Aquatic Conservation Assessments (ACA)

using AquaBAMM

for the riverine and non-riverine wetlands

of the Wide Bay-Burnett catchments

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Prepared by:

Steven Howell[1] Manager, Biodiversity Assessment
Maria Zann[2] Scientist, Planning and Assessment, South East Region
Selena Rollason[1] Principal Planning Officer, Biodiversity Assessment

[1] Water and Ecosystem Outcomes Business Group, Department of Environment and Resource Management, GPO Box 2454 BRISBANE QLD 4001 Australia
[2] Operations and Environmental Regulator Business Group, Department of Environment and Resource Management, PO Box 212 MARYBOROUGH QLD 4650 Australia

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Cover photos (from top to bottom)

1. Wetland near the Monto Airfield (bu_w00048) – Steven Howell
2. Mary River at the road and railway crossing near Miva (my_00116) – Steven Howell
3. Fish ladder at Teddington Weir on Tinana Creek (my_w00171) – Steven Howell
4. Kolan River (ko_00038) – Steven Howell
5. Ban Ban Springs (bu_w00338) – Steven Howell
6. Jumpo Creek (my_w00175) – Steven Howell (background photo)

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1 Introduction

The Aquatic Biodiversity Assessment and Mapping Method (AquaBAMM) (Clayton *et al.* 2006), was developed to assess conservation values of wetlands in Queensland, and may also have application in broader geographical contexts. It is a comprehensive method that uses available data, including data resulting from expert opinion, to identify relative wetland conservation/ecological values within a specified study area (usually a catchment). The product of applying this method is an Aquatic Conservation Assessment (ACA) for the study area.

An ACA using AquaBAMM is non-social, non-economic and identifies the conservation/ecological values of wetlands at a user-defined scale. It provides a robust and objective conservation assessment using criteria, indicators and measures that are founded upon a large body of national and international literature. The criteria, each of which may have variable numbers of indicators and measures, are naturalness (aquatic), naturalness (catchment), diversity and richness, threatened species and ecosystems, priority species and ecosystems, special features, connectivity and representativeness. An ACA using AquaBAMM is a powerful decision support tool that is easily updated and simply interrogated through a geographic information system (GIS).

Where they have been conducted, ACAs can provide a source of baseline wetland conservation/ecological information to support natural resource management and planning processes. They are useful as an independent product or as an important foundation upon which a variety of additional environmental and socio-economic elements can be added and considered (i.e. an early input to broader 'triple-bottom-line' decision-making processes). An ACA 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.

To date, ACAs have contributed to the following:

- State Planning Policy (04/11) for Protecting Wetlands of High Ecological Significance in the Great Barrier Reef
- Delbessie Agreement (formerly the State Rural Leasehold Land Strategy)
- Queensland Murray-Darling Basin Plan
- Wide Bay-Burnett Regional Plan
- Develo pment Assessment
- Water Resource Management and Planning.

The Department of Environment and Resource Management (DERM) has conducted ACAs for the freshwater non-riverine (i.e. palustrine and lacustrine) and riverine wetlands in each of the six Wide Bay-Burnett (WBB) catchments—Burnett, Burrum, Cooloola coast, Fraser Island (K'gari or Gari), Kolan and Mary. Estuarine wetlands have not been included in these assessments.

Data for three of the AquaBAMM criteria are primarily derived by expert elicitation (Criterion 5 Priority Species and Ecosystems, Criterion 6 Special Features and Criterion 7 Connectivity). To consider the measures within these criteria, three separate expert panels were conducted to address aquatic fauna, aquatic and riparian flora and wetland ecology for the six Wide Bay-Burnett catchments. The panels, held in Maryborough during July 2010, involved invited

experts with expertise in aquatic fauna, aquatic and riparian flora and/or wetland ecology. Experts were presented with ecological data relevant to their area of expertise and asked to make decisions relevant to the respective measures, such as which aquatic species should be included in the assessment or whether there were special features in the landscape that contained ecological significance. The expert panel reports contained within Attachments A, B and C present the findings and recommendations from each panel, including their terms of reference and final decisions.

Results from the non-riverine and riverine WBB ACAs are intended for use under two statutory Queensland government planning processes:

1) A statutory regional planning process has commenced for the Wide Bay-Burnett region under the *Sustainable Planning Act 2009*. The Wide Bay-Burnett Regional Plan aims to protect and enhance the environment by mapping areas of ecological significance (AES) and identifying areas of high ecological significance (HES), including wetlands and waterways. This process can then inform the regulatory process for protection. For riverine and non-riverine wetlands a recognised criterion for inclusion in HES mapping is that the wetland is identified as having a 'high' or 'very high' value under an ACA

2) Under the Reef Water Quality Protection Plan (Reef Plan) the importance of wetland function in maintaining water quality entering the Great Barrier Reef lagoon is recognised. Wetlands of 'high' and 'very high' value under an ACA will be identified as 'wetland protection areas' on a map of referable wetlands under the State Planning Policy: Protecting wetlands of high ecological significance in Great Barrier Reef catchments within the WBB region. The Wide Bay Burnett ACA has assessed freshwater wetlands only. Estuarine wetlands have not been assessed under this process. Protection of these (freshwater) wetlands will also maintain and enhance water quality of the local WBB coral reefs and extensive seagrass beds within the Great Sandy Strait Ramsar area, the dugong protection area and the Great Sandy Marine Park.

1.1 The Wide Bay-Burnett study area

DERM has mapped and classified wetlands according to a peer reviewed and published mapping and classification methodology[1]. These wetland maps were used as a platform for the conservation assessments reported here. ACAs accept the released wetland maps unmodified and therefore, are limited by inherent mapping and classification accuracy. Issues to do with wetland mapping or classification errors are dealt with by DERM mapping update processes and are not part of an ACA.

The WBB ACA is made up of six individual catchments—the Burnett, Mary, Kolan, Burrum, Cooloola and Fraser Island catchments (Figure 1). DERM has applied AquaBAMM separately to the non-riverine (i.e. palustrine and lacustrine) and riverine wetlands within each of the six WBB catchments. In effect, there are 12 ACAs for the riverine and non-riverine wetlands in the WBB study area. Table 1 shows the six catchments/study areas for which ACAs were undertaken and the number of mapped non-riverine wetlands and riverine spatial units within each catchment.

[1] DERM wetland mapping and classification methodology is available at http://www.epa.qld.gov.au/wetlandinfo/site/MappingFandD/WetlandMandDBackground.html

Table 1: WBB catchments subject to an ACA using AquaBAMM

ACA study areas or catchments	Catchment code	Catchment area (ha)	Number of freshwater non-riverine wetlands	Area of freshwater non-riverine wetlands (ha)	Number of riverine spatial units
Burrum	bm	336,215	403	10,441	38
Burnett	bu	3,321,842	343	8,308	381
Cooloola coast	cc	134,299	380	25,675	137
Fraser Island	fr	169,405	469	17,297	234
Kolan	ko	290,059	75	6,760	40
Mary	my	946,772	472	7,256	164
	TOTAL	**5,198,592**	**2,142**	**75,737**	**994**

A description of each of these catchments is provided in the following sections.

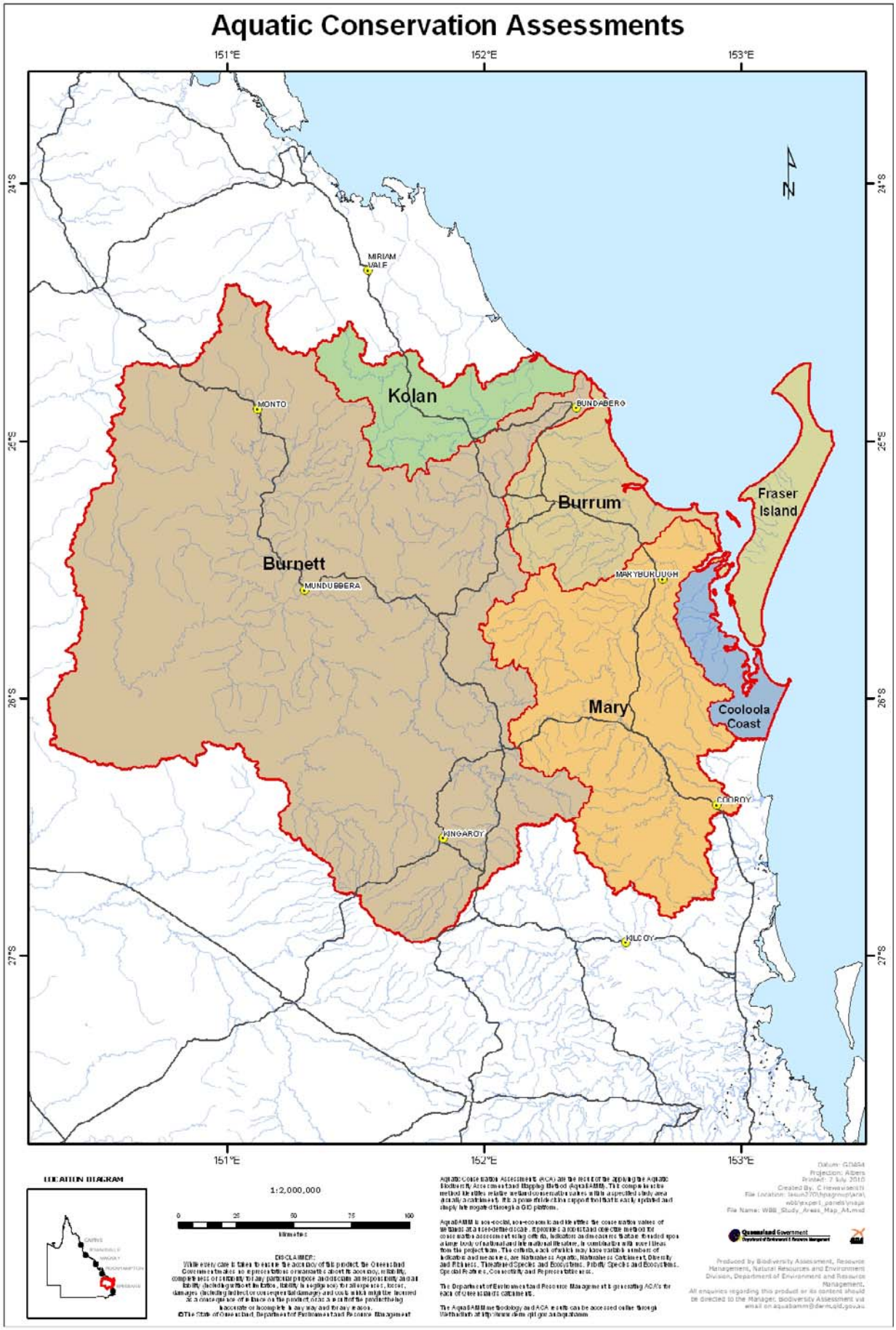


Figure 1: The six WBB catchments where ACAs have been conducted

1.2 Burnett catchment

The Burnett River catchment lies in the South East Queensland and Brigalow Belt bioregions and is located approximately 200 km north-west of Brisbane. The Burnett is the third largest river basin on the east coast of Queensland, with a catchment area of approximately 34 500 km^2 (Van Manen 1999). The Burnett River flows for 420 km from its source in the Burnett Range to its mouth at Burnett Heads. The main tributaries of the Burnett River include the Auburn, Nogo, Boyne and Stuart Rivers and the Barambah and Three Moon Creeks (Van Manen 1999). The catchment is fringed by the Burnett and Dawes Ranges in the north, the Auburn Range to the west, the Great Dividing Range to the south-west and the Cooyar and Brisbane Ranges in the south. Major urban and regional centres in the Burnett River catchment include Bundaberg, Kingaroy, Gayndah, Eidsvold, Murgon, Nanango and Monto. Rainfall in the catchment is variable with both tropical and temperate weather patterns. Cattle grazing and crop production dominate the catchments land use.

The Burnett River catchment is subject to a number of new water infrastructure projects being approved for development. The State of Queensland utilising State legislation, and the Commonwealth Minister for Environment and Heritage under the provisions of the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth) granted environmental approvals for Barlil Weir, Jones Weir Stage 2 and Eidsvold Weir in late 2001, and approval for Paradise Dam in late January 2002. Eidsvold Weir was completed in 2004 and Paradise Dam was completed in late 2005. Consequently, the Burnett River catchment is one of the most developed areas in Queensland in terms of water infrastructure. Increasing demands for water from irrigators, industry and the domestic sector have resulted in high levels of river regulation. There are currently approximately 41 water storages in the Burnett catchment, six of which are situated in the main river channel (Brizga *et al.* 2000).

As has been observed during the construction of dams in other areas, the raising of the Walla Weir in conjunction with the construction of the Paradise Dam is expected to have significantly reduced suitable habitats for aquatic fauna (Gehrke *et al.* 2002), particularly the Australian lungfish (*Neoceratodus forsteri*) and *Elseya* species of turtle. In response to these concerns, DERM and the Department of Employment, Economic Development and Innovation (DEEDI) were asked to develop eight projects that aim to address catchment-wide, environmental issues associated with the construction and operation of the proposed infrastructure known collectively as the Burnett Plan of Actions (BPOA). The BPOA included an AquaBAMM project in 2006 which aimed to assess 'riverine conservation values of the Burnett'. The initial trial application of the AquaBAMM was conducted in the Burnett River catchment to produce an Aquatic Conservation Assessment (ACA) for riverine wetlands. The ACA being reported here supersedes the first Burnett River ACA version released in 2006 which pre-dated construction of the Paradise Dam.

Additionally, under the Coastal Catchments Initiative, the Australian Government has funded the Burnett-Mary Regional NRM Group (BMRG) to develop the Burnett-Baffle Water Quality Improvement Plan (WQIP) (Burnett-Mary Regional NRM Group/DERM, 2010). DERM and the BMRG have completed a joint project to establish the waterway values and uses (i.e. environmental values), and developed water quality objectives/targets to protect these values and uses consistent with the Environmental Protection (Water) Policy 2009. As part of this project High Ecological Value waterways were determined for the Burnett catchment.

1.3 Mary River catchment

The Mary River flows from the moist, subtropical southern part of the South East Queensland bioregion into a drier corridor to the north, and consequently varies considerably in its character. The Mary's freshwater reaches support a distinctive fauna which is close to range limits and adapted to its episodic flood regime, and is one of two catchments supporting the iconic Australian lungfish (*Neoceratodus forsteri*). The Mary catchment is an important source of sediment and freshwater flows for seagrass ecosystems and shorebird feeding habitat in the northern Great Sandy Strait Ramsar area and Hervey Bay. Many of its riverine and non-riverine wetlands are also scheduled as High Ecological Value waterways under the Environmental Protection (Water) Policy 2009.

While most rainfall occurs in late summer to early autumn, flood events may occur in any month but are typically episodic in occurrence (e.g. 5–10 years frequency) and may be interspersed by long dry periods. Irregular high rainfall events associated with cyclones and east coast low depressions feed the southern tributaries of the Mary. While mean annual rainfall near Maleny is 2000 mm, as much as 900 mm has been recorded in a day. Much of this elevated southern catchment falls within protected areas containing rainforest, wet and dry sclerophyll ecosystems although significant areas have been cleared. Obi Obi creek rises from a basaltic plateau in the Sunshine Coast hinterland, falling steeply through gorge country before flowing north to join the Mary River. In contrast Six Mile Creek is a low energy rainforest stream retaining large woody debris. The banks of some of the major streams, such as Obi Obi, Six Mile, Deep and Tinana Creeks, have rainforest and/or tall open (wet sclerophyll) forest riparian vegetation (e.g. Araucarian notophyll vine forest or mesophyll gallery forest). Riverbank erosion due to the poor condition of riparian vegetation in the Mary is also being linked to increased sediment discharge to the Great Sandy Strait (Esslemont *et al.* 2006 a, b, c, d; DeRose *et al.* 2002).

There is a need for further mapping and rehabilitation of riparian vegetation, especially rainforest, since this vegetation type is habitat for several endemic, endangered, vulnerable, near-threatened and priority species including both fauna species (e.g. Mary River cod *(Maccullochella mariensis),* Richmond birdwing (*Ornithoptera richmondia)*, the pink underwing moth (*Phyllodes imperialis* southern subspecies*)*, Coxen's fig parrot (*Cyclopsitta diopthalma coxeni)*, black-breasted button-quail (*Turnix melanogaster);* the giant barred frog *(Mixophyes iterates),* the tusked frog *(Adelotus brevis);* the cascade tree frog, *(Litoria pearsoniana)* (Fleay 1997, Mathieson and Smith 2009, Simpson and Jackson 1996, Sands & Scott 1998)) and flora species (e.g. *Xanthostemon oppositifolius, Fontainea rostrata,* macadamia nut tree (*Macadamia integrifolia*) and Gympie nut (*Macadamia ternifolia*)). The South East Queensland Rainforest Recovery Program describes the association between several of these species and regional ecosystem 12.3.1 (gallery rainforest on alluvial plains). While some remnant riparian vegetation mapping of 12.3.1 exists in the Mary, mapping and identification of other riparian rainforest below the mapping scale and suitable for rehabilitation may inform NRM decisions e.g. a future Mary River Recovery Plan.

Resembling those of the drier Burnett (mean annual rainfall less than 800 mm), the intermittent western tributaries of Wide Bay and Munna Creeks are moderate to high-energy sand and gravel-bed stream systems able to accommodate substantial flows within their wide flow channels. A substantial coarse sediment load from all these tributaries has resulted in distinctive pool, riffle and sand bar sequences chiefly in the main trunk of the Mary River. These areas are notable as habitat for the Australian lungfish (*Neoceratodus forsteri*) and the highest turtle diversity in Queensland (including the endemic Mary River turtle (*Elusor macrurus*)). To the east, Coondoo and Tinana Creeks sustain important riparian rainforest and wallum vegetation on sandy alluvium with natural water quality and relatively intact fauna (including endemic Mary River cod (*Maccullochella peelii mariensis*), oxleyan pygmy perch (*Nannoperca oxleyana*) and the Australian lungfish (*Neoceratodus forsteri*) populations). These creeks flow into the turbid Mary estuary at Maryborough and are joined by the unimpounded Susan River and its mangrove wetlands near the mouth of the river. The tidal delta of the Mary extends into the Great Sandy Strait, encompassing an extensive complex of mangrove islands, saltpans and sandbanks comprising the largest Fish Habitat Area in southern Queensland. Flood events from the Mary River periodically reverse the normally highly saline conditions of Hervey Bay, producing an inverse estuary (Ribbe 2008).

Presently, catchment land use in the area chiefly comprise dryland grazing, sugar cane and plantation forestry, with tree crops and dairying in the elevated south. European settlement and dairying land use resulted extensively in clearing of its upper reaches and riparian area. Land use and modifications of the freshwater reaches have produced erosion and siltation of parts of the river and sedimentation of deep pools. Excess sediment discharge into the Mary estuary, Great Sandy Strait and Hervey Bay from the Mary flood events and subsequent resuspension occasionally results in catastrophic loss of seagrass beds and dugong (e.g. 1992 – Preen *et al.* 1995) and continues to create marine water quality issues.

Within the freshwater reaches regulation of its southern tributaries for extraction of water supplies for Gympie, inter-basin transfers to the Sunshine Coast and flow releases for downstream irrigation of canelands have modified the original episodic flows to a smaller, more regular runoff regime, altering the physical structure of the channel (Department of Natural Resources & Mines 2005). Barrages on former estuarine reaches of the Mary River and Tinana Creek provide for irrigated canelands and the Maryborough water supply respectively, but also restrict the freshwater flow regime and fish passage to the estuary. Most of the floodplain wetlands have been converted to cultivated paddocks or canelands. Nevertheless the Mary River catchment still supports a high diversity in riverine and non-riverine wetland types, including wallum wetlands, melaleuca swamps and inland freshwater swamps.

1.4 Burrum catchment

The Burrum catchment consists of an amalgam of coastal catchments between the Burnett and Mary catchments. The catchment is dominated by the Burrum sand mass characterised by aggregations of coastal Melaleuca wetlands and heaths with connectivity in a north-south direction. The non-riverine and riverine wetlands of the Burrum play a significant role in reef resilience due to their high connectivity with adjacent estuarine salt marshes, mangroves, seagrass meadows and coral reefs of the Great Sandy Strait Ramsar area and Hervey Bay. Many of the Burrum's riverine, non-riverine and estuarine wetlands are also scheduled as High Ecological Value waterways under the Environmental Protection (Water) Policy 2009.

Of lower relief than the Mary and Cooloola-Great Sandy Strait catchments, the Burrum receives most of its rainfall as northern monsoons, cyclones or troughs occurring in late summer to autumn (averaging 1000–1200 mm per annum). The climatic variability and low freshwater discharge in combination with evaporation on expansive tidal flats have created an 'inverse estuary' in the receiving waters of Hervey Bay (i.e. strongly hypersaline; Ribbe 2008, Grawe 2010).

The catchment logically falls into five geomorphic subdivisions; the Woongarra coastal streams draining a gently-sloping, fertile Quaternary basalt deposit, the groundwater-fed Elliott River, the Coonarr to Beelbi region of extensive sandy beach ridges and swales, the Burrum, Isis, Gregory and Cherwell rivers draining into the Burrum estuary, and the O'Regan's Creek to the Mary River area, typified by short coastal streams and alluvial wetlands sloping from a ridgeline behind Hervey Bay City. In the hinterland, sedimentary rocks of the Maryborough formation formed in Mesozoic marine waters have resulted in saline-tolerant Melaleuca wetlands along drainage lines.

The Burrum Coast sits within the Directory of Important Wetlands area between Theodolite and Beelbi creeks and includes both freshwater and estuarine wetlands (mangroves and seagrass beds). As a succession of both Holocene and Pleistocene beach ridges, and swales and Quaternary freshwater swamp deposits, it represents the most significant coastal dune system north of the Cooloola sand mass. A large proportion of this dune system is conserved within the Burrum Coast National Park. Wetland types of the Burrum Coast include wallums, closed wet heath and swale wetlands dominated by Melaleuca species. These wetlands and adjacent habitats include several species approaching their geographic limits (such as *Strangea linearis*, *Callistemon pachyphylla* and *Melaleuca sieberi*) and a number of endangered, vulnerable and near-threatened plant species including the paperbark tree (*Melaleuca cheelii*), tiny wattle (*Acacia baueri subsp baueri*) and an alyxia (*Alyxia sharpei*). The wallum froglet (*Crinia tinnula)* has also been recorded in the Burrum Coast National Park and other wetlands in the catchment. Inland from the coastal dune systems lie wetlands and streams of the Burrum and Cherwell. In these areas, deep weathering of Tertiary sediments has formed duricrust pans on a slightly elevated plateau, inhibiting the surface drainage. The Cherwell River has good examples of perched healthy wetlands associated with these pans as well as Melaleuca swampy drainage lines dissecting the edges of the plateau.

The Elliott River catchment, which sits within the Burrum study area, is largely groundwater-fed, containing aquifers that consist of a series of poorly interconnected sand and gravel channels and intervening clay layers sloping gently towards the coast. This areas unique hydrology, freshwater wetlands and excellent connectivity to high receiving water values (including seagrass and corals) were recognised in the Burnett-Baffle Water Quality Improvement Plan (Burnett-Mary Regional NRM Group/DERM 2010).

Dominant land uses in the Burrum catchment are irrigated cropping, grazing, coastal urban development and minor plantation forestry, with the majority of intensive land use north of the Isis River. However, extensive vegetated tracts of state land remains within the bioregional corridor in the hinterland and within protected estate on the coast. Irrigation from groundwater provides for intensive cane farming and horticulture north of the Burrum River. Lenthalls Dam on the Burrum supplies the expanding city of Hervey Bay with water. Other weirs and barrages on the Burrum and Isis Rivers also sever connectivity between freshwater areas and the estuary.

Clearing of wetlands for agriculture and fragmentation associated with coastal development has impacted on the Woongarra coast and, to a lesser extent, south of Burrum Heads. Wetland function in these catchments provides water quality protection for significant estuarine and marine values–most notably the Burrum seagrass meadow dugong nursery (Sheppard 2006), Mon Repos turtle rookery and subtropical coral reefs fringing both Woongarra and Hervey Bay coastlines.

Urban development, artificial lakes and sand extraction are increasingly impacting on the natural hydrology of wetlands and streams south of Burrum Heads, with impacts such as de-watering of heathland wetlands in adjacent protected estate. There is potential for excavation of wetland soil to mobilise acid sulfate runoff and seepage from septics to eutrophy groundwater. In other parts of Australia and the world, the importance of hydrological connectivity between groundwater and adjacent inshore marine ecosystems (Maji and Smith 2008), such as seagrass, is acknowledged (Coles *et al.* 2007; Eamus *et al.* 2006; Kammermans *et al.* 2002; Johannes and Hearn 1985) and the impacts coastal urban development has on these groundwater dependent ecosystems has been demonstrated (Carruthers *et al.* 2005, Valeila *et al.* 1990). While groundwater connectivity to seagrass is yet to be investigated for the Burrum catchment, the maintenance of intact wetland function is an important consideration for the health of connected ecosystems.

1.5 Kolan catchment

The Kolan catchment is a coastal catchment between the Burnett to the south and the Littabella and Baffle Creek catchments to the north. This catchment features mainly agricultural land use and water resources, but there are some wetlands of biodiversity significance in its headwaters and adjoining its estuary.

The Kolan falls within the northern half of the South East Queensland bioregion, and has a subtropical climate with an average rainfall of 1200 -1400 mm per annum. Most of this rainfall occurs during late summer commonly associated with cyclones and troughs, but can be sporadic. Most of the Kolan catchment is relatively flat, below 80 m above sea level (ASL). However, the headwaters arise in the rugged Many Peaks Range which rises to 700 m ASL. There are a number of different protected areas in the headwaters, notably Bulburin National Park and Bulburin Forest Reserve which feature subtropical dry rainforest with emergent hoop pines; gallery rainforest; and drier eucalypt forests. Hoop pine plantations adjoin protected estates at Bulburin.

On the south side of the Kolan, a series of parallel dunes has formed a barrier and swale system in the Moore Park area. This wetland complex of Melaleuca swamps and lakes is fragmented by the urban settlement of Moore Park Beach. However, the freshwater wetlands have reasonable connectivity to the Kolan Fish Habitat Area in the estuarine waters of the Kolan and west of Barubbra Island in the delta of the Burnett.

Agricultural and water resource land uses dominate much of the Kolan and as a result much of the catchment is cleared. Grazing dominates the upper and central catchment, while irrigated sugar cane and horticultural crops (including macadamia nut plantations) predominate in the lower catchment. The Fred Haigh Dam is a large impoundment within the central-upper reaches of the Kolan with a pipeline providing inter-basin transfers into the Burnett for irrigation. Bucca Weir and the Kolan barrage provides freshwater for agriculture in the central and lower reaches. Irrigation from the Gooburrum aquifer, which extends from the Elliott River north to the Kolan, supplements the variable rainfall experienced within the Kolan. To date, connectivity has been poor and hence environmental flows to the estuary have been low. However, the revised water resource plan covering the region is focussing more on improvements to freshwater flows in order to benefit catadromous fish.

Under its Coastal Catchments Initiative, the Australian Government has funded the Burnett-Mary Regional NRM Group (BMRG) to develop the Burnett-Baffle Water Quality Improvement Plan (WQIP). DERM and the BMRG have completed a joint project to establish the waterway values and uses (i.e. environmental values) and develop water quality objectives/targets to protect the values and uses consistent with the Environmental Protection (Water) Policy 2009. As part of this project High Ecological Value waterways were determined for the Kolan catchment.

1.6 Cooloola catchment (previously Noosa north)

Previously this catchment was referred to as Noosa north, however to more accurately represent the geographical location, the wetland ecology expert panel recommended that it be renamed the Cooloola catchment .The Cooloola region has the oldest and largest unconsolidated sand mass in the world, nominated as World Heritage for its spectacular natural values, geomorphology, and the most extensive and intact complex of heath and swamp communities in south-eastern Australia (Fraser Island World Heritage Scientific Advisory Committee, 2004a). The Cooloola sand mass and its very high rainfall volume, often exceeding 1200 mm annually, determines the hydrology and character of most of this catchment. Many of its freshwater wetlands fall within the Great Sandy Strait Ramsar area, and together with the dunes are important groundwater recharge areas. Many of Cooloola's riverine, non-riverine and estuarine wetlands are also scheduled as High Ecological Value waterways under the Environmental Protection (Water) Policy 2009.

Streams of the Cooloola catchment flow in four separate directions, three of which are in protected area estate within the Cooloola section of the Great Sandy National Park. To the north flow the Cooloola and Great Sandy Strait streams; to the south flows the Noosa River; and various streams and springs within the narrow dune corridor of the eastern seaboard discharge directly across the beach to the sea. East of the Mary River catchment and north of Kauri Creek, coastal creeks from other, smaller sand masses than Cooloola flow directly into the Great Sandy Strait Ramsar area, whose sandbanks and mangrove-lined waterways provide significant seagrass habitat for shorebirds, dugong and dolphins.

Catchments of the Cooloola area are typified by their dependence on groundwater flows emanating chiefly from the Cooloola Sand Mass, high dunes (to 258 m ASL), resembling those of Fraser Island in geomorphology, hydrology, flora and fauna. This sand mass is derived from quartz sands blown and buried in a low hilly landscape of Mesozoic sandstones, covered by successively younger sand deposits until the Holocene (including parabolic dunes). Long-term leaching of humic acids has formed deep podzolic soils and peat-swamps with various layers of coffee rock impeding drainage and forming perched water tables, overlying a deeper regional groundwater table close to sea level and connected to estuarine waters. While hydrologically linked to the Noosa River catchment, the divide between these groundwater-sourced systems approximately coincides with the topographic watershed along the highest dunes of the sandmass. Groundwater of the Cooloola area is characterised by organic stained 'black waters' in its perched system and unstained 'white water' in the prime aquifer below (NLWRA 2000).

This variety of hydrological regimes produces a wide range of highly significant wetland types including patterned fens similar to those of Fraser Island, the only subtropical patterned fens in the world; 'swamp hummocks' of patterned peat microrelief; perched (e.g. Poona Lake) and regional water table 'window' lakes (e.g. Freshwater Lake); perched heath swamps with christmas bells (*Blandfordia grandiflora*) and other rare wetland flora species; episodic springs or 'bubblers' of 'white' water across the beach; 'black' tannin-stained wallum streams; vineforest riparian vegetation surrounding 'white water' springs; and melaleuca wetlands to name a few. Many are 'acid' habitats with a pH so low that they have developed a unique suite of acid-tolerant fauna including four vulnerable and near-threatened frogs (the Cooloola sedgefrog (*Litoria cooloolensis*), wallum rocketfrog (*Litoria freycineti*), wallum sedgefrog (*Litoria olongurensis*) and wallum froglet *Crinia tinnula)*, fish, the crayfish (*Cherax robustus*) and earthworms. Northward to the Great Sandy Strait the continuity between the freshwater streams, groundwater and the estuary is largely uninterrupted and natural, supporting very high values in the freshwater/estuarine interface including the most significant mainland populations of water mouse (*Xeromys myoides*); species tolerant of brackish water and low pH (e.g. honey blue eye (*Pseudomugil mellis*) and oxleyan pygmy perch (*Nannoperca oxleyana*)) and very high fish diversity. Most notable is Kauri Creek and streams discharging from the Wide Bay Military Training Area whose adjacent seagrass beds constitute the most significant dugong habitat in the southern Great Sandy Strait (Sheppard 2006).

Further north beyond Kauri Creek, smaller coastal creeks of the Great Sandy Strait (including Maaroom, Tuan and Poona creeks) drain flatter, sandy terrain as far north as the Mary River mouth. There is limited knowledge of these catchments typified by heath and wallum complexes often connected to a network of mangrove channels within the Great Sandy Strait Ramsar Area. They preserve natural connectivity from fresh to estuarine waters but within a catchment of exotic pine plantations. Poona National Park represents a complex of fresh and estuarine wetlands with similar acid frog habitat and faunal features to those of Cooloola including honey blue eye (*Pseudomugil mellis*).

The Noosa River catchment is a largely undisturbed basin within protected area, featuring deltaic and estuarine lake systems draining southward towards the Sunshine Coast from the Cooloola sand mass. In contrast with Cooloola, it has developed alluvial features and is surrounded by sandstone and alluvium on the west and Pleistocene and Holocene dunes on the east and has high recreational values.

Whilst a lack of urban settlement has left the Cooloola-Great Sandy Strait catchment largely intact, establishment of exotic pine plantations has modified catchments to the north of Kauri Creek. Extraction from Teewah Creek (Noosa River catchment), and the regional groundwater table for the townships of Tin Can Bay and Rainbow Beach respectively have potential to impact on wetlands surrounding Seary's Creek and the Noosa River if water resource management for the environment is not effective. Coastal developments at Cooloola Cove, and to a lesser extent Tin Can Bay, Poona, Big Tuan and Boonooroo sever the connectivity between freshwater and estuarine wetlands and there is potential for excavation of wetland soil to mobilise acid sulfate runoff and seepage from septics to eutrophy groundwater. Monitoring in the Great Sandy Strait has documented seagrass declines since the early 1990s. In other parts of Australia and the world, the importance of the hydrological connectivity between groundwater and adjacent inshore marine ecosystems (Maji and Smith 2008), such as seagrass, is acknowledged (Coles *et al.* 2007; Eamus *et al.* 2006; Kammermans *et al.* 2002, Johannes and Hearn 1985) and the impacts coastal urban development has on these groundwater dependent ecosystems has been demonstrated (Carruthers *et al.* 2005, Valeila *et al.* 1990). While groundwater connectivity to seagrass is yet to be investigated for the Cooloola-Great Sandy Strait catchment, the maintenance of intact freshwater wetland function is an important consideration for the health of connected aquatic ecosystems in the Ramsar area.

1.7 Fraser Island catchment

Fraser Island is the largest sand island in the world, recognised as containing World Heritage Outstanding Universal Values including geomorphic and ecological processes, exceptional beauty, biodiversity, threatened species, and cultural heritage (Fraser Island World Heritage Scientific Advisory Committee, 2004b). The areas substantial dune aquifer characterises the island's unique wetlands which includes half the freshwater dune lakes in the world and the only known subtropical patterned fens. In the western parts, the streams of Fraser Island flow into the Great Sandy Strait Ramsar area, which has also recently been nominated for World Heritage value, while Breaksea Spit to the north provides connectivity to coral reefs in the southern Great Barrier Reef. Many of Fraser Island's riverine, non-riverine and estuarine wetlands are also scheduled as High Ecological Value waterways under the Environmental Protection (Water) Policy 2009.

Fraser Island consists of a complex of high dunes rising to a maximum height of 235 m ASL. Annual rainfall ranges between 1200 and 1800 mm, falling mostly over autumn when seasonal cyclonic weather results in high rain events. North of Indian Head (Tukkee) the relief is low and dune formation is more recent, resulting in a network of exposed dunes, freshwater swamps and lakes.

Formed by continuous deposition of quartz dune deposits over the last 700 000 years, Fraser Island represents an intact sequence of dune development from west to east. These wind-blown dunes were deposited during periods of low sea level during interglacials of the Pleistocene and high winds of the Holocene. Successively younger deposits of parabolic dunes are superimposed over these older dune deposits now stabilised by towering rainforests and wet sclerophyll, forming a high diversity of dune forms with complex hydrological relationships. Similarities with the Cooloola coast area include the heavily leached deep podzolic soils and peat-swamps; layers of coffee rock impeding drainage and forming perched water tables, overlying a deeper regional groundwater table 'lens' close to sea level and connected to estuarine waters.

The advance and retreat of dunes over time has created a complex of dynamic hydrologies resulting in spring-fed streams and freshwater dune lakes. The lakes feature relict formations from past water levels such as multiple shorelines, lunettes and relict spits. Perched lakes formed in wind scoured depressions where organic matter built up impermeable layers. Up to an estimated 300 000 years old, their sediments document changes to the island's hydrology and vegetation through Quaternary glacial and interglacial cycles. These lakes form an age sequence related to the episodic periods of dune building and include some of the largest (e.g. Lake Boomanjin) and highest perched lakes (i.e. Boomerang Lakes) in the world. Window lakes intersect the regional groundwater table. Lake Wabby is a scenic barrage lake, thought to be formed by groundwater springs dammed by a wall of landward migrating sand.

A high diversity of palustrine wetland types are also represented on the island including closed wet heaths, wallum banksia communities, Melaleuca swamps and forests, riparian rainforest and palm forests, and brackish swamps. Notable among these are the patterned fens, formed at the base of high dunes where a build up of peat ridges and pools have formed in response to discharges from the regional water table. A suite of acid-tolerant fauna are associated with the fens and other acid swamps include oxleyan pygmy perch (*Nannoperca oxleyana*) and honey blue eye (*Pseudomugil mellis*), four acid frog species (the Cooloola sedgefrog (*Litoria cooloolensis*), the wallum rocketfrog (*Litoria freycineti*), the *w*allum sedgefrog (*Litoria olongurensis*) and the wallum froglet (*Crinia tinnula*) and a crayfish (*Cherax robustus*). The swamp eel (*Ophisternon gutturale*) has also been recorded at Lake Wabby.

Most of the streamflow for Fraser Island's freshwater streams is baseflow from the aquifer, which may be 'black' tannin-stained water discharging from wallum heaths or 'white' clear waters emerging from the lower water table. There is a small pocket of Angiopteris fern at Wanggoolba creek. Freshwater streams also designate the southern range limit of jungle perch (*Kuhlia rupestris*).

Connectivity between freshwater and estuarine waters is an important feature of Fraser Island waterways, and, as a result, populations of the Water mouse (*Xeromys myoides*) are high as they are able to access both habitat types. Fraser Island's western creeks feature the region's highest diversity of mangroves, several of which are freshwater-dependent such as the cannonball mangrove (*Xylocarpus granatum*) and extensive Bruguiera forests, both at their southern range limits. Fraser Island wetlands perform an important water quality protection function for seagrass beds and sandbanks of the Great Sandy Strait; the humpback whale migration area in Platypus Bay; and the loggerhead turtle rookery at Sandy Cape.

Fraser Island is largely undeveloped and heavily vegetated, and the north is largely wilderness. Most of the island is in protected area estate, although there are freehold settlements and resorts at Eurong, Happy Valley and Kingfisher Bay which source their water from bores. A network of forestry tracks traverses the inland, however most traffic uses the eastern beach. Currently tourism is at a relatively high volume, notably around Lake Mackenzie where there have been concerns about trampling of riparian vegetation and water quality.

2 Methods and Implementation

2.1 AquaBAMM

The WBB ACAs were undertaken using AquaBAMM (Clayton *et al.* 2006). The method as published in 2006 was revised to incorporate non-riverine wetlands measures, and minor changes made to the AquaBAMM tool.

2.2 Spatial units

In implementing an ACA, spatial units need to be defined in order to assign conservation/ecological values when they are calculated. This issue is dealt with in detail in the published methodology (Clayton *et al.* 2006).

For a non-riverine ACA a map of the palustrine and lacustrine wetlands is normally used and the individual mapped wetlands are employed as the ACA spatial units. Clearly, this way of defining spatial units is dependent on an accurate map of classified wetlands being available for the study area. In Queensland, DERM is producing wetland maps state-wide which define wetland location, extent and attributes by applying the Wetland Mapping and Classification Methodology (EPA, 2005). These maps, where available, are used as the platform for ACAs using AquaBAMM.

The number of spatial units included in an ACA can vary greatly between study areas. For the WBB catchment, there were 2,142 non-riverine spatial units (mapped palustrine or lacustrine wetlands) drawn directly from DERM's wetland mapping v2.0. Only natural (H1) or slightly modified (H2M1, H2M2, H2M3, H2M5) wetlands were included (see the Wetland Mapping and Classification Methodology (2005) for more information on these hydrological modifier codes).

For the riverine ACA the spatial units were based on the subsections from the State of the Rivers reports. Where there were no State of the Rivers reports, the subsections were derived using modelling by applying RivaTools v3.0. The riverine ACAs included 994 spatial units (or subsections).

2.3 Assessment parameters

The criteria, indicators and measures (CIM) list outlined in Table 2 outlines the CIM that were implemented as part of the riverine and non-riverine ACAs in the WBB catchments. The list has been developed from a default list of criteria, indicators and measures that may be considered for an ACA. The default CIM list is not mandatory for any particular ACA; however, it provides a "starter set" for consideration in setting the assessment parameters for each ACA.

Table 2: CIM list for the WBB catchments

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	✓	✓
	1.1.2	Presence of exotic aquatic and semi-aquatic plants within the wetland	✓	✓
	1.1.3	Presence of exotic invertebrate fauna within the wetland	✓	✓
	1.1.4	Presence of feral/exotic vertebrate fauna (other than fish) within the wetland	✓	✓
1.2 Aquatic communities/ assemblages	1.2.1	SOR[1] aquatic vegetation condition	✓	
	1.2.2	SIGNAL2 score (Max)	✓	
	1.2.3	AUSRIVAS[2] score - edge (Min band)	✓	
	1.2.4	AUSRIVAS[2] score - pool (Min band)	✓	
	1.2.9	AUSRIVAS[2] score - riffle (Min band)	✓	
1.3 Habitat features modification	1.3.1	SOR[1] bank stability	✓	
	1.3.2	SOR[1] bed and bar stability	✓	
	1.3.3	SOR[1] aquatic habitat condition	✓	
	1.3.4	Presence/absence of dams/weirs within the wetland	✓	
	1.3.5	Inundation by dams/weirs (% of waterway length within the wetland)	✓	
	1.3.8	Presence of dredging/extraction (including for navigation) and channel modification within the wetland	✓	
1.4 Hydrological modification	1.4.1	APFD[3] score - modelled deviation from natural under full development	✓	
	1.4.2	Percent natural flows - modelled flows remaining relative to predevelopment	✓	
	1.4.3	Percent no flows - modelled low flows relative to predevelopment	✓	
	1.4.5	Hydrological disturbance/modification of the wetland (e.g. as determined through DERM wetland mapping and classification)		✓
	1.4.8	High Ecological Value (HEV) Areas	✓	
2 Naturalness catchment				
2.1 Exotic flora/fauna	2.1.1	Presence of exotic terrestrial plants in the assessment unit	✓	✓
2.2 Riparian disturbance	2.2.1	% area remnant vegetation relative to preclear extent within buffered riverine wetland or watercourses	✓	
	2.2.2	Total number of regional ecosystems relative to preclear number of regional ecosystems within buffered riverine wetland or watercourses	✓	
	2.2.3	SOR1 reach environs	✓	
	2.2.4	SOR1 riparian vegetation condition	✓	
	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		✓

Criteria and indicators	Measures		Riverine	Non-riverine
2.3 Catchment disturbance	2.3.1	% "agricultural" land-use area (i.e. cropping and horticulture)	✓	✓
	2.3.2	% "grazing" land-use area	✓	✓
	2.3.3	% "vegetation" land-use area (i.e. native veg + regrowth)	✓	✓
	2.3.4	% "settlement" land-use area (i.e. towns, cities, etc)	✓	✓
2.4 Flow modification	2.4.1	Farm storage (overland flow harvesting, floodplain ring tanks, gully dams) calculated by surface area	✓	✓
3 Diversity and richness				
3.1 Species	3.1.1	Richness of native amphibians (riverine wetland breeders)	✓	
	3.1.2	Richness of native fish	✓	✓
	3.1.3	Richness of native aquatic dependent reptiles	✓	✓
	3.1.4	Richness of native waterbirds	✓	✓
	3.1.5	Richness of native aquatic plants	✓	✓
	3.1.6	Richness of native amphibians (non-riverine wetland breeders)		✓
	3.1.7	Richness of native aquatic dependent mammals	✓	✓
3.2 Communities/ assemblages	3.2.1	Richness of macroinvertebrate taxa	✓	✓
	3.2.2	Richness of regional ecosystems along riverine wetlands or watercourses within a specified buffer distance	✓	
3.3 Habitat	3.3.1	SOR[1] channel diversity	✓	
	3.3.2	Richness of wetland types within the local catchment (e.g. SOR[1] subsection)	✓	✓
	3.3.3	Richness of wetland types within the sub-catchment	✓	✓
4 Threatened species and ecosystems				
4.1 Species	4.1.1	Presence of rare or threatened aquatic ecosystem dependent fauna species – NC Act[4], EPBC Act[5]	✓	✓
	4.1.2	Presence of rare or threatened aquatic ecosystem dependent flora species – NC Act[4], EPBC Act[5]	✓	✓
4.2 Communities/ assemblages	4.2.1	Conservation status of wetland regional ecosystems – Herbarium biodiversity status, NC Act[4], EPBC Act[5]	✓	✓
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[6], WWF, etc)	✓	✓
	5.1.2	Presence of aquatic ecosystem dependent 'priority' flora species	✓	✓
	5.1.3	Habitat for, or presence of, migratory species (expert panel list/discussion and/or JAMBA[7] / CAMBA[8] agreement lists and/or Bonn Convention)	✓	✓
	5.1.4	Habitat for significant numbers of waterbirds	✓	✓
5.2 Ecosystems	5.2.1	Presence of 'priority' aquatic ecosystem	✓	✓
6 Special features				
6.1 Geomorphic features	6.1.1	Presence of distinct, unique or special geomorphic features	✓	✓
6.2 Ecological processes	6.2.1	Presence of (or requirement for) distinct, unique or special ecological processes	✓	✓

Criteria and indicators	Measures		Riverine	Non-riverine
6.3 Habitat	6.3.1	Presence of distinct, unique or special habitat (including habitat that functions as refugia or other critical purpose)	✓	✓
	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.	✓	✓
	6.3.3	Ecologically significant wetlands identified through expert opinion and/or documented study	✓	✓
6.4 Hydrological	6.4.1	Presence of distinct, unique or special hydrological regimes (e.g. spring fed stream, ephemeral stream, boggomoss)	✓	✓
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	✓	
	7.1.2	Migratory or routine 'passage' of fish and other fully aquatic species (upstream, lateral or downstream movement) within the spatial unit	✓	
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)	✓	✓
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	✓	
	7.3.2	Extent to which the wetland retains critical ecological and hydrological connectivity, where it should exist, with floodplains, rivers, groundwater etc.		✓
7.5 Estuarine and marine ecosystems	7.5.1	The contribution of the spatial unit to the maintenance of estuarine and marine ecosystems with significant biodiversity values, including those features identified through criteria 5 and/or 6	✓	✓
8 Representativeness				
8.1 Wetland protection	8.1.1	The percent area of each wetland type within protected areas.		✓
	8.1.2	The percent area of each wetland type within a coastal/estuarine area subject to the *Fisheries Act 1994*, *Coastal Protection and Management Act 1995* or *Marine Parks Act 2004*.		✓
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)		✓
	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)		✓
	8.2.3	The size of each wetland type relative to others of its management group within the catchment or study area		✓

Criteria and indicators	Measures		Riverine	Non-riverine
	8.2.4	The size of each wetland type relative to others of its type within a sub-catchment (or estuarine zone)		✓
	8.2.5	Wetland type representative of the study 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		✓

[1] SOR – State of the Rivers
[2] AUSRIVAS – Australian River Assessment System
[3] APFD – Annual Proportional Flow Deviation
[4] NC Act – *Nature Conservation Act 1992* (Queensland legislation)
[5] EPBC Act – *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth legislation)
[6] ASFB – Australian Society of Fish Biology
[7] JAMBA – Japan-Australia Migratory Bird Agreement
[8] CAMBA – China-Australia Migratory Bird Agreement

The Burnett catchment was the only one with results for Measures 1.4.1 and 1.4.3 (based on results from the previous Burnett ACA). These measures were turned off for the other catchments.

2.4 Stratification

Study area stratification for application to relevant measures of AquaBAMM is a user decision and is not mandatory for a successful assessment. However, AquaBAMM makes provision for data to be stratified in any user-defined manner that is determined to be ecologically appropriate. Stratification mitigates the effects of data averaging across large study areas, and is particularly important where ecological diversity and complexity is high. An example where stratification may be appropriate is fish diversity where fewer species inhabit the upland zone compared to lowland floodplains. For measure datasets where there is an equal probability of scoring across a range of values throughout the study area, stratification is unwarranted. To date, the use of strata in completed ACAs has been based on elevation (e.g. 150 m ASL for coastal catchments and 400 m ASL for catchments west of the Great Dividing Range in the Murray-Darling Basin) or bioregional boundaries.

Stratification was considered by the Wide Bay-Burnett expert panels. The panels considered applying a 150 m ASL stratification boundary similar to that used in previous ACAs. However, an additional stratification boundary was recommended by the fauna panel which also included the lowland subsections in the western part of the Mary catchment (a much drier area than the remainder of the Mary that was considered to result in a different ecology). After further consideration by the wetland ecology panel a final decision was made to apply a combination of the 150 m ASL stratification boundary line and the additional boundary line recommended for the western Mary as the means through which stratification was implemented within the Wide Bay-Burnett region.

Therefore subsections above the 150 m ASL and those contained within the western part of the Mary catchment were assigned as upland subsections. Conversely, subsections below 150m ASL and outside the western part of the Mary catchment were assigned as lowland subsections.

Based on these rules there was no stratification for the Burrum, Noosa North and Fraser Island study areas. In the Kolan there was only one non-riverine wetland (ko_w00075) in the western part of the study area that appeared in the upland zone. Having only one wetland (or subsection) in a stratification zone skews the calculations and as the non-riverine wetland was close to the upland/lowland boundary, it was decided not to stratify as part of the non-riverine ACA for the Kolan catchment.

2.5 Datasets

Typically, an ACA using AquaBAMM draws on a wide range of datasets with a wide range of formats. This will generally include published scientific documents, unpublished data (grey literature) and officially collated data from various Queensland Government sources including

data from the Queensland Museum, Queensland Herbarium, DERM WildNet, DEEDI, and modelled hydrological data from DERM.

In addition, data derived from one or more expert elicitation processes is included for every ACA for a number of measures. Expert advice and data is sought formally through an expert panel process. For the WBB ACAs, a series of expert panels were conducted to address aquatic and riparian flora, aquatic fauna, and wetland ecology. Reports for each of these expert panels are presented as attachments to this report.

2.6 Implementation

Each ACA may have a different combination of assessment parameters (refer to section 2.3), is likely to draw on a different combination of datasets and will have a different set of criteria, indicators and measures. Implementation to complete the assessment can be complex and comprehensive implementation tables are maintained by DERM throughout each ACA. A description of how each measure was implemented as part of the ACA is provided in Table 3.

Table 3: Non-riverine implementation table for the WBB ACA

Measure	Description	Implementation	Primary data sets used	Threshold type	Stratified
1.1.1	Presence of 'alien' fish species within the wetland	An expert panel list of alien fish species found in non-riverine freshwater wetlands was used to calculate this measure. A subsection that had one or more alien fish species recorded (point records or site based lists, >=1975, precision <= 2000 m) from within its boundaries received a score of 1 which was then attributed to all the spatial units in this subsection. No score was allocated to any spatial unit where the associated subsection had an absence of exotic species (i.e. they were treated as a missing value).	WildNet, Queensland Museum, Department of Employment, Economic Development and Innovation (DEEDI), Queensland Historical Fauna Database (QHFD)	Presence negative	
1.1.2	Presence of exotic aquatic and semi-aquatic plants within the wetland	An expert panel list of exotic aquatic plants was used to calculate this measure. A subsection that had one or more exotic species recorded (point records or site based lists, >=1950, precision <= 2000 m) from within its boundaries received a score of 1, which was then attributed to all spatial units in the subsection. No score was allocated to any spatial unit where the associated subsection had an absence of exotic species (i.e. they were treated as a missing value).	WildNet, CORVEG, Herbrecs, ParkInfo	Presence negative	
1.1.3	Presence of exotic invertebrate fauna within the wetland	An expert panel list of exotic invertebrate fauna found in non-riverine freshwater wetlands was used to calculate this measure. A subsection that had one or more exotic invertebrate fauna species recorded (point records or site based lists, >=1975, precision <= 2000 m) from within its boundaries received a score of 1, which was then attributed to all spatial units in the subsection. No score was allocated to any spatial unit where the associated subsection had an absence of exotic species (i.e. they were treated as a missing value).	WildNet, Queensland Museum, Queensland Historical Fauna Database (QHFD)	Presence negative	

Measure	Description	Implementation	Primary data sets used	Threshold type	Stratified
1.1.4	Presence of feral/exotic vertebrate fauna (other than fish) within the wetland	An expert panel list of feral/exotic vertebrate fauna found in non-riverine freshwater wetlands was used to calculate this measure. A subsection that had one or more feral/exotic vertebrate species recorded (point records or site based lists, >=1975, precision <= 2000 m) from within its boundaries received a score of 1, which was then attributed to all spatial units in the subsection. No score was allocated to any spatial unit where the associated subsection had an absence of exotic species (i.e. they were treated as a missing value).	WildNet, Queensland Museum, Queensland Historical Fauna Database (QHFD)	Presence negative	
1.4.5	Hydrological disturbance/modification of the wetland (e.g. as determined through DERM wetland mapping and classification)	Score spatial units according to their modification code. H1 = 4; H2M1, H2M2 and H2M3 = 2; H2M5 = 1	DERM Queensland Wetlands Mapping	Categorical	
2.1.1	Presence of exotic terrestrial plants in the assessment unit	An expert panel list of exotic plants found within the riparian zone of streams and wetlands was used to calculate this measure. A subsection that had one or more exotic species recorded (point records or site based lists, >=1950, precision <=2000 m) from within its boundaries received a score of 1, which was then attributed to all spatial units in the subsection. No score was allocated to any spatial unit where the associated subsection had an absence of exotic species (i.e. they were treated as a missing value).	WildNet, CORVEG, Herbrecs, ParkInfo	Presence negative	Y
2.2.5	Per cent (%) 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	Divided spatial units into 4 classes (>=60 ha; >=20<60 ha; >=8<20 ha; <8 ha) and then buffered according to their area (500 m buffer for spatial units >=8 ha, 200 m buffer for smaller spatial units); buffers were dissolved where buffer zones of adjacent spatial units of the same class overlapped. The percent remnant verses pre-clear vegetation was calculated for each buffer, and then reapplied to each spatial unit within the buffer.	DERM Queensland Wetlands Mapping V2.0, RE V6.0, RE Pre-Clear V6.0	Quartile - continuous ascending	Y

Measure	Description	Implementation	Primary data sets used	Threshold type	Stratified
2.3.1	Per cent (%) "agricultural" land-use area (i.e. cropping and horticulture)	“Agricultural” land-use included (QLUMP secondary categories) intensive animal production, intensive horticulture, cropping, perennial horticulture, plantation forestry, irrigated cropping, irrigated perennial horticulture, irrigated seasonal horticulture and reservoir/dam. These land-use types were allocated an agriculture attribute and a percent area was calculated for agricultural areas within each subsection; this value was then applied to each spatial unit within the subsection. Spatial units that extend across subsections have already been allocated to a subsection based on the maximum area. Average of the 3 highest weighted percent scores (by subsection).	QLUMP	Quartile - continuous descending	Y
2.3.2	Per cent (%) "grazing" land-use area	“Grazing” land-use included (QLUMP secondary categories) grazing natural vegetation. These land-use types were allocated a grazing attribute and a percent area was calculated for grazing areas within each subsection; this value was then applied to each spatial unit within the subsection. Spatial units that extend across subsections have already been allocated to a subsection based on the maximum area. Average of the 3 highest weighted percent scores (by subsection).	QLUMP	Quartile - continuous descending	Y
2.3.3	Per cent (%) "vegetation" land-use area (i.e. native veg + regrowth)	“Vegetation” land-use included (QLUMP secondary categories) managed resource protection, nature conservation, other minimal use, production forestry, estuary/coastal waters, lake, marsh/wetland, river. These land-use types were allocated a vegetation attribute and a percent area was calculated for vegetation areas within each subsection; this value was then applied to each spatial unit within the subsection. Spatial units that extend across subsections have already been allocated to a subsection based on the maximum area. Average of the 3 highest weighted percent scores (by subsection).	QLUMP	Quartile - continuous ascending	Y

Measure	Description	Implementation	Primary data sets used	Threshold type	Stratified
2.3.4	Per cent (%) "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 percent area was calculated for settlement areas within each subsection; this value was then applied to each spatial unit within the subsection. Spatial units that extend across subsections have already been allocated to a subsection based on the maximum area. Average of the 3 highest weighted percent scores (by subsection).	QLUMP	Quartile - continuous descending	Y
2.4.1	Farm storage (overland flow harvesting, floodplain ring tanks, gully dams) calculated by surface area	The total surface area of artificial wetlands (H2M6, H2M7, H2C1, H2C2, H2C3, H3C1 and H3C2) within each subsection was calculated, and subsequently applied to all spatial units already allocated to that subsection (spatial units are allocated to a subsection based on max area).	Modified wetlands from DERM Queensland Wetlands Mapping	Continuous descending logarithmic	Y
3.1.2	Richness of native fish	An expert panel list of fish dependent on freshwater wetlands (non-riverine) for all or part of their lifecycles was used to calculate this measure. Records >=1975 and a precision <2000 m were included. A subsection was attributed with the number of species records it contained. this value was then attributed to all the spatial units in the subsection. No score was allocated to any spatial unit where the associated subsection had an absence of species (i.e. they were treated as a missing value).	WildNet, Queensland Museum, Department of Employment, Economic Development and Innovation (DEEDI), Queensland Historical Fauna Database (QHFD)	Quartile - Continuous Ascending	Y
3.1.3	Richness of native aquatic dependent reptiles	An expert panel list of reptiles dependent on streams for all or part of their lifecycles was used to calculate this measure. Records >=1975 and a precision <2,000 m were included. A subsection was attributed with the number of species records it contained; this value was then attributed to all the spatial units in the subsection. No score was allocated to any spatial unit where the associated subsection had an absence of species (i.e. they were treated as a missing value).	WildNet, Queensland Museum, Queensland Historical Fauna Database (QHFD)	Quartile - Continuous Ascending	Y

Measure	Description	Implementation	Primary data sets used	Threshold type	Stratified
3.1.4	Richness of native waterbirds	An expert panel list of waterbirds dependent on streams for all or part of their lifecycles was used to calculate this measure. Records >=1975 and a precision <2000 m were included. A subsection was attributed with the number of species records it contained. This value was then attributed to all the spatial units in the subsection. No score was allocated to any spatial unit where the associated subsection had an absence of species (i.e. they were treated as a missing value).	WildNet, Queensland Museum, Queensland Historical Fauna Database (QHFD)	Quartile - Continuous Ascending	Y
3.1.5	Richness of native aquatic plants	An expert panel list of aquatic and semi-aquatic plants (macrophytes) was used to calculate this measure. Records >=1950 and a precision <2000 m were included. A subsection was attributed with the number of species records it contained. This value was then attributed to all the spatial units in the subsection. No score was allocated to any spatial unit where the associated subsection had an absence of species (i.e. they were treated as a missing value).	WildNet, CORVEG, Herbrecs	Quartile - Continuous Ascending	Y
3.1.6	Richness of native amphibians (non-riverine wetland breeders)	An expert panel list of amphibians dependent on non-riverine wetlands for all or part of their lifecycles was used to calculate this measure. Records >=1975 and a precision <2000 m were included. A subsection was attributed with the number of species records it contained. This value was then attributed to all the spatial units in the subsection. No score was allocated to any spatial unit where the associated subsection had an absence of species (i.e. they were treated as a missing value). Fauna model for *Crinia tinnula* was used instead of species records.	WildNet, Queensland Museum, Queensland Historical Fauna Database (QHFD)	Quartile - Continuous Ascending	Y
3.1.7	Richness of native aquatic dependent mammals	An expert panel list of mammals dependant on non-riverine wetlands for all or part of their lifecycles was used to calculate this measure. Records >=1975 and a precision <2000 m were included. A subsection was attributed with the number of species records it contained. This value was then attributed to all the spatial units in the subsection. No score was allocated to any spatial unit where the associated subsection had an absence of species (i.e. they were treated as a missing value).	WildNet, Queensland Museum, Queensland Historical Fauna Database (QHFD)	Quartile - Continuous Ascending	Y

Measure	Description	Implementation	Primary data sets used	Threshold type	Stratified
3.2.1	Richness of macroinvertebrate taxa	An expert panel list of macroinvertebrate taxa dependant on non-riverine wetlands for all or part of their lifecycles was used to calculate this measure. Records >=1975 and a precision <2000 m were included. A subsection was attributed with the number of species records it contained. This value was then attributed to all the spatial units in the subsection. No score was allocated to any spatial unit where the associated subsection had an absence of species (i.e. they were treated as a missing value). Due to the low number of records the threshold was made presence positive.	WildNet, Queensland Museum, Queensland Historical Fauna Database (QHFD)	Presence Positive	Y
3.3.2	Richness of wetland types within the local catchment (e.g. SOR subsection)	The number of different wetland habitat types (based on TYPE_RE field - a concatenation of wetland class, water regime, salinity modifier and 'wetre' fields from the QWM data) were calculated for each subsection, and subsequently applied to all spatial units already allocated to that subsection (wetlands are allocated to a subsection based on the subsection that contains the maximum portion of their area). Threshold values were calculated based on the average of the 3 highest weighted richness scores by spatial unit. Wetlands with H2M1 and H2M5 hydromodifiers were not assessed in this measure.	DERM Queensland Wetlands Mapping	Quartile - continuous ascending	Y
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, water regime, salinity modifier and 'wetre' fields from the QWM data) were calculated for each sub-catchment, and subsequently applied to all spatial units already allocated to that sub-catchment (spatial units are allocated to a subsection and sub-catchment based on whichever one contains the maximum portion of their area). Sub-catchment = catchment within SOR data. Threshold values were calculated based on the average of the 3 highest weighted richness scores (by spatial unit). Wetlands with H2M1 and H2M5 hydromodifiers were not assessed in this measure.	DERM Queensland Wetlands Mapping	Quartile - continuous ascending	Y

Measure	Description	Implementation	Primary data sets used	Threshold type	Stratified
4.1.1	Presence of rare or threatened aquatic ecosystem dependent fauna species – NC Act, EPBC Act	A list of threatened fauna species dependent on wetlands for all or part of their lifecycles was used to calculate this measure. Subsections that had one or more threatened fauna species recorded (point records or site based lists >=1975; precision <=2000 m) from within its boundaries received a score of 4; this score was then attributed to all mapped and classified spatial units associated with that subsection. No score was allocated to spatial units within subsections where there was an absence of threatened species (i.e. they were treated as a missing value). *Crinia tinnula* fauna model was used instead of point records for this species.	WildNet, Queensland Museum, Department of Employment, Economic Development and Innovation (DEEDI), Queensland Historical Fauna Database (QHFD)	Presence positive	
4.1.2	Presence of rare or threatened aquatic ecosystem dependent flora species – NC Act, EPBC Act	A list of threatened flora species dependent on wetlands for all or part of their lifecycles was used to calculate this measure. Subsections that had one or more threatened flora species recorded (point records or site based lists >=1950, precision <=2000m) from within its boundaries received a score of 4; this score was then attributed to all mapped and classified spatial units associated with the subsection. No score was allocated to spatial units within subsections where there was an absence of threatened species (i.e. they were treated as a missing value).	WildNet, CORVEG, Herbrecs	Presence positive	
4.2.1	Conservation status of wetland regional ecosystems – Herbarium biodiversity status, NC Act, EPBC Act	The regional ecosystem biodiversity status was used to score spatial units. The 'WETRE' (previously WB_RE) field in the wetland mapping was used to identify the associated REs for each spatial unit. Endangered REs scored a 4, of concern REs scored a 3, no concern at present REs scored a 2 and spatial units without a RE category (i.e. "water") scored 1. Where a spatial unit had several polygons of differing REs, the maximum RE score was assigned to the spatial units (a deconcatenation code was used to separate these).	DERM Queensland Wetlands Mapping	Categorical E = 4, OC = 3, NOC = 2, noRE = 1	

Measure	Description	Implementation	Primary data sets used	Threshold type	Stratified
5.1.1	Presence of aquatic ecosystem dependent 'priority' fauna species (expert panel list/discussion or other lists such as ASFB, WWF, etc)	An expert panel list of priority fauna species dependent on wetlands for all or part of their lifecycles was used to calculate this measure. A subsection that had one priority fauna species recorded (point records or site based lists >1975, precision <2000 m) from within its boundaries received a score of 3. Where there were 2 or more priority fauna species recorded from within a subsection, it received a score of 4. These scores were then attributed to all the spatial units the subsection contained. No score was allocated to any spatial unit where the subsection it was in had an absence of priority species (i.e. they were treated as a missing value).	WildNet, Queensland Museum, Department of Employment, Economic Development and Innovation (DEEDI), Queensland Historical Fauna Database (QHFD)	User Defined 1 = 3; >1 = 4	
5.1.2	Presence of aquatic ecosystem dependent 'priority' flora species	An expert panel list of priority flora species dependent on wetlands for all or part of their lifecycles was used to calculate this measure. A subsection that had one priority flora species recorded (point records or site based lists >1950, precision <2000 m) from within its boundaries received a score of 3. Where there were two or more priority flora species recorded from within a subsection, it received a score of 4. These scores were then attributed to all the spatial units the subsection contained. No score was allocated to any spatial unit where the subsection it was in had an absence of priority species (i.e. they were treated as a missing value).	WildNet, CORVEG, Herbrecs	User Defined 1 = 3; >1 = 4	
5.1.3	Habitat for, or presence of, migratory species (expert panel list/discussion and/or JAMBA / CAMBA agreement lists and/or Bonn Convention)	An expert panel list of migratory species dependent on wetlands for all or part of their lifecycles was used to calculate this measure. A subsection that had one migratory species recorded (point records or site based lists >1950, precision <2000 m) from within its boundaries received a score of 3. Where there were two or more migratory species recorded from within a subsection, it received a score of 4. These scores were then attributed to all the spatial units the subsection contained. No score was allocated to any spatial unit where the associated subsection had an absence of migratory species (i.e. they were treated as a missing value).	WildNet, Queensland Museum, Queensland Historical Fauna Database (QHFD)	User Defined 1 = 3; >1 = 4	
5.1.4	Habitat for significant numbers of waterbirds	The expert panels identified these special features. The assigned conservation ratings for this measure were attributed. There was no need to apply thresholds as conservation ratings represent the final score for this measure.	Expert panels	Categorical	

Measure	Description	Implementation	Primary data sets used	Threshold type	Stratified
5.2.1	Presence of 'priority' aquatic ecosystem	The expert panels identified these special features. The assigned conservation ratings for this measure were attributed. There was no need to apply thresholds as conservation ratings represent the final score for this measure.	Expert panels	Categorical	
6.1.1	Presence of distinct, unique or special geomorphic features	The expert panels identified these special features. The assigned conservation ratings for this measure were attributed. There was no need to apply thresholds as conservation ratings represent the final score for this measure.	Expert panels	Categorical	
6.2.1	Presence of (or requirement for) distinct, unique or special ecological processes	The expert panels identified these special features. The assigned conservation ratings for this measure were attributed. There was no need to apply thresholds as conservation ratings represent the final score for this measure.	Expert panels	Categorical	
6.3.1	Presence of distinct, unique or special habitat (including habitat that functions as refugia or other critical purpose)	The expert panels identified these special features. The assigned conservation ratings for this measure were attributed. There was no need to apply thresholds as conservation ratings represent the final score for this measure.	Expert panels	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.	Spatial units that occurred within the mapped boundaries of Ramsar and WHA, (world heritage areas) and Directory of Important Wetlands were identified. For those spatial units that had at least 50% of their area within this special areas layer were allocated a score of 4. No score was allocated to spatial units that were not identified as significant by such methods (i.e. they were treated as a missing value).	DOIW, Ramsar, WHA	Categorical	
6.3.3	Ecologically significant wetlands identified through expert opinion and/or documented study	The expert panel considered these special features from other documented studies and assigned conservation ratings for this measure. There was no need to apply thresholds as conservation ratings represent the final score for this measure.	Biodiversity planning assessments (BPAs) and other documented reports external to the ACA process	Categorical	
6.4.1	Presence of distinct, unique or special hydrological regimes (e.g. spring fed stream, ephemeral stream, boggomoss)	The expert panels identified these special features. The assigned conservation ratings for this measure were attributed. There was no need to apply thresholds as conservation ratings represent the final score for this measure.	Expert panels	Categorical	

Measure	Description	Implementation	Primary data sets used	Threshold type	Stratified
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)	Non-riverine implementation is only for the expert panel decisions for this measure. The expert panels identified these special features. The assigned conservation ratings for this measure were attributed. There was no need to apply thresholds as conservation ratings represent the final score for this measure.	Expert panels	Categorical	
7.3.2	Extent to which the wetland retains critical ecological and hydrological connectivity, where it should exist, with floodplains, rivers, groundwater, etc	Within DOIW, any wetlands that fall within the DOIW polygon or that intersect the same subsection that intersects the DOIW are attributed a 4. Connecting subsections do not get a score as there is a loss of confidence in the connectivity value. The results from selecting the non-riverine wetlands that intersect the DOIW areas (using select by location in GIS) were checked carefully and any wetlands that are only just selected were removed from the selection i.e. the majority of the wetland needs to intersect with the DOIW.	Expert panel, Directory of Important Wetlands	Categorical	
7.5.1	The contribution of the spatial unit to the maintenance of estuarine and marine ecosystems with significant biodiversity values, including those features identified through criteria 5 and/or 6	Any non-riverine wetlands within a subsection containing an estuarine wetland were assigned a 4 as long as the estuarine wetland did not contain a barrage. All non-riverine wetlands in the next upstream subsection score a 3, then 2 then 1. If the subsection contained an estuarine wetland and a barrage then the non-riverine wetlands within that subsection will score a 2 and the next subsection upstream will score a 1 as long as it does not contain a barrage.	Expert panels	Categorical	

Measure	Description	Implementation	Primary data sets used	Threshold type	Stratified
8.1.1	The percent area of each wetland habitat type within protected areas	The DERM Estates (CP, FR, NC, NP, NS, RR, SF and TR) and nature refuge data was used to calculate the percent 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 thresholds from Sattler & Williams (1999). >10% = 1; >4% = 2; >1% = 3; <1% = 4. The minimum per cent area was used for individual wetlands with more than 1 wetland habitat type to account for habitats less protected. Wetlands with H2M1 and H2M5 hydromodifiers were not assessed in this measure.	DERM Queensland Wetlands Mapping (with TYPE_RE concatenated field), DERM Protected Areas of Queensland (estate) and Other Lands, DERM Nature Refuges and Coordinated Conservation Areas	Continuous descending (Sattler & Williams 1999)	
8.1.2	The percent area of each wetland habitat type within a coastal/estuarine area subject to the *Fisheries Act 1994, Coastal Protection* and *Management Act 1995* or *Marine Parks Act 2004*.	The DEEDI fish habitat data was used to calculate the percent 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 thresholds from Sattler & Williams (1999). >10% = 1; >4% = 2; >1% = 3; <1% = 4. The minimum percent area was used for individual wetlands with more than 1 wetland habitat type to account for habitats less protected. Wetlands with H2M1 and H2M5 hydromodifiers were not assessed in this measure.	DERM Queensland Wetlands Mapping (with TYPE_RE concatenated field), DEEDI fish habitat areas layer	Continuous descending (Sattler & Williams 1999)	
8.2.1	The relative abundance of the wetland management group to which the wetland habitat belongs within the catchment or study area (management groups ranked least common to most common)	Each wetland habitat is assigned a wetland management group (WMG), assigned via the wetland habitat typology. Then a count of each WMG is conducted across the whole study area. Each wetland habitat polygon will be assigned a score based on the abundance of the WMG. The maximum value will be assigned to a spatial unit where it contains 2 or more WMGs (based on the wetlands habitat polygons it contains). The maximum conservation rating is associated with the lowest frequency so the wetland habitat from the WMG with the lowest frequency was attributed to spatial units with more than one WMG. Wetlands with H2M1 and H2M5 hydromodifiers were not assessed in this measure.	DERM Queensland Wetlands Mapping with DERM habitat typology applied to determine wetland management groups, study area layer	Continuous descending logarithmic	

Measure	Description	Implementation	Primary data sets used	Threshold type	Stratified
8.2.2	The relative abundance of the wetland management group to which the wetland habitat belongs within the sub-catchment or estuarine/marine zone (management groups ranked least common to most common)	Each wetland habitat is assigned a wetland management group (WMG), assigned via the wetland habitat typology. Then a count of each WMG is conducted across the sub-catchments (there are typically several sub-catchments within a study area). Each wetland habitat polygon will be assigned a score based on the abundance of the WMG it belongs to within a sub-catchment. The maximum value will be assigned to a spatial unit where it contains 2 or more WMGs (based on the wetlands habitat polygons it contains). The maximum conservation rating is associated with the lowest frequency so the wetland habitat from the WMG with the lowest frequency was attributed to spatial units with more than one WMG. Wetlands with H2M1 and H2M5 hydromodifiers were not assessed in this measure.	DERM Queensland Wetlands Mapping with DERM habitat typology applied to determine wetland management groups, sub-catchments layer	Continuous descending logarithmic	
8.2.3	The size of each wetland habitat relative to others of its management group within the catchment or study area	Each wetland habitat is assigned a wetland management group (WMG), assigned via the wetland habitat typology. This measure is based on an area calculation of each wetland habitat polygon within a WMG. The resulting list of area values for a WMG across a whole study area is quartiled (thresholds applied using the average of the three maximum values). When there are 2 or more values for a spatial unit, the spatial unit will receive the score of the highest scoring wetland habitat polygon it contains The maximum conservation rating is associated with the largest wetland habitat polygon within each WMG. Wetlands with H2M1 and H2M5 hydromodifiers were not assessed in this measure.	DERM Queensland Wetlands Mapping with DERM habitat typology applied to determine wetland management groups, study area layer	Categorical	
8.2.4	The size of each wetland habitat relative to others of its management group within a sub-catchment (or estuarine zone)	Each wetland habitat is assigned a wetland management group (WMG), assigned via the wetland habitat typology. This measure is based on an area calculation of each wetland habitat polygon within a WMG. The resulting list of area values for a WMG across a sub-catchment area is quartiled (thresholds applied using the average of the three maximum values). When there are 2 or more values for a spatial unit, the spatial unit will receive the score of the highest scoring wetland habitat polygon it contains. The maximum conservation rating is associated with the largest wetland habitat polygon within each WMG. Wetlands with H2M1 and H2M5 hydromodifiers were not assessed in this measure.	DERM Queensland Wetlands Mapping with DERM habitat typology applied to determine wetland management groups, sub-catchments layer	Categorical	

Measure	Description	Implementation	Primary data sets used	Threshold type	Stratified
8.2.5	Wetland (either wetland habitat or SPUNITID) representative of the study area – identified by expert opinion	The expert panels identified these special features. The assigned conservation ratings for this measure were attributed. There was no need to apply thresholds as conservation ratings represent the final score for this measure.	Expert panels	Categorical	
8.2.6	The size of each wetland habitat relative to others of its 'type' within the catchment or study area	Area calculation of wetland habitat polygons across whole study area based on the wetland habitat type (based on TYPE_RE field - a concatenation of wetland class, water regime, salinity modifier and 'wetre' fields from the QWM data). Each wetland habitat type in each study area (usually with multiple wetland habitat polygons) is then quartiled and thresholded. Based on the thresholds a categorical value is attributed to the wetland habitats. Where a spatial unit only contains one wetland habitat, the categorical value is directly attributed. When there are 2 or more values for a spatial unit, the spatial unit will receive the score of the highest scoring wetland habitat polygon it contains. The maximum conservation rating is associated with the largest wetland habitat polygon within each TYPE_RE group in the study area. Wetlands with H2M1 and H2M5 hydromodifiers were not assessed in this measure.	DERM Queensland Wetlands Mapping (with TYPE_RE concatenated field), study area layer	Categorical	

Table 4 Riverine implementation table for the WBB ACA

Measure	Description	Implementation	Primary Data	Threshold Type	Stratified
1.1.1	Presence of 'alien' fish species within the wetland	An expert panel list of alien fish species found in riverine freshwater wetlands was used to calculate this measure. A subsection that had one or more alien fish species recorded (point records or site based lists, >=1975, precision <= 2000 m) from within its boundaries received a score of one. No score was allocated to any spatial unit (subsection) that had an absence of exotic species (i.e. they were treated as a missing value).	WildNet, Department of Employment, Economic Development and Innovation (DEEDI), Queensland Historical Fauna Database (QHFD)	Presence negative	

Measure	Description	Implementation	Primary Data	Threshold Type	Stratified
1.1.2	Presence of exotic aquatic and semi-aquatic plants within the wetland	An expert panel list of exotic aquatic plants was used to calculate this measure. A subsection that had one or more exotic species recorded (point records or site based lists, >=1950, precision <= 2000 m) from within its boundaries received a score of one. No score was allocated to any spatial unit (subsection) that had an absence of exotic species (i.e. they were treated as a missing value).	WildNet, CORVEG, Herbrecs, ParkInfo, Wetland Information Capture Project	Presence negative	
1.1.3	Presence of exotic invertebrate fauna within the wetland	An expert panel list of exotic invertebrate fauna found in riverine freshwater wetlands was used to calculate this measure. A subsection that had one or more exotic invertebrate fauna species recorded (point records or site based lists, >=1975, precision <= 2000 m) from within its boundaries received a score of one. No score was allocated to any spatial unit (subsection) that had an absence of exotic species (i.e. they were treated as a missing value).	WildNet, Queensland Museum, Queensland Historical Fauna Database (QHFD)	Presence negative	
1.1.4	Presence of feral/exotic vertebrate fauna (other than fish) within the wetland	An expert panel list of feral/exotic vertebrate fauna found in riverine freshwater wetlands was used to calculate this measure. A subsection that had one or more feral/exotic vertebrate species recorded (point records or site based lists, >=1975, precision <= 2000 m) from within its boundaries received a score of one, which was then attributed to all spatial units in the subsection. No score was allocated to any spatial unit (subsection) that had an absence of exotic species (i.e. they were treated as a missing value).	WildNet, Queensland Museum, Queensland Historical Fauna Database (QHFD)	Presence negative	
1.2.1	SOR aquatic vegetation condition	The SOR score (percent) for the 'AQUVEG' field for each spatial unit was directly incorporated into the analysis. This was done by converting the SOR polygons to points, attributing the points to the ACA subsections and then taking the average value for each subsection.	DERM State of the Rivers	Quartile - continuous ascending	
1.2.2	SIGNAL2 score (Max)	The maximum Signal2 score for each spatial unit, where one or more Signal2 scores had been calculated, was used in the analysis. No score was allocated to any spatial unit that did not have a Signal2 score (i.e. they were treated as a missing value).	DERM AUSRIVAS	Quartile - continuous ascending	

Measure	Description	Implementation	Primary Data	Threshold Type	Stratified
1.2.3	AUSRIVAS score - edge (Min band)	The AUSRIVAS modelled bands (seasonal + habitat) were identified for each score. Band D was scored one, Band C was scored 2, Bands B & X were scored three and Band A was scored 4. No score was allocated to any spatial unit that did not have an AUSRIVAS score (i.e. they were treated as a missing value).	DERM AUSRIVAS	Categorical	
1.2.4	AUSRIVAS score - pool (Min band)	The AUSRIVAS modelled bands (seasonal + habitat) were identified for each score. Band D was scored one, Band C was scored 2, Bands B & X were scored three and Band A was scored 4. No score was allocated to any spatial unit that did not have an AUSRIVAS score (i.e. they were treated as a missing value).	DERM AUSRIVAS	Categorical	
1.2.9	AUSRIVAS score - riffle (Min band)	The AUSRIVAS modelled bands (seasonal + habitat) were identified for each score. Band D was scored one, Band C was scored 2, Bands B & X were scored three and Band A was scored 4. No score was allocated to any spatial unit that did not have an AUSRIVAS score (i.e. they were treated as a missing value).	DERM AUSRIVAS	Categorical	
1.3.1	SOR bank stability	The SOR score (per cent) for the 'BSTAB' field for each spatial unit was directly incorporated into the analysis. This was done by converting the SOR polygons to points, attributing the points to the ACA subsections and then taking the average value for each subsection.	DERM State of the Rivers	Quartile - continuous ascending	
1.3.2	SOR bed & bar stability	The SOR score (per cent) for the 'B_B' field for each spatial unit was directly incorporated into the analysis. This was done by converting the SOR polygons to points, attributing the points to the ACA subsections and then taking the average value for each subsection.	DERM State of the Rivers	Quartile - continuous ascending	
1.3.3	SOR aquatic habitat condition	The SOR score (per cent) for the 'AQUHAB' field for each spatial unit was directly incorporated into the analysis. This was done by converting the SOR polygons to points, attributing the points to the ACA subsections and then taking the average value for each subsection.	DERM State of the Rivers	Quartile - continuous ascending	

Measure	Description	Implementation	Primary Data	Threshold Type	Stratified
1.3.4	Presence/absence of dams/weirs within the wetland	A subsection that had one or more instream dams or weirs located within its boundaries received a score of one. Other ACAs have scored those with weirs only as a two but this was not applied due to lack of time. Subsections without instream dams or weirs received no score and this measure was thresholded as presence negative (this differs to the earlier standalone Baffle Riverine ACA which scored subsections without dams or weirs as a four).	DERM Dams and Weirs Coverage	Presence negative	
1.3.5	Inundation by dams/weirs (% of waterway length within the wetland)	A dams and weirs extent layer was determined by using the Dams, Weirs, Barrages - QLD 100K point dataset to manually identify and select H2M1 polygons from the Queensland Wetlands Mapping. Were a H2M1 polygon from the Queensland Wetlands Mapping didn't exist, the wetlands mapping was checked for other polygons and, in some cases, H3C1 polygons which appeared to be misclassified in the wetlands mapping were used. The 100K drainage lines were intersected with the subsections and dissolved on the SUBS_ID to get total length of drainage lines for each subsection. The length of streams inundated by the selected dams and weirs layer was divided by the total stream length for each subsection. Thresholds used as follows: <100% inundation = one; <10% = two; <1% = three; 0% = four.	DERM Dams and Weirs coverage, DERM Queensland Wetlands Mapping, directionalised stream network with stream order based on DERM 100K drainage layer	Presence negative or categorical	
1.3.8	Presence of dredging/extraction (including for navigation) and channel modification within the wetland	Extractions sites were supplied as lot on plan numbers and these sites were found as polygons in the digital cadastral database. These polygons were interested with the ACA subsections which were attributed a value of one. No value was assigned to other subsections.	DERM Digital Cadastral Database and DERM QMAN Quarry extraction information list	Presence negative	

Measure	Description	Implementation	Primary Data	Threshold Type	Stratified
1.4.1	APFD score - modelled deviation from natural under full development	The results from the Burnett Riverine ACA V 1.0 were joined to the Wide Bay Burnett V1.0 subsections layer using their centroids. Null values were deleted.	Burnett Riverine ACA Version 1.0 results.	Previously categories we applied to APFD score were: AScore 4 = 0 3 = <=1 2 = <=10 1 = >10. Could consider changing to: 4 = 0 3 = <=1.2 2 = <=2 1 = >2)	
1.4.2	Percent natural flows - modelled flows remaining relative to predevelopment	Streams were categorised based on the flow information from the WRPs. This was done by colouring PDFs for the Mary, Kolan and Burrum study areas and attributing the previous results for Burnett Riverine ACA V1.0 using centroids. These results were attributed to the relevant subsection. All subsections without a value were assigned a four. Values for Cooloola Coast and Fraser Island could not be accessed, so all subsections were assigned a 4. Considered assigning Teewah Creek a lower rating but unable to identify the specific subsection (suspected cc_00043) so left as 4. The four subsections in the lower part of the Burnett (bu_00343, bu_00339, bu_00348, bu_00356) were assigned a value of 2.	Water Resource Plans (WRPs) for the Kolan (from Burnett WRP), Burrum and Mary study areas (from the Mary WRP). Burnett Riverine ACA Version 1.0 results, expert opinion.	Categorical Cullen (2003) Heritage Rivers AScore 4 = >=95; 3 = >=85; 2 = >=67; 1 = <67%.	
1.4.8	HEV Areas	The freshwater HEV areas (MI_TYPE = HEVm_fw) in the management intent for waters layer for south-east Queensland were selected. Then all subsections that intersected these areas were given a value of one. No value was assigned to other subsections.	EPP Water South-East Queensland Management Intent for Water (published 16/7/2010)	Presence positive	

Measure	Description	Implementation	Primary Data	Threshold Type	Stratified
2.1.1	Presence of exotic terrestrial plants in the assessment unit	An expert panel list of exotic plants found within the riparian zone of streams and wetlands was used to calculate this measure. A subsection that had one or more exotic species recorded (point records or site based lists, >=1950, precision <=2000 m) from within its boundaries received a score of one. No score was allocated to any spatial unit (subsection) that had an absence of exotic species (i.e. they were treated as a missing value).	WildNet, CORVEG, Herbrecs, ParkInfo, Wetland Information Capture Project	Presence negative	Y
2.2.1	Per cent (%) area remnant vegetation relative to preclear extent within buffered riverine wetland or watercourses	Streams were buffered according to their stream order (1:100,000) (first and second order = 50 m; third and fourth order = 100 m; >fifth = 200 m). The percent remnant verses non-remnant vegetation was calculated for each spatial unit (SOR subsections).	Directionalised stream network with stream order based on DERM 100K drainage layer, Queensland Herbarium remnant vegetation mapping	Quartile - continuous ascending	
2.2.2	Total number of REs relative to preclear number of REs within buffered riverine wetland or watercourses	Streams were buffered according to their stream order (1:100,000) (first and second order = 50 m; third and fourth order = 100 m; >fifth = 200 m). The stream buffers were intersected with remnant vegetation and preclear vegetation. These were then intersected with the spatial units. The number of regional ecosystems remaining verses pre-clear vegetation mapping was calculated for each spatial unit. That is, this measure is an observed verses expected (O/E) value for regional ecosystems within each spatial unit.	Directionalised stream network with stream order based on DERM 100K drainage layer, Queensland Herbarium remnant vegetation mapping	Quartile - continuous ascending	
2.2.3	SOR reach environs	The SOR score (per cent) for the 'RENV' field for each spatial unit was directly incorporated into the analysis. This was done by converting the SOR polygons to points, attributing the points to the ACA Subsections and then taking the average value for each subsection.	DERM State of the Rivers	Quartile - continuous ascending	
2.2.4	SOR riparian vegetation condition	The SOR score (per cent) for the 'RIPVEG' field for each spatial unit was directly incorporated into the analysis. This was done by converting the SOR polygons to points, attributing the points to the ACA subsections and then taking the average value for each subsection.	DERM State of the Rivers	Quartile – continuous ascending	

Measure	Description	Implementation	Primary Data	Threshold Type	Stratified
2.3.1	Per cent (%) "agricultural" land-use area (i.e. cropping and horticulture)	“Agricultural” land-use included (QLUMP secondary categories) intensive animal production, intensive horticulture, cropping, perennial horticulture, plantation forestry, irrigated cropping, irrigated perennial horticulture, irrigated seasonal horticulture and reservoir/dam. These land-use types were allocated an agriculture attribute and a percent area was calculated for agricultural areas within each subsection. Thresholding applied the average of the three highest weighted per cent scores (by subsection).	DERM QLUMP	Quartile - continuous descending	Y
2.3.2	Per cent (%) "grazing" land-use area	“Grazing” land-use included (QLUMP secondary category) grazing natural vegetation. This land-use type was allocated a grazing attribute and a percent area was calculated for grazing areas within each subsection. Thresholding applied the average of the three highest weighted per cent scores (by subsection).	DERM QLUMP	Quartile - continuous descending	Y
2.3.3	Per cent (%) "vegetation" land-use area (i.e. native veg + regrowth)	“Vegetation” land-use included (QLUMP secondary categories) managed resource protection, nature conservation, other minimal use, production forestry, estuary/coastal waters, lake, marsh/wetland, river. These land-use types were allocated a vegetation attribute and a percent area was calculated for vegetation areas within each subsection. Thresholding applied the average of the three highest weighted per cent scores (by subsection).	DERM QLUMP	Quartile - continuous ascending	Y
2.3.4	Per cent (%) "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 percent area was calculated for settlement areas within each subsection; this value was then applied to each spatial unit within the subsection. Thresholding applied the average of the three highest weighted per cent scores (by subsection).	DERM QLUMP	Quartile - continuous descending	Y
2.4.1	Farm storage (overland flow harvesting, floodplain ring tanks, gully dams) calculated by surface area	The total surface area, in hectares, of artificial wetlands (H2M6, H2M7, H2C1, H2C2, H2C3, H3C1 and H3C2) within each subsection was calculated.	Modified wetlands from DERM Queensland Wetlands Mapping	Continuous descending logarithmic	Y

Measure	Description	Implementation	Primary Data	Threshold Type	Stratified
3.1.1	Richness of native amphibians (riverine wetland breeders)	An expert panel list of amphibians dependent on streams for all or part of their lifecycles was used to calculate this measure. Records >=1975 and a precision <2000 m were included. No score was allocated to any spatial unit that had an absence of amphibians (i.e. they were treated as a missing value).	WildNet, Queensland Museum, Queensland Historical Fauna Database (QHFD)	Quartile - Continuous Ascending	
3.1.2	Richness of native fish	An expert panel list of fish dependent on freshwater streams for all or part of their lifecycles was used to calculate this measure. Records >=1975 and a precision <2000 m were included. A subsection was attributed with the number of species records it contained. No score was allocated to any subsection that had an absence of species (i.e. they were treated as a missing value).	WildNet, Queensland Museum, Employment, Economic Development and Innovation (DEEDI), Queensland Historical Fauna Database (QHFD)	Quartile - Continuous Ascending	Y
3.1.3	Richness of native aquatic dependent reptiles	An expert panel list of reptiles dependent on streams for all or part of their lifecycles was used to calculate this measure. Records >=1975 and a precision <2000 m were included. A subsection was attributed with the number of species records it contained; this value was then attributed to all the spatial units in the subsection. No score was allocated to any spatial unit where the associated subsection had an absence of species (i.e. they were treated as a missing value).	WildNet, Queensland Museum, Queensland Historical Fauna Database (QHFD)	Quartile - Continuous Ascending	Y
3.1.4	Richness of native waterbirds	An expert panel list of waterbirds dependent on streams for all or part of their lifecycles was used to calculate this measure. Records >=1975 and a precision <2 000 m were included. No score was allocated to any spatial unit that had an absence of waterbirds (i.e. they were treated as a missing value).	WildNet, Queensland Museum, Queensland Historical Fauna Database (QHFD)	Quartile - Continuous Ascending	Y
3.1.5	Richness of native aquatic plants	An expert panel list of aquatic and semi-aquatic plants (macrophytes) was used to calculate this measure. Records >=1950 and a precision <2000 m were included. A subsection was attributed with the number of species records it contained. No score was allocated to any spatial unit (subsection) that had an absence of species (i.e. they were treated as a missing value).	WildNet, CORVEG, Herbrecs, Wetland Information Capture Project	Quartile - Continuous Ascending	Y

Measure	Description	Implementation	Primary Data	Threshold Type	Stratified
3.1.7	Richness of native aquatic dependent mammals	An expert panel list of mammals dependant on freshwater streams for all or part of their lifecycles was used to calculate this measure. Records >=1975 and a precision <2000 m were included. A subsection was attributed with the number of species records it contained. No score was allocated to any spatial unit (subsection) that had an absence of species (i.e. they were treated as a missing value).	WildNet, Queensland Museum, Queensland Historical Fauna Database (QHFD)	Quartile - Continuous Ascending	Y
3.2.1	Richness of macroinvertebrate taxa	An expert panel list of macroinvertebrate taxa dependant on freshwater streams for all or part of their lifecycles was used to calculate this measure. Records >=1975 and a precision <2000 m were included. A subsection was attributed with the number of species records it contained. No score was allocated to any spatial unit (subsection) that had an absence of species (i.e. they were treated as a missing value). Due to the low number of records the threshold was made presence positive.	WildNet, Queensland Museum, Queensland Historical Fauna Database (QHFD)	Presence Positive	Y
3.2.2	Richness of REs along riverine wetlands or watercourses within a specified buffer distance	Streams were buffered according to their stream order (1:100,000) (first and second order = 50 m; third and fourth order = 100 m; >fifth = 200 m). The number of remnant regional ecosystems was calculated for each spatial unit.	Directionalised stream network with stream order based on DERM 100K drainage layer, Queensland Herbarium Remnant Vegetation Mapping	Quartile - Continuous Ascending	
3.3.1	SOR channel diversity	The SOR score (per cent) for the 'CHDIV' field for each spatial unit was directly incorporated into the analysis. This was done by converting the SOR polygons to points, attributing the points to the ACA subsections and then taking the average value for each subsection.	DERM State of the Rivers	Quartile - continuous ascending	
3.3.2	Richness of wetland types within the local catchment (e.g. SOR subsection)	The number of different wetland habitat types (based on TYPE_RE field - a concatenation of wetland class, hydromodifier, water regime, salinity modifier and 'wetre' fields from the QWM data) were calculated for each subsection. Threshold values were calculated based on the average of the 3 highest weighted richness scores (by subsection).	DERM Queensland Wetlands Mapping	Quartile - continuous ascending	Y

Measure	Description	Implementation	Primary Data	Threshold Type	Stratified
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, hydromodifier, water regime, salinity modifier and 'wetre' fields from the QWM data) were calculated for each sub-catchment, and subsequently applied to all subsections already allocated to that sub-catchment (each sub-catchment is made up of one or more subsections). Threshold values were calculated based on the average of the 3 highest weighted richness scores (by sub-catchment).	DERM Queensland Wetlands Mapping	Quartile - continuous ascending	Y
4.1.1	Presence of rare or threatened aquatic ecosystem dependent fauna species – NC Act, EPBC Act	A list of threatened fauna species dependent on freshwater streams for all or part of their lifecycles was used to calculate this measure. Subsections that had one or more threatened fauna species recorded (point records or site based lists >=1975; precision <=2000m) from within its boundaries received a score of 4. No score was allocated to subsections where there was an absence of threatened species (i.e. they were treated as a missing value).	WildNet, Queensland Museum, Employment, Economic Development and Innovation (DEEDI), Queensland Historical Fauna Database (QHFD)	Presence positive	
4.1.2	Presence of rare or threatened aquatic ecosystem dependent flora species – NC Act, EPBC Act	A list of threatened flora species dependent on freshwater streams for all or part of their lifecycles was used to calculate this measure. Subsections that had one or more threatened flora species recorded (point records or site based lists >=1950, precision <=2000m) from within its boundaries received a score of 4. No score was allocated to subsections where there was an absence of threatened species (i.e. they were treated as a missing value).	WildNet, CORVEG, Herbrecs, Wetland Information Capture Project	Presence positive	
4.2.1	Conservation status of wetland regional ecosystems – Herbarium biodiversity status, NC Act, EPBC Act	The regional ecosystem biodiversity Status was used to score spatial units. The 'WETRE' (previously WB_RE) field in the riverine polygons in the Queensland Wetlands Mapping version 2.0 was used to identify the associated REs for each spatial unit. Endangered REs scored a 4, of concern REs scored a 3, no concern at present REs scored a 2 and spatial units without a RE category (i.e. "water") scored 1. Where a spatial unit had several polygons of differing REs, the maximum RE score was assigned to the spatial units (deconcatenation code was used to separate these).	DERM Queensland Wetlands Mapping	Categorical E = 4, OC = 3, NOC = 2, noRE = 1	

Measure	Description	Implementation	Primary Data	Threshold Type	Stratified
5.1.1	Presence of aquatic ecosystem dependent 'priority' fauna species (expert panel list/discussion or other lists such as ASFB, WWF, etc)	An expert panel list of priority fauna species dependent on streams for all or part of their lifecycles was used to calculate this measure. A spatial unit that had one priority fauna species recorded (point records or site based lists >1975, precision <2000 m) from within its boundaries received a score of three. Where there were 2 or more priority fauna species recorded from within a spatial unit, it received a score of 4. No score was allocated to any spatial unit that had an absence of priority species (i.e. they were treated as a missing value).	WildNet, Queensland Museum, Employment, Economic Development and Innovation (DEEDI), Queensland Historical Fauna Database (QHFD)	User Defined 1 = 3; >1 = 4	
5.1.2	Presence of aquatic ecosystem dependent 'priority' flora species	An expert panel list of priority flora species dependent on streams for all or part of their lifecycles was used to calculate this measure. A spatial unit that had one priority flora species recorded (point records or site based lists >1950, precision <2000 m) from within its boundaries received a score of 3. Where there were two or more priority flora species recorded from within a spatial unit, it received a score of 4. No score was allocated to any spatial unit that had an absence of priority species (i.e. they were treated as a missing value).	WildNet, CORVEG, Herbrecs, Wetland Information Capture project	User Defined 1 = 3; >1 = 4	
5.1.3	Habitat for, or presence of, migratory species (expert panel list/discussion and/or JAMBA / CAMBA agreement lists and/or Bonn Convention)	An expert panel list of migratory species dependent on freshwater streams for all or part of their lifecycles was used to calculate this measure. A spatial unit that had one migratory species recorded (point records or site based lists >1950, precision <2000 m) from within its boundaries received a score of 3. Where there were two or more migratory species recorded from within a spatial unit, it received a score of 4. No score was allocated to any spatial unit that had an absence of migratory species (i.e., they were treated as a missing value).	WildNet, Queensland Museum, Queensland Historical Fauna Database (QHFD)	User Defined 1 = 3; >1 = 4	
5.1.4	Habitat for significant numbers of waterbirds	The expert panels identified these special features. The assigned conservation ratings for this measure were attributed. There was no need to apply thresholds as conservation ratings represent the final score for this measure.	Expert panel	Categorical	

Measure	Description	Implementation	Primary Data	Threshold Type	Stratified
5.2.1	Presence of 'priority' aquatic ecosystem	The expert panels identified these special features. The assigned conservation ratings for this measure were attributed. There was no need to apply thresholds as conservation ratings represent the final score for this measure.	Expert panel	Categorical	
6.1.1	Presence of distinct, unique or special geomorphic features	The expert panels identified these special features. The assigned conservation ratings for this measure were attributed. There was no need to apply thresholds as conservation ratings represent the final score for this measure.	Expert panel	Categorical	
6.2.1	Presence of (or requirement for) distinct, unique or special ecological processes	The expert panels identified these special features. The assigned conservation ratings for this measure were attributed. There was no need to apply thresholds as conservation ratings represent the final score for this measure.	Expert panel	Categorical	
6.3.1	Presence of distinct, unique or special habitat (including habitat that functions as refugia or other critical purpose)	The expert panels identified these special features. The assigned conservation ratings for this measure were attributed. There was no need to apply thresholds as conservation ratings represent the final score for this measure.	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.	Spatial units that occurred within the mapped boundaries of Ramsar and WHA, (world heritage areas) and Directory of Important Wetlands were identified. For those spatial units that had at least 50% of their area within this special areas layer were allocated a score of 4. No score was allocated to spatial units that were not identified as significant by such methods (i.e. they were treated as a missing value).	DOIW, Ramsar, WHA	Categorical	
6.3.3	Ecologically significant wetlands identified through expert opinion and/or documented study	The expert panel considered these special features from other documented studies and assigned conservation ratings for this measure. There was no need to apply thresholds as conservation ratings represent the final score for this measure.	Biodiversity planning assessments (BPAs) and other documented reports external to the ACA process	Categorical	
6.4.1	Presence of distinct, unique or special hydrological regimes (e.g. spring fed stream, ephemeral stream, boggomoss)	The expert panels identified these special features. The assigned conservation ratings for this measure were attributed. There was no need to apply thresholds as conservation ratings represent the final score for this measure.	Expert panels	Categorical	

Measure	Description	Implementation	Primary Data	Threshold Type	Stratified
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	For spatial units with a rating of 4 for 5.1.4, 6.3.1 or 6.3.2 assign 4 to the next spatial unit upstream, then 3 to next spatial unit, then 2 to next spatial unit, then 1 to next spatial unit. Implement this only for upstream. Original recommendation from EP was to assign a value of four for connectivity to the spatial unit with the special feature. However the intent of this Measure is to assign connectivity value to the spatial units that are connected to the special feature. To be consistent, implementation of this Measure will assign connectivity values to the spatial units connected to the spatial unit and not the spatial unit with the special feature. Also previous implementation of this measure used a decrease of 4 then 2 then 1. WBB ecology panel recommended to use 4, 3, 2, 1 which stretches out the connectivity values. This recommended change has been implemented.	Riverine expert panel measures 5.1.4 and 6.3.1 and calculations for 6.3.2	Categorical	
7.1.2	Migratory or routine 'passage' of fish and other fully aquatic species (upstream, lateral or downstream movement) within the spatial unit	Fish passage barriers were allocated fish passage ratings of 4,3,2 and 1 where 4 is the most difficult to pass. Fish passage barriers were taken from the Biopass Strategy barriers and the DERM Dams and Weirs coverage. Paradise Dam and Kirar weir were allocated fish passage ratings of 3. Dams and weirs outside the Burnett were assigned default values of 3. The assignment of fish passage ratings by DEEDI from the expert panel process of the previous Burnett ACA was also used. The stream network was then allocated intrinsic connectivity scores based on stream order and the maximum stream order in each catchment (quartiling). The fish passage ratings were subtracted from the intrinsic connectivity scores to give the overall scores for this measure, with the lowest possible result being a 1.	Expert Panel, Barrier index in Burnett Mary regional biopass strategy (DEEDI) and DERM Dams and Weirs coverage	Categorical	

Measure	Description	Implementation	Primary Data	Threshold Type	Stratified
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)	The connectivity value of spatial units upstream from a special feature identified (and implemented) in Measure 6.4.1 was scored in this measure. For spatial unit with a rating of four for 6.4.1 assign four to the next SU upstream, then 3 to the next, then 2 then 1 as per the methodology for Measure 7.1.1. If a spatial unit has been nominated by the panel as having a CIM number of 7.2.1 then assign 4 to the next spatial unit upstream then 3, 2, 1. The spatial unit nominated as having 7.2.1 would not get a value for connectivity under 7.2.1, only the spatial units upstream. If a spatial unit only had a CIM number of 7.2.1 then is interpreted as 6.4.1 and the usual rules apply. This situation does not occur in the WBB.	Riverine expert panel decision 6.4.1	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	The connectivity value of spatial units that contained the special features identified in the non-riverine ACA for measure 6.3.2 and 6.3.3 was assessed. Subsections (spatial units) that contained features identified in the non riverine WBB ACA Version 1.1 (only those with a conservation rating of 4), were given a value of 4. This is not applied to the subsection containing Coulstoun Lake	Expert panel decision 6.3.2 and 6.3.3	Categorical	
7.5.1	The contribution of the spatial unit to the maintenance of estuarine and marine ecosystems with significant biodiversity values, including those features identified through criteria 5 and/or 6	Any riverine subsection containing an estuarine wetland is assigned a four, as long as the estuarine wetland does not contain a barrage. The next subsections upstream score a 4 until the stream order changes and then the score drops by one progressively as the stream order changes. Wherever there is a barrage, this scoring stops.	Expert panel	Categorical	

2.7 Transparency of results

ACAs produce results at a number of levels despite its initial presentation as a single score called AquaScore. After running the AquaBAMM tool, ACA results are available at AquaScore, criterion, indicator, measure or raw data levels. The results are also available through the use of user-defined queries that may interrogate one or more levels within the assessment in an almost infinite number of possible combinations. This transparency of results provides the ACA end user (e.g. scientists, resource managers and conservation organisations) with a unique level of flexibility for ACA interrogation, interpretation and presentation. Links between the ACA results and a geographic information system (GIS) facilitate this interrogation and provide a means and visualising the ACA results (Figure 2 and Figure 3).

This data access and interrogation flexibility is important and enables investigation of the influence of different data contributions to the overall conservation value, investigation of missing data, and an ability to tailor the ACA output for a particular purpose.

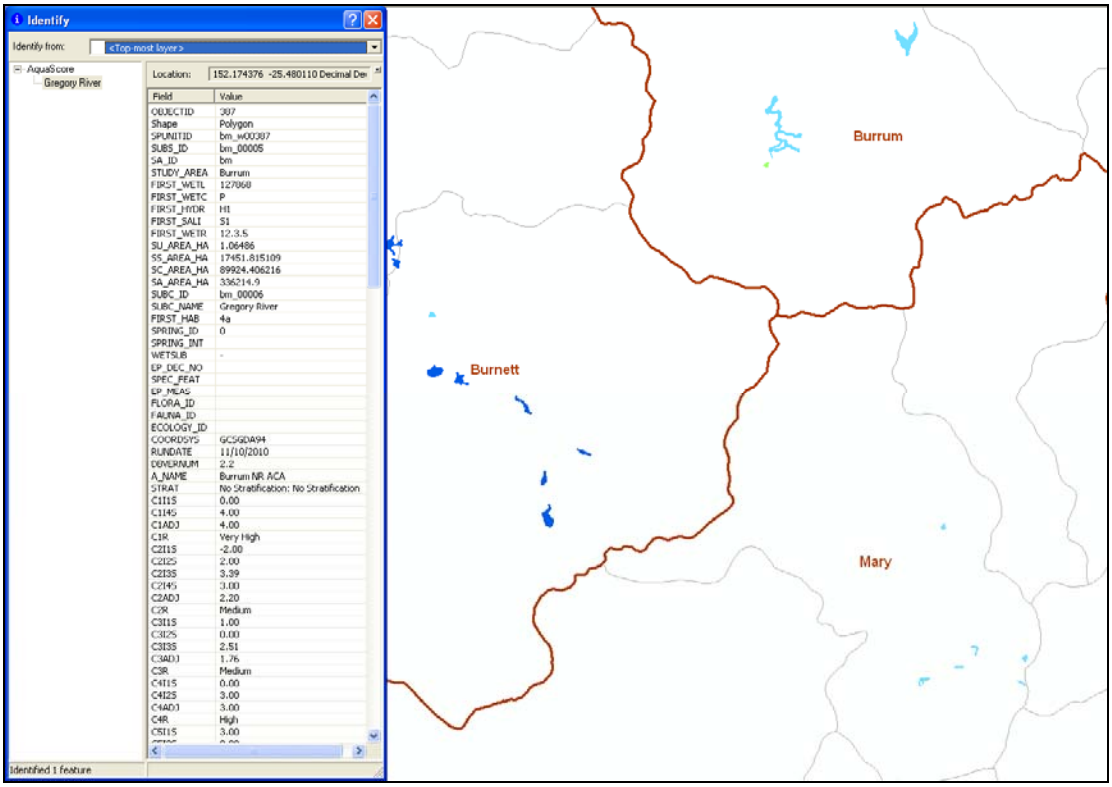


Figure 2: Interrogating the non-riverine ACA results for a spatial unit in the GIS environment

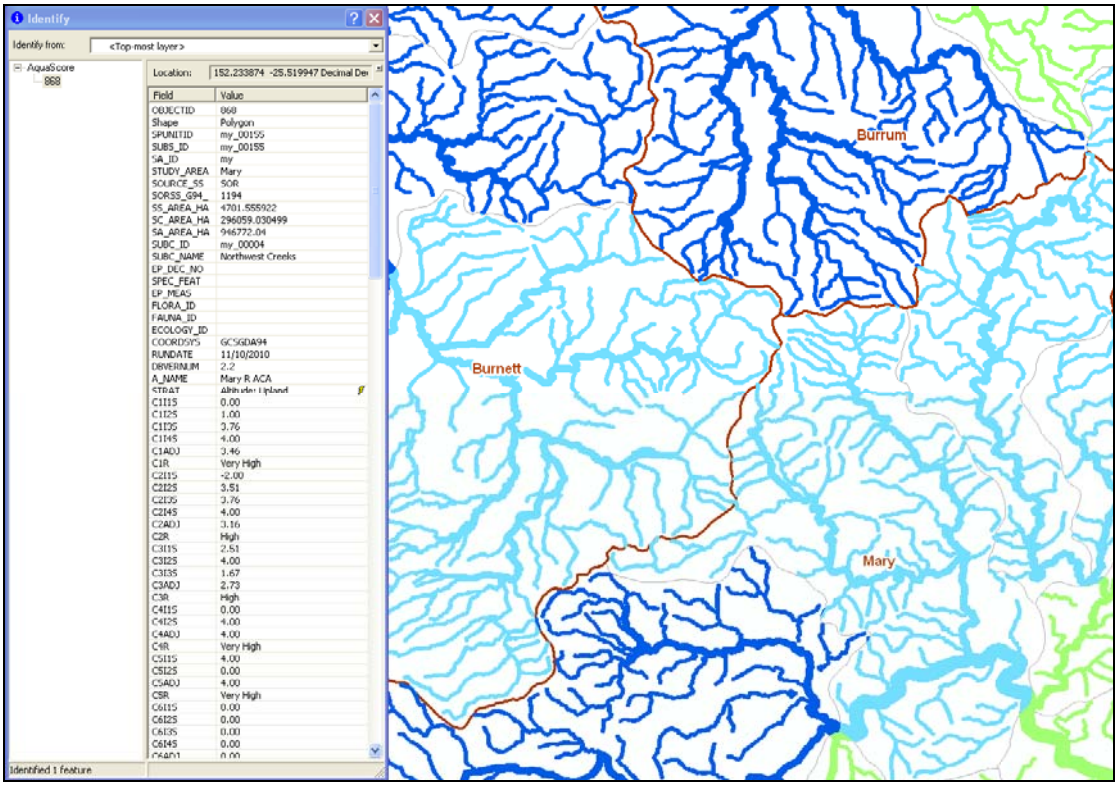


Figure 3: Interrogating the riverine ACA results for a spatial unit in the GIS environment

3 Results

3.1 Conservation value categories

The conservation value results for wetlands are referential within each study area, but each value category has characteristics in common. AquaBAMM uses combinations of criterion level scores to determine a wetland's final AquaScore and based on these combinations, the following descriptions provide context for each AquaScore value category.

"Very high" wetlands

These wetlands have very high values across all criteria (aquatic naturalness, catchment naturalness, diversity & richness, threatened species, special features and representativeness), or they have very high representativeness values in combination with very high aquatic naturalness, catchment naturalness or threatened species values. They may also be wetlands nominated as a special feature by an expert panel for their very high flora, fauna and/or ecological values, regardless of values across other criteria.

"High" wetlands

These wetlands are mainly those that have very high aquatic naturalness or representativeness values in combination respectively with very high/high threatened species values or very high diversity and richness values. Other combinations of very high or high values amongst the criteria may also indicate one of these wetlands.

"Medium" wetlands

These wetlands have varied combinations of high and medium values amongst the criteria.

"Low" wetlands

These wetlands have limited aquatic and catchment naturalness values. They have varied combinations of medium and low values amongst the other criteria.

"**Very low" wetlands**

These wetlands have very limited or no aquatic and catchment naturalness values and they lack any other known significant value. They may also be wetlands that are largely data deficient.

3.2 WBB catchment overall results – riverine

An ACA was conducted for the riverine wetlands in each of the six catchments of the WBB region. The results outlined below are a summary of the results for all six study areas.

AquaScore

Table 5: AquaScore summary for riverine wetlands

AquaScore	Number of spatial units	Per cent of spatial units (%)	Area (ha)	Area (%)
Very high	280	28.2	1,365,430	26.3%
High	490	49.3	2,447,325	47.1%
Medium	194	19.5	1,355,297	26.1%
Low	30	3.0	30,541	0.59%
Very Low	0	0		
Total	**994**	**100%**	**5,198,592**	**100%**

A few broad trends in wetland conservation values were shown in the results:

- Overall, approximately 77.5 per cent of all subsections scored very high or high for the overall AquaScore.
- All subsections on Fraser Island scored a very high or high AquaScore with all subsections scoring very high or high for both Aquatic and Catchment naturalness (Criteria 1 and 2).
- Most of the subsections that scored very high for Threatened species and ecosystems (criterion 4) were in the Mary and Burrum catchments and the eastern part of the Burnett catchment.
- AquaScore dependability was proportionally highest in the Mary and Burrum catchments.

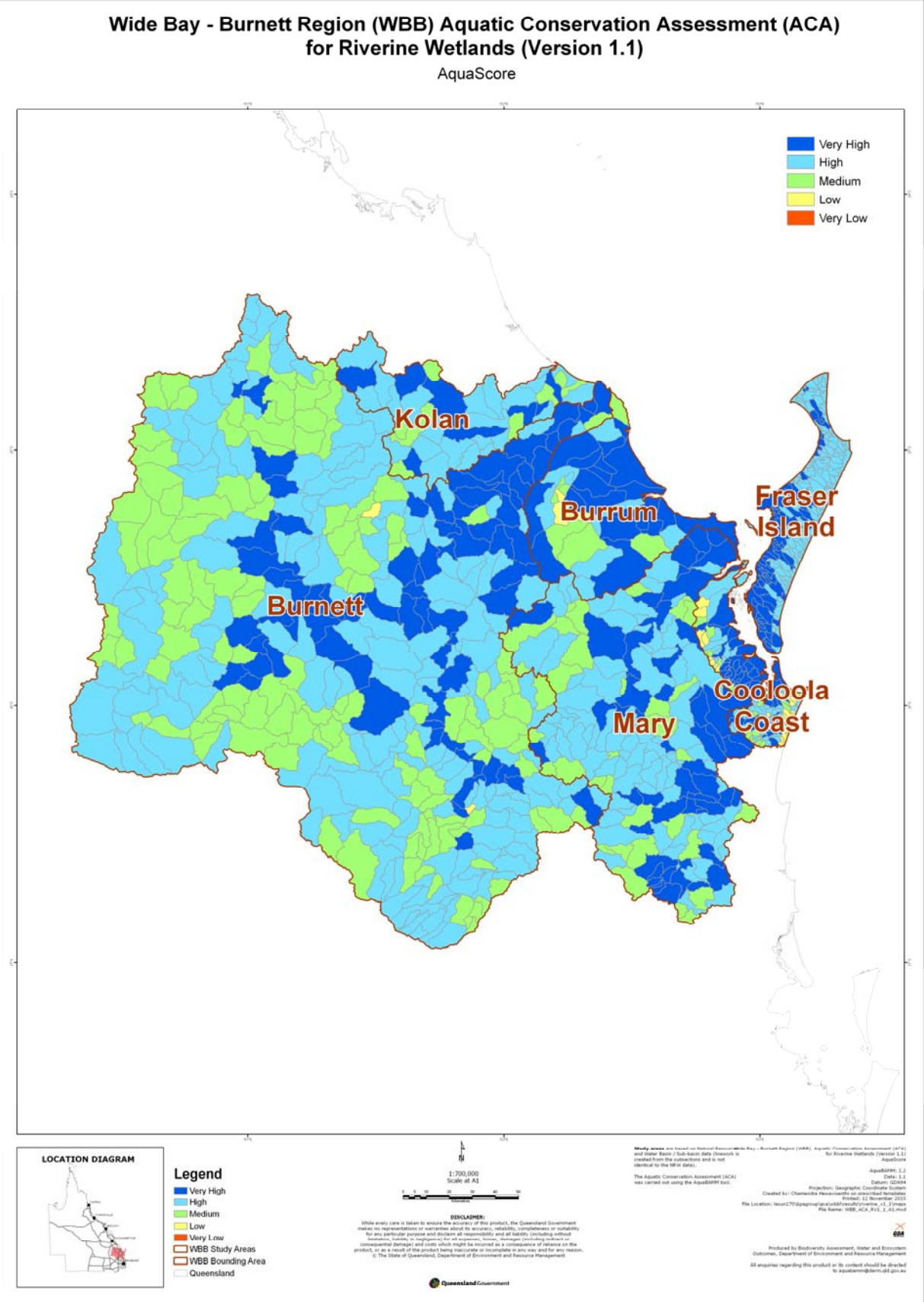
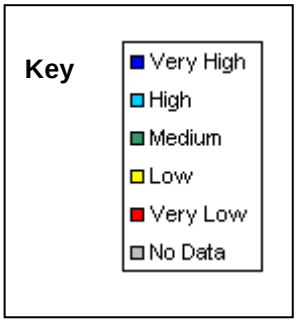
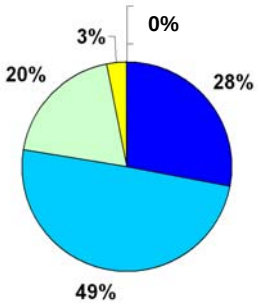
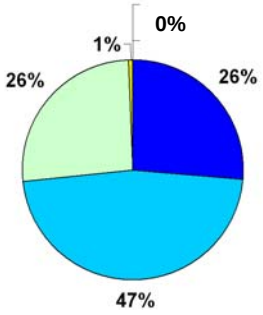
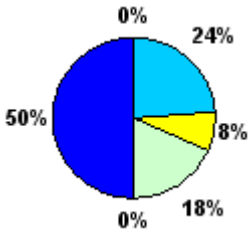
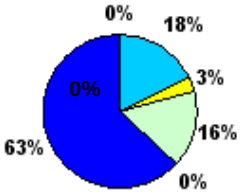
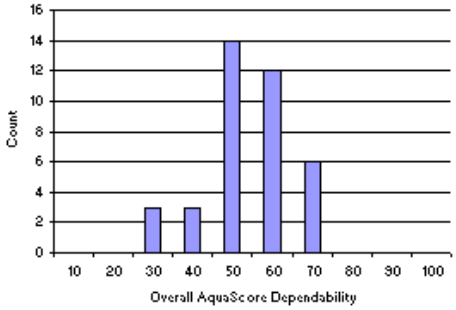
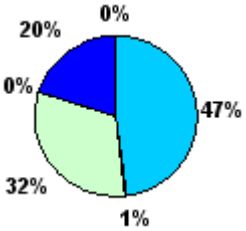
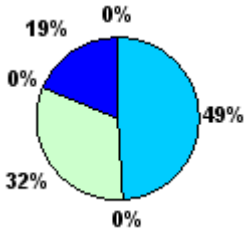
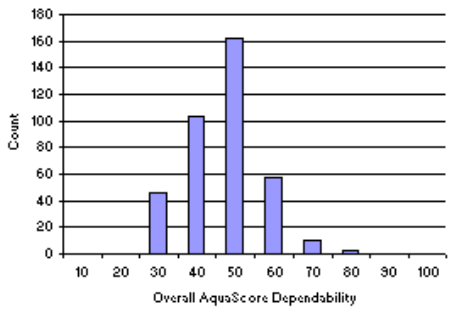
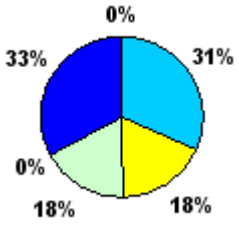
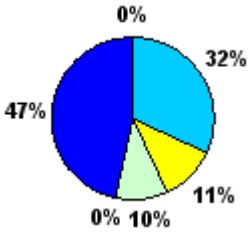
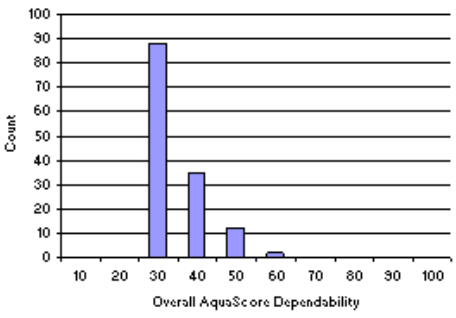
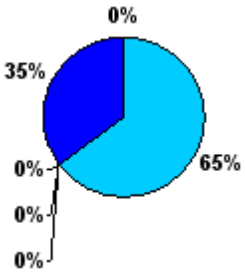
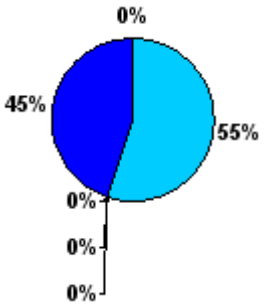
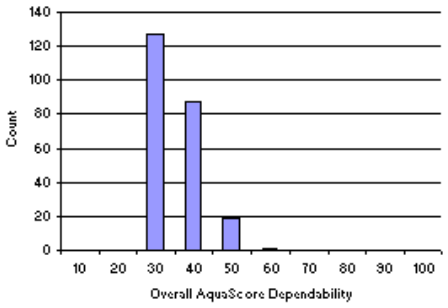
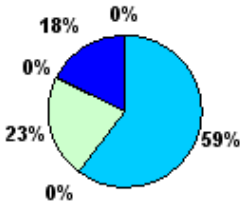
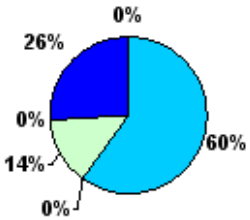
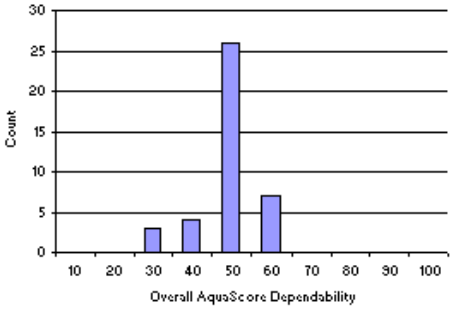
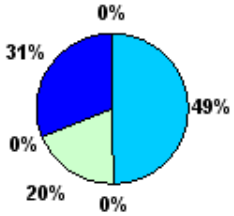
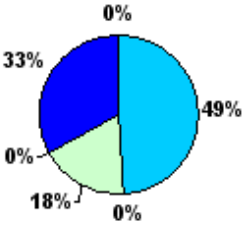
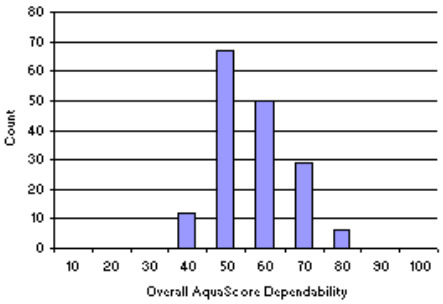


Figure 4: Riverine AquaScore for all catchments

Table 6: Riverine AquaScore and dependability summary for all study areas



Catchment	AquaScore by number of spatial units	AquaScore by total area of spatial units	AquaScore dependability
All catchments (riverine)			
Burrum			
Burnett			
Cooloola coast			

Catchment	AquaScore by number of spatial units	AquaScore by total area of spatial units	AquaScore dependability
Fraser Island			
Kolan			
Mary			

3.3 WBB catchment overall results – non-riverine

An ACA was conducted for the non-riverine wetlands in each of the six catchments of the WBB region. The results outlined below are a summary of the results for all six study areas.

AquaScore

Table 7: AquaScore summary for non-riverine wetlands

AquaScore	Number of spatial units	Per cent of spatial units (%)	Area (ha)	Area (%)
Very high	596	27.8%	40,593	53.6%
High	855	39.9%	15,226	20.1%
Medium	656	30.6%	18,043	23.8%
Low	1	0.05%	1	0.00%
Very Low	34	1.6%	1,873	2.5%
Total	**2,142**	**100%**	**75,736**	**100%**

A few broad trends in wetland conservation values were shown in the results:

- Overall, approximately 68 per cent of all wetlands scored very high or high for AquaScore. This equated to 78 per cent of all wetland area. Most of these wetlands were near the coast or on Fraser Island.

- Criterion 4 (Threatened species and ecosystems) contained the highest proportion of very high AquaScore values for any criteria with 63 per cent of spatial units in the study area scoring Very High. This was followed by Criterion 5 (Priority species and ecosystems) for which 57 per cent of all spatial units scored Very High. The Very High values for these criteria equate to 73 per cent and 68 per cent of wetland area respectively.

- Overall 81 per cent of spatial units rated High or Very High for Criterion1 (Aquatic naturalness). Criterion 2 (Catchment naturalness) rated significantly lower with 59 per cent of spatial units scoring High or Very High.

- All spatial units on Fraser Island scored very high or high for AquaScore. This is due to the influence of Criteria 6, Special features. This criterion is based on the expert panel decisions and is weighted highly in the filtering table that produces the final AquaScore.

- The western spatial units of the Burnett catchment are especially data poor. Across the WBB catchments, there is a trend toward greater numbers of very high and high value wetlands near the coast. This trend is evident in the distribution of the AquaScore dependability in the western catchment being at the lower end of the scale compared with those catchments on the coast. During the expert panels, particular attention was paid to the western catchments. However, the panels noted that there was a distinct lack of knowledge in western parts of the WBB.

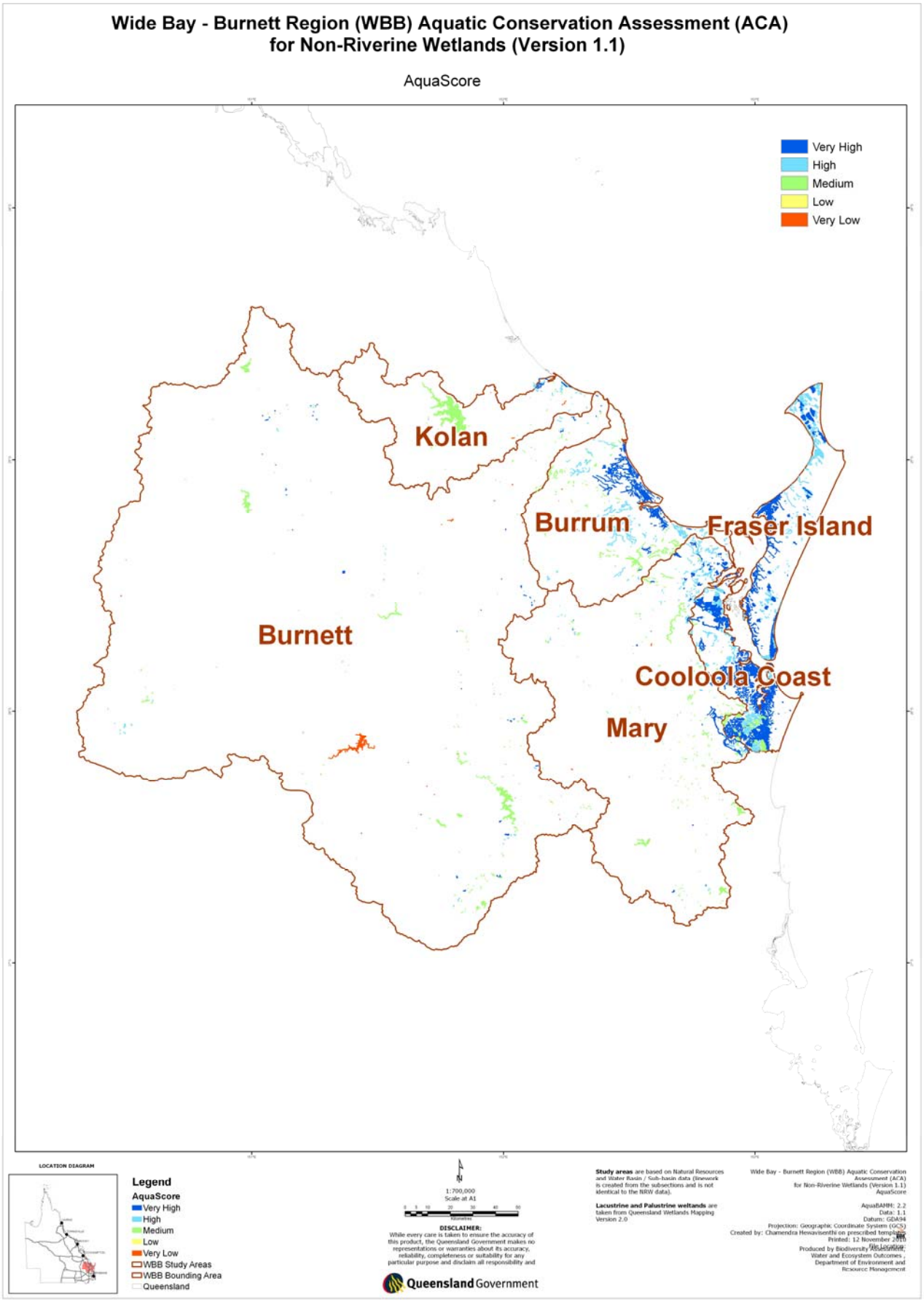
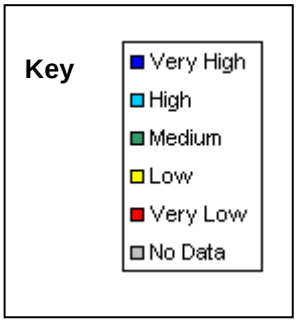
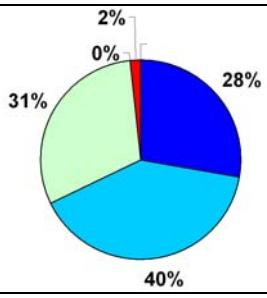
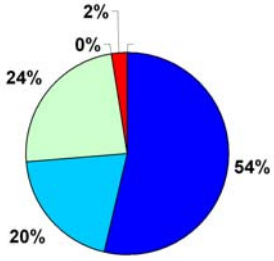
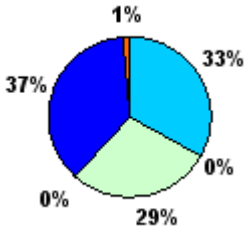
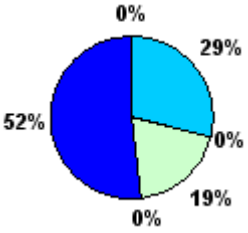
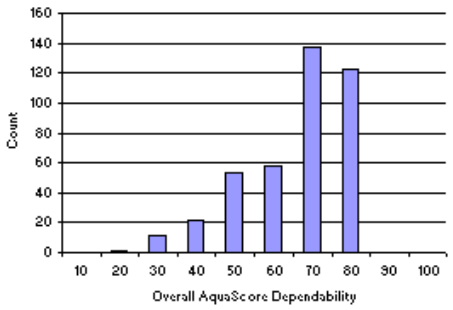
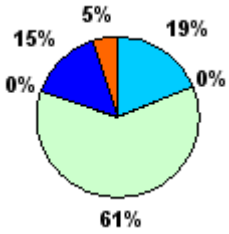
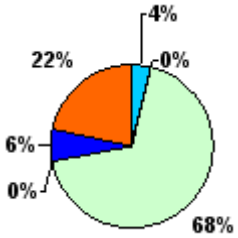
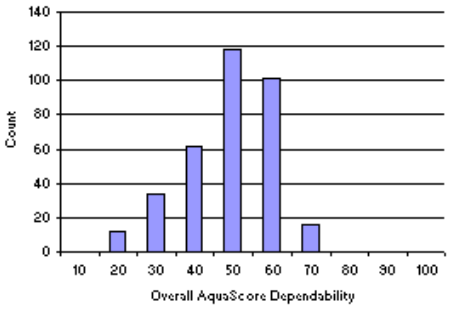
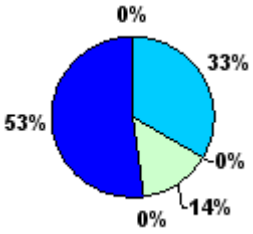
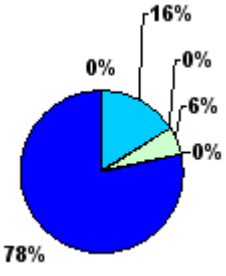
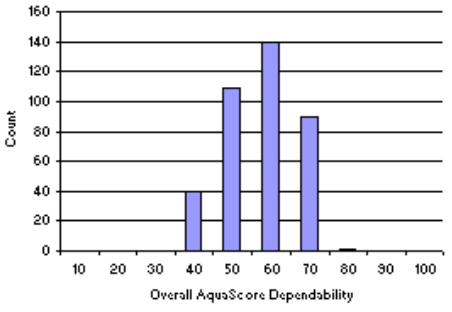
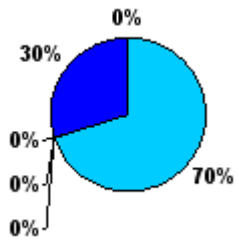
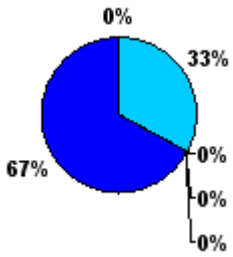
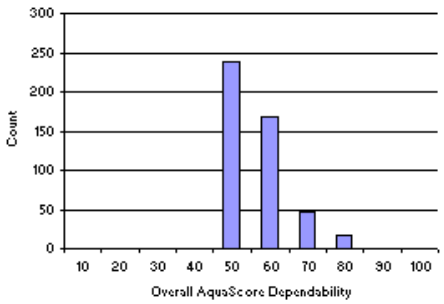
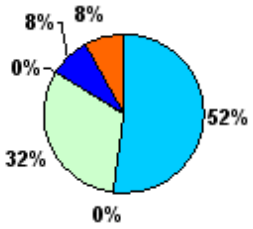
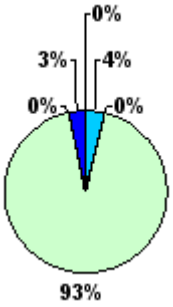
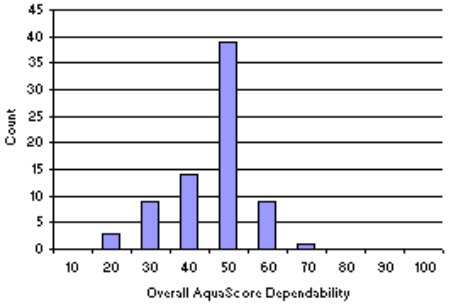
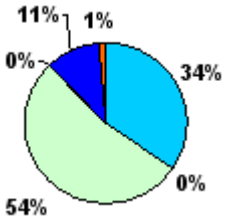
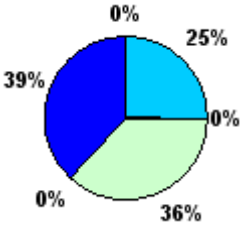
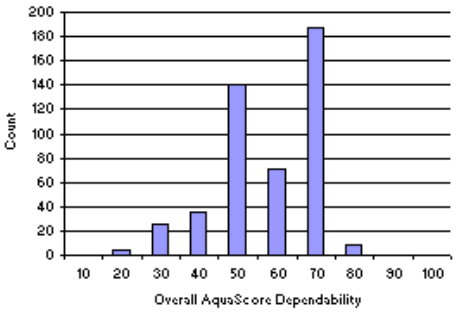


Figure 5: Non-Riverine AquaScore for all catchments

Table 8: Non-Riverine AquaScore and dependability summary for all study areas



Catchment	AquaScore by number of spatial units	AquaScore by total area of spatial units	AquaScore dependability
All catchments (non-riverine)			
Burrum			
Burnett			
Cooloola coast			

Catchment	AquaScore by number of spatial units	AquaScore by total area of spatial units	AquaScore dependability
Fraser Island			
Kolan			
Mary			

3.4 Summary of results for the Mary catchment

The following discussion provides an analysis of a representative catchment from the entire study area.

The Mary River flows from the moist, subtropical southern part of the South East Queensland bioregion into a drier corridor to the north, and consequently varies considerably in its character. The Mary's freshwater reaches support a distinctive fauna which is close to range limits and adapted to its episodic flood regime, and is one of two catchments supporting the iconic Australian lungfish (*Neoceratodus forsteri*). The Mary catchment is an important source of sediment and freshwater flows for seagrass ecosystems and shorebird feeding habitat in the northern Great Sandy Strait Ramsar area and Hervey Bay. Many of its riverine and non-riverine wetlands are also scheduled as High Ecological Value waterways under the Environmental Protection (Water) Policy 2009.

Riverine

In the Mary River catchment, 31 per cent of the subsections scored a very high AquaScore equating to 33 per cent of total area of subsections (Table 6). These values were distributed throughout the Mary catchment (Figure 4). Altogether, 80 per cent of subsections scored either very high or high equating to 82 per cent of total area of subsections.

Criterion 4 (Threatened species and ecosystems) contained the highest proportion of very high values for any criteria with 60.5 percent of subsections in the Mary catchment scoring very high for C4. This was followed by Criterion 5 (Priority species and ecosystems) for which 52.5 per cent of all subsections scored very high.

When combining very high and high criterion scores, Criterion 1 (Naturalness aquatic) ranked highest with 93 per cent of all subsections having a Criterion 1 rating of very high or high. This was followed by Connectivity (Criterion 7) for which 87 per cent of all subsections scored very high or high. It is noteworthy that Catchment naturalness (Criterion 2) had a significantly lower proportion of very high and high scores – 65 percent of all subsections in the catchment compared to Aquatic naturalness (Criterion 1 – 93 per cent).

In total there were 16 decisions identified by the fauna and ecology expert panels consisting of six ecology and 10 fauna decisions (see Attachments B and C). As would be expected in this catchment, some of the decisions are related to iconic threatened species found in this river system including the

- Australian lungfish (*Neoceratodus forsteri),* decisions my_r_fa_07, my_r_ec_02;
- Mary River cod (*Maccullochella peelii mariensis*) decisions my_r_fa_03, my_r_fa_04, my_r_fa_05, my_r_fa_10, my_r_ec_02, my_r_ec_06, and
- Mary river turtle (*Elusor macrurus*) decisions my_r_fa_06, my_r_fa_07.

In the Mary catchment, the AquaScore dependability was concentrated approximately 50 to 60 per cent (Table 6) which is a greater AquaScore dependability than other catchments in the study. Criterion 2 (Naturalness catchment) had the highest dependability of any criteria at 96 per cent. The summary section of this report contains more detailed information on the overall dependability trends across the WBB.

Non-riverine

In the Mary River catchment, 11 per cent of the spatial units scored a very high AquaScore equating to 39 per cent of total area of spatial units (Table 6). These values were distributed throughout the Mary catchment (Table 4). Altogether, 45 per cent of subsections scored either very high or high equating to 64 per cent of total area of spatial units.

Criterion 5 (Priority species and ecosystems) contained the highest proportion of very high values for any criteria with 81 per cent of spatial units scoring very high. This was followed by Criterion 4 (Threatened species and ecosystems) for which 69 per cent of all spatial units scored very high.

When combining very high and high criterion scores, Criterion 5 (Priority species and ecosystems) ranked highest with 94 per cent of all spatial units having a Criterion 5 score of very high or high. This was followed by Criterion 4 (Threatened species and ecosystems) for which 86 per cent of all spatial units rated very high or high for Criterion 4.

When comparing Criterion 1 (Aquatic naturalness) to Criterion 2 (catchment naturalness), it is noteworthy that Aquatic naturalness had a significantly higher proportion of very high and high scores – 70 per cent of all spatial units in the catchment compared to Catchment naturalness at 29 per cent.

In total there were eight decisions identified by the flora, fauna and ecology expert panels consisting of five ecology, two fauna, and one flora decisions (see attachments A, B and C).

In the Mary catchment, the AquaScore dependability was concentrated around 50 to 70 per cent (Table 8). Criterion 2 (Naturalness catchment) had the highest dependability of any criteria at 94 per cent. The summary section of this report contains more detailed information on the overall dependability trends across the WBB.

3.5 Field truthing

Field validation of the ACA results is important to test the accuracy of the wetland values attributed. Field validation (or truthing) is a critical step in any ACA using AquaBAMM and it precedes final data corrections, resulting from the field work, and a final re-run of the assessment.

The outcomes from field truthing are regularly:

- minor changes to the filtering table and/or
- missing datasets identified and implemented.

In general the field truthing will:

- Check spatial units across the range of values from very low to very high. There is usually a focus on the very low and very high valued spatial units 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.
- Check spatial units where there is a very low right next to a very high.
- Che ck stratification.
- Preference for field truthing spatial units is given to units in the coastal areas as this is where the regulations will impact the most. There is also a preference to validate the medium and high spatial units as this is the borderline between whether they will be included in the regulations (i.e. the difference between wetlands of general ecological significance (GES) and high ecological significance (HES)).
- Field truthing is not an attempt to confirm individual measure data (e.g. there is no effort to confirm the presence of a particular threatened species).

3.6 Field interpretation of ACA results

When looking at wetlands or spatial units in a catchment and comparing them to their AquaScore, there is a strong tendency to observe a spatial unit's 'condition'. 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.

ACAs are primarily focussed on aquatic ecological or conservation value such that the condition contributes to, but does not solely determine a spatial unit's value. A spatial unit's value is a composite of several criteria, indicators and measures. Of the measures used in these assessments, usually less than 10 per cent are related to aquatic, riparian and/or catchment condition.

Consequently, when in the field, the successful interpretation of a spatial unit's conservation value is reliant on the observer to not view 'condition' in isolation from other values (seen or unseen).

Confidence in the AquaScore

Conservation assessments of landscapes, by their very nature, apply ratings along a continuum of values. Hence, the extremes in values (very highs and very lows) are relatively easier to determine in the field than defining the cut-offs in between these extreme values (e.g. lows, mediums and highs). This is particularly difficult to distinguish between spatial units rated as either medium or high. Possible reasons for this difficulty whilst in the field may include:

- insufficient datasets for some spatial units to allow for a precise determination of conservation value
- the differences between spatial units are real, but are not easily observed in the field because of 'hidden' instream values and
- often, only a small part of a spatial unit can be seen and assessed in the field. For instance, smaller tributaries within a spatial unit may be devoid of values but the main channel may have significant values that increase the spatial unit's overall value.

A lack of data for some spatial units is recognised as a limitation to any ACA. This limitation has been addressed in part by calculating a per cent dependability score for each wetland. The spatial unit's dependability score is the proportion of measures with data for that spatial unit against measures that had 'missing values' or no data. The dependability score is an important parameter when interpreting the AquaScore, or any other conservation value score from criterion or indicator level within the ACA. The lower the dependability score for a spatial unit means a lower confidence level the user will have in the conservation value. Conversely, the higher the dependability scores for a spatial unit, the more confident the user is in the conservation value assigned to the spatial unit (Clayton *et al.* 2006).

In the end, wetlands or spatial units are ecologically complex and field truthing must be undertaken with observer perspective driven strictly by the limitations of each ACA, such as scale, datasets, etc. With this approach, an indication of confidence in the accuracy of any ACA using AquaBAMM can be reached. In the case of the WBB catchments, the assessment results compared well with field truthing results.

Spatial units inspected

The six catchments of the WBB contain a total of 944 riverine and 2142 non-riverine spatial units. From the 2010 field trip, a total of 31 riverine subsections and 47 non-riverine wetlands across the six WBB catchments were inspected by vehicle as part of the field truthing exercise (Table 9and Table 11). This equated to approximately 3.1 per cent of the total riverine subsections and approximately 2.2 per cent of the total non-riverine spatial units within the WBB catchment.

As non-riverine spatial units can be difficult to access, the majority were inspected from gazetted roads or where possible by foot. The issue of accessibility together with the scale of the WBB catchment area accounted for the relatively small number of spatial units visited. No spatial units were visited in the Fraser Island study area. Despite the small number visited, the exercise allowed the direct checking of many of the riverine and non-riverine wetlands and covered a range of AquaScores (Table 10 and Table 12). A map of the route taken during the field truthing exercise is provided in Figure 6 and Figure 7. Images of spatial units inspected during the field are provided in the following plates.

In addition to those spatial units mentioned in Table 9 to Table 12, a desktop analysis of the results for other wetlands was undertaken using satellite imagery (e.g. SPOT).

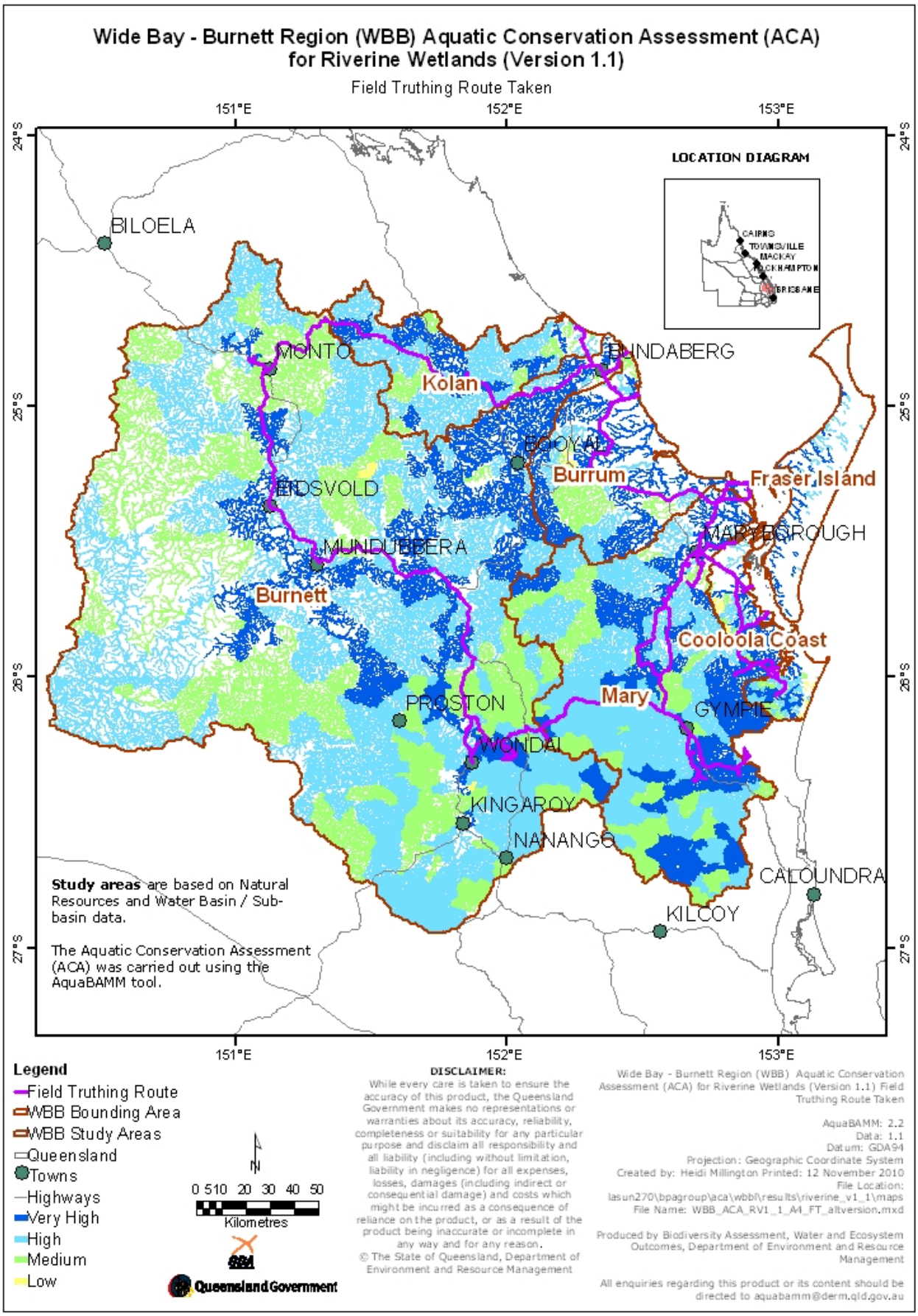


Figure 6: Route undertaken during field truthing exercise for riverine wetlands

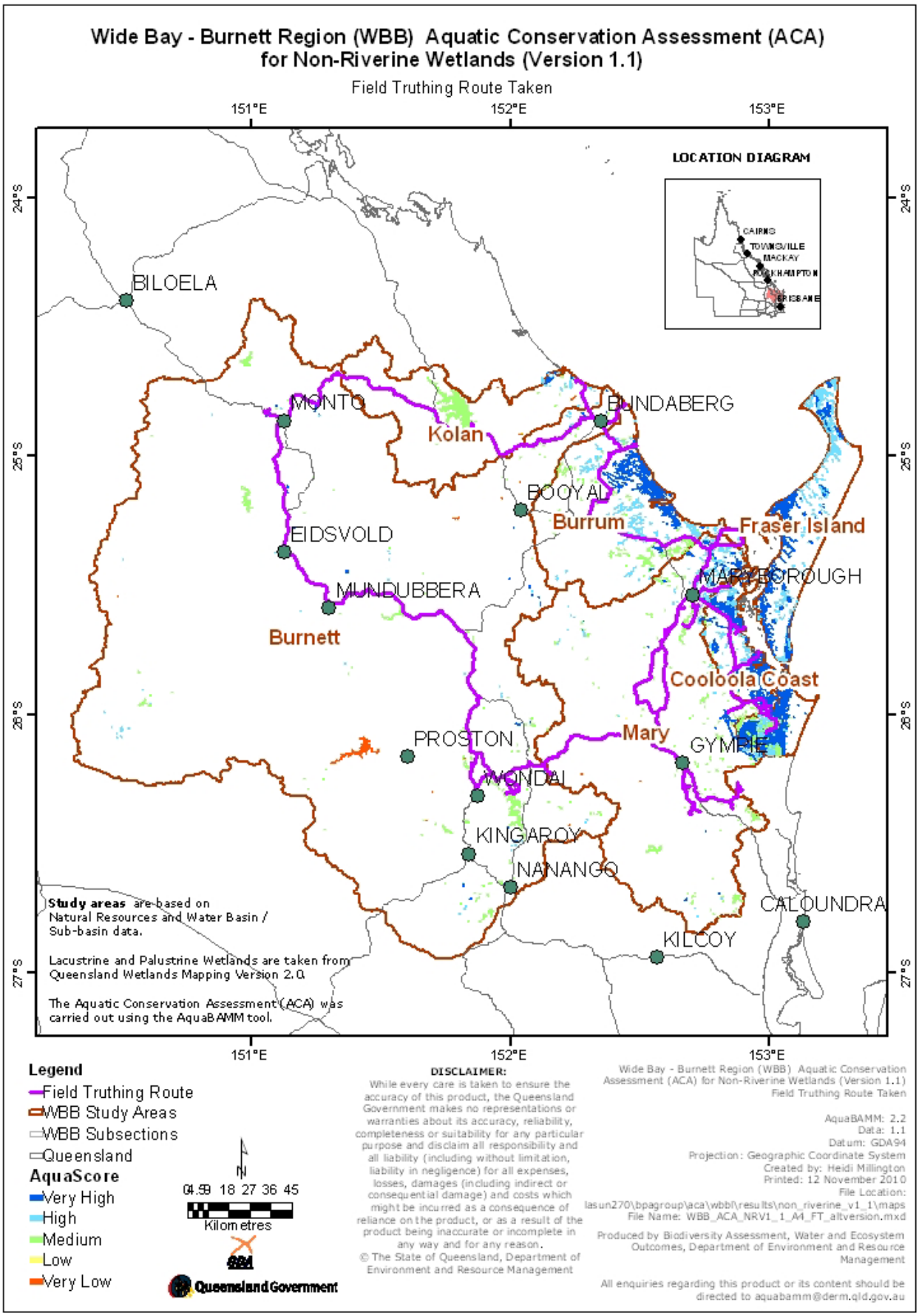


Figure 7: Route undertaken during field truthing exercise for riverine wetlands

Table 9: Riverine subsections inspected during field truthing by catchment

ACA study areas or catchments	Subsections traversed	Per cent of subsections within study area
Burrum	8	21%
Burnett	14	3.7%
Cooloola coast	0	0
Fraser Island	0	0
Kolan	3	7.5%
Mary	6	3.7%
	31	**Per cent of total subsections = 3.1 %**

Table 10: Riverine subsections inspected during field truthing by AquaScore

AquaScore	Total number of subsections	Number of subsections field truthed	Per cent field truthed
Very high	280	15	5.4%
High	490	9	2.0%
Medium	194	7	3.6%
Low	30	0	0%
Very low			%
	994	**31**	**3.1%**

Table 11: Non-riverine spatial units inspected during field truthing by catchment

ACA study areas or catchments	Spatial units inspected	Per cent of spatial units within study area
Burrum	10	2.5%
Burnett	17	5%
Cooloola coast	1	0.25%
Fraser Island	0	0
Kolan	6	8%
Mary	13	2.8%
	47	**Per cent of total spatial units = 2.2 %**

Table 12: Non-riverine spatial units inspected during field truthing by AquaScore

AquaScore	Total number of spatial units	Number of spatial units field truthed	Per cent field truthed
Very High	596	10	1.7%
High	855	17	2.0%
Medium	656	18	2.7%
Low	1	0	0%
Very Low	34	2	6.0%
	2,142	**47**	**2.2%**

Photo 1: Bjelke Petersen Dam. Photo: Steven Howell, DERM

This dam is on Barkers Creek to the south east of Murgon. The wetland associated with the dam (bu_w00237) is a modified riverine wetland located in a natural channel (H2M1). The wetland scored very high for Criterion 3 Diversity and richness, Criterion a 4 Threatened species and ecosystems and Criterion 5 Priority species and ecosystems. Overall the AquaScore was medium with a relatively low dependability of 41 per cent.

Photo 2: Subsection bu_00103 north-west of Murgon. Photo: Steven Howell, DERM

This subsection scored very high for Criterion 1 Naturalness aquatic and Criterion 7 Connectivity. Overall the AquaScore was high with very low dependability of 27 per cent.

Photo 3: Ban Ban Springs. Photo: Steven Howell, DERM

This wetland scored very high for Criterion 3 Diversity and richness, Criterion 5 Priority species and ecosystems, Criterion 6 Special features and Criterion 8 Representativeness. This wetland is part of decisions by the fauna and ecology panels (decisions bu_nr_fa_01 and bu_nr_ec_02) which identified permanently wet wetlands or artesian springs as having very significant aquatic values.

Photo 4: Wetland south-east of Tiaro. Photo: Steven Howell, DERM

This wetland (my_w00225) scored very high for Criterion 1 Naturalness aquatic and Criterion 8 Representativeness. The overall AquaScore was very low. Three criteria did not have any data and the dependability was relatively low at 39 per cent.

3.7 General Summary

Significant environmental features (or geographic areas) that are nominated by agreements or instruments such as Ramsar, Directory of Important Wetlands and World Heritage Area, influence conservation value results through the ACA process. These features/areas are not evenly distributed throughout the WBB catchments and are especially focussed in the coastal areas. Wetlands in these areas usually score very high or high with respect to their conservation values and due to the distribution of the significant environmental areas, the wetlands are often spatially concentrated. For these reasons, for example, catchments such as Fraser Island have large numbers of very high value wetlands.

Field validation (truthing) of the ACA results is important to test the accuracy of the assessment. Field truthing is a critical step in any ACA and it precedes final data corrections and a final re-run of the assessment. Field truthing was conducted prior to the release of the final ACA results. Based on the results from the field truthing, the criterion and AquaScore for a number of riverine and non-riverine wetlands was confirmed. For a small number of wetlands, the field truthing resulted in some corrections and adjustments being made to the data and calculations.

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 spatial units with very low AquaScore values have low dependability, the results should be used with caution 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.

When compared across Queensland the catchments of the WBB are generally data rich as is reflected in the dependability values which are often 50 per cent or greater. The Fraser Island and Cooloola coast study areas however, have low levels of dependability in the riverine ACAs. This is primarily due to the absence of broadscale datasets which are associated with the mainland and not Fraser Island.

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.

Whenever lines are drawn on a map (e.g. from the expert panels or Directory of Important Wetlands etc), there is a risk that the boundary may be approximate at the scale of the individual spatial unit. 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 wetlands are mapped at a scale of 1:100,000, except for areas along the east cost which are mapped at the 1:50,000 scale.

Wetlands mapping decisions concerning allocation of wetland regional ecosystem class have influenced the base data available (i.e. some wetlands associated with riverine drainage lines are attributed as palustrine and yet others riverine) however, the wetlands ACA only captures information on palustrine (and lacustrine) wetlands. For example, on field inspection some wetlands along drainage lines were not captured by the ACA wetland regional ecosystem layer, but still appear to be palustrine rather than riverine, such as groundwater-fed wetlands associated with the Elliott River for example. This has implications for the riverine ACA because only the statutory buffer distance from the riverine drainage line is captured. Options where palustrine wetlands along a drainage line exceed the statutory riverine buffer may include:

- wetlands within the wetlands layer identified for future ACAs, or
- the addition of an extra riverine ACA connectivity measure flagging the occurrence of palustrine wetlands along the drainage line.

Consistency between the riverine and non-riverine ACA ratings needs to align with expert panel intentions (i.e. if a riverine expert panel decision identifies special values associated with riverine drainage lines), then this same value needs to be attributed for the wetlands ACA along the drainage lines within the riverine subunit (if considered appropriate).

The expert panels and in particular the flora panel, identified a significant number of priority species. The usual thresholding for these measures is user defined where the presence of one priority species in a spatial unit scores a three and spatial units with more than one priority species scored a four. The large number of priority species and records meant that a significant number of spatial units scored either a three or a four for these measures which usually translates into a very high AquaScore for Criterion 5. It was found that this was overwhelming the results for Criterion 5, although the effect on the final AquaScore was not as pronounced as Criterion 5 does not have a large influence through the filtering table. The use of continuous ascending thresholds based on quartiles was investigated and was found to be too punishing and a large number of spatial units had a value of low for criterion 5 and then a very low AquaScore result. Based on the underlying distribution of the species records per spatial unit, the thresholds were modified to continuous ascending where:

- spatial units with three or more priority species scored a four
- spatial units with two priority species scored a three and
- spatial units with one priority species scored a two.

This thresholding gave a more realistic set of values and was implemented for riverine and as part of measure 5.1.2 only for non-riverine.

All of the Fraser Island study area is listed on the Directory of Important Wetlands of Australia. This means that for both riverine and non-riverine:

- all spatial units on Fraser Island scored a four for measure 6.3.2
- indicator 6.3 results were a four
- criterion 6 results equalled very high and
- the final AquaScore for all spatial units was very high.

Therefore all of Fraser Island scored very high for the final AquaScore and hence there is no discrimination in the AquaScore values. The concern is that the Directory of Important Wetlands measure (6.3.2) is part of criterion 6 which has a strong influence in the filtering table and the AquaScore values are being flooded. The AquaScore values are about relative values within a study area and having such a powerful value might be masking the true AquaScores. The value for 6.3.2 was therefore changed from four to three in the AquaBAMM tool for both riverine and non-riverine and this resulted in discrimination of very high and high values for Fraser Island.

This is the first time that criterion 7 has been implemented for non-riverine. The non-riverine filtering table was modified to reflect the inclusion of criterion 7. The modifications reflected the criterion 7 decisions in the riverine filtering table. Six decisions were modified by adding criterion 7 to the query. Six new decisions were added. Measures 7.2.1, 7.3.2 and 7.5.1 were assessed for non-riverine connectivity. An analysis of the results shows that the addition of criterion 7 to the filtering table for non-riverine appears to be working well based on a hit analysis and the filtering table.

Dependability for both the Fraser Island and Cooloola coast riverine results appear to be at the lower end of the scale, especially when compared with the other study areas. Non-riverine dependability does not show this trend. AquaScore dependability is usually focussed around an average of 40 to 60 per cent. In ACAs that are data poor (such as the Condamine) the dependability is 20 to 40 per cent and in ACAs that are data rich (such as the Brisbane City Council area) the dependability is around 60 to 80 per cent.

Further investigation of the dependability for the individual criteria shows that Fraser Island and Cooloola coast have low dependability for criteria 4 and criteria 5. This is due to the relative lack of species records for these study areas.

Areas within protected area estate will be minimally impacted by these scores, but outside estates may be a significant issue (e.g. where forestry riparian areas are concerned and the risk of increased fragmentation of these without knowledge of their values.

Small subunit size due to flat terrain and the threshold set by the RivaTools model has compounded the problem of low dependencies. Some of these subunits should have been amalgamated up to the next level as field inspection did not confirm any obvious terrain separation between their catchments. It's also important to acknowledge that there are true data gaps within the Cooloola coast catchment notably in inaccessible parts of the Great Sandy Strait coastline and within the Cooloola section of the Great Sandy National Park.

Given that most of Fraser Island and to a lesser extent Cooloola coast have mainly high and very high AquaScores, the lack of data for these measures is not a significant issue.

The Burnett riverine ACA version 1.0 was released on 18 July 2006. Fifty-two (52) measures were assessed under this previous version. In the current version, 59 measures were assessed. Since version 1.0 there have been changes to the base wetlands mapping, species records, measures assessed etc. Some measures such as QLUMP have not changed. A number of spatial units changed values between versions and the main reason for the changes is the addition of more special features identified by the expert panels.

The expert panels for the current version (v1.1) reviewed the original Burnett ACA expert panel decisions and of the original 25 decisions (covering flora, fauna and wetland ecology), only one was not implemented in version 1.1 as the values were no longer considered to be present. The version 1.1 expert panels added an additional 12 decisions and it is these additional decisions, plus refinements to the previous ACA decisions that are the main reasons for the differences between versions.

Due to the comparatively small size of islands, the values can sometimes not be attributed and calculated correctly. In the Great Barrier Reef ACA for example, the islands were included together as a single study area. In the WBB ACA the following eight islands were included as part of the Fraser Island study area:

- Woody Island – fr_00105
- Walsh Island – fr_00054
- Turkey Island – fr_00053
- Garden Island – fr_00029
- Stewart Island (Coonangoor) – fr_00021
- Stewart Island East (not official name) – fr_00020
- Dream Island – fr_00025
- Boonlye Point Island (not official name) – fr_00033.

Each island is a separate subsection.

After further investigation of the results the values for the islands appear to have been attributed and calculated correctly. The data is only as accurate as the coastline, catchments layer and wetlands mapping. There are smaller islands with wetlands on them in the Great Sandy Strait, but these are below the mapping scale and have not been picked up in these layers (e.g. Moonboom Island which has significant melaleuca wetlands connected to Bruguiera mangrove wetlands).

In previous riverine ACAs in coastal areas the predominantly estuarine subsections were excluded from the riverine assessment. The exclusion rule does not apply to non-riverine ACAs and the subsections are still used for the calculations. The impact of not excluding the riverine subsections that are predominately estuarine is minimal. Due to time constraints these subsections remained in the riverine ACA.

During field truthing it was identified that some non-riverine wetlands that received significant values for criterion 4 (Threatened species and ecosystems) and criterion 8 (Representativeness) but are in poor condition, received a very 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. After further investigation of this issue, decision four in the non-riverine filtering table was slightly modified to address this. The result is that wetlands scoring low for criterion 1 and 2 (condition) cannot get a very high Aquascore under decision four.

4 Weighting of measures

The panel members and project officers that attended the three expert panel workshops weighted the measures within each indicator. Measures were weighted according to their importance to an indicator and based on the following rules:

1. At least one measure within each indicator must be weighted 10 which is the highest weighting.

2. The other measures within each indicator were weighted compared to the weighting of 10 assigned in the first step.

3. It was okay to have different measures with the same weight (i.e. all measures could be weighted 10).

4. Some indicators only had one measure and had already been given a weighting of 10.

5. Measures shouldn't be weighted down because of the quality or lack of data for that measure.

The individual weights were averaged and reviewed with particular attention to averages having a high variance. In order to improve the statistical reliability of the final weights it was decided to average the weights across the entire Wide Bay-Burnett region, rather than average the weights for each study area/catchment.

The final weights for each measure were then applied in the AquaBAMM assessment (Table 13 and Table 14). The measure number in the following tables relates to the hierarchical approach of the AquaBAMM method. The first number refers to a criterion and the second number to an indicator within a criterion followed by the individual measure number.

There are a number of different methods for eliciting expert information, however many of these can become very complicated and time intensive. The benefits of refining the weights through a more detailed method were considered minimal. The result from the approach adopted at the workshop was considered by the AquaBAMM development team to accurately reflect the expert panel's decisions.

Table 13: The average weights for each non-riverine measure

Maximum possible score from participants was 10; but averages are shown here. The total number of participants was 17.

Criteria and Indicators	Measures		Weight
1 Naturalness Aquatic			
1.1 Exotic flora/fauna	1.1.1	Presence of 'alien' fish species within the wetland	9.0
	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	8.3
	1.1.4	Presence of feral/exotic vertebrate fauna (other than fish) within the wetland	8.7
1.4 Hydrological modification	1.4.5	Hydrological disturbance/modification of the wetland (e.g. as determined through EPA wetland mapping and classification)	9.5
2 Naturalness Catchment			
2.1 Exotic flora/fauna	2.1.1	Presence of exotic terrestrial plants in the assessment unit	10.0
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	10.0
2.3 Catchment disturbance	2.3.1	% "agricultural" land-use area (i.e. cropping and horticulture)	9.0
	2.3.2	% "grazing" land-use area	8.9
	2.3.3	% "vegetation" land-use area (i.e. native veg + regrowth)	9.1
	2.3.4	% "settlement" land-use area (i.e. towns, cities, etc)	9.8

Criteria and Indicators	Measures		Weight
2.4 Flow modification	2.4.1	Farm storage (overland flow harvesting, floodplain ring tanks, gully dams) calculated by surface area	9.4
3 Diversity and Richness			
3.1 Species	3.1.2	Richness of native fish	9.5
	3.1.3	Richness of native aquatic dependent reptiles	9.5
	3.1.4	Richness of native waterbirds	9.3
	3.1.5	Richness of native aquatic plants	9.6
	3.1.6	Richness of native amphibians (non-riverine wetland breeders)	9.6
	3.1.7	Richness of native aquatic dependent mammals	9.1
3.2 Communities/ assemblages	3.2.1	Richness of macroinvertebrate taxa	9.8
3.3 Habitat	3.3.2	Richness of wetland types within the local catchment (e.g. SOR subsection)	8.9
	3.3.3	Richness of wetland types within the sub-catchment	9.3
4 Threatened Species and Ecosystems			
4.1 Species	4.1.1	Presence of rare or threatened aquatic ecosystem dependent fauna species – NCAct, EPBCAct	9.9
	4.1.2	Presence of rare or threatened aquatic ecosystem dependent flora species - NCAct, EPBCAct	9.9
4.2 Communities/ assemblages	4.2.1	Conservation status of wetland Regional Ecosystems – Herbarium biodiversity status, NCAct, EPBCAct	10.0
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	9.8
	5.1.3	Habitat for, or presence of, migratory species (Expert Panel list/discussion and/or JAMBA / CAMBA agreement lists and/or Bonn Convention)	9.3
	5.1.4	Habitat for significant numbers of waterbirds	8.8
5.2 Ecosystems	5.2.1	Presence of 'priority' aquatic ecosystem	10.0
6 Special Features			
6.1 Geomorphic features	6.1.1	Presence of distinct, unique or special geomorphic features	10.0
6.2 Ecological processes	6.2.1	Presence of (or requirement for) distinct, unique or special ecological processes	10.0
6.3 Habitat	6.3.1	Presence of distinct, unique or special habitat (including habitat that functions as refugia or other critical purpose)	9.5
	6.3.2	Significant wetlands identified by an accepted method such as Ramsar, Australian Directory of Important Wetlands, Regional Coastal Management Planning, World Heritage Areas, etc.	9.6
	6.3.3	Ecologically significant wetlands identified through expert opinion and/or documented study	9.4
6.4 Hydrological	6.4.1	Presence of distinct, unique or special hydrological regimes (e.g. Spring fed stream, ephemeral stream, boggomoss)	10.0
7 Connectivity			
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)	10.0
	7.3.2	Extent to which the wetland retains critical ecological and hydrological connectivity, where it should exist, with floodplains, rivers, groundwater, etc.	9.9
7.5 Estuarine and marine ecosystems	7.5.1	The contribution of the spatial unit to the maintenance of estuarine and marine ecosystems with significant biodiversity values, including those features identified through Criteria 5 and/or 6	10.0

Criteria and Indicators	Measures		Weight
8 Representativeness			
8.1 Wetland protection	8.1.1	The percent area of each wetland type within Protected Areas.	9.6
	8.1.2	The percent area of each wetland type within a coastal/estuarine area subject to the Fisheries Act, Coastal Management Act or Marine Parks Act.	9.2
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)	9.7
	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)	9.5
	8.2.3	The size of each wetland type relative to others of its management group within the catchment or study area	8.8
	8.2.4	The size of each wetland type relative to others of its type within a sub-catchment (or estuarine zone)	8.5
	8.2.5	Wetland type representative of the study area – identified by expert opinion	8.6
	8.2.6	The size of each wetland type relative to others of its type within the catchment or study area	8.8

Table 14: The average weights for each riverine measure

Maximum score is 10; total number of participants was 18.

Criteria and Indicators	Measures		Weight
1 Naturalness Aquatic			
1.1 Exotic flora/fauna	1.1.1	Presence of 'alien' fish species within the wetland	9.3
	1.1.2	Presence of exotic aquatic and semi-aquatic plants within the wetland	9.8
	1.1.3	Presence of exotic invertebrate fauna within the wetland	8.3
	1.1.4	Presence of feral/exotic vertebrate fauna (other than fish) within the wetland	8.5
1.2 Aquatic communities/ assemblages	1.2.1	SOR aquatic vegetation condition	7.0
	1.2.2	SIGNAL2 score (Max)	8.1
	1.2.3	AUSRIVAS score - Edge (Min band)	8.6
	1.2.4	AUSRIVAS score - Pool (Min band)	8.5
	1.2.9	AUSRIVAS score - Riffle (Min band)	9.0
1.3 Habitat features modification	1.3.1	SOR bank stability	6.8
	1.3.2	SOR bed and bar stability	6.7
	1.3.3	SOR aquatic habitat condition	7.2
	1.3.4	Presence/absence of dams/weirs within the wetland	9.3
	1.3.5	Inundation by dams/weirs (% of waterway length within the wetland)	9.6
	1.3.8	Presence of dredging/extraction (including for navigation) and channel modification within the wetland	8.6
1.4 Hydrological modification	1.4.1	APFD score - modelled deviation from natural under full development	9.4
	1.4.2	Percent natural flows - modelled flows remaining relative to predevelopment	8.9
	1.4.3	Percent no flows - modelled low flows relative to predevelopment	9.2
	1.4.8	HEV Areas	7.9
2 Naturalness Catchment			
2.1 Exotic flora/fauna	2.1.1	Presence of exotic terrestrial plants in the assessment unit	10.0
2.2 Riparian disturbance	2.2.1	% area remnant vegetation relative to preclear extent within buffered riverine wetland or watercourses	9.8
	2.2.2	Total number of REs relative to preclear number of REs within buffered riverine wetland or watercourses	7.8
	2.2.3	SOR reach environs	6.8

Criteria and Indicators	Measures		Weight
	2.2.4	SOR riparian vegetation condition	7.1
2.3 Catchment disturbance	2.3.1	% "agricultural" land-use area (i.e. cropping and horticulture)	8.9
	2.3.2	% "grazing" land-use area	8.6
	2.3.3	% "vegetation" land-use area (i.e. native veg + regrowth)	8.9
	2.3.4	% "settlement" land-use area (i.e. towns, cities, etc)	9.5
2.4 Flow modification	2.4.1	Farm storage (overland flow harvesting, floodplain ring tanks, gully dams) calculated by surface area	10.0
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	9.8
	3.1.3	Richness of native aquatic dependent reptiles	9.4
	3.1.4	Richness of native waterbirds	9.3
	3.1.5	Richness of native aquatic plants	9.7
	3.1.7	Richness of native aquatic dependent mammals	9.1
3.2 Communities/ assemblages	3.2.1	Richness of macroinvertebrate taxa	9.8
	3.2.2	Richness of REs along riverine wetlands or watercourses within a specified buffer distance	8.8
3.3 Habitat	3.3.1	SOR channel diversity	8.6
	3.3.2	Richness of wetland types within the local catchment (e.g. SOR subsection)	8.8
	3.3.3	Richness of wetland types within the sub-catchment	9.3
4 Threatened Species and Ecosystems			
4.1 Species	4.1.1	Presence of rare or threatened aquatic ecosystem dependent fauna species – NCAct, EPBCAct	9.9
	4.1.2	Presence of rare or threatened aquatic ecosystem dependent flora species - NCAct, EPBCAct	9.9
4.2 Communities/ assemblages	4.2.1	Conservation status of wetland Regional Ecosystems – Herbarium biodiversity status, NCAct, EPBCAct	10.0
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	9.8
	5.1.3	Habitat for, or presence of, migratory species (Expert Panel list/discussion and/or JAMBA / CAMBA agreement lists and/or Bonn Convention)	9.4
	5.1.4	Habitat for significant numbers of waterbirds	8.9
5.2 Ecosystems	5.2.1	Presence of 'priority' aquatic ecosystem	10.0
6 Special Features			
6.1 Geomorphic features	6.1.1	Presence of distinct, unique or special geomorphic features	10.0
6.2 Ecological processes	6.2.1	Presence of (or requirement for) distinct, unique or special ecological processes	10.0
6.3 Habitat	6.3.1	Presence of distinct, unique or special habitat (including habitat that functions as refugia or other critical purpose)	9.6
	6.3.2	Significant wetlands identified by an accepted method such as Ramsar, Australian Directory of Important Wetlands, Regional Coastal Management Planning, World Heritage Areas, etc.	9.6
	6.3.3	Ecologically significant wetlands identified through expert opinion and/or documented study	9.4
6.4 Hydrological	6.4.1	Presence of distinct, unique or special hydrological regimes (e.g. Spring fed stream, ephemeral stream, boggomoss)	10.0
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	9.4
	7.1.2	Migratory or routine 'passage' of fish and other fully aquatic species (upstream, lateral or downstream movement) within the spatial unit	9.6

Criteria and Indicators	Measures		Weight
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)	10.0
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	10.0
7.5 Estuarine and marine ecosystems	7.5.1	The contribution of the spatial unit to the maintenance of estuarine and marine ecosystems with significant biodiversity values, including those features identified through Criteria 5 and/or 6	10.0

5 Ranking of indicators

The panel members and project officers that attended each expert panel workshop ranked the indicators within each criterion. Indicators were ranked according to their importance to a criterion and based on the following rules:

1. At least one indicator within each criterion must be ranked one which is the highest ranking.

2. The other indicators were ranked within each criterion relative to the ranking of one assigned in the first step.

3. It was okay to have different indicators with the same ranking (i.e. all indicators may be ranked 1).

4. Indicator shouldn't be ranked down because of the quality or lack of data for that indicator.

The individual rankings were averaged and reviewed with particular attention to averages having a high variance. In order to improve the statistical reliability of the final rankings it was decided to average the ranks across the entire Wide Bay-Burnett region, rather than average the ranks for each study area/catchment.

The final ranks for each indicator were then applied in the AquaBAMM assessment (Table 15 and Table 16).

Table 15: The average rank for each non-riverine indicator

Maximum rank is 1; total number of participants was 17.

Criteria	Indicator	Rank
1 Naturalness Aquatic		
1.1	Exotic flora/fauna	2
2 Naturalness Catchment		
2.1	Exotic flora/fauna	2
2.3	Catchment disturbance	2
2.4	Flow modification	1
3 Diversity and Richness		
3.2	Communities/ assemblages	1
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	Ecosystems	1
6 Special Features		
6.1	Geomorphic features	3
6.2	Ecological processes	2
6.3	Habitat	2
6.4	Hydrological	1
7 Connectivity		
7.2	Groundwater dependent ecosystems	2
7.5	Estuarine and marine ecosystems	1
8 Representativeness		
8.1	Wetland protection	1
8.2	Wetland uniqueness	1

Table 16: The average rank for each riverine indicator

Maximum rank is 1; total number of participants was 18.

Criteria	Indicator	Rank
1 Naturalness Aquatic		
1.1	Exotic flora/fauna	2
1.2	Aquatic communities/ assemblages	2
1.3	Habitat features modification	2
1.4	Hydrological 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	1
3.2	Communities/ assemblages	1
3.3	Habitat	1
4 Threatened Species and Ecosystems		
4.1	Species	1
4.2	Communities/ assemblages	1
5 Priority Species and Ecosystems		
5.1	Species	1
5.2	Ecosystems	1
6 Special Features		
6.1	Geomorphic features	2
6.2	Ecological processes	2
6.3	Habitat	2
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
7.5	Estuarine and marine ecosystems	2

6 Filter Tables

For each spatial unit, a single 'summary' score is derived by combining all of the final Criteria scores/ratings. This summary score is called 'AquaScore'.
A series of arithmetic techniques are used to bring data from their raw form through to scores for each criterion. To combine the Criterion scores/ratings in this final step, however, arithmetic techniques were considered to mask a number of important effects (as perceived by expert opinion) or to simply not provide sufficient discrimination between spatial units. Other authors (e.g. Chessman 2002) also discuss this issue.

Rather than a final arithmetic combination, AquaBAMM uses a criterion rating combination table (or 'filtering' decision table) that provides an ordered series of 'decisions' that are tested against the final criterion ratings for each spatial unit (Table 17). Each decision is a unique combination of criterion ratings that is associated with a final AquaScore category. The decisions are effectively a number of 'if-then' statements and are tested in sequence for each spatial unit. An AquaScore is assigned immediately when a match is achieved between the Criterion rating combination of the 'decision' and that of the 'spatial unit'. This combination table (or filtering table) technique has previously been used successfully in the DERM's terrestrial BAMM (EPA 2002).

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

Table 17: Criteria rating combination table (filter table) as used for the Wide Bay-Burnett riverine ACA

Decision	Order	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	Additional Criteria	AquaScore
0	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	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	2	equal to (Very High) and			equal to (Very High) and	equal to (Very High) and		equal to (Very High)		Very High
3	3	equal to (Very High or High)							and number of Criteria with Very High >= 4	Very High
4	4						equal to (Very High)			Very High
5	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	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	7	equal to (Very High) and			equal to (Very High)					High
8	8	equal to (Very High) and				equal to (Very High)				High
9	9		equal to (Very High) and		equal to (Very High)					High
10	10			equal to (Very High) and				equal to (Very High)		High

Decision	Order	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	Additional Criteria	AquaScore
11	11	equal to (Very High) and	equal to (Very High) and	equal to (Very High)						High
12	12	equal to (High) and		equal to (Very High)						High
13	13	equal to (Very High or High) and						equal to (Very High)		High
14	14			equal to (Very High) and	equal to (Very High) and	equal to (Very High)				High
15	15					equal to (High) and		equal to (Very High)		High
16	16		equal to (Very High) and	equal to (Very High) and			equal to (High)			High
17	17		equal to (Very High) and				equal to (High)			High
18	18	equal to (High) and	equal to (Very High) and				equal to (High)			High
19	19		equal to (Very High) and		equal to (High) and		equal to (High)			High
20	20		equal to (Very High) and			equal to (High) and	equal to (High)			High
21	21	equal to (High) and			equal to (High) and	equal to (High)				High

Decision	Order	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	Additional Criteria	AquaScore
22	22					equal to (Very High or High) and	equal to (High)			High
23	23	equal to (Very High or High) and		equal to (High) and	equal to (High)					High
23a	24						equal to (High)			High
24	25				equal to (Very High or High)					Medium
25	26					equal to (Very High or High)				Medium
26	27			equal to (High) and				equal to (High)		Medium
27	28	equal to (Medium) and		equal to (High)						Medium
28	29	equal to (Very High or High or Medium) and	equal to (Very High or High or Medium) and					equal to (High)		Medium
29	30			equal to (High) and		equal to (Medium)				Medium
30	31					equal to (Medium) and		equal to (High)		Medium
31	32		equal to (High) and	equal to (High) and			equal to (High)			Medium
32	33		equal to (High) and				equal to (High) and	equal to (High)		Medium

Decision	Order	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	Additional Criteria	AquaScore
33	34	equal to (Medium) and	equal to (High) and				equal to (High)			Medium
34	35		equal to (High) and		equal to (Medium) and		equal to (High)			Medium
35	36		equal to (High) and			equal to (Medium) and	equal to (High)			Medium
36	37	equal to (Medium) and			equal to (Medium) and	equal to (Medium)				Medium
36a	38						equal to (Medium)			Medium
37	39	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
38	40	not equal to (Very High) and	not equal to (Very High)						and number of Criteria with Low or No data >= 4	Very Low
1000	41	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

In the case of the Wide Bay Burnett River Riverine Assessment, the Criterion rating combination table has 41 separate ‘decisions’ that were constructed and ordered by expert opinion and expert panel processes. The number of decisions and their structure, however, may be varied if necessary by simple adjustment in the Tool.

The criteria rating combination table may contain decisions that are based on scores for a single criterion or scores for multiple criteria. For example:

- Decision 4 If Criterion 6 = Very High, then AquaScore = Very High

- Decision 18 If Criterion 1 = High AND Criterion 2 = Very High AND Criterion 6 = High, then AquaScore = High.

To reiterate, decisions within the combination table are deliberately ordered and tested in sequence. Once a spatial unit triggers a decision, it is assigned the AquaScore relevant to that decision and further testing against the combination table ends for that spatial unit.
Combination (or filtering tables) with large numbers of decisions can be difficult to establish and specific attention was paid to ensure that all decisions are theoretically possible, and that there was no duplication within or between decisions.

Table 18: Criteria rating combination table (filter table) as used for the Wide Bay-Burnett non-riverine ACA

Decision	Order	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	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	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	2	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
3	3	equal to (Very High) and	equal to (Very High) and						equal to (Very High)		Very High
4	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	5						equal to (Very High)				Very High
6	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	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	8	equal to (Very High) and			equal to (Very High or High) and				equal to (High)		High

Decision	Order	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
9	9	equal to (Very High) and				equal to (Very High) and			equal to (High)		High
10	10	equal to (Very High) and	equal to (Very High) and			equal to (Very High)					High
10a	11			equal to (Very High) and				equal to (Very High)			High
11	12			equal to (Very High) and					equal to (Very High)		High
11a	13	equal to (Very High or High) and						equal to (Very High)			High
12	14	equal to (Very High) and				equal to (Very High or High) and			equal to (Very High)		High
13	15	equal to (High) and	equal to (Very High) and		equal to (Very High or High)						High
14	16	equal to (High) and	equal to (Very High) and			equal to (Very High)					High
15	17	equal to (High) and	equal to (High) and	equal to (Very High) and					equal to (High)		High
15a	18						equal to (High)				High
16	19		equal to (High) and	equal to (Very High)							Medium
17	20			equal to (Very High) and					equal to (High)		Medium
18	21	equal to (High) and	equal to (High or Medium) and						equal to (Very High or High)		Medium

Decision	Order	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
19	22				equal to (High)						Medium
20	23					equal to (Very High)					Medium
20a	24					equal to (High) and		equal to (Very High)			Medium
20b	25			equal to (High) and				equal to (Very High)			Medium
21	26	equal to (Medium) and	equal to (High) and				equal to (Medium)				Medium
22	27		equal to (High) and	equal to (High) and		equal to (Medium)					Medium
23	28		equal to (High) and		equal to (Medium) and		equal to (Medium)				Medium
24	29	equal to (Medium) and			equal to (Medium) and				equal to (Medium)		Medium
25	30	equal to (High or Medium) and	equal to (Very High)								Medium
25a	31	equal to (Very High or High or Medium) and	equal to (Very High or High or Medium) and					equal to (High)			Medium
26	32	equal to (Very High or High or Medium) and	equal to (Very High or High or Medium) and	equal to (Medium) and					equal to (Medium)		Medium
26a	33						equal to (Medium)				Medium

Decision	Order	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
26b	34	equal to (Very High) and	equal to (Very High) and	equal to (Very High)							Medium
26c	35					equal to (Medium) and		equal to (High)			Medium
26d	36		equal to (High) and				equal to (High) and	equal to (High)			Medium
27	38	equal to (Very High or High)								and number of Criteria with Very High >= 4	Very High
28	39									and number of Criteria with Low or No data >= 4	Very Low
29	40									and number of Criteria with High >= 3	Medium
30	41									and number of Criteria with Medium >= 4	Medium
1000	42	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

7 Summary and recommendations

The results of an ACA, or AquaBAMM assessment output, may be used in a number of ways and for a number of purposes. Well founded ecological or conservation values for aquatic ecosystems are a useful input to many natural resource management decision making processes including, for example, regional planning, development assessment, tenure negotiations or protected area estate review. In addition to the use of final AquaBAMM analysis scores, subordinate elements from each assessment may also be used for management and planning purposes. For example, prioritising natural resource management actions within a catchment (or other spatial unit) for rehabilitation, protection of high ecological value areas or other on-ground works may be achieved through the use of data from individual measures within AquaBAMM.

Interpretation of the WBB ACA results for the purposes of management priority or for development of management actions has not been undertaken as part of this project.

An analysis of the filtering table and how many spatial units triggered at each decision was performed. There does not appear to be any major inconsistencies in the hit analysis. In the longer term the hit analysis for all the ACAs should be compared to see if there are any redundant decisions or decisions that are inconsistent.

Within the Cooloola coast catchment the small subunit size due to flat terrain and the threshold set by the Rivatools model has compounded the problem of low dependencies. Field inspection did not confirm any obvious terrain separation between their catchments. It is recommended that the next time an ACA is completed for Cooloola coast that the subunits are reviewed and adjacent ones with marginal terrain differences amalgamated. Recommend that dependability is used as an overlay when interpreting the results for all catchments but especially Fraser Island and Cooloola coast.

It is important to acknowledge that there are true data gaps within the Cooloola coast catchment notably in inaccessible parts of the Great Sandy Strait coastline, and within the Cooloola section of the Great Sandy National Park. Further survey work in these areas would benefit future ACAs as well as a range of other planning processes.

LIDAR Highest Astronomical Tide mapping should be used to define the differences between islands and estuarine wetlands.

In order to assist with interpretation of the results the streams above the HAT and the estuaries should be coloured as riverine and below as estuarine when displaying the AquaScore values.

Species habitat models and pest habitat mapping from DEEDI were available but were unable to be implemented due to time constraints and as an alternative, the species records were used. Habitat models usually provide a more ecologically realistic indication of habitat and is the preferred avenue for including species information in the ACAs. Future ACA versions should incorporate these habitat models, where possible.

Riverine wetlands as mapped by the Queensland Wetlands Program were not included in the riverine ACA. The ACA was based on the stream network from the QWP and the subsections. The ACA values are assigned to the subsection and the assumption is that all riverine wetlands (regardless of mapping source) have the relevant values. Further work is required to incorporate the excluded riverine wetlands into the riverine ACA.

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9 Attachments

Attachment A **Aquatic flora expert panel report**

Attachment B **Aquatic fauna expert panel report**

Attachment C **Wetland ecology expert panel report**

Attachment A **Wide Bay-Burnett ACA –**
Aquatic flora expert panel report

Water and Ecosystem Outcomes Business Group
Queensland Department of Environment and Resource Management

An Aquatic Conservation Assessment for the non-riverine and riverine wetlands of the Wide Bay-Burnett region

Aquatic Flora
Expert Panel report

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Acronyms and abbreviations

ACA	Aquatic Conservation Assessment
ARFEP	Aquatic and Riparian Flora Expert Panel for the Burnett ACA
ASL	Above sea level
BPA	Biodiversity Planning Assessment
DEEDI	Department of Employment, Economic Development and Innovation
DERM	Department of Environment and Resource Management
DIWA	Directory of Important Wetlands Australia
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
GIS	Geographic information system
HEV	High ecological value (under a water quality improvement plan)
NC Act	*Nature Conservation Act 1992*
Ramsar	Ramsar Convention on Wetlands
RE	Regional ecosystem
WBB	Wide Bay-Burnett

1 Introduction

The Department of Environment and Resource Management (DERM) has conducted an Aquatic Conservation Assessment (ACA) for the non-riverine and riverine wetlands of the Wide Bay-Burnett region using the Aquatic Biodiversity Assessment and Mapping Method (AquaBAMM; Clayton *et al*. 2006). The ACA relied on expert panels convened to address aquatic and riparian flora, aquatic fauna and wetland ecology for some of the data inputs.

AquaBAMM provides a robust and easily accessible analysis of wetland conservation values associated with a catchment or other defined study area. The AquaBAMM provides a decision support tool that utilises existing information, with moderation by expert panels (e.g. flora, fauna and wetland ecology expert panels) to ensure scientific rigour resulting in an ACA for a nominated geographic area—in this case, the Wide Bay-Burnett region.

The potential for adding additional data into the system as it becomes available, with consequent updates to planning outcomes, is not limited. The AquaBAMM tool is a map/data output in a geographic information system (GIS) environment based on spatial mapping units that describe conservation significance or value for planning and assessment purposes.

The Wide Bay-Burnett region ACA is made up of six individual catchments—the Burnett, Mary, Kolan, Burrum, Cooloola and Fraser Island catchments. DERM is applying AquaBAMM separately to the non-riverine (i.e. palustrine and lacustrine) and riverine wetlands within each of the six Wide Bay-Burnett catchments. In effect, there are 12 ACAs for the area—covering non-riverine and riverine wetlands in each of the catchments. A map of the Wide Bay-Burnett region showing each study area is provided in Attachment A.

As part of the ACA, three expert panels were conducted to address aquatic and riparian flora, aquatic fauna, and wetland ecology for the six Wide Bay-Burnett catchments. The non-riverine and riverine wetlands were covered in combined workshops. The panels, held in Maryborough during July 2010, involved invited experts with expertise in aquatic and riparian flora, aquatic fauna and/or wetland ecology.

This report documents the findings and recommendations of the aquatic flora expert panel held in Maryborough on 14th and 15th July 2010. The report presents supporting information and panel input that addresses non-riverine and riverine wetland systems. Terms of reference for the panel are provided in Attachment B.

2 Method

2.1 Study area

Burnett catchment

The Burnett River catchment lies in the South East Queensland and Brigalow Belt bioregions and is located approximately 200 km north-west of Brisbane. The Burnett is the third largest river basin on the east coast of Queensland, with a catchment area of approximately 34 500 km^2 (Van Manen 1999). The Burnett River flows for 420 km from its source in the Burnett Range to its mouth at Burnett Heads. The main tributaries of the Burnett River include the Auburn, Nogo, Boyne and Stuart Rivers and the Barambah and Three Moon Creeks (Van Manen 1999). The catchment is fringed by the Burnett and Dawes Ranges in the north, the Auburn Range to the west, the Great Dividing Range to the south-west and the Cooyar and Brisbane Ranges in the south. Major urban and regional centres in the Burnett River catchment include Bundaberg, Kingaroy, Gayndah, Eidsvold, Murgon, Nanango and Monto. Rainfall in the catchment is variable with both tropical and temperate weather patterns. Cattle grazing and crop production dominate the catchments land use.

The Burnett River catchment is subject to a number of new water infrastructure projects being approved for development. Jointly with the State of Queensland, the Commonwealth Minister for Environment and Heritage under the provisions of the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth) granted environmental approvals for Barlil Weir, Jones Weir Stage 2 and Eidsvold Weir in late 2001, and approval for Paradise Dam in late January 2002. Eidsvold Weir was completed in 2004 and Paradise Dam was completed in late 2005. Consequently, the Burnett River catchment is one of the most developed areas in Queensland in terms of water infrastructure. Increasing demands for water from irrigators, industry and the domestic sector have resulted in high levels of river regulation. There are currently approximately 41 water storages in the Burnett catchment, six of which are situated in the main river channel (Brizga *et al.* 2000).

As has been observed during the construction of dams in other areas, the raising of the Walla Weir in conjunction with the construction of the Paradise Dam is expected to have significantly reduced suitable habitats for aquatic fauna (Gehrke et al. 2002), particularly the Australian lungfish (Neoceratodus forsteri) and Elseya species of turtle. In response to these concerns, DERM and the Department of Employment, Economic Development and Innovation (DEEDI) were asked to develop eight projects that aim to address catchment-wide, environmental issues associated with the construction and operation of the proposed infrastructure known collectively as the Burnett Plan of Actions (BPOA). The BPOA included an AquaBAMM project in 2006 which aimed to assess 'riverine conservation values of the Burnett'. The initial trial application of the AquaBAMM was conducted in the Burnett River catchment to produce an Aquatic Conservation Assessment (ACA) for riverine wetlands. The ACA being reported here supersedes the first Burnett River ACA version released in 2006 which pre-dated construction of the Paradise Dam.

Additionally, under the Coastal Catchments Initiative, the Australian Government has funded the Burnett-Mary Regional NRM Group (BMRG) to develop the Burnett-Baffle Water Quality Improvement Plan (WQIP) (Burnett-Mary Regional NRM Group/DERM, 2010). DERM and the BMRG have completed a joint project to establish the waterway values and uses (i.e. environmental values), and developed water quality objectives/targets to protect these values and uses consistent with the Environmental Protection (Water) Policy 2009. As part of this project High Ecological Value waterways were determined for the Burnett catchment.

Mary River catchment

The Mary River flows from the moist, subtropical southern part of the South East Queensland bioregion into a drier corridor to the north, and consequently varies considerably in its character. The Mary's freshwater reaches support a distinctive fauna which is close to range limits and adapted to its episodic flood regime, and is one of two catchments supporting the iconic Australian lungfish (*Neoceratodus forsteri*). The Mary catchment is an important source of sediment and freshwater flows for seagrass ecosystems and shorebird feeding habitat in the northern Great Sandy Strait Ramsar area and Hervey Bay. Many of its riverine and non-riverine wetlands are also scheduled as High Ecological Value waterways under the Environmental Protection (Water) Policy 2009.

While most rainfall occurs in late summer to early autumn, flood events may occur in any month but are typically episodic in occurrence (e.g. 5–10 years frequency) and may be interspersed by long dry periods. Irregular high rainfall events associated with cyclones and east coast low depressions feed the southern tributaries of the Mary. While mean annual rainfall near Maleny is 2000 mm, as much as 900 mm has been recorded in a day. Much of this elevated southern catchment falls within protected areas containing rainforest, wet and dry sclerophyll ecosystems although significant areas have been cleared. Obi Obi creek rises from a basaltic plateau in the Sunshine Coast hinterland, falling steeply through gorge country before flowing north to join the Mary River. In contrast, Six Mile Creek is a low energy rainforest stream retaining large woody debris. The banks of some of the major streams, such as Obi Obi, Six Mile, Deep and Tinana Creeks, have rainforest and/or tall open (wet sclerophyll) forest riparian vegetation (e.g. Araucarian notophyll vine forest or mesophyll gallery forest).

Riverbank erosion due to the poor condition of riparian vegetation in the Mary is also being linked to increased sediment discharge to the Great Sandy Strait (Esslemont *et al.* 2006a, b, c, d; DeRose *et al.* 2002). There is a need for further mapping and rehabilitation of riparian vegetation, especially rainforest, since this vegetation type is habitat for several endemic, endangered, vulnerable, near-threatened and priority species including both fauna species (e.g. Mary River cod *(Maccullochella mariensis),* Richmond birdwing (*Ornithoptera richmondia)*, the Pink underwing moth (*Phyllodes imperialis* southern subspecies*)*, Coxen's fig parrot (*Cyclopsitta diopthalma coxeni)*, Black-breasted button-quail (*Turnix melanogaster);* the Giant barred frog *(Mixophyes iterates),* the Tusked frog *(Adelotus brevis);* the Cascade tree frog, *(Litoria pearsoniana)* (Fleay 1997, Mathieson and Smith 2009, Simpson and Jackson 1996, Sands and Scott 1998)) and flora species (e.g. *Xanthostemon oppositifolius, Fontainea rostrata,* Macadamia nut tree (*Macadamia integrifolia*) and Gympie nut (*Macadamia ternifolia*)). The South East Queensland Rainforest Recovery Program describes the association between several of these species and regional ecosystem 12.3.1 (gallery rainforest on alluvial plains). While some remnant riparian vegetation mapping of 12.3.1 exists in the Mary, mapping and identification of other riparian rainforest below the mapping scale and suitable for rehabilitation may inform NRM decisions e.g. a future Mary River Recovery Plan.

Resembling those of the drier Burnett (mean annual rainfall less than 800 mm), the intermittent western tributaries of Wide Bay and Munna Creeks are moderate to high-energy sand and gravel-bed stream systems able to accommodate substantial flows within their wide flow channels. A substantial coarse sediment load from all these tributaries has resulted in distinctive pool, riffle and sand bar sequences chiefly in the main trunk of the Mary River. These areas are notable as habitat for the Australian lungfish (*Neoceratodus forsteri*) and the highest turtle diversity in Queensland (including the endemic Mary River turtle (*Elusor macrurus*)). To the east, Coondoo and Tinana Creeks sustain important riparian rainforest and wallum vegetation on sandy alluvium with natural water quality and relatively intact fauna (including endemic Mary River cod (*Maccullochella peelii mariensis*), Oxleyan Pygmy Perch (*Nannoperca oxleyana*) and the Australian lungfish (*Neoceratodus forsteri*) populations). These creeks flow into the turbid Mary estuary at Maryborough and are joined by the unimpounded Susan River and its mangrove wetlands near the mouth of the river. The tidal delta of the Mary extends into the Great Sandy Strait, encompassing an extensive complex of mangrove islands, saltpans and sandbanks comprising the largest fish habitat area in southern Queensland. Flood events from the Mary River periodically reverse the normally highly saline conditions of Hervey Bay, producing an inverse estuary (Ribbe 2008).

Presently, catchment land use in the area chiefly comprise dryland grazing, sugar cane and plantation forestry, with tree crops and dairying in the elevated south. European settlement and dairying land use resulted extensively in clearing of its upper reaches and riparian area. Land use and modifications of the freshwater reaches have produced erosion and siltation of parts of the river and sedimentation of deep pools. Excess sediment discharge into the Mary estuary, Great Sandy Strait and Hervey Bay from Mary flood events and subsequent resuspension occasionally results in catastrophic loss of seagrass beds and dugong (for example 1992) (Preen *et al.* 1995) and continues to create marine water quality issues. Within the freshwater reaches regulation of its southern tributaries for extraction of water supplies for Gympie, inter-basin transfers to the Sunshine Coast and flow releases for downstream irrigation of canelands have modified the original episodic flows to a smaller, more regular runoff regime, altering the physical structure of the channel (Department of Natural Resources and Mines 2005). Barrages on former estuarine reaches of the Mary River and Tinana Creek provide for irrigated canelands and the Maryborough water supply respectively, but also restrict the freshwater flow regime and fish passage to the estuary. Most of the floodplain wetlands have been converted to cultivated paddocks or canelands. Nevertheless the Mary River catchment still supports a high diversity in riverine and non-riverine wetland types, including wallum wetlands, melaleuca swamps and inland freshwater swamps.

Burrum catchment

The Burrum catchment consists of an amalgam of coastal catchments between the Burnett and Mary catchments. The catchment is dominated by the Burrum sand mass characterised by aggregations of coastal Melaleuca wetlands and heaths with connectivity in a north-south direction. The non-riverine and riverine wetlands of the Burrum play a significant role in reef resilience due to their high connectivity with adjacent estuarine salt marshes, mangroves, seagrass meadows and coral reefs of the Great Sandy Strait Ramsar area and Hervey Bay. Many of the Burrum's riverine, non-riverine and estuarine wetlands are also scheduled as High Ecological Value waterways under the Environmental Protection (Water) Policy 2009.

Of lower relief than the Mary and Cooloola-Great Sandy Strait catchments, the Burrum receives most of its rainfall as northern monsoons, cyclones or troughs occurring in late summer-autumn (averaging 1000-1200 mm per annum). The climatic variability and low freshwater discharge in combination with evaporation on expansive tidal flats have created an 'inverse estuary' in the receiving waters of Hervey Bay (i.e. strongly hypersaline; Ribbe 2008, Grawe 2010).

The catchment logically falls into five geomorphic subdivisions: the Woongarra coastal streams draining a gently-sloping, fertile Quaternary basalt deposit; the groundwater-fed Elliott River; the Coonarr to Beelbi region of extensive sandy beach ridges and swales; the Burrum, Isis, Gregory and Cherwell rivers draining into the Burrum estuary; and the O'Regan's Creek to the Mary River area, typified by short coastal streams and alluvial wetlands sloping from a ridgeline behind Hervey Bay City. In the hinterland, sedimentary rocks of the Maryborough formation formed in Mesozoic marine waters have resulted in saline-tolerant Melaleuca wetlands along drainage lines.

The Burrum Coast sits within the Directory of Important Wetlands area between Theodolite and Beelbi creeks and includes both freshwater and estuarine wetlands (mangroves and seagrass beds). As a succession of both Holocene and Pleistocene beach ridges, and swales and Quaternary freshwater swamp deposits, it represents the most significant coastal dune system north of the Cooloola sand mass. A large proportion of this dune system is conserved within the Burrum Coast National Park. Wetland types of the Burrum Coast include wallums, closed wet heath and swale wetlands dominated by Melaleuca species. These wetlands and adjacent habitats include several species approaching their geographic limits (such as *Strangea linearis*, *Callistemon pachyphylla* and *Melaleuca sieberi*) and a number of endangered, vulnerable and near-threatened plant species including the paperbark tree (*Melaleuca cheelii*), tiny wattle (*Acacia baueri subsp baueri*) and an alyxia (*Alyxia sharpei*). The Wallum froglet (*Crinia tinnula)* has also been recorded in the Burrum Coast National Park and other wetlands in the catchment. Inland from the coastal dune systems lie wetlands and streams of the Burrum and Cherwell. In these areas, deep weathering of Tertiary sediments have formed duricrust pans on a slightly elevated plateau, inhibiting the surface drainage. The Cherwell River has good examples of perched heathy wetlands associated with these pans as well as Melaleuca swampy drainage lines dissecting the edges of the plateau.

The Elliott River catchment, which sits within the Burrum study area, is largely groundwater-fed, containing aquifers that consist of a series of poorly interconnected sand and gravel channels and intervening clay layers sloping gently towards the coast. This area's unique hydrology, freshwater wetlands and excellent connectivity to high receiving water values (including seagrass and corals) were recognised in the Burnett-Baffle Water Quality Improvement Plan (Burnett-Mary Regional NRM Group/DERM 2010).

Dominant land uses in the Burrum catchment are irrigated cropping, grazing, coastal urban development and minor plantation forestry, with the majority of intensive land use north of the Isis River. However, extensive vegetated tracts of state land remains within the bioregional corridor in the hinterland and within protected estate on the coast. Irrigation from groundwater provides for intensive cane farming and horticulture north of the Burrum River. Lenthalls Dam on the Burrum supplies the expanding city of Hervey Bay with water. Other weirs and barrages on the Burrum and Isis Rivers also sever connectivity between freshwater areas and the estuary.

Clearing of wetlands for agriculture and fragmentation associated with coastal development has impacted on the Woongarra coast and, to a lesser extent, south of Burrum Heads. Wetland function in these catchments provides water quality protection for significant estuarine and marine values–most notably the Burrum seagrass meadow dugong nursery (Sheppard 2006), Mon Repos turtle rookery and subtropical coral reefs fringing both Woongarra and Hervey Bay coastlines.

Urban development, artificial lakes and sand extraction are increasingly impacting on the natural hydrology of wetlands and streams south of Burrum Heads, with impacts such as de-watering of heathland wetlands in adjacent protected estate. There is potential for excavation of wetland soil to mobilise acid sulfate runoff and seepage from septics to eutrophy groundwater. In other parts of Australia and the world, the importance of hydrological connectivity between groundwater and adjacent inshore marine ecosystems (Maji and Smith 2008), such as seagrass, is acknowledged (Coles *et al.* 2007; Eamus *et al.* 2006; Kammermans *et al.* 2002; Johannes and Hearn 1985) and the impacts coastal urban development has on these groundwater dependent ecosystems has been demonstrated (Carruthers *et al.* 2005, Valeila *et al.* 1990). While groundwater connectivity to seagrass is yet to be investigated for the Burrum catchment, the maintenance of intact wetland function is an important consideration for the health of connected ecosystems.

Kolan catchment

The Kolan catchment is a coastal catchment between the Burnett to the south and the Littabella and Baffle Creek catchments to the north. This catchment features mainly agricultural land use and water resources, but there are some wetlands of biodiversity significance in its headwaters and adjoining its estuary.

The Kolan falls within the northern half of the South East Queensland bioregion, and has a subtropical climate with an average rainfall of 1200 -1400 mm per annum. Most of this rainfall occurs during late summer commonly associated with cyclones and troughs, but can be sporadic. Most of the Kolan catchment is relatively flat, below 80 m above sea level (ASL). However, the headwaters arise in the rugged Many Peaks Range rise to 700 m ASL. There are a number of different protected areas in the headwaters, notably Bulburin National Park and Bulburin Forest Reserve which feature subtropical dry rainforest with emergent hoop pines; gallery rainforest; and drier eucalypt forests. Hoop pine plantations adjoin protected estates at Bulburin.

On the south side of the Kolan, a series of parallel dunes has formed a barrier and swale system in the Moore Park area. This wetland complex of Melaleuca swamps and lakes is fragmented by the urban settlement of Moore Park Beach. However, the freshwater wetlands have reasonable connectivity to the Kolan Fish Habitat Area in the estuarine waters of the Kolan and west of Barubbra Island in the delta of the Burnett.

Agricultural and water resource land uses dominate much of the Kolan and as a result much of the catchment is cleared. Grazing dominates the upper and central catchment, while irrigated sugar cane and horticultural crops (including macadamia nut plantations) predominate in the lower catchment. The Fred Haigh Dam is a large impoundment within the central-upper reaches of the Kolan with a pipeline providing inter-basin transfers into the Burnett for irrigation. Bucca Weir and the Kolan barrage provides freshwater for agriculture in the central and lower reaches. Irrigation from the Gooburrum aquifer, which extends from the Elliott River north to the Kolan, supplements the variable rainfall experienced within the Kolan. To date, connectivity has been poor and hence environmental flows to the estuary have been low. However, the revised water resource plan covering the region is focussing more on improvements to freshwater flows in order to benefit catadromous fish.

Under its Coastal Catchments Initiative, the Australian Government has funded the Burnett-Mary Regional NRM Group (BMRG) to develop the Burnett-Baffle Water Quality Improvement Plan (WQIP). DERM and the BMRG have completed a joint project to establish the waterway values and uses (i.e. environmental values) and develop water quality objectives/targets to protect the values and uses consistent with the Environmental Protection (Water) Policy 2009. As part of this project High Ecological Value waterways were determined for the Kolan catchment.

Cooloola catchment (previously Noosa North)

Previously this catchment was referred to as Noosa North, however to more accurately represent the geographical location, the wetland ecology expert panel recommended that it be renamed the Cooloola catchment .The Cooloola region has the oldest and largest unconsolidated sand mass in the world, nominated as World Heritage for its spectacular natural values, geomorphology, and the most extensive and intact complex of heath and swamp communities in south-eastern Australia (Fraser Island World Heritage Scientific Advisory Committee, 2004a). The Cooloola Sand Mass, and its very high rainfall volume (often exceeding 1200 mm annually) determines the hydrology and character of most of this catchment. Many of its freshwater wetlands fall within the Great Sandy Strait Ramsar area, and together with the dunes are important groundwater recharge areas. Many of Cooloola's riverine, non-riverine and estuarine wetlands are also scheduled as High Ecological Value waterways under the Environmental Protection (Water) Policy 2009.

Streams of the Cooloola catchment flow in four separate directions, three of which are in protected area estate within the Cooloola section of the Great Sandy National Park. To the north flow the Cooloola and Great Sandy Strait streams; to the south flows the Noosa River; and various streams and springs within the narrow dune corridor of the eastern seaboard discharge directly across the beach to the sea. East of the Mary River catchment and north of Kauri Creek, coastal creeks from other, smaller sand masses than Cooloola flow directly into the Great Sandy Strait Ramsar area, whose sandbanks and mangrove-lined waterways provide significant seagrass habitat for shorebirds, dugong and dolphins.

Catchments of the Cooloola area are typified by their dependence on groundwater flows emanating chiefly from the Cooloola Sand Mass, high dunes (to 258 m ASL), resembling those of Fraser Island in geomorphology, hydrology, flora and fauna. This sand mass is derived from quartz sands blown and buried in a low hilly landscape of Mesozoic sandstones, covered by successively younger sand deposits until the Holocene (including parabolic dunes). Long-term leaching of humic acids has formed deep podzolic soils and peat-swamps with various layers of coffee rock impeding drainage and forming perched water tables, overlying a deeper regional groundwater table close to sea level and connected to estuarine waters. While hydrologically linked to the Noosa River catchment, the divide between these groundwater-sourced systems approximately coincides with the topographic watershed along the highest dunes of the sandmass. Groundwater of the Cooloola area is characterised by organic stained 'black waters' in its perched system and unstained 'white water' in the prime aquifer below (NLWRA 2000).

This variety of hydrological regimes produces a wide range of highly significant wetland types including patterned fens similar to those of Fraser Island, the only subtropical patterned fens in the world; 'swamp hummocks' of patterned peat microrelief; perched (e.g. Poona Lake) and regional water-table 'window' lakes (e.g. Freshwater Lake); perched heath swamps with Christmas bells and other rare wetland flora species; episodic springs or 'bubblers' of 'white' water across the beach; 'black' tannin-stained wallum streams; vineforest riparian vegetation surrounding 'white water' springs; and melaleuca wetlands to name a few. Many are 'acid' habitats with a pH so low that they have developed a unique suite of acid-tolerant fauna including four vulnerable and near-threatened frogs (the Cooloola sedgefrog (*Litoria cooloolensis*), Wallum rocketfrog (*Litoria freycineti*), Wallum sedgefrog (*Litoria olongurensis*) and Wallum froglet *Crinia tinnula)*, fish, the crayfish (*Cherax robustus*) and earthworms.

Northward to the Great Sandy Strait the continuity between the freshwater streams, groundwater and the estuary is largely uninterrupted and natural, supporting very high values in the freshwater/estuarine interface including the most significant mainland populations of Water Mouse; species tolerant of brackish water and low pH (e.g. Honey Blue Eye (*Pseudomugil mellis*) and Oxleyan Pygmy perch (*Nannoperca oxleyana*)) and very high fish diversity. Most notable is Kauri Creek and streams discharging from the Wide Bay Military Training Area whose adjacent seagrass beds constitute the most significant dugong habitat in the southern Great Sandy Strait (Sheppard 2006).

Further north beyond Kauri Creek, smaller coastal creeks of the Great Sandy Strait (including Maaroom, Tuan and Poona creeks) drain flatter, sandy terrain as far north as the Mary River mouth. There is limited knowledge of these catchments typified by heath and wallum complexes often connected to a network of mangrove channels within the Great Sandy Strait Ramsar Area. They preserve natural connectivity from fresh to estuarine waters but within a catchment of exotic pine plantations. Poona National Park represents a complex of fresh and estuarine wetlands with similar acid frog habitat and faunal features to those of Cooloola including Honey Blue Eye (*Pseudomugil mellis*).

The Noosa River catchment is a largely undisturbed basin within protected area, featuring deltaic and estuarine lake systems draining southward towards the Sunshine Coast from the Cooloola sand mass. In contrast with Cooloola, it has developed alluvial features and is surrounded by sandstone and alluvium on the west and Pleistocene and Holocene dunes on the east and has high recreational values.

Whilst a lack of urban settlement has left the Cooloola-Great Sandy Strait catchment largely intact, establishment of exotic pine plantations has modified catchments to the north of Kauri Creek. Extraction from Teewah Creek (Noosa River catchment), and the regional groundwater table for the townships of Tin Can Bay and Rainbow Beach respectively have potential to impact on wetlands surrounding Seary's Creek and the Noosa River if water resource management for the environment is not effective. Coastal developments at Cooloola Cove, and to a lesser extent Tin Can Bay, Poona, Big Tuan and Boonooroo sever the connectivity between freshwater and estuarine wetlands and there is potential for excavation of wetland soil to mobilise acid sulfate runoff and seepage from septics to eutrophy groundwater. Monitoring in the Great Sandy Strait has documented seagrass declines since the early 1990s. In other parts of Australia and the world, the importance of the hydrological connectivity between groundwater and adjacent inshore marine ecosystems (Maji and Smith 2008), such as seagrass, is acknowledged (Coles *et al.* 2007; Eamus *et al.* 2006; Kammermans *et al.* 2002, Johannes and Hearn 1985) and the impacts coastal urban development has on these groundwater dependent ecosystems has been demonstrated (Carruthers *et al.* 2005, Valeila *et al.* 1990). While groundwater connectivity to seagrass is yet to be investigated for the Cooloola-Great Sandy Strait catchment, the maintenance of intact freshwater wetland function is an important consideration for the health of connected aquatic ecosystems in the Ramsar area.

Fraser Island catchment

Fraser Island is the largest sand island in the world, recognised as containing World Heritage Outstanding Universal Values including geomorphic and ecological processes, exceptional beauty, biodiversity, threatened species, and cultural heritage (Fraser Island World Heritage Scientific Advisory Committee, 2004b). The areas substantial dune aquifer characterises the island's unique wetlands which includes half the freshwater dune lakes in the world and the only known subtropical patterned fens. In the western parts, the streams of Fraser Island flow into the Great Sandy Strait Ramsar area, which has also recently been nominated for World Heritage value, while Breaksea Spit to the north provides connectivity to coral reefs in the southern Great Barrier Reef. Many of Fraser Island's riverine, non-riverine and estuarine wetlands are also scheduled as High Ecological Value waterways under the Environmental Protection (Water) Policy 2009.

Fraser Island consists of a complex of high dunes rising to a maximum height of 235 m ASL. Annual rainfall ranges between 1200 and 1800 mm, falling mostly over autumn when seasonal cyclonic weather results in high rain events. North of Indian Head the relief is low and dune formation is more recent, resulting in a network of exposed dunes, freshwater swamps and lakes.

Formed by continuous deposition of quartz dune deposits over the last 700 000 years, Fraser Island represents an intact sequence of dune development from west to east. These wind-blown dunes were deposited during periods of low sea level during interglacials of the Pleistocene and high winds of the Holocene. Successively younger deposits of parabolic dunes are superimposed over these older dune deposits now stabilised by towering rainforests and wet sclerophyll, forming a high diversity of dune forms with complex hydrological relationships. Similarities with the Cooloola Coast area include the heavily leached deep podzolic soils and peat-swamps, layers of coffee rock impeding drainage and forming perched water tables, overlying a deeper regional groundwater table 'lens' close to sea level and connected to estuarine waters.

The advance and retreat of dunes over time has created a complex of dynamic hydrologies resulting in spring-fed streams and freshwater dune lakes. The lakes feature relict formations from past water levels such as multiple shorelines, lunettes and relict spits. Perched lakes formed in wind scoured depressions where organic matter built up impermeable layers. Up to an estimated 300 000 years old, their sediments document changes to the island's hydrology and vegetation through Quaternary glacial and interglacial cycles. These lakes form an age sequence related to the episodic periods of dune building and include some of the largest (e.g. Lake Boomanjin) and highest perched lakes (i.e. Boomerang Lakes) in the world. Window lakes intersect the regional groundwater table. Lake Wabby is a scenic barrage lake, thought to be formed by groundwater springs dammed by a wall of landward migrating sand.

A high diversity of palustrine wetland types are also represented on the island including closed wet heaths, wallum banksia communities, Melaleuca swamps and forests, riparian rainforest and palm forests, and brackish swamps. Notable among these are the patterned fens, formed at the base of high dunes where a build up of peat ridges and pools have formed in response to discharges from the regional water table. A suite of acid-tolerant fauna are associated with the fens and other acid swamps include Oxleyan Pygmy Perch (*Nannoperca oxleyana*) and Honey Blue-Eye (*Pseudomugil mellis*), four acid frog species (the Cooloola sedgefrog (*Litoria cooloolensis*), the Wallum rocketfrog (*Litoria freycineti*), the Wallum sedgefrog (*Litoria olongurensis*) and the Wallum froglet (*Crinia tinnula*) and a crayfish (*Cherax robustus*). The swamp eel (*Ophisternon gutturale*) has also been recorded at Lake Wabby.

Most of the streamflow for Fraser Island's freshwater streams is baseflow from the aquifer, which may be 'black' tannin-stained water discharging from wallum heaths or 'white' clear waters emerging from the lower water table. There is a small pocket of Angiopteris fern at Wanggoolba creek. Freshwater streams also designate the southern range limit of jungle perch (*Kuhlia rupestris*).

Connectivity between freshwater and estuarine waters is an important feature of Fraser Island waterways, and, as a result, populations of the Water mouse (*Xeromys myoides*) are high as they are able to access both habitat types. Fraser Island's western creeks feature the region's highest diversity of mangroves, several of which are freshwater dependent such as the Cannonball Mangrove (*Xylocarpus* granatum) and extensive Bruguiera forests, both at their southern range limits. Fraser Island wetlands perform an important water quality protection function for seagrass beds and sandbanks of the Great Sandy Strait, the humpback whale migration area in Platypus Bay, and the loggerhead turtle rookery at Sandy Cape.

Fraser Island is largely undeveloped and heavily vegetated, and the north is largely wilderness. Most of the island is in protected area estate, although there are freehold settlements and resorts at Eurong, Happy Valley and Kingfisher Bay which source their water from bores. A network of forestry tracks traverses the inland, however most traffic uses the eastern beach. Currently tourism is at a relatively high volume, notably around Lake Mackenzie where there have been concerns about trampling of riparian vegetation and water quality.

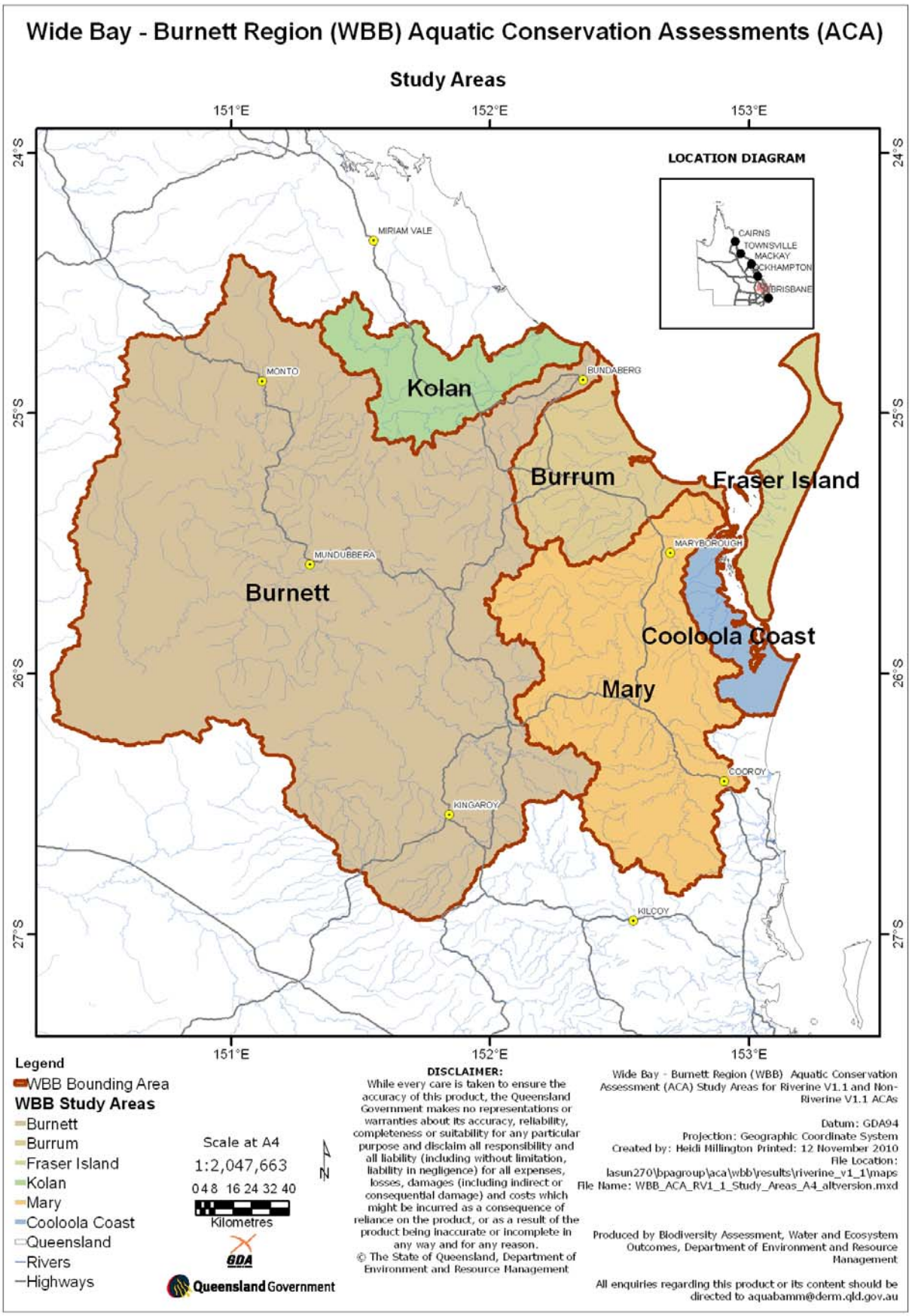

Figure 1. The Wide Bay-Burnett study area.

2.2 Panel composition

The expert panel comprised of persons listed below in Table 1 who are familiar with aquatic and riparian flora in the Wide Bay-Burnett region.

Some members who were unavailable to attend the workshop were consulted prior to, or after, the workshop.

Table 1. Panel members.

Name	Position/Organisation	Expertise
Ann Moran	Botanist/consultant	Wetland flora
Caroline Haskard	Environmental consultant, Vegetation Matters	Wetland flora and ecology (Burnett)
Kathy Stephens	Principal botanist, Queensland Herbarium, Department of Environment and Resource Management	Wetland flora, ecology and weeds
Maree Prior	Cooloola Coastcare	Wetland flora and ecology (Cooloola Coast)
Maria Zann	Scientist, Department of Environment and Resource Management	Wetland ecology and environmental values (Wide Bay-Burnett)
Maureen Schmitt	Environmental consultant	Wetland flora and ecology (Burnett)
Michael Low	Environmental consultant	Wetland flora and ecology (Cooloola Coast)
Sharon Marshall	Aquatic ecologist, Department of Environment and Resource Management	Aquatic flora and fauna
Tony Van Kampen	Parks/open Space, Fraser Coast Regional Council	Wetland flora, fauna and ecology

Renae Measom; Justin Kingsford and Chamendra Hewavisenthi provided administrative and technical support for the workshop which was facilitated by Steven Howell and Shane Chemello.

2.3 Workshop format

The workshop used an interactive approach of ArcView GIS software to display point records of species and their spatial distributions. A background of topographic 1:250,000 maps, roads, rivers and other relevant datasets were used to identify areas of interest, where necessary. Additional supporting information on flora in the Wide Bay-Burnett region was also sourced from various technical reports.

3 Rare and threatened flora

The panel identified five 'endangered', 10 'vulnerable' and 11 'near threatened' flora taxa in the Wide Bay-Burnett region (Table 2). Threatened taxa were excluded from the list if they did not correspond to one of these categories. This list of flora will be used as the basis for identifying areas of significance for 'Criterion 4 Threatened species and ecosystems' (4.1.2).

Table 2. Aquatic, semi-aquatic and riparian flora species listed under Queensland or Commonwealth legislation.

This list was used to generate the values for the AquaBAMM measure 4.1.2.

Scientific name	Common name	Status	NR[1]	R[1]	Comments
Acacia baueri subsp. baueri	Tiny wattle	V[2]	Y		Found on sandhills but also found in heathland which is wet underneath
Aponogeton elongatus subsp. elongatus		NT[2]	Y	Y	
Aponogeton elongatus subsp. fluitans		V[2]		Y	Should be subspecies elongatus
Arthraxon hispidus		V[2,3]	Y		Found in springs and creek lines
Blandfordia grandiflora	Christmas bells	E[2]	Y		
Boronia keysii	Keys' boronia	V[2,3]	Y		Heath species, also found outside the study area. Restricted to Noosa plains.
Boronia rivularis	Wide Bay boronia	NT[2]	Y		
Durringtonia paludosa	Durringtonia	NT[2]	Y		
Eleocharis blakeana		NT[2]	Y	Y	Found in non-riverine and edges of riverine
Eucalyptus conglomerata	Swamp stringybark	E[2,3]	Y		Only records are outside of study area although it is known to occur within the study area
Macadamia jansenii		E[2,3]		Y	Found on creek beds
Melaleuca cheelii		NT[2]	Y		Heathland species
Melaleuca formosa		NT[2]	Y	Y	
Phaius australis		E[2,3]	Y		Found mainly in springs
Phaius bernaysii	Yellow swamp orchid	E[2,3]	Y		Found on edges of melaleuca swamps
Prasophyllum exilis		NT[2]	Y		Found in melaleuca areas
Pratia podenzanae		NT[2]		Y	Found along dry creek lines at Rosedale
Pterostylis nigricans		NT[2]	Y		Wet heath species
Samadera bidwillii	Quassia	V[2,]		Y	Main areas of Quassia occur along the Mary river. The species is mostly found in riparian areas, and even though they are also found on top of mountains the majority of its habitat is in aquatic areas. These areas are generally not burnt. Also found at back of Kilkivan on drier areas. Only seen in their proper form along riverine areas as the other records are stunted.

Scientific name	Common name	Status	NR[1]	R[1]	Comments
Rhaponticum australe		V[2,3]	Y		Floodplain species found around Coulston Lakes. Primarily non-riverine species also found close to Ban Ban springs.
Schoenus scabripes		NT[2]	Y		
Thelypteris confluens		V[2]	Y		Found in swamps and heath areas
Thesium australe	Toadflax	V[2,3]	Y		Mapped in south Burnett, found in flood areas near creeks
Xanthostemon oppositifolius	Southern penda	V[2,3]		Y	Found along creeks

- recent records (>1950) and records with precision <2000 m only

1. Assessment type (NR – non-riverine, R – riverine)
2 Queensland *Nature Conservation Act 1992* (E – endangered, V – vulnerable, NT – near threatened, LC – least concern)
3. *Environment Protection and Biodiversity Conservation Act 1999* (E – endangered, V – vulnerable)

4 Priority flora

The panel deliberated on all aquatic, semi-aquatic and riparian species within the Wide Bay-Burnett region to identify 'priority flora' (excluding the rare or threatened species listed in Table 2). The panel adopted a revised version of the earlier definition of a priority species from the Burnett River ACA namely that a priority species must exhibit one or more of the following significant values:

1. It forms significant macrophyte beds (in shallow or deep water).
2. It is an important/critical food source.
3. It is important/critical habitat.
4. It is implicated in spawning or reproduction for other fauna and/or flora species.
5. It is at its distributional limit or is a disjunct population.
6. It provides stream bank or bed stabilisation or has soil-binding properties.
7. It is a small population and subject to threatening processes.

The panel identified 104 non-riverine and 83 riverine priority flora species (Table 3). These species are to be included as part of 'Criterion 5 Priority species and ecosystems' (5.1.2).

Table 3. Identified priority flora species, and their significant values.

This list was used to generate the values for the AquaBAMM measure (5.1.2).

Scientific name	Common name	NR[1]	R[1]	Priority number[2]	Comments
Azolla filiculoides	Red azolla	Y	Y	1,2,3,4	
Azolla pinnata	Ferny azolla	Y	Y	1,2,3,4	
Bacopa monnieri		Y	Y	1,6	
Banksia robur		Y		2,6	Priority only along coastal areas. Robur stands out above all other banksia.
Baumea arthrophylla		Y	Y	2,3,4,6	
Baumea articulata	Jointed twigrush	Y	Y	2,3,4,6	
Baumea articulata		Y	Y	2,3,4,6	
Baumea gunnii		Y	Y	2,3,4,6	
Baumea juncea		Y	Y	2,3,4,6	
Baumea muelleri		Y	Y	2,3,4,6	
Baumea nuda		Y	Y	2,3,4,6	
Baumea planifolia		Y	Y	2,3,4,6	
Baumea rubiginosa	Soft twigrush	Y		2,3,4,6	
Baumea rubiginosa		Y	Y	2,3,4,6	
Baumea teretifolia		Y	Y	2,3,4,6	
Bertya cunninghamii			Y	5,7	Priority only in coastal Burnett River area
Bolboschoenus fluviatilis		Y	Y	2,3,4,6	
Casuarina cunninghamiana subsp. cunninghamiana			Y	2,3,4,6	
Ceratophyllum demersum	Hornwort		Y	1,2,3,4	

Scientific name	Common name	NR[1]	R[1]	Priority number[2]	Comments
Ceratopteris thalictroides		Y	Y	2,3,4	
Chara fibrosa		Y	Y	1,2,3,4,6	Species has sediment trapping properties and is know to be associated with lungfish.
Crinum flaccidum	Murray lily			na	This species was initially nominated as a non-riverine priority species because it was flagged as a potential ecological asset for monitoring. Further post panel discussions with panel members however resulted in its removal as a priority species because although it has some documented links to flow, it is at low risk from water management activities.
Crinum pedunculatum	River lily	Y	Y	2,3,4,6	Priority in the Burnett catchment
Cyperus exaltatus	Tall flatsedge	Y	Y	2,3,4,6	Usually riverine but can also be non-riverine
Damasonium minus	Starfruit	Y	Y	2,3,4	
Eleocharis cylindrostachys		Y	Y	2,3,4,6	
Eleocharis equisetina		Y		2,3,4,6	
Eleocharis geniculata		Y		2,3,4,6	
Eleocharis philippinensis		Y		2,3,4,6	
Eleocharis sphacelata	Tall spikerush	Y		2,3,4,6	
Eleocharis tetraquetra		Y		3,7	More a northern species
Eucalyptus tereticornis		Y	Y	3,6,7	Considered an important component of regional ecosystems 12.3.3 and 12.3.8
Ficus racemosa var. racemosa			Y	2,3,6	
Gahnia clarkei	Tall sawsedge	Y		2,3,4,6	Priority for Poona Creek, where large populations occur (priority in Noosa north catchment only)
Gahnia sieberiana	Sword grass	Y		2,3,4	
Hydrilla verticillata	Hydrilla	Y	Y	1,2,3,4,6	Found to be associated with lungfish spawning
Juncus aridicola	Tussock rush	Y	Y	2,3,4,6	
Juncus cognatus		Y	Y	2,3,4,6	
Juncus continuus		Y	Y	2,3,4,6	
Juncus homalocaulis	Wiry rush	Y	Y	2,3,4,6	
Juncus planifolius		Y	Y	2,3,4,6	
Juncus polyanthemus		Y	Y	2,3,4,6	
Juncus prismatocarpus	Branching rush	Y	Y	2,3,4,6	
Juncus remotiflorus		Y	Y	2,3,4,6	

Scientific name	Common name	NR[1]	R[1]	Priority number[2]	Comments
Juncus subsecundus		Y	Y	2,3,4,6	
Juncus usitatus		Y	Y	2,3,4,6	Priority for the central Burnett, not a priority for the other catchments
Leersia hexandra	Swamp rice grass	Y	Y	2,3,4,6	
Lemna aequinoctialis	Common duckweed	Y	Y	2,3,4	
Lepironia articulata		Y	Y	2,3,4,6	Occurs in up to 2 meters of water with tops still sticking out
Lomandra hystrix		Y	Y	2,3,4,6	
Ludwigia peploides subsp. montevidensis		Y	Y	2,3,4,6	
Marsilea drummondii	Common nardoo	Y		2,3,4,6	Important food source
Marsilea hirsuta	Hairy nardoo	Y		2,3,4,6	Important food source
Marsilea mutica	Shiny nardoo	Y		2,3,4,6	Important food source
Melaleuca bracteata		Y	Y	2,3,4,6	
Melaleuca dealbata	Swamp tea-tree	Y	Y	2,3,4,6	More a dry land/dunal species
Melaleuca fluviatilis			Y	2,3,4,6	Doesn't occur away from rivers
Melaleuca linariifolia	Snow-in summer	Y	Y	2,3,4,6	
Melaleuca pachyphylla		Y		5	This species is a main food source for honeyeaters in wet heath areas. The red and green form in Wide Bay-Burnett with different forms overlapping in the Cooloola/Fraser region.
Melaleuca quinquenervia	Swamp paperbark	Y	Y	2,3,4,6	
Melaleuca sieberi		Y		5,7	Occurs in small, disjunct populations in Noosa north catchment.
Melaleuca trichostachya		Y	Y	2,3,4,6	
Melaleuca viminalis			Y	2,3,4,6	
Melaleuca viridiflora		Y		5	Southern limit of its range
Monochoria cyanea		Y		2,3,4	
Myriophyllum simulans		Y	Y	2,3,4	Poorly collected, two records in the Mary River catchment
Myriophyllum verrucosum	Water milfoil	Y	Y	1,2,3,4,6	Found to be associated with lungfish spawning
Najas tenuifolia	Water nymph	Y	Y	1,2,3,4	
Nitella tasmanica		Y	Y	1,2,3,4	
Nymphaea gigantea		Y	Y	2,3,4,6,7	Records are assumed to be genuine. Considered rare in south-east Queensland.
Nymphoides exiliflora		Y	Y	2,3,4	All Nymphoides are priority species

Scientific name	Common name	NR[1]	R[1]	Priority number[2]	Comments
Nymphoides indica	Water snowflake	Y	Y	2,3,4	
Ottelia alismoides		Y	Y	1,2,3,4	
Ottelia ovalifolia	Swamp lily	Y	Y	2,3,4	
Ottelia ovalifolia	Swamp lily	Y		1,2,3,4,6	
Paspalum distichum	Water couch	Y	Y	2,3,4,6	
Persicaria attenuata		Y	Y	2,3,4,6	
Persicaria barbata		Y	Y	2,3,4,6	
Persicaria decipiens	Slender knotweed	Y	Y	2,3,4,6	
Persicaria dichotoma		Y	Y	2,3,4,6	
Persicaria hydropiper	Water pepper	Y	Y	2,3,4,6	
Persicaria lapathifolia	Pale knotweed	Y	Y	2,3,4,6	
Persicaria orientalis	Princes feathers	Y	Y	2,3,4,6	
Persicaria praetermissa		Y	Y	2,3,4,6	
Persicaria prostrata	Creeping knotweed	Y	Y	2,3,4,6	
Persicaria strigosa		Y	Y	2,3,4,6	
Persicaria subsessilis	Hairy knotweed	Y	Y	2,3,4,6	
Phragmites australis	Common reed	Y	Y	2,3,4,6	
Potamogeton crispus	Curly pondweed	Y	Y	1,2,3,4	
Potamogeton octandrus		Y	Y	1,2,3,4	
Potamogeton pectinatus	Fennel pondweed	Y	Y	1,2,3,4	
Potamogeton perfoliatus	Perfoliate pondweed	Y	Y	1,2,3,4	
Potamogeton tricarinatus	Floating pondweed	Y	Y	1,2,3,4	
Pseudoraphis spinescens	Spiny mudgrass	Y		2,3,4,6	
Schoenoplectus litoralis		Y	Y	2,3,4,6	
Schoenoplectus mucronatus		Y		2,3,4,6	
Schoenoplectus validus		Y	Y	2,3,4,6	
Sphaerolobium vimineum		Y		5	Found in wet heath
Spirodela polyrhiza	Large duckweed	Y	Y	2,3,4	
Spirodela punctata	Thin duckweed	Y	Y	2,3,4	
Triglochin procerum		Y	Y	2,3,4	Not as widespread as Vallisneria nana but still critical
Typha orientalis	Broad-leaved cumbungi	Y	Y	2,3,4,6	
Utricularia aurea	Golden bladderwort	Y		1,2,3,4	Forms significant macrophyte beds
Utricularia biloba	Moth bladderwort	Y		1,2,3,4	Forms significant macrophyte beds
Utricularia caerulea	Blue bladderwort	Y		1,2,3,4	Forms significant macrophyte beds
Utricularia dichotoma	Fairy aprons	Y		1,2,3,4	Forms significant macrophyte beds

Scientific name	Common name	NR[1]	R[1]	Priority number[2]	Comments
Utricularia gibba	Floating bladderwort	Y		1,2,3,4	Forms significant macrophyte beds
Utricularia lateriflora	Small bladderwort	Y		1,2,3,4	Forms significant macrophyte beds
Utricularia stellaris		Y		1,2,3,4	Forms significant macrophyte beds
Utricularia uliginosa	Asian bladderwort	Y		1,2,3,4	Forms significant macrophyte beds
Vallisneria nana		Y	Y	1,2,3,4	Forms significant macrophyte beds, important habitat for lungfish spawning
Waterhousea floribunda	Weeping lilly pilly		Y	2,3,4,6	Found in regional ecosystem 12.3.1, in Tinana creek

- recent records (>1950) and records with precision <2000 m only

1. Assessment type (NR – non-riverine, R – riverine)
2 The priority numbers are the values that a species must exhibit to be a priority species as listed in dot points above Table 3

5 Species Richness

Species richness (total number of species) was scored for wetland indicator species. Stratifying the catchments is important to describe variability in richness. The panel discussed a number of options for stratification, including the use of rainfall or the split between coastal sandy soils and other soils (perhaps based on landzones). The recommendation from the fauna panel was to use the 150 m ASL as stratification between upland and lowland. Additionally, a number of subsections in the western part of the Mary were identified as being drier and with generally different species ecology from the rest of the Mary and it was decided that these should be included in the upland stratification. This method was endorsed by the both the aquatic flora and ecology panels.

The six catchments of the Wide Bay-Burnett region have a number of non-riverine and riverine plants that are referred to in this report as 'wetland indicator species' (Table 4). The datasets for these species were accessed from DERM corporate databases of WildNet and Herbrecs and from panel member records.

The panel defined a 'wetland indicator species' to mean 'those species that are adapted to and dependent on living in wet conditions for at least part of their life and are found either within or immediately adjoining a riverine, non-riverine or estuarine wetland'.

This definition of a wetland indicator species extends beyond the more traditional definition of submerged and floating aquatic plants to include plants inhabiting the littoral zone (waters edge) and plants that usually have 'wet feet' on the toe of the bank. This meaning was chosen because it was considered to best capture the intent of the AquaBAMM indicator and measure of species richness "Richness of wetland dependent plants" (3.1.5). The indicator is a measure of floristic richness of a particular spatial unit's aquatic environment, and hence, a broad definition will better depict the flora richness value at a given location.

Table 4. Wetland-dependent native flora species including priority species.

This list will be used to calculate an aquatic and riparian flora richness score (3.1.5), threatened flora species (4.1.2) and priority flora species (5.1.2).

Scientific name	Common name	Status	NR[1]	R[1]	Comments
Abildgaardia ovata		LC	Y		
Abildgaardia vaginata		LC	Y		
Acacia baueri subsp. baueri	Tiny wattle	V[2,3]	Y		
Acacia suaveolens	Sweet wattle	LC	Y		
Acrostichum speciosum	Mangrove fern	LC	Y	Y	
Aeschynomene indica	Budda pea	LC	Y		
Ammannia multiflora	Jerry-jerry	LC	Y	Y	
Angophora floribunda	Rough-barked apple	LC		Y	
Aotus lanigera	Pointed aotus	LC		Y	
Aponogeton elongatus subsp. elongatus		NT[2]		Y	
Aponogeton queenslandicus		LC	Y	Y	
Arthraxon hispidus		V[2,3]	Y		
Avicennia marina		LC		Y	

Scientific name	Common name	Status	NR[1]	R[1]	Comments
Azolla filiculoides	Red azolla	LC	Y	Y	
Azolla pinnata	Ferny azolla	LC	Y	Y	
Bacopa monnieri		LC	Y	Y	
Baeckea frutescens		LC	Y		
Baloskion pallens		LC	Y		
Baloskion tetraphyllum		LC	Y		
Banksia robur	Broad-leaved banksia	LC	Y		
Baumea arthrophylla		LC	Y	Y	
Baumea articulata	Jointed twigrush	LC	Y	Y	
Baumea gunnii		LC	Y	Y	
Baumea juncea	Bare twigrush	LC	Y	Y	
Baumea muelleri			Y	Y	
Baumea nuda			Y	Y	
Baumea planifolia		LC		Y	
Baumea rubiginosa	Soft twigrush	LC	Y		
Baumea teretifolia		LC	Y	Y	
Bertya cunninghamii		LC		Y	
Blandfordia grandiflora	Christmas bells	E[2]	Y		
Blechnum indicum	Swamp water fern	LC	Y	Y	
Bolboschoenus caldwellii		LC	Y		
Bolboschoenus fluviatilis		LC	Y	Y	
Boronia falcifolia	Wallum boronia	LC	Y		
Boronia keysii	Keys' boronia	V[2,3]	Y		
Boronia parviflora	Swamp boronia	LC	Y		
Boronia rivularis	Wide Bay boronia	NT[2]	Y		
Bruguiera gymnorhiza	Large-fruited orange mangrove	LC		Y	
Bulbostylis barbata		LC	Y		
Burchardia umbellata		LC	Y		
Byblis liniflora		LC	Y		
Callitriche muelleri		LC	Y		
Callitriche sonderi		LC	Y		
Carex appressa		LC	Y	Y	
Carex breviculmis		LC	Y	Y	
Carex brunnea		LC	Y	Y	
Carex declinata		LC	Y	Y	
Carex fascicularis	Tassel sedge	LC	Y	Y	
Carex gaudichaudiana		LC	Y	Y	
Carex inversa	Knob sedge	LC	Y	Y	
Carex lobolepis		LC	Y	Y	
Carex maculata		LC	Y	Y	
Carex polyantha		LC	Y	Y	
Castanospermum australe	Black bean	LC		Y	Coastal, gallery rainforest, riparian species
Casuarina cunninghamiana		LC		Y	

Scientific name	Common name	Status	NR[1]	R[1]	Comments
Casuarina cunninghamiana subsp. cunninghamiana		LC		Y	
Casuarina glauca	Swamp she-oak	LC	Y		
Caustis recurvata		LC	Y		
Centella asiatica		LC	Y		
Centipeda minima		LC	Y		
Centrolepis exserta		LC	Y		
Centrolepis strigosa		LC	Y	Y	
Ceratophyllum demersum	Hornwort	LC		Y	
Ceratopteris thalictroides		LC	Y	Y	
Chara fibrosa		LC	Y	Y	
Chordifex fastigiatus		LC	Y		
Chorizandra cymbaria		LC	Y		
Cladium procerum	Leafy twigrush	LC	Y		
Coleocarya gracilis		LC	Y		
Crinum flaccidum	Murray lily	LC	Y		
Crinum pedunculatum	River lily	LC	Y	Y	
Cyathochaeta diandra	Sheath rush	LC	Y		
Cyperus aquatilis		LC	Y		
Cyperus betchei		LC	Y		
Cyperus bifax	Western nutgrass	LC	Y	Y	
Cyperus bowmannii		LC	Y	Y	
Cyperus castaneus		LC	Y	Y	
Cyperus clarus		V[2]	Y		
Cyperus concinnus		LC		Y	
Cyperus conicus var. conicus		LC		Y	
Cyperus curvistylis		LC	Y		
Cyperus cyperoides		LC	Y	Y	
Cyperus decompositus		LC	Y	Y	
Cyperus dietrichiae		LC	Y	Y	
Cyperus dietrichiae var. brevibracteatus		LC	Y	Y	
Cyperus dietrichiae var. dietrichiae		LC	Y	Y	
Cyperus difformis	Rice sedge	LC	Y		
Cyperus distans		LC		Y	
Cyperus enervis		LC		Y	
Cyperus exaltatus	Tall flatsedge	LC	Y	Y	
Cyperus flaccidus		LC	Y	Y	
Cyperus flavidus		LC	Y		
Cyperus fulvus		LC	Y	Y	
Cyperus gracilis		LC	Y		
Cyperus gunnii subsp. gunnii		LC	Y	Y	
Cyperus gymnocaulos	Spiny flatsedge	LC		Y	
Cyperus haspan		LC	Y	Y	
Cyperus haspan subsp. haspan		LC	Y		

Scientific name	Common name	Status	NR[1]	R[1]	Comments
Cyperus iria		LC	Y		
Cyperus javanicus		LC		Y	
Cyperus laevigatus		LC	Y	Y	
Cyperus laevis		LC	Y	Y	
Cyperus leiocaulon		LC	Y	Y	
Cyperus lucidus		LC		Y	
Cyperus mirus		LC	Y	Y	
Cyperus nervulosus		LC	Y	Y	
Cyperus perangustus		LC	Y	Y	
Cyperus pilosus		LC	Y		
Cyperus polystachyos		LC	Y	Y	
Cyperus polystachyos var. polystachyos		LC		Y	
Cyperus procerus		LC	Y		
Cyperus sanguinolentus		LC	Y	Y	
Cyperus scariosus		LC	Y		
Cyperus sculptus		LC	Y	Y	
Cyperus sphaeroideus		LC	Y	Y	
Cyperus squarrosus	Bearded flatsedge	LC	Y		
Cyperus subulatus		LC	Y		
Cyperus tetracarpus		LC	Y	Y	
Cyperus tetraphyllus		LC	Y	Y	
Cyperus trinervis		LC		Y	
Cyperus vaginatus		LC		Y	
Cyperus victoriensis		LC		Y	
Damasonium minus	Starfruit	LC	Y	Y	
Dicranopteris linearis var. linearis		LC	Y		
Drosera angustifolia		LC	Y		
Drosera binata	Forked sundew	LC	Y		
Drosera burmanni		LC	Y		
Drosera indica		LC	Y	Y	
Drosera peltata	Pale sundew	LC	Y		
Drosera spatulata		LC	Y		
Durringtonia paludosa	Durringtonia	NT[2]	Y		
Echinochloa telmatophila	Swamp barnyard grass	LC	Y	Y	
Eclipta prostrata	White eclipta	LC	Y		
Elatine gratioloides	Waterwort	LC	Y	Y	
Eleocharis atricha	Tuber spikerush	LC	Y		
Eleocharis atropurpurea		LC	Y		
Eleocharis blakeana		NT[2]	Y	Y	
Eleocharis cylindrostachys		LC	Y	Y	
Eleocharis dietrichiana		LC	Y		
Eleocharis equisetina		LC	Y		
Eleocharis geniculata		LC	Y		
Eleocharis ochrostachys		LC	Y	Y	
Eleocharis pallens	Pale spikerush	LC	Y		

Scientific name	Common name	Status	NR[1]	R[1]	Comments
Eleocharis philippinensis		LC	Y		
Eleocharis plana	Ribbed spikerush	LC	Y		
Eleocharis sphacelata	Tall spikerush	LC	Y		
Eleocharis spiralis		LC	Y		
Eleocharis tetraquetra		LC	Y		
Empodisma minus	Spreading rope rush	LC	Y		
Enchylaena tomentosa		LC	Y		
Enydra fluctuans		LC			Outside study area
Epacris microphylla		LC	Y		
Epacris pulchella	Wallum heath	LC	Y		
Epaltes australis	Spreading nutheads	LC	Y		
Eriocaulon australe		LC	Y		
Eriocaulon nanum		LC	Y		
Eriocaulon scariosum		LC	Y		
Eryngium plantagineum	Long eryngium	LC	Y		
Eucalyptus conglomerata	Swamp stringybark	E[2,3]	Y		
Eucalyptus microtheca	Coolibah	LC	Y		
Eucalyptus robusta	Swamp mahogany	LC	Y		
Eucalyptus tereticornis		LC	Y	Y	
Eurychorda complanata		LC	Y		
Exocarya scleroides		LC	Y		
Ficus racemosa		LC		Y	
Ficus racemosa var. racemosa		LC		Y	
Fimbristylis aestivalis		LC	Y	Y	
Fimbristylis aestivalis var. aestivalis		LC	Y		
Fimbristylis depauperata		LC		Y	
Fimbristylis dichotoma	Common fringe-rush	LC	Y	Y	
Fimbristylis ferruginea		LC	Y		
Fimbristylis microcarya		LC	Y		
Fimbristylis nuda		LC	Y		
Fimbristylis nutans		LC	Y		
Fimbristylis oxystachya		LC	Y	Y	
Fimbristylis pauciflora		LC	Y		
Fimbristylis polytrichoides		LC	Y		
Fimbristylis velata		LC	Y		
Fuirena ciliaris		LC	Y		
Fuirena incrassata		LC	Y		
Fuirena umbellata		LC	Y		

Scientific name	Common name	Status	NR[1]	R[1]	Comments
Gahnia clarkei	Tall sawsedge	LC	Y		
Gahnia sieberiana	Sword grass	LC	Y		
Gleichenia dicarpa	Pouched coral fern	LC	Y	Y	
Gleichenia mendellii		LC	Y		
Gonocarpus chinensis		LC	Y	Y	
Haloragis heterophylla	Rough raspweed	LC	Y		
Hemarthria uncinata		LC	Y		
Hibiscus tiliaceus	Cotton tree	LC		Y	
Hydrilla verticillata	Hydrilla	LC	Y	Y	
Hydrocotyle tripartita		LC	Y		
Hydrocotyle verticillata	Shield pennywort	LC	Y		
Hygrophila angustifolia		LC	Y	Y	
Hypolaena fastigiata	Tassel rope rush	LC	Y		
Ipomoea aquatica		LC	Y		
Isachne globosa	Swamp millet	LC	Y		
Ischaemum australe var. australe		LC	Y		
Ischaemum fragile		LC	Y		
Isolepis cernua	Nodding club rush	LC	Y	Y	
Isolepis inundata	Swamp club rush	LC	Y	Y	
Juncus aridicola	Tussock rush	LC	Y	Y	
Juncus cognatus		LC	Y	Y	
Juncus continuus		LC	Y	Y	
Juncus fockei		LC	Y	Y	
Juncus homalocaulis	Wiry rush	LC	Y	Y	
Juncus planifolius		LC	Y	Y	
Juncus polyanthemus		LC	Y	Y	
Juncus prismatocarpus	Branching rush	LC	Y	Y	
Juncus remotiflorus		LC	Y	Y	
Juncus subsecundus		LC	Y	Y	
Juncus usitatus		LC	Y		
Leersia hexandra	Swamp rice grass	LC	Y	Y	
Lemna aequinoctialis	Common duckweed	LC	Y	Y	
Lepidosperma laterale		LC	Y		
Lepidosperma longitudinale	Pithy swordsedge	LC	Y		
Lepironia articulata		LC	Y	Y	
Leptocarpus tenax		LC	Y		
Leptochloa digitata		LC	Y	Y	
Leptochloa fusca	Brown beetle grass	LC	Y	Y	
Leptospermum brachyandrum	Weeping tea-tree	LC		Y	
Leptospermum liversidgei		LC	Y		
Leptospermum semibaccatum	Wallum tea-tree	LC	Y		
Lepyrodia scariosa		LC	Y		

Scientific name	Common name	Status	NR[1]	R[1]	Comments
Limnophila brownii		LC	Y		
Liparophyllum exaltatum		LC	Y		
Lipocarpha microcephala		LC	Y	Y	
Livistona australis	Cabbage tree palm		Y		
Livistona decora		LC	Y	Y	
Lomandra hystrix		LC	Y	Y	
Lomandra longifolia		LC		Y	Most common species along Mary River
Lophostemon suaveolens	Swamp box	LC	Y	Y	
Ludwigia octovalvis	Willow primrose	LC	Y		
Ludwigia peploides subsp. montevidensis		LC	Y	Y	
Luzula flaccida		LC	Y		
Lycopodiella cernua		LC	Y		
Lygodium microphyllum	Snake fern	LC	Y		
Lythrum salicaria	Purple loosestrife	LC	Y		
Macadamia jansenii		E[2,3]		Y	
Marsilea costulifera	Narrow-leaved nardoo	LC	Y		
Marsilea drummondii	Common nardoo	LC	Y		
Marsilea hirsuta	Hairy nardoo	LC	Y		
Marsilea mutica	Shiny nardoo	LC	Y		
Melaleuca bracteata		LC	Y	Y	
Melaleuca cheelii		NT[2]	Y		
Melaleuca dealbata	Swamp tea-tree	LC	Y	Y	
Melaleuca fluviatilis		LC		Y	
Melaleuca formosa		NT[2]	Y	Y	
Melaleuca leucadendra	Broad-leaved tea-tree	LC		Y	
Melaleuca linariifolia	Snow-in summer	LC	Y	Y	
Melaleuca nodosa		LC	Y		
Melaleuca pachyphylla		LC	Y		
Melaleuca quinquenervia	Swamp paperbark	LC	Y	Y	
Melaleuca sieberi		LC	Y		
Melaleuca thymifolia	Thyme honeymyrtle	LC	Y		
Melaleuca trichostachya		LC	Y	Y	
Melaleuca viminalis		LC		Y	
Melaleuca viridiflora		LC	Y		
Melaleuca viridiflora var. viridiflora		LC	Y		
Melastoma malabathricum subsp. malabathricum		LC	Y		
Monochoria cyanea		LC	Y		
Murdannia gigantea		LC	Y		

Scientific name	Common name	Status	NR[1]	R[1]	Comments
Myriophyllum crispatum		LC	Y	Y	
Myriophyllum gracile var. gracile		LC	Y	Y	
Myriophyllum gracile var. lineare		LC		Y	
Myriophyllum implicatum		LC	Y		
Myriophyllum simulans		LC	Y	Y	
Myriophyllum variifolium		LC	Y	Y	
Myriophyllum verrucosum	Water milfoil	LC	Y	Y	
Najas marina		LC	Y		
Najas tenuifolia	Water nymph	LC	Y	Y	
Nitella tasmanica		LC	Y	Y	
Nymphaea gigantea		LC	Y	Y	
Nymphoides crenata	Wavy marshwort	LC	Y	Y	
Nymphoides exiliflora		LC	Y	Y	
Nymphoides geminata		LC	Y		
Nymphoides indica	Water snowflake	LC	Y	Y	
Ornduffia reniformis		LC	Y		
Ottelia alismoides		LC	Y	Y	
Ottelia ovalifolia	Swamp lily	LC	Y	Y	
Panicum larcomianum		LC	Y		
Panicum obseptum	White water panic	LC	Y		
Panicum paludosum	Swamp panic	LC	Y		
Paspalum distichum	Water couch	LC	Y	Y	
Paspalum vaginatum	Saltwater couch	LC	Y		
Patersonia sericea var. sericea		LC	Y		
Pennisetum alopecuroides	Swamp foxtail	LC	Y	Y	
Persicaria attenuata		LC	Y	Y	
Persicaria barbata		LC	Y	Y	
Persicaria decipiens	Slender knotweed	LC	Y	Y	
Persicaria dichotoma		LC	Y	Y	
Persicaria hydropiper	Water pepper	LC	Y	Y	
Persicaria lapathifolia	Pale knotweed	LC	Y	Y	
Persicaria orientalis	Princes feathers	LC	Y	Y	
Persicaria praetermissa		LC	Y	Y	
Persicaria prostrata	Creeping knotweed	LC	Y	Y	
Persicaria strigosa		LC	Y	Y	
Persicaria subsessilis	Hairy knotweed	LC	Y	Y	
Persoonia amaliae		LC		Y	
Phaius australis		E[2,3]	Y		
Phaius bernaysii	Yellow swamp orchid	E[2,3]	Y		
Philydrum lanuginosum	Frogsmouth	LC	Y		

Scientific name	Common name	Status	NR[1]	R[1]	Comments
Phragmites australis	Common reed	LC	Y	Y	
Phyla nodiflora	Carpetweed	LC	Y		
Polygonum plebeium	Small knotweed	LC	Y	Y	
Potamogeton crispus	Curly pondweed	LC	Y	Y	
Potamogeton octandrus		LC	Y	Y	
Potamogeton pectinatus	Fennel pondweed	LC	Y	Y	
Potamogeton perfoliatus	Perfoliate pondweed	LC	Y	Y	
Potamogeton tricarinatus	Floating pondweed	LC	Y	Y	
Prasophyllum exilis		NT[2]	Y		
Pratia podenzanae		NT[2]	Y	Y	
Pseudoraphis spinescens	Spiny mudgrass	LC	Y		
Pterostylis nigricans		NT[2]	Y		
Ptilothrix deusta		LC	Y		
Ranunculus inundatus	River buttercup	LC	Y		
Rhaponticum australe		V[2,3]	Y		
Rhizoclonium implexum		LC	Y	Y	
Rhizoclonium tortuosum		LC	Y	Y	
Rhynchospora brownii	Beak rush	LC	Y	Y	
Rhynchospora corymbosa		LC	Y	Y	
Rhynchospora heterochaeta		LC	Y	Y	
Rhynchospora rubra		LC	Y	Y	
Ricciocarpus natans		LC	Y		
Rotala mexicana		LC	Y		
Rotala occultiflora		LC	Y		
Rotala tripartita		LC	Y		
Rumex brownii	Swamp dock	LC	Y		
Ruppia maritima	Sea tassel	LC	Y		
Sacciolepis indica	Indian cupscale grass	LC	Y		
Samadera bidwillii	Quassia	V[2]		Y	
Schoenoplectus litoralis		LC	Y	Y	
Schoenoplectus mucronatus		LC	Y		
Schoenoplectus validus		LC	Y	Y	
Schoenus apogon var. apogon		LC	Y	Y	
Schoenus brevifolius		LC	Y	Y	
Schoenus falcatus		LC	Y	Y	
Schoenus kennyi		LC	Y	Y	
Schoenus lepidosperma subsp. pachylepis		LC	Y	Y	
Schoenus maschalinus		LC	Y	Y	

Scientific name	Common name	Status	NR[1]	R[1]	Comments
Schoenus melanostachys		LC	Y		
Schoenus scabripes		NT[2]	Y		
Schoenus sparteus		LC	Y		
Schoenus vaginatus		LC	Y	Y	
Scleria brownii		LC	Y	Y	
Scleria mackaviensis		LC	Y	Y	
Scleria rugosa		LC			
Scleria sphacelata		LC	Y	Y	
Selaginella uliginosa	Swamp selaginella	LC	Y		
Sesbania cannabina		LC	Y	Y	
Sowerbaea juncea	Vanilla plant	LC	Y		
Sparganium subglobosum	Floating bur-reed	LC		Y	
Sphaerolobium vimineum			Y		
Spirodela polyrhiza	Large duckweed	LC	Y	Y	
Spirodela punctata	Thin duckweed	LC	Y	Y	
Sprengelia sprengelioides	Sprengelia	LC	Y		
Sticherus flabellatus var. flabellatus		LC		Y	
Stylidium eriorhizum		LC	Y		
Stylidium graminifolium	Grassy-leaved trigger-flower	LC	Y		
Stylidium schizanthum		LC	Y		
Syzygium australe	Scrub cherry	LC		Y	
Syzygium oleosum	Blue cherry	LC		Y	
Tetragonia tetragonioides	New Zealand spinach	LC	Y		
Tetraria capillaris		LC	Y	Y	
Thelypteris confluens		V[2]	Y		
Thesium australe	Toadflax	V[2,3]	Y		
Trachystylis stradbrokensis		LC	Y		
Trentepohlia abietina		LC		Y	
Trentepohlia abietina var. tenue		LC		Y	
Trentepohlia arborum		LC		Y	
Trentepohlia bossei var. brevicellulis		LC		Y	
Trentepohlia bossei var. samoensis		LC		Y	
Trentepohlia odorata		LC		Y	
Trentepohlia peruana		LC		Y	
Trentepohlia rigidula		LC		Y	
Triglochin dubium		LC	Y		
Triglochin multifructum		LC	Y		
Triglochin procerum		LC	Y	Y	
Triglochin rheophilum		LC		Y	

Scientific name	Common name	Status	NR[1]	R[1]	Comments
Triglochin striatum	Streaked arrowgrass	LC	Y	Y	
Typha domingensis		LC	Y	Y	
Typha orientalis	Broad-leaved cumbungi	LC	Y	Y	
Typha orientalis	Broad-leaved cumbungi	LC	Y	y	
Utricularia aurea	Golden bladderwort	LC	Y		
Utricularia biloba	Moth bladderwort	LC	Y		
Utricularia caerulea	Blue bladderwort	LC	Y		
Utricularia dichotoma	Fairy aprons	LC	Y		
Utricularia gibba	Floating bladderwort	LC	Y		
Utricularia lateriflora	Small bladderwort	LC	Y		
Utricularia stellaris		LC	Y		
Utricularia uliginosa	Asian bladderwort	LC	Y		
Vallisneria annua		LC	Y		
Vallisneria gigantea	Ribbonweed	LC	Y		This should probably be *Vallisneria nana*
Vallisneria nana		LC	Y	Y	
Viola hederacea		LC	Y	Y	
Walwhalleya subxerophila		LC	Y	Y	
Waterhousea floribunda	Weeping lilly pilly	LC		Y	
Wolffia angusta	Tiny duckweed	LC		Y	
Xanthorrhoea fulva	Swamp grasstree	LC	Y		
Xanthostemon oppositifolius	Southern penda	V[2,3]		Y	
Xyris complanata	Yellow-eye	LC	Y		
Xyris juncea	Dwarf yellow-eye	LC	Y		
Zoysia macrantha	Prickly couch	LC	Y		
Zygogonium ericetorum		LC	Y	Y	

- recent records (>1950) and records with precision <2000 m only

1. Assessment type (NR – non-riverine, R – riverine)

2 Queensland *Nature Conservation Act 1992* (E – endangered, V – vulnerable, NT – near threatened, LC – least concern)

3. Environment Protection and Biodiversity Conservation Act 1999 (E – endangered, V – vulnerable)

6 Exotic flora

The panel recommended that only exotic plants that cause, or have the potential to cause, significant detrimental impact on natural systems within a non-riverine or riverine landscape be included for the Wide Bay-Burnett region ACA. Fifty-two non-riverine and 54 riverine taxa that are known to occur within the Wide Bay-Burnett region were nominated by the panel (Table 5). The presence of aquatic and semi-aquatic flora species was recorded under 'Criterion 1 Naturalness (aquatic)' (1.1.2). Riparian exotic flora species were recorded under 'Criterion 2 Naturalness (catchment)' (2.1.1).

The degree of infestation and abundance of an exotic plant at a particular locality was acknowledged by the panel as being an important factor in determining the level of impact to a natural ecosystem. Where available, information and mapping of exotic species' extent (sourced from DERM and regional bodies) were used instead of point records to flag the spatial units that have an exotic species present. Where only a point record is available for a location, then the record was used to identify the spatial units as having an exotic species present. Hence, an individual point record may or may not correspond to localities of dense weed infestations.

Where there had been broadscale mapping of exotic flora undertaken by DEEDI, the panel recommended to utilise this mapping rather than relying on species records. The DEEDI mapping technique comprised of assigning species presence/absence on a 16.67 km^2 statewide grid based on records and expert review. Not all exotic fauna species were modelled by DEEDI. Those that were modelled are identified in the model column in Table 5. Unfortunately, due to time constraints the DEEDI mapping was not able to be implemented for this version of the ACA and the species records were used instead. However, the DEEDI mapping will be considered for inclusion in the next release of the WBB ACA.

Table 5. Exotic flora species.

This list was used to calculate the measures for 1.1.2 and 2.1.1 in the AquaBAMM assessment.

Scientific name	Common name	Habitat	NR[1]	R[1]	Model[2]	Comments
Baccharis halimifolia	Groundsel bush	Aquatic	Y		Y	
Cabomba caroliniana var. caroliniana	Cabomba	Aquatic	Y	Y	Y	
Cyperus involucratus		Aquatic	Y	Y		
Echinochloa colona	Awnless barnyard grass	Aquatic	Y	Y		
Echinochloa crus-galli	Barnyard grass	Aquatic	Y	Y		
Egeria densa	Dense waterweed	Aquatic		Y		
Eichhornia crassipes	Water hyacinth	Aquatic	Y	Y	Y	
Hygrophila costata	Glush weed	Aquatic	Y	Y	Y	
Hymenachne amplexicaulis cv. Olive		Aquatic	Y	Y	Y	
Myriophyllum aquaticum	Brazilian water milfoil	Aquatic	Y	Y		Declared species
Nymphaea caerulea		Aquatic	Y	Y		
Pennisetum clandestinum	Kikuyu grass	Aquatic	Y	Y		
Pistia stratiotes	Water lettuce	Aquatic	Y	Y	Y	
Sagittaria platyphylla		Aquatic	Y	Y		Deliberately planted as water treatment

Scientific name	Common name	Habitat	NR[1]	R[1]	Model[2]	Comments
Salix babylonica	Weeping willow	Aquatic		Y		Exotic in the Burnett only. At the northern end of its range in the Burnett, occasionally planted, particularly bad in creeks on the northern side of the Bunya Mountains, prefers the colder climate, a weed in the darling downs.
Salvinia molesta	Salvinia	Aquatic	Y	Y	Y	Declared
Urochloa mutica		Aquatic	Y	Y		
Zantedeschia aethiopica		Aquatic	Y			Major weed in Western Australia, starting to become naturalised in Queensland
Anredera cordifolia	Madeira vine	Riparian		Y	Y	
Aristolochia elegans	Dutchman's pipe	Riparian	Y	Y	Y	
Bryophyllum delagoense	Mother-of-millions	Riparian	Y	Y	Y	
Bryophyllum pinnatum	Resurrection plant	Riparian	Y	Y	Y	
Cardiospermum grandiflorum	Heart seed vine	Riparian	Y	Y	Y	
Cardiospermum halicacabum		Riparian		Y		
Celtis sinensis	Chinese elm	Riparian	Y	Y	Y	
Cinnamomum camphora	Camphor laurel	Riparian	Y	Y	Y	
Cryptostegia grandiflora	Rubber vine	Riparian		Y	Y	On the Mary River
Eugenia uniflora	Brazilian cherry tree	Riparian	Y	Y		Becoming established and crowding native vegetation
Gleditsia triacanthos	Honey locust	Riparian	Y	Y		Class 1 weed
Harrisia martini		Riparian	Y	Y	Y	
Ipomoea cairica		Riparian	Y	Y		Grows on river banks also
Lantana camara		Riparian	Y	Y	Y	Grows in gullys, creeks and melaleuca wetlands
Lantana montevidensis	Creeping lantana	Riparian	Y	Y		
Leucaena leucocephala subsp. glabrata		Riparian	Y	Y		
Leucaena leucocephala subsp. leucocephala		Riparian	Y	Y		
Ligustrum lucidum	Large-leaved privet	Riparian	Y	Y		

Scientific name	Common name	Habitat	NR[1]	R[1]	Model[2]	Comments
Macfadyena unguis-cati	Cat's claw creeper	Riparian	Y	Y	Y	
Macroptilium atropurpureum	Siratro	Riparian	Y	Y		Smothers everything
Megathyrsus maximus		Riparian	Y	Y		
Melinis minutiflora	Molasses grass	Riparian	Y			Grows in melaleuca wetlands on the coast
Neonotonia wightii var. wightii		Riparian	Y	Y		
Opuntia aurantiaca	Tiger pear	Riparian	Y	Y		
Opuntia streptacantha	Cardona pear	Riparian	Y	Y		
Opuntia stricta		Riparian	Y	Y		
Opuntia tomentosa	Velvety tree pear	Riparian	Y	Y		
Parthenium hysterophorus	Parthenium weed	Riparian	Y		Y	
Phyla canescens	Lippia	Riparian	Y	Y	Y	
Pinus elliottii	Slash pine	Riparian	Y			Grows in melaleuca swamps due to proximity to them
Praxelis clematidea		Riparian	Y	Y		On the national alert list
Psidium guajava	Guava	Riparian		Y		Hard to eradicate
Psidium guineense	Cherry guava	Riparian		Y		
Ricinus communis	Castor oil bush	Riparian	Y	Y		
Rivina humilis		Riparian	Y	Y		
Schinus terebinthifolius	Broadleaved pepper tree	Riparian	Y	Y	Y	
Solanum seaforthianum	Brazilian nightshade	Riparian	Y	Y		Worst of the solanums in all catchments
Sorghum halepense	Johnson grass	Riparian	Y	Y		
Sphagneticola trilobata	Singapore daisy	Riparian	Y	Y	Y	
Stenotaphrum secundatum	Buffalo grass	Riparian		Y		Occurs to the waters edge and on the bank edge particularly in the Burnett
Tecoma stans var. stans	Yellow bells	Riparian	Y	Y	Y	
Thunbergia grandiflora	Sky flower	Riparian	Y	Y		
Xanthium occidentale		Riparian		Y	Y	Bathurst bur, primarily a terrestrial weed

- recent records (>1950) and records with precision <2000 m only

1. Assessment type (NR – non-riverine, R – riverine)
2. DEEDI model

7 Priority ecosystems and special features

The panel identified several non-riverine and riverine priority ecosystems in the Wide Bay-Burnett region (Table 6). These were identified for their aquatic and riparian flora values. The panel also nominated several special features in the region known to contain flora values however as these were identified as also containing other values by the fauna or wetland ecology expert panels, these special areas were implemented as wetland ecology special area decisions (see the wetland ecology report for more information on these areas).

Each spatial unit that intersected with a particular ecosystem or feature in Table 6 was given a score equal to the conservation rating.

Table 6: Identified priority ecosystems, or special features, and their values.

Decisions listed by catchment. These features were intersected with the spatial units to identify the values for 'Criterion 5 Priority species and ecosystems' and 'Criterion 6 Special features'. All implemented priority ecosystems and special features were given a conservation rating of between one and four assigned by the panel. Decisions that were not able to be implemented due to a lack of readily available data or unconfirmed values, are indicated as '_not_implemented' in the decision implementation number column.

Priority ecosystem/ special feature	Values	Catchment	Decision implementation number	Criteria/indicator/ /measure	Conservation rating (1–4)
Non–riverine					
Lakeside	This special feature was identified in the South East Queensland Biodiversity Planning Assessment (decision number seqn_fl_3). The following values were identified: Wildlife refugia (Criterion Ib). Wetland taxa at or near western limits of geographic range (*Melaleuca quinquenervia, Lepironia articulata*) (Criterion Id). Criterion ratings were: Ib (wildlife refugia): HIGH, Id (limits of geographic range): MEDIUM. This area is a wetland complex with permanent waterhole and ephemeral swamp at Lakeside on Maryborough – Biggenden Road	Burnett	bu_nr_fl_01	6.3.3	3

Priority ecosystem/ special feature	Values	Catchment	Decision implementation number	Criteria/indicator/ /measure	Conservation rating (1–4)
Remnant swamps in Monto	This special feature was identified in the Brigalow Belt Biodiversity Planning Assessment (decision number brbs_fl_34). The following values were identified: Small wetlands with tortoises, wetland birds and jabiru. These wetlands have large *Eucalyptus tereticornis* around their margins and *Eleocharis plana* is present, an indicator of ephemeral wetlands. Criterion Ib (wetland) rating was "y"	Burnett	bu_nr_fl_02	6.3.3	2
Archookoora State Forest	These floodplain wetlands contain the most significant population of *Melaleuca formosa* in the area. The wetlands are located within the State Forest. Note: This decision could not be implemented due to the lack of wetland mapping in this area.	Burnett	bu_nr_fl_03_not_implemented	na	na
Elliott River coastal heaths	A coastal heath and wallum complex south of the Elliott River. The area has many threatened species values and species at the limits of their range (i.e.northern limit of *Strangea linaris* and *Callistemon pachyphylla*) and high coastal wet heath diversity – includes also Kinkuna National Park where *Acacia baueri ssp baueri* is recorded. Values listed in Coonar development proposal include significant tracts of *Melaleuca cheelii*, high wetland regional ecosystem diversity and high connectivity to estuarine wetlands. Includes an intact sequence of geomorphic features i.e. also parallel Pleistocene dunes backed by Tertiary Elliott formation – Burrum Coast National Park (Kinkuna section) and Coonarr area including wildflower reserve (WBBCC inventory 47A). Note: This decision also applies as an ecology decision (decision number bm_nr_ec_01).	Burrum	bm_nr_fl_01	6.3.1	4

Priority ecosystem/ special feature	Values	Catchment	Decision implementation number	Criteria/indicator/ /measure	Conservation rating (1–4)
Woodgate wetlands	Significant numbers of threatened species including *Melaleuca cheelii, Eucalyptus hallii*, (as well as a number of non-wetland plant species) and species at the northern limits of their range *Melaleuca sieberi, Strangea linaris* and *Callistemon pachyphylla*. Wet and dry heathlands. Part of the Burrum Coast National Park (Woodgate section) where an intact sequence of geomorphic features exist (e.g. parallel Holocene beach ridges occur in front of Pleistocene ridges and Quaternary alluvium) (WBBCC inventory 48C).	Burrum	bm_nr_fl_02	6.3.1	4
Burrum Heads wetlands	The Burrum Heads wetlands have similar values to the Woodgate wetlands (decision number bm_nr_fl_02). These wetlands are south of the Burrum and are a separate system to Woodgate. The seagrass that occurs offshore from here (which provides food for dugongs) is thought to be dependant on groundwater provided by these wetlands, although this link requires further investigation. These wetlands also include habitat for wallum frog species. Note: This decision also applies as an ecology decision (decision number bm_nr_ec_04).	Burrum	bm_nr_fl_03	6.4.1, 7.2.1	4, 4
Acid swamp wetlands	This special feature was identified in the South East Queensland Biodiversity Planning Assessment (decision number seqn_fl_32). The following values were identified: It is a near-coastal wetland complex including permanent waterholes. Wildlife refugia (Criterion Ib). Rating for Ib (wildlife refugia): VERY HIGH. The flora expert panel noted that the assessment of the conservation values of the area would benefit from more detailed information. Note: This decision also applies in the Mary catchment (decision number my_nr_fl_01).	Burrum	bm_nr_fl_04	6.3.3	4

Priority ecosystem/ special feature	Values	Catchment	Decision implementation number	Criteria/indicator/ /measure	Conservation rating (1–4)
Cooloola cove	Wet heaths with populations of Christmas bells (*Blandfordia grandiflora*) as well as non-wetland threatened species; high wetland regional ecosystem diversity and excellent connectivity to estuarine wetlands. Wetlands mapping underestimates area of wetland. This decision applies also to Tin Can Bay, most of the Great Sandy Strait and Cooloola Cove area.	Cooloola Coast	cc_nr_fl_01	6.3.1	4
Drapers land	A large tract of wet heaths with minimum impact. Populations of threatened species include Christmas bells, Melaleuca heath as well as non-wetland threatened species; high wetland regional ecosystem diversity and excellent connectivity to estuarine wetlands. The area also provides habitat for ground parrot (*Pezoporus wallicus*).	Cooloola Coast	cc_nr_fl_02	6.3.1	4
Tin Can Snapper Creek area	Wet heaths with Christmas bells populations. Contains significant threatened species and has excellent connectivity to estuarine wetlands. Location – Salmon St, Tin Can Bay School.	Cooloola Coast	cc_nr_fl_03	6.3.1	3
Acid swamp wetlands	This special feature was identified in the South East Queensland Biodiversity Planning Assessment (decision number seqn_fl_40). The following values were identified: Wildlife refugia (Criterion Ib). Rating for Ib (wildlife refugia): VERY HIGH. Located at Murphys Lakes, near Tinana Creek, Tooloora State Forest. Additional comments from the Wide Bay-Burnett flora panel include: These lakes are located on the mainland, but have similar characteristics to those on Fraser Island. Note: This decision also applies in the Burrum catchment (decision number bm_nr_fl_04).	Mary	my_nr_fl_01	6.3.3	3

Priority ecosystem/ special feature	Values	Catchment	Decision implementation number	Criteria/indicator/ /measure	Conservation rating (1–4)
Riverine					
Extensive *Vallisneria nana* macrophyte beds	Where these macrophyte beds occur, they provide significant habitat and food resources for instream fauna including macroinvertebrates, fish and turtles. The aquatic and riparian flora expert panel for the Burnett ACA conducted in 2006 noted *Vallisneria nana* as the most critical aquatic plant for maintaining complex food webs and aquatic ecosystems because of its extensive macrophyte beds and broad geographic coverage of the Burnett catchment. As there are not many macrophyte beds remaining, the panel considered it to be important as a flora decision. Note: This decision was taken from the previous Burnett River ACA (decision number afep_burn_11).	Burnett	bu_r_fl_01	6.3.1	3
Lower Burnett	Where these macrophyte beds occur, they provide significant habitat and food resources for instream fauna including macroinvertebrates, fish and turtles. *Vallisneria nana* is the most critical aquatic plant for maintaining complex food webs and aquatic ecosystems because of its extensive macrophyte beds and broad geographic coverage of the Burnett catchment. As there are not many macrophyte beds remaining, the panel considered it to be important as a flora decision.	Burnett	bu_r_fl_02	6.3.1	4

Priority ecosystem/ special feature	Values	Catchment	Decision implementation number	Criteria/indicator/ /measure	Conservation rating (1–4)
Coomba Falls	Located at these falls is a unique species of Xanthorrhoea which is thought to be a natural hybrid between *Xanthorrhoea johnsonii* and *Xanthorrhoea latifolia subsp. latifolia*. The Coomba Falls have created large deep permanent waterholes which are refuges for fauna and flora from drought. It was also the location of an Aboriginal massacre by early settlers of the area and is therefore a culturally and historically significant site. The panel have revised the conservation rating to a 2 in terms of the flora values as it is not considered to be very diverse floristically – rather it should be regarded as a special geomorphic feature. The area is located east of the township of Maidenwell. Note: This decision was taken from the previous Burnett River ACA (decision number arfep_burn_1).	Burnett	bu_r_fl_03	6.3.1	2
Ceratodus crossing	The riparian zone of this section of the Burnett River, north of Eidsvold is in very good condition. The area also has macrophyte beds with a possible presence of *Aponogeton.* However, this species is most likely extinct now due to the altered flow regime. Note: This decision was taken from the previous Burnett River ACA (decision number arfep_burn_2).	Burnett	bu_r_fl_04	5.2.1	3

Priority ecosystem/ special feature	Values	Catchment	Decision implementation number	Criteria/indicator/ /measure	Conservation rating (1–4)
Walla Island	This vegetated island located in the Burnett River near Tim Fischer Bridge on the highway is located within the weir impoundment on the Burnett River and, consequently, it is partially submerged by Walla Weir. At least seven significant fig trees are extant on the island. These are an important food source for the threatened Burnett River snapping turtle (*Elseya* sp.) and for the endangered Coxen's fig parrot (*Cyclopsitta diophthalma coxeni*). The highest risk to the fig trees is weeds, namely cat's claw creeper (*Macfadyena unguis-cati*), which is invading the island. The flora panel from the Burnett River ACA conducted in 2006 identified an urgent need to control cat's claw creeper on the island. The island also contains macrophyte beds; a rainforest stand, some heritage–listed figs and an occurrence of the Australian lungfish (*Neoceratodus forsteri*). Note: This decision was taken from the previous Burnett River ACA (decision number arfep_burn_3).	Burnett	bu_r_fl_05	5.2.1, 6.3.1	3, 3
Lowland riparian rainforest remnants	These mostly small, isolated rainforest remnants are in good condition and are a good representation of riparian ecosystems on the Burnett River within in the more developed sugar cane areas of the lower Burnett catchment. This area contains one of the few remaining remnants of rainforest in the region. Some cat's claw creeper (*Macfadyena unguis-cati*) is present. High species diversity occurs on the lowlands. The area contains regional ecosystem 12.3.1 throughout. Note: This decision was taken from the previous Burnett River ACA (decision number arfep_burn_4).	Burnett	bu_r_fl_06	5.2.1	4

Priority ecosystem/ special feature	Values	Catchment	Decision implementation number	Criteria/indicator/ /measure	Conservation rating (1–4)
Barambah Gorge	Species at the limit of their distributions (coastal species) occur in Barambah Gorge. Also, new species are likely to occur here and they are being collected from the area for example an endemic *Hibiscus* sp. (Barambah Creek P. Grimshaw+ PG2484). Barambah Gorge also has high geomorphic and scenic values. The area is an intact piece of the system that has not been extensively explored. The boundaries of the area can be defined using Barambah Gorge High Ecological Value (HEV) area (Burnett–Baffle Water Quality Improvement Plan data). Records for Hibiscus species (Barambah Creek P. Grimshaw+ PG2484) were located in a gully area high within the HEV area. Note: This decision was taken from the previous Burnett River ACA (decision number arfep_burn_5).	Burnett	bu_r_fl_07	6.1.1	3
Cania Gorge	Species at the limit of their distributions occur in Cania Gorge. Also, new species are likely and being collected from the area. Cania Gorge also has high geomorphic and scenic values. The area has similar values to Barambah gorge and possible impacts from tourism. Note: This decision was taken from the previous Burnett River ACA (decision number arfep_burn_6).	Burnett	bu_r_fl_08	6.1.1	3

Priority ecosystem/ special feature	Values	Catchment	Decision implementation number	Criteria/indicator/ /measure	Conservation rating (1–4)
Perry River system	Perry River was identified as having a high richness of fish, macrophytes (34 spp.) and macroinvertebrates (at the family level). In addition, habitat values were quite high and remain intact. These values stand out from other river systems in Queensland. Most of the flora species are callistemon and there is grazing up to the edge. The area is important for migrating birds during winter and is relatively dry, tough country. Palms may also provide value for bats. Note: This decision was taken from the previous Burnett River ACA (decision number arfep_burn_9).	Burnett	bu_r_fl_09	6.3.1	4
Barambah Creek *Aponogeton* beds between Silver Leaf Weir and Ficks Crossing	At least two large beds of *Aponogeton elongatus subsp. elongatus* occur within this reach of Barambah Creek. These unusual macrophyte beds provide significant habitat and food resources for instream fauna including macroinvertebrates, fish and turtles. The area also contains significant numbers of threatened species. Note: This decision was taken from the previous Burnett River ACA (decision number arfep_burn_10).	Burnett	bu_r_fl_10	6.3.1	3
Bania National Park	Located in the headwaters of the Burnett River within Bania National Park and for about 5 km downstream of the State Forest boundary. Special biodiversity and geomorphic values. The area contains weed free Callistemon communities that are lightly grazed but still in good condition. Note: This decision was taken from the previous Burnett River ACA (decision number arfep_burn_7).	Burnett	bu_r_fl_11	6.1.1, 6.3.1	3, 3

Priority ecosystem/ special feature	Values	Catchment	Decision implementation number	Criteria/indicator/ /measure	Conservation rating (1–4)
Elliott River	From Dr Mays crossing to the freshwater Elliot River are significant reed beds and freshwater wetlands, beginning at the fresh/tidal interface. The river dries up to a series of wetlands and waterholes further upstream which are largely fed by groundwater. The unique hydrology of the Elliott River area has been recognised.	Burrum	bm_r_fl_01	6.3.1	3
Kingfern on Fraser Island	Kingfern (*Angiopteris evecta)* is a unique aquatic plant found in Waangoolbva Creek (found nowhere else on Fraser Island). This fern is only known from three places in the world – Carnarvon Gorge, Mooloolah and Fraser Island.	Fraser Island	fr_r_fl_01	5.2.1	4

Attachments

Attachment A – Wide Bay-Burnett region study areas

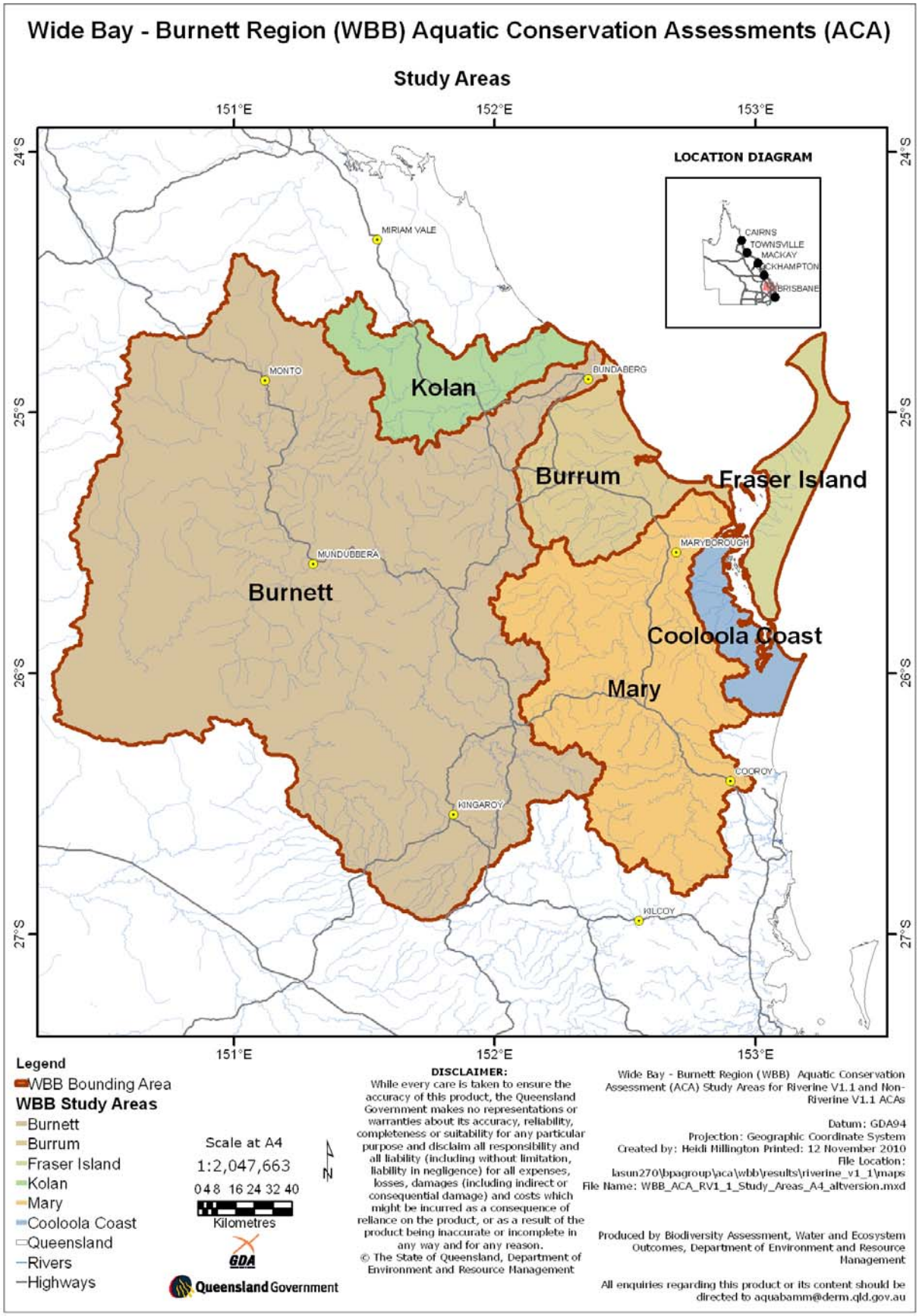

Figure 2: The Wide Bay-Burnett region showing the six study area.

Attachment B – Terms of reference (aquatic flora expert panel)

The terms of reference presented below are to be read in conjunction with the AquaBAMM report that requires expert panel workshops to be run to gain information for a number of AquaBAMM criteria and their associated indicators and measures (Clayton *et al*. 2006).

Members of the panel were experts in scientific disciplines relevant to freshwater ecosystems, processes and species. Panel members were required to have professional or semi-professional standing in their fields of expertise and have direct knowledge and experience with the Wide Bay-Burnett region. Experience in the identification and assessment of non-riverine and riverine values including natural processes, species and places of significance was an important factor in the selection process; the panel included members with experience in these areas, as well as in their areas of specialist technical expertise. Panel members were appointed on the basis of their individual standing rather than as representatives of a particular interest group or organisation.

Aquatic flora

The tasks to be undertaken by the panel include, but are not limited to, the following:

- review relevant existing spatial data (species point records) and available information
- provide advice on non-riverine and riverine ecosystem threatened flora species, habitat and localities
- provide advice on non-riverine and riverine ecosystem priority flora species, habitat and localities
- identify priority ecosystems or areas important for significant floral communities or species
- provide advice on non-riverine and riverine ecosystem exotic flora species, localities and abundance
- weight measures relative to their importance for an indicator
- rank indicators relative to their importance for a criterion.

Attachment C – Criteria, indicators and measures for the Wide Bay-Burnett region

The criteria, indicators and measures (CIM) list outlines the CIM that may be implemented as part of the ACA using AquaBAMM for the non–riverine and riverine wetlands of the Wide Bay-Burnett region.

The list has been developed from a default list of criteria, indicators and measures that may be considered when an ACA is conducted. The default CIM list is not mandatory for any particular ACA however it provides a "starter set" for consideration in setting the assessment parameters for each ACA.

AquaBAMM does not allow criteria change, addition or deletion. However, AquaBAMM does allow the addition or deletion of indicators and/or measures for each ACA when its assessment parameters are set. Generally, modification of the default set of indicators is discouraged because the list has been developed to be generic and inclusive of all aquatic ecosystems. Modification of the default set of measures may or may not be necessary but full flexibility is provided in this regard using AquaBAMM. In particular, measures may need to be added where unusual or restricted datasets are available that are specific to an ACA or study area.

Table 7: CIM list for the Wide Bay-Burnett region.

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	✓	✓
	1.1.2	Presence of exotic aquatic and semi-aquatic plants within the wetland	✓	✓
	1.1.3	Presence of exotic invertebrate fauna within the wetland	✓	✓
	1.1.4	Presence of feral/exotic vertebrate fauna (other than fish) within the wetland	✓	✓
1.2 Aquatic communities/assemblages	1.2.1	SOR[1] aquatic vegetation condition	✓	
	1.2.2	SIGNAL2 score (Max)	✓	
	1.2.3	AUSRIVAS[2] score - edge (Min band)	✓	
	1.2.4	AUSRIVAS[2] score - pool (Min band)	✓	
	1.2.9	AUSRIVAS[2] score - riffle (Min band)	✓	
1.3 Habitat features modification	1.3.1	SOR[1] bank stability	✓	
	1.3.2	SOR[1] bed and bar stability	✓	
	1.3.3	SOR[1] aquatic habitat condition	✓	
	1.3.4	Presence/absence of dams/weirs within the wetland	✓	
	1.3.5	Inundation by dams/weirs (% of waterway length within the wetland)	✓	
	1.3.8	Presence of dredging/extraction (including for navigation) and channel modification within the wetland	✓	
1.4 Hydrological modification	1.4.1	APFD[3] score - modelled deviation from natural under full development	✓	
	1.4.2	Percent natural flows - modelled flows remaining relative to predevelopment	✓	
	1.4.3	Percent no flows - modelled low flows relative to predevelopment	✓	
	1.4.5	Hydrological disturbance/modification of the wetland (e.g. as determined through DERM wetland mapping and		✓

Criteria and indicators	Measures		Riverine	Non-riverine
		classification)		
	1.4.8	High Ecological Value (HEV) Areas	✓	
2 Naturalness catchment				
2.1 Exotic flora/fauna	2.1.1	Presence of exotic terrestrial plants in the assessment unit	✓	✓
2.2 Riparian disturbance	2.2.1	% area remnant vegetation relative to preclear extent within buffered riverine wetland or watercourses	✓	
	2.2.2	Total number of regional ecosystems relative to preclear number of regional ecosystems within buffered riverine wetland or watercourses	✓	
	2.2.3	SOR[1] reach environs	✓	
	2.2.4	SOR[1] riparian vegetation condition	✓	
	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		✓
2.3 Catchment disturbance	2.3.1	% "agricultural" land-use area (i.e. cropping and horticulture)	✓	✓
	2.3.2	% "grazing" land-use area	✓	✓
	2.3.3	% "vegetation" land-use area (i.e. native veg + regrowth)	✓	✓
	2.3.4	% "settlement" land-use area (i.e. towns, cities, etc)	✓	✓
2.4 Flow modification	2.4.1	Farm storage (overland flow harvesting, floodplain ring tanks, gully dams) calculated by surface area	✓	✓
3 Diversity and richness				
3.1 Species	3.1.1	Richness of native amphibians (riverine wetland breeders)	✓	
	3.1.2	Richness of native fish	✓	✓
	3.1.3	Richness of native aquatic dependent reptiles	✓	✓
	3.1.4	Richness of native waterbirds	✓	✓
	3.1.5	Richness of native aquatic plants	✓	✓
	3.1.6	Richness of native amphibians (non-riverine wetland breeders)		✓
	3.1.7	Richness of native aquatic dependent mammals	✓	✓
3.2 Communities/assemblages	3.2.1	Richness of macroinvertebrate taxa	✓	✓
	3.2.2	Richness of regional ecosystems along riverine wetlands or watercourses within a specified buffer distance	✓	
3.3 Habitat	3.3.1	SOR[1] channel diversity	✓	
	3.3.2	Richness of wetland types within the local catchment (e.g. SOR[1] subsection)	✓	✓
	3.3.3	Richness of wetland types within the sub-catchment	✓	✓
4 Threatened species and ecosystems				
4.1 Species	4.1.1	Presence of rare or threatened aquatic ecosystem dependent fauna species – NC Act[4], EPBC Act[5]	✓	✓
	4.1.2	Presence of rare or threatened aquatic ecosystem dependent flora species –	✓	✓

Criteria and indicators	Measures		Riverine	Non-riverine
		NC Act[4], EPBC Act[5]		
4.2 Communities/assemblages	4.2.1	Conservation status of wetland regional ecosystems – Herbarium biodiversity status, NC Act[4], EPBC Act[5]	✓	✓
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[6], WWF etc)	✓	✓
	5.1.2	Presence of aquatic ecosystem dependent 'priority' flora species	✓	✓
	5.1.3	Habitat for, or presence of, migratory species (expert panel list/discussion and/or JAMBA[7]/CAMBA[8] agreement lists and/or Bonn Convention)	✓	✓
	5.1.4	Habitat for significant numbers of waterbirds	✓	✓
5.2 Ecosystems	5.2.1	Presence of 'priority' aquatic ecosystem	✓	✓
6 Special features				
6.1 Geomorphic features	6.1.1	Presence of distinct, unique or special geomorphic features	✓	✓
6.2 Ecological processes	6.2.1	Presence of (or requirement for) distinct, unique or special ecological processes	✓	✓
6.3 Habitat	6.3.1	Presence of distinct, unique or special habitat (including habitat that functions as refugia or other critical purpose)	✓	✓
	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.	✓	✓
	6.3.3	Ecologically significant wetlands identified through expert opinion and/or documented study	✓	✓
6.4 Hydrological	6.4.1	Presence of distinct, unique or special hydrological regimes (e.g. spring fed stream, ephemeral stream, boggomoss)	✓	✓
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	✓	
	7.1.2	Migratory or routine 'passage' of fish and other fully aquatic species (upstream, lateral or downstream movement) within the spatial unit	✓	
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)	✓	✓

Criteria and indicators	Measures		Riverine	Non-riverine
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	✓	
	7.3.2	Extent to which the wetland retains critical ecological and hydrological connectivity, where it should exist, with floodplains, rivers, groundwater etc.		✓
7.5 Estuarine and marine ecosystems	7.5.1	The contribution of the spatial unit to the maintenance of estuarine and marine ecosystems with significant biodiversity values, including those features identified through criteria 5 and/or 6	✓	✓
8 Representativeness				
8.1 Wetland protection	8.1.1	The percent area of each wetland type within protected areas.		✓
	8.1.2	The percent area of each wetland type within a coastal/estuarine area subject to the *Fisheries Act 1994*, *Coastal Protection and Management Act 1995* or *Marine Parks Act 2004*.		✓
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)		✓
	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)		✓
	8.2.3	The size of each wetland type relative to others of its management group within the catchment or study area		✓
	8.2.4	The size of each wetland type relative to others of its type within a sub-catchment (or estuarine zone)		✓
	8.2.5	Wetland type representative of the study 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		✓

[1] SOR – State of the Rivers
[2] AUSRIVAS – Australian River Assessment System
[3] APFD – Annual Proportional Flow Deviation
[4] NC Act – *Nature Conservation Act 1992* (Queensland legislation)
[5] EPBC Act – *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth legislation)
[6] ASFB – Australian Society of Fish Biology
[7] JAMBA – Japan-Australia Migratory Bird Agreement
[8] CAMBA – China-Australia Migratory Bird Agreement

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Attachment B **Wide Bay-Burnett ACA –**
Aquatic fauna expert panel report

Water and Ecosystem Outcomes Business Group
Queensland Department of Environment and Resource Management

An Aquatic Conservation Assessment for the non-riverine and riverine wetlands of the Wide Bay-Burnett region

Aquatic Fauna Expert Panel report

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Acronyms and abbreviations

ACA	Aquatic Conservation Assessment
AFEP	Aquatic Fauna Expert Panel Report for the Burnett ACA
ASL	above sea level
BPA	Biodiversity Planning Assessment
CAMBA	China-Australia Migratory Birds Agreement
CMS	Convention of Migratory Species of Wild Animals (also known as the Bonn Convention)
DERM	Department of Environment and Resource Management
DIWA	Directory of Important Wetlands Australia
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
GIS	Geographic Information System
HEV	High ecological value (under a water quality improvement plan)
JAMBA	Japan-Australia Migratory Birds Agreement
MRCCC	Mary River Catchment Coordinating Committee
NC Act	*Nature Conservation Act 1992*
Ramsar	Ramsar Convention on Wetlands
RE	Regional ecosystem
ROKAMBA	Republic of Korea-Australia Migratory Bird Agreement
SOR	State of the Rivers
WBB	Wide Bay-Burnett

1 Introduction

The Department of Environment and Resource Management (DERM) is conducting an Aquatic Conservation Assessment (ACA) for the non-riverine and riverine wetlands in the Wide Bay-Burnett region using the Aquatic Biodiversity Assessment and Mapping Method (AquaBAMM) (Clayton *et al*. 2006). The ACA relied on expert panels convened to address aquatic and riparian flora, aquatic fauna and wetland ecology for some of the data inputs.

AquaBAMM provides a robust and easily accessible analysis of wetland conservation values associated with a catchment or other defined study area. The AquaBAMM provides a decision support tool that utilises existing information, with moderation by expert panels (e.g. flora, fauna and wetland ecology expert panels) to ensure scientific rigour and accountability, resulting in an ACA for a nominated geographic area—in this case, the Wide Bay-Burnett region.

The potential for adding additional data into the system as it becomes available, with consequent updates to planning outcomes, is not limited. The AquaBAMM tool is a map/data output in a geographic information system (GIS) environment based on spatial mapping units that describe conservation significance or value for planning and assessment purposes.

The Wide Bay-Burnett region ACA is made up of six individual catchments— the Burnett, Mary, Kolan, Burrum, Cooloola and Fraser Island catchments. DERM is applying AquaBAMM separately to the non-riverine (palustrine and lacustrine), riverine and estuarine wetlands within each of the six Wide Bay-Burnett catchments. In effect, there are six ACAs for the area—covering non-riverine and riverine wetlands in each of the catchments. A map of the Wide Bay-Burnett region showing each study area is provided in Attachment A.

Three expert panels were conducted to address aquatic fauna, aquatic and riparian flora and wetland ecology for the six Wide Bay-Burnett catchments. The non-riverine and riverine wetlands were covered in combined workshops. The panels, held in Maryborough during July 2010, involved invited experts with expertise in aquatic and riparian flora, aquatic fauna and/or wetland ecology.

This report documents the findings and recommendations of the aquatic fauna expert panel held in Maryborough on 12th and 13th July 2010. The report presents supporting information and panel input that addresses non-riverine and riverine wetland systems. Terms of reference for the panel are provided in Attachment B.

2 Method

2.1 Study area

Burnett catchment

The Burnett River catchment lies in the South East Queensland and Brigalow Belt bioregions and is located approximately 200 km north-west of Brisbane. The Burnett is the third largest river basin on the east coast of Queensland, with a catchment area of approximately 34 500 km^2 (Van Manen 1999). The Burnett River flows for 420 km from its source in the Burnett Range to its mouth at Burnett Heads. The main tributaries of the Burnett River include the Auburn, Nogo, Boyne and Stuart Rivers and the Barambah and Three Moon Creeks (Van Manen 1999). The catchment is fringed by the Burnett and Dawes Ranges in the north, the Auburn Range to the west, the Great Dividing Range to the south-west and the Cooyar and Brisbane Ranges in the south. Major urban and regional centres in the Burnett River catchment include Bundaberg, Kingaroy, Gayndah, Eidsvold, Murgon, Nanango and Monto. Rainfall in the catchment is variable with both tropical and temperate weather patterns. Cattle grazing and crop production dominate the catchments land use.

The Burnett River catchment is subject to a number of new water infrastructure projects being approved for development. Jointly with the State of Queensland, the Commonwealth Minister for Environment and Heritage under the provisions of the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth) granted environmental approvals for Barlil Weir, Jones Weir Stage 2 and Eidsvold Weir in late 2001, and approval for Paradise Dam in late January 2002. Eidsvold Weir was completed in 2004 and Paradise Dam was completed in late 2005. Consequently, the Burnett River catchment is one of the most developed areas in Queensland in terms of water infrastructure. Increasing demands for water from irrigators, industry and the domestic sector have resulted in high levels of river regulation. There are currently approximately 41 water storages in the Burnett catchment, six of which are situated in the main river channel (Brizga *et al.* 2000).

As has been observed during the construction of dams in other areas, the raising of the Walla Weir in conjunction with the construction of the Paradise Dam is expected to have significantly reduced suitable habitats for aquatic fauna (Gehrke *et al.* 2002), particularly the Australian lungfish (*Neoceratodus forsteri*) and *Elseya* species of turtle. In response to these concerns, DERM and the Department of Employment, Economic Development and Innovation (DEEDI) were asked to develop eight projects that aim to address catchment-wide, environmental issues associated with the construction and operation of the proposed infrastructure known collectively as the Burnett Plan of Actions (BPOA). The BPOA included an AquaBAMM project in 2006 which aimed to assess 'riverine conservation values of the Burnett'. The initial trial application of the AquaBAMM was conducted in the Burnett River catchment to produce an Aquatic Conservation Assessment (ACA) for riverine wetlands. The ACA being reported here supersedes the first Burnett River ACA version released in 2006 which pre-dated construction of the Paradise Dam.

Additionally, under the Coastal Catchments Initiative, the Australian Government has funded the Burnett-Mary Regional NRM Group (BMRG) to develop the Burnett-Baffle Water Quality Improvement Plan (WQIP) (Burnett-Mary Regional NRM Group/DERM, 2010). DERM and the BMRG have completed a joint project to establish the waterway values and uses (i.e. environmental values), and developed water quality objectives/targets to protect these values and uses consistent with the Environmental Protection (Water) Policy 2009. As part of this project High Ecological Value waterways were determined for the Burnett catchment.

Mary River catchment

The Mary River flows from the moist, subtropical southern part of the South East Queensland bioregion into a drier corridor to the north, and consequently varies considerably in its character. The Mary's freshwater reaches support a distinctive fauna which is close to range limits and adapted to its episodic flood regime, and is one of two catchments supporting the iconic Australian lungfish (*Neoceratodus forsteri*). The Mary catchment is an important source of sediment and freshwater flows for seagrass ecosystems and shorebird feeding habitat in the northern Great Sandy Strait Ramsar area and Hervey Bay. Many of its riverine and non-riverine wetlands are also scheduled as High Ecological Value waterways under the Environmental Protection (Water) Policy 2009.

While most rainfall occurs in late summer to early autumn, flood events may occur in any month but are typically episodic in occurrence (e.g. 5–10 years frequency) and may be interspersed by long dry periods. Irregular high rainfall events associated with cyclones and east coast low depressions feed the southern tributaries of the Mary. While mean annual rainfall near Maleny is 2000 mm, as much as 900 mm has been recorded in a day. Much of this elevated southern catchment falls within protected areas containing rainforest, wet and dry sclerophyll ecosystems although significant areas have been cleared. Obi Obi creek rises from a basaltic plateau in the Sunshine Coast hinterland, falling steeply through gorge country before flowing north to join the Mary River. In contrast Six Mile Creek is a low energy rainforest stream retaining large woody debris. The banks of some of the major streams, such as Obi Obi, Six Mile, Deep and Tinana Creeks, have rainforest and/or tall open (wet sclerophyll) forest riparian vegetation (e.g. Araucarian notophyll vine forest or mesophyll gallery forest). Riverbank erosion due to the poor condition of riparian vegetation in the Mary

is also being linked to increased sediment discharge to the Great Sandy Strait (Esslemont *et al.* 2006a, b,c,d; DeRose *et al.* 2002).

There is a need for further mapping and rehabilitation of riparian vegetation, especially rainforest, since this vegetation type is habitat for several endemic, endangered, vulnerable, near-threatened and priority species including both fauna species (e.g. Mary River cod *(Maccullochella mariensis),* Richmond birdwing (*Ornithoptera richmondia)*, the Pink underwing moth (*Phyllodes imperialis* southern subspecies*)*, Coxen's fig parrot (*Cyclopsitta diopthalma coxeni)*, Black-breasted button-quail (*Turnix melanogaster);* the Giant barred frog *(Mixophyes iterates),* the Tusked frog *(Adelotus brevis);* the Cascade tree frog, *(Litoria pearsoniana)* (Fleay 1997, Mathieson and Smith 2009, Simpson and Jackson 1996, Sands and Scott 1998)) and flora species (e.g. *Xanthostemon oppositifolius, Fontainea rostrata,* Macadamia nut tree (*Macadamia integrifolia*) and Gympie nut (*Macadamia ternifolia*)). The South East Queensland Rainforest Recovery Program describes the association between several of these species and regional ecosystem 12.3.1 (gallery rainforest on alluvial plains). While some remnant riparian vegetation mapping of 12.3.1 exists in the Mary, mapping and identification of other riparian rainforest below the mapping scale and suitable for rehabilitation may inform NRM decisions e.g. a future Mary River Recovery Plan.

Resembling those of the drier Burnett (mean annual rainfall less than 800 mm), the intermittent western tributaries of Wide Bay and Munna Creeks are moderate to high-energy sand and gravel-bed stream systems able to accommodate substantial flows within their wide flow channels. A substantial coarse sediment load from all these tributaries has resulted in distinctive pool, riffle and sand bar sequences chiefly in the main trunk of the Mary River. These areas are notable as habitat for the Australian lungfish (*Neoceratodus forsteri*) and the highest turtle diversity in Queensland (including the endemic Mary River turtle (*Elusor macrurus*)). To the east, Coondoo and Tinana Creeks sustain important riparian rainforest and wallum vegetation on sandy alluvium with natural water quality and relatively intact fauna (including endemic Mary River Cod (*Maccullochella peelii mariensis*), Oxleyan Pygmy Perch (*Nannoperca oxleyana*) and the Australian lungfish (*Neoceratodus forsteri*) populations). These creeks flow into the turbid Mary estuary at Maryborough and are joined by the unimpounded Susan River and its mangrove wetlands near the mouth of the river. The tidal delta of the Mary extends into the Great Sandy Strait, encompassing an extensive complex of mangrove islands, saltpans and sandbanks comprising the largest Fish Habitat Area in southern Queensland. Flood events from the Mary River periodically reverse the normally highly saline conditions of Hervey Bay, producing an inverse estuary (Ribbe 2008).

Presently, catchment land use in the area chiefly comprise dryland grazing, sugar cane and plantation forestry, with tree crops and dairying in the elevated south. European settlement and dairying land use resulted extensively in clearing of its upper reaches and riparian area. Land use and modifications of the freshwater reaches have produced erosion and siltation of parts of the river and sedimentation of deep pools. Excess sediment discharge into the Mary estuary, Great Sandy Strait and Hervey Bay from Mary flood events and subsequent resuspension occasionally results in catastrophic loss of seagrass beds and dugong (e.g. 1992 – Preen *et al.* 1995) and continues to create marine water quality issues. Within the freshwater reaches regulation of its southern tributaries for extraction of water supplies for Gympie, inter-basin transfers to the Sunshine Coast and flow releases for downstream irrigation of canelands have modified the original episodic flows to a smaller, more regular runoff regime, altering the physical structure of the channel (Department of Natural Resources and Mines 2005). Barrages on former estuarine reaches of the Mary River and Tinana Creek provide for irrigated canelands and the Maryborough water supply respectively, but also restrict the freshwater flow regime and fish passage to the estuary. Most of the floodplain wetlands have been converted to cultivated paddocks or canelands. Nevertheless the Mary River catchment still supports a high diversity in riverine and non-riverine wetland types, including wallum wetlands, melaleuca swamps and inland freshwater swamps.

Burrum catchment

The Burrum catchment consists of an amalgam of coastal catchments between the Burnett and Mary catchments. The catchment is dominated by the Burrum sand mass characterised by aggregations of coastal Melaleuca wetlands and heaths with connectivity in a north-south direction. The non-riverine and riverine wetlands of the Burrum play a significant role in reef resilience due to their high connectivity with adjacent estuarine salt marshes, mangroves, seagrass meadows and coral reefs of the Great Sandy Strait Ramsar area and Hervey Bay. Many of the Burrum's riverine, non-riverine and estuarine wetlands are also scheduled as High Ecological Value waterways under the Environmental Protection (Water) Policy 2009.

Of lower relief than the Mary and Cooloola-Great Sandy Strait catchments, the Burrum receives most of its rainfall as northern monsoons, cyclones or troughs occurring in late summer to autumn (averaging 1000–1200 mm per annum). The climatic variability and low freshwater discharge in combination with evaporation on expansive tidal flats have created an 'inverse estuary' in the receiving waters of Hervey Bay (i.e. strongly hypersaline; Ribbe 2008, Grawe 2010).

The catchment logically falls into five geomorphic subdivisions: the Woongarra coastal streams draining a gently-sloping, fertile Quaternary basalt deposit; the groundwater-fed Elliott River; the Coonarr to Beelbi region of extensive sandy beach ridges and swales; the Burrum, Isis, Gregory and Cherwell rivers draining into the Burrum estuary; and the O'Regan's Creek to the Mary River area, typified by short coastal streams and alluvial wetlands sloping from a ridgeline behind Hervey Bay City. In the hinterland, sedimentary rocks of the Maryborough formation formed in Mesozoic marine waters have resulted in saline-tolerant Melaleuca wetlands along drainage lines.

The Burrum Coast sits within the Directory of Important Wetlands area between Theodolite and Beelbi creeks and includes both freshwater and estuarine wetlands (mangroves and seagrass beds). As a succession of both Holocene and Pleistocene beach ridges, and swales and Quaternary freshwater swamp deposits, it represents the most significant coastal dune system north of the Cooloola sand mass. A large proportion of this dune system is conserved within the Burrum Coast National Park. Wetland types of the Burrum Coast include wallums, closed wet heath and swale wetlands dominated by Melaleuca species. These wetlands and adjacent habitats include several species approaching their geographic limits (such as *Strangea linearis*, *Callistemon pachyphylla* and *Melaleuca sieberi*) and a number of endangered, vulnerable and near-threatened plant species including the paperbark tree (*Melaleuca cheelii*), tiny wattle (*Acacia baueri subsp baueri*) and an alyxia (*Alyxia sharpei*). The Wallum froglet (*Crinia tinnula)* has also been recorded in the Burrum Coast National Park and other wetlands in the catchment. Inland from the coastal dune systems lie wetlands and streams of the Burrum and Cherwell. In these areas, deep weathering of Tertiary sediments have formed duricrust pans on a slightly elevated plateau, inhibiting the surface drainage. The Cherwell River has good examples of perched heathy wetlands associated with these pans as well as Melaleuca swampy drainage lines dissecting the edges of the plateau.

The Elliott River catchment, which sits within the Burrum study area, is largely groundwater-fed, containing aquifers that consist of a series of poorly interconnected sand and gravel channels and intervening clay layers sloping gently towards the coast. This areas unique hydrology, freshwater wetlands and excellent connectivity to high receiving water values (including seagrass and corals) were recognised in the Burnett-Baffle Water Quality Improvement Plan (Burnett-Mary Regional NRM Group/DERM 2010).

Dominant land uses in the Burrum catchment are irrigated cropping, grazing, coastal urban development and minor plantation forestry, with the majority of intensive land use north of the Isis River. However, extensive vegetated tracts of state land remains within the bioregional corridor in the hinterland and within protected estate on the coast. Irrigation from groundwater provides for intensive cane farming and horticulture north of the Burrum River. Lenthalls Dam on the Burrum supplies the expanding city of Hervey Bay with water. Other weirs and barrages on the Burrum and Isis Rivers also sever connectivity between freshwater areas and the estuary.

Clearing of wetlands for agriculture and fragmentation associated with coastal development has impacted on the Woongarra coast and, to a lesser extent, south of Burrum Heads. Wetland function in these catchments provides water quality protection for significant estuarine and marine values–most notably the Burrum seagrass meadow dugong nursery (Sheppard 2006), Mon Repos turtle rookery and subtropical coral reefs fringing both Woongarra and Hervey Bay coastlines.

Urban development, artificial lakes and sand extraction are increasingly impacting on the natural hydrology of wetlands and streams south of Burrum Heads, with impacts such as de-watering of heathland wetlands in adjacent protected estate. There is potential for excavation of wetland soil to mobilise acid sulfate runoff and seepage from septics to eutrophy groundwater. In other parts of Australia and the world, the importance of hydrological connectivity between groundwater and adjacent inshore marine ecosystems (Maji and Smith 2008), such as seagrass, is acknowledged (Coles *et al.* 2007; Eamus *et al.* 2006; Kammermans *et al.* 2002; Johannes and Hearn 1985) and the impacts coastal urban development has on these groundwater dependent ecosystems has been demonstrated (Carruthers *et al.* 2005, Valeila *et al.* 1990). While groundwater connectivity to seagrass is yet to be investigated for the Burrum catchment, the maintenance of intact wetland function is an important consideration for the health of connected ecosystems.

Kolan catchment

The Kolan catchment is a coastal catchment between the Burnett to the south and the Littabella and Baffle Creek catchments to the north. This catchment features mainly agricultural land use and water resources, but there are some wetlands of biodiversity significance in its headwaters and adjoining its estuary.

The Kolan falls within the northern half of the South East Queensland Bioregion, and has a subtropical climate with an average rainfall of 1200-1400 mm per annum. Most of this rainfall occurs during late summer commonly associated with cyclones and troughs, but can be sporadic. Most of the Kolan catchment is relatively flat, below 80 m above seal level (ASL). However, the headwaters arise in the rugged Many Peaks Range which rises to 700 m ASL. There are a number of different protected areas in the headwaters, notably Bulburin National Park and Bulburin Forest Reserve which feature subtropical dry rainforest with emergent hoop pines; gallery rainforest; and drier eucalypt forests. Hoop pine plantations adjoin protected estates at Bulburin.

On the south side of the Kolan, a series of parallel dunes has formed a barrier and swale system in the Moore Park area. This wetland complex of Melaleuca swamps and lakes is fragmented by the urban settlement of Moore Park Beach. However, the freshwater wetlands have reasonable connectivity to the Kolan Fish Habitat Area in the estuarine waters of the Kolan and west of Barubbra Island in the delta of the Burnett.

Agricultural and water resource land uses dominate much of the Kolan and as a result much of the catchment is cleared. Grazing dominates the upper and central catchment, while irrigated sugar cane and horticultural crops (including macadamia nut plantations) predominate in the lower catchment. The Fred Haigh Dam is a large impoundment within the central-upper reaches of the Kolan with a pipeline providing inter-basin transfers into the Burnett for irrigation. Bucca Weir and the Kolan barrage provides freshwater for agriculture in the central and lower reaches. Irrigation from the Gooburrum aquifer, which extends from the Elliott River north to the Kolan, supplements the variable rainfall experienced within the Kolan. To date, connectivity has been poor and hence environmental flows to the estuary have been low. However, the revised water resource plan covering the region is focussing more on improvements to freshwater flows in order to benefit catadromous fish.

Under its Coastal Catchments Initiative, the Australian Government has funded the Burnett-Mary Regional NRM Group (BMRG) to develop the Burnett-Baffle Water Quality Improvement Plan (WQIP). DERM and the BMRG have completed a joint project to establish the waterway values and uses (i.e. environmental values) and develop water quality objectives/targets to protect the values and uses consistent with the Environmental Protection (Water) Policy 2009. As part of this project High Ecological Value waterways were determined for the Kolan catchment.

Cooloola catchment (previously Noosa North)

Previously this catchment was referred to as Noosa North, however to more accurately represent the geographical location, the wetland ecology expert panel recommended that it be renamed the Cooloola catchment .The Cooloola region has the oldest and largest unconsolidated sand mass in the world, nominated as World Heritage for its spectacular natural values, geomorphology, and the most extensive and intact complex of heath and swamp communities in south-eastern Australia (Fraser Island World Heritage Scientific Advisory Committee, 2004a). The Cooloola Sand Mass, and its very high rainfall volume (often exceeding 1200 mm annually) determines the hydrology and character of most of this catchment. Many of its freshwater wetlands fall within the Great Sandy Strait Ramsar area, and together with the dunes are important groundwater recharge areas. Many of Cooloola's riverine, non-riverine and estuarine wetlands are also scheduled as High Ecological Value waterways under the Environmental Protection (Water) Policy 2009.

Streams of the Cooloola catchment flow in four separate directions, three of which are in protected area estate within the Cooloola section of the Great Sandy National Park. To the north flow the Cooloola and Great Sandy Strait streams; to the south flows the Noosa River; and various streams and springs within the narrow dune corridor of the eastern seaboard discharge directly across the beach to the sea. East of the Mary River catchment and north of Kauri Creek, coastal creeks from other, smaller sand masses than Cooloola flow directly into the Great Sandy Strait Ramsar area, whose sandbanks and mangrove-lined waterways provide significant seagrass habitat for shorebirds, dugong and dolphins.

Catchments of the Cooloola area are typified by their dependence on groundwater flows emanating chiefly from the Cooloola Sand Mass, high dunes (to 258 m ASL), resembling those of Fraser Island in geomorphology, hydrology, flora and fauna. This sand mass is derived from quartz sands blown and buried in a low hilly landscape of Mesozoic sandstones, covered by successively younger sand deposits until the Holocene (including parabolic dunes). Long-term leaching of humic acids has formed deep podzolic soils and peat-swamps with various layers of coffee rock impeding drainage and forming perched water tables, overlying a deeper regional groundwater table close to sea level and connected to estuarine waters. While hydrologically linked to the Noosa River catchment, the divide between these groundwater-sourced systems approximately coincides with the topographic watershed along the highest dunes of the sandmass. Groundwater of the Cooloola area is characterised by organic stained 'black waters' in its perched system and unstained 'white water' in the prime aquifer below (NLWRA 2000).

This variety of hydrological regimes produces a wide range of highly significant wetland types including patterned fens similar to those of Fraser Island, the only subtropical patterned fens in the world, 'swamp hummocks' of patterned peat microrelief, perched (e.g. Poona Lake) and regional water-table 'window' lakes (e.g. Freshwater Lake), perched heath swamps with Christmas Bells and other rare wetland flora species, episodic springs or 'bubblers' of 'white' water across the beach, 'black' tannin-stained wallum streams, vineforest riparian vegetation surrounding 'white water' springs, and melaleuca wetlands to name a few.

Many are acid habitats with a pH so low that they have developed a unique suite of acid-tolerant fauna including four vulnerable and near-threatened frogs (the Cooloola sedgefrog (*Litoria cooloolensis*), Wallum rocketfrog (*Litoria freycineti*), Wallum sedgefrog (*Litoria olongurensis*) and Wallum froglet (*Crinia tinnula)*, fish, the crayfish (*Cherax robustus*) and earthworms. Northward to the Great Sandy Strait the continuity between the freshwater streams, groundwater and the estuary is largely uninterrupted and natural, supporting very high values in the freshwater/estuarine interface including the most significant mainland populations of Water Mouse; species tolerant of brackish water and low pH (e.g. Honey Blue Eye (*Pseudomugil mellis*) and Oxleyan Pygmy perch (*Nannoperca oxleyana*)) and very high fish diversity. Most notable is Kauri Creek and streams discharging from the Wide Bay Military Training Area whose adjacent seagrass beds constitute the most significant dugong habitat in the southern Great Sandy Strait (Sheppard 2006).

Further north beyond Kauri Creek, smaller coastal creeks of the Great Sandy Strait (including Maaroom, Tuan and Poona creeks) drain flatter, sandy terrain as far north as the Mary River mouth. There is limited knowledge of these catchments typified by heath and wallum complexes often connected to a network of mangrove channels within the Great Sandy Strait Ramsar Area. They preserve natural connectivity from fresh to estuarine waters but within a catchment of exotic pine plantations. Poona National Park represents a complex of fresh and estuarine wetlands with similar acid frog habitat and faunal features to those of Cooloola including Honey Blue Eye (*Pseudomugil mellis*).

The Noosa River catchment is a largely undisturbed basin within protected area, featuring deltaic and estuarine lake systems draining southward towards the Sunshine Coast from the Cooloola sand mass. In contrast with Cooloola, it has developed alluvial features and is surrounded by sandstone and alluvium on the west and Pleistocene and Holocene dunes on the east and has high recreational values.

Whilst a lack of urban settlement has left the Cooloola-Great Sandy Strait catchment largely intact, establishment of exotic pine plantations has modified catchments to the north of Kauri Creek. Extraction from Teewah Creek (Noosa River catchment), and the regional groundwater table for the townships of Tin Can Bay and Rainbow Beach respectively have potential to impact on wetlands surrounding Seary's Creek and the Noosa River if water resource management for the environment is not effective. Coastal developments at Cooloola Cove and to a lesser extent Tin Can Bay, Poona, Big Tuan and Boonooroo sever the connectivity between freshwater and estuarine wetlands and there is potential for excavation of wetland soil to mobilise acid sulfate runoff and seepage from septics to eutrophy groundwater. Monitoring in the Great Sandy Strait has documented seagrass declines since the early 1990s. In other parts of Australia and the world, the importance of the hydrological connectivity between groundwater and adjacent inshore marine ecosystems (Maji and Smith 2008), such as seagrass, is acknowledged (Coles *et al.* 2007; Eamus *et al.* 2006; Kammermans *et al.* 2002, Johannes and Hearn 1985) and the impacts coastal urban development has on these groundwater dependent ecosystems has been demonstrated (Carruthers *et al.* 2005, Valeila *et al.* 1990). While groundwater connectivity to seagrass is yet to be investigated for the Cooloola-Great Sandy Strait catchment, the maintenance of intact freshwater wetland function is an important consideration for the health of connected aquatic ecosystems in the Ramsar area.

Fraser Island catchment

Fraser Island is the largest sand island in the world, recognised as containing World Heritage Outstanding Universal Values including geomorphic and ecological processes, exceptional beauty, biodiversity, threatened species, and cultural heritage (Fraser Island World Heritage Scientific Advisory Committee, 2004b). The areas substantial dune aquifer characterises the island's unique wetlands which includes half the freshwater dune lakes in the world and the only known subtropical patterned fens. In the western parts, the streams of Fraser Island flow into the Great Sandy Strait Ramsar area, which has also recently been nominated for World Heritage value, while Breaksea Spit to the north provides connectivity to coral reefs in the southern Great Barrier Reef. Many of Fraser Island's riverine, non-riverine and estuarine wetlands are also scheduled as High Ecological Value waterways under the Environmental Protection (Water) Policy 2009.

Fraser Island consists of a complex of high dunes rising to a maximum height of 235 m ASL. Annual rainfall ranges between 1200 and 1800 mm, falling mostly over autumn when seasonal cyclonic weather results in high rain events. North of Indian Head the relief is low and dune formation is more recent, resulting in a network of exposed dunes, freshwater swamps and lakes.

Formed by continuous deposition of quartz dune deposits over the last 700 000 years, Fraser Island represents an intact sequence of dune development from west to east. These wind-blown dunes were deposited during periods of low sea level during interglacials of the Pleistocene and high winds of the Holocene. Successively younger deposits of parabolic dunes are superimposed over these older dune deposits now stabilised by towering rainforests and wet sclerophyll, forming a high diversity of dune forms with complex hydrological relationships. Similarities with the Cooloola Coast area include the heavily leached deep podzolic soils and peat-swamps; layers of coffee rock impeding drainage and forming perched water tables, overlying a deeper regional groundwater table 'lens' close to sea level and connected to estuarine waters.

The advance and retreat of dunes over time has created a complex of dynamic hydrologies resulting in spring-fed streams and freshwater dune lakes. The lakes feature relict formations from past water levels such as multiple shorelines, lunettes and relict spits. Perched lakes formed in wind scoured depressions where organic matter built up impermeable layers. Up to an estimated 300 000 years old, their sediments document changes to the island's hydrology and vegetation through Quaternary glacial and interglacial cycles. These lakes form an age sequence related to the episodic periods of dune building and include some of the largest (e.g. Lake Boomanjin) and highest perched lakes (i.e. Boomerang Lakes) in the world. Window lakes intersect the regional groundwater table. Lake Wabby is a scenic barrage lake, thought to be formed by groundwater springs dammed by a wall of landward migrating sand.

A high diversity of palustrine wetland types are also represented on the island including closed wet heaths, wallum banksia communities, Melaleuca swamps and forests, riparian rainforest and palm forests, and brackish swamps. Notable among these are the patterned fens, formed at the base of high dunes where a build up of peat ridges and pools have formed in response to discharges from the regional water table. A suite of acid-tolerant fauna are associated with the fens and other acid swamps include Oxleyan Pygmy Perch (*Nannoperca oxleyana*) and Honey blue eye (*Pseudomugil mellis*), four acid frog species (the Cooloola sedgefrog (*Litoria cooloolensis*), the Wallum rocketfrog (*Litoria freycineti*), the Wallum sedgefrog (*Litoria olongurensis*) and the Wallum froglet (*Crinia tinnula*) and a crayfish (*Cherax robustus*).. The swamp eel (*Ophisternon gutturale*) has also been recorded at Lake Wabby.

Most of the streamflow for Fraser Island's freshwater streams is baseflow from the aquifer, which may be 'black' tannin-stained water discharging from wallum heaths or 'white' clear waters emerging from the lower water table. There is a small pocket of Angiopteris fern at Wanggoolba creek. Freshwater streams also designate the southern range limit of jungle perch (*Kuhlia rupestris*).

Connectivity between freshwater and estuarine waters is an important feature of Fraser Island waterways, and, as a result, populations of the Water mouse (*Xeromys myoides*) are high as they are able to access both habitat types. Fraser Island's western creeks feature the region's highest diversity of mangroves, several of which are freshwater-dependent such as the Cannonball Mangrove (*Xylocarpus* granatum) and extensive Bruguiera forests, both at their southern range limits. Fraser Island wetlands perform an important water quality protection function for seagrass beds and sandbanks of the Great Sandy Strait; the humpback whale migration area in Platypus Bay; and the loggerhead turtle rookery at Sandy Cape.

Fraser Island is largely undeveloped and heavily vegetated, and the north is largely wilderness. Most of the island is in protected area estate, although there are freehold settlements and resorts at Eurong, Happy Valley and Kingfisher Bay which source their water from bores. A network of forestry tracks traverses the inland, however most traffic uses the eastern beach. Currently tourism is at a relatively high volume, notably around Lake Mackenzie where there have been concerns about trampling of riparian vegetation and water quality.

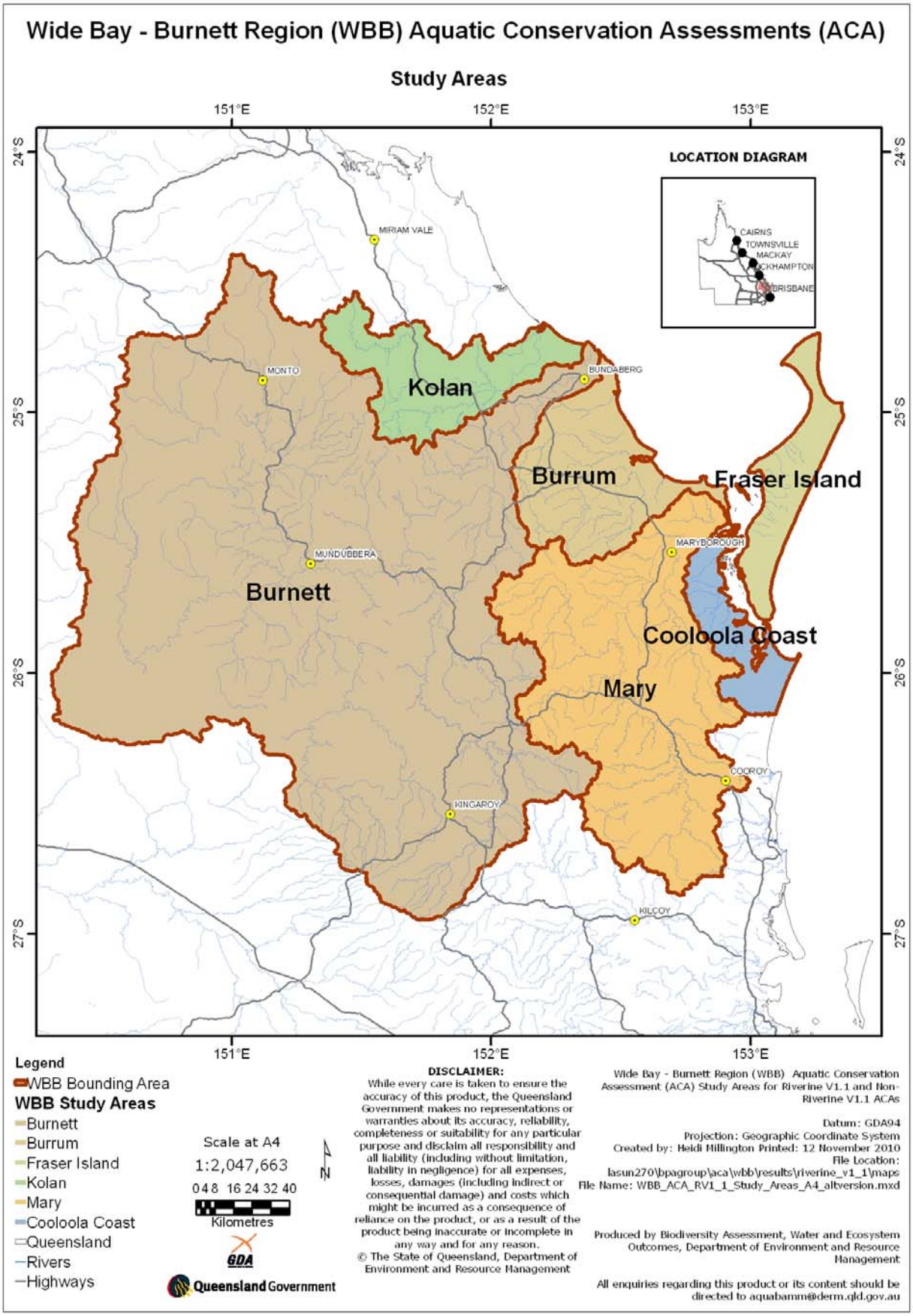

Figure 1: The Wide Bay-Burnett study area.

2.2 Panel composition

The expert panel comprised of the persons listed in Table 1 who are familiar with aquatic fauna in the Wide Bay-Burnett region.

Some members who were unavailable to attend the workshop were consulted prior to, or after, the workshop.

Table 1: Panel members.

Name	Position /Organisation	Expertise
Carol Bussey	Fraser Coast branch of the Wildlife Preservation Society of Queensland	Frogs/wetlands (Burrum area)
Darren Fielder	Principal environmental officer (water planning), Department of Environment and Resource Management	Freshwater biodiversity, notably turtles
Eva Ford	Threatened species coordinator, Mary River Catchment Coordinating Committee	Frogs, Richmond birdwing butterfly
Glenda Pickersgill	Mary River Catchment Coordinating Committee	Mary River cod
Maria Zann	Scientist, resource assessment and information south-east, Department of Environment and Resource Management	Aquatic biodiversity and environmental values of Wide Bay-Burnett region
Marilyn Connell	Tiaro Landcare	Mary River aquatic biodiversity including turtles
Peter Kind	Principal scientist, fisheries, Department of Employment, Economic Development and Innovation	Freshwater fish, notably lungfish
Rachel Lyons	Biodiversity coordinator, Burnett-Mary Regional Natural Resource Management Group	Terrestrial and aquatic biodiversity of Wide Bay-Burnett region
Rachael Nasplezes	Wetlands education officer, Burnett-Mary Regional Natural Resource Management Group	Wetlands education
Rod Hobson	Ranger, western region, Queensland Parks and Wildlife Service, Department of Environment and Resource Management	Aquatic fauna
Tom Espinoza	Project leader, aquatic ecosystem programme, Department of Environment and Resource Management	Freshwater biodiversity

Renae Measom, Justin Kingsford, Darren Fielder and Heidi Millington provided administrative and technical support for the workshop which was facilitated by Steven Howell.

2.3 Workshop format

The workshop used an interactive approach of ArcView GIS software to display point records of species and their spatial distributions. Where necessary, a background of topographic 1:250,000 maps, roads, rivers and other relevant datasets were used to identify areas of interest. Additional supporting information on fauna and flora in the Wide Bay-Burnett region was also sourced from various technical reports.

3 Near-threatened and threatened fauna

The panel identified eight 'near-threatened', 11 'vulnerable' and 11 'endangered' fauna taxa within the non-riverine and riverine wetlands of the Wide Bay-Burnett region (Table 2). Only threatened taxa listed either on a schedule of the Queensland *Nature Conservation Act 1992* or the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*, and considered to be wetland dependent by the panel were included in Table 2. This list of fauna was used as the basis for identifying areas of significance for 'Criterion 4 Threatened species and ecosystems' (4.1.1). A spatial unit with one or more of these species present was scored the highest category of four.

Table 2: Aquatic, semi-aquatic and riparian fauna species listed under Queensland or Commonwealth legislation.

This list was used to generate the values for the AquaBAMM measure 4.1.1.

Scientific name	**Common name**	**Status**	**NR[1]**	**R[1]**	**Comments**
Adelotus brevis	Tusked frog	V[2]	Y	Y	Stronghold is on the east coast now, rather than inland.
Argyreus hyperbius inconstans	Australian rritillary	E[2]	Y		
Crinia tinnula	Wallum froglet	V[2]	Y		
Cyclopsitta diophthalma coxeni	Coxen's fig-parrot	E[2,3]	Y	Y	Was not always dependent on riparian zones, but due to clearing of habitat, it now relies on riparian figs in the study areas. (RE 12.3.1 and possibly other REs).
Cyclorana verrucosa	Rough-collared frog	NT[2]	Y		Western parts of the Burnett. Found in Brigalow gilgai wetlands.
Elusor macrurus	Mary River turtle	E[2,3]	*	Y	
Ephippiorhynchus asiaticus	Black-necked stork	NT[2]	Y	Y	
Hemiaspis damelii	Grey snake	E[2]	Y	Y	Associated with swamps, marshlands, gilgais and can be on creeks in western areas.
Lewinia pectoralis	Lewin's rail	NT[2]	Y	Y	Can be found around salt marshes, reeds at creek mouths.
Litoria brevipalmata	Green-thighed frog	NT[2]	Y		Comes up to ground after rain. Not much known about its behaviour. Breeds in temporary pools and gullies.
Litoria cooloolensis	Cooloola sedgefrog	NT[2]	Y		
Litoria freycineti	Wallum rocketfrog	V[2]	Y		Can be found in dry heaths on Fraser Island, but require water to breed.
Litoria olongburensis	Wallum Sedgefrog	V[2,3]	Y	Y	Can be found around lakes on Fraser Island and along sedges on Noosa River.
Litoria pearsoniana	Cascade treefrog	V[2]		Y	
Litoria pearsoniana (Kroombit Tops)	Cascade treefrog (Kroombit Tops)	E[2]		Y	
Litoria revelata	Whirring treefrog	NT[2]	Y	Y	Well outside its range in the northern Burnett. Probably most northern record. Very significant record.
Maccullochella peelii mariensis	Mary River cod	E[3]	*	Y	

Scientific name	Common name	Status	NR[1]	R[1]	Comments
Mixophyes fleayi	Fleay's barred frog	E[2,3]		Y	Extinct from Bunya Mountains. Records in Mary River catchment (Conondale National Park) are current.
Mixophyes iteratus	Giant barred frog	E[2,3]		Y	Extinct from Bunya Mountains. Records in Mary River catchment (Conondale National Park) are current.
Nannoperca oxleyana	Oxleyan pygmy perch	E[3]	Y	Y	
Neoceratodus forsteri	Australian lungfish	V[3]	*	Y	Riverine species, but also found in impoundments (i.e. H2M1 wetlands).
Nettapus coromandelianus	Cotton pygmy-goose	NT[2]	Y		Like open water with lilies, lagoons etc. Not found on fast flowing sections of watercourses. Has been seen ~30 km above the barrage on the Mary River.
Ornithoptera richmondia	Richmond birdwing butterfly	V[2]	Y	Y	Were widespread, but now restricted to riparian vegetation in the study area and primarily rainforest riparian areas. In the headwaters, it is both riverine and non-riverine however in the lowland areas it primarily occurs in riparian zones.
Phyllodes imperialis (southern subspecies)	Pink underwing moth	E[3]		Y	Dependent on old growth lowland rainforest including riparian with *Carronia multisepalea.*
Pseudomugil mellis	Honey blue eye	V[2,3]	Y	Y	
Pteropus poliocephalus	Grey-headed flying-fox	V[3]		Y	Food sources are primarily restricted to riparian areas. Camps can also be found along rivers, potentially because of microhabitat (humidity) and water resources for drinking.
Rostratula australis	Australian painted snipe	V[2,3]	Y		Can be found on dams and lagoons where there is heavy vegetation along the edges. Species is a non-resident species. But can show up in different seasons/years.
Tadorna radjah	Radjah shelduck	NT[2]	Y	Y	Found on still water lagoons. Can also be found in estuaries. This is the southern extent of records, possibly re-establishing southern distribution.
Taudactylus pleione	Kroombit tinkerfrog	E[2]		Y	
Xeromys myoides	Water mouse	V[2,3]	Y	Y	Found in estuarine and some freshwater swamps. In Fraser Island they have been captured along freshwater creeks.

- recent records (>1975) and records with precision <2000 m only

1. Assessment type (NR – non-riverine, R – riverine)
2. *Queensland Nature Conservation Act 1992* (E – endangered, V – vulnerable, NT – near threatened, LC – least concern)
3. *Environment Protection and Biodiversity Conservation Act 1999* (Ex – extinct, CE – critically endangered, E – endangered, V – vulnerable)

* Panel noted that this taxon is found in riverine and H2M1 wetlands (i.e. impoundments such as dams and weirs).

4 Priority fauna

The panel deliberated on all aquatic-dependent fauna species within the Wide Bay-Burnett region to identify 'priority fauna' (excluding the rare or threatened species listed in Table 2). The panel identified that species with records in the study area that are at the limit of the species range should be identified as priority species. This has been added as priority definition number eight.

The panel agreed to a definition of a priority species namely that a priority species must exhibit one or more of the following significant values:

1. It is endemic to the study area (>75 per cent of its distribution is in the study area/catchment).
2. It has experienced, or is suspected of experiencing, a serious population decline.
3. It has experienced a significant reduction in its distribution and has a naturally restricted distribution in the study area/catchment.
4. It is currently a small population and threatened by loss of habitat.
5. It is a significant disjunct population.
6. It is a migratory species (other than birds).
7. A significant proportion of the breeding population (>one per cent for waterbirds, >75 per cent other species) occurs in the waterbody (see Ramsar criterion 6 for waterbirds).
8. Limit of species range.

4.1 Priority species

The panel identified nine non-riverine and 15 riverine priority fauna species (Table 3). These species were included in 'Criterion 5 Priority species and ecosystems' (5.1.2). A spatial unit with one or more of these species present was scored the highest category four.

Table 3: Identified priority fauna species, and their significant values.

This list was used to generate the values for the AquaBAMM measure (5.1.2).

Scientific name	Common name	NR[1]	R[1]	Priority number[2]	Comments
Anguilla obscura	Pacific shortfin eel	Y	Y	6	Not common. Migratory species on southern edge of its range. Not a lot known about it. Data poor.
Chelodina expansa	Broad-shelled river turtle	Y	Y	1, 5	Fraser Island population may be a new species (genetics and morphologically).
Cherax robustus	Sand yabby	Y		2	It has disappeared from mainland in most areas but has been rediscovered on Poona National Park. It is now restricted to islands including Fraser Island.
Cyclorana alboguttata	Greenstripe frog	Y		2	Decline due to habitat loss/fragmentation
Elseya albagula	Southern snapping turtle	*	Y	8	Vulnerable to further population declines
Euastacus hystricosus	Giant spiny crayfish		Y	1	Endemic to upland high altitude areas (headwaters of the Brisbane and Mary River Catchments – Maleny Plateau -see Coughran and Furse 2010)
Euastacus monteithorum	Freshwater crayfish		Y	1	This is a critical species. Most *Euastacus spp.* are endemic to catchments and hence study areas. This species is endemic to upland high altitude areas (See Coughran and Furse 2010).
Euastacus sp.	Freshwater crayfish sp.		Y	1	Endemic to upland high altitude areas
Euastacus urospinosus	Rainforest crayfish		Y	1	Endemic to upland high altitude areas (Obi Obi Creek – Coughran and Furse 2010)
Kuhlia rupestris	Jungle perch		Y	1, 2, 3	Practically extinct in southern distribution except for Fraser Island (only eastern seaboard). It is genetically distinct from mainland populations, potentially a new species.
Lates calcarifer	Barramundi	Y	Y	2, 4 (Burnett) 8 (Mary)	The Burnett River population hasn't changed (small population), but are suspected to occur from stocked fish. Only in the Burnett River is it a priority. Mary River is going well although it is at its southern distribution (i.e. limit of its range). The estuary is an important habitat for juveniles although the Burnett estuary is not in good condition.
Limnodynastes salmini	Salmon striped frog	Y		2, 3, 8	Declining and at the limit of its range for the Burnett. It occurs in gilgais and floodplains.
Litoria rothii		Y	Y	8	Southern limit of its distribution
Litoria tyleri			Y	8	Possibly northern limit of distribution
Litoria verreauxii	Whistling treefrog		Y	8	Northern most limits of its range.

Scientific name	Common name	NR[1]	R[1]	Priority number[2]	Comments
Macquaria novemaculeata	Australian bass	*	Y	2, 8	Declining along Australian coast. The WBB study areas are at the northern edge of its range. Habitat change in the estuaries is a threat to the species.
Ophisternon gutturale	Swamp eel	Y		5	A few specimens from Fraser Island from Lake Wabby.. Only been found in lakes to date. Data poor.
Rhadinocentrus ornatus	Ornate rainbow fish	Y	Y	5	
Trachystoma petardi	Pinkeye mullet		Y	2	Relies on marine and freshwater environments. Still healthy/common in Mary but suffering a dramatic decline in the Burnett. Is only a priority species in Burnett and Kolan. It does need connectivity between marine and freshwater habitats (migratory species) and interruption to this connectivity is the main threat to this species.

- recent records (>1975) and records with precision <2000 m only
  1. Assessment type (NR – non-riverine, R – riverine)
  2. The priority number are the values that a species must exhibit to be a priority species as listed in dot points above Table 3

* Panel noted that this taxon is found in riverine and H2M1 wetlands (i.e. impoundments such as dams and weirs).

4.2 Migratory species

In addition to the priority species identified above, the panel nominated migratory species listed under the Japan-Australia Migratory Bird Agreement (JAMBA), the China-Australia Migratory Bird Agreement (CAMBA), the Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA) or the Convention on the Conservation of Migratory Species of Wild Animals (CMS; also known as the Bonn Convention) as priority fauna. A total of 22 non-riverine and 13 riverine migratory species (Table 4) were included in the AquaBAMM assessment in 'Criterion 5 Priority species and ecosystems' (5.1.3). A spatial unit containing one species record scored a three. A four was scored if more than one migratory species occurred within its boundary.

Table 4: A list of migratory species.

This list was used to generate the values for the AquaBAMM Measure (5.1.3). These lists were sourced from JAMBA, CAMBA, ROKAMBA and CMS and are found at <www.environment.gov.au/biodiversity/migratory/waterbirds>.

Scientific name	Common name	Agreements/ conventions	NR[1]	R[1]	Comments
Acrocephalus australis	Australian reed-warbler	CMS[5]	Y	Y	
Actitis hypoleucos	Common sandpiper	CAMBA[2], JAMBA[3], ROKAMBA[4], CMS[5]		Y	It inhabits dams and river mouths, mud bars
Ardea ibis	Cattle egret	CAMBA[2], JAMBA[3]	Y	Y	Under review and possibly will be removed from conventions
Ardea modesta	Eastern great egret	CAMBA[2], JAMBA[3]	Y	Y	Nomadic species
Calidris acuminata	Sharp-tailed Sandpiper	CAMBA[2], JAMBA[3], ROKAMBA[4], CMS[5]	Y		
Calidris ferruginea	Curlew sandpiper	CAMBA[2], JAMBA[3], ROKAMBA[4], CMS[5]	Y		
Charadrius leschenaultii	Greater sand plover	CAMBA[2], JAMBA[3], ROKAMBA[4], CMS[5]	Y		
Charadrius mongolus	Lesser sand plover	CAMBA[2], JAMBA[3], ROKAMBA[4], CMS[5]	Y		
Charadrius veredus	Oriental plover	JAMBA[3], ROKAMBA[4], CMS[5]	Y		
Chlidonias leucopterus	White-winged Black Tern	CAMBA[2], JAMBA[3], ROKAMBA[4]	Y	Y	
Cyclopsitta diophthalma coxeni	Coxen's fig-parrot	JAMBA[3]	Y	Y	
Gallinago hardwickii	Latham's snipe	CAMBA[2], JAMBA[3], ROKAMBA[4], CMS[5]	Y	Y	
Glareola maldivarum	Oriental pratincole	CAMBA[2], JAMBA[3], ROKAMBA[4]	Y		
Haliaeetus leucogaster	White-bellied Sea-Eagle	CAMBA[2]	Y	Y	
Hydroprogne caspia	Caspian tern	CAMBA[2], JAMBA[3]	Y	Y	
Limosa limosa	Black-tailed Godwit	CAMBA[2], JAMBA[3], ROKAMBA[4], CMS[5]	Y	Y	
Numenius minutus	Little curlew	CAMBA[2], JAMBA[3], ROKAMBA[4], CMS[5]	Y		
Pandion cristatus	Eastern osprey	CMS[5]	Y	Y	
Plegadis falcinellus	Glossy ibis	CAMBA[2], CMS[5]	Y	Y	
Rostratula australis	Australian painted snipe	CAMBA[2]	Y		
Tringa glareola	Wood sandpiper	CAMBA[2], JAMBA[3], ROKAMBA[4], CMS[5]	Y		
Tringa nebularia	Common greenshank	CAMBA[2], JAMBA[3], ROKAMBA[4], CMS[5]	Y		Coastal and inland
Tringa stagnatilis	Marsh sandpiper	CAMBA[2], JAMBA[3], ROKAMBA[4], CMS[5]	Y	Y	

- recent records (>1975) and records with precision <2000 m only

1. Assessment type (NR – non-riverine, R – riverine)
2. China-Australia Migratory Birds Agreement (CAMBA)
3. Japan-Australia Migratory Birds Agreement (JAMBA)
4. Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA)
5. Convention on the Conservation of Migratory Species of Wild Animals (CMS) otherwise know as the Bonn Convention

5 Species richness

Species richness (i.e. total number of species) was scored for each class of fauna (amphibians (frogs), fish, reptiles, and waterbirds).

Stratifying the catchments is important to describe variability in richness. For example, fish richness is expected to be greater in the floodplain river channels than headwater streams which are smaller, with less food availability and unable to support high fish richness. The panel discussed a number of options for stratification and recommended to use the 150 m ASL as a stratification between upland and lowland. A number of subsections in the western part of the Mary were identified as being drier and with generally different species ecology from the rest of the Mary and should be included in the upland stratification. This method was endorsed by the flora and ecology panels.

5.1 Fish richness

There were 17 non-riverine and 49 riverine native fish species identified in the Wide Bay-Burnett region. Table 5 lists fish species that were used under the 'Criterion 3 Diversity and richness' measure (3.1.2).

Table 5: Native fish.

This list was used to generate the values for the AquaBAMM measure (3.1.2).

Scientific name	Common name	Status	NR[1]	R[1]	Comments
Ambassis agassizii	Agassiz's glassfish		*	Y	
Amniataba percoides	Barred grunter			Y	
Anguilla australis	Southern shortfin eel		Y	Y	Eels can be found in interdunal wetlands
Anguilla obscura	Pacific shortfin eel		Y	Y	
Anguilla reinhardtii	Longfin eel		Y	Y	
Arrhamphus sclerolepis	Snubnose garfish		*	Y	Found in impoundments (H2M1 wetlands) also
Carcharhinus leucas	Bull shark			Y	
Craterocephalus marianae	Mariana's hardyhead		*	Y	Found in impoundments (H2M1 wetlands) also
Craterocephalus marjoriae	Silverstreak hardyhead		*	Y	Found in impoundments (H2M1 wetlands) also
Craterocephalus stercusmuscarum	Flyspecked hardyhead		*	Y	Found in impoundments (H2M1 wetlands) also
Glossamia aprion	Mouth almighty		*	Y	Found in impoundments (H2M1 wetlands) also
Gobiomorphus australis	Striped gudgeon		*	Y	
Hypseleotris compressa	Empire gudgeon		*	Y	
Hypseleotris galii	Firetail gudgeon		*	Y	
Hypseleotris klunzingeri	Western carp gudgeon		*	Y	
Hypseleotris sp.	Gudgeon sp.		*	Y	
Hypseleotris sp. 1	Midgley's carp gudgeon		*	Y	
Hypseleotris sp. 2	Lake's carp gudgeon		*	Y	
Kuhlia rupestris	Jungle perch			Y	
Lates calcarifer	Barramundi		Y	Y	Barramundi will use non-riverine as well.
Leiopotherapon unicolor	Spangled perch		Y	Y	
Lutjanus argentimaculatus	Mangrove jack			Y	
Maccullochella peelii mariensis	Mary River cod	E[3]	*	Y	Found in impoundments (H2M1 wetlands) also

Scientific name	Common name	Status	NR[1]	R[1]	Comments
Macquaria novemaculeata	Australian bass		*	Y	Found in impoundments (H2M1 wetlands) also
Megalops cyprinoides	Oxeye herring/tarpon			Y	Predominantly marine, but does occur in freshwater
Melanotaenia duboulayi	Crimsonspotted rainbowfish		Y	Y	
Melanotaenia splendida	Eastern rainbowfish		Y	Y	Records in Mary River catchment misidentified, all other catchments are correct
Mogurnda adspersa	Southern purplespotted gudgeon		*	Y	
Mugil cephalus	Sea mullet		*	Y	
Nannoperca oxleyana	Oxleyan pygmy perch	E[3]	Y	Y	
Nematalosa erebi	Bony bream		*	Y	
Neoarius graeffei	Blue catfish		*	Y	
Neoceratodus forsteri	Australian lungfish	V[3]	*	Y	
Neosilurus hyrtlii	Hyrtl's catfish		Y	Y	
Notesthes robusta	Bullrout		Y	Y	
Ophisternon gutturale	Swamp eel		Y		Found in still water and lakes
Ophisternon sp.	Swamp eel sp.		Y		
synbranchid sp.	Swamp eel sp.		Y		
Philypnodon grandiceps	Flathead gudgeon		*	Y	
Philypnodon macrostomus	Dwarf flathead gudgeon		*	Y	
Porochilus rendahli	Rendahl's catfish		*	Y	
Porochilus sp. cf. *rendahli*	Eel-tailed catfish sp.		*	Y	
Pseudomugil mellis	Honey blue eye	V[2,3]	Y	Y	
Pseudomugil signifer	Pacific blue eye		Y	Y	
Redigobius bikolanus	Speckled goby		*	Y	
Redigobius macrostomus	Largemouth goby		Y	Y	
Retropinna semoni	Australian smelt		*	Y	
Rhadinocentrus ornatus	Ornate rainbowfish		Y	Y	
Strongylura krefftii	Freshwater longtom		*	Y	
Tandanus tandanus	Freshwater catfish		*	Y	
Terapon jarbua	Crescent grunter			Y	
Trachystoma petardi	Pinkeye mullet		*	Y	

- recent records (>1975) and records with precision <2000 m only

1. Assessment type (NR – non-riverine, R – riverine)
2. Queensland *Nature Conservation Act 1992* (E – endangered, V – vulnerable, NT – near threatened, LC – least concern)
3. *Environment Protection and Biodiversity Conservation Act 1999* (Ex – extinct, E – endangered, V – vulnerable)

* Panel noted that this taxon is found in riverine and H2M1 wetlands (i.e. impoundments such as dams and weirs).

5.2 Reptile richness

There were 15 non-riverine and 17 riverine native reptile species identified in the Wide Bay-Burnett region. Table 6 lists the wetlands-dependant reptiles that were considered in the AquaBAMM under 'Criterion 3 Diversity and richness' (3.1.3).

Table 6: Freshwater reptiles.

This list was used to generate the values for the AquaBAMM Measure (3.1.3).

Scientific name	Common name	Status	NR[1]	R[1]	Comments
Chelodina expansa	Broad-shelled River Turtle		Y	Y	
Chelodina longicollis	Eastern snake-necked Turtle		Y	Y	
Elseya albagula	Southern snapping turtle		*	Y	
Elusor macrurus	Mary River turtle	E[2,3]	*	Y	
Emydura macquarii krefftii	Krefft's river turtle		Y	Y	
Emydura macquarii macquarii	Murray turtle		Y	Y	
Emydura macquarii nigra	Fraser Island short-neck turtle		Y	Y	
Emydura macquarii macquarii	Brisbane short-necked turtle		Y	Y	No longer recognised as distinct taxon
Emydura sp.	Turtle sp.		Y	Y	
Eulamprus quoyii	Eastern water skink		Y	Y	
Hemiaspis damelii	Grey snake	E[2]	Y	Y	
Hemiaspis signata	Black-bellied swamp snake		Y	Y	
Physignathus lesueurii	Eastern water dragon		Y	Y	
Pseudechis porphyriacus	Red-bellied black snake		Y	Y	
Tropidechis carinatus	Rough-scaled snake		Y	Y	
Tropidonophis mairii	Freshwater snake		Y	Y	
Wollumbinia latisternum	Saw-shelled turtle		Y	Y	

- recent records (>1975) and records with precision <2000 m only

1. Assessment type (NR – non-riverine, R – riverine)
2. Queensland *Nature Conservation Act* 1992 (E – endangered, V – vulnerable, NT – near threatened, LC – least concern)
3. *Environment Protection and Biodiversity Conservation Act 1999* (Ex – extinct, E – endangered, V – vulnerable)

* Panel noted that this taxon is found in riverine and H2M1 wetlands (i.e. impoundments such as dams and weirs).

5.3 Waterbird richness

There were 85 non-riverine and 76 riverine native waterbird species identified in the Wide Bay-Burnett region. Table 7 lists the wetland-dependant waterbirds that were considered in the AquaBAMM under 'Criterion 3 Diversity and richness' (3.1.4). These species were expert panel derived using WildNet and Queensland Museum records. Only those species that were considered to inhabit freshwater wetland environments for part or all of their natural life functions were included (Table 7).

Table 7: Native waterbirds.

This list was used to generate the values of the AquaBAMM measure (3.1.4).

Scientific name	Common name	Status	NR[1]	R[1]	Comments
Acrocephalus australis	Australian reed-warbler		Y	Y	
Actitis hypoleucos	Common sandpiper			Y	
Amaurornis moluccana	Pale-vented bush-hen		Y	Y	
Anas castanea	Chestnut teal		Y	Y	
Anas gracilis	Grey teal		Y	Y	
Anas rhynchotis	Australasian shoveler		Y	Y	
Anas superciliosa	Pacific black duck		Y	Y	
Anhinga novaehollandiae	Australasian darter		Y	Y	
Anseranas semipalmata	Magpie goose		Y	Y	
Ardea ibis	Cattle egret		Y	Y	
Ardea intermedia	Intermediate egret		Y	Y	
Ardea modesta	Eastern great egret		Y	Y	
Ardea pacifica	White-necked heron		Y	Y	
Ardea sumatrana	Great-billed heron		Y	Y	
Aythya australis	Hardhead		Y	Y	
Biziura lobata	Musk duck			Y	
Botaurus poiciloptilus	Australasian bittern		Y	Y	
Butorides striata	Striated heron		Y	Y	Found in mangroves and can also go up rivers
Calidris acuminata	Sharp-tailed sandpiper		Y		
Calidris ferruginea	Curlew sandpiper		Y		
Calidris ruficollis	Red-necked stint		Y		
Ceyx azureus	Azure kingfisher		Y	Y	
Charadrius leschenaultii	Greater sand plover		Y		
Charadrius mongolus	Lesser sand plover		Y		
Charadrius ruficapillus	Red-capped plover			Y	
Charadrius veredus	Oriental plover		Y		Rare for south east Queensland
Chenonetta jubata	Australian wood duck		Y	Y	
Chlidonias hybrida	Whiskered tern		Y	Y	
Chlidonias leucopterus	White-winged black tern		Y	Y	
Chroicocephalus novaehollandiae	Silver gull		Y	Y	
Cyclopsitta diophthalma coxeni	Coxen's fig-parrot	E[2,3]	Y	Y	
Cygnus atratus	Black swan		Y	Y	
Dendrocygna arcuata	Wandering whistling-duck		Y	Y	
Dendrocygna eytoni	Plumed whistling-duck		Y	Y	

Scientific name	Common name	Status	NR[1]	R[1]	Comments
Egretta garzetta	Little egret		Y	Y	
Egretta novaehollandiae	White-faced heron		Y	Y	
Elseyornis melanops	Black-fronted dotterel		Y	Y	
Ephippiorhynchus asiaticus	Black-necked stork	NT[2]	Y	Y	
Erythrogonys cinctus	Red-kneed dotterel		Y	Y	
Fulica atra	Eurasian coot		Y	Y	
Gallinago hardwickii	Latham's snipe		Y	Y	
Gallinula tenebrosa	Dusky moorhen		Y	Y	
Gallirallus philippensis	Buff-banded rail		Y	Y	
Gelochelidon nilotica	Gull-billed tern		Y	Y	
Glareola maldivarum	Oriental pratincole		Y		
Grus rubicunda	Brolga		Y	Y	
Haliaeetus leucogaster	White-bellied sea-eagle		Y	Y	
Haliastur indus	Brahminy kite		Y	Y	
Himantopus himantopus	Black-winged stilt		Y	Y	
Hydroprogne caspia	Caspian tern		Y	Y	
Irediparra gallinacea	Comb-crested jacana		Y	Y	
Ixobrychus dubius	Australian little bittern		Y	Y	
Ixobrychus flavicollis	Black bittern		Y	Y	
Lewinia pectoralis	Lewin's rail	NT[2]	Y	Y	
Lichenostomus penicillatus	White-plumed honeyeater		Y	Y	In the western parts of Queensland, they occur along watercourses and are also known to nest along watercourses
Limosa limosa	Black-tailed godwit		Y	Y	
Malacorhynchus membranaceus	Pink-eared duck		Y	Y	
Megalurus gramineus	Little grassbird		Y	Y	
Microcarbo melanoleucos	Little pied cormorant		Y	Y	
Neochmia modesta	Plum-headed finch			Y	Western parts of the Burnett in drier areas and are found along creeks and rivers
Nettapus coromandelianus	Cotton pygmy-goose	NT[2]	Y		
Nettapus pulchellus	Green pygmy-goose		Y	Y	
Numenius minutus	Little curlew		Y		
Nycticorax caledonicus	Nankeen night-heron		Y	Y	
Pandion cristatus	Eastern osprey		Y	Y	
Pelecanus conspicillatus	Australian pelican		Y	Y	
Phalacrocorax carbo	Great cormorant		Y	Y	
Phalacrocorax sulcirostris	Little black cormorant		Y	Y	
Phalacrocorax varius	Pied cormorant		Y	Y	
Platalea flavipes	Yellow-billed Spoonbill		Y	Y	
Platalea regia	Royal spoonbill		Y	Y	
Plegadis falcinellus	Glossy ibis		Y	Y	
Pluvialis fulva	Pacific golden plover		Y		
Podiceps cristatus	Great crested grebe		Y	Y	

Scientific name	Common name	Status	NR[1]	R[1]	Comments
Poliocephalus poliocephalus	Hoary-headed grebe		Y	Y	
Porphyrio porphyrio	Purple swamphen		Y	Y	
Porzana fluminea	Australian spotted crake		Y	Y	
Porzana pusilla	Baillon's crake		Y	Y	
Porzana tabuensis	Spotless crake		Y	Y	
Recurvirostra novaehollandiae	Red-necked avocet		Y	Y	
Rostratula australis	Australian painted snipe	V[2,3]	Y		
Tachybaptus novaehollandiae	Australasian grebe		Y	Y	
Tadorna radjah	Radjah shelduck	NT[2]	Y	Y	
Tadorna tadornoides	Australian shelduck		Y	Y	
Threskiornis molucca	Australian white ibis		Y	Y	
Threskiornis spinicollis	Straw-necked Ibis		Y	Y	
Tringa glareola	Wood sandpiper		Y		
Tringa nebularia	Common greenshank		Y		
Tringa stagnatilis	Marsh sandpiper		Y	Y	

- recent records (>1975) and records with precision <2000 m only

1. Assessment type (NR – non-riverine, R – riverine)
2. Queensland *Nature Conservation Act* 1992 (E – endangered, V – vulnerable, NT – near threatened, LC – least concern)
3. *Environment Protection and Biodiversity Conservation Act 1999* (Ex – extinct, E – endangered, V – vulnerable)

5.4 Frog richness

There were 41 non-riverine and 25 riverine amphibian species identified within the Wide Bay-Burnett region. Table 8 lists frog species that were used in the AquaBAMM under 'Criterion 3 Diversity and richness' (3.1.1 and 3.1.6).

Table 8: Native frogs.

This list was used to generate the values of the AquaBAMM measures (3.1.1 and 3.1.6).

Scientific name	Common name	Status	NR[1]	R[1]	Comments
Adelotus brevis	Tusked frog	V[2]	Y	Y	
Crinia deserticola	Chirping froglet		Y		
Crinia parinsignifera	Beeping froglet		Y		
Crinia signifera	Clicking froglet		Y	Y	
Crinia tinnula	Wallum froglet	V[2]	Y		
Cyclorana alboguttata	Greenstripe frog		Y		
Cyclorana brevipes	Superb collared frog		Y		
Cyclorana cultripes	Grassland collared frog		Y		
Cyclorana novaehollandiae	Eastern snapping frog		Y		
Cyclorana verrucosa	Rough-collared frog	NT[2]	Y		
Limnodynastes fletcheri	Barking frog		Y	Y	
Limnodynastes peronii	Striped marshfrog		Y	Y	
Limnodynastes salmini	Salmon striped frog		Y		
Limnodynastes tasmaniensis	Spotted grassfrog		Y		
Limnodynastes terraereginae	Scarlet sided pobblebonk		Y		
Litoria brevipalmata	Green-thighed frog	NT[2]	Y		
Litoria caerulea	Common green treefrog		Y	Y	Breed in still parts of rivers
Litoria chloris	Orange eyed treefrog			Y	
Litoria cooloolensis	Cooloola sedgefrog	NT[2]	Y		
Litoria dentata	Bleating treefrog		Y		
Litoria fallax	Eastern sedgefrog		Y	Y	Can be found along rivers
Litoria freycineti	Wallum rocketfrog	V[2]	Y		
Litoria gracilenta	Graceful treefrog		Y	Y	
Litoria inermis	Bumpy rocketfrog		Y		
Litoria latopalmata	Broad palmed rocketfrog		Y	Y	
Litoria nasuta	Striped rocketfrog		Y	Y	Found on creeks
Litoria olongburensis	Wallum sedgefrog	V[2]	Y	Y	
Litoria pearsoniana	Cascade treefrog	V[2]		Y	
Litoria pearsoniana (Kroombit Tops)	Cascade treefrog (kroombit tops)	E[2]		Y	
Litoria peronii	Emerald spotted treefrog		Y	Y	
Litoria revelata	Whirring treefrog	NT[2]	Y	Y	
Litoria rothii	Northern laughing treefrog		Y	Y	
Litoria rubella	Ruddy treefrog		Y		
Litoria tyleri	Southern laughing treefrog			Y	Found along anabranches

Scientific name	Common name	Status	NR[1]	R[1]	Comments
Litoria verreauxii	Whistling treefrog		Y	Y	
Litoria wilcoxii	Eastern stony creek frog		Y	Y	
Mixophyes fasciolatus	Great barred frog		Y	Y	
Mixophyes fleayi	Fleay's barred frog	E[2]		Y	
Mixophyes iteratus	Giant barred frog	E[2]		Y	
Platyplectrum ornatum	Ornate burrowing frog		Y	Y	
Pseudophryne coriacea	Red backed broodfrog		Y		
Pseudophryne major	Great brown broodfrog		Y	Y	
Pseudophryne raveni	Copper backed broodfrog		Y		
Taudactylus pleione	Kroombit tinkerfrog	E[2]		Y	
Uperoleia capitulata	Big shouldered gungan		Y		
Uperoleia fusca	Dusky gungan		Y		
Uperoleia laevigata	Eastern gungan		Y		
Uperoleia rugosa	Chubby gungan		Y		

- recent records (>1975) and records with precision <2000 m only

1. Assessment type (NR – non-riverine, R – riverine)
2. Queensland *Nature Conservation Act 1992* (E – endangered, V – vulnerable, NT – near threatened, LC – least concern)
3. *Environment Protection and Biodiversity Conservation Act 1999* (Ex – extinct, E – endangered, V – vulnerable)

5.5 Mammal richness

There were four non-riverine and five riverine species of mammal identified in the Wide Bay-Burnett region. Table 9 lists the mammal species that was used in the AquaBAMM under 'Criterion 3 Diversity and richness' (3.1.7).

Table 9: Native mammals.

This list was used to generate the values of the AquaBAMM measure (3.1.7)

Scientific name	Common name	Status	NR[1]	R[1]	Comments
Hydromys chrysogaster	Water rat		Y	Y	
Myotis macropus	Large-footed myotis		Y	Y	
Ornithorhynchus anatinus	Platypus		Y	Y	
Pteropus poliocephalus	Grey-headed flying-fox	V[3]		Y	
Xeromys myoides	Water mouse	V[2]	Y	Y	

- recent records (>1975) and records with precision <2000 m only

1. Assessment type (NR – non-riverine, R – riverine)
2. Queensland *Nature Conservation Act* (E – endangered, V – vulnerable, NT – near threatened, LC – least concern)
3. *Environment Protection and Biodiversity Conservation Act 1999* (Ex – extinct, E – endangered, V – vulnerable)

5.6 Macroinvertebrate richness

There were 11 non-riverine and 12 riverine species of macroinvertebrates identified in the Wide Bay-Burnett region. Table 10 lists macroinvertebrate species that were used in the AquaBAMM under 'Criterion 3 Diversity and richness' (3.2.1).

Table 10: Native macroinvertebrates.

This list was used to generate the values of the AquaBAMM measure (3.2.1)

Scientific name	Common name	Status	NR[1]	R[1]	Comments
Argyreus hyperbius inconstans	Australian fritillary	E[2]	Y		
Caridina indistincta	Freshwater shrimp		Y	Y	
Cherax dispar	Lobby		Y	Y	
Cherax punctatus	Land yabby		Y	Y	
Cherax robustus	Sand yabby		Y		Found on Fraser and Cooloola
Euastacus hystricosus	Giant spiny crayfish			Y	
Euastacus monteithorum	Freshwater crayfish			Y	
Euastacus sp.	Freshwater crayfish sp.			Y	
Euastacus urospinosus	Rainforest crayfish			Y	
Macrobrachium australiense	Common Australian river prawn		Y	Y	
Macrobrachium novaehollandiae	New holland river prawn		Y	Y	
Nesolycaena albosericea	Satin opal		Y	Y	Found on *Boronia rivularis*
Ornithoptera richmondia	Richmond birdwing butterfly	V[2]	Y	Y	
Petalura litorea	Coastal petaltail		Y		Wetland dependent for larval stage
Phyllodes imperialis (southern subspecies)	Pink underwing moth	E[3]		Y	
Tenuibranchiurus glypticus	Swamp crayfish		Y		

- recent records (>1975) and records with precision <2000 m only

1. Assessment type (NR – non-riverine, R – riverine)
2. Queensland *Nature Conservation Act 1992* (E – endangered, V – vulnerable, NT – near threatened, LC – least concern)
3. *Environment Protection and Biodiversity Conservation Act 1999* (Ex – extinct, E – endangered, V – vulnerable)

6 Exotic fauna

Four bird, one amphibian, 12 fish, one macroinvertebrate and seven mammal species were nominated by the panel (Table 11) as being exotic wetland fauna in the Wide Bay-Burnett region. The presence of aquatic exotic fauna species was recorded under 'Criterion 1 Naturalness aquatic' (1.1.1, 1.1.3, 1.1.4).

Where there had been broadscale mapping of exotic fauna undertaken by the Department of Employment, Economic Development and Innovation (DEEDI), the panel decided to utilise this mapping rather than relying on species records. The DEEDI mapping technique comprised of assigning species presence/absence on a 16.67 km^2 statewide grid based on records and expert review. Not all exotic fauna species were modelled by DEEDI. Those that were modelled are identified in the model column in Table 11.

Table 11: Alien fauna species.

This list was used to generate the values of the AquaBAMM measure (1.1.1, 1.1.3, 1.1.4)

Scientific name	Common name	NR[1]	R[1]	Model[2]	Measure[3]	Comments
Anas platyrhynchos	Northern mallard	Y			1.1.4	There are hybrids with Pacific black ducks. They can be a serious threat to common native ducks (e.g. New Zealand grey duck (*Anas superciliosa)*)
Bidyanus bidyanus	Silver perch	Y	Y		1.1.1	Translocated native species
Bos spp.	Cattle spp.	Y	Y		1.1.4	They tend to stay localised, eat vegetation and trample, causing degradation to wetlands and nutrifrication of water through defecation
Cacatua sanguinea	Little corella	Y	Y		1.1.4	Roost and nest in riverine trees displacing native species of birds. Big populations (300+) occur around Kondari and Hervey Bay.
Canis familiaris	Dog	Y	Y	Y	1.1.4	
Carassius auratus	Goldfish	Y	Y		1.1.1	
Cervus elaphus	Red deer	Y	Y	Y	1.1.4	Eat vegetation, trample and strip bark off plants causing degradation to wetlands
Cherax quadricarinatus	Redclaw crayfish	Y	Y		1.1.3	The dams have heaps of these present. As the Redclaw aquaculture industry is established now, there are incidental releases across the state.
Felis catus	Cat	Y	Y	Y	1.1.4	Feral cats occur everywhere in Wide Bay-Burnett. Their numbers are increasing on Fraser Island.
Gambusia holbrooki	Eastern gambusia	Y	Y		1.1.1	
Hephaestus fuliginosus	Sooty grunter	Y	Y		1.1.1	Translocated native species. Records for Mary River above the barrage.
Macquaria ambigua	Yellowbelly	Y	Y		1.1.1	Translocated native species
Oreochromis mossambicus	Mozambique tilapia	Y	Y		1.1.1	

Scientific name	Common name	NR[1]	R[1]	Model[2]	Measure[3]	Comments
Oryctolagus cuniculus	Rabbit	Y	Y	Y	1.1.4	
Oxyeleotris lineolata	Sleepy cod	Y	Y		1.1.1	Translocated native species.
Poecilia latipinna	Sailfin molly		Y		1.1.1	
Poecilia reticulatus	Guppy		Y		1.1.1	
Rhinella marina	Cane toad	Y	Y	Y	1.1.4	
Scleropages leichardti	Southern saratoga	Y	Y		1.1.1	Translocated native species
Sturnus tristis	Common myna	Y	Y		1.1.4	Increasing in numbers rapidly and will use riparian trees for nesting. Emerging threat to native species.
Sturnus vulgaris	Common starling	Y			1.1.4	Form massive aggregations and roost in reeds during winter
Sus scrofa	Pig	Y	Y	Y	1.1.4	
Vulpes vulpes	Fox	Y	Y	Y	1.1.4	
Xiphophorus helleri	Swordtail		Y		1.1.1	
Xiphophorus maculatus	Platy		Y		1.1.1	

- recent records (>1975) and records with precision <2000 m only

[1] Assessment type (NR – non-riverine, R – riverine)

[2] Department of Employment, Economic Development and Innovation (DEEDI) model

[3] Measure to which the species was attributed (1.1.1 - Presence of 'alien' fish species within the wetland; 1.1.3 – Presence of exotic invertebrate fauna within the wetland and 1.1.4 – Presence of feral/exotic vertebrate fauna (other than fish) within the wetland

7 Special features

The panel identified several non-riverine and riverine special features in the Wide Bay-Burnett region (Table 12). These were identified for their aquatic fauna values. Where special features nominated by the aquatic fauna expert panel were also considered to have additional values (e.g. flora, ecology) by the aquatic flora or wetland ecology expert panels, the special area was implemented as a wetland ecology special feature.

Each spatial unit that intersected with a particular ecosystem or feature in TTable 12 was given a score equal to the conservation rating. Decisions are listed alphabetically by catchment. These features were intersected with the spatial units to identify the values for 'Criterion 6 Special features'. All implemented special features were given a conservation rating of between one and four assigned by the panel. Decisions that were not able to be implemented due to a lack of readily available data or unconfirmed values, are indicated with _not_implemented in the decision implementation number column.

Table 12: Identified special features and their values.

Special feature	Values	Catchment	Decision implementation number	Criteria/indicator/ measure	Conservation rating (1-4)
NON-RIVERINE					
Roosting sites	Shorebird roosting sites in south of Fraser Island (Hook Point). Note: This special feature was not implemented because the available data only identified estuarine or artificial waterbodies and did not identify any natural (i.e. H1) wetlands. This decision was also not implemented as a riverine decision (all_r_fa_01_not_implemented).	All coastal study areas	all_nr_fa_01_not_implemented	5.1.4	4
Artesian springs	3 Artesian springs complexes (Abercorn, Ceratodus, Spring Grove) between Mundubbera and Monto and two other complexes along Barambah Creek. Threatened species dependent on springs are listed on DERM Wetland*Info (*DERM 2005) and documented in Fensham *et al.* 2004 and Fensham and Fairfax 2004. Spring Grove is the most important complex. Also includes significant flora values, particularly Ban Ban Springs which is currently in poor condition/dry.	Burnett	bu_nr_fa_01	6.3.1	4

Special feature	Values	Catchment	Decision implementation number	Criteria/indicator/ measure	Conservation rating (1-4)
Barakula black soil habitats	Black soil wetlands (e.g. gilgais) occurring within the northern part of Barakula State Forest are important for brigalow belt frog species (e.g. *Cyclorana spp.)*, burrowing black cracking clay soil frogs, grey snake (*Hemiaspis damelii*) habitat and waterfowl habitat/refuge. They occur within regional ecosystems 11.4.3 and 11.9.5 brigalow. Note: This decision also applies as a riverine decision (decision number bu_r_fa_02).	Burnett	bu_nr_fa_02	6.3.1	3
Wattle Camp wetland	This wetland is important for migratory birds. Some species such as duck species; white-necked heron (*Ardea pacifica*); white-faced heron (*Egretta novaehollandiae*); spoonbills; Australian pelican (*Pelecanus conspicillatus*) and the black swan (*Cygnus atratus*) are known to nest and breed at this wetland. The wetland is some what degraded and there are no significant flora values. It forms part of a flood plain system that meets just south of the dam. Note: This decision is related to a riverine ecology decision (decision number bu_r_ec_01).	Burnett	bu_nr_fa_03	5.1.4, 6.3.1	2, 2
Wongi waterholes	These waterholes are within Wongi State Forest in the upper Burrum River above Lenthall's Dam. This series of very stable, deep pools has been persistent over thousands of years. It contains unique geomorphological features and aquatic fauna including honey blue eyes (*Pseudomugil mellis*) and the southern purplespotted gudgeon (*Mogurnda adspersa*) (QPWS 2010 unpublished). The area also has high Indigenous cultural heritage values including a women's site, and is one of the regionally prioritised wetlands by the Burnett-Mary Regional Group.	Burrum	bm_nr_fa_01	6.1.1, 6.3.1	4, 4

Special feature	Values	Catchment	Decision implementation number	Criteria/indicator/ measure	Conservation rating (1-4)
Flying fox camps	The aquatic fauna expert panel convened for the Burnett ACA (conducted in 2006) considered flying fox camps to be a significant breeding or roosting phenomenon. The black flying-fox (*Pteropus alecto*), little red flying-fox (*Pteropus scapulatus*) and the 'vulnerable' grey headed flying fox (*Pteropus poliocephalus)* are known to make camp in the Burnett River catchment. The majority of camps for these species are located along watercourses. It is thought that the riparian zone is favoured because of the higher humidity levels than the surrounding terrestrial areas and because the flying foxes may use the streams for navigation. Wherever permanent and temporary camps occur, the riparian zone vegetation should be identified as special habitat. The panel noted that some roosts occurred within non-riverine wetlands. Note: This decision was taken from the previous Burnett River ACA (decision number afep_burn_7). It has been applied as a non riverine decision in all the other catchments (cc_nr_fa_04; my_nr_fa_02) and as a riverine decision in all catchments (bu_r_fa_07; bm_r_fa_04; cc_r_fa_01; fr_r_fa_02; ko_r_fa_01; my_r_fa_09) within the Wide Bay-Burnett study area.	Burrum	bm_nr_fa_02	6.3.1	4
Patterned fens wetlands	Patterned Fens on the mainland. These fens have the same values as those on Fraser Island (fr_nr_fa_01). Note: This decision also applies as a non-riverine decision (decision number fr_nr_fa_01) and as a riverine decision in the Fraser Island catchment (decision number fr_r_fa_01).	Cooloola Coast	cc_nr_fa_01	6.3.1	4
Perched lakes	40 % of the world's perched lakes occur on Fraser Island and Cooloola. Their water quality is documented (Hadwen 2002). *Archidendron lovelliae* is present at these lakes.	Cooloola Coast	cc_nr_fa_02	6.3.1	4
Poona National Park	Poona National Park is the only remaining location on the mainland known to contain the acid-tolerant crayfish, the Sand yabby (*Cherax robustus)*.	Cooloola Coast	cc_nr_fa_03	6.3.1	3

Special feature	Values	Catchment	Decision implementation number	Criteria/indicator/ measure	Conservation rating (1-4)
Flying fox camps	The aquatic fauna expert panel convened for the Burnett ACA (conducted in 2006) considered flying fox camps to be a significant breeding or roosting phenomenon. The black flying-fox (*Pteropus alecto*), little red flying-fox (*Pteropus scapulatus*) and the 'vulnerable' grey headed flying fox (*Pteropus poliocephalus)* are known to make camp in the Burnett River catchment. The majority of camps for these species are located along watercourses. It is thought that the riparian zone is favoured because of the higher humidity levels than the surrounding terrestrial areas and because the flying foxes may use the streams for navigation. Wherever permanent and temporary camps occur, the riparian zone vegetation should be identified as special habitat. The panel noted that some roosts occurred within non-riverine wetlands. Note: This decision was taken from the previous Burnett River ACA (decision number afep_burn_7). It has been applied as a non riverine decision in all the other catchments (bm_nr_fa_02; my_nr_fa_02) and as a riverine decision in all catchments (bu_r_fa_07; bm_r_fa_04; cc_r_fa_01; fr_r_fa_02; ko_r_fa_01; my_r_fa_09) within the Wide Bay-Burnett study area.	Cooloola Coast	cc_nr_fa_04	6.3.1	4
Patterned fens wetlands	This area of patterned fen wetlands occur along the western side of Fraser Island. They are globally unique as these are the only sub-tropical patterned fens and the only fens flowing into tidal wetlands in the world. They are the only fens with an acid-tolerant invertebrate fauna, notably rare endemic acid-tolerant earthworms; and the sand yabby (*Cherax robustus* – an acid tolerant crayfish, found in the running streams within the fens). This crayfish has disappeared from mainland habitats and is now restricted to Fraser Island. Vertebrate fauna in the fens include: honey blue-eye (*Pseudomugil mellis*) (found in the fens proper within acid ponds); oxleyan pygmy perch (*Nannoperca oxleyana*) (found in the running streams in the fens); shrimps, acid frogs (*Crinia tinnula, Litoria freycineti, Litoria olongburensis* and *Litoria cooloolensis*), water mouse (*Xeromys myoides*) ground parrot (*Pezoporus wallicus*) and Lewin's Rail (*Lewinia pectoralis*). The flora panel commented on the limited floristic surveys of the fens. This special feature was also nominated as an ecology decision and additional ecological values include: unique hydrology in terms of the soils including unusual conditions, chemistry and representation. Note: This decision also applies as a riverine decision (decision number fr_r_fa_01) and as a non-riverine decision in the Cooloola Coast catchment (decision number cc_nr_fa_01).	Fraser Island	fr_nr_fa_01	6.3.1, 6.3.3	4, 4

Special feature	Values	Catchment	Decision implementation number	Criteria/indicator/ measure	Conservation rating (1-4)
Lake Wabby	Lake Wabby is one of the few lakes on Fraser Island with the good presence and diversity of fish (11 species). A record of blue catfish (*Neoarius graeffei*) is unusual because the lake is cut off from the sea. Acid frogs are also present.	Fraser Island	fr_nr_fa_02	6.3.1	3
Moore Park coastal wetlands	Significant coastal wetlands occurring as swales and lakes within parallel dunal systems. Lowland rainforest in the area provides possible Coxen's fig parrot (*Cyclopsitta diophthalma coxeni*) habitat. Parts of this area is subject to tidal influence and vegetation is in good condition. Broad vegetation types include melaleuca wetlands, littoral rainforest and eucalypt/rainforest mix. Wetlands include *Melaleuca quinquenervia* /*Livistonia decipiens*, fringing Casuarinas and rushes/sedges (WBBCC 2001 inventory 38,39A,B and C) Note: This area contains similar values to a decision from the ecology report that was not implemented (cc_nr_ec_02_not_implemeted).	Kolan	ko_nr_fa_01	6.3.1	3
Scientific lagoons	Wallum frogs have been recorded in this area including *Litoria lesueuri, Litoria fallax, Litoria freycineti* and *Adelotus brevis*. Native fish species known to be present include *Hypseleotris galii, Hypseleotris klunzingeri, Craterocephalus stercusmuscarum fulvus* and*, Melanotaenia duboulayi.* The area is also high in invertebrate diversity: notably 21 butterflies, 2 moths, 3 dragonflies, 3 damselflies, 2 beetles and 4 crustaceans. 6 wetland bird species have also been recorded. Exotic species such as cane toads (*Rhinella marina*) and eastern gambusia (*Gambusia holbrooki*) are also present.	Mary	my_nr_fa_01	6.3.1	3

Special feature	Values	Catchment	Decision implementation number	Criteria/indicator/ measure	Conservation rating (1-4)
Flying fox camps	The aquatic fauna expert panel convened for the Burnett ACA (conducted in 2006) considered flying fox camps to be a significant breeding or roosting phenomenon. The black flying-fox (*Pteropus alecto*), little red flying-fox (*Pteropus scapulatus*) and the 'vulnerable' grey headed flying fox (*Pteropus poliocephalus)* are known to make camp in the Burnett River catchment. The majority of camps for these species are located along watercourses. It is thought that the riparian zone is favoured because of the higher humidity levels than the surrounding terrestrial areas and because the flying foxes may use the streams for navigation. Wherever permanent and temporary camps occur, the riparian zone vegetation should be identified as special habitat. The panel noted that some roosts occurred within non-riverine wetlands. Note: This decision was taken from the previous Burnett River ACA (decision number afep_burn_7). It has been applied as a non-riverine decision in all the other catchments (bm_nr_fa_02; cc_nr_fa_04) and as a riverine decision in all catchments (bu_r_fa_07; bm_r_fa_04; cc_r_fa_01; fr_r_fa_02; ko_r_fa_01; my_r_fa_09) within the Wide Bay-Burnett study area.	Mary	my_nr_fa_02	6.3.1	4
RIVERINE					
Roosting sites	Shorebird roosting sites in south of Fraser Island (Hook Point). Note: This special feature was not implemented because the available data only identified estuarine or artificial waterbodies and did not identify any natural (i.e. H1) wetlands. This decision was also not implemented as a non-riverine decision (all_nr_fa_01_not_implemented).	All coastal study areas	all_r_fa_01_not_implemented	5.1.4	4
Ben Anderson Barrage	Large numbers of female southern snapping turtle (*Elseya albagula*) nest in the upper impoundment of Ben Anderson Barrage. This is a significant nesting area for the species. Note: This decision also applies as an ecology decision (decision number bu_r_ec_09).	Burnett	bu_r_fa_01	6.3.1	4

Special feature	Values	Catchment	Decision implementation number	Criteria/indicator/ measure	Conservation rating (1-4)
Barakula black soil habitats	Black soil wetlands (e.g. gilgais) occurring within the northern part of Barakula State Forest are important for brigalow belt frog species (e.g. *Cyclorana spp.)*, burrowing black cracking clay soil frogs, grey snake (*Hemiaspis damelii*) habitat and waterfowl habitat/refuge. They occur within regional ecosystems 11.4.3 and 11.9.5 brigalow. Note: This decision also applies as a riverine decision (decision number bu_r_fa_02).	Burnett	bu_r_fa_02	6.3.1	3
Grays waterhole	Grays waterhole is known to be important for lungfish because it is a deep, permanent waterhole. Very old lungfish have been recorded from this waterhole. This waterhole is also the upper reach of nesting habitat for the southern snapping turtle (*Elseya albagula*). The area identified is downstream of Gayndah, at the upper limit of Paradise Dam. Note: This decision was taken from the previous Burnett River ACA (decision number afep_burn_1).	Burnett	bu_r_fa_03	6.3.1	3
Walla Weir impoundment	An artificial impoundment known to be important for waterfowl and water raptors. However the quality of the habitat is deteriorating over time (e.g., dead trees falling into water). Note: This decision was taken from the previous Burnett River ACA (decision number afep_burn_2).	Burnett	bu_r_fa_04	5.1.4	2
Kroombit Tops headwater streams	Kroombit Tops has narrow strips of riverine aquatic habitat where three endemic species occur—spiny crayfish (*Euastacus monteithorum*), and frogs species (*Litoria pearsoniana)* and *(Taudactylus pleione*). This habitat is also home to a number of unique aquatic invertebrates. Note: This decision was taken from the previous Burnett River ACA (decision number afep_burn_3).	Burnett	bu_r_fa_05	6.3.1	4
Bunya Mountains headwater streams	The unique vegetation in combination with the high altitude of the Bunya Mountains has resulted in a distinct habitat for montane frog species and for some aquatic invertebrates. Note: This decision was taken from the previous Burnett River ACA (decision number afep_burn_6).	Burnett	bu_r_fa_06	6.3.1	4

Special feature	Values	Catchment	Decision implementation number	Criteria/indicator/ measure	Conservation rating (1-4)
Flying fox camps	The aquatic fauna expert panel convened for the Burnett ACA (conducted in 2006) considered flying fox camps to be a significant breeding or roosting phenomenon. The black flying-fox (*Pteropus alecto*), little red flying-fox (*Pteropus scapulatus*) and the 'vulnerable' grey headed flying fox (*Pteropus poliocephalus)* are known to make camp in the Burnett River catchment. The majority of camps for these species are located along watercourses. It is thought that the riparian zone is favoured because of the higher humidity levels than the surrounding terrestrial areas and because the flying foxes may use the streams for navigation. Wherever permanent and temporary camps occur, the riparian zone vegetation should be identified as special habitat. The panel noted that some roosts occurred within non-riverine wetlands. Note: This decision was taken from the previous Burnett River ACA (decision number afep_burn_7). It has been applied as a riverine decision in all the other catchments (bm_r_fa_04; cc_r_fa_01; fr_r_fa_02; ko_r_fa_01; my_r_fa_09) and as a non-riverine decision in other catchments (bm_nr_fa_02; ko_nr_fa_02; my_nr_fa_02) within the Wide Bay-Burnett study area.	Burnett	bu_r_fa_07	6.3.1	4
Splitters Creek	Splitters creek is the only stream that is still open and connected with estuarine areas in the Burnett River. It is an area for barramundi (*Lates calcarifer*) nursery area and possible refuge for the Australian lungfish (*Neoceratodus forsteri*). Fish barrier restoration is occurring here. The area has a reasonably undisturbed riparian area, big storage areas and nice tributaries. Note: This decision also applies as a ecology decision (decision number bu_r_ec_03).	Burnett	bu_r_fa_08	6.3.1, 7.5.1	3, 3
Flowing streams between impoundments	The remaining fish diversity and the majority of the *Elseya sp*. and the Australian lungfish (*Neoceratodus forsteri*) populations will be retained in these flowing river sections in the future. Note: This decision was taken from the previous Burnett River ACA (decision number afep_burn_5).	Burnett	bu_r_fa_09	6.3.1	4
Elliott River	The Elliott River has unique hydrology because the majority of its base flow is sourced from groundwater and is assumed to provide important habitat for faunal communities. The surface water-groundwater connectivity of the Elliott has been found to have a connection between perennial waterholes and groundwater levels of the Elliott Aquifer.	Burrum	bm_r_fa_01	6.3.1, 6.4.1	4, 4

Special feature	Values	Catchment	Decision implementation number	Criteria/indicator/ measure	Conservation rating (1-4)
Doongul Creek	Doongul Creek above Lenthalls Dam was identified as providing important frog habitat, notably being the northern range limit of the giant barred frog (*Mixophyes iterates*).	Burrum	bm_r_fa_02	6.3.1	4
Elliott River estuarine connectivity	The Elliot River was nominated by the fauna panel for its near intact connectivity between estuarine and freshwater systems, a connection that is important for diadromous fish migration. A subsequent review by the wetland ecology panel considered that the area of interest was closer to the river mouth, noting the ecology values ~50 % of the water inflow is from ground water, providing for the persistence of the water holes (see bm_r_fa_01 above). Note: This decision also applies as a ecology decision (decision number bm_r_ec_01).	Burrum	bm_r_fa_03	7.5.1, 6.4.1	4, 4
Flying fox camps	The aquatic fauna expert panel convened for the Burnett ACA (conducted in 2006) considered flying fox camps to be a significant breeding or roosting phenomenon. The black flying-fox (*Pteropus alecto*), little red flying-fox (*Pteropus scapulatus*) and the 'vulnerable' grey headed flying fox (*Pteropus poliocephalus)* are known to make camp in the Burnett River catchment. The majority of camps for these species are located along watercourses. It is thought that the riparian zone is favoured because of the higher humidity levels than the surrounding terrestrial areas and because the flying foxes may use the streams for navigation. Wherever permanent and temporary camps occur, the riparian zone vegetation should be identified as special habitat. The panel noted that some roosts occurred within non-riverine wetlands. Note: This decision was taken from the previous Burnett River ACA (decision number afep_burn_7). It has been applied as a riverine decision in all the other catchments (bu_r_fa_07; cc_r_fa_01; fr_r_fa_02; ko_r_fa_01; my_r_fa_09) and as a non-riverine decision in other catchments (bm_nr_fa_02; ko_nr_fa_02; my_nr_fa_02) within the Wide Bay-Burnett study area.	Burrum	bm_r_fa_04	6.3.1	4

Special feature	Values	Catchment	Decision implementation number	Criteria/indicator/ measure	Conservation rating (1-4)
Flying fox camps	The aquatic fauna expert panel convened for the Burnett ACA (conducted in 2006) considered flying fox camps to be a significant breeding or roosting phenomenon. The black flying-fox (*Pteropus alecto*), little red flying-fox (*Pteropus scapulatus*) and the 'vulnerable' grey headed flying fox (*Pteropus poliocephalus)* are known to make camp in the Burnett River catchment. The majority of camps for these species are located along watercourses. It is thought that the riparian zone is favoured because of the higher humidity levels than the surrounding terrestrial areas and because the flying foxes may use the streams for navigation. Wherever permanent and temporary camps occur, the riparian zone vegetation should be identified as special habitat. The panel noted that some roosts occurred within non-riverine wetlands. Note: This decision was taken from the previous Burnett River ACA (decision number afep_burn_7). It has been applied as a riverine decision in all the other catchments (bu_r_fa_07; bm_r_fa_04; fr_r_fa_02; ko_r_fa_01; my_r_fa_09) and as a non-riverine decision in other catchments (bm_nr_fa_02; ko_nr_fa_02; my_nr_fa_02) within the Wide Bay-Burnett study area.	Cooloola Coast	cc_r_fa_01	6.3.1	4
Patterned fens wetlands	This area of patterned fen wetlands occurs along the western side of Fraser Island. They are globally unique as these are the only sub-tropical patterned fens and the only fens flowing into tidal wetlands in the world. They are the only fens with an acid-tolerant invertebrate fauna, notably rare endemic acid-tolerant earthworms; and the sand yabby (*Cherax robustus)*, an acid tolerant crayfish, found in the running streams within the fens. This crayfish has disappeared from mainland habitats and is now restricted to Fraser Island. Vertebrate fauna in the fens include: honey blue-eye (*Pseudomugil mellis*) (found in the fens proper within acid ponds); oxleyan pygmy perch (*Nannoperca oxleyana*) (found in the running streams in the fens); shrimps, acid frogs (*Crinia tinnula, Litoria freycineti, Litoria olongburensis* and *Litoria cooloolensis*), water mouse (*Xeromys myoides*) ground parrot (*Pezoporus wallicus*) and Lewin's Rail (*Lewinia pectoralis*). The flora panel commented on the limited floristic surveys of the fens. This special feature was also nominated as an ecology decision and additional ecological values include: unique hydrology in terms of the soils including unusual conditions, chemistry and representation. Note: This decision also applies as a non-riverine decision (decision number fr_nr_fa_01) and as a non-riverine decision in the Cooloola Coast catchment (decision number cc_nr_fa_01).	Fraser Island	fr_r_fa_01	6.3.1	4

Special feature	Values	Catchment	Decision implementation number	Criteria/indicator/ measure	Conservation rating (1-4)
Flying fox camps	The aquatic fauna expert panel convened for the Burnett ACA (conducted in 2006) considered flying fox camps to be a significant breeding or roosting phenomenon. The black flying-fox (*Pteropus alecto*), little red flying-fox (*Pteropus scapulatus*) and the 'vulnerable' grey headed flying fox (*Pteropus poliocephalus)* are known to make camp in the Burnett River catchment. The majority of camps for these species are located along watercourses. It is thought that the riparian zone is favoured because of the higher humidity levels than the surrounding terrestrial areas and because the flying foxes may use the streams for navigation. Wherever permanent and temporary camps occur, the riparian zone vegetation should be identified as special habitat. The panel noted that some roosts occurred within non-riverine wetlands. Note: This decision was taken from the previous Burnett River ACA (decision number afep_burn_7). It has been applied as a riverine decision in all the other catchments (bu_r_fa_07; bm_r_fa_04; cc_r_fa_01; ko_r_fa_01; my_r_fa_09) and as a non-riverine decision in other catchments (bm_nr_fa_02; ko_nr_fa_02; my_nr_fa_02) within the Wide Bay-Burnett study area.	Fraser Island	fr_r_fa_02	6.3.1	4
Flying fox camps	The aquatic fauna expert panel convened for the Burnett ACA (conducted in 2006) considered flying fox camps to be a significant breeding or roosting phenomenon. The black flying-fox (*Pteropus alecto*), little red flying-fox (*Pteropus scapulatus*) and the 'vulnerable' grey headed flying fox (*Pteropus poliocephalus)* are known to make camp in the Burnett River catchment. The majority of camps for these species are located along watercourses. It is thought that the riparian zone is favoured because of the higher humidity levels than the surrounding terrestrial areas and because the flying foxes may use the streams for navigation. Wherever permanent and temporary camps occur, the riparian zone vegetation should be identified as special habitat. The panel noted that some roosts occurred within non-riverine wetlands. Note: This decision was taken from the previous Burnett River ACA (decision number afep_burn_7). It has been applied as a riverine decision in all the other catchments (bu_r_fa_07; bm_r_fa_04; cc_r_fa_01; fr_r_fa_02; my_r_fa_09) and as a non-riverine decision in other catchments (bm_nr_fa_02; ko_nr_fa_02; my_nr_fa_02) within the Wide Bay-Burnett study area.	Kolan	ko_r_fa_01	6.3.1	4

Special feature	Values	Catchment	Decision implementation number	Criteria/indicator/ measure	Conservation rating (1-4)
Reaches associated with Conondale National Park	This special feature covers the stream sections associated with the lower reach of Little Yabba Creek within Conondale National Park. Fauna values include the presence of crayfish, threatened frog species, Coxen's fig parrot (*Cyclopsitta diophthalma coxeni*) and Richmond birdwing butterfly (*Ornithoptera richmondii*).	Mary	my_r_fa_01	6.3.1	4
Maleny plateau above Baroon Pocket Dam	This area is a basalt red soil plateau, the most extensive one within the Mary catchment and is unique in fluvial-geomorphic terms. As such it is considered an important groundwater recharge area which provides flow to the western upper Mary, as it has a high rainfall of around 1800 mm per annum. Existing rainforest riparian vegetation remains in places (e.g. (i) some intact rainforest drainage lines are mapped as regional ecosystem 12.3.1 between Baroon Pocket Dam and Maleny; and (ii) Mary Cairncross Park rainforest drainage lines with palm wetlands, representative of the former more extensive palm forest wetlands are thought to have occurred across the plateau before clearing). Remaining biodiversity values include: - giant spiny crayfish (*Euastacus hystricosus*); and also the pink underwing moth (*Phyllodes imperialis*) and the Richmond birdwing butterfly (*Ornithoptera richmondia*) which both utilise riparian rainforest habitat. Historically it is extensively cleared, but prior to clearing it could have been a chain-of-ponds system. Weed infestation is now an issue. Note: This decision is related to my_r_fa_10.	Mary	my_r_fa_02	6.3.1	3

Special feature	Values	Catchment	Decision implementation number	Criteria/indicator/ measure	Conservation rating (1-4)
Tinana and Coondoo Creeks	Tinana and Coondoo Creeks contain important self-sustaining Mary River cod (*Maccullochella peelii mariensis*) populations. It is the only area now containing wild stocks. These creeks support fish species including ornate rainbow *(Rhadinocentrus ornatus),* honey blue eye (*Pseudomugil mellis*) and oxleyan pygmy perch (*Nannoperca oxleyana*). Frog species include the giant barred frog (*Mixophyes iterates*) and wallum frogs. The flora panel commented on the significant macrophyte beds of these tributaries. It is also the centre of *Quassia bidwillii* distribution. This area was originally nominated by fauna panel but was considered to have multiple values. The wetland ecology panel agreed that this should also be an ecology decision, observing that Tinana and Coondoo Creeks are more of a complete functioning system with reasonable riparian buffers. These are scheduled as High Ecological Value (HEV) waters: Upstream of the impoundments has good water quality and streams are characterised by low pH levels. Note: This decision also applies as a ecology decision (decision number my_r_ec_06).	Mary	my_r_fa_03	6.3.1, 6.4.1	4, 4
Belli Creek	Belli Creek is a deep pool alluvial system which remains relatively intact and is one of the few well-connected reaches in the Mary River. It has a high frog species diversity including threatened frog species such as the giant barred frog (*Mixophyes iterates*), the cascade treefrog (*Litoria pearsoniana*) and the tusked frog (*Adelotus brevis*); the Richmond birdwing butterfly (*Ornithoptera richmondii*); natural records of Mary River cod (*Maccullochella peelii mariensis*) and good cod habitat with deep pools and riffles. The area contains riparian rainforest vegetation (regional ecosystem 12.3.1) and includes threatened plant species.	Mary	my_r_fa_04	6.3.1	3

Special feature	Values	Catchment	Decision implementation number	Criteria/indicator/ measure	Conservation rating (1-4)
Six Mile Creek	This tributary of the Mary was recognised within the Mary Water Resource Plan especially for its values as Mary River cod (*Maccullochella peelii mariensis*) habitat and one of three known significant cod breeding populations (as per Mary River Cod Recovery Plan). This species requires deep pools with in-stream large woody debris (e.g. logs) as well as canopy closure to reduce noise and provide stream shading. All values are linked back to the riparian vegetation. This means that if there is no vegetation it is of no habitat value for the species. Six Mile Creek is an unusual alluvial system in that it is a sandy stream without gravel riffles which are formed by large woody debris and exhibits all the above features. Riparian vegetation in this area has been mapped at a finer scale appropriate to identify habitat. Six Mile Creek has good connectivity, despite being impounded in its upper reach. Its water quality is statistically different from other tributaries of the Mary due to its significantly lower pH. In addition to the Mary River cod, other notable fauna species include threatened frog species such as the giant barred frog (*Mixophyes iterates*) and the tusked frog (*Adelotus brevis*); the Australian lungfish (*Neoceratodus forsteri*) and honey blue eye (*Pseudomugil mellis*). The panel indicated this decision should also include the rock pools and streams of Mothar Mountain, which is the northern limit of the cascade treefrog (*Litoria pearsoniana*) south of Kroombit. The wetland ecology panel also recommended extending this area to include Dingo, Coomber, Sandy and Boulder creeks which have slightly different ecological values including remnant lowland rainforest, tall messmate and significant cultural values. However, following further consideration, this decision remained as a fauna panel decision.	Mary	my_r_fa_05	6.3.1	4
Mary River turtle nesting sites	Significant Mary River turtle (*Elusor macrurus*) nesting sites, from Emery's Bridge to upstream of the Mary River barrage ponded reach	Mary	my_r_fa_06	6.3.1	4

Special feature	Values	Catchment	Decision implementation number	Criteria/indicator/ measure	Conservation rating (1-4)
Pools, riffles and sand bars	Pool, riffle and sand bar sequences commence above the upper end of the Mary barrage impoundment, but also occur upstream chiefly along the main trunk of the Mary River. Pool, riffle and sand bar sequence ecosystems has been nominated as an endangered ecosystem under the *Environmental Protection and Biodiversity Conservation Act 1999*, for its geomorphological values, transient, dynamic nature and diversity of special ecological processes. Fauna utilising these sequences include the Mary River Cod (*Maccullochella peelii mariensis*) (pools), Mary River Turtle (*Elusor macrurus*) (pool, riffles and sandbar) and the Australian lungfish (*Neoceratodus forsteri*). The wetland ecology panel recommended that known locations be captured by selecting: (i) nine deep pools monitored by the DERM Aquatic Ecosystems group; and (ii) areas within the lowland reaches of the main branch of the Mary, where pool/riffle/sand bars ecosystems have been previously identified by DERM during the identification of High Ecological Value areas in 2004. The Mary River turtle (*Elusor macrurus*) is dependent on pools for adult habitat, riffles for juvenile habitat associated with their macroinvertebrate diet, and sand bars for nesting habitat (Flakus and Connell 2008). There was some discussion during the wetland ecology panel that sequences of pools, riffles and sand bars can apply to the whole catchment and this is a representative example of the values. This area was originally nominated by the fauna panel and was reviewed and endorsed by the wetland ecology panel as both an ecology and fauna decision. The wetland ecology panel also noted that these ecosystems are on the current federal priority list. Note: This decision also applies as a ecology decision (decision number my_r_ec_02).	Mary	my_r_fa_07	6.3.1, 6.2.1	4, 4
Large old fig trees	The fig species (*Ficus racemosa)* occurs at its range limit in this area, and is a food tree for the southern snapping turtle (*Elseya albagula*), the grey headed flying fox (*Pteropus poliocephalus*), Coxen's fig parrot (*Cyclopsitta diophthalma coxeni*) and the Australian lungfish (*Neoceratodus forsteri*). Note: This decision was not implemented in the WBB ACA because a review by the flora panel indicated that the species was not considered a flora specific value because the species is actually becoming invasive on the Cooloola coast.	Mary	my_r_fa_08_not_implemented	6.3.1	3

Special feature	Values	Catchment	Decision implementation number	Criteria/indicator/ measure	Conservation rating (1-4)
Flying fox camps	The aquatic fauna expert panel convened for the Burnett ACA (conducted in 2006) considered flying fox camps to be a significant breeding or roosting phenomenon. The black flying-fox (*Pteropus alecto*), little red flying-fox (*Pteropus scapulatus*) and the 'vulnerable' grey headed flying fox (*Pteropus poliocephalus)* are known to make camp in the Burnett River catchment. The majority of camps for these species are located along watercourses. It is thought that the riparian zone is favoured because of the higher humidity levels than the surrounding terrestrial areas and because the flying foxes may use the streams for navigation. Wherever permanent and temporary camps occur, the riparian zone vegetation should be identified as special habitat. The panel noted that some roosts occurred within non-riverine wetlands. Note: This decision was taken from the previous Burnett River ACA (decision number afep_burn_7). It has been applied as a riverine decision in all the other catchments (bu_r_fa_07; bm_r_fa_04; cc_r_fa_01; fr_r_fa_02; ko_r_fa_01) and as a non-riverine decision in other catchments (bm_nr_fa_02; ko_nr_fa_02; my_nr_fa_02) within the Wide Bay-Burnett study area.	Mary	my_r_fa_09	6.3.1	4
The narrows	This special feature includes the Obi Obi Gorge National Park, which is a non-fishing area for about 3 km downstream under the *Fisheries Act 1994*. This is a key spawning area for the Mary River cod (*Maccullochella peelii mariensis*) as far as the confluence with Baxter Creek from Kondalilla National Park. It also includes Kondalilla Falls which was original habitat for the presumed extinct gastric brooding frog (*Rheobatrachus silus*), as well as habitat for the cascade treefrog (*Litoria pearsoniana*), the giant barred frog (*Mixophyes iterates*) and the tusked frog (*Adelotus brevis*). This subsection has better values than the next subsection upstream (my_0005) however the reaches in this subsection are dependent upon flows from (and the water quality of) the upstream subsection above the Baroon Pocket Dam. Note: This decision is related to my_r_fa_02.	Mary	my_r_fa_10	6.3.1, 6.4.1	4

Attachments

Attachment A – Wide Bay-Burnett region study areas

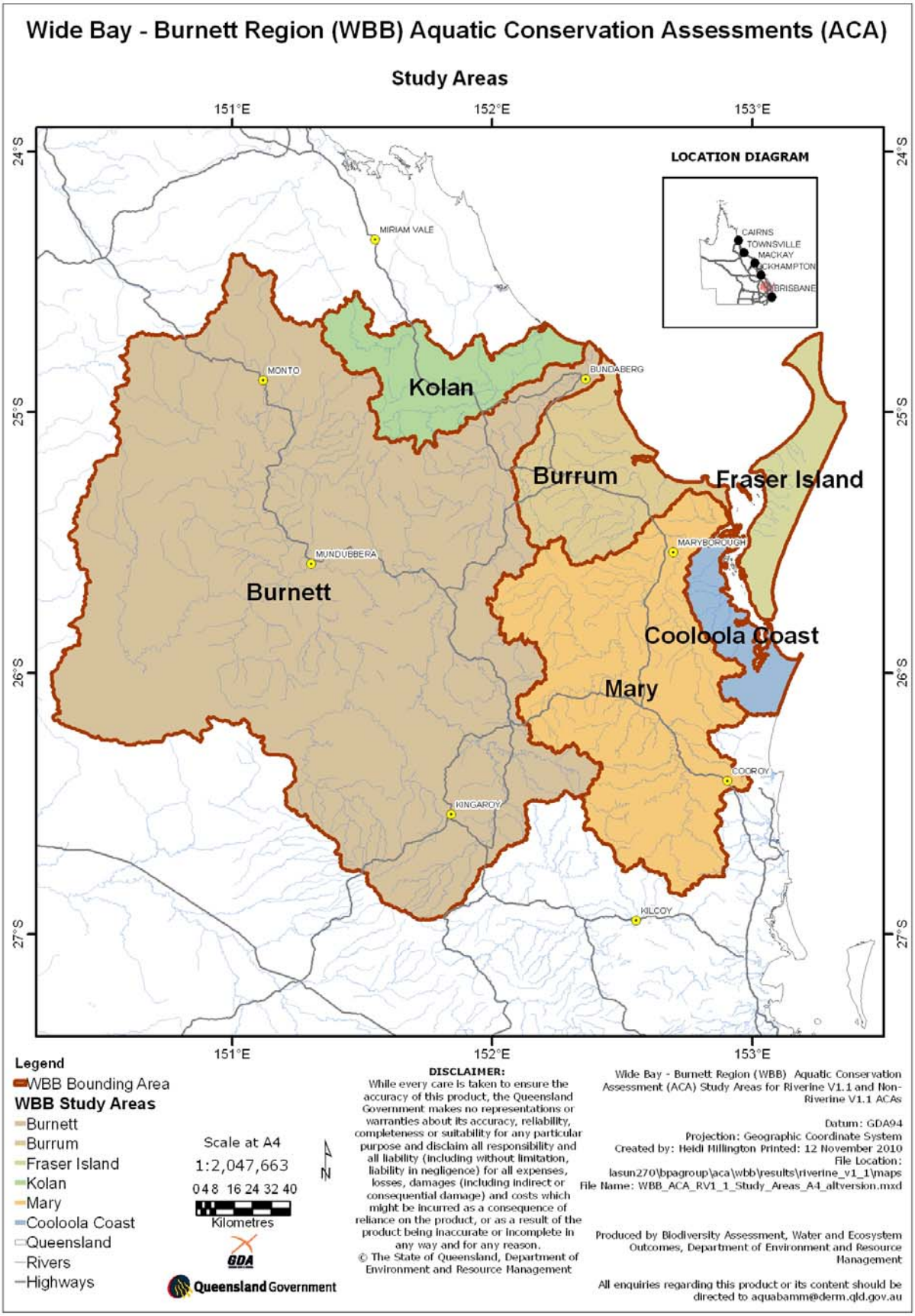

Figure 2: The Wide Bay–Burnett Region showing the six study areas.

Attachment B – Terms of reference (aquatic fauna expert panel)

The terms and reference presented below are to be read in conjunction with the AquaBAMM report that requires expert panel workshops to be run to inform a number of AquaBAMM criteria and their associated indicators and measures (Clayton *et al*. 2006).

Members of the expert panel were experts in scientific disciplines relevant to freshwater and estuarine ecosystems, processes and species. Panel members were required to have professional or semi-professional standing in their fields of expertise and have direct knowledge and experience of the Wide Bay-Burnett region. Experience in the identification and assessment of non-riverine and riverine values including natural processes, species and places of significance was an important factor in the selection process; the panel included members with experience in these areas, as well as in their areas of specialist technical expertise. Panel members were appointed on the basis of their individual standing rather than as representatives of a particular interest group or organisation.

Aquatic fauna

The aquatic fauna expert panel was established to provide expert advice on priority species, special features and/or ecosystems that are of ecological significance to the non-riverine and riverine wetlands of the Wide Bay-Burnett region. The panel consisted of professionals with expertise relating to aquatic fauna values.

The tasks undertaken by the panel included, but were not limited to, the following:

- review relevant existing spatial data (species point records) and available information
- provide advice on riverine and non-riverine threatened fauna species, habitat and localities
- provide advice on riverine and non-riverine priority fauna species, habitat and localities
- identify priority ecosystems or areas important for significant faunal communities or species
- provide advice on riverine and non-riverine ecosystem exotic fauna species localities and abundance
- weight measures relative to their importance for an indicator
- rank indicators relative to their importance for a criterion.

Attachment C – Criteria, indicators and measures for the Wide Bay-Burnett region

The criteria, indicators and measures (CIM) list outlines the CIM that were implemented as part of the ACA using AquaBAMM for the non-riverine and riverine wetlands of the Wide Bay-Burnett region.

The list has been developed from a default list of criteria, indicators and measures that may be considered when an ACA is conducted using AquaBAMM. The default CIM list is not mandatory for any particular ACA however it provides a "starter set" for consideration in setting the assessment parameters for each ACA.

AquaBAMM does not allow criteria change, addition or deletion. However, AquaBAMM does allow the addition or deletion of indicators and/or measures for each ACA when its assessment parameters are set. Generally modification of the default set of indicators is discouraged because the list has been developed to be generic and inclusive of all aquatic ecosystems. Modification of the default set of measures may or may not be necessary but full flexibility is provided in this regard. In particular, measures may need to be added where unusual or restricted datasets are available that are specific to an ACA or study area.

Table 13: CIM list for the Wide Bay-Burnett region.

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	✓	✓
	1.1.2	Presence of exotic aquatic and semi-aquatic plants within the wetland	✓	✓
	1.1.3	Presence of exotic invertebrate fauna within the wetland	✓	✓
	1.1.4	Presence of feral/exotic vertebrate fauna (other than fish) within the wetland	✓	✓
1.2 Aquatic communities/ assemblages	1.2.1	SOR[1] aquatic vegetation condition	✓	
	1.2.2	SIGNAL2 score (Max)	✓	
	1.2.3	AUSRIVAS[2] score - edge (Min band)	✓	
	1.2.4	AUSRIVAS[2] score - pool (Min band)	✓	
	1.2.9	AUSRIVAS[2] score - riffle (Min band)	✓	
1.3 Habitat features modification	1.3.1	SOR[1] bank stability	✓	
	1.3.2	SOR[1] bed and bar stability	✓	
	1.3.3	SOR[1] aquatic habitat condition	✓	
	1.3.4	Presence/absence of dams/weirs within the wetland	✓	
	1.3.5	Inundation by dams/weirs (% of waterway length within the wetland)	✓	
	1.3.8	Presence of dredging/extraction (including for navigation) and channel modification within the wetland	✓	
1.4 Hydrological modification	1.4.1	APFD[3] score - modelled deviation from natural under full development	✓	
	1.4.2	Percent natural flows - modelled flows remaining relative to predevelopment	✓	
	1.4.3	Percent no flows - modelled low flows relative to predevelopment	✓	
	1.4.5	Hydrological disturbance/modification of the wetland (e.g. as determined through DERM wetland mapping and classification)		✓
	1.4.8	High Ecological Value (HEV) Areas	✓	

Criteria and indicators	Measures		Riverine	Non-riverine
2 Naturalness catchment				
2.1 Exotic flora/fauna	2.1.1	Presence of exotic terrestrial plants in the assessment unit	✓	✓
2.2 Riparian disturbance	2.2.1	% area remnant vegetation relative to preclear extent within buffered riverine wetland or watercourses	✓	
	2.2.2	Total number of regional ecosystems relative to preclear number of regional ecosystems within buffered riverine wetland or watercourses	✓	
	2.2.3	SOR[1] reach environs	✓	
	2.2.4	SOR[1] riparian vegetation condition	✓	
	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		✓
2.3 Catchment disturbance	2.3.1	% "agricultural" land-use area (i.e. cropping and horticulture)	✓	✓
	2.3.2	% "grazing" land-use area	✓	✓
	2.3.3	% "vegetation" land-use area (i.e. native veg + regrowth)	✓	✓
	2.3.4	% "settlement" land-use area (i.e. towns, cities, etc)	✓	✓
2.4 Flow modification	2.4.1	Farm storage (overland flow harvesting, floodplain ring tanks, gully dams) calculated by surface area	✓	✓
3 Diversity and richness				
3.1 Species	3.1.1	Richness of native amphibians (riverine wetland breeders)	✓	
	3.1.2	Richness of native fish	✓	✓
	3.1.3	Richness of native aquatic dependent reptiles	✓	✓
	3.1.4	Richness of native waterbirds	✓	✓
	3.1.5	Richness of native aquatic plants	✓	✓
	3.1.6	Richness of native amphibians (non-riverine wetland breeders)		✓
	3.1.7	Richness of native aquatic dependent mammals	✓	✓
3.2 Communities/ assemblages	3.2.1	Richness of macroinvertebrate taxa	✓	✓
	3.2.2	Richness of regional ecosystems along riverine wetlands or watercourses within a specified buffer distance	✓	
3.3 Habitat	3.3.1	SOR[1] channel diversity	✓	
	3.3.2	Richness of wetland types within the local catchment (e.g. SOR[1] subsection)	✓	✓
	3.3.3	Richness of wetland types within the sub-catchment	✓	✓
4 Threatened species and ecosystems				
4.1 Species	4.1.1	Presence of rare or threatened aquatic ecosystem dependent fauna species – NC Act[4], EPBC Act[5]	✓	✓
	4.1.2	Presence of rare or threatened aquatic ecosystem dependent flora species – NC Act[4], EPBC Act[5]	✓	✓
4.2 Communities/ assemblages	4.2.1	Conservation status of wetland regional ecosystems – Herbarium biodiversity status, NC Act[4], EPBC Act[5]	✓	✓

Criteria and indicators	Measures		Riverine	Non-riverine
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[6], WWF, etc)	✓	✓
	5.1.2	Presence of aquatic ecosystem dependent 'priority' flora species	✓	✓
	5.1.3	Habitat for, or presence of, migratory species (expert panel list/discussion and/or JAMBA[7]/ CAMBA[8] agreement lists and/or Bonn Convention)	✓	✓
	5.1.4	Habitat for significant numbers of waterbirds	✓	✓
5.2 Ecosystems	5.2.1	Presence of 'priority' aquatic ecosystem	✓	✓
6 Special features				
6.1 Geomorphic features	6.1.1	Presence of distinct, unique or special geomorphic features	✓	✓
6.2 Ecological processes	6.2.1	Presence of (or requirement for) distinct, unique or special ecological processes	✓	✓
6.3 Habitat	6.3.1	Presence of distinct, unique or special habitat (including habitat that functions as refugia or other critical purpose)	✓	✓
	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.	✓	✓
	6.3.3	Ecologically significant wetlands identified through expert opinion and/or documented study	✓	✓
6.4 Hydrological	6.4.1	Presence of distinct, unique or special hydrological regimes (e.g. spring fed stream, ephemeral stream, boggomoss)	✓	✓
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	✓	
	7.1.2	Migratory or routine 'passage' of fish and other fully aquatic species (upstream, lateral or downstream movement) within the spatial unit	✓	
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)	✓	✓
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	✓	

Criteria and indicators	Measures		Riverine	Non-riverine
	7.3.2	Extent to which the wetland retains critical ecological and hydrological connectivity, where it should exist, with floodplains, rivers, groundwater etc.		✓
7.5 Estuarine and marine ecosystems	7.5.1	The contribution of the spatial unit to the maintenance of estuarine and marine ecosystems with significant biodiversity values, including those features identified through criteria 5 and/or 6	✓	✓
8 Representativeness				
8.1 Wetland protection	8.1.1	The percent area of each wetland type within protected areas.		✓
	8.1.2	The percent area of each wetland type within a coastal/estuarine area subject to the *Fisheries Act 1994*, *Coastal Protection and Management Act 1995* or *Marine Parks Act 2004*.		✓
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)		✓
	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)		✓
	8.2.3	The size of each wetland type relative to others of its management group within the catchment or study area		✓
	8.2.4	The size of each wetland type relative to others of its type within a sub-catchment (or estuarine zone)		✓
	8.2.5	Wetland type representative of the study 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		✓

[1] SOR – State of the Rivers
[2] AUSRIVAS – Australian River Assessment System
[3] APFD – Annual Proportional Flow Deviation
[4] NC Act – *Nature Conservation Act 1992* (Queensland legislation)
[5] EPBC Act – *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth legislation)
[6] ASFB – Australian Society of Fish Biology
[7] JAMBA – Japan-Australia Migratory Bird Agreement
[8] CAMBA – China-Australia Migratory Bird Agreement

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Attachment C **Wide Bay-Burnett ACA –**
Wetland ecology expert panel report

Water and Ecosystem Outcomes Business Group
Queensland Department of Environment and Resource Management

An Aquatic Conservation Assessment

for the non-riverine and riverine wetlands of the

Wide Bay-Burnett region

Wetland Ecology
Expert Panel report

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Acronyms and abbreviations

ACA	Aquatic Conservation Assessment
ASL	Above sea level
BPA	Biodiversity Planning Assessment
CS	Connectivity score
DERM	Department of Environment and Resource Management
DIWA	Directory of Important Wetlands
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
FPR	Fish passage rating
GIS	Geographic information system
HEV	High ecological value (under a water quality improvement plan)
ICS	Intrinsic connectivity score
NC Act	*Nature Conservation Act 1992*
Ramsar	Ramsar Convention on Wetlands
RE	Regional ecosystem
WBB	Wide Bay-Burnett

1 Introduction

The Department of Environment and Resource Management (DERM) is conducting an Aquatic Conservation Assessment (ACA) for the non-riverine and riverine wetlands in the Wide Bay-Burnett region using the Aquatic Biodiversity Assessment and Mapping Method (AquaBAMM; Clayton *et al*. 2006). The ACA relied on expert panels convened to address aquatic fauna, aquatic and riparian flora and wetland ecology for some of the data inputs.

AquaBAMM provides a robust and easily accessible analysis of wetland conservation values associated with a catchment or other defined study area. The AquaBAMM provides a decision support tool that utilises existing information, with moderation by expert panels (e.g. flora, fauna and wetland ecology expert panels) to ensure scientific rigour and accountability, resulting in an ACA for a nominated geographic area—in this case, the Wide Bay-Burnett region.

The potential for adding additional data into the system as it becomes available, with consequent updates to planning outcomes, is not limited. The AquaBAMM tool is a map/data output in a geographic information system (GIS) environment based on spatial mapping units that describe conservation significance or value for planning and assessment purposes.

The Wide Bay-Burnett ACA is made up of six individual catchments— the Burnett, Mary, Kolan, Burrum, Cooloola and Fraser Island catchments. DERM is applying AquaBAMM separately to the non-riverine (palustrine and lacustrine) and riverine wetlands within each of the six Wide Bay-Burnett catchments. In effect, there are six ACAs for the area—covering non-riverine and riverine wetlands in each of the catchments. A map of the Wide Bay-Burnett region showing each study area is provided in Attachment A.

Three expert panels were conducted to address aquatic fauna, aquatic and riparian flora and wetland ecology for the six Wide Bay-Burnett catchments. The non-riverine and riverine wetlands were covered in combined workshops. The panels, held in Maryborough during July 2010, involved invited experts with expertise in aquatic fauna, aquatic and riparian flora and/or wetland ecology.

This report documents the findings and recommendations of the aquatic ecology expert panel held in Maryborough on 22nd and 23rd July 2010. The report presents supporting information and panel input that addresses non-riverine and riverine wetland systems. Terms of reference for the panel are provided in Attachment B.

2 Method

2.1 Study area

Burnett catchment

The Burnett River catchment lies in the South East Queensland and Brigalow Belt bioregions and is located approximately 200 km north-west of Brisbane. The Burnett is the third largest river basin on the east coast of Queensland, with a catchment area of approximately 34 500 km^2 (Van Manen 1999). The Burnett River flows for 420 km from its source in the Burnett Range to its mouth at Burnett Heads. The main tributaries of the Burnett River include the Auburn, Nogo, Boyne and Stuart Rivers and the Barambah and Three Moon Creeks (Van Manen 1999). The catchment is fringed by the Burnett and Dawes Ranges in the north, the Auburn Range to the west, the Great Dividing Range to the south-west and the Cooyar and Brisbane Ranges in the south. Major urban and regional centres in the Burnett River catchment include Bundaberg, Kingaroy, Gayndah, Eidsvold, Murgon, Nanango and Monto. Rainfall in the catchment is variable with both tropical and temperate weather patterns. Cattle grazing and crop production dominate the catchments land use.

The Burnett River catchment is subject to a number of new water infrastructure projects being approved for development. Jointly with the State of Queensland, the Commonwealth Minister for Environment and Heritage under the provisions of the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth) granted environmental approvals for Barlil Weir, Jones Weir Stage 2 and Eidsvold Weir in late 2001, and approval for Paradise Dam in late January 2002. Eidsvold Weir was completed in 2004 and Paradise Dam was completed in late 2005. Consequently, the Burnett River catchment is one of the most developed areas in Queensland in terms of water infrastructure. Increasing demands for water from irrigators, industry and the domestic sector have resulted in high levels of river regulation. There are currently approximately 41 water storages in the Burnett catchment, six of which are situated in the main river channel (Brizga *et al.* 2000).

As has been observed during the construction of dams in other areas, the raising of the Walla Weir in conjunction with the construction of the Paradise Dam is expected to have significantly reduced suitable habitats for aquatic fauna (Gehrke *et al.* 2002), particularly the Australian lungfish (*Neoceratodus forsteri*) and *Elseya* species of turtle. In response to these concerns, DERM and the Department of Employment, Economic Development and Innovation (DEEDI) were asked to develop eight projects that aim to address catchment-wide, environmental issues associated with the construction and operation of the proposed infrastructure known collectively as the Burnett Plan of Actions (BPOA). The BPOA included an AquaBAMM project in 2006 which aimed to assess 'riverine conservation values of the Burnett'. The initial trial application of the AquaBAMM was conducted in the Burnett River catchment to produce an Aquatic Conservation Assessment (ACA) for riverine wetlands. The ACA being reported here supersedes the first Burnett River ACA version released in 2006 which pre-dated construction of the Paradise Dam.

Additionally, under the Coastal Catchments Initiative, the Australian Government has funded the Burnett-Mary Regional NRM Group (BMRG) to develop the Burnett-Baffle Water Quality Improvement Plan (WQIP) (Burnett-Mary Regional NRM Group/DERM, 2010). DERM and the BMRG have completed a joint project to establish the waterway values and uses (i.e. environmental values), and developed water quality objectives/targets to protect these values and uses consistent with the Environmental Protection (Water) Policy 2009. As part of this project High Ecological Value waterways were determined for the Burnett catchment.

Mary River catchment

The Mary River flows from the moist, subtropical southern part of the South East Queensland bioregion into a drier corridor to the north, and consequently varies considerably in its character. The Mary's freshwater reaches support a distinctive fauna which is close to range limits and adapted to its episodic flood regime, and is one of two catchments supporting the iconic Australian lungfish (*Neoceratodus forsteri*). The Mary catchment is an important source of sediment and freshwater flows for seagrass ecosystems and shorebird feeding habitat in the northern Great Sandy Strait Ramsar area and Hervey Bay. Many of its riverine and non-riverine wetlands are also scheduled as High Ecological Value waterways under the Environmental Protection (Water) Policy 2009.

While most rainfall occurs in late summer to early autumn, flood events may occur in any month but are typically episodic in occurrence (e.g. 5–10 years frequency) and may be interspersed by long dry periods. Irregular high rainfall events associated with cyclones and east coast low depressions feed the southern tributaries of the Mary. While mean annual rainfall near Maleny is 2000 mm, as much as 900 mm has been recorded in a day. Much of this elevated southern catchment falls within protected areas containing rainforest, wet and dry sclerophyll ecosystems although significant areas have been cleared. Obi Obi creek rises from a basaltic plateau in the Sunshine Coast hinterland, falling steeply through gorge country before flowing north to join the Mary River. In contrast Six Mile Creek is a low energy rainforest stream retaining large woody debris. The banks of some of the major streams, such as Obi Obi, Six Mile, Deep and Tinana Creeks, have rainforest and/or tall open (wet sclerophyll) forest riparian vegetation (e.g. Araucarian notophyll vine forest or mesophyll gallery forest). Riverbank erosion due to the poor condition of riparian vegetation in the Mary is also being linked to increased sediment discharge to the Great Sandy Strait (Esslemont *et al.* 2006a, b, c, d; DeRose *et al.* 2002).

There is a need for further mapping and rehabilitation of riparian vegetation, especially rainforest, since this vegetation type is habitat for several endemic, endangered, vulnerable, near-threatened and priority species including both fauna species (e.g. Mary River cod *(Maccullochella mariensis),* Richmond birdwing (*Ornithoptera richmondia)*, the Pink underwing moth (*Phyllodes imperialis* southern subspecies*)*, Coxen's fig parrot (*Cyclopsitta diopthalma coxeni)*, Black-breasted button-quail (*Turnix melanogaster);* the Giant barred frog *(Mixophyes iterates),* the Tusked frog *(Adelotus brevis);* the Cascade tree frog, *(Litoria pearsoniana)* (Fleay 1997, Mathieson and Smith 2009, Simpson and Jackson 1996, Sands and Scott 1998)) and flora species (e.g. *Xanthostemon oppositifolius, Fontainea rostrata,* Macadamia nut tree (*Macadamia integrifolia*) and Gympie nut (*Macadamia ternifolia*)). The South East Queensland Rainforest Recovery Program describes the association between several of these species and regional ecosystem 12.3.1 (gallery rainforest on alluvial plains). While some remnant riparian vegetation mapping of 12.3.1 exists in the Mary, mapping and identification of other riparian rainforest below the mapping scale and suitable for rehabilitation may inform NRM decisions e.g. a future Mary River Recovery Plan.

Resembling those of the drier Burnett (mean annual rainfall less than 800 mm), the intermittent western tributaries of Wide Bay and Munna Creeks are moderate to high-energy sand and gravel-bed stream systems able to accommodate substantial flows within their wide flow channels. A substantial coarse sediment load from all these tributaries has resulted in distinctive pool, riffle and sand bar sequences chiefly in the main trunk of the Mary River. These areas are notable as habitat for the Australian lungfish (*Neoceratodus forsteri*) and the highest turtle diversity in Queensland (including the endemic Mary River turtle (*Elusor macrurus*).

To the east, Coondoo and Tinana Creeks sustain important riparian rainforest and wallum vegetation on sandy alluvium with natural water quality and relatively intact fauna including the endemic Mary River cod (*Maccullochella peelii mariensis*), Oxleyan Pygmy Perch (*Nannoperca oxleyana*) and the Australian lungfish (*Neoceratodus forsteri*) populations. These creeks flow into the turbid Mary estuary at Maryborough and are joined by the unimpounded Susan River and its mangrove wetlands near the mouth of the river. The tidal delta of the Mary extends into the Great Sandy Strait, encompassing an extensive complex of mangrove islands, saltpans and sandbanks comprising the largest Fish Habitat Area in southern Queensland. Flood events from the Mary River periodically reverse the normally highly saline conditions of Hervey Bay, producing an inverse estuary (Ribbe 2008).

Presently, catchment land use in the area chiefly comprise dryland grazing, sugar cane and plantation forestry, with tree crops and dairying in the elevated south. European settlement and dairying land use resulted extensively in clearing of its upper reaches and riparian area. Land use and modifications of the freshwater reaches have produced erosion and siltation of parts of the river and sedimentation of deep pools. Excess sediment discharge into the Mary estuary, Great Sandy Strait and Hervey Bay from Mary flood events and subsequent resuspension occasionally results in catastrophic loss of seagrass beds and dugong (for example 1992) (Preen *et al.* 1995) and continues to create marine water quality issues. Within the freshwater reaches regulation of its southern tributaries for extraction of water supplies for Gympie, inter-basin transfers to the Sunshine Coast and flow releases for downstream irrigation of canelands have modified the original episodic flows to a smaller, more regular runoff regime, altering the physical structure of the channel (Department of Natural Resources and Mines 2005). Barrages on former estuarine reaches of the Mary River and Tinana Creek provide for irrigated canelands and the Maryborough water supply respectively, but also restrict the freshwater flow regime and fish passage to the estuary. Most of the floodplain wetlands have been converted to cultivated paddocks or canelands. Nevertheless the Mary River catchment still supports a high diversity in riverine and non-riverine wetland types, including wallum wetlands, melaleuca swamps and inland freshwater swamps.

Burrum catchment

The Burrum catchment consists of an amalgam of coastal catchments between the Burnett and Mary catchments. The catchment is dominated by the Burrum sand mass characterised by aggregations of coastal Melaleuca wetlands and heaths with connectivity in a north-south direction. The non-riverine and riverine wetlands of the Burrum play a significant role in reef resilience due to their high connectivity with adjacent estuarine salt marshes, mangroves, seagrass meadows and coral reefs of the Great Sandy Strait Ramsar area and Hervey Bay. Many of the Burrum's riverine, non-riverine and estuarine wetlands are also scheduled as High Ecological Value waterways under the Environmental Protection (Water) Policy 2009.

Of lower relief than the Mary and Cooloola-Great Sandy Strait catchments, the Burrum receives most of its rainfall as northern monsoons, cyclones or troughs occurring in late summer to autumn (averaging 1000–1200 mm per annum). The climatic variability and low freshwater discharge in combination with evaporation on expansive tidal flats have created an 'inverse estuary' in the receiving waters of Hervey Bay (i.e. strongly hypersaline; Ribbe 2008, Grawe 2010).

The catchment logically falls into five geomorphic subdivisions: the Woongarra coastal streams draining a gently-sloping, fertile Quaternary basalt deposit; the groundwater-fed Elliott River; the Coonarr to Beelbi region of extensive sandy beach ridges and swales; the Burrum, Isis, Gregory and Cherwell rivers draining into the Burrum estuary; and the O'Regan's Creek to the Mary River area, typified by short coastal streams and alluvial wetlands sloping from a ridgeline behind Hervey Bay City. In the hinterland, sedimentary rocks of the Maryborough formation formed in Mesozoic marine waters have resulted in saline-tolerant Melaleuca wetlands along drainage lines.

The Burrum Coast sits within the Directory of Important Wetlands area between Theodolite and Beelbi creeks and includes both freshwater and estuarine wetlands (mangroves and seagrass beds). As a succession of both Holocene and Pleistocene beach ridges, and swales and Quaternary freshwater swamp deposits, it represents the most significant coastal dune system north of the Cooloola sand mass. A large proportion of this dune system is conserved within the Burrum Coast National Park. Wetland types of the Burrum Coast include wallums, closed wet heath and swale wetlands dominated by Melaleuca species. These wetlands and adjacent habitats include several species approaching their geographic limits (such as *Strangea linearis*, *Callistemon pachyphylla* and *Melaleuca sieberi*) and a number of endangered, vulnerable and near-threatened plant species including the paperbark tree (*Melaleuca cheelii*), tiny wattle (*Acacia baueri subsp baueri*) and an alyxia (*Alyxia sharpei*). The Wallum froglet (*Crinia tinnula)* has also been recorded in the Burrum Coast National Park and other wetlands in the catchment. Inland from the coastal dune systems lie wetlands and streams of the Burrum and Cherwell. In these areas, deep weathering of Tertiary sediments have formed duricrust pans on a slightly elevated plateau, inhibiting the surface drainage. The Cherwell River has good examples of perched heathy wetlands associated with these pans as well as Melaleuca swampy drainage lines dissecting the edges of the plateau.

The Elliott River catchment, which sits within the Burrum study area, is largely groundwater-fed, containing aquifers that consist of a series of poorly interconnected sand and gravel channels and intervening clay layers sloping gently towards the coast. This areas unique hydrology, freshwater wetlands and excellent connectivity to high receiving water values (including seagrass and corals) were recognised in the Burnett-Baffle Water Quality Improvement Plan (Burnett-Mary Regional NRM Group/DERM 2010).

Dominant land uses in the Burrum catchment are irrigated cropping, grazing, coastal urban development and minor plantation forestry, with the majority of intensive land use north of the Isis River. However, extensive vegetated tracts of state land remains within the bioregional corridor in the hinterland and within protected estate on the coast. Irrigation from groundwater provides for intensive cane farming and horticulture north of the Burrum River. Lenthalls Dam on the Burrum supplies the expanding city of Hervey Bay with water. Other weirs and barrages on the Burrum and Isis Rivers also sever connectivity between freshwater areas and the estuary.

Clearing of wetlands for agriculture and fragmentation associated with coastal development has impacted on the Woongarra coast and, to a lesser extent, south of Burrum Heads. Wetland function in these catchments provides water quality protection for significant estuarine and marine values—most notably the Burrum seagrass meadow dugong nursery (Sheppard 2006), Mon Repos turtle rookery and subtropical coral reefs fringing both Woongarra and Hervey Bay coastlines.

Urban development, artificial lakes and sand extraction are increasingly impacting on the natural hydrology of wetlands and streams south of Burrum Heads, with impacts such as de-watering of heathland wetlands in adjacent protected estate. There is potential for excavation of wetland soil to mobilise acid sulfate runoff and seepage from septics to eutrophy groundwater. In other parts of Australia and the world, the importance of hydrological connectivity between groundwater and adjacent inshore marine ecosystems (Maji and Smith 2008), such as seagrass, is acknowledged (Coles *et al.* 2007; Eamus *et al.* 2006; Kammermans *et al.* 2002; Johannes and Hearn 1985) and the impacts coastal urban development has on these groundwater dependent ecosystems has been demonstrated (Carruthers *et al.* 2005, Valeila *et al.* 1990). While groundwater connectivity to seagrass is yet to be investigated for the Burrum catchment, the maintenance of intact wetland function is an important consideration for the health of connected ecosystems.

Kolan catchment

The Kolan catchment is a coastal catchment between the Burnett to the south and the Littabella and Baffle Creek catchments to the north. This catchment features mainly agricultural land use and water resources, but there are some wetlands of biodiversity significance in its headwaters and adjoining its estuary.

The Kolan falls within the northern half of the South East Queensland bioregion, and has a subtropical climate with an average rainfall of 1200–1400 mm per annum. Most of this rainfall occurs during late summer commonly associated with cyclones and troughs, but can be sporadic. Most of the Kolan catchment is relatively flat, below 80 m above sea level (ASL), however the headwaters arise in the rugged Many Peaks Range which rises to 700 m ASL. There are a number of different protected areas in the headwaters, notably Bulburin National Park and Bulburin Forest Reserve which feature subtropical dry rainforest with emergent hoop pines, gallery rainforest, and drier eucalypt forests. Hoop pine plantations adjoin protected estates at Bulburin.

On the south side of the Kolan, a series of parallel dunes has formed a barrier and swale system in the Moore Park area. This wetland complex of Melaleuca swamps and lakes is fragmented by the urban settlement of Moore Park Beach. However, the freshwater wetlands have reasonable connectivity to the Kolan Fish Habitat Area in the estuarine waters of the Kolan and west of Barubbra Island in the delta of the Burnett.

Agricultural and water resource land uses dominate much of the Kolan and as a result much of the catchment is cleared. Grazing dominates the upper and central catchment, while irrigated sugar cane and horticultural crops,,including macadamia nut plantations,, predominate in the lower catchment. The Fred Haigh Dam is a large impoundment within the central-upper reaches of the Kolan with a pipeline providing inter-basin transfers into the Burnett for irrigation. Bucca Weir and the Kolan barrage provides freshwater for agriculture in the central and lower reaches. Irrigation from the Gooburrum aquifer, which extends from the Elliott River north to the Kolan, supplements the variable rainfall experienced within the Kolan. To date, connectivity has been poor and hence environmental flows to the estuary have been low. However, the revised water resource plan covering the region is focussing more on improvements to freshwater flows in order to benefit catadromous fish.

Under its Coastal Catchments Initiative, the Australian Government has funded the Burnett-Mary Regional NRM Group (BMRG) to develop the Burnett-Baffle Water Quality Improvement Plan (WQIP). DERM and the BMRG have completed a joint project to establish the waterway values and uses (i.e. environmental values) and develop water quality objectives/targets to protect the values and uses consistent with the Environmental Protection (Water) Policy 2009. As part of this project High Ecological Value waterways were determined for the Kolan catchment.

Cooloola catchment (previously Noosa North)

Previously this catchment was referred to as Noosa North, however to more accurately represent the geographical location, the wetland ecology expert panel recommended that it be renamed the Cooloola catchment .The Cooloola region has the oldest and largest unconsolidated sand mass in the world, nominated as World Heritage for its spectacular natural values, geomorphology, and the most extensive and intact complex of heath and swamp communities in south-eastern Australia (Fraser Island World Heritage Scientific Advisory Committee, 2004a). The Cooloola Sand Mass, and its very high rainfall volume (often exceeding 1200 mm annually) determines the hydrology and character of most of this catchment. Many of its freshwater wetlands fall within the Great Sandy Strait Ramsar area, and together with the dunes are important groundwater recharge areas. Many of Cooloola's riverine, non-riverine and estuarine wetlands are also scheduled as High Ecological Value waterways under the Environmental Protection (Water) Policy 2009.

Streams of the Cooloola catchment flow in four separate directions, three of which are in protected area estate within the Cooloola section of the Great Sandy National Park. To the north flow the Cooloola and Great Sandy Strait streams; to the south flows the Noosa River; and various streams and springs within the narrow dune corridor of the eastern seaboard discharge directly across the beach to the sea. East of the Mary River catchment and north of Kauri Creek, coastal creeks from other, smaller sand masses than Cooloola flow directly into the Great Sandy Strait Ramsar area, whose sandbanks and mangrove-lined waterways provide significant seagrass habitat for shorebirds, dugong and dolphins.

Catchments of the Cooloola area are typified by their dependence on groundwater flows emanating chiefly from the Cooloola Sand Mass, high dunes (to 258 m ASL), resembling those of Fraser Island in geomorphology, hydrology, flora and fauna. This sand mass is derived from quartz sands blown and buried in a low hilly landscape of Mesozoic sandstones, covered by successively younger sand deposits until the Holocene including parabolic dunes. Long-term leaching of humic acids has formed deep podzolic soils and peat-swamps with various layers of coffee rock impeding drainage and forming perched water tables, overlying a deeper regional groundwater table close to sea level and connected to estuarine waters. While hydrologically linked to the Noosa River catchment, the divide between these groundwater-sourced systems approximately coincides with the topographic watershed along the highest dunes of the sandmass. Groundwater of the Cooloola area is characterised by organic stained 'black waters' in its perched system and unstained 'white water' in the prime aquifer below (NLWRA 2000).

This variety of hydrological regimes produces a wide range of highly significant wetland types including patterned fens similar to those of Fraser Island, the only subtropical patterned fens in the world, 'swamp hummocks' of patterned peat microrelief, perched (e.g. Poona Lake) and regional water-table 'window' lakes (e.g. Freshwater Lake), perched heath swamps with Christmas bells and other rare wetland flora species, episodic springs or 'bubblers' of 'white' water across the beach, 'black' tannin-stained wallum streams, vineforest riparian vegetation surrounding 'white water' springs, and melaleuca wetlands to name a few. Many are acid habitats with a pH so low that they have developed a unique suite of acid-tolerant fauna including four vulnerable and near-threatened frogs (the Cooloola sedgefrog (*Litoria cooloolensis*), Wallum rocketfrog (*Litoria freycineti*), Wallum sedgefrog (*Litoria olongurensis*) and Wallum froglet *Crinia tinnula)*, fish, the crayfish (*Cherax robustus*) and earthworms.

Northward to the Great Sandy Strait the continuity between the freshwater streams, groundwater and the estuary is largely uninterrupted and natural, supporting very high values in the freshwater/estuarine interface including the most significant mainland populations of Water Mouse, species tolerant of brackish water and low pH (e.g. Honey Blue Eye (*Pseudomugil mellis*) and Oxleyan Pygmy perch (*Nannoperca oxleyana*)) and very high fish diversity. Most notable is Kauri Creek and streams discharging from the Wide Bay Military Training Area whose adjacent seagrass beds constitute the most significant dugong habitat in the southern Great Sandy Strait (Sheppard 2006).

Further north beyond Kauri Creek, smaller coastal creeks of the Great Sandy Strait (including Maaroom, Tuan and Poona creeks) drain flatter, sandy terrain as far north as the Mary River mouth. There is limited knowledge of these catchments typified by heath and wallum complexes often connected to a network of mangrove channels within the Great Sandy Strait Ramsar Area. They preserve natural connectivity from fresh to estuarine waters but within a catchment of exotic pine plantations. Poona National Park represents a complex of fresh and estuarine wetlands with similar acid frog habitat and faunal features to those of Cooloola including Honey Blue Eye (*Pseudomugil mellis*).

The Noosa River catchment is a largely undisturbed basin within protected area, featuring deltaic and estuarine lake systems draining southward towards the Sunshine Coast from the Cooloola sand mass. In contrast with Cooloola, it has developed alluvial features and is surrounded by sandstone and alluvium on the west and Pleistocene and Holocene dunes on the east and has high recreational values.

A lack of urban settlement has left the Cooloola-Great Sandy Strait catchment largely intact, while the establishment of exotic pine plantations has modified catchments to the north of Kauri Creek. Extraction from Teewah Creek (Noosa River catchment), and the regional groundwater table for the townships of Tin Can Bay and Rainbow Beach respectively have potential to impact on wetlands surrounding Seary's Creek and the Noosa River if water resource management for the environment is not effective. Coastal developments at Cooloola Cove, and to a lesser extent Tin Can Bay, Poona, Big Tuan and Boonooroo sever the connectivity between freshwater and estuarine wetlands and there is potential for excavation of wetland soil to mobilise acid sulfate runoff and seepage from septics to eutrophy groundwater. Monitoring in the Great Sandy Strait has documented seagrass declines since the early 1990s. In other parts of Australia and the world, the importance of the hydrological connectivity between groundwater and adjacent inshore marine ecosystems (Maji and Smith 2008), such as seagrass, is acknowledged (Coles *et al.* 2007; Eamus *et al.* 2006; Kammermans *et al.* 2002, Johannes and Hearn 1985) and the impacts coastal urban development has on these groundwater dependent ecosystems has been demonstrated (Carruthers *et al.* 2005, Valeila *et al.* 1990). While groundwater connectivity to seagrass is yet to be investigated for the Cooloola-Great Sandy Strait catchment, the maintenance of intact freshwater wetland function is an important consideration for the health of connected aquatic ecosystems in the Ramsar area.

Fraser Island catchment

Fraser Island is the largest sand island in the world, recognised as containing World Heritage Outstanding Universal Values including geomorphic and ecological processes, exceptional beauty, biodiversity, threatened species, and cultural heritage (Fraser Island World Heritage Scientific Advisory Committee, 2004b). The areas substantial dune aquifer characterises the island's unique wetlands which includes half the freshwater dune lakes in the world and the only known subtropical patterned fens. In the western parts, the streams of Fraser Island flow into the Great Sandy Strait Ramsar area, which has also recently been nominated for World Heritage value, while Breaksea Spit to the north provides connectivity to coral reefs in the southern Great Barrier Reef. Many of Fraser Island's riverine, non-riverine and estuarine wetlands are also scheduled as High Ecological Value waterways under the Environmental Protection (Water) Policy 2009.

Fraser Island consists of a complex of high dunes rising to a maximum height of 235 m ASL. Annual rainfall ranges between 1200 and 1800 mm, falling mostly over autumn when seasonal cyclonic weather results in high rain events. North of Indian Head the relief is low

and dune formation is more recent, resulting in a network of exposed dunes, freshwater swamps and lakes.

Formed by continuous deposition of quartz dune deposits over the last 700 000 years, Fraser Island represents an intact sequence of dune development from west to east. These wind-blown dunes were deposited during periods of low sea level during interglacials of the Pleistocene and high winds of the Holocene. Successively younger deposits of parabolic dunes are superimposed over these older dune deposits now stabilised by towering rainforests and wet sclerophyll, forming a high diversity of dune forms with complex hydrological relationships. Similarities with the Cooloola Coast area include the heavily leached deep podzolic soils and peat-swamps; layers of coffee rock impeding drainage and forming perched water tables, overlying a deeper regional groundwater table 'lens' close to sea level and connected to estuarine waters.

The advance and retreat of dunes over time has created a complex of dynamic hydrologies resulting in spring-fed streams and freshwater dune lakes. The lakes feature relict formations from past water levels such as multiple shorelines, lunettes and relict spits. Perched lakes formed in wind scoured depressions where organic matter built up impermeable layers. Up to an estimated 300 000 years old, their sediments document changes to the island's hydrology and vegetation through Quaternary glacial and interglacial cycles. These lakes form an age sequence related to the episodic periods of dune building and include some of the largest (e.g. Lake Boomanjin) and highest perched lakes (i.e. Boomerang Lakes) in the world. Window lakes intersect the regional groundwater table. Lake Wabby is a scenic barrage lake, thought to be formed by groundwater springs dammed by a wall of landward migrating sand.

A high diversity of palustrine wetland types are also represented on the island including closed wet heaths, wallum banksia communities, Melaleuca swamps and forests, riparian rainforest and palm forests, and brackish swamps. Notable among these are the patterned fens, formed at the base of high dunes where a build up of peat ridges and pools have formed in response to discharges from the regional water table. A suite of acid-tolerant fauna are associated with the fens and other acid swamps include Oxleyan Pygmy Perch (*Nannoperca oxleyana*) and Honey Blue-Eye (*Pseudomugil mellis*), four acid frog species (the Cooloola sedgefrog (*Litoria cooloolensis*), the Wallum rocketfrog (*Litoria freycineti*), the Wallum sedgefrog (*Litoria olongurensis*) and the Wallum froglet (*Crinia tinnula*) and a crayfish (*Cherax robustus*).The swamp eel (*Ophisternon gutturale*) has also been recorded at Lake Wabby.

Most of the streamflow for Fraser Island's freshwater streams is baseflow from the aquifer, which may be 'black' tannin-stained water discharging from wallum heaths or 'white' clear waters emerging from the lower water table. There is a small pocket of Angiopteris fern at Wanggoolba creek. Freshwater streams also designate the southern range limit of jungle perch (*Kuhlia rupestris*).

Connectivity between freshwater and estuarine waters is an important feature of Fraser Island waterways and as a result, populations of the Water mouse (*Xeromys myoides*) are high as they are able to access both habitat types. Fraser Island's western creeks feature the region's highest diversity of mangroves, several of which are freshwater dependent such as the Cannonball mangrove (*Xylocarpus* granatum) and extensive Bruguiera forests, both at their southern range limits. Fraser Island wetlands perform an important water quality protection function for seagrass beds and sandbanks of the Great Sandy Strait; the humpback whale migration area in Platypus Bay; and the loggerhead turtle rookery at Sandy Cape.

Fraser Island is largely undeveloped and heavily vegetated, and the north is largely wilderness. Most of the island is in protected area estate, although there are freehold settlements and resorts at Eurong, Happy Valley and Kingfisher Bay which source their water from bores. A network of forestry tracks traverses the inland, however most traffic uses the eastern beach. Currently tourism is at a relatively high volume, notably around Lake Mackenzie where there have been concerns about trampling of riparian vegetation and water quality.

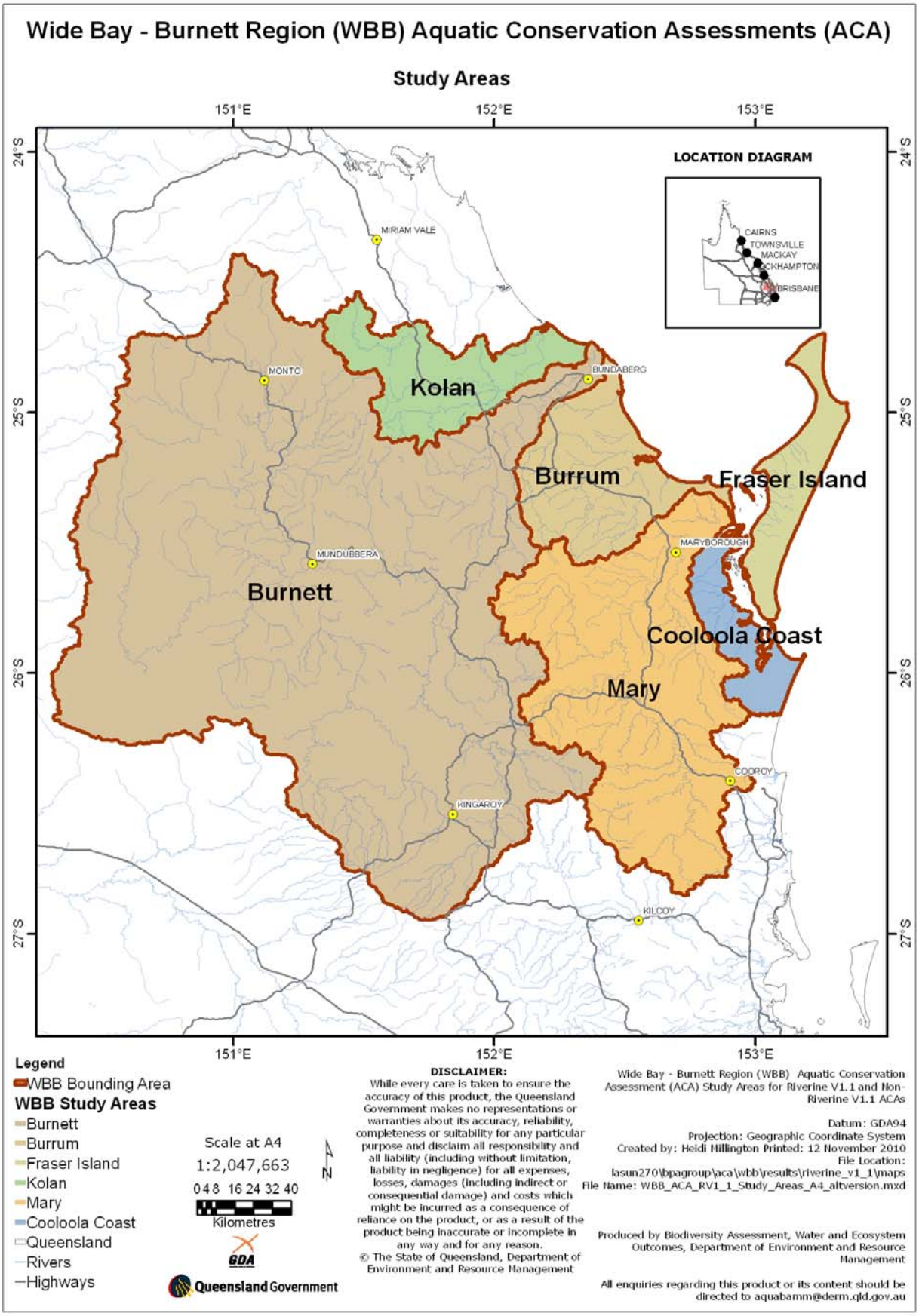

Figure 1: The Wide Bay-Burnett study area

2.2 Panel composition

The expert panel comprised of persons listed in Table 1 who are familiar with non-riverine and riverine wetland ecology, including fish, macroinvertebrates, water quality, hydrology, geomorphology and vegetation, in the Wide Bay-Burnett region.

Table 1: Panel members

Name	Position / Organisation	Expertise
Andrew McDougall	Team leader, Aquatic Ecology South-East Region, Department of Environment and Resource Management	Aquatic flora and fauna
Arthur Knight	Senior Biodiversity Planning Officer, Department of Environment and Resource Management	Wetlands mapping, ecology and function
Brad Wedlock	Mary River Catchment Coordinating Committee	Mary River catchment aquatic ecology and hydrology
Cameron Colebatch	Northern Australia Water Futures Assessment (NAWFA) Aquatic Ecosystems Policy Section Aquatic Systems Health Branch Department of the Environment, Water, Heritage and the Arts	Aquatic systems health
David Scheltinga	Principal Project Officer, Freshwater and Marine Sciences, Department of Environment and Resource Management	Wetlands ecology and function
Glenda Pickersgill	Local landholder and environmental consultant	Mary River cod, water quality, river bank restoration and environmental management
Lee Dorahy	Natural Resource Management Officer, North Burnett Regional Council	Wetlands of the North Burnett
Maria Zann	Scientist, Resource Assessment and Information South-East Region, Department of Environment and Resource Management	Wetlands mapping, ecology and environmental values
Rachel Nasplezes	Wetlands Education Officer, Burnett-Mary Regional Natural Resource Management Group	Wide Bay-Burnett wetlands rehabilitation
Roger Currie	Consultant, Wide Bay Conservation Council	Wide Bay wetlands and regional ecosystems
Steve Burgess	Mary River Catchment Coordinating Committee	Mary River catchment aquatic ecology and hydrology
Trevor Ritchie	Senior Conservation Officer Queensland Parks and Wildlife Service, Department of Environment and Resource Management	Wide Bay-Burnett wetland ecology

Renae Measom, Justin Kingsford and Hari Kishore provided administrative and technical support for the workshop which was facilitated by Steven Howell and Darren Fielder.

2.3 Workshop format

The workshop used an interactive approach of ArcView GIS software to display the Wide Bay-Burnett region and, where necessary, a background of topographic 1:250,000 maps, roads, rivers and other relevant datasets were used to identify areas of interest.

3 Special features

The panel identified several non-riverine and riverine special features in the Wide Bay-Burnett region (Table 2). These were identified for their ecological values. Some special features nominated by either the aquatic flora and/or the aquatic fauna expert panels that were considered to have additional values (e.g. geomorphological or hydrological) were implemented as wetland ecology special features instead.

Each spatial unit that intersected with a particular ecosystem or feature in Table 2 was given a score equal to the conservation rating.

Table 2: Identified special features

Decisions are listed alphabetically by catchment. These features were intersected with the spatial units to identify the values for 'Criterion 5 Priority species' and ecosystems and 'Criterion 6 Special features'. All implemented special features were given a conservation rating of between one and four as assigned by the panel. Decisions that were not able to be implemented due to a lack of readily available data or unconfirmed values are indicated with '_not_implemented' in the decision implementation number column.

Special feature	Identified values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
NON-RIVERINE					
Wetland Assessment	Wetlands suitable for nomination as special features were identified from a BMRG WetlandCare Assessment by recommendation of the Fauna Panel. These areas were referred to the Ecology Panel and where appropriate new ecology decisions were created.	All	na	6.3.3	na

Special feature	Identified values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Wide Bay-Burnett Conservation Council (WBBCC) wetlands assessment	This special feature was originally nominated by the fauna panel. However, the wetland ecology panel noted that this study was more of an inventory than an ecological assessment. WBCC inventoried wetlands within the study area were reviewed post panel and rated in one of six categories: (i) Queensland Wetlands Program (QWP) mapping exists and values warrant identification as a special feature (e.g.) new decision bu_nr_ec_03); (ii) feature is part of an existing panel decision – identified values were added to the relevant decision (see decisions bu_r_ec_03, bu_r_fa_08, bm_nr_fl_01, bm_r_ec_03, bm_nr_ec_01, bm_nr_fl_01, ko_nr_fa_01, bm_r_ec_03 and bm_nr_fl_02; (iii) QWP mapping exists, but the flora expert panel determined that its values did not warrant identification as a special area; (iv) values are present which warrant identification as a special area, but no QWP mapping exists and should be considered for implementation in subsequent versions of the WBB ACA (e.g.37: Pasturage Reserve – paperbark wetlands part of bm_nr_ec_02 –Mon Repos (also identified in the Wetland Assessment decision) and 41AandB: Bundaberg Port Swamp (also the most significant migratory roost in the Burnett with >10 000 birds). (v) no QWP mapping exists but report indicates values are no longer present (e.g. 11A and B, 36, 42, 45, 53); and (vi) estuarine (n/a): (e.g. 46, 48A and B) Note: Where appropriate special features identified by the Wide Bay-Burnett Conservation Council report have been implemented.	All	na	6.3.3	na
South-east of Archookoora State Forest	This wetland was nominated by the flora panel mainly for its significant fauna values (migratory birds including species from the *Environmental Protection and Biodiversity Conservation Act 1999*). The decision was referred to the ecology panel for review. The ecology panel commented that these values require further investigation and post-panel follow up was unable to provide additional information. Due to the lack of further information this decision was not implemented but will be reviewed as part of the next ACA.	Burnett	bu_nr_ec_01_not_implemented	6.3.1	3
Permanently wet wetlands	These wetlands are refugia for non-riverine dependent species in an otherwise relatively dry landscape. Note: This decision also applies in the Mary catchment (decision number my_nr_ec_03).	Burnett	bu_nr_ec_02	6.3.1	2

Special feature	Identified values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Meadowvale	This special feature is a large waterhole along Splitters Creek with fringing Melaleuca. The area contains high fish species diversity (with >12 species tagged including the Australian lungfish (*Neoceratodus forsteri*), Mullet, Australian Bass (*Macquaria novemaculeata)*, Barramundi (*Lates calcarifer*) and high connectivity to the estuary confirmed by the capture of tagged mullet in the estuary and off beaches. This is the largest lagoon within Splitter's Creek (the only remaining major freshwater creek downstream of the barrage with a natural freshwater estuarine interface) and, as such, is an important refuge for large (>600 mm) Australian lungfish (*Neoceratodus forsteri*) that are washed over the barrage and cannot get back upstream through the fishway. The WBBCC inventory notes the presence of melaleuca/palm rainforests that are subject to inundation, in the riparian vegetation. Note: This decision relates to WBBCC wetland 44B.	Burnett	bu_nr_ec_03	6.3.1, 7.5.1	3, 3
Elliott River coastal heaths	This area, which includes the Burrum Coast National Park, has many threatened species and flora values with high coastal wet heath diversity. Values include dense stands of *Melaleuca cheelii* scattered throughout the area and fig trees that provide possible habitat for Coxen's Fig Parrot (*Cyclopsitta diophthalma coxeni*). The area was nominated by the flora panel but underwent a subsequent review by the ecology panel. The wetland ecology panel endorsed this decision and noted the presence of potential Water mouse (*Xeromys myoides*) habitat. The area is mostly wallum with lower lying areas and significant floristic values e.g. *Melaleuca cheelii*, macrozamias. The wetlands contain a large area of intact continuous vegetation types within a variety of habitats. They encompass a transition between landzone 5 (Tertiary Elliott Formation) and landzone 2 (parallel Pleistocene beach ridges and dune barriers) and provide good connectivity to estuarine, marine and saltpan areas. The wetlands are important as constant water sources as wetting remains on site and in soaks during dry periods. The area includes Burrum Coast National Park (Kinkuna section) and Coonarr area including wildflower reserve (WBBCC inventory 47A and 48C). Note: This decision also applies as a riverine decision (decision number bm_r_ec_03).	Burrum	bm_nr_ec_01	6.3.1, 7.5.1	4, 4
Freshwater wetlands at Mon Repos	While this is a highly modified wetland, it is suggested that the hydrology of the wetland is linked with dune moisture content and temperature which are important for nesting/hatching turtles as the sands of the egg chamber must be sufficiently moist to be cohesive enough not to collapse while the chamber is being constructed (Sinclair-Knight Merz 2005). This decision relates to WBB inventory 2001 37 – Pasturage Reserve (which was not implemented in the ACA).	Burrum	bm_nr_ec_02	6.2.1	2

Special feature	Identified values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Waterholes associated with Mahogany Creek	These paperbark waterholes contain threatened species including *Melaleuca cheelii, Eucalyptus hallii* (groundwater dependent), *Macrozamia lomandroides* and species at their northern range limits (e.g. *Callistemon pachyphylla* and *Strangea linearis*). The wetlands are fed by leakage via channels. The decision includes all wetlands within the Bingera National Park, wetlands which also feed the upper Elliott River and discharge from the Elliott aquifer. Waterhole vegetation includes various sedges including *Lepironia articulata* and *Baumea articulate* whilst the wetlands include tea -tree heathland, old-growth Melaleucas, tall Casuarinas, *Banksia robur* and Grevilleas, with a tussock grass understorey. Note: This decision also applies as a riverine decision (decision number bm_r_ec_04).	Burrum	bm_nr_ec_03	6.3.1, 6.4.1	3
Burrum Heads wetlands	This area was originally identified by the flora panel and although it has similar values to decision number bm_nr_fl_02 the area is south of the Burrum and was therefore regarded as a separate system. Review by the wetland ecology panel noted that this was also an ecology decision as seagrass occurring offshore is dependent on groundwater discharges. Seagrass species in this area provide an important food source as a dugong nursery (Sheppard *et al.* 2006, Sheppard *et al.* 2007). Seagrass species in this area (*Halodule* and *Zostera* species) may require lower pore water salinities to germinate. While nutrients or toxicants in groundwater may have a negative influence on seagrass health, the link between seagrass and the hydrology of the wetlands identified here warrants further investigation (Sinclair-Knight Merz 2005). The area also includes habitat for threatened species of wallum frogs including the wallum froglet (*Crinia tinnula*) and the wallum rocketfrog (*Litoria freycineti*). Note: This decision also applies as a flora decision (see decision number bm_nr_fl_03 in the WBB flora expert panel report).	Burrum	bm_nr_ec_04	6.4.1, 7.2.1	4, 4

Special feature	Identified values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Wide Bay military area	This area is relatively undisturbed that includes wallum and wet heath wetlands with significant threatened species (such as the ground parrot (*Pezoporus wallicus*)). The area was originally nominated by the flora panel and reviewed by the wetland ecology panel. The wetland ecology panel noted that a BioCondition assessment has been conducted within the Wide Bay Military Training Area by the BMRG and the Queensland Herbarium. This assessment identified regional ecosystems 12.3.5 (Melaleuca wetlands) and 12.3.11 (Bluegum flats containing palustrine wetlands) as being of class 1 condition relative to benchmarks established for these regional ecosystems within the Wide Bay-Burnett region. These regional ecosystems received overall high scores (≥ 80% of the benchmark) for the measured surrogates of ecosystem function on the Wide Bay Military Training Area (refer to the BioCondition methodology <www.derm.qld.gov.au/services_resources> for further information). Regional ecosystem 12.3.5 adjoins saltpan and therefore the ecotone between these 2 regional ecosystems is likely to be Water mouse (*Xeromys myoides*) habitat (note: Water mouse habitat occurs to the north outside this area). An impermeable clay layer underlies most of the area, creating a high water table (URS Australia Pty Ltd 2000). A pig and dog control program has been implemented over the last few years. The wetland ecology panel decided to extend this decision to include the wetland areas (within remnant vegetation) to the north of the military area as they exhibit similar values.	Cooloola Coast	cc_nr_ec_01	6.3.1	4

Special feature	Identified values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Below sea level wetlands	Important values in relation to the geomorphic/vegetation relationship. Wetlands occur 1m below sea level. The panel suggested evaluating the LiDAR Digital Elevation Model (DEM) values and the values pertaining to the Moore Park wetlands (a better example of this type of wetland in the Burnett / Kolan area) include: the palustrine and estuarine wetlands (regional ecosystem classified 1-50% and full wetland systems) in this area have been recently recognised to lie below the open coast highest astronomical tide tidal plane, and are separated from the closely adjacent marine and tidal systems by low dunes, restricted creeklines, tidal barrages and levees. The wetlands within and behind the coastal dunes provide a good example of wetland systems in the Burnett-Kolan area which are characterised by their relatively low elevation due to highest astronomical tide being reduced in the area due to hydraulic and physical constraints. These wetlands may be at risk of flooding by fresh flood waters or tidal waters as a result of storms, storm surges and/or the increasing effects of climate change on climate systems and sea levels. This may threaten the values and status (e.g. wetland type) of the Moore Park wetlands (for example palustrine wetlands may be at greater risk of salinisation and erosion, and estuarine wetlands for either erosion or accretion than similar wetlands in the Burnett-Kolan area). It should therefore be noted that the conservation value of these below sea-level (very low elevation) wetlands in this Burnett Heads to Kolan area should account for their representation as an important representative of their type in this terrain and geographic location context. It should be noted also that significant proportions of these wetlands have been utilised for agricultural purposes (cane) and grazing and can no longer be considered wetlands. Note: This decision has been specifically applied to the existing Moore Park special feature (decision number ko_nr_fa_01) and hence was not implemented separately.	Cooloola Coast	cc_nr_ec_02_not_implemented	6.1.1	3
Fraser Island lakes	All lakes in Fraser Island were nominated as special features because approximately 40% of the world's perched lakes occur on Fraser Island and the Cooloola sand mass. The Fraser Island short-neck turtle (*Emydura macquarii nigra*) is present in most lakes. A study of the water quality of the lakes found that the clear perched dune lakes were naturally low in nutrients and that chemistry varied highly between lakes, and recommended ongoing water quality monitoring (especially of lakes with high visitation levels) to ensure thresholds are not exceeded (Hadwen 2002). This area was originally nominated by the fauna panel and reviewed by the wetland ecology panel. The flora panel commented on the significant floristic values including reed stands. The wetland ecology panel endorsed this area as an ecology decision and noted that the lakes are one of the defining ecological features of the World Heritage listing.	Fraser Island	fr_nr_ec_01	6.3.1, 6.2.1	4, 4

Special feature	Identified values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Wallum vegetation	This area of flat landscape is similar to wallum landscape on the mainland. The dune system in this location is more recent than the rest of Fraser and is currently in the early dune formation stage. The area has similar values to Kinkuna (decision number bm_nr_fl_01), however it was not implemented in the assessment due to lack of knowledge about the specific values.	Fraser Island	fr_nr_ec_02_not_implemented	na	na
Munna, Eel, Sandy and Teebar Creeks	These are unusual wetlands with a natural rocky base, intermittent streams and deep pools. The area was originally nominated by the fauna panel but underwent review by the wetland ecology panel. The wetland ecology panel noted that these wetlands are ecologically more similar to the Burnett Basin rather than the Mary in which they are situated. The wetlands have aquatic flora values (e.g. *Monochoria* and *Aponogeton* species*)*. Waterbirds use these wetlands. Groundwater linkages here require more scientific investigation. Munna Creek is potentially of high ecological value because of its unusual hydrology—while it can dry out for 3 or 4 consecutive years, there is anecdotal evidence of large cod populations and a need for further cod surveys is required. This decision was endorsed by the ecology expert panel and values copied from the incorrectly attributed Burnett decision - bu_nr_ec_01 and the original Burnett decision were removed.	Mary	my_nr_ec_01	6.1.1	3
Saltwater Creek	This area is a small wetland with high waterbird diversity and nesting sites for threatened species such as Brolgas (*Grus rubicunda*), Jabirus (*Ephippiorhynchus asiaticus*) and *Quassia bidwillii.* While the wetland itself is in good condition, the riparian boundary and surrounding areas are highly impacted. The decision was originally nominated by flora panel, who noted the presence of significant reed beds, and underwent further review by the wetland ecology panel. The wetland ecology panel noted that while the area is surrounded by cane, it has connectivity with the creek and water bird values.	Mary	my_nr_ec_02	6.3.1	3
Permanently wet wetlands	These wetlands are refugia for non-riverine dependent species in an otherwise relatively dry landscape. Note: This decision also applies to the western areas of the Mary catchment subject to stratification (see section 6 of this report) and within the Burnett catchment (decision number bu_nr_ec_02).	Mary	my_nr_ec_03	6.3.1	2

Special feature	Identified values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Garnetts Lagoon and Tandoora Lagoon	These lagoons are freshwater lagoons close to estuarine wetlands with high waterbird and migratory wader bird richness as well as good species diversity. The area boasts higher numbers of waterbird species than the rest of the Great Sandy Strait and surveys by the Qld Wader Study Group have recorded 26 waterbird species present. This area is also a hotspot for migratory and resident shorebirds. Note: This decision was not implemented as further investigation post-panel revealed that both lagoons are classified as artificial wetlands (H3C1) in the Queensland Wetlands Mapping, a classification that is not included in the WBB ACA.	Mary	my_nr_ec_04_not_implemented	5.1.4	4
Kooringa wetland	This wetland is a paperbark and reed swamp wetland of approximately 20 acres on the Mary River flood plain (although the wetland is located at a much higher elevation and is very rarely flooded by the river). While it is surrounded by regrowth and sugar cane, it is geomorphically/hydrologically unique in relation to its location high above the floodplain. The water source comes from either seepage or within a localised catchment. Some *Salvinia* is present.	Mary	my_nr_ec_05	6.4.1	2

Special feature	Identified values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
RIVERINE					
Confluence of Frickey and Barker Creek floodplains	This special feature is a floodplain system that meets just south of the dam and includes the area on the confluence to Frickey Creek and Wattle Camp wetland on Frickey Creek. The special feature was originally nominated by the flora panel for its values for migratory birds and referred to the wetland ecology panel for further review. The decision was made to change it to a wetland ecology special feature although no further information was provided by the wetland ecology panel. Note: This decision is related to a non-riverine fauna decision (decision number bu_nr_fa_03).	Burnett	bu_r_ec_01	5.1.4, 6.3.1	2, 2
Ironpot Creek	This area contains the flora species Toadflax (*Thesium australe*) as well as floodplain, geomorphic and scenic values. The area was originally nominated by the flora panel and underwent further review by the wetland ecology panel. The wetland ecology panel considered that it does not contain significant wetland values, recommending that it not be included.	Burnett	bu_r_ec_02_not_implemented	na	na
Splitters Creek	This creek is the only remaining stream of the Burnett which is open and connected with estuarine areas. It is a Barramundi (*Lates calcarifer*) nursery area and possible refuge for the Australian lungfish (*Neoceratodus forsteri*). Fish barrier restoration is also occurring here. It has a reasonably undisturbed riparian area, big storage areas and relatively intact tributaries. The area was originally nominated by the fauna panel and was referred to the wetland ecology panel for further review. The wetland ecology panel endorsed this as an ecology decision and noted that it has significant riparian zone retention (also noted in the WBBCC inventory (44A, B, C and D)). Note: This decision also applies as a fauna decision (decision number bu_r_fa_08).	Burnett	bu_r_ec_03	6.3.1, 7.5.1	3, 3

Special feature	Identified values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Auburn River Gorge	This area was identified for its special biodiversity and geomorphic values. It was originally nominated by the flora panel and later referred to the wetland ecology panel for further review. The flora panel noted that this is a fairly dry gorge most of the year and is of limited floristic value as the values are considered to be more relation to scenic amenity. The wetland ecology panel endorsed its ecology values noting that it is a series of very deep waterholes in a granite gorge with aquatic fauna values (e.g. the Australian lungfish (*Neoceratodus forsteri)*, turtles, frogs and brush tail wallabies in the riparian area). The gorge is contained to the Auburn River National Park with permanent upstream water holes containing flora and fauna values. Note: This decision was taken from the previous Burnett River Aquatic Conservation Assessment (decision number afep_burn_4a).	Burnett	bu_r_ec_04	6.1.1, 6.3.1	4, 4
Riparian rainforest	The riparian rainforest was identified for its fauna values including habitat for the 'endangered' Coxen's Fig Parrot (*Cyclopsitta diophthalma coxeni*) and the 'vulnerable' Black-breasted Button Quail (*Turnix melanogaster*). The wetland panel suggested that regional ecosystem mapping may be used to locate riparian areas, wherever they occur. The South East Queensland Rainforest Recovery program noted that this is confined to regional ecosystem 12.3.1.The decision was originally nominated by the fauna panel and underwent further review by the wetland ecology panel. The wetland ecology panel noted that this regional ecosystem is most likely to occur at Good Night Scrub, suggesting that Black Breasted Button Quail (*Turnix melanogaster)* records would confirm the presence of rainforest. Threatened flora and fauna associated with this RE include *Xanthostemon oppositifolius, Fontainea rostrata,* Macadamia nut tree (*Macadamia integrifolia*), Gympie nut (*Macadamia ternifolia*), Richmond birdwing (*Ornithoptera richmondii)* and Coxen's fig parrot (*Cyclopsitta diopthalma coxen)*. Note: This decision was taken from the previous Burnett River Aquatic Conservation Assessment (decision number afep_burn_4) and implemented in the Burnett catchment only. It is recommended that the next ACA expert panel consider whether this decision needs to be expanded to all the catchments in the Wide Bay-Burnett.	Burnett	bu_r_ec_05	6.3.1	4

Special feature	Identified values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Natural flowing streams	These streams were nominated because they have a natural undisturbed hydrological regime. Streams included under this decision include the Auburn River, Upper Burnett River upstream of Splinter Creek, Three Moon Creek upstream of Cania Dam, Kroombit Tops, Eastern Creek upstream of Eidsvold, Nogo River upstream of Wuruma Dam, Boyne River upstream of Boondooma Dam, Bunya Mountains catchments (Stuart River and Barker Creek) and Barker Ck.	Burnett	bu_r_ec_06	6.4.1	3
Ephemeral, wide, sandy streams	These streams were nominated because they are distinct ephemeral, wide, sandy streams. Streams included under this decision include the Nogo River,Treventhan Creek, Cattle Creek and upstream of Wuruma Dam.	Burnett	bu_r_ec_07	6.4.1	3
Cadarga Creek	This creek has geomorphic values and is one of the few remaining gorge systems in the region. The area is unlikely to be altered due to the terrain. Its geology consists of laterised sandstone overlying granite and there are several large granite basins (waterholes) which fill with water and sand slugs, as well as sandy creeks. The upper section occurs in cleared Brigalow country although areas associated with this decision are predominantly uncleared. Endemic terrestrial flora or flora species at their range limits are likely to occur within the gorge. The boundary of the decision was compared with high ecological value mapping to ensure that high ecological value waterways were captured.	Burnett	bu_r_ec_08	6.1.1	4
Ben Anderson Barrage	This special feature is located at the top end of the Ben Anderson Barrage. The area is the main nesting site for the white throat snapping turtle (*Elseya albagula*) and this species would be severely impacted if the height of the barrage was raised. Note: This decision also applies as a fauna decision (decision number bu_r_fa_01).	Burnett	bu_r_ec_09	6.3.1	3
Gravelly and Sandy Creeks	These areas are heavily groundwater dependent systems unique to the Burnett area. The creeks are located near Ban Ban Springs and provide persistent waterholes important during drought periods.	Burnett	bu_r_ec_10	6.4.1	3
Bunyip Hole in Selene State Forest	This area contains a deep, permanent riverine waterhole on a section of Three Moon Creek located within the Selene State Forest. Note: It was not possible to implement this decision as it could not be mapped for the purpose of the ACA (location details – 611452.749, 317817.035).	Burnett	bu_r_ec_11_not_implemented	na	na

Special feature	Identified values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Elliott River estuarine connectivity	The Elliot River maintains intact connectivity between estuarine and freshwater systems essential for diadromous fish migration. The decision was originally nominated by fauna panel and underwent review by the wetland ecology panel. The wetland ecology panel endorsed this as an ecology decision and noted that the area of interest is close to the river mouth. With 30 -50 % of the water inflow coming from ground water, providing for the persistence of the water holes, this area is of significant ecological value (CSIRO 2009; DERM 2009; Sinclair-Knight Merz 2005). Note: This decision also applies as a fauna decision (decision number bm_r_fa_03).	Burrum	bm_r_ec_01	7.5.1, 6.4.1	4, 4
Cherwell River and Stockyard Creek estuarine connectivity	The Cherwell River maintains intact connectivity between estuarine and freshwater systems, essential for diadromous fish migration. Melaleuca wetlands along drainage lines of the Cherwell river include *Melaleuca cheelii* and riverine drainage lines in the area support species with restricted range (e.g. the vulnerable *Eucalyptus hallii)* or approaching northern range limits (e.g. *Strangea linaris)*. This area was originally nominated by the fauna panel and underwent further review by the wetland ecology panel. The wetland ecology panel noted that the Cherwell River and Stockyard Creek contain different fish assemblages from the other tributaries in the Burrum catchment located below the weir.	Burrum	bm_r_ec_02	7.5.1, 6.3.1	4, 4

Special feature	Identified values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Elliott River coastal heaths	This area, which includes the Burrum Coast National Park, has many threatened species and flora values with high coastal wet heath diversity. Values include dense stands of *Melaleuca cheelii* scattered throughout the area and fig trees that provide possible habitat for Coxen's Fig Parrot (*Cyclopsitta diophthalma coxeni)*. The area was nominated by the flora panel but underwent a subsequent review by the ecology panel. The wetland ecology panel endorsed this decision and noted the presence of potential Water mouse (*Xeromys myoides)* habitat. The area is mostly wallum within lower lying areas and contains significant floristic values e.g. *Melaleuca cheelii*, macrozamias. The wetlands contain a large area of intact continuous vegetation types within a variety of habitats. They encompass a transition between landzone 5 (Tertiary Elliott Formation) and landzone 2 (parallel Pleistocene beach ridges and dune barriers) and provide good connectivity to estuarine, marine and saltpan areas. The wetlands are important as constant water sources as wetting remains on site and in soaks during dry periods. The area includes Burrum Coast National Park (Kinkuna section) and Coonarr area including wildflower reserve (WBBCC inventory 47A and 48C). Note: This decision also applies as a non-riverine decision (decision number bm_nr_ec_01) and is related to a flora non-riverine decision (decision number bm_nr_fl_01).	Burrum	bm_r_ec_03	6.3.1, 7.5.1	4, 4
Waterholes associated with Mahogany Creek	These waterholes are paperbark waterholes fed from leakage via channels and include the presence of the threatened species including *Melaleuca cheelii, Eucalyptus hallii* (groundwater dependent), *Macrozamia lomandroides* and species a the northern limit of their range including *Strangea linearis* and *Callistemon pachyphylla*. Wetlands within Bingera National Park). These areas are also in relatively good condition and provide an important recharge and discharge function in the headwaters of the Elliott River and Elliott aquifer (WBBCC inventory 43). Note: This decision also applies as a non-riverine decision (decision number bm_nr_ec_03).	Burrum	bm_r_ec_04	6.3.1	3
Teewah Creek	This tributary of the Noosa River is noted for its rich macroinvertebrate composition, high fish species diversity and intact riparian vegetation. While some water extraction occurs, its values remain relatively intact.	Cooloola Coast	cc_r_ec_01	6.3.1	4

Special feature	Identified values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Harry's Gulch	This tributary of the Noosa River is the main source of water for Teewah Creek and the upper Noosa River. It is a groundwater fed system discharging from dunes to the east.	Cooloola Coast	cc_r_ec_02	6.4.1	4
Eli Creek	This creek is the only stream of its magnitude flowing to the east side of Fraser Island, discharging across the dunes and beach. The creek is large enough to have its own aquatic ecosystem associated with it. It occurs within a confined catchment and is permanently flowing. Jungle perch (*Kuhlia rupestris*) have been recorded here and the creek contributes to one of the few remaining populations of jungle perch. The species that occurs in this location are a unique genetic subspecies found on the eastern side of Fraser Island. It's possible that this may be a unique attribute for other fish found in the area as well.	Fraser Island	fr_r_ec_01	6.2.1,6.4.1	4, 4
Persistent waterholes associated with the Kolan River	The permanent waterholes above Bucca Weir are some of the few remaining waterholes on the Kolan and provide refugia for wildlife. They are the only example of deep semi-natural waterholes in the Kolan and upstream of Fred Haig Dam the waterholes are less persistent.	Kolan	ko_r_ec_01	6.3.1	3
Headwaters of the Kolan	These reaches of the Kolan River include alluvial flats with reasonable examples of regional ecosystem 12.3.3 regrowth, on mostly freehold land. This section of river is positioned between the highlands creating a contained catchment that boasts some permanent waterholes. The area, however, is also subject to some invasion by Cats claw creeper (*Macfadyena unguis-cati*).	Kolan	ko_r_ec_02	6.3.1	3
Bucca reach	This reach is the only remaining habitat with a pool riffle sequence within the Kolan. It includes the section below Fred Haig Dam to the top end of the barrage, only sustained through release from Bucca weir. It has a diverse fish community, and its values are only maintained with environmental flows. The riparian area is impacted by Cats claw creeper (*Macfadyena unguis-cati*), but in-stream habitat includes good Vallisneria beds.	Kolan	ko_r_ec_03	6.3.1, 6.2.1	4, 4

Special feature	Identified values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Susan River estuarine connectivity	The Susan River catchment is notable for its intact connectivity between estuarine and freshwater systems which is important for diadromous fish migration. This area was originally nominated by the fauna panel subsequently reviewed by the wetland ecology panel, who endorsed it as an ecology decision. The wetland ecology panel noted that the Susan River has similar geology and systems to the Cherwell River in that it drains to the RAMSAR boundary, has similar wallum wetland system, good fish habitat at the bottom end of the system and intact catchment values. Acid frog habitat occurs within the upper catchment wetlands and Melaleuca wetlands occur along most of the drainage lines. Its upper catchment has unusual geology with perched wetlands located on landzone 5 (similar to Cherwell River values). The wetland ecology panel also observed that an improvement in wetlands mapping is required in the Upper Susan River catchment.	Mary	my_r_ec_01	7.5.1, 6.3.1	4, 4
Pools, riffles and sand bars	Pool, riffle and sand bar sequences commence above the upper end of the Mary barrage impoundment, but also occur upstream chiefly along the main trunk of the Mary River. Pool, riffle and sand bar sequence ecosystems has been nominated as an endangered ecosystem under the *Environmental Protection and Biodiversity Conservation Act 1999*, for its geomorphological values, transient, dynamic nature and diversity of special ecological processes. Fauna utilising these sequences include the Mary River Cod (*Maccullochella peelii mariensis*) (pools), Mary River Turtle (*Elusor macrurus*) (pool, riffles and sandbar) and the Australian lungfish (*Neoceratodus forsteri*). The wetland ecology panel recommended that known locations be captured by selecting: (i) nine deep pools monitored by the DERM Aquatic Ecosystems group; and (ii) areas within the lowland reaches of the main branch of the Mary, where pool/riffle/sand bars ecosystems have been previously identified by DERM during the identification of High Ecological Value areas in 2004. The Mary River turtle (*Elusor macrurus)* is dependent on pools for adult habitat, riffles for juvenile habitat associated with their macroinvertebrate diet, and sand bars for nesting habitat (Flakus and Connell 2008). There was some discussion during the wetland ecology panel that sequences of pools, riffles and sand bars can apply to the whole catchment and this is a representative example of the values. This area was originally nominated by the fauna panel and was reviewed and endorsed by the wetland ecology panel as both an ecology and fauna decision. The wetland ecology panel also noted that these ecosystems are on the current federal priority list. Note: This decision also applies as a fauna decision (decision number my_r_fa_07).	Mary	my_r_ec_02	6.3.1, 6.2.1	4, 4

Special feature	Identified values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Myrtle Creek (also encompassing Aramara and Teebar Creeks)	This area of riparian wetlands in a western Mary catchment occur mostly within forestry areas however they are in good condition and have retained good longitudinal connectivity. These wetlands have important values including shallow lagoons and wallum-style wetlands on a sandy base. Species present include Melaleuca, reed, acacia and banksia species. This area was originally nominated by the fauna panel but underwent further review by the wetland ecology panel. This decision also includes wetlands and lagoons along drainage lines within Aramara and Teebar Creek catchments. These wetlands are high in native fish diversity (e.g. Purple-spotted and Firetailed gudgeons(*Mogurnda adspersa* and *Hypseleotris galii* respectively), Australian smelt (*Retropinna semoni*) and flyspecked hardiheads (*Craterocephalus stercusmuscarum)*). Wetland plants recorded in the area include the Giant water lily (*Nymphaea gigantea*) and the Water snowflake (*Nymphoides indica*). Bird species present include Jabiru (*Ephippiorhynchus asiaticus)*, black swans (*Cygnus atratus)*, magpie geese (*Anseranas semipalmata*) and other wader species. The wetland ecology panel also noted that this area contains potential turtle and Australian lungfish (*Neoceratodus forsteri*) habitat as well as sandy wallum vegetation, that is unusual this far west.	Mary	my_r_ec_03	6.3.1	3
Mt Walsh National Park rock pools	The values outlined for this area are primarily associated with the Coongarra Falls rock pools at the headwaters of Sandy Creek. This series of small rock pools leading to one big pool within big open granite slabs is different geologically and ecologically, maintaining a constant water source during dry periods. The water level also remains constant. The pools contain freshwater fish (not yet surveyed) and riparian vegetation is high in regional ecosystem diversity including hoop pine, vinescrub, riparian vegetation and regional ecosystem 12.3.3.	Mary	my_r_ec_04	6.1.1	4
Kinbombi Falls	This area is a unique gorge with permanent water in a dry landscape, occurring on the Brisbane-Barambah volcanics, an area that is geologically distinct within the Mary. Kinbombi Creek captures part of an adjoining sub-catchment and the waterfall feature located in this area is rare within the Mary catchment.	Mary	my_r_ec_05	6.1.1	4

Special feature	Identified values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Tinana and Coondoo Creeks	Tinana and Coondoo Creeks are important Mary River cod (*Maccullochella peelii mariensis*) habitat and are one of two areas left unstocked. The area is identified as an area of high ecological value (HEV) and values listed in the HEV report (EPP Water 2009) include the only self-sustaining naturally occurring populations of cod in the Mary catchment (and Qld), supports Ornate Rainbow (*Rhadinocentrus ornatus*), Honey Blue Eye (*Pseudomugil mellis*) and Oxleyan Pygmy Perch (*Nannoperca oxleyana)*. In-stream and riparian habitat are natural, intact and high in quality, although it is naturally low in fish and aquatic plan species richness. Threatened species of frog include the Giant barred (*Mixophyes iterates*) and wallum frogs. Water quality is good upstream of the impoundments although pH levels are low. This area was originally nominated by the fauna panel and later reviewed by both the flora and wetland ecology panes. The flora panel commented that there are significant macrophyte beds as well as being is a centre of *Quassia bidwillii* distribution. The wetland ecology panel endorsed this as an ecology decision and noted its value as a complete functioning system with reasonable riparian buffers. Note: This decision also applies as a fauna decision (decision number my_r_fa_03).	Mary	my_r_ec_06	6.3.1, 6.4.1	4, 4

4 Connectivity

The panel members were asked to develop and/or identify a set of principles that could be applied to determine relative connectivity scores of non-riverine and riverine spatial units within the Wide Bay-Burnett region.

4.1 Importance of connectivity

There was broad agreement by the panel that the concept of connectivity is important, and it is directly or indirectly linked to most facets of aquatic ecology, geomorphology and water quality. The scientific literature reviewed for the AquaBAMM program reflects this view. The ecological value of a particular reach of river is directly linked in quantity and quality to the movement both up and downstream (and between adjoining terrestrial lands) of resources such as water, sediment and debris and recruitment and distribution of species (Cullen 2003).

An inherent connectivity (or lack of connectivity in drier periods) is a significant feature of fresh waters. In arid-zone systems, and floodplains, the irregular flow regime and sporadic connectivity underpins the conservation of the instream and floodplain wetland biota such as the invertebrate assemblages (Sheldon *et al.* 2002). Similarly, this relationship is evident for maintaining the health and productivity of end-of-river estuarine systems (Cullen 2003).

A largely unknown and unseen linkage occurs within the hyporheic zone between surface waters and groundwater ecosystems sustaining many endemic or relictual invertebrate fauna (Boulton *et al.* 2003).

The panel discussed the importance of connectivity for species adaption and survival in relation to the effects of climate change. The panel felt it was difficult to specifically categorise and measure the importance of particular aspects of connectivity in relation to climate change as the effects of climate change are so broad and will impact on all systems and species. The panel commented that sea level rise will significantly impact on whole ecosystems containing low-lying wetlands such as consequential flooding of the patterned fens on Fraser Island and along the Cooloola coast. Increased temperatures will result in the drying of areas containing wetlands, and replacement by weeds and rainforest species. Maintenance of connectivity between wetlands will be critical as this will provide the resilience needed to ensure species migration routes are retained. For example, the coastal wetland aggregations from Elliot Heads south to Beelbi Creek and the Great Sand Strait from Poona to Cooloola National Park. The panel specifically noted the importance of maintaining riparian vegetation to provide the necessary shading required to counter act the effects of increases in temperature on the reproductive habits of freshwater turtles and the Mary River cod. It was also noted that inland gorges, such as in the Bunya Mountains are important as climatic refugia.

4.2 Applying principles for measuring connectivity

The practicalities of measuring connectivity in a riverine environment are complex making general principles difficult to develop and implement. Connectivity in its broadest meaning incorporates hydrological processes (quantity and quality, temporal and spatial variability), organism dispersal (barriers) and disturbances from natural conditions. Connectivity can be bi-directional movements within a stream (e.g., fish passage), uni-directional contribution to a downstream spatial unit or special area, or lateral connectivity to floodplain wetlands or groundwater ecosystems. These aspects of connectivity combine to provide a matrix of competing and differing values from an ecological conservation viewpoint.

4.3 Fish passage (riverine)

The principles for the fish passage connectivity rating (measure 7.1.2) developed by the riverine ecology expert panel from the Burnett River Aquatic Conservation Assessment (Clayton *et al.* 2006) were tabled at the wetland ecology expert panel workshop.

Under this methodology, the agreed assumption was that barriers lower in the catchment have more impact on total fish movements then those in upper reaches of the catchment. There was also recognition that each barrier can be rated according to its relative level of fish passage. The steps outlined below are used to calculate a connectivity score for each spatial unit.

Step 1: Each stream segment was scored for its intrinsic connectivity according to its stream order when mapped at a scale of 1:100,000.

An intrinsic connectivity value for each stream segment can be calculated from a fish migration point of view. The higher the stream order, the higher its intrinsic connectivity score for fish species. Table 3 provides the scoring system using the stream order of each stream segment.

Table 3: The intrinsic connectivity score for streams

Stream order was calculated using the buffered stream network at a scale of 1:100,000.

Stream order	Intrinsic connectivity score
1	1
2 and 3	2
4 and 5	3
>5	4

Step 2: Modify the intrinsic connectivity score using the fish passage rating for each barrier.

DEEDI rated the major instream barriers in the Burnett catchment for their ability to allow fish passage both up and down the stream based on the storage height at the spillway. Only artificial barriers were considered for a fish passage rating. This fish passage rating was then subtracted from the intrinsic connectivity score to provide a connectivity score for each segment of stream within a spatial unit as shown below:

Connectivity score (CS) = Intrinsic connectivity score (ICS) – Fish passage rating (FPR)

For example, the ICS score for a river segment having a stream order of six would be four, and if a barrier exists on this river reach, its FPR score would be two; resulting in an overall CS score of two (under measure 7.1.2) for the spatial unit (i.e., ICS – FPR = 4 – 2 = 2).

Rules for calculating the connectivity score:

- the CS cannot be lower than one
- a spatial unit's CS pertains to the highest stream order present in the unit
- where there is no barrier within a spatial unit, the ICS for the highest stream order is used as the CS.

Table 4 provides the calculation matrix for each combination using the rules outlined below.

Table 4: Calculation matrix for the connectivity score (7.1.2)

	Fish passage rating (FPR)			
Intrinsic connectivity Score (ICS)	**No barrier Present**	**1 Good**	**2 Moderate**	**3 Poor**
1 (Low)	1	1	1	1
2 (Medium)	2	1	1	1
3 (High)	3	2	1	1
4 (Very high)	4	3	2	1

These ratings were used to score the fish passage connectivity for the AquaBAMM measure 7.1.2.

The panel discussed various methods for determining riverine connectivity in relation to fish passage and barriers and agreed that this method was not sufficient for implementation within all areas of the Wide Bay-Burnett region. It was decided that rather than score fish passage connectivity according to the connectivity matrix above, a combination of barrier indexes contained within the Burnett Mary Regional Biopass Strategy (for small barriers) and assessments by DEEDI (for large barriers such as dams and weirs) should be used to assess fish passage connectivity. It was also noted by the panel that the Paradise Dam and Kirar Weir are additional barriers in the Burnett.

The additional DEEDI data was not obtained in time for inclusion in this ACA. However the Biopass Strategy data was received and processed. This was supplemented with the fish passage ratings allocated by DEEDI in the previous Burnett Riverine ACA, and with other Dams and Weirs from the DERM Dams and Weirs layer outside of the Burnett catchment, as well as Paradise Dam and Kirar Weir.

The full list of fish barriers used under measure 7.1.2 for the Wide Bay-Burnett region is obtainable from the Department of Environment and Resource Management by forwarding an email to <aquabamm@derm.qld.gov.au>.

4.4 Connectivity between riverine and non-riverine wetlands

Lateral connectivity between the aquatic riverine system and adjacent ecosystems was recognised by the panel as an important value. The panel members deliberated on several models or methods to assess the level of lateral connectivity between the riverine and non-riverine wetlands. The practicalities of measuring connectivity between wetlands are complex making general principles difficult to develop and implement.

The panel discussed the difficulty in differentiating between those wetlands that have more value in contributing to riverine connectivity. In relation to measure 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) it was suggested to assign floodplain wetlands a higher connectivity value than those that are not a floodplain wetland. This could be implemented using floodplain information contained within current wetland mapping. In this instance, and in the absence of more defining data, wetlands associated with a floodplain should be given a score of two. However, this suggestion was not able to be implemented due time constraints and will be considered as part of the next Wide Bay-Burnett ACA.

Riverine subsections that contain a non-riverine wetland with a value of four for measures 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.) and 6.3.3 (Ecologically significant wetlands identified through expert opinion and/or documented study) will be assigned a connectivity value of four for measure 7.3.1. The connectivity value of Coulston Lake was discussed specifically and it was agreed not to apply measure 7.3.1 to the riverine subsection as there is no immediate connectivity between the lake and riverine systems.

The panel agreed that within a Directory of Important Wetland (DIWA) listed wetland, any individual non-riverine wetland that has the majority of its area (e.g. >50%) either located within the DIWA polygon, or intersecting the same subsection that contains a DIWA, will be scored a four for measure 7.3.2 (Extent to which the wetland retains critical ecological and hydrological connectivity, where it should exist, with floodplains, rivers, groundwater, etc.).The connecting subsections are not attributed a score as there is a loss of confidence in the connectivity value.

4.5 Connectivity between freshwater and estuarine wetlands

Connectivity between freshwater wetlands (riverine and non-riverine) and estuarine ecosystems was also recognised by the panel as being important. The panel members discussed several methods for assessing the lateral connectivity of freshwater and estuarine wetlands and agreed that anything that is connected hydrologically and/or biologically to estuarine areas should be given a higher connectivity rating.

The importance of seagrass beds (believed to be a groundwater dependent ecosystem in the Wide Bay-Burnett region, particularly around the Burrum Heads township and Kinkuna National Park) for dugong, was noted by the panel. However, it was recognised that the functional relationship between coastal wetlands and seagrass beds requires further investigation before assumptions can be made about their connectivity value.

The impacts that barrages pose to freshwater and estuarine wetland connectivity was also discussed. The panel agreed that riverine systems without a barrage should score higher than those systems with a barrage. As part of measure 7.5.1 (The contribution of the spatial unit to the maintenance of estuarine and marine ecosystems with significant biodiversity values, including those features identified through Criteria 5 and/or 6), riverine subsections containing estuarine wetlands without a barrage were scored a four, with the next subsection upstream also scoring a four until the stream order changed. Each progressive drop in stream order subsequent to this, dropped the score progressively by one. Scoring continued upstream and stopped when a barrage occurred.

As part of measure 7.5.1 (The contribution of the spatial unit to the maintenance of estuarine and marine ecosystems with significant biodiversity values, including those features identified through Criteria 5 and/or 6), the panel suggested that wherever there is an estuarine mapped wetland including water bodies and regional ecosystems, without a barrage within a subsection, the non-riverine wetlands are assigned a score of four within that subsection. The non-riverine wetlands within the next upstream subsection are then assigned a three, then a two, then a one. If the upstream subsections contained a barrage then the scoring stopped. Additionally, where a subsection included an estuarine wetland and a barrage, the non-riverine wetlands within that subsection would score a two and the next subsection upstream would score a one. Again, if the upstream subsections contained a barrage then the scoring stopped. This approach was subsequently implemented as part of the Wide Bay-Burnett ACA.

The panel also discussed estuarine connectivity on Fraser Island. The panel decided that because many of the rivers on Fraser Island do not change stream order or cross catchment boundaries, further investigation was required to establish whether the rules discussed above should apply. It was then decided post-panel to apply the same rules to Fraser Island.

4.6 Connectivity between freshwater wetlands and groundwater

Connectivity between freshwater wetlands (riverine and non-riverine) and groundwater was also recognised by the panel as being important. The panel members discussed several methods for assessing the connectivity of freshwater and groundwater systems and agreed that anything that is connected hydrologically and/or biologically to groundwater areas should be given a higher connectivity rating.

For subsections with a rating of four for measure 6.4.1 (Presence of distinct, unique or special hydrological regimes e.g. Spring fed stream, ephemeral stream, boggomoss), the next subsection upstream scored a four, the next subsection upstream a two, and the next subsection upstream a one. If a subsection had been nominated by the wetland ecology panel as having a value for measure 7.2.1 (The contribution (upstream or downstream) of the spatial unit to the maintenance of groundwater ecosystems with significant biodiversity values identified through Criterion 5 and/or 6.), then the next subsection upstream scored a four, the next a three, then two and then one. The subsection with a value for measure 7.2.1 did not receive a connectivity value itself, only those subsections upstream. This was implemented for both riverine and non-riverine assessments.

In addition the panel demonstrated aspects of a new hydrology information system to characterise hydrological processes within ecoregions (e.g. sub-basins within sub-bioregions) to support wetland management. The approach was supported by a state-wide data base that is accessible through the DERM Wetland*Info* web facility. The intention was to release the information freely to support the appropriate selection of satellite imagery to characterise flood significance by rating against historical records; and to characterise hydrological processes and conditions relevant to wetland filling, including seasonality (within year variation). The method achieves this by attributing time series rainfall, runoff, stream flow and height information by reference and benchmark information, which reveals the variation (emergent hydrological regimes) in water supplies within year (for dry, median and wet reference regimes) and between year for a regime.

It was suggested that this rich suite of statistics be used to identify catchment areas with different levels of water stress. Some aquatic stressors become apparent when flows are reduced or stopped and aquatic biological products and human pressures result in an increasing number and magnitude of impacts, such as a reduction in oxygen levels. Aquatic weeds are used to provide an example of stress outcomes (e.g. in some pools in the Mary River) because aquatic weeds often have a competitive advantage when flows are reduced and pressures increase.

In areas where stream systems are characterised by losses to ground water and or water extraction, it was suggested that permanent wetlands and pools may provide vital refugia and connectivity for wildlife. This information and data was not used for this ACA, however at a future date the hydrological characterisation tools may link to the ACA process, providing information to improve the scoring of the importance of wetland inundation processes and inundation permanence. The method is also expected to be used to profile wetland inundation processes, which will inform assessments of wetland aquatic connectivity. The outcomes from these future projects may be used to inform the ACA connectivity assessment and scoring process in the future.

The method uses simple statistics and is evidence based, so that the relationships between hydrological statistics and wetland processes are associative and not determined (mathematically predictable). Models that determine stream flows and potential floodplain wetland filling quantities include the Integrated Quality Quantity Model (IQQM), which is used by DERM to determine in-stream environmental flows to regulate reservoir releases. Deterministic models are unable to characterise the wetland filling processes for many wetland types and locations across Queensland, and this is why the presented evidence based approach is required. The sub-basins and mapping used by the method is concordant with DERM attribution, so standard period of record stream flow information obtained from DERM or the Bureau of Meteorology can be compared with the evidence based approach for comparable areas.

4.7 Connectivity of special features

The panel members were also asked to develop principles for scoring connectivity for special features such as waterfalls, macrophyte beds, significant instream habitats, and other areas or features identified through expert opinion. This question primarily relates to uni-directional connectivity, i.e. quantity or quality of flow to a downstream special feature.

The principles for assessing connectivity values for special features (measures 7.1.1 and 7.2.1) developed by the riverine ecology expert panel from the Burnett River Aquatic Conservation Assessment (Clayton *et al* 2006) were tabled at the panel workshop. The panel considered implementing the "Model 4 Inverse exponential scoring of spatial units upstream" method for the Wide Bay-Burnett region. This model is presented below.

Inverse exponential scoring of spatial units upstream.

This model uses the spatial units rather than a distance to determine how they are scored. Every contributing spatial unit above a particular special feature was logarithmically scored with the spatial units immediately upstream of a special feature being scored a four, the next adjoining upstream spatial units received a score of two and the remainder above a special feature were scored a one. The spatial unit having the special feature located within it would not receive a score because it was already scored in Criterion 6. Where a spatial unit had more than one calculation (i.e. overlapping scores), the maximum value was incorporated.

This model better reflects the importance of spatial units immediately above a special feature by applying a logarithmic threshold to scoring. It is also an efficient and practical application of a complex issue. A disadvantage of this model is that it treats all special features (e.g. macrophyte bed, geomorphological feature, hydrological feature) equally where there may be reasons to differentiate between them. Also, this model can result in some variation of the real distances upstream of a special feature being scored.

While the panel endorsed using the inverse exponential scoring model for the Wide Bay-Burnett, a variation was recommended to reflect the importance of connectivity to a special feature within the immediate subsection. The panel recommended applying a score of four to the subsection containing the special feature, and then a decreasing score by one as the subsections move further from the special feature subsection (e.g. 4, 3, 2, and 1). As the intent of this measure is to assign connectivity values to the subsections that are connected to the special feature, the measure was implemented to assign connectivity values to only those subsections that 'connect to' the special feature subsection, not the special feature subsection itself. The decrease in score by one as the subsection changes is a variation to the standard method (e.g. 4, 2, and 1) and has been implemented for the Wide Bay-Burnett.

Therefore, for measure 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), the riverine subsection upstream from subsections was allocated a value of four. For measures 5.1.4 (Habitat for significant numbers of waterbirds) ,6.3.1 (Presence of distinct, unique or special habitat (including habitat that functions as refugia or other critical purpose), or 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.) was assigned a connectivity value of four. The next subsection upstream was assigned a three; the next upstream subsection a two and the next upstream subsection a one.

5 Modelled natural flows

Cullen (2003) proposed an Australian river classification based solely on flow extractions from rivers (Table 5). He argued that flow diversion is the most important threatening process, and one that is easily understood and managed. Cullen (2003) believed a flow classification could be useful in water planning in Australia. These flow extraction thresholds were used as thresholds for the AquaBAMM measure 1.4.2 “Percent natural flows – modelled flows remaining relative to predevelopment”.

Table 5: Australian river classification

River class	**Per cent mean annual flow**	**Subsection rating for measure 1.4.2**
Heritage river	>95%	4
Conservation river	85 – 95%	3
Sustainable working river	67 – 85%	2
Managed working river	<67%	1

To determine how this classification related to each catchment and its spatial units, DERM hydrology experts in the IQQM hydrological model were consulted. For each spatial unit of a catchment the hydrologists were asked to allocate an appropriate class (Table 5) related to modelled extraction data for the relevant gauging station within the spatial unit. A value of four (heritage river) was allocated to any spatial unit which was upstream from those with heritage river rating of four and for spatial units without hydrological modification. Through this exercise, the flow classes above represent only broad-scale trends with spatial boundaries between classes necessarily approximate. The per cent natural flow class of the highest stream order within a spatial unit was assigned to all of the other streams within a spatial unit.

6 Stratification

Study area stratification for application to relevant measures of AquaBAMM is a user decision and is not mandatory for a successful assessment. However, AquaBAMM makes provision for data to be stratified in any user-defined way that is determined to be ecologically appropriate. Stratification mitigates the effects of data averaging across large study areas, and is particularly important where ecological diversity and complexity is high. An example where stratification may be appropriate is fish diversity where fewer species inhabit the upland zone compared to lowland floodplains. For measure datasets where there is an equal probability of scoring across a range of values throughout the study area, stratification is unwarranted. To date, the use of strata in completed ACAs has been based on elevation (e.g. 150 m (ASL) for coastal flowing catchments and 400 m ASL for catchments west of the Great Dividing Range in the Murray-Darling Basin) or bioregional boundaries.

Stratification was considered by the Wide Bay-Burnett expert panels. The panels considered applying a 150 m ASL stratification boundary similar to that used in previous ACAs. However, an additional stratification boundary was recommended by the fauna panel which also included the lowland subsections in the western part of the Mary catchment (a much drier area than the remainder of the Mary that was considered to result in a different ecology). After further consideration by the wetland ecology panel a final decision was made to apply a combination of the 150 m ASL stratification boundary line and the additional boundary line recommended in the western Mary as the means through which stratification was implemented within the Wide Bay-Burnett region.

Therefore, subsections above the 150 m ASL and those contained within the western part of the Mary catchment were assigned as upland subsections. Conversely, subsections below 150 m ASL and outside the western part of the Mary catchment were assigned as lowland subsections.

Based on these rules there was no stratification for the Burrum, Noosa North and Fraser Island study areas. In the Kolan there was only one non-riverine wetland (ko_w00075) in the western part of the study area that appeared in the upland zone. Having only one wetland (or subsection) in a stratification zone skews the calculations and as the non-riverine wetland was close to the upland/lowland boundary, it was decided not to stratify as part of the non-riverine ACA for the Kolan catchment.

7 Weighting of measures

The panel members and project officers that attended the three expert panel workshops weighted the measures within each indicator. Measures were weighted according to their importance to an indicator and based on the following rules:

- at least one measure within each indicator must be weighted 10 which is the highest weighting
- the 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.

The individual weights were averaged and reviewed with particular attention to averages having a high variance. In order to improve the statistical reliability of the final weights it was decided to average the weights across the entire Wide Bay-Burnett region, rather than average the weights for each study area/catchment.

The final weights for each measure were then applied in the AquaBAMM assessment (Table 6). The measure number in Table 6 relates to the hierarchical approach of the AquaBAMM method. The first number refers to a criterion and the second number to an indicator within a criterion followed by the individual measure number.

There are a number of different methods for eliciting expert information, however many of these can become very complicated and time intensive. The benefits of refining the weights through a more detailed method were considered minimal. The result from the approach adopted at the workshop was considered by the AquaBAMM development team to accurately reflect the expert panel's decisions.

Table 6: The average weights for each non-riverine measure

Maximum score is 10; total number of participants was approximately 17.

Criteria and Indicators	Measures		Weight
1 Naturalness Aquatic			
1.1 Exotic flora/fauna	1.1.1	Presence of 'alien' fish species within the wetland	9.0
	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	8.3
	1.1.4	Presence of feral/exotic vertebrate fauna (other than fish) within the wetland	8.7
1.4 Hydrological modification	1.4.5	Hydrological disturbance/modification of the wetland (e.g. as determined through EPA wetland mapping and classification)	9.5
2 Naturalness Catchment			
2.1 Exotic flora/fauna	2.1.1	Presence of exotic terrestrial plants in the assessment unit	10.0
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	10.0
2.3 Catchment disturbance	2.3.1	% "agricultural" land-use area (i.e. cropping and horticulture)	9.0
	2.3.2	% "grazing" land-use area	8.9
	2.3.3	% "vegetation" land-use area (i.e. native veg + regrowth)	9.1
	2.3.4	% "settlement" land-use area (i.e. towns, cities, etc)	9.8
2.4 Flow modification	2.4.1	Farm storage (overland flow harvesting, floodplain ring tanks, gully dams) calculated by surface area	9.4
3 Diversity and Richness			
3.1 Species	3.1.2	Richness of native fish	9.5
	3.1.3	Richness of native aquatic dependent reptiles	9.5
	3.1.4	Richness of native waterbirds	9.3
	3.1.5	Richness of native aquatic plants	9.6
	3.1.6	Richness of native amphibians (non-riverine wetland breeders)	9.6
	3.1.7	Richness of native aquatic dependent mammals	9.1
3.2 Communities/ assemblages	3.2.1	Richness of macroinvertebrate taxa	9.8
3.3 Habitat	3.3.2	Richness of wetland types within the local catchment (e.g. SOR subsection)	8.9
	3.3.3	Richness of wetland types within the sub-catchment	9.3
4 Threatened Species and Ecosystems			
4.1 Species	4.1.1	Presence of rare or threatened aquatic ecosystem dependent fauna species – NCAct, EPBCAct	9.9
	4.1.2	Presence of rare or threatened aquatic ecosystem dependent flora species - NCAct, EPBCAct	9.9
4.2 Communities/ assemblages	4.2.1	Conservation status of wetland Regional Ecosystems – Herbarium biodiversity status, NCAct, EPBCAct	10.0
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	9.8
	5.1.3	Habitat for, or presence of, migratory species (Expert Panel list/discussion and/or JAMBA / CAMBA agreement lists and/or Bonn Convention)	9.3
	5.1.4	Habitat for significant numbers of waterbirds	8.8
5.2 Ecosystems	5.2.1	Presence of 'priority' aquatic ecosystem	10.0
6 Special Features			
6.1 Geomorphic features	6.1.1	Presence of distinct, unique or special geomorphic features	10.0

Criteria and Indicators	Measures		Weight
6.2 Ecological processes	6.2.1	Presence of (or requirement for) distinct, unique or special ecological processes	10.0
6.3 Habitat	6.3.1	Presence of distinct, unique or special habitat (including habitat that functions as refugia or other critical purpose)	9.5
	6.3.2	Significant wetlands identified by an accepted method such as Ramsar, Australian Directory of Important Wetlands, Regional Coastal Management Planning, World Heritage Areas, etc.	9.6
	6.3.3	Ecologically significant wetlands identified through expert opinion and/or documented study	9.4
6.4 Hydrological	6.4.1	Presence of distinct, unique or special hydrological regimes (e.g. Spring fed stream, ephemeral stream, boggomoss)	10.0
7 Connectivity			
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)	10.0
	7.3.2	Extent to which the wetland retains critical ecological and hydrological connectivity, where it should exist, with floodplains, rivers, groundwater, etc.	9.9
7.5 Estuarine and marine ecosystems	7.5.1	The contribution of the spatial unit to the maintenance of estuarine and marine ecosystems with significant biodiversity values, including those features identified through Criteria 5 and/or 6	10.0
8 Representativeness			
8.1 Wetland protection	8.1.1	The percent area of each wetland type within Protected Areas.	9.6
	8.1.2	The percent area of each wetland type within a coastal/estuarine area subject to the Fisheries Act, Coastal Management Act or Marine Parks Act.	9.2
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)	9.7
	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)	9.5
	8.2.3	The size of each wetland type relative to others of its management group within the catchment or study area	8.8
	8.2.4	The size of each wetland type relative to others of its type within a sub-catchment (or estuarine zone)	8.5
	8.2.5	Wetland type representative of the study area – identified by expert opinion	8.6
	8.2.6	The size of each wetland type relative to others of its type within the catchment or study area	8.8

Table 7: The average weights for each riverine measure

Maximum score is 10; total number of participants was approximately 18.

Criteria and Indicators	Measures		Weight
1 Naturalness Aquatic			
1.1 Exotic flora/fauna	1.1.1	Presence of 'alien' fish species within the wetland	9.3
	1.1.2	Presence of exotic aquatic and semi-aquatic plants within the wetland	9.8
	1.1.3	Presence of exotic invertebrate fauna within the wetland	8.3
	1.1.4	Presence of feral/exotic vertebrate fauna (other than fish) within the wetland	8.5
1.2 Aquatic communities/ assemblages	1.2.1	SOR aquatic vegetation condition	7.0
	1.2.2	SIGNAL2 score (Max)	8.1
	1.2.3	AUSRIVAS score - Edge (Min band)	8.6
	1.2.4	AUSRIVAS score - Pool (Min band)	8.5
	1.2.9	AUSRIVAS score - Riffle (Min band)	9.0
1.3 Habitat features modification	1.3.1	SOR bank stability	6.8
	1.3.2	SOR bed and bar stability	6.7
	1.3.3	SOR aquatic habitat condition	7.2
	1.3.4	Presence/absence of dams/weirs within the wetland	9.3
	1.3.5	Inundation by dams/weirs (% of waterway length within the wetland)	9.6
	1.3.8	Presence of dredging/extraction (including for navigation) and channel modification within the wetland	8.6
1.4 Hydrological modification	1.4.1	APFD score - modelled deviation from natural under full development	9.4
	1.4.2	Percent natural flows - modelled flows remaining relative to predevelopment	8.9
	1.4.3	Percent no flows - modelled low flows relative to predevelopment	9.2
	1.4.8	HEV Areas	7.9
2 Naturalness Catchment			
2.1 Exotic flora/fauna	2.1.1	Presence of exotic terrestrial plants in the assessment unit	10.0
2.2 Riparian disturbance	2.2.1	% area remnant vegetation relative to preclear extent within buffered riverine wetland or watercourses	9.8
	2.2.2	Total number of REs relative to preclear number of REs within buffered riverine wetland or watercourses	7.8
	2.2.3	SOR reach environs	6.8
	2.2.4	SOR riparian vegetation condition	7.1
2.3 Catchment disturbance	2.3.1	% "agricultural" land-use area (i.e. cropping and horticulture)	8.9
	2.3.2	% "grazing" land-use area	8.6
	2.3.3	% "vegetation" land-use area (i.e. native veg + regrowth)	8.9
	2.3.4	% "settlement" land-use area (i.e. towns, cities, etc)	9.5
2.4 Flow modification	2.4.1	Farm storage (overland flow harvesting, floodplain ring tanks, gully dams) calculated by surface area	10.0
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	9.8
	3.1.3	Richness of native aquatic dependent reptiles	9.4
	3.1.4	Richness of native waterbirds	9.3
	3.1.5	Richness of native aquatic plants	9.7
	3.1.7	Richness of native aquatic dependent mammals	9.1
3.2 Communities/ assemblages	3.2.1	Richness of macroinvertebrate taxa	9.8
	3.2.2	Richness of REs along riverine wetlands or watercourses within a specified buffer distance	8.8
3.3 Habitat	3.3.1	SOR channel diversity	8.6
	3.3.2	Richness of wetland types within the local catchment (e.g. SOR subsection)	8.8
	3.3.3	Richness of wetland types within the sub-catchment	9.3

Criteria and Indicators	Measures		Weight
4 Threatened Species and Ecosystems			
4.1 Species	4.1.1	Presence of rare or threatened aquatic ecosystem dependent fauna species – NCAct, EPBCAct	9.9
	4.1.2	Presence of rare or threatened aquatic ecosystem dependent flora species - NCAct, EPBCAct	9.9
4.2 Communities/ assemblages	4.2.1	Conservation status of wetland Regional Ecosystems – Herbarium biodiversity status, NCAct, EPBCAct	10.0
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	9.8
	5.1.3	Habitat for, or presence of, migratory species (Expert Panel list/discussion and/or JAMBA / CAMBA agreement lists and/or Bonn Convention)	9.4
	5.1.4	Habitat for significant numbers of waterbirds	8.9
5.2 Ecosystems	5.2.1	Presence of 'priority' aquatic ecosystem	10.0
6 Special Features			
6.1 Geomorphic features	6.1.1	Presence of distinct, unique or special geomorphic features	10.0
6.2 Ecological processes	6.2.1	Presence of (or requirement for) distinct, unique or special ecological processes	10.0
6.3 Habitat	6.3.1	Presence of distinct, unique or special habitat (including habitat that functions as refugia or other critical purpose)	9.6
	6.3.2	Significant wetlands identified by an accepted method such as Ramsar, Australian Directory of Important Wetlands, Regional Coastal Management Planning, World Heritage Areas, etc.	9.6
	6.3.3	Ecologically significant wetlands identified through expert opinion and/or documented study	9.4
6.4 Hydrological	6.4.1	Presence of distinct, unique or special hydrological regimes (e.g. Spring fed stream, ephemeral stream, boggomoss)	10.0
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	9.4
	7.1.2	Migratory or routine 'passage' of fish and other fully aquatic species (upstream, lateral or downstream movement) within the spatial unit	9.6
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)	10.0
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	10.0
7.5 Estuarine and marine ecosystems	7.5.1	The contribution of the spatial unit to the maintenance of estuarine and marine ecosystems with significant biodiversity values, including those features identified through Criteria 5 and/or 6	10.0

8 Ranking of indicators

The panel members and project officers that attended each expert panel workshop ranked the indicators within each criterion. Indicators were ranked according to their importance to a criterion and based on the following rules:

- at least one indicator within each criterion must be ranked one which is the highest ranking
- the other indicators were ranked within each criterion relative to the ranking of one assigned in the first step
- it was okay to have different indicators with the same ranking (i.e. all indicators may be ranked one)
- indicator should not be ranked down because of the quality or lack of data for that indicator.

The individual rankings were averaged and reviewed with particular attention to averages having a high variance. In order to improve the statistical reliability of the final rankings it was decided to average the ranks across the entire Wide Bay-Burnett region, rather than average the ranks for each study area/catchment.

The final ranks for each indicator were then applied in the AquaBAMM assessment (Table 8).

Table 8: The average rank for each non-riverine indicator

Maximum rank is one; total number of participants was approximately 17.

Criteria	Indicator	Rank
1 Naturalness Aquatic		
1.1	Exotic flora/fauna	2
2 Naturalness Catchment		
2.1	Exotic flora/fauna	2
2.3	Catchment disturbance	2
2.4	Flow modification	1
3 Diversity and Richness		
3.2	Communities/ assemblages	1
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	Ecosystems	1
6 Special Features		
6.1	Geomorphic features	3
6.2	Ecological processes	2
6.3	Habitat	2
6.4	Hydrological	1
7 Connectivity		
7.2	Groundwater dependent ecosystems	2
7.5	Estuarine and marine ecosystems	1
8 Representativeness		
8.1	Wetland protection	1
8.2	Wetland uniqueness	1

Table 9: The average rank for each riverine indicator

Maximum rank is one; total number of participants was approximately 18.

Criteria	Indicator	Rank
1 Naturalness Aquatic		
1.1	Exotic flora/fauna	2
1.2	Aquatic communities/ assemblages	2
1.3	Habitat features modification	2
1.4	Hydrological 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	1
3.2	Communities/ assemblages	1
3.3	Habitat	1
4 Threatened Species and Ecosystems		
4.1	Species	1
4.2	Communities/ assemblages	1
5 Priority Species and Ecosystems		
5.1	Species	1
5.2	Ecosystems	1
6 Special Features		
6.1	Geomorphic features	2
6.2	Ecological processes	2
6.3	Habitat	2
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
7.5	Estuarine and marine ecosystems	2

Attachments

Attachment A – Wide Bay-Burnett study area

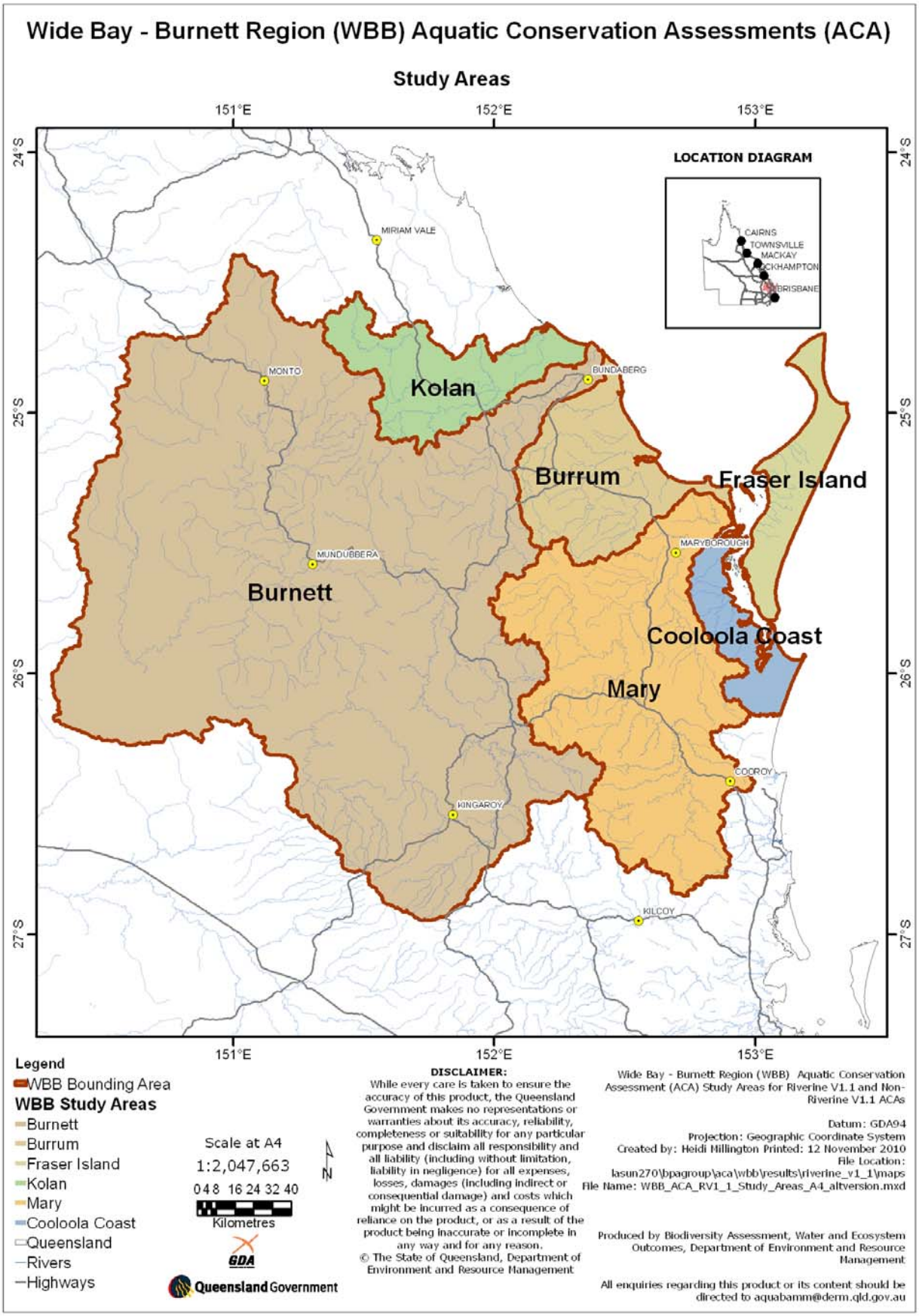

Figure 2: Wide Bay-Burnett study area

Attachment B – Terms of reference (wetland ecology expert panel)

The terms of reference presented below are to be read in conjunction with the AquaBAMM report that requires expert panel workshops to be run to inform a number of AquaBAMM criteria and their associated indicators and measures (Clayton et al. 2006).

Members of the expert panel were experts in scientific disciplines relevant to freshwater ecosystems, processes and species. Panel members were required to have professional or semi-professional standing in their fields of expertise and have direct knowledge and experience with the Wide Bay-Burnett region. Experience in the identification and assessment of non-riverine and riverine values including natural processes, species and places of significance was an important factor in the selection process. The panel included members with experience in these areas, as well as in their areas of specialist technical expertise. Panel members were appointed on the basis of their individual standing rather than as representatives of a particular interest group or organisation.

Wetland ecology

The wetland ecology expert panel was established to provide expert advice based on experience and demonstrated scientific theory on natural ecological, geological or geo-morphological and hydrological processes, and issues of connectivity between aquatic systems within the non-riverine and riverine wetlands of the Wide Bay-Burnett region. The panel consisted of professionals in fields of expertise relating to wetland ecology, water quality, geomorphology, fisheries and hydrological processes.

The tasks undertaken by the panel included, but were not limited to, the following:

- identify areas of significant geomorphological, ecological or hydrological processes, or priority areas—special features
- provide advice on biodiversity 'hot-spots' or areas of particular significance for species or communities
- establish principles for applying the connectivity criterion (bi-directional, unidirectional and lateral directions) in the wetland ecosystems
- consider whether to stratify the study areas
- weight measures relative to their importance for an indicator
- rank indicators relative to their importance for a criterion.

Attachment C – Criteria, indicators and measures for the Wide Bay-Burnett region

The criteria, indicators and measures (CIM) list indicate the CIM that were implemented as part of the ACA using AquaBAMM for the non-riverine and riverine wetlands of the Wide Bay-Burnett region.

The list has been developed from a default list of criteria, indicators and measures that may be considered when an ACA is conducted using AquaBAMM. The default CIM list is not mandatory for any particular ACA however it provides a "starter set" for consideration in setting the assessment parameters for each ACA.

AquaBAMM does not allow criteria change, addition or deletion. However, AquaBAMM does allow the addition or deletion of indicators and/or measures for each ACA when its assessment parameters are set. Generally, modification of the default set of indicators is discouraged because the list has been developed to be generic and inclusive of all aquatic ecosystems. Modification of the default set of measures may or may not be necessary but full flexibility is provided in this regard. In particular, measures may need to be added where unusual or restricted datasets are available that are specific to an ACA or study area.

Table 10: CIM list for the Wide Bay-Burnett region

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	✓	✓
	1.1.2	Presence of exotic aquatic and semi-aquatic plants within the wetland	✓	✓
	1.1.3	Presence of exotic invertebrate fauna within the wetland	✓	✓
	1.1.4	Presence of feral/exotic vertebrate fauna (other than fish) within the wetland	✓	✓
1.2 Aquatic communities/ assemblages	1.2.1	SOR[1] aquatic vegetation condition	✓	
	1.2.2	SIGNAL2 score (Max)	✓	
	1.2.3	AUSRIVAS[2] score - edge (Min band)	✓	
	1.2.4	AUSRIVAS[2] score - pool (Min band)	✓	
	1.2.9	AUSRIVAS[2] score - riffle (Min band)	✓	
1.3 Habitat features modification	1.3.1	SOR[1] bank stability	✓	
	1.3.2	SOR[1] bed and bar stability	✓	
	1.3.3	SOR[1] aquatic habitat condition	✓	
	1.3.4	Presence/absence of dams/weirs within the wetland	✓	
	1.3.5	Inundation by dams/weirs (% of waterway length within the wetland)	✓	
	1.3.8	Presence of dredging/extraction (including for navigation) and channel modification within the wetland	✓	
1.4 Hydrological modification	1.4.1	APFD[3] score - modelled deviation from natural under full development	✓	
	1.4.2	Percent natural flows - modelled flows remaining relative to predevelopment	✓	
	1.4.3	Percent no flows - modelled low flows relative to predevelopment	✓	
	1.4.5	Hydrological disturbance/modification of the wetland (e.g. as determined through DERM wetland mapping and classification)		✓
	1.4.8	High Ecological Value (HEV) Areas	✓	

Criteria and indicators	Measures		Riverine	Non-riverine
2 Naturalness catchment				
2.1 Exotic flora/fauna	2.1.1	Presence of exotic terrestrial plants in the assessment unit	✓	✓
2.2 Riparian disturbance	2.2.1	% area remnant vegetation relative to preclear extent within buffered riverine wetland or watercourses	✓	
	2.2.2	Total number of regional ecosystems relative to preclear number of regional ecosystems within buffered riverine wetland or watercourses	✓	
	2.2.3	SOR[1] reach environs	✓	
	2.2.4	SOR[1] riparian vegetation condition	✓	
	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		✓
2.3 Catchment disturbance	2.3.1	% "agricultural" land-use area (i.e. cropping and horticulture)	✓	✓
	2.3.2	% "grazing" land-use area	✓	✓
	2.3.3	% "vegetation" land-use area (i.e. native veg + regrowth)	✓	✓
	2.3.4	% "settlement" land-use area (i.e. towns, cities, etc)	✓	✓
2.4 Flow modification	2.4.1	Farm storage (overland flow harvesting, floodplain ring tanks, gully dams) calculated by surface area	✓	✓
3 Diversity and richness				
3.1 Species	3.1.1	Richness of native amphibians (riverine wetland breeders)	✓	
	3.1.2	Richness of native fish	✓	✓
	3.1.3	Richness of native aquatic dependent reptiles	✓	✓
	3.1.4	Richness of native waterbirds	✓	✓
	3.1.5	Richness of native aquatic plants	✓	✓
	3.1.6	Richness of native amphibians (non-riverine wetland breeders)		✓
	3.1.7	Richness of native aquatic dependent mammals	✓	✓
3.2 Communities/ assemblages	3.2.1	Richness of macroinvertebrate taxa	✓	✓
	3.2.2	Richness of regional ecosystems along riverine wetlands or watercourses within a specified buffer distance	✓	
3.3 Habitat	3.3.1	SOR[1] channel diversity	✓	
	3.3.2	Richness of wetland types within the local catchment (e.g. SOR[1] subsection)	✓	✓
	3.3.3	Richness of wetland types within the sub-catchment	✓	✓
4 Threatened species and ecosystems				
4.1 Species	4.1.1	Presence of rare or threatened aquatic ecosystem dependent fauna species – NC Act[4], EPBC Act[5]	✓	✓
	4.1.2	Presence of rare or threatened aquatic ecosystem dependent flora species – NC Act[4], EPBC Act[5]	✓	✓
4.2 Communities/ assemblages	4.2.1	Conservation status of wetland regional ecosystems – Herbarium biodiversity status, NC Act[4], EPBC Act[5]	✓	✓

Criteria and indicators	Measures		Riverine	Non-riverine
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[6], WWF, etc)	✓	✓
	5.1.2	Presence of aquatic ecosystem dependent 'priority' flora species	✓	✓
	5.1.3	Habitat for, or presence of, migratory species (expert panel list/discussion and/or JAMBA[7] / CAMBA[8] agreement lists and/or Bonn Convention)	✓	✓
	5.1.4	Habitat for significant numbers of waterbirds	✓	✓
5.2 Ecosystems	5.2.1	Presence of 'priority' aquatic ecosystem	✓	✓
6 Special features				
6.1 Geomorphic features	6.1.1	Presence of distinct, unique or special geomorphic features	✓	✓
6.2 Ecological processes	6.2.1	Presence of (or requirement for) distinct, unique or special ecological processes	✓	✓
6.3 Habitat	6.3.1	Presence of distinct, unique or special habitat (including habitat that functions as refugia or other critical purpose)	✓	✓
	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.	✓	✓
	6.3.3	Ecologically significant wetlands identified through expert opinion and/or documented study	✓	✓
6.4 Hydrological	6.4.1	Presence of distinct, unique or special hydrological regimes (e.g. spring fed stream, ephemeral stream, boggomoss)	✓	✓
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	✓	
	7.1.2	Migratory or routine 'passage' of fish and other fully aquatic species (upstream, lateral or downstream movement) within the spatial unit	✓	
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)	✓	✓
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	✓	

Criteria and indicators	Measures		Riverine	Non-riverine
	7.3.2	Extent to which the wetland retains critical ecological and hydrological connectivity, where it should exist, with floodplains, rivers, groundwater etc.		✓
7.5 Estuarine and marine ecosystems	7.5.1	The contribution of the spatial unit to the maintenance of estuarine and marine ecosystems with significant biodiversity values, including those features identified through criteria 5 and/or 6	✓	✓
8 Representativeness				
8.1 Wetland protection	8.1.1	The percent area of each wetland type within protected areas.		✓
	8.1.2	The percent area of each wetland type within a coastal/estuarine area subject to the *Fisheries Act 1994*, *Coastal Protection and Management Act 1995* or *Marine Parks Act 2004*.		✓
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)		✓
	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)		✓
	8.2.3	The size of each wetland type relative to others of its management group within the catchment or study area		✓
	8.2.4	The size of each wetland type relative to others of its type within a sub-catchment (or estuarine zone)		✓
	8.2.5	Wetland type representative of the study 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		✓

[1] SOR – State of the Rivers
[2] AUSRIVAS – Australian River Assessment System
[3] APFD – Annual Proportional Flow Deviation
[4] NC Act – *Nature Conservation Act 1992* (Queensland legislation)
[5] EPBC Act – *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth legislation)
[6] ASFB – Australian Society of Fish Biology
[7] JAMBA – Japan-Australia Migratory Bird Agreement
[8] CAMBA – China-Australia Migratory Bird Agreement

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