- 15a: C6=H THEN AquaScore = H

These filter decisions accounted for approximately 72% of all wetland AquaScore values.

The Flinders catchment contained the highest proportion of wetlands with 'Low' or 'Very Low' value (11.1%). All other catchments had less than 8% of their wetlands with those AquaScores. Most of these pertained to highly modified wetlands. The Flinders catchment also had the highest proportion of wetlands with a 'Medium' AquaScore rating (54.2%).

The overall dependability (data richness) score was high especially when compared to other ACAs. This is influenced by changes in the way true absence was represented in the dependability calculations (i.e. we now use -999 to represent data where a value has been assessed and it is not present)(i.e. true absence). In previous assessments this would have been represented as 'No data'. At least 85% of all wetlands had a dependability score of at least 70% with approximately 68.5% of all wetlands having a dependability score between 70 to 80 percent. Criteria observations are outlined below.

- Criterion 1 (Aquatic Naturalness) - At least 88% of wetlands rated 'Very High' for aquatic naturalness across all catchments. This is understandable given the very low level of urbanisation, and relatively low level of direct wetland disturbance. Flinders was the lowest with 88% while almost all wetlands in the Staaten rated 'Very High' for C1.
- Criterion 2 (Catchment Naturalness) - Overall almost 75% of all wetlands rated 'Medium' for catchment naturalness. This is partly influenced by the predominant land use which is grazing. The Mitchell catchment had the highest proportion of 'High' or 'Very High' ratings with 44% of wetlands in the catchment achieving this. Catchments that had the highest proportion of wetlands rated 'Medium' or lower were Flinders and Norman (95.3% and 93.5% respectively).
- Criterion 3 - (Diversity and richness) rated highly for the majority of wetlands in all catchments. The Flinders catchment had the lowest proportion of 'Very High' or 'High' ratings at 88% of wetlands. All other catchments rated from 92% to 99% of wetlands having these ratings.
- Criterion 4 (Threatened species and Ecosystems) - The Norman catchment had the highest proportion of wetlands (77.5%) rating 'Very High' or 'High' for threatened species and ecosystems. The Staaten catchment had the lowest at 16.5%. This criterion is heavily influenced by survey effort and the Staaten catchment is the most remote with respect to accessibility.
- Criterion 5 (Priority species and ecosystems) - The Staaten, Norman and Mitchell catchments displayed the best results for priority species and ecosystems with 81.5%, 82.2% and 81% respectively of wetlands in each catchment rated as 'Very High' or 'High'. The wetlands of the Norman catchment had the lowest proportion given these ratings (33%).
- Criterion 6 (Special Features) - the Staaten, Mitchell and Gilbert catchments had the greatest proportion of wetlands captured under special features and assigned 'Very high' or 'High' ratings for C6 (83.2%, 92.2% and 81.7% respectively). The Flinders catchment had the lowest proportion at 31.5% of wetlands within the catchment.

- Criterion 7 (Connectivity) - Very few wetlands were considered to have connectivity value. The Gilbert catchment had the highest proportion at 7.5%.
- Criterion 8 - (Representativeness) ratings of 'Very High' or 'High' tended to be similar across the Flinders, Gilbert and Staaten in terms of proportions of wetlands (58.8%, 59.5% and 53.5% respectively). The Mitchell and Norman catchments had 31.8% and 32.8% respectively of wetlands assigned these ratings. The Mitchell catchments had, by far, the highest proportion of wetlands rated as 'Low' for C8 (44.1%).

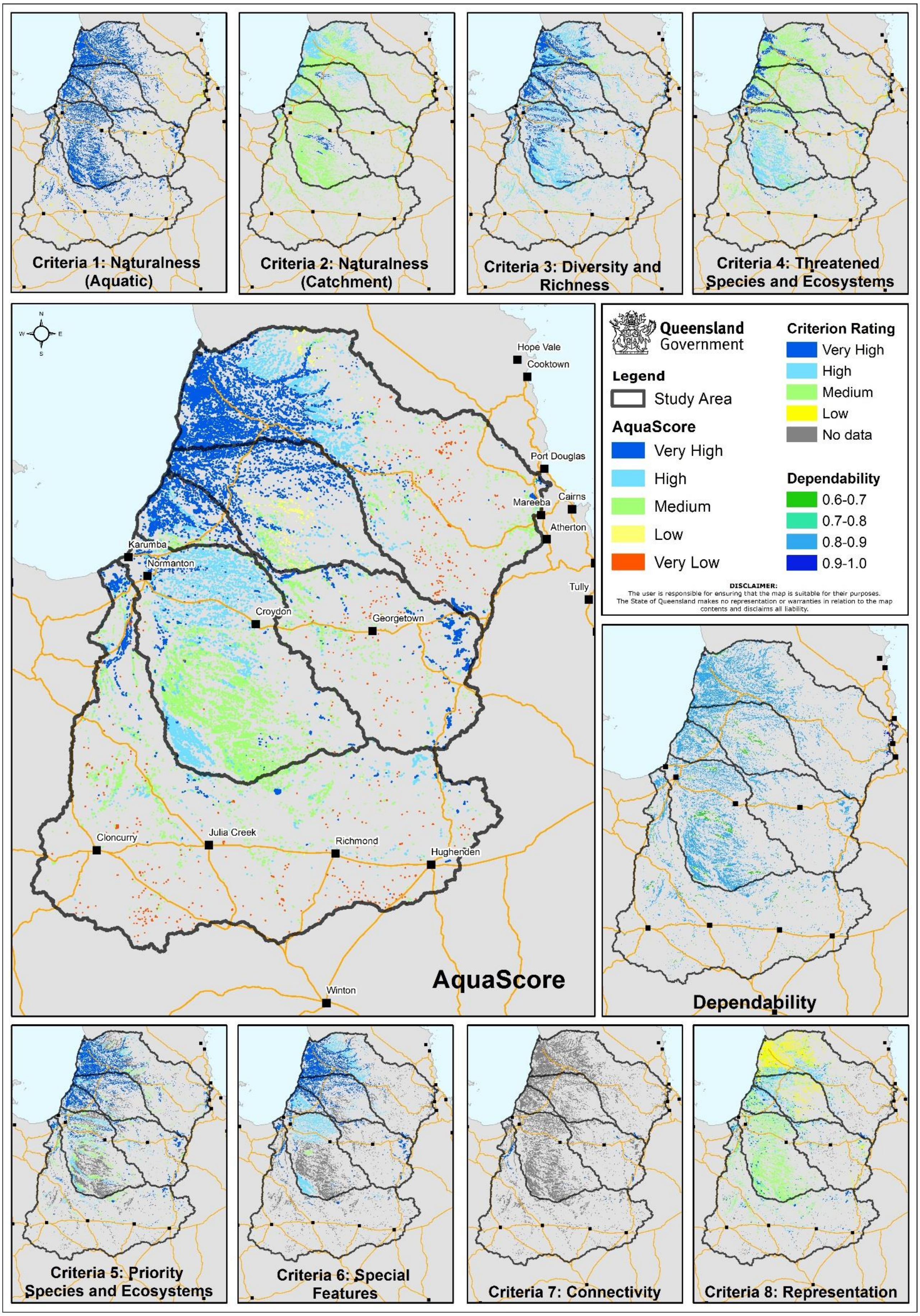
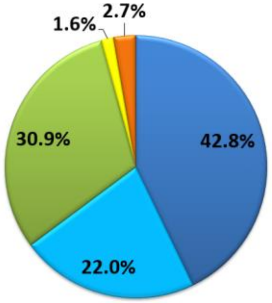
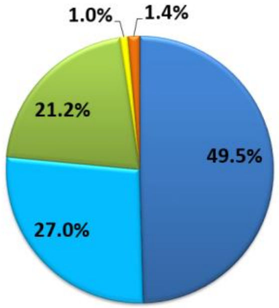
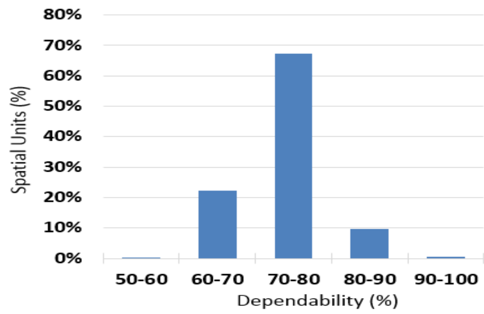
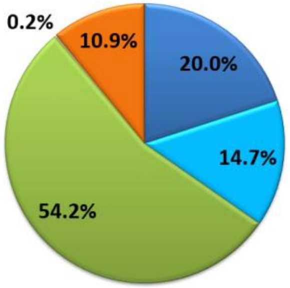
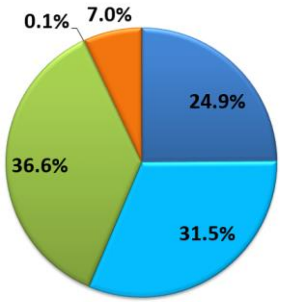
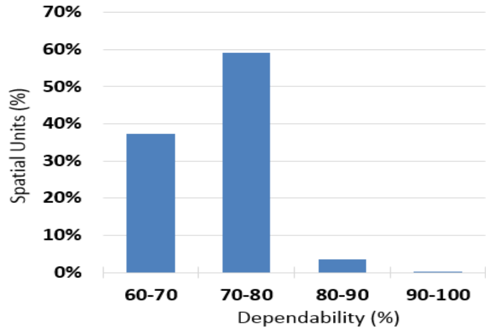
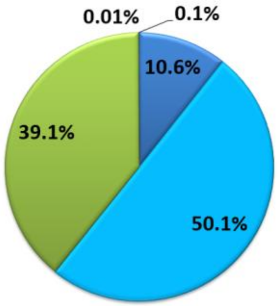
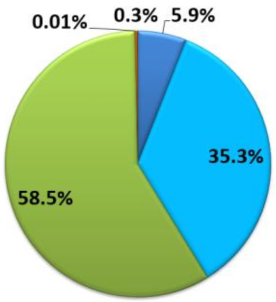
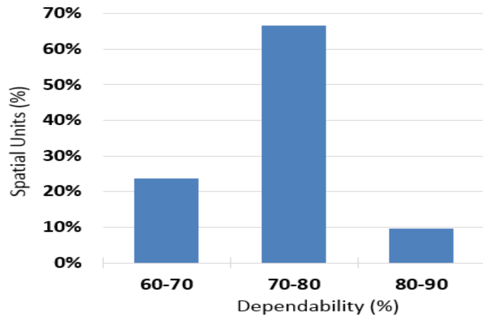
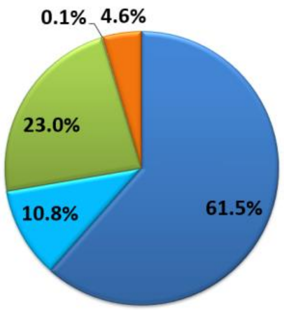
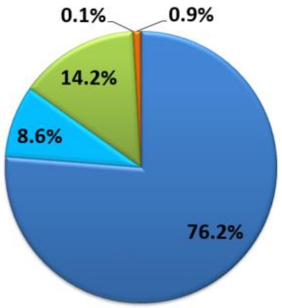
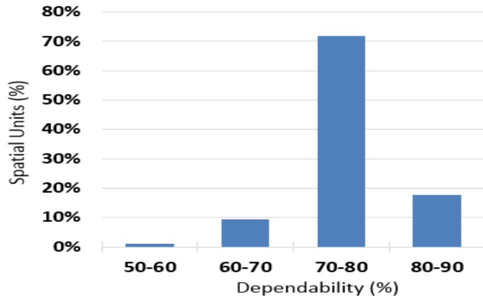
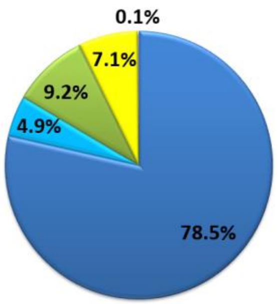
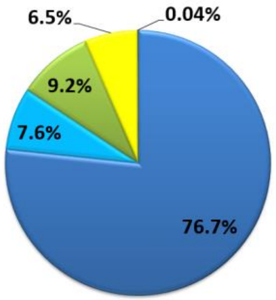
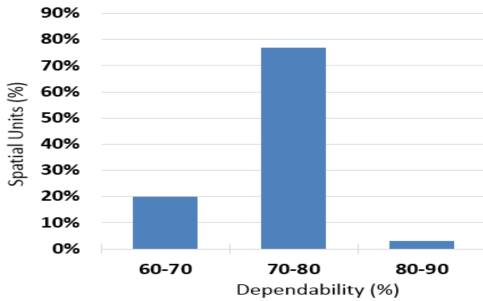


Figure 5. AquaScore, dependability and Criterion rating by non-riverine spatial unit.

3.3.1 AquaScore

Table 5. Non-riverine AquaScore and dependability summary statistics, by study area.

Catchment	AquaScore by % of spatial units	AquaScore by % of total area of spatial units	AquaScore dependability
All Very High High Medium Low Very Low			
Flinders Very High High Medium Low Very Low			

Catchment	AquaScore by % of spatial units	AquaScore by % of total area of spatial units	AquaScore dependability
Norman Very High High Medium Low Very Low			
Gilbert Very High High Medium Low Very Low			
Staaten Very High High Medium Low Very Low			

<table>
<tr><th>Catchment</th><th>AquaScore by % of spatial units</th><th>AquaScore by % of total area of spatial units</th><th>AquaScore dependability</th></tr>
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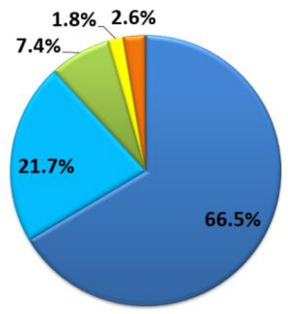
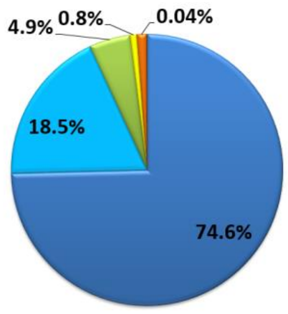
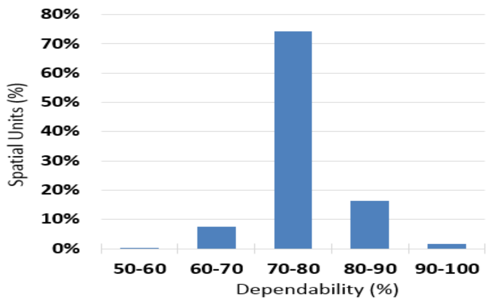
Very High
High
Medium
Low
Very Low</td><td>
</td><td>
</td><td>
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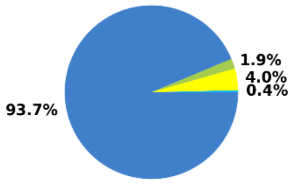
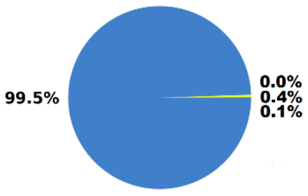
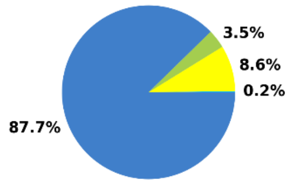
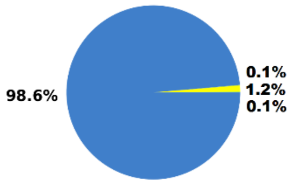
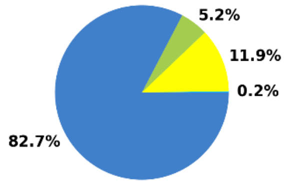
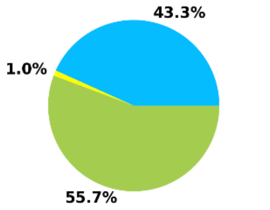
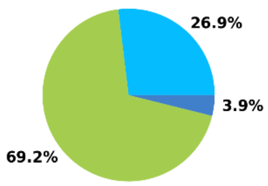
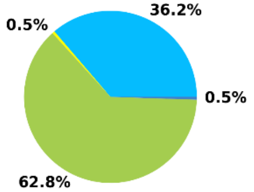
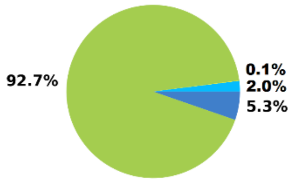
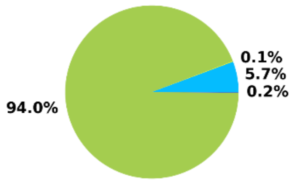
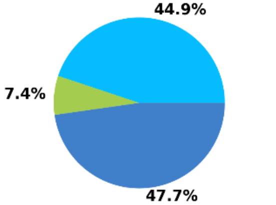
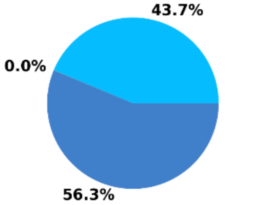
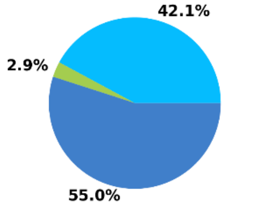
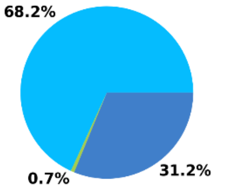
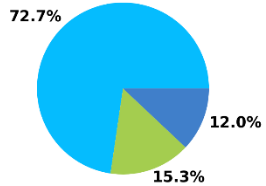
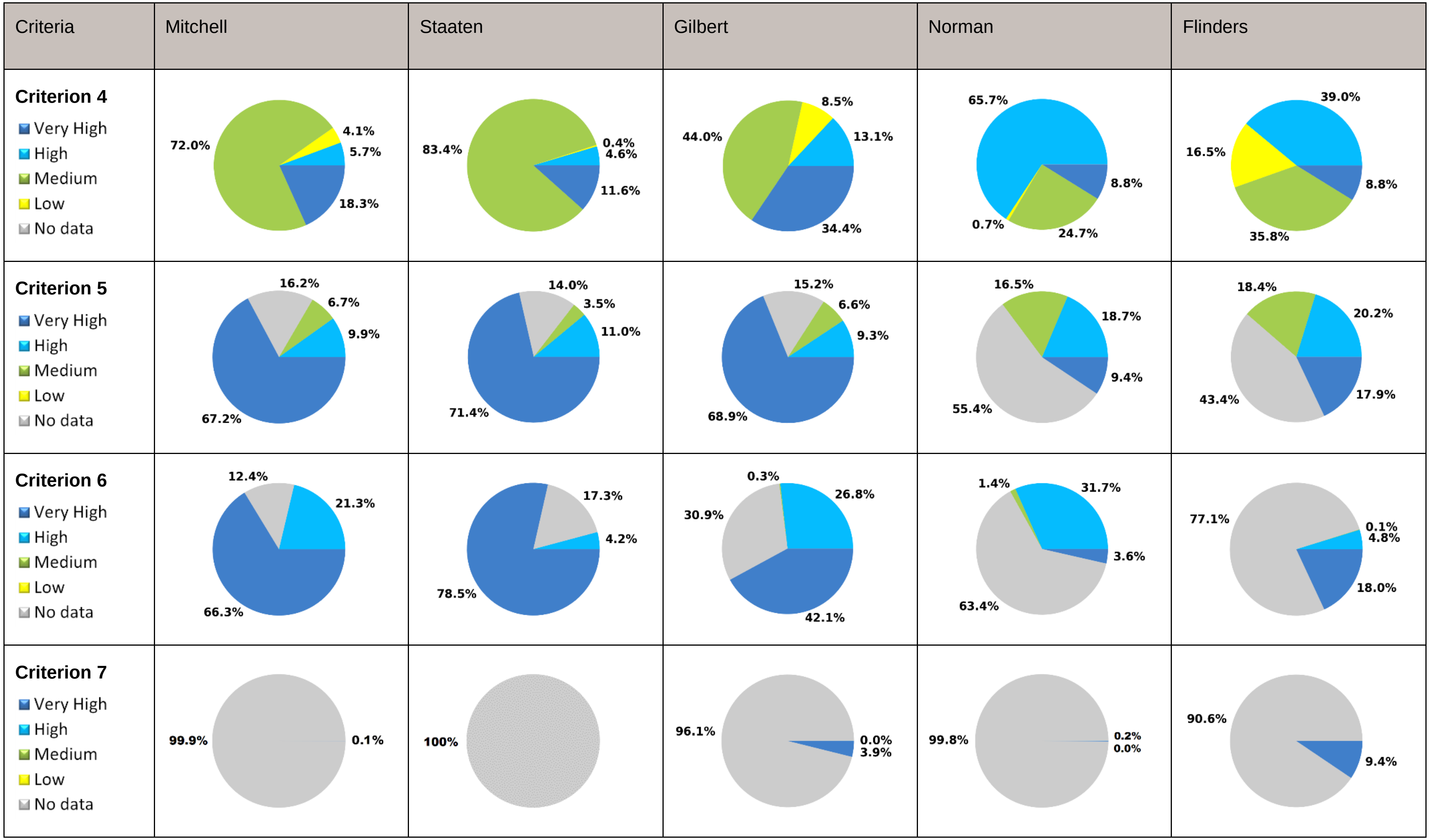
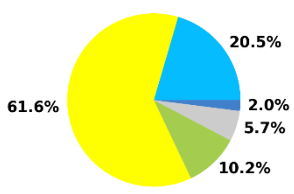
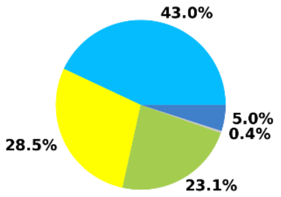
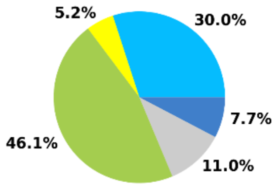
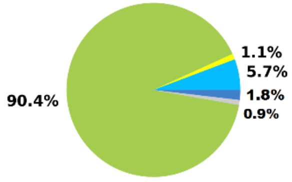
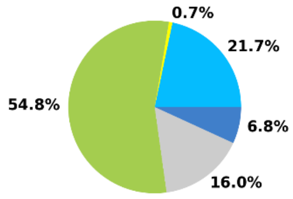
3.3.2 Criteria scores

Table 6. Non-Riverine Aqua Score percentages by criterion and study area by number of spatial units

Criteria	Mitchell	Staaten	Gilbert	Norman	Flinders
Criterion 1 Very High High Medium Low No data					
Criterion 2 Very High High Medium Low No data					
Criterion 3 Very High High Medium Low No data					


Criteria
Mitchell
Staaten
Gilbert
Norman
Flinders
Criterion 4
Very High
High
Medium
Low
No data
72.0%
4.1%
5.7%
18.3%
83.4%
0.4%
4.6%
11.6%
44.0%
8.5%
13.1%
34.4%
65.7%
8.8%
0.7%
24.7%
39.0%
16.5%
8.8%
35.8%
Criterion 5
Very High
High
Medium
Low
No data
16.2%
6.7%
9.9%
67.2%
14.0%
3.5%
11.0%
71.4%
15.2%
6.6%
9.3%
68.9%
16.5%
18.7%
9.4%
55.4%
18.4%
20.2%
43.4%
17.9%
Criterion 6
Very High
High
Medium
Low
No data
12.4%
21.3%
66.3%
17.3%
4.2%
78.5%
0.3%
26.8%
30.9%
42.1%
1.4%
31.7%
3.6%
63.4%
77.1%
0.1%
4.8%
18.0%
Criterion 7
Very High
High
Medium
Low
No data
99.9%
0.1%
100%
96.1%
0.0%
3.9%
99.8%
0.2%
0.0%
90.6%
9.4%

Criteria	Mitchell	Staaten	Gilbert	Norman	Flinders
Criterion 8 Very High High Medium Low No data					

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3.4 Field validation

Field validation is important to identify potential anomalies in assessment results or data implementation. Field-truthing is a critical step in any ACA and it precedes method adjustments and corrections prior to a final run of the AquaBAMM assessment tool.

A field validation trip was undertaken from June 26th to June 30th, 2017. The trip involved ground-truthing results using a 4WD vehicle and a 3 hour flight in a light plane. The overall study area is vast and relatively remote so not all areas could covered.

Field validation utilising a 4WD was undertaken in parts of the Gilbert catchment and the upper portion of the Mitchell catchment. A three hour flight in a Piper Cherokee covered a large portion of the Mitchell and Staaten catchments. The Flinders and Norman catchments, while not surveyed in 2017, were traversed in 2011 for the field-truthing trip relevant to the SGoC ACA.

3.4.1 Field interpretation of ACA results–ecological versus condition assessment

When visually assessing the assessment results there is a strong tendency for observations to be made from a ‘condition’ or 'naturalness' perspective. Wetland ‘condition’ or ‘health’ has been a major focus of aquatic assessment in Australia (such as the nationally agreed protocol of Monitoring River Health Initiative, Index of Stream Condition, Queensland State of the Rivers) (Dunn 2000). However, several authors make a clear distinction between ‘river health’ and ‘ecological value’ of a river (Dunn 2000; Bennett et al. 2002; Chessman 2002). Wetland health data may inform assessment of ‘value’, and usually does so where data are available, but is not interchangeable with it and the two are not necessarily correlated.

Aquatic Conservation Assessments are primarily focussed on aquatic ecological or conservation value, such that the condition contributes to, but does not solely determine its value. Of the measures used in these assessments, usually less than 10 per cent are related to aquatic, riparian and/or catchment condition. Consequently, when in the field, the successful interpretation of a spatial unit’s conservation value is reliant on the observer viewing ‘condition’ in combination with the other values (seen or unseen).

3.4.2 Field validation principles

Field inspection of the draft ACA results is important to test the validity of the implementation method. In general, the field validation will:

- Inspect spatial units across the range of values from Very Low to Very High. There is usually a focus on spatial units with Very Low, Low and Very High values as these are considered to have the most influence to reduce the potential of a false negative (type I error) or a false positive (type II error) result.
- Ascertain from observation, whether the implementation of Criterion 1 and Criterion 2 needs any adjustment with respect to Measure weights and Indicator ranks. Some Measures or Indicators may have an overpowering influence which is not consistent with observation e.g. influence of dams or weirs. This may be due to limitations and availability of relevant base datasets.
- Ascertain whether the size of subsections is adequate to discern variability in criteria (1 and 2) scores or whether values are extrapolated too far an area.
- For non-riverine wetlands inspected, ascertain if the criteria values and AquaScore ascribed are logical as determined by implementation methodology.
- Inspect wetlands with different levels of hydro-modification (i.e. H1, H2m1, H3 etc.)
- Check where scores or ratings differ markedly between adjacent wetlands.

3.4.3 Field validation route

Field truthing was undertaken from Monday June 26th to Friday June 30th, 2017 (inclusive). An overview of the itinerary is shown in **Error! Reference source not found.**11.

Table 7. Field validation itinerary

Day	Route and Task
Day 1	Drive Cairns to Georgetown checking results for accessible spatial units along the way. Distance approx. 390 km
Day 2	Georgetown and surrounds: checking results for accessible spatial units from gazetted roads. Distance approx. 250 km
Day 3	Drive Georgetown to Chillagoe checking results for accessible spatial units along the way. Distance approx. 480km
Day 4	Fixed-wing flight from Chillagoe – 3 hr approx. 600 km round trip. Flight plan covered a large portion of Mitchell and Staaten study areas
Day 5	Drive Chillagoe to Cairns checking results for accessible spatial units along the way. Distance approx. 230 km

Non-riverine wetlands selected for investigation were limited by proximity to gazetted road and those that could be safely accessed. Riverine subsections traversed were those intersected by the road route undertaken. It should be noted that visibility from the fixed wing flight extended well beyond those subsections that intersected the flight path.

All together - twenty non-riverine wetlands were specifically targeted for observation. These covered a range of hydromodifications including: H1 (Natural wetland, no modification observed); H2M1 (dams or weirs within riverine channels); H3C1 - (Artificial stand-alone water storage not in a natural water body or channel).

Many other non-riverine wetlands were observed during the flight. These covered the range of hydromodification attributes mentioned above.

Table 8. A summary of riverine subsections traversed

Route type	Catchment	Riverine subsections traversed	Percentage of total in catchment
Road	Gilbert	19	10%
Road	Mitchell	23	9%
Flight	Mitchell	28	11%
Flight	Staaten	17	17%

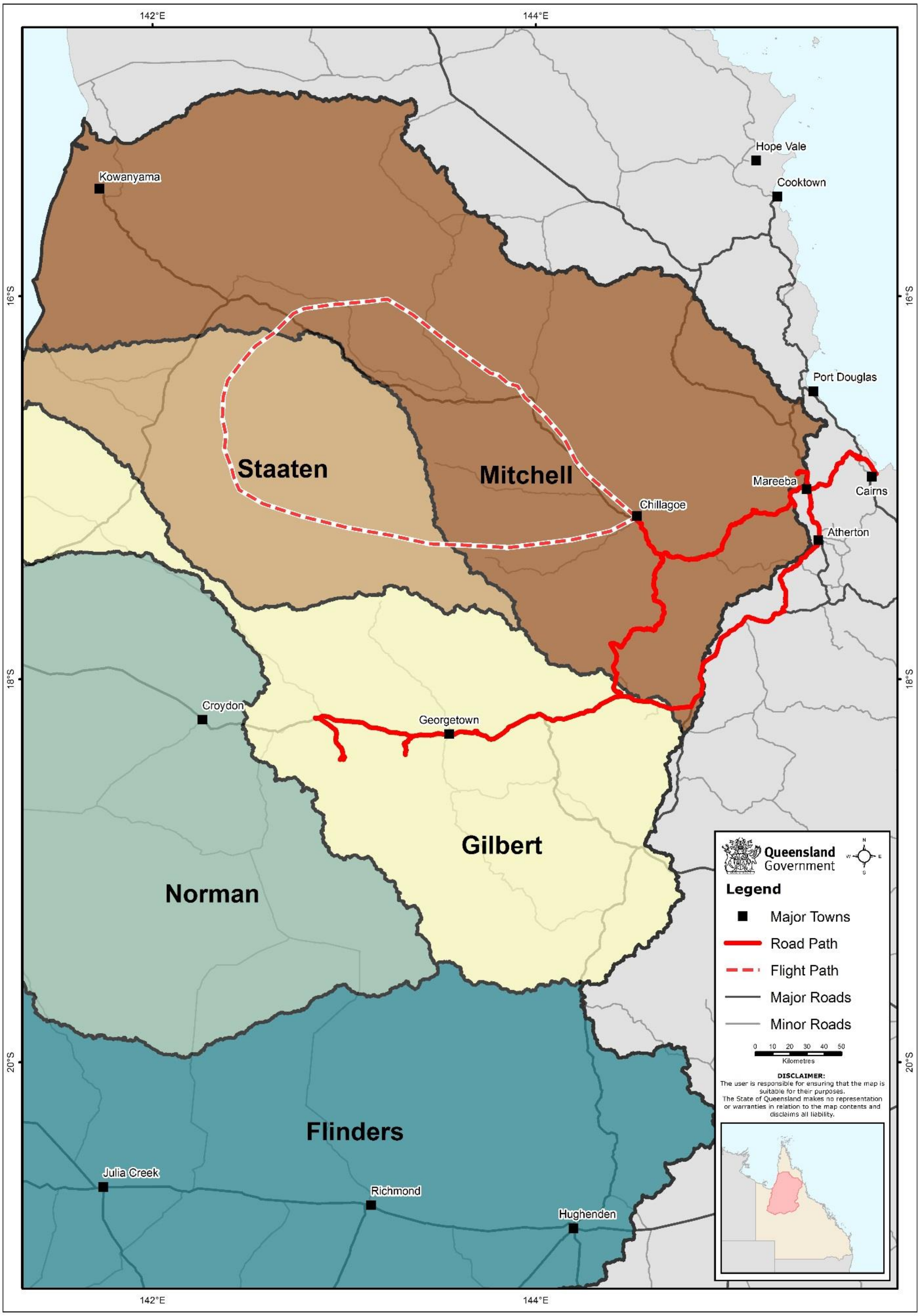

Figure 6. Road and flight path undertaken during field validation

3.4.4 Examples of wetlands and areas visited

Plate 1. A large natural non-riverine wetland (gi_w00186) surrounded by grazing in the Gilbert catchment.

This is a H1 (natural) wetland in the Gilbert catchment with grazing as the major surrounding land use. This wetland had a High Criterion 3 score for species diversity and richness and a High Criterion 5 rating for priority species. Due to the presence of pest species and the surrounding land use a Medium Criterion 2 rating was assigned to this wetland. (Photo - Biodiversity Assessment Team, DES)

Plate 2. Cumberland wetland (gi_w02455), an artificial dam within a riverine channel, near Georgetown.

This is a H2M1 wetland with an abundance of waterbirds and hydrophytes. Consequently it scored well for criteria containing species measures (Criterion 3 - Very High; Criterion 4 - High; Criterion 5 - Very High). Its overall AquaScore is Medium. (Photo - Biodiversity Assessment Team, DES)

Plate 3. Roadside view of the Gilbert River in the riverine spatial unit gi_r00187 between Georgetown and Croydon.

This segment of the river is part of a special feature highlighting hyporheic fauna and ecology in this catchment that continues a long way up and down the stream. Criterion 6 rating is assigned as High. The AquaScore for the subsection is High. The spatial unit also scored High for Diversity and richness (criterion 3). It also contains threatened species and consequently scored High for criterion 4. (Photo - Biodiversity Assessment Team, DES)

Plate 4. A large artificial stand-alone non-riverine water storage not in a natural waterbody or channel (gi_w02599) in the Gilbert catchment.

This is a H3C1 wetland (artificial stand-alone water storage not in a natural water body or channel). Waterbird and hydrophyte presence was observed. The observed presence and abundance of native wildlife in this wetland was a driver in changing the implementation methodology to include H3 wetlands in the assessment of criteria 3, 4, and 5. In initial draft results, H3 wetlands were previously excluded from these criteria ratings. Apart from Diversity and Richness - there were very few other values - consequently the wetland was rated Very Low for overall AquaScore. (Photo - Biodiversity Assessment Team, DES).

Plate 5. Fossil brook creek crossing in the riverine spatial unit ml_r00234 on the road between Georgetown and Chillagoe.

This is part of a special feature ml_r_ec_19. This is a prime driver of the overall AquaScore. The system of wetlands and streams in this upper Lynd / Fossilbrook area are spring fed. This was one of the few streams / rivers that was observed to have surface flow during the trip in late June 2017. The AquaScore for this subsection is rated at Very High. The spatial unit rated Very High for species diversity and presence of priority species (criteria 3 and 5). It also rated High for the presence of Threatened species. (Photo - Biodiversity Assessment Team, DES)

Plate 6. Double barrel creek crossing, in riverine spatial unit ml_r00214, between Georgetown and Chillagoe in the upper Mitchell catchment.

Like most of the streams in this area at this time of year, there is very little surface flow.. The spatial unit scored High for species diversity (criterion 3) and presence of Threatened species and ecosystems (criterion 4). The aquatic naturalness (criterion 1) of this unit was rated as High. An overall AquaScore of High was assigned to this riverine spatial unit. (Photo - Biodiversity Assessment Team, DES)

Plate 7. Aerial view of the section of the Mitchell River in the riverine spatial unit ml_r00133.

This section of river is characterised by perennial waterholes within the active stream network (special features ml_r_ec_06). The hydrology of this section is influenced by Major Groundwater Baseflow Reach - Mitchell Falls to Walsh and Lynd confluence (special features ml_r_ec_13). A "Very High" criterion 6 rating is assigned to this subsection. The AquaScore for this unit was rated as Very High. While special features, criterion 6, was the main driver, there were also High ratings for criteria 1,3,4,5 and 7. (Photo - Biodiversity Assessment Team, DES)

Plate 8. Aerial view of two natural non-riverine wetlands (ml_w00570, ml_w00577) in the Mitchell catchment.

They form part of the Pliocene fan special feature (ml_nr_ec_11). While the majority of wetlands are seasonal and formed as sunken holes on the late tertiary sandstone, seepage from the adjoining sand sheets and deep sandy soils make these wetlands last longer into the dry season than those associated with hardpan areas of the active floodplain. The overall AquaScore for both wetlands is High. The wetlands scored Very High for their aquatic naturalness (criterion1) and rated High for species and ecosystem diversity (criterion 3). These wetlands are poorly represented in protected areas (Very High for criterion 8). (Photo - Biodiversity Assessment Team, DES).

Plate 9. Aerial view of severe gully erosion adjacent to the Palmer River (ml_r00078).

This occurs across the Mitchell River megafan. There is diversity in alluvial form and erosion process in the Mitchell making it difficult to define gully erosion geomorphology (Brooks et. al. 2009). The AquaScore for this riverine segment is Very High. A rating of High was assigned to criteria 1,3,5 and 7. The segment is part of a special feature (Very High for criterion 6). This is the main driver for its AquaScore rating. The special feature (ml_r_ec_06) relates to perennial waterholes in active streams. (Photo - Biodiversity Assessment Team, DES)

Plate 10. Aerial view of a large artificial stand-alone non-riverine water storage not in a natural waterbody or channel (ml_w08550) in the Mitchell catchment.

This is a H2M1 non-riverine wetland in Mitchell catchment. It's AquaScore is rated as Very Low. While it did score High for diversity and richness, other criteria were rated as Medium, Low or No Data. (Photo - Biodiversity Assessment Team, DES)

Plate 11. Aerial view of a section of the Staaten River in riverine subsection sn_r00028.

This part of the river is captured under 2 special features: sn_r_ec_06 (perennial waterholes in active streams) and sn_r_fl_01 (Mixed woodland to open forest on elevated, stabilised terraces in channels of larger watercourses). It is assigned a Very High rating for criterion 6.Its AquaScore is Very High and the spatial unit scored Very High or High for all other criteria. (Photo - Biodiversity Assessment Team, DES)

Plate 12. Aerial view of a natural non-riverine wetlands (sn_w00286) in Staaten catchment.

This wetland is part of the Pliocene fan special feature (sn_nr_ec_09) and is assigned a Very High rating for Criterion 6. It is an unmodified wetland (H1) which had an AquaScore of High. Its naturalness helped it attain a Very High rating for criterion 1. It also had a Very High rating for species and ecosystem diversity and richness.(Photo - Biodiversity Assessment Team, DES).

Plate 13. Aerial view of sn_w00452 in the Staaten catchment.

This wetland is currently mapped as H1 (natural). As can obviously be seen, the wetland has been modified, most probably since the current version of the Queensland wetlands mapping was released. The original wetland boundary is clearly visible. This should be ultimately mapped as H2M6 (wetlands completely converted to a ring tank or other controlled storage) in future version releases of wetlands mapping. Its AquaScore is rated as Medium (Photo - Biodiversity Assessment Team, DES)

Plate 14. river crossing at the upper Walsh River near Dimbulah in riverine spatial unit ml_r00210.

At this location the steam is intersected by Leadingham creek road. The riverine segment rated an overall AquaScore of Medium. The only values of significance were those for criteria 3, 4 and 5 each attained a rating of High. The surrounding land use was agriculture which was the most intense in the Mitchell catchment. (Photo - Biodiversity Assessment Team, DES)

3.4.5 Recommendations following field-truthing exercise (April 2017)

The following recommendations were proposed as a result of the field-truthing exercise.

- Calculate riverine and some relevant non-riverine metrics at the smallest riverine spatial unit scale rather than the original subsections which were at a much broader scale. In some instances the original subsections were covering different general land uses (within a single subsection) which complicated evaluation of certain measures and didn't "fit" with field observations.
- There are very few dams/weirs in the catchments traversed. Their impact (measure 1.3.4) was considered to be overstated by initial results. Calculating at the smaller spatial scale (see above) would reduce the impact.
- Consider using species records sightings that were collected before 1950 for flora and 1975 for fauna as the landscape is relatively intact and the usual specie records filters may be justifiably relaxed upon recommendation by the expert panels.
- The inclusion of DAF pest species raster models may better represent the true presence of those pests nominated by the expert panels.
- Include H3 wetlands when implementing species measures. Some of the larger H3 artificial wetlands were observed, during field truthing, to have the highest abundance and variety of waterbirds. Native species measures were originally not applied to these wetlands.
- Investigate distinguishing H3 wetlands based on size. The smaller artificial wetlands contained limited biodiversity value in the opinion of the field trip participants. These could possibly be excluded from future assessments. The larger wetlands appeared to contain significant values especially for species diversity and should be retained.
- Investigate possibilities for discerning areas of higher grazing pressure. These areas were observed around townships (e.g. Georgetown) and had lower ground cover relative to other subsections despite the remnant vegetation being intact.
- Refinement of/ or inclusion of additional specific special features based on observations from the flight and ground work. These include: removal of off-stream waterholes from the raw input dataset which were incorrectly captured as perennial water holes in active streams; include Cumberland dam (near Georgetown) as special feature due to diversity and abundance of waterbirds and its perenniality in the dry season; Mareeba wetlands special feature has also captured other wetlands not meant to be part of this feature.

4 Discussion

4.1 Broad trends

The high proportion of Very High and High AquaScores can be attributed to the relatively intact landscape and high number of special and unique features attributed under Criterion 6. There are minimal urban centres, the entire region is sparsely populated and there is minimal water capture by weirs or large dams. Grazing is the predominant land use type with minimal intensive land uses such as irrigated cropping outside Dimbulah/Mareeba area. The main impact on riverine and non-riverine aquatic systems is likely due to grazing. Several exotic flora and fauna species are known to occur in the catchments however the expert panel noted that impacts associated with these are likely to be low.

The Mitchell and Staaten catchments contained the most spatial units with the highest AquaScores for both riverine and non-riverine assessments. The Flinders catchment contained the most spatial units that rated Low or Very Low in AquaScore for both riverine and non-riverine assessments. This reflects the prevalence of highly modified non-riverine wetlands particularly wetlands completely converted to a ring tank or other controlled storage and wetlands mapped as artificial stand-alone waterbodies not in a water body or channel. Non-riverine wetlands across the eastern parts of the Mitchell and Gilbert catchment also scored low reflecting the low scores for criteria 1 and 4 and lack of data for criterion 5 and 6.

Dependability scores were relatively high for this assessment compared to other ACAs. The majority of both riverine and non-riverine spatial units had a dependability of at least 70%.

The main driver for values in riverine spatial units were special features as this alone accounted for 35% of all units being assigned a Very High AquaScore. Aquatic naturalness along with species richness was a significant driver in assigning a High AquaScore to 24% of all spatial units.

Special features were a primary driver of results for non-riverine wetlands with just over two thirds (69.6%) of all wetlands containing special features. This criterion was not the sole driver however as many wetlands (approximately 28.3%) had multiple (i.e. at least 4) criteria with Very High ratings.

4.2 Constraints and Caveats

The following constraints and caveats need to be considered when interpreting the results:

- A general lack of survey data for the region in part due to accessibility and funding limitations.
- A general lack of knowledge of the ecology for remote areas.
- Bias in species point records due to the difficulty of collection in remote areas.
- A lack of an individual springs assessment may be a constraint depending on end purpose.
- There may be springs and non-riverine wetlands not included in current wetlands mapping. This will improve with each wetlands mapping release.
- Some non-riverine wetlands may not be mapped as they fall below threshold for size.
- The end user should use terrestrial (BPA) and aquatic (ACA) assessments in conjunction to obtain comprehensive information and analysis of biodiversity values.
- Highly modified wetlands e.g. H3 hydromod may have species values and should only be assigned a special feature value if specifically selected by the expert panels. The values assigned to highly modified wetlands are meant to serve primarily as an ecological inventory. They are not meant to imply any policy or legislative imperatives.
- There were some limitations in engaging with experts post panels due to project time constraints and availability of experts.
- The size of the riverine spatial units can influence species counts, although this can be addressed through appropriate thresholding and/or stratification.

Another constraint is the issue of AquaScores being driven by high scoring measures within criterion containing few measures was also identified as part of an independent sensitivity analysis (Robinson & Lee 2009) and is a known limitation of the AquaBAMM. There is a necessary trade-off between the inclusion of measures in an assessment and the assessments ability to detect variability in wetland values across a study area. As a consequence, measures that score highly across all spatial units and which have an undue influence on the results are sometimes omitted from the assessments.

4.3 Recommendations

ACA results have a wide range of applications. Well-founded ecological or conservation values for aquatic ecosystems are a useful input to many natural resource management decision making processes including, for example, regional planning, development assessment, tenure negotiations or protected area estate assessment. In addition to the overall AquaScore, individual criteria, indicators and measures from each assessment may be used for management and planning purposes.

Despite the multiple potential uses of an ACA, the product is essentially an ecological inventory of relative values associated with individual wetlands. It is not undertaken with any special considerations of policy or legislation. It is up to the end user to carefully gauge suitability for their intended purpose, giving due diligence to the caveats and constraints discussed above.

The improvement of data input to this type of assessment is ongoing. Often data is sparse, inadequate or limited in spatial extent. The use of incomplete data is unavoidable in an ecological assessment of this size and nature. Specific examples of where future data enhancements could improve the quality of output of this type of assessment include:

- The inclusion of habitat models rather than point records, particularly for threatened species. Habitat models often provide a more ecologically realistic indication of habitat.
- The development of a metric for assessing aquatic and catchment naturalness and threats as current methodology (criteria 1 and 2) has some limitations in addressing these issues (NB: A metric is currently in progress).
- The refinement of a methodology to spatially define units suitable for estuarine assessments.

4.4 References

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Appendix I - Riverine Implementation Table

Measure	Description	Implementation	Primary data sets used	Threshold type
1.1.1	Presence of 'alien' fish species within the wetland	An expert panel list of relevant exotic species was used to calculate this measure. Species records (year ≥1950, precision ≤2000m) were used to count the exotic riverine species found within riverine spatial unit. A score of NODATA was allocated to any riverine spatial unit that had an absence of exotic species data.	DES QLD Historical Fauna Database (QHFD), WildNet, and Expert Panel.	Presence Negative (-2)
1.1.2	Presence of exotic aquatic and semi-aquatic plants within the wetland	An expert panel list of relevant exotic species was used to calculate this measure. Records were utilised as follows: Records: point records or site based lists, year ≥1950, and precision ≤2000m). DAF pest grids: For listed non-riverine exotic species. Conducted a frequency of species by riverine spatial unit. 1. Convert the pest grid to point then buffer by 4.5 km. This makes a circle which is half the diameter of the original grid. 2. Intersect this circle with the riverine spatial units. Convert to point (inside polygon). 3. For areas that were missed by the steps in 1 and 2. A straight intersect and count by species of all overlapping grids was applied. Using the points derived from both methods, The number of species present within each riverine spatial unit was compiled. A score of NODATA was allocated to any riverine spatial unit that had an absence of species data.	Flora species records from DES databases WildNet, Herbrecs, Corveg and Expert Panel. DAF pest species grid data from 2011 to 2014.	Presence Negative (-2)

Measure	Description	Implementation	Primary data sets used	Threshold type
1.1.3	Presence of exotic invertebrate fauna within the wetland	An expert panel list of relevant exotic species was used to calculate this measure. Records were utilised as follows: Records: Point records or site based lists, ≥1950, and precision ≤2000m). The number of species present within each riverine spatial unit was compiled. A score of NODATA was allocated to any riverine spatial unit that had an absence of species data. **Note that no exotic invertebrates were nominated by the panel. Nevertheless this measure was included to inform dependability. All spatial units were given the same score.**	DES QLD Historical Fauna Database (QHFD), WildNet, and Expert Panel.	Presence Negative (-2)

Measure	Description	Implementation	Primary data sets used	Threshold type
1.1.4	Presence of feral/exotic vertebrate fauna (other than fish) within the wetland	An expert panel list of relevant exotic species was used to calculate this measure. Records were utilised as follows: Records: point records or site based lists, ≥1950, and precision ≤2000m). DAF pest grids: For listed non-riverine exotic species. Conducted a frequency of species by riverine spatial unit. Applied to all wetlands. 1. Convert the pest grid to point then buffer by 4.5 km. This makes a circle which is half the diameter of the original grid. 2. Intersect this circle with the riverine spatial units. Convert to point (inside polygon). 3. For areas that were missed by the steps in 1 and 2. A straight intersect and count by species of all overlapping grids was applied. Using the points derived from both methods, the number of species present within each riverine spatial unit was compiled. A score of NODATA was allocated to any riverine spatial unit that had an absence of species data.	DES QLD Historical Fauna Database (QHFD), WildNet, and Expert Panel. DAF pest species grid data from 2011 to 2014.	Presence Negative (-2)
1.3.4	Presence/absence of dams/weirs within the wetland	For each riverine spatial unit, if there is an intersection of a dam or weir point from the 100K dams and weirs dataset, or H2M1 from the Qld wetland mapping a presence negative was assigned to the riverine spatial unit.	DNRME Dams and Weirs (including private dams not include in original data). DES QLD Wetland Mapping data v4.	Presence Negative (-2)

Measure	Description	Implementation	Primary data sets used	Threshold type
1.3.5	Inundation by dams/weirs (% of waterway length within the wetland)	The reservoir layer was intersected against the drainage line work The proportion length covered by a reservoir was then calculated for each riverine spatial unit.	DNRME Blue Line drainage mapping and reservoirs layers (extracted 23/03/2017).	Logarithmic (User Defined >100 =1, <10 = 2, <0.1 = 3, 0 = 4)
1.3.7	% area of remnant wetland relative to preclear extent for each riverine spatial unit	Extract from the preclear regional ecosystems mapping polygons that contain P, L, PL, C, R, F and IR add to this unmodified (H1) wetlands (excluding estuarine types) and extract by the riparian mask. Overlay the riverine spatial units and dissolve. This defines the preclear wetland boundary extent. Overlay the remnant regional ecosystems and the QLD wetland mapping v4. Where the overlayed area is remnant and not considered a highly modified or artificial wetland ['H2M1','H2M6', 'H2M7', 'H3C1', 'H3C2', 'H3C3'] , add the area as connected, else if the preclear extent is a H1, add the area as connected, else if the preclear extent is ['H2M2', 'H2M3', 'H2M5', 'H2M8'] and covered in remnant, add the area as connected. Apply the proportion to each riverine spatial unit with no underlying preclear extent were give a value of -999.	DES Queensland wetland mapping data v4, remnant and preclear regional ecosystem mapping v10, REDD v10.	Quartered mean of the maximum 3 in the sample. Continuous Ascending

Measure	Description	Implementation	Primary data sets used	Threshold type
2.1.1	Presence of exotic terrestrial plants in the assessment unit	An expert panel list of relevant exotic species was used to calculate this measure. Records were utilised as follows: Records: species recorded (point records or site based lists, ≥1950, precision ≤2000m). DAF pest grids: For listed non-riverine exotic species. Conducted a frequency of species by riverine spatial unit. Applied to all wetlands. 1. Convert the pest grid to point then buffer by 4.5 km. This makes a circle which is half the diameter of the original grid. 2. Intersect this circle with the riverine spatial units. Convert to point (inside polygon). 3. For areas that were missed by the steps in 1 and 2. A straight intersect and count by species of all overlapping grids was applied. Using the points derived from both methods, where presence of exotic species was found within riverine spatial unit, a score of -2 was applied. This was then attributed to all the riverine spatial units unit nested within it. -999 (No data) was allocated to any riverine spatial units unit that had an absence of exotic species data.	Flora species records from DES databases WildNet, Herbrecs, Corveg and Expert Panel. DAF pest species grid data from 2011 to 2014.	Presence Negative
2.2.1	% area remnant vegetation relative to preclear extent within buffered riverine wetland or watercourses	The pre-clear and remnant regional ecosystem mapping was overlayed with the riparian mask. The percentage of remnant/preclear was then calculated for each riverine spatial unit.	DES remnant and preclear regional ecosystem mapping v10. River buffers derived from DNRME rivers line features, riverine wetlands from the QWM and height above the nearest drainage analysis.	Quartered mean of the maximum 3 in the sample. Continuous Ascending

Measure	Description	Implementation	Primary data sets used	Threshold type
2.2.2	Total number of remnant regional ecosystems relative to preclear number of REs within buffered riverine wetland or watercourses	Using the pre-clear x remnant regional ecosystems x study area intersection product from 2.2.1, the numbers of distinct REs and pre-clear regional ecosystems in each riverine spatial unit was calculated. The regional ecosystems count was compared to that of the preclear extent.	DES remnant and preclear regional ecosystem mapping v10. River buffers derived from NRM river line features, riverine wetlands from the QWM and height above the nearest drainage analysis.	Quartered mean of the maximum 3 in the sample. Continuous Ascending
2.3.1	% "agricultural" land-use area (i.e. cropping and horticulture)	“Agricultural” land-use included (Queensland Land Use Mapping Program (QLUMP) secondary categories) intensive animal production, intensive horticulture, cropping, perennial horticulture, plantation forestry, irrigated cropping, irrigated perennial horticulture, irrigated seasonal horticulture and reservoir/dam. These land-use types were allocated an agriculture attribute and a % area was calculated for agricultural areas within each riverine spatial unit.	DES QLUMP (version March 2017).	Logarithmic (User Defined, 0 = 4, <0.1 = 3, <10 = 2, <100 =1)
2.3.2	% "grazing" land-use area	“Grazing” land-use included (QLUMP secondary categories) “grazing natural vegetation”, "Grazing irrigated modified pastures", "Grazing modified pastures". These land-use types were allocated a grazing attribute and a % area was calculated for grazing areas within each riverine spatial unit.	DES QLUMP (version March 2017).	Quartered mean of the maximum 3 in the sample. Continuous Descending

Measure	Description	Implementation	Primary data sets used	Threshold type
2.3.3	% "vegetation" land-use area (i.e. native veg + regrowth)	“Vegetation” land-use included (QLUMP secondary categories) managed resource protection, nature conservation, other minimal use, production forestry, estuary/coastal waters, lake, marsh/wetland, river. These land-use types were allocated a vegetation attribute and a % area was calculated for vegetation areas within each riverine spatial unit.	DES QLUMP (version March 2017).	Quartered mean of the maximum 3 in the sample. Continuous Ascending
2.3.4	% "settlement" land-use area (i.e. towns, cities, etc.)	“Settlement” land-use included (QLUMP secondary categories) manufacturing and industrial, mining, residential, services, transport and communication, utilities, waste treatment and disposal, and channel/aqueduct. These land-use types were allocated a settlement attribute and a % area was calculated for settlement areas within each riverine spatial unit.	DES QLUMP (version March 2017).	Logarithmic (User Defined, 0 = 4, <0.1 = 3, <10 = 2, <100 =1)
3.1.1	Richness of native amphibians (riverine wetland breeders)	An expert panel list of native amphibians (riverine wetland breeders) was used to calculate this measure. Records ≥1975, precision ≤ 2000m were included. Upland and lowland stratification was applied. Records were used to derive a count of species for each riverine spatial unit, with NODATA allocated where the riverine spatial unit had an absence of species information.	DES QLD Historical Fauna Database (QHFD), WildNet, and Expert Panel.	Quartile thresholds (Q2, Q3 above and below) Continuous Ascending.

Measure	Description	Implementation	Primary data sets used	Threshold type
3.1.2	Richness of native fish	An expert panel list of native fish dependent on freshwater streams for all or part of their lifecycles was used to calculate this measure. A combination of species records (≥1975, precision ≤ 2000m) and TRaCK species habitat models were included. Upland and lowland stratification was applied. Records and the centroids derived from the TRaCK models were used to derive a count of species for each riverine spatial unit, with NODATA allocated where the associated spatial unit had an absence of species information.	DES QLD Historical Fauna Database (QHFD), WildNet, and Expert Panel. TRaCK Models 2010, Australian Rivers Institute.	Quartered mean of the maximum 3 in the sample. Continuous Ascending.
3.1.3	Richness of native aquatic dependent reptiles	An expert panel list of native reptiles dependent on freshwater streams for all or part of their lifecycles was used to calculate this measure. A combination of species records (≥1975, precision ≤ 2000m) and TRaCK species habitat models were included. Upland and lowland stratification was applied. Records and the centroids derived from the TRaCK models were used to derive a count of species for each riverine spatial unit, with NODATA allocated where the associated spatial unit had an absence of species information.	DES QLD Historical Fauna Database (QHFD), WildNet, and Expert Panel. TRaCK Models 2010, Australian Rivers Institute.	Quartile thresholds, Q3 above and below) Continuous Ascending.
3.1.4	Richness of native waterbirds	An expert panel list of native waterbirds dependent on freshwater streams for all or part of their lifecycles was used to calculate this measure. A combination of species records (≥1975, precision ≤ 2000m) and TRaCK species habitat models were included. Upland and lowland stratification was applied. Species records and the centroids derived from the TRaCK models were used to derive a count of fish species for each riverine spatial unit, with NODATA allocated where the associated spatial unit had an absence of species information.	DES QLD Historical Fauna Database (QHFD), WildNet, and Expert Panel. TRaCK Models 2010, Australian Rivers Institute.	Continuous Ascending or Categorical

Measure	Description	Implementation	Primary data sets used	Threshold type
3.1.5	Richness of native aquatic plants	An expert panel list of aquatic and semi-aquatic plants was used to calculate this measure. Records ≥1950 and a precision ≤2000m were included. Upland and lowland stratification was applied. Records were used to derive a count of species for each riverine spatial unit, with NODATA allocated where the associated spatial unit had an absence of species information.	Flora species records from DES databases WildNet, Herbrecs, Corveg and Expert Panel.	Quartered mean of the maximum 3 in the sample. Continuous Ascending.
3.1.7	Richness of native aquatic dependent mammals	An expert panel list of native mammal dependent on fresh water streams for all or part of their lifecycles was used to calculate this measure. Records ≥1975, precision ≤ 2000m were included. Upland and lowland stratification was applied. Records were used to derive a count of species for each riverine spatial unit, with NODATA where the associated spatial unit had an absence of species information.	DES QLD Historical Fauna Database (QHFD), WildNet, and Expert Panel.	Quartered mean of the maximum 3 in the sample. Continuous Ascending.
3.2.1	Richness of macroinvertebrate taxa	The macro-invertebrate richness points were intersected with the riverine spatial units. The mean richness score was then calculated for each riverine spatial unit. Catchment connectivity information was then used to allocate scores to spatial units without a score. These were allocated based on closest proximity. Upland and lowland stratification was also applied.	AUSRIVAS data.	Quartered mean of the maximum 3 in the sample. Continuous Ascending.

Measure	Description	Implementation	Primary data sets used	Threshold type
3.2.2	Richness of REs along riverine wetlands or watercourses within a specified buffer distance	A count of regional ecosystems within the riparian mask was calculated for each riverine spatial unit.	DES remnant and preclear regional ecosystem mapping v10. River buffers derived from DNRME rivers line features, riverine wetlands from the QWM and height above the nearest drainage analysis.	Quartered mean of the maximum 3 in the sample. Continuous Ascending.
3.3.2	Richness of wetland types within the local catchment	A count of different wetland habitat types (based on TYPE_RE field—a concatenation of wetland class, hydro-modifier, water regime, salinity modifier and WETRE fields from the QWM data) was calculated for each riverine spatial unit. Only wetlands of hydro-modification type H1, H2M2, H2M3, H2M8 were included in the calculations. Riverine spatial units with no valid wetland habitat types were given a value of -999.	EGoC non-riverine wethabitats, riverine spatial units.	Quartered mean of the maximum three riverine spatial units within the study area. Continuous Ascending.
3.3.3	Richness of wetland types within the sub-catchment	A count of different wetland habitat types (based on TYPE_RE field—a concatenation of wetland class, hydro-modifier, water regime, salinity modifier and WETRE fields from the QWM data) was calculated for each sub-catchment. Only wetlands of hydro-modification type H1, H2M2, H2M3, H2M8 were included in the calculations.	EGoC non-riverine wethabitats, riverine spatial units.	Quartered mean of the maximum three subcatchments within the study area. Continuous Ascending.

Measure	Description	Implementation	Primary data sets used	Threshold type
4.1.1	Presence of rare or threatened aquatic ecosystem dependent fauna species — NCA, EPBC Act	A list of rare or threatened (NCA or EPBC) riverine aquatic ecosystem dependent fauna species identified by the expert fauna panel was used to generate the records dataset. These records were intersected with the riverine spatial units to determine species richness in each.	DES QLD Historical Fauna Database (QHFD), WildNet, and Expert Panel.	Presence positive
4.1.2	Presence of rare or threatened aquatic ecosystem dependent flora species - NCA Act, EPBC Act	A list of rare or threatened (NCA or EPBC) riverine aquatic ecosystem dependent flora species identified by the expert fauna panel was used to generate the records dataset. These records were intersected with each riverine spatial units to determine species richness in each.	Flora species records from DES databases WildNet, Herbrecs, Corveg and Expert Panel.	Presence positive

Measure	Description	Implementation	Primary data sets used	Threshold type
4.2.1	Conservation status of wetland Regional Ecosystems — Herbarium biodiversity status, NCA Act, EPBC Act	The following Queensland Wetland data wetland types were assessed within buffer areas around drainage lines: 'R', 'F', 'IR', 'P', and C. XRE types from remnant regional ecosystem mapping where used where no wetland mapping was present. The following ratings were applied based on the Biodiversity Status and EPBC Status of palustrine and lacustrine regional ecosystems: For biodiversity status Endangered = 4 Of Concern = 3 No Concern at Present/Least Concern = 2 For EPBC listed communities Critically Endangered or Endangered = 4 Vulnerable = 3 Other = 2 Presence of the highest conservation status regional ecosystem in the riverine spatial unit was applied. Spatial units that contained no regional ecosystems of those type received a score of 1. **Note. V9.0 RE mapping was used for M4.2.1 because Wetlands Mapping used in this assessment (V4.0) was based on this version**. There have been significant changes to RE Conservation Status across the regions between v9.0 and V10.0	DES Queensland Wetland Mapping data v4, REDD version 9. EPBC community regional ecosystem list. River buffers derived from DNRME rivers line features, riverine wetlands from the QWM and height above the nearest drainage analysis.	Categorical

Measure	Description	Implementation	Primary data sets used	Threshold type
5.1.1	Presence of aquatic ecosystem dependent 'priority' fauna species (expert panel list/discussion or other lists such as ASFB, etc.)	An expert panel derived list of priority non-riverine aquatic ecosystem dependent fauna species was used to generate the records dataset. These records were intersected with each riverine spatial unit to determine species richness. Spatial units without records were given a value of NODATA.	DES QLD Historical Fauna Database (QHFD), WildNet, and Expert Panel.	Quartile thresholds (Q2, Q3 above and below)
5.1.2	Presence of aquatic ecosystem dependent 'priority' flora species	An expert panel derived list of priority non-riverine aquatic ecosystem dependent flora species was used to generate the records dataset. These records were intersected with each riverine spatial unit to determine species richness. Spatial units without records were given a value of NODATA.	Flora species records from DES databases WildNet, Herbrecs, Corveg and Expert Panel.	Quartile thresholds (Q2, Q3 above and below)
5.1.3	Habitat for, or presence of, migratory species (Expert Panel list/discussion and/or JAMBA/ CAMBA/ ROKAMBA agreement lists and/or Bonn Convention)	An expert panel derived list of migratory species dependent on non-riverine wetlands for all or part of their lifecycles was used to calculate this measure. These records were intersected with each riverine spatial unit to determine species richness. Spatial units without records were given a value of NODATA.	DES QLD Historical Fauna Database (QHFD), WildNet, and Expert Panel.	Using the quartile thresholds (Q2, Q3 above and below)

Measure	Description	Implementation	Primary data sets used	Threshold type
5.1.4	Habitat for significant numbers of waterbirds	Expert panels identified riverine spatial units that contained notable values associated with this measure. The resulting value was then given a conservation rating out of 4. Spatial units not identified in the panel for this measure were given a known absence value of -999.	Expert Panel	Categorical
5.2.1	Presence of 'priority' aquatic ecosystem	Expert panels identified riverine spatial units that contained notable values associated with this measure. The resulting value was then given a conservation rating out of 4. Spatial units not identified in the panel for this measure were given a known absence value of -999.	Expert Panel	Categorical
6.1.1	Presence of distinct, unique or special geomorphic features	Expert panels identified riverine spatial units that contained notable values associated with this measure. The resulting value was then given a conservation rating out of 4. Spatial units not identified in the panel for this measure were given a known absence value of -999.	Expert Panel	Categorical
6.2.1	Presence of (or requirement for) distinct, unique or special ecological processes	Expert panels identified riverine spatial units that contained notable values associated with this measure. The resulting value was then given a conservation rating out of 4. Spatial units not identified in the panel for this measure were given a known absence value of -999.	Expert Panel	Categorical

Measure	Description	Implementation	Primary data sets used	Threshold type
6.3.1	Presence of distinct, unique or special habitat (including habitat that functions as refugia or other critical purpose)	Expert panels identified riverine spatial units that contained notable values associated with this measure. The resulting value was then given a conservation rating out of 4. Spatial units not identified in the panel for this measure were given a known absence value of -999.	Expert Panel	Categorical
6.3.2	Significant wetlands identified by an accepted method such as Ramsar, Australian Directory of Important Wetlands, Regional Coastal Management Planning, World Heritage Areas, etc.	Combine significant wetland category 4 areas (Ramsar, World Heritage) and significant wetland category 3 areas (DIOW). These were then overlayed with the riverine spatial units. Calculate the proportion for each riverine spatial unit that overlaps a category 4 and category 3 signification wetland category. These are not mutually exclusive. For Score 4 area; if proportion >= 0.05 score as 4. For Score 3 area; if proportion >= 0.05 score as 3. Spatial units outside of these areas were given a known absence value of -999.	RAMSAR areas. World Heritage Areas. Directory of Important Wetlands (DOIW).	Categorical
6.3.3	Ecologically significant wetlands identified through expert opinion and/or documented study	Expert panels identified riverine spatial units that contained notable values associated with this measure. The resulting value was then given a conservation rating out of 4. Spatial units not identified in the panel for this measure were given a known absence value of -999.	Documented reports external to the ACA process.	Categorical

Measure	Description	Implementation	Primary data sets used	Threshold type
6.3.4	Climate change refugia	Expert panels identified riverine spatial units that contained notable values associated with this measure. The resulting value was then given a conservation rating out of 4. Spatial units not identified in the panel for this measure were given a known absence value of -999.	Expert Panel	Categorical
6.4.1	Presence of distinct, unique or special hydrological regimes (e.g. Spring fed stream, ephemeral stream, boggomoss).	Expert panels identified riverine spatial units that contained notable values associated with this measure. The resulting value was then given a conservation rating out of 4. Spatial units not identified in the panel for this measure were given a known absence value of -999.	Expert Panel	Categorical
7.1.2	Biodiversity service a wetland provides to support the migration or routine movement aquatic species.	Expert panels identified riverine spatial units that contained notable values associated with this measure. The resulting value was then given a conservation rating out of 4.	Expert Panel	Categorical
7.2.1	The contribution (upstream or downstream) of the riverine spatial unit to the maintenance of groundwater ecosystems with significant biodiversity values.	Expert panels identified riverine spatial units that contained notable values associated with this measure. The resulting value was then given a conservation rating out of 4.	Expert Panel	Categorical
7.5.1	The contribution of the riverine spatial unit to the maintenance of estuarine and marine ecosystems with significant biodiversity values.	Expert panels identified riverine spatial units that contained notable values associated with this measure. The resulting value was then given a conservation rating out of 4.	Expert Panel	Categorical

Measure	Description	Implementation	Primary data sets used	Threshold type
8.2.5	Wetland type representative of the study area – identified by expert opinion.	Expert panels identified riverine spatial units that contained notable values associated with this measure. The resulting value was then given a conservation rating out of 4. Spatial units not identified in the panel for this measure were given a known absence value of -999.	Expert Panel	Categorical

Appendix II - Non-riverine Implementation Table

Measure	Description	Implementation	Primary datasets used	Threshold type
1.1.1	Presence of 'alien' fish species within the wetland	An expert panel list of relevant exotic species was used to calculate this measure. Species records (year ≥1950, precision ≤2000m) were used to count the exotic species found within an subsection. This was then attributed to all the non-riverine spatial units nested within it. A score of NODATA was allocated to any non-riverine spatial unit that had an absence of species data.	DES QLD Historical Fauna Database (QHFD), WildNet, and Expert Panel.	Presence Negative (-2)
1.1.2	Presence of exotic aquatic and semi-aquatic plants within the wetland	An expert panel list of relevant exotic species was used to calculate this measure. Records were utilised as follows: Records: point records or site based lists, ≥1950, and precision ≤2000m). DAF pest grids: For listed non-riverine exotic species. Conducted a frequency of species by subsection. Applied to all wetlands. 1. Convert the pest grid to point then buffer by 4.5 km. This makes a circle which is half the diameter of the original grid. 2. Intersect this circle with the subsection. Convert to point (inside polygon). 3. For areas that were missed by the steps in 1 and 2. A straight intersect and count by species of all overlapping grids was applied. Using the points derived from both methods, The number of species present within each subsection was compiled and applied to each nested non-riverine spatial unit. A score of NODATA was allocated to any non-riverine spatial unit that had an absence of species data.	Flora species records from DES databases WildNet, Herbrecs, Corveg and Expert Panel. DAF pest species grid data from 2011 to 2014.	Presence Negative (-2)

Measure	Description	Implementation	Primary datasets used	Threshold type
1.1.3	Presence of exotic invertebrate fauna within the wetland	An expert panel list of relevant exotic species was used to calculate this measure. Records were utilised as follows: Records: point records or site based lists, ≥1950, and precision ≤2000m). The number of species present within each subsection was compiled and applied to each non-riverine spatial unit. A score of NO DATA was allocated to any non-riverine spatial unit that had an absence of species data. **Note that no exotic invertebrates were nominated by the panel. Nevertheless this measure was included to inform dependability. All spatial units were given the same score.**	DES QLD Historical Fauna Database (QHFD), WildNet, and Expert Panel.	Presence Negative (-2)
1.1.4	Presence of feral/exotic vertebrate fauna (other than fish) within the wetland	An expert panel list of relevant exotic species was used to calculate this measure. Records were utilised as follows: Records: species recorded (point records or site based lists, ≥1950, precision ≤2000m). DAF pest grids: For listed non-riverine exotic species. Conducted a frequency of species by subsection. Applied to all wetlands. 1. Convert the pest grid to point then buffer by 4.5 km. This makes a circle which is half the diameter of the original grid. 2. Intersect this circle with the subsection. Convert to point (inside polygon). 3. For areas that were missed by the steps in 1 and 2. A straight intersect and count by species of all overlapping grids was applied. Using the points derived from both methods, the number of species present within each subsection was compiled and applied to each nested non-riverine spatial unit. A score of NODATA was allocated to any non-riverine spatial unit that had an absence of species data.	DES QLD Historical Fauna Database (QHFD), WildNet, and Expert Panel. DAF pest species grid data from 2011 to 2014.	Presence Negative

Measure	Description	Implementation	Primary datasets used	Threshold type
1.3.7	% area of remnant wetland relative to preclear extent for each non-riverine spatial unit	Extract from the preclear mapping polygons that contain P, L, PL, C add to this unmodified (H1) wetlands from non-riverine spatial unit. Overlay the study areas and dissolve (single part) on SA_ID. This defines the preclear wetland boundary extent. Overlay the remnant and the QLD wetland mapping v4. Where the overlayed area is remnant and not considered a highly modified or artificial wetland ['H2M1','H2M6', 'H2M7', 'H3C1', 'H3C2', 'H3C3'] , add the area as connected, else if the preclear extent is a H1, add the area as connected, else if the preclear extent is ['H2M2', 'H2M3', 'H2M5', 'H2M8'] and covered in remnant, add the area as connected. Apply the proportion score to wetlands that have underlying connectivity information. Modifiers of 'H2M1','H2M6', 'H2M7', 'H3C1', 'H3C2', 'H3C3 were given a value of -999. Assessable wetlands with no underlying preclear extent were give a value of NO DATA.	DES Queensland Wetland Mapping data v4, remnant and preclear regional ecosystem mapping v10, REDD v10.	Quartered mean of the maximum 3 in the sample. Continuous Ascending
1.4.5	Hydrological disturbance/modification of the wetland (e.g. as determined through DES wetland mapping and classification)	Score non-riverine spatial units according to their modification code. H1 = 4; H2M8 = 3; H2M1, H2M2 and H2M3 = 2; H2M4, H2M5, H2M6, H3C1, H3C3, H3C2, H2M7 =1	DES Queensland Wetland Mapping data v4.	Categorical

Measure	Description	Implementation	Primary datasets used	Threshold type
2.1.1	Presence of exotic terrestrial plants in the assessment unit	An expert panel list of relevant exotic species was used to calculate this measure. Records were utilised as follows: Records: species recorded (point records or site based lists, ≥1950, precision ≤2000m). DAF pest grids: For listed non-riverine exotic species. Conducted a frequency of species by subsection. Applied to all wetlands. 1. Convert the pest grid to point then buffer by 4.5 km. This makes a circle which is half the diameter of the original grid. 2. Intersect this circle with the subsection. Convert to point (inside polygon). 3. For areas that were missed by the steps in 1 and 2. A straight intersect and count by species of all overlapping grids was applied. Using the points derived from both methods, where presence of exotic species was found within an subsection, a score of -2 was applied. This was then attributed to all the non-riverine spatial unit nested within it.	Flora species records from DES databases WildNet, Herbrecs, Corveg and Expert Panel. DAF pest species grid data from 2011 to 2014.	Presence Negative
2.2.5	% area of remnant vegetation relative to preclear extent within buffered non-riverine wetland: 500 m buffer for wetlands ≥ 8 ha, 200 m buffer for smaller wetlands	Each non-riverine spatial unit was buffered by 500m buffer for wetlands >= 8ha, 200m buffer for smaller wetlands. A multi-ring buffer was used as it allowed for the exclusion of the wetland itself from the analysis. The remnant and pre-clear vegetation mapping was then intersected with area calculated. De-concatenating the RE and PERCENT, The area of each value with a valid RE vegetation code was calculated to get the total area occupied by RE for pre-clear and remnant. The percentage of remnant to pre-clear was calculated and applied to each non-riverine spatial unit.	DES remnant and preclear regional ecosystem mapping v10, Queensland Wetland Mapping data v4.	Quartered mean of the maximum 3 in the sample. Continuous Ascending

Measure	Description	Implementation	Primary datasets used	Threshold type
2.3.1	% "agricultural" land-use area (i.e. cropping and horticulture)	"Agricultural" land-use included (QLUMP secondary categories) intensive animal production, intensive horticulture, cropping, cropping-Cotton, Cropping-sugar, perennial horticulture, plantation forestry, irrigated cropping, irrigated perennial horticulture, irrigated seasonal horticulture and reservoir/dam, irrigated and in transition. These land-use types were allocated an agriculture attribute and a % area was calculated for agricultural areas within each subsection. This value was then applied to all nested non-riverine spatial unit.	DES QLUMP (version March 2017).	Logarithmic (User Defined >100 =1, <10 = 2, <0.1 = 3, 0 = 4)
2.3.2	% "grazing" land-use area	"Grazing" land-use included (QLUMP secondary categories) Livestock grazing, grazing natural vegetation, grazing modified pastures. These land-use types were allocated a grazing attribute and a % area was calculated for grazing areas within each subsection. This value was then applied to all nested non-riverine spatial unit.	DES QLUMP (version March 2017).	Quartered mean of the maximum 3 in the sample. Continuous Descending
2.3.3	% "vegetation" land-use area (i.e. native veg + regrowth)	"Vegetation" land-use included (QLUMP secondary categories): waters", "Lake", "Managed resource protection", "Marsh/wetland", "Nature conservation", "Other minimal use", "Production native forests", "River", "Uncertain". These land-use types were allocated a vegetation attribute and a % area was calculated for vegetation areas within each subsection. This value was then applied to all nested non-riverine spatial unit.	DES QLUMP (version March 2017).	Quartered mean of the maximum 3 in the sample. Continuous Ascending
2.3.4	% "settlement" land-use area (i.e. towns, cities, etc.)	"Settlement" land-use included (QLUMP secondary categories) : "Land in transition", "Manufacturing and industrial", "Mining", "Residential", "Services" ,"Transport and communication", "Utilities", "Waste treatment and disposal". These land-use types were allocated a settlement attribute and a % area was calculated for settlement areas within each subsection. This value was then applied to all nested non-riverine spatial unit.	DES QLUMP (version March 2017).	Logarithmic (User Defined >100 =1, <10 = 2, <0.1 = 3, 0 = 4)

Measure	Description	Implementation	Primary datasets used	Threshold type
3.1.2	Richness of native fish	An expert panel list of native fish dependent on non-riverine wetlands for all or part of their lifecycles was used to calculate this measure. A combination of species records (≥1975, precision ≤ 2000m) and TRaCK species habitat models were included. Upland and lowland stratification was applied. Records and the centroids derived from the TRaCK models were used to derive a count of species for each subsection. This value was then attributed to nested non-riverine spatial units of H1, H2M1, H2M2, H2M3, H2M5 or H2M8 hydro-modification type, with NODATA allocated where the associated subsection had an absence of species information. All other non-riverine spatial unit of H2M4, H2M6, H2M7, H3C1, H3C2, or H3C3 hydro-modification type were given a known absence value of -999.	DES QLD Historical Fauna Database (QHFD), WildNet, and Expert Panel TRaCK Models 2010, Australian Rivers Institute.	Quarter of the mean of the 3 maximums scores. Continuous Ascending
3.1.3	Richness of native aquatic dependent reptiles	An expert panel list of native reptiles dependent on non-riverine wetlands for all or part of their lifecycles was used to calculate this measure. A combination of species records (≥1975, precision ≤ 2000m) and TRaCK species habitat models were included. Upland and lowland stratification was applied. Records and the centroids derived from the TRaCK models were used to derive a count of species for each subsection. This value was then attributed to nested non-riverine spatial units of H1, H2M1, H2M2, H2M3, H2M5 or H2M8 hydro-modification type, with NODATA allocated where the associated subsection had an absence of species information. All other non-riverine spatial unit of H2M4, H2M6, H2M7, H3C1, H3C2, or H3C3 hydro-modification type were given a known absence value of -999.	DES QLD Historical Fauna Database (QHFD), WildNet, and Expert Panel. TRaCK Models 2010, Australian Rivers Institute	Quartile above and below Q3. Continuous Ascending

Measure	Description	Implementation	Primary datasets used	Threshold type
3.1.4	Richness of native waterbirds	An expert panel list of native waterbirds dependent on non-riverine wetlands for all or part of their lifecycles was used to calculate this measure. A combination of species records (≥1975, precision ≤ 2000m) and TRaCK species habitat models were included. Upland and lowland stratification was applied. Records and the centroids derived from the TRaCK models were used to derive a count of species for each subsection. This value was then attributed to nested non-riverine spatial units of H1, H2M1, H2M2, H2M3, H2M5 or H2M8 hydro-modification type, with NODATA where the associated subsection had an absence of species information. All other non-riverine spatial unit of H2M4, H2M6, H2M7, H3C1, H3C2, or H3C3 hydro-modification type were given a known absence value of -999.	DES QLD Historical Fauna Database (QHFD), WildNet, and Expert Panel TRaCK Models 2010, Australian Rivers Institute.	Quarter of the mean of the 3 maximums scores. Continuous Ascending
3.1.5	Richness of native aquatic plants	An expert panel list of aquatic and semi-aquatic plants was used to calculate this measure. Records ≥1950 and a precision ≤2000m were included. Upland and lowland stratification was applied. Records were used to derive a count of species for each subsection. This value was then attributed to nested non-riverine spatial units of H1, H2M1, H2M2, H2M3, H2M5 or H2M8 hydro-modification type, with NODATA allocated where the associated subsection had an absence of species information. All other non-riverine spatial unit of H2M4, H2M6, H2M7, H3C1, H3C2, or H3C3 hydro-modification type were given a known absence value of -999.	Flora species records from DES databases WildNet, Herbrecs, Corveg and Expert Panel	Quarter of the mean of the 3 maximums scores. Continuous Ascending

Measure	Description	Implementation	Primary datasets used	Threshold type
3.1.6	Richness of native amphibians (non-riverine wetland breeders)	An expert panel list of native amphibians (non-riverine wetland breeders) was used to calculate this measure. Records ≥1975, precision ≤ 2000m were included. Upland and lowland stratification was applied. Records were used to derive a count of species for each subsection. This value was then attributed to nested non-riverine spatial units of H1, H2M1, H2M2, H2M3, H2M5 or H2M8 hydro-modification type, with NODATA where the associated subsection had an absence of species information. All other non-riverine spatial unit of H2M4, H2M6, H2M7, H3C1, H3C2, or H3C3 hydro-modification type were given a known absence value of -999.	DES QLD Historical Fauna Database (QHFD), WildNet, and Expert Panel	Quartile thresholds (Q2, Q3 above and below)
3.1.7	Richness of native aquatic dependent mammals	An expert panel list of native mammal dependent on non-riverine wetlands for all or part of their lifecycles was used to calculate this measure. Records ≥1975, precision ≤ 2000m were included. Upland and lowland stratification was applied. Records were used to derive a count of species for each subsection. This value was then attributed to nested non-riverine spatial units of H1, H2M1, H2M2, H2M3, H2M5 or H2M8 hydro-modification type, with NODATA where the associated subsection had an absence of species information. All other non-riverine spatial unit of H2M4, H2M6, H2M7, H3C1, H3C2, or H3C3 hydro-modification type were given a known absence value of -999. Note that no records nor models of aquatic dependant mammals were found across the bounding area. Nevertheless this measure was included to inform dependability.	DES QLD Historical Fauna Database (QHFD), WildNet, and Expert Panel	Presence positive

Measure	Description	Implementation	Primary datasets used	Threshold type
3.3.2	Richness of wetland types within the local catchment	A count of different wetland habitat types (based on TYPE_RE field—a concatenation of wetland class, hydro-modifier, water regime, salinity modifier and WETRE fields from the QWM data) was calculated for each subsection. This count was then applied to each non-riverine spatial unit based on its subsection membership. Only wetlands of hydro-modification type H1, H2M2, H2M3, H2M8 were included in the calculations. All other non-riverine spatial units were given a value of -999.	DES Queensland Wetland Mapping data v4, EGoC subsections.	Quartered mean of the maximum three non-riverine spatial units within the study area. Continuous Ascending.
3.3.3	Richness of wetland types within the sub-catchment	A count of different wetland habitat types (based on TYPE_RE field—a concatenation of wetland class, hydro-modifier, water regime, salinity modifier and WETRE fields from the QWM data) was calculated for each sub-catchment. Only wetlands of hydro-modification type H1, H2M2, H2M3, H2M8 were included in the calculations.	DES Queensland Wetland Mapping data v4, EGoC subsections.	Quartered mean of the maximum three subcatchments within the study area. Continuous Ascending.

Measure	Description	Implementation	Primary datasets used	Threshold type
4.1.1	Presence of rare or threatened aquatic ecosystem dependent fauna species — NCA, EPBC Act	A list of rare or threatened (NCA or EPBC) non-riverine aquatic ecosystem dependent fauna species identified by the expert fauna panel was used to generate the records dataset. Records were intersected with subsections to determine species richness in each. This value was then attributed to all nested non-riverine spatial units.	DES QLD Historical Fauna Database (QHFD), WildNet, and Expert Panel.	Presence positive.
4.1.2	Presence of rare or threatened aquatic ecosystem dependent flora species - NCA Act, EPBC Act	A list of rare or threatened (NCA or EPBC) non-riverine aquatic ecosystem dependent flora species identified by the expert fauna panel was used to generate the records dataset. Records were intersected with subsections to determine species richness in each. This value was then attributed to all nested non-riverine spatial units.	Flora species records from DES databases WildNet, Herbrecs, Corveg and Expert Panel.	Presence positive

Measure	Description	Implementation	Primary datasets used	Threshold type
4.2.1	Conservation status of wetland Regional Ecosystems — Herbarium biodiversity status, NCA Act, EPBC Act	The following ratings were applied based on the Biodiversity Status and EPBC Status of palustrine and lacustrine regional ecosystems: For biodiversity status Endangered = 4 Of Concern = 3 No Concern at Present/Least Concern = 2 For EPBC listed communities Critically Endangered or Endangered = 4 Vulnerable = 3 Other = 2 The maximum score was applied within each non-riverine spatial unit. **Note. V9.0 RE mapping was used for M4.2.1 because Wetlands Mapping used in this assessment (V4.0) was based on this version**. There have been significant changes to RE Conservation Status across the regions between v9.0 and V10.0	DES Queensland Wetland Mapping data v4, REDD version 9. EPBC community regional ecosystem list.	Categorical
5.1.1	Presence of aquatic ecosystem dependent 'priority' fauna species (expert panel list/discussion or other lists such as ASFB, etc.)	An expert panel derived list of priority non-riverine aquatic ecosystem dependent fauna species was used to generate the records dataset. Records were intersected with subsections to determine species richness in each. This was then attributed to all nested non-riverine spatial units. Non-riverine spatial units without records were given a value of NODATA.	DES QLD Historical Fauna Database (QHFD), WildNet, and Expert Panel.	Quartile thresholds (Q2, Q3 above and below). Continuous ascending.

Measure	Description	Implementation	Primary datasets used	Threshold type
5.1.2	Presence of aquatic ecosystem dependent 'priority' flora species	An expert panel derived list of priority non-riverine aquatic ecosystem dependent flora species was used to generate the records dataset. Records were intersected with subsections to determine species richness in each. This was then attributed to all nested non-riverine spatial units. Non-riverine spatial units without records were given a value of NODATA.	Flora species records from DES databases WildNet, Herbrecs, Corveg and Expert Panel.	Quartile thresholds (Q2, Q3 above and below). Continuous ascending.
5.1.3	Habitat for, or presence of, migratory species (Expert Panel list/discussion and/or JAMBA / CAMBA / ROKAMBA agreement lists and/or Bonn Convention)	An expert panel derived list of migratory species dependent on non-riverine wetlands for all or part of their lifecycles was used to calculate this measure. Records were intersected with subsections to determine species richness in each. This was then attributed to all nested non-riverine spatial units. Non-riverine spatial units without records were given a value of NODATA.	DES QLD Historical Fauna Database (QHFD), WildNet, and Expert Panel.	Quartile thresholds (Q2, Q3 above and below). Continuous ascending.
5.1.4	Habitat for significant numbers of waterbirds	Expert panels identified non-riverine spatial units that contained notable values associated with this measure. The resulting value was then given a conservation rating out of 4. Non-riverine spatial units not identified in the panel for this measure were given a known absence value of -999.	Expert Panel	Categorical
5.2.1	Presence of 'priority' aquatic ecosystem	Expert panels identified non-riverine spatial units that contained notable values associated with this measure. The resulting value was then given a conservation rating out of 4. Non-riverine spatial units not identified in the panel for this measure were given a known absence value of -999.	Expert Panel	Categorical

Measure	Description	Implementation	Primary datasets used	Threshold type
6.1.1	Presence of distinct, unique or special geomorphic features	Expert panels identified non-riverine spatial units that contained notable values associated with this measure. The resulting value was then given a conservation rating out of 4. Non-riverine spatial units not identified in the panel for this measure were given a known absence value of -999.	Expert Panel	Categorical
6.2.1	Presence of (or requirement for) distinct, unique or special ecological processes	Expert panels identified non-riverine spatial units that contained notable values associated with this measure. The resulting value was then given a conservation rating out of 4. Non-riverine spatial units not identified in the panel for this measure were given a known absence value of -999.	Expert Panel	Categorical
6.3.1	Presence of distinct, unique or special habitat (including habitat that functions as refugia or other critical purpose)	Expert panels identified non-riverine spatial units that contained notable values associated with this measure. The resulting value was then given a conservation rating out of 4. Non-riverine spatial units not identified in the panel for this measure were given a known absence value of -999.	Expert Panel	Categorical
6.3.2	Significant wetlands identified by an accepted method such as Ramsar, Australian Directory of Important Wetlands, Regional Coastal Management Planning, World Heritage Areas, etc.	Combine significant wetland category 4 areas (Ramsar, World Heritage) and significant wetland category 3 areas (DIOW). These were then overlayed with the non-riverine spatial units. Calculate the proportion for each non-riverine spatial unit that overlaps a category 4 and category 3 signification wetland category. These are not mutually exclusive. For Score 4 area; if proportion >= 0.05 score as 4. For Score 3 area; if proportion >= 0.05 score as 3. Non-riverine spatial units outside of these areas were given a known absence value of -999.	RAMSAR areas. World Heritage Areas. Directory of Important wetlands (DOIW).	Categorical

Measure	Description	Implementation	Primary datasets used	Threshold type
6.3.3	Ecologically significant wetlands identified through expert opinion and/or documented study	Expert panels identified non-riverine spatial units that contained notable values associated with this measure. The resulting value was then given a conservation rating out of 4. Non-riverine spatial units not identified in the panel for this measure were given a known absence value of -999.	Documented reports external to the ACA process.	Categorical
6.3.4	Climate change refugia	Expert panels identified non-riverine spatial units that contained notable values associated with this measure. The resulting value was then given a conservation rating out of 4. Non-riverine spatial units not identified in the panel for this measure were given a known absence value of -999.	Expert Panel	Categorical
6.4.1	Presence of distinct, unique or special hydrological regimes (e.g. Spring fed stream, ephemeral stream, boggomoss).	Expert panels identified non-riverine spatial units that contained notable values associated with this measure. The resulting value was then given a conservation rating out of 4. Non-riverine spatial units not identified in the panel for this measure were given a known absence value of -999.	Expert Panel	Categorical
7.1.2	Biodiversity service a wetland provides to support the migration or routine movement aquatic species.	Expert panels identified non-riverine spatial units that contained notable values associated with this measure. The resulting value was then given a conservation rating out of 4.	Expert Panel	Categorical
7.2.1	The contribution (upstream or downstream) of the non-riverine spatial unit to the maintenance of groundwater ecosystems with significant biodiversity values.	Expert panels identified non-riverine spatial units that contained notable values associated with this measure. The resulting value was then given a conservation rating out of 4.	Expert Panel	Categorical
7.5.1	The contribution of the non-riverine spatial unit to the maintenance of estuarine and marine ecosystems with significant biodiversity values.	Expert panels identified non-riverine spatial units that contained notable values associated with this measure. The resulting value was then given a conservation rating out of 4.	Expert Panel	Categorical

Measure	Description	Implementation	Primary datasets used	Threshold type
8.1.1	% area of each wetland type within Protected Areas.	Protected area estates (CP, FR, NC, NP, NS, RR, SF and TR) and nature refuge data was used to calculate the % area of each wetland habitat type (based on TYPE_RE field—a concatenation of wetland class, water regime, salinity modifier and WETRE fields from the QWM data) located within these protected areas. The minimum % area was used for individual wetlands with more than one wetland habitat type to account for habitats less protected. Only non-riverine spatial units with a hydro-modification of H1, H2M2, H2M3, and H2M8 were included in the analysis. All other non-riverine spatial units were given a value of -999.	DES Queensland Wetland Mapping data v4, QLD protected area estate.	Continuous Descending (Sattler & Williams 1999) (>10% = 1; >4% = 2; >1% = 3; <1% = 4)
8.2.1	The relative abundance of the wetland management group to which the wetland type belongs within the catchment or study area (management groups ranked least common to most common)	Utilising the habitat classification in the Queensland Wetland Mapping [HAB] a frequency habitat types occurring in the nr_wethabitats layer of each was calculated for the study area. For each non-riverine spatial unit a list of habitat types were then identified, and a score applied based on the habitat with the lowest abundance present. Only non-riverine spatial units with a hydro-modification of H1, H2M2, H2M3, and H2M8 were included in the analysis. All other non-riverine spatial units were given a value of -999.	DES Queensland Wetland Mapping data v4.	Logarithmic (User Defined >100 =1, <=100 = 2, <=10 = 3, 1 = 4)
8.2.2	The relative abundance of the wetland management group to which the wetland type belongs within the sub-catchment (management groups ranked least common to most common)	Utilising the habitat classification in the Queensland Wetland Mapping [HAB] a frequency habitat types occurring in the nr_wethabitats layer of each was calculated for the sub-catchment. For each non-riverine spatial unit a list of habitat types were then identified, and a score applied based on the habitat with the lowest abundance present. Only non-riverine spatial units with a hydro-modification of H1, H2M2, H2M3, and H2M8 were included in the analysis. All other non-riverine spatial units were given a value of -999.	DES Queensland Wetland Mapping data v4.	Logarithmic (User Defined >100 =1, <=100 = 2, <=10 = 3, 1 = 4)

Measure	Description	Implementation	Primary datasets used	Threshold type
8.2.3	The size of each wetland type relative to others of its management group within the catchment or study area	Utilising the habitat classification in the Queensland Wetland Mapping [HAB] the size of each wetland in the nr_wethabitats layer was calculated and grouped into their respective habitat classification by study area. A threshold based on a quartering of the mean of the top 3 sizes was then calculated for each habitat type. The maximum threshold was then applied to each non-riverine spatial unit based on the habitat types present in each. Only non-riverine spatial units with a hydro-modification of H1, H2M2, H2M3, and H2M8 were included in the analysis. All other non-riverine spatial units were given a value of -999.	DES Queensland Wetland Mapping data v4.	Categorical
8.2.4	The size of each wetland type relative to others of its type within a sub-catchment.	Utilising the habitat classification in the Queensland Wetland Mapping [HAB] the size of each wetland in the nr_wethabitats layer was calculated and grouped into their respective habitat classification by sub-catchment. A threshold based on a quartering of the mean of the top 3 sizes was then calculated for each habitat type and group. The maximum threshold was then applied to each non-riverine spatial unit based on the habitat types present in each. Only non-riverine spatial units with a hydro-modification of H1, H2M2, H2M3, and H2M8 were included in the analysis. All other non-riverine spatial units were given a value of -999.	DES Queensland Wetland Mapping data v4.	Categorical
8.2.5	Wetland type representative of the study area – identified by expert opinion.	Expert panels identified non-riverine spatial units that contained notable values associated with this measure. The resulting value was then given a conservation rating out of 4. Non-riverine spatial units not identified in the panel for this measure were given a known absence value of -999.	Expert Panel	

Measure	Description	Implementation	Primary datasets used	Threshold type
8.2.6	The size of each wetland type relative to others of its type within the catchment or study area.	Based on a concatenation of wetland class, water regime, salinity modifier and WETRE fields from the QWM data [TYPE_RE], the size distribution of each type was derived from the nr_wethabitats layer and grouped into their respective study area. A threshold based on a quartering of the mean of the top 3 sizes was then calculated. The maximum threshold was then applied to each non-riverine spatial unit based on the types present. Only non-riverine spatial units with a hydro-modification of H1, H2M2, H2M3, and H2M8 were included in the analysis. All other non-riverine spatial units were given a value of -999.	DES Queensland Wetland Mapping data v4.	Categorical

Appendix III - Riverine Filter Table

Decision	1 Naturalness Aquatic	2 Naturalness Catchment	3 Diversity and Richness	4 Threatened Species and Ecosystems	5 Priority Species and Ecosystems	6 Special Features	7 Connectivity	8 Representativeness	Additional Criteria	AquaScore
0	equal to (No data) and	equal to (No data) and	equal to (No data) and	equal to (No data) and	equal to (No data) and	equal to (No data) and	equal to (No data)			No data
1	equal to (Very High) and	equal to (Very High) and	equal to (Very High) and	equal to (Very High) and	equal to (Very High) and	equal to (Very High) and	equal to (Very High)			Very High
2	equal to (Very High) and			equal to (Very High) and	equal to (Very High) and		equal to (Very High)			Very High
3	equal to (Very High or High)								and number of Criteria with Very High >= 4	Very High
4						equal to (Very High)				Very High
5	equal to (Low) and	equal to (Low) and	equal to (Low) and	equal to (Low) and	equal to (Low) and	equal to (Low) and	equal to (Low)			Very Low

Decision	1 Naturalness Aquatic	2 Naturalness Catchment	3 Diversity and Richness	4 Threatened Species and Ecosystems	5 Priority Species and Ecosystems	6 Special Features	7 Connectivity	8 Representativeness	Additional Criteria	AquaScore
6	equal to (Low) and	equal to (Medium) and	equal to (Low) and	equal to (Low) and	equal to (Low) and	equal to (Low) and	equal to (Low)			Very Low
7	equal to (Very High) and			equal to (Very High)						High
8	equal to (Very High) and				equal to (Very High)					High
9		equal to (Very High) and		equal to (Very High)						High
10			equal to (Very High) and				equal to (Very High)			High
11	equal to (Very High) and	equal to (Very High) and	equal to (Very High)							High
12	equal to (High) and		equal to (Very High)							High
13	equal to (Very High or High) and						equal to (Very High)			High

Decision	1 Naturalness Aquatic	2 Naturalness Catchment	3 Diversity and Richness	4 Threatened Species and Ecosystems	5 Priority Species and Ecosystems	6 Special Features	7 Connectivity	8 Representativeness	Additional Criteria	AquaScore
14			equal to (Very High) and	equal to (Very High) and	equal to (Very High)					High
15					equal to (Very High or High) and		equal to (Very High)			High
18	equal to (High) and	equal to (Very High) and				equal to (High)				High
16		equal to (Very High) and	equal to (Very High) and			equal to (High)				High
19		equal to (Very High) and		equal to (High) and		equal to (High)				High
20		equal to (Very High) and			equal to (High) and	equal to (High)				High
17		equal to (Very High) and				equal to (High)				High
21	equal to (High) and			equal to (High) and	equal to (High)					High

Decision	1 Naturalness Aquatic	2 Naturalness Catchment	3 Diversity and Richness	4 Threatened Species and Ecosystems	5 Priority Species and Ecosystems	6 Special Features	7 Connectivity	8 Representativeness	Additional Criteria	AquaScore
22					equal to (Very High or High) and	equal to (High)				High
23	equal to (Very High or High) and		equal to (High) and	equal to (High)						High
23a						equal to (High)				High
24				equal to (Very High or High)						Medium
25					equal to (Very High or High)					Medium
26			equal to (High) and				equal to (High)			Medium
27	equal to (Very High or High or Medium) and		equal to (Very High or High)							Medium

Decision	1 Naturalness Aquatic	2 Naturalness Catchment	3 Diversity and Richness	4 Threatened Species and Ecosystems	5 Priority Species and Ecosystems	6 Special Features	7 Connectivity	8 Representativeness	Additional Criteria	AquaScore
28	equal to (Very High or High or Medium) and	equal to (Very High or High or Medium) and					equal to (High)			Medium
29			equal to (High) and		equal to (Medium)					Medium
30					equal to (Medium) and		equal to (High)			Medium
36	equal to (Very High or High or Medium) and			equal to (Medium) and	equal to (Medium)					Medium
36a						equal to (Medium)				Medium
37	equal to (Very High or High or Medium) and	equal to (Very High or High or Medium) and	equal to (Very High or High or Medium) and				equal to (Very High or High or Medium)			Medium

Decision	1 Naturalness Aquatic	2 Naturalness Catchment	3 Diversity and Richness	4 Threatened Species and Ecosystems	5 Priority Species and Ecosystems	6 Special Features	7 Connectivity	8 Representativeness	Additional Criteria	AquaScore
37a									and number of Criteria with Very High >= 3	Medium
37b									and number of Criteria with High >= 3	Medium
37c	equal to (High) or	equal to (High) or	equal to (High) or	equal to (High) or	equal to (High) or	equal to (High) or	equal to (High)		and number of Criteria with Very High >= 2	Medium
37d									and number of Criteria with Very High >= 2	Low
37e									and number of Criteria with High >= 2	Low

Decision	1 Naturalness Aquatic	2 Naturalness Catchment	3 Diversity and Richness	4 Threatened Species and Ecosystems	5 Priority Species and Ecosystems	6 Special Features	7 Connectivity	8 Representativeness	Additional Criteria	AquaScore
37f	equal to (High) or	equal to (High) or	equal to (High) or	equal to (High) or	equal to (High) or	equal to (High) or	equal to (High)		and number of Criteria with Very High >= 1	Low
38	not equal to (Very High) and	not equal to (Very High)							and number of Criteria with Low or No data >= 4	Very Low
1000	equal to (Very High or High or Medium or Low or No data) and	equal to (Very High or High or Medium or Low or No data) and	equal to (Very High or High or Medium or Low or No data) and	equal to (Very High or High or Medium or Low or No data) and	equal to (Very High or High or Medium or Low or No data) and	equal to (Very High or High or Medium or Low or No data) and	equal to (Very High or High or Medium or Low or No data)			Low

Appendix IV - Non riverine Filter Table

Decision	1 Naturalness Aquatic	2 Naturalness Catchment	3 Diversity and Richness	4 Threatened Species and Ecosystems	5 Priority Species and Ecosystems	6 Special Features	7 Connectivity	8 Representativeness	Additional Criteria	AquaScore
0	equal to (No data) and	equal to (No data) and	equal to (No data) and	equal to (No data) and	equal to (No data) and	equal to (No data) and	equal to (No data) and	equal to (No data)		No data
1	equal to (Very High) and	equal to (Very High) and	equal to (Very High) and	equal to (Very High) and	equal to (Very High) and	equal to (Very High) and	equal to (Very High) and	equal to (Very High)		Very High
2	equal to (Very High) and			equal to (Very High) and	equal to (Very High) and			equal to (Very High)		Very High
27	equal to (Very High or High)								and number of Criteria with Very High >= 4	Very High
3	equal to (Very High) and	equal to (Very High) and						equal to (Very High)		Very High
4	equal to (Very High or High or Medium) and	equal to (Very High or High or Medium) and		equal to (Very High) and				equal to (Very High)		Very High
5						equal to (Very High)				Very High

Decision	1 Naturalness Aquatic	2 Naturalness Catchment	3 Diversity and Richness	4 Threatened Species and Ecosystems	5 Priority Species and Ecosystems	6 Special Features	7 Connectivity	8 Representativeness	Additional Criteria	AquaScore
6	equal to (Low) and	equal to (Low) and	equal to (Low) and	equal to (Low) and	equal to (Low) and	equal to (Low) and	equal to (Low) and	equal to (Low)		Very Low
7		equal to (Medium or Low) and	equal to (Low) and	equal to (Low) and	equal to (Low) and	equal to (Low or No data) and	equal to (Low) and	equal to (Medium or Low)		Very Low
8	equal to (Very High) and			equal to (Very High or High) and				equal to (Very High or High)		High
9	equal to (Very High) and				equal to (Very High) and			equal to (High)		High
10	equal to (Very High) and	equal to (Very High) and			equal to (Very High)					High
10a			equal to (Very High) and				equal to (Very High)			High
11			equal to (Very High) and					equal to (Very High)		High
11a	equal to (Very High or High) and						equal to (Very High)			High

Decision	1 Naturalness Aquatic	2 Naturalness Catchment	3 Diversity and Richness	4 Threatened Species and Ecosystems	5 Priority Species and Ecosystems	6 Special Features	7 Connectivity	8 Representativeness	Additional Criteria	AquaScore
12	equal to (Very High) and				equal to (Very High or High) and			equal to (Very High)		High
13	equal to (Very High or High) and	equal to (Very High) and		equal to (Very High or High)						High
14	equal to (High) and	equal to (Very High) and			equal to (Very High)					High
15	equal to (Very High or High) and	equal to (Very High or High) and	equal to (Very High) and					equal to (High)		High
15a						equal to (High)				High
16		equal to (Very High or High) and	equal to (Very High)							Medium
17			equal to (Very High) and					equal to (High)		Medium
18	equal to (Very High or High)	equal to (Very High or High or						equal to (Very High or High)		Medium

Decision	1 Naturalness Aquatic	2 Naturalness Catchment	3 Diversity and Richness	4 Threatened Species and Ecosystems	5 Priority Species and Ecosystems	6 Special Features	7 Connectivity	8 Representativeness	Additional Criteria	AquaScore
	and	Medium) and								
19				equal to (Very High or High)						Medium
20					equal to (Very High or High)					Medium
20b			equal to (High) and				equal to (Very High)			Medium
21	equal to (Very High or High or Medium) and	equal to (Very High or High) and				equal to (Medium)				Medium
22		equal to (Very High or High) and	equal to (High) and		equal to (Medium)					Medium
23		equal to (Very High or High) and		equal to (Medium) and		equal to (Medium)				Medium
24	equal to (Very High or High or Medium)			equal to (Medium) and				equal to (Very High or High or Medium)		Medium

Decision	1 Naturalness Aquatic	2 Naturalness Catchment	3 Diversity and Richness	4 Threatened Species and Ecosystems	5 Priority Species and Ecosystems	6 Special Features	7 Connectivity	8 Representativeness	Additional Criteria	AquaScore
	and									
25	equal to (Very High or High or Medium) and	equal to (Very High)								Medium
25a	equal to (Very High or High or Medium) and	equal to (High or Medium) and					equal to (High)			Medium
26	equal to (Very High or High or Medium) and	equal to (High or Medium) and	equal to (Medium) and					equal to (Medium)		Medium
26a						equal to (Medium)				Medium
26c					equal to (Medium) and		equal to (High)			Medium
29									and number of Criteria with High >= 3	Medium

Decision	1 Naturalness Aquatic	2 Naturalness Catchment	3 Diversity and Richness	4 Threatened Species and Ecosystems	5 Priority Species and Ecosystems	6 Special Features	7 Connectivity	8 Representativeness	Additional Criteria	AquaScore
30									and number of Criteria with Medium >= 4	Medium
30a									and number of Criteria with Very High >= 3	Medium
30c	equal to (High) or	equal to (High) or	equal to (High) or	equal to (High) or	equal to (High) or	equal to (High) or	equal to (High) or	equal to (High)	and number of Criteria with Very High >= 2	Medium
30d									and number of Criteria with Very High >= 2	Low
30e									and number of Criteria with High >= 2	Low
30f	equal to (High) or	equal to (High) or	equal to (High) or	equal to (High) or	equal to (High) or	equal to (High) or	equal to (High) or	equal to (High)	and number of Criteria	Low

Decision	1 Naturalness Aquatic	2 Naturalness Catchment	3 Diversity and Richness	4 Threatened Species and Ecosystems	5 Priority Species and Ecosystems	6 Special Features	7 Connectivity	8 Representativeness	Additional Criteria	AquaScore
									with Very High >= 1	
28									and number of Criteria with Low or No data >= 4	Very Low
1000	equal to (Very High or High or Medium or Low or No data) and	equal to (Very High or High or Medium or Low or No data) and	equal to (Very High or High or Medium or Low or No data) and	equal to (Very High or High or Medium or Low or No data) and	equal to (Very High or High or Medium or Low or No data) and	equal to (Very High or High or Medium or Low or No data) and	equal to (Very High or High or Medium or Low or No data) and	equal to (Very High or High or Medium or Low or No data)		Low

Appendix V - Riverine Measure weights relative to each other in the same Indicator

Maximum weight is 10

Criteria and indicators	Measure	Measure description	Weight
1 Naturalness aquatic			
1.1 Exotic flora/fauna	1.1.1	Presence of 'alien' fish species within the wetland	10
	1.1.2	Presence of exotic aquatic and semi-aquatic plants within the wetland	10
	1.1.3	Presence of exotic invertebrate fauna within the wetland	8.6
	1.1.4	Presence of feral/exotic vertebrate fauna (other than fish) within the wetland	8.6
1.3 Habitat features modification	1.3.4	Presence/absence of dams/weirs within the wetland	10
	1.3.5	Inundation by dams/weirs (% of waterway length within the wetland)	10
	1.3.7	% area of remnant wetland relative to preclear extent for each spatial unit	5
2 Naturalness catchment			
2.1 Exotic flora/fauna	2.1.1	Presence of exotic terrestrial plants in the assessment unit	10
2.2 Riparian disturbance	2.2.1	% area of remnant vegetation relative to preclear extent within buffered riverine wetland or watercourses	10
	2.2.2	Total number of REs relative to preclear number of REs within buffered riverine wetland or watercourses	8.3
2.3 Catchment disturbance	2.3.1	% "agricultural" land-use area (i.e. cropping and horticulture)	7.5
	2.3.2	% "grazing" land-use area	10
	2.3.3	% "vegetation" land-use area (i.e. native veg + regrowth)	10
	2.3.4	% "settlement" land-use area (i.e. towns, cities, etc.)	5
2.4 Flow modification	2.4.1	Farm storage (overland flow harvesting, floodplain ring tanks, gully dams) calculated by surface area	10
3 Diversity and richness			
3.1 Species	3.1.1	Richness of native amphibians (riverine wetland breeders)	9.7
	3.1.2	Richness of native fish	10
	3.1.3	Richness of native aquatic dependent reptiles	9
	3.1.4	Richness of native waterbirds	9.2
	3.1.5	Richness of native aquatic plants	10
	3.1.7	Richness of native aquatic dependent mammals	9.2

Criteria and indicators	Measure	Measure description	Weight
3.2 Communities/ assemblages	3.2.1	Richness of macroinvertebrate taxa	10
	3.2.2	Richness of REs along riverine wetlands or watercourses within a specified buffer distance	8.7
3.3 Habitat	3.3.2	Richness of wetland types within the local catchment (e.g. SOR sub-section)	10
	3.3.3	Richness of wetland types within the sub-catchment	9.7
4 Threatened species and ecosystems			
4.1 Species	4.1.1	Presence of rare or threatened aquatic ecosystem dependent fauna species — NCA, EPBC Act	9.9
	4.1.2	Presence of rare or threatened aquatic ecosystem dependent flora species — NCA, EPBC Act	10
4.2 Communities/ assemblages	4.2.1	Conservation status of wetland Regional Ecosystems — Herbarium biodiversity status, NCA, EPBC Act	10
5 Priority species and ecosystems			
5.1 Species	5.1.1	Presence of aquatic ecosystem dependent 'priority' fauna species (expert panel list/discussion or other lists such as ASFB, WWF, etc.)	10
	5.1.2	Presence of aquatic ecosystem dependent 'priority' flora species	9.8
	5.1.3	Habitat for, or presence of, migratory species (expert panel list/discussion and/or JAMBA / CAMBA / ROKAMBA agreement lists and/or Bonn Convention)	8.8
	5.1.4	Habitat for significant numbers of waterbirds	8.8
5.2 Ecosystems	5.2.1	Presence of 'priority' aquatic ecosystem	10
6 Special Features			
6.1 Geomorphic features	6.1.1	Presence of distinct, unique or special geomorphic features	10
6.2 Ecological processes	6.2.1	Presence of (or requirement for) distinct, unique or special ecological processes	10
6.3 Habitat	6.3.1	Presence of distinct, unique or special habitat (including habitat that functions as refugia or other critical purpose)	10
	6.3.2	Significant wetlands identified by an accepted method such as Ramsar, Australian Directory of Important Wetlands, Regional Coastal Management Planning, World Heritage Areas, etc.	9.2
	6.3.3	Ecologically significant wetlands identified through expert opinion and/or documented study	9.6
	6.3.4	Areas important as refugia from the predicted effects of climate change (e.g. source of species re-population)	9.8

Criteria and indicators	Measure	Measure description	Weight
7 Connectivity			
7.1 Significant species or populations	7.1.2	Migratory or routine 'passage' of fish and other fully aquatic species (upstream, lateral or downstream movement) within the spatial unit	10
7.2 Groundwater dependent ecosystems	7.2.1	The contribution (upstream or downstream) of the spatial unit to the maintenance of groundwater ecosystems with significant biodiversity values, including those features identified through criteria 5 and/or 6 (e.g., karsts, cave streams, artesian springs)	10
7.5 Estuarine and marine ecosystems	7.5.1	The contribution of the spatial unit to the maintenance of estuarine and marine ecosystems with significant biodiversity values, including those features identified through criteria 5 and/or 6	10

Appendix VI - Non-riverine Measure weights relative to each other in each Indicator

Maximum score is 10

Criteria and indicators	Measure	Measure description	Weight
1 Naturalness aquatic			
1.1 Exotic flora/fauna	1.1.1	Presence of ‘alien' fish species within the wetland	8.6
	1.1.2	Presence of exotic aquatic and semi-aquatic plants within the wetland	10
	1.1.3	Presence of exotic invertebrate fauna within the wetland	8.6
	1.1.4	Presence of feral/exotic vertebrate fauna (other than fish) within the wetland	8.6
1.3 Habitat features modification	1.3.7	% area of remnant wetland relative to preclear extent for each spatial unit	10
1.4 Hydrological Modification	1.4.5	Hydrological disturbance/modification of the wetland (as determined through the DES wetland mapping and classification)	10
2 Naturalness catchment			
2.1 Exotic flora/fauna	2.1.1	Presence of exotic terrestrial plants in the assessment unit	10
2.2 Riparian disturbance	2.2.5	% area of remnant vegetation relative to preclear extent within buffered non-riverine wetland: 500m buffer for wetlands >= 8Ha, 200m buffer for smaller wetlands	10
2.3 Catchment disturbance	2.3.1	% "agricultural" land-use area (i.e. cropping and horticulture)	7.5
	2.3.2	% "grazing" land-use area	10
	2.3.3	% "vegetation" land-use area (i.e. native veg + regrowth)	10
	2.3.4	% "settlement" land-use area (i.e. towns, cities, etc.)	5
3 Diversity and richness			
3.1 Species	3.1.2	Richness of native fish	9.9
	3.1.3	Richness of native aquatic dependent reptiles	8.7
	3.1.4	Richness of native waterbirds	9.1
	3.1.5	Richness of native aquatic plants	10
	3.1.6	Richness of native amphibians (non-riverine wetland breeders)	9.2
	3.1.7	Richness of native aquatic dependent mammals	8.8
3.3 Habitat	3.3.2	Richness of wetland types within the local catchment (e.g. SOR sub-section)	10
	3.3.3	Richness of wetland types within the sub-catchment	9.5
4 Threatened species and ecosystems			

Criteria and indicators	Measure	Measure description	Weight
4.1 Species	4.1.1	Presence of rare or threatened aquatic ecosystem dependent fauna species — NCA, EPBC Act	10
	4.1.2	Presence of rare or threatened aquatic ecosystem dependent flora species — NCA, EPBC Act	10
4.2 Communities/ assemblages	4.2.1	Conservation status of wetland Regional Ecosystems — Herbarium biodiversity status, NCA, EPBC Act	10
5 Priority species and ecosystems			
5.1 Species	5.1.1	Presence of aquatic ecosystem dependent 'priority' fauna species (expert panel list/discussion or other lists such as ASFB, WWF, etc.)	10
	5.1.2	Presence of aquatic ecosystem dependent 'priority' flora species	9.9
	5.1.3	Habitat for, or presence of, migratory species (Expert Panel list/discussion and/or JAMBA / CAMBA / ROKAMBA agreement lists and/or Bonn Convention)	8.8
	5.1.4	Habitat for significant numbers of waterbirds	8.6
5.2 Ecosystems	5.2.1	Presence of 'priority' aquatic ecosystem	10
6 Special features			
6.1 Geomorphic features	6.1.1	Presence of distinct, unique or special geomorphic features	10
6.2 Ecological processes	6.2.1	Presence of (or requirement for) distinct, unique or special ecological processes.	10
6.3 Habitat	6.3.1	Presence of distinct, unique or special habitat (including habitat that functions as refugia or other critical purpose)	10
	6.3.2	Significant wetlands identified by an accepted method such as Ramsar, Australian Directory of Important Wetlands, Regional Coastal Management Planning, World Heritage Areas, etc.	9
	6.3.3	Ecologically significant wetlands identified through expert opinion and/or documented study	9.6
	6.3.4	Areas important as refugia from the predicted effects of climate change (e.g. source of species re-population)	9.6
7 Connectivity			
7.1 Significant species or populations	7.1.2	Migratory or routine 'passage' of fish and other fully aquatic species (upstream, lateral or downstream movement) within the spatial unit.	10
7.2 Groundwater dependent ecosystems	7.2.1	The contribution (upstream or downstream) of the spatial unit to the maintenance of groundwater ecosystems with significant biodiversity values, including those features identified through criteria 5 and/or 6 (e.g. karsts, cave streams, artesian springs)	10
7.5 Estuarine and marine ecosystems	7.5.1	The contribution of the spatial unit to the maintenance of estuarine and marine ecosystems with significant biodiversity values, including those features identified through criteria 5 and/or 6	10
8 Representativeness			

Criteria and indicators	Measure	Measure description	Weight
8.1 Wetland protection	8.1.1	The percentage of each wetland type within Protected Areas.	10
8.2 Wetland uniqueness	8.2.1	The relative abundance of the wetland management group to which the wetland type belongs within the catchment or study area (management groups ranked least common to most common)	7.1
	8.2.2	The relative abundance of the wetland management group to which the wetland type belongs within the subcatchment or estuarine/marine zone (management groups ranked least common to most common)	7
	8.2.3	The size of each wetland type relative to others of its management group within the catchment or study area	6.9
	8.2.4	The size of each wetland type relative to others of its type within a subcatchment (or estuarine zone)	7.5
	8.2.5	Wetland type representative of the study area – identified by expert opinion	10
	8.2.6	The size of each wetland type relative to others of its type within the catchment or study area	8

Appendix VII - Riverine Indicator Ranks

The maximum rank is 1. If both Indicators within a Criterion are ranked 1 - they are considered of equal importance.

Criterion	Indicator description	Rank
1 Naturalness aquatic		
1.1	Exotic flora / fauna	1
1.3	Habitat features modification	1
2 Naturalness catchment		
2.1	Exotic flora / fauna	2
2.2	Riparian disturbance	2
2.3	Catchment disturbance	1
3 Diversity and richness		
3.1	Species	2
3.2	Communities / assemblages	1
3.3	Habitat	2
4 Threatened species and ecosystems		
4.1	Species	1
4.2	Communities / assemblages	2
5 Priority species and ecosystems		
5.1	Species	2
5.2	Communities / assemblages	1
6 Special features		
6.1	Geomorphic features	2
6.2	Ecological processes	1
6.3	Habitat	1
6.4	Hydrological	2
7 Connectivity		
7.1	Significant species or populations	1
7.3	Floodplain and wetland ecosystems	1
7.5	Estuarine and marine ecosystems	1

Appendix VIII - Non-riverine Indicator Ranks

The maximum rank is 1. If both Indicators within a Criterion are ranked 1 - they are considered of equal importance.

Criterion	Indicator	Rank
1 Naturalness aquatic		
1.1	Exotic flora / fauna	2
1.3	Habitat features modification	1
1.4	Hydrological modification	2
2 Naturalness catchment		
2.1	Exotic flora / fauna	2
2.2	Riparian disturbance	2
2.3	Catchment disturbance	1
3 Diversity and richness		
3.1	Species	1
3.3	Habitat	1
4 Threatened species and ecosystems		
4.1	Species	1
4.2	Communities / assemblages	2
5 Priority species and ecosystems		
5.1	Species	2
5.2	Communities / assemblages	1
6 Special features		
6.1	Geomorphic features	2
6.2	Ecological processes	1
6.3	Habitat	1
6.4	Hydrological	2
7 Connectivity		
7.1	Significant species or populations	1
7.2	Groundwater dependent ecosystems	2
7.5	Estuarine and marine ecosystems	3
8 Representativeness		
8.1	Wetland protection	1

Criterion	Indicator	Rank
8.2	Wetland uniqueness	1

5 Attachments

Attachment A: An Aquatic Conservation Assessment for the riverine and non-riverine wetlands of the Eastern Gulf of Carpentaria - Flora, Fauna and Ecology Expert Panel Report, Version 1.1.