Aquatic Conservation Assessment using AquaBAMM for the riverine and non-riverine wetlands of the Queensland Murray-Darling and Bulloo Basins

Summary Report

Version 2.1

Queensland Government

Prepared by: Biodiversity Assessment Team, Queensland Herbarium, Department of Environment and Science

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Citation

DES 2022. Aquatic Conservation Assessment using AquaBAMM for the riverine and non-riverine wetlands of the Queensland Murray-Darling and Bulloo Basins: Summary Report, Version 2.1. Department of Environment and Science, Queensland Government.

Acknowledgements

This report was prepared by Mark Kelton, Linda Lawrence, Chris Sanderson, Shane Chemello. The authors wish to thank all the experts who gave their time and knowledge at the expert panel workshops. Thanks to members of the Biodiversity Assessment Team and the Queensland Herbarium for assisting in running the expert panels and general report preparation. Thanks to Southern Queensland Landscapes for their assistance in running the assessment. Special thanks to Mike Ronan and the Wetlands team within DES for kindly providing funding and support for running the expert panels and the assessment.

Cover photo

The small palustrine wetlands north of Currawinya Lakes to Lake Bindegolly National Park in the Paroo study area. Photo supplied by Gary Cranitch, © Queensland Museum.

2022

Version History

Version	Type	Release Date	Description
1.4	riverine, non-riverine	12/11/2011	Aquatic Conservation Assessments (ACA) using AquaBAMM for wetlands of the Queensland Murray-Darling Basin.
2.1	riverine, non-riverine	08/12/2022	Aquatic Conservation Assessment using AquaBAMM for the riverine and non-riverine wetlands of the Queensland Murray-Darling and Bulloo Basins.

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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
CE	Critically endangered
CIM	Criterion, Indicator and Measure (used in AquaBAMM)
DIWA	Directory of Important Wetlands in Australia
DES	Department of Environment and Science
E	Endangered
EPBC	*Environment Protection and Biodiversity Conservation Act 1999*
JAMBA	Japan–Australia Migratory Bird Agreement
NCA	*Nature Conservation Act 1992*
NP	National Park
NR	Non-riverine
NT	Near threatened
QHFD	Queensland Historical Fauna Database
QMDB	Queensland Murray-Darling Basin
QMDBB	Queensland Murray-Darling and Bulloo Basins
R	Riverine
Ramsar	Ramsar Convention on Wetlands
RE	Regional Ecosystem
ROKAMBA	Republic of Korea–Australia Migratory Bird Agreement
SOR	State of the Rivers
V	Vulnerable

1 Introduction

The Department of Environment and Science (DES) has undertaken freshwater Aquatic Conservation Assessments (ACA) for the Border Rivers, Moonie, Condamine-Balonne, Maranoa, Wallam, Warrego, Paroo and Bulloo basins. The combined assessments are titled – Queensland Murray-Darling and Bulloo Basins Aquatic Conservation Assessments (QMDBB ACA) v2.1.

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. Criteria are combined to assign an overall biodiversity value (AquaScore) to each wetland or spatial unit assessed. The criteria, each of which have a variable number of indicators and measures, include Naturalness Aquatic, Naturalness Catchment, Diversity and Richness, Threatened Species and Ecosystems, Priority Species and Ecosystems, Special 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. In addition to the AquaScore, assessment results include a comprehensive set of baseline ecological information at the individual wetland scale. Assessment measures are populated with data from a range of sources including expert opinion elicited during structured expert panel workshops. Aquatic Conservation Assessments 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, Aquatic Conservation Assessment 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 catchments listed in Table 1. Freshwater riverine and non-riverine systems have been assessed.

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 Queensland Murray-Darling and Bulloo Basins: Flora, Fauna and Ecology Expert Panel Report, Version 2.1 (DES 2022).

Table 1. Study areas of the Queensland Murray-Darling and Bulloo Basins Aquatic Conservation Assessment

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)
Condamine - Balonne	cb	6,875,602	517	3,854	77,797
Border Rivers	bd	2,439,715	167	1,746	24,827
Moonie Basin	mn	1,465,745	38	619	7,440
Maranoa	mz	2,003,528	72	365	2,493
Wallam	wm	4,786,278	164	1,422	96,891
Warrego	wg	5,216,154	165	803	19,577
Paroo	pa	3,523,665	103	2,696	76,559
Bulloo	ul	5,203,568	49	6,938	275,624
TOTAL		31,514,256	1,275	18,443	581,207

1.1 Queensland Murray-Darling and Bulloo Basins study region

1.1.1 General region

This Aquatic Conservation Assessment covers the Queensland sections of the Murray-Darling drainage basin and the Bulloo drainage basin.

The Murray–Darling Basin (MDB) is one of the largest and most complex river basins in Australia. It extends across part of Queensland and then through New South Wales, Victoria and lastly South Australia. The Queensland section consists of seven study areas, which include Border Rivers, Moonie, Condamine-Balonne, Maranoa, Warrego, Wallam, and Paroo (Figure 1). The Bulloo drainage basin (Figure 1) is included in the current QMDBB ACA assessment. Previous versions of the QMDB ACA excluded the Bulloo, and the basin was included as part of the Lake Eyre and Bulloo Basins ACA assessment version 1.1 (EHP 2016a). The decision to include the Bulloo as part of the QMDB ACA v2.1 was based on a number of different factors including:

- The Bulloo catchment has similar characteristics to the Paroo catchment.
- The Bulloo falls under the Southern Queensland Landscapes Natural Resource Management (NRM) body (Southern Queensland Landscapes 2019).
- The Department of Environment and Science (DES) incorporates the Bulloo as part of the Warrego, Paroo, Bulloo and Nebine Healthy Waters Management Plan (EHP 2016b).

The Queensland Murray-Darling and Bulloo Basin (QMDBB) region contains a wide range of wetland types that cover the terrestrial bioregions of the Brigalow Belt, New England Tableland, Mulga Lands, Mitchell Grass Downs and the Channel Country. As a result, there is a distinct variation between the east and west that is reflected by the agricultural use of the land. Intensive agriculture (mostly irrigated cropping of cotton) mainly occurs in the east within the Condamine-Balonne, Border Rivers and Moonie drainage basins, whilst grazing of sheep and cattle dominates the western catchments.

The terrain of the region is generally very flat except around the foothills of the Great Dividing Range to the east and north. The average slope of river channels is very low which results in water moving relatively slowly down the river channels accumulating fine sediments (Queensland Museum, 2022). During high rainfall events, river waters break their banks and inundate large areas of floodplains and associated wetlands (Queensland Museum, 2022).

These flooding events are essential in releasing nutrients and promoting the growth of algae and plants, which in turn support large populations of fish, birds and other fauna species (Queensland Museum, 2022). As rainfall can be volatile, creating long periods with no water flow, the presence of persistent waterholes are a vital form of refugium and maintain many populations of flora and fauna species. Some of these species are not located anywhere else in Queensland (Queensland Museum, 2022).

Pest species that are aquatic or occupy the riparian zone are major threats to riverine systems. Sediment deposits and changes in hydrology due to dams and weirs also play a major role in limiting aquatic fauna movements and water flow connectivity (Queensland Museum, 2022).

Sections of the individual catchment descriptions below are copied directly from the references cited (Murray-Darling Basin Authority) and (Queensland Museum, 2022).

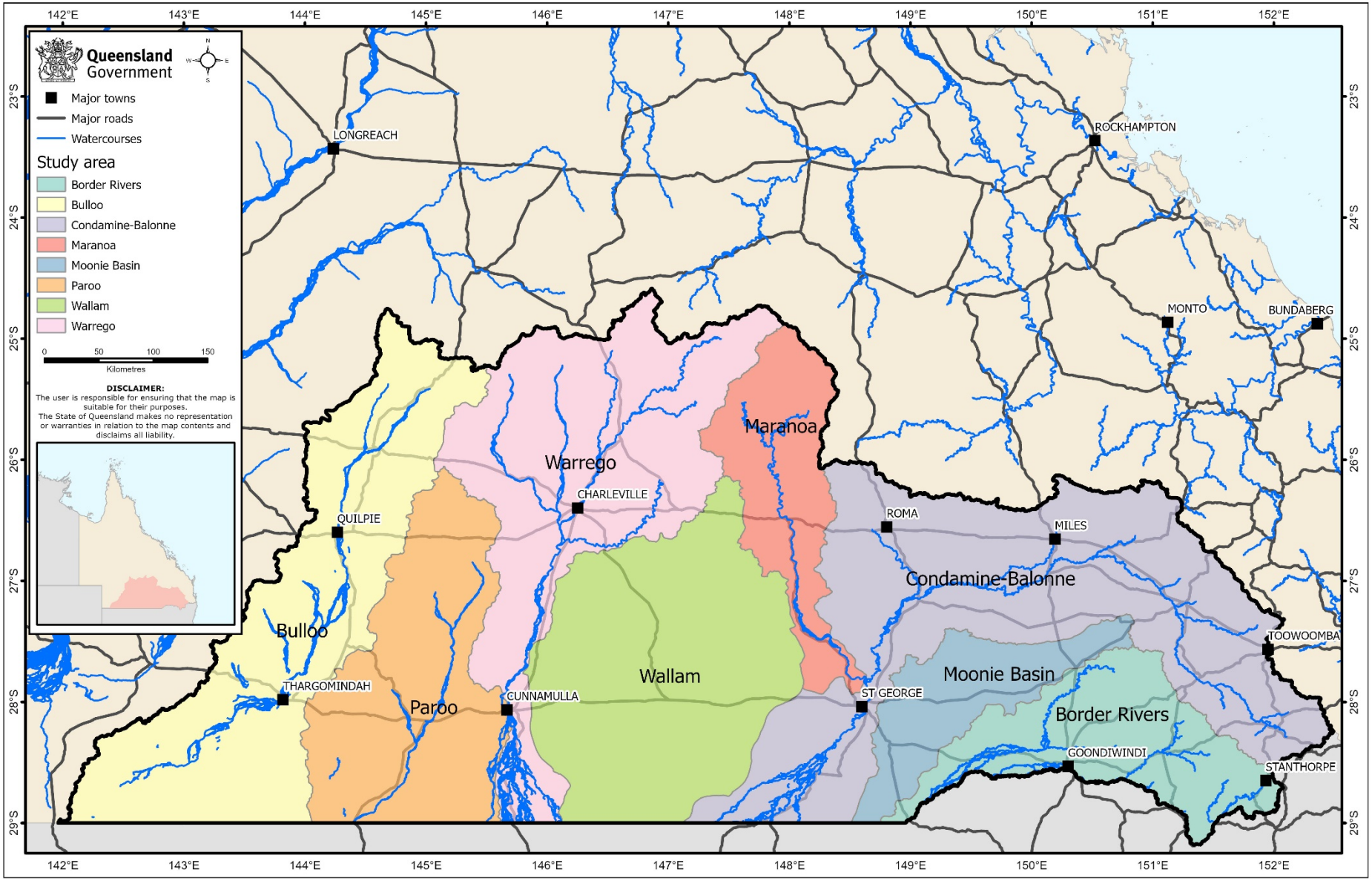


Figure 1. Study areas of the Queensland Murray-Darling and Bulloo Basins Aquatic Conservation Assessment v2.1

1.1.2 Condamine-Balonne, Maranoa and Wallam study areas

(https://www.mdba.gov.au/water-management/catchments/condamine-balonne)

The Murray-Darling Basin Authority combines the Condamine-Balonne, Maranoa and Wallam study areas together into one catchment. The QMDBB ACA will assess the area as three individual study areas to gain a more accurate picture of the conservation values across the region.

In the Condamine-Balonne study area, the Condamine River rises on the Darling Downs in Queensland and then flows north-west past Dalby to Chinchilla. It then flows south-west to the plains, where it meets the Dogwood Creek and becomes the Balonne River, near Surat.

The Maranoa study area consists of the Maranoa River which rises in the Carnarvon National Park and flows south-east through the town of Mitchell before joining the Balonne River at Lake Kajarabie (Beardmore Dam), just upstream of St George.

The Wallam study area has Nebine Creek and Wallam Creek as it's main waterways. Nebine Creek flows south from near Morven and meets the Culgoa River in norther New South Wales. Wallam Creek also flows south from near Mitchell, through the town of Bollon before opening up onto the Culgoa floodplain.

The landscape of the Condamine–Balonne, Maranoa and Wallam catchments are diverse, ranging from tablelands and slopes in the east; gorges in the north-west; to semi-arid plains in the south-west. Elevations in the Great Dividing Range (where the Condamine River rises) can be up to 1,400 m, whereas the flat expansive floodplains that cover a large part of the Wallam study area have an elevation of between 100 m and 200 m above sea level.

The eastern part of the catchment has an annual average rainfall of 600–800 mm. The floodplains of the south-west have an average 300–500 mm. Rainfall throughout the catchment is summer-dominant and the climate is described as subhumid and subtropical. Evaporation rates in the south-west of the catchment are very high

The Condamine–Balonne, Maranoa and Wallam catchments are above an extensive and deep groundwater system, the Great Artesian Basin. There is some interaction between water of the Great Artesian Basin and overlying surface water or shallow groundwater (contained in near-surface aquifers). Shallow groundwater exists in alluvial aquifers that are associated with the major rivers and creeks of the region. Basalt and sandstone aquifers exist in the upper and mid catchment; and groundwater also exists in sand beds and gravel layers in the mid to lower catchment. Recharge to the aquifers occurs through rainfall throughout the catchment, flooding in the lower catchment, and lateral flow between the different groundwater systems.

The floodplains of the whole region are ecologically significant because they support endangered ecological communities, such as the brigalow–gidgee woodland/shrubland in the Mulga Lands and Darling Riverine Plains Bioregions. The wetlands support a diverse range of flora and fauna providing habitat for migratory birds and vulnerable and endangered species, such as silver perch, Murray cod, freckled duck, Australian painted snipe, the great egret and the cattle egret.

The lower Balonne is a complex floodplain channel system where a number of nationally significant wetlands are located, including the Ramsar-listed Narran Lake Nature Reserve. Annual inflows to the wetlands are highly variable and lakes within the system usually retain water for approximately 4–6 months following inundation. The Narran Lakes area also has a very high social and spiritual significance for Aboriginal people.

Gilgai wetlands are especially important across the floodplain regions of the Wallam and lower Balonne. They are small, shallow waterholes formed in the depressions of shrink-swell and cracking clay soils. The vegetation associated with them tends to be dominated by acacias (mostly *Acacia harpophylla*) and casuarinas (mostly *Casuarina cristata*), along with melaleuca, corymbia and eucalypt species (Queensland Museum, 2022). These landforms were once common through the Brigalow Belt region, but are now prevented from forming by agricultural tillage.

Land use is dominated by cattle and sheep grazing on dryland pasture. Grain and cotton crops are a significant contributor to the regional economy and are grown under dryland and irrigated farming respectively.

1.1.3 Border Rivers study area

(https://www.mdba.gov.au/water-management/catchments/border-rivers)

The Border rivers catchment is one of the northern-most catchments in the Murray–Darling Basin. It is made up of a group of rivers in a region straddling the New South Wales and Queensland border. The rivers of the catchment rise on the western slopes of the Great Dividing Range and run westward, gradually merging with one another to become the Barwon River on the floodplains upstream of Mungindi.

A 450 km section of the Dumaresq, Macintyre and the Barwon rivers forms the border between Queensland and New South Wales. At Mungindi, the Barwon River heads south-west and the border between the states continues

as a straight line following the 29th degree of latitude south of the equator.

The landscape of the Border rivers catchment is diverse, ranging from tablelands and slopes in the east to semi-arid plains in the south-west. Elevations in the Great Dividing Range, near where the Macintyre River rises, can be up to 1,500 metres, whereas the floodplains have an elevation between 100 and 200 metres above sea level.

The eastern part of the catchment where most of the rivers rise has an annual average rainfall of 800–1,100 mm. The Maranoa Valley has an average annual rainfall of around 500–600 mm, and the floodplains to the west have an average of around 500 mm. Rainfall throughout the catchment is summer dominant and the climate is described as subtropical on the plains and temperate at higher altitudes.

The central and western part of the Border rivers catchment is underlain by the Great Artesian Basin. There is some interaction between water of the Great Artesian Basin and overlying surface water or shallow groundwater (contained in near-surface aquifers). Shallow groundwater exists in aquifers in a range of rock types in the highlands of the catchment, and in alluvial aquifers throughout the catchment, particularly associated with the Dumaresq River in Queensland and the Macintyre River in New South Wales. Recharge to the aquifers occurs through rainfall, floodwater and lateral flow between the different groundwater systems.

Land use is dominated by cattle and sheep grazing predominantly on the tablelands and western plains, with dryland crops grown on the slopes. Small-scale crops such as grapes, stone fruit, vegetables and apples are also grown in the upland areas. Irrigated crops on the western plains account for about 2% of the land area. Around 75% of irrigated crops are cotton. Most groundwater extraction for irrigation occurs along the Dumaresq River for horticultural crops such as potatoes, for fodder crops including lucerne and for livestock pasture. Viticulture and horticulture crops are expanding enterprises in the upper catchment region.

The Border rivers catchment supports a diverse range of flora and fauna including species listed as vulnerable, such as the great egret, Australian painted snipe, Murray cod and Warra broad-leaved sally. The extensive wetlands in the catchment provide large amounts of carbon to the riverine ecosystems, which support a diverse population of waterbirds.

The nationally significant Morella Watercourse, Boobera Lagoon and Pungbougal Lagoon are located on the Macintyre River floodplain and collectively are one the few permanent waterbodies in the northern Basin. These waterbodies are an important refuge for wildlife during periods of drought.

1.1.4 Moonie Basin study area

(https://www.mdba.gov.au/water-management/catchments/moonie)

The Moonie River flows across south-west Queensland, through a very flat landscape into northern New South Wales. The Moonie is joined by 13 minor tributaries before merging with the Barwon River, downstream of Mungindi. Most of the catchment (98%) is in Queensland. The river is unregulated and surface water diversions are small.

The Moonie River is a simple channel system with few tributaries compared with other rivers in the Basin. The river exists as a series of unconnected waterholes for most of the time, flowing about one third of the year.

The catchment is heavily cleared and impacted by agricultural development, with highly eroded banks and riparian zones. The region features remnant areas of brigalow scrub, mixed eucalypt woodland areas and open grasslands.

The Moonie flows from an altitude of 350 metres at its source on the Southern Downs, down to 150 metres where it meets the Barwon River on the flat expansive floodplain.

The Moonie catchment has a hot to warm semi-arid climate, with an average annual rainfall of 500–600 mm. There is considerable annual variation in temperature and as well as variations within years and between years in rainfall, resulting in irregular and infrequent river flows.

There are major shallow and deep groundwater aquifers in the Moonie catchment in the St George alluvium, and in sedimentary aquifers above the Great Artesian Basin. The sedimentary rock aquifers of the Great Artesian Basin, deep beneath the catchment, are also an important water source for the region.

More than 70% of the catchment is used for grazing, mainly beef cattle, on native and improved pasture. About 10% of the land is used for dryland cropping and about 15% is native vegetation. There is a very small area of irrigated crops in the west of the catchment, mainly cotton, which accounts for about 90% of water use in the region.

The Moonie catchment is ecologically significant as it flows through the endangered southern brigalow belt, which contains remnants of brigalow forests, poplar box, wilga and white cypress pine. The Moonie River system has more than 100 floodplain wetlands, many of which support bird breeding, and includes high biodiversity and unique in-stream systems.

The catchment provides habitat to several protected species of birds, including the Australian painted snipe and the freckled duck, and contains threatened and endangered plant species and three endangered vegetation communities.

The Thallon Waterholes, while not formally recognised as nationally or internationally important, are significant for waterbirds in the Basin. The waterholes include two relatively permanent lakes of approximately 12 and 21 hectares, which are filled by overbank flows during floods and provide habitat for a range of aquatic organisms and up to 20,000 waterbirds.

1.1.5 Warrego study area

(https://www.mdba.gov.au/water-management/catchments/warrego)

The Warrego River is located in the top north-west of the Murray–Darling Basin, directly east of the Paroo River catchment. The river source is in the Carnarvon Range.

Most of the Warrego catchment (80%) is in Queensland and the remainder is in New South Wales. Its rivers flow through flat semi-arid plains that are sparsely populated and where extensive grazing is the predominant land use.

From it's source in range country, the Warrego flows south across semi-arid plains where there is very little surface water, other than the river and its tributaries and distributaries, which flow intermittently.

The Warrego has several major tributaries in its upper reaches, which include the Nive, Langlo and Ward rivers. South of Cunnamulla the river becomes a complex distributary system with flows leaving the river via creeks and anabranches. The river is ephemeral, and flows vary with the season and rainfall. When not flowing, the Warrego River becomes a chain of permanent waterholes providing critical refuge for fish and waterbirds populations. In wet years, waters of the Warrego River system may flow through the Cuttaburra Creek to the lower reaches of the Paroo River.

The elevation of the Warrego's headwaters in the Carnarvon Range is around 600 m. At the southern end of the catchment, the floodplains have an elevation of around 100 m. Annual rainfall is low, ranging from 500 mm in the north east of the catchment to 250 mm on the plains of the lower catchment. However, nearly half of the catchment receives less than 400 mm each year, with most of the rain falling in the north, mainly in summer and autumn. Evaporation in the region is high.

Mulga shrubland is the predominant vegetation type in the Warrego catchment with areas of brigalow in the north. The major channels of the waterways support cypress pine woodland and gidgee can be found within the catchment floodplain areas. In the lower reaches of the catchment, river red gum, coolibah and river cooba grow along channels and wetland areas.

The Warrego region is underlain by shallow alluvial and sandstone aquifers. Shallow groundwater is generally saline, and supply is unreliable. The deeper confined aquifers of the Great Artesian Basin also lie beneath the catchment, supplying the bulk of groundwater used in the region. Artesian springs occur through the region.

There are over more than 300,000 ha of wetlands in the Warrego catchment including saline lakes, lignum swamps, flood channels, freshwater lakes, claypans and semi-permanent water holes. Twelve wetlands are considered of national significance including the Yantabulla Swamp and the Warrego River waterholes.

Yantabulla Swamp is part of the Cuttaburra Basin system, which is filled from various sources including Cuttaburra Creek and the Paroo River overflow. The swamp covers over more than 37,000 ha and has been identified as the most important waterbird breeding site in north-west New South Wales. The main vegetation communities are cane grass, lignum, fringing yapunyah, river red gum, coolabah and river cooba.

The Warrego River waterholes are a string of large permanent and intermittent waterholes covering some around 500 ha along the river channel in southern Queensland. These sites are flooded seasonally in most years. They provide an invaluable habitat and refuge for a wide range of aquatic fauna including species such as Murray cod that are listed under the Environment Protection and Biodiversity Conservation Act 1999. Significant waterbird populations are known to inhabit the waterholes, particularly during periods of high flows. The waterholes are also Aboriginal cultural sites.

The Warrego River is one of the only places in the Murray–Darling Basin where silver perch breed naturally. In the south of the catchment, creeks branch off the Warrego River to supply water to extensive wetlands, such as the nationally important Yantabulla Swamp. The region provides important breeding sites for waterbirds.

1.1.6 Paroo study area

(https://www.mdba.gov.au/water-management/catchments/paroo)

The Paroo River is the last free-flowing river of the Murray–Darling Basin, flowing when heavy rains fall in its northern catchment. The river is a series of waterholes, lakes and wetlands. Only in wet years will the Paroo join the Darling River.

The Paroo River catchment is in the top north-west corner of the QMD Basin, with half of its area in Queensland and half in New South Wales. The river flows through sparsely populated, flat semi-arid plains, where extensive grazing is the predominant land use.

Water from the Great Artesian Basin is the major domestic and stock water source for the region. There are no major dams and little irrigation along the Paroo River.

The catchment contains significant wetlands including Currawinya Lakes, Nocoleche Nature Reserve and Peery Lake. These sites support many thousands of waterbirds. River flow is critical to retaining the biological diversity.

The river begins in the Warrego Range, west of Charleville. From the range country, the Paroo flows across semi-arid plains with little surface water.

The river ends on the floodplains south of Wanaaring, in the top north-west corner of New South Wales. The Paroo is a series of waterholes, lakes and wetlands, some which remain permanently wet. With major rainfall, breakouts occur along the watercourses causing widespread flooding across the plains. In wet years, the lower Paroo receives flows from the Warrego River system via Cuttaburra Creek. In very wet years the waters of the Paroo will flow to reach the Darling River, between Louth and Wilcannia.

The elevation of the Paroo's headwaters in the Warrego Range is around 330 metres. At the southern end of the catchment, the floodplains have an elevation of around 100 metres. Annual rainfall is low, with averages of 200–400 mm across the catchment. Most of the rain falls in the north of the catchment and occurs in summer and autumn. Evaporation in the region is high.

Mulga scrub and shrubland are the main vegetation types on the plains of the Paroo catchment. Eucalypt and gidgee fringe the river and streams. The dominant eucalypt species in the catchment are river red gum, coolabah and poplar box. In the lower reaches of the catchment many types of wetland vegetation are found, including black box, river cooba, grasses and forbs, herbaceous flowering plants.

The Paroo region is underlain by shallow alluvial and sandstone aquifers. Shallow groundwater is generally saline, and supply is unreliable. The deeper confined aquifers of the Great Artesian Basin also lie beneath the catchment, supplying the bulk of groundwater used in the region. Artesian springs are a feature through the region, including the Eulo artesian springs supergroup, which is a collection of more than 40 springs scattered in the area south-west of Eulo.

The region is a habitat for many animal and plant species, including a diverse range of waterbirds, as well as for many fish species, including a genetically distinct population of golden perch.

1.1.7 Bulloo study area

(https://environment.des.qld.gov.au/__data/assets/pdf_file/0020/214229/Warrego-Paroo-Bulloo-Rivers-Nebine-Mungallala-Wallam-Creeks-Basins.pdf)

The Bulloo River basin is an internally draining system, which drains into ephemeral lakes and is located between the Queensland Lake Eyre and Murray-Darling Basins. The ephemeral lakes are blocked by low hills from reaching the Lake Frome, the Paroo River or the Lake Bancannia systems.

Three wetlands within the Basin are recognised as having national significance due to their biological and conservation value or uniqueness. These wetlands include the Quilpie Waterholes, Lake Bullawarra and Bulloo Lake.

The upland zone of the Bulloo River basin is characterised by mulga, and desert eucalypt woodlands across the landscape. The average annual rainfall ranges from 200-500 mm/year, with the heavier rainfall located north of Adavale. Despite receiving less rainfall than the Warrego River basin, the Bulloo River basin has a higher average annual runoff. This is due to comparatively low levels of groundcover and shallower, less permeable soils.

The Lower Bulloo River water type consists of the alluvial floodplain featuring closed depressions and claypans. The landscape is predominately comprised of clay soil (Vertosols) and sandy, stony soil (Tenosols and Rudosols). This part of the catchment has the driest conditions, receiving an average annual rainfall less than 300mm per year.

Grazing of native vegetation is the main land-use of the region, although the harsh and changeable climate has

resulted in relatively low stocking rates and lower impacts when compared to other study areas such as the Maranoa and Warrego Basins.

The main threatening processes include total grazing pressure in the riparian areas, changes in hydrology, invasion by exotic and translocated native species and changes to water quality and quantity (Pisanu et al. 2015). Another emerging threat to biodiversity is a reduction in the volume, height and frequency of flood waters due to climate change.

The Bulloo wetlands and associated riparian vegetation are regarded as critical for the maintenance of local and regional biodiversity because of their role in providing wildlife corridors and habitat. The freshwater lakes are semipermanent, whereas the swamps and floodplains are inundated seasonally. Following significant rains in the northern part of the Basin, the floodplains transform from an extremely arid environment to one with volumes of water bursting into life with grasses, wildflowers, fish, birds and many other forms of life. Massive water flows create a vast natural flood irrigation system that drives ecosystem processes and productivity. The swamps and channel networks of the Bulloo floodplain provides temporary habitat for wetland fauna and causing the lateral migration of species. The boom/bust cycle of the region is also central in maintaining ecological connectivity between wetland habitats.

Lignum swamps constitute the major habitat with emergent river cooba and coolabah in places. The less frequently flooded areas and claypans support swamp canegrass, forbs, samphires, mulga and blackbox scattered throughout the area. During wet seasons, open water provides habitat for numerous bird species listed under the Japanese and Australian Migratory Birds Agreement (JAMBA) and the Chinese and Australian Migratory Birds Agreement (CAMBA).

2 Methods and implementation

2.1 AquaBAMM

The Queensland Murray-Darling and Bulloo Basins Aquatic Conservation Assessments were undertaken using AquaBAMM (Clayton et al 2006). The method has been updated since its development including minor changes to the AquaBAMM tool and revisions to the filter table.

2.2 Spatial Units

In implementing an Aquatic Conservation Assessment, subsections and spatial units are defined in order to calculate and attribute the conservation/ecological values of riverine and non-riverine wetlands. This section describes the subsection and spatial units used for each riverine and non-riverine assessment.

2.2.1 Riverine Spatial Units

Riverine spatial units and subsections are best defined by considering hydrological patterns and processes in the landscape. They are generally of a size that balances reporting needs with data availability and can be determined in a number of ways, including modelling.

The spatial units were based on those used for the QMDB ACA v1.4 and LEBB ACA v1.1. Please refer to the QMDB v1.4 (Fielder et al. 2011) and LEBB v1.1 (EHP 2016a) summary reports associated with these assessments for a description of how the spatial units were generated. Minor adjustments were made for the current assessment to align the spatial units with new bounding area and study area linework (see section 2.12). A small number (13) of units were also split at the location of in-stream barriers (e.g. weirs) provided by DES Water Planning/Ecology. During the 2020 drought breaking rain event, 22 in-stream barriers did not drown-out. Seven of these are already along the boundaries of the spatial units while the remaining 13 were used to split the spatial units into two.

The QMDBB riverine assessments included 1,275 riverine spatial units (Table 1) derived from the methods described above. The minimum size for a spatial unit is 594 ha in the Border Rivers study area. The maximum size for a spatial unit is 281,279 ha in the Bulloo study area. Overall, the average size for the spatial units is 24,717 ha.

2.2.2 Non-Riverine Spatial Units

The Queensland Herbarium uses the Wetland Mapping and Classification Methodology (EPA 2005) to map the location, extent, and attributes of Queensland's wetlands. Linework and attribute descriptions are based on satellite derived waterbody and regional ecosystem mapping (Neldner et al. 2020). The QMDBB assessments used Queensland Wetland Data Version 5.0 – Wetland Data (2017) which is based on Version 11.0 regional ecosystem mapping.

The non-riverine assessments included 18,443 spatial units derived from palustrine and lacustrine wetland waterbodies and wet regional ecosystems present in the Queensland Wetland Mapping data. All hydromodification categorised wetlands were assessed as part of this QMDBB assessment, including natural (H1), slightly modified (H2M1b, H2M1d, H2M2, H2M2a, H2M2b, H2M2c, H2M2d, H2M2e, H2M2f, H2M2g, H2M3, H2M8), highly modified (H2M1, H2M1a, H2M1c, H2M5, H2M6, H2M6a, H2M6b, H2M6c, H2M6e, H2M7) and artificial (H3C1, H3C1a, H3C1b, H3C1c, H3C1d, H3C2, H3C3). Please refer to the Wetland Mapping and Classification Methodology (EPA 2005) for more information on hydrological modifiers.

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 (e.g. species habitat). Expert panels in a very small number of instances, may consider artificial wetlands as playing a role in a special feature. For example, the Thallon Waterholes in the Moonie River catchment and the modified artesian springs in the Paroo River catchment. Artificial wetlands have been included in this ACA for the purpose of ecological comprehensiveness. The values assigned to artificial wetlands are meant to serve primarily as an ecological inventory. Their inclusion is not meant to imply any policy, protective or legislative requirements.

The minimum size for a non-riverine spatial unit within the QMDBB assessment is 0.1 ha and the maximum size is 154,001 ha. Overall, the average size for the spatial units is 32 ha.

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 deep artesian aquifers result in numerous spring systems displaying unique geomorphic appearances and specialised habitats of high intrinsic conservation value (Fensham 2006).

Spring wetlands were not explicitly assessed as part of the Queensland Murray-Darling and Bulloo Basins assessment. In the absence of an Aquatic Conservation Assessment for spring wetlands, the reader is referred to the Queensland spring database published by the Queensland Herbarium (Queensland Herbarium 2020). 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:

- Category 1a: These spring wetlands provide habitat for biota endemic to one spring complex.
- Category 1b: These spring wetlands provide habitat for biota endemic to more than one spring complex.
- 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*).
- Category 2: These spring wetlands provide habitat for some isolated populations of plant species or are outstanding examples of their type.
- Category 3: Any spring of lower value than above that is relatively intact.
- Category 4: Severely degraded by any threatening processes.

The Queensland Murray-Darling and Bulloo Basins assessment assigned a value under Criterion 6 (Special and Unique Values) to any non-riverine spatial units containing active springs. The Queensland Herbarium Groundwater Dependent Ecosystems Surface Points dataset was used as a basis for selecting springs locations. Springs were selected and grouped based on their hydrological modification (hydromod) attribute as either unmodified (H1) or slightly modified (H2M4). Highly modified and dormant springs were not included in the assessment.

Conservation value ratings were assigned to Measures 6.1.1 (Presence of distinct, unique or special geomorphic features) and 6.3.1 (Presence of distinct, unique or special habitat including habitat that functions as refugia or other critical purpose), based on the springs hydromod as follows:

- Non-riverine spatial units that contained an unmodified spring (H1) were assigned a value of 4 for Measures 6.1.1, 6.3.1, 6.4.1
- Non-riverine spatial units that contained a slightly modified spring (H2M4) were assigned a value of 3 for Measures 6.1.1, 6.3.1, 6.4.1

See the accompanying expert panel report (DES 2022) for more details.

2.3 Assessment parameters

The Criteria, Indicators and Measures (CIM) implemented for each QMDBB Aquatic Conservation Assessment are outlined in Table 2. These CIM lists were 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 Aquatic Conservation Assessment.

Each Aquatic Conservation Assessment can have a different combination of assessment parameters 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 contained in Appendix I - Riverine Implementation Table and Appendix II - Non-riverine Implementation Table.

Measure data used in an Aquatic Conservation Assessment come from different sources and in different data types (i.e. continuous, presence/absence, categorical, etc.). A procedure called thresholding is used to standardise measure data to a common scale so it can be compared within the database. The six threshold types used to standardise AquaBAMM measure data include:

- Categorical
- Continuous Ascending
- Continuous Descending
- Presence Positive
- Presence Negative, and
- User Defined.

The threshold type chosen for a particular measure depends upon the type and distribution of the data.

Thresholding involves applying rules to assign a threshold score of 1 (i.e. Low), 2 (i.e. Medium), 3 (i.e. High), or 4 (i.e. Very High) to each spatial unit for each measure. Threshold scores do not need to be specified for measures with a threshold type of Presence Positive and Presence Negative as these are defined using code within the AquaBAMM database.

Measure scores of -999 are used for spatial units being assessed (e.g. for special features) to have no value (i.e. true-absence) for a particular measure. Using a value of -999 ensures the measure is considered as having data when calculating a spatial unit's dependability score.

Measure scores of No Data indicate there is no data available to evaluate the measure for a particular spatial unit. Measures with No Data lower a spatial unit's dependability score.

Not all measures are applied to all spatial units. Highly modified and artificial wetlands are not suitable for inclusion in the assessment of representativeness and were excluded from Measures 8.1.1, 8.2.1, 8.2.2, 8.2.3, 8.2.4 and 8.2.6. The Diversity and Richness Measures 3.3.2 and 3.3.3 also exclude highly modified and artificial wetlands. The Threatened Species and Priority Species Measures (4.1.1, 4.1.2, 5.1.1, 5.1.2 and 5.1.3) exclude artificial wetlands as their conservation values are continually being eroded by anthropogenic processes.

Table 2. Criterion, indicator, measure list used for the Queensland Murray-Darling and Bulloo Basins 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
	1.1.4	Presence of feral/exotic vertebrate fauna (other than fish) within the wetland	Y	Y
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	

Criteria and Indicators	Measures		Riverine	Non-riverine
	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
	2.2.9	% tree cover within the waterway corridor	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
	2.3.9	Number of intensive animal production sites	Y	Y
	2.3.11	Presence of aquaculture	Y	Y
2.4 Flow Modifications	2.4.1	Farm storage (overland flow harvesting, floodplain ring tanks, gully dams) calculated by surface area	Y	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 wetland breeders)		Y
	3.1.7	Richness of native aquatic dependent mammals	Y	Y
3.2 Communities/ assemblages	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. 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 – NC Act, EPBC Act	Y	Y
	4.1.2	Presence of rare or threatened aquatic ecosystem dependent flora species - NC Act, EPBC Act	Y	Y
4.2 Communities/ assemblages	4.2.1	Conservation status of wetland Regional Ecosystems	Y	Y

Criteria and Indicators	Measures		Riverine	Non-riverine
		– Herbarium biodiversity status, NC Act, EPBC Act		
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
	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	7.1.1	The contribution (upstream or downstream) of the spatial unit to the maintenance of significant species or populations, including those features identified through Criteria 5 and/ or 6	Y	
	7.1.2	Migratory or routine 'passage' of fish and other fully aquatic species (upstream, lateral or downstream movement) within the spatial unit	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,	Y	

Criteria and Indicators	Measures		Riverine	Non-riverine
		including those features identified through Criteria 5 and/or 6 (e.g. karsts, cave streams, artesian springs)		
7.3 Floodplain and wetland ecosystems	7.3.1	The contribution of the spatial unit to the maintenance of floodplain and wetland ecosystems with significant biodiversity values, including those features identified through Criteria 5 and/or 6	Y	Y
	7.3.2	Extent to which the wetland retains critical ecological and hydrological connectivity, where it should exist, with floodplains, rivers, groundwater, etc.	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 wetland management group within the catchment or study area		Y
	8.2.4	The size of each wetland type relative to others of its wetland management group within a sub-catchment (or estuarine zone)		Y
	8.2.5	Wetland type representative of the study area – identified by expert opinion	Y	Y
	8.2.6	The size of each wetland type relative to others of its type within the catchment or study area		Y

NC Act *Nature Conservation Act 1992* (Queensland)

EPBC Act *Environment Protection and Biodiversity Conservation Act 1999* (Cth)

ASFB Australian Society for Fish Biology

WWF World Wildlife Fund

JAMBA Japan–Australia Migratory Bird Agreement

CAMBA China–Australia Migratory Bird Agreement

ROKAMBA Republic of Korea–Australia Migratory Bird Agreement

BONN Bonn Convention on the Conservation of Migratory Species

2.4 Wetland management groups

The Queensland Wetlands Program 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 (DES 2020). 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 Aquatic Conservation Assessment. Wetland management groups are used for AquaBAMM Measures 8.2.1, 8.2.2, 8.2.3 and 8.2.4.

2.5 Stratification

AquaBAMM stratification attempts to mitigate the effect of data averaging across large study areas. Stratification is particularly useful when ecological diversity is high. For example, in the Wet Tropics bioregion stratification would be appropriate because higher numbers of native amphibian species (i.e. AquaBAMM Measure 3.1.1 (Richness of native amphibians (riverine wetland breeders)) are known to inhabit upland areas compared to adjacent lowland floodplains. Stratification is unwarranted for measures where there is an equal probability of species throughout the study area.

Study area stratification is an expert panel decision and is not mandatory for a successful assessment. In fact, the AquaBAMM makes provision for one or more measures to be stratified in any manner determined to be ecologically appropriate. Decisions concerning how to stratify are typically considered by the ecology expert panel. To date, assessments have been stratified 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.

For the Queensland Murray-Darling and Bulloo Basins, the ecology expert panel noted that fish, invertebrates and some frog assemblages are likely affected by elevation. The experts also noted that differences in flow regimes and water chemistry can exist between creeks, which may affect fish diversity.

On the panel's advice we stratified the Condamine-Balonne and Border Rivers study areas for the purpose of assessing like systems for Measures 3.1.1 (Richness of native amphibians (riverine wetland breeders)), 3.1.2 (Richness of native fish), 3.1.6 (Richness of native amphibians (non-riverine wetland breeders)). The study areas were each stratified into two strata including uplands and lowlands based on the 400m ASL boundary.

Subsections and non-riverine wetlands were assigned to each stratum based on a majority rule (i.e. >= 50%). For example, riverine subsections were assigned the stratum containing the majority of the subsection; non-riverine spatial units were assigned the stratum of the subsection containing the majority of the non-riverine spatial unit.

2.6 Weighting of measures

AquaBAMM measures are 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.

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

The measure weights used for the QMDBB assessments were based on the average weights derived from the workshops held for Southeast Queensland (2015), Lake Eyre and Bulloo Basins (2016), Eastern Gulf of Carpentaria (2018) and Southern Gulf Catchments (2020). If no measures within an indicator received an average weight of 10, then the weights for all measures within the indicator were adjusted relative to each other to ensure that at least one measure had a weight of 10. For example, if an indicator had three measures with average scores of 9.5, 9.0 and 8.0, the adjusted weights were 10, 9.5 and 8.5 (i.e. 0.5 was added to the weights of all three measures). This is done because at least one measure within each indicator must have a weight of 10.

The riverine and non-riverine measure weights are outlined in Appendix V - Riverine Measure weights relative to each other in the same Indicator and Appendix VI - Non-riverine Measure weights relative to each other in each Indicator.

2.7 Ranking of indicators

AquaBAMM 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.

Similar to the measure weights, an indicator rank given to each indicator within a criterion was based on the ranks derived by the expert panel workshops for Southeast Queensland (2015), Lake Eyre and Bulloo Basins (2016), Eastern Gulf of Carpentaria (2018) and Southern Gulf Catchments (2020).

For each panel workshop, ranks from all respondents were reviewed and the common rank assigned to each indicator. Where two or more ranks were most common, we used the highest rank for the indicator. For example, if an indicator was raked 1, 1, 2, 2, 3 by the expert panel, we used an indicator rank of 1.

For the QMDBB assessments, the same process was used to calculate the average rank based on the Southeast Queensland (2015), Lake Eyre and Bulloo Basins (2016), Eastern Gulf of Carpentaria (2018) and Southern Gulf Catchments (2020) expert panel workshops.

The riverine and non-riverine indicator ranks are outlined in Appendix VII - Riverine Indicator Ranks and Appendix VIII - Non-riverine Indicator Ranks.

2.8 Filter tables

A series of arithmetic techniques are used to bring measure data through to ratings for each criterion. Arithmetic techniques can mask important effects or insufficiently discriminate between spatial units when used to create an overall AquaScore. Authors such as Chessman 2002 discuss this issue.

Rather than a final arithmetic combination, AquaBAMM uses a criterion rating combination table (i.e. filter table) that provides an ordered series of decisions that are tested against the final criterion ratings for each spatial unit (See Appendix III - Riverine Filter Table and Appendix IV - Non-riverine Filter Table). Each decision contains a unique combination of criterion ratings and associated AquaScore. These decisions are essentially 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 the Biodiversity Assessment and Mapping Methodology (EPA 2014). 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.

2.9 Dependability and data richness

The AquaBAMM calculates a dependability score to provide an indication of the richness of data for each spatial unit. 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.

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

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

Dependability scores indicate the potential for an AquaScore to change (upgrade or downgrade) with the addition of new data. Furthermore, spatial units with low dependability and a Very Low AquaScore should be used with caution as this result can 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.

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 can be Very High, High, Medium, Low or 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 combinations of High and Medium rating across the various AquaBAMM 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 across the criteria. These wetlands do not contain special or unique features.

Very Low

Wetlands given an AquaScore of Very 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 Transparency of results

Despite presentation as a single AquaScore, Aquatic Conservation Assessments results are available at the AquaScore, Criterion, Indicator, Measure threshold and Measure data level. All results are available to the user through the use of user-defined queries inside a Geographical Information System (GIS) or other database applications (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 Aquatic Conservation Assessment end users with a unique level of flexibility for 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 Aquatic Conservation Assessment outputs for a particular purpose. The intent of an Aquatic Conservation Assessment is not only to evaluate aquatic ecological and conservation values, but just as importantly, to identify variability in these values. Links between the Aquatic Conservation Assessment results and GIS facilitate this and constitute the complete Aquatic Conservation Assessment results release package.

2.12 Updates and differences from QMDB ACA version 1.4

The previous version (1.4) of the QMDB ACA was released in 2011. While the general methodology (AquaBAMM) has remained unchanged, there have been numerous changes with regard to base input datasets in addition to refinements of some elements of the methodology. This makes any direct comparison to the previous version difficult.

With each successive ACA, there are refinements to input datasets and methodology implementation. Each ACA uses the most up-to-date data available at the time the project work is undertaken. These updates can alter the individual spatial units AquaBAMM scores for each criterion and overall AquaScore. Some of these updates for the QMDBB ACA v2.1 include:

1. The QLD wetland mapping v2.0 was utilised for QMDB v1.4 while QMDBB v2.1 has utilised the wetland mapping v5.0.
2. Refinements to the filter table is an ongoing process in which there is potential for each assessment to produce a unique combination of criteria ratings, that on a rare occasion, may not be captured at the right level in the filter table. For the current filter tables (see Appendix III - Riverine Filter Table and Appendix IV - Non-riverine Filter Table).
3. Additional species records from survey work.
4. There has been a considerable refinement of the Wetland Species Indicator List, which helps guide species inclusion.
5. There have been changes in NCA species status for some Threatened and Near-threatened species. This is an ongoing process undertaken by the Species Technical Committee, coordinated by DES.
6. The weights and ranks for measures and indicators have been reviewed and updated. With the completion of ACAs statewide, there is comprehensive information on weights and ranks, as provided by expert panels. The decision was made to utilise the overall average weight/rank score for each measure and indicator respectively as it was not possible to undertake this process with the v2.1 expert panels due to time constraints.
7. The QMDBB v2.1 expert panel has reviewed and updated special features from the previous ACAs. Additional special features have also been added to the current assessment.
8. There were some differences between assessments in the measures utilised (see Appendix IX - Criterion, indicator, measure list comparison between QMDB v1.4 and QMDBB v2.1). An additional 5 Non-riverine measures were incorporated in QMDBB v2.1 that were not utilised in QMDB v1.4 (including: 1.3.7, 2.3.9, 2.3.11, 6.3.4, 7.3.1). There were 24 riverine measures that were used for some catchments only in v1.4 but were not utilised in v2.1. QMDBB v2.1 only utilised measures that had available and current datasets for the entire QMDBB assessment area. It is recognised that datasets may have been missed.

Major differences that can affect the proportions (% of spatial units) of scores for each criterion and AquaScore are set out below.

9. QMDBB v2.1 assessment boundary has been cut to the Queensland border. In QMDB v1.4 the Border Rivers catchment area extended into northern NSW, even though it was data deficient.
10. Framework datasets, (bounding area, study area and sub catchments) have been updated to match a point of truth framework (see section2.12.1 below).
11. A number (13) of spatial units have been split by in-stream fish barriers.
12. QMDBB v2.1 has included H3 (artificial) wetlands. There are 3,700 H3 wetlands, which comprise 20% of total wetland proportion. While artificial wetlands are recognised as having some potential ecological value, they are not included in all measures (for further details see section 2.3 and the implementation tables in Appendix I - Riverine Implementation Table and Appendix II - Non-riverine Implementation Table).

2.12.1 Updates to framework datasets

A review of the framework datasets was completed to provide a contextual reference for Aquatic Conservation Assessments in relation to other data sources and projects that work with drainage basins.

Spatial data was provided by the Department of Resources which is an authoritative single point of truth for the extent of river drainage in the State of Queensland. The spatial data includes the extent and name for Drainage Divisions and Drainage Basins as defined by the Australian Water Resources Management Committee (WRMC). It also includes River Basins which were compiled by determining watersheds based on 1:100,000 topographic contours. Each of the three data layers have boundaries that are aligned to and nested with each other.

The QMDBB framework bounding area was determined by the drainage divisions that best aligned with the NRM (Natural Resource Management) regional boundaries and cut at the Queensland border. Nested within this bounding area layer are the study areas and sub-catchments. These were determined by the Drainage Basins and River Basins linework that best aligned with the original QMDB ACA v1.4. To maintain a relatively similar size for each study area, the original Balonne-Condamine study area was split into two to give the Maranoa study area and the Condamine-Balonne study area.

3 Results

3.1 Accuracy and dependability

The Queensland Wetland Mapping data is the core dataset Aquatic Conservation Assessments 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 Aquatic Conservation Assessment results should be interpreted in conjunction with the dependability score.

3.2 Riverine results

Aquatic Conservation Assessments were conducted for the riverine spatial units within each study area. Figure 2, Figure 3 and Figure 4 map the riverine AquaScores, dependability scores and criteria ratings for each riverine spatial unit. Figure 5, Figure 6 and Figure 7 map the AquaScores, dependability scores and criteria ratings for buffered riverine drainage lines.

Table 3 and Table 4 provide summary statistics of the riverine AquaScores, dependability scores and criteria ratings by study area.

Key Findings

- All study areas had 50% or greater riverine spatial units receiving an AquaScore of Very High or High. This is primarily driven by Very High and High ratings for Criterion 2 (Catchment Naturalness), Criterion 6 (Special Features) and Criterion 7 (Connectivity) as can be seen in Figure 2, Figure 3 and Figure 4.
- Much of the eastern half of the QMDBB, spanning the study areas of Condamine-Balonne, Moonie, and Border Rivers, are Medium to Low for Criterion 1 (Aquatic Naturalness). This is likely due to the amount of cultivation and agriculture that occurs in the regions.
- Criterion 2 (Catchment Naturalness) has four of the eight study areas scoring 100% of Very High or High values. These include Bulloo, Paroo, Warrego and Wallam catchments. The Maranoa catchment scored 97% of Very High or High values. The other three study areas (Condamine-Balonne, Moonie Basin and Border Rivers) range from Very High to Low values depending on their proximity to major rivers, riparian vegetation, cultivation, and agriculture. The spatial units with values of Medium to Low appear to be where more cultivation and agriculture is present.
- The diversity and richness of species within the regions appears to be evenly spread across the whole QMDBB. This is very dependent of the number of field surveys that have been conducted and the limitations to reach all areas for all different types of species. The western regions were more limited in species records.
- The limitations in available species records are also reflected in Criterion 4 (Threatened species and ecosystems) and Criterion 5 (Priority Species and Ecosystems), where many spatial units are either Low or have No Data. Thresholding the different measures has attempted to balance the resulting conservation values across the different study areas.
- In general, threatened and priority species values (Criterion 3, 4 and 5 respectively) is Very High to High in most of the Bulloo study area. These High values also appear to occur in the high-altitude regions of the Warrego and the Border Rivers study areas.
- Many areas (64%) within all study areas were selected for their connectivity values by the expert panel. These spatial units were given Very High values for Criterion 7 (Connectivity).
- Only a few riverine spatial units (1.3%) were selected by the expert panel for their ‘representativeness’ in Criterion 8 (Representation). These are in the Bulloo, Paroo and Warrego study areas.
- Data limitations and wide variations within study areas are clearly visible in the Dependability score (Figure 2 and Table 4). Three study areas are rich in data including the Border Rivers, Moonie Basin and the Condamine-Balonne. The Wallam study area is very data deficient. This may be due to the inaccessible nature of the region with few rivers and vast, flat clay pans that spread across the landscape providing little in the way of accessibility for field studies.
- Criterion 6 (Special Features), 7 (Connectivity) and 8 (Representation) all have 100% dependability (Table 4). This is due to how the dependability score is calculated i.e. -999 is used to represent data where a conservation value has been assessed (by the expert panel) but it is not provided (true absence). True absence is considered as data for the measure when calculating the dependability score.

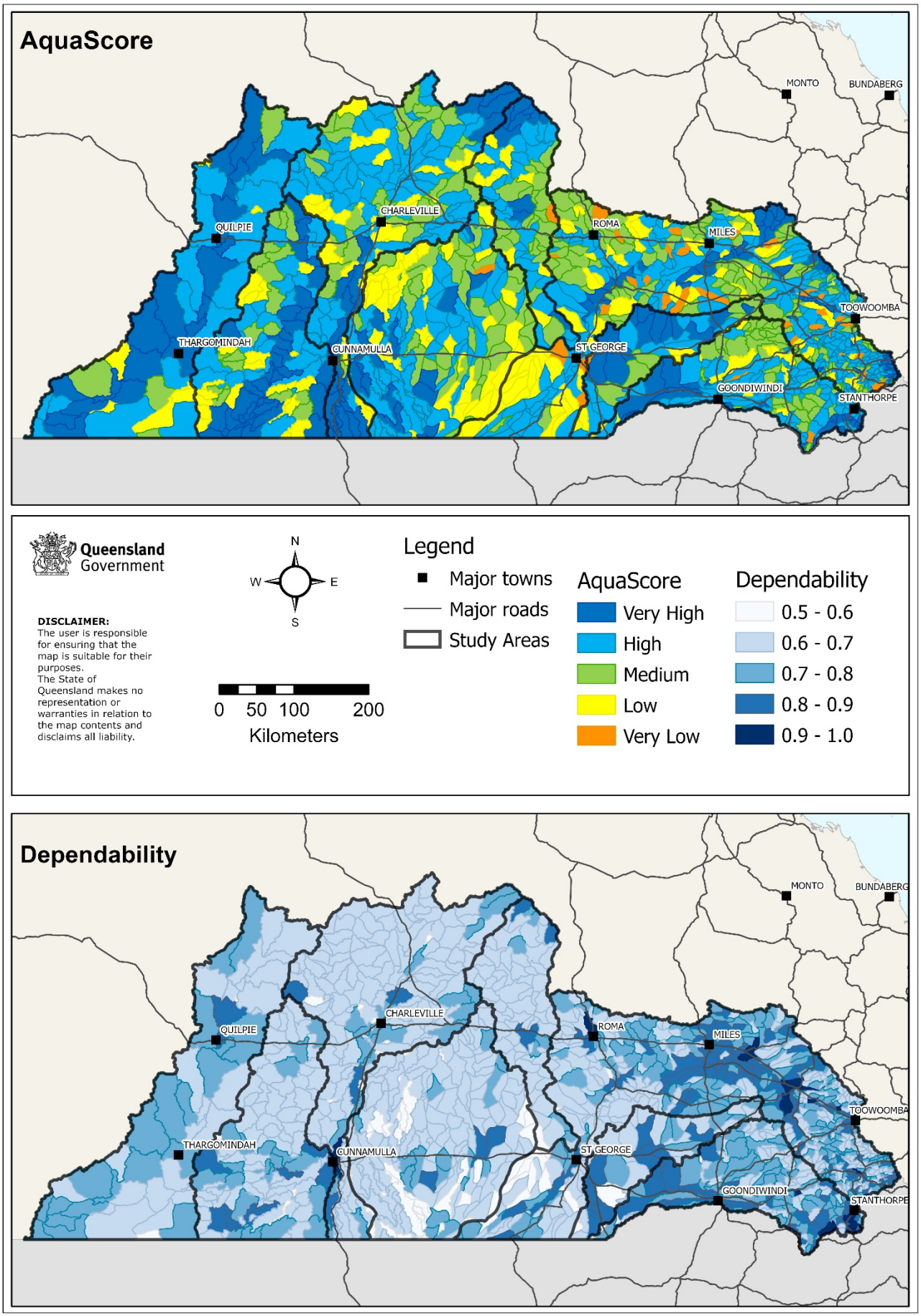


Figure 2. AquaScore and Dependability by riverine spatial unit

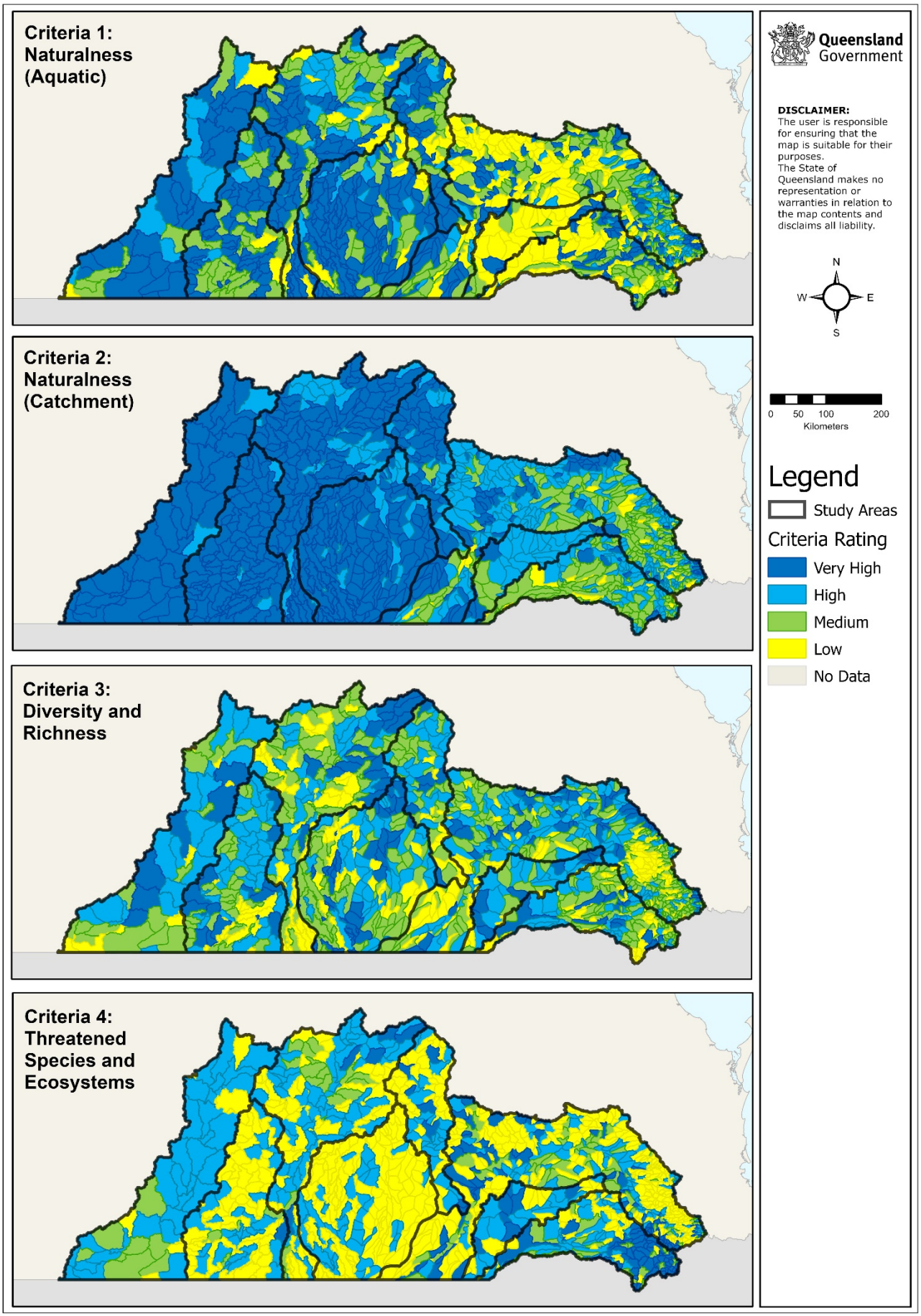


Figure 3. Ratings for Criteria 1 - 4 by riverine spatial unit

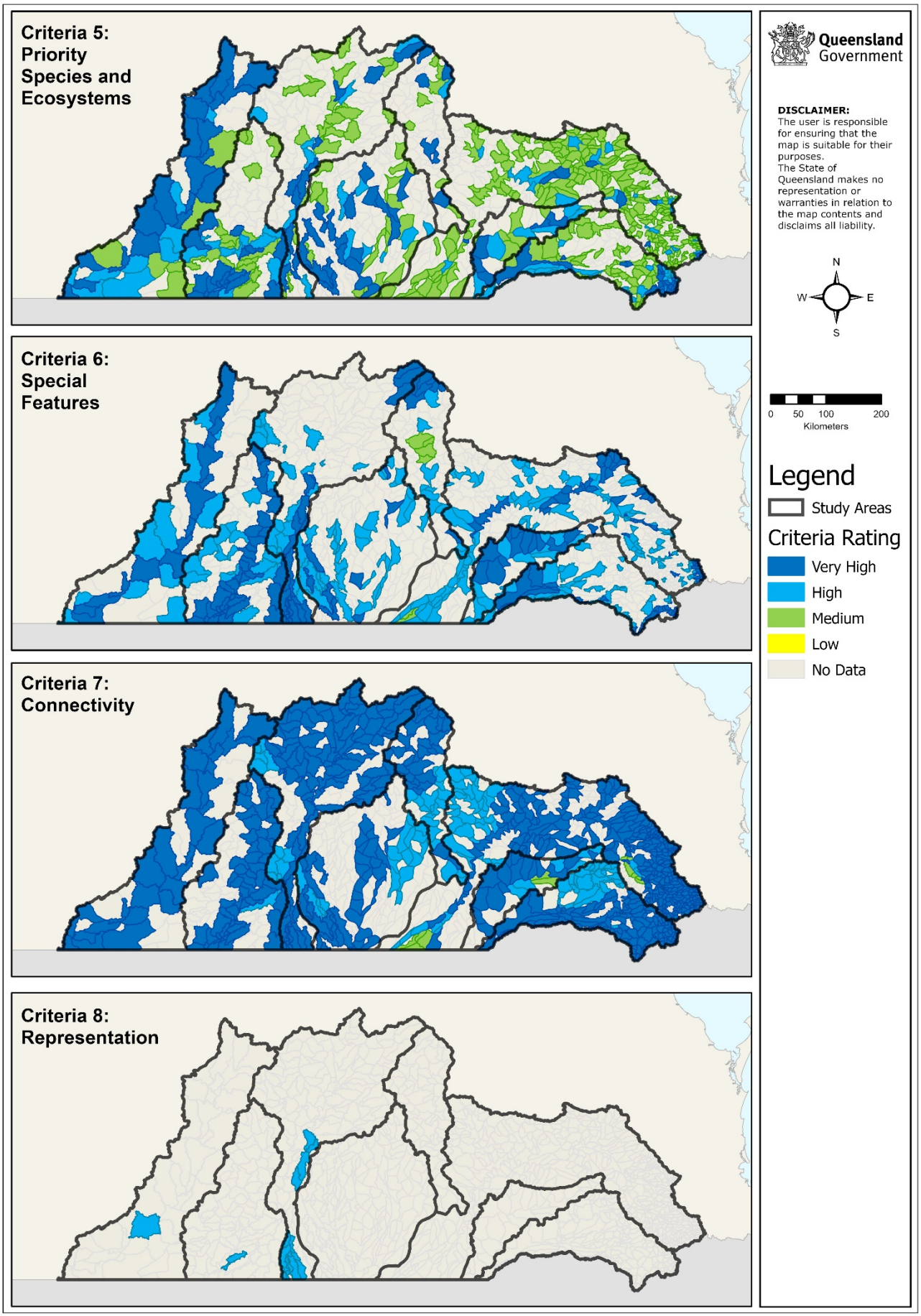


Figure 4. Ratings for Criteria 5 - 8 by riverine spatial unit

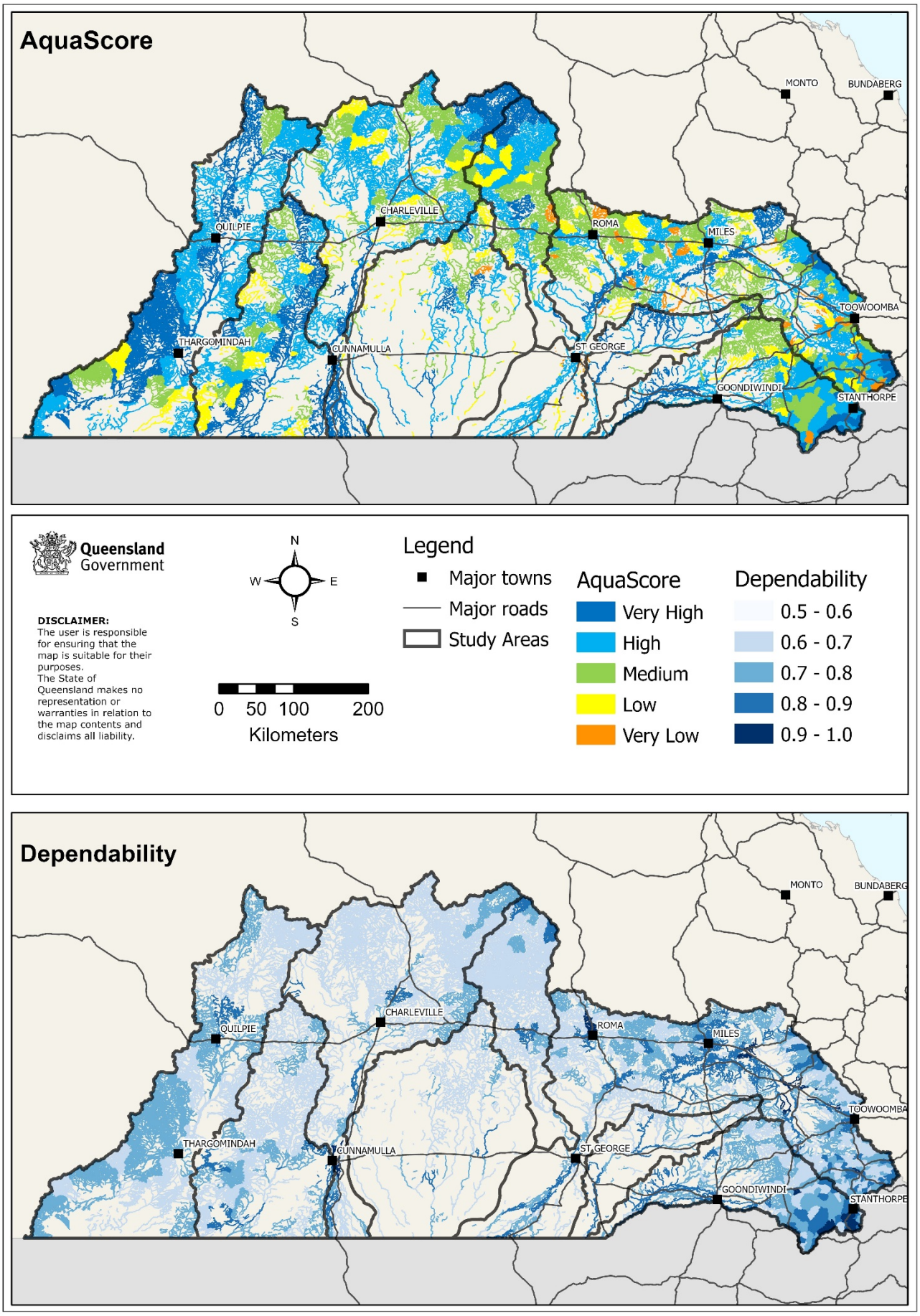


Figure 5. AquaScore and Dependability by riverine drainage lines

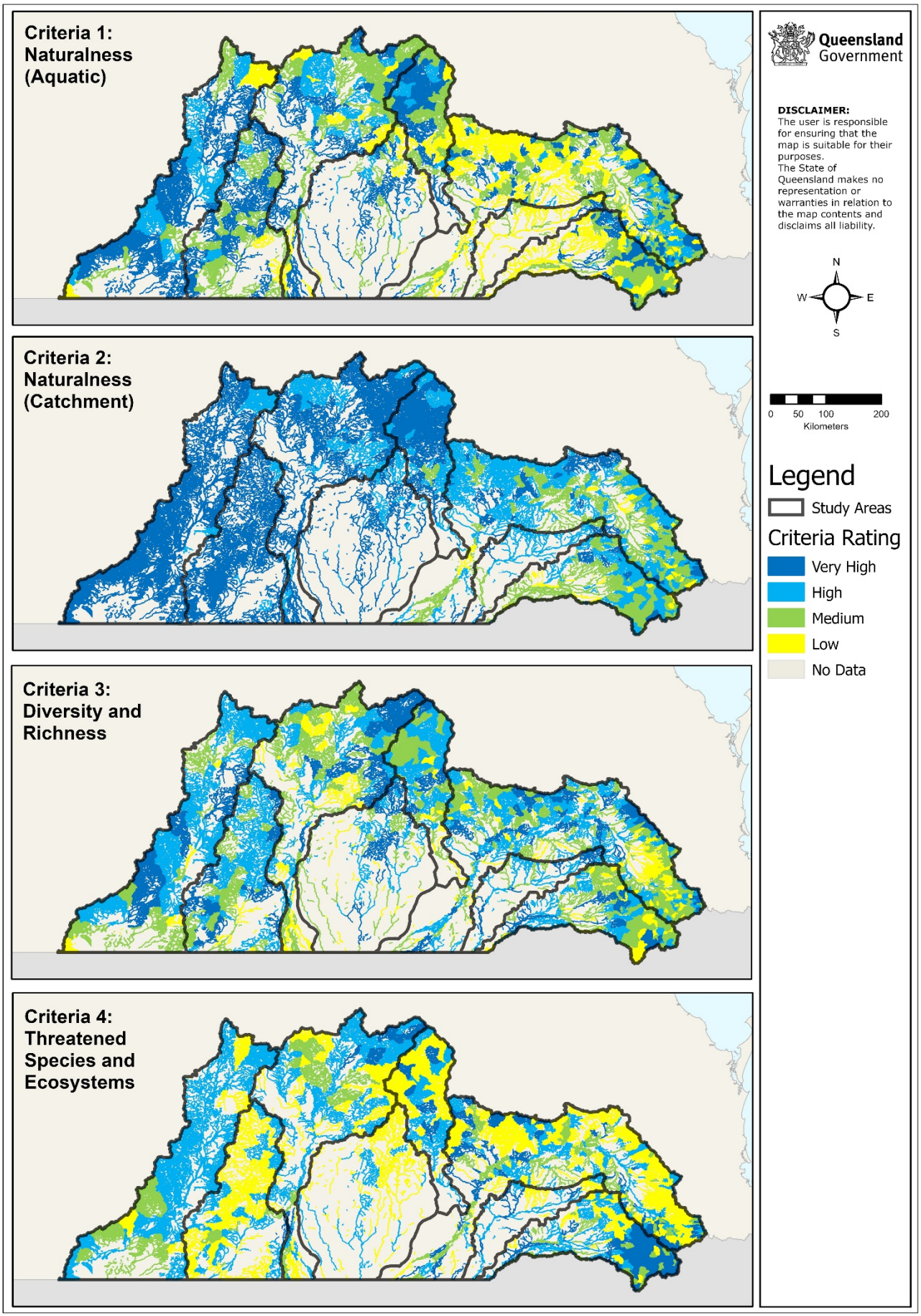


Figure 6. Ratings for Criteria 1 - 4 by riverine drainage lines

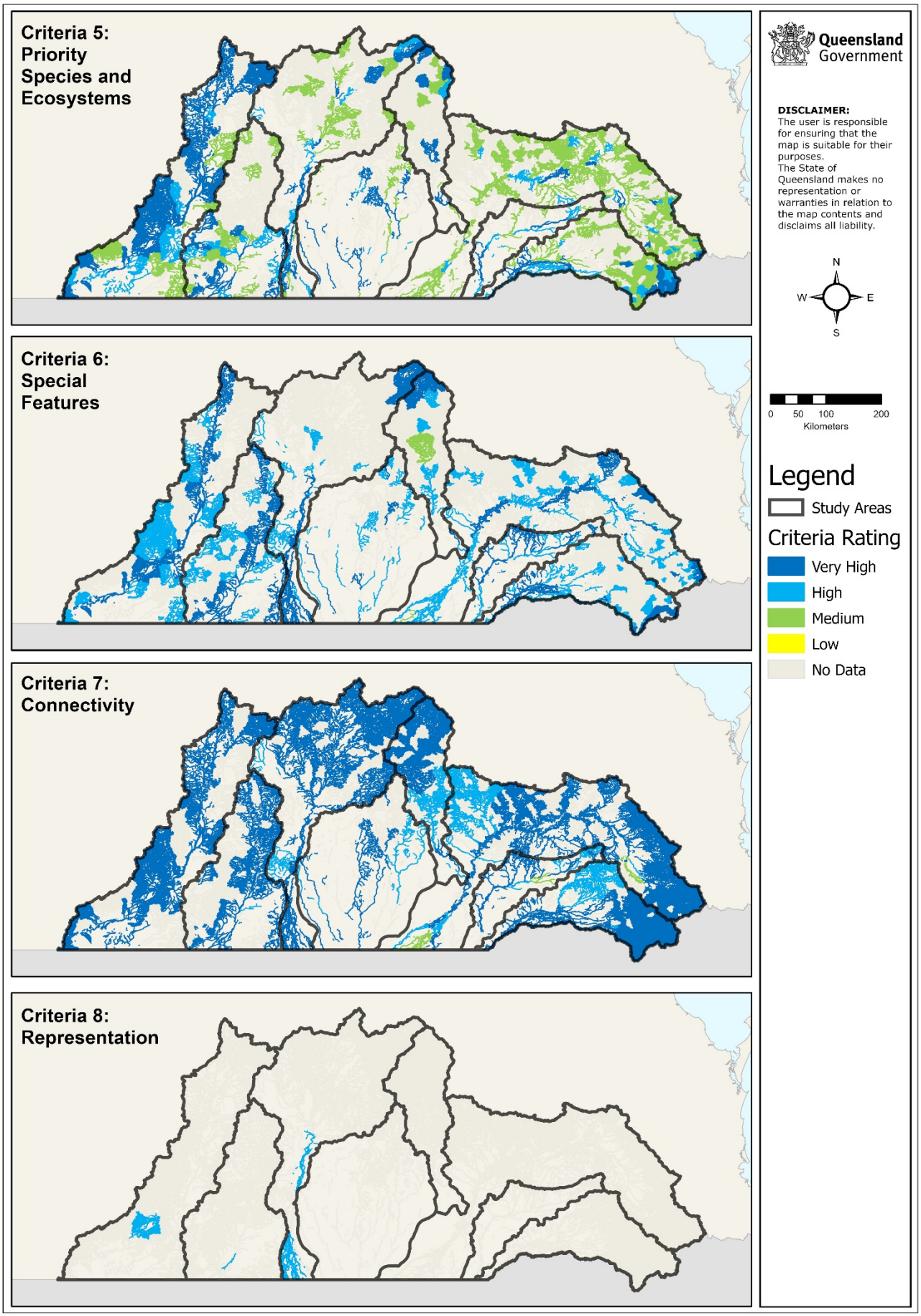
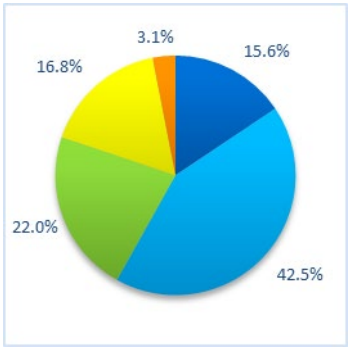
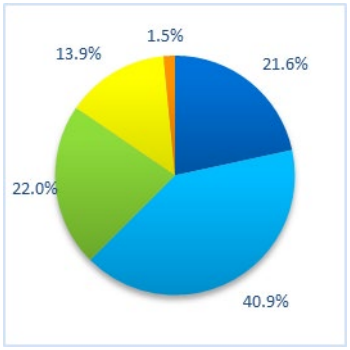
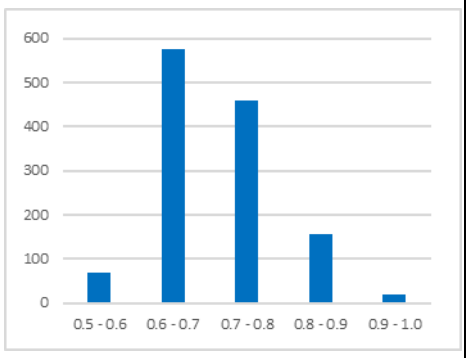
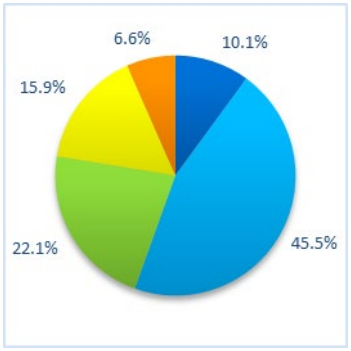
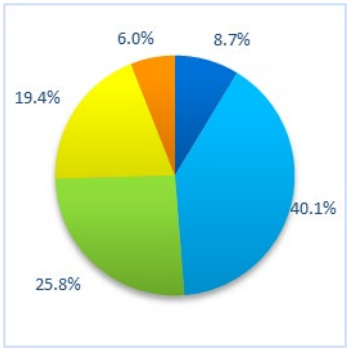
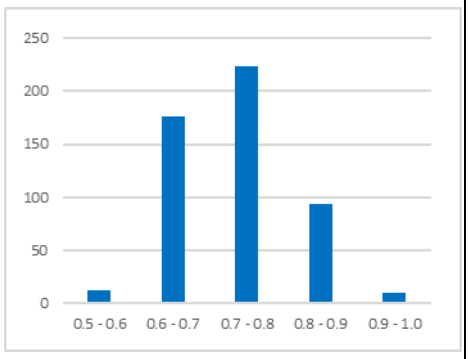
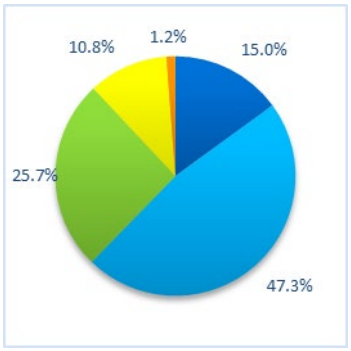
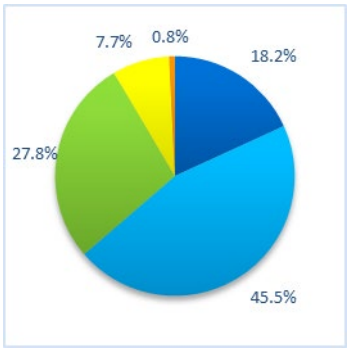
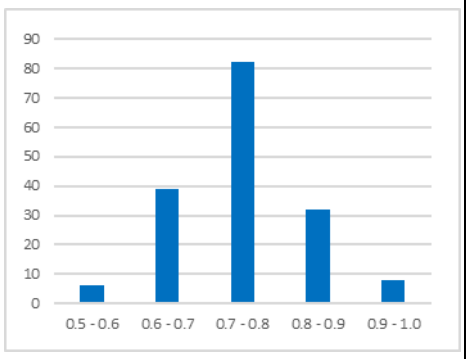
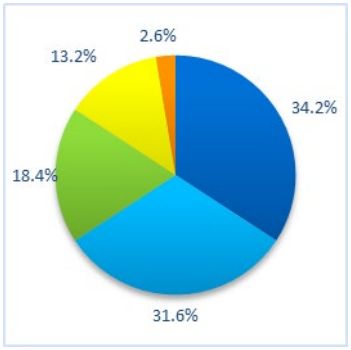
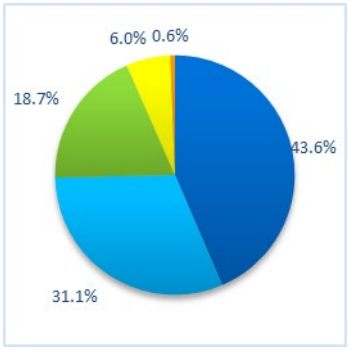
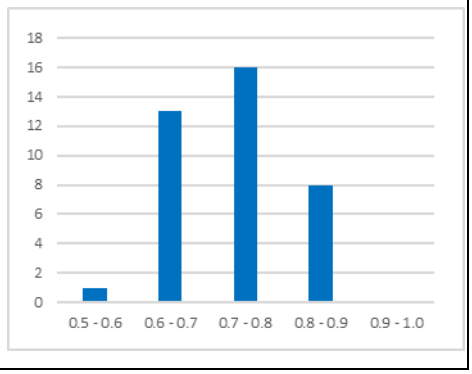
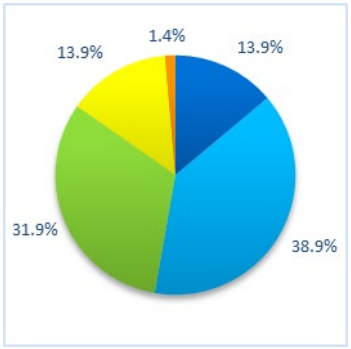
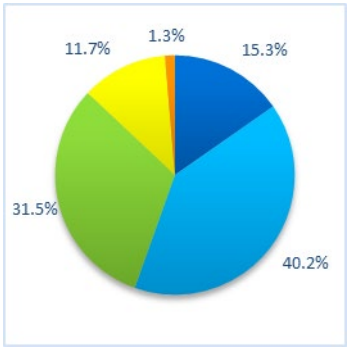
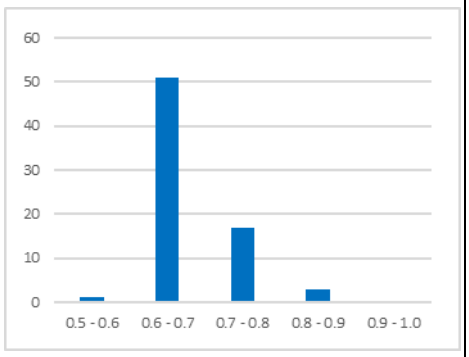
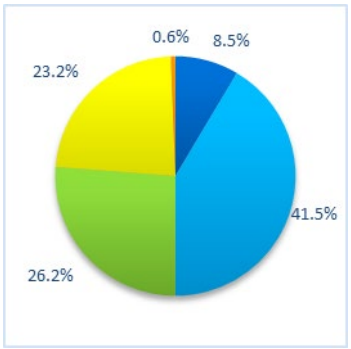
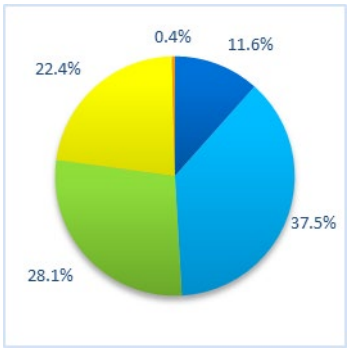
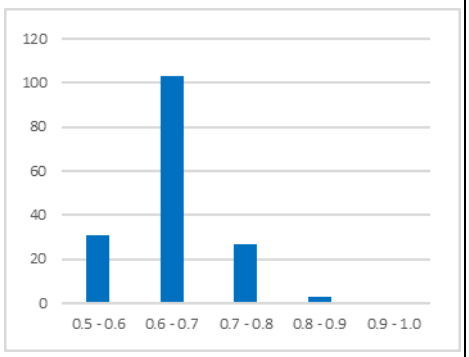
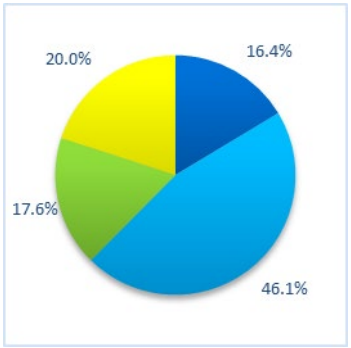
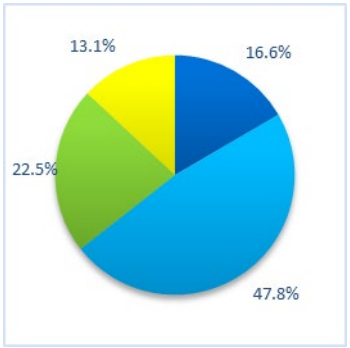
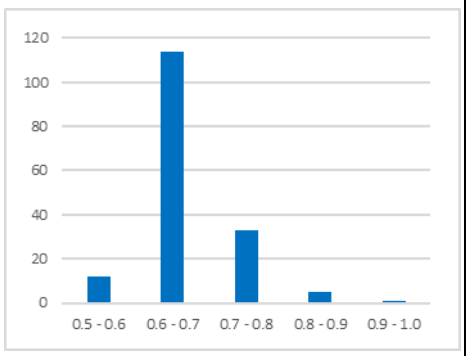
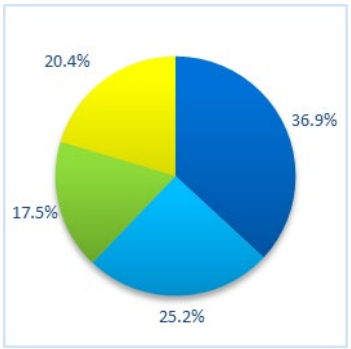
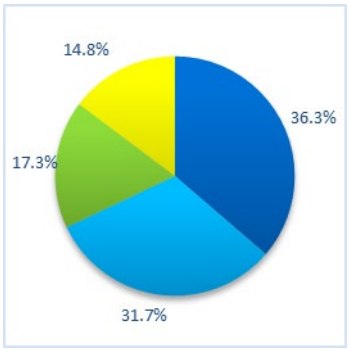
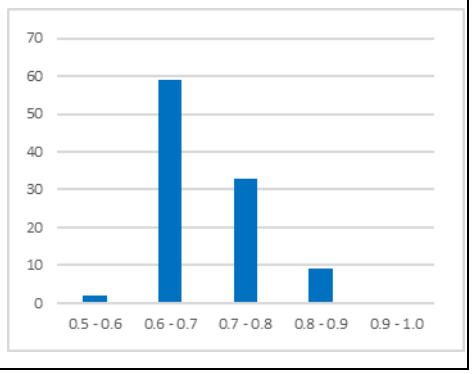


Figure 7. Ratings for Criteria 5 - 8 by riverine drainage lines

Table 3. Riverine spatial unit AquaScore and Dependability summary statistics by study area.

Study Area	AquaScore by % of spatial units	AquaScore by & of total area of spatial units	AquaScore Dependability
All			
Condamine -Balonne			
Border Rivers			
Moonie Basin			

Study Area	AquaScore by % of spatial units	AquaScore by & of total area of spatial units	AquaScore Dependability
Maranoa			
Wallam			
Warrego			
Paroo			

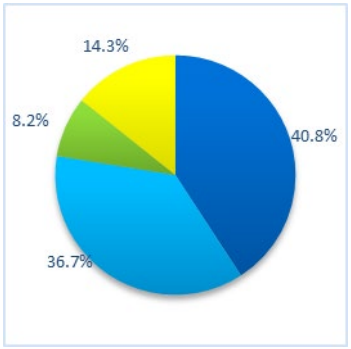
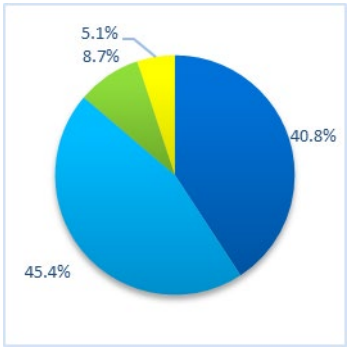
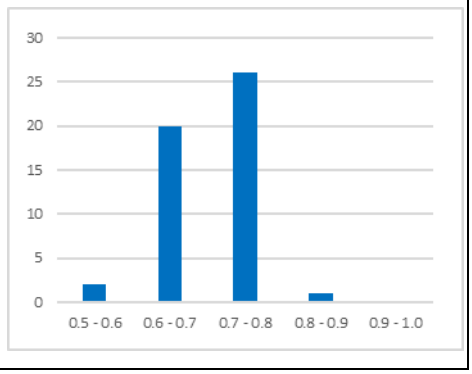
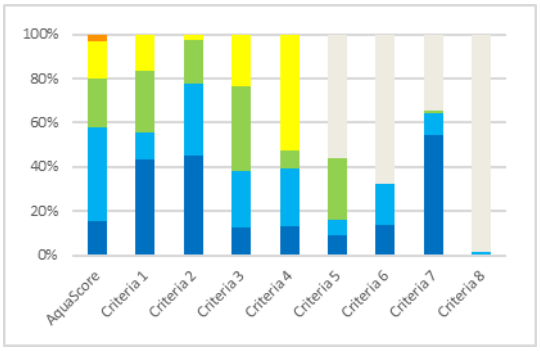
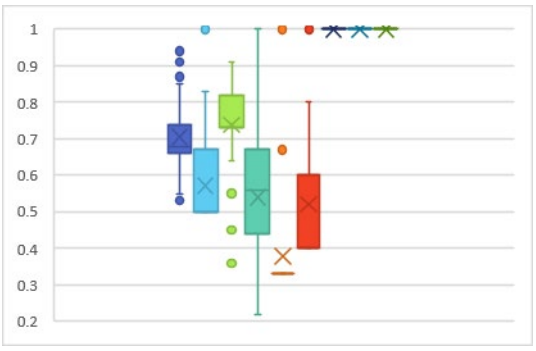
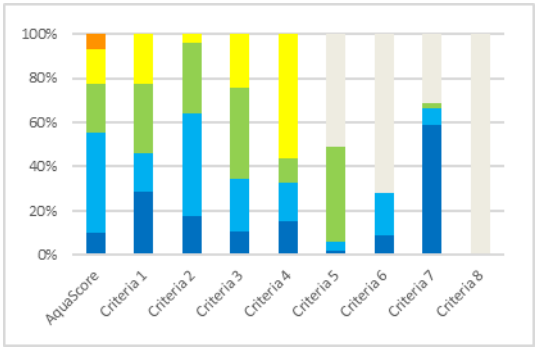
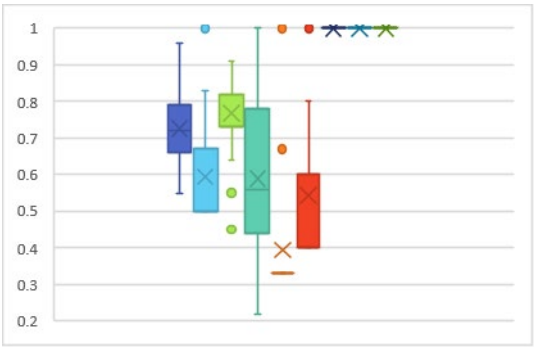
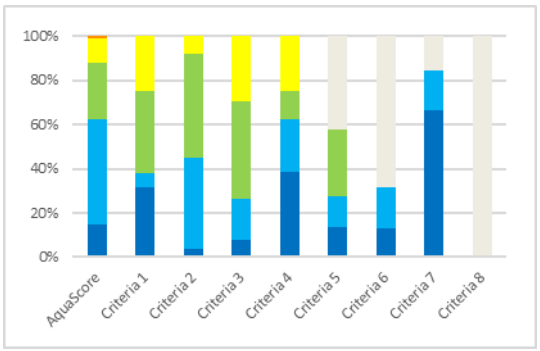
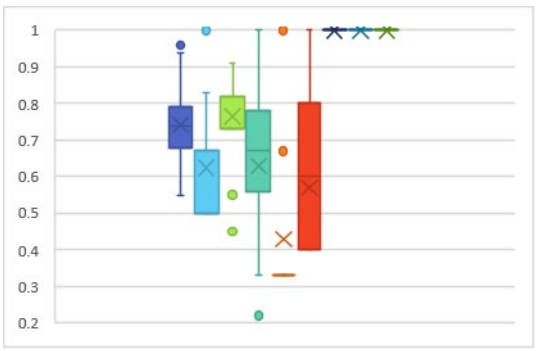
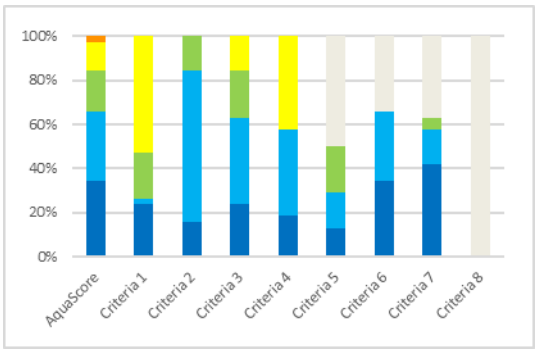
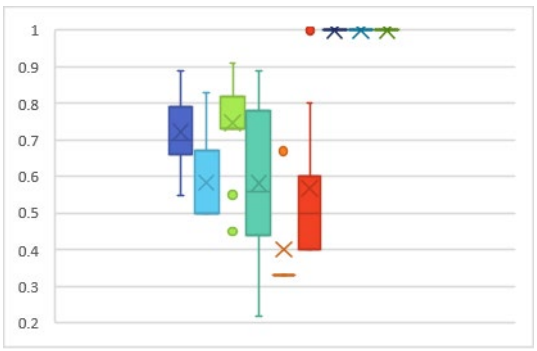
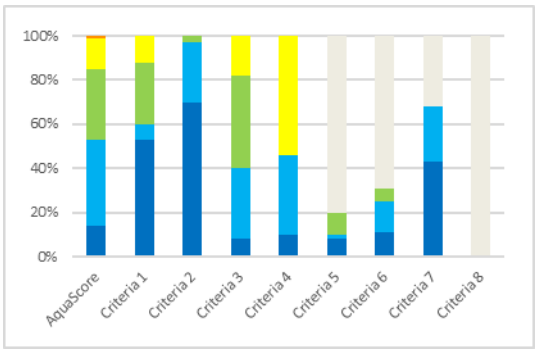
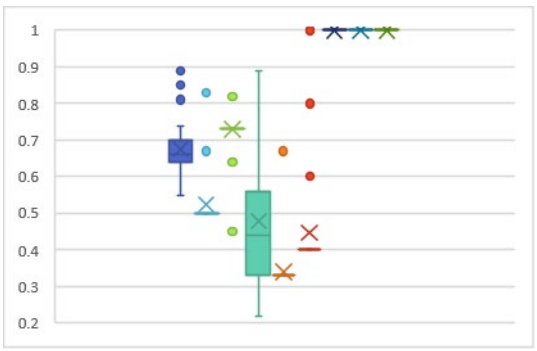
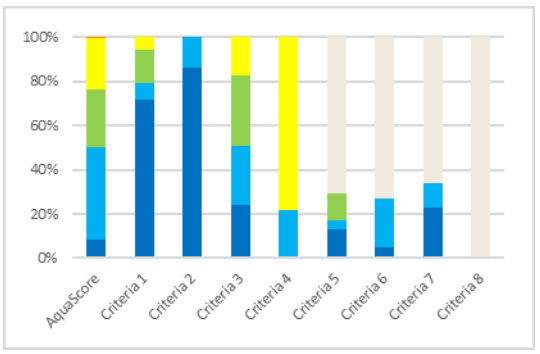
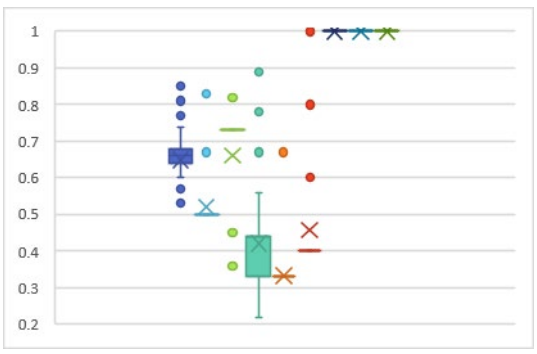
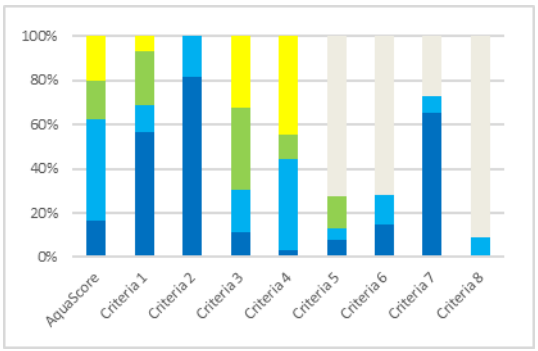
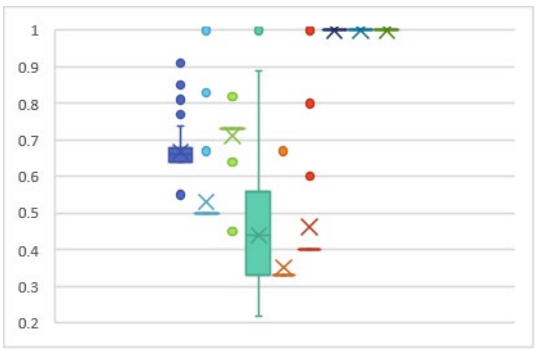
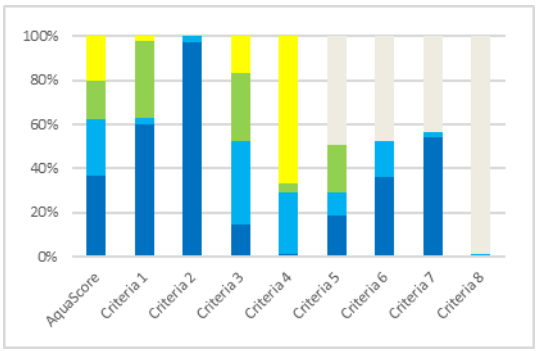
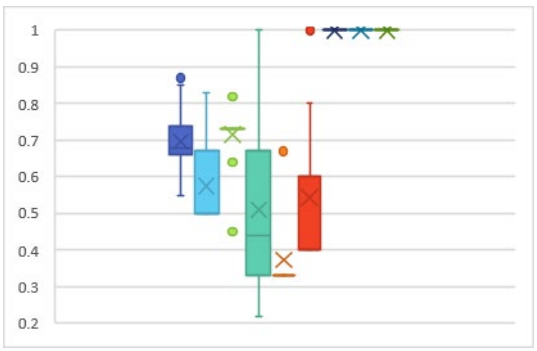
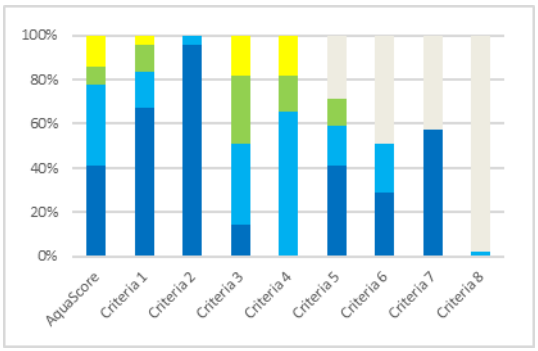
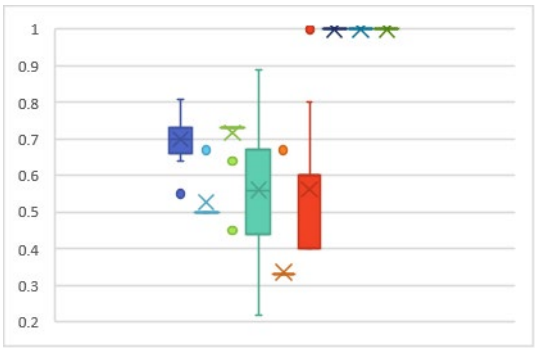
Study Area	AquaScore by % of spatial units	AquaScore by & of total area of spatial units	AquaScore Dependability
Bulloo			

Table 4. Riverine spatial unit AquaScore, Criteria Score and Dependability summary statistics by % of spatial units and Study Area.

Study Area	Scores by % of spatial units	Dependability
All		
Condamine-Balonne		

Study Area	Scores by % of spatial units	Dependability
Border Rivers		
Moonie Basin		
Maranoa		
Wallam		

Study Area	Scores by % of spatial units	Dependability
Warrego		
Paroo		
Bulloo		

3.3 Non-riverine results

Aquatic Conservation Assessments were conducted for the non-riverine spatial units within each study area. Figure 8, Figure 9 and Figure 10 map of the non-riverine AquaScores, dependability scores and criteria ratings for each non-riverine spatial unit.

Table 5 and Table 6 provide summary statistics of the non-riverine AquaScores, criteria ratings and dependability scores by study area.

Key Findings

- Three study areas stand out as having a majority of Very Low and Low AquaScores (Figure 8). These include the Condamine-Balonne, Moonie Basin and Border Rivers. The regions predominantly support cultivation and agricultural practices which influence Criterion 1 (Aquatic Naturalness) and Criterion 2 (Catchment Naturalness) (Figure 9 and Table 6).
- There are 3700 artificial wetlands across all catchments, with 3002 artificial wetlands located within the three eastern study areas (Condamine-Balonne, Moonie Basin and Border Rivers). Just within these three study areas, this is 93% (3002 from a total of 3217 non-riverine spatial units) of all non-riverine spatial units being classified as artificial and given a Low rating for Criterion 1 (Table 6).
- The diversity and richness of species (Criterion 3) scoring Very High or High within the three eastern study areas is relatively high and similar to the other study areas. This is due to the amount of available data for the region. All study areas scored a Very High or High for 30% to 70% of the spatial units, except for the Bulloo Basin where 80% of the spatial units scored a Very High or High.
- The western study areas that include the Bulloo, Paroo, and Wallam are predominantly Very High and High for Criterion 1 (Aquatic Naturalness) (99%, 97% and 86% respectively) and Criterion 2 (Catchment Naturalness) (99%, 98% and 70% respectively). The Warrego and Maranoa study areas are more evenly spread (from Very High to Low) within their criteria ratings. This is predominantly due to more agriculture occurring in the regions and the varying degrees of vegetation cleared for pasture grazing (mostly mulga, *Acacia aneura*).
- The Bulloo, Paroo and Wallam study areas have Very High and High values for Criterion 6 (Special Features) and Criterion 7 (Connectivity). These high values are related to three distinct areas of wetlands, including the claypan wetlands of Bulloo Lake in the Bulloo study area (2% and 0.1% of the spatial units respectively), the sandsheet wetlands in the Paroo study area (93% and 92% respectively) and the Wyandra-Cunnamulla claypan wetlands in the Wallam study area (74% and 32% respectively).
- Table 4 illustrates that only 2.6% of all spatial units within the Bulloo study area have an AquaScore of Very High. However, these spatial units occupy 65.21% in area. This is mainly due to the Bulloo Lake wetland which is one large non-riverine spatial unit covering 55% of the total area of all spatial units, but only 0.5% of the whole Bulloo catchment area.
- Data limitations and wide variations within study areas are clearly visible in the Dependability score (Figure 8 and Table 5). Three study areas are potentially limited in data including the Maranoa, Wallam and the Warrego, averaging about 0.6 to 0.7 (see Table 5), compared to the other study areas which average around 0.7 to 0.8.

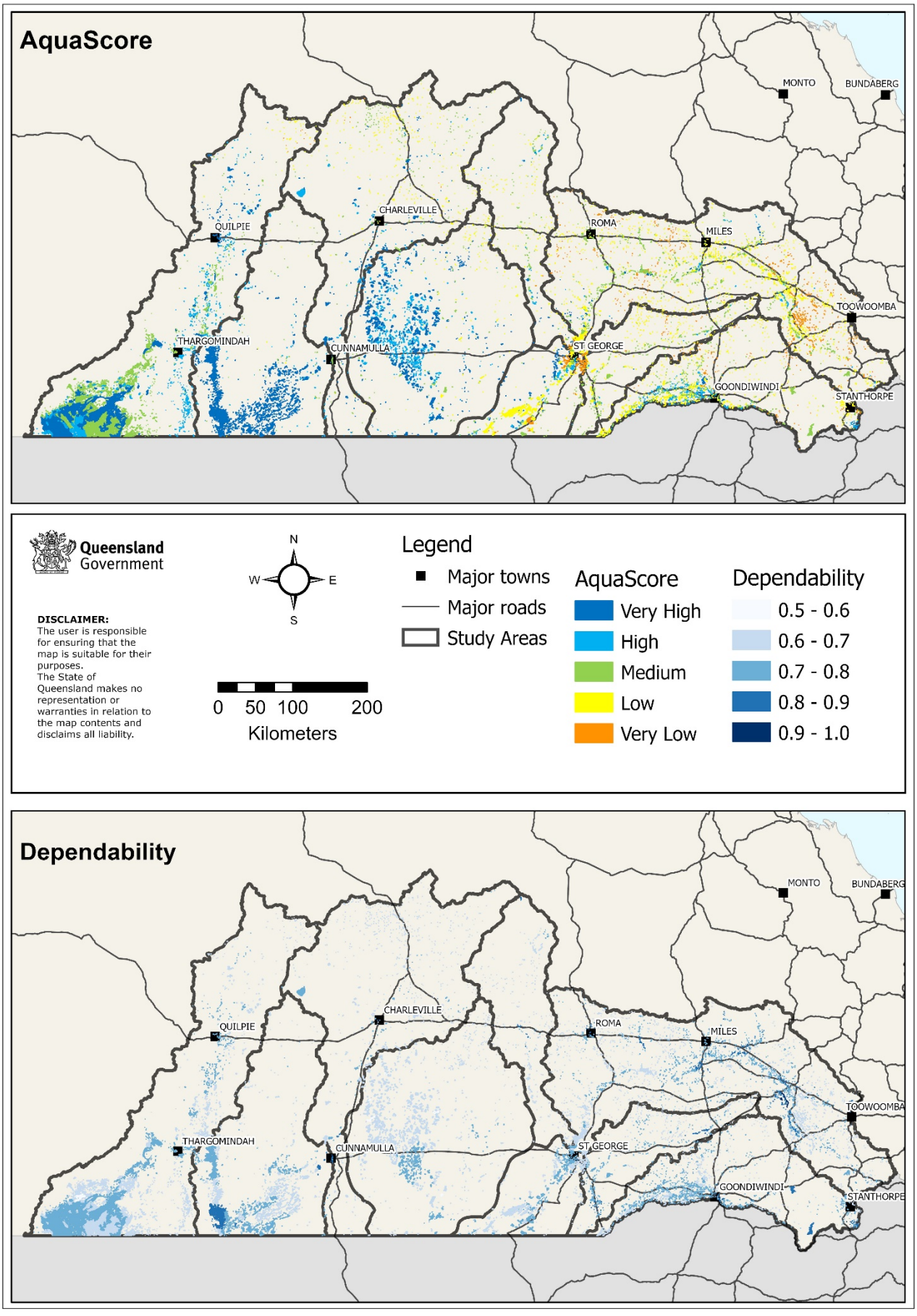


Figure 8. AquaScore, Dependability and Criterion rating by non-riverine spatial unit

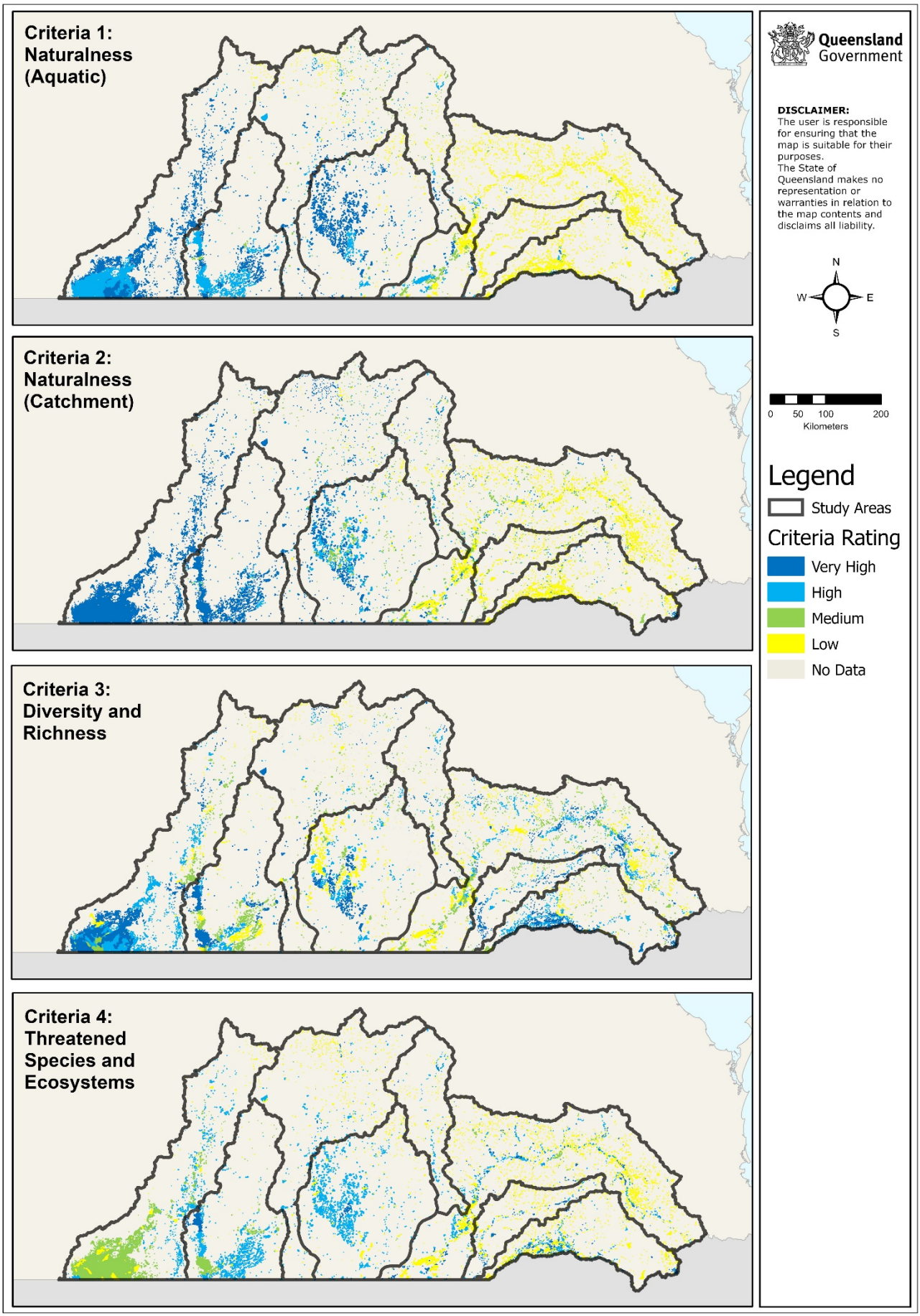


Figure 9. Ratings for Criteria 1 - 4 by non-riverine spatial unit

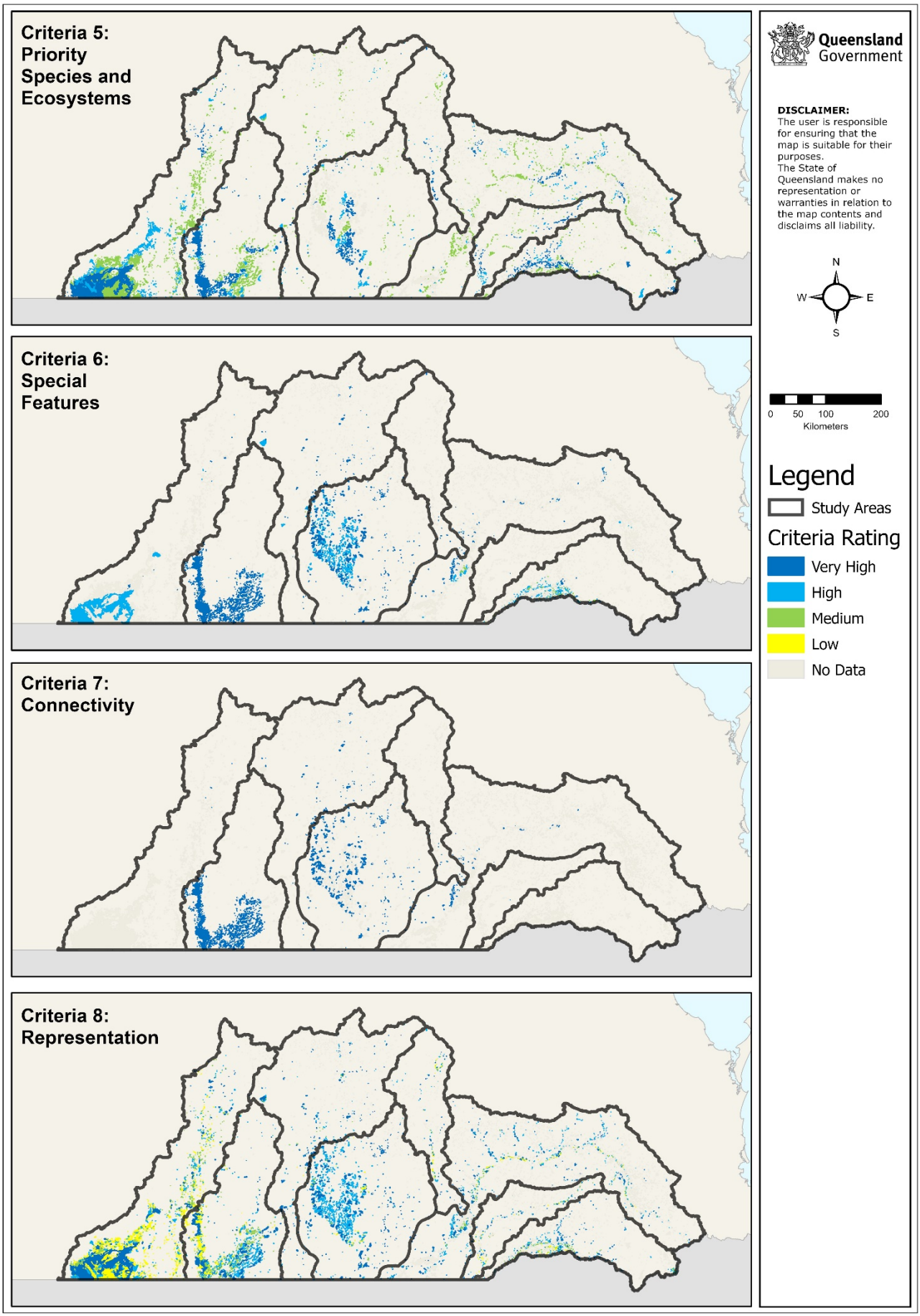
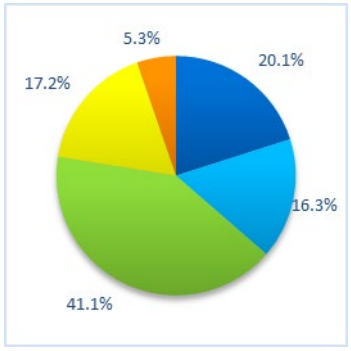
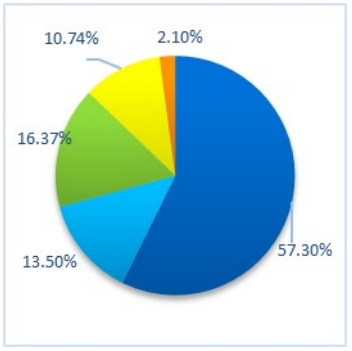
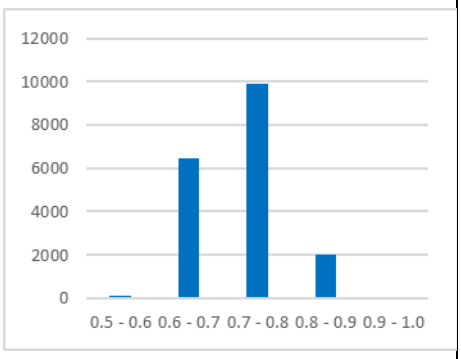
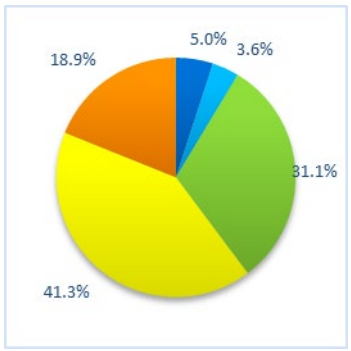
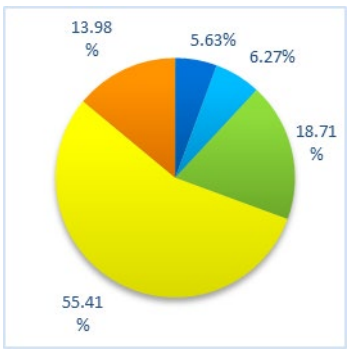
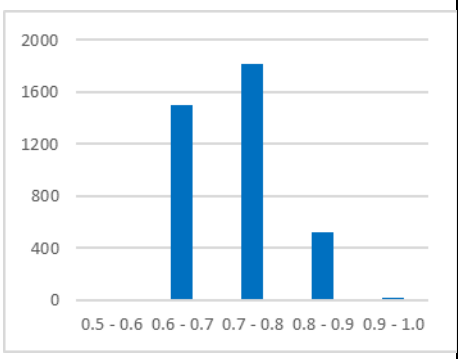
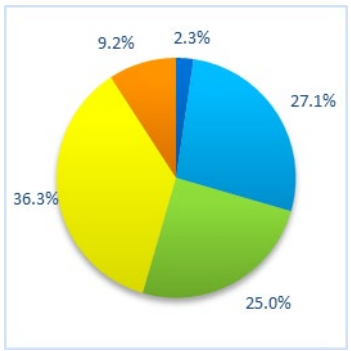
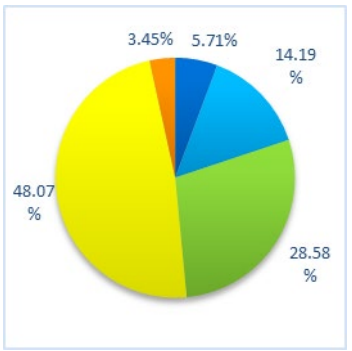
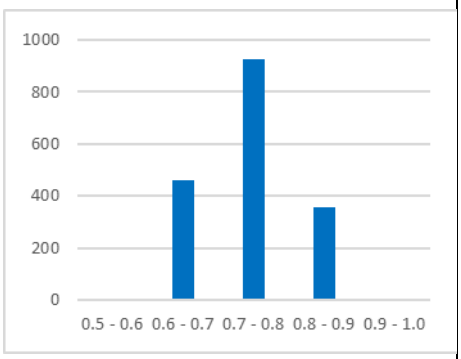
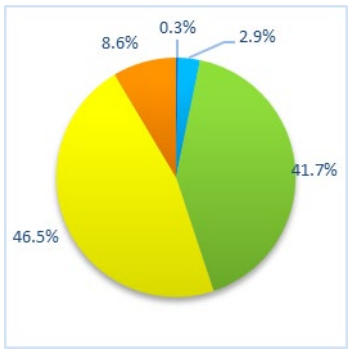
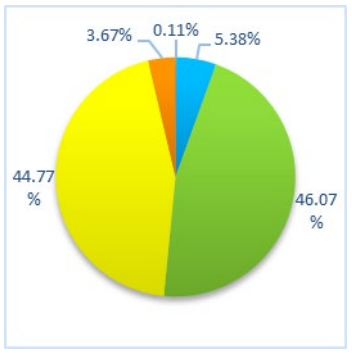
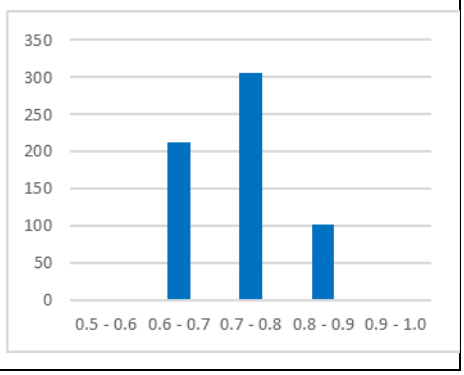
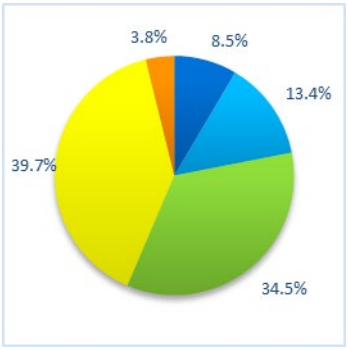
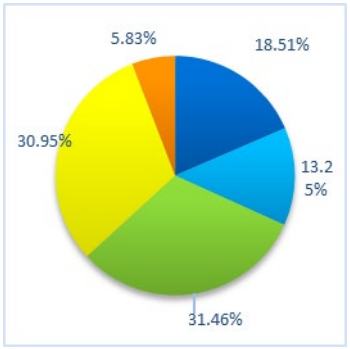
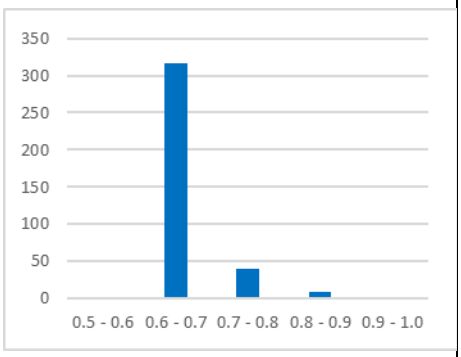
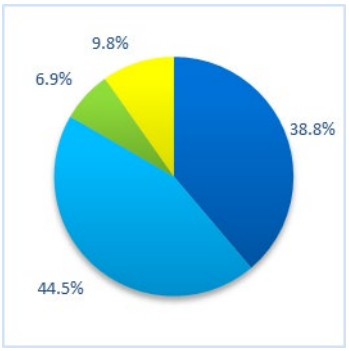
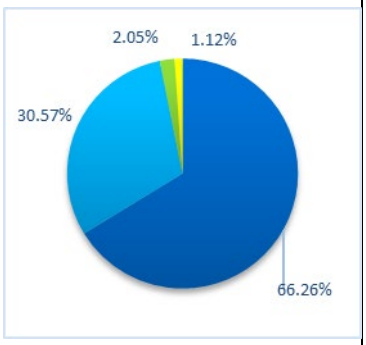
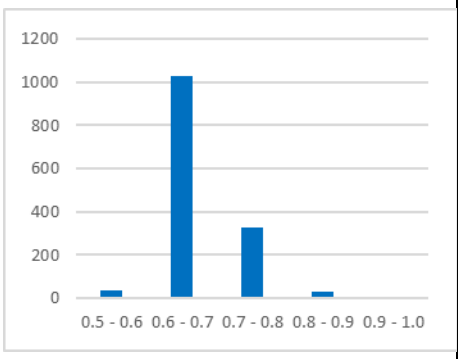
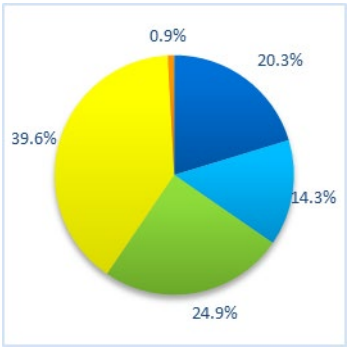
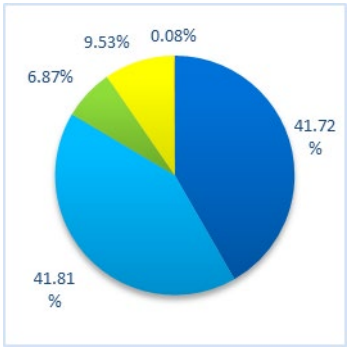
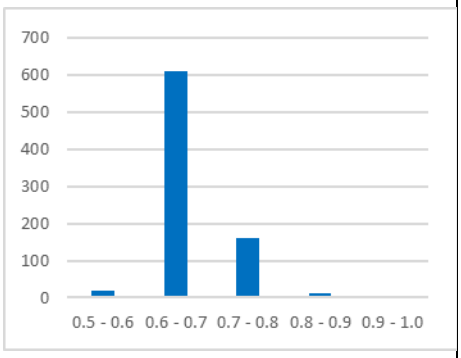
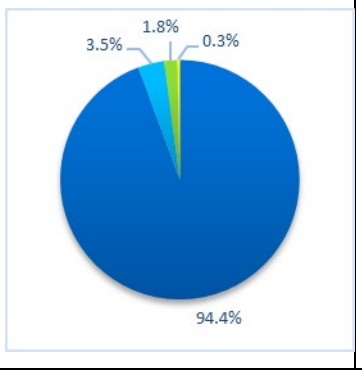
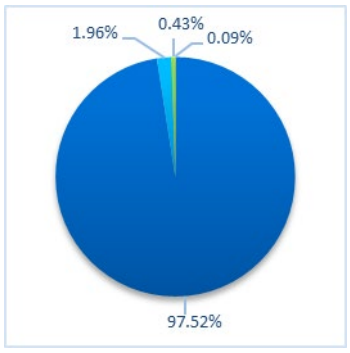
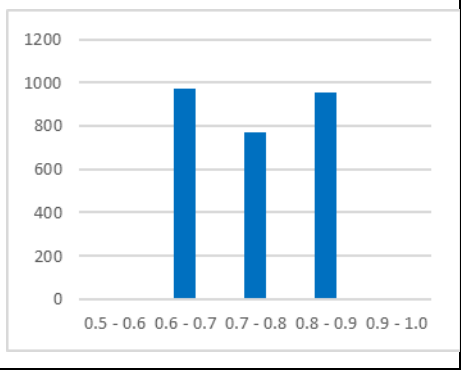


Figure 10. Ratings for Criteria 5 - 8 by non-riverine spatial unit

Table 5. Non-Riverine spatial unit AquaScore and Dependability summary statistics by study area.

Study Area	AquaScore by % of spatial units	AquaScore by & of total area of spatial units	AquaScore Dependability
All			
Condamine -Balonne			
Border Rivers			
Moonie Basin			

Study Area	AquaScore by % of spatial units	AquaScore by & of total area of spatial units	AquaScore Dependability
Maranoa			
Wallam			
Warrego			
Paroo			

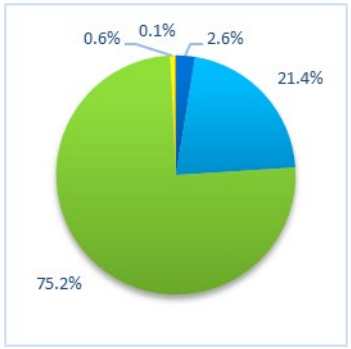
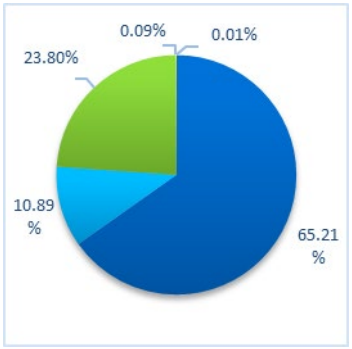
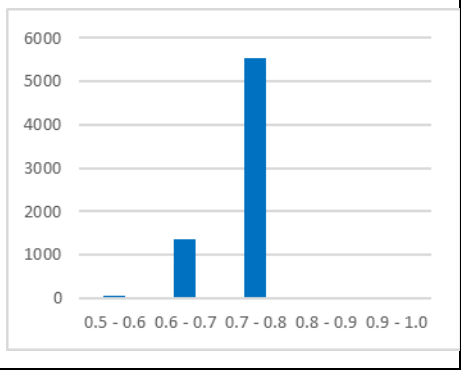
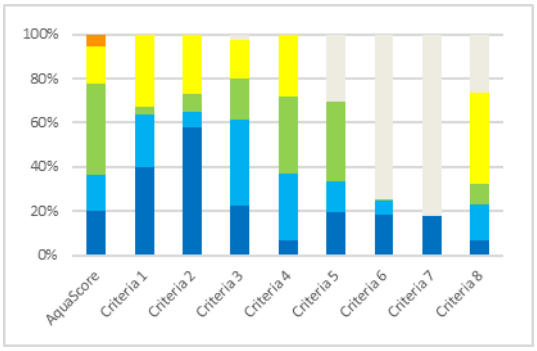
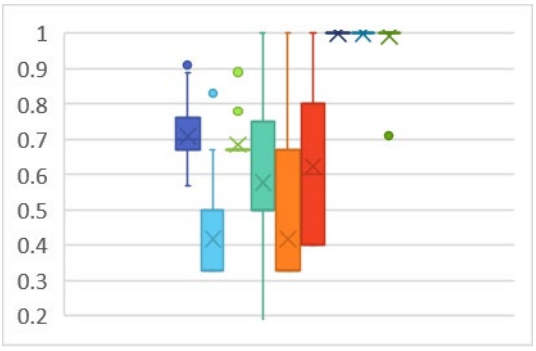
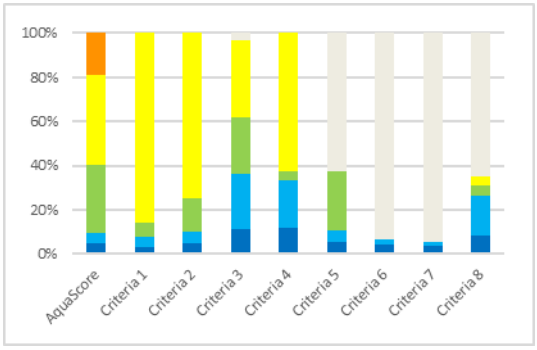
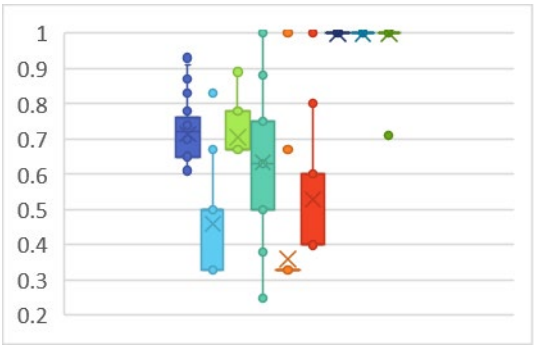
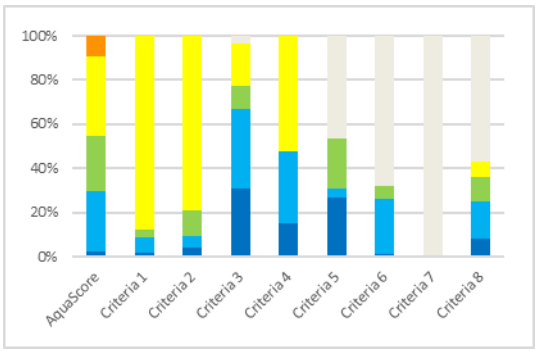
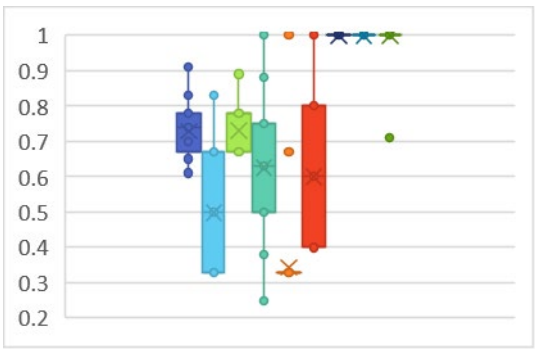
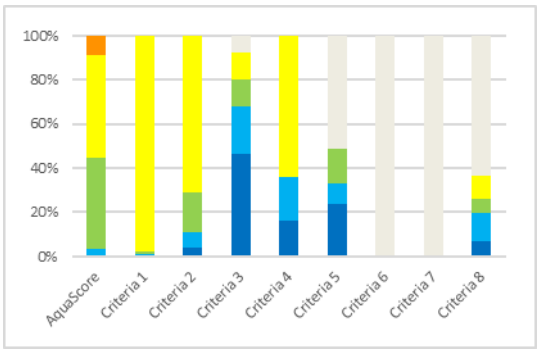
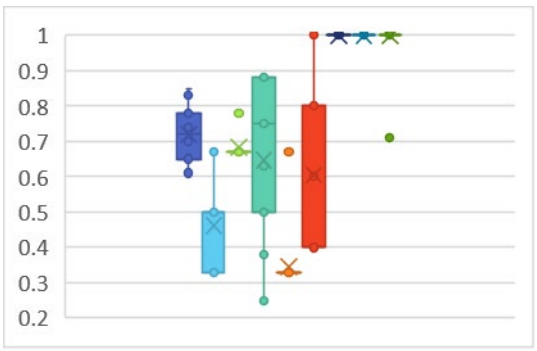
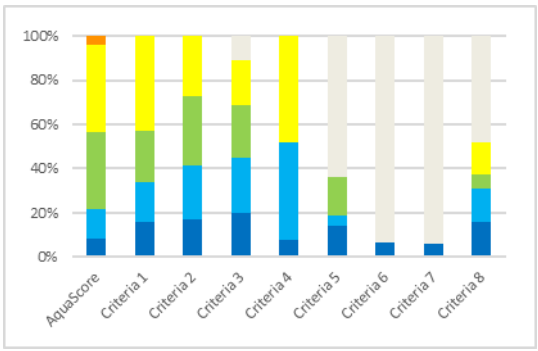
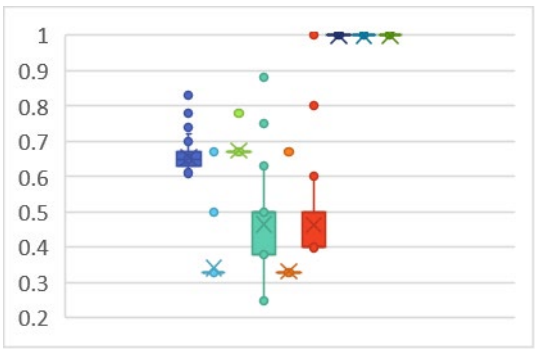
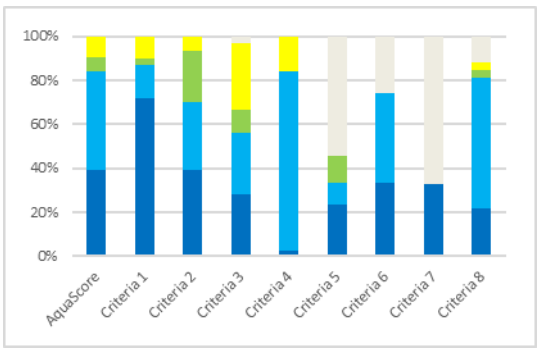
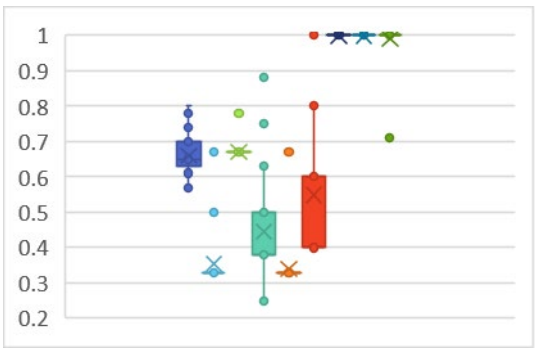
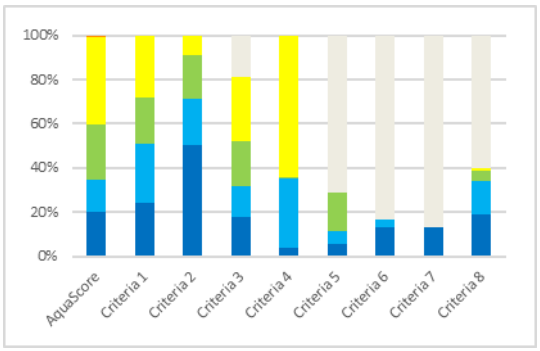
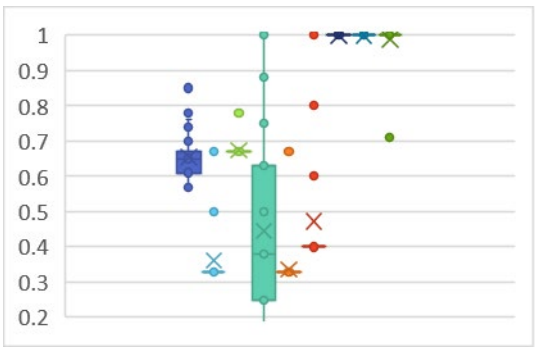
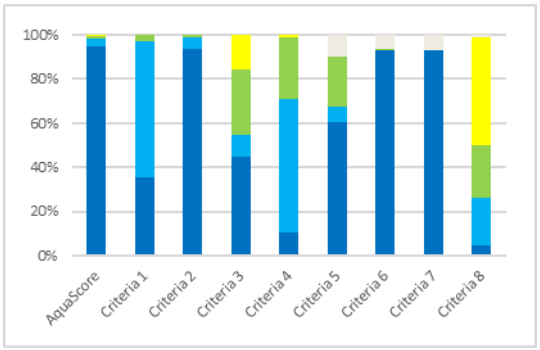
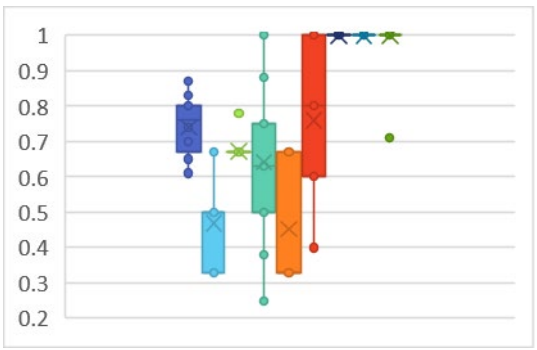
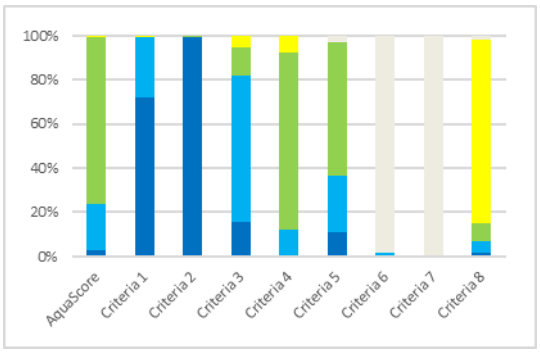
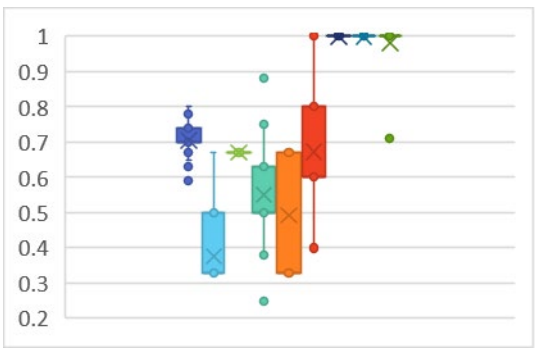
Study Area	AquaScore by % of spatial units	AquaScore by & of total area of spatial units	AquaScore Dependability
Bulloo			

Table 6. Non-Riverine spatial unit AquaScore, Criteria Score and Dependability summary statistics by % of spatial units and Study Area.

Study Area	Scores by % of spatial units	Dependability
All		
Condamine-Balonne		

Study Area	Scores by % of spatial units	Dependability
Border Rivers		
Moonie Basin		
Maranoa		
Wallam		

Study Area	Scores by % of spatial units	Dependability
Warrego		
Paroo		
Bulloo		

3.4 Ground-truthing

Ground-truthing by field observations are important to identify potential anomalies in assessment results or data implementation. It is an important step in any ACA and it precedes method adjustments and corrections prior to a final run of the AquaBAMM assessment tool.

COVID-19 travel restrictions and lack of available time meant that traveling into the field was unable to be undertaken for this assessment. High resolution satellite imagery, aerial photography and other on-line ancillary data sources (including Queensland Globe, Google Earth imagery and photographs) provided a valuable resource to visually review individual wetlands and their surroundings (see section 3.4.2).

While visually interpreting the high-resolution imagery, validation principles were used to test the validity of the implementation method. These include:

- Inspect spatial units across the range of values from Very Low to Very High. There is 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 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 reviewed, ascertain if the Criteria values and AquaScore are logical as determined by the 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.

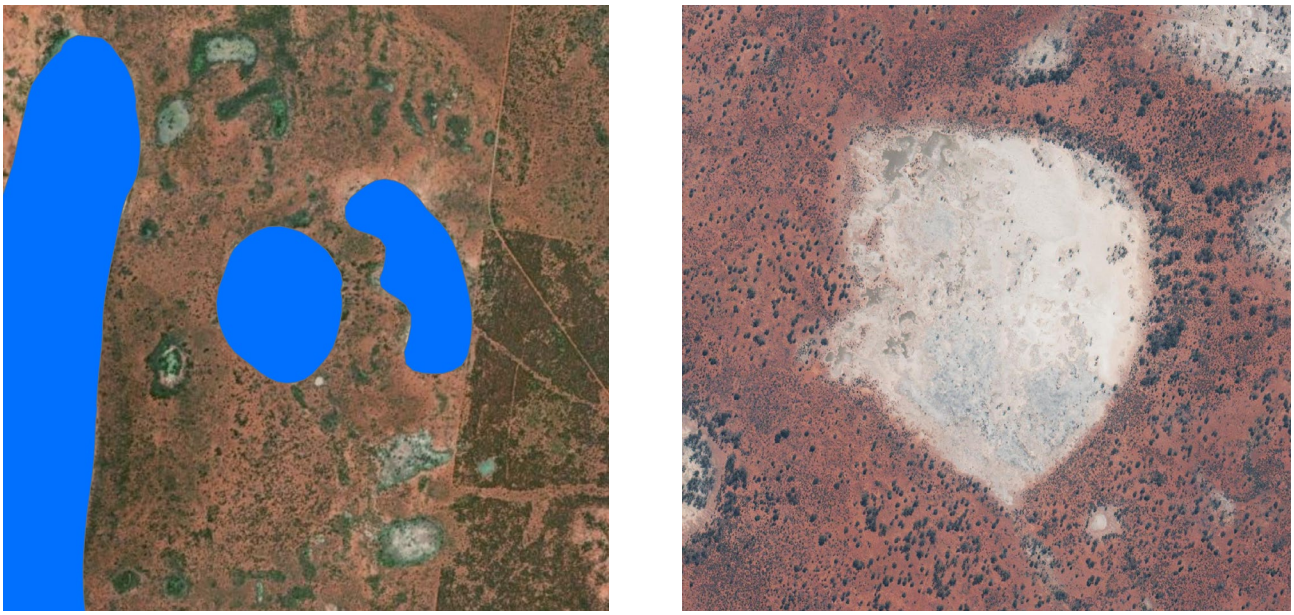
3.4.1 Field interpretation of Aquatic Conservation Assessment results–ecological versus condition assessment

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 or interpreting high resolution imagery, 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 Examples of wetlands within the QMDBB assessment study areas

Figure 11, Figure 12 and Figure 13 show different wetlands with their AquaScore and corresponding high-resolution imagery. The amount of woody vegetation (trees and shrubs) is clearly visible surrounding wetlands in Figure 11 and Figure 13, indicating some habitat remains for aquatic naturalness, species richness and connectivity. Anthropogenic processes are clearly visible in Figure 12 and Figure 13 where dam walls have been constructed for retaining overland flow which restricts connectivity between wetlands and reduces aquatic naturalness.



a) AquaScore – Very High

b) High resolution imagery

Figure 11. Lignum wetland in the Wallam study area.

a) The AquaScore conservation value is Very High. b) A high resolution image of the wetland.

The lignum shrub wetland in Figure 11 is located on the claypans of the Wallam study area. It has been identified as a Very High rating special feature by the expert panel for the Wyandra-Cunnamulla Claypans aggregation

(wm_nr_ec_12) and Poplar Box swamps (wm_nr_fl_10). Natural vegetation appears to be intact with very little evidence of anthropogenic processes. This is confirmed by the Very High to High rating scores for all Criteria.

Criterion	Score	Criterion	Score
C1 Naturalness aquatic	Very High	C5 Priority species and ecosystems	Very High
C2 Naturalness catchment	Very High	C6 Special features	Very High
C3 Diversity and richness	Very High	C7 Connectivity	Very High
C4 Threatened species and ecosystems	High	C8 Representativeness	High

a) AquaScore – Very High | b) High resolution imagery

Figure 12. A semi-modified wetland in the Condamine-Balonne study area, which sits between Barakula State Forest and Nudley State Forest.

a) The AquaScore conservation value for the wetland is Very High. b) A high resolution image of the wetland.

The semi-modified wetland in Figure 12 is located between the Barakula State Forest and Nudley State Forest in the Condamine-Balonne study area. It has been identified as a Very High rating special feature by the expert panel for a non-riverine wetland of Charley's Creek catchment (cb_nr_ec_06). The wetland scores Low for naturalness (C1 and C2), but Very High for threatened and priority species and ecosystems (C4, C5 and C6). Anthropogenic processes are clearly visible for agriculture and a wall to retain overland flow. Little natural vegetation remains within the area.

Criterion	Score	Criterion	Score
C1 Naturalness aquatic	Low	C5 Priority species and ecosystems	Very High
C2 Naturalness catchment	Low	C6 Special features	Very High
C3 Diversity and richness	Medium	C7 Connectivity	No Data
C4 Threatened species and ecosystems	Very High	C8 Representativeness	Very High

a) AquaScore – Low, Medium and High

b) High resolution imagery

Figure 13. Natural, modified and artificial wetlands in the Border Rivers study area.

a) The AquaScore conservation value for the wetlands are High, Medium and Low respectively. b) A high-resolution image of the wetlands.

The natural, modified and artificial wetlands in Figure 13 are located in the agricultural region of the Border Rivers study area. The modified wetland has been identified as a Medium rating special feature for the Non-riverine wetlands of the Macintyre – Weir Fan subregion (slightly modified hydrology) (bd_nr_ec_27). The natural wetland has been identified as a High-rating special feature for the Non-riverine wetlands of the Macintyre – Weir Fan subregion (natural hydrology) (bd_nr_ec_25). Both the natural and modified wetlands score Very High or High in species richness and diversity (C3, C4 and C5), but Low in aquatic naturalness (C1). The artificial wetland scores Low or No Data in all Criteria, except for diversity and richness (C3). Some vegetation cover is maintained for the natural and modified wetlands, while the artificial wetland has been cleared of remnant vegetation and visible dam walls have been constructed.

Criterion	Score	Criterion	Score
C1 Naturalness aquatic	natural wetland: Low modified wetland: Low artificial wetland: Low	C5 Priority species and ecosystems	natural wetland: Very High modified wetland: Very High artificial wetland: No Data
C2 Naturalness catchment	natural wetland: High modified wetland: Low artificial wetland: Low	C6 Special features	natural wetland: High modified wetland: Medium artificial wetland: No Data
C3 Diversity and richness	natural wetland: Very High modified wetland: Very High artificial wetland: Very High	C7 Connectivity	natural wetland: No Data modified wetland: No Data artificial wetland: No Data
C4 Threatened species and ecosystems	natural wetland: High modified wetland: Very High artificial wetland: Low	C8 Representativeness	natural wetland: Medium modified wetland: Low artificial wetland: No Data

4 Discussion

4.1 Summary

The Aquatic Biodiversity Assessment and Mapping Methodology or AquaBAMM is a robust and comprehensive method for assessing the biodiversity values of Queensland's wetlands. The method assigns an overall biodiversity value (AquaScore) to each wetland or spatial unit based on a comprehensive set of criteria.

For this current assessment a series of ACAs were completed for the riverine and non-riverine wetlands of the Queensland Murray-Darling and Bulloo Basins. For the non-riverine assessments, there was an overall visible difference between the eastern study areas of the Condamine-Balonne, Moonie Basin and Border Rivers compared to the western study areas. This notable difference is largely due to the intensive agriculture (Indicator 2.3) that occurs in the east, the lack of remnant riparian vegetation (Indicators 1.3 and 2.2) and the number of artificial wetlands (Indicator 1.4) constructed to retain overland flow for irrigation or livestock water.

There are instances where some non-riverine wetlands that received significant values for Criterion 6 (Special features) but are in poor condition, receive a Very High or High AquaScore. AquaBAMM is a values assessment rather than a condition assessment, thus caution is needed so as not to devalue a wetland that has significant threatened species habitat and/or is a unique or unprotected wetland type. No changes were made to the filtering combination table to account for this, but it is important to note when interpreting ACA results on the ground.

For the riverine assessments the results are more evenly distributed across the study areas. This can be attributed to a few criteria including high levels of aquatic naturalness (Criterion 1) and connectivity (Criterion 7), or high numbers of threatened species or ecosystems (Criterion 4) or have been identified as areas with special features (Criterion 6).

Overall, the availability of species records data was reasonably limited in providing an even spread of records for all spatial units. Many records are concentrated in the eastern study areas and along major roads which is known as collection bias (Smith 2013). Over 50% of spatial units recorded no value for Indicator 3.1 (richness of native flora and fauna species) and close to 90% for Measure 3.1.7 (richness of native aquatic mammals) and Indicator 4.1 (threatened aquatic dependant flora and fauna species). This limitation is reflected in the dependability scores for Criteria 3 and 4 (Table 4 and Table 6) where the score is low with a wide variability. This highlights that species records can under-represent species distribution and the habitats they occupy (Laidlaw and Butler 2021, Fourcade et al. 2014), especially for threatened species listed under the NCA. Though the AquaBAMM process attempts to moderate the results, the outcomes are only as comprehensive as the range of available data and the experts who contribute their knowledge. To provide a better representation of species and their niche requirements, it is ideal to incorporate predictive habitat suitability models where available (Fourcade et al. 2014) and appropriate for use in an ACA.

Species records data for macroinvertebrates was particularly sparse for the region meaning the Criterion 3 richness of macroinvertebrates measure could not be used. Some ACAs have used maximum richness scores derived from higher-level macroinvertebrates studies undertaken using recognised survey and analysis methods (e.g. such as those used by Conrick & Cockayne 2000, Chessman 2002, and Healthy Waterways 2014). These methods estimate macroinvertebrate diversity at the broad taxonomic group level (e.g. sub-family, family, order or class) and can provide suitable representations of macroinvertebrate richness. The availability of this type of data for the QMDBB study areas would help improve the Criterion 3 results.

Data from the State of the Rivers program, which featured heavily in early ACAs, was unavailable for the current QMDBB assessment. Data collection for this program ceased in the early 2000's and is incomplete for the state. To deal with issues of data availability, the AquaBAMM project team are developing a new implementation for Criteria 1 and 2. This new implementation aims to use more current datasets and importantly, datasets that cover the entire state. The aim is to incorporate this new implementation into future ACAs.

Mapping scales also reduce available data. Non-riverine wetlands below the scale (i.e. 1:100,000) or minimum polygon threshold size (i.e. 1 Ha) of the Queensland Wetlands Mapping were not assessed as part of the QMDBB assessment. For example, ACAs derive the non-riverine spatial units from Queensland Wetland Mapping wetland area features which are sourced from classified Landsat 5 TM (Thematic Mapper) or 7 ETM+ (Enhanced Thematic Mapper Plus) satellite imagery, digital topographic data (GEODATA TOPO 250K Series), and Queensland Herbarium regional ecosystem mapping. Wetlands below the mapping scale of these products are not present in the Queensland Wetland Mapping data. Furthermore, ACAs only include non-riverine wetland area features from the Queensland Wetland where palustrine or lacustrine wetlands are dominant, or the sum of subdominant palustrine or lacustrine wetland regional ecosystem area is >50%. Therefore, non-riverine wetlands with an area below the mapping scale of the Queensland Wetland Mapping or which occupy less than <=50% of a heterogenous wetland regional ecosystem polygon were not assessed as part of the QMDBB assessments. Finer scale mapping of non-riverine wetlands would allow more precise delineation of wetland conservation values

particularly special features and connectivity values.

Riverine waterbodies, such as instream rock holes, are also often well below the minimum mapping scale of the Queensland Wetland Mapping. Furthermore, the linear nature of many riverine wetlands means they are commonly included as subdominant wetland regional ecosystems within much larger regional ecosystem polygons. Both of these factors result in riverine wetland areas generally not being as well represented in the Queensland Wetland Mapping as their non-riverine counterparts.

To address this, riverine ACAs use fine-scale riverine catchments for spatial units. These fine-scale catchments (subsections) are used to represent specific stream reaches, or groups of reaches, and are synonymous with State of the Rivers subsections or fine-scale sub-catchments of the Australian Hydrological Geospatial Fabric (Geofabric). The implications of this from an ACA perspective are two-fold. Firstly, riverine conservation values calculated as part of an ACA generally only apply to the watercourses within each riverine spatial unit. Secondly, riverine special features may only apply to specific reaches, sections of reaches, or discrete locations (e.g. waterholes) within a riverine spatial unit. Where possible, descriptions of the precise location and extent of riverine special features have been included with the riverine special feature values descriptions and this information can be used to aid interpretation. Finer scale riverine wetland area mapping similar to the non-riverine wetlands would allow more precise delineation of riverine conservation values particular special features and connectivity values.

4.2 Constraints and Caveats

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

- A general lack of survey data for the region.
- Survey bias in species point records.
- Small non-riverine wetlands below the scale of the wetlands mapping have not been assessed.
- The accuracy and confidence of the assessment results are dependent on the availability, accuracy and scale of all input data.
- The end user should use the terrestrial (BPA) and aquatic (ACA) assessments in conjunction to obtain comprehensive information and analysis of biodiversity values.
- The size of the riverine spatial units can influence species counts.
- Riverine conservation values generally only relate to the watercourse section within each riverine spatial unit.
- Certain conservation values, such as special features and connectivity may only apply to specific locations (e.g. instream waterholes) or reaches within each riverine spatial unit.
- Cultural values were recorded in the special feature descriptions where noted by the expert panel. The experts highlighted that engagement with Traditional Owners should be undertaken where possible to assist with identifying ecological values. Unfortunately, time constraints meant that detailed engagement with Traditional Owners during the expert panel process was limited.

Another constraint is that AquaScores can be driven by high scoring measures within criteria containing few measures. This was identified as part of an independent sensitivity analysis (Robinson & Lee 2009) and is a known limitation of the AquaBAMM.

- Data availability is never equal for all wetlands in a study area. In the same way, expert knowledge is not usually available for every wetland in a study area. Dataset completeness is influenced spatially by research effort, enthusiast search effort, political focus, etc. AquaBAMM is designed to cope with data deficiencies. However, wetlands with complete datasets are more likely to show an accurate final conservation value and they are more likely to have a species record of significance or other special feature (most likely due to increased investigative effort or functional understanding) that results in a very high or high conservation value score.
- The dependability score is a percentage of how many available measures have data. The dependability does not influence or change the final AquaScore. The ACA results should be interpreted in conjunction with the dependability score. For example, where subsections with very low AquaScore values have low dependability, the results should be used cautiously as the AquaScore may be due to the inherent lack of values or the lack of data. In the case of missing data, further survey work may add more data which may, or may not, change the AquaScore.
- Whenever lines are drawn on a map from the expert panels or Directory of Important Wetlands for example, there is a risk that the boundary may not be correct at the scale of the individual subsection. For these types of decisions the boundary should always be considered at the appropriate scale. The wetlands mapping is the fundamental spatial input into this ACA and the positional accuracy of the wetlands mapping is 1:100 000, except for areas along the east cost which are mapped at the 1:50 000 scale.

4.3 Recommendations

Aquatic Conservation Assessment results have a wide range of applications. Well-founded ecological or conservation values for aquatic ecosystems are an important input to natural resource management and regulatory decision-making processes including, for example, regional planning, development assessment, and tenure negotiations such as those related to protected area estates. In addition to the overall AquaScore, individual Criteria, Indicators and Measures from each assessment may be used for management and planning purposes.

At its most basic level this product is an inventory of the ecological values associated with individual wetlands. It is not undertaken with any special considerations of policy, legislation or cultural values. 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 inputs to this type of assessment is ongoing. Input data, especially for remote areas such as the western catchments of QMDBB basin, is often sparse, dated 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 use of species predictive habitat suitability models for Criterion 4 threatened species and Criterion 5 priority species measures.
- Integration of a new method for calculating aquatic and catchment naturalness (i.e. Criteria 1 and 2) as the current implementation is limited by data availability.
- Finer scale mapping of both riverine and non-riverine wetlands would allow more precise delineation of wetland conservation values particularly special features and connectivity values.
- Future wetlands mapping may consider whether springs have a surface expression and if these should be included in the ACAs depending on their scale.

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Appendix I - Riverine Implementation Table

Measure	Description	Riverine Implementation	Primary data sets used	Threshold type
1.1.1	Presence of ‘alien' fish species within the wetland	An expert panel list of exotic fish species dependent on freshwater streams for all or part of their lifecycle, was used to calculate this measure. Species records (year ≥1950, precision ≤2000m) were used to count the different exotic riverine species found within a riverine spatial unit. A score of ’No Data’ 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 exotic aquatic plant species was used to calculate this measure. Species records (year ≥1950, precision ≤2000m) were used to count the different exotic riverine species found within a riverine spatial unit. A score of ’No Data’ was allocated to any riverine spatial unit that had an absence of exotic species data.	Flora species records from DES databases WildNet, Herbrecs, Corveg and Expert Panel.	Presence Negative (-2)
1.1.3	Presence of exotic invertebrate fauna within the wetland	An expert panel list of exotic invertebrate fauna species was used to calculate this measure. Species records (year ≥1950, precision ≤2000m) were used to count the different exotic riverine species found within a riverine spatial unit. A score of ’No Data’ was allocated to any riverine spatial unit that had an absence of species data.	DES QLD Historical Fauna Database (QHFD), WildNet, and Expert Panel.	Presence Negative (-2)
1.1.4	Presence of feral/exotic vertebrate fauna (other than fish) within the wetland	An expert panel list of exotic vertebrate fauna species was used to calculate this measure. Species records (year ≥1950, precision ≤2000m) were used to count the different exotic riverine species found within a riverine spatial unit. A score of ’No Data’ was allocated to any riverine spatial unit that had an absence of species data.	DES QLD Historical Fauna Database (QHFD), WildNet, and Expert Panel.	Presence Negative (-2)

Measure	Description	Riverine Implementation	Primary data sets used	Threshold type
1.3.4	Presence/absence of dams/weirs within the wetland	For each riverine spatial unit, calculate the total number of dams/weirs using dam and weir points from the 100K DNRM dams and weirs dataset, and non-riverine spatial units with a Queensland Wetland mapping HYDRMOD attribute of H2M1, H2M1a, H2M1b, H2M1c.	DNRME Dams and Weirs coverage including private dams do not included in original data. DES QLD Wetland Mapping data v5.	Presence Negative (-2)
1.3.5	Inundation by dams/weirs (% of waterway length within the wetland)	The reservoir layer was intersected against the watercourses. The proportional length covered by a reservoir was then calculated for each riverine spatial unit.	DNRME Dams and Weirs coverage; DNRME watercourses; DES QLD Wetland Mapping data v5.	Continuous Descending 1: >=10; 2: >=1; 3: >=0.1; 4: <0.1
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) (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 v5. Where the overlayed area is remnant and or not a highly modified or artificial wetland, 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. Assessable wetlands with no underlying preclear extent were given a value of NO DATA.	DES Queensland wetland mapping data v5; remnant and preclear regional ecosystem mapping v11, REDD v11.	Continuous Ascending 1: <=25; 2: <=50; 3: <=75; 4: >75
2.1.1	Presence of exotic terrestrial plants in the assessment unit	An expert panel list of exotic terrestrial plant species was used to calculate this measure. Species records (year ≥1950, precision ≤2000m) were used to count the different exotic riverine species found within a riverine spatial unit. A score of 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.	Presence Negative (-2)

Measure	Description	Riverine Implementation	Primary data sets used	Threshold type
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 v11. River buffers based on DNRME watercourses	Continuous Ascending 1: <=25; 2: <=50; 3: <=75; 4: >75
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 v11. River buffers based on DNRME watercourses.	Continuous Ascending 1: <=25; 2: <=50; 3: <=75; 4: >75
2.2.9	% tree cover within the waterway corridor	Overlayed the woody vegetation layer with the riparian mask where a percentage of woody vegetation was calculated for each spatial unit.	River buffers based on DNRME watercourses; DES 2019 woody vegetation extent coverage.	Continuous Ascending 1: <=25; 2: <=50; 3: <=75; 4: >75
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. 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 2018).	Continuous Descending User defined for each study area using natural breaks.

Measure	Description	Riverine Implementation	Primary data sets used	Threshold type
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 riverine spatial unit.	DES QLUMP (version March 2018).	Continuous Descending 1: >=75; 2: >=50; 3: >=25; 4: <25
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 riverine spatial unit.	DES QLUMP (version March 2018).	Continuous Ascending 1: <=25; 2: <=50; 3: <=75; 4: >75
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 2018).	Continuous Descending 1: >=75; 2: >=50; 3: >=25; 4: <25
2.3.9	Number of intensive animal production sites within a buffered distance of the wetland.	Counted the presence of a site location within the spatial unit.	DAF 2021 Feedlots, piggeries and poultry farms that are listed in the DAF Animal Industries database and have current environmental authority under the EPA94.	Presence Negative (-2)

Measure	Description	Riverine Implementation	Primary data sets used	Threshold type
2.3.11	Presence of aquaculture within a buffered distance of the wetland.	Counted the presence of a site location within the spatial unit.	DAF 2018 data collected from the authorisation of aquaculture development permits issued under the IPA 1997 and SPA 2009.	Presence Negative (-2)
2.4.1	Farm storage (overland flow harvesting, floodplain ring tanks, gully dams) calculated by surface area	Selects all non-riverine spatial units with a HYDROMOD of H2M6, H2M6a, H2M6b, H2M6c, H2M6e, H2M7, H3C1, H3C1a, H3C1b, H3C1c, H3C1d, H3C2 from the Queensland Wetland mapping. Then appends the NRM RESERVOIRS (Rural Water Storage Category only).	DES Queensland Wetland Mapping data v5; NRM Reservoirs	Continuous Descending 1: >=10; 2: >=1; 3: >=0.1; 4: <0.1
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. Records were used to derive a count of different species for each riverine spatial unit, with No Data allocated where the riverine spatial unit had an absence of species information. Upland and lowland stratification was applied.	DES QLD Historical Fauna Database (QHFD), WildNet, and Expert Panel.	Continuous Ascending User defined for each study area using natural breaks.
3.1.2	Richness of native fish	An expert panel list of native fish dependent on riverine wetlands for all or part of their lifecycles was used to calculate this measure. Records ≥1975, precision ≤ 2000m were included. Records were used to derive a count of different species for each riverine spatial unit, with 'No Data' allocated where the riverine spatial unit had an absence of species information. Upland and lowland stratification was applied.	DES QLD Historical Fauna Database (QHFD), WildNet, and Expert Panel.	User Defined Ascending User defined for each study area using natural breaks.

Measure	Description	Riverine Implementation	Primary data sets used	Threshold type
3.1.3	Richness of native aquatic dependent reptiles	An expert panel list of native reptiles dependent on riverine wetlands for all or part of their lifecycles was used to calculate this measure. Records ≥1975, precision ≤ 2000m were included. Records were used to derive a count of different species for each riverine spatial unit, with 'No Data' allocated where the riverine spatial unit had an absence of species information.	DES QLD Historical Fauna Database (QHFD), WildNet, and Expert Panel.	Continuous Ascending User defined for each study area using natural breaks.
3.1.4	Richness of native waterbirds	An expert panel list of native (freshwater) waterbirds fish dependent on riverine wetlands for all or part of their lifecycles was used to calculate this measure. Records ≥1975, precision ≤ 2000m were included. Records were used to derive a count of different species for each riverine spatial unit, with 'No Data' allocated where the riverine spatial unit had an absence of species information.	DES QLD Historical Fauna Database (QHFD), WildNet, and Expert Panel.	Continuous Ascending User defined for each study area using natural breaks.
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. Records were used to derive a count of different species for each riverine spatial unit, with No Data allocated where the associated spatial unit had an absence of species information.	Flora species records from DES databases WildNet, Herbrecs, Corveg and Expert Panel.	Continuous Ascending User defined for each study area using natural breaks.
3.1.7	Richness of native aquatic dependent mammals	An expert panel list of native mammal dependent on freshwater streams for all or part of their lifecycles was used to calculate this measure. Records ≥1975, precision ≤ 2000m were included. Records were used to derive a count of different species for each riverine spatial unit, with No Data allocated where the associated spatial unit had an absence of species information.	DES QLD Historical Fauna Database (QHFD), WildNet, and Expert Panel.	Presence Positive (4)

Measure	Description	Riverine 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 v11. River buffers based on DNRME watercourses	Continuous Ascending User defined for each study area using natural breaks.
3.3.2	Richness of wetland types within the local catchment (ACA subsection)	The number 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 subsection. The calculation was completed only for Natural and Semi-modified wetlands. Highly Modified and Artificial wetlands are not valid for this measure. Non-riverine spatial units with the word "None" in the TYPE_RE are data deficient and are also not valid for this measure. Also, non-riverine spatial units less than 1ha are not valid for this measure.	DES Queensland Wetland Mapping data v5, ACA subsections.	Continuous Ascending User defined for each study area using natural breaks.
3.3.3	Richness of wetland types within the sub-catchment (ACA sub-catchment)	The number 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. This number was then applied to each riverine spatial unit based on its sub-catchment membership. The calculation was completed only for Natural and Semi-modified wetlands. Highly Modified and Artificial wetlands are not valid for this measure. Non-riverine spatial units with the word "None" in the TYPE_RE are data deficient and are also not valid for this measure. Also, non-riverine spatial units less than 1ha are not valid for this measure.	DES Queensland Wetland Mapping data v5, ACA sub-catchments. River buffers based on DNRME watercourses.	Continuous Ascending User defined for each study area using natural breaks.

Measure	Description	Riverine Implementation	Primary data sets used	Threshold type
4.1.1	Presence of rare or threatened aquatic ecosystem dependent fauna species — NCA Act, 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 spatial units to determine species richness in each. Spatial units with an absence of records were given a value of 'No Data'.	DES QLD Historical Fauna Database (QHFD), WildNet, and Expert Panel.	User Defined for each study area using either natural breaks (with no spatial units being given a score of 1) or Presence Positive (4).
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 spatial units to determine species richness in each. Spatial units without records were given a value of 'No Data'.	Flora species records from DES databases WildNet, Herbrecs, Corveg and Expert Panel.	User Defined for each study area using either natural breaks (with no spatial units being given a score of 1) or Presence Positive (4).

Measure	Description	Riverine 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 were used where no wetland mapping was present. The following ratings were applied based on the Queensland Herbarium 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.	DES Queensland Wetland Mapping data v5, REDD version 11. 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 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 'No Data'.	DES QLD Historical Fauna Database (QHFD), WildNet, and Expert Panel.	User Defined for each study area using either natural breaks (with no spatial units being given a score of 1) or Presence Positive (4).

Measure	Description	Riverine Implementation	Primary data sets used	Threshold type
5.1.2	Presence of aquatic ecosystem dependent 'priority' flora species	An expert panel derived list of priority 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 'No Data'.	Flora species records from DES databases WildNet, Herbrecs, Corveg and Expert Panel.	User Defined for each study area using either natural breaks (with no spatial units being given a score of 1) or Presence Positive (4).
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 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 'No Data'.	DES QLD Historical Fauna Database (QHFD), WildNet, and Expert Panel.	User Defined for each study area using either natural breaks (with no spatial units being given a score of 1) or Presence Positive (4).
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 3 or 4. Spatial units not identified by experts 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 3 or 4. Spatial units not identified by experts 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 of 2, 3 or 4. Spatial units not identified by experts for this measure were given a known absence value of -999.	Expert Panel	Categorical

Measure	Description	Riverine Implementation	Primary data sets used	Threshold type
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 3 or 4. Spatial units not identified by experts 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 riverine spatial units that contained notable values associated with this measure. The resulting value was then given a conservation rating out of 3 or 4. Spatial units not identified by experts 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 (DIWA). These were then overlayed with the riverine spatial units. Spatial units were manually selected based on an interpretation of the DIWA criteria. The resulting value was then given a conservation rating out of 3 or 4. Spatial units not identified by experts for this measure were given a known absence value of -999.	RAMSAR areas. World Heritage Areas. Directory of Important Wetlands (DIWA).	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 3 or 4. Spatial units not identified by experts for this measure were given a known absence value of -999.	Documented reports external to the ACA process.	Categorical

Measure	Description	Riverine 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 3 or 4. Spatial units not identified by experts 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 3 or 4. Spatial units not identified by experts for this measure were given a known absence value of -999.	Expert Panel	Categorical
7.1.1	The contribution (upstream or downstream) of the spatial unit to the maintenance of significant species or populations, including those features identified through Criteria 5 and/ or 6.	Expert panels identified riverine spatial units that had a conservation rating of 4 for measures 5.1.4, 6.3.1 and 6.3.2. These spatial units were given a conservation rating of 4 for this measure. Spatial units not identified by experts 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.	Hydro risk scores relate to the reduction in longitudinal connectivity days in the presence of an in-stream barrier. Scores are displayed as low (<50% loss of connectivity flows), moderate (>50% loss of connectivity flows), high (>70% loss of connectivity flows), extreme (100% loss of connectivity flows). These scores were converted to conservation ratings as: Low = 4; Moderate = 3; High = 2; Extreme = 1 Where there was more than one risk value for a spatial unit, the % coverage was calculated, and the maximum value was used. Spatial units where no value was calculated, a value of -999 was given.	DES Water Planning/Ecology Hydro Risk (major streams only) data.	Categorical

Measure	Description	Riverine Implementation	Primary data sets used	Threshold type
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 3 or 4. Spatial units not identified by experts for this measure were given a known absence value of -999.	Expert Panel	Categorical
7.3.1	The contribution of the spatial unit to the maintenance of floodplain and wetland ecosystems with significant biodiversity values, including those features identified through Criteria 5 and/or 6,	Expert panels identified riverine spatial units that had a conservation rating of 4 for measures 5.2.1, 6.2.1 and 6.3.3. These spatial units were then given a conservation rating of 4 for this measure. Spatial units not identified by experts for this measure were given a known absence value of -999.	Expert Panel	Categorical
7.3.2	Extent to which the wetland retains critical ecological and hydrological connectivity, where it should exist, with floodplains, rivers, groundwater, etc.	Expert panels identified riverine spatial units that had a conservation rating of 4 for measure 6.4.1. The spatial units were then given a conservation rating 3 or 4 for this measure. Spatial units not identified by experts for this measure were given a known absence value of -999.	Expert Panel	Categorical
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 3 or 4. Spatial units not identified by experts for this measure were given a known absence value of -999.	Expert Panel	Categorical

Appendix II - Non-riverine Implementation Table

Measure	Description	Non-riverine Implementation	Primary datasets used	Threshold type
1.1.1	Presence of 'alien' fish species within the wetland	An expert panel list of exotic fish species dependent on freshwater streams for all or part of their lifecycle, was used to calculate this measure. Species records (year ≥1950, precision ≤2000m) were used to count the different exotic species found within a subsection. This was then attributed to all the non-riverine spatial units nested within it. A score of 'No Data' 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 exotic aquatic plant species was used to calculate this measure. Species records (year ≥1950, precision ≤2000m) were used to count the different exotic species found within a subsection. This was then attributed to all the non-riverine spatial units nested within it. A score of 'No Data' 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.	Presence Negative (-2)
1.1.3	Presence of exotic invertebrate fauna within the wetland	An expert panel list of exotic invertebrate fauna species was used to calculate this measure. Species records (year ≥1950, precision ≤2000m) were used to count the different exotic species found within a subsection. This was then attributed to all the non-riverine spatial units nested within it. A score of 'No Data' 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)
1.1.4	Presence of feral/exotic vertebrate fauna (other than fish) within the wetland	An expert panel list of exotic vertebrate fauna species was used to calculate this measure. Species records (year ≥1950, precision ≤2000m) were used to count the different exotic species found within a subsection. This was then attributed to all the non-riverine spatial units nested within it. A score of 'No Data' 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)

Measure	Description	Non-riverine 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 units. Overlay the study areas and dissolve. This defines the preclear wetland boundary extent. Overlay the remnant regional ecosystems and the QLD wetland mapping v5. Where the overlayed area is remnant and or not a highly modified or artificial wetland, add the area as connected, else if the preclear extent is a natural wetland, add the area as connected, else if the preclear extent is semi-modified and covered in remnant, add the area as connected. Assessable wetlands with no underlying preclear extent were given a value of 'No Data'.	DES Queensland Wetland Mapping data v5, remnant and preclear regional ecosystem mapping v11, REDD v11	Continuous Ascending 1: <=25; 2: <=50; 3: <=75; 4: >75
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 level of Queensland Wetland Mapping hydromodification: 4 = (natural) H1; 3 = (semi-modified) H2M1b, H2M1d, H2M2, H2M2a, H2M2b, H2M2c, H2M2d, H2M2e, H2M2f, H2M2g, H2M3, H2M8; 2 = (highly-modified) H2M1, H2M1a, H2M1c, H2M5, H2M6, H2M6a, H2M6b, H2M6c, H2M6e, H2M7; 1 = (artificial) H3C1, H3C1a, H3C1b, H3C1c, H3C1d, H3C2, H3C3.	DES Queensland Wetland Mapping data v5	Categorical
2.1.1	Presence of exotic terrestrial plants in the assessment unit	An expert panel list of exotic terrestrial plant species was used to calculate this measure. Species records (year ≥1950, precision ≤2000m) were used to count the different exotic species found within a subsection. This was then attributed to all the non-riverine spatial units nested within it. A score of 'No Data' 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.	Presence Negative (-2)

Measure	Description	Non-riverine Implementation	Primary datasets used	Threshold type
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 for wetlands >= 8ha and 200m 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 the area calculated. De-concatenating the RE and PERCENT, the area of each value with a valid RE vegetation code was calculated to gain 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 v11, Queensland Wetland Mapping data v5	Continuous Ascending 1: <=25; 2: <=50; 3: <=75; 4: >75
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 2018)	Continuous Descending User defined for each study area using natural breaks.
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 2018)	Continuous Descending 1: >=75; 2: >=50; 3: >=25; 4: <25
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 2018)	Continuous Ascending 1: <=25; 2: <=50; 3: <=75; 4: >75

Measure	Description	Non-riverine Implementation	Primary datasets used	Threshold type
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 2018)	Continuous Descending 1: >=10; 2: >=1; 3: >=0.1; 4: <0.1
2.3.9	Number of intensive animal production sites within a buffered distance of the wetland.	Counted the presence of a site location within 500m buffered distance of the spatial unit.	DAF 2021 Feedlots, piggeries and poultry farms that are listed in the DAF Animal Industries database and have current environmental authority under the EPA94.	Presence Negative (-2)
2.3.11	Presence of aquaculture within a buffered distance of the wetland.	Counted the presence of a site location within 500m buffered distance of the spatial unit.	DAF 2018 data collected from the authorisation of aquaculture development permits issued under the IPA 1997 and SPA 2009.	Presence Negative (-2)
2.4.1	Farm storage (overland flow harvesting, floodplain ring tanks, gully dams) calculated by surface area	Selects all non-riverine spatial units with a HYDROMOD of H2M6, H2M6a, H2M6b, H2M6c, H2M6e, H2M7, H3C1, H3C1a, H3C1b, H3C1c, H3C1d, H3C2 from the Queensland Wetland mapping. Then appends the NRM RESERVOIRS (Rural Water Storage Category only).	DES Queensland Wetland Mapping data v5; NRM Reservoirs	Continuous Descending 1: >=10; 2: >=1; 3: >=0.1; 4: <0.1
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. Species records (≥1975, precision ≤ 2000m) were included. Records were used to derive a count of different species for each subsection. This value was then attributed to nested non-riverine spatial units. Upland and lowland stratification was applied. Non-riverine spatial units without records were given a value of ’No Data’.	DES QLD Historical Fauna Database (QHFD), WildNet, and Expert Panel.	User Defined Ascending User defined for each study area using natural breaks.

Measure	Description	Non-riverine Implementation	Primary datasets used	Threshold type
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. Species records (≥1975, precision ≤ 2000m) were included. Records were used to derive a count of different species for each subsection. This value was then attributed to nested non-riverine spatial units. Non-riverine spatial units without records were given a value of 'No Data'.	DES QLD Historical Fauna Database (QHFD), WildNet, and Expert Panel.	Continuous Ascending User defined for each study area using natural breaks.
3.1.4	Richness of native waterbirds	An expert panel list of native (freshwater) waterbirds dependent on non-riverine wetlands for all or part of their lifecycles was used to calculate this measure. Species records (≥1975, precision ≤ 2000m) were included. Records were used to derive a count of different species for each subsection. This value was then attributed to nested non-riverine spatial units. Non-riverine spatial units without records were given a value of 'No Data'.	DES QLD Historical Fauna Database (QHFD), WildNet, and Expert Panel.	Continuous Ascending User defined for each study area using natural breaks.
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. Records were used to derive a count of different species for each subsection. This value was then attributed to nested non-riverine spatial units, with 'No Data' allocated where the associated spatial unit had an absence of species information.	Flora species records from DES databases WildNet, Herbrecs, Corveg and Expert Panel	Continuous Ascending User defined for each study area using natural breaks.
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 different species for each subsection. This value was then attributed to nested non-riverine spatial units, with 'No Data' allocated where the associated spatial unit had an absence of species information.	DES QLD Historical Fauna Database (QHFD), WildNet, and Expert Panel	Continuous Ascending User defined for each study area using natural breaks.

Measure	Description	Non-riverine Implementation	Primary datasets used	Threshold type
3.1.7	Richness of native aquatic dependent mammals	An expert panel list of native mammals dependent on non-riverine wetlands for all or part of their lifecycles was used to calculate this measure. Records ≥1975, precision ≤ 2000m were included. Records were used to derive a count of different species for each subsection. This value was then attributed to nested non-riverine spatial units, with 'No Data' allocated where the associated spatial unit had an absence of species information.	DES QLD Historical Fauna Database (QHFD), WildNet, and Expert Panel	Presence Positive (4)
3.3.2	Richness of wetland types within the local catchment	The number 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 number was then applied to each non-riverine spatial unit based on its subsection membership. The calculation was completed only for Natural and Semi-modified wetlands. Highly Modified and Artificial wetlands are not valid for this measure. Spatial units less than 1ha are not valid for this measure. All non-valid spatial units were given a score of -999 (i.e. true-absence) for this measure. In addition, non-riverine spatial units with the word "None" in the TYPE_RE are data deficient and get a score of 'No Data'.	DES Queensland Wetland Mapping data v5, ACA subsections	Continuous Ascending User defined for each study area using natural breaks.

Measure	Description	Non-riverine Implementation	Primary datasets used	Threshold type
3.3.3	Richness of wetland types within the sub-catchment	The number 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. This number was then applied to each non-riverine spatial unit based on its sub-catchment membership. The calculation was completed only for Natural and Semi-modified wetlands. Highly Modified and Artificial wetlands are not valid for this measure. Spatial units less than 1ha are not valid for this measure. All non-valid spatial units were given a score of -999 (i.e. true-absence) for this measure. In addition, non-riverine spatial units with the word "None" in the TYPE_RE are data deficient and get a score of 'No Data'.	DES Queensland Wetland Mapping data v5, SGC ACA subsections	Continuous Ascending User defined for each study area using natural breaks.
4.1.1	Presence of rare or threatened aquatic ecosystem dependent fauna species — NCA Act, 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. The calculation was completed only for Natural, Semi-modified and Highly Modified wetlands. Artificial wetlands are not valid for this measure. Non-riverine spatial units without records were given a value of 'No Data'.	DES QLD Historical Fauna Database (QHFD), WildNet, and Expert Panel.	User Defined for each study area using either natural breaks (with no spatial units being given a score of 1) or Presence Positive (4).
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. The calculation was completed only for Natural, Semi-modified and Highly Modified wetlands. Artificial wetlands are not valid for this measure. Non-riverine spatial units without records were given a value of 'No Data'.	Flora species records from DES databases WildNet, Herbrecs, Corveg and Expert Panel.	User Defined for each study area using either natural breaks (with no spatial units being given a score of 1) or Presence Positive (4).

Measure	Description	Non-riverine 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 Queensland Herbarium 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.	DES Queensland Wetland Mapping data v5, REDD version 11. 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. The calculation was completed only for Natural, Semi-modified and Highly Modified wetlands. Artificial wetlands are not valid for this measure. Non-riverine spatial units without records were given a value of 'No Data'.	DES QLD Historical Fauna Database (QHFD), WildNet, and Expert Panel.	User Defined for each study area using natural breaks (with no spatial units being given a score of 1).
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. The calculation was completed only for Natural, Semi-modified and Highly Modified wetlands. Artificial wetlands are not valid for this measure. Non-riverine spatial units without records were given a value of 'No Data'.	Flora species records from DES databases WildNet, Herbrecs, Corveg and Expert Panel.	User Defined for each study area using natural breaks (with no spatial units being given a score of 1).

Measure	Description	Non-riverine Implementation	Primary datasets used	Threshold type
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. The calculation was completed only for Natural, Semi-modified and Highly Modified wetlands. Artificial wetlands are not valid for this measure. Non-riverine spatial units without records were given a value of 'No Data'.	DES QLD Historical Fauna Database (QHFD), WildNet, and Expert Panel.	User Defined for each study area using natural breaks (with no spatial units being given a score of 1).
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 of 3 or 4. Spatial units not identified by experts 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 of 3 or 4. Spatial units not identified by experts 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 non-riverine spatial units that contained notable values associated with this measure. The resulting value was then given a conservation rating of 3 or 4. Spatial units not identified by experts 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 of 3 or 4. Spatial units not identified by experts for this measure were given a known absence value of -999.	Expert Panel	Categorical

Measure	Description	Non-riverine Implementation	Primary datasets 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 non-riverine spatial units that contained notable values associated with this measure. The resulting value was then given a conservation rating of 3 or 4. Spatial units not identified by experts 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 (DIWA). These were then overlayed with the non-riverine spatial units. Spatial units were manually selected based on an interpretation of the DIWA criteria. The resulting value was then given a conservation rating out of 3 or 4. Spatial units not identified by experts for this measure were given a known absence value of -999.	RAMSAR areas. World Heritage Areas. Directory of Important wetlands (DIWA).	Categorical
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 of 3 or 4. Spatial units not identified by experts 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 of 3 or 4. Spatial units not identified by experts 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 of 3 or 4. Spatial units not identified by experts for this measure were given a known absence value of -999.	Expert Panel	Categorical

Measure	Description	Non-riverine Implementation	Primary datasets used	Threshold type
7.3.1	The contribution of the spatial unit to the maintenance of floodplain and wetland ecosystems with significant biodiversity values, including those features identified through Criteria 5 and/or 6,	Expert panels identified non-riverine spatial units that contained notable values associated with this measure. The resulting value was then given a conservation rating of 3 or 4. Spatial units that scored a 4 for measures 6.3.2 and 6.3.3 were given a conservation rating of 4. Spatial units not identified by experts for this measure were given a known absence value of -999.	Expert Panel	Categorical
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. The calculation was completed only for Natural and Semi-modified wetlands. Highly Modified and Artificial wetlands are not valid for this measure. All non-valid spatial units were given a score of -999 (i.e. true-absence) for this measure. In addition, non-riverine spatial units with the word "None" in the TYPE_RE are data deficient and get a score of ‘No Data’.	DES Queensland Wetland Mapping data v5, QLD protected area estate.	Continuous Descending User Defined for each study area using natural breaks.
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)	The frequency of each wetland management group was calculated for the study area. Where a wetland had two or more management groups, the management group with the lowest abundance was assigned to that wetland. The calculation was completed only for Natural and Semi-modified wetlands. Highly Modified and Artificial wetlands are not valid for this measure. All non-valid spatial units were given a score of -999 (i.e. true-absence) for this measure.	DES Queensland Wetland Mapping data v5, utilising the Habitat Type (HAB) field.	Continuous Descending User Defined for each study area using natural breaks.

Measure	Description	Non-riverine Implementation	Primary datasets used	Threshold type
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)	The frequency of each wetland management group was calculated for the sub-catchment. Where a wetland had two or more management groups, the management group with the lowest abundance was assigned to that wetland. The calculation was completed only for Natural and Semi-modified wetlands. Highly Modified and Artificial wetlands are not valid for this measure. All non-valid spatial units were given a score of -999 (i.e. true-absence) for this measure.	DES Queensland Wetland Mapping data v5, utilising the Habitat Type (HAB) field.	Continuous Descending User Defined for each study area using natural breaks.
8.2.3	The size of each wetland type relative to others of its wetland management group within the catchment or study area	Each non-riverine spatial unit was ranked (quartiles) by its size relative to other non-riverine spatial units with the same management group within the study area. The calculation was completed only for Natural and Semi-modified wetlands. Highly Modified and Artificial wetlands are not valid for this measure. All non-valid spatial units were given a score of -999 (i.e. true-absence) for this measure.	DES Queensland Wetland Mapping data v5, utilising the Habitat Type (HAB) field.	Categorical
8.2.4	The size of each wetland type relative to others of its wetland management group within a sub-catchment.	Each non-riverine spatial unit was ranked (quartiles) by its size relative to other non-riverine spatial units with the same management group within the study area. The calculation was completed only for Natural and Semi-modified wetlands. Highly Modified and Artificial wetlands are not valid for this measure. All non-valid spatial units were given a score of -999 (i.e. true-absence) for this measure.	DES Queensland Wetland Mapping data v5, utilising the Habitat Type (HAB) field.	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. Spatial units not identified by experts for this measure were given a known absence value of -999.	Expert Panel	Categorical

Measure	Description	Non-riverine 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 and grouped into their respective study area. A quartile threshold was then calculated. The maximum threshold was applied to each non-riverine spatial unit based on the types present. The calculation was completed only for Natural and Semi-modified wetlands. Highly Modified and Artificial wetlands are not valid for this measure. All non-valid spatial units were given a score of -999 (i.e. true-absence) for this measure. In addition, non-riverine spatial units with the word "None" in the TYPE_RE are data deficient and get a score of ‘No Data’.	DES Queensland Wetland Mapping data v5.	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
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

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
13	equal to (Very High or High) and						equal to (Very High)			High
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
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

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
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
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
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

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
37d									and number of Criteria with Very High >= 2	Low
37e									and number of Criteria with High >= 2	Low
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 >= 2	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
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

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
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
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) and	equal to (Very High or High or Medium) and						equal to (Very High or High)		Medium
19				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
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) and			equal to (Medium) and				equal to (Very High or High or Medium)		Medium
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

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
29									and number of Criteria with High >= 3	Medium
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 with Very High >= 1	Low
28									and number of Criteria with Low >= 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	9.9
	1.1.2	Presence of exotic aquatic and semi-aquatic plants within the wetland	10
	1.1.4	Presence of feral/exotic vertebrate fauna (other than fish) within the wetland	9.6
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)	9.7
	1.3.7	% area of remnant wetland relative to preclear extent for each spatial unit	7.7
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	7.9
	2.2.9	% tree cover within the waterway corridor	9
2.3 Catchment disturbance	2.3.1	% "agricultural" land-use area (i.e. cropping and horticulture)	9
	2.3.2	% "grazing" land-use area	10
	2.3.3	% "vegetation" land-use area (i.e. native veg + regrowth)	8.8
	2.3.4	% "settlement" land-use area (i.e. towns, cities, etc.)	7.8
	2.3.9	Number of intensive animal production sites	9
	2.3.11	Number of aquaculture sites	9
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)	9.5
	3.1.2	Richness of native fish	10
	3.1.3	Richness of native aquatic dependent reptiles	8.9
	3.1.4	Richness of native waterbirds	9.3
	3.1.5	Richness of native aquatic plants	9.3
	3.1.7	Richness of native aquatic dependent mammals	8.7

Criteria and indicators	Measure	Measure description	Weight
3.2 Communities/ assemblages	3.2.2	Richness of REs along riverine wetlands or watercourses within a specified buffer distance	10
3.3 Habitat	3.3.2	Richness of wetland types within the local catchment (e.g. SOR sub-section)	9
	3.3.3	Richness of wetland types within the sub-catchment	10
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.)	9.8
	5.1.2	Presence of aquatic ecosystem dependent 'priority' flora species	10
	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)	8.9
	5.1.4	Habitat for significant numbers of waterbirds	8.7
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.	9.7
	6.3.3	Ecologically significant wetlands identified through expert opinion and/or documented study	9.8
	6.3.4	Areas important as refugia from the predicted effects of climate change (e.g. source of species re-population)	9.7
6.4 Hydrological	6.4.1	Presence of distinct, unique or special hydrological regimes (e.g. Spring fed stream, ephemeral stream, boggomoss)	10
7 Connectivity			
7.1 Significant species or populations	7.1.1	The contribution (upstream or downstream) of the spatial unit to the maintenance of significant species or populations, including those features identified through Criteria 5 and/or 6	9.5

Criteria and indicators	Measure	Measure description	Weight
	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
7.3 Floodplain and wetland ecosystems	7.3.1	The contribution of the spatial unit to the maintenance of floodplain and wetland ecosystems with significant biodiversity values, including those features identified through Criteria 5 and/ 6	10
	7.3.2	Extent to which the wetland retains critical ecological and hydrological connectivity, where it should exist, with floodplains, rivers, groundwater, etc.	10
8 Representativeness			
8.2 Wetland uniqueness	8.2.5	Wetland type representative of the study area - identified by expert opinion	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	9.6
	1.1.2	Presence of exotic aquatic and semi-aquatic plants within the wetland	9.9
	1.1.3	Presence of exotic invertebrate fauna within the wetland	9
	1.1.4	Presence of feral/exotic vertebrate fauna (other than fish) within the wetland	10
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)	9.8
	2.3.2	% "grazing" land-use area	10
	2.3.3	% "vegetation" land-use area (i.e. native veg + regrowth)	9.4
	2.3.4	% "settlement" land-use area (i.e. towns, cities, etc.)	8.5
	2.3.9	Number of intensive animal production sites	9
	2.3.11	Number of aquaculture sites	8
3 Diversity and richness			
3.1 Species	3.1.2	Richness of native fish	10
	3.1.3	Richness of native aquatic dependent reptiles	9.1
	3.1.4	Richness of native waterbirds	9.5
	3.1.5	Richness of native aquatic plants	9.7
	3.1.6	Richness of native amphibians (non-riverine wetland breeders)	9.5
	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)	9.3
	3.3.3	Richness of wetland types within the sub-catchment	10
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	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.)	9.8
	5.1.2	Presence of aquatic ecosystem dependent 'priority' flora species	10
	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)	8.9
	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.	9.4
	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)	9.5
6.4 Hydrological	6.4.1	Presence of distinct, unique or special hydrological regimes (e.g. Spring fed stream, ephemeral stream, boggomoss)	10
7 Connectivity			
7.3 Floodplain and wetland ecosystems	7.3.1	The contribution of the spatial unit to the maintenance of floodplain and wetland ecosystems with significant biodiversity values, including those features identified through Criteria 5 and/or 6	10
8 Representativeness			
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)	9
	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)	8.7

Criteria and indicators	Measure	Measure description	Weight
	8.2.3	The size of each wetland type relative to others of its wetland management group within the catchment or study area	8.9
	8.2.4	The size of each wetland type relative to others of its wetland management group within a subcatchment (or estuarine zone)	8.1
	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	8.5

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	2
1.3	Habitat features modification	1
2 Naturalness catchment		
2.1	Exotic flora / fauna	3
2.2	Riparian disturbance	2
2.3	Catchment disturbance	2
2.4	Flow modification	1
3 Diversity and richness		
3.1	Species	2
3.2	Communities / assemblages	1
3.3	Habitat	3
4 Threatened species and ecosystems		
4.1	Species	1
4.2	Communities / assemblages	2
5 Priority species and ecosystems		
5.1	Species	1
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	1
7 Connectivity		
7.1	Significant species or populations	2
7.2	Groundwater dependent ecosystems	3
7.3	Floodplain and wetland ecosystems	1
8 Representativeness		
8.2	Wetland uniqueness	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	3
2.2	Riparian disturbance	1
2.3	Catchment disturbance	2
2.4	Flow modification	2
3 Diversity and richness		
3.1	Species	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	1
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	1
7 Connectivity		
7.3	Floodplain and wetland ecosystems	1
8 Representativeness		
8.1	Wetland protection	2
8.2	Wetland uniqueness	1

Appendix IX - Criterion, indicator, measure list comparison between QMDB v1.4 and QMDBB v2.1

Criteria and Indicators	Measures		Riverine – v1.4	Riverine – v2.1	Non-riverine – v1.4	Non-riverine – v2.1
1 Naturalness aquatic						
1.1 Exotic flora/fauna	1.1.1	Presence of 'alien' fish species within the wetland	Y	Y	Y	Y
	1.1.2	Presence of exotic aquatic and semi-aquatic plants within the wetland	Y	Y	Y	Y
	1.1.3	Presence of exotic invertebrate fauna within the wetland				Y
	1.1.4	Presence of feral/exotic vertebrate fauna (other than fish) within the wetland		Y	Y	Y
1.2 Aquatic communities / assemblages	1.2.1	SOR[1] aquatic vegetation condition	Y			
	1.2.2	SIGNAL2[4] score (max)	Y			
	1.2.3	AUSRIVAS[2] score-edge (min band)	Y			
	1.2.4	AUSRIVAS[2] score-pool (min band)	Y			
	1.2.6	Wetland condition, as measured by an acknowledged condition metric	Y		Y	
	1.3.1	SOR[1] bank stability	Y			
	1.3.2	SOR[1] bed & bar stability	Y			
	1.3.3	SOR[1] aquatic habitat condition	Y			
1.3 Habitat features modification	1.3.4	Presence/absence of dams/weirs within the wetland	Y	Y		
	1.3.5	Inundation by dams/weirs (% of waterway length within the wetland)	Y	Y		
	1.3.7	% area of remnant wetland relative to preclear extent for each spatial unit	Y	Y	Y	Y
1.4 Hydrological modification	1.4.1	APFD[3] score-modelled deviation from natural under full development	Y			
	1.4.2	% natural flows-modelled flows remaining relative to predevelopment	Y			
	1.4.3	% no flows-modelled low flows relative to predevelopment	Y			
	1.4.5	Hydrological disturbance/modification of the wetland (e.g. as determined through DES wetland mapping and classification)			Y	Y

Criteria and Indicators	Measures		Riverine – v1.4	Riverine – v2.1	Non-riverine – v1.4	Non-riverine – v2.1
1.5 Water quality	1.5.1	Median total phosphorous (ug/L)	Y			
	1.5.2	Median total nitrogen (ug/L)	Y			
	1.5.3	Median turbidity (ug/L)	Y			
	1.5.4	Median conductivity (ug/L)	Y			
	1.5.5	Median pH	Y			
2 Naturalness catchment						
2.1 Exotic flora/fauna	2.1.1	Presence of exotic terrestrial plants in the assessment unit	Y	Y	Y	Y
2.2 Riparian disturbance	2.2.1	% area remnant vegetation relative to preclear extent within buffered riverine wetland or watercourses	Y	Y		
	2.2.2	Total number of REs relative to preclear number of REs within buffered riverine wetland or watercourses	Y	Y		
	2.2.3	SOR[1] reach environs	Y			
	2.2.4	SOR[1] riparian vegetation condition	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	Y
	2.2.9	% tree cover within the waterway corridor		Y		
2.3 Catchment disturbance	2.3.1	% "agricultural" land-use area (i.e. cropping and horticulture)	Y	Y	Y	Y
	2.3.2	% "grazing" land-use area	Y	Y	Y	Y
	2.3.3	% "vegetation" land-use area (i.e. native veg + regrowth)	Y	Y	Y	Y
	2.3.4	% "settlement" land-use area (i.e. towns, cities, etc)	Y	Y	Y	Y
	2.3.5	% “rural-residential” land-use area by spatial unit	Y			
	2.3.6	% area of known contaminated land adjacent to the wetland, measured within a 200m buffer around the wetland	Y		Y	
	2.3.9	Number of intensive animal production sites		Y		Y
	2.3.11	Presence of aquaculture		Y		Y
2.4 Flow Modifications	2.4.1	Farm storage (overland flow harvesting, floodplain ring tanks, gully dams)	Y	Y	Y	Y

Criteria and Indicators	Measures		Riverine – v1.4	Riverine – v2.1	Non-riverine – v1.4	Non-riverine – v2.1
		calculated by surface area				
	2.4.3	% area of impervious surfaces within the assessment unit	Y		Y	
3 Diversity and richness						
3.1 Species	3.1.1	Richness of native amphibians (riverine wetland breeders)	Y	Y		
	3.1.2	Richness of native fish	Y	Y	Y	Y
	3.1.3	Richness of native aquatic dependent reptiles	Y	Y	Y	Y
	3.1.4	Richness of native waterbirds	Y	Y	Y	Y
	3.1.5	Richness of native aquatic plants	Y	Y	Y	Y
	3.1.6	Richness of native amphibians (non-riverine wetland breeders)			Y	Y
	3.1.7	Richness of native aquatic dependent mammals	Y	Y	Y	Y
3.2 Communities/ assemblages	3.2.1	Richness of macroinvertebrate taxa	Y		Y	
	3.2.2	Richness of REs along riverine wetlands or watercourses within a specified buffer distance	Y	Y		
	3.2.4	Native fish biotic index (observed: expected ratio) as measured by an acknowledged metric	Y		Y	
3.3 Habitat	3.3.1	SOR[1] channel diversity	Y			
	3.3.2	Richness of wetland types within the local catchment (e.g. sub-section)	Y	Y	Y	Y
	3.3.3	Richness of wetland types within the sub-catchment	Y	Y	Y	Y
3.4 Geomorphology	3.4.1	Richness of geomorphic features	Y		Y	
4 Threatened species and ecosystems						
4.1 Species	4.1.1	Presence of rare or threatened aquatic ecosystem dependent fauna species – NCA, EPBC	Y	Y	Y	Y
	4.1.2	Presence of rare or threatened aquatic ecosystem dependent flora species - NCA, EPBC	Y	Y	Y	Y
4.2 Communities/ assemblages	4.2.1	Conservation status of wetland Regional Ecosystems – Herbarium biodiversity status, NCA, EPBC	Y	Y	Y	Y

Criteria and Indicators	Measures		Riverine – v1.4	Riverine – v2.1	Non-riverine – v1.4	Non-riverine – v2.1
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	Y	Y
	5.1.2	Presence of aquatic ecosystem dependent 'priority' flora species	Y	Y	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	Y	Y
	5.1.4	Habitat for significant numbers of waterbirds	Y	Y	Y	Y
5.2 Ecosystems	5.2.1	Presence of 'priority' aquatic ecosystem	Y	Y	Y	Y
6 Special features						
6.1 Geomorphic features	6.1.1	Presence of distinct, unique or special geomorphic features	Y	Y	Y	Y
6.2 Ecological processes	6.2.1	Presence of (or requirement for) distinct, unique or special ecological processes	Y	Y	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	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	Y	Y
	6.3.3	Ecologically significant wetlands identified through expert opinion and/or documented study	Y	Y	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	Y	Y
7 Connectivity						
7.1 Significant species or populations	7.1.1	The contribution (upstream or downstream) of the spatial unit to the maintenance of significant species or populations, including those features identified through Criteria 5 and/ or 6	Y	Y		

Criteria and Indicators	Measures		Riverine – v1.4	Riverine – v2.1	Non-riverine – v1.4	Non-riverine – v2.1
	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		
	7.1.3	Presence of aerial or terrestrial migratory route for biological connectivity	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		
7.3 Floodplain and wetland ecosystems	7.3.1	The contribution of the spatial unit to the maintenance of floodplain and wetland ecosystems with significant biodiversity values, including those features identified through Criteria 5 and/or 6	Y	Y		Y
	7.3.2	Extent to which the wetland retains critical ecological and hydrological connectivity, where it should exist, with floodplains, rivers, groundwater, etc.	Y	Y		
8 Representativeness						
8.1 Wetland protection	8.1.1	The percent area of each wetland type within Protected Areas.			Y	Y
	8.1.2	The % area of each wetland type within a coastal/estuarine area subject to the Fisheries Act, Coastal Management Act or marine Parks Act.			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	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	Y
	8.2.3	The size of each wetland type relative to others of its wetland management group within the catchment or study area			Y	Y
	8.2.4	The size of each wetland type relative to others of its wetland management group within a sub-catchment (or estuarine zone)			Y	Y
	8.2.5	Wetland type representative of the study	Y	Y	Y	Y

Criteria and Indicators	Measures		Riverine – v1.4	Riverine – v2.1	Non-riverine – v1.4	Non-riverine – v2.1
		area – identified by expert opinion				
	8.2.6	The size of each wetland type relative to others of its type within the catchment or study area			Y	Y

[1] SOR – State of the Rivers
[2] AUSRIVAS – Australian River Assessment System
[3] APFD – Annual Proportional Flow Deviation
[4] SIGNAL2 – Stream Invertebrate Grade Number – Average Level

Attachment A - An Aquatic Conservation Assessment for the riverine and non-riverine wetlands of the Queensland Murray-Darling and Bulloo Basins - Flora, Fauna and Ecology Expert Panel Report, Version 2.1.