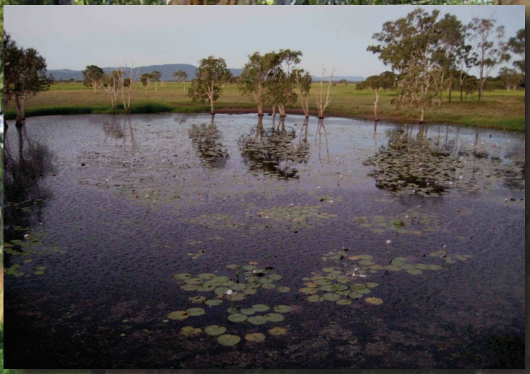
Aquatic Conservation Assessments (ACA)

using AquaBAMM



for the non-riverine wetlands of the Great Barrier Reef catchment

Version 1.3
April 2011

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Content in this report was prepared by the former Department of Environment and Resource Management. This revision (Version 1.3) reflects updated results produced from reapplication of the AquaBAMM methodology to the catchments of the Great Barrier Reef Region. Section 3.6 of this document provides a detailed description of the changes implemented between versions.

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Cover photos (from top to bottom):

1. Unnamed waterhole located 144 km north-west of Clermont (be_w00638) – Selena Rollason

2. Unnamed waterhole near Serpentine Lagoon, approx. 35 km south of Townsville (ha_w00429) – Selena Rollason

3. Gorganga Plain (pr_w00041) – Selena Rollason

4. Waterhole at Lotus Creek (is_w00571) – Selena Rollason

5. Unnamed waterhole located approximately 90 km northwest of Charters Towers (bp_w00540) – Selena Rollason

5. Willmott Lagoon (ca_w00005) – Selena Rollason (background photo)

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1.1	20 April 2009
1.2	8 July 2009
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1 Introduction

The Aquatic Biodiversity Assessment and Mapping Method or 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, in combination with novel ideas from the developmental team. 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.

The Department of Environment and Resource Management (DERM) conducted ACAs for the non-riverine (i.e. palustrine and lacustrine) freshwater wetlands in each of the 35 GBR catchments. In effect, there are 35 ACAs for the entire Great Barrier Reef (GBR) catchment. Estuarine wetlands are excluded from these assessments.

1.1 The Great Barrier Reef study area

There are many catchments along Queensland's eastern seaboard that potentially influence water quality in the GBR. As a result, the GBR catchment has been the subject of interest from the State and Federal Government. Part of this interest has led to the need to better understand the conservation values of wetlands within these catchments.

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 adopt the released wetland maps unmodified and, therefore, are limited by the 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.

Thirty-five (35) GBR catchments were the subject of ACAs, focusing on their freshwater non-riverine wetlands (

Figure ***1***). Table 1 shows the names of the 35 catchments/study areas for which ACAs were undertaken and the number of mapped non-riverine freshwater wetlands within each catchment.

Table 1 GBR catchments subject to an ACA using AquaBAMM

ACA study areas or catchments	Catchment code	Number of freshwater non-riverine wetlands	Area (ha)
Baffle	ba	478	11,228
Barron	bn	1,217	32,800
Belyando	be	88	454
Black	bk	193	13,112
Bowen	bw	78	4,928
Boyne	bo	9	4,914
Burdekin Lower	bl	1,019	40,860
Burdekin Upper	bp	71	1324
Calliope	ca	31	163
Comet	ct	31	773
Curtis Island	ci	454	7,639
Daintree	da	186	1,932
Dawson	dn	1,653	17,306
Don	do	166	4,471
Fitzroy	fi	490	13,595
Haughton	ha	563	12,239
Herbert	he	709	14,078
Hinchinbrook	hi	96	482
Isaac	is	765	5,726
Johnstone	jo	156	3,506
Mackenzie	ma	496	5,207
Mossman	mo	39	189
Mulgrave Russel	mr	198	9,165
Murray	mu	255	4,564
Nogoa	no	501	20,272
O'Connell	oc	90	792
Other Islands	oi	56	454

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

ACA study areas or catchments	Catchment code	Number of freshwater non-riverine wetlands	Area (ha)
Pioneer	pi	39	2,026
Plane	pl	158	2,000
Proserpine	pr	126	10,811
Ross	ro	151	8,696
Shoalwater	sh	101	15,236
Styx	st	92	1,350
Tully	tu	281	5,849
Waterpark	wa	376	9,977
	TOTAL	**11,412**	**288,121 ha**

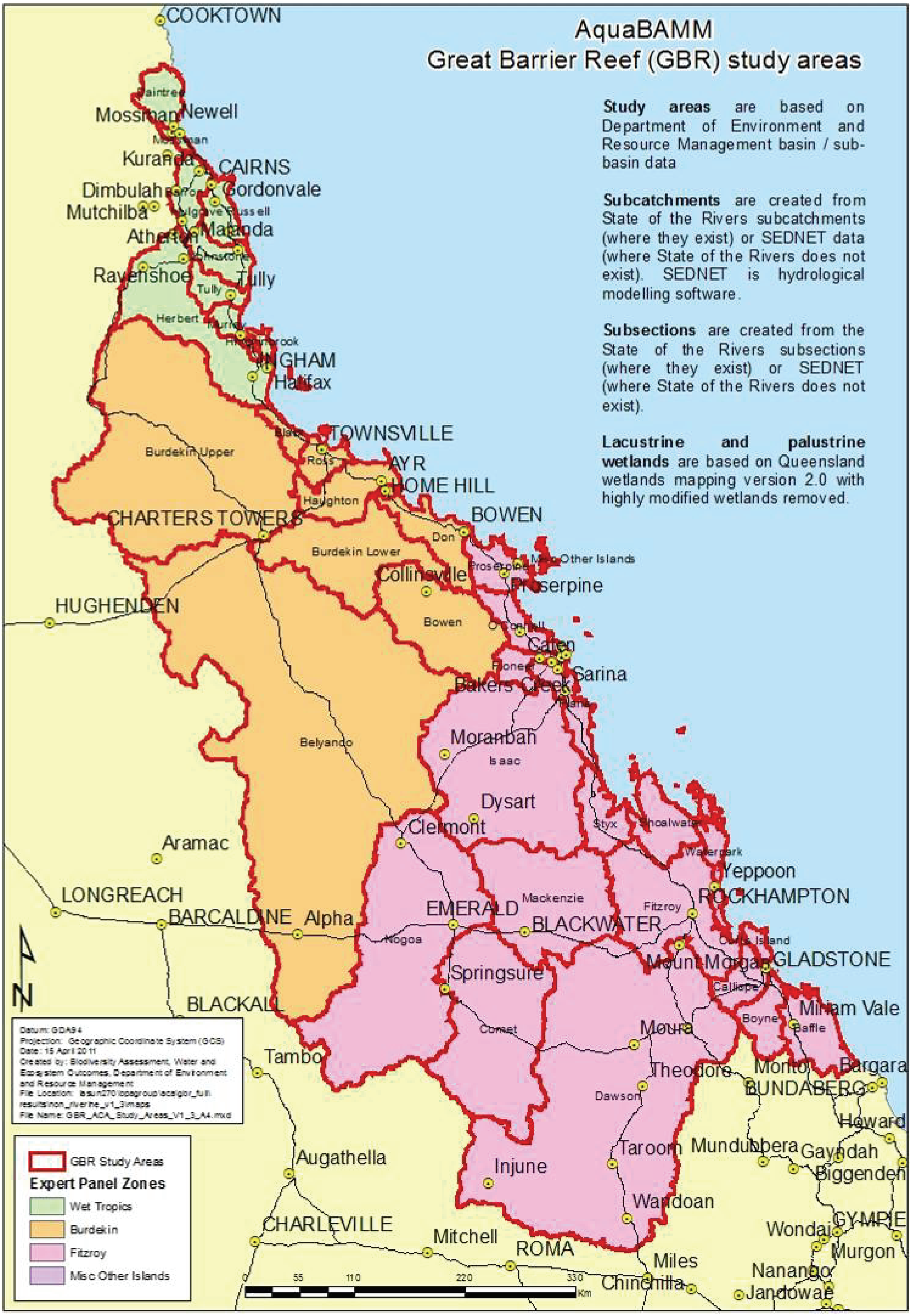


Figure 1 The 35 GBR catchments where ACAs have been conducted

The 35 catchments of the GBR extend from the Daintree River in the north, to Baffle Creek in the south. The area contains a wide range of wetlands types contained within the boundaries of five bioregions, including Wet Tropics, Brigalow Belt, Einasleigh Uplands, Central Queensland Coast and South East Queensland. As a result, a variance in wetland ecology, geomorphology, hydrology, habitat and species composition can be found throughout the region.

For the purposes of the ACA, the 35 catchments of the GBR were divided into three main regions covering the Wet Tropics, Burdekin and Fitzroy (see Figure 1). The purpose of this division was primarily so that expert panel advice could be provided on the aquatic and riparian flora, aquatic fauna and wetland ecology in these regions. ACAs assess wetland conservation values relative to other wetlands within the catchment. Care was taken at the expert panels to ensure that each catchment within a region was considered separately. A description of each of the three regions is provided below.

1.2 Wet Tropics

The study areas used to implement the AquaBAMM assessments are based on the DERM basin/sub-basin data. The Wet Tropics study area largely corresponds to the Wet Tropics Natural Resource Management (NRM) region and contains the majority of the Wet Tropics World Heritage Area (WTWHA). In total the study area covers approximately 22,100 km^2 and lies across the majority of the Wet Tropics bioregion and a part of the Einasleigh Uplands bioregion to the west in the Upper Herbert and Upper Barron basins. It includes the nine basins shown in Figure 1, which comprise the coastal basins of the Daintree, Mossman, Barron, Mulgrave/Russelll, Johnstone, Tully, Murray, and Herbert rivers and Hinchinbrook Island. Each of these is treated as an individual study area for the purpose of the AquaBAMM analyses.

As the name suggests the Wet Tropics is characterised by high rainfall largely due to the conspicuous topography. The major mountain masses exceed elevations of 1,000 m and all are granitic, although some have flanking acid volcanic and metamorphic rocks. Extensive areas of basalt occur, particularly through the Atherton Tablelands, an extensive plateau between 600 m and 900 m that covers a large part of the upper Barron River catchment. The region contains a number of high peaks including the two highest mountains in Queensland, Mount Bartle Frere (1,622 m) and Mount Belenden Ker (1,593 m). The mountain ranges generally have steep precipitous mountain sides with deeply incised valleys. They run north to south, rising sharply near the coast and capture the moisture-laden air from the warm waters of the Coral Sea, resulting in generally high rainfall across the region. The most extensive lowlands are in the south of the study area, associated with the floodplains of the Tully and Herbert rivers, with extensive coastal freshwater and estuarine wetlands.

Mean annual rainfall for the Wet Tropics bioregion is above 1,500 mm, three times the continental average of below 500 mm, with several areas within the study area receiving much higher rainfall. Rainfall patterns are strongly seasonal with a distinct wet season occurring in the warmer months between December and April and, although generally wet, can vary substantially from year to year. Interannual variability is mainly driven by major rainfall events which commonly occur and are associated with cyclones and low pressure depressions. These can flood large areas of the region resulting in huge volumes of water being discharged to the inshore waters of the Great Barrier Reef lagoon. For example, in the Herbert River total mean annual discharge is approximately 3.7 million megalitres and in the Johnstone and South Johnstone it is 3.23 million megalitres. The amount of rain also varies throughout the region due to topography and there is a distinct gradient to drier conditions from the western side of the ranges towards where the study area crosses into the Einasleigh Uplands bioregion. Rainfall is not recorded from the peak of Mount Bartle Frere, but at the summit of the adjacent Mount Belenden Ker records show an annual average rainfall of 8,312 mm, making it the wettest meteorological station in Australia. It also holds the record for the highest rainfall in a calendar year of 12,461 mm in 2000. On the lowlands the Daintree area and the area from Cairns south to Tully receives the highest rainfall with Babinda typically receiving rainfall in excess of 4,000 mm annually. In contrast, the western side of the study area, in the Upper Herbert and Upper Barron basins, on average, receives less than 800 mm annually.

The study area also has generally warm and uniform temperatures throughout the year. Typical daytime minimum and maximum temperatures range on the coast from 22ºC to 31ºC in summer and from 15ºC to 22ºC in winter. The tablelands and uplands are generally much cooler. On the western side of the study area temperatures vary slightly more and tend towards being hotter in summer.

As a consequence of the high rainfall, rainforest cover is extensive across the ranges and coastal lowlands and streams and wetlands are numerous and important features in the landscape. For millions of years the consistent runoff has resulted in most streams and many wetlands being perennial systems, in contrast to most other parts of Australia, including most of the tropical region. As a result the Wet Tropics has sustained a unique and diverse freshwater fauna and flora with many endemic species present.

The high degree of variation in rainfall, topography, combined with a complex evolutionary history has resulted in a diverse spectrum of forest types and plant and animal communities. The rainforests of the region which dominates the narrow, high rainfall coastal belt have been classified into 16 major structural types and 30 broad community types (Tracey and Webb, 1975; Tracey, 1982). In addition the rainforests are fringed and dissected by a range of sclerophyll forests and woodlands as well as wetlands including estuarine mangrove communities. Tall woodlands, open *Eucalyptus* forests and grasslands extend into the drier western parts of the study area in to the Einasleigh Upland bioregion.

Wetland types include an enormous number of low order, perennial or near perennial, streams descending the steep ranges. These join in to several major river systems that define the basins within the study area. The coastal lowland floodplains are generally narrow, with the most extensive lowlands occurring in the south of the study area associated with the floodplains of the Tully/Murray and the Herbert rivers. These areas contain complex systems of numerous interconnecting wetlands and extensive coastal estuarine areas. The Herbert floodplain receives the lowest rainfall of the coastal lowlands in the study area but can have the highest discharge from runoff in the upper catchment. Its floodplain is dominated by woodlands with extensive areas of grass and sedge swamps laying adjacent to dune systems and connected estuaries. This area also contains the Herbert River delta which is formed at the southern end of the Hinchinbrook Channel, with its extensive stands of mangrove forest. In the Tully/Murray floodplain (and areas to the north) rainfall is higher and the coastal vegetation is dominated by forest, rainforest and extensive wetland areas. Unfortunately many of the coastal wetlands throughout the study area have been lost or are now largely modified through drainage and reclamation works. Many of the remaining wetlands are also heavily impacted by clearing of riparian and fringing vegetation, infestation by weeds and by events resulting in a decline in water quality through runoff from adjacent agriculture. Fractured basalt and other fractured rock aquifers occur throughout the study area supporting unique fauna and flora. These aquifer systems are particularly significant in some of the areas within the drier parts of the study area in the Einasleigh Upland. Crater lakes are also a unique feature of the plateaus of the study area.

Approximately 35 per cent of the study area is covered by the Wet Tropics World Heritage Area, taking in most of the ranges and large areas of lowland rainforest. The World Heritage Area consists of extensive areas of National Park and other protected estate as well as areas of private land. The major commercial land uses in the study area include extensive areas of lowlands, and some uplands, used for sugar cane production. Extensive areas in the lowlands are also used for banana production with a diverse range of other horticultural crops occurring throughout. On the fertile Atherton Tablelands dairy is a major industry along with a variety of horticulture and crops. Cattle grazing is a minor land use in the coastal lowlands but extensive cattle grazing is the major land use in the western part of the study area. The area was once heavily dependent on native forestry. However, this has declined with the protection of much of the native rainforest areas in the Wet Tropics World Heritage Area and in recent times forestry has depended on broad hectare softwood plantations on the Atherton Tablelands and the Cardwell area. Increasingly, other forestry plantations are being established on what was traditionally land used for sugar cane production.

1.3 Burdekin

The study areas used to implement the AquaBAMM assessments were based on the DERM basin/sub-basin data. The Burdekin study area lies within the wet-dry tropics and includes the eight basins shown in Figure 1, as well as, the adjacent continental islands of the Palm Island group and Magnetic Island. This area takes in the coastal basins of the Black, Ross, Haughton, and Don rivers, and the sub-basins of the greater Burdekin River catchment; the Burdekin Lower, Burdekin Upper, Belyando and Bowen sub-basins. Apart from the inclusion of the Don Basin, the Burdekin study area largely corresponds to the Burdekin Dry Tropics NRM region and covers an area of approximately 140,000 km^2.

The area includes the Burdekin River catchment; Australia's largest in terms of peak discharge. It covers a diversity of landscapes crossing five bioregions: the Wet Tropics, the Einasleigh Uplands, the Desert Uplands, the Brigalow Belt North, and a small section of the Central Queensland Coast bioregion on the southern edge. The physical environments include mountain ranges rising to 1,359 m at Mount McCartney in the Clarke Range to the south, 1,221 m at Mount Elliot near Townsville, 1,063 m at Mount Halifax in the Paluma Range to the north and 1,002 m at Mount Tabletop on the Great Dividing Range to the west. Other features include lower rock hills, coastal plains, floodplains, deltas, beach ridges and continental islands. Undulating plains with escarpments and dissected plateaus are found inland to the west. Vegetation types are equally diverse including tropical rainforest, vine thickets, forested swamps, drier woodlands, grassy plains, sedgelands, and coastal mangroves and saltpans.

The area has a tropical sub-humid climate with relatively high temperatures all year round and a pronounced wet and dry season with most rain falling in the warm, humid months of November through to April. Rainfall is highly variably across the region and influenced by monsoonal and cyclonic activity. There is a distinct gradient to drier conditions from the coast westward. Average annual rainfall varies through the area from above 3,000 mm in the coastal peaks of the Seaview and Paluma Ranges to the north, Mount Elliot near Townsville, and the Clarke Range to south, to below 500 mm in the south-west of the Belyando sub-basin. The spatial and seasonal variability and the high interannual variability of rainfall are an overriding characteristic of the study area that greatly influences the nature and distribution of its wetlands. Most streams and wetlands are subject to seasonal flows and are subject to irregular flooding. The exceptions to this are the perennial streams that rise in the high rainfall ranges and the wetlands fed by the large basalt aquifers in the Upper Burdekin sub-basin.

In general, the Burdekin study area can be broadly divided into higher rainfall, more densely populated coastal areas with urban, industrial and irrigated agriculture land uses predominant and lower rainfall, sparsely populated inland areas used principally for rangeland grazing with some dryland agriculture and mining activity. There are several major water storages and large weirs located within the Burdekin study area, the largest being the Burdekin Falls Dam, which was completed in 1987 forming Lake Dalrymple, with a capacity of 1.86 million megalitres. Other major dams include the Ross River Dam, Paluma and Eungella dams.

The Ross basin is the most developed in the study area containing the regional city of Townsville. Many of the streams and wetlands in this basin are highly modified and impacted by water quality contamination and altered hydrology associated with urban development. Other major towns in the study area include Ayr and Home Hill to the south in the Lower Burdekin and Charters Towers in the Upper Burdekin.

The completion of the Burdekin Falls Dam and the subsequent development of the Burdekin-Haughton Water Supply Scheme (BHWSS, previously known as the Burdekin River Irrigation Area (BRIA)) for intensive sugarcane production, has dramatically altered the environmental conditions of the streams and wetlands in the lower floodplain of the Haughton and Lower Burdekin basins. The Lower Burdekin is dominated by the Burdekin River delta, where the coastal plain widens and is prone to widespread flooding, with vast areas of wetlands. The Burdekin Delta and the floodplains and estuaries of the coastal rivers form the Townsville-Burdekin coastal wetland aggregation, one of the most extensive on the Australian east coast. This area includes the wetlands of Bowling Green Bay National Park listed under the international Ramsar Convention. Prior to development, streams in this coastal plain, such as Barratta Creek, consisted of a series of clear or tannin-coloured seasonal in-stream and off-stream lagoons that connected across the floodplain during flood events. Flows were very variable between seasons and interannually. These systems have now been extensively modified. Flows to the streams and wetlands across this floodplain have been radically altered as a result of supplementation through the irrigation delivery system and by irrigation tail waters. This has removed the seasonality in much of the system and in combination with riparian disturbance and nutrient contamination has contributed to extensive weed infestation of wetlands by pasture grasses and aquatic weeds. These impacts have resulted in severe water quality degradation and altered ecology in the wetlands of this coastal plain and presented an enormous task to natural resource managers.

The Don Basin to the south of the Burdekin delta also contains extensive aggregations of coastal wetlands and estuaries. This area has remained one of the least developed along this coast due to relatively low rainfall and the unsuitability of soil types for large-scale irrigated agriculture, although horticulture, largely dependent on ground water, is common in some areas. Although, proposed developments associated with industrial developments at Abbott Point and the Water for Bowen water transfer scheme is likely to increase the pressure on coastal wetlands in this area.

The study area extends more than 300 km westwards, with the Upper Burdekin sub-basin draining the western side of the coastal ranges and the eastern side of the Great Dividing Range. This basin is contained almost entirely in the Einasleigh Uplands. The area contains a major basalt feature with highly productive black and red soils and numerous springs emanating from many locations that drive permanent flow and clear-water waterholes in many streams. This creates not only many significant waterbodies but a wide variety of wetland types. The Burdekin River channel, a large sand and gravel bed channel is another prominent feature. It consists of a small meandering low flow channel bordered by sand and gravel bars which in turn is located within the high flow channel with established riparian communities. Flow to this channel is almost perennial most years and comes from two sources: tributaries on the western slopes of the high rainfall coastal ranges; and the extensive basalt aquifers formed by the Toomba basalts flows.

The Belyando sub-basin covers a large part of the study area to the south west and includes the Cape-Campaspe, Belyando and Suttor River catchments. The source of the Belyando River in central western Queensland is almost 500 km from the mouth of the Burdekin River, and extends in to the black-soil grasslands of Central Queensland. The Belyando sub-basin contains two bioregions; the Desert Uplands in the west and the Brigalow Belt North bioregion to the east. The Belyando basin is the area that consistently receives the least rainfall in the study area, with streams and wetlands receiving ephemeral or intermittent flows. In contrast to the Burdekin River channel in the Upper Burdekin, the flow capacity of the main channels of the Cape-Campaspe, Belyando and Suttor River is relatively low resulting in braided (anastomosing) river channels with broad floodplains. The extent of water in the floodplain landscape is highly variable and strongly influenced by flood events which create large temporary wetlands and replenish several permanent waterholes that provide key refugia between flow events. Under flood conditions, flows are spread broadly across the floodplain.

The natural vegetation in the western part of the study area, away from the coast, largely consists of dry eucalypt and acacia savannah woodlands on typical infertile laterised soils and includes grasslands of perennial Mitchell and annual Flinders grasses to the west. Cattle grazing is widespread and a major industry in the inland areas. Land degradation, water quality contamination and erosion are major management problems. Consequently, the Burdekin River catchment has been identified as the biggest single source of sediment to the Great Barrier Reef lagoon and is targeted for improved management actions.

1.4 Fitzroy

The Fitzroy section of the GBR catchment is a vast and extremely varied area. It ranges from the high rainfall, short fast streams surrounded by rainforest on the Whitsunday coast to the slow, turbid meandering floodplain streams of the Fitzroy catchment. It encompasses parts of three bioregions, supports Ramsar listed wetlands and its waters impact on the southern and central GBR. It includes iconic sandstone gorges in places like the Carnarvon Ranges to perched lakes in the upper Comet sub-catchment to world recognised wetland complexes such as the Goorganga Plains as well as waterfalls, cascades and torrents in the rainforests of the Whitsundays.

The Fitzroy catchment itself is the largest eastward flowing system in Australia only exceeded in total flow Australia-wide, by the Murray-Darling system. The area includes two catchments (Waterpark Creek and Repulse Creek) that are almost entirely surrounded by protected areas. Other catchments are highly modified with a number of rivers heavily regulated by dams, weirs and irrigation development.

The climate of the area is also highly variable. It ranges from distinctly tropical in the north to subtropical in the south. Rainfall is distinctly seasonal with a pronounced wet season from December to March but the amount of rain that falls is amongst the most variable in the world. Between 1976 and 2008, wet season flow to the mouth of the Fitzroy varied from around 349,677 megalitres to 22,903,390 megalitres. Much of the aquatic ecology of the area is driven by variable boom and bust cycles and is consequently amongst the most resilient anywhere.

The largest land use in terms of area is cattle grazing, however extensive cropping and intensive cultivation of sugar cane is also very important. The area also contributes a huge quantity of coal that is vital to the Queensland and Australian economy.

It is not possible to adequately give an overview of such a vast and varied area, so a brief description of the 17 catchment areas is provided in Attachment C. This attachment should be considered when interpreting the contents of this report.

2 Methods and Implementation

2.1 AquaBAMM

The GBR 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, including an update to the filter table.

2.2 Spatial units

In implementing an ACA, spatial units need to be defined *a priori* in order to assign conservation/ecological values when they are calculated. This issue is dealt with in detail in the published method documentation (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 ACA using AquaBAMM.

The number of spatial units included in an ACA can vary greatly between study areas. For the GBR catchment, there are 11,412 spatial units (mapped palustrine or lacustrine wetlands) in the non-riverine ACA. For this ACA only natural (H1) or slightly modified (H2M1, H2M2, H2M3, H2M8) wetlands were included. See the Wetland Mapping and Classification Methodology (2005) for more information on these hydrological modifier codes.

2.3 Assessment parameters

There were 11,412 spatial units (wetlands) defined for the GBR non-riverine wetland ACAs. These spatial units were drawn directly from DERM's wetland map for the GBR catchment region. The 11,412 GBR non-riverine wetlands have an average area of 25.2 ha and a total wetland area of 288,121 ha. The spatial unit area varied from 0.18 ha to 18,730 ha.

The criteria, indicators and measures (CIM) list outlined in Table 2 were implemented as part of the non-riverine ACA of the freshwater wetlands of the GBR catchment. 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 GBR catchment

Criteria & indicators	Measures	
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
1.4 Hydrological modification	1.4.5	Hydrological disturbance/modification of the wetland (e.g. as determined through DERM wetland mapping and classification)
2 Naturalness catchment		
2.1 Exotic flora/fauna	2.1.1	Presence of exotic terrestrial plants in the assessment unit
2.2 Riparian disturbance	2.2.5	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
2.3 Catchment	2.3.1	Per cent "agricultural" land-use area (i.e. cropping and horticulture)

Criteria & indicators	Measures	
disturbance	2.3.2	Per cent "grazing" land-use area
	2.3.3	Per cent "vegetation" land-use area (i.e. native veg + regrowth)
	2.3.4	Per cent "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	3.1.2	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
3.3 Habitat	3.3.2	Richness of wetland types within the local catchment (e.g. SOR sub-section)
	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[1], EPBC Act[2]
	4.1.2	Presence of rare or threatened aquatic ecosystem dependent flora species – NC Act[1], EPBC Act[2]
4.2 Communities/ assemblages	4.2.1	Conservation status of wetland Regional Ecosystems – Herbarium biodiversity status, NC Act[1], EPBC Act[2]
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)
	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[3]/CAMBA[4] 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)
8 Representativeness		
8.1 Wetland protection	8.1.1	The per cent area of each wetland habitat type within protected areas
	8.1.2	The per cent 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*

Criteria & indicators	Measures	
8.2 Wetland uniqueness	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)
	8.2.2	The relative abundance of the wetland management group to which the wetland habitat belongs within the subcatchment or estuarine/marine zone (management groups ranked least common to most common)
	8.2.3	The size of each wetland habitat relative to others of its management group within the catchment or study area
	8.2.4	The size of each wetland habitat relative to others of its management group within a subcatchment (or estuarine zone)
	8.2.5	Wetland habitat representative of the study area – identified by expert opinion
	8.2.6	The size of each wetland habitat relative to others of its 'type' within the catchment or study area

[1] NC Act – *Nature Conservation Act 1992* (Queensland legislation)
[2] EPBC Act – *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth legislation)
[3] JAMBA – Japan-Australia Migratory Bird Agreement
[4] CAMBA – China-Australia Migratory Bird Agreement

Stratification was applied in a number of GBR catchment study areas for the purpose of measures calculation. Stratification mitigates the effects of data averaging across large study areas, and is particularly important where ecological habitat diversity and complexity is high (refer to Clayton *et al.* 2006 for more information on stratification). The stratification levels applied in the GBR non-riverine ACA were identified by the expert panels (refer to the wetland ecology expert panel reports in Attachments C, F and I for more information). The GBR catchments stratified for the purposes of the GBR riverine ACA are outlined in Table 3.

Table 3 Stratification in study areas of the GBR catchment

Study area	Stratification
Daintree	150 m above sea level
Mossman	150 m above sea level
Barron	150 m above sea level
Johnstone	150 m above sea level
Mulgrave Russell	150 m above sea level
Tully	150 m above sea level
Murray	150 m above sea level
Herbert	150 m above sea level
Burdekin Lower	150 m above sea level
Haughton	150 m above sea level
Belyando	Desert Uplands/Brigalow Belt bioregional boundary
Baffle	150 m above sea level

2.4 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 the 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 GBR catchment ACAs, a series of nine 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.

2.5 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 CIM. 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 4.

Table 4 Implementation table for the GBR catchment non-riverine ACA V1.3

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, Queensland Historical Fauna Database	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	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 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	Presence Negative	

Measure	Description	Implementation	Primary Data Sets Used	Threshold Type	Stratified
1.4.5	Hydrological disturbance/ modification of the wetland (e.g. as determined through Department of Environment and Resource Management wetland mapping and classification)	Score spatial units according to their modification code. H1, H2M8 = 4; H2M1, H2M2 and H2M3 = 2; H2M5 = 1	Department of Environment and Resource Management Queensland Wetlands Mapping V2.0	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	
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	Divided spatial units into four classes (>=60ha; >=20<60ha; >=8<20ha; <8ha) and then buffered according to their area (500m buffer for spatial units >=8ha, 200m buffer for smaller spatial units); buffers were dissolved where buffer zones of adjacent spatial units of the same class overlapped. The per cent remnant verses pre-clear vegetation was calculated for each buffer, and then reapplied to each spatial unit within the buffer.	Department of Environment and Resource Management Queensland Wetlands Mapping V2.0, RE V6.0b, RE Pre-Clear V6.0b	Quartile - Continuous Ascending	Y
2.3.1	% "agricultural" land-use area (i.e. cropping and horticulture)	"Agricultural" land-use included (Queensland Land Use and Mapping Program 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 per cent 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 per cent scores (by subsection).	Queensland Land Use and Mapping Program (1999)	Quartile - Continuous Descending	Y
2.3.2	% "grazing" land-use area	"Grazing" land-use included (Queensland Land Use and Mapping Program secondary categories) grazing natural vegetation. These land-use types were allocated a grazing attribute and a per cent 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 per cent scores (by subsection).	Queensland Land Use and Mapping Program (1999)	Quartile - Continuous Descending	Y

Measure	Description	Implementation	Primary Data Sets Used	Threshold Type	Stratified
2.3.3	% "vegetation" land-use area (i.e. native veg + regrowth)	"Vegetation" land-use included (Queensland Land Use and Mapping Program 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 per cent 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 per cent scores (by subsection).	Queensland Land Use and Mapping Program (1999)	Quartile - Continuous Ascending	Y
2.3.4	% "settlement" land-use area (i.e. towns, cities, etc)	"Settlement" land-use included (Queensland Land Use and Mapping Program 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 per cent 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 per cent scores (by subsection).	Queensland Land Use and Mapping Program (1999)	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 Department of Environment and Resource Management Queensland Wetlands Mapping V2.0	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, Queensland Historical Fauna Database	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	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	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, and was directly attributed to the wetland spatial units.	WildNet, Queensland Museum, Queensland Historical Fauna Database, *Crinia tinnula* fauna model from *Vegetation Management Act 1999* (VMA) Essential Habitat Version 3.0	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	Quartile - Continuous Ascending	Y
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	Presence Positive	

Measure	Description	Implementation	Primary Data Sets Used	Threshold Type	Stratified
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 Queensland Wetland Mapping 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. H2M1 wetlands were removed from this measure because the WETRE value they are attributed should always be 'water'. H2M5 wetlands were also removed as their WETRE value is impacted by gross mechanical disturbance e.g. cropping. Springs are included. They are processed with the other wetlands.	Department of Environment and Resource Management Queensland Wetlands Mapping V2.0	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 Queensland Wetland Mapping 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). H2M1 wetlands were removed from this measure because the WETRE value they are attributed should always be 'water'. H2M5 wetlands were also removed as their WETRE value is impacted by gross mechanical disturbance e.g. cropping. Springs are included. They are processed with the other wetlands.	Department of Environment and Resource Management Queensland Wetlands Mapping V2.0	Quartile - Continuous Ascending	
4.1.1	Presence of rare or threatened aquatic ecosystem dependent fauna species – *Nature Conservation Act 1992*, *Environmental Protection and Biodiversity Conservation Act 1999*	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 <=2000m) 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, and was directly attributed to the wetland spatial units.	WildNet, Queensland Museum, Department of Employment, Economic Development and Innovation, Queensland Historical Fauna Database, *Crinia tinnula* fauna model from *Vegetation Management Act 1999* (VMA) Essential Habitat Version 3.0	Presence Positive	

Measure	Description	Implementation	Primary Data Sets Used	Threshold Type	Stratified
4.1.2	Presence of rare or threatened aquatic ecosystem dependent flora species - *Nature Conservation Act 1992*, *Environmental Protection and Biodiversity Conservation Act 1999*	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, *Nature Conservation Act 1992*, *Environmental Protection and Biodiversity Conservation Act 1999*	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. (Deconcatenation code was used to separate these). H2M1 and H2M5 wetlands are excluded from this measure. Springs are included. They are processed with the other wetlands.	Department of Environment and Resource Management Queensland Wetlands Mapping V2.0	Categorical	
5.1.1	Presence of aquatic ecosystem dependent 'priority' <u>fauna</u> 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 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 two 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, Queensland Historical Fauna Database	User Defined 1 = 3; >1 = 4	
5.1.2	Presence of aquatic ecosystem dependent 'priority' <u>flora</u> 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 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	

Measure	Description	Implementation	Primary Data Sets Used	Threshold Type	Stratified
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 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	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	
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. Springs were included. They were processed with the other wetlands.	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 world heritage areas (WHA) were identified. Those spatial units that had at least 50% of their area within this special areas layer were allocated a score of 4. Similarly, spatial units spatial units that had at least 50% of their area within the mapped boundaries of Directory of Important Wetlands were identified and these spatial units were allocated a score of 3. 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).	Directory of Important Wetlands (2005) , Ramsar Sites (QLD) (November 2002), World Heritage Areas (May 2008)	Categorical	

Measure	Description	Implementation	Primary Data Sets Used	Threshold Type	Stratified
6.3.3	Ecologically significant wetlands identified through expert opinion and/or documented study	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.	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 (eg. 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	
8.1.1	The per cent area of each wetland habitat type within Protected Areas	The Department of Environment and Resource Management Estates (Conservation Park, Forest Reserve, National Park (Recovery), National Park, National Park (Scientific), Resource Reserve, State Forest and Timber Reserve) and nature refuge data was used to calculate the per cent 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 Queensland Wetland Mapping 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. H2M1 and H2M5 wetlands are excluded from this measure. Springs are included but processed separately to other wetlands.	Department of Environment and Resource Management Queensland Wetlands Mapping V2.0 (with TYPE_RE concatenated field), Protected Areas of Queensland (estate) and Other Lands (March 2010), Nature Refuges and Coordinated Conservation Areas (March 2010)	Continuous Descending (Sattler & Williams 1999)	
8.1.2	The per cent 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 Fish Habitat data was used to calculate the per cent 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 Queensland Wetland Mapping 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. H2M1 and H2M5 wetlands are excluded from this measure. Springs are included but processed separately to other wetlands.	Department of Environment and Resource Management Queensland Wetlands Mapping V2.0 (with TYPE_RE concatenated field), Fish Habitat Areas (Qld Fisheries 1994) (August 2009)	Continuous Descending (Sattler & Williams 1999)	

Measure	Description	Implementation	Primary Data Sets Used	Threshold Type	Stratified
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 Queensland Wetland Habitat Typology (the HAB field in the Queensland Wetland Mapping). 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. H2M1 and H2M5 wetlands are excluded from this measure. Springs are included. They are processed with the other wetlands.	Department of Environment and Resource Management Queensland Wetlands Mapping V2.0 with Queensland Wetland Habitat Typology applied to determine wetland management groups, ACA study area layer	Continuous Descending Logarithmic	
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 Queensland Wetland Habitat Typology (the HAB field in the Queensland Wetland Mapping). 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. H2M1 and H2M5 wetlands are excluded from this measure. Springs are included. They are processed with the other wetlands.	Department of Environment and Resource Management Queensland Wetlands Mapping V2.0 with Queensland Wetland Habitat Typology applied to determine wetland management groups, ACA 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 Queensland Wetland Habitat Typology (the HAB field in the Queensland Wetland Mapping). 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. H2M1 and H2M5 wetlands are excluded from this measure. Springs are excluded from this area based measure.	Department of Environment and Resource Management Queensland Wetlands Mapping V2.0 with Queensland Wetland Habitat Typology applied to determine wetland management groups, ACA study area layer	Categorical	

Measure	Description	Implementation	Primary Data Sets Used	Threshold Type	Stratified
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 Queensland Wetland Habitat Typology (the HAB field in the Queensland Wetland Mapping). 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. H2M1 and H2M5 wetlands are excluded from this measure. Springs are excluded from this area based measure.	Department of Environment and Resource Management Queensland Wetlands Mapping V2.0 with Queensland Wetland Habitat Typology applied to determine wetland management groups, ACA sub-catchments layer	Categorical	
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 Queensland Wetland Mapping 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. H2M1 and H2M5 wetlands are excluded from this measure. Springs are excluded from this area based measure.	Department of Environment and Resource Management Queensland Wetlands Mapping V2.0 (with TYPE_RE concatenated field), ACA study area layer	Categorical	

Note: Flora records were extracted from the following sources:

Wildnet on 19/02/2010
Corveg on 4/01/2010
Wetland Information Capture Project on 28/01/2009
Parkinfo on 8/02/2010
BPA and ACA Expert panel flora data sets provided up to March 1 2010.

Note: Fauna records were extracted from the following sources:

Queensland Historical Fauna Database on 11/03/2010. This database includes extracts from WildNet, Queensland Museum, Department of Employment, Economic Development and Innovation (DEEDI), and Queensland Historical Fauna Database (QHFD)

Note: Various BPAs and ACAs current or in draft at 1 March 2011 used in measure 6.3.3:

Brigalow Belt (BRB) BPA v1.3 released 22 Sept 2008
Einasleigh Uplands (EIU) BPA v1.1 released 30 September 2009
Desert Uplands (DEU) BPA v1.2 released 30 Sept 2005
South East Queensland (SEQ) BPA v3.5 released 3 Dec 2007
Central Queensland Coast (CQC) BPA v1.3 released 29 Jan 2007
Baffle ACA v1.1 released 2 Feb 2009
Herbert ACA (draft)

2.6 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 and provide the complete ACA package (Figure 2).

This data access and interrogation flexibility is important and enables investigation 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.

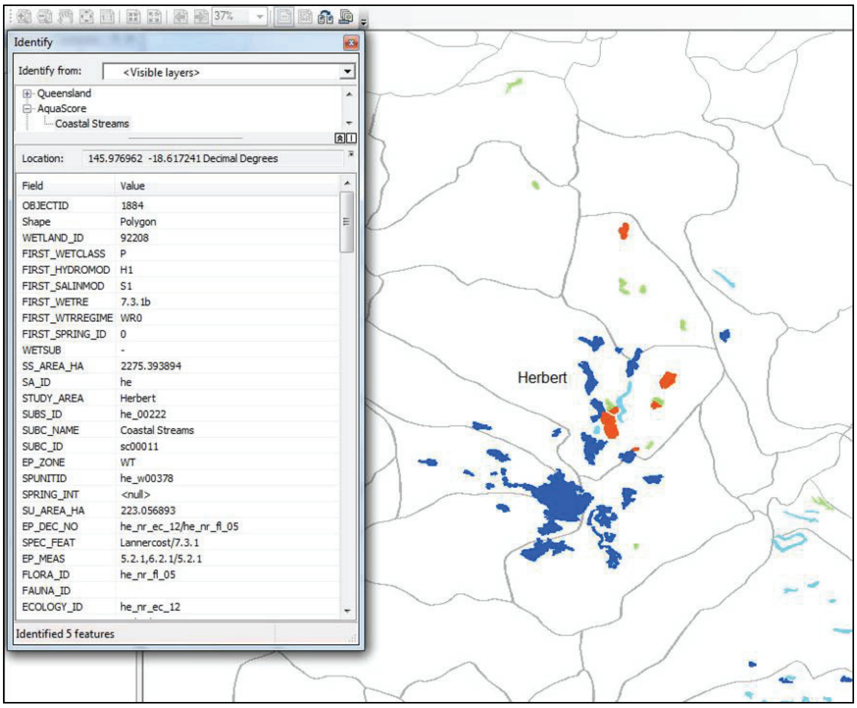


Figure 2 Interrogating the ACA results for a spatial unit in the GIS environment

3 Results

3.1 GBR catchment overall results

An ACA was conducted for each of the 35 catchments of the GBR catchment. The results outlined below are a summary of the results for all 35 study areas. The results for the Herbert and Mackenzie catchments ACA are in sections 3.2 and 3.4 as an example of the results from an individual catchment.

3.1.1 AquaScore

Table 5 AquaScore summary

AquaScore	Number of spatial units	Per cent of spatial units (%)	Area (ha)	Area (%)
Very high	2,909	25.49	130,558	45.31
High	2,396	21.00	94,487	32.79
Medium	4,822	42.25	47,589	16.52
Low	162	1.42	5,575	1.93
Very Low	1,123	9.84	9,913	3.44
Total	**11,412**	**100%**	**288,121 ha**	**100%**

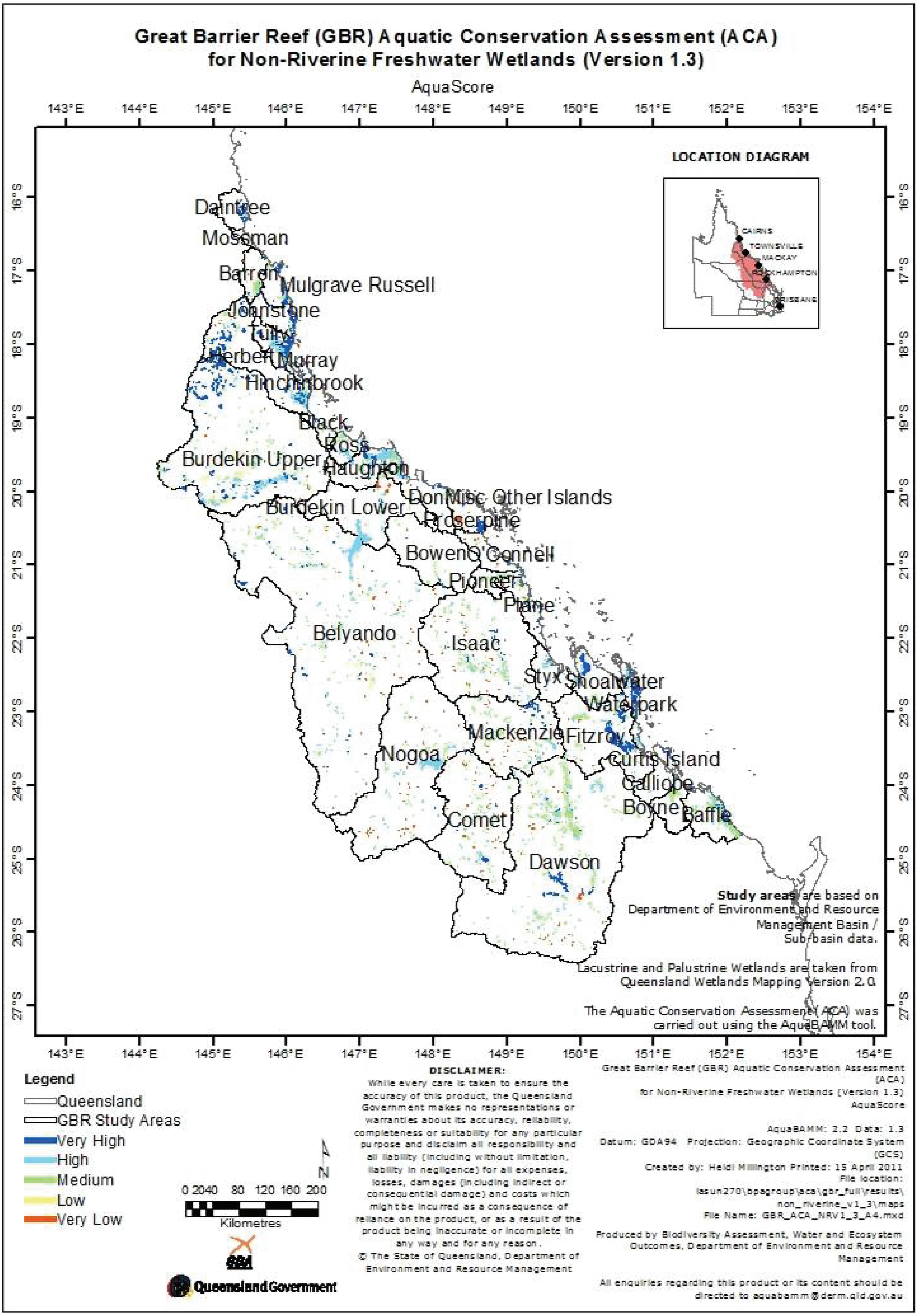
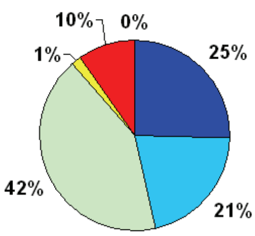
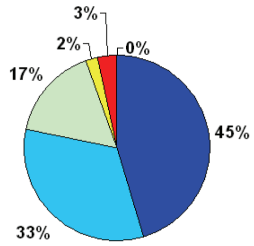
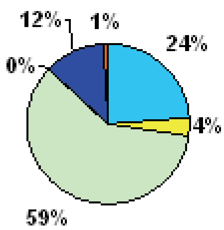
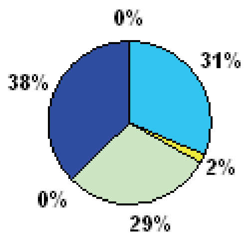
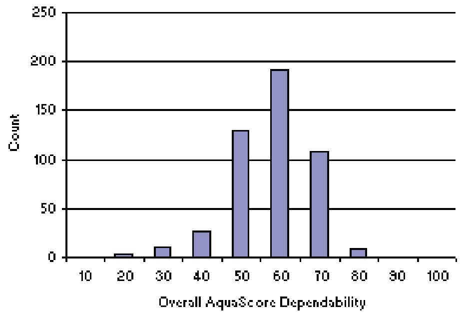
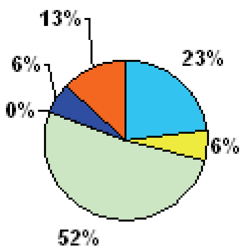
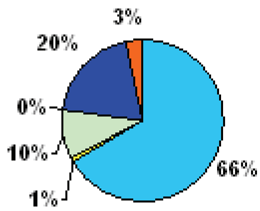
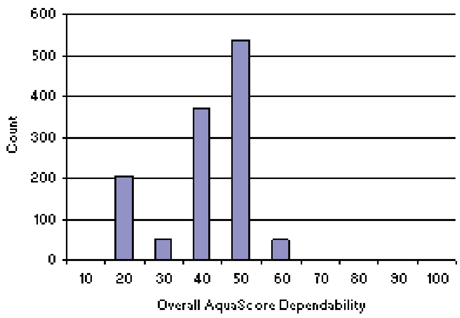
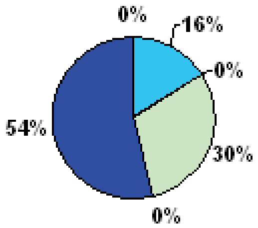
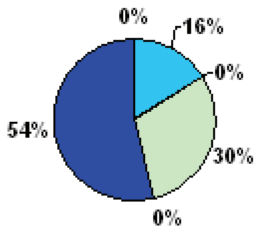
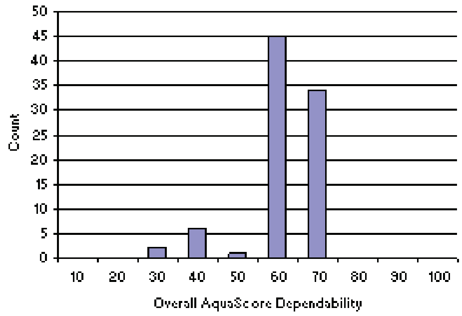


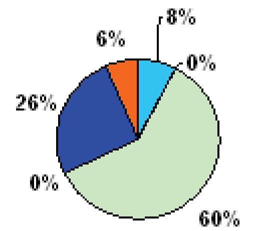
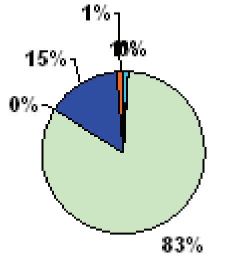
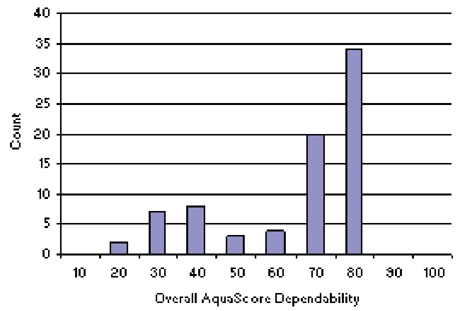
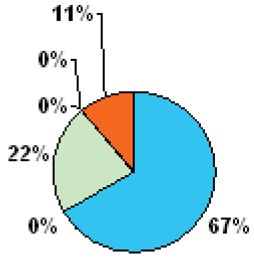
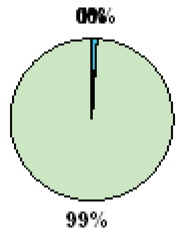
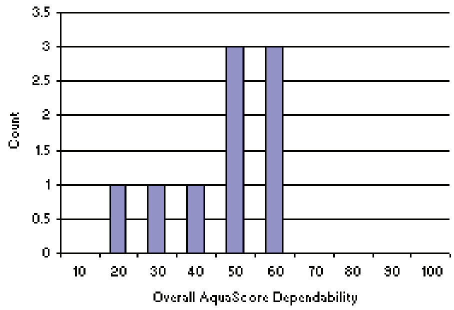
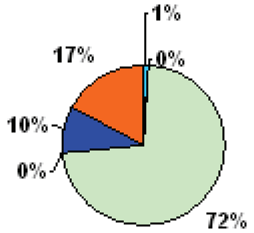
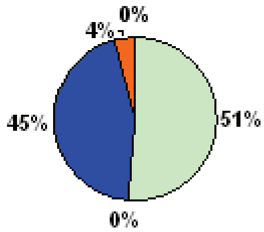
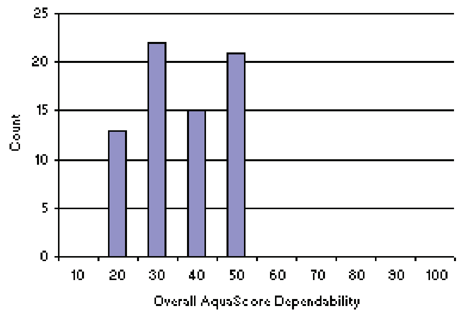
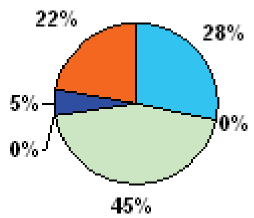
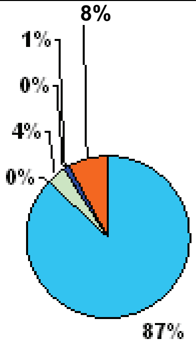
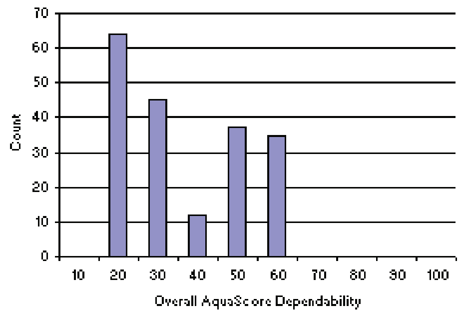
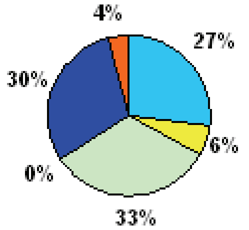
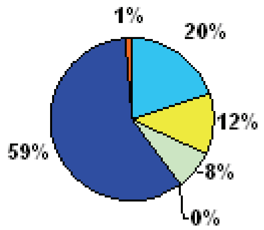
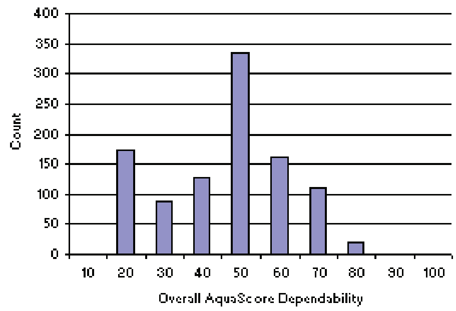
Figure 3 AquaScore for all catchments

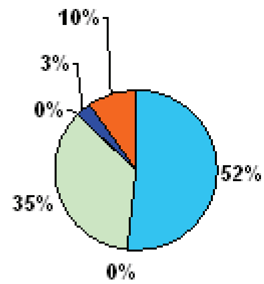
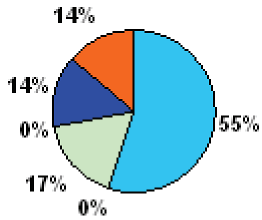
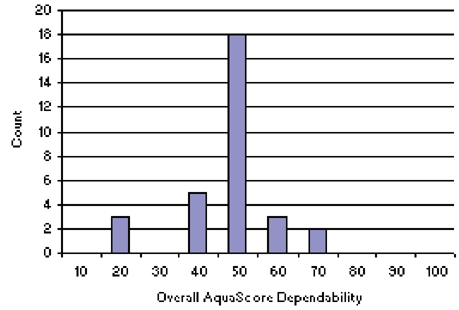
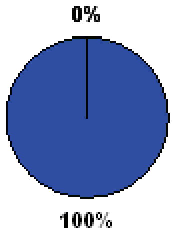
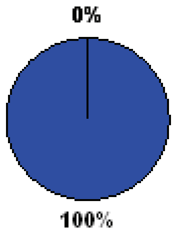
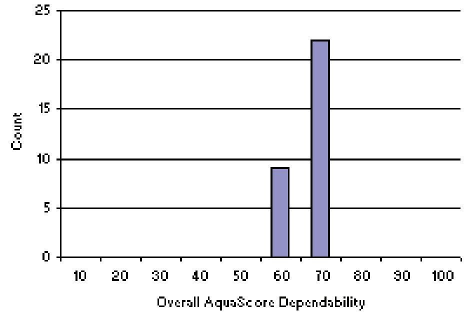
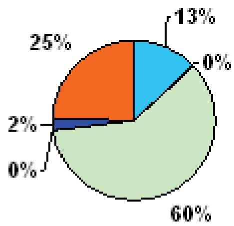
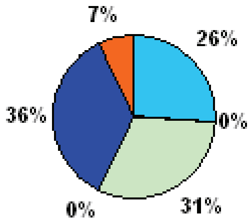
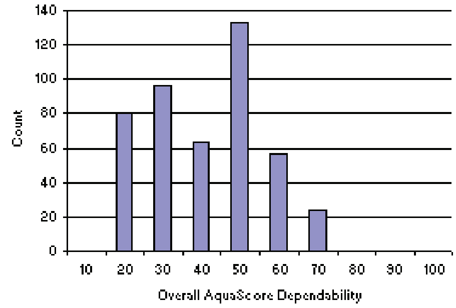
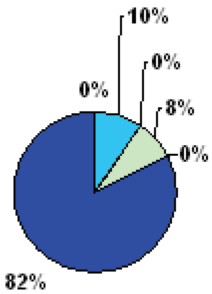
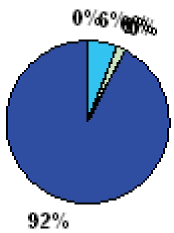
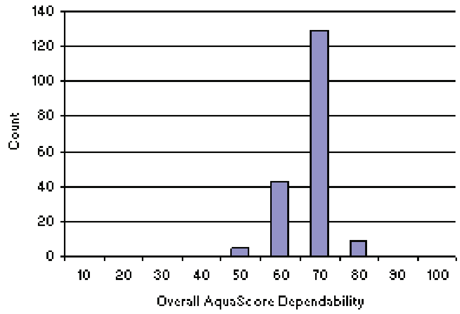
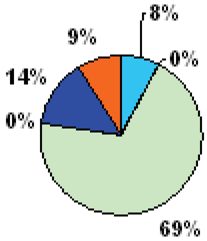
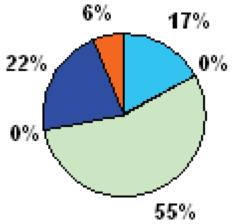
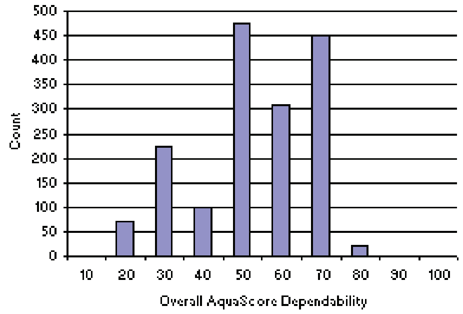
Table 6 AquaScore and dependability summary for all study areas

Key

- Very High
- High
- Medium
- Low
- Very Low
- No Data

Catchment	AquaScore by number of spatial units	AquaScore by total area of spatial units	AquaScore dependability
All			
Baffle			
Belyando			
Black			

Catchment	AquaScore by number of spatial units	AquaScore by total area of spatial units	AquaScore dependability
Barron			
Boyne			
Bowen			
Burdekin Lower			
Burdekin Upper			

Catchment	AquaScore by number of spatial units	AquaScore by total area of spatial units	AquaScore dependability
Calliope			
Curtis Island			
Comet			
Daintree			
Dawson			

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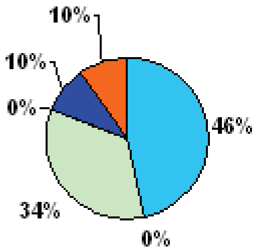
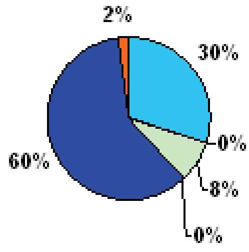
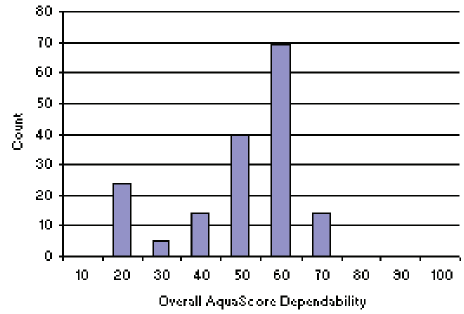
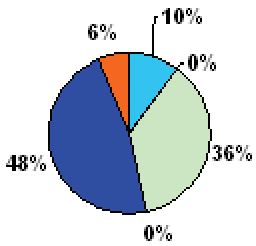
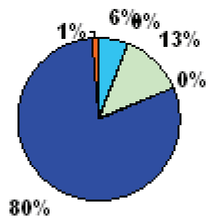
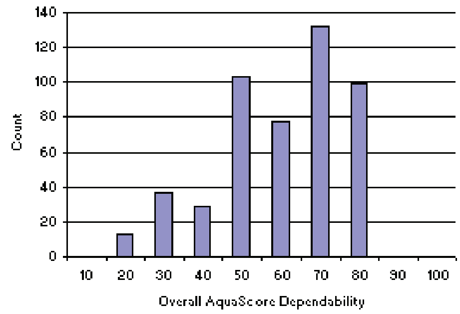
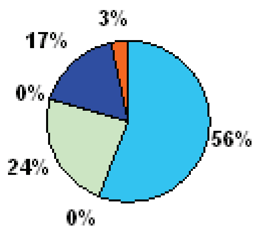
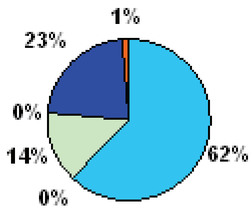
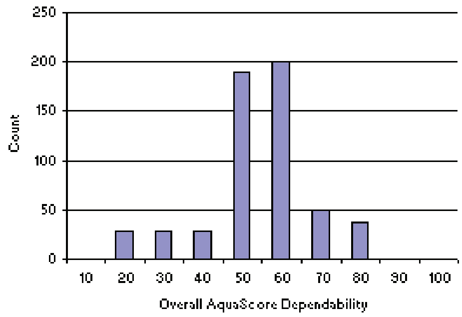
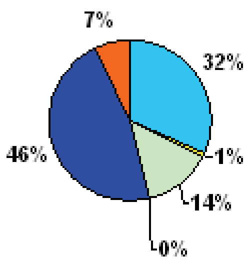
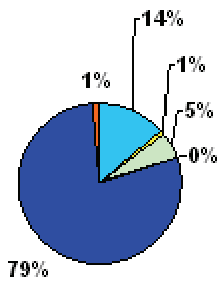
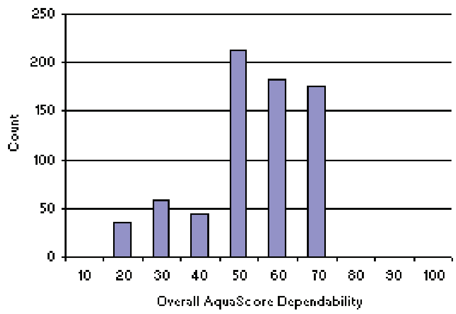
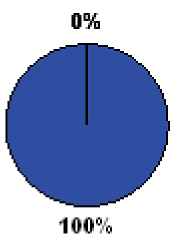
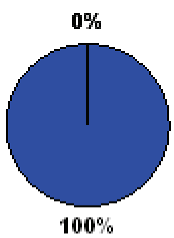
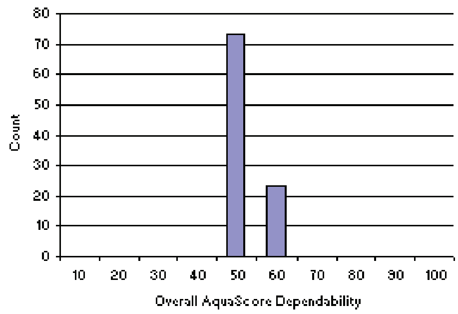
<tr><td>Don</td><td></td><td></td><td></td></tr>
<tr><td>Fitzroy</td><td></td><td></td><td></td></tr>
<tr><td>Haughton</td><td></td><td></td><td></td></tr>
<tr><td>Herbert</td><td></td><td></td><td></td></tr>
<tr><td>Hinchinbrook</td><td></td><td></td><td></td></tr>
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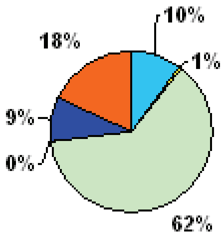
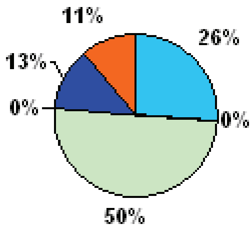
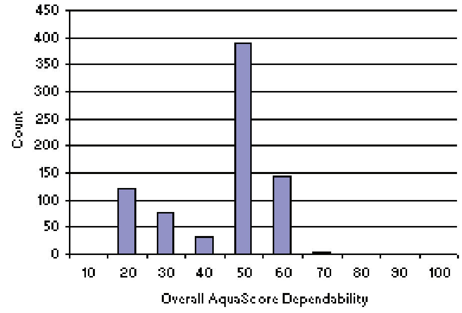
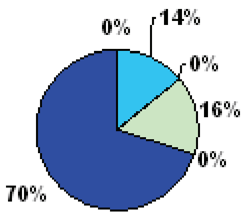
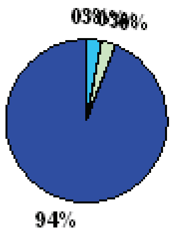
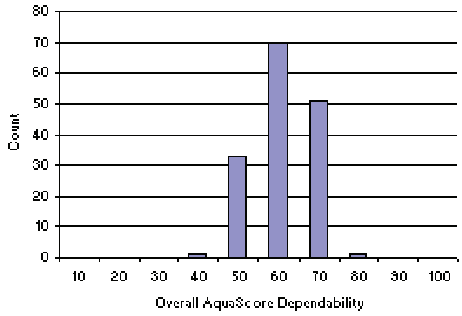
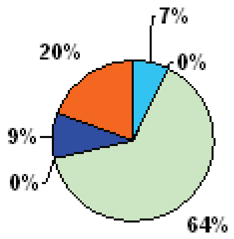
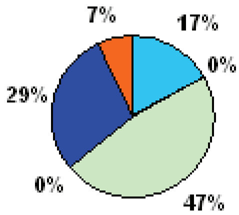
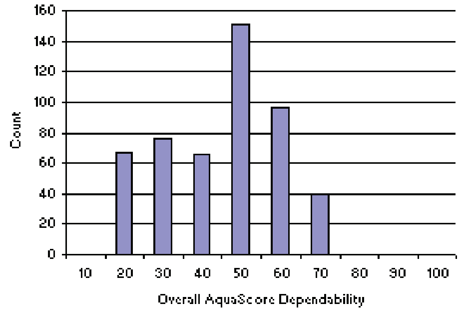
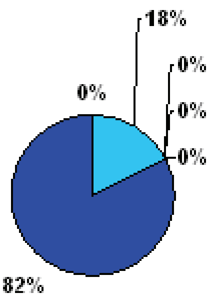
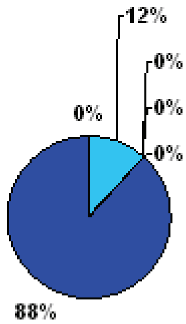
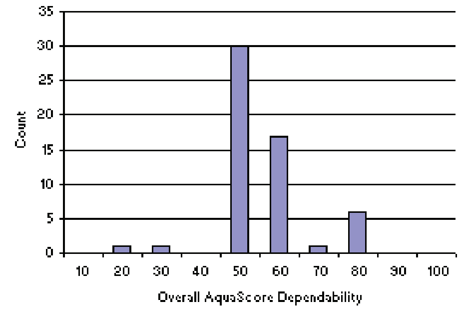
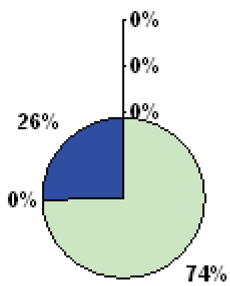
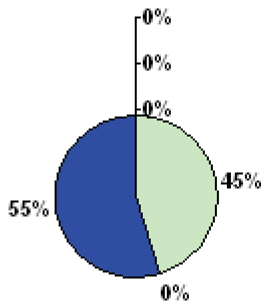
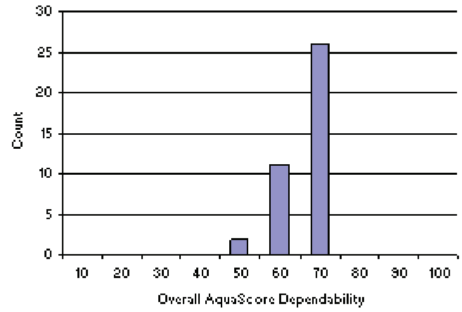
Isaac			
Johnstone			
Mackenzie			
Misc Other Islands			
Mossman			

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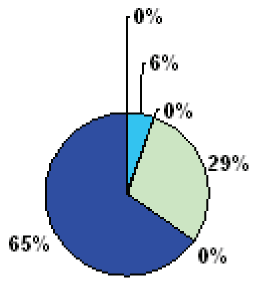
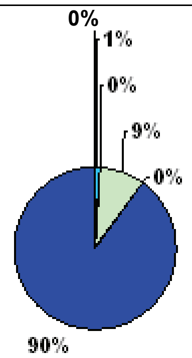
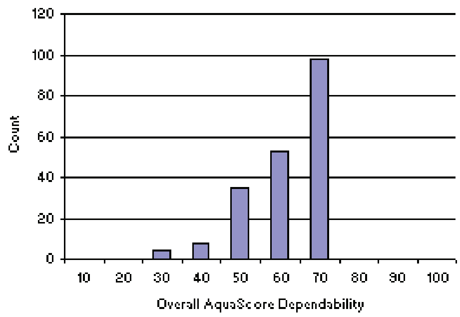
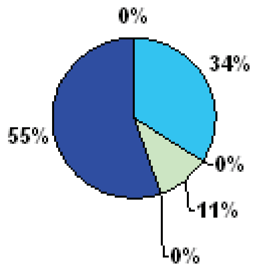
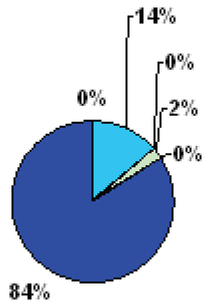
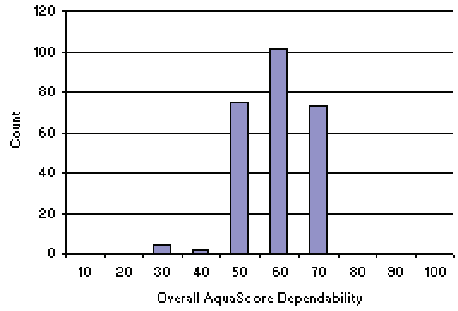
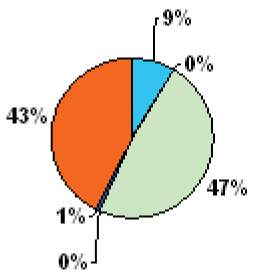
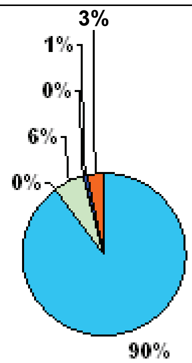
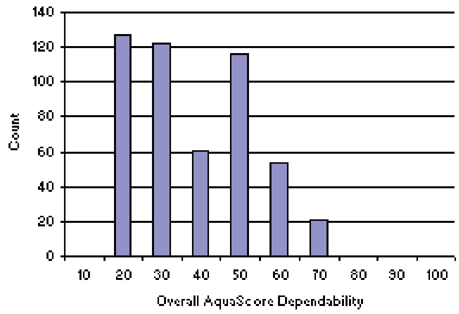
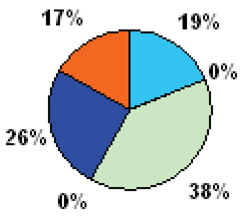
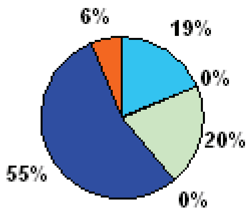
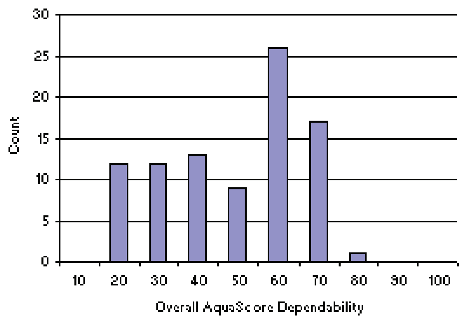
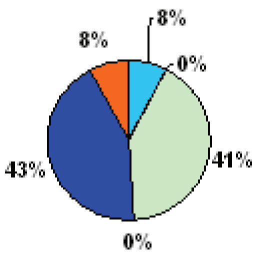
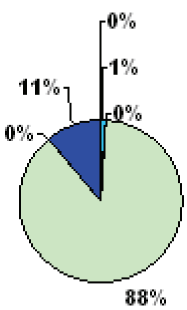
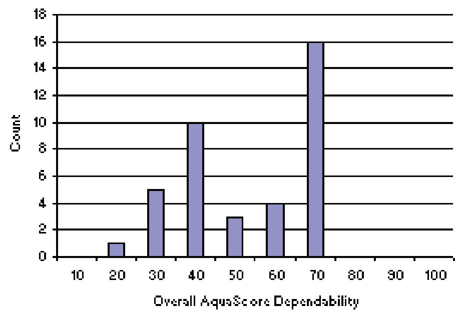
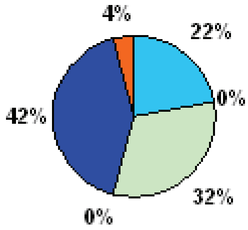
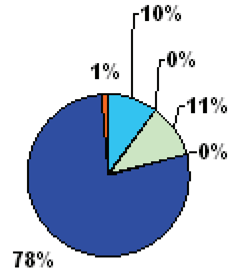
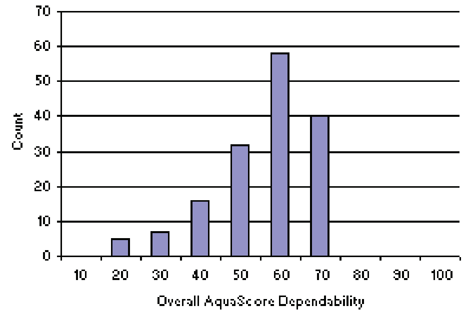
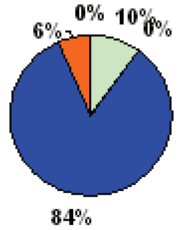
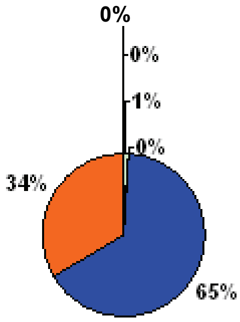
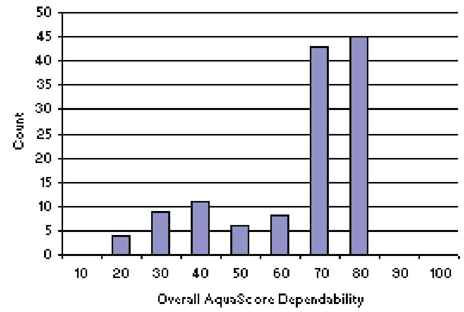
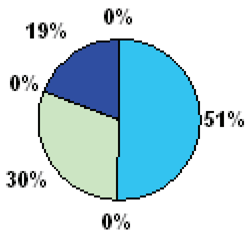
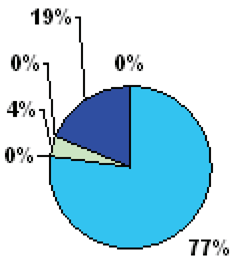
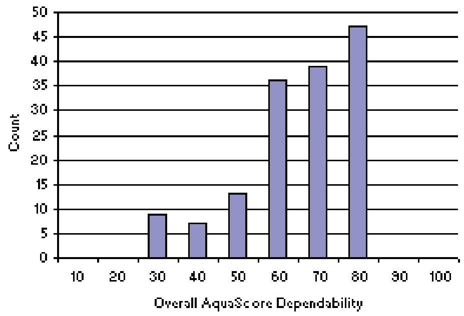
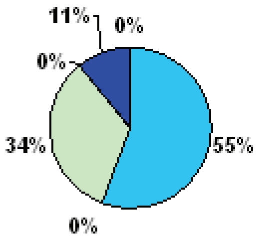
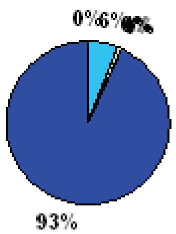
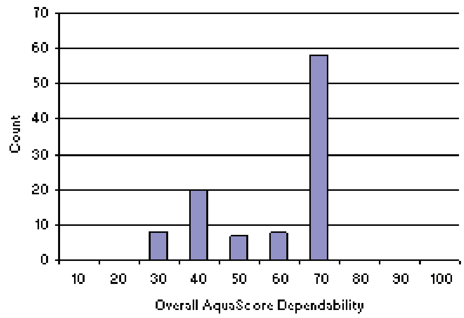
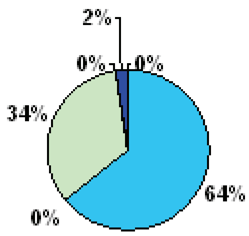
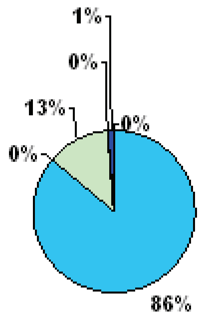
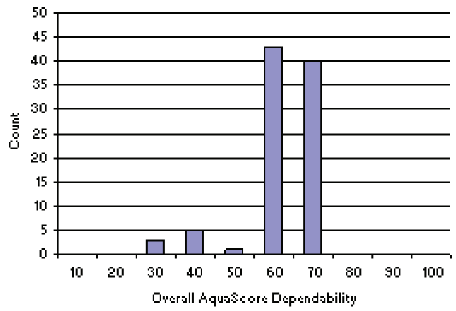
Mulgrave Russell			
Murray			
Nogoa			
O'Connell			
Pioneer			

Catchment	AquaScore by number of spatial units	AquaScore by total area of spatial units	AquaScore dependability
Plane			
Proserpine			
Ross			
Shoalwater			
Styx			

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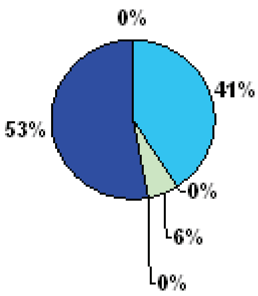
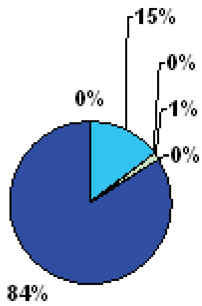
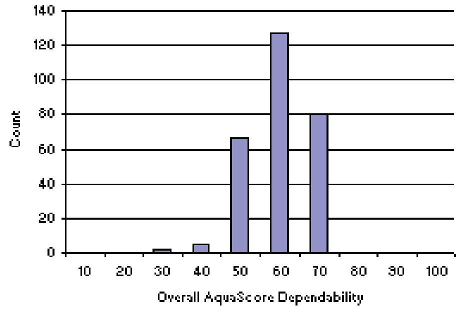
<tr><td>Tully</td><td>
</td><td>
</td><td>
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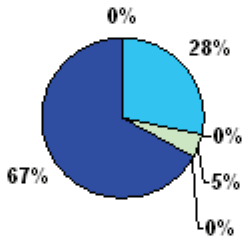
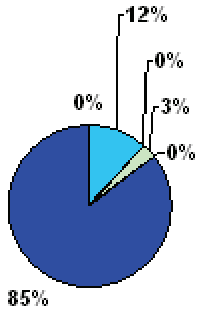
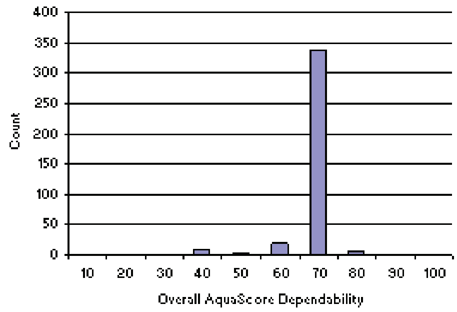
<tr><td>Waterpark</td><td>
</td><td>
</td><td>
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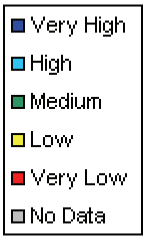
3.1.2 Criteria scores

Table 7 Summary by criteria

Key



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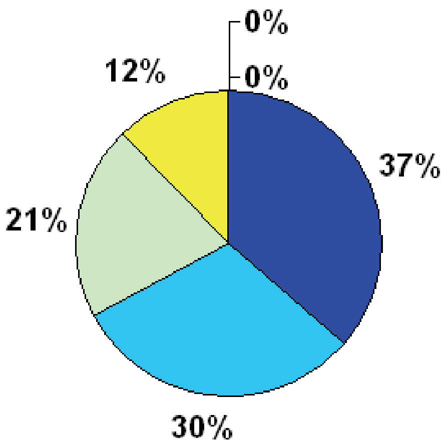
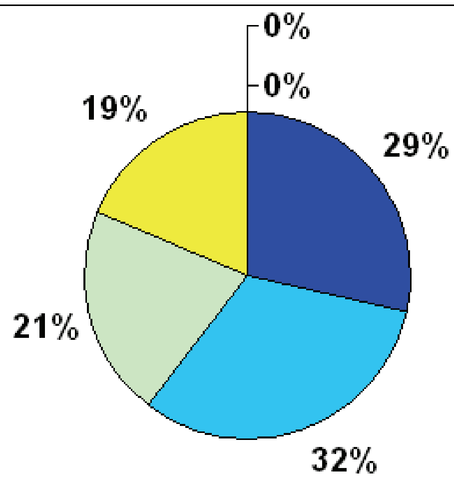
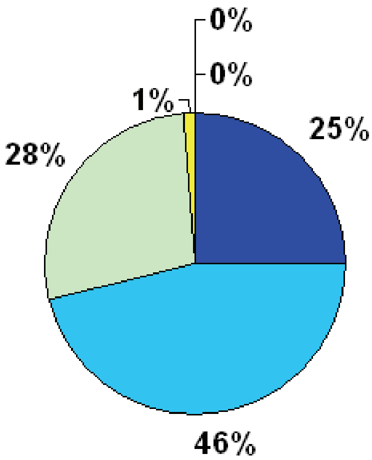
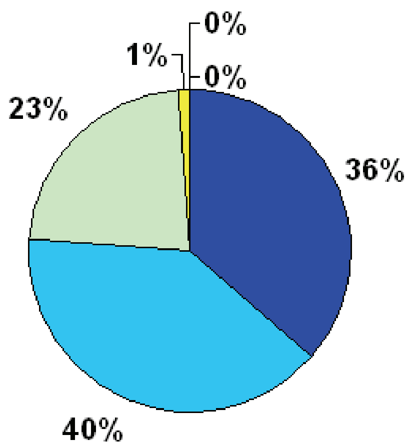
Criterion 1		
Criterion 2		

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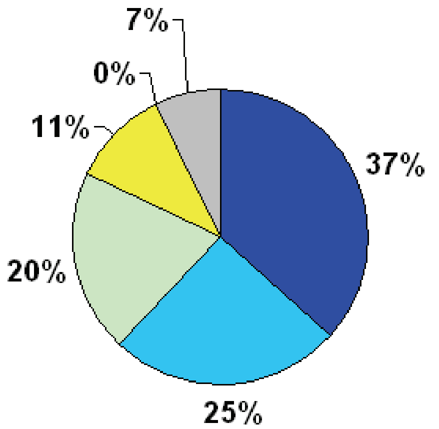
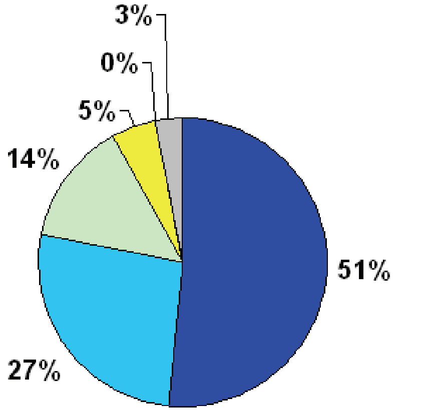
<tr><td>Criterion 3</td><td>
</td><td>
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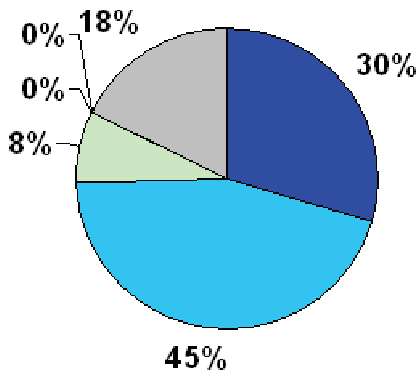
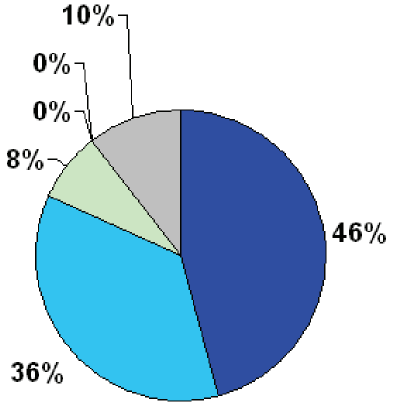
<tr><td>Criterion 4</td><td>
</td><td>
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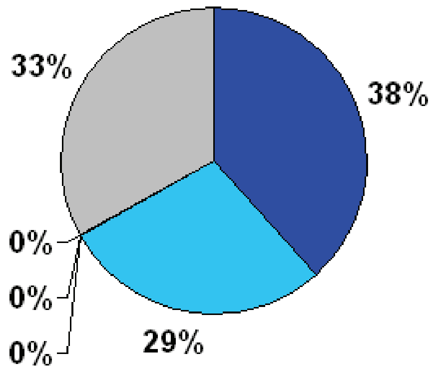
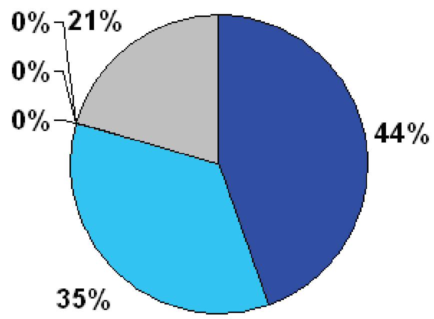
<tr><td>Criterion 5</td><td>
</td><td>
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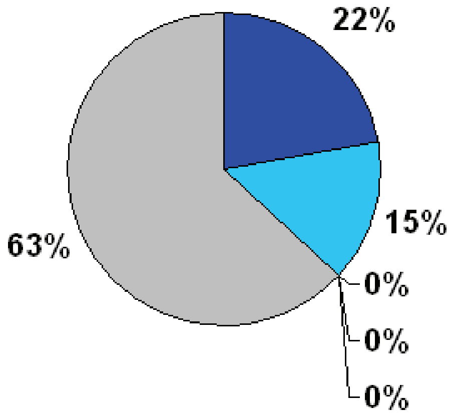
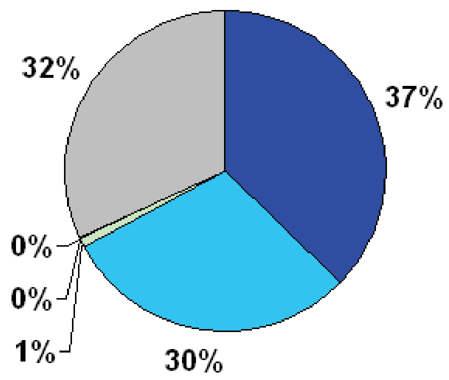
<tr><td>Criterion 6</td><td>
</td><td>
</td></tr>
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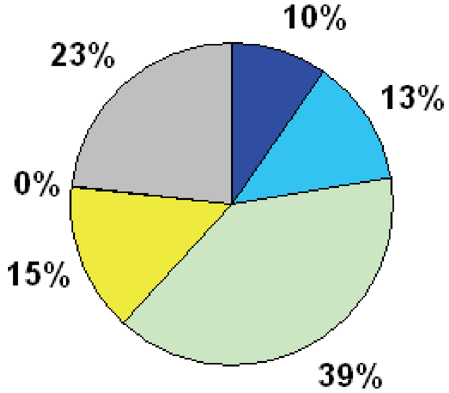
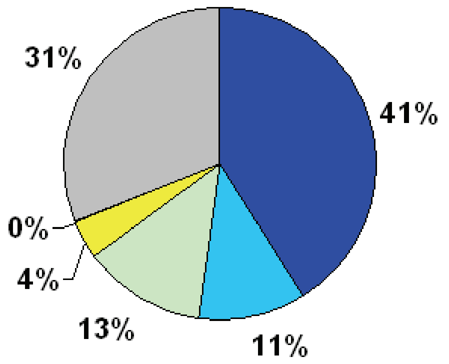
Catchment	Criteria scores by number of spatial units	Criteria scores by total area of spatial units
Criterion 8		

3.2 Summary

3.2.1 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 by an expert panel for their very high special feature 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.

3.2.2 Broad trends

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

- For some catchments there are significant differences between the distributions of AquaScores when summarised by number of spatial units versus per cent of total spatial unit. This is to be expected in catchments where not all spatial units are the same size. For example in the Boyne there are nine spatial units. Of these, six are High but only comprise 1.4 per cent of the total area of spatial units. One spatial unit with a medium value comprises 98.6 per cent of the total area which is why there are significant differences between the AquaScore distribution by area vs number. A related trend is seen in Proserpine where the very low spatial units are 6 per cent of the number but 33.5 per cent of the area. Which graph is used (number versus area) can depend on the type of questions being asked, however it is recommended that both be considered.

- Significant environmental features (or geographic areas) that are nominated by agreements or instruments such as Ramsar, Directory of Important Wetlands, World Heritage Area, etc., influence conservation value results through the ACA process. These features/areas are not evenly distributed throughout the GBR catchments. 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 Daintree and Barron have relatively large numbers of very high value wetlands.

- The western catchments of the GBR are especially data poor. As a result, across the GBR 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 catchments e.g. Comet and Nogoa, being at the lower end of the scale compared with those catchments on the coast e.g. Barron and Styx. 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 these catchments.

- All spatial units in the Curtis Island and Hinchinbrook Island catchments are very high. 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.

- Field validation (truthing) of the GBR 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. Results from the field truthing were implemented where possible (Section 3.5).

- Data availability is never equal for all wetlands in a study area. In the same way, expert knowledge is not usually available for every wetland in a study area. Dataset completeness is influenced spatially by research effort, enthusiast search effort, political focus, etc. AquaBAMM is designed to cope with data deficiencies; however, wetlands with complete datasets are more likely to show an accurate final conservation value and they are more likely to have a species record of significance or other special feature (most likely due to increased investigative effort or functional understanding) that results in a very high or high conservation value score.

- The dependability score is a per centage of the 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 e.g. where spatial units with very low AquaScore values have low dependability, the results should be used cautiously as the AquaScore may be due to the inherent lack of values or the lack of data. In the case of missing data, further survey work may add more data which may, or may not, change the AquaScore.

- Whenever lines are drawn on a map e.g. from the expert panels or Directory of Important Wetlands etc, there is a risk that the boundary may not be correct 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 positional accuracy of the wetlands mapping is 1:100 000, except for areas along the east coast which are mapped at the 1:50 000 scale.

3.3 Herbert catchment results

3.3.1 Introduction

The Herbert River catchment is located adjacent to the central part of the Great Barrier Reef, covering an area of 9,841 km^2. The Herbert River creates a gap in the Great Dividing Range linking areas included in the Einasleigh Upland bioregion with floodplains of the Wet Tropics bioregion. As a consequence of climatic variance between sections the Herbert River catchment has characteristics of both wet tropical and dry tropical catchments and can be stratified into three distinct areas within the catchment: the Wet Tropics lowland coastal floodplain, the Wet Tropics upland ranges and the drier Einasleigh Upland catchment section. Almost all of the upper catchment is greater than 600m ASL, with the highest areas in the northeast ranges reaching over 1,000 m.

The climate of the area is humid-tropical with pronounced dry and wet seasons. The summer is hot and humid, with most of the annual precipitation falling between January and March and associated with tropical low pressure systems, including cyclones. While the mean annual rainfall for the whole catchment is 1,506 mm with an average runoff ratio of 27 per cent, rainfall and runoff is much greater in the sections of the catchment in the Wet Tropics and much lower in the Einasleigh Uplands. The Einasleigh upland sections receive approximately 750 mm rainfall per annum. Whereas, the sections in the Wet Tropics ranges receive up to 3,000 mm and the section of coastal lowlands receives between 1,500 and 2,200 mm rainfall per annum.

Prior to European settlement the Herbert catchment was largely heavily timbered, with extensive freshwater wetlands and areas of grasslands on the coastal lowlands. It has since undergone significant development with approximately 40 per cent of the coastal lowlands cleared for intensive agriculture and grazing.

The variability in rainfall distribution and intensity, and in geomorphic character of sections of the catchment, results in highly variable hydrology throughout the area. The lowland floodplain includes an active delta and is subjected to regular flooding, inundating large areas of fertile alluvial soils. Major flooding occurs on average every 3.5 years and minor flooding almost every two years. This has driven significant hydrological modification of the floodplain to enable agricultural development, including numerous drainage systems that have developed without strategic consideration. It is estimated by DERM that approximately 70 per cent of the coastal wetlands have been lost as a result of this development and the character of many of the remaining wetlands has been significantly altered.

Land use within the catchment differs greatly between the Einasleigh Uplands and the Wet Tropics lowlands. Cattle grazing is the dominant land use in terms of area, covering 7,330 km^2 and is the principal land use type in the Einasleigh Uplands section of the catchment, dependent on native pastures, with some fodder cropping. Some horticulture occurs in the north and there exist a number of operational and abandoned tin mines. Significant areas of the lowland floodplain are utilised for developed pasture for cattle grazing. However, by far the most significant land use in the lowland coastal floodplain area is intensive sugar cane cultivation, covering 691 km^2 and supporting two sugar mills (Victoria and Macknade). Sugar cane cultivation has undergone significant and rapid expansion over the last two decades, largely on the more marginal lands for production. These lands included large areas of poorly drained coastal wetlands used previously for grazing.

State forests and timber reserves occupy 990 km^2 and total protected areas cover approximately 1,825 km^2. Approximately 1,417 km^2 of the catchment is in the Wet Tropics World Heritage Area. These protected areas are the dominant tenure and land use in the Wet Tropics highlands parts of the catchment. On the lowlands urban development is concentrated around the township of Ingham, with smaller settlements including Abergowerie, Trebonne, Halifax and coastal settlements Forest and Taylor’s Beaches and Lucinda. There are few towns in the upper catchment, the largest being Mount Garnet and Herberton. The population of the catchment is approaching 9,000 people.

3.3.2 Summary of results for the Herbert catchment

In the Herbert catchment ACA, 47 per cent of the spatial units scored an AquaScore of very high, equating to approximately 79 per cent of the total area (

Figure ***4***). These results were distributed throughout the Herbert catchment (

Figure ***6***). The majority of very high spatial units were very high as a result of expert panel decisions identified through criteria 5 and 6 (refer Table 8 and Figure 7 for criteria results). In total there were 29 decisions identified by the flora, fauna and ecology expert panels – 20 ecology, 5 flora and 4 fauna decisions (see attachments A, B and C). The large number of expert panel decisions in the Herbert catchment compared with other study areas is due to decisions made during an expert panel process conducted as part of a draft ACA for the Herbert catchment, which was not released.

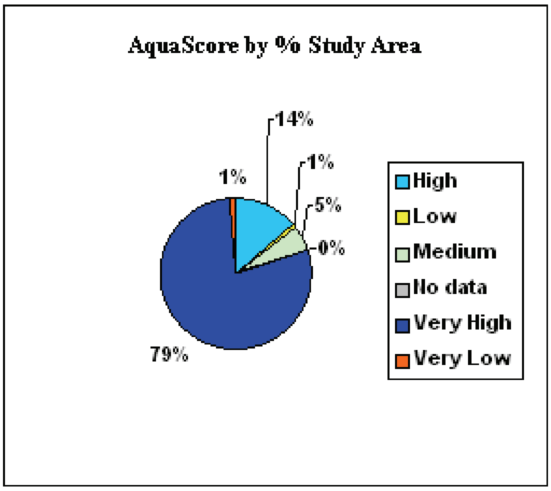
The AquaScore dependability for the Herbert catchment is concentrated around 55 per cent (

Figure ***5***) which is to be expected for this coastal catchment. The summary section of this report contains more detailed information on the overall dependability trends across the GBR.

3.3.3 AquaScore results

AquaScore by % Study Area

AquaScore	Area (ha)	Area (%)
No data	0.00	0
Very Low	193.82	1
Low	105.88	1
Medium	668.73	5
High	2040.48	14
Very High	11069.55	79



AquaScore by % Spatial Units

Aqua Score Value	Number of Spatial Units	% of SpatialUnits
No data	0	0.00
Very Low	49	6.91
Low	6	0.85
Medium	96	13.54
High	225	31.73
Very High	333	46.97

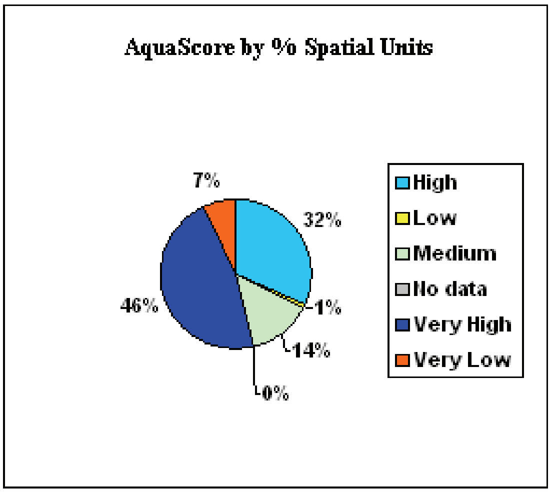


Figure 4 Herbert catchment AquaScore

AquaScore Dependability

Overall AquaScore Dependability	Count
10	0
20	35
30	58
40	44
50	213
60	183
70	176
80	0
90	0
100	0

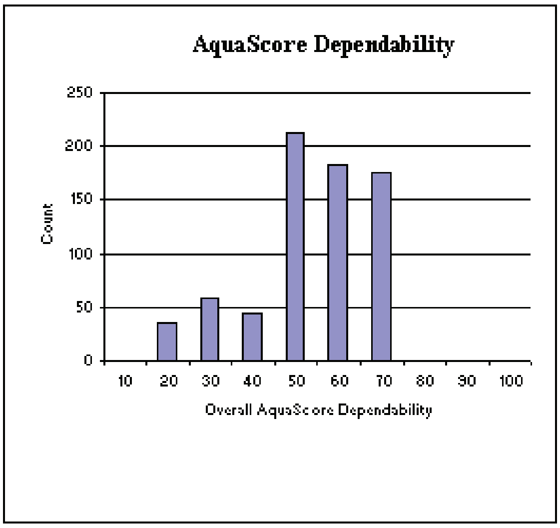


Figure 5 Herbert catchment dependability

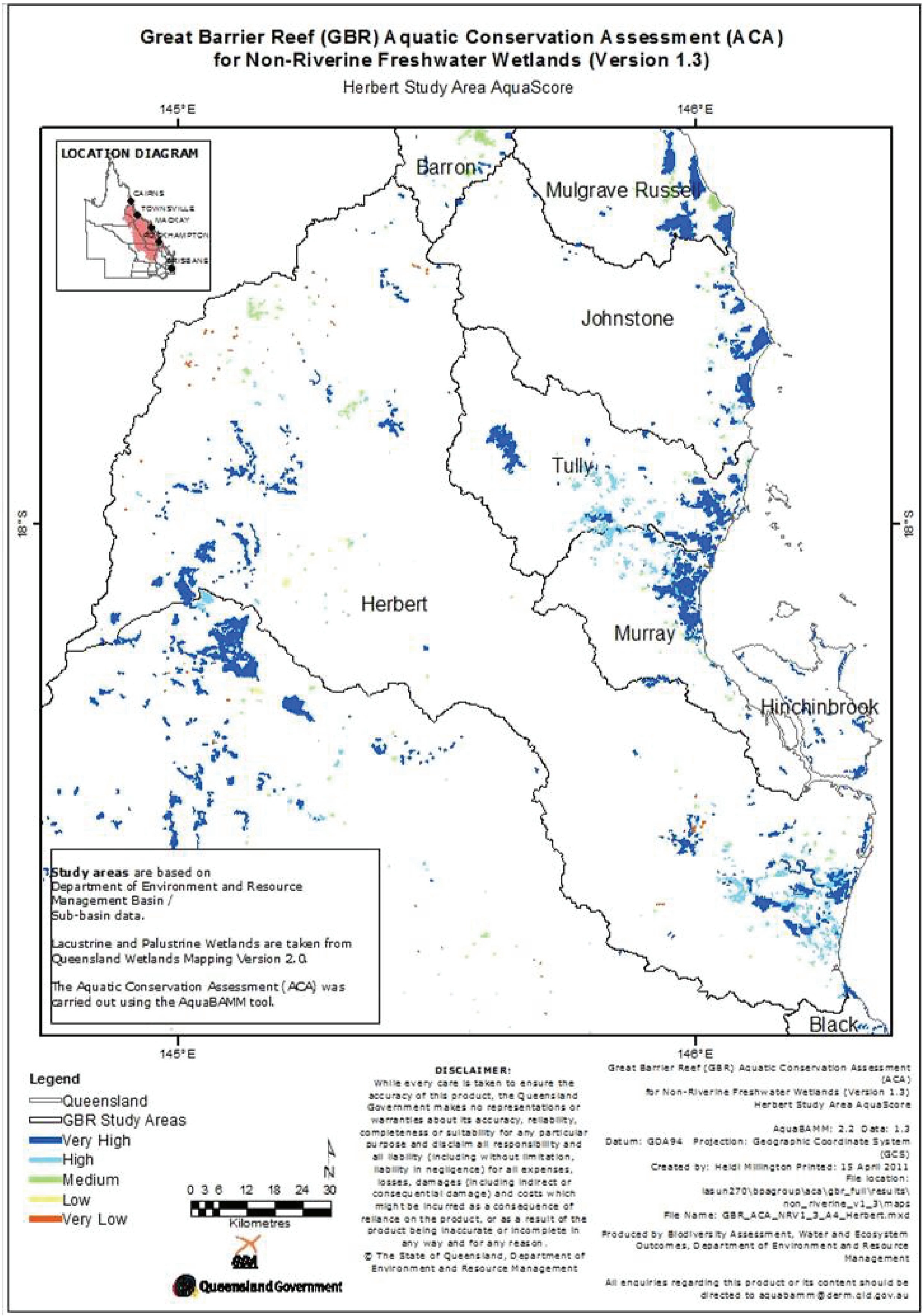


Figure 6 Herbert catchment AquaScore

3.3.4 Criteria results

Table 8 Herbert catchment criteria rating distribution by AquaScore value and dependability

Criteria	No data (%)	Low (%)	Medium (%)	High (%)	Very high (%)	Dependability (%)
1. Naturalness aquatic		**14**	**10**	**41**	**35**	**35**
2. Naturalness catchment			**22**	**52**	**26**	**95**
3. Diversity and richness	**4**	**11**	**25**	**21**	**40**	**37**
4. Threatened species and ecosystems	**12**		**3**	**35**	**50**	**42**
5. Priority species and ecosystems	**53**			**9**	**38**	**11**
6. Special features	**24**		**0**	**33**	**44**	**25**
8.Representativeness	**17**	**5**	**47**	**20**	**11**	**73**

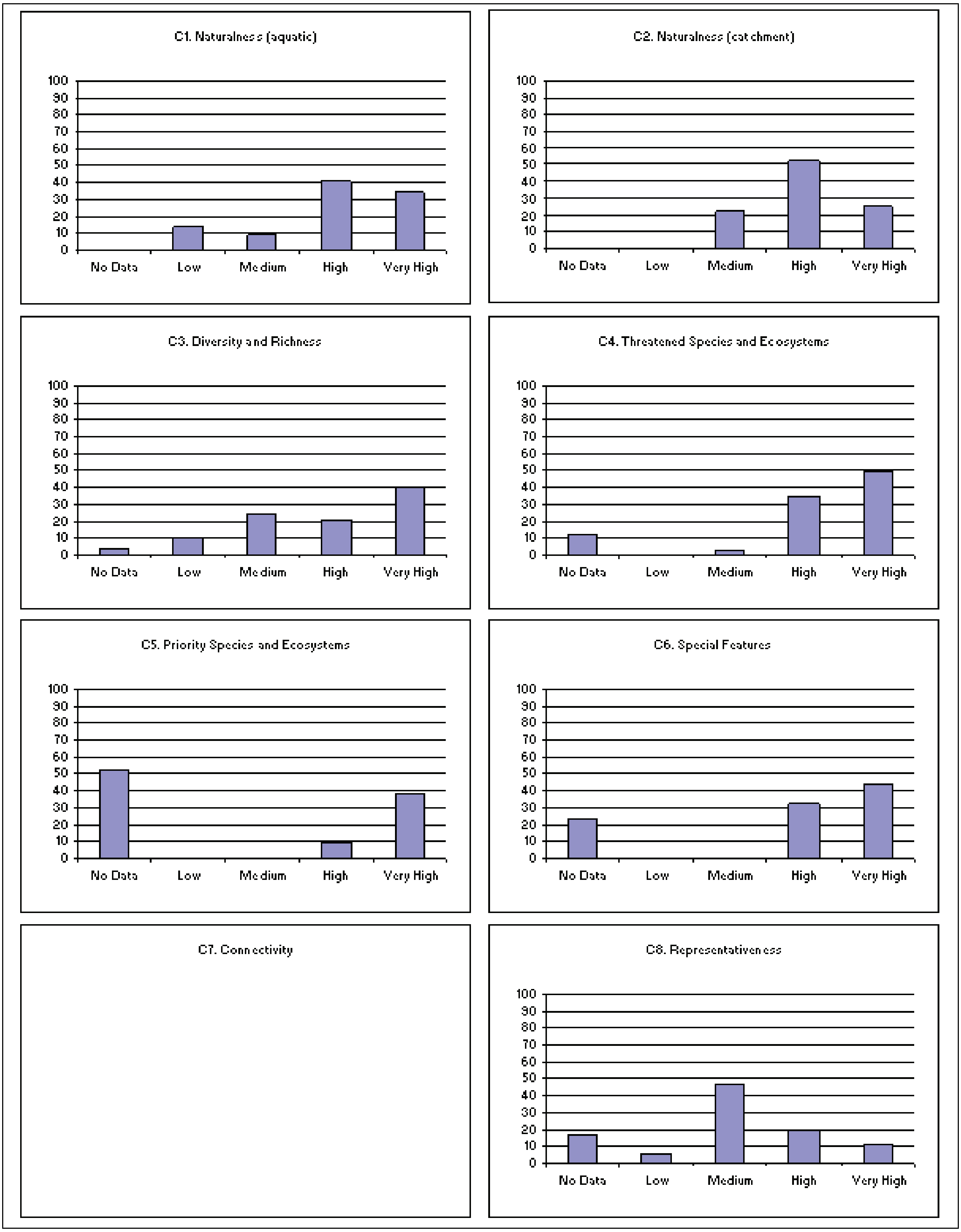


Figure 7 Herbert catchment criteria rating distribution by AquaScore

3.4 Mackenzie catchment results

3.4.1 Introduction

The Mackenzie sub-catchment of the Fitzroy receives flows from the Nogoa, Comet and Isaac rivers. The catchment extends downstream to the confluence with the Dawson River where it becomes the Fitzroy River. Townships in the sub-catchment include Middlemount, Blackwater and Dingo.

Grazing is the predominant land use in the catchment but there are a number of coal mines and irrigated and dry land cropping. The catchment is highly regulated with flows being controlled through Bingegang, Bedford and Tartrus weirs as well as a number of water harvesting operations.

Most of the upper catchment flows through a single channel however at the confluence with the Isaac River there are several large floodplain waterholes such as Lake Mary that may become river channels during floods.

Taunton National Park. several state forests and part of Blackdown Tableland National Park are located within the catchment.

3.4.2 Summary of results for the Mackenzie catchment

In the Mackenzie catchment, nine per cent of the spatial units scored a very high AquaScore equating to approximately 29 per cent of the total area of spatial units (Figure 8). These results were distributed throughout the Mackenzie catchment (

Figure ***10***).The very high AquaScores were primarily due to very high values for criteria 6 or criteria 4 and criteria 8 (refer Table 9 and

Figure ***11*** for criteria results).

Only two expert panel decisions were identified by the expert panels (ma_nr_ec_01, ma_nr_fl_01 – refer to the Fitzroy expert panel reports in attachments G and I for more details) and as a result not many spatial units scored a very high for criteria 6 (Table 9 and

Figure ***11***).

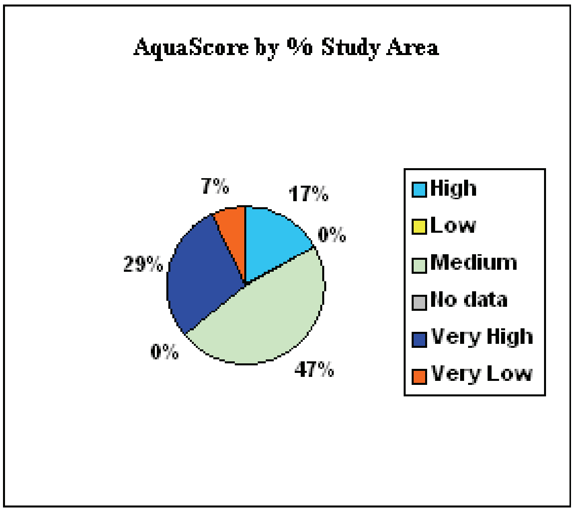
In the Mackenzie catchment, the AquaScore dependability was concentrated around 50 per cent (

Figure ***9***) which is to be expected for this catchment. The summary section of this report contains more detailed information on the overall dependability trends across the GBR.

3.4.3 AquaScore results

AquaScore by % Study Area

AquaScore	Area (ha)	Area (%)
No data	0.00	0
Very Low	359.89	7
Low	0.00	0
Medium	2427.47	47
High	907.83	17
Very High	1512.19	29



AquaScore by % Spatial Units

Aqua Score Value	Number of Spatial Units	% of SpatialUnits
No data	0	0.00
Very Low	97	19.56
Low	0	0.00
Medium	318	64.11
High	36	7.26
Very High	45	9.07

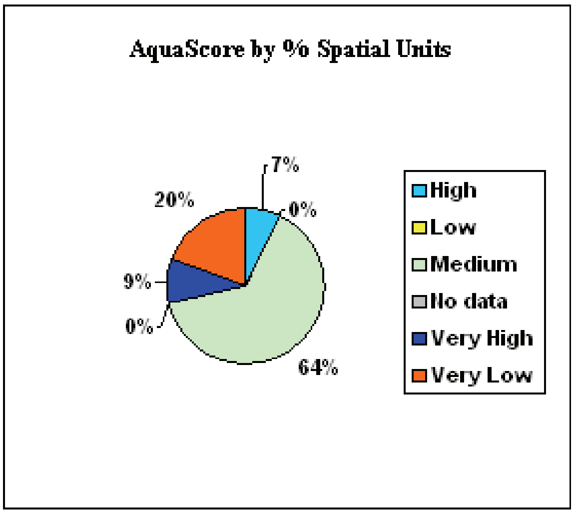


Figure 8 Mackenzie catchment AquaScore

AquaScore Dependability

Overall AquaScore Dependability	Count
10	0
20	67
30	76
40	66
50	151
60	96
70	40
80	0
90	0
100	0

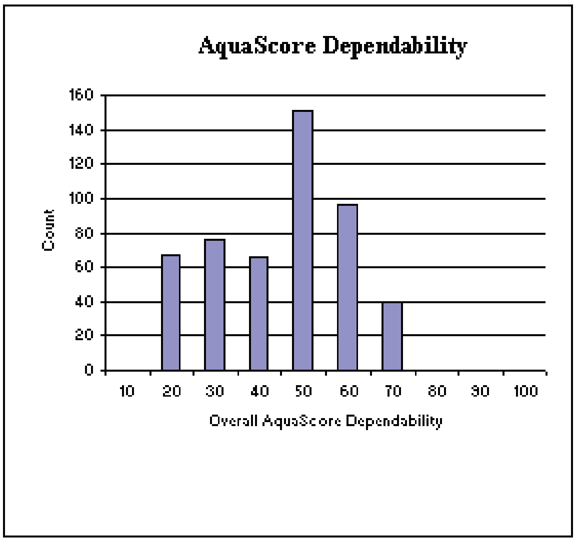


Figure 9 Mackenzie catchment dependability

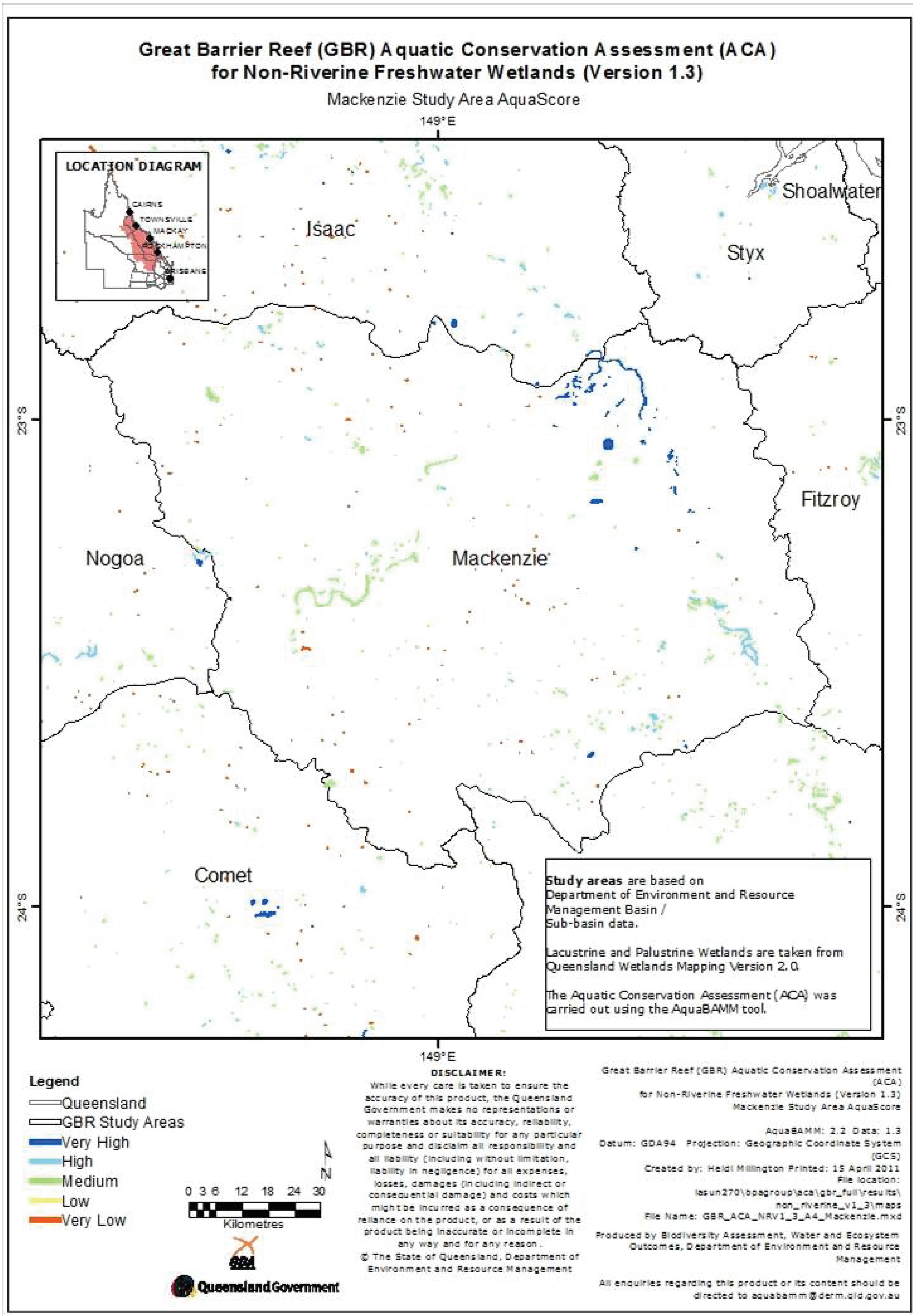


Figure 10 Mackenzie catchment AquaScore

3.4.4 Criteria results

Table 9 catchment criteria rating distribution by AquaScore value and dependability

Criteria	No data (%)	Low (%)	Medium (%)	High (%)	Very high (%)	Dependability (%)
1. Naturalness aquatic		20	27	24	30	30
2. Naturalness catchment			56	40	4	95
3. Diversity and richness	13	9	21	15	42	32
4. Threatened species and ecosystems	31			43	25	27
5. Priority species and ecosystems	35			38	27	19
6. Special features	92			0	8	3
8.Representativeness	40		46	11	4	52

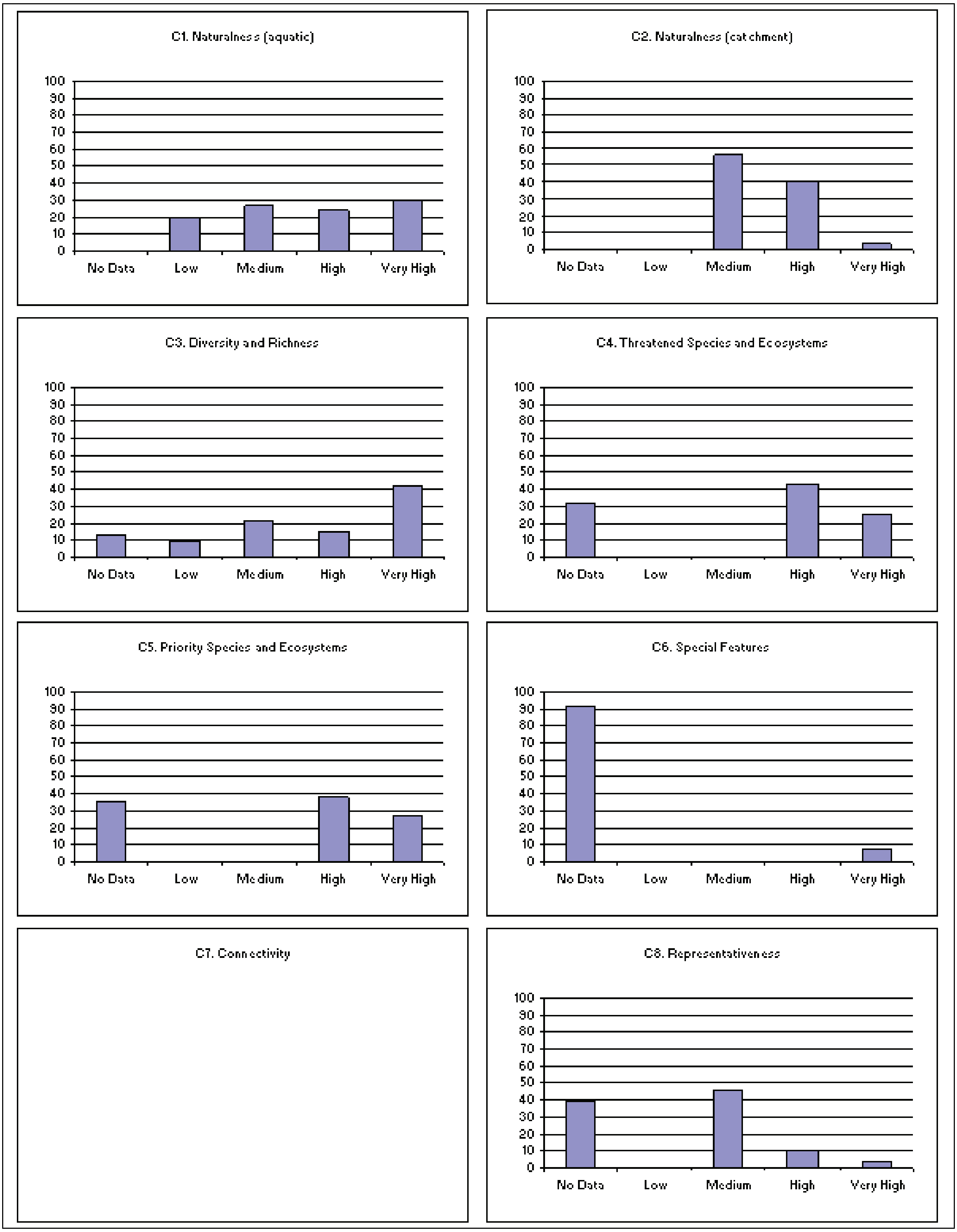


Figure 11 Mackenzie catchment criteria rating distribution by AquaScore

3.5 Field truthing

Field validation of ACA results is important to test the accuracy of the wetland conservation values attributed. Field validation (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.

Spatial units for field validation are selected based upon the following guiding principles:

- to check a representative sample of wetlands types;
- to cover a range of Aquascores (i.e. very high to very low), with a focus on the very high and very low spatial units as these are considered to be the most important values to reduce the potential of a false negative (Type 1 error) or false positive (Type 2 error) result;
- to assess the general accuracy of calculated Aquascores for spatial units which are contiguous, and are attributed with significantly different Aquascores.
- to check within stratification if stratification has been implemented; and
- that both riverine and non-riverine results can be field truthed at the same time to reduce sampling effort.

Notwithstanding, the above principles are subject to accessibility, budget, time and environmental constraints (i.e. weather). In addition, potentially only a small part of a much larger spatial unit can be, or is, assessed in the field. Lastly, it should be noted that the intent of field validation is not to confirm individual measure data (i.e. the presence of a particular threatened species), rather to undertake a gross check of the spatial unit.

A previous field truthing exercise for the GBR ACA Version 1.2 showed that the ACA results for the GBR catchment were an accurate reflection of wetland conservation values with only a few exceptions. Based on the results from the field truthing, a number of changes were made to the filtering table and measure calculations in the previous GBR ACA version. Approximately one per cent of the spatial units visited required further consideration or correction prior to the final run of each ACA.

Outputs of the current non-riverine GBR ACA Version 1.3 have not been subject to field validation and the following figures and tables in this section relate to the field validation process undertaken for the GBR ACA Version 1.2. Notwithstanding, it should be noted that the findings from the field validation exercise undertaken for Version 1.2 were implemented and reapplied during development of the current Version 1.3.

3.5.1 Spatial units inspected

The 35 catchments of the GBR contain a total of 10,464 spatial units. From the 1st June to the 12th June 2009, a total of 107 spatial units across 15 catchments were inspected by vehicle as part of the field truthing exercise (Table 10). This equated to approximately one per cent of the total spatial units within the GBR 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 GBR catchment area accounted for the relatively small number of spatial units visited. Despite the small number visited, the exercise allowed the direct checking of many of the non-riverine wetlands and covered a range of AquaScores (Table 11). A map of the route taken during the field truthing exercise is provided in

Figure *12*. Images of spatial units inspected during the field are provided in the following plates.

In addition to those spatial units mentioned in Table 10, a desktop analysis of the results for other wetlands was undertaken using satellite imagery (e.g. SPOT).

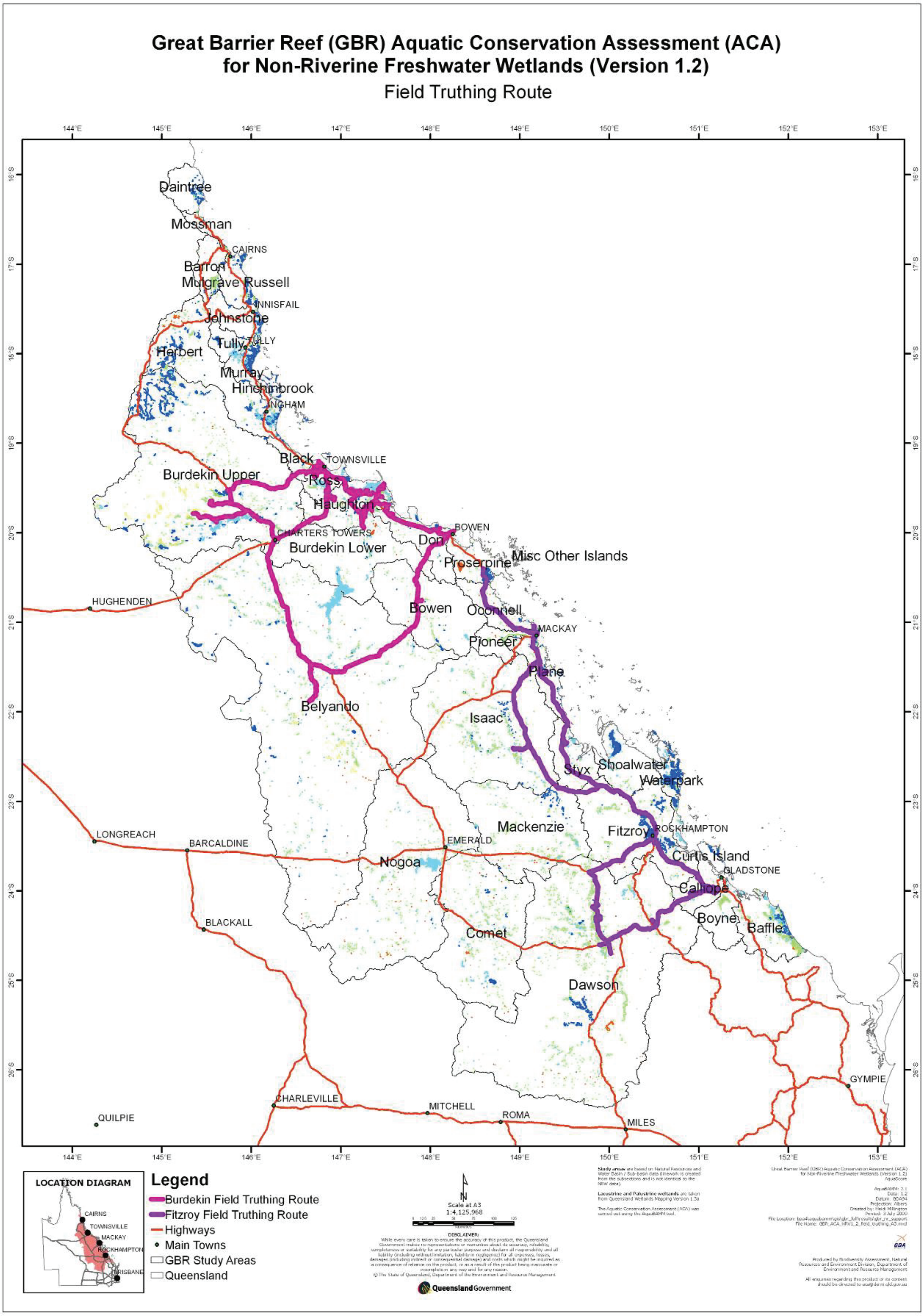


Figure 12 Route undertaken during field truthing exercise for the GBR ACA Version 1.2

Table 10 Spatial units inspected during field truthing by catchment for the GBR ACA Version 1.2

ACA study areas or catchments	Spatial units inspected	Percent of spatial units within study area
Baffle	0	0.0%
Barron	0	0.0%
Belyando	4	0.4%
Black	0	0.0%
Bowen	0	0.0%
Boyne	0	0.0%
Burdekin Lower	11	6.0%
Burdekin Upper	10	1.0%
Calliope	4	14.3%
Comet	0	0.0%
Curtis Island	0	0.0%
Daintree	0	0.0%
Dawson	12	0.8%
Don	4	2.8%
Fitzroy	8	1.9%
Haughton	24	4.7%
Herbert	0	0.0%
Hinchinbrook	0	0.0%
Isaac	2	0.4%
Johnstone	0	0.0%
Mackenzie	0	0.0%
Mossman	0	0.0%
Mulgrave Russell	0	0.0%
Murray	0	0.0%
Nogoa	0	0.0%
O'Connell	1	0.3%
Other Islands	0	0.0%
Pioneer	2	5.0%
Plane	3	2.0%
Proserpine	1	0.8%
Ross	18	12.4%
Shoalwater	0	0.0%
Styx	3	3.3%
Tully	0	0.0%
Waterpark	0	0.0%
	107	**Percent of total spatial units = 1.0%**

Table 11 Spatial units traversed during field truthing by AquaScore for the GBR ACA Version 1.2

AquaScore	Total number of spatial units	Number of spatial units field truthed	Per cent field truthed
Very High	2,847	38	1.3%
High	2,186	22	1.0%
Medium	4,863	37	0.8%
Low	278	4	1.4%
Very Low	290	6	2.1%
	10,464	**107**	**1.0%**

Photo: Selena Rollason, DERM

Plate 1 Townsville Town Common

A large palustrine system on the outskirts of Townsville (wetlands surrounding spatial unit ro_w00014) scored high under the GBR ACA (AquaScore dependability 72 per cent). This spatial unit is located in the north east section of the Ross catchment. It scored high or very high in all criteria except “Criteria 8 Representativeness” where it achieved a medium.

Photo: Selena Rollason, DERM

Plate 2 Near Serpentine Lagoon

This small wetland, located approximately 35 km south of Townsville (spatial unit ha_ w00429) scored High (AquaScore dependability 53 per cent). This spatial unit is located within the southern part of the Haughton catchment near Serpentine Lagoon. It scored either high or very high in all criteria.

Photo: Selena Rollason, DERM

Plate 3 Near the Great Basalt Wall

Located approximately 100 km northwest of Charters Towers, this ephemeral wetland (spatial unit bp_ w00599) was rated low (AquaScore dependability 44 per cent). The spatial unit is located in the southern part of the Burdekin Upper catchment. The wetland scored very high for 'Criteria 1 Naturalness aquatic' and high for 'Criteria 2 Naturalness catchment' but has limited values or lacked data for the other criteria, hence the overall AquaScore of low.

Photo: Selena Rollason, DERM

Plate 4 Cromarty wetlands

Cromarty wetlands, southeast of Townsville (spatial unit ha_w00057) scored a very high under the assessment (AquaScore dependability 79 per cent). The spatial unit is located in the northern section of the Haughton catchment. It scored either high or very high in all criteria. The result is primarily the result of expert panel decisions covering the area (ha_nr_fa_01, ha_nr_fl_02 and ha_nr_fl_03).

Photo: Selena Rollason, DERM

Plate 5 Tedlands wetland system

Tedlands wetland system east of Koumala (spatial unit pl_w00111) was rated as very high (AquaScore dependability 65 per cent). The wetland is located in the eastern part of the plane catchment. Although the area scored low for ‘Criteria 1 Naturalness aquatic’ and medium for ‘Criteria 2 Naturalness catchment’, the wetland achieved an AquaScore of very high primarily the result of very high scores in the other criteria and the presence of expert panel decisions (pl_nr_ec_01 and pl_nr_fl_03).

Photo: Selena Rollason, DERM

Plate 6 Wilmott Lagoon

Wilmott Lagoon, located approximately 25 km west of Gladstone (spatial unit ca_w00008), was rated as high (AquaScore dependability 49 per cent). The wetland is located in the northern section of the Calliope catchment. It scored high or very high for most criteria giving it an overall AquaScore of high despite receiving a medium for ‘Criteria 2 Naturalness catchment’.

Photo: Selena Rollason, DERM

Plate 7 Plane Creek

Plane Creek, south of Sarina (spatial unit pl_w00073) was rated Medium (AquaScore dependability 30 per cent). The site is located in the central section of the plane catchment. Its highest rating was a very high for ‘Criteria 4 Threatened species’. All other criteria rated low or had limited data resulting in an overall AquaScore of Medium.

3.5.2 Field interpretation of ACA results – ecological versus condition assessment

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 GBR catchment, the assessment results compared well with field truthing results.

3.6 Changes in results from ACA Version 1.2 to Version 1.3

Following the provision of updated wetlands mapping and additional further investigation of the GBR non-riverine Version 1.2 results, a number of changes were made between Version 1.2 and Version 1.3. These changes include:

- Base wetlands mapping updated from v1.3a to v2.0. The total number of ACA assessed wetlands increased from 10,464 to 11,412. The total area of ACA assessed wetlands reduced from 290,792ha to 288,121ha.

- Updated species records and, in particular, fauna records.

- Minor changes to the thresholding of species measures.

- Springs have now been included.

- Minor edits to the implementation of expert panel measures based on detailed checking (details of these edits are listed below).

- H2M5 wetlands were removed from measures that use the wetland RE (WETRE) field. Any RE that still exists for H2M5s is vastly different to the preclear RE and the indicated WETRE. H2M5s have had their ecological character altered due to gross mechanical disturbance (e.g. cropping).

- H2M1 wetlands removed from calculations for measure 4.2.1. H2M1s should not have received a score for 4.2.1 in GBR ACA NR v1.2. This measure is based on the WETRE field which should be 'water' for all H2M1s. In the previous wetlands mapping, a significant number of H2M1s had REs listed in their WETRE fields. This was an error picked up in all other measures based on WETRE in GBR ACA NR v1.2 and has now been corrected for GBR ACA NR v1.3 for this measure as well.

- Nature Refuges have now been included in the protected area estate definitions for the representativeness measures within criteria 8.

- H2M8 wetlands are now included.

- Expert panels were not rerun but the results from the previous expert panels were reapplied to the new wetlands mapping. Whilst it is preferable to rerun the panels for each ACA release, the panels were run relatively recently and there would be little benefit in rerunning each panel for this new version.

- Field truthing of the v1.3 results was not undertaken, however results from the v1.2 field truthing were incorporated into v1.3 where appropriate.

Details of the differences in expert panel special features and priority species and ecosystem decisions between Version 1.2 and Version 1.3 are listed below. A small number of decisions have been edited, added or removed. These are listed here. There will be some other differences in expert panel decisions between versions due to ensuring the removal of H2M1 and H2M5 wetlands from 5.2.1. There are also changes in mapped wetlands within the extents of the decision boundaries based on the updated Queensland Wetlands Mapping.

Table 12 Changes to expert panel special features and priority species and ecosystem decisions between Version 1.2 and Version 1.3

Decision	Change	Description
	Burdekin Decisions	
bk_nr_fl_03	Added	This study area was omitted last time for this priority species and ecosystems decision

Decision	Change	Description
bw_nr_fl_01	Removed	ACA Wetlands are no longer picked up in this area
do_nr_fl_03	Added	This study area was omitted last time for this priority species and ecosystems decision
ha_nr_fl_01	Removed	ACA Wetlands are no longer picked up in this area. All of RE 11.3.4 is now strongly associated with floodplains and as such it is not included this time
bk_nr_fa_01	Added	Decision extent was re-checked and extended into this study area
bk_nr_ec_04	Added	Decision extent was re-checked and extended into this study area
bp_nr_ec_04	Added	Due to addition of springs to Version 1.3
bp_nr_ec_05	Added	Due to addition of springs to Version 1.3
bp_nr_fa_02	Edited	Addition of 6.3.1 to decision based on recheck of recorded expert panel values
do_nr_ec_01	Edited	Addition of 6.1.1 to decision based on recheck of recorded expert panel values
ha_nr_ec_05	Edited	Addition of 6.2.1 to decision based on recheck of recorded expert panel values
ha_nr_ec_06	Edited	Removal of 5.1.4 to decision based on recheck of recorded expert panel values
oi_nr_ec_01	Edited	Addition of 6.3.1 to decision based on recheck of recorded expert panel values
	Fitzroy Decisions	
dn_nr_fl_01	Added	Due to addition of springs to Version 1.3
oc_nr_fl_03	Added	This additional area was picked up for priority species and ecosystems decision for Version 1.3
oc_nr_fl_02	Added	This additional area was picked up for priority species and ecosystems decision for Version 1.3
pi_nr_fl_02	Added	This additional area was picked up for priority species and ecosystems decision for Version 1.3
fi_nr_ec_03	Edited	Expert panel decision name was edited
wa_nr_fl_04	Edited	Decision number was updated from fi_nr_fl_02 but this decision was still not implemented

Decision	Change	Description
sh_nr_fl_01	Edited	Decision renumbered from sh_nr_fl_02 in Version 1.2
wa_nr_fa_02	Edited	Addition of 6.1.1 in report
	Wet Tropics	
he_nr_ec_21	Added	Due to addition of springs to Version 1.3
da_nr_ec_04	Edited	Had H1 wetland on edge of bounding box which was removed from decision
he_nr_ec_12	Edited	Had 32 wetlands with 6.1.1 in error, changed to 6.2.1 for Version 1.3

4 Summary

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

5 Recommendations

1. The spatial distribution of wetlands of different conservation value is not even across the whole GBR study area and this distribution cannot be easily demonstrated by the summary statistics in Table 6. Results for the individual catchments as presented in Table 6 and available through the spatial data should be consulted to provide a comprehensive interpretation of the ACA results.

2. The results shown in this report are a summary of the information in the ACAs. A large amount of additional information lies at subordinate levels within any ACA. It is recommended that assessment detail at the criterion level (at least) should be considered when undertaking any queries about specific spatial units.

3. As a result of updating the base wetlands mapping and species records, as well as correcting issues identified in Version 1.2 with the benefit of hindsight, a number of changes were made between GBR non-riverine ACA Version 1.2 and Version 1.3. These changes have strengthened the ACA results and these results can be used to inform a wide range of planning processes including the wetlands regulatory framework (keeping in mind the usual considerations of data gaps etc).

6 References

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7 Attachments

Attachment A	Wet Tropics aquatic flora expert panel report
Attachment B	Wet Tropics aquatic fauna expert panel report
Attachment C	Wet Tropics wetland ecology expert panel report
Attachment D	Burdekin aquatic flora expert panel report
Attachment E	Burdekin aquatic fauna expert panel report
Attachment F	Burdekin wetland ecology expert panel report
Attachment G	Fitzroy aquatic flora expert panel report
Attachment H	Fitzroy aquatic fauna expert panel report
Attachment I	Fitzroy wetland ecology expert panel report

Attachment A GBR catchments ACA – Aquatic flora expert panel report (Wet Tropics region)

An Aquatic Conservation Assessment for the non-riverine wetlands of the Great Barrier Reef catchment

Aquatic flora Expert panel report

(Version 1.3)

Wet Tropics region

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Acronyms and abbreviations

ACA	Aquatic Conservation Assessment
ASL	Above sea level
BPA	Biodiversity Planning Assessment
DERM	Department of Environment and Resource Management
DIWA	Directory of Important Wetlands
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
GBR	Great Barrier Reef
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

1 Introduction

The Department of Environment and Resource Management (DERM) conducted an Aquatic Conservation Assessment (ACA) for the non-riverine wetlands in the Great Barrier Reef (GBR) catchment using the Aquatic Biodiversity Assessment and Mapping Method (AquaBAMM; Clayton *et al*. 2006). The ACA relied upon 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 GBR catchment.

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 GBR catchment is made up of 35 individual catchments from the Daintree River, north of Cairns to Baffle Creek, south of Gladstone. DERM applied AquaBAMM separately to the non-riverine (palustrine and lacustrine) and riverine wetlands within each of the 35 GBR catchments. In effect, there are 70 ACAs for the entire GBR catchment—covering non-riverine and riverine wetlands. A map of the GBR catchment showing each study area is provided in Attachment A.

A series of nine expert panels were conducted to address aquatic fauna, aquatic and riparian flora, and wetland ecology for the GBR catchments. The non-riverine and riverine wetlands were covered in combined workshops. The panels, held in Cairns, Townsville and Rockhampton during November and December 2008, involved invited experts with expertise in aquatic fauna, aquatic and riparian flora and/or wetland ecology in the Wet Tropics, Burdekin and Fitzroy sections of the GBR catchment.

This report documents the findings and recommendations of the aquatic flora expert panel for the Wet Tropics region held in Cairns on Tuesday 2 December, 2008. This report presents supporting information and panel input that only addresses the non-riverine wetland systems. The riverine component has been addressed in a separate report. Terms of reference for the aquatic flora expert panel are provided in Attachment B.

2 Method

2.1 Study area

The study areas used to implement the AquaBAMM assessments are based on the DERM basin/sub-basin data. The Wet Tropics study area largely corresponds to the Wet Tropics Natural Resource Management (NRM) region and contains the majority of the Wet Tropics World Heritage Area (WTWHA). In total the study area covers approximately 22,100 km^2 and lies across the majority of the Wet Tropics bioregion and a part of the Einasleigh Uplands bioregion to the west in the Upper Herbert and Upper Barron basins. It includes the nine basins shown in Figure 1, which comprise the coastal basins of the Daintree, Mossman, Barron, Mulgrave/Russelll, Johnstone, Tully, Murray, and Herbert rivers and Hinchinbrook Island. Each of these is treated as an individual study area for the purpose of the AquaBAMM analyses.

As the name suggests the Wet Tropics is characterised by high rainfall largely due to the conspicuous topography. The major mountain masses exceed elevations of 1,000 m and all are granitic, although some have flanking acid volcanic and metamorphic rocks. Extensive areas of basalt occur, particularly through the Atherton Tablelands, an extensive plateau between 600 m and 900 m that covers a large part of the upper Barron River catchment. The region contains a number of high peaks including the two highest mountains in Queensland, Mount Bartle Frere (1,622 m) and Mount Belenden Ker (1,593 m). The mountain ranges generally have steep precipitous mountain sides with deeply incised valleys. They run north to south, rising sharply near the coast and capture the moisture-laden air from the warm waters of the Coral Sea, resulting in generally high rainfall across the region. The most extensive lowlands are in the south of the study area, associated with the floodplains of the Tully and Herbert rivers, with extensive coastal freshwater and estuarine wetlands.

Mean annual rainfall for the Wet Tropics bioregion is above 1,500 mm, three times the continental average of below 500 mm, with several areas within the study area receiving much higher rainfall. Rainfall patterns are strongly seasonal with a distinct wet season occurring in the warmer months between December and April and, although generally wet, can vary substantially from year to year. Interannual variability is mainly driven by major rainfall events which commonly occur and are associated with cyclones and low pressure depressions. These can flood large areas of the region resulting in huge volumes of water being discharged to the inshore waters of the Great Barrier Reef lagoon. For example, in the Herbert River total mean annual discharge is approximately 3.7 million megalitres and in the Johnstone and South Johnstone it is 3.23 million megalitres. The amount of rain also varies throughout the region due to topography and there is a distinct gradient to drier conditions from the western side of the ranges towards where the study area crosses into the Einasleigh Uplands bioregion. Rainfall is not recorded from the peak of Mount Bartle Frere, but at the summit of the adjacent Mount Belenden Ker records show an annual average rainfall of 8,312 mm, making it the wettest meteorological station in Australia. It also holds the record for the highest rainfall in a calendar year of 12,461 mm in 2000. On the lowlands the Daintree area and the area from Cairns south to Tully receives the highest rainfall with Babinda typically receiving rainfall in excess of 4,000 mm annually. In contrast, the western side of the study area, in the Upper Herbert and Upper Barron basins, on average, receives less than 800 mm annually.

The study area also has generally warm and uniform temperatures throughout the year. Typical daytime minimum and maximum temperatures range on the coast from 22ºC to 31ºC in summer and from 15ºC to 22ºC in winter. The tablelands and uplands are generally much cooler. On the western side of the study area temperatures vary slightly more and tend towards being hotter in summer.

As a consequence of the high rainfall, rainforest cover is extensive across the ranges and coastal lowlands and streams and wetlands are numerous and important features in the landscape. For millions of years the consistent runoff has resulted in most streams and many wetlands being perennial systems, in contrast to most other parts of Australia, including most of the tropical region. As a result the Wet Tropics has sustained a unique and diverse freshwater fauna and flora with many endemic species present.

The high degree of variation in rainfall, topography, combined with a complex evolutionary history has resulted in a diverse spectrum of forest types and plant and animal communities. The rainforests of the region which dominates the narrow, high rainfall coastal belt have been classified into 16 major structural types and 30 broad community types (Tracey and Webb, 1975; Tracey, 1982). In addition the rainforests are fringed and dissected by a range of sclerophyll forests and woodlands as well as wetlands including estuarine mangrove communities. Tall woodlands, open *Eucalyptus* forests and grasslands extend into the drier western parts of the study area in to the Einasleigh Upland bioregion.

Wetland types include an enormous number of low order, perennial or near perennial, streams descending the steep ranges. These join in to several major river systems that define the basins within the study area. The coastal lowland floodplains are generally narrow, with the most extensive lowlands occurring in the south of the study area associated with the floodplains of the Tully/Murray and the Herbert rivers. These areas contain complex systems of numerous interconnecting wetlands and extensive coastal estuarine areas. The Herbert floodplain receives the lowest rainfall of the coastal lowlands in the study area but can have the highest discharge from runoff in the upper catchment. Its floodplain is dominated by woodlands with extensive areas of grass and sedge swamps laying adjacent to dune systems and connected estuaries. This area also contains the Herbert River delta which is formed at the southern end of the Hinchinbrook Channel, with its extensive stands of mangrove forest. In the Tully/Murray floodplain (and areas to the north) rainfall is higher and the coastal vegetation is dominated by forest, rainforest and extensive wetland areas. Unfortunately many of the coastal wetlands throughout the study area have been lost or are now largely modified through drainage and reclamation works. Many of the remaining wetlands are also heavily impacted by clearing of riparian and fringing vegetation, infestation by weeds and by events resulting in a decline in water quality through runoff from adjacent agriculture. Fractured basalt and other fractured rock aquifers occur throughout the study area supporting unique fauna and flora. These aquifer systems are particularly significant in some of the areas within the drier parts of the study area in the Einasleigh Upland. Crater lakes are also a unique feature of the plateaus of the study area.

Approximately 35 per cent of the study area is covered by the Wet Tropics World Heritage Area, taking in most of the ranges and large areas of lowland rainforest. The World Heritage Area consists of extensive areas of National Park and other protected estate as well as areas of private land. The major commercial land uses in the study area include extensive areas of lowlands, and some uplands, used for sugar cane production. Extensive areas in the lowlands are also used for banana production with a diverse range of other horticultural crops occurring throughout. On the fertile Atherton Tablelands dairy is a major industry along with a variety of horticulture and crops. Cattle grazing is a minor land use in the coastal lowlands but extensive cattle grazing is the major land use in the western part of the study area. The area was once heavily dependent on native forestry. However, this has declined with the protection of much of the native rainforest areas in the Wet Tropics World Heritage Area and in recent times forestry has depended on broad hectare softwood plantations on the Atherton Tablelands and the Cardwell area. Increasingly, other forestry plantations are being established on what was traditionally land used for sugar cane production.

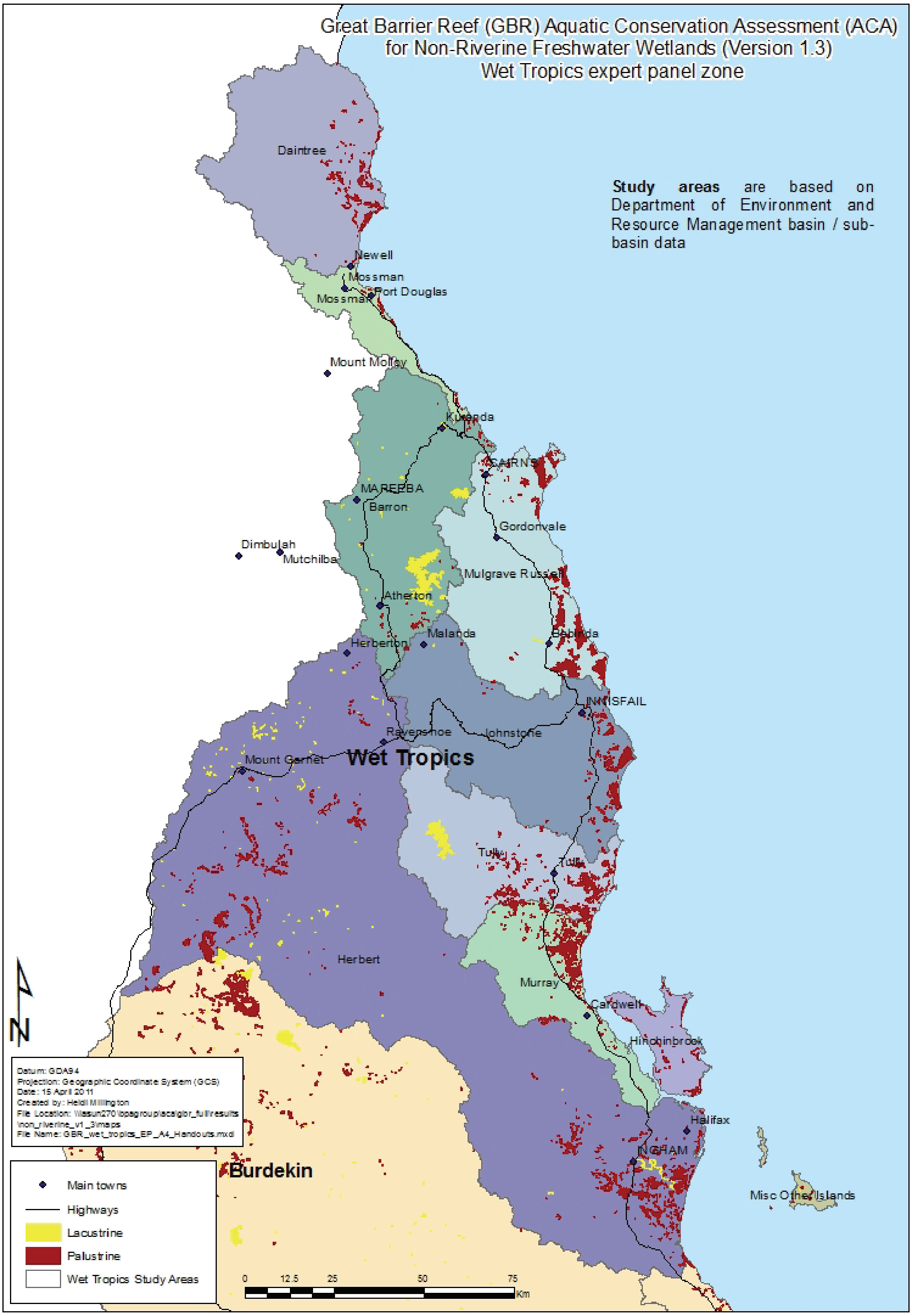

Figure 1 Wet Tropics section of the GBR catchment (incorporating nine individual catchments)

2.2 Panel composition

The expert panel (the panel) comprised invited persons (Table 1) familiar with aquatic flora in the Wet Tropics section of the GBR catchment.

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
Niall Connolly	Principal Conservation Officer, Department of Environment and Resource Management	Biodiversity planning, aquatic ecology and water quality
Nick Cuff	Senior Botanist, Queensland Herbarium, Department of Environment and Resource Management	Botany and regional ecosystem assessment
John Dowe	Botanist, Australian Centre for Tropical Freshwater Research, James Cook University	Riparian vegetation
Andrew Ford	Technical Officer (Botanist), CSIRO	Tropical flora and Wet Tropics biogeography
Prof. Paul Gadek	Professor, School of Marine and Tropical Biology, James Cook University	Tropical flora and biogeography
Jeanette Kemp	Principal Botanist, Department of Environment and Resource Management	Native and exotic flora
George Lukacs	Director, Australian Centre for Tropical Freshwater Research, James Cook University	Wetland ecology
Keith McDonald	Principal Technical Officer (Threatened Species), Department of Environment and Resource Management	Tropical ecology and conservation
Tim Perry	Principal Ecologist, NRA Environmental Consultants	Native and exotic vegetation
Michaelie Pollard	Project Officer (aquatic ecology), Department of Environment and Resource Management	Aquatic ecology
Travis Sydes	Hymenachne/Rehabilitation Project Officer, Hinchinbrook Shire Council	Invasive species management and planning
Jim Tait	Ecologist, Ecoconcern Pty Ltd	Wetland ecology and management
Michael Trenerry	Team Leader (Regional Services), Department of Environment and Resource Management	Tropical ecology and conservation
Bruce Wannan	Principal Biodiversity Planning Officer, Department of Environment and Resource Management	Tropical flora and conservation planning
Frank Zich	Curator, Australian Tropical Herbarium, James Cook University	Tropical flora

Selena Inglis 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 GBR catchment was also sourced from various technical reports.

3 Rare and threatened flora

The panel identified one 'rare' and two 'vulnerable' and six 'endangered' flora taxa in the Wet Tropics section of the GBR catchment as being primarily aquatic, semi-aquatic or riparian in habit (Table 2). Threatened taxa were excluded from this list if they did not correspond to one of these categories. This list of flora was used as the basis for identifying areas of significance for 'Criterion 4 Threatened Species and ecosystems' (4.1.2). Point records were used to identify the spatial units having that species present.

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**	**Habitat**	**Comments**
Aponogeton bullosus		E[1,2]		
Eleocharis retroflexa		V[1,2]		
Fimbristylis adjuncta		E[1,2]		No valid records available at time of processing.
Hedyotis novoguineensis		E[1]		Wetland dependant species.
Myrmecodia beccarii	Ant plant	V[1,2]		
Nepenthes mirabilis (Bramston Beach)	Tropical pitcher plant	E[1]		
Phaius australis		E[1,2]		Occurs in hanging swamps and springs.
Rhamphicarpa australiensis		R[1]		
Sankowskya stipularis		E[1,2]		

- *recent records (>1950) and records with precision (<2,000 m) only*

1. *Queensland Nature Conservation Act 1992 (E – Endangered, V – Vulnerable, R – Rare, LC – Least Concern)*
2. *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 GBR catchment 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, 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 32 non-riverine priority flora species (Table 3). These species were included in 'Criterion 5 Priority species and ecosystems' (5.1.2). Point records were buffered using their precision to identify the spatial units having a priority species present.

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**	**Habitat**	**Priority number**[4]	**Comments**
Azolla pinnata	Ferny azolla	Aquatic[3]	1,2,3,4	Good indicator of ecosystem health.
Baumea articulata	Jointed twigrush		1,2,3	Usually found in standing water or depressions forming palustrine swamps which are restricted in their distribution. It forms dense stands and significant macrophyte beds providing important habitat and food source for fauna.
Baumea rubiginosa	Soft twigrush		1,2,3	Usually found in standing water or depressions forming palustrine swamps which are restricted in their distribution. It forms dense stands and significant macrophyte beds providing important habitat and food source for fauna.
Bolboschoenus fluviatilis			7	Small population subject to threatening processes.
Cyperus exaltatus	Tall flatsedge	Semi-aquatic[3]	3,5	Large sedge found on open plains which provides good habitat for fauna species and is quite rare as it is at its northern limit.
Eleocharis acutangula			7	Species is out-competed by exotic grasses and is subject to threatening processes associated with sugarcane farming.
Eleocharis atropurpurea			7	Species is out-competed by exotic grasses and is subject to threatening processes associated with sugarcane farming.
Eleocharis brassii			7	Species is out-competed by exotic grasses and is subject to threatening processes associated with sugarcane farming.

Scientific name	Common name	Habitat	Priority number[4]	Comments
Eleocharis cylindrostachys		Semi-aquatic[3]	7	Species is out-competed by exotic grasses and is subject to threatening processes associated with sugarcane farming.
Eleocharis dulcis			1,6,7	Defining species of regional ecosystem 7.3.1. It forms significant macrophyte beds, provides stream bank or bed stabilisation and is subject to threatening processes.
Eleocharis equisetina			7	Species is out-competed by exotic grasses and is subject to threatening processes associated with sugarcane farming.
Eleocharis geniculata			7	Species is out-competed by exotic grasses and is subject to threatening processes associated with sugarcane farming.
Eleocharis minuta			7	Species is out-competed by exotic grasses and is subject to threatening processes associated with sugarcane farming.
Eleocharis nuda			7	Species is out-competed by exotic grasses and is subject to threatening processes associated with sugarcane farming.
Eleocharis philippinensis		Aquatic[3]	7	Species is out-competed by exotic grasses and is subject to threatening processes associated with sugarcane farming.
Eleocharis sphacelata	Tall spikerush	Aquatic[3], Riparian[3]	7	Species is out-competed by exotic grasses and is subject to threatening processes associated with sugarcane farming.
Eleocharis spiralis			7	Species is out-competed by exotic grasses and is subject to threatening processes associated with sugarcane farming.
Eleocharis tetraquetra			7	Species is out-competed by exotic grasses and is subject to threatening processes associated with sugarcane farming.
Gahnia sieberiana	Sword grass		2,3,4,6	Forms extensive swathes in lowlands and swamps important for reproduction of various fauna species by providing significant habitat (particularly for butterflies) and important food sources. Also helps with bed stabilisation.
Hemarthria uncinata		Aquatic[3]	7	Small population subject to threatening processes.
Hydrilla verticillata	Hydrilla	Aquatic[3]	1,3,4	Mainly important in the Herbert River catchment as it forms significant macrophyte beds providing important habitat for fish spawning and reproduction. Species improves water quality but is susceptible to sedimentation and turbidity.
Hymenachne acutigluma			7	Small population subject to threatening processes.
Isolepis fluitans	Floating club rush		5,7	A disjunct small population subject to threatening processes, only known from streams at Ravenshoe.
Leersia hexandra	Swamp rice grass		1,6	Forms significant macrophyte beds and provides bed stabilisation.
Lepironia articulata			1,2,3,6	Forms significant macrophyte beds which are critical habitat and source of food for fauna species, particularly invertebrates. It also provides bed stabilisation.

Scientific name	Common name	Habitat	Priority number[4]	Comments
Lomandra hystrix		Semi-aquatic[3]	3,6	Species hosts more butterflies than any other species on the list and also provides stream bank stabilisation. It also has a restricted distribution.
Ludwigia adscendens			1,2,5	Forms significant macrophyte beds which provide important/critical habitat particularly for fish. It is at its distributional limit or is a disjunct population.
Melaleuca quinquenervia	Swamp paperbark	Riparian[3]	3,6	Forms extensive stands in freshwater wetlands and wetlands that fluctuate between fresh water and saline. Also provides important fauna habitat for species such as mahogany gliders (*Petaurus gracilis*) and cassowaries (*Casuarius casuarius johnsonii*).
Oryza australiensis			2,3	It is an important food source and provides important habitat.
Oryza meridionalis			2,3	It is an important food source and provides important habitat.
Oryza rufipogon			2,3	It is an important food source and provides important habitat.
Pseudoraphis sp. (Port Douglas R.L.Jago 6610)			7	This species is only known form about 20 individuals in a single dune swale at Port Douglas thus qualifying as a small population subject to threatening processes.

- *recent records (>1950) and records with precision (<2,000 m) only*

1. Queensland *Nature Conservation Act 1992 (E – Endangered, V – Vulnerable, R – Rare, LC – Least Concern)*
2. *Environment Protection and Biodiversity Conservation Act 1999 (E – Endangered, V – Vulnerable)*
3. *Clayton, P.C., Fielder, D.F., Howell, S. and Hill, C.J. 2006. Aquatic biodiversity assessment and mapping method (AquaBAMM): a conservation values assessment tool with trial application in the Burnett River catchment. Queensland Environmental Protection Agency, Brisbane.*
4. Refers to the significant values required to be a priority species, as listed above Table 3.

5 Species richness

Species richness (i.e. total number of species) was scored for aquatic-dependant flora, stratified by 150 m above sea level (asl) for all study areas in the Wet Tropics (see the Wet Tropics ecology expert panel report for more information on stratification).

The Wet Tropics section of the GBR catchment has 144 plants that are referred to in this report as being 'aquatic-dependant' in non-riverine wetlands (Table 4). The datasets for these species were accessed from the DERM corporate databases of WildNet and Herbrecs and from panel member records.

The panel defined 'aquatic-dependant flora' to mean:

> 'those species that are adapted to and dependant on living in wet conditions for at least part of their life cycle and found either within or immediately adjoining a non-riverine wetland'.

This definition of a wetland dependent plant 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 better depicts the flora richness value at a given location.

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

This list was 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	Habitat	Comments
Actinoscirpus grossus		LC[1]		
Ammannia multiflora	Jerry-jerry	LC[1]		
Aponogeton proliferus		E[1,2]		
Aponogeton vanbruggenii		LC[1]		
Azolla pinnata	Ferny azolla	LC[1]	Aquatic[3]	
Banksia robur	Broad-leaved banksia	LC[1]		
Barringtonia racemosa		LC[1]		
Baumea articulata	Jointed twigrush	LC[1]		
Baumea juncea	Bare twigrush	LC[1]		
Baumea rubiginosa	Soft twigrush	LC[1]		
Blechnum indicum	Swamp water fern	LC[1]		
Bolboschoenus fluviatilis		LC[1]		
Caldesia oligococca		LC[1]		
Caldesia parnassifolia		LC[1]		
Centipeda borealis		LC[1]		
Centipeda minima		LC[1]		
Ceratophyllum demersum	Hornwort	LC[1]	Aquatic[3]	Potentially important fish habitat.
Cladium procerum	Leafy twigrush	LC[1]		
Cyanotis axillaris		LC[1]		

Scientific name	Common name	Status	Habitat	Comments
Cyperus exaltatus	Tall flatsedge	LC[1]	Semi-aquatic[3]	
Drosera angustifolia		LC[1]		
Drosera burmanni		LC[1]		
Drosera peltata	Pale sundew	LC[1]		
Drosera spatulata		LC[1]	Semi-aquatic[3]	
Eclipta prostrata	White eclipta	LC[1]	Riparian[3]	
Eleocharis acutangula		LC[1]		
Eleocharis atropurpurea		LC[1]		
Eleocharis brassii		LC[1]		
Eleocharis cylindrostachys		LC[1]	Semi-aquatic[3]	
Eleocharis dulcis		LC[1]		
Eleocharis equisetina		LC[1]		
Eleocharis geniculata		LC[1]		
Eleocharis minuta		LC[1]		
Eleocharis nuda		LC[1]		
Eleocharis philippinensis		LC[1]	Aquatic[3]	
Eleocharis retroflexa		V[1,2]		
Eleocharis sphacelata	Tall spikerush	LC[1]	Aquatic, riparian[3]	
Eleocharis spiralis		LC[1]		
Eleocharis tetraquetra		LC[1]		
Epaltes australis	Spreading nutheads	LC[1]		
Eriocaulon		LC[1]		
Eriocaulon athertonense		LC[1]		
Eriocaulon cinereum		LC[1]		
Eriocaulon nanum		LC[1]		
Eriocaulon odontospermum		LC[1]		
Eriocaulon pygmaeum		LC[1]		
Eriocaulon scariosum		LC[1]		
Eriocaulon setaceum		LC[1]		
Exocarya scleroides		LC[1]		
Fimbristylis adjuncta		E[1,2]		No valid records available at time of processing.
Fimbristylis aestivalis var. aestivalis		LC[1]		
Gahnia sieberiana	Sword grass	LC[1]		
Haloragis heterophylla	Rough raspweed	LC[1]		
Hedyotis novoguineensis		E[1]		Wetland dependant species.
Hemarthria uncinata		LC[1]	Aquatic[3]	
Hydrilla verticillata	Hydrilla	LC[1]	Aquatic[3]	
Hymenachne acutigluma		LC[1]		
Ipomoea aquatica		LC[1]	Riparian[3]	
Isachne confusa		LC[1]		
Isachne globosa	Swamp millet	LC[1]		

Scientific name	Common name	Status	Habitat	Comments
Isolepis fluitans	Floating club rush	LC[1]		
Juncus continuus		LC[1]		
Juncus polyanthemus		LC[1]		
Juncus usitatus		LC[1]	Aquatic[3], riparian[3]	
Leersia hexandra	Swamp rice grass	LC[1]		
Lemna aequinoctialis	Common duckweed	LC[1]		
Lepironia articulata		LC[1]		
Limnophila brownii		LC[1]	Riparian[3]	
Lomandra hystrix		LC[1]	Semi-aquatic[3]	
Ludwigia adscendens		LC[1]		
Ludwigia peploides subsp. montevidensis		LC[1]	Aquatic[3]	
Marsilea		LC[1]		
Marsilea crenata		LC[1]		
Marsilea drummondii	Common nardoo	LC[1]	Semi-aquatic[3]	
Marsilea hirsuta	Hairy nardoo	LC[1]	Semi-aquatic[3]	
Marsilea mutica	Shiny nardoo	LC[1]	Semi-aquatic[3]	
Melaleuca quinquenervia	Swamp paperbark	LC[1]	Riparian[3]	
Monochoria cyanea		LC[1]		
Monochoria vaginalis		LC[1]		
Myrmecodia beccarii	Ant plant	V[1,2]		
Najas tenuifolia	Water nymph	LC[1]	Aquatic[3]	
Nepenthes mirabilis (Bramston Beach)	Tropical pitcher plant	E[1]		
Nymphaea gigantea		LC[1]	Aquatic[3]	
Nymphaea immutabilis		LC[1]		
Nymphaea nouchali		LC[1]		
Nymphaea pubescens		LC[1]		
Nymphoides aurantiaca		LC[1]		
Nymphoides exiliflora		LC[1]		
Nymphoides indica	Water snowflake	LC[1]	Aquatic[3]	
Nymphoides parvifolia		LC[1]		
Oryza australiensis		LC[1]		
Oryza meridionalis		LC[1]		
Oryza rufipogon		LC[1]		
Ottelia alismoides		LC[1]		
Paspalum distichum	Water couch	LC[1]	Semi-aquatic[3]	
Paspalum vaginatum	Saltwater couch	LC[1]	Riparian[3]	
Persicaria barbata		LC[1]		
Persicaria subsessilis	Hairy knotweed	LC[1]		
Phaius australis		E[1,2]		

Scientific name	Common name	Status	Habitat	Comments
Philydrum lanuginosum	Frogsmouth	LC[1]	Riparian[3]	
Phragmites australis	Common reed	LC[1]	Aquatic[3]	
Phragmites karka		LC[1]		
Phragmites vallatoria		LC[1]		
Potamogeton crispus	Curly pondweed	LC[1]	Aquatic[3]	
Potamogeton tepperi		LC[1]		
Potamogeton tricarinatus	Floating pondweed	LC[1]	Aquatic[3]	
Pseudoraphis spinescens	Spiny mudgrass	LC[1]		
Pseudoraphis sp. (Port Douglas R.L. Jago 6610)		LC[1]		
Rhamphicarpa australiensis		R[1]		
Rotala diandra		LC[1]		
Rotala mexicana		LC[1]		
Rotala occultiflora		LC[1]		
Rotala tripartita		LC[1]		
Rumex brownii	Swamp dock	LC[1]		
Sacciolepis indica	Indian cupscale grass	LC[1]		
Sankowskya stipularis		E[1,2]		
Schoenoplectus litoralis		LC[1]		
Schoenus apogon var. apogon		LC[1]		
Schoenus melanostachys		LC[1]		
Selaginella		LC[1]		
Spirodela punctata	Thin duckweed	LC[1]	Aquatic[3]	
Stylidium eriorhizum		LC[1]		
Stylidium graminifolium	Grassy-leaved trigger-flower	LC[1]		
Triglochin		LC[1]		
Triglochin dubium		LC[1]		
Triglochin multifructum		LC[1]		
Triglochin procerum		LC[1]	Aquatic[3]	
Typha domingensis		LC[1]	Aquatic[3]	
Typha orientalis	Broad-leaved cumbungi	LC[1]		
Utricularia aurea	Golden bladderwort	LC[1]		
Utricularia bifida		LC[1]	Aquatic[3]	
Utricularia caerulea	Blue bladderwort	LC[1]		
Utricularia chrysantha		LC[1]		
Utricularia dichotoma	Fairy aprons	LC[1]	Aquatic[3]	
Utricularia foveolata		LC[1]		
Utricularia gibba	Floating bladderwort	LC[1]	Aquatic[3]	
Utricularia minutissima		LC[1]		
Utricularia quinquedentata		LC[1]		

Scientific name	Common name	Status	Habitat	Comments
Utricularia uliginosa	Asian bladderwort	LC[1]		
Vallisneria		LC[1]		
Vallisneria nana		LC[1]	Aquatic[3]	
Villarsia reniformis		LC[1]		Not officially recorded from the Wet Tropics.
Villarsia sp. (Laura C. Dalliston CC18)		LC[1]		
Xyris complanata	Yellow-eye	LC[1]		

- *recent records (>1950) and records with precision (<2,000 m) only*

1. Queensland *Nature Conservation Act 1992 (E – Endangered, V – Vulnerable, R – Rare, LC – Least Concern)*
2. *Environment Protection and Biodiversity Conservation Act 1999 (E – Endangered, V – Vulnerable)*
3. *Clayton, P.C., Fielder, D.F., Howell, S. and Hill, C.J. 2006. Aquatic biodiversity assessment and mapping method (AquaBAMM): a conservation values assessment tool with trial application in the Burnett River catchment. Queensland Environmental Protection Agency, Brisbane.*

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 landscape be included for the GBR ACA using AquaBAMM. The panel identified 110 exotic plants that are known to occur within the Wet Tropics section of the GBR catchment (Table 5). The presence of aquatic and semi-aquatic flora species were recorded under ‘Criterion 1 Naturalness (instream)’ (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 the 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.

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	Comments
Aeschynomene villosa			Associated with wetland and riparian ecosystems.
Alternanthera philoxeroides			Not common and its absence is an indicator of good condition. Currently on the national alert list it may become a serious issue in the future.
Ageratina riparia	Mistflower		
Ageratum conyzoides	Billygoat weed		Replaces native species.
Ageratum conyzoides subsp. conyzoides			Replaces native species.
Ageratum houstonianum	Blue billygoat weed		Replaces native species.
Allamanda cathartica			Becoming a significant problem around Mission Beach and El Arish.
Annona glabra			
Anredera cordifolia	Madeira vine		
Ardisia crenata			Emerging weed beginning to impact on riparian areas.
Ardisia solanacea			
Calopogonium mucunoides			
Cabomba caroliniana var. caroliniana	Cabomba		
Canna indica	Indian shot		
Cascabela thevetia	Yellow oleander		Problem on the Walsh River. Common in drier areas of upper catchments, however, only seen on road edges and rocky gullies in these areas.
Cecropia peltata			Present in region, class 1 weed.
Chromolaena odorata	Siam weed		

Scientific name	Common name	Habitat	Comments
Chrysopogon aciculatus	Mackie's pest		
Coffea arabica	Arabian coffee		
Cryptostegia grandiflora	Rubber vine		Indication of condition.
Cyperus aromaticus			
Cyperus involucratus			Problem weed.
Cyperus rotundus	Nutgrass	Semi-aquatic[1]	
Echinochloa colona	Awnless barnyard grass		Agricultural weed, problem in Herbert grasslands.
Echinochloa crus-galli	Barnyard grass		Agricultural weed, problem in Herbert grasslands.
Echinochloa polystachya cv. Amity	Aleman grass		Deep water, ponded pasture species.
Eichhornia crassipes	Water hyacinth		Very data poor with only two records. It is mainly a problem in non-riverine areas as riverine flows may be too high in this area.
Eleusine indica	Crowsfoot grass		Occurs in grasslands.
Eleutheranthera ruderalis			Prevalent in disturbed area with heavier soils along rivers.
Flacourtia jangomas			Common around the Daintree River and upper Daintree River catchment.
Harungana madagascariensis			
Heliotropium indicum			
Hiptage benghalensis			Concentrated near Mossman.
Hydrocleys nymphoides			Forms thick growths.
Hymenachne amplexicaulis cv. Olive			
Hyparrhenia rufa			Emerging weed found in dune swales and tea tree woodlands.
Hyptis capitata			Problem in grasslands around Ingham and has been seen on disturbed areas on banks of streams.
Impatiens walleriana	Balsam		Indicator of wetland integrity.
Lantana camara	Lantana		Impacts riparian areas.
Leucaena leucocephala	Leucaena		Favours creeks.
Leucaena leucocephala subsp. glabrata	Leucaena		Favours creeks.
Leucaena leucocephala subsp. leucocephala	Leucaena		Favours creeks.
Ligustrum sinense	Small-leaved privet		
Limnocharis flava			Should be on alert list as it is a potential future problem.
Macroptilium atropurpureum	Siratro		
Macroptilium lathyroides			
Macroptilium lathyroides var. semierectum			
Megathyrsus maximus			

Scientific name	Common name	Habitat	Comments
Megathyrsus maximus var. coloratus			
Megathyrsus maximus var. maximus			
Megathyrsus maximus var. maximus cv. Hamil			
Megathyrsus maximus var. pubiglumis			
Melinis minutiflora	Molasses grass		
Miconia calvescens	Miconia		
Miconia nervosa			
Miconia racemosa			
Mikania micrantha	Mikania vine		
Mimosa pudica			
Mimosa pudica var. hispida			
Mimosa pudica var. unijuga			
Momordica charantia	Balsam pear		Significant problem near Mulgrave River.
Montanoa hibiscifolia			Chokes gullies and creeks.
Neonotonia wightii			
Neonotonia wightii var. wightii			
Odontonema tubaeforme			
Parthenium hysterophorus	Parthenium		Flood plain weed.
Pennisetum alopecuroides	Swamp foxtail		Very invasive in southern Australian, and should be on alert list as potential future problem. It is known to invade swampy grasslands in the central Queensland coast and may be an emerging wetland weed in the study area. It is presently found in grassy valleys of the study area.
Pennisetum purpureum	Elephant grass		Invasive along river banks.
Phytolacca rivinoides			
Praxelis clematidea			
Psidium guajava	Guava		
Sagittaria platyphylla			Species should be on alert list as a potential future problem. It is an indicator of declining ecosystem health.
Salvinia molesta	Salvinia		
Sanchezia parvibracteata			
Sauropus androgynus			
Selaginella willdenovii			Its absence is a good indicator of ecosystem health.
Senna obtusifolia			Resides on banks.
Senna tora			
Sida rhombifolia			
Solanum americanum			
Solanum americanum subsp. nodiflorum			
Solanum americanum subsp. nutans			

Scientific name	Common name	Habitat	Comments
Solanum mauritianum	Wild tobacco		
Solanum nigrum			
Solanum nigrum subsp. nigrum			
Solanum seaforthianum	Brazilian nightshade		
Solanum torvum	Devil's fig		
Spathodea campanulata	West African tulip tree		
Spathodea campanulata subsp. nilotica			
Sphagneticola trilobata			
Sporobolus africanus	Parramatta grass		
Sporobolus jacquemontii			
Sporobolus natalensis			Can be either terrestrial or wetland weed.
Sporobolus pyramidalis			Can be either terrestrial or wetland weed.
Stachytarpheta jamaicensis	Jamaica snakeweed		
Synedrella nodiflora			
Syngonium podophyllum			
Thunbergia alata	Black-eyed susan		
Thunbergia fragrans			
Thunbergia grandiflora	Sky flower		Riparian vine.
Thunbergia laurifolia			
Thunbergia mysorensis			
Tithonia diversifolia	Japanese sunflower		
Tradescantia fluminensis			
Tradescantia spathacea			
Tradescantia zebrina			
Turbina corymbosa			Especially a problem on the Baron River.
Urena lobata	Urena weed		
Urochloa humidicola			
Urochloa mutica	Para grass	Semi-aquatic[3]	Coastal weed that creates ponded pastures.

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

1. *Clayton, P.C., Fielder, D.F., Howell, S. and Hill, C.J. 2006. Aquatic biodiversity assessment and mapping method (AquaBAMM): a conservation values assessment tool with trial application in the Burnett River catchment. Queensland Environmental Protection Agency, Brisbane.*

7 Priority ecosystems and special features

The panel identified several non-riverine priority ecosystems/special features in the Wet Tropics section of the GBR catchment (Table 6). These were identified for their aquatic and riparian flora values. Where special features nominated by the aquatic flora expert panel were also considered to have additional values (eg. fauna, ecology) by the aquatic fauna 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 Table 6 was given a score equal to the conservation rating.

Table 6 Priority ecosystems and special features

Decisions listed 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.

Priority ecosystem/ special feature	**Values**	**Catchment**	**Decision implementation number**	**Criteria/ indicator/ measure**	**Conservation rating (1-4)**
Barney spring	Barney Spring is characterised by its unique geomorphology and floristic composition evident by the abundance of macrophyte and rainforest species. The area is also under the influence of groundwater. Note: This decision could not be implemented in this assessment due to lack of non-riverine mapping in this area.	Barron	bn_nr_fl_ 02	6.4.1	
Wetlands of Carrington Falls Creek	The wetlands of this special area are located between Wongabell Road and the Kennedy Highway. The area contains soils with high humic component although not as waterlogged as peat swamps. The area is formed by an alteration of drainage patterns in the late Tertiary by basalt flows and contains a mix of remnant and disturbed vegetation with many of the physical drainage features still intact. Threatened species and regional ecosystems are known to occur in this area.	Barron	bn_nr_fl_ 03	6.1.1 6.3.1	3

Priority ecosystem/ special feature	Values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Seeps of eastern Herberton Range	The seeps in this area (located under Mt Misch) are swampy during and after the wet season. Groundwater seeps out of the hills and expresses itself either at the flat-hill inflection or on the range as small hanging swamps (which have *Ophioglossum* sp. and *Osbeckia chinensis* as significant species). On the groundwater flats *Salomonia ciliata* has been collected, which is the highest recorded occurrence of this forest giant. At the same location are *Drosera spp.*, several species of *Cyperaceae* and the only occurrence in the Cook district of *Goodenia rosulata*. The vegetation is expressed differently from these seeps along the Herberton Range, ranging from hanging and flat swamps to well wooded communities, which have a swampy understorey. The seeps also have great landscape and scenery values due to the terrain of the adjacent Great Dividing Range. The water in this area has been known to be extracted or stored as dams or drains.	Barron	bn_nr_fl_ 04	6.2.1 6.3.1	4
Regional ecosystem 7.3.4	This regional ecosystem is fan palm swamp, a restricted habitat type subject to a threatening process. It contains significant habitat complexity. <u>Note</u>: This priority ecosystem decision also applies to the following catchments: Daintree, Johnstone, Mulgrave Russelll, Murray and Tully.	Barron	bn_nr_fl_ 05	5.2.1	4
Thornton peak uplands and mid-altitude areas	These palustrine wetlands in part encompassing perched sedgeland swamps in the Thornton Peak/Helder Creek upland and mid-altitude areas include significant perched sedgeland swamps containing disjunct populations of flora species many of which are rare and threatened. The area is also thought to be home to an endemic crayfish species (*Euastacus robertsi*).	Daintree	da_nr_fl_ 01	6.3.1	4
Daintree River	The Daintree River contains significant areas of *Melaleuca cajuputi* in a series of large swamp ecosystems. The area also contains many unique and disjunct habitats as well as disjunct and threatened species. <u>Note</u>: This decision was also included in the riverine ACA assessment (decision number da_r_fl_02). See the Wet Tropics riverine report for more details.	Daintree	da_nr_fl_ 02	6.3.1	4

Priority ecosystem/ special feature	Values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Regional ecosystem 7.3.4	This regional ecosystem is fan palm swamp, a restricted habitat type subject to a threatening process. It contains significant habitat complexity. Note: This priority ecosystem decision also applies to the following catchments: Barron, Johnstone, Mulgrave Russell, Murray and Tully.	Daintree	da_nr_fl_ 03	5.2.1	4
Regional ecosystem 7.3.1	This priority ecosystem is an endangered regional ecosystem containing *Hemarthria uncinata*. The community is restricted, has limited distribution and has been extensively cleared/altered. Note: This priority ecosystem decision also applies to the following catchments: Herbert, Johnstone, Mulgrave Russelll, Murray and Tully.	Daintree	da_nr_fl_ 04	5.2.1	4
Princess Hills	The Princess Hills area is an area of unique habitat being the only timbered wetland in the Herbert catchment. Note: This decision was also a flora decision from the Herbert aquatic flora expert panel 2007 (decision number he_fl_1).	Herbert	he_nr_fl_ 01	6.3.1	4
Wet uplands seeps of Cardwell Range	The wet upland seeps of the Cardwell Range are unique within the Herbert catchment. The geology consists of sheets of granites that seep for a long time after rain. The area also contains a number of highland swamps. Note: This decision was also a flora decision from the Herbert aquatic flora expert panel 2007 (decision number he_fl_2).	Herbert	he_nr_fl_ 02	6.3.1	4
Plateau just north of Mount Hawkins	The plateau north of Mount Hawkins is unique within the Herbert catchment. The geology consists of sheets of granites that seep for a long time after rain. The area also contains a number of highland swamps. Note: This decision was also a flora decision from the Herbert aquatic flora expert panel 2007 (decision number he_fl_3).	Herbert	he_nr_fl_ 03	6.3.1	4

Priority ecosystem/ special feature	Values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Upper Stone River	The Upper Stone River is one of the least disturbed tributary streams within the Herbert catchment containing permanent water despite being very seasonal. The stream is unique in the region being a dry tropics stream in a wet tropics area. The area contains intact grassland communities likely to be representative of a flora composition previously more widely distributed. The area receives seep water for a long time after rain, contains high diversity of fish species and provides good fish habitat. Although subject to little or no grazing pressure the area has suffered a significant reduction in extent across the floodplain. <u>Note</u>: This decision is a revised decision from the Herbert aquatic flora expert panel 2007 (decision number he_fl_4).	Herbert	he_nr_fl_04	6.3.1	4
Regional ecosystem 7.3.1	This priority ecosystem is an endangered regional ecosystem containing *Hemarthria uncinata*. The community is restricted, has limited distribution and has been extensively cleared/altered. <u>Note</u>: This priority ecosystem decision also applies to the following catchments: Daintree, Johnstone, Mulgrave Russelll, Murray and Tully.	Herbert	he_nr_fl_05	5.2.1	4
Regional ecosystem 7.12.64 (Hinchinbrook island)	This regional ecosystem consists of heathlands with *Xanthorrhoea* spp., *Allocasuarina littoralis*, *Banksia plagiocarpa* and often *Leptospermum polygalifolium* and *Rhodomyrtus trineura subsp. trineura*. The ecosystem is associated with rock pavements in the wet granite uplands and highlands of Hinchinbrook Island.	Hinchinbrook Island	hi_nr_fl_01	5.2.1	4

Priority ecosystem/ special feature	Values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
North Cowley Beach (wetlands of the Moresby and swales around Double Point)	The wetlands of North Cowley Beach contain a dune swale complex with threatened regional ecosystems and threatened species including ant plant (*Myrmecodia beccarii)* forming a diversity of habitats. It contains a mix of sclerophyll and rainforest communities. The area demonstrates an interplay between freshwater and estuarine ecosystems consisting of alluvial regional ecosystems sitting within a matrix of land zone two units. The area is associated with Pleistocene dunes and contains significant swamp paperbark (*Melaleuca quinquenervia)* stands, disjunct floral species and ant plant (*Myrmecodia beccarii*) communities. The site also contains a high concentration of fruiting plants which provide food for threatened species such as cassowary (*Casuarius casuarius johnsonii)*, flying foxes and various nectar feeding birds. Additionally, the area acts as a filtering system.	Johnstone	jo_nr_fl_01	6.3.1	4
Regional ecosystem 7.3.1	This priority ecosystem is an endangered regional ecosystem containing *Hemarthria uncinata*. The community is restricted, has limited distribution and has been extensively cleared/altered. Note: This priority ecosystem decision also applies to the following catchments: Daintree, Herbert, Mulgrave Russelll, Murray and Tully.	Johnstone	jo_nr_fl_02	5.2.1	4
Regional ecosystem 7.3.4	This regional ecosystem is fan palm swamp, a restricted habitat type subject to a threatening process. It contains significant habitat complexity. Note: This priority ecosystem decision also applies to the following catchments: Barron, Daintree, Mulgrave Russell, Murray and Tully.	Johnstone	jo_nr_fl_03	5.2.1	4
Mount Bartle Frere	The wetlands of Mount Bartle Frere are significant perched sedgeland swamps containing disjunct flora species many of which are rare and threatened.	Mulgrave Russelll	mr_nr_fl_01	6.3.1	4

Priority ecosystem/ special feature	Values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Yarrabah	The wetlands of Yarrabah contain considerable flora values supporting disjunct flora species and communities many of which are threatened. The site is unique in that it is a very large coastal wetland complex in an intact catchment. The area shares some characteristics of wetlands in the Cape York bioregion thus supporting several plant species that are Cape York outliers. These include the tropical pitcher plant (*Nepenthes mirabilis)*, *Thryptomene oligandra,* and *Leucopogon yorkensis*. The area also has large areas of *Barringtonia racemosa* (regional ecosystems 7.3.3c) which is the largest and the best preserved example of this type. The regional ecosystem 7.2.10 (and its sub-units) is entirely unique to this area.	Mulgrave Russelll	mr_nr_fl_ 02	6.3.1	4
Russelll Heads	The interplay of freshwater and marine wetlands with threatened regional ecosystems and species makes this area special. There is a mix of sclerophyll and rainforest communities and high habitat diversity.	Mulgrave Russelll	mr_nr_fl_ 03	6.2.1 6.3.1	3
Regional ecosystem 7.3.1	This priority ecosystem is an endangered regional ecosystem containing *Hemarthria uncinata*. The community is restricted, has limited distribution and has been extensively cleared/altered. Note: This priority ecosystem decision also applies to the following catchments: Daintree, Herbert, Johnstone, Murray and Tully.	Mulgrave Russelll	mr_nr_fl_ 04	5.2.1	4
Regional ecosystem 7.3.4	This regional ecosystem is fan palm swamp, a restricted habitat type subject to a threatening process. It contains significant habitat complexity. Note: This priority ecosystem decision also applies to the following catchments: Barron, Daintree, Johnstone, Murray and Tully.	Mulgrave Russelll	mr_nr_fl_ 05	5.2.1	4
Wetlands adjoining Cardwell State Forest and Edmund Kennedy National Park	This area contains remnant vegetation, endangered regional ecosystems and threatened plant species including many *Melaleuca* and swamp species. The site provides good connectivity between protected estates, maintains a high abundance of ant plants (*Myrmecodia beccarii)*, and provides important habitat for crocodiles and mahogany gliders (*Petaurus gracilis)*. Regional ecosystems present in this area include 7.3.8 & 7.3.1.	Murray	mu_nr_fl_ 01	6.3.1	4

Priority ecosystem/ special feature	Values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Dallachy Airport Reserve	The Dallachy Airport Reserve contains primarily *Melaleuca* communities with a high diversity of ground strata. The site is in good condition and is known to contain a high density of ant plants as well as many endangered species.	Murray	mu_nr_fl_02	6.3.1	4
Regional ecosystem 7.3.1	This priority ecosystem is an endangered regional ecosystem containing *Hemarthria uncinata*. The community is restricted, has limited distribution and has been extensively cleared/altered. <u>Note</u>: This priority ecosystem decision also applies to the following catchments: Daintree, Herbert, Johnstone, Mulgrave Russelll and Tully.	Murray	mu_nr_fl_03	5.2.1	4
Regional ecosystem 7.3.4	This regional ecosystem is fan palm swamp, a restricted habitat type subject to a threatening process. It contains significant habitat complexity. <u>Note</u>: This priority ecosystem decision also applies to the following catchments: Barron, Daintree, Johnstone, Mulgrave Russelll and Tully.	Murray	mu_nr_fl_04	5.2.1	4
Jara Creek wetland	Jara Creek wetland is an example of a disjunct ecological occurrence high in biodiversity. The wetland, which is fully contained within the Tully Gorge and Alcock State Forest, is known to contain significant numbers of threatened species.	Tully	tu_nr_fl_01	6.3.1	3
Wetlands within Hull River National Park (off Mount Macky)	The wetlands in this area contain the largest remaining fan palm swamp in the wet tropics. The area is a large mosaic of very diverse, intact ecosystems known to contain ant plants (*Myrmecodia beccarii*) and other threatened species.	Tully	tu_nr_fl_02	6.3.1	4
Regional ecosystem 7.3.1	This priority ecosystem is an endangered regional ecosystem containing *Hemarthria uncinata*. The community is restricted, has limited distribution and has been extensively cleared/altered. <u>Note</u>: This priority ecosystem decision also applies to the following catchments: Daintree, Herbert, Johnstone, Mulgrave Russelll and Murray.	Tully	tu_nr_fl_03	5.2.1	4
Regional ecosystem 7.3.4	This regional ecosystem is fan palm swamp, a restricted habitat type subject to a threatening process. It contains significant habitat complexity. <u>Note</u>: This priority ecosystem decision also applies to the following catchments: Barron, Daintree, Johnstone, Mulgrave Russelll and Murray.	Tully	tu_nr_fl_04	5.2.1	4

Priority ecosystem/ special feature	Values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Melaleuca dealbata on old alluvials including gilgai landforms and seasonal drainage depressions with or without livistona decipiens	Rare (riparian) ecosystem. Note: This decision has not been implemented in this assessment because further investigation into its implementation is required.	Various	NA	5.2.1	4
Regional ecosystem 7.3.8	This regional ecosystem is important habitat for the ant plant (*Myrmecodia beccarii*) and provides part of a transitionary habitat for mahogany glider (*Petaurus gracilis*). Note: This decision was not implemented in this assessment as it was not considered to be a wetland related decision.	Various	NA	5.2.1	4

Attachments

Attachment A – GBR catchment study area

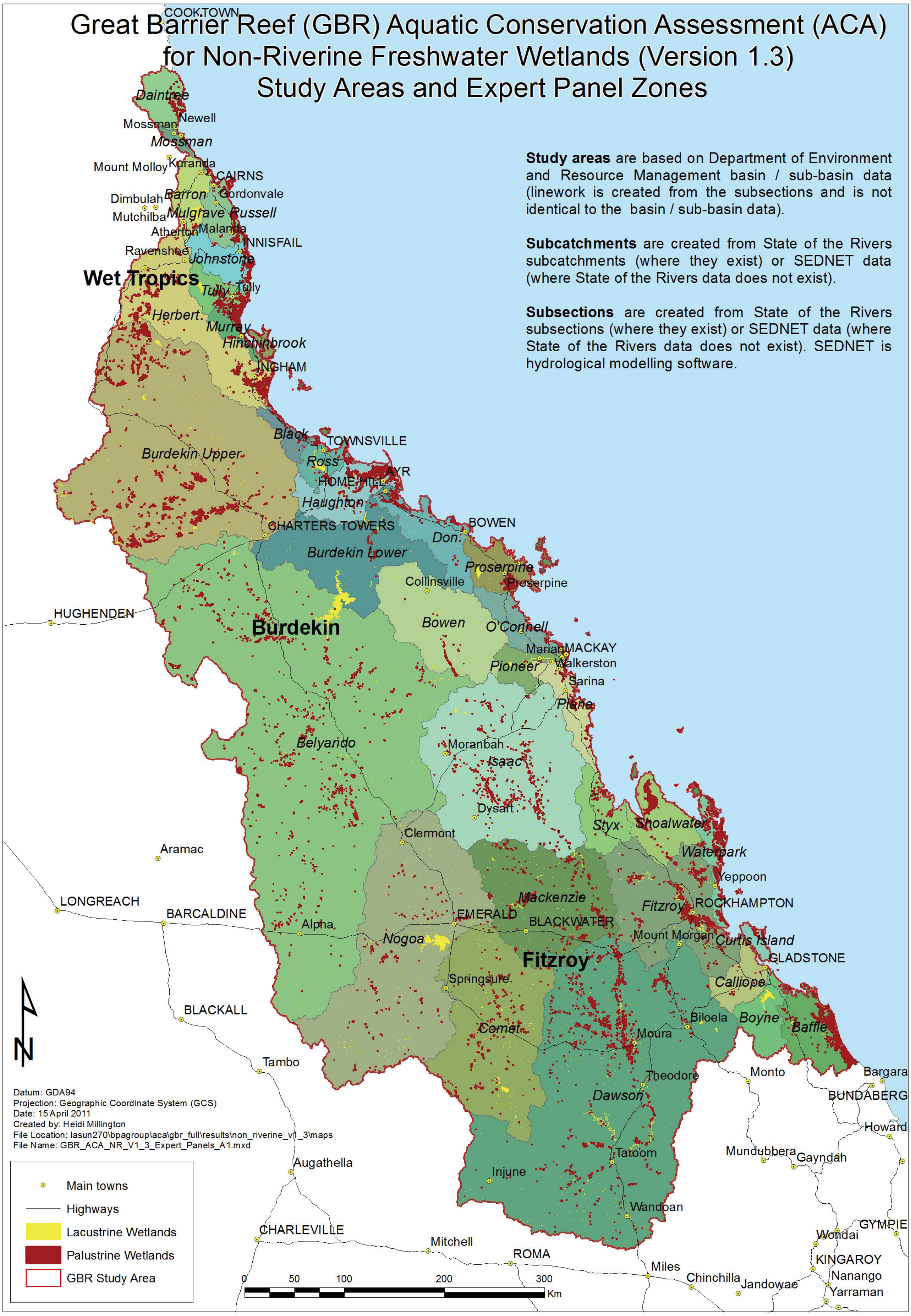

Figure 2 GBR catchment study area

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 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 of the GBR catchment. Experience in the identification and assessment of riverine and non-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 aquatic flora expert panel was established to provide expert advice on priority species, special features and/ or ecosystems that are of ecological significance to both the riverine and non-riverine wetlands of the GBR catchment. The panel consisted of professionals with expertise relating to aquatic flora and floristic communities.

The tasks undertaken by the panel included, but without limitation, 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 GBR catchment

The criteria, indicators and measures (CIM) list outlines the CIM that were implemented as part of the non-riverine Aquatic Conservation Assessment (ACA) using AquaBAMM of the freshwater wetlands of the GBR catchment.

The list has been developed from a default list of CIM that may be considered when an Aquatic Conservation Assessment (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. AquaBAMM does allow addition or deletion of indicators and/or measures for each ACA when its assessment parameters are set. However, 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 GBR catchment

Criteria & indicators	Measures	
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
1.4 Hydrological modification	1.4.5	Hydrological disturbance/modification of the wetland (e.g. as determined through DERM wetland mapping and classification)
2 Naturalness catchment		
2.1 Exotic flora/fauna	2.1.1	Presence of exotic terrestrial plants in the assessment unit
2.2 Riparian disturbance	2.2.5	Per cent area of remnant vegetation relative to preclear extent within buffered non-riverine wetland: 500 m buffer for wetlands >= 8Ha, 200 m buffer for smaller wetlands
2.3 Catchment disturbance	2.3.1	Per cent "agricultural" land-use area (i.e. cropping and horticulture)
	2.3.2	Per cent "grazing" land-use area
	2.3.3	Per cent "vegetation" land-use area (i.e. native veg + regrowth)
	2.3.4	Per cent "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	3.1.2	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
3.3 Habitat	3.3.2	Richness of wetland types within the local catchment (e.g. SOR sub-section)
	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[1], EPBC Act[2]

Criteria & indicators	Measures	
	4.1.2	Presence of rare or threatened aquatic ecosystem dependent flora species – NC Act[1], EPBC Act[2]
4.2 Communities/ assemblages	4.2.1	Conservation status of wetland Regional Ecosystems – Herbarium biodiversity status, NC Act[1], EPBC Act[2]
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)
	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[3]/CAMBA[4] 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)
8 Representativeness		
8.1 Wetland protection	8.1.1	The percent area of each wetland habitat type within protected areas
	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*
8.2 Wetland uniqueness	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)
	8.2.2	The relative abundance of the wetland management group to which the wetland habitat belongs within the subcatchment or estuarine/marine zone (management groups ranked least common to most common)
	8.2.3	The size of each wetland habitat relative to others of its management group within the catchment or study area
	8.2.4	The size of each wetland habitat relative to others of its management group within a subcatchment (or estuarine zone)
	8.2.5	Wetland habitat representative of the study area – identified by expert opinion
	8.2.6	The size of each wetland habitat relative to others of its 'type' within the catchment or study area

[1] NC Act – *Nature Conservation Act 1992* (Queensland legislation)
[2] EPBC Act – *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth legislation)
[3] JAMBA – Japan-Australia Migratory Bird Agreement
[4] CAMBA – China-Australia Migratory Bird Agreement

References

Clayton, P.D., Fielder, D.F., Howell, S. and Hill, C.J. (2006) *Aquatic biodiversity assessment and mapping method (AquaBAMM): a conservation values assessment tool for wetlands with trial application in the Burnett River catchment.* Published by the Environmental Protection Agency, Brisbane. ISBN 1-90928-07-3

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Attachment B GBR catchments ACA – Aquatic fauna expert panel report (Wet Tropics region)

An Aquatic Conservation Assessment for the non-riverine wetlands of the Great Barrier Reef catchment

Aquatic fauna
Expert panel report

(Version 1.3)

Wet Tropics region

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Acronyms and abbreviations

ACA	Aquatic Conservation Assessment
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
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
GBR	Great Barrier Reef
GIS	Geographic information system
HEV	High ecological value (under a Water Quality Improvement Plan)
JAMBA	Japan-Australia Migratory Birds Agreement
NC Act	*Nature Conservation Act 1992*
Ramsar	Ramsar Convention on Wetlands
RE	Regional ecosystem

1 Introduction

The Department of Environment and Resource Management (DERM) conducted an Aquatic Conservation Assessment (ACA) for the non-riverine wetlands in the Great Barrier Reef (GBR) catchment using the Aquatic Biodiversity Assessment and Mapping Method (AquaBAMM; Clayton *et al*. 2006). The ACA relied upon 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 GBR catchment.

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 GBR catchment is made up of 35 individual catchments from the Daintree River north of Cairns, to Baffle Creek south of Gladstone. DERM applied AquaBAMM separately to the non-riverine (palustrine and lacustrine) and riverine wetlands within each of the 35 GBR catchments. In effect, there are 70 ACAs for the entire GBR catchment—covering non-riverine and riverine wetlands. A map of the GBR catchment showing each study area is provided in Attachment A.

A series of nine expert panels were conducted to address aquatic fauna, aquatic and riparian flora, and wetland ecology for the GBR catchments. The non-riverine and riverine wetlands were covered in combined workshops. The panels, held in Cairns, Townsville and Rockhampton during November and December 2008, involved invited experts with expertise in aquatic fauna, aquatic and riparian flora and/or wetland ecology in the Wet Tropics, Burdekin and Fitzroy sections of the GBR catchment.

This report documents the findings and recommendations of the aquatic fauna expert panel for the Wet Tropics region held in Cairns on Wednesday 3 December, 2008. This report presents supporting information and panel input that only addresses the non-riverine wetland systems. The riverine component has been addressed in a separate report. Terms of reference for the aquatic fauna expert panel are provided in Attachment B.

2 Method

2.1 Study area

The study areas used to implement the AquaBAMM assessments are based on the DERM basin/sub-basin data. The Wet Tropics study area largely corresponds to the Wet Tropics Natural Resource Management (NRM) region and contains the majority of the Wet Tropics World Heritage Area (WTWHA). In total the study area covers approximately 22,100 km^2 and lies across the majority of the Wet Tropics bioregion and a part of the Einasleigh Uplands bioregion to the west in the Upper Herbert and Upper Barron basins. It includes the nine basins shown in Figure 1, which comprise the coastal basins of the Daintree, Mossman, Barron, Mulgrave/Russelll, Johnstone, Tully, Murray, and Herbert rivers and Hinchinbrook Island. Each of these is treated as an individual study area for the purpose of the AquaBAMM analyses.

As the name suggests the Wet Tropics is characterised by high rainfall largely due to the conspicuous topography. The major mountain masses exceed elevations of 1,000 m and all are granitic, although some have flanking acid volcanic and metamorphic rocks. Extensive areas of basalt occur, particularly through the Atherton Tablelands, an extensive plateau between 600 m and 900 m that covers a large part of the upper Barron River catchment. The region contains a number of high peaks including the two highest mountains in Queensland, Mount Bartle Frere (1,622 m) and Mount Belenden Ker (1,593 m). The mountain ranges generally have steep precipitous mountain sides with deeply incised valleys. They run north to south, rising sharply near the coast and capture the moisture-laden air from the warm waters of the Coral Sea, resulting in generally high rainfall across the region. The most extensive lowlands are in the south of the study area, associated with the floodplains of the Tully and Herbert rivers, with extensive coastal freshwater and estuarine wetlands.

Mean annual rainfall for the Wet Tropics bioregion is above 1,500 mm, three times the continental average of below 500 mm, with several areas within the study area receiving much higher rainfall. Rainfall patterns are strongly seasonal with a distinct wet season occurring in the warmer months between December and April, and although generally wet, can vary substantially from year to year. Interannual variability is mainly driven by major rainfall events which commonly occur and are associated with cyclones and low pressure depressions. These can flood large areas of the region resulting in huge volumes of water being discharged to the inshore waters of the Great Barrier Reef lagoon. For example, in the Herbert River total mean annual discharge is approximately 3.7 million megalitres and in the Johnstone and South Johnstone it is 3.23 million megalitres. The amount of rain also varies throughout the region due to topography and there is a distinct gradient to drier conditions from the western side of the ranges towards where the study area crosses into the Einasleigh Uplands bioregion. Rainfall is not recorded from the peak of Mount Bartle Frere, but at the summit of the adjacent Mount Belenden Ker records show an annual average rainfall of 8,312 mm, making it the wettest meteorological station in Australia. It also holds the record for the highest rainfall in a calendar year of 12,461 mm in 2000. On the lowlands the Daintree area and the area from Cairns south to Tully receives the highest rainfall with Babinda typically receiving rainfall in excess of 4,000 mm annually. In contrast, the western side of the study area, in the Upper Herbert and Upper Barron basins, on average, receives less than 800 mm annually.

The study area also has generally warm and uniform temperatures throughout the year. Typical daytime minimum and maximum temperatures range on the coast from 22ºC to 31ºC in summer and from 15ºC to 22ºC in winter. The tablelands and uplands are generally much cooler. On the western side of the study area temperatures vary slightly more and tend towards being hotter in summer.

As a consequence of the high rainfall, rainforest cover is extensive across the ranges and coastal lowlands and streams and wetlands are numerous and important features in the landscape. For millions of years the consistent runoff has resulted in most streams and many wetlands being perennial systems, in contrast to most other parts of Australia, including most of the tropical region. As a result the Wet Tropics has sustained a unique and diverse freshwater fauna and flora with many endemic species present.

The high degree of variation in rainfall, topography, combined with a complex evolutionary history has resulted in a diverse spectrum of forest types and plant and animal communities. The rainforests of the region which dominates the narrow, high rainfall coastal belt have been classified into 16 major structural types and 30 broad community types (Tracey and Webb, 1975; Tracey, 1982). In addition the rainforests are fringed and dissected by a range of sclerophyll forests and woodlands as well as wetlands including estuarine mangrove communities. Tall woodlands, open *Eucalyptus* forests and grasslands extend into the drier western parts of the study area in to the Einasleigh Upland bioregion.

Wetland types include an enormous number of low order, perennial or near perennial, streams descending the steep ranges. These join in to several major river systems that define the basins within the study area. The coastal lowland floodplains are generally narrow, with the most extensive lowlands occurring in the south of the study area associated with the floodplains of the Tully/Murray and the Herbert rivers. These areas contain complex systems of numerous interconnecting wetlands and extensive coastal estuarine areas. The Herbert floodplain receives the lowest rainfall of the coastal lowlands in the study area but can have the highest discharge from runoff in the upper catchment. Its floodplain is dominated by woodlands with extensive areas of grass and sedge swamps laying adjacent to dune systems and connected estuaries. This area also contains the Herbert River delta which is formed at the southern end of the Hinchinbrook Channel, with its extensive stands of mangrove forest. In the Tully/Murray floodplain (and areas to the north) rainfall is higher and the coastal vegetation is dominated by forest, rainforest and extensive wetland areas. Unfortunately many of the coastal wetlands throughout the study area have been lost or are now largely modified through drainage and reclamation works. Many of the remaining wetlands are also heavily impacted by clearing of riparian and fringing vegetation, infestation by weeds and by events resulting in a decline in water quality through runoff from adjacent agriculture. Fractured basalt and other fractured rock aquifers occur throughout the study area supporting unique fauna and flora. These aquifer systems are particularly significant in some of the areas within the drier parts of the study area in the Einasleigh Upland. Crater lakes are also a unique feature of the plateaus of the study area.

Approximately 35 per cent of the study area is covered by the Wet Tropics World Heritage Area, taking in most of the ranges and large areas of lowland rainforest. The World Heritage Area consists of extensive areas of National Park and other protected estate as well as areas of private land. The major commercial land uses in the study area include extensive areas of lowlands, and some uplands, used for sugar cane production. Extensive areas in the lowlands are also used for banana production with a diverse range of other horticultural crops occurring throughout. On the fertile Atherton Tablelands dairy is a major industry along with a variety of horticulture and crops. Cattle grazing is a minor land use in the coastal lowlands but extensive cattle grazing is the major land use in the western part of the study area. The area was once heavily dependent on native forestry. However, this has declined with the protection of much of the native rainforest areas in the Wet Tropics World Heritage Area and in recent times forestry has depended on broad hectare softwood plantations on the Atherton Tablelands and the Cardwell area. Increasingly, other forestry plantations are being established on what was traditionally land used for sugar cane production.

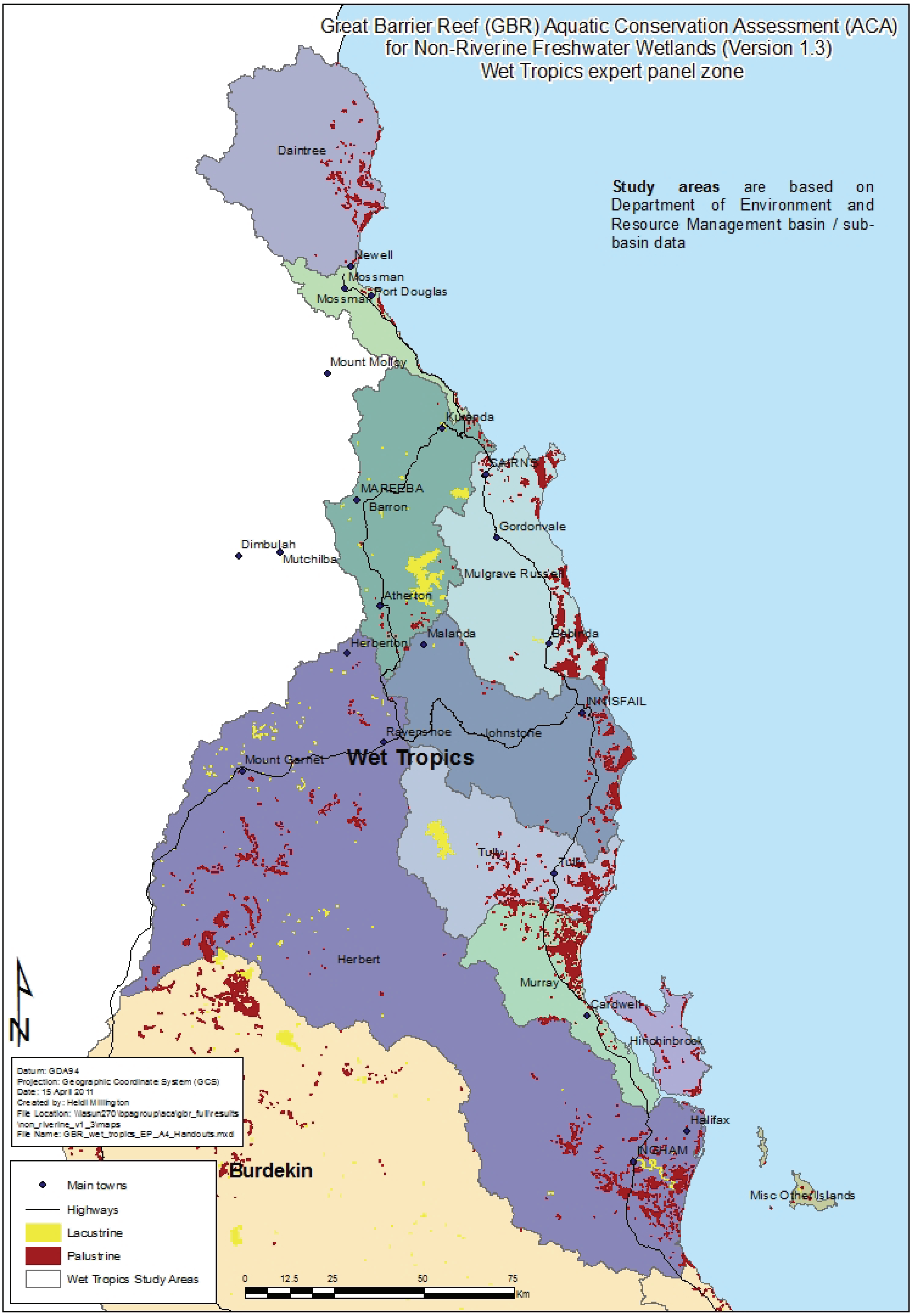

Figure 1 Wet Tropics section of the GBR catchment (incorporating nine individual catchments)

2.2 Panel composition

The expert panel (the panel) comprised of persons listed in Table 1 who are familiar with aquatic fauna in the Wet Tropics section of the GBR catchment.

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
Ant Backer	Senior Planning Officer, Department of Environment and Resource Management	Biodiversity planning, terrestrial ecology
Niall Connolly	Principal Conservation Officer, Department of Environment and Resource Management	Biodiversity planning, aquatic ecology and water quality
Paul Godfrey	Research scientist, Australian Rivers Institute, Griffith University	Fish and aquatic ecology
Alf Hogan	Fisheries Scientist, Alf Hogan and Associates Fish Ecologists	Fish ecologist
Keith McDonald	Principal Technical Officer (threatened species), Department of Environment and Resource Management	Tropical ecology and conservation
Malcom Pearce	Senior Fisheries Biologist, Department of Primary Industries and Fisheries	Fish
Michaelie Pollard	Project Officer (aquatic ecology), Department of Natural Resources and water	Aquatic ecology
Jim Tait	Ecologist, Ecoconcern Pty Ltd	Wetland ecology and management
Paul Thuesen	Fisheries Biologist, Department of Primary Industries and Fisheries	Fish
Michael Trenerry	Team Leader (Regional Services), Department of Environment and Resource Management	Tropical ecology and conservation
Dr David Wescott	Principal research scientist, CSIRO	Tropical ecology

Selena Inglis, Heidi Millington and Steven Howell provided administrative and technical support for the workshop which was facilitated by Darren Fielder.

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 GBR catchment was also sourced from various technical reports.

3 Rare and threatened fauna

The panel identified six ‘rare’, three ‘vulnerable’ and two ‘endangered’ fauna taxa associated with non-riverine wetlands in the Wet Tropics section of the GBR catchment (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 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	Comments
Crocodylus porosus	Estuarine crocodile	V[1]	
Ephippiorhynchus asiaticus	Black-necked stork	R[1]	
Hypochrysops apollo apollo	Apollo jewel (Wet Tropics subsp.)	V[1]	
Lewinia pectoralis	Lewin's rail	R[1]	
Litoria myola	Kuranda treefrog	R[1] E[2]	Panel originally identified this species as a priority species. No valid records available at time of processing.
Litoria revelata	Whirring treefrog	R[1]	
Litoria rheocola	Common mistfrog	E[1,2]	
Melanotaenia eachamensis	Lake Eacham rainbowfish	E[2]	
Nettapus coromandelianus	Cotton pygmy-goose	R[1]	
Pseudophryne covacevichae	Magnificent broodfrog	V[1,2]	Species may not necessarily be wetland dependent. Inclusion of the species in the GBR ACA to be reviewed during subsequent updates.
Stictonetta naevosa	Freckled duck	R[1]	
Tadorna radjah	Radjah shelduck	R[1]	

- *recent records (>1975) and records with precision (<2,000 m) only*

1. *Queensland Nature Conservation Act 1992 (E – Endangered, V – Vulnerable, R – Rare, LC – Least Concern)*
2. *Environment Protection and Biodiversity Conservation Act 1999 (Ex – Extinct, CE – Critically Endangered, E – Endangered, V – Vulnerable)*

4 Priority fauna

The panel deliberated on all aquatic-dependent fauna species within the Wet Tropics section of the GBR catchment to identify ‘priority fauna’ (excluding the rare or threatened species listed in Table 2). The panel agreed to a definition of a priority species: namely, 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 (>1 per cent for waterbirds, >75 per cent other species) occurs in the waterbody (see Ramsar Criterion 6 for waterbirds).

4.1 Priority species

The panel identified 14 priority fauna species associated with non-riverine wetlands (Table 3). These species were included in ‘Criterion 5 Priority species and ecosystems’ (5.1.2). Point records were buffered using their precision to identify the spatial units having a priority species present. A spatial unit with one or more of these species present scored the highest category of 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	Priority number[1]	Comments
Bunaka gyrinoides	Greenback gudgeon	5	Significant disjunct population.
Craterocephalus stercusmuscarum	Flyspecked hardyhead	5	Significant disjunct population.
Denariusa bandata	Pennyfish	5	Significant disjunct population.
Hephaestus tulliensis	Khaki grunter	1	Endemic to the Wet Tropics region.
Hypseleotris sp.	Gudgeon sp.	1, 4	Endemic to the Wet Tropics region, currently a small population subject to threatening processes.
Litoria jungguy	Stony-creek frog	1	Endemic to the Wet Tropics region.
Litoria nigrofrenata	Tawny rocketfrog	5	Significant disjunct population.
Litoria xanthomera	Orange thighed treefrog	1	Endemic to the Wet Tropics region.
Melanotaenia maccullochi	Mcculloch's rainbowfish	5	Significant disjunct population.
Mixophyes carbinensis		1	Endemic to the Wet Tropics region.
Mixophyes coggeri		1	Endemic to the Wet Tropics region.
Mixophyes schevilli		1	Endemic to the Wet Tropics region.
Pseudomugil gertrudae	Spotted blue eye	5	Significant disjunct population.
Tropidechis carinatus		5	Significant disjunct population.

- *recent records (>1975) and records with precision (<2,000 m) only*

1. Refers to the significant values required to be a priority species, as listed above Table 3.

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) or the Convention on the Conservation of Migratory Species of Wild Animals (CMS) as priority fauna. Only one migratory species (Table 4) was included in the AquaBAMM assessment in ‘Criterion 5 Priority species and ecosystems’ (5.1.3). Any spatial unit containing a record for this species within its boundary will score a 4 under measure (5.1.3).

Table 4 A list of migratory species

This list was used to generate the values for the AquaBAMM measure (5.1.3). Sourced from the China-Australia Migratory Bird Agreement (CAMBA) at: http://www.environment.gov.au/biodiversity/migratory/waterbirds/index.html

Scientific name	**Common name**	**Agreements/ conventions**	**Comments**
Acrocephalus orientalis	Oriental reed-warbler	CAMBA[1]	

- *recent records (>1975) and records with precision (<2,000 m) only*

1 China-Australia Migratory Birds Agreement (CAMBA)

5 Species richness

Species richness (i.e. total number of species) was scored for each class (frogs, fish, reptiles, waterbirds) of fauna stratified by 150 m above sea level (asl) for all study areas in the Wet Tropics (see the Wet Tropics wetland ecology expert panel report for more information on stratification). Stratifying the catchment 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.

5.1 Fish richness

There were 41 native fish species identified in the non-riverine wetlands of the Wet Tropics section of the GBR catchment. A further ten species were considered to be alien to the region and included some translocated species. Table 5 lists fish species that were used under the diversity and richness criterion (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	Comments
Ambassis agassizii	Agassiz's glassfish	LC[1]	
Ambassis agrammus	Sailfin glassfish	LC[1]	
Ambassis macleayi	Macleay's glassfish	LC[1]	
Ambassis miops	Flag-tailed glassfish	LC[1]	Found across several catchments.
Amniataba percoides	Barred grunter	LC[1]	
Anguilla obscura	Pacific shortfin eel	LC[1]	Found virtually everywhere.
Anguilla reinhardtii	Longfin eel	LC[1]	
Bunaka gyrinoides	Greenback gudgeon	LC[1]	
Chanos chanos	Milkfish	LC[1]	
Craterocephalus stercusmuscarum	Flyspecked hardyhead	LC[1]	
Denariusa bandata	Pennyfish	LC[1]	Common in the Tully River.
Giurus margaritacea	Snakehead gudgeon	LC[1]	
Glossamia aprion	Mouth almighty	LC[1]	
Hephaestus fuliginosus	Sooty grunter	LC[1]	Translocated and genetics have been mixed.
Hephaestus tulliensis	Khaki grunter	LC[1]	Translocated to the tablelands.
Hypseleotris compressa	Empire gudgeon	LC[1]	
Hypseleotris sp.	Gudgeon sp.	LC[1]	
Hypseleotris sp. A	Midgley's carp gudgeon	LC[1]	
Hypseleotris sp. C	Boofhead carp gudgeon	LC[1]	Found in the Tully/Murray Rivers.
Lates calcarifer	Barramundi	LC[1]	
Leiopotherapon unicolor	Spangled perch	LC[1]	Translocated native.
Lutjanus argentimaculatus	Mangrove jack	LC[1]	
Megalops cyprinoides	Oxeye herring/tarpon	LC[1]	
Melanotaenia eachamensis	Lake Eacham rainbowfish	E[2]	Known to occur in the Daintree.
Melanotaenia maccullochi	McCulloch's rainbowfish	LC[1]	Disappearing out of the wetlands in the Tully catchment but still common in the Cardwell region.
Melanotaenia sp.	Rainbowfish sp.	LC[1]	
Melanotaenia splendida	Eastern rainbowfish	LC[1]	

Scientific name	Common name	Status	Comments
Nematalosa erebi	Bony bream	LC[1]	
Neosilurus ater	Black catfish	LC[1]	
Neosilurus hyrtlii	Hyrtl's catfish	LC[1]	
Neosilurus sp.	Eel-tailed catfish sp.	LC[1]	
Ophisternon gutturale	Swamp eel	LC[1]	
Oxyeleotris lineolata	Sleepy cod	LC[1]	
Oxyeleotris nullipora	Poreless gudgeon	LC[1]	
Oxyeleotris selheimi	Black banded gudgeon	LC[1]	Debate over whether or not it is an introduced native.
Porochilus rendahli	Rendahl's catfish	LC[1]	
Pseudomugil gertrudae	Spotted blue eye	LC[1]	
Redigobius bikolanus	Speckled goby	LC[1]	
Tandanus sp.		LC[1]	
Tandanus tandanus	Freshwater catfish	LC[1]	Translocated although there is a local species (new species based on genetics).
Toxotes chatareus	Sevenspot archerfish	LC[1]	

- *recent records (>1975) and records with precision (<2,000 m) only*

1. Queensland *Nature Conservation Act 1992 (E – Endangered, V – Vulnerable, R – Rare, LC – Least Concern)*
2. *Environment Protection and Biodiversity Conservation Act 1999 (E – Endangered, V – Vulnerable)*

5.2 Reptile richness

There were eight native reptile species identified in the non-riverine wetlands of the Wet Tropics section of the GBR catchment. 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	Comments
Chelodina canni	Cann's longneck turtle	LC[1]	
Crocodylus porosus	Estuarine crocodile	V[1]	
Emydura macquarii krefftii	Krefft's river turtle	LC[1]	
Liasis mackloti	Water python	LC[1]	
Physignathus lesueurii	Eastern water dragon	LC[1]	
Tropidonophis mairii	Freshwater snake	LC[1]	
Tropidechis carinatus		LC[1]	
Varanus semiremex	Rusty monitor	R[1]	

- *recent records (>1975) and records with precision (<2,000 m) only*

1. Queensland *Nature Conservation Act 1992 (E – Endangered, V – Vulnerable, R – Rare, LC – Least Concern)*

5.3 Waterbird richness

There were 58 native waterbird species identified in the non-riverine wetlands of the Wet Tropics section of the GBR catchment. Table 7 lists the wetlands-dependant waterbird species 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	Comments
Acrocephalus australis	Australian reed-Warbler	LC[1]	
Acrocephalus orientalis	Oriental reed-Warbler	LC[1]	
Amaurornis cinerea	White-browed crake	LC[1]	
Amaurornis moluccana	Pale-vented bush-hen	LC[1]	
Anas castanea	Chestnut teal	LC[1]	
Anas gracilis	Grey teal	LC[1]	
Anas rhynchotis	Australasian shoveler	LC[1]	
Anas superciliosa	Pacific black duck	LC[1]	
Anhinga melanogaster	Australasian darter	LC[1]	
Anseranas semipalmata	Magpie goose	LC[1]	
Ardea intermedia	Intermediate egret	LC[1]	
Ardea modesta	Eastern great egret	LC[1]	
Ardea pacifica	White-necked heron	LC[1]	
Ardea sumatrana	Great-billed heron	LC[1]	
Aythya australis	Hardhead	LC[1]	
Botaurus poiciloptilus	Australasian bittern	LC[1]	
Ceyx azureus	Azure kingfisher	LC[1]	
Ceyx pusilla	Little kingfisher	LC[1]	
Chenonetta jubata	Australian wood duck	LC[1]	
Cygnus atratus	Black swan	LC[1]	
Dendrocygna arcuata	Wandering whistling-duck	LC[1]	
Dendrocygna eytoni	Plumed whistling-duck	LC[1]	
Egretta garzetta	Little egret	LC[1]	
Egretta novaehollandiae	White-faced heron	LC[1]	
Egretta picata	Pied heron	LC[1]	
Ephippiorhynchus asiaticus	Black-necked stork	R[1]	
Fulica atra	Eurasian coot	LC[1]	
Gallinula tenebrosa	Dusky moorhen	LC[1]	
Gallirallus philippensis	Buff-banded rail	LC[1]	
Grus antigone	Sarus crane	LC[1]	
Grus rubicunda	Brolga	LC[1]	
Himantopus himantopus	Black-winged stilt	LC[1]	
Irediparra gallinacea	Comb-crested jacana	LC[1]	
Ixobrychus flavicollis	Black bittern	LC[1]	
Lewinia pectoralis	Lewin's rail	R[1]	
Malacorhynchus	Pink-eared duck	LC[1]	

Scientific name	Common name	Status	Comments
membranaceus			
Microcarbo melanoleucos	Little pied cormorant	LC[1]	
Nettapus coromandelianus	Cotton pygmy-goose	R[1]	
Nettapus pulchellus	Green pygmy-goose	LC[1]	
Nycticorax caledonicus	Nankeen night-heron	LC[1]	
Pelecanus conspicillatus	Australian pelican	LC[1]	
Phalacrocorax carbo	Great cormorant	LC[1]	
Phalacrocorax sulcirostris	Little black cormorant	LC[1]	
Phalacrocorax varius	Pied cormorant	LC[1]	
Platalea flavipes	Yellow-billed spoonbill	LC[1]	
Platalea regia	Royal spoonbill	LC[1]	
Plegadis falcinellus	Glossy ibis	LC[1]	
Podiceps cristatus	Great crested grebe	LC[1]	
Poliocephalus poliocephalus	Hoary-headed grebe	LC[1]	
Porphyrio porphyrio	Purple swamphen	LC[1]	
Porzana fluminea	Australian spotted crake	LC[1]	
Porzana pusilla	Baillon's crake	LC[1]	
Porzana tabuensis	Spotless crake	LC[1]	
Stictonetta naevosa	Freckled duck	R[1]	
Tachybaptus novaehollandiae	Australasian grebe	LC[1]	
Tadorna radjah	Radjah shelduck	R[1]	
Threskiornis molucca	Australian white ibis	LC[1]	
Threskiornis spinicollis	Straw-necked ibis	LC[1]	

- *recent records (>1975) and records with precision (<2,000 m) only*

1. Queensland *Nature Conservation Act 1992 (E – Endangered, V – Vulnerable, R – Rare, LC – Least Concern)*

5.4 Frog richness

There were 35 species of amphibians identified as being associated with non-riverine wetlands in the Wet Tropics section of the GBR catchment. 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 frog species

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

Scientific name	Common name	Status	Comments
Crinia deserticola	Chirping froglet	LC[1]	
Crinia remota	Northern froglet	LC[1]	
Cyclorana alboguttata	Greenstripe frog	LC[1]	
Cyclorana brevipes	Superb collared frog	LC[1]	
Cyclorana novaehollandiae	Eastern snapping frog	LC[1]	
Hylarana daemeli	Australian woodfrog	LC[1]	
Limnodynastes convexiusculus	Marbled frog	LC[1]	

Scientific name	Common name	Status	Comments
Limnodynastes peronii	Striped marshfrog	LC[1]	
Limnodynastes tasmaniensis	Spotted grassfrog	LC[1]	
Limnodynastes terraereginae	Scarlet sided pobblebonk	LC[1]	
Litoria bicolor	Northern sedgefrog	LC[1]	
Litoria caerulea	Common green treefrog	LC[1]	
Litoria fallax	Eastern sedgefrog	LC[1]	
Litoria gracilenta	Graceful treefrog	LC[1]	
Litoria inermis	Bumpy rocketfrog	LC[1]	
Litoria jungguy	Stony-creek frog	LC[1]	
Litoria latopalmata	Broad palmed rocketfrog	LC[1]	
Litoria microbelos	Javelin frog	LC[1]	
Litoria myola	Kuranda treefrog	R[1] E[2]	No valid records available at time of processing.
Litoria nasuta	Striped rocketfrog	LC[1]	
Litoria nigrofrenata	Tawny rocketfrog	LC[1]	
Litoria revelata	Whirring treefrog	R[1,2]	
Litoria rothii	Northern laughing treefrog	LC[1]	
Litoria rubella	Ruddy treefrog	LC[1]	
Litoria sp. '*wilcoxii/ jungguy*'		LC[1]	
Litoria wilcoxii	Wilcox's stony-creek frog	LC[1]	
Litoria xanthomera	Orange thighed treefrog	LC[1]	
Mixophyes carbinensis		LC[1]	
Mixophyes coggeri		LC[1]	
Mixophyes schevilli		LC[1]	
Mixophyes schevilli (spp. complex)		LC[1]	
Platyplectrum ornatum	Ornate burrowing frog	LC[1]	
Pseudophryne covacevichae	Magnificent broodfrog	V[1,2]	Species may not necessarily be wetland dependent. Inclusion of the species in the GBR ACA to be reviewed during subsequent updates.
Uperoleia altissima	Tableland gungan	LC[1]	
Uperoleia littlejohni	Einasleigh gungan	LC[1]	
Uperoleia mimula	Mimicking gungan	LC[1]	

- *recent records (>1975) and records with precision (<2,000 m) only*

1. Queensland *Nature Conservation Act 1992 (E – Endangered, V – Vulnerable, R – Rare, LC – Least Concern)*
2. *Environment Protection and Biodiversity Conservation Act 1999 (Ex – Extinct, CE – Critically Endangered, E – Endangered, V – Vulnerable)*

5.5 Mammal richness

There was one species of mammal identified in the non-riverine wetlands of the Wet Tropics section of the GBR catchment. 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	Comments
Hydromys chrysogaster	Water rat	LC[1]	

- *recent records (>1975) and records with precision (<2,000 m) only*

1. Queensland *Nature Conservation Act 1992 (E – Endangered, V – Vulnerable, R – Rare, LC – Least Concern)*

5.6 Macroinvertebrate richness

There was one species of macroinvertebrates identified in the non-riverine wetlands of the Wet Tropics section of the GBR catchment. Table 10 lists the macroinvertebrate species that was 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	Comments
Hypochrysops apollo apollo	Apollo jewel (Wet Tropics subsp.)	V[1]	

- *recent records (>1975) and records with precision (<2,000 m) only*

1. Queensland *Nature Conservation Act 1992 (E – Endangered, V – Vulnerable, R – Rare, LC – Least Concern)*

6 Exotic fauna

Ten fish, one crustacean and seven vertebrate species were nominated by the panel (Table 11) as exotic wetland fauna. The presence of aquatic exotic fauna species were recorded under 'Criterion 1 Naturalness (aquatic)' (1.1.1).

Table 11 Alien fauna

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

Scientific name	Common name	Comments
Amphilophus citrinellus	Midas cichlid, red devil	Established populations in north Queensland (Webb 2008).
Bos sp.	Cattle	
Bos taurus		
Cherax quadricarinatus	Redclaw crayfish	Translocated native found in the Barron, Herbert and upper Johnstone Rivers, its impact fluctuates but is generally low.
Felis catus	Cat	
Gambusia holbrooki	Mosquitofish	Becoming less common in the region as it is now only found in pockets around Cairns, but big patches still persist on the Tablelands. It is also found in the Johnstone River catchment.
Haplochromis burtoni	Burton's haplochromis	Established populations in north Queensland (Webb 2008).
Lonchura punctulata	Nutmeg mannikin	Species is a significant problem as it excludes other finches from nesting sites and out competes native species.
Oreochromis mossambicus	Mozambique mouthbrooder	Widely distributed including the Barron River catchment and northern beaches area, Saltwater Creek, Lily Creek, creeks draining into upper Herbert River, Wild River and Wright Creek.
Poecilia latipinna	Sailfin molly	Used to be in Jumrum Creek, believed to be a threat but not widely established. Lesser threat than other livebearers in this group.
Poecilia reticulata	Guppy	Found virtually everywhere.
Rhinella marina	Cane toad	Roads and tracks in urban and dry areas Note: new taxonomic name for cane toad.
Sturnus tristis	Indian miner	Nests around streamlines in cities and out of towns it uses any nesting hollow available. Has only minor impact by competing with native species. Tends to favour agricultural land but may invade wetland areas in the future, also found in Cairns central swamp.
Sus scrofa	Pig	
Tilapia mariae	Spotted tilapia	Found in the Johnstone, Mulgrave/Russelll and Barron River catchments as well as at the northern beaches and Cairns inlet.
Trichogaster trichopterus	Three-spot gourami	Established populations in north Queensland (Webb 2008).
Xiphophorus helleri	Swordtail	Found virtually everywhere.
Xiphophorus maculatus	Platy	Species has a patchy distribution throughout the Mulgrave River but large numbers can be found in the Tully River catchment and it is also present at Kuranda.

- *recent records (>1975) and records with precision (<2,000 m) only*

7 Special features

The panel identified several non-riverine special features in the Wet Tropics section of the GBR catchment (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 were implemented as a wetland ecology special feature.

Each spatial unit that intersected with a particular ecosystem or feature in Table 12 was given a score equal to the conservation rating.

Table 12 Identified special features, and their values

Decisions 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.

Special feature	**Values**	**Catchment**	**Decision implementation number**	**Criteria/ indicator/ measure**	**Conservation rating (1-4)**
Generals Plain complex	The Generals Plain complex is known to contain around 1,000 brolga (*Grus rubicunda)* individuals making it the biggest roosting/feeding site in the region. It also contains significant numbers of pelicans, stilts, dottrels, sandpiper, kookaburra, sea eagle, magpie geese (*Neochmia phaeton*) and occasionally up to 40 sarus cranes (*Grus antigone*) have been observed. The site boasts good connectivity, increased representativeness and high diversity and integrity values. Note: This decision is also a fauna decision in the Einasleigh Uplands Biodiversity Planning Assessment (decision number eiu_fa_14).	Herbert	he_nr_fa_01	5.1.4 6.3.1	4
Kemp Wetlands, Horseshoe Wetland, Maskells Wetlands, Silvini Wetland. All in the Mandam drainage area	This area of Bulgaroo wetland is well known for large aggregations of birds that feed on bulbs when the area dries out. Large numbers of magpie geese (*Neochmia phaeton*) are also known to gather in this area. Note: This decision was also a flora decision from the Herbert aquatic flora expert panel 2007 (decision number he_fa_3).	Herbert	he_nr_fa_02	5.1.4	3
Wetlands south of Forest Beach	This area provides significant habitat for the apollo jewel butterfly (*Hypochrysops apollo apollo*) where it is at the most southerly extent of its range. Note: This decision is a revised decision based on decision number he_fa_6 (Herbert aquatic fauna expert panel 2007).	Herbert	he_nr_fa_03	6.3.1	4
Trebonne Creek delta	The Trebonne Creek delta is prime wader bird feeding ground and is also known to contain nesting sites for brolga (*Grus rubicunda)* and cotton pygmy geese (*Nettapus coromandelianus)*. Note: This decision is a revised decision based on decision number he_fa_8 (Herbert aquatic fauna expert panel 2007).	Herbert	he_nr_fa_04	6.3.1	3

Attachments

Attachment A – GBR catchment study area

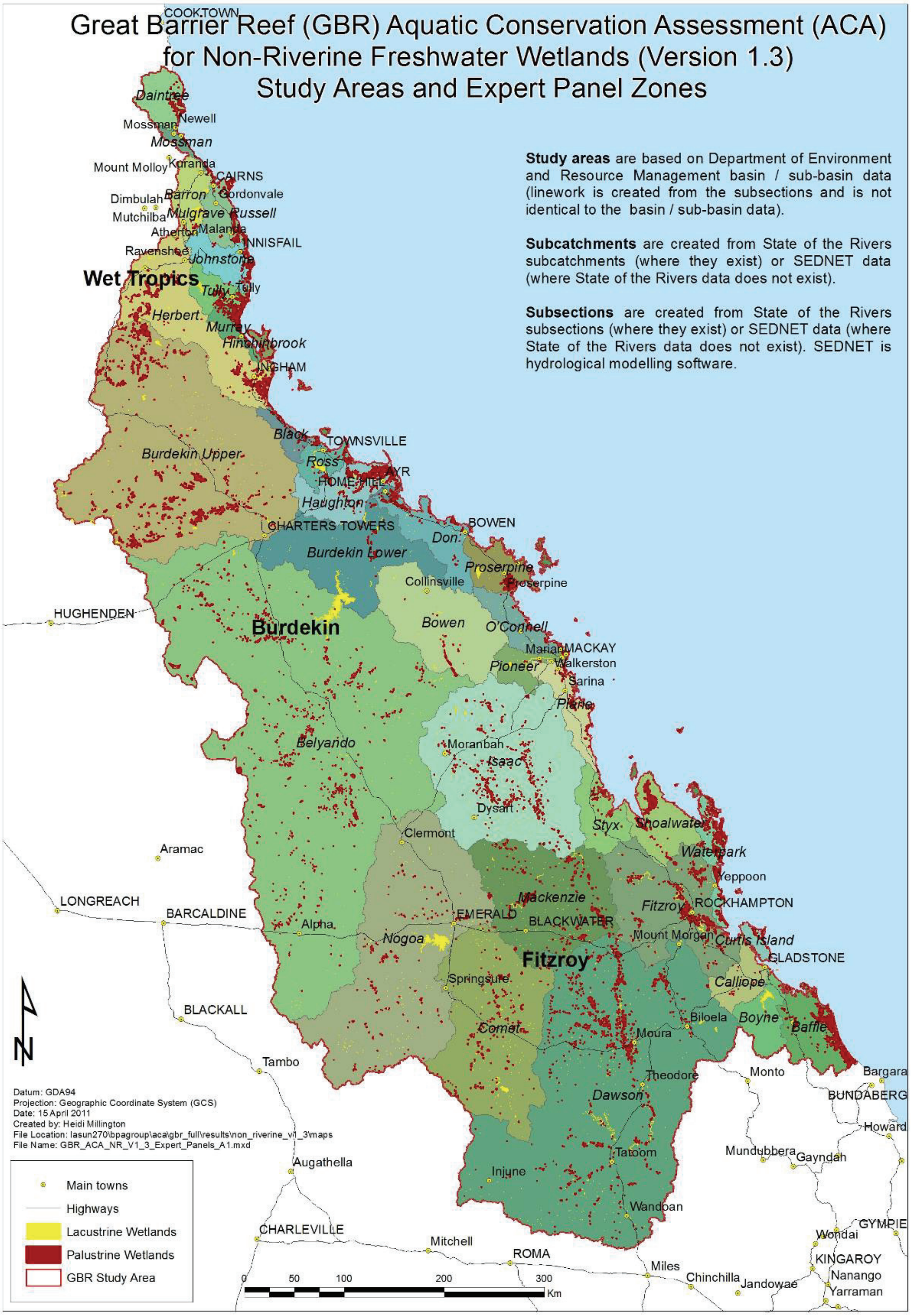

Figure 2 GBR catchment study area

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 gain information for 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 of the GBR catchment. Experience in the identification and assessment of riverine and non-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 riverine and non-riverine wetlands of the GBR catchment. The panel consisted of professionals with expertise relating to aquatic fauna values.

The tasks undertaken by the panel included, but without limitation, 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 GBR catchment

The criteria, indicators and measures (CIM) list outlines the CIM that were implemented as part of the non-riverine Aquatic Conservation Assessment (ACA) using AquaBAMM of the freshwater wetlands of the GBR catchment.

The list has been developed from a default list of CIM that may be considered when an Aquatic Conservation Assessment (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. AquaBAMM does allow addition or deletion of indicators and/or measures for each ACA when its assessment parameters are set. However, 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 13 CIM list for the GBR catchment

Criteria & indicators	Measures	
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
1.4 Hydrological modification	1.4.5	Hydrological disturbance/modification of the wetland (e.g. as determined through DERM wetland mapping and classification)
2 Naturalness catchment		
2.1 Exotic flora/fauna	2.1.1	Presence of exotic terrestrial plants in the assessment unit
2.2 Riparian disturbance	2.2.5	Per cent area of remnant vegetation relative to preclear extent within buffered non-riverine wetland: 500 m buffer for wetlands >= 8Ha, 200 m buffer for smaller wetlands
2.3 Catchment disturbance	2.3.1	Per cent "agricultural" land-use area (i.e. cropping and horticulture)
	2.3.2	Per cent "grazing" land-use area
	2.3.3	Per cent "vegetation" land-use area (i.e. native veg + regrowth)
	2.3.4	Per cent "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	3.1.2	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
3.3 Habitat	3.3.2	Richness of wetland types within the local catchment (e.g. SOR sub-section)
	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[1], EPBC Act[2]
	4.1.2	Presence of rare or threatened aquatic ecosystem dependent flora species – NC Act[1], EPBC Act[2]

Criteria & indicators	Measures	
4.2 Communities/ assemblages	4.2.1	Conservation status of wetland Regional Ecosystems – Herbarium biodiversity status, NC Act[1], EPBC Act[2]
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)
	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[3]/CAMBA[4] 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)
8 Representativeness		
8.1 Wetland protection	8.1.1	The per cent area of each wetland habitat type within protected areas
	8.1.2	The per cent 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*
8.2 Wetland uniqueness	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)
	8.2.2	The relative abundance of the wetland management group to which the wetland habitat belongs within the subcatchment or estuarine/marine zone (management groups ranked least common to most common)
	8.2.3	The size of each wetland habitat relative to others of its management group within the catchment or study area
	8.2.4	The size of each wetland habitat relative to others of its management group within a subcatchment (or estuarine zone)
	8.2.5	Wetland habitat representative of the study area – identified by expert opinion
	8.2.6	The size of each wetland habitat relative to others of its 'type' within the catchment or study area

[1] NC Act – *Nature Conservation Act 1992* (Queensland legislation)
[2] EPBC Act – *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth legislation)
[3] JAMBA – Japan-Australia Migratory Bird Agreement
[4] CAMBA – China-Australia Migratory Bird Agreement

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Attachment C GBR catchments ACA – Aquatic ecology expert panel report (Wet Tropics region)

An Aquatic Conservation Assessment for the non-riverine wetlands of the Great Barrier Reef catchment

Wetland ecology
Expert panel report

(Version 1.3)

Wet Tropics region

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Acronyms and abbreviations

ACA	Aquatic Conservation Assessment
ASL	Above sea level
BPA	Biodiversity Planning Assessment
DERM	Department of Environment and Resource Management
DIWA	Directory of Important Wetlands
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
GBR	Great Barrier Reef
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

1 Introduction

The Department of Environment and Resource Management (DERM) conducted an Aquatic Conservation Assessment (ACA) for the non-riverine wetlands in the Great Barrier Reef (GBR) catchment using the Aquatic Biodiversity Assessment and Mapping Method (AquaBAMM; Clayton *et al*. 2006). The ACA relied upon 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 GBR catchment.

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 GBR catchment is made up of 35 individual catchments from the Daintree River north of Cairns, to Baffle Creek south of Gladstone. DERM applied AquaBAMM separately to the non-riverine (palustrine and lacustrine) and riverine wetlands within each of the 35 GBR catchments. In effect, there are 70 ACAs for the entire GBR catchment—covering non-riverine and riverine wetlands. A map of the GBR catchment showing each study area is provided in Attachment A.

A series of nine expert panels were conducted to address aquatic fauna, aquatic and riparian flora, and wetland ecology for the GBR catchments. The non-riverine and riverine wetlands were covered in combined workshops. The panels, held in Cairns, Townsville and Rockhampton during November and December 2008, involved invited experts with expertise in aquatic fauna, aquatic and riparian flora and/or wetland ecology in the Wet Tropics, Burdekin and Fitzroy sections of the GBR catchment.

This report documents the findings and recommendations of the wetland ecology expert panel for the Wet Tropics region held in Cairns on Thursday 4 December, 2008. This report presents supporting information and panel input that only addresses the non-riverine wetland systems. The riverine component has been addressed in a separate report. Terms of reference for the wetland ecology expert panel are provided in Attachment B.

2 Method

2.1 Study area

The study areas used to implement the AquaBAMM assessments are based on the DERM basin/sub-basin data. The Wet Tropics study area largely corresponds to the Wet Tropics Natural Resource Management (NRM) region and contains the majority of the Wet Tropics World Heritage Area (WTWHA). In total the study area covers approximately 22,100 km^2 and lies across the majority of the Wet Tropics bioregion and a part of the Einasleigh Uplands bioregion to the west in the Upper Herbert and Upper Barron basins. It includes the nine basins shown in Figure 1, which comprise the coastal basins of the Daintree, Mossman, Barron, Mulgrave/Russelll, Johnstone, Tully, Murray, and Herbert rivers and Hinchinbrook Island. Each of these is treated as an individual study area for the purpose of the AquaBAMM analyses.

As the name suggests the Wet Tropics is characterised by high rainfall largely due to the conspicuous topography. The major mountain masses exceed elevations of 1,000 m and all are granitic, although some have flanking acid volcanic and metamorphic rocks. Extensive areas of basalt occur, particularly through the Atherton Tablelands, an extensive plateau between 600 m and 900 m that covers a large part of the upper Barron River catchment. The region contains a number of high peaks including the two highest mountains in Queensland, Mount Bartle Frere (1,622 m) and Mount Belenden Ker (1,593 m). The mountain ranges generally have steep precipitous mountain sides with deeply incised valleys. They run north to south, rising sharply near the coast and capture the moisture-laden air from the warm waters of the Coral Sea, resulting in generally high rainfall across the region. The most extensive lowlands are in the south of the study area, associated with the floodplains of the Tully and Herbert rivers, with extensive coastal freshwater and estuarine wetlands.

Mean annual rainfall for the Wet Tropics bioregion is above 1,500 mm, three times the continental average of below 500 mm, with several areas within the study area receiving much higher rainfall. Rainfall patterns are strongly seasonal with a distinct wet season occurring in the warmer months between December and April and, although generally wet, can vary substantially from year to year. Interannual variability is mainly driven by major rainfall events which commonly occur and are, associated with cyclones and low pressure depressions. These can flood large areas of the region resulting in huge volumes of water being discharged to the inshore waters of the Great Barrier Reef lagoon. For example, in the Herbert River total mean annual discharge is approximately 3.7 million megalitres and in the Johnstone and South Johnstone it is 3.23 million megalitres. The amount of rain also varies throughout the region due to topography and there is a distinct gradient to drier conditions from the western side of the ranges towards where the study area crosses into the Einasleigh Uplands bioregion. Rainfall is not recorded from the peak of Mount Bartle Frere, but at the summit of the adjacent Mount Belenden Ker records show an annual average rainfall of 8,312 mm, making it the wettest meteorological station in Australia. It also holds the record for the highest rainfall in a calendar year of 12,461 mm in 2000. On the lowlands the Daintree area and the area from Cairns south to Tully receives the highest rainfall with Babinda typically receiving rainfall in excess of 4,000 mm annually. In contrast, the western side of the study area, in the Upper Herbert and Upper Barron basins, on average, receives less than 800 mm annually.

The study area also has generally warm and uniform temperatures throughout the year. Typical daytime minimum and maximum temperatures range on the coast from 22ºC to 31ºC in summer and from 15ºC to 22ºC in winter. The tablelands and uplands are generally much cooler. On the western side of the study area temperatures vary slightly more and tend towards being hotter in summer.

As a consequence of the high rainfall, rainforest cover is extensive across the ranges and coastal lowlands and streams and wetlands are numerous and important features in the landscape. For millions of years the consistent runoff has resulted in most streams and many wetlands being perennial systems and they have been so for millions of years, in contrast to most other parts of Australia, including most of the tropical region. As a result the Wet Tropics has sustained a unique and diverse freshwater fauna and flora with many endemic species present.

The high degree of variation in rainfall, topography, combined with a complex evolutionary history has resulted in a diverse spectrum of forest types and plant and animal communities. The rainforests of the region which dominates the narrow, high rainfall coastal belt have been classified into 16 major structural types and 30 broad community types (Tracey and Webb, 1975; Tracey, 1982). In addition the rainforests are fringed and dissected by a range of sclerophyll forests and woodlands as well as wetlands including estuarine mangrove communities. Tall woodlands, open *Eucalyptus* forests and grasslands extend into the drier western parts of the study area in to the Einasleigh Upland bioregion.

Wetland types include an enormous number of low order, perennial or near perennial, streams descending the steep ranges. These join in to several major river systems that define the basins within the study area. The coastal lowland floodplains are generally narrow, with the most extensive lowlands occurring in the south of the study area associated with the floodplains of the Tully/Murray and the Herbert rivers. These areas contain complex systems of numerous interconnecting wetlands and extensive coastal estuarine areas. The Herbert floodplain receives the lowest rainfall of the coastal lowlands in the study area but can have the highest discharge from runoff in the upper catchment. Its floodplain is dominated by woodlands with extensive areas of grass and sedge swamps laying adjacent to dune systems and connected estuaries. This area also contains the Herbert River delta which is formed at the southern end of the Hinchinbrook Channel, with its extensive stands of mangrove forest. In the Tully/Murray floodplain (and areas to the north) rainfall is higher and the coastal vegetation is dominated by forest, rainforest and extensive wetland areas. Unfortunately many of the coastal wetlands throughout the study area have been lost or are now largely modified through drainage and reclamation works. Many of the remaining wetlands are also heavily impacted by clearing of riparian and fringing vegetation, infestation by weeds and by events resulting in a decline in water quality through runoff from adjacent agriculture. Fractured basalt and other fractured rock aquifers occur throughout the study area supporting unique fauna and flora. These aquifer systems are particularly significant in some of the areas within the drier parts of the study area in the Einasleigh Upland. Crater lakes are also a unique feature of the plateaus of the study area.

Approximately 35 per cent of the study area is covered by the Wet Tropics World Heritage Area, taking in most of the ranges and large areas of lowland rainforest. The World Heritage Area consists of extensive areas of National Park and other protected estate as well as areas of private land. The major commercial land uses in the study area include extensive areas of lowlands, and some uplands, used for sugar cane production. Extensive areas in the lowlands are also used for banana production with a diverse range of other horticultural crops occurring throughout. On the fertile Atherton Tablelands dairy is a major industry along with a variety of horticulture and crops. Cattle grazing is a minor land use in the coastal lowlands but extensive cattle grazing is the major land use in the western part of the study area. The area was once heavily dependent on native forestry. However, this has declined with the protection of much of the native rainforest areas in the Wet Tropics World Heritage Area and in recent times forestry has depended on broad hectare softwood plantations on the Atherton Tablelands and the Cardwell area. Increasingly, other forestry plantations are being established on what was traditionally land used for sugar cane production.

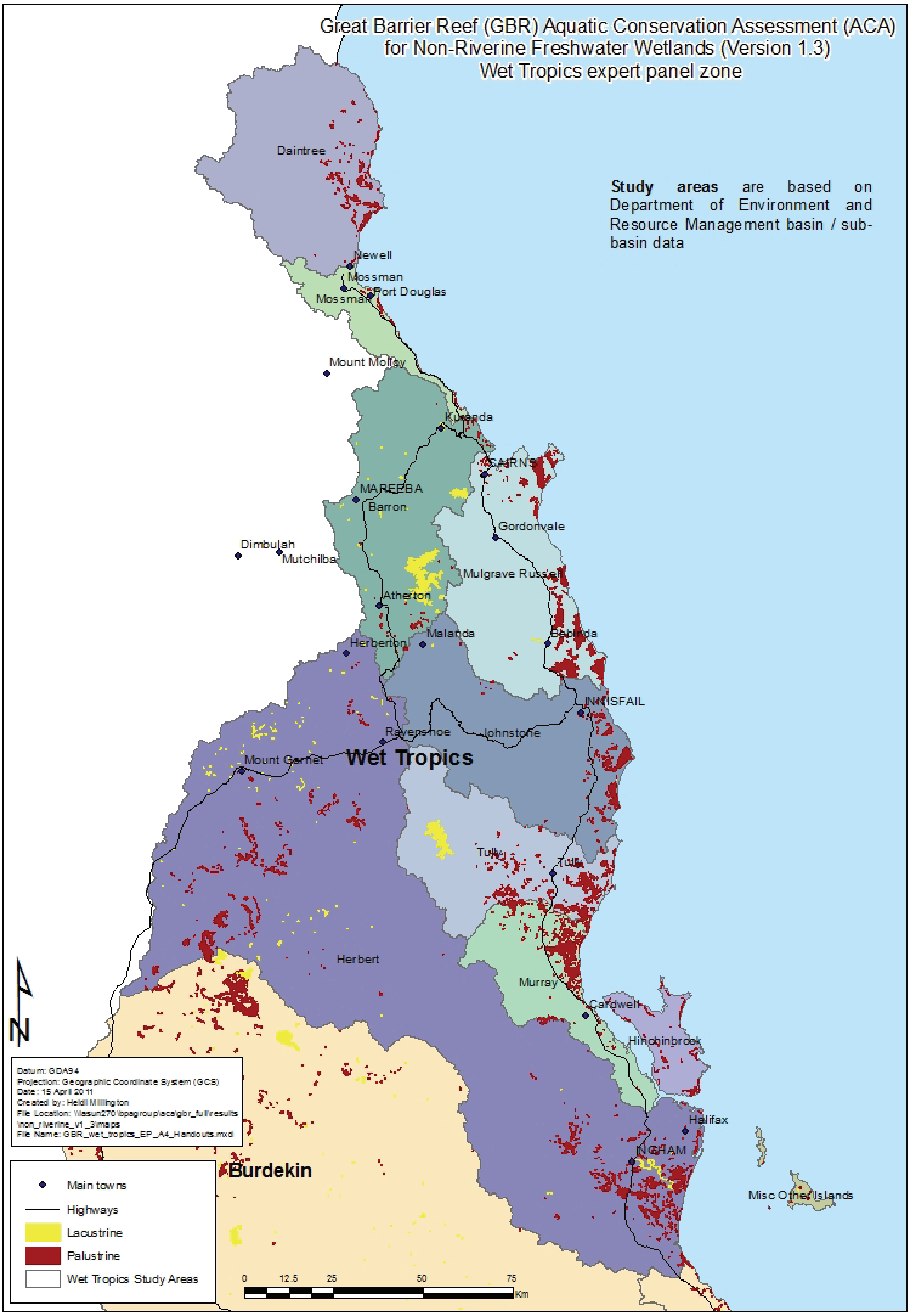

Figure 1 Wet Tropics section of the GBR catchment (incorporating nine individual catchments)

2.2 Panel composition

The expert panel (the panel) comprised of the 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 Wet Tropics section of the GBR catchment.

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
Donna Audas	Project Manager – GBR Wetlands Coastal ecosystems & Water Quality, Great Barrier Reef Marine Park Authority	Coastal ecosystems, GIS and wetlands
Ant Backer	Senior Planning Officer, Department of Environment and Resource Management	Biodiversity planning and terrestrial ecology
Damien Burrows	Aquatic ecologist, Australian Centre for Tropical Freshwater Research, James Cook University	Aquatic ecology and water quality
Niall Connolly	Principal Conservation Officer, Department of Environment and Resource Management	Biodiversity planning, aquatic ecology and water quality
Nick Cuff	Senior Botanist, Queensland Herbarium, Department of Environment and Resource Management	Botany and regional ecosystem assessment
Alf Hogan	Fisheries Scientist, Alf Hogan and Associates Fish Ecologists	Fish ecologist
Jeanette Kemp	Principal Botanist, Department of Environment and Resource Management	Native and exotic flora
Dominica Loong	Aquatic Ecologist, Australian Centre for Tropical Freshwater Research, James Cook University	Aquatic ecology and water quality
George Lukacs	Director, Australian Centre for Tropical Freshwater Research, James Cook University	Wetland ecology
Keith McDonald	Principal Technical Officer (threatened species), Department of Environment and Resource Management	Tropical ecology and conservation
Steve McDermott	Programme Leader - Wetlands, Waterways and Coastal Ecosystem, Terrain Natural Resource Management	Natural resource management and conservation planning
Tim Perry	Principal Ecologist, NRA Environmental Consultants	Native and exotic vegetation
Damon Sydes	Project Officer, Terrain Natural Resource Management	Natural resource management and conservation planning
Jim Tait	Ecologist, Ecoconcern Pty Ltd	Wetland ecology and management
Michael Trenerry	Team Leader (Regional Services), Department of Environment and Resource Management	Tropical ecology and conservation
Bruce Wannan	Principal Biodiversity Planning Officer, Department of Environment and Resource Management	Tropical flora and conservation planning

Selena Inglis 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 GBR catchment was also sourced from various technical reports.

3 Special features

The panel identified several priority ecosystems/special features in the Wet Tropics section of the GBR catchment (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 considered to have additional values (e.g. geomorphological or hydrological) were implemented as wetland ecology special features.

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 priority ecosystems and special features

Decisions 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.

Special feature	**Values**	**Catchment**	**Decision implementation number**	**Criteria/ indicator/ measure**	**Conservation rating (1-4)**
Crater lakes, and peaty sedge swamps in craters.	The crater lakes and maars identified under this decision are rare and the Atherton tablelands provide some excellent examples. The area includes peat based soils in volcanic craters (Bromfield Swamp, Quincan Crater & Lynches Crater), peat swamps formed by alteration of drainage patterns in late tertiary by basalt flows (Hasties and two unnamed areas, one near hasties and one at Herberton) and smaller deposits within basalt creeks. The area contains a range of unique and threatened regional ecosystems including 7.3.33a, 7.3.33b (crater lakes), 7.3.39 and 7.3.2 (peat sedge swamps in craters). The crater lakes also have considerable fauna values (particularly for some waterbird species) despite being under severe threat from weed and feral fish invasion. The area also supports disjunct distributions of species more typical of southern bioregions. Whilst Lake Eacham was originally prime habitat for the Lake Eacham rainbow fish (*Melanotaenia eachamensis*) it is now extinct from the lake and is listed as endangered under the *Environment Protection and Biodiversity Conservation Act 1999*.	Barron	bn_nr_ec_01	6.1.1 6.3.1	4
Tinaroo Dam	Despite Tinaroo Dam being an artificial wetland the site contains very high abundances of platypus (*Ornithorhynchus anatinus*), high fish diversity and abundance, significant habitat and abundance for waterbird species such as black swans (*Cygnus atratus*).	Barron	bn_nr_ec_03	6.3.1	2

Special feature	Values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Wetland complexes	This decision covers 12 wetland complexes in the Einasleigh Uplands bioregion. These wetlands were considered to be so significant at the landscape scale. These complexes were identified as being important as wildlife refugia, containing high species richness and a high density of hollow-bearing trees. Additionally, these complexes were considered to be important for taxa at the limit of their ranges, provided significant breeding and roosting sites and were known to contain regional ecosystems with distinct variation. <u>Note</u>: This decision is also a landscape decision in the Einasleigh Uplands Biodiversity Planning Assessment (eiu_l_9) but implementation of this decision is subject to the finalisation and release of the Einasleigh Uplands Biodiversity Planning Assessment report.	Barron	bn_nr_ec_04	6.3.1	
Wetlands of Cow and Alexandria Bays	The wetlands in this area contain intact remnant vegetation including the most intact fan palm swamp in the northern wet tropics region. The series of wetland types in this area are important as a wildlife resource providing food for many species including cassowaries (*Casuarius casuarius johnsonii)*, fruit pigeons and other rainforest species.	Daintree	da_nr_ec_01	6.3.1	3
Roaring Meg Falls to Bloomfield Falls	The Roaring Meg Falls is intact with very high biodiversity values. It encompasses significant stands of trailing sundew (*Drosera prolifera*) found from Roaring Meg Creek, Mt Pieter Botte and Noah Creek through to Thornton Peak. Roaring Meg and Alexandra Creeks have many significant rare and threatened species, some of which are endemic to those catchments (including *Hollandaea riparia* and *Diospyros* sp. Baird LA). The upper reaches of Alexandra Creek have hanging *melaleuca* swamps which contain broad leafed banksia (*Banksia robur*). These communities are poorly known and are in need of surveying. In addition, the area contains species of fish which are unique from an evolutionary perspective, including the only tropic member of the percichthyidae (perch) family as well as a high diversity of endangered frogs and significant cultural values. <u>Note</u>: This decision was also included in the riverine ACA assessment (decision number da_r_ec_01). See the Wet Tropics riverine report for more details.	Daintree	da_nr_ec_02	6.2.1 6.3.1	4

Special feature	Values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
McDowall Swamp	McDowall Swamp contains a mix of freshwater and estuarine species. The swamp has connectivity with surrounding riverine and estuarine wetlands in the Daintree River. The area is under threat from surrounding land uses. The swamp has been identified as a good site to focus rehabilitation efforts.	Daintree	da_nr_ec_03	6.4.1	2
Wawudimbi Swamp	The Wawudimbi Swamp consists of a series of about 20 or 30 depressions located across a couple of floodplain levels and depressions. The swamp provides a filtering function to the subcatchments that flow into it despite being subject to crash grazing and other management practices.	Daintree	da_nr_ec_04	6.2.1	2
Brown Creek wetlands south of Alexandra Range	The wetlands south of Alexandra Range identified in this decision are an interplay of tidal and freshwater wetlands containing a big complex of mangroves and freshwater wetland species. The site contains many threatened communities and species and provides an important function as a fish nursery area. Note: This decision was also included in the riverine ACA assessment (decision number da_r_ec_02). See the Wet Tropics riverine report for more details.	Daintree	da_nr_ec_05	6.3.1	3
Wonga north	The wetlands in this area contain a mixture of estuarine and freshwater communities including rare and threatened regional ecosystems. The area provides good crocodile (*Crocodylus porosus*) habitat and is an important fish nursery area. The area is also recognised as having significant non-indigenous cultural heritage values as well as indigenous values.	Daintree	da_nr_ec_06	6.3.1	4
Springs in upper Herbert tablelands at basalt rhyolite interface	This area, located between Herbert and Ravenshoe, represents important refugia in an otherwise dry area, maintains running groundwater from wet tropics to drier areas, supports threatened species and contains significant populations of *Aponogeton belosa*.	Herbert	he_nr_ec_01	6.3.1 6.4.1	
Gunnawarra wetland aggregation	The Gunnawarra wetland aggregation boasts unique geomorphology including basalt intrusions. The area is home to stands of *Eucalyptus corymbia* on plains and contains a high abundance of freshwater crocodiles (*Crocodylus johnstoni*). Note: This decision was also included in the riverine ACA assessment (decision number he_r_ec_02). See the Wet Tropics riverine report for more details.	Herbert	he_nr_ec_02	6.1.1	4

Special feature	Values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Porters Wetland	The Porters Wetland is a rehabilitated wetland that is part of the drainage direct from Ingham. The wetland provides both a filtering function and a flood mitigation function and contains significant bird and fish habitat values.	Herbert	he_nr_ec_03	6.2.1	1
Tyto Wetland – adjacent to Ingham	The Tyto Wetland area provides the only patch of blady grass left in floodplain with <1 per cent of this habitat left in Australia. The area contains a high diversity of fauna species and provides habitat for grassfowl and other bird species in the broader floodplain area including being a migratory site for the sharp tailed sandpiper (*Calidris acuminata*), a breeding site for painted snipes (one of the few remaining) and supporting a large population of crimson finches (*Neochmia phaeton*). Extensive *Pandanus* stands are also present in the area. Blady grass cover currently extends outside wetland mapping boundaries, and surrounds airport. Despite being highly modified the area is being rehabilitated and managed for long term conservation. The control of pest species in the area may mean that it will become an increasingly significant refuge for flora and fauna species. The wetland is currently being developed/rehabilitated for tourism. Note: This decision is a revised decision based on decision number he_ec_1 (Herbert wetland ecology expert panel 2007).	Herbert	he_nr_ec_04	5.2.1 6.1.1 6.3.1	4

Special feature	Values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Cattle Creek/ Warps Holding	The Cattle Creek/ Warps Holding area has unique geomorphology with a sand and gravel substrate. The wetlands at the site are permanent waterbodies with many large wetland areas. The wetlands contain a number of endangered species and communities and has high connectivity with surrounding wetland areas - important for fish migration. The area is known to support nesting brolga (*Grus rubicunda)*, black necked stork (*Ephippiorhynchus asiaticus*), cotton pygmy goose (*Nettapus coromandelianus)*, rufous throated honey eater (*Conopophila rufogularis*), little bitten and white browed crake (*Amaurornis cinerea*) and is the second best fish habitat area after Ripple Creek. The area is unique in the Herbert catchment and is thought to protect groundwater regime dynamics as well as maintain the freshwater head for upstream saltwater intrusion. The area is under threat from local runoff and infestations by Hymenachne although it is thought to provide a buffer from agricultural runoff. <u>Note</u>: This decision is a revised decision based on decision number he_ec_2 (Herbert wetland ecology expert panel 2007).	Herbert	he_nr_ec_05	5.2.1 6.3.1 8.2.5	4
Ripple Creek	The wetlands of Ripple Creek contain a diversity of diversity of remnant vegetation and habitats due to its position in the landscape and are considered to be by far the most important wetland complex and fish nursery area in the best condition on the floodplain. The area is highly connected from the upland to estuarine ecosystems and it is known to contain a significant abundance of ant plants (*Myrmecodia beccarii*), *Lophostemon suaveolens*, and several different types of *Melaleuca* communities (which are quite a rare combination) as well as another unique unnamed *Melaleuca* community. The site also supports large populations of mahogany glider (*Petaurus gracilis)*, crocodiles (*Crocodylus porosus*) and little kingfishers (*Ceyx pusilla*) as well as approximately 250 other species of birds The area therefore contains a complexity of regional ecosystems associated with a complex geomorphology. The different substrates in this area represent different origins and this is reflected in the complexity of habitats. <u>Note</u>: This decision is a revised decision based on decision number he_ec_3 (Herbert wetland ecology expert panel 2007).	Herbert	he_nr_ec_06	6.3.1 6.1.1	4

Special feature	Values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Warps	This area is a unique and relatively intact complex of wetlands containing unique geomorphic and hydrological components supporting restricted and threatened ecosystems that are important hydrologically and provide a water quality filtering function for Cattle Creek. Note: This decision is a revised decision based on decision number he_ec_4 (Herbert wetland ecology expert panel 2007).	Herbert	he_nr_ec_07	5.2.1 6.2.1	4
Blunder Park	The wetlands at Blunder Park are unique black plain swamps usually only found in the Einasleigh Uplands bioregion. The only other similar permanent systems in the Upper Herbert are subject to modification. The vegetation is unique due to its altitude and location and the area is high in geomorphic diversity. The permanent water in the area is provided by reliable local runoff from hard surrounding catchment. Note: This decision is a revised decision based on decision number he_ec_5 (Herbert wetland ecology expert panel 2007).	Herbert	he_nr_ec_08	6.1.1 6.4.1	4
Boomerang/ Minnamoolka/ Wombinoo	These areas are unique geomorphically and hydrologically fed from spring systems. Note: This decision is a revised decision based on decision number he_ec_7 (Herbert wetland ecology expert panel 2007).	Herbert	he_nr_ec_09	6.1.1 6.4.1	3
Wairuna Creek Plateau complex	The Wairuna Creek Plateau complex is a large complex of back-plain wetlands that collectively represent a large wetland area. The wetlands are frequently filled by the relatively high rainfall although this can be seasonal. The area also has high connectivity. Note: This decision is a revised decision based on decision number he_ec_8 (Herbert wetland ecology expert panel 2007).	Herbert	he_nr_ec_10	6.1.1 6.2.1 8.2.5	3
Regional ecosystems 7.12.64e & 7.12.37g (highland seeps)	These regional ecosystems contain several rare species endemic to highlands such as the sundew (*Drosera adelae*). The area also contains unique fauna values (including *Trichoptera*) and is in good condition due to inaccessibility and the harsh environment. This area may potentially be under threat by climate change. Note: This decision is a revised decision based on decision number he_ec_9 (Herbert wetland ecology expert panel 2007).	Herbert	he_nr_ec_11	6.1.1 6.4.1	4

Special feature	Values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Lannercost	The Lannercost area is a unique and relatively intact complex of wetlands with regards to its geomorphic and hydrological components. The area contains restricted and threatened ecosystems and is thought to be important hydrologically by providing a water quality filtering function for Cattle Creek. <u>Note</u>: This decision is a revised decision based on decision number he_ec_10 (Herbert wetland ecology expert panel 2007).	Herbert	he_nr_ec_12	5.2.1 6.2.1	4
Allingham/ Mungulla wetland aggregation. southeast of Allingham	The Allingham/Mungulla wetland aggregation area is an example of former grassland on the Herbert floodplain, most of which is now under sugar cane agriculture. The contains significant fauna values including supporting populations of the rufous throated honeyeater (*Conopophila rufogularis*) and breeding grounds for the crimson finch (*Neochmia phaeton*), cotton pygmy goose (*Nettapus coromandelianus*) and brolga (*Grus rubicunda)*. The area is important crocodile (*Crocodylus porosus*) habitat and is known to contain around 12 species of fish. Although it is degraded, its hydrology and structure is similar in ecological character to its previous state. The area still contains significant Pandanus stands. <u>Note</u>: This decision is a revised decision based on decision number he_ec_11 (Herbert wetland ecology expert panel 2007).	Herbert	he_nr_ec_13	6.2.1 6.3.1	3
Coastal dune swales Taylor's and Forest Beach area	The habitats of the coastal swales surrounding Taylor's Beach are in very good condition compared to other swale systems. The area contains special geomorphic and hydrological features contributing to special habitat values. The site includes various wetland types containing mangrove and *Melaleuca* species and supports significant wildlife populations including a pair of great billed herons (*Ardea sumatrana*) and one of the biggest populations of the apollo jewel butterfly (*Hypochrysops apollo apollo*). <u>Note</u>: This decision is a revised decision based on decision number he_ec_12 (Herbert wetland ecology expert panel 2007).	Herbert	he_nr_ec_14	6.1.1 6.3.1 6.4.1	4

Special feature	Values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
The Orient	The Orient area is an example of former big open plain grasslands on the Herbert floodplain, most of which is now under sugar cane. Although it is degraded, its hydrology and structure is similar in ecological character to its previous state. The area still contains significant pandanus stands. Note: This decision is a revised decision based on decision number he_ec_13 (Herbert wetland ecology expert panel 2007).	Herbert	he_nr_ec_15	6.2.1	2
Trebonne Creek delta	The Trebonne Creek delta is the only remaining intact freshwater delta system from a major channel in the Herbert catchment. It contains an endangered plant community dominated by palm trees (*Alexandra palm*). Note: This decision is a revised decision based on decision number he_ec_14 (Herbert wetland ecology expert panel 2007).	Herbert	he_nr_ec_16	6.3.1 6.1.1 8.2.5	4
Cattle Creek complex hills to estuary	The Cattle Creek wetlands complex functions as one large complex from hills to estuary. Note: This decision is a revised decision based on decision number he_ec_15 (Herbert wetland ecology expert panel 2007).	Herbert	he_nr_ec_17	6.1.1	4
Wetland complexes	This decision covers 12 wetland complexes in the Einasleigh Uplands bioregion., considered to be significant at the landscape scale. These complexes were identified as being important as wildlife refugia, containing high species richness and a high density of hollow-bearing trees. Additionally, these complexes were considered to be important for taxa at the limit of their ranges, provided significant breeding and roosting sites and were known to contain regional ecosystems with distinct variation. Note: This decision is also a landscape decision in the Einasleigh Uplands Biodiversity Planning Assessment (eiu_l_9) but implementation of this decision is subject to the finalisation and release of the Einasleigh Uplands Biodiversity Planning Assessment report.	Herbert	he_nr_ec_18_not_implemented	6.3.1	

Special feature	Values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Basalt swamps, Undara area	The Basalt swamps, Undara area contains good connectivity, increased representativeness, high diversity and good integrity. It is important as wildlife refugia and is a centre of endemism, containing disjunct populations and high species richness many of which are at the limit of their geographical distribution. Note: This decision was also included in the riverine ACA assessment (decision number he_r_ec_04). See the Wet Tropics riverine report for more details. This decision is also a revised decision based on eiu_l_27 (Einasleigh uplands biodiversity planning assessment).	Herbert	he_nr_ec_ 19	6.3.1 6.3.3	4
Peat swamps (Atherton Tablelands)	Peat swamps formed in the Atherton Tablelands are formed by alteration of drainage patterns in late Tertiary by basalt flows and smaller deposits within basalt creeks. Values of these peat swamps are not all similar but a range of threatened REs (e.g. 7.3.2, 7.3.39) and species occur. They are also key habitat for some waterbird species particularly late in the dry season. They are good examples of subtropical wetlands within the tropical bioregion - altitude 700-1000m ASL. They also support disjunct distributions of species more typical of southern bioregions. Note: This decision has similar values to the peat swamps and crater lakes of jo_nr_ec_03	Herbert	he_nr_ec_ 20	6.1.1 6.3.1	4
Springs	Springs in the Herbert catchment provide important wildlife refugia and disjunct populations. Note: This decision was implemented in this assessment as springs were added to the wetlands base layer for this ACA version (1.3) although they were not included in the previous version (1.2).	Herbert	he_nr_ec_ 21	6.4.1	3

Special feature	Values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Hinchinbrook Island	Hinchinbrook Island is nationally and internationally recognised for its values. The island is covered by the Great Barrier Reef World Heritage Area, Hinchinbrook Island National Park and a Wild Rivers area. Additionally, the Missionary Bay Wetlands on the island are listed on the Directory of Important Wetlands. Hinchinbrook Island contains lush rainforests, rugged, misty and heath-covered mountains, sweeping sandy beaches, rocky headlands, paperbark and palm wetlands, mangrove-fringed shores and extensive open forests and woodlands. The mangrove forests on the island are some of the richest and most varied in Australia and are an important breeding ground for many marine animals. Note: This decision was also included in the riverine ACA assessment (decision number hi_r_ec_01). See the Wet Tropics riverine report for more details.	Hinchinbrook	hi_nr_ec_01	6.2.1 6.3.1 6.3.3	4
Southeast Hinchinbrook Island	The southeast section of Hinchinbrook Island contains good freshwater seeps coming off the granite mountains. The area is a largely intact ecosystem that provides a good transitional zone from mountain to mangroves. Note: This decision was also included in the riverine ACA assessment (decision number hi_r_ec_02). See the Wet Tropics riverine report for more details.	Hinchinbrook	hi_nr_ec_02	6.4.1	4
Kurrimine Beach	The wetlands of Kurrimine Beach demonstrate interplay between freshwater and estuarine ecosystems consisting of alluvial regional ecosystems sitting within a matrix of land zone two units. The area, associated with Pleistocene dunes, contains significant swamp paperbark (*Melaleuca quinquenervia*) stands, disjunct floral species and ant plant communities. The site contains a high concentration of fruiting plants which provide food for threatened species such as cassowary (*Casuarius casuarius johnsonii*), flying foxes and various nectar feeding birds. The wetland is likely to also provide a significant reef water quality protection function.	Johnstone	jo_nr_ec_01	6.3.1	4

Special feature	Values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Sedge swamp on way to Etty Bay	The sedge swamp identified here as a special area is one of the few sedge swamps with high connectivity between mountain and mangrove. The swamp is located on an old dune system on land zone 2 (regional ecosystem 7.l2.9c) and contains primarily *Lepironia articulata*. This swamp is a very large and rare treeless dune swamp, formerly part of a dune complex consisting of beach scrubs, tea-tree and sedge swamps. The area also provides significant waterbird habitat.	Johnstone	jo_nr_ec_02	6.3.1	4
Crater lakes and peaty sedge swamps in craters	The Crater lakes and maars identified under this decision are rare and the Atherton Tablelands provide some excellent examples. The area has unique geomorphology containing peat based soils in volcanic craters (Bromfield swamp, Quincan Crater & Lynches Crater), peat swamps formed by alteration of drainage patterns in late Tertiary by basalt flows (Hasties and two unnamed areas, one near Hasties and one at Herberton) and smaller deposits within basalt creeks. The area contains a range of unique and threatened regional ecosystems including 7.3.33a, 7.3.33b (crater lakes), 7.3.39 and 7.3.2 (peat sedge swamps in craters). The crater lakes also have considerable fauna values (particularly for some bird species) containing a significant sarus crane (*Grus antigone*) roosting site. The area also supports disjunct distributions of species more typical of southern bioregions. The area is under severe threat from land uses such as cattle grazing, weed and feral fish invasion. Whilst Lake Eacham was originally prime habitat for the Lake Eacham rainbow fish (*Melanotaenia eachamensis*) it is now extinct from the lake and is listed as endangered under the *Environment Protection and Biodiversity Conservation Act 1999.*	Johnstone	jo_nr_ec_03	6.1.1 6.3.1	4
Etty Bay wetland	Etty Bay wetland provides an important habitat for wetland dependant fauna. Now under threat from land use the area previously contained the biggest population of cassowaries (*Casuarius casuarius johnsonii*) in the region. The wetland is also home to many *Aponogeton* species, the Cairns Rainbowfish (*Cairnsichthys rhombosomoides*), the McCulloch's rainbowfish (*Melanotaenia maccullochi*) and Gertrude's blue-eye (*Pseudomugil gertrudae*). The area is an important resource area for fruiting floral species and fruit eating fauna species.	Johnstone	jo_nr_ec_04	6.3.1	4

Special feature	Values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Maria Creek National Park	The Maria Creek National Park is located at a transition zone containing palm swamps grading into *Melaleuca* ecosystems grading into estuarine areas. The area is thought to contain endangered orchids including the blue orchid (*Dendrobium nindii*) and mangrove orchid (*Dendrobium mirbelianum*).	Johnstone	jo_nr_ec_05	6.2.1 7.3.2	3
Wyvuri Swamp & Russelll River National Park	The highly connected wetlands of Wyvuri Swamp and Russelll River National Park contain threatened and disjunct flora and fauna species and provide important habitat for crocodiles (*Crocodylus porosus*) and cassowaries (*Casuarius casuarius johnsonii*). The area contains many endangered and threatened regional ecosystems including regional ecosystems 7.3.1.	Mulgrave Russelll	mr_nr_ec_01	6.3.1	4
Eubenangee Swamp wetland aggregation	Eubenangee Swamp is considered to be one of the best examples of a non-riverine freshwater wetland in the Wet Tropics region. The area contains significant floristic values found within sedgeland and grassland ecosystems in good condition and contains one of the few remaining areas of intact regional ecosystem 7.3.1. The area has good connectivity with Russell River and the Wet Tropics World Heritage Area and provides good habitat for threatened species and various fish species. The area is currently subject to threatening processes, for example streams feeding the swamp are subject to threatening process which is thought to be adversely impacting the area. Note: This decision was also included in the riverine ACA assessment (decision number mr_r_ec_01). See the Wet Tropics riverine report for more details.	Mulgrave Russelll	mr_nr_ec_02	6.3.1	4
Edmund Kennedy National Park to Hull River National Park	The area between Edmund Kennedy National Park and Hull River National Park provide a good example of remnant vegetation found on pleistocene dunes containing significant wetlands/swales. Although the area is poorly surveyed it is known to support populations of the ant plant (*Myrmecodia beccarii)*, cassowary (*Casuarius casuarius johnsonii*), crocodile (*Crocodylus porosus*) and mahogany glider (*Petaurus gracilis*). Note: This decision straddles the Tully and Murray study areas. The Tully component of this decision is covered by decision number tu_nr_ec_06.	Murray	mu_nr_ec_01	6.3.1	4
Girramay National Park	The Girramay National Park is very seasonal in terms of the values due to being subject to decreased rainfall. Despite this, the area is important for larval fish recruitment.	Murray	mu_nr_ec_02	6.3.1	2

Special feature	Values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Tully/Murray floodplain aggregation – upper Murray	The Tully/Murray floodplain, which encompasses the Murray Upper Wetlands Nature Refuge, contains unique geomorphology influenced by an interaction with groundwater. The area is highly important for maintaining ecosystem processes providing drought refugia areas during dry times. The floodplain consists mainly of *Melaleuca* swamps which provide important habitat for crocodiles (*Crocodylus porosus*), mahogany gliders (*Petaurus gracilis*), cassowaries (*Casuarius casuarius johnsonii)*, and various species of fish. The area also has a high diversity of rainforest bird species and is an important fish nursery and breeding area. Some wetlands in the area are either rehabilitated or constructed wetlands. The upper Murray system consists of vegetated swamps with elements of lacustrine and riverine systems. <u>Note</u>: This decision straddles the Tully and Murray study areas. The Tully component of this decision is covered by decision number tu_nr_ec_02.	Murray	mu_nr_ec_03	6.2.1 6.3.1 6.4.1	3
Tully/Hull lowlands	The wetlands of the Tully/Hull lowlands are within the biggest floodplain in the wet tropics and provide a good example of adventitious lowland streams, most of which are relatively intact. The wetlands in this area provide good general ecological resources and have a significant reef water quality protection function. The area consists of lowland fan palm and *Melaleuca* swamps close to the coast providing important habitat for crocodiles (*Crocodylus porosus*), cassowaries (*Casuarius casuarius johnsonii*) and numerous bird species. The area is the northern most limit of mahogany glider (*Petaurus gracilis)* habitat and is known to contain many endemic and disjunct wet tropics fish species, assisted by the provision of significant fish nursery areas. The area also contains significant indigenous values as well as commercial and recreational fishing values. <u>Note:</u> This decision straddles the Tully and Murray study areas and covers both riverine and non-riverine wetlands. The riverine component of this decision in the Murray study area is covered by decision number mu_r_ec_03. The riverine and non-riverine components of this decision in the Tully study area are covered by decision numbers tu_r_ec_04 and tu_nr_ec_03 respectively (see the Wet Tropics riverine report for more details on the riverine decisions).	Murray	mu_nr_ec_04	6.2.1 6.3.1	4

Special feature	Values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Tully/Murray floodplain aggregation – middle Murray	The Tully/Murray floodplain, which encompasses the Murray Upper Wetlands Nature Refuge, contains unique geomorphology influenced by an interaction with groundwater. The area is highly important for maintaining ecosystem processes providing drought refugia areas during dry times. The floodplain consists mainly of *Melaleuca* swamps which provide important habitat for crocodiles (*Crocodylus porosus*), mahogany gliders (*Petaurus gracilis*), cassowaries (*Casuarius casuarius johnsonii)*, and various species of fish. The area also has a high diversity of rainforest bird species and is an important fish nursery and breeding area. Some wetlands in the area are either rehabilitated or constructed wetlands. The middle Murray is mainly a lacustrine system with riverine and palustrine systems within it. The DERM wetland mapping does not pick up the majority of these as they are under 1ha. <u>Note</u>: This decision straddles the Tully and Murray study areas. The Tully component of this decision is covered by decision number tu_nr_ec_04.	Murray	mu_nr_ec_05	6.3.1	
Bellenden Plains	The wetlands of Bellenden Plains in the Tully and Murray catchment are groundwater fed melon holes with unique geomorphology. <u>Note</u>: This decision straddles the Tully and Murray study areas. The Tully component of this decision is covered by decision number tu_nr_ec_05.	Murray	mu_nr_ec_06	6.4.1	2
Wongaling and Porters Creek (reserve 2.1.4)	The Wongaling and Porters Creek area is a very unique mosaic of estuarine and freshwater ecosystems containing patchwork vegetation and endangered regional ecosystems. The area is also thought to be critical habitat for cassowaries (*Casuarius casuarius johnsonii*).	Tully	tu_nr_ec_01	6.2.1	2

Special feature	Values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Tully/Murray floodplain aggregation – upper Murray	The Tully/Murray floodplain, which encompasses the Murray Upper Wetlands Nature Refuge, contains unique geomorphology influenced by an interaction with groundwater. The area is highly important for maintaining ecosystem processes providing drought refugia areas during dry times. The floodplain consists mainly of *Melaleuca* swamps which provide important habitat for crocodiles (*Crocodylus porosus*), mahogany gliders (*Petaurus gracilis*), cassowaries (*Casuarius casuarius johnsonii)*, and various species of fish. The area also has a high diversity of rainforest bird species and is an important fish nursery and breeding area. Some wetlands in the area are either rehabilitated or constructed wetlands. The upper Murray system consists of vegetated swamps with elements of lacustrine and riverine systems. <u>Note</u>: This decision straddles the Tully and Murray study areas. The Murray component of this decision is covered by decision number mu_nr_ec_03.	Tully	tu_nr_ec_ 02	6.2.1 6.3.1 6.4.1	3
Tully/Hull lowlands	The wetlands of the Tully/Hull lowlands are within the biggest floodplain in the wet tropics and provide a good example of adventitious lowland streams, most of which are relatively intact. The wetlands in this area provide good general ecological resources and have a significant reef water quality protection function. The area consists of lowland fan palm and *Melaleuca* swamps close to the coast providing important habitat for crocodiles (*Crocodylus porosus*), cassowaries (*Casuarius casuarius johnsonii*) and numerous bird species. The area is the northern most limit of mahogany glider (*Petaurus gracilis)* habitat and is known to contain many endemic and disjunct wet tropics fish species, assisted by the provision of significant fish nursery areas. The area also contains significant indigenous values as well as commercial and recreational fishing values. <u>Note</u>: This decision straddles the Tully and Murray study areas and covers both riverine and non-riverine wetlands. The riverine component of this decision in the Tully study area is covered by decision number tu_r_ec_04. The riverine and non-riverine components of this decision in the Murray study area are covered by decision numbers mu_r_ec_03 and mu_nr_ec_04 respectively (see the Wet Tropics riverine report for more details on the riverine decisions).	Tully	tu_nr_ec_ 03	6.2.1 6.3.1	4

Special feature	Values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Tully/Murray floodplain aggregation – middle Murray	The Tully/Murray floodplain, which encompasses the Murray Upper Wetlands Nature Refuge, contains unique geomorphology influenced by an interaction with groundwater. The area is highly important for maintaining ecosystem processes providing drought refugia areas during dry times. The floodplain consists mainly of *Melaleuca* swamps which provide important habitat for crocodiles (*Crocodylus porosus*), mahogany gliders (*Petaurus gracilis*), cassowaries (*Casuarius casuarius johnsonii)*, and various species of fish. The area also has a high diversity of rainforest bird species and is an important fish nursery and breeding area. Some wetlands in the area are either rehabilitated or constructed wetlands. The middle Murray is mainly a lacustrine system with riverine and palustrine systems within it. The DERM wetland mapping does not pick up the majority of these as they are under 1ha. <u>Note</u>: This decision straddles the Tully and Murray study areas. The Murray component of this decision is covered by decision number mu_nr_ec_05.	Tully	tu_nr_ec_04	6.3.1	3
Bellenden Plains	The wetlands of Bellenden Plains in the Tully and Murray catchment are groundwater fed melon hole with unique geomorphology. <u>Note</u>: This decision straddles the Tully and Murray study areas. The Murray component of this decision is covered by decision number mu_nr_ec_06.	Tully	tu_nr_ec_05	6.4.1	2
Edmund Kennedy National Park to Hull River National Park	The area between Edmund Kennedy National Park and Hull River National Park provide a good example of remnant vegetation found on Pleistocene dunes containing significant wetlands/swales. Although the area is poorly surveyed it is known to support populations of the ant plant, *Myrmecodia beccarii*, cassowary (*Casuarius casuarius johnsonii*), crocodile (*Crocodylus porosus*) and mahogany glider (*Petaurus gracilis*). <u>Note</u>: This decision straddles the Tully and Murray study areas. The Tully component of this decision is covered by decision number mu_nr_ec_01.	Tully	tu_nr_ec_06	6.3.1	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 for the non-riverine wetlands of the GBR catchment. After some time discussing connectivity for non-riverine wetlands, the panel members agreed that connectivity Criterion 7 be turned off for the GBR non-riverine ACA due to issues associated with its implementation (including method of implementation and resources). The following sections detail discussions from the panel regarding the implementation of non-riverine connectivity in the Burdekin section of the GBR catchment and possible options for future investigation.

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 riverine and non-riverine wetlands can often be directly linked in quantity and quality to the movement of resources, such as water, sediment, debris, recruitment and distribution of species, between wetland systems and adjoining terrestrial lands (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).

4.2 Applying principles for measuring connectivity

The practicalities of measuring connectivity in both riverine and non-riverine environments 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 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.

One suggestion was to use aerial photography showing one in five year flood events to identify the connectivity of wetland systems in conjunction with the wetland mapping. This analysis would identify the extent of connectivity for non-riverine wetlands and enable thresholds to be developed for when particular non-riverine wetlands are connected to a riverine wetland. It was however identified that this would become an issue for those wetlands that do not rely on flood events, such as those that are groundwater fed or fed from seepage areas. In addition to this, there is difficulty in obtaining the hydrological data and having the

satellite imagery to interpret the connectivity. There would also be a significant investment of time and resources to undertake an assessment such as this.

The panel agreed that where there is connectivity between riverine and non-riverine wetlands, these non-riverine wetlands should be given a higher connectivity value. It was suggested that the main river channels be buffered and any non-riverine wetlands that intersect the buffer can be considered to be connected. However some areas may not have a main river channel going through (possibly due to the scale of the wetland mapping) but the non-riverine wetlands are still connected. This approach will be considered for future investigation and implementation.

4.4 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 panel suggested assigning a three to an area with hydrological estuarine connectivity and a four to an area that has freshwater wetlands and hydrological estuarine and/or biological connectivity. This approach is to be investigated further before being implemented.

The panel also recommended that wetlands located a significant distance inland from estuarine areas, yet still have connectivity with estuarine ecosystems, should be given a higher value.

5 Stratification

Study area stratification for application to relevant measures of AquaBAMM is a user decision and is not mandatory for 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 limited to 150 m above sea level (asl) for coastal flowing catchments and 400 m asl for catchments west of the Great Dividing Range in the Murray-Darling Basin.

Stratification was considered by the panel and it was recommended that the study areas be stratified by 100 m asl. After further investigation post panel, and to maintain consistency with other ACAs, it was decided to stratify using 150 m asl for all study areas in the Wet Tropics.

Spatial units above 150 m asl were grouped together as “upland” for the purpose of measures calculation. Spatial units below 150 m asl were grouped together as “lowland” for the purpose of measures calculation. Spatial units containing the 150 m asl contour were allocated to one or other stratum according to the elevation of the majority of the spatial unit (e.g. “upland” where more than 50 per cent of the spatial unit’s area is greater than 150 m asl). When stratification is applied to the spatial units in an ACA, a separate set of measure thresholds is calculated for each stratum (refer Clayton *et al.* 2006).

6 Weighting of measures

The panel members that attended the nine 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 weight.
2. Weight the other measures within each indicator compared to the weighting of 10 assigned in the first step.
3. Different measures may have the same weight (i.e. all measures could be weighted 10).
4. Some indicators only have one measure and have already been given a weighting of 10.
5. Don't weight a measure 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 all three expert panel zones within the Great Barrier Reef study area, rather than average the weights for each zone or study area.

The final weights for each measure were then applied in the AquaBAMM assessment (Table 3). The measure number in Table 3 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 3 The average weights for each measure

Maximum score is 10; total number of participants was approximately 20.

Criteria & indicators	Measures		Weighting
1 Naturalness aquatic			
1.1 Exotic flora/fauna	1.1.1	Presence of ‘alien' fish species within the wetland	7.6
	1.1.2	Presence of exotic aquatic and semi-aquatic plants within the wetland	9.9
	1.1.3	Presence of exotic invertebrate fauna within the wetland	5.9
	1.1.4	Presence of feral/exotic vertebrate fauna (other than fish) within the wetland	7.2
1.4 Hydrological modification	1.4.5	Hydrological disturbance/modification of the wetland (e.g. as determined through DERM wetland mapping and classification)	9.9
2 Naturalness catchment			
2.1 Exotic flora/fauna	2.1.1	Presence of exotic terrestrial plants in the assessment unit	10
2.2 Riparian disturbance	2.2.5	Per cent area of remnant vegetation relative to pre-clearing extent within buffered non-riverine wetland: 500 m buffer for wetlands >= 8Ha, 200 m buffer for smaller wetlands	10

Criteria & indicators	Measures		Weighting
2.3 Catchment disturbance	2.3.1	Per cent "agricultural" land-use area (i.e. cropping and horticulture)	8.9
	2.3.2	Per cent "grazing" land-use area	7.7
	2.3.3	Per cent "vegetation" land-use area (i.e. native veg + regrowth)	9.1
	2.3.4	Per cent "settlement" land-use area (i.e. towns, cities, etc)	8.8
2.4 Flow modification	2.4.1	Farm storage (overland flow harvesting, floodplain ring tanks, gully dams) calculated by surface area	9.0
3 Diversity and richness			
3.1 Species	3.1.2	Richness of native fish	9.8
	3.1.3	Richness of native aquatic dependent reptiles	8.2
	3.1.4	Richness of native waterbirds	8.8
	3.1.5	Richness of native aquatic plants	9.5
	3.1.6	Richness of native amphibians (non-riverine wetland breeders)	8.8
	3.1.7	Richness of native aquatic dependent mammals	7.8
3.2 Communities/ assemblages	3.2.1	Richness of macroinvertebrate taxa	9.2
3.3 Habitat	3.3.2	Richness of wetland types within the local catchment (e.g. SOR[1] sub-section)	9.4
	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 – NC Act[2], EPBC Act[3]	9.8
	4.1.2	Presence of rare or threatened aquatic ecosystem dependent flora species – NC Act[2], EPBC Act[3]	9.8
4.2 Communities/ assemblages	4.2.1	Conservation status of wetland Regional Ecosystems – Herbarium biodiversity status, NC Act[2], EPBC Act[3]	10
5 Priority species and ecosystems			
5.1 Species	5.1.1	Presence of aquatic ecosystem dependent 'priority' fauna species (expert panel list/discussion or other lists such as ASFB, WWF, etc)	9.6
	5.1.2	Presence of aquatic ecosystem dependent 'priority' flora species	9.7
	5.1.3	Habitat for, or presence of, migratory species (expert panel list/discussion and/or JAMBA[4] / CAMBA[5] agreement lists and/or Bonn Convention)	8.9
	5.1.4	Habitat for significant numbers of waterbirds	8.7
5.2 Ecosystems	5.2.1	Presence of 'priority' aquatic ecosystem	10
6 Special features			
6.1 Geomorphic features	6.1.1	Presence of distinct, unique or special geomorphic features	10
6.2 Ecological processes	6.2.1	Presence of (or requirement for) distinct, unique or special ecological processes	10
6.3 Habitat	6.3.1	Presence of distinct, unique or special habitat (including habitat that functions as refugia or other critical purpose)	9.4
	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	8.1
	6.3.3	Ecologically significant wetlands identified through expert opinion and/or documented study	9.1
6.4 Hydrological	6.4.1	Presence of distinct, unique or special hydrological regimes (e.g. spring fed stream, ephemeral stream, boggomoss)	10
8 Representativeness			
8.1 Wetland protection	8.1.1	The per cent area of each wetland habitat type within Protected Areas	10

Criteria & indicators	Measures		Weighting
	8.1.2	The per cent 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*	8.9
8.2 Wetland uniqueness	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)	8.5
	8.2.2	The relative abundance of the wetland management group to which the wetland habitat belongs within the subcatchment or estuarine/marine zone (management groups ranked least common to most common)	8.8
	8.2.3	The size of each wetland habitat relative to others of its management group within the catchment or study area	7.6
	8.2.4	The size of each wetland habitat relative to others of its management group within a subcatchment (or estuarine zone)	7.9
	8.2.5	Wetland habitat representative of the study area – identified by expert opinion	9.4
	8.2.6	The size of each wetland habitat relative to others of its 'type' within the catchment or study area	8.0

[1] SOR – State of the Rivers
[2] NC Act – Nature Conservation Act 1992 (Queensland legislation)
[3] EPBC Act – Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth legislation)
[4] JAMBA – Japan Australia Migratory Bird Agreement
[5] CAMBA – China Australia Migratory Bird Agreement

7 Ranking of indicators

The panel members that attended the nine workshops 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 1 which is the highest ranking.
2. Rank the other indicators within each criterion relative to the ranking of 1 assigned in the first step.
3. Different indicators may have the same ranking (i.e. all indicators may be ranked 1).
4. Don't rank an indicator 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 all three expert panel zones within the GBR study area, rather than average the ranks for each zone or study area.

The final ranks for each indicator were then applied in the AquaBAMM assessment (Table 4).

Table 4 The average ranks for each indicator

Maximum rank is 1; total number of participants was approximately 20.

Indicator	Description	Ranking
1 Naturalness aquatic		
1.1	Exotic flora/fauna	2
1.4	Hydrological modification	1
2 Naturalness catchment		
2.1	Exotic flora/fauna	3
2.2	Riparian disturbance	3
2.3	Catchment disturbance	1
2.4	Flow modification	2
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	2
4.2	Communities/ assemblages	1
5 Priority species and ecosystems		
5.1	Species	2
5.2	Ecosystems	1
6 Special features		
6.1	Geomorphic features	3
6.2	Ecological processes	2
6.3	Habitat	1
6.4	Hydrological	3
8 Representativeness		
8.1	Wetland protection	2
8.2	Wetland uniqueness	1

Attachments

Attachment A – GBR catchment study area

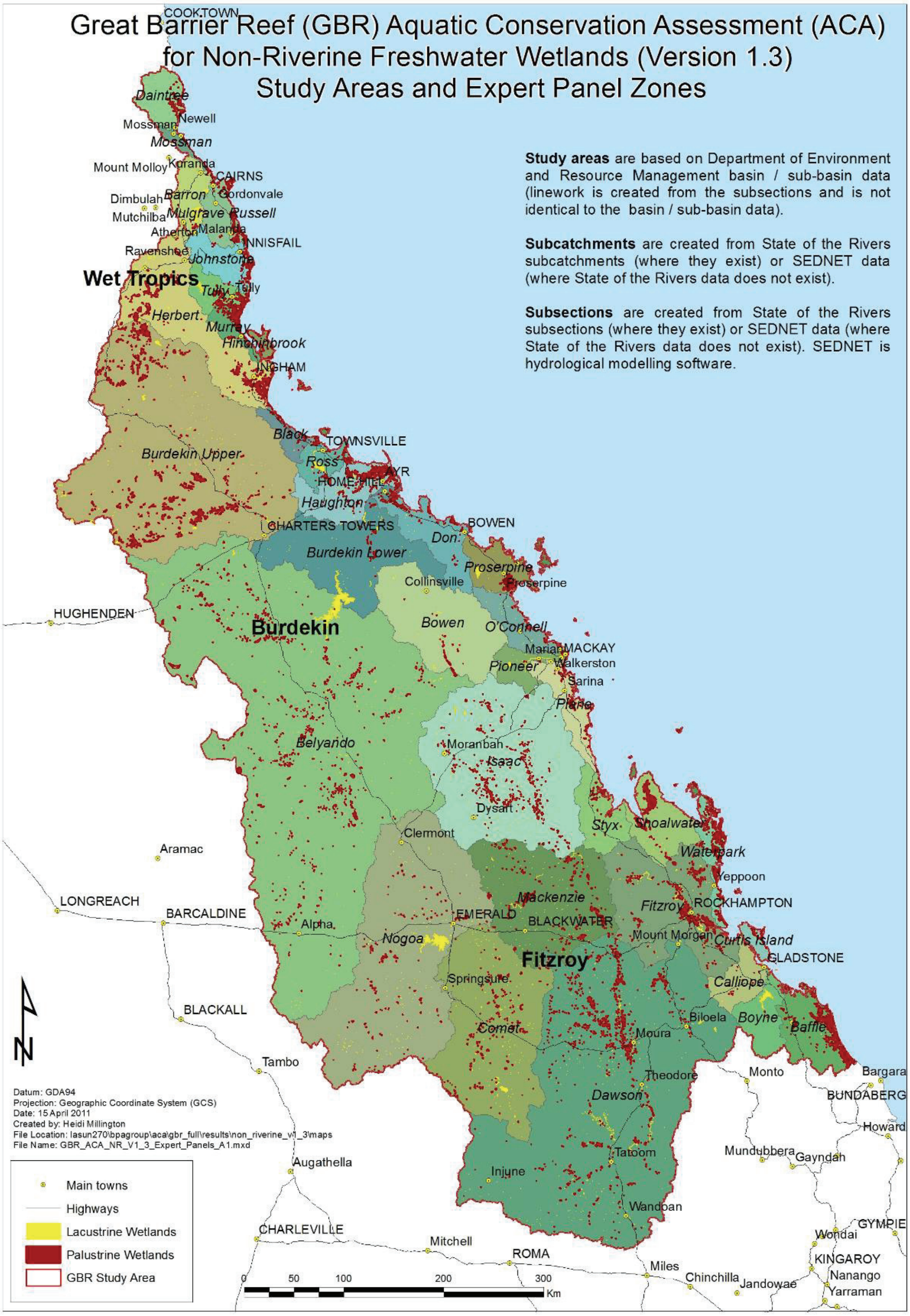

Figure 2 GBR catchment study area.

Attachment B – Terms of reference (wetland ecology 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 gain information for 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 of the GBR catchment. Experience in the identification and assessment of riverine and non-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 riverine and non-riverine wetlands of the GBR. The panel consisted of professionals in fields of expertise relating to riverine and wetland ecology, water quality, geomorphology, fisheries and hydrological processes.

The tasks undertaken by the panel included, but without limitation, 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.
- 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 GBR catchment

The criteria, indicators and measures (CIM) list outlines the CIM that were implemented as part of the non-riverine Aquatic Conservation Assessment (ACA) using AquaBAMM of the freshwater wetlands of the GBR catchment.

The list has been developed from a default list of CIM that may be considered when an Aquatic Conservation Assessment (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. AquaBAMM does allow addition or deletion of indicators and/or measures for each ACA when its assessment parameters are set. However, 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 5 CIM list for the GBR catchment

Criteria & indicators	Measures	
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
1.4 Hydrological modification	1.4.5	Hydrological disturbance/modification of the wetland (e.g. as determined through DERM wetland mapping and classification)
2 Naturalness catchment		
2.1 Exotic flora/fauna	2.1.1	Presence of exotic terrestrial plants in the assessment unit
2.2 Riparian disturbance	2.2.5	Per cent area of remnant vegetation relative to preclear extent within buffered non-riverine wetland: 500 m buffer for wetlands >= 8Ha, 200 m buffer for smaller wetlands
2.3 Catchment disturbance	2.3.1	Per cent "agricultural" land-use area (i.e. cropping and horticulture)
	2.3.2	Per cent "grazing" land-use area
	2.3.3	Per cent "vegetation" land-use area (i.e. native veg + regrowth)
	2.3.4	Per cent "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	3.1.2	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
3.3 Habitat	3.3.2	Richness of wetland types within the local catchment (e.g. SOR sub-section)
	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[1], EPBC Act[2]
	4.1.2	Presence of rare or threatened aquatic ecosystem dependent flora species – NC Act[1], EPBC Act[2]

Criteria & indicators	Measures	
4.2 Communities/ assemblages	4.2.1	Conservation status of wetland Regional Ecosystems – Herbarium biodiversity status, NC Act[1], EPBC Act[2]
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)
	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[3]/CAMBA[4] 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)
8 Representativeness		
8.1 Wetland protection	8.1.1	The per cent area of each wetland habitat type within protected areas
	8.1.2	The per cent 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*
8.2 Wetland uniqueness	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)
	8.2.2	The relative abundance of the wetland management group to which the wetland habitat belongs within the subcatchment or estuarine/marine zone (management groups ranked least common to most common)
	8.2.3	The size of each wetland habitat relative to others of its management group within the catchment or study area
	8.2.4	The size of each wetland habitat relative to others of its management group within a subcatchment (or estuarine zone)
	8.2.5	Wetland habitat representative of the study area – identified by expert opinion
	8.2.6	The size of each wetland habitat relative to others of its ‘type’ within the catchment or study area

[1] NC Act – *Nature Conservation Act 1992* (Queensland legislation)
[2] EPBC Act – *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth legislation)
[3] JAMBA – Japan-Australia Migratory Bird Agreement
[4] CAMBA – China-Australia Migratory Bird Agreement

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Attachment D GBR catchments ACA – Aquatic flora expert panel report (Burdekin region)

An Aquatic Conservation Assessment for the non-riverine wetlands of the Great Barrier Reef catchment

Aquatic flora
Expert panel report

(Version 1.3)

Burdekin region

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Tables

Figures

Acronyms

ACA	Aquatic Conservation Assessment
ASL	Above Sea Level
BPA	Biodiversity Planning Assessment
DERM	Department of Environment and Resource Management
DIWA	Directory of Important Wetlands
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
GBR	Great Barrier Reef
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

1 Introduction

The Department of Environment and Resource Management (DERM) conducted an Aquatic Conservation Assessment (ACA) for the non-riverine wetlands in the Great Barrier Reef (GBR) catchment using the Aquatic Biodiversity Assessment and Mapping Method (AquaBAMM; Clayton *et al*. 2006). The ACA relied upon 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 GBR catchment.

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 GBR catchment is made up of 35 individual catchments from the Daintree River north of Cairns, to Baffle Creek south of Gladstone. DERM applied AquaBAMM separately to the non-riverine (palustrine and lacustrine) and riverine wetlands within each of the 35 GBR catchments. In effect, there are 70 ACAs for the entire GBR catchment—covering non-riverine and riverine wetlands. A map of the GBR catchment showing each study area is provided in Attachment A.

A series of nine expert panels were conducted to address aquatic fauna, aquatic and riparian flora, and wetland ecology for the GBR catchments. The non-riverine and riverine wetlands were covered in combined workshops. The panels, held in Cairns, Townsville and Rockhampton during November and December 2008, involved invited experts with expertise in aquatic fauna, aquatic and riparian flora and/or wetland ecology in the Wet Tropics, Burdekin and Fitzroy sections of the GBR catchment.

This report documents the findings and recommendations of the aquatic flora expert panel for the Burdekin region held in Townsville on Tuesday 18 November, 2008. This report presents supporting information and panel input that only addresses the non-riverine wetland systems. The riverine component has been addressed in a separate report. Terms of reference for the aquatic flora expert panel are provided in Attachment B.

2 Method

2.1 Study area

The study areas used to implement the AquaBAMM assessments were based on the DERM basin/sub-basin data. The Burdekin study area lies within the wet-dry tropics and includes the eight basins shown in Figure 1, as well as, the adjacent continental islands of the Palm Island group and Magnetic Island. This area takes in the coastal basins of the Black, Ross, Haughton, and Don rivers, and the sub-basins of the greater Burdekin River catchment; the Burdekin Lower, Burdekin Upper, Belyando and Bowen sub-basins. Apart from the inclusion of the Don Basin, the Burdekin study area largely corresponds to the Burdekin Dry Tropics Natural Resource Management (NRM) region and covers an area of approximately 140,000 km^2.

The area includes the Burdekin River catchment; Australia's largest in terms of peak discharge. It covers a diversity of landscapes crossing five bioregions: the Wet Tropics, the Einasleigh Uplands, the Desert Uplands, the Brigalow Belt North, and a small section of the

Central Queensland Coast bioregion on the southern edge. The physical environments include mountain ranges rising to 1,359 m at Mount McCartney in the Clarke Range to the south, 1,221 m at Mount Elliot near Townsville, 1,063 m at Mount Halifax in the Paluma Range to the north and 1,002 m at Mount Tabletop on the Great Dividing Range to the west. Other features include lower rock hills, coastal plains, floodplains, deltas, beach ridges and continental islands. Undulating plains with escarpments and dissected plateaus are found inland to the west. Vegetation types are equally diverse including tropical rainforest, vine thickets, forested swamps, drier woodlands, grassy plains, sedgelands, and coastal mangroves and saltpans.

The area has a tropical sub-humid climate with relatively high temperatures all year round and a pronounced wet and dry season with most rain falling in the warm, humid months of November through to April. Rainfall is highly variably across the region and influenced by monsoonal and cyclonic activity. There is a distinct gradient to drier conditions from the coast westward. Average annual rainfall varies through the area from above 3,000 mm in the coastal peaks of the Seaview and Paluma Ranges to the north, Mount Elliot near Townsville, and the Clarke Range to south, to below 500 mm in the south-west of the Belyando sub-basin. The spatial and seasonal variability and the high interannual variability of rainfall are an overriding characteristic of the study area that greatly influences the nature and distribution of its wetlands. Most streams and wetlands are subject to seasonal flows and are subject to irregular flooding. The exceptions to this are the perennial streams that rise in the high rainfall ranges and the wetlands fed by the large basalt aquifers in the Upper Burdekin sub-basin.

In general, the Burdekin study area can be broadly divided into higher rainfall, more densely populated coastal areas with urban, industrial and irrigated agriculture land uses predominant and lower rainfall, sparsely populated inland areas used principally for rangeland grazing with some dryland agriculture and mining activity. There are several major water storages and large weirs located within the Burdekin study area, the largest being the Burdekin Falls Dam, which was completed in 1987 forming Lake Dalrymple, with a capacity of 1.86 million megalitres. Other major dams include the Ross River Dam, Paluma and Eungella dams.

The Ross basin is the most developed in the study area containing the regional city of Townsville. Many of the streams and wetlands in this basin are highly modified and impacted by water quality contamination and altered hydrology associated with urban development. Other major towns in the study area include Ayr and Home Hill to the south in the Lower Burdekin and Charters Towers in the Upper Burdekin.

The completion of the Burdekin Falls Dam and the subsequent development of the Burdekin-Haughton Water Supply Scheme (BHWSS, previously known as the Burdekin River Irrigation Area (BRIA)) for intensive sugarcane production, has dramatically altered the environmental conditions of the streams and wetlands in the lower floodplain of the Haughton and Lower Burdekin basins. The Lower Burdekin is dominated by the Burdekin River delta, where the coastal plain widens and is prone to widespread flooding, with vast areas of wetlands. The Burdekin Delta and the floodplains and estuaries of the coastal rivers form the Townsville-Burdekin coastal wetland aggregation, one of the most extensive on the Australian east coast. This area includes the wetlands of Bowling Green Bay National Park listed under the international Ramsar Convention. Prior to development, streams in this coastal plain, such as Barratta Creek, consisted of a series of clear or tannin-coloured seasonal in-stream and off-stream lagoons that connected across the floodplain during flood events. Flows were very variable between seasons and interannually. These systems have now been extensively modified. Flows to the streams and wetlands across this floodplain have been radically altered as a result of supplementation through the irrigation delivery system and by irrigation tail waters. This has removed the seasonality in much of the system and in combination with riparian disturbance and nutrient contamination has contributed to extensive weed infestation of wetlands by pasture grasses and aquatic weeds. These impacts have resulted in severe water quality degradation and altered ecology in the wetlands of this coastal plain and presented an enormous task to natural resource managers.

The Don Basin to the south of the Burdekin delta also contains extensive aggregations of coastal wetlands and estuaries. This area has remained one of the least developed along this coast due to relatively low rainfall and the unsuitability of soil types for large-scale irrigated agriculture, although horticulture, largely dependent on ground water, is common in some areas. Although, proposed developments associated with industrial developments at Abbott Point and the Water for Bowen water transfer scheme is likely to increase the pressure on coastal wetlands in this area.

The study area extends more than 300 km westwards, with the Upper Burdekin sub-basin draining the western side of the coastal ranges and the eastern side of the Great Dividing Range. This basin is contained almost entirely in the Einasleigh Uplands. The area contains a major basalt feature with highly productive black and red soils and numerous springs emanating from many locations that drive permanent flow and clear-water waterholes in many streams. This creates not only many significant waterbodies but a wide variety of wetland types. The Burdekin River channel, a large sand and gravel bed channel is another prominent feature. It consists of a small meandering low flow channel bordered by sand and gravel bars which in turn is located within the high flow channel, with established riparian communities. Flow to this channel is almost perennial most years and comes from two sources: tributaries on the western slopes of the high rainfall coastal ranges; and the extensive basalt aquifers formed by the Toomba basalts flows.

The Belyando sub-basin covers a large part of the study area to the south west and includes the Cape-Campaspe, Belyando and Suttor River catchments. The source of the Belyando River in central western Queensland is almost 500 km from the mouth of the Burdekin River, and extends in to the black-soil grasslands of Central Queensland. The Belyando sub-basin contains two bioregions; the Desert Uplands in the west and the Brigalow Belt North bioregion to the east. The Belyando basin is the area that consistently receives the least rainfall in the study area, with streams and wetlands receiving ephemeral or intermittent flows. In contrast to the Burdekin River channel in the Upper Burdekin, the flow capacity of the main channels of the Cape-Campaspe, Belyando and Suttor River is relatively low resulting in braided (anastomosing) river channels with broad floodplains. The extent of water in the floodplain landscape is highly variable and strongly influenced by flood events which create large temporary wetlands and replenish several permanent waterholes that provide key refugia between flow events. Under flood conditions, flows are spread broadly across the floodplain.

The natural vegetation in the western part of the study area, away from the coast, largely consists of dry eucalypt and acacia savannah woodlands on typical infertile laterised soils and includes grasslands of perennial Mitchell and annual Flinders grasses to the west. Cattle grazing is widespread and a major industry in the inland areas. Land degradation, water quality contamination and erosion are major management problems. Consequently, the Burdekin River catchment has been identified as the biggest single source of sediment to the Great Barrier Reef lagoon and is targeted for improved management actions.

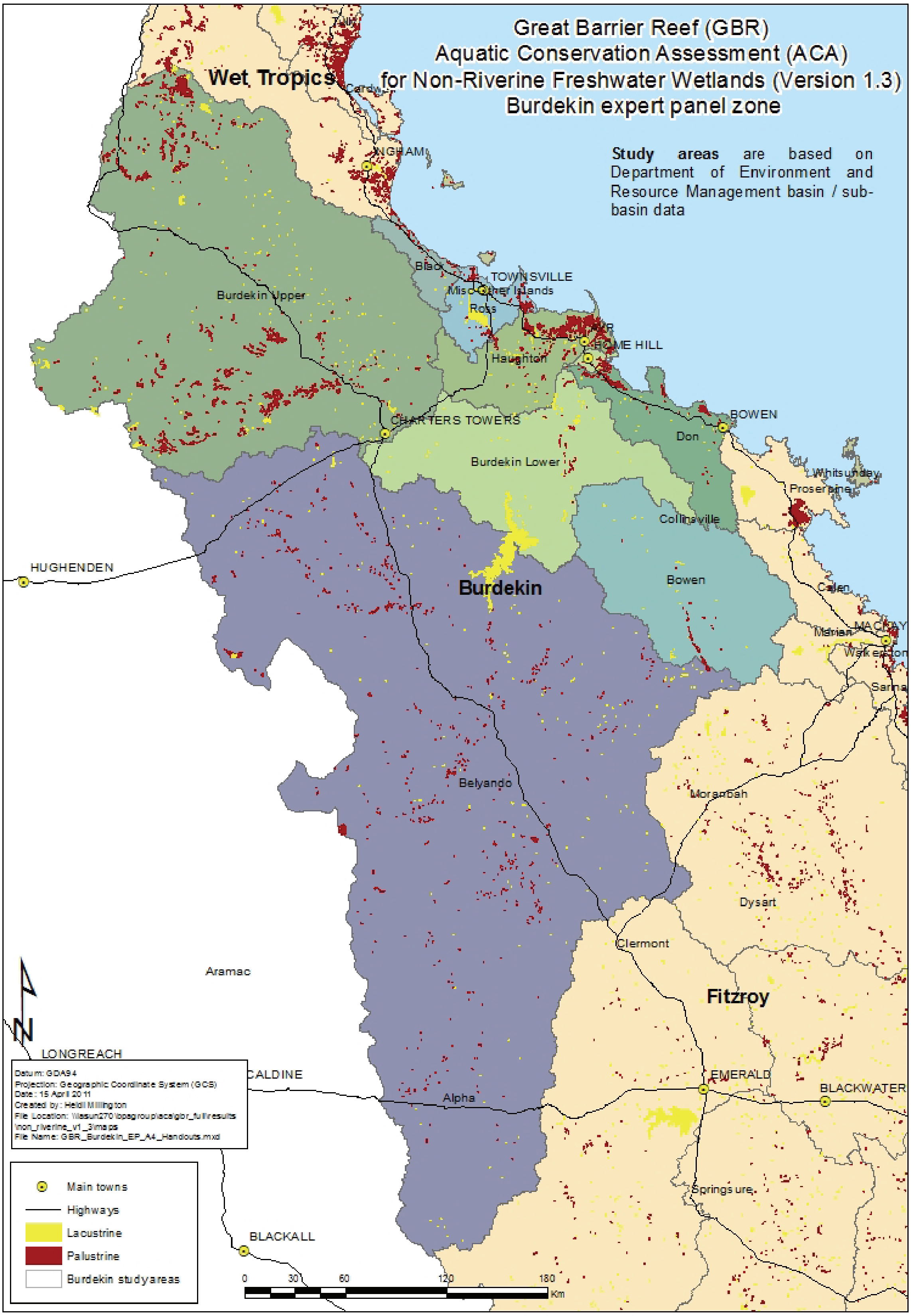

Figure 1 Burdekin section of the GBR catchment (incorporating eight individual catchments)

2.2 Panel composition

The expert panel (the panel) comprised of persons listed below in Table 1 who are familiar with aquatic flora in the Burdekin section of the GBR Catchment.

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
Niall Connolly	Principal Conservation Officer, Department of Environment and Resource Management	Biodiversity planning, aquatic ecology and water quality
Nick Cuff	Senior Botanist, Queensland Herbarium, Department of Environment and Resource Management	Flora and regional ecosystems
Russell Cumming	Principal Botanist, Department of Environment and Resource Management	Native and exotic vegetation
John Dowe	Botanist, Australian Centre for Tropical Freshwater Research, James Cook University	Riparian vegetation
George Lukacs	Director, Australian Centre for Tropical Freshwater Research, James Cook University	Wetland ecology
Michaelie Pollard	Project Officer (aquatic ecology), Department of Environment and Resource Management	Aquatic ecology
Jim Tait	Ecologist, Ecoconcern Pty Ltd	Wetland ecology and management

Selena Inglis and Heidi Millington provided administrative and technical support for the workshop which was facilitated by Darren Fielder.

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 flora in the GBR catchment was also sourced from various technical reports.

3 Rare and threatened flora

The panel identified four ‘rare’, two ‘vulnerable’ and three ‘endangered’ flora taxa in the Burdekin section of the GBR catchment as being primarily aquatic, semi-aquatic or riparian in habit (Table 2). Threatened taxa were excluded from this list if they did not correspond to one of these categories. This list of flora was used as the basis for identifying areas of significance for ‘Criterion 4 Threatened species and ecosystems’ (4.1.2). Point records were buffered using their precision to identify the spatial units having a priority species present.

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	Habitat	Comments
Aponogeton queenslandicus		LC[1]	Aquatic[3]	Previous status was listed as R[1]. Status is now LC[1]. No valid records available at time of processing. To be reviewed for potential priority species inclusion during subsequent ACA update.
Cartonema brachyantherum		LC[1]		Previous status was listed as R[1]. Status is now LC[1]. No valid records available at time of processing. To be reviewed for potential priority species inclusion during subsequent ACA updates. Found in tea tree woodlands and on creek banks
Eriocaulon carsonii subsp. orientale		E[1]		Semi-aquatic species, some can be fully aquatic
Eryngium fontanum		E[1, 2]		Spring species
Hydrocharis dubia	Frogbit	V[1]	Aquatic[3]	
Myriophyllum artesium		E[1]		
Myriophyllum implicatum		LC[1]		Previous status was listed as R1. Status is now LC1. To be reviewed for potential priority species inclusion during subsequent ACA update.
Paspalidium udum		V[1]		Wetland dependant species
Rhamphicarpa australiensis		R[1]		
Sporobolus pamelae		E[1]		

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

1. *Queensland Nature Conservation Act 1992 (E – Endangered, V – Vulnerable, R – Rare, LC – Least Concern)*
2. *Environment Protection and Biodiversity Conservation Act 1999 (E – Endangered, V – Vulnerable)*
3. *Clayton, P.C., Fielder, D.F., Howell, S. and Hill, C.J. 2006. Aquatic biodiversity assessment and mapping method (AquaBAMM): a conservation values assessment tool with trial application in the Burnett River catchment. Queensland Environmental Protection Agency, Brisbane.*

4 Priority flora

The panel deliberated on all aquatic, semi-aquatic and riparian species within the GBR catchment 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, 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 20 priority flora species associated with non-riverine wetlands (Table 3). These species were included in 'Criterion 5 Priority species and ecosystems' (5.1.2). Point records were buffered using their precision to identify the spatial units having a priority species present.

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	Habitat	Priority Number[2]	Comments
Ceratopteris thalictroides		Aquatic[1]	3	Indicator of better water quality systems.
Eleocharis dulcis		Aquatic[1]	2, 3	Forms large areas of monotypic sedgeland that is a key threatened wetland community in Burdekin Dry Tropics.
Eleocharis sphacelata	Tall spikerush	Aquatic[1]	7	Subject to threatening processes.
Eucalyptus coolabah	Coolabah	Riparian[1]	3, 6	Provides both important habitat and bank/bed stability.
Eucalyptus tereticornis			3	Provides good fish habitat.
Hydrilla verticillata	Hydrilla	Aquatic[1]	7	Small population subject to threatening processes.
Hymenachne acutigluma			3	Key indicator of waterfowl habitat value.
Leersia hexandra	Swamp rice grass	Aquatic[1]	6	Significant soil binding species providing bank stability.
Marsilea drummondii	Common nardoo	Aquatic, semi-aquatic[1]	1, 3, 6	This species forms a key threatened macrophyte community on the Burdekin floodplain. It provides bank stability and helps retain surface moisture in wetlands during dry periods. It also provides habitat for amphibians and macroinvertebrates.
Melaleuca dealbata	Swamp tea-tree		7	Once was a widespread floodplain species preferring seasonally wet areas, however, much of its original habitat has been highly impacted by agriculture and hydrological modification and is now too wet.

Scientific name	Common name	Habitat	Priority Number[2]	Comments
Nymphaea gigantea		Aquatic[1]	1	Forms a key threatened macrophyte community on the Burdekin floodplain.
Nymphaea immutabilis		Aquatic[1]	2, 3, 5	Important food source and habitat, at distributional limit in Burdekin Region.
Oryza australiensis			2, 3, 5	Important food source and habitat, at distributional limit in Burdekin Region.
Oryza meridionalis			2, 3, 5	Important food source and habitat, at distributional limit in Burdekin Region.
Oryza rufipogon			2	Important food source for fish and vertebrates such as waterbirds particularly during winter.
Ottelia alismoides		Aquatic[1]	2, 3	Important food source for fish, vertebrates and waterbirds especially during winter. Provides a good indicator of saline palustrine wetlands and hence restricted in distribution.
Ottelia ovalifolia	Swamp lily	Aquatic[1]	2, 3	Important food source for fish, vertebrates and waterbirds especially during winter.
Pseudoraphis spinescens	Spiny mudgrass		3,6	Native aquatic/ emergent grass species being excluded by Para grass and other exotics in floodplain habitats. It is an indicator of habitat integrity and provides good waterfowl habitat.
Sphenoclea zeylanica		Aquatic[1]	1	Forms significant macrophyte beds, reduced in Burdekin Dry Tropics region.
Vallisneria nana			1,2,3	Important in the Burdekin Dry Tropics as a food source, habitat for aquatic fauna and it sustains a diverse food web. It is dependent upon alluvial soils and is associated with threatened riparian and wetland ecosystems.

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

1. *Clayton, P.C., Fielder, D.F., Howell, S. and Hill, C.J. 2006. Aquatic biodiversity assessment and mapping method (AquaBAMM): a conservation values assessment tool with trial application in the Burnett River catchment. Queensland Environmental Protection Agency, Brisbane.*
2. Refers to the significant values required to be a priority species, as listed above Table 3.

5 Species richness

Species richness (i.e. total number of species) was scored for aquatic-dependant flora, stratified using 150 m above sea level (asl) for the Burdekin Lower and Haughton study areas and the Desert Uplands\Brigalow Belt bioregional boundary above the Burdekin Dam in the Belyando study area (see the Burdekin ecology expert panel report for more information on stratification).

The Burdekin section of the GBR catchment has 132 plants that are referred to in this report as 'aquatic-dependant' in non-riverine wetlands (Table 4). The datasets for these species were accessed from DERM corporate databases of WildNet and Herbrecs and from panel member records.

Table 4 Wetland-dependent native flora species including priority species

This list was 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	Habitat	Comments
Acacia stenophylla	Belalie	LC[1]	Riparian[3]	
Ammannia multiflora	Jerry-jerry	LC[1]		
Aponogeton queenslandicus		LC[1]	Aquatic[3]	
Byblis liniflora		LC[1]		Found in seepage patches on the ranges and in the coastal plains.
Caldesia oligococca		LC[1]		
Caldesia parnassifolia		LC[1]		
Cartonema brachyantherum		LC[1]		Found in tea tree woodlands and on creek banks.
Centipeda borealis		LC[1]		
Centipeda minima		LC[1]		
Ceratopteris thalictroides		LC[1]	Aquatic[3]	Indicator of better water quality systems.
Cyanotis axillaris		LC[1]		Wet season wetland species.
Eclipta prostrata	White eclipta	LC[1]	Riparian[3]	
Eleocharis acuta		LC[1]		
Eleocharis atropurpurea		LC[1]		
Eleocharis cylindrostachys		LC[1]	Semi-aquatic[3]	
Eleocharis dulcis		LC[1]		The closed sedge land community this species forms should be listed as a threatened community and afforded high conservation value on the east coast.
Eleocharis equisetina		LC[1]		
Eleocharis geniculata		LC[1]		
Eleocharis nuda		LC[1]		
Eleocharis pallens	Pale spikerush	LC[1]		
Eleocharis philippinensis		LC[1]	Aquatic[3]	
Eleocharis plana	Ribbed spikerush	LC[1]	Aquatic[3]	
Eleocharis setifolia subsp. setifolia		LC[1]		
Eleocharis sphacelata	Tall spikerush	LC[1]	Aquatic, riparian[3]	
Eleocharis spiralis		LC[1]		

Scientific name	Common name	Status	Habitat	Comments
Eleocharis tetraquetra		LC[1]		
Eriocaulon		LC[1]		Semi-aquatic species, some can be fully aquatic.
Eriocaulon athertonense		LC[1]		Semi-aquatic species, some can be fully aquatic.
Eriocaulon carsonii subsp. orientale		E[1]		Semi-aquatic species, some can be fully aquatic.
Eriocaulon cinereum		LC[1]		Semi-aquatic species, some can be fully aquatic.
Eriocaulon nanum		LC[1]		Semi-aquatic species, some can be fully aquatic.
Eriocaulon odontospermum		LC[1]		Semi-aquatic species, some can be fully aquatic.
Eriocaulon pygmaeum		LC[1]		Semi-aquatic species, some can be fully aquatic.
Eriocaulon scariosum		LC[1]		Semi-aquatic species, some can be fully aquatic.
Eriocaulon setaceum		LC[1]		Semi-aquatic species, some can be fully aquatic.
Eryngium fontanum		E[1, 2]		Spring species
Eucalyptus camaldulensis		LC[1]	Riparian[3]	Taxon identifies a priority ecosystem.
Eucalyptus camaldulensis subsp. simulata		LC[1]		
Eucalyptus camaldulensis var. obtusa		LC[1]		
Eucalyptus camaldulensis x E. platyphylla		LC[1]		
Eucalyptus coolabah	Coolabah	LC[1]	Riparian[3]	
Eucalyptus platyphylla	Poplar gum	LC[1]		Important in drier areas as depend more on water.
Eucalyptus tereticornis		LC[1]		Riparian species, wetland dependant in drier areas.
Exocarya scleroides		LC[1]		
Fimbristylis aestivalis var. aestivalis		LC[1]		
Fimbristylis bisumbellata		LC[1]		Riparian species.
Gonocarpus chinensis		LC[1]		Found on creek banks and seepage areas.
Haloragis heterophylla	Rough raspweed	LC[1]		Swamp species.
Hydrilla verticillata	Hydrilla	LC[1]	Aquatic[3]	
Hydrocharis dubia	Frogbit	V[1]	Aquatic[3]	
Hydrocotyle dipleura		LC[1]		
Hydrocotyle grammatocarpa		LC[1]		
Hydrocotyle tripartita		LC[1]		
Hydrocotyle verticillata	Shield pennywort	LC[1]		
Hydrolea zeylanica		LC[1]		
Hygrophila angustifolia		LC[1]		
Hymenachne acutigluma		LC[1]		Significant aquatic species.
Ipomoea aquatica		LC[1]	Riparian[3]	

Scientific name	Common name	Status	Habitat	Comments
Juncus continuus		LC[1]		
Juncus polyanthemus		LC[1]		
Juncus usitatus		LC[1]	Aquatic, riparian[3]	
Leersia hexandra	Swamp rice grass	LC[1]	Aquatic[3]	Significant soil binding species providing bank stability.
Lemna aequinoctialis	Common duckweed	LC[1]		
Lemna trisulca		LC[1]		
Livistona decora		LC[1]		Present in swale wetlands and riparian areas.
Lophostemon suaveolens	Swamp box	LC[1]	Riparian[3]	Riparian species, wetland dependant in drier areas.
Marsilea		LC[1]		
Marsilea costulifera	Narrow-leaved nardoo	LC[1]		
Marsilea crenata		LC[1]		
Marsilea drummondii	Common nardoo	LC[1]	Semi-aquatic[3]	
Marsilea exarata	Sway-back nardoo	LC[1]		
Marsilea hirsuta	Hairy nardoo	LC[1]	Semi-aquatic[3]	
Marsilea mutica	Shiny nardoo	LC[1]	Semi-aquatic[3]	
Melaleuca bracteata	Black tea-tree	LC[1]		
Melaleuca dealbata	Swamp tea-tree	LC[1]		
Melaleuca leucadendra	Broad-leaved tea-tree	LC[1]		
Murdannia gigantea		LC[1]		Wet season wetland species.
Murdannia graminea	Murdannia	LC[1]		Wet season wetland species.
Myriophyllum		LC[1]		
Myriophyllum artesium		E[1]		
Myriophyllum dicoccum		LC[1]		
Myriophyllum filiforme		LC[1]		
Myriophyllum implicatum		LC[1]		
Myriophyllum muricatum		LC[1]		
Myriophyllum simulans		LC[1]		
Myriophyllum striatum		LC[1]		
Myriophyllum verrucosum	Water milfoil	LC[1]	Aquatic[3]	
Nymphaea gigantea		LC[1]	Aquatic[3]	Forms a key threatened macrophyte community on the Burdekin floodplain.
Nymphaea immutabilis		LC[1]	Aquatic[3]	Important food source and habitat, at distributional limit in Burdekin Region.
Nymphoides aurantiaca		LC[1]		
Nymphoides crenata	Wavy marshwort	LC[1]		
Nymphoides exiliflora		LC[1]		
Nymphoides geminata		LC[1]		
Nymphoides indica	Water snowflake	LC[1]	Aquatic[3]	
Nymphoides parvifolia		LC[1]		

Scientific name	Common name	Status	Habitat	Comments
Nymphoides quadriloba		LC[1]		
Oryza australiensis		LC[1]		
Oryza meridionalis		LC[1]		
Oryza rufipogon		LC[1]		
Ottelia		LC[1]		
Ottelia alismoides		LC[1]		Species often indicative of good condition macrophyte communities due to its dependence on sunny shallow margins and good water quality.
Ottelia ovalifolia	Swamp lily	LC[1]	Aquatic[3]	
Paspalidium udum		V[1]		Wetland dependant species.
Pseudoraphis spinescens	Spiny mudgrass	LC[1]		Native aquatic/ emergent grass species being excluded by Para grass and other exotics in floodplain habitats. It is also an indicator of habitat integrity. Good waterfowl habitat.
Rhamphicarpa australiensis		R[1]		
Rotala diandra		LC[1]		
Rotala mexicana		LC[1]		
Rotala occultiflora		LC[1]		
Rotala tripartita		LC[1]		
Schoenus apogon var. apogon		LC[1]		
Sphenoclea zeylanica		LC[1]		
Spirodela punctata	Thin duckweed	LC[1]	Aquatic[3]	
Sporobolus pamelae		E[1]		
Triglochin dubium		LC[1]		Restricted in distribution.
Triglochin multifructum		LC[1]		Restricted in distribution.
Triglochin procerum		LC[1]	Aquatic[3]	Restricted in distribution.
Typha domingensis		LC[1]		Although native the species tends to dominate disturbed wetlands reducing diversity including loss of waterfowl habitat.
Utricularia aurea	Golden bladderwort	LC[1]		
Utricularia australis	Yellow bladderwort	LC[1]		
Utricularia bifida		LC[1]	Aquatic[3]	
Utricularia caerulea	Blue bladderwort	LC[1]		
Utricularia dichotoma	Fairy aprons	LC[1]	Aquatic[3]	
Utricularia gibba	Floating bladderwort	LC[1]	Aquatic[3]	
Utricularia lateriflora	Small bladderwort	LC[1]	Aquatic[3]	
Utricularia limosa		LC[1]		
Utricularia minutissima		LC[1]		
Utricularia stellaris		LC[1]		
Utricularia uliginosa	Asian bladderwort	LC[1]		
Vallisneria		LC[1]		
Vallisneria annua		LC[1]		

Scientific name	Common name	Status	Habitat	Comments
Vallisneria caulescens		LC[1]		
Vallisneria nana		LC[1]	Aquatic[3]	Abundance thought to be reduced significantly within the region.
Villarsia reniformis		LC[1]		

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

1. Queensland *Nature Conservation Act 1992 (E – Endangered, V – Vulnerable, R – Rare, LC – Least Concern)*
2. *Environment Protection and Biodiversity Conservation Act 1999 (E – Endangered, V – Vulnerable)*
3. *Clayton, P.C., Fielder, D.F., Howell, S. and Hill, C.J. 2006. Aquatic biodiversity assessment and mapping method (AquaBAMM): a conservation values assessment tool with trial application in the Burnett River catchment. Queensland Environmental Protection Agency, Brisbane.*

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 landscape be included for the GBR ACA using AquaBAMM. Sixteen exotic plant taxa that are known to occur within non-riverine wetlands in the Burdekin section of the GBR catchment were nominated by the panel (Table 5). The presence of aquatic and semi-aquatic flora species were 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 the Department of Environment and Resource Management 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.

Table 5 Exotic flora species

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

Scientific name	**Common name**	**Habitat**	**Comments**
Aeschynomene villosa			Associated with wetland and riparian ecosystems.
Cabomba caroliniana var. caroliniana	Cabomba		
Centrosema molle			
Chromolaena odorata	Siam weed		
Cryptostegia grandiflora	Rubber vine		
Echinochloa polystachya cv. Amity	Aleman grass		A ponded pasture species.
Eichhornia crassipes	Water hyacinth	Aquatic[1]	Key species in terms of wetland condition indicator.
Hymenachne amplexicaulis cv. Olive			Key species in terms of wetland condition indicator.
Myriophyllum aquaticum	Brazilian water milfoil		
Parkinsonia aculeata	Jerusalem thorn		Wetland, woody weed.
Pistia stratiotes	Water lettuce		
Salvinia molesta	Salvinia		
Sphagneticola trilobata			Large populations occur along the Ross River.
Thunbergia grandiflora	Sky flower		Riparian vine species.
Urochloa mutica		Semi-aquatic[1]	Considered a semi-aquatic exotic, not terrestrial. Key species as a wetland condition indicator.
Ziziphus mauritiana	Indian jujube		Widely spread, significantly impacts riparian zones, density important to transforming riparian zones.

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

1. *Clayton, P.C., Fielder, D.F., Howell, S. and Hill, C.J. 2006. Aquatic biodiversity assessment and mapping method (AquaBAMM): a conservation values assessment tool with trial application in the Burnett River catchment. Queensland Environmental Protection Agency, Brisbane.*

7 Priority ecosystems and special features

The panel identified several non-riverine priority ecosystems/special features in the Burdekin section of the GBR catchment (Table 6). These were identified for their aquatic and riparian flora values. Where special features nominated by the aquatic flora expert panel were also considered to have additional values (e.g. fauna, ecology) by the aquatic fauna or wetland ecology expert panels, the special area was implemented as a wetland ecology special area decision.

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 and special features, and their values

Decisions listed 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.

Priority ecosystem/ special feature	Values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Degulla Lagoon	Degulla Lagoon, located on the 'Degulla' property contains permanent water and an intact fringing riparian zone.	Belyando	be_nr_fl_01	6.4.1	3
Seasonal palustrine/ swamps of the floodplain with native macrophyte communities (regional ecosystem 11.3.27)	Around 80 per cent of these communities have been have been filled, or become receptacles for irrigation tailwater. As a result, the native macrophyte community has been lost due to exotic emergent grasses (para grass (*Urochloa mutica*) and *Hymenachne*). The communities in this area have lost their seasonality and become subject to nutrient loading and floating exotics (such as hyacinth). The intact systems include native species such as native water lily (*Nymphea*), ottelia, rice grasses and liza. One of major drivers of impact is alienation of grazing in the presence of invasive exotic pastures. Water fowl used to use these frequently during the wet season. <u>Note</u>: This priority ecosystem decision also applies to the following catchments: Bowen, Burdekin Lower, Don, Haughton and Ross.	Belyando	be_nr_fl_02	5.2.1	4
Melaleuca dealbata on old alluvials including gilgai landforms and seasonal drainage depressions with or without *Livistona decipiens* (regional ecosystem 7.3.6)	Rare (riparian) ecosystem. <u>Note</u>: This priority ecosystem decision also applies to the miscellaneous other islands (see decision number oi_nr_fl_01).	Black	bk_nr_fl_01	5.2.1	4

Priority ecosystem/ special feature	Values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Melaleuca dealbata on old alluvials including gilgai landforms and seasonal drainage depressions with or without *Livistona decipiens* (regional ecosystem 11.3.12)	Rare (riparian) ecosystem. Note: This priority ecosystem decision also applies to the following catchments: Burdekin Lower, Don, Haughton, Misc Other Islands, Ross.	Black	bk_nr_fl_02	5.2.1	4
Seasonal palustrine/ swamps of the floodplain with native macrophyte communities (regional ecosystem 11.3.27)	Around 80 per cent of these communities have been have been filled, or become receptacles for irrigation tailwater. As a result, the native macrophyte community has been lost due to exotic emergent grasses (para grass (*Urochloa mutica*) and *Hymenachne*). The communities in this area have lost their seasonality and become subject to nutrient loading and floating exotics (such as hyacinth). The intact systems include native species such as native water lily (*Nymphea*), ottelia, rice grasses and liza. One of major drivers of impact is alienation of grazing in the presence of invasive exotic pastures. Water fowl used to use these frequently during the wet season. Note: This priority ecosystem decision also applies to the following catchments: Bowen, Burdekin Lower, Don, Haughton and Ross.	Black	bk_nr_fl_03	5.2.1	4
Blue Gum on Alluvial Floodplains/ Delta land system (regional ecosystems 11.3.4 and 11.3.4a)	Rare (riparian) ecosystem Note: This priority ecosystem decision also applies to the Haughton catchment (see decision number ha_nr_fl_01). In the Bowen catchment this decision was not picked up in this ACA version (1.3) because all the wetlands that had this RE are now classed as H2M1 or H3C1. All of RE 11.3.4 is now associated strongly with floodplains in the Queensland Wetlands Mapping V2.0. So this decision is not picked up in this ACA version (1.3).	Bowen	bw_nr_fl_01_not_implemented	5.2.1	4

Priority ecosystem/ special feature	Values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Seasonal palustrine/ swamps of the floodplain with native macrophyte communities (regional ecosystem 11.3.27)	Around 80 per cent of these communities have been have been filled, or become receptacles for irrigation tailwater. As a result, the native macrophyte community has been lost due to exotic emergent grasses (para grass (*Urochloa mutica*) and *Hymenachne*). The communities in this area have lost their seasonality and become subject to nutrient loading and floating exotics (such as hyacinth). The intact systems include native species such as native water lily (*Nymphea*), ottelia, rice grasses and liza. One of major drivers of impact is alienation of grazing in the presence of invasive exotic pastures. Water fowl used to use these frequently during the wet season. Note: This priority ecosystem decision also applies to the following catchments: Belyando, Burdekin Lower, Don, Haughton and Ross.	Bowen	bw_nr_fl_02	5.2.1	4
Seasonal palustrine/ swamps of the floodplain with native macrophyte communities (regional ecosystem 11.3.27)	Around 80 per cent of these communities have been have been filled, or become receptacles for irrigation tailwater. As a result, the native macrophyte community has been lost due to exotic emergent grasses (para grass (*Urochloa mutica*) and *Hymenachne*). The communities in this area have lost their seasonality and become subject to nutrient loading and floating exotics (such as hyacinth). The intact systems include native species such as native water lily (*Nymphea*), ottelia, rice grasses and liza. One of major drivers of impact is alienation of grazing in the presence of invasive exotic pastures. Water fowl used to use these frequently during the wet season. Note: This priority ecosystem decision also applies to the following catchments: Belyando, Bowen, Don, Haughton and Ross.	Burdekin Lower	bl_nr_fl_01	5.2.1	4
Melaleuca dealbata on old alluvials including gilgai landforms and seasonal drainage depressions with or without *Livistona decipiens* (regional ecosystem 11.3.12)	Rare (riparian) ecosystem. Note: This priority ecosystem decision also applies to the following catchments: Black, Don, Haughton, Misc Other Islands, Ross.	Burdekin Lower	bl_nr_fl_02	5.2.1	4

Priority ecosystem/ special feature	Values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Basalt swamps, Undarra area	Geology of this area includes vesicular basalt that contains springs, black tea-tree swamps, discharge areas & drainage depressions. The area includes RE 9.3.4 (wetlands), 9.3.10 (*Melaleuca bracteata* creeks and swamps) and 9.3.11 (wetlands on basalts). Note: This decision is a flora decision in the Einasleigh Uplands Biodiversity Planning Assessment (decision number eiu_fl_14).	Burdekin Upper	bp_nr_fl_01	6.2.1 6.3.3	4
Seasonal palustrine/ swamps of the floodplain with native macrophyte communities (regional ecosystem 11.3.27)	Around 80 per cent of these communities have been have been filled, or become receptacles for irrigation tailwater. As a result, the native macrophyte community has been lost due to exotic emergent grasses (para grass (*Urochloa mutica*) and *Hymenachne*). The communities in this area have lost their seasonality and become subject to nutrient loading and floating exotics (such as hyacinth). The intact systems include native species such as native water lily (*Nymphea*), ottelia, rice grasses and liza. One of major drivers of impact is alienation of grazing in the presence of invasive exotic pastures. Water fowl used to use these frequently during the wet season. Note: This priority ecosystem decision also applies to the following catchments: Belyando, Bowen, Burdekin Lower, Haughton and Ross.	Don	do_nr_fl_01	5.2.1	4
Melaleuca dealbata on old alluvials including gilgai landforms and seasonal drainage depressions with or without *Livistona decipiens* (regional ecosystem 11.3.12)	Rare (riparian) ecosystem. Note: This priority ecosystem decision also applies to the following catchments: Black, Burdekin Lower, Haughton, Misc Other Islands, Ross.	Don	do_nr_fl_02	5.2.1	4
Eleocharis dulcis (bulkuru) closed sedgelands (regional ecosystems 11.1.3 and 11.3.27d)	Community that used to occur from Herbert to Fitzroy. It provides key resources and breeding habitat for a range of waterfowl such as brolgas and magpie geese. It is currently threatened by development, being a preferred landform setting for ponded pasture development (bunding).	Don	do_nr_fl_03	5.2.1	4

Priority ecosystem/ special feature	Values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Blue Gum on alluvial Floodplains/ Delta land system (regional ecosystems 11.3.4 and 11.3.4a)	Rare (riparian) ecosystem. Note: This priority ecosystem decision also applies to the Bowen catchment (decision number bw_na_fl_01). All of RE 11.3.4 is now associated strongly with floodplains in the Queensland Wetlands Mapping V2.0. So this decision is not picked up in this ACA version (1.3).	Haughton	ha_nr_fl_01	5.2.1	4
Seasonal palustrine/ swamps of the floodplain with native macrophyte communities (regional ecosystem 11.3.27)	Around 80 per cent of these communities have been have been filled, or become receptacles for irrigation tailwater. As a result, the native macrophyte community has been lost due to exotic emergent grasses (para grass (*Urochloa mutica*) and *Hymenachne*). The communities in this area have lost their seasonality and become subject to nutrient loading and floating exotics (such as hyacinth). The intact systems include native species such as native water lily (*Nymphea*), ottelia, rice grasses and liza. One of major drivers of impact is alienation of grazing in the presence of invasive exotic pastures. Water fowl used to use these frequently during the wet season. Note: This priority ecosystem decision also applies to the following catchments: Belyando, Bowen, Burdekin Lower, Don and Ross.	Haughton	ha_nr_fl_02	5.2.1	4
Melaleuca dealbata on old alluvials including gilgai landforms and seasonal drainage depressions with or without *Livistona decipiens* (regional ecosystem 11.3.12)	Rare (riparian) ecosystem. Note: This priority ecosystem decision also applies to the following catchments: Black, Burdekin Lower, Don, Misc Other Islands and Ross.	Haughton	ha_nr_fl_03	5.2.1	4
Melaleuca dealbata on old Alluvials including gilgai landforms and seasonal drainage depressions with or without *Livistona decipiens* (regional ecosystem 7.3.6)	Rare (riparian) ecosystem Note: This priority ecosystem decision also applies to the Black catchment (decision number bk_na_fl_01).	Misc. other Islands	oi_nr_fl_01	5.2.1	4

Priority ecosystem/ special feature	Values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Melaleuca dealbata on old alluvials including gilgai landforms and seasonal drainage depressions with or without *Livistona decipiens* (regional ecosystem 11.3.12)	Rare (riparian) ecosystem. Note: This priority ecosystem decision also applies to the following catchments: Black, Burdekin Lower, Don, Haughton, Misc Other Islands, Ross.	Misc. other Islands	oi_nr_fl_04	5.2.1	4
Seasonal palustrine/ swamps of the floodplain with native macrophyte communities (regional ecosystem 11.3.27)	Around 80 per cent of these communities have been have been filled, or become receptacles for irrigation tailwater. As a result, the native macrophyte community has been lost due to exotic emergent grasses (para grass (*Urochloa mutica*) and *Hymenachne*). The communities in this area have lost their seasonality and become subject to nutrient loading and floating exotics (such as hyacinth). The intact systems include native species such as native water lily (*Nymphea*), ottelia, rice grasses and liza. One of major drivers of impact is alienation of grazing in the presence of invasive exotic pastures. Water fowl used to use these frequently during the wet season. Note: This priority ecosystem decision also applies to the following catchments: Belyando, Bowen, Burdekin Lower, Don and Haughton.	Ross	ro_nr_fl_01	5.2.1	4
Eleocharis dulcis (bulkuru) closed sedgelands (regional ecosystems 11.1.3 and 11.3.27d)	Community that used to occur from Herbert to Fitzroy. It provides key resources and breeding habitat for a range of waterfowl such as brolgas and magpie geese. It is currently threatened by development, being a preferred landform setting for ponded pasture development (bunding). Note: This decision has not been implemented in this assessment because further investigation into its implementation is required.	Ross	ro_nr_fl_02	5.2.1	4
Melaleuca dealbata on old alluvials including gilgai landforms and seasonal drainage depressions with or without *Livistona decipiens* (regional ecosystem 11.3.12)	Rare (riparian) ecosystem. Note: This priority ecosystem decision also applies to the following catchments: Black, Burdekin Lower, Haughton and Misc Other Islands.	Ross	ro_nr_fl_03	5.2.1	4

Priority ecosystem/ special feature	Values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Deepwater floodplain lagoons on distributary stream channels with 'blackwater' (natural tannin stained water) and native emergent species.	Threatened ecosystem type declining in extent. Previously seasonal lagoons are now full of turbid water year round. Getting taken over by para grass (*Urochloa mutica*) and guinea grass (*Megathyrsus maximus var. maximus*). Many emergent and submergent macrophyte communities have disappeared. Note: This decision has not been implemented in this assessment because further investigation into its implementation is required.	Various	NA	5.2.1	4
Regional ecosystem 11.3.31 (floodplain)	This endangered grassland has a restricted distribution. The habitat provided includes gilgais and waterbird breeding habitat. It has been extensively cleared/altered throughout the region. Note: This decision has not been implemented in this assessment because further investigation into its implementation is required.	Various	NA	5.2.1	3

Attachments

Attachment A – GBR catchment study area

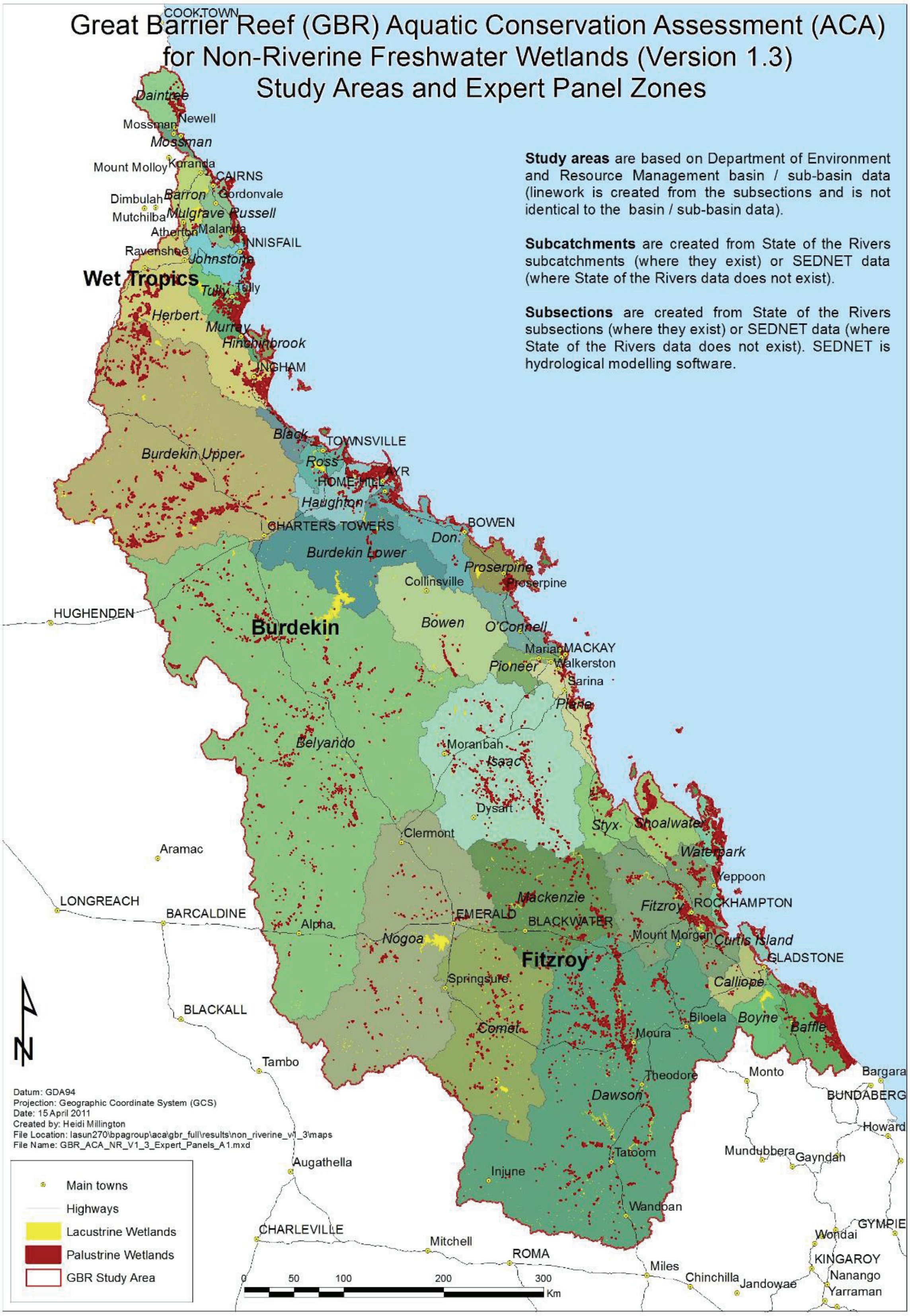

Figure 2 GBR catchment study area

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 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 of the GBR catchment. Experience in the identification and assessment of riverine and non-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 aquatic flora expert panel was established to provide expert advice on priority species, special features and/ or ecosystems that are of ecological significance to both the riverine and non-riverine wetlands of the GBR catchment. The panel consisted of professionals with expertise relating to aquatic flora and floristic communities.

The tasks undertaken by the panel included, but without limitation, 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 GBR catchment

The criteria, indicators and measures (CIM) list outlines the CIM that were implemented as part of the non-riverine Aquatic Conservation Assessment (ACA) using AquaBAMM of the freshwater wetlands of the GBR catchment.

The list has been developed from a default list of CIM that may be considered when an Aquatic Conservation Assessment (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. AquaBAMM does allow addition or deletion of indicators and/or measures for each ACA when its assessment parameters are set. However, 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 GBR catchment.

Criteria & indicators	Measures	
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
1.4 Hydrological modification	1.4.5	Hydrological disturbance/modification of the wetland (e.g. as determined through DERM wetland mapping and classification)
2 Naturalness catchment		
2.1 Exotic flora/fauna	2.1.1	Presence of exotic terrestrial plants in the assessment unit
2.2 Riparian disturbance	2.2.5	Per cent area of remnant vegetation relative to preclear extent within buffered non-riverine wetland: 500 m buffer for wetlands >= 8Ha, 200 m buffer for smaller wetlands
2.3 Catchment disturbance	2.3.1	Per cent "agricultural" land-use area (i.e. cropping and horticulture)
	2.3.2	Per cent "grazing" land-use area
	2.3.3	Per cent "vegetation" land-use area (i.e. native veg + regrowth)
	2.3.4	Per cent "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	3.1.2	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
3.3 Habitat	3.3.2	Richness of wetland types within the local catchment (e.g. SOR sub-section)
	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[1], EPBC Act[2]

Criteria & indicators	Measures	
	4.1.2	Presence of rare or threatened aquatic ecosystem dependent flora species – NC Act[1], EPBC Act[2]
4.2 Communities/ assemblages	4.2.1	Conservation status of wetland Regional Ecosystems – Herbarium biodiversity status, NC Act[1], EPBC Act[2]
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)
	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[3]/CAMBA[4] 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)
8 Representativeness		
8.1 Wetland protection	8.1.1	The per cent area of each wetland habitat type within protected areas
	8.1.2	The per cent 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*
8.2 Wetland uniqueness	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)
	8.2.2	The relative abundance of the wetland management group to which the wetland habitat belongs within the subcatchment or estuarine/marine zone (management groups ranked least common to most common)
	8.2.3	The size of each wetland habitat relative to others of its management group within the catchment or study area
	8.2.4	The size of each wetland habitat relative to others of its management group within a subcatchment (or estuarine zone)
	8.2.5	Wetland habitat representative of the study area – identified by expert opinion
	8.2.6	The size of each wetland habitat relative to others of its 'type' within the catchment or study area

[1] NC Act – *Nature Conservation Act 1992* (Queensland legislation)
[2] EPBC Act – *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth legislation)
[3] JAMBA – Japan-Australia Migratory Bird Agreement
[4] CAMBA – China-Australia Migratory Bird Agreement

References

Clayton, P.D., Fielder, D.F., Howell, S. and Hill, C.J. (2006) *Aquatic biodiversity assessment and mapping method (AquaBAMM): a conservation values assessment tool for wetlands with trial application in the Burnett River catchment.* Published by the Environmental Protection Agency, Brisbane. ISBN 1-90928-07-3

Clayton, P.D., Fielder, D.P., Barratt, P.J. and Hill, C.J. (2008). *Aquatic Conservation Assessments (ACA), using AquaBAMM, for freshwater wetlands of the Baffle Creek catchment*. Published by the Environmental Protection Agency, Brisbane.

DERM (In prep) *Biodiversity Planning Assessment, Einasleigh Uplands, Flora, Fauna and Landscape Expert Panel Report.* Department of Environment and Resource Management.

Attachment E GBR catchments ACA – Aquatic fauna expert panel report (Burdekin region)

An Aquatic Conservation Assessment for the non-riverine wetlands of the Great Barrier Reef catchment

Aquatic fauna
Expert panel report

(Version 1.3)

Burdekin region

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Acronyms and abbreviations

ACA	Aquatic Conservation Assessment
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
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
GBR	Great Barrier Reef
GIS	Geographic Information System
HEV	High ecological value (under a water quality improvement plan)
JAMBA	Japan-Australia Migratory Birds Agreement
NC Act	*Nature Conservation Act 1992*
Ramsar	Ramsar Convention on Wetlands
RE	Regional ecosystem

1 Introduction

The Department of Environment and Resource Management (DERM) conducted an Aquatic Conservation Assessment (ACA) for the non-riverine wetlands in the Great Barrier Reef (GBR) catchment using the Aquatic Biodiversity Assessment and Mapping Method (AquaBAMM; Clayton *et al*. 2006). The ACA relied upon 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 GBR catchment.

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 GBR catchment is made up of 35 individual catchments from the Daintree River north of Cairns, to Baffle Creek south of Gladstone. DERM applied AquaBAMM separately to the non-riverine (palustrine and lacustrine) and riverine wetlands within each of the 35 GBR catchments. In effect, there are 70 ACAs for the entire GBR catchment—covering non-riverine and riverine wetlands. A map of the GBR catchment showing each study area is provided in Attachment A.

A series of nine expert panels were conducted to address aquatic fauna, aquatic and riparian flora, and wetland ecology for the GBR catchments. The non-riverine and riverine wetlands were covered in combined workshops. The panels, held in Cairns, Townsville and Rockhampton during November and December 2008, involved invited experts with expertise in aquatic fauna, aquatic and riparian flora and/or wetland ecology in the Wet Tropics, Burdekin and Fitzroy sections of the GBR catchment.

This report documents the findings and recommendations of the aquatic fauna expert panel for the Burdekin region held in Townsville on Wednesday 19 November, 2008. This report presents supporting information and panel input that only addresses the non-riverine wetland systems. The riverine component has been addressed in a separate report. Terms of reference for the aquatic fauna expert panel are provided in Attachment B.

2 Method

2.1 Study area

The study areas used to implement the AquaBAMM assessments were based on the DERM basin/sub-basin data. The Burdekin study area lies within the wet-dry tropics and includes the eight basins shown in Figure 1, as well as, the adjacent continental islands of the Palm Island group and Magnetic Island. This area takes in the coastal basins of the Black, Ross, Haughton, and Don rivers, and the sub-basins of the greater Burdekin River catchment; the Burdekin Lower, Burdekin Upper, Belyando and Bowen sub-basins. Apart from the inclusion of the Don Basin, the Burdekin study area largely corresponds to the Burdekin Dry Tropics Natural Resource Management (NRM) region and covers an area of approximately 140,000 km^2.

The area includes the Burdekin River catchment; Australia's largest in terms of peak discharge. It covers a diversity of landscapes crossing five bioregions: the Wet Tropics, the Einasleigh Uplands, the Desert Uplands, the Brigalow Belt North, and a small section of the

Central Queensland Coast bioregion on the southern edge. The physical environments include mountain ranges rising to 1,359 m at Mount McCartney in the Clarke Range to the south, 1,221 m at Mount Elliot near Townsville, 1,063 m at Mount Halifax in the Paluma Range to the north and 1,002 m at Mount Tabletop on the Great Dividing Range to the west. Other features include lower rock hills, coastal plains, floodplains, deltas, beach ridges and continental islands. Undulating plains with escarpments and dissected plateaus are found inland to the west. Vegetation types are equally diverse including tropical rainforest, vine thickets, forested swamps, drier woodlands, grassy plains, sedgelands, and coastal mangroves and saltpans.

The area has a tropical sub-humid climate with relatively high temperatures all year round and a pronounced wet and dry season with most rain falling in the warm, humid months of November through to April. Rainfall is highly variably across the region and influenced by monsoonal and cyclonic activity. There is a distinct gradient to drier conditions from the coast westward. Average annual rainfall varies through the area from above 3,000 mm in the coastal peaks of the Seaview and Paluma Ranges to the north, Mount Elliot near Townsville, and the Clarke Range to south, to below 500 mm in the south-west of the Belyando sub-basin. The spatial and seasonal variability and the high interannual variability of rainfall are an overriding characteristic of the study area that greatly influences the nature and distribution of its wetlands. Most streams and wetlands are subject to seasonal flows and are subject to irregular flooding. The exceptions to this are the perennial streams that rise in the high rainfall ranges and the wetlands fed by the large basalt aquifers in the Upper Burdekin sub-basin.

In general, the Burdekin study area can be broadly divided into higher rainfall, more densely populated coastal areas with urban, industrial and irrigated agriculture land uses predominant and lower rainfall, sparsely populated inland areas used principally for rangeland grazing with some dryland agriculture and mining activity. There are several major water storages and large weirs located within the Burdekin study area, the largest being the Burdekin Falls Dam, which was completed in 1987 forming Lake Dalrymple, with a capacity of 1.86 million megalitres. Other major dams include the Ross River Dam, Paluma and Eungella dams.

The Ross basin is the most developed in the study area containing the regional city of Townsville. Many of the streams and wetlands in this basin are highly modified and impacted by water quality contamination and altered hydrology associated with urban development. Other major towns in the study area include Ayr and Home Hill to the south in the Lower Burdekin and Charters Towers in the Upper Burdekin.

The completion of the Burdekin Falls Dam and the subsequent development of the Burdekin-Haughton Water Supply Scheme (BHWSS, previously known as the Burdekin River Irrigation Area (BRIA)) for intensive sugarcane production, has dramatically altered the environmental conditions of the streams and wetlands in the lower floodplain of the Haughton and Lower Burdekin basins. The Lower Burdekin is dominated by the Burdekin River delta, where the coastal plain widens and is prone to widespread flooding, with vast areas of wetlands. The Burdekin Delta and the floodplains and estuaries of the coastal rivers form the Townsville-Burdekin coastal wetland aggregation, one of the most extensive on the Australian east coast. This area includes the wetlands of Bowling Green Bay National Park listed under the international Ramsar Convention. Prior to development, streams in this coastal plain, such as Barratta Creek, consisted of a series of clear or tannin-coloured seasonal in-stream and off-stream lagoons that connected across the floodplain during flood events. Flows were very variable between seasons and interannually. These systems have now been extensively modified. Flows to the streams and wetlands across this floodplain have been radically altered as a result of supplementation through the irrigation delivery system and by irrigation tail waters. This has removed the seasonality in much of the system and in combination with riparian disturbance and nutrient contamination has contributed to extensive weed infestation of wetlands by pasture grasses and aquatic weeds. These impacts have resulted in severe water quality degradation and altered ecology in the wetlands of this coastal plain and presented an enormous task to natural resource managers.

The Don Basin to the south of the Burdekin delta also contains extensive aggregations of coastal wetlands and estuaries. This area has remained one of the least developed along this coast due to relatively low rainfall and the unsuitability of soil types for large-scale irrigated agriculture, although horticulture, largely dependent on ground water, is common in some areas. Although, proposed developments associated with industrial developments at Abbott Point and the Water for Bowen water transfer scheme is likely to increase the pressure on coastal wetlands in this area.

The study area extends more than 300 km westwards, with the Upper Burdekin sub-basin draining the western side of the coastal ranges and the eastern side of the Great Dividing Range. This basin is contained almost entirely in the Einasleigh Uplands. The area contains a major basalt feature with highly productive black and red soils and numerous springs emanating from many locations that drive permanent flow and clear-water waterholes in many streams. This creates not only many significant waterbodies but a wide variety of wetland types. The Burdekin River channel, a large sand and gravel bed channel, is another prominent feature. It consists of a small meandering low-flow channel bordered by sand and gravel bars which in turn is located within the high flow channel with established riparian communities. Flow to this channel is almost perennial most years and comes from two sources: tributaries on the western slopes of the high rainfall coastal ranges; and the extensive basalt aquifers formed by the Toomba basalts flows.

The Belyando sub-basin covers a large part of the study area to the south west and includes the Cape-Campaspe, Belyando and Suttor River catchments. The source of the Belyando River in central western Queensland is almost 500 km from the mouth of the Burdekin River, and extends in to the black-soil grasslands of Central Queensland. The Belyando sub-basin contains two bioregions; the Desert Uplands in the west and the Brigalow Belt North bioregion to the east. The Belyando basin is the area that consistently receives the least rainfall in the study area, with streams and wetlands receiving ephemeral or intermittent flows. In contrast to the Burdekin River channel in the Upper Burdekin, the flow capacity of the main channels of the Cape-Campaspe, Belyando and Suttor River is relatively low resulting in braided (anastomosing) river channels with broad floodplains. The extent of water in the floodplain landscape is highly variable and strongly influenced by flood events which create large temporary wetlands and replenish several permanent waterholes that provide key refugia between flow events. Under flood conditions, flows are spread broadly across the floodplain.

The natural vegetation in the western part of the study area, away from the coast, largely consists of dry eucalypt and acacia savannah woodlands on typical infertile laterised soils and includes grasslands of perennial Mitchell and annual Flinders grasses to the west. Cattle grazing is widespread and a major industry in the inland areas. Land degradation, water quality contamination and erosion are major management problems. Consequently, the Burdekin River catchment has been identified as the biggest single source of sediment to the Great Barrier Reef lagoon and is targeted for improved management actions.

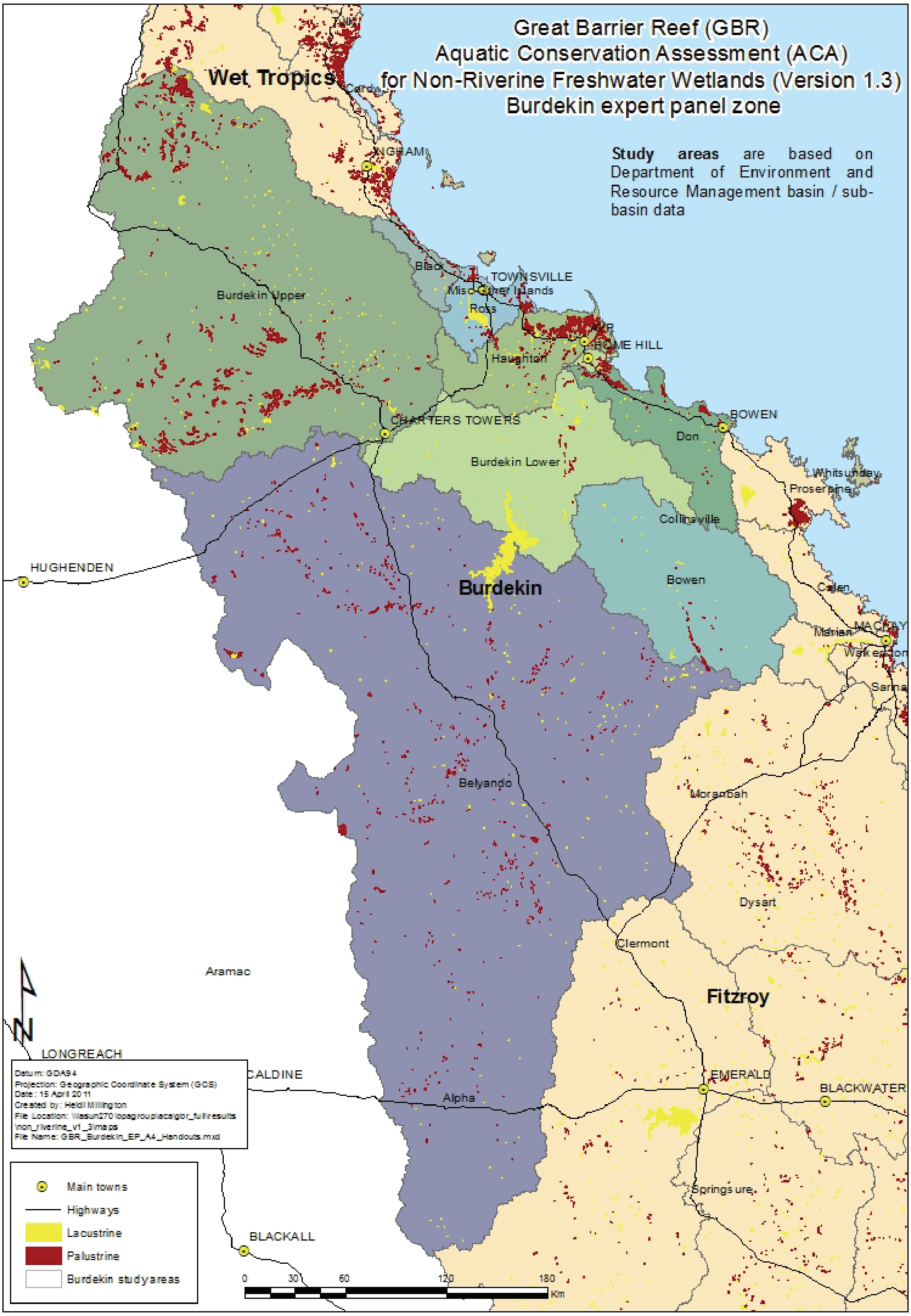

Figure 1 Burdekin section of the GBR catchment (incorporating eight individual catchments)

2.2 Panel composition

The expert panel (the panel) comprised of the persons listed in Table 1 who are familiar with aquatic fauna in the Burdekin section of the GBR catchment.

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
Ant Backer	Senior Conservation Officer, Department of Environment and Resource Management	Biodiversity planning, terrestrial vertebrate ecology
Jason Carter	Business and Natural Resources Manager, Alluvium Consulting Pty Ltd	River and wetland management
Niall Connolly	Principal Conservation Officer, Department of Environment and Resource Management	Biodiversity planning, aquatic ecology and water quality
Mark Kelton	Senior Conservation Officer, Department of Environment and Resource Management	Geographic Information Systems (GIS) analyst
Michaelie Pollard	Project Officer (aquatic ecology), Department of Environment and Resource Management	Aquatic ecology
Jim Tait	Ecologist, Ecoconcern Pty Ltd	Wetland ecology and management
Alan Webb	Aquatic Ecologist, Australian Centre for Tropical Freshwater Research, James Cook University	Aquatic ecology, exotic fish
Jo Winnieke	Regional Bird Observer and Author	Birds

Selena Inglis, Heidi Millington and Steven Howell provided administrative and technical support for the workshop which was facilitated by Darren Fielder.

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 GBR catchment was also sourced from various technical reports.

3 Rare and threatened fauna

The panel identified five 'rare', six 'vulnerable' and one 'endangered' fauna taxa within the non-riverine wetlands of the Burdekin section of the GBR catchment (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	Comments
Adelotus brevis	Tusked frog	V[1]	
Crocodylus porosus	Estuarine crocodile	V[1]	
Denisonia maculata	Ornamental snake	V[1,2]	
Ephippiorhynchus asiaticus	Black-necked stork	R[1]	
Litoria revelata	Whirring treefrog	R[1]	The Eungella population is one of three disjunct populations of conservation significance with potential poor taxonomic resolution.
Neochmia phaeton	Crimson finch	V[1]	
Nettapus coromandelianus	Cotton pygmy-goose	R[1]	
Poephila cincta cincta	Black-throated finch (white-rumped subsp.)	V[1], E[2]	
Pristis microdon	Freshwater sawfish	V[2]	Rarely observed, historically recorded from floodplain and lower reaches. Has been recorded in Horseshoe Lagoon (Haughton). This species is dependent on estuarine ecosystems and expected to occur in estuarine reaches of the lower Burdekin, Burdekin Delta distributaries and Ross basins including the Bohle River although is possibly locally extinct.
Rostratula australis	Australian painted snipe	V[1,2]	
Stictonetta naevosa	Freckled duck	R[1]	
Varanus semiremex	Rusty monitor	R[1]	

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

1. *Queensland Nature Conservation Act 1992 (E – Endangered, V – Vulnerable, R – Rare, LC – Least Concern)*
2. *Environment Protection and Biodiversity Conservation Act 1999 (Ex – Extinct, E – Endangered, V – Vulnerable)*

4 Priority fauna

The panel deliberated on all aquatic-dependent fauna species within the Burdekin section of the GBR catchment to identify 'priority fauna' (excluding the rare or threatened species listed in Table 2). The panel agreed to a definition of a priority species: namely, 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 (>1 per cent for waterbirds, >75 per cent other species) occurs in the waterbody (see Ramsar Criterion 6 for waterbirds).

4.1 Priority species

The panel identified 12 priority fauna species associated with non-riverine wetlands (Table 3). These species were included in 'Criterion 5 Priority species and ecosystems' (5.1.2). Point records were buffered using their precision to identify the spatial units having a priority species present. 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	Priority number[1]	Comments
Anguilla obscura	Pacific shortfin eel	2	Presence of species indicates good habitat connectivity. Evidence suggests the population above Burdekin Dam is in decline. Populations are declining state-wide, due to over fishing and fish barriers. The species is now restricted to a small number of regions.
Anguilla reinhardtii	Longfin eel	2	Presence of species indicates good habitat connectivity. Evidence suggests the population above Burdekin Dam is in decline. Populations are declining state-wide, due to over fishing and fish barriers. Species is now restricted to a small number of regions.
Chanos chanos	Milkfish	2	Historically occurred all the way up the Burdekin River catchment to the falls and across perennial floodplain water bodies. Species is dependent on good connectivity with estuarine ecosystems and therefore provides a good indicator of hydrological and habitat connectivity with estuaries. This species is only found in a few floodplain locations.
Elops hawaiensis	Giant herring	2	Historically occurred in all accessible lower catchment floodplain and riverine habitats. Species is dependent on good connectivity with estuarine ecosystems and therefore provides a good indicator of hydrological and habitat connectivity with estuaries. This species is only found in a few floodplain locations.

Scientific name	Common name	Priority number[1]	Comments
Haliaeetus leucogaster	White-bellied sea-eagle	2	The nesting habitat of this species has declined as a result of coastal development.
Mogurnda adspersa	Southern purple spotted gudgeon	2	Declining populations and local extinctions. Sleepy cod (*Oxyeleotris lineolata*) and yellow belly (*Macquaria ambigua*) translocations to upper catchments are placing direct predation pressure on this species.
Neosilurus hyrtlii	Hyrtl's catfish, Hyrtl's tandan	2	Priority just for the Ross River catchment as the Ross River is full of fish passage barriers and this species requires access to free flowing water. Population decline coincides with barramundi (*Lates calcarifer*) stocking; however, it is probably not predation but the limited access to free flowing water that is causing the decline.
Notaden melanoscaphus	Brown shovelfoot	2, 5	Extremely geographically restricted species on the east coast with populations in the wider Burdekin catchment extremely isolated from other populations given current knowledge. Species may be either a distinct species or a distinct genetic lineage. Species is seriously threatened by coastal development.
Ophiocara porocephala	Spangled gudgeon	2, 3	Largely a brackish species restricted in distribution and suffering from loss of habitat. Impoundments such as tidal bunds are of some concern.
Philypnodon grandiceps	Flathead gudgeon	3	Restricted in distribution.
Pseudophryne raveni	Copper backed broodfrog	5	The Burdekin population may be a significant disjunct population.
Strongylura krefftii	Freshwater longtom	2	Suffering declining populations and distribution, this species has disappeared from the Haughton and Ross Rivers above Applin weir although it is still known occur in Stuart Creek and Alligator Creek above the weir. This species is a floodplain breeder and alienation of floodplain habitat physically or exposure to low dissolved oxygen is a concern.

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

1. The priority numbers are the values that a species must exhibit to be a priority species as listed in dot points above Table 3.

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) or the Convention on the Conservation of Migratory Species of Wild Animals (CMS) as priority fauna. A total of 22 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 and a four 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). Sourced from Japan-Australia Migratory Bird Agreement (JAMBA), China-Australia Migratory Bird Agreement (CAMBA), and the Convention on the Conservation of Migratory Species of Wild Animals (CMS) at:
http://www.environment.gov.au/biodiversity/migratory/waterbirds/index.html

Scientific name	Common name	Agreements/ conventions	Comments
Anas querquedula	Garganey	CAMBA[1], JAMBA[2]	
Ardea ibis	Cattle egret	CAMBA[1], JAMBA[2]	
Calidris acuminata	Sharp-tailed sandpiper	CAMBA[1], JAMBA[2], CMS[3]	Considered to be both a saline and freshwater species.
Calidris alba	Sanderling	CAMBA[1], JAMBA[2], CMS[3]	

Scientific name	Common name	Agreements/ conventions	Comments
Calidris canutus	Red knot	CAMBA[1], JAMBA[2], CMS[3]	
Calidris ferruginea	Curlew sandpiper	CAMBA[1], JAMBA[2], CMS[3]	
Calidris melanotos	Pectoral sandpiper	JAMBA[2], CMS[3]	
Calidris ruficollis	Red-necked stint	CAMBA[1], JAMBA[2], CMS[3]	
Calidris subminuta	Long-toed stint	CAMBA[1], JAMBA[2], CMS[3]	
Calidris tenuirostris	Great knot	CAMBA[1], JAMBA[2], CMS[3]	
Ceyx azureus	Azure kingfisher		
Chlidonias leucopterus	White-winged black tern	CAMBA[1], JAMBA[2]	
Circus approximans	Swamp harrier		
Gallinago hardwickii	Latham's snipe	CAMBA[1], JAMBA[2], CMS[3]	
Glareola maldivarum	Oriental pratincole	CAMBA[1], JAMBA[2]	
Limosa lapponica	Bar-tailed godwit	CAMBA[1], JAMBA[2], CMS[3]	
Limosa limosa	Black-tailed godwit	CAMBA[1], JAMBA[2], CMS[3]	
Numenius minutus	Little curlew	CAMBA[1], JAMBA[2], CMS[3]	
Philomachus pugnax	Ruff	CAMBA[1], JAMBA[2], CMS[3]	
Tringa glareola	Wood sandpiper	CAMBA[1], JAMBA[2], CMS[3]	
Tringa nebularia	Common greenshank	CAMBA[1], JAMBA[2], CMS[3]	
Tringa stagnatilis	Marsh sandpiper	CAMBA[1], JAMBA[2], CMS[3]	

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

1 *China-Australia Migratory Birds Agreement (CAMBA)*
2 *Japan-Australia Migratory Birds Agreement (JAMBA)*
3 *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 (amphibians – frogs, fish, reptiles, and birds – waterbirds) of fauna, stratified using 150 m above sea level (asl) for the Burdekin Lower and Haughton study areas and the Desert Uplands\Brigalow Belt bioregional boundary above the Burdekin Dam in the Belyando study area (see the Burdekin wetland ecology expert panel report for more information on stratification). 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.

5.1 Fish richness

There were 33 native fish species identified in the non-riverine wetlands of the Burdekin section of the GBR catchments. A further 18 species were considered to be alien to the region and included some translocated species. Table 5 lists fish species that were used under the 'Criteria 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	Comments
Ambassis agassizii	Agassiz's glassfish	LC[1]	Found in Ross River
Amniataba percoides	Barred grunter	LC[1]	
Anguilla obscura	Pacific shortfin eel	LC[1]	Presence of species indicates good habitat connectivity. Evidence suggests the population above Burdekin Dam is in decline. Populations declining state-wide due to over fishing and fish barriers. This species is now restricted in a small number of regions.
Anguilla reinhardtii	Longfin eel	LC[1]	Presence of this species indicates good habitat connectivity. Evidence suggests the population above Burdekin Dam is in decline. Populations are currently declining state-wide due to over fishing and fish barriers. This species is now restricted in a small number of regions.
Arius graeffei	Blue catfish	LC[1]	
Arrhamphus sclerolepis	Snubnose garfish	LC[1]	Widely distributed but reduced in abundance in floodplain distributaries. This species may have separate freshwater and marine breeding populations or subspecies.
Chanos chanos	Milkfish	LC[1]	Historically this fish occurred all the way up the Burdekin catchment to the falls and across perennial floodplain water bodies. The species is dependent on good connectivity with estuarine ecosystems and therefore provides a good indicator of hydrological and habitat connectivity with estuaries. This species is only found in a few floodplain locations.
Craterocephalus stercusmuscarum	Flyspecked hardyhead	LC[1]	

Scientific name	Common name	Status	Comments
Elops hawaiensis	Giant herring	LC[1]	Historically occurred in all accessible lower catchment floodplain and riverine habitats. Species is dependent on good connectivity with estuarine ecosystems and therefore provides a good indicator of hydrological and habitat connectivity with estuaries. This species is only found in a few floodplain locations.
Glossamia aprion	Mouth almighty	LC[1]	
Hypseleotris compressa	Empire gudgeon	LC[1]	
Hypseleotris galii	Firetail gudgeon	LC[1]	This species has been caught in freshwater reach of Ross River.
Hypseleotris sp. A midgleyi	Midgley's carp gudgeon	LC[1]	
Lates calcarifer	Barramundi	LC[1]	Widely stocked distribution on the floodplain but severely impacted by fish passage barriers and habitat quality. Its presence remains a legitimate indicator of floodplain habitat and ecosystem quality.
Leiopotherapon unicolor	Spangled perch	LC[1]	
Megalops cyprinoides	Oxeye herring/tarpon	LC[1]	
Melanotaenia splendida splendida	Eastern rainbowfish	LC[1]	
Mogurnda adspersa	Southern purple-spotted gudgeon	LC[1]	Declining populations and local extinctions. Sleepy cod (*Oxyeleotris lineolata*) and yellow belly (*Macquaria ambigua*) translocations to upper catchments are placing direct predation pressure on this species.
Monodactylus argenteus	Diamondfish, silver batfish	LC[1]	Predominantly a marine vagrant commonly found in freshwater
Mugil cephalus	Sea mullet	LC[1]	Impacted by fish passage barriers and floodplain habitat decline
Nematalosa erebi	Bony bream	LC[1]	This species is intolerant to low dissolved oxygen levels. Its presence is indicative of good ecosystem function and primary productivity.
Neosilurus ater	Black catfish, butter jew, narrow-fronted tandan	LC[1]	
Neosilurus hyrtlii	Hyrtl's catfish, Hyrtl's tandan	LC[1]	This species requires access to free flowing water. The population decline coincides with barramundi (*Lates calcarifer*) stocking; however, it is probably not predation but the limited access to free flowing water that is causing the decline.
Notesthes robusta	Bullrout	LC[1]	Records in Wet Tropics and Gulf
Ophiocara porocephala	Spangled gudgeon	LC[1]	Largely a brackish species restricted in distribution and suffering from loss of habitat. Impoundments such as tidal bunds are of some concern.
Ophisternon bengalense	One-gilled eel, swamp eel	LC[1]	
Ophisternon gutturale	Swamp Eel	LC[1]	
Philypnodon grandiceps	Flathead gudgeon	LC[1]	
Porochilus rendahli	Rendahl's catfish	LC[1]	

Scientific name	Common name	Status	Comments
Pristis microdon	Freshwater sawfish	V[2]	Rarely observed, historically recorded from floodplain and lower reaches. Has been recorded in Horseshoe Lagoon (Haughton). This species is dependent on estuarine ecosystems and expected to occur in estuarine reaches of the lower Burdekin, Burdekin Delta distributaries and Ross basins including the Bohle River although is possibly locally extinct.
Selenotoca multifasciata	Striped scat, banded scat	LC[1]	
Strongylura krefftii	Freshwater longtom	LC[1]	This species has undergone a major reduction in distribution and abundance in floodplain habitat due to impacts on habitat and water quality, therefore it provides good indicator of habitat quality.
Toxotes chatareus	Sevenspot archerfish	LC[1]	This species has undergone a major reduction in distribution and abundance in the floodplain habitat and is a good indicator of habitat quality.

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

1. Queensland *Nature Conservation Act 1992 (E – Endangered, V – Vulnerable, R – Rare, LC – Least Concern)*
2. *Environment Protection and Biodiversity Conservation Act 1999 (E – Endangered, V – Vulnerable)*

5.2 Reptile richness

There were 13 native reptile species identified in the non-riverine wetlands of the Burdekin section of the GBR catchment. 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	Comments
Chelodina canni	Cann's longneck turtle	LC[1]	
Chelodina longicollis	Eastern snake-necked turtle	LC[1]	
Crocodylus porosus	Estuarine crocodile	V[1]	
Denisonia maculata	Ornamental snake	V[1,2]	
Emydura macquarii krefftii	Krefft's river turtle	LC[1]	
Emydura macquarii macquarii	Murray turtle	LC[1]	
Eulamprus quoyii	Eastern water skink	LC[1]	
Hemiaspis signata	Black-bellied swamp snake	LC[1]	
Liasis mackloti	Water python	LC[1]	
Physignathus lesueurii	Eastern water dragon	LC[1]	
Stegonotus cucullatus	Slaty-grey snake	LC[1]	
Tropidonophis mairii	Freshwater snake	LC[1]	
Varanus semiremex	Rusty monitor	R[1]	

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

1. Queensland *Nature Conservation Act 1992 (E – Endangered, V – Vulnerable, R – Rare, LC – Least Concern)*
2. *Environment Protection and Biodiversity Conservation Act 1999 (E – Endangered, V – Vulnerable)*

5.3 Waterbird richness

There were 95 native waterbird species identified in the non-riverine wetlands of the Burdekin section of the GBR catchment. Table 7 lists the wetlands-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	Comments
Acrocephalus australis	Australian reed-warbler	LC[1]	
Amaurornis cinerea	White-browed crake	LC[1]	
Amaurornis moluccana	Pale-vented bush-hen	LC[1]	
Anas gracilis	Grey teal	LC[1]	
Anas querqueldula	Garganey	LC[1]	
Anas superciliosa	Pacific black duck	LC[1]	
Anhinga melanogaster	Australasian darter	LC[1]	
Anseranas semipalmata	Magpie goose	LC[1]	
Ardea ibis	Cattle egret	LC[1]	
Ardea intermedia	Intermediate egret	LC[1]	
Ardea modesta	Eastern great egret	LC[1]	
Ardea pacifica	White-necked heron	LC[1]	
Aythya australis	Hardhead	LC[1]	
Calidris acuminata	Sharp-tailed sandpiper	LC[1]	Considered to be both a saline and freshwater species.
Calidris alba	Sanderling	LC[1]	
Calidris canutus	Red knot	LC[1]	
Calidris ferruginea	Curlew sandpiper	LC[1]	
Calidris melanotos	Pectoral sandpiper	LC[1]	
Calidris ruficollis	Red-necked stint	LC[1]	
Calidris subminuta	Long-toed stint	LC[1]	
Calidris tenuirostris	Great knot	LC[1]	
Ceyx azureus	Azure kingfisher	LC[1]	
Ceyx pusilla	Little kingfisher	LC[1]	
Chenonetta jubata	Australian wood duck	LC[1]	
Chlidonias hybrida	Whiskered tern	LC[1]	
Chlidonias leucopterus	White-winged black tern	LC[1]	
Chroicocephalus novaehollandiae	Silver gull	LC[1]	
Circus approximans	Swamp harrier	LC[1]	
Cisticola exilis	Golden-headed cisticola	LC[1]	
Cisticola juncidis	Zitting cisticola	LC[1]	
Cygnus atratus	Black swan	LC[1]	
Dendrocygna arcuata	Wandering whistling-duck	LC[1]	
Dendrocygna eytoni	Plumed whistling-duck	LC[1]	
Egretta garzetta	Little egret	LC[1]	
Egretta novaehollandiae	White-faced heron	LC[1]	
Egretta picata	Pied heron	LC[1]	

Scientific name	Common name	Status	Comments
Elseyornis melanops	Black-fronted dotterel	LC[1]	
Ephippiorhynchus asiaticus	Black-necked stork	R[1]	
Erythrogonys cinctus	Red-kneed dotterel	LC[1]	Not present in large numbers but are wetland dependant when present.
Fulica atra	Eurasian coot	LC[1]	
Gallinago hardwickii	Latham's snipe	LC[1]	
Gallinula tenebrosa	Dusky moorhen	LC[1]	
Gallirallus philippensis	Buff-banded rail	LC[1]	
Glareola maldivarum	Oriental pratincole	LC[1]	
Gelochelidon nilotica	Gull-billed tern	LC[1]	Found far inland sometimes.
Grus rubicunda	Brolga	LC[1]	
Haliaeetus leucogaster	White-bellied sea-eagle	LC[1]	These species are known to occur in inland areas.
Himantopus himantopus	Black-winged stilt	LC[1]	
Hydroprogne caspia	Caspian tern	LC[1]	
Irediparra gallinacea	Comb-crested jacana	LC[1]	
Ixobrychus dubius	Australian little bittern	LC[1]	
Ixobrychus flavicollis	Black bittern	LC[1]	
Limosa lapponica	Bar-tailed godwit	LC[1]	
Limosa limosa	Black-tailed godwit	LC[1]	
Lonchura castaneothorax	Chestnut-breasted mannikin	LC[1]	
Malacorhynchus membranaceus	Pink-eared duck	LC[1]	
Megalurus timoriensis	Tawny grassbird	LC[1]	
Microcarbo melanoleucos	Little pied cormorant	LC[1]	
Neochmia phaeton	Crimson finch	V[1]	
Nettapus coromandelianus	Cotton pygmy-goose	R[1]	
Nettapus pulchellus	Green pygmy-goose	LC[1]	
Numenius minutus	Little curlew	LC[1]	
Nycticorax caledonicus	Nankeen night-heron	LC[1]	
Pandion cristatus	Eastern osprey	LC[1]	Species relies on fish and can be found in riparian areas.
Pelecanus conspicillatus	Australian pelican	LC[1]	
Phalacrocorax carbo	Great cormorant	LC[1]	
Phalacrocorax sulcirostris	Little black cormorant	LC[1]	
Phalacrocorax varius	Pied cormorant	LC[1]	
Philomachus pugnax	Ruff	LC[1]	
Platalea flavipes	Yellow-billed spoonbill	LC[1]	
Platalea regia	Royal spoonbill	LC[1]	
Plegadis falcinellus	Glossy ibis	LC[1]	
Podiceps cristatus	Great crested grebe	LC[1]	
Poephila cincta	Black-throated finch	LC[1]	
Poephila cincta cincta	Black-throated finch (white-rumped subsp.)	V[1], E[2]	

Scientific name	Common name	Status	Comments
Poliocephalus poliocephalus	Hoary-headed grebe	LC[1]	
Porphyrio porphyrio	Purple swamphen	LC[1]	
Porzana fluminea	Australian spotted crake	LC[1]	
Porzana pusilla	Baillon's crake	LC[1]	
Porzana tabuensis	Spotless crake	LC[1]	
Rallina tricolor	Red-necked crake	LC[1]	
Ramsayornis modestus	Brown-backed honeyeater	LC[1]	Prefer to nest over water.
Recurvirostra novaehollandiae	Red-necked avocet	LC[1]	
Rostratula australis	Australian painted snipe	V[1,2]	
Stictonetta naevosa	Freckled duck	R[1]	
Stiltia isabella	Australian pratincole	LC[1]	
Tachybaptus novaehollandiae	Australasian grebe	LC[1]	
Tadorna radjah	Radjah shelduck	R[1]	
Threskiornis molucca	Australian white ibis	LC[1]	Biggest colony in Queensland is known to sit on the Ross River.
Threskiornis spinicollis	Straw-necked Ibis	LC[1]	
Tribonyx ventralis	Black-tailed native-hen	LC[1]	
Tringa glareola	Wood sandpiper	LC[1]	Considered to be both a saline and freshwater species.
Tringa nebularia	Common greenshank	LC[1]	Considered to be both a saline and freshwater species.
Tringa stagnatilis	Marsh sandpiper	LC[1]	Considered to be both a saline and freshwater species.
Vanellus miles	Masked lapwing	LC[1]	

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

1. Queensland *Nature Conservation Act 1992 (E – Endangered, V – Vulnerable, R – Rare, LC – Least Concern)*
2. *Environment Protection and Biodiversity Conservation Act 1999 (E – Endangered, V – Vulnerable)*

5.4 Frog richness

There were 40 species of amphibians identified as being associated with non-riverine wetlands in the Burdekin section of the GBR catchment. 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	Comments
Adelotus brevis	Tusked frog	V[1]	
Crinia deserticola	Chirping froglet	LC[1]	
Cyclorana alboguttata	Greenstripe frog	LC[1]	
Cyclorana brevipes	Superb collared frog	LC[1]	
Cyclorana cultripes	Grassland collared frog	LC[1]	
Cyclorana novaehollandiae	Eastern snapping frog	LC[1]	
Cyclorana platycephala	Water holding frog	LC[1]	One identified record.
Hylarana daemeli	Australian woodfrog	LC[1]	

Scientific name	Common name	Status	Comments
Limnodynastes convexiusculus	Marbled frog	LC[1]	
Limnodynastes peronii	Striped marshfrog	LC[1]	
Limnodynastes salmini	Salmon striped frog	LC[1]	
Limnodynastes tasmaniensis	Spotted grassfrog	LC[1]	
Limnodynastes terraereginae	Scarlet sided pobblebonk	LC[1]	
Litoria bicolor	Northern sedgefrog	LC[1]	
Litoria caerulea	Common green treefrog	LC[1]	
Litoria chloris	Orange eyed treefrog	LC[1]	
Litoria fallax	Eastern sedgefrog	LC[1]	
Litoria gracilenta	Graceful treefrog	LC[1]	
Litoria inermis	Bumpy rocketfrog	LC[1]	
Litoria infrafrenata	White lipped treefrog	LC[1]	
Litoria latopalmata	Broad palmed rocketfrog	LC[1]	
Litoria microbelos	Javelin frog	LC[1]	
Litoria nasuta	Striped rocketfrog	LC[1]	
Litoria pallida	Pallid rocketfrog	LC[1]	
Litoria revelata	Whirring treefrog	R[1]	Eungella population is one of three disjunct populations of conservation significance with potential poor taxonomic resolution.
Litoria rothii	Northern laughing treefrog	LC[1]	
Litoria rubella	Ruddy treefrog	LC[1]	
Litoria xanthomera	Orange thighed treefrog	LC[1]	
Neobatrachus sudelli	Meeowing frog	LC[1]	
Notaden bennettii	Holy cross frog	LC[1]	
Notaden melanoscaphus	Brown shovelfoot	LC[1]	
Platyplectrum ornatum	Ornate burrowing frog	LC[1]	
Pseudophryne major	Great brown broodfrog	LC[1]	
Pseudophryne raveni	Copper backed broodfrog	LC[1]	
Uperoleia altissima	Tableland gungan	LC[1]	
Uperoleia fusca	Dusky gungan	LC[1]	
Uperoleia lithomoda	Stonemason gungan	LC[1]	
Uperoleia littlejohni	Einasleigh gungan	LC[1]	
Uperoleia mimula	Mimicking gungan	LC[1]	
Uperoleia rugosa	Chubby gungan	LC[1]	

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

1. Queensland *Nature Conservation Act 1992 (E – Endangered, V – Vulnerable, R – Rare, LC – Least Concern)*

5.5 Mammal richness

There was only one species of mammal identified in the non-riverine wetlands of the Burdekin section of the GBR catchment. 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	Comments
Hydromys chrysogaster	Water rat	LC[1]	

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

1. Queensland *Nature Conservation Act 1992 (E – Endangered, V – Vulnerable, R – Rare, LC – Least Concern)*

5.6 Macroinvertebrate richness

There were two species of macroinvertebrates identified in the non-riverine wetlands of the Burdekin section of the GBR catchments. 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	Comments
Junonia hedonia zelima	Brown argus	LC[1]	
Telicota eurotas laconia	Northern sedge darter	LC[1]	

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

1. Queensland *Nature Conservation Act 1992 (E – Endangered, V – Vulnerable, R – Rare, LC – Least Concern)*

6 Exotic fauna

Eighteen fish, one crustacean and one vertebrate species were nominated by the panel (Table 11) as being exotic wetland fauna the non-riverine wetlands of the Burdekin section of the GBR catchment. Some species identified by the panel were considered to only be exotic in certain areas of the Burdekin region despite being a native species. This was mainly due to translocations or introductions upstream of natural instream barriers. The presence of aquatic exotic fauna species was recorded under ‘Criterion 1 Naturalness aquatic’ (1.1.1).

Table 11 Alien fauna species

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

Scientific name	Common name	Comments
Aequidens rivulatus	Green terror	One-off record from Ross River weirs in Townsville.
Amphilophus citrinellus	Midas cichlid, red devil	Breeding populations known to occur in the Ross River weirs in Townsville.
Archocentrus spilurus	Blue eye cichlid	One-off report from sheep station lagoon.
Archocentrus nigrofasciatus	Convict cichlid	Several isolated reports from Townsville (note: genus has changed to *Amatitlania*).
Astronotus ocellatus	Oscar	Breeding population in the Ross River weirs in Townsville & other specimen from various parts in catchment.
Bos sp.	Cattle	Differential impacts, impacts particularly bad in rainforest areas. Certain pastoral holdings have cattle that are impacting on all wetlands in that holding.
Cherax quadricarinatus	Redclaw crayfish	Translocated species becoming a problem with observations in the Upper Ross River and Burdekin Dam (introduced). It is currently moving into tributaries of the Belyando and is thought to out-compete native crayfish.
Gambusia holbrooki	Mosquitofish	Preferred common name is now eastern gambusia.
Geophagus brasiliensis	Pearl cichlid	One-off report from sheep station lagoon.
Haplochromis burtoni	Burton's haplochromis	Breeding population in the Ross River weirs in Townsville, local dispersal occurring.
Hemichromis guttatus/bimaculatus	Jewel cichlid	Population known to occur in the Ross River.
Heros severus	Banded cichlid	One-off from Ross River weirs in Townsville.
Lates calcarifer	Barramundi	Only considered to be an exotic above Burdekin falls due to translocation.
Oreochromis mossambicus	Mozambique mouthbrooder	Widely distributed in the Burdekin and Ross River catchments and rapidly spreading.
Poecilia latipinna	Sailfin molly	Specimens recorded in Majors creek.
Poecilia reticulata	Guppy	
Thorichthys meeki	Firemouth cichlid	One-off from Ross River weirs in Townsville.
Trichogaster trichopterus	Three-spot gourami	Found in sheep station creek, reports from lower Burdekin and Townsville weirs. This species is of major concern as it is rapidly spreading.
Xiphophorus helleri	Swordtail	Breeding populations of this species are mainly in Applin Weir in Townsville and other small creeks leading into Applin Weir.
Xiphophorus maculatus	Platy	

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

7 Special features

The panel identified several non-riverine special features in the Burdekin section of the GBR catchment (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 were implemented as a wetland ecology special area.

Each spatial unit that intersected with a particular ecosystem or feature in Table 12 was given a score equal to the conservation rating.

Table 12 Identified special features, and their values

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.

Special feature	**Values**	**Catchment**	**Decision implementation number**	**Criteria/ indicator/ measure**	**Conservation rating (1-4)**
Wetlands south of Forest Beach	This area provides significant habitat for the apollo jewel butterfly (*Hypochrysops apollo apollo*) where it is at the most southerly extent of its range. <u>Note</u>: This decision is a revised decision based on decision number he_fa_6 (Herbert aquatic fauna expert panel 2007). This wetland in the Black catchment was visually checked and appears to be connected to this decision.	Black	bk_nr_fa_01	6.3.1	4
Lake Powlathanga	Lake Powlathanga is the largest wetland of the Cape-Campaspe Plains subregion. The special feature covers both the lakebed and a surrounding less frequently flooded area.	Belyando	be_nr_fa_01	6.3.3	4
Toomba lake	Toomba Lake is a shallow permanent to semi-permanent lake containing a diversity of wetland types providing good waterbird habitat and abundances for species such as the freckled duck (*Stictonetta naevosa*) and endemic grass species. The lake is an extensive wetland on a flat plain that boasts unique geomorphology and hydrology being one of the youngest basalt flows in Queensland fed by reliable groundwater from basalt aquifers. The persistence of surface water provides reliable habitats for birds, macrophytes and other aquatic biota. High nutrient concentrations are also present in the lake which is currently protected from cattle grazing.	Burdekin Upper	bp_nr_fa_01	6.1.1 6.3.1 6.4.1	4
Upper Burdekin/ Wairuna plateau	The Upper Burdekin/ Wairuna plateau contains a variety of wetland types including permanent and semi-permanent wetlands which help to maintain water quality. <u>Note</u>: This decision is also a fauna decision in the Einasleigh Uplands Biodiversity Planning Assessment (decision number eiu_fa_5).	Burdekin Upper	bp_nr_fa_02	6.2.1 6.3.1 6.3.3	4

Special feature	Values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Caley Valley (aka Kaillie) wetlands	The Caley Valley wetlands are a large coastal wetland with a saline influence and old marine sediments. The wetlands provide important habitat for waterbirds including migratory species. The wetlands also contain significant limestone formations.	Don	do_nr_fa_01	5.1.4 6.3.1	3
Cromarty Wetlands/ Wongaloo swamps	Cromarty wetlands provide significant waterbird breeding and habitat values, high biodiversity, huge biomass production of vertebrate and invertebrate biomass including frogs, snakes, fish and birds. The wetlands are highly connected from upland areas in the Mount Elliott range and remaining unbroken down to the streams and wetlands prior to reaching the coasts. This connectivity is important for fish and other aquatic fauna. The wetlands are in good condition and have suffered limited habitat and hydrological modification including no tailing waters. The site contains the Wongaloo Fans Aggregations (DIWA) and part of the Wongaloo Swamps (DIWA) which goes in to the Ross basin. <u>Note</u>: This decision straddles the Haughton and Ross study areas. The Ross component of this decision is covered by decision number ro_nr_fa_01.	Haughton	ha_nr_fa_01	5.1.4 6.3.1	4
Serpentine Lagoon Complex/ Toonpan	The serpentine lagoon complex/Toonpan area are relatively intact ecosystems that provide important habitat for various species of waterbirds and fish. The area is covered by a parks reserve (voluntary conservation agreement) and/or nature refuge and is under threat from weed invasion. <u>Note</u>: This decision straddles the Haughton and Ross study areas. The Ross component of this decision is covered by decision number ro_nr_fa_02.	Haughton	ha_nr_fa_02	6.3.1	3

Special feature	Values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Cromarty Wetland /Wongaloo Swamps	Cromarty wetlands provide significant waterbird breeding and habitat values, high biodiversity, huge biomass production of vertebrate and invertebrate biomass including frogs, snakes, fish and birds. The wetlands are highly connected from upland areas in the Mount Elliott range and remaining unbroken down to the streams and wetlands prior to reaching the coasts. This connectivity is important for fish and other aquatic fauna. The wetlands are in good condition and have suffered limited habitat and hydrological modification including no tailing waters. The site contains the Wongaloo Fans Aggregations (DIWA) and part of the Wongaloo Swamps (DIWA) which goes in to the Ross basin. Note: This decision straddles the Haughton and Ross study areas. The Haughton component of this decision is covered by decision number ha_nr_fa_01.	Ross	ro_nr_fa_01	6.3.1	4
Serpentine Lagoon Complex/ Toonpan	The Serpentine Lagoon complex/Toonpan area is a relatively intact ecosystem that provides important habitat for various species of waterbirds and fish. The area is covered by a parks reserve (voluntary conservation agreement) and/or nature refuge and is under threat from weed invasion. Note: This decision straddles the Haughton and Ross study areas. The Haughton component of this decision is covered by decision number ha_nr_fa_02.	Ross	ro_nr_fa_02	6.3.1	3

Attachments

Attachment A – GBR catchment study area

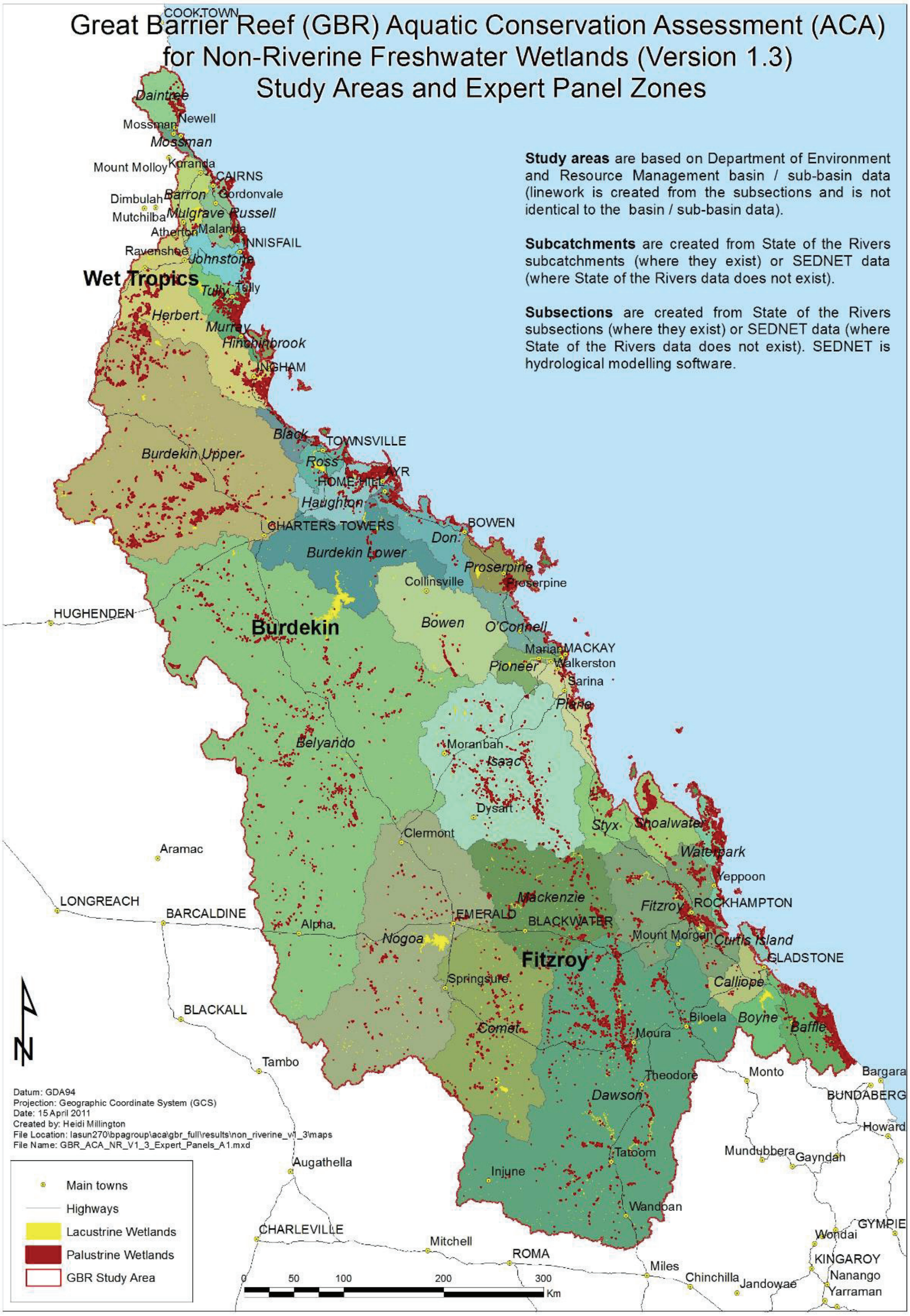

Figure 2 GBR catchment study area

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 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 GBR catchment. Experience in the identification and assessment of riverine and non-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 riverine and non-riverine wetlands of the GBR catchment. The panel consisted of professionals with expertise relating to aquatic fauna values.

The tasks undertaken by the panel included, but without limitation, 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 GBR catchment

The criteria, indicators and measures (CIM) list outlines the CIM that were implemented as part of the non-riverine Aquatic Conservation Assessment (ACA) using AquaBAMM of the freshwater wetlands of the GBR catchment.

The list has been developed from a default list of CIM that may be considered when an Aquatic Conservation Assessment (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. AquaBAMM does allow addition or deletion of indicators and/or measures for each ACA when its assessment parameters are set. However, 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 13 CIM list for the GBR catchment

Criteria & indicators	Measures	
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
1.4 Hydrological modification	1.4.5	Hydrological disturbance/modification of the wetland (e.g. as determined through DERM wetland mapping and classification)
2 Naturalness catchment		
2.1 Exotic flora/fauna	2.1.1	Presence of exotic terrestrial plants in the assessment unit
2.2 Riparian disturbance	2.2.5	Per cent area of remnant vegetation relative to preclear extent within buffered non-riverine wetland: 500 m buffer for wetlands >= 8Ha, 200 m buffer for smaller wetlands
2.3 Catchment disturbance	2.3.1	Per cent "agricultural" land-use area (i.e. cropping and horticulture)
	2.3.2	Per cent "grazing" land-use area
	2.3.3	Per cent "vegetation" land-use area (i.e. native veg + regrowth)
	2.3.4	Per cent "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	3.1.2	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
3.3 Habitat	3.3.2	Richness of wetland types within the local catchment (e.g. SOR sub-section)
	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[1], EPBC Act[2]

Criteria & indicators	Measures	
	4.1.2	Presence of rare or threatened aquatic ecosystem dependent flora species – NC Act[1], EPBC Act[2]
4.2 Communities/ assemblages	4.2.1	Conservation status of wetland Regional Ecosystems – Herbarium biodiversity status, NC Act[1], EPBC Act[2]
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)
	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[3]/CAMBA[4] 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)
8 Representativeness		
8.1 Wetland protection	8.1.1	The per cent area of each wetland habitat type within protected areas
	8.1.2	The per cent 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*
8.2 Wetland uniqueness	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)
	8.2.2	The relative abundance of the wetland management group to which the wetland habitat belongs within the subcatchment or estuarine/marine zone (management groups ranked least common to most common)
	8.2.3	The size of each wetland habitat relative to others of its management group within the catchment or study area
	8.2.4	The size of each wetland habitat relative to others of its management group within a subcatchment (or estuarine zone)
	8.2.5	Wetland habitat representative of the study area – identified by expert opinion
	8.2.6	The size of each wetland habitat relative to others of its 'type' within the catchment or study area

[1] NC Act – *Nature Conservation Act 1992* (Queensland legislation)
[2] EPBC Act – *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth legislation)
[3] JAMBA – Japan-Australia Migratory Bird Agreement
[4] CAMBA – China-Australia Migratory Bird Agreement

References

Clayton, P.D., Fielder, D.F., Howell, S. and Hill, C.J. (2006) *Aquatic biodiversity assessment and mapping method (AquaBAMM): a conservation values assessment tool for wetlands with trial application in the Burnett River catchment.* Published by the Environmental Protection Agency, Brisbane. ISBN 1-90928-07-3

Clayton, P.D., Fielder, D.P., Barratt, P.J. and Hill, C.J. (2008). *Aquatic Conservation Assessments (ACA), using AquaBAMM, for freshwater wetlands of the Baffle Creek catchment*. Published by the Environmental Protection Agency, Brisbane.

DERM (In prep) Biodiversity Planning Assessment, Einasleigh Uplands, Flora, Fauna and Landscape Expert Panel Report. Department of Environment and Resource Management.

Attachment F GBR catchments ACA – Aquatic ecology expert panel report (Burdekin region)

An Aquatic Conservation Assessment for the non-riverine wetlands of the Great Barrier Reef catchment

Wetland ecology Expert panel report

(Version 1.3)

Burdekin region

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Tables

Figures

Acronyms and abbreviations

ACA	Aquatic Conservation Assessment
ASL	Above sea level
BPA	Biodiversity Planning Assessment
DERM	Department of Environment and Resource Management
DIWA	Directory of Important Wetlands Australia
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
GBR	Great Barrier Reef
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

1 Introduction

The Department of Environment and Resource Management (DERM) conducted an Aquatic Conservation Assessment (ACA) for the non-riverine wetlands in the Great Barrier Reef (GBR) catchment using the Aquatic Biodiversity Assessment and Mapping Method (AquaBAMM; Clayton *et al*. 2006). The ACA relied upon 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 GBR catchment.

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 GBR catchment is made up of 35 individual catchments from the Daintree River north of Cairns, to Baffle Creek south of Gladstone. DERM applied AquaBAMM separately to the non-riverine (palustrine and lacustrine) and riverine wetlands within each of the 35 GBR catchments. In effect, there are 70 ACAs for the entire GBR catchment—covering non-riverine and riverine wetlands. A map of the GBR catchment showing each study area is provided in Attachment A.

A series of nine expert panels were conducted to address aquatic fauna, aquatic and riparian flora, and wetland ecology for the GBR catchments. The non-riverine and riverine wetlands were covered in combined workshops. The panels, held in Cairns, Townsville and Rockhampton during November and December 2008, involved invited experts with expertise in aquatic fauna, aquatic and riparian flora and/or wetland ecology in the Wet Tropics, Burdekin and Fitzroy sections of the GBR catchment.

This report documents the findings and recommendations of the wetland ecology expert panel for the Burdekin region held in Townsville on Thursday 20 November 2008. This report presents supporting information and panel input that only addresses the non-riverine wetland systems. The riverine component has been addressed in a separate report. Terms of reference for the wetland ecology expert panel are provided in attachment B.

2 Method

2.1 Study area

The study areas used to implement the AquaBAMM assessments were based on the DERM basin/sub-basin data. The Burdekin study area lies within the wet-dry tropics and includes the eight basins shown in Figure 1 as well as, the adjacent continental islands of the Palm Island group and Magnetic Island. This area takes in the coastal basins of the Black, Ross, Haughton, and Don rivers, and the sub-basins of the greater Burdekin River catchment; the Burdekin Lower, Burdekin Upper, Belyando and Bowen sub-basins. Apart from the inclusion of the Don Basin, the Burdekin study area largely corresponds to the Burdekin Dry Tropics Natural Resource Management (NRM) region and covers an area of approximately 140,000 km^2.

The area includes the Burdekin River catchment; Australia's largest in terms of peak discharge. It covers a diversity of landscapes crossing five bioregions: the Wet Tropics, the

Einasleigh Uplands, the Desert Uplands, the Brigalow Belt North, and a small section of the Central Queensland Coast bioregion on the southern edge. The physical environments include mountain ranges rising to 1,359 m at Mount McCartney in the Clarke Range to the south, 1,221 m at Mount Elliot near Townsville, 1,063 m at Mount Halifax in the Paluma Range to the north and 1,002 m at Mount Tabletop on the Great Dividing Range to the west. Other features include lower rock hills, coastal plains, floodplains, deltas, beach ridges and continental islands. Undulating plains with escarpments and dissected plateaus are found inland to the west. Vegetation types are equally diverse including tropical rainforest, vine thickets, forested swamps, drier woodlands, grassy plains, sedgelands, and coastal mangroves and saltpans.

The area has a tropical sub-humid climate with relatively high temperatures all year round and a pronounced wet and dry season with most rain falling in the warm, humid months of November through to April. Rainfall is highly variably across the region and influenced by monsoonal and cyclonic activity. There is a distinct gradient to drier conditions from the coast westward. Average annual rainfall varies through the area from above 3,000 mm in the coastal peaks of the Seaview and Paluma Ranges to the north, Mount Elliot near Townsville, and the Clarke Range to south, to below 500 mm in the south-west of the Belyando sub-basin. The spatial and seasonal variability and the high interannual variability of rainfall are an overriding characteristic of the study area that greatly influences the nature and distribution of its wetlands. Most streams and wetlands are subject to seasonal flows and are subject to irregular flooding. The exceptions to this are the perennial streams that rise in the high rainfall ranges and the wetlands fed by the large basalt aquifers in the Upper Burdekin sub-basin.

In general, the Burdekin study area can be broadly divided into higher rainfall, more densely populated coastal areas with urban, industrial and irrigated agriculture land uses predominant and lower rainfall, sparsely populated inland areas used principally for rangeland grazing with some dryland agriculture and mining activity. There are several major water storages and large weirs located within the Burdekin study area, the largest being the Burdekin Falls Dam, which was completed in 1987 forming Lake Dalrymple, with a capacity of 1.86 million megalitres. Other major dams include the Ross River Dam, Paluma and Eungella dams.

The Ross basin is the most developed in the study area containing the regional city of Townsville. Many of the streams and wetlands in this basin are highly modified and impacted by water quality contamination and altered hydrology associated with urban development. Other major towns in the study area include Ayr and Home Hill to the south in the Lower Burdekin and Charters Towers in the Upper Burdekin.

The completion of the Burdekin Falls Dam and the subsequent development of the Burdekin-Haughton Water Supply Scheme (BHWSS, previously known as the Burdekin River Irrigation Area (BRIA)) for intensive sugarcane production, has dramatically altered the environmental conditions of the streams and wetlands in the lower floodplain of the Haughton and Lower Burdekin basins. The Lower Burdekin is dominated by the Burdekin River delta, where the coastal plain widens and is prone to widespread flooding, with vast areas of wetlands. The Burdekin Delta and the floodplains and estuaries of the coastal rivers form the Townsville-Burdekin coastal wetland aggregation, one of the most extensive on the Australian east coast. This area includes the wetlands of Bowling Green Bay National Park listed under the international Ramsar Convention. Prior to development, streams in this coastal plain, such as Barratta Creek, consisted of a series of clear or tannin-coloured seasonal in-stream and off-stream lagoons that connected across the floodplain during flood events. Flows were very variable between seasons and interannually. These systems have now been extensively modified. Flows to the streams and wetlands across this floodplain have been radically altered as a result of supplementation through the irrigation delivery system and by irrigation tail waters. This has removed the seasonality in much of the system and in combination with riparian disturbance and nutrient contamination has contributed to extensive weed infestation of wetlands by pasture grasses and aquatic weeds. These impacts have resulted in severe water quality degradation and altered ecology in the wetlands of this coastal plain and presented an enormous task to natural resource managers.

The Don Basin to the south of the Burdekin delta also contains extensive aggregations of coastal wetlands and estuaries. This area has remained one of the least developed along this coast due to relatively low rainfall and the unsuitability of soil types for large-scale irrigated agriculture, although horticulture, largely dependent on ground water, is common in some areas. Although, proposed developments associated with industrial developments at Abbott Point and the Water for Bowen water transfer scheme is likely to increase the pressure on coastal wetlands in this area.

The study area extends more than 300 km westwards, with the Upper Burdekin sub-basin draining the western side of the coastal ranges and the eastern side of the Great Dividing Range. This basin is contained almost entirely in the Einasleigh Uplands. The area contains a major basalt feature with highly productive black and red soils and numerous springs emanating from many locations that drive permanent flow and clear-water waterholes in many streams. This creates not only many significant waterbodies but a wide variety of wetland types. The Burdekin River channel, a large sand and gravel bed channel is another prominent feature. It consists of a small meandering low flow channel bordered by sand and gravel bars which in turn is located within the high flow channel, with established riparian communities. Flow to this channel is almost perennial most years and comes from two sources: tributaries on the western slopes of the high rainfall coastal ranges; and the extensive basalt aquifers formed by the Toomba basalts flows.

The Belyando sub-basin covers a large part of the study area to the south west and includes the Cape-Campaspe, Belyando and Suttor River catchments. The source of the Belyando River in central western Queensland is almost 500 km from the mouth of the Burdekin River, and extends in to the black-soil grasslands of Central Queensland. The Belyando sub-basin contains two bioregions; the Desert Uplands in the west and the Brigalow Belt North bioregion to the east. The Belyando basin is the area that consistently receives the least rainfall in the study area, with streams and wetlands receiving ephemeral or intermittent flows. In contrast to the Burdekin River channel in the Upper Burdekin, the flow capacity of the main channels of the Cape-Campaspe, Belyando and Suttor River is relatively low resulting in braided (anastomosing) river channels with broad floodplains. The extent of water in the floodplain landscape is highly variable and strongly influenced by flood events which create large temporary wetlands and replenish several permanent waterholes that provide key refugia between flow events. Under flood conditions, flows are spread broadly across the floodplain.

The natural vegetation in the western part of the study area, away from the coast, largely consists of dry eucalypt and acacia savannah woodlands on typical infertile laterised soils and includes grasslands of perennial Mitchell and annual Flinders grasses to the west. Cattle grazing is widespread and a major industry in the inland areas. Land degradation, water quality contamination and erosion are major management problems. Consequently, the Burdekin River catchment has been identified as the biggest single source of sediment to the Great Barrier Reef lagoon and is targeted for improved management actions.

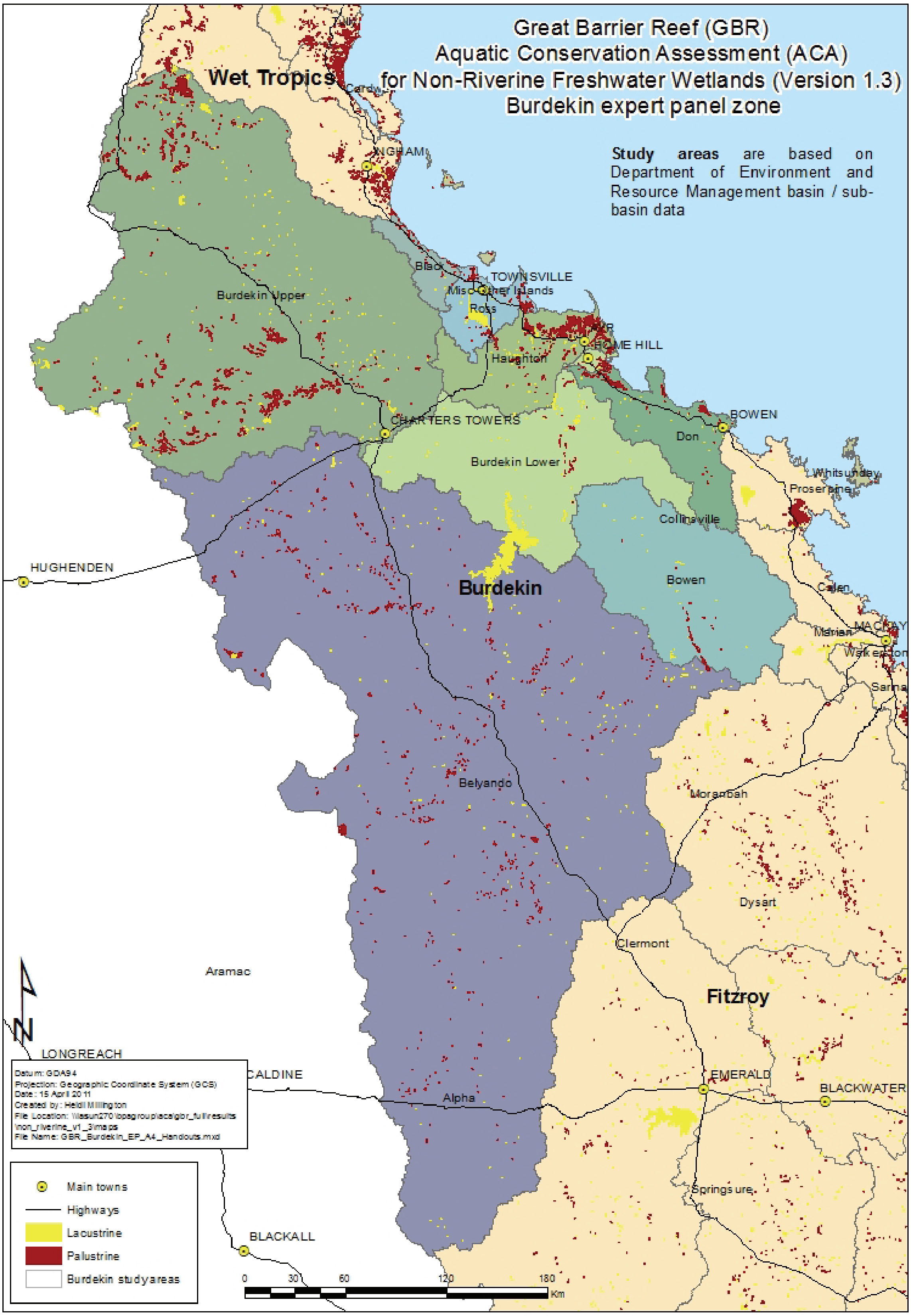

Figure 1 Burdekin section of the GBR catchment (incorporating eight individual catchments)

2.2 Panel composition

The expert panel (the 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 Burdekin section of the GBR catchment.

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
Donna Audas	Project Manager – GBR Wetlands Coastal ecosystems & Water Quality, Great Barrier Reef Marine Park Authority	Coastal ecosystems, GIS and wetlands
Anthony Backer	Senior Planning Officer, Department of Environment and Resource Management	Biodiversity planning and terrestrial ecology
Jon Brodie	Water Quality Scientist, Australian Centre for Tropical Freshwater Research, James Cook University	Water quality and catchment management
Barry Butler	Water Quality Scientist, Australian Centre for Freshwater Tropical Research, James Cook University	Aquatic ecology and water quality
Jason Carter	Business and Natural Resources Manager, Alluvium Consulting Pty Ltd	River and wetland management
Niall Connolly	Principal Conservation Officer, Department of Environment and Resource Management	Biodiversity planning – Aquatic ecology and water quality
Nick Cuff	Senior Botanist, Queensland Herbarium, Department of Environment and Resource Management	Aquatic flora and regional ecosystems
Carol Honchin	Project Manager – GBR Ecosystem Health, Great Barrier Reef Marine Park Authority	Marine ecosystem health and water quality
Brett King	Project Officer, Conservation Volunteers	Natural resource management and conservation
Dominica Loong	Aquatic Ecologist, Australian Centre for Tropical Freshwater Research, James Cook University	Aquatic ecology and water quality
Mal Lorimer	Principal Conservation Officer, Department of Environment and Resource Management	Biodiversity planning – land classification & soils
George Lukacs	Director, Australian Centre for Tropical Freshwater Research, James Cook University	Wetland ecology
Chris Manning	Total Water Cycle Coordinator, Townsville City Council	Water quality improvement and conservation planning
Tim Marsden	Senior Fisheries Biologist (Fishway), Department of Primary Industries and Fisheries	Fish and aquatic ecology
Gethin Morgan	Principal Biodiversity Planning Officer, Department of Environment and Resource Management	Biodiversity planning – landscape ecology
Diana O'Donnell	Programme Coordinator – Water, Burdekin Dry Tropics Natural Resource Management Group	Natural resource management and conservation planning
Tim Perry	Principal Ecologist, NRA Environmental Consultants	Native and exotic vegetation

Name	Position / Organisation	Expertise
Michaelie Pollard	Project Officer (aquatic ecology), Department of Environment and Resource Management	Aquatic ecology
Jim Tait	Ecologist, Ecoconcern Pty Ltd	Wetland ecology and management
Amber Webster	Senior Project Officer, Burdekin Dry Tropics Natural Resource Management Group	Wetland conservation
Carla Wegscheidl	Project Manager, Tide to Table – Burdekin Dry Tropics, OceanWatch Australia	Natural resource management and aquatic ecology
Adam West	Catchment Ecologist, Department of Primary Industries and Fisheries	Land use practices and influences

Selena Inglis 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 the Burdekin River catchment and, where necessary, a background of topographic 1:250,000 maps, roads, rivers and other relevant datasets were used to identify areas of interest. A draft report was circulated to panel members prior to the production of the final report.

3 Special features

The panel identified several non-riverine special features in the Burdekin section of the GBR catchment (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 a wetland ecology special area.

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 6 Special features'. All implemented special features were given a conservation rating of between 1 and 4 as assigned by the panel.

Special feature	Identified values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Belyando River/ Mistake Creek floodplain/ Nairana National Park	The Belyando floodplain area contains many large, deep and persistent billabong waterholes. These waterholes represent important aquatic habitat and drought refuge for fish, crustaceans and other aquatic biota. Turbidity is thought to be natural due to tertiary clay sediments and saline influences from the substrate making it geologically unique. The condition of the wetlands within this area is poorly documented. The area within Nairana National Park has been selected as a representative section of this floodplain system at the junction of the Belyando River and Mistake Creek. This section is a good example of a large inland river floodplain with good riparian habitat. 'Dead Horse Waterhole' occurs within this park and appears to hold surface water on a semi-permanent basis and lies on the edge of 'endangered' brigalow (*Acacia harpophylla*) and/or belah (*Casuarina cristata*) open forest on alluvial plains regional ecosystem (RE 11.3.1). Note: This decision was also included in the riverine ACA assessment (decision number be_r_ec_01). See the Burdekin riverine report for more details.	Belyando	be_nr_ec_01	6.1.1	3

Special feature	Identified values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Webb Lake	The complex includes mapped lakebeds, and the surrounding alluvial sand plain that is confined within a broad seasonally waterlogged depression within a land zone five surface. Numerous small seasonally flooded linear depressions are also present in this confined sand plain. Regional ecosystems that are mapped as part of the wetland complex fall into one of three functional groups: Lakebed: These circular depressions are periodically flooded, and consist entirely of regional ecosystems 10.3.15e and 10.3.15j. Periodically inundated depressions and plains: These depressions occur as a mosaic within the confined sand plain and are seasonally inundated. They are almost entirely 10.3.15e and 10.3.15j. Confined sand plain: The associated sand plain has seasonally high water tables and numerous unmapped linear seasonally flooded depressions. It appears comparable in function to the weathered sand dunes of Lake Buchanan and Lake Galilee. The confined sand plain is largely RE 10.3.12a, with small areas of 10.3.6a, while the unmapped depressions are RE 10.3.15e. Note: 10.3.15e and 10.3.15j cover the full range of the wetland types. They have been divided into functional groups on the basis of their appearance on the satellite image. Note: This decision was a landscape decision under the Desert Uplands Biodiversity Planning Assessment (decision number – deu_l_3). Values listed here are taken from that decision.	Belyando	be_nr_ec_02	6.1.1 6.2.1 6.3.1 6.3.3	4

Special feature	Identified values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Lake Moocha	This complex is confined within a broad seasonally waterlogged depression within land zone five and land zone three surfaces. The complex includes seasonal wetlands, periodically inundated plains, and small adjacent fringing areas. There are also small sandy alluvial fans that adjoin the northern-most wetland, and whose watercourses feed into and distribute from it. The regional ecosystems that are part of the wetland complex fall into one of three functional groups: <u>Lakebed</u>: These depressions are periodically flooded, and consist almost entirely of RE 10.3.15e, with a small area of 10.3.15j. <u>Periodically inundated depressions and plains</u>: There are two areas in this group. The first is a slightly higher surface adjacent to and downstream of the southern lake bed that is predominantly box (10.3.6a), with small areas of river red gum (10.3.15e). The second links the two northern lakebed parts of the complex, and is a low lying plain that appears to have relatively fine textured soils. It is a new polygon that has yet to be field sampled. It is presumed to be primarily box (10.3.6a) but is included in this functional group as a periodically inundated plain. <u>Confined sand plain</u>: There are two different types. The first are fringing areas formed on the narrow slope between the surrounding higher land zone five surface and the drainage depression wetlands. This is likely to be a seasonal discharge zone, with paler soils than the adjacent sand plain surface, and is grouped within this functional category as the best fit. It is entirely 10.5.2a and 10.3.6a. The second type is small current alluvial fans closely associated with the major lake. They are new polygons that have yet to be field sampled, but are presumed to be mainly 10.3.10. <u>Note</u>: This decision was a landscape decision under the Desert Uplands Biodiversity Planning Assessment (decision number – deu_l_3). Values listed here are taken from that decision.	Belyando	be_nr_ec_03	6.1.1 6.2.1 6.3.1 6.3.3	4
Frankfield Swamp	Mapped wetlands (RE 11.3.27) on 'Frankfield' were considered to have an excellent condition rating. <u>Note</u>: This decision was a landscape decision under the Brigalow Belt Biodiversity Planning Assessment (decision number – brbn_l_28). Values listed here are taken from that decision.	Belyando	be_nr_ec_04	6.3.3	4
Reilly's Swamp	Reilly's swamp is an intact *Eucalyptus coolabah* fringed anabranch ecosystem potentially at its northern distributional limit.	Belyando	be_nr_ec_06	6.3.1	4
Harvest Home wetland	The Harvest Home wetland contains relatively intact vegetation, including a rare palm species and good waterbird habitat.	Belyando	be_nr_ec_07	6.3.1	3

Special feature	Identified values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Longweed Lagoon & Bulgrum Waterhole	The Longweed Lagoon and Bulgrum Waterhole are permanent deep water wetlands fringed by *Eucalyptus coolabah*. Despite suffering impacts from pigs the area contains good waterbird habitat.	Belyando	be_nr_ec_08	6.3.1	3
Twin Hills Lagoon	Twin Hills lagoon is a large permanent waterhole on Mistake Creek. This lagoon is a representative example of large permanent in-stream lagoons in Mistake Creek and other large riverine systems of the lower Belyando-Suttor catchment. These differ from water bodies in other parts of the Burdekin basin because they are persistently highly turbid with generally no or limited growth of submerged aquatic macrophytes. Their benthic substratum is generally fine mud over heavy black clay.	Belyando	be_nr_ec_09	6.1.1	3
Billillbania Lagoon	Billillbania Lagoon is an excellent large example of a uncleared and hydrologically unmodified Belyando floodplain lagoon retaining native floodplain woodland, ground covers and emergent wetland vegetation (ACTFR 1999). The lagoon contains waterfowl habitat values and is the only local site noted to retain native species of cherax crayfish in the face of an aggressive invasion of translocated redclaw crayfish (*Cherax quadricarinatus*) in upper the Burdekin / Belyando basin.	Belyando	be_nr_ec_10	6.3.1 6.4.1	3
Remnant vegetation surrounding Webb Lake and Lake Moocha	The area surrounding the wetland complexes described in the Desert Uplands Biodiversity Planning Decision deu_l_3 is identified as having special biodiversity value for the long-term functioning of the wetland and is rated very high for wildlife refugia. Where more than 50 per cent of the extent of adjacent remnant units is within this 500 metre buffer the unit should be identified as state significant. <u>Note</u>: This decision was a landscape decision in the Desert Uplands Biodiversity Planning Assessment (deu_l_18). Whilst the panel recommended this decision be included, further investigation revealed the decision is related to the terrestrial component of the non-riverine wetlands and as such can not be included in the ACA. However the values are identified in the DEU BPA v1.2.	Belyando	be_nr_ec_11_not_implemented	6.3.1 6.3.3	

Special feature	**Identified values**	**Catchment**	**Decision implementation number**	**Criteria/ indicator/ measure**	**Conservation rating (1-4)**
Remnant vegetation surrounding Powlathanga Lake	The area surrounding the wetland complexes described in Desert Uplands Biodiversity Planning Assessment decision deu_l_3 is identified as having special biodiversity value for the long-term functioning of the wetland and is rated very high for wildlife refugia. Where non-remnant adjoins the complex, the buffer is reduced to 200 m, and is also of state significance. Note: This decision also a landscape decision in the Desert Uplands Biodiversity Planning Assessment (deu_l_21). Whilst the panel recommended this decision be included, further investigation revealed the decision is related to the terrestrial component of the non-riverine wetlands and as such can not be included in the ACA. However the values are identified in the DEU BPA v1.2.	Belyando	be_nr_ec_12_not_implemented	6.3.1 6.3.3	NA
Moongabulla/ Hencamp-Balgal swale swamps	Moongabulla has significant threatened/listed species values, extensive examples of seasonally inundated woodlands in relatively good condition and is an intact remnant area of seasonal lowland palustrine wetlands in the southern Wet Tropics bioregion, a vegetation type which has been heavily impacted elsewhere in the southern area of the bioregion. There is connectivity from the World Heritage Area ranges through to the riparian areas of Ollera and other creek systems. These palustrine wetlands are also thought to provide a filtering function for waters entering the Great Barrier Reef catchment. The area provides important intact habitat for the mahogany glider (*Petaurus gracilis*) and other rare and threatened species. The overall intactness of the heterogeneous coastal plain landscape mosaic, including its riverine, palustrine and marine wetlands, is a key value. Specific sites include Ant Plant Swamp, Ollera – Scrubby Creek Swamp, Ollera Creek estuary and swale swamps, Hencamp–Balgal estuaries and coastal swamps, Rollingstone Paperbark Swamp (See Tait, 2006c for more information on these sites). The Hencamp coastal swale swamp identified in this decision also has some of the best developed and condition beach ridge vine thickets in the region.	Black	bk_nr_ec_01	6.2.1 6.3.1	4
Saunders Beach swales	This swale aggregation is a swale swamp containing unique and diverse floristic values. This site is widely considered to have good conservation values.	Black	bk_nr_ec_03	6.3.3	2

Special feature	Identified values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Coastal dune swales Taylor's and Forest Beach area	The habitats of the coastal swales surrounding Taylor's Beach are in very good condition compared to other swale systems. The area contains special geomorphic and hydrological features contributing to special habitat values. The site includes various wetland types containing mangrove and *Melaleuca* species and supports significant wildlife populations including a pair of great billed herons (*Ardea sumatrana*) and one of the biggest populations of the apollo jewel butterfly (*Hypochrysops apollo apollo*). Note: This decision is a revised decision based on decision number he_ec_12 (Herbert wetland ecology expert panel 2007).	Black	bk_nr_ec_04	6.1.1 6.3.1 6.4.1	4
Bohle River back levee lagoons	An area containing some of the last representative examples of Bohle River floodplain lagoons which elsewhere on the floodplain, are impacted by clearing, weeds, urbanisation and hydrological modification. Hydrology varies from near perennial for larger lagoons to seasonal for smaller sites. Includes good examples of melaleuca dominated riparian vegetation and native emergent communities (See Tait, 2006b). Note: Although this special area was considered for inclusion it has not been implemented in this assessment due to the highly modified state of the site.	Black	bk_nr_ec_05_not_implemented	6.3.1 8.2.5	
Strathalbyn Station levee woodland and lagoons	This uncleared Burdekin River levee is representative of the alluvial landform ecosystems that have been largely converted to agriculture in the lower floodplain. It includes blue gum dominated woodland (historically occupied by koala (*Phascolarctos cinereus*)), floodplain lagoons and seasonally flooded grasslands / palustrine swamps.	Burdekin Lower	bl_nr_ec_01	6.3.1 8.2.5	4
Swans Lagoon Millaroo	This Burdekin River back levee lagoon is largely upstream of irrigation tailwater inputs ensuring the retention of natural hydrology, water quality and macrophyte communities, seasonally important to waterbirds. The area retains a good freshwater fish community though catadromous species populations are impacted by a downstream barrier (Clare weir).	Burdekin Lower	bl_nr_ec_02	6.3.1	4
Eight Mile Creek Confluence Lagoon Dalbeg	This Burdekin River back levee lagoon is largely upstream of irrigation tailwater inputs ensuring the retention of natural hydrology, water quality and macrophyte communities, seasonally important to waterbirds. The area retains a good freshwater fish community though catadromous species populations are impacted by a downstream barrier (Clare weir).	Burdekin Lower	bl_nr_ec_03	6.2.1 6.4.1	4
Lower Landers Creek	Site is hydrologically modified and receives a significant percentage of its flow from tailwater discharge from the Millaroo irrigation area however this is lower now. The perennial reaches support well developed riparian forest community and provide clear water sub catchment refugia for modified Burdekin main river channel.	Burdekin Lower	bl_nr_ec_04	6.3.1	3

Special feature	Identified values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Kinnrara/ Valley of Lagoons	The Kinnrara/Valley of Lagoons aggregation contains riverine, lacustrine and palustrine wetlands in a complex continuous aggregation of spring fed, permanent and seasonal wetlands. The basalt soil system is listed as a significant wetland on the Directory of Important Wetlands (DIWA). The aggregation is large, unique and biologically rich constituting an outstanding geological phenomenon with high aesthetic value. It is a particularly good example of a wetland complex in the headwaters of the Burdekin River. The aggregation provides habitat for significant flora and fauna populations boasting rare and endangered regional ecosystems, good biomass production and high fish diversity and is on a flight migration route to the southwest of Cape York Peninsula. The site was also nominated as a special area in the Einasleigh Uplands Biodiversity Planning Assessment where values included were: * refugia and spawning area for *Macropus dorsalis*, sooty grunter (*Hephaestus fuliginosus*), small headed grunter (*Scortum parviceps*) and other species associated with lagoons; * international significance for cotton pygmy goose (*Nettapus coromandelianus*); and * significant vine thicket species. <u>Note</u>: This decision was also included in the riverine ACA assessment (decision number bp_r_ec_01). See the Burdekin riverine report for more details.	Burdekin Upper	bp_nr_ec_01	6.1.1 6.3.1 6.4.1	4
Great Basalt Wall	The Great Basalt Wall contains a series of wetlands that range significantly in wetland type. The area boasts an endemic grass species (*Digitaria basaltica*) as well as unique geomorphology being one of the youngest basalt flows in Queensland and is protected from cattle grazing.	Burdekin Upper	bp_nr_ec_02	6.1.1	4
Wetland complexes	This decision covers 12 wetland complexes in the Einasleigh Uplands bioregion. These wetlands were considered to be so significant at the landscape scale. These complexes were identified as being important as wildlife refugia, containing high species richness and a high density of hollow-bearing trees. Additionally, these complexes were considered to be important for taxa at the limit of their ranges, provided significant breeding and roosting sites and were known to contain regional ecosystems with distinct variation. <u>Note</u>: This decision is also a landscape decision in the Einasleigh Uplands Biodiversity Planning Assessment (decision number eiu_l_9) but implementation of this decision is subject to the finalisation and release of the Einasleigh Uplands Biodiversity Planning Assessment report.	Burdekin Upper	bp_nr_ec_03_not_implemented	6.3.3	

Special feature	Identified values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Artesian Springs	The biodiversity value of springs as refuges varies widely depending on their condition and reliability of discharge. Fensham and Fairfax from the Queensland Herbarium have mapped, assessed and classified springs in the Einasleigh Uplands (Fensham and Fairfax 2002). Class 3 and 4 springs are rated as high as wildlife refugia. Note: This decision is also a landscape decision in the Einasleigh Uplands Biodiversity Planning Assessment (decision number eiu_l_8).	Burdekin Upper	bp_nr_ec_04	6.4.1	3
Artesian Springs	The biodiversity value of springs as refuges varies widely depending on their condition and reliability of discharge. Fensham and Fairfax from the Queensland Herbarium have mapped and classified springs in the Einasleigh Uplands (Fensham and Fairfax 2002). Class 1 and 2 springs are rated as very high as wildlife refugia. Note: This decision is also a landscape decision in the Einasleigh Uplands Biodiversity Planning Assessment (decision number eiu_l_7).	Burdekin Upper	bp_nr_ec_05	6.4.1	3
Southern upstart bay/ Elliot River	This special feature contains a series of small ephemeral freshwater wetlands less than one hectare in size. The wetlands have unique geomorphology, contain swale wetlands and are considered to hold high conservation value due to limited habitat modification and minimal grazing. The site is a relatively intact delta that boasts a high diversity of habitats and good connectivity between the dunal areas, freshwater wetlands and the estuarine/marine habitats.	Don	do_nr_ec_01	6.1.1 6.3.1	4
Wangaratta Creek wetlands/ Wunjunga	This special area contains a reasonably intact example of RE 11.3.27x1c, a restricted habitat type. The site provides good foraging habitat for waterbirds and other species and is thought to be important for fish breeding and spawning. This wetland connects to Yellow Gin Creek/ Saltwater Creek estuarine system and complex dune systems that are all in very good condition with high values. It is a large site connected to relatively intact systems including estuarine ecosystems. The area has very little intensive agricultural development in its catchment compared to other coastal areas in the Burdekin. This wetland is similar in its values to the Caley Valley wetlands.	Don	do_nr_ec_02	6.3.1	4

Special feature	Identified values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Splitters Creek	The riverine and non-riverine wetlands of Splitters Creek contain a good diversity of flora species in an intact riparian zone such as *Potamogeton* and seasonal bulkuru (*Eleocharis dulcis*). The area also has good connectivity with estuarine areas providing good habitat for crocodiles and various species of bird and fish. Note: This decision was also included in the riverine ACA assessment (decision number do_r_ec_01). See the Burdekin riverine report for more details.	Don	do_nr_ec_03	6.3.1	4
Saltwater Creek wetlands	The wetlands in this area contain a good diversity of native macrophyte species in permanent water. Despite being a regulated (South Burdekin Water Board) distributary system, the area contains good riparian vegetation remnant, fish and waterbird habitat.	Don	do_nr_ec_04	6.3.1	3
Lillesmere Swamp	Lillesmere Swamp is important within the context of the Lower Burdekin region. Although it is highly impacted by weed infestation, hydrological modification and nutrient loading (being used as a source of cooling water for an adjoining sugar mill), it contains good floral diversity and good fish habitat.	Haughton	ha_nr_ec_01	6.3.1	2
Northern Bowling Green Bay wetlands	The Northern Bowling Green Bay wetlands are the most reliable and extensive wetlands left in the lower Burdekin providing an important buffer and filter zone between the cane fields and the estuarine areas. Part of the area is listed as a significant wetland system under the Ramsar convention and the DIWA also identifies the area as being significant because the site contains a diverse complex of coastal wetland systems formed on four broad physiographic types viz., mountainous areas of Cape Cleveland and Feltham Conex, elevated parallel dune systems, coastal plain wetlands and an actively prograding sand spit at Cape Bowling Green. Over most of the site, coastal mangrove communities give way inland to the highly saline communities of the salt pans which in turn lead to the brackish and freshwater communities of the lower lying coastal plain further inland. These lowland areas are typified by communities whose dominant ecological characteristic is a tolerance of saline conditions. Extensive areas of forest and woodland, and some closed forest, occur on the mountainous areas and the coastal dune system.	Haughton	ha_nr_ec_02	6.2.1	4

Special feature	Identified values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Upper Barratta Creek	This site is a floodplain distributary creek system with a relatively intact upper catchment. There is several thousand hectares of well connected habitat included in the overall site including three DIWA sites, Barratta channels, Jerona and Townsville-Burdekin. Non-riverine wetlands have a history of grazing and retention of native macrophyte communities. Retained corridors are from one kilometre up to several kilometres wide. Thus ecotonal and back levy communities have been retained. The site is also a breeding habitat for crocodiles and black-throated finch (*Poephila cincta*). The sites values are largely captured in the DIWA site listings for Barratta Channels Aggregation Qld [196] and the Jerona Aggregation Qld [201]. A key feature of the palustrine wetlands in this area is the retention of thousands of hectares of floodplain vegetation, including riparian and back levee swamps, retained during the development of the Burdekin-Haughton Water Supply Scheme (see Tait and Veitch, 2007).	Haughton	ha_nr_ec_03	6.3.1	4
Horseshoe Lagoon and downstream palustrine wetlands to tidal limit	This natural, relatively large coastal floodplain lake is well connected by riparian forest to surrounding deepwater lagoons and coastal bulkuru sedge swamp. The area provides good waterfowl and fish habitat including suitable breeding sites. The condition of the ecosystem is being affected by irrigation tail-water inputs and weed infestation however active management has been implemented. Note: This decision was also included in the riverine ACA assessment (decision number ha_r_ec_05). See the Burdekin riverine report for more details.	Haughton	ha_nr_ec_04	6.3.1	3
Kelly's Lagoon	Kelly's Lagoon is a fauna sanctuary. It is a remnant delta lagoon uninfluenced by irrigation. It has diverse and abundant aquatic macrophytes. The area retains quality natural clear blackwater and a native macrophyte community. The site is hydrologically modified by flow augmentation in the broader catchment. The lagoon also contains examples of alluvial levee riparian woodland and palustrine emergent communities (see Tait, 2005 a&b).	Haughton	ha_nr_ec_05	6.2.1 6.3.1	2
Kelly’s Seasonal Swamp – Sheep Station Creek	This swamp is the only example of a hydrologically unmodified large seasonal palustrine wetland in the upper catchment of Sheep Station Creek (see Tait, 2005 a&b). The site has been continuously grazed but retains good native ground cover and emergent wetland vegetation including the listed species frogbit (*Hydrocharis dubia).* The area also seasonally hosts large waterbird populations including breeding colonies of several species.	Haughton	ha_nr_ec_06	6.3.1	3

Special feature	Identified values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Castelanelli's Lagoon – Sheep Station Creek	Castelanelli's Lagoon is a subcatchment lagoon with groundwater hydraulic head (preventing inflow of pumped artificial flows) that retains quality natural clear blackwater and a native macrophyte community. The site contains examples of alluvial levee riparian woodland and palustrine emergent communities also present. The site has acted as biological refugia for fish community when broader catchment experienced ecosystem collapse due to catchment wide weed infestation and is currently undergoing revegetation with parts seasonally grazed (see Tait, 2005 a&b).	Haughton	ha_nr_ec_07	6.3.1 6.4.1	3
Highway Wetland – Sheep Station Creek	This site is hydrologically modified by irrigation tailwater inputs but retains good, rare example of *Melaleuca dealbata* swamp forest. Seasonally important for waterbirds including nesting magpie geese (see Tait, 2005 a&b). <u>Note</u>: This special area was considered for inclusion but has not been implemented in this assessment due to the highly modified state of the site.	Haughton	ha_nr_ec_08_not_implemented	5.2.1 6.3.1	
Flood Runner Confluence – Sheep Station Creek	This site is a diverse habitat complex comprised of a remnant seasonal flowing Burdekin River flood runner distributary channel with remnant riparian woodland typical of alluvial landforms developed to agriculture. This site is in a sub catchment upstream of flow augmentation and therefore is representative of the pre–hydrologically modified floodplain and illustrates the historical natures of floodplain distributary creek systems such as Sheep Station Creek. Downstream the site joins the flow augmented Sheep Station Creek channel which has developed a closed canopy riparian forest reach which includes rainforest elements in the presence of perennial flow that is protected from burning. Downstream of this site is Rose's Lagoon the most upstream main channel lagoon in the creek system (see Tait, 2005 a&b). <u>Note</u>: This special area was considered for inclusion but has not been implemented in this assessment because it is too modified (H2M8).	Haughton	ha_nr_ec_09_not_implemented	6.4.1	
Hoey's Hole – Didgeridoo Lagoons	This high value deepwater lagoon habitat has a large breeding population of estuarine and freshwater crocodiles and well connected catadromous fish populations. The area has retained riparian vegetation that includes poorly conserved examples of swamp tea-tree (*Melaleuca dealbata)* woodland. The site receives irrigation tailwater but lower lagoons establish 'natural' clear blackwater quality (see Tait and Veitch, 2007). <u>Note</u>: This decision could not be implemented due to lack of non-riverine wetland mapping in this area.	Haughton	ha_nr_ec_10_not_implemented	6.3.1	

Special feature	Identified values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Gilgai paperbark forest remnant Collinsons Creek catchment	This site lies upstream of the Collinson's lagoon complex within the broader Barratta Creek catchment and is essentially the last representative stand of a dense swamp forest / soil association (*Melelaeuca dealbata* on heavy clay gilgai) that was historically widespread across the coastal margin of the older Burdekin floodplain. Livistona occurs as a sub storey beneath the paperbark canopy and a host of native emergent macrophytes occur in seasonally filled gilgai depressions. The site represents the natural broad drainage depression of the floodplain but has also been hydrologically modified by an irrigation scheme area drain running through it (see Tait and Veitch, 2007). Note: This decision could not be implemented due to lack of non-riverine wetland mapping in this area.	Haughton	ha_nr_ec_11_not_implemented	5.2.1	
Horseshoe Bay lagoon - Magnetic Island	This site has complex geomorphology typical of a behind dune system. The lagoon is significant because not only it is the only big wetland on Magnetic island but few other islands have wetlands of this type. The lagoon also provides important habitat for waterbirds.	Misc Other Islands	oi_nr_ec_01	6.1.1 6.3.1	4
Cleveland Bay (also known as Riley's Wetland)	Cleveland Bay boasts high flora values, in a transitional wetland environment transitioning from freshwater to saline influences. The site is an excellent example of its kind being unique given the surrounding land use and containing low weed abundances. Cleveland Bay is a good example of coastal ecological process which is becoming rarer on the coast given coastal development.	Ross	ro_nr_ec_01	6.2.1	4
Townsville Town Common	Townsville Town Common boasts a complexity of habitat size, fauna values, reptiles and birds with high biomass production. It has recently been identified as a new location for *Paspalidium udum*. The site is significantly under threat from weed invasion and declining water quality caused by surrounding land uses such as nearby sewerage treatment plants.	Ross	ro_nr_ec_02	6.3.1	3
Artesian Springs	Any artesian springs with medium to high conservation priorities should be included. See brbs_l_20 for more information. Note: None of the springs this decision refers to occur in the Burdekin catchment and therefore this decision could not be implemented in this assessment. However other separate spring decisions are picked up as bp_nr_ec_04 and bp_nr_ec_05.	Various	NA	6.4.1 6.3.3	

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 for the non-riverine wetlands of the GBR catchment. After some time discussing connectivity for non-riverine wetlands, the panel members agreed that connectivity Criterion 7 be turned off for the GBR non-riverine ACA due to issues associated with its implementation (including method of implementation and resources). The following sections detail discussions from the panel regarding the implementation of non-riverine connectivity in the Burdekin section of the GBR catchment and possible options for future investigation.

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 riverine and non-riverine wetlands can often be directly linked in quantity and quality to the movement of resources, such as water, sediment, debris, recruitment and distribution of species, between wetland systems and adjoining terrestrial lands (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).

4.2 Applying principles for measuring connectivity

The practicalities of measuring connectivity in both riverine and non-riverine environments 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 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.

One suggestion was to use aerial photography showing one in five year flood events to identify the connectivity of wetland systems in conjunction with the wetland mapping. This analysis would identify the extent of connectivity for non-riverine wetlands and enable thresholds to be developed for when particular non-riverine wetlands are connected to a riverine wetland. It was however identified that this would become an issue for those wetlands that do not rely on flood events, such as those that are groundwater fed or fed from seepage areas. In addition to this, there is difficulty in obtaining the hydrological data and having the

satellite imagery to interpret the connectivity. There would also be a significant investment of time and resources to undertake an assessment such as this.

The panel noted that in a number of areas within the Burdekin, fish move into other areas during flood events and this provides good temporal connectivity. However, fish that move to these new areas may or may not survive.

The panel agreed that where there is connectivity between riverine and non-riverine wetlands, these non-riverine wetlands should be given a higher connectivity value. It was suggested that the main river channels be buffered and any non-riverine wetlands that intersect the buffer can be considered to be connected. However some areas may not have a main river channel going through (possibly due to the scale of the wetland mapping) but the non-riverine wetlands are still connected. This approach will be considered for future investigation and implementation.

4.4 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 panel suggested assigning a three to an area with hydrological estuarine connectivity and a four to an area that has freshwater wetlands and hydrological estuarine and/or biological connectivity. Whilst this approach has merit, issues associated with its implementation (including method and resources) meant that it could not be implemented in this assessment. This approach will be considered for future investigation and implementation.

5 Stratification

Study area stratification for application to relevant Measures of AquaBAMM is a user decision and is not mandatory for 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 limited to 150 m above sea level (ASL) for coastal flowing catchments and 400 m ASL for catchments west of the Great Dividing Range in the Murray-Darling Basin.

Stratification was considered by the Burdekin wetland ecology panel and it was determined that the following stratification would be applied in the respective catchments:

- Belyando – Desert Uplands/Brigalow Belt bioregion boundary in the western part of the subcatchment.
- Black – break of slope based on 150 m ASL.
- Bowen – eastern part of Desert Uplands/Brigalow Belt bioregion boundary.
- Burdekin lower – 150 m ASL.
- Burdekin upper – any subsections that adjoin the Wet Tropics bioregion.
- Haughton and Ross – break of slope based on 150 m ASL with Mt Stuart, The Pinnacles, Castle Hill and Cape Cleveland to be included in the lower stratification.

After further investigation post panel, to maintain consistency with other ACAs and to reduce the complexity of the calculations, it was decided to stratify using 150 m ASL for the Burdekin Lower and Haughton study areas and the Desert Uplands\Brigalow Belt bioregional boundary the Belyando study area. The panel noted that whilst the bioregional boundary is terrestrial, it does reflect relatively abrupt changes in aquatic diversity and richness.

Spatial units above 150 m ASL were grouped together as "upland" for the purpose of measures calculation. Spatial units below 150 m ASL were grouped together as "lowland" for the purpose of measures calculation. Spatial units containing the 150 m ASL contour were allocated to one or other stratum according to the elevation of the majority of the spatial unit (e.g. "upland" where more than 50 per cent of the spatial unit's area is more than 150 m ASL). When stratification is applied to the spatial units in an ACA, a separate set of measure thresholds is calculated for each stratum (refer Clayton *et al.* 2006).

6 Weighting of measures

The panel members that attended the nine 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 weight.
2. Weight the other measures within each indicator compared to the weighting of 10 assigned in the first step.
3. Different measures may have the same weight (i.e. all measures could be weighted 10).
4. Some indicators only have one measure and have already been given a weighting of 10.
5. Don't weight a measure 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 all three expert panel zones within the Great Barrier Reef study area, rather than average the weights for each zone or study area.

The final weights for each measure were then applied in the AquaBAMM assessment (Table 3). The measure number in Table 3 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 3 The average weights for each measure

Maximum score is 10; total number of participants was approximately 20.

Criteria & indicators	Measures		Weighting
1 Naturalness aquatic			
1.1 Exotic flora/fauna	1.1.1	Presence of 'alien' fish species within the wetland	7.6
	1.1.2	Presence of exotic aquatic and semi-aquatic plants within the wetland	9.9
	1.1.3	Presence of exotic invertebrate fauna within the wetland	5.9
	1.1.4	Presence of feral/exotic vertebrate fauna (other than fish) within the wetland	7.2
1.4 Hydrological modification	1.4.5	Hydrological disturbance/modification of the wetland (e.g. as determined through DERM wetland mapping and classification)	9.9
2 Naturalness catchment			
2.1 Exotic flora/fauna	2.1.1	Presence of exotic terrestrial plants in the assessment unit	10
2.2 Riparian disturbance	2.2.5	Per cent area of remnant vegetation relative to pre-clearing extent within buffered non-riverine wetland: 500 m buffer for wetlands >= 8Ha, 200 m buffer for smaller wetlands	10

Criteria & indicators	Measures		Weighting
2.3 Catchment disturbance	2.3.1	Per cent "agricultural" land-use area (i.e. cropping and horticulture)	8.9
	2.3.2	Per cent "grazing" land-use area	7.7
	2.3.3	Per cent "vegetation" land-use area (i.e. native veg + regrowth)	9.1
	2.3.4	Per cent "settlement" land-use area (i.e. towns, cities, etc)	8.8
2.4 Flow modification	2.4.1	Farm storage (overland flow harvesting, floodplain ring tanks, gully dams) calculated by surface area	9.0
3 Diversity and richness			
3.1 Species	3.1.2	Richness of native fish	9.8
	3.1.3	Richness of native aquatic dependent reptiles	8.2
	3.1.4	Richness of native waterbirds	8.8
	3.1.5	Richness of native aquatic plants	9.5
	3.1.6	Richness of native amphibians (non-riverine wetland breeders)	8.8
	3.1.7	Richness of native aquatic dependent mammals	7.8
3.2 Communities/ assemblages	3.2.1	Richness of macroinvertebrate taxa	9.2
3.3 Habitat	3.3.2	Richness of wetland types within the local catchment (e.g. SOR[1] sub-section)	9.4
	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 – NC Act[2], EPBC Act[3]	9.8
	4.1.2	Presence of rare or threatened aquatic ecosystem dependent flora species – NC Act[2], EPBC Act[3]	9.8
4.2 Communities/ assemblages	4.2.1	Conservation status of wetland Regional Ecosystems – Herbarium biodiversity status, NC Act[2], EPBC Act[3]	10
5 Priority species and ecosystems			
5.1 Species	5.1.1	Presence of aquatic ecosystem dependent 'priority' fauna species (expert panel list/discussion or other lists such as ASFB, WWF, etc)	9.6
	5.1.2	Presence of aquatic ecosystem dependent 'priority' flora species	9.7
	5.1.3	Habitat for, or presence of, migratory species (expert panel list/discussion and/or JAMBA[4] / CAMBA[5] agreement lists and/or Bonn Convention)	8.9
	5.1.4	Habitat for significant numbers of waterbirds	8.7
5.2 Ecosystems	5.2.1	Presence of 'priority' aquatic ecosystem	10
6 Special features			
6.1 Geomorphic features	6.1.1	Presence of distinct, unique or special geomorphic features	10
6.2 Ecological processes	6.2.1	Presence of (or requirement for) distinct, unique or special ecological processes	10
6.3 Habitat	6.3.1	Presence of distinct, unique or special habitat (including habitat that functions as refugia or other critical purpose)	9.4
	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	8.1
	6.3.3	Ecologically significant wetlands identified through expert opinion and/or documented study	9.1
6.4 Hydrological	6.4.1	Presence of distinct, unique or special hydrological regimes (e.g. spring fed stream, ephemeral stream, boggomoss)	10
8 Representativeness			
8.1 Wetland protection	8.1.1	The per cent area of each wetland habitat type within Protected Areas	10

Criteria & indicators	Measures		Weighting
	8.1.2	The per cent 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*	8.9
8.2 Wetland uniqueness	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)	8.5
	8.2.2	The relative abundance of the wetland management group to which the wetland habitat belongs within the subcatchment or estuarine/marine zone (management groups ranked least common to most common)	8.8
	8.2.3	The size of each wetland habitat relative to others of its management group within the catchment or study area	7.6
	8.2.4	The size of each wetland habitat relative to others of its management group within a subcatchment (or estuarine zone)	7.9
	8.2.5	Wetland habitat representative of the study area – identified by expert opinion	9.4
	8.2.6	The size of each wetland habitat relative to others of its 'type' within the catchment or study area	8.0

[1] SOR – State of the Rivers
[2] NC Act – Nature Conservation Act 1992 (Queensland legislation)
[3] EPBC Act – Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth legislation)
[4] JAMBA – Japan Australia Migratory Bird Agreement
[5] CAMBA – China Australia Migratory Bird Agreement

7 Ranking of indicators

The panel members that attended the nine workshops ranked the indicators within each criterion. Indicators were ranked according to their importance to a criteria and based on the following rules:

1. At least one indicator within each criterion must be ranked 1 which is the highest ranking.
2. Rank the other indicators within each criterion relative to the ranking of 1 assigned in the first step.
3. Different indicators may have the same ranking (i.e. all indicators may be ranked 1).
4. Don't rank an indicator 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 all three expert panel zones within the GBR study area, rather than average the ranks for each zone or study area.

The final ranks for each indicator were then applied in the AquaBAMM assessment (Table 4).

Table 4 The average rank for each indicator

Maximum rank is 1; total number of participants was approximately 20.

Indicator	Description	Ranking
1 Naturalness aquatic		
1.1	Exotic flora/fauna	2
1.4	Hydrological modification	1
2 Naturalness catchment		
2.1	Exotic flora/fauna	3
2.2	Riparian disturbance	3
2.3	Catchment disturbance	1
2.4	Flow modification	2
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	2
4.2	Communities/ assemblages	1
5 Priority species and ecosystems		
5.1	Species	2
5.2	Ecosystems	1
6 Special features		
6.1	Geomorphic features	3
6.2	Ecological processes	2
6.3	Habitat	1
6.4	Hydrological	3
8 Representativeness		
8.1	Wetland protection	2
8.2	Wetland uniqueness	1

Attachments

Attachment A – GBR catchment study area

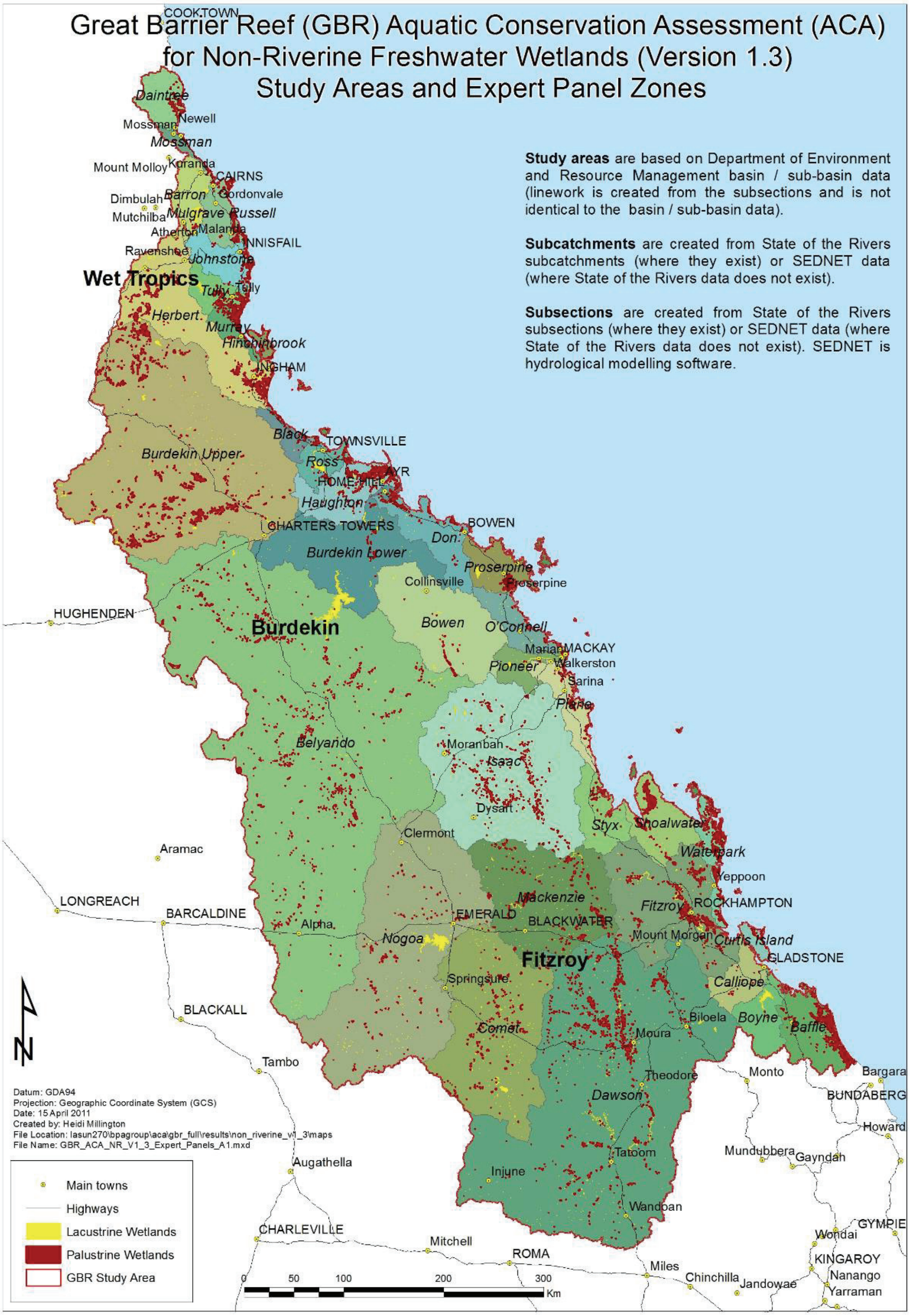

Figure 2 GBR catchment study area

Attachment B – Terms of reference (wetland ecology 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 gain information for 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 of the GBR catchment. Experience in the identification and assessment of riverine and non-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 riverine and non-riverine wetlands of the GBR. The panel consisted of professionals in fields of expertise relating to riverine and wetland ecology, water quality, geomorphology, fisheries and hydrological processes.

The tasks undertaken by the panel included, but without limitation, 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
- 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 GBR catchment

The criteria, indicators and measures (CIM) list outlines the CIM that were implemented as part of the non-riverine Aquatic Conservation Assessment (ACA) using AquaBAMM of the freshwater wetlands of the GBR catchment.

The list has been developed from a default list of CIM that may be considered when an Aquatic Conservation Assessment (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. AquaBAMM does allow addition or deletion of indicators and/or measures for each ACA when its assessment parameters are set. However, 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 5 CIM list for the GBR catchment

Criteria & indicators	Measures	
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
1.4 Hydrological modification	1.4.5	Hydrological disturbance/modification of the wetland (e.g. as determined through DERM wetland mapping and classification)
2 Naturalness catchment		
2.1 Exotic flora/fauna	2.1.1	Presence of exotic terrestrial plants in the assessment unit
2.2 Riparian disturbance	2.2.5	Per cent area of remnant vegetation relative to preclear extent within buffered non-riverine wetland: 500 m buffer for wetlands >= 8Ha, 200 m buffer for smaller wetlands
2.3 Catchment disturbance	2.3.1	Per cent "agricultural" land-use area (i.e. cropping and horticulture)
	2.3.2	Per cent "grazing" land-use area
	2.3.3	Per cent "vegetation" land-use area (i.e. native veg + regrowth)
	2.3.4	Per cent "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	3.1.2	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
3.3 Habitat	3.3.2	Richness of wetland types within the local catchment (e.g. SOR sub-section)
	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[1], EPBC Act[2]
	4.1.2	Presence of rare or threatened aquatic ecosystem dependent flora species – NC Act[1], EPBC Act[2]

Criteria & indicators	Measures	
4.2 Communities/ assemblages	4.2.1	Conservation status of wetland Regional Ecosystems – Herbarium biodiversity status, NC Act[1], EPBC Act[2]
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)
	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[3]/CAMBA[4] 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)
8 Representativeness		
8.1 Wetland protection	8.1.1	The per cent area of each wetland habitat type within protected areas
	8.1.2	The per cent 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*
8.2 Wetland uniqueness	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)
	8.2.2	The relative abundance of the wetland management group to which the wetland habitat belongs within the subcatchment or estuarine/marine zone (management groups ranked least common to most common)
	8.2.3	The size of each wetland habitat relative to others of its management group within the catchment or study area
	8.2.4	The size of each wetland habitat relative to others of its management group within a subcatchment (or estuarine zone)
	8.2.5	Wetland habitat representative of the study area – identified by expert opinion
	8.2.6	The size of each wetland habitat relative to others of its 'type' within the catchment or study area

[1] NC Act – *Nature Conservation Act 1992* (Queensland legislation)
[2] EPBC Act – *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth legislation)
[3] JAMBA – Japan-Australia Migratory Bird Agreement
[4] CAMBA – China-Australia Migratory Bird Agreement

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Attachment G GBR catchments ACA – Aquatic flora expert panel report (Fitzroy region)

An Aquatic Conservation Assessment for the non-riverine wetlands of the Great Barrier Reef catchment

Aquatic flora Expert panel report

(Version 1.3)

Fitzroy region

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Acronyms and abbreviations

ACA	Aquatic Conservation Assessment
ASL	Above sea level
BPA	Biodiversity Planning Assessment
DERM	Department of Environment and Resource Management
DIWA	Directory of Important Wetlands
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
GBR	Great Barrier Reef
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

1 Introduction

The Department of Environment and Resource Management (DERM) conducted an Aquatic Conservation Assessment (ACA) for the non-riverine wetlands in the Great Barrier Reef (GBR) catchment using the Aquatic Biodiversity Assessment and Mapping Method (AquaBAMM; Clayton *et al*. 2006). The ACA relied upon 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 GBR catchment.

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 GBR catchment is made up of 35 individual catchments from the Daintree River north of Cairns, to Baffle Creek south of Gladstone. DERM applied AquaBAMM separately to the non-riverine (palustrine and lacustrine) and riverine wetlands within each of the 35 GBR catchments. In effect, there are 70 ACAs for the entire GBR catchment—covering non-riverine and riverine wetlands. A map of the GBR catchment showing each study area is provided in Attachment A.

A series of nine expert panels were conducted to address aquatic fauna, aquatic and riparian flora, and wetland ecology for the GBR catchments. The non-riverine and riverine wetlands were covered in combined workshops. The panels, held in Cairns, Townsville and Rockhampton during November and December 2008, involved invited experts with expertise in aquatic fauna, aquatic and riparian flora and/or wetland ecology in the Wet Tropics, Burdekin and Fitzroy sections of the GBR catchment.

This report documents the findings and recommendations of the aquatic flora expert panel for the Fitzroy region held in Rockhampton on Tuesday 9 December, 2008. This report presents supporting information and panel input that only addresses the non-riverine wetland systems. The riverine component has been addressed in a separate report. Terms of reference for the aquatic flora expert panel are provided in Attachment B.

2 Method

2.1 Study area

The Fitzroy section of the GBR catchment is a vast and extremely varied area. It ranges from the high rainfall, short fast streams surrounded by rainforest on the Whitsunday coast to the slow, turbid meandering floodplain streams of the Fitzroy catchment. It encompasses parts of three bioregions, supports Ramsar listed wetlands and its waters impact on the southern and central GBR. It includes iconic sandstone gorges in places like the Carnarvon Ranges to perched lakes in the upper Comet sub-catchment to world recognised wetland complexes such as the Goorganga Plains as well as waterfalls, cascades and torrents in the rainforests of the Whitsundays.

The Fitzroy catchment itself is the largest eastward flowing system in Australia only exceeded in total flow Australia wide, by the Murray-Darling system. The area includes two catchments (Waterpark Creek and Repulse Creek) that are almost entirely surrounded by protected areas. Other catchments are highly modified with a number of rivers heavily regulated by dams, weirs and irrigation development.

The climate of the area is also highly variable. It ranges from distinctly tropical in the north to subtropical in the south. Rainfall is distinctly seasonal with a pronounced wet season from December to March but the amount of rain that falls is amongst the most variable in the world. Between 1976 and 2008, wet season flow to the mouth of the Fitzroy varied from around 349,677 megalitres to 22,903,390 megalitres. Much of the aquatic ecology of the area is driven by variable boom and bust cycles and is consequently amongst the most resilient anywhere.

The largest land use in terms of area is cattle grazing, however extensive cropping and intensive cultivation of sugar cane is also very important. The area also contributes a huge quantity of coal that is vital to the Queensland and Australian economy.

It is not possible to adequately give an overview of such a vast and varied area, so a brief description of the 17 catchment areas is provided in Attachment C. This attachment should be considered when interpreting the contents of this report.

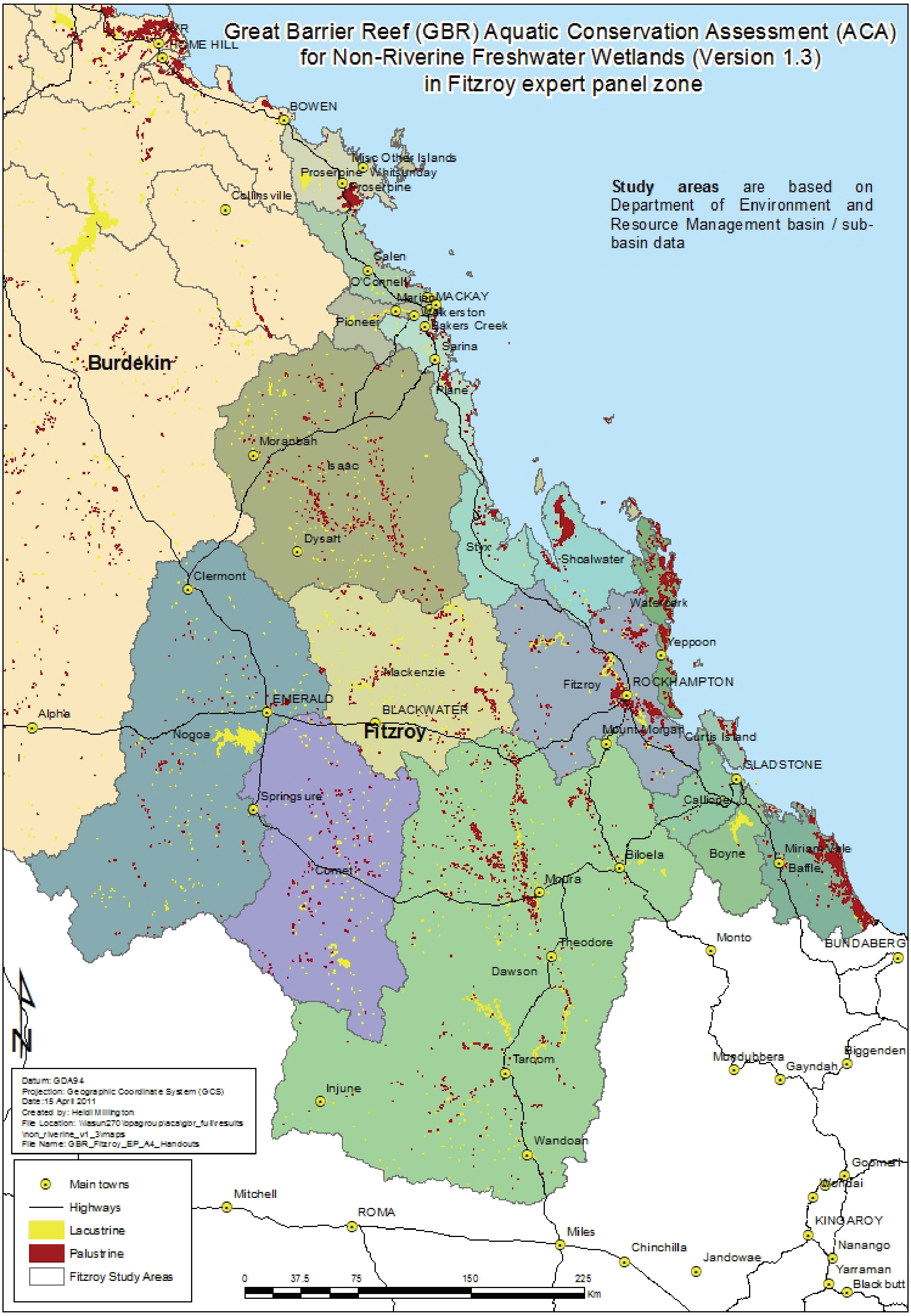

Figure 1 Fitzroy section of the GBR catchment (incorporating 17 individual catchments)

2.2 Panel composition

The expert panel (the panel) comprised of invited persons (Table 1) familiar with aquatic flora in the Fitzroy section of the GBR catchment.

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
Jeanette Kemp	Principal Botanist, Department of Environment and Resource Management	Native and exotic flora
Jim Tait	Ecologist, Ecoconcern Pty Ltd	Wetland ecology and management
John McCabe	Senior Extension Officer, Nature Refuges, Department of Environment and Resource Management	Waterbirds, flora, and landscape restoration
John Platten	Principal Biodiversity Planning Officer, Department of Environment and Resource Management	Biodiversity planning, aquatic ecology and water quality
Joy Brusch	Senior Botanist, Department of Environment and Resource Management	Tropical flora
Leo Duivenvoorden	Senior Lecturer/ Researcher, Central Queensland University	Aquatic and semi-aquatic plants
Nick Cuff	Senior Botanist, Queensland Herbarium, Department of Environment and Resource Management	Botany and regional ecosystem assessment
Rhonda Melzer	Team Leader, Conservation Management Branch, Department of Environment and Resource Management	Botany and terrestrial ecology
Steve Elson	Principal Planning Officer, Department of Environment and Resource Management	Biodiversity planning

Selena Inglis 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 flora in the GBR catchment was also sourced from various technical reports.

3 Rare and threatened flora

The panel identified five 'rare', four 'vulnerable' and two 'endangered' flora taxa in the Fitzroy section of the GBR catchment as being primarily aquatic, semi-aquatic or riparian in habit (Table 2). Threatened taxa were excluded from this list if they did not correspond to one of these categories. This list of flora was used as the basis for identifying areas of significance for 'Criterion 4 Threatened species and ecosystems' (4.1.2). Point records were used to identify the spatial units having that species present.

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	Habitat	Comments
Aponogeton queenslandicus		LC[1]		Previous status was listed as R[1]. Status is now LC[1]. No valid records available at time of processing. To be reviewed for potential priority species inclusion during subsequent ACA update.
Cyperus clarus		V[1]		
Eleocharis blakeana		R[1]		Found mainly in Brigalow gilgais.
Fimbristylis vagans		R[1]		No valid records available at time of processing.
Germainia capitata		V[1,2]		Grows in Baffle Creek and Agnes Waters region.
Livistona nitida		R[1]		
Myriophyllum artesium		E[1]		
Myriophyllum implicatum		LC[1]		Previous status was listed as R1. Status is now LC1. To be reviewed for potential priority species inclusion during subsequent ACA update.
Phaius australis	Swamp orchid	E[1,2]		
Sowerbaea subtilis		V[1,2]		Groundwater dependant in areas with high watertable on sand flats.
Thelypteris confluens		V[1]		Mound spring species.

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

1. *Queensland Nature Conservation Act 1992 (E – Endangered, V – Vulnerable, R – Rare, LC – Least Concern)*
2. *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 GBR catchment 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, 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 31 priority flora species associated with non-riverine wetlands (Table 3). These species were included in 'Criterion 5 Priority species and ecosystems' (5.1.2). Point records were buffered using their precision to identify the spatial units having a priority species present.

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**	**Habitat**	**Priority Number[3]**	**Comments**
Baumea articulata	Jointed twigrush		1,2,3	Forms significant macrophyte beds providing important habitat and source of food for fauna species.
Baumea rubiginosa	Soft twigrush		1,2,3	Forms monotypic stands providing important habitat and source of food for fauna species.
Cyperus exaltatus	Tall flatsedge	Semi-aquatic[2]	1,2,3	Forms significant macrophyte beds providing important habitat and source of food for fauna species.
Eleocharis dulcis			1,2,3	Forms significant macrophyte beds providing important habitat and source of food for fauna species.
Eleocharis sphacelata	Tall spikerush	Aquatic[2]	1,2,3	Forms significant macrophyte beds providing important habitat and source of food for fauna species.
Eucalyptus coolabah	Coolabah	Riparian[1]	2,3,6	One of the canopy dominants in regional ecosystem 11.3.25 that contributes to structural complexity. It provides important habitat and source of food for fauna species.
Eucalyptus robusta	Swamp mahogany	Riparian[1]	3,5	Provides important/critical habitat and is at its distributional limit or is a disjunct population.
Eucalyptus tereticornis			2,3,6	One of the canopy dominants in regional ecosystem 11.3.25 that contributes to structural complexity. It provides important habitat and source of food for fauna species.
Gahnia sieberiana	Sword grass		1,2,3	Forms significant macrophyte beds providing important habitat and source of food for fauna species.

Scientific name	Common name	Habitat	Priority Number[3]	Comments
Leersia hexandra	Swamp rice grass		1,2	Forms significant macrophyte beds providing an important source of food for fauna species.
Lepironia articulata			1,2,3	Forms significant macrophyte beds providing important habitat and source of food for fauna species.
Melaleuca bracteata	Black tea-tree	Riparian[1]	2,3,6	One of the canopy dominants in regional ecosystem 11.3.25 that contributes to structural complexity. It provides important habitat and source of food for fauna species.
Melaleuca leucadendra	Broad-leaved tea-tree		2,3,6	One of the canopy dominants in regional ecosystem 11.3.25 that contributes to structural complexity. It provides important habitat and source of food for fauna species.
Melaleuca linariifolia	Snow-in summer	Riparian[1]	2,3,6	One of the canopy dominants in regional ecosystem 11.3.25 that contributes to structural complexity. It provides important habitat and source of food for fauna species.
Melaleuca quinquenervia	Swamp paperbark	Riparian[1]	2,3,6	One of the canopy dominants in regional ecosystem 11.3.25 that contributes to structural complexity. It provides important habitat and source of food for fauna species.
Melaleuca viminalis	Callistemon	Riparian[1]	2,3,6	One of the canopy dominants in regional ecosystem 11.3.25 that contributes to structural complexity. It provides important habitat and source of food for fauna species.
Monochoria cyanea			1,2,3	Forms significant macrophyte beds providing important habitat and source of food for fauna species.
Muehlenbeckia florulenta	Lignum	Riparian[1]	1,2,3	Forms significant macrophyte beds providing important habitat and source of food for fauna species.
Myriophyllum simulans			1,2,3	Forms significant macrophyte beds providing important habitat and source of food for fauna species.
Myriophyllum verrucosum	Water milfoil	Aquatic[2]	1,2,3	Forms significant macrophyte beds providing important habitat and source of food for fauna species.
Najas tenuifolia	Water nymph	Aquatic[2]	1,2,3	Forms significant macrophyte beds providing important habitat and source of food for fauna species.
Nelumbo nucifera	Pink waterlily		1,2,3	Forms significant macrophyte beds providing important habitat and source of food for fauna species.
Nymphaea gigantea		Aquatic[2]	1	Forms significant macrophyte beds.
Nymphoides exiliflora			1,2,3	Forms significant macrophyte beds providing critical habitat and source of food for threatened fauna species.
Nymphoides indica	Water snowflake	Aquatic[2]	1,2,3	Forms significant macrophyte beds providing critical habitat and source of food for threatened fauna species.
Ottelia alismoides			1,2,3	Forms significant macrophyte beds providing critical habitat and source of food for threatened fauna species.
Paspalum distichum	Water couch	Semi-aquatic[2]	1,2,3,6	Forms significant macrophyte beds providing important habitat and source of food for fauna species. Also plays a soil binding and stabilisation role.

Scientific name	Common name	Habitat	Priority Number[3]	Comments
Phragmites australis	Common reed	Aquatic[2]	1,3,4,6	Forms significant macrophyte beds providing important habitat including spawning grounds for fauna. Also plays a soil binding and stabilisation role.
Schoenoplectus mucronatus			1,3,4	Forms significant macrophyte beds providing important habitat including spawning grounds for fauna.
Typha orientalis	Broad-leaved cumbungi		1,3,4,6	Forms significant macrophyte beds providing important habitat including spawning grounds for fauna. Also plays a soil binding and stabilisation role.
Vallisneria nana		Aquatic[2]	1	Forms significant macrophyte beds.

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

1. *Queensland Herbarium list of wetland species (contact Bruce Wilson)*
2. *Clayton, P.C., Fielder, D.F., Howell, S. and Hill, C.J. 2006. Aquatic biodiversity assessment and mapping method (AquaBAMM): a conservation values assessment tool with trial application in the Burnett River catchment. Queensland Environmental Protection Agency, Brisbane.*
3. Refers to the significant values required to be a priority species, as listed above Table 3.

5 Species richness

Species richness (i.e. total number of species) was scored for aquatic-dependant flora, stratified using 150 m above seal level (asl) for the Baffle study area (see the Fitzroy ecology expert panel report for more information on stratification).

The Fitzroy section of the GBR Catchment has 175 plants that are referred to in this report as 'aquatic-dependant' in non-riverine wetlands (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 'aquatic-dependent flora' to mean:

> 'those species that are adapted to and dependant on living in wet conditions for at least part of their life cycle and found either within or immediately adjoining a non-riverine or riverine wetland'.

This definition of a wetland-dependent plant 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 better depicts the flora richness value at a given location.

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

This list was 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	Habitat	Comments
Abildgaardia ovata		LC[1]		Important habitat
Abildgaardia vaginata		LC[1]		Important habitat
Actinoscirpus grossus		LC[1]		Important habitat
Aponogeton queenslandicus		LC[1]		Small population, threatened.
Arthrostylis aphylla		LC[1]		Important habitat
Baumea articulata	Jointed twigrush	LC[1]		Important habitat
Baumea juncea	Bare twigrush	LC[1]		Important habitat
Baumea planifolia		LC[1]		Important habitat
Baumea rubiginosa	Soft twigrush	LC[1]		Important habitat
Bolboschoenus fluviatilis		LC[1]		Important habitat
Bulbochaete kwangtungensis		LC[1]		Macrophyte beds
Bulbochaete polyandria		LC[1]		Macrophyte beds
Bulbostylis barbata		LC[1]		Important habitat
Carex breviculmis		LC[1]		Important habitat
Carex brunnea		LC[1]		Important habitat
Carex declinata		LC[1]		Important habitat
Carex fascicularis	Tassel sedge	LC[1]		Important habitat
Carex gaudichaudiana		LC[1]		Important habitat
Carex inversa	Knob sedge	LC[1]		Important habitat
Carex lobolepis		LC[1]		Important habitat
Carex polyantha		LC[1]		Important habitat
Chara fibrosa		LC[1]		Macrophyte beds

Scientific name	Common name	Status	Habitat	Comments
Chara vulgaris		LC[1]		Macrophyte beds
Cladium procerum	Leafy twigrush	LC[1]		Important habitat
Cyathochaeta diandra	Sheath rush	LC[1]		Important habitat
Cyperus aggregatus				Important habitat
Cyperus alterniflorus		LC[1]		Important habitat
Cyperus bifax	Western nutgrass	LC[1]		Important habitat
Cyperus bowmannii		LC[1]		Important habitat
Cyperus castaneus		LC[1]		Important habitat
Cyperus clarus		V[1]		Important habitat
Cyperus curvistylis		LC[1]		Important habitat
Cyperus cyperinus		LC[1]		Important habitat
Cyperus cyperoides		LC[1]	Semi-aquatic[4]	Important habitat
Cyperus dietrichiae		LC[1]		Important habitat
Cyperus dietrichiae var. brevibracteatus		LC[1]		Important habitat
Cyperus dietrichiae var. dietrichiae		LC[1]		Important habitat
Cyperus difformis	Rice sedge	LC[1]	Semi-aquatic[4]	Important habitat
Cyperus fulvus		LC[1]		Important habitat
Cyperus gilesii		LC[1]		Important habitat
Cyperus gunnii		LC[1]		Important habitat
Cyperus gunnii subsp. gunnii		LC[1]		Important habitat
Cyperus haspan		LC[1]	Semi-aquatic[4]	Important habitat
Cyperus isabellinus		LC[1]		Important habitat
Cyperus laevigatus		LC[1]		Important habitat
Cyperus laevis		LC[1]		Important habitat
Cyperus leiocaulon		LC[1]		Important habitat
Cyperus mirus		LC[1]		Important habitat
Cyperus nervulosus		LC[1]		Important habitat
Cyperus perangustus		LC[1]		Important habitat
Cyperus polystachyos		LC[1]	Semi-aquatic[4]	Important habitat
Cyperus procerus		LC[1]		Important habitat
Cyperus pulchellus		LC[1]		Important habitat
Cyperus pygmaeus	Dwarf sedge	LC[1]		Important habitat
Cyperus rigidellus		LC[1]		Important habitat
Cyperus sculptus		LC[1]		Important habitat
Cyperus sphaeroideus		LC[1]		Important habitat
Cyperus subulatus		LC[1]		Important habitat
Cyperus tetracarpus		LC[1]		Important habitat
Cyperus tetraphyllus		LC[1]		Important habitat
Cyperus victoriensis		LC[1]		Important habitat
Desmococcus viridis		LC[1]		Macrophyte beds
Eleocharis acuta		LC[1]		Important habitat
Eleocharis blakeana		R[1]		Found mainly in Brigalow gilgais
Eleocharis cylindrostachys		LC[1]	Semi-aquatic[4]	Important habitat

Scientific name	Common name	Status	Habitat	Comments
Eleocharis dulcis		LC[1]		Important habitat
Eleocharis equisetina		LC[1]		Important habitat
Eleocharis geniculata		LC[1]		Important habitat
Eleocharis pallens	Pale spikerush	LC[1]		Important habitat
Eleocharis philippinensis		LC[1]	Aquatic[4]	Important habitat
Eleocharis plana	Ribbed spikerush	LC[1]	Aquatic[4]	Important habitat
Eleocharis setifolia subsp. setifolia		LC[1]		Important habitat
Eleocharis sphacelata	Tall spikerush	LC[1]	Aquatic[4]	Important habitat
Eleocharis spiralis		LC[1]		Important habitat
Eleocharis tetraquetra		LC[1]		Important habitat
Eucalyptus coolabah	Coolabah	LC[1]	Riparian[3]	Bank stabilisation
Eucalyptus robusta	Swamp mahogany	LC[1]	Riparian[3]	
Exocarya scleroides		LC[1]		Important habitat
Fimbristylis aestivalis var. aestivalis		LC[1]		Important habitat
Fimbristylis bisumbellata		LC[1]		Important habitat
Fimbristylis dichotoma	Common fringe-rush	LC[1]		Important habitat
Fimbristylis oxystachya		LC[1]		Important habitat
Fimbristylis vagans		R[1]		Important habitat
Gahnia aspera		LC[1]		Important habitat
Gahnia sieberiana	Sword grass	LC[1]		Important habitat
Germainia capitata		V[1,2]		Grows in Baffle Creek and Agnes Waters region.
Hemarthria uncinata		LC[1]	Aquatic[4]	Small population, subject to threatening processes
Hydrilla verticillata	Hydrilla	LC[1]	Aquatic[4]	Macrophyte beds
Hymenachne acutigluma		LC[1]		Small population
Isolepis cernua	Nodding club rush	LC[1]		Important habitat
Isolepis fluitans	Floating club rush	LC[1]		Important habitat
Isolepis inundata	Swamp club rush	LC[1]		Important habitat
Leersia hexandra	Swamp rice grass	LC[1]		Important habitat
Lepidosperma laterale var. angustum		LC[1]		Important habitat
Lepidosperma laterale var. laterale		LC[1]		Important habitat
Lepilaena bilocularis		LC[1]		Macrophyte beds
Lepironia articulata		LC[1]		Important habitat
Livistona nitida		R[1]		
Melaleuca bracteata	Black tea-tree	LC[1]	Riparian[3]	Important for structural complexity
Melaleuca leucadendra	Broad-leaved tea-tree	LC[1]		Important for structural complexity
Melaleuca linariifolia	Snow-in summer	LC[1]	Riparian[3]	Important for structural complexity
Melaleuca quinquenervia	Swamp paperbark	LC[1]	Riparian[3]	Important for structural complexity
Monochoria cyanea		LC[1]		Macrophyte beds
Muehlenbeckia florulenta	Lignum	LC[1]	Riparian[3]	Macrophyte beds

Scientific name	Common name	Status	Habitat	Comments
Myriophyllum artesium		E[1]		Macrophyte beds
Myriophyllum gracile var. gracile		LC[1]		Macrophyte beds
Myriophyllum implicatum		LC[1]		Macrophyte beds
Myriophyllum variifolium		LC[1]		Macrophyte beds
Najas tenuifolia	Water nymph	LC[1]	Aquatic[4]	Macrophyte beds
Nelumbo nucifera	Pink waterlily	LC[1]		Macrophyte beds
Nitella cristata		LC[1]		Macrophyte beds
Nitella penicillata		LC[1]		Macrophyte beds
Nitella pseudoflabellata		LC[1]		Macrophyte beds
Nitella tasmanica		LC[1]		Macrophyte beds
Nymphaea gigantea		LC[1]	Aquatic[4]	Macrophyte beds
Nymphoides aurantiaca		LC[1]		Macrophyte beds
Nymphoides crenata	Wavy marshwort	LC[1]		Macrophyte beds
Nymphoides exiliflora		LC[1]		Macrophyte beds
Nymphoides geminata		LC[1]		Macrophyte beds
Nymphoides indica	Water snowflake	LC[1]	Aquatic[4]	Macrophyte beds
Oedogonium itzigsohnii		LC[1]		Macrophyte beds
Oedogonium rufescens				
Oedogonium tapeinosporum		LC[1]		Macrophyte beds
Oryza rufipogon		LC[1]		
Ottelia alismoides		LC[1]		Macrophyte beds
Ottelia ovalifolia	Swamp lily	LC[1]	Aquatic[4]	Macrophyte beds
Paspalum distichum	Water couch	LC[1]	Semi-aquatic[4]	
Phaius australis	Swamp orchid	E[1,2]		
Phragmites australis	Common reed	LC[1]	Aquatic[4]	Macrophyte beds
Potamogeton crispus	Curly pondweed	LC[1]	Aquatic[4]	Macrophyte beds
Potamogeton tepperi		LC[1]		Macrophyte beds
Potamogeton tricarinatus	Floating pondweed	LC[1]	Aquatic[4]	Macrophyte beds
Pseudendoclonium		LC[1]		Macrophyte beds
Rhizoclonium implexum		LC[1]		Macrophyte beds
Rhizoclonium tortuosum		LC[1]		Macrophyte beds
Rhynchospora brownii	Beak rush	LC[1]		Important habitat
Rhynchospora corymbosa		LC[1]		Important habitat
Rhynchospora heterochaeta		LC[1]		Important habitat
Rhynchospora rubra		LC[1]		Important habitat
Schoenoplectus lateriflorus		LC[1]		Important habitat
Schoenoplectus litoralis		LC[1]		Important habitat
Schoenoplectus mucronatus		LC[1]		Important habitat
Schoenoplectus validus		LC[1]		Important habitat
Schoenus apogon var. apogon		LC[1]		Important habitat
Schoenus brevifolius		LC[1]		Important habitat
Schoenus falcatus		LC[1]		Important habitat

Scientific name	Common name	Status	Habitat	Comments
Schoenus kennyi		LC[1]		Important habitat
Schoenus lepidosperma subsp. pachylepis		LC[1]		Important habitat
Schoenus maschalinus		LC[1]		Important habitat
Schoenus melanostachys		LC[1]		Important habitat
Schoenus sparteus		LC[1]		Important habitat
Schoenus vaginatus		LC[1]		Important habitat
Scleria brownii		LC[1]		Important habitat
Scleria mackaviensis		LC[1]		Important habitat
Scleria sphacelata		LC[1]		Important habitat
Sowerbaea subtilis		V[1,2]		Groundwater dependant in areas with high watertable on sand flats
Tetraria capillaris		LC[1]		Important habitat
Thelypteris confluens		V[1]		Mound spring species
Trachystylis stradbrokensis		LC[1]		Important habitat
Typha orientalis	Broad-leaved cumbungi	LC[1]		Macrophyte beds
Typha domingensis		LC[1]	Aquatic[4]	Important habitat
Utricularia aurea	Golden bladderwort	LC[1]		Macrophyte beds
Utricularia australis	Yellow bladderwort	LC[1]		Macrophyte beds
Utricularia bifida		LC[1]	Aquatic[4]	Macrophyte beds
Utricularia biloba	Moth bladderwort	LC[1]		Macrophyte beds
Utricularia caerulea	Blue bladderwort	LC[1]		Macrophyte beds
Utricularia chrysantha		LC[1]		Macrophyte beds
Utricularia dichotoma	Fairy aprons	LC[1]	Aquatic[4]	Macrophyte beds
Utricularia gibba	Floating bladderwort	LC[1]	Aquatic[4]	Macrophyte beds
Utricularia lateriflora	Small bladderwort	LC[1]	Aquatic[4]	Macrophyte beds
Utricularia stellaris		LC[1]		Macrophyte beds
Utricularia uliginosa	Asian bladderwort	LC[1]		Macrophyte beds
Vallisneria gigantea	Ribbonweed	LC[1]		Macrophyte beds
Vallisneria nana		LC[1]	Aquatic[4]	Macrophyte beds
Zygogonium ericetorum		LC[1]		Macrophyte beds

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

1. Queensland *Nature Conservation Act 1992 (E – Endangered, V – Vulnerable, R – Rare, LC – Least Concern)*
2. *Environment Protection and Biodiversity Conservation Act 1999 (E – Endangered, V – Vulnerable)*
3. *Queensland Herbarium list of wetland species (contact Bruce Wilson)*
4. *Clayton, P.C., Fielder, D.F., Howell, S. and Hill, C.J. 2006. Aquatic biodiversity assessment and mapping method (AquaBAMM): a conservation values assessment tool with trial application in the Burnett River catchment. Queensland Environmental Protection Agency, Brisbane.*

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 riverine or non-riverine landscape be included for the GBR ACA using AquaBAMM. Ninety-one (91) exotic plant taxa that are known to occur within non-riverine wetlands in the Fitzroy section of the GBR catchment were nominated by the panel (Table 5). The presence of aquatic and semi-aquatic flora species were 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 the Department of Environment and Resource Management 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.

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**	**Comments**
Baccharis halimifolia	Groundsel bush		Limited in this region where it is mainly a pest on the edge of melaleuca swamps. It also occurs near Granite Creek and is prevalent adjacent the mangroves near Eurimbula.
Cyperus involucratus			It is a problem in small streams with particularly bad infestations near Gladstone.
Echinochloa polystachya cv. Amity	Aleman grass		A deep water ponded pasture species that builds up causing significant problems particularly in impoundments with no significant flow. It also invades streams and outcompetes water lilies. It is a major threat in very specific locations for example the Fitzroy River barrage.
Eichhornia crassipes	Water hyacinth	Aquatic[2]	Key species in terms of wetland condition indicator.
Hymenachne amplexicaulis cv. Olive			Significant weed that outcompetes native species.
Mimosa pigra		Riparian[1]	Significant weed but very limited distribution within the region. Main occurrence is at Peter Faust Dam where it is being dealt with. May become a significant threat in the future.
Myriophyllum aquaticum	Brazilian water milfoil		Limited in this region but should be flagged as becoming a potential future problem as it becomes a threat when deliberately introduced.
Pennisetum alopecuroides	Swamp foxtail		Still being distributed as a nursery plant. It is posing a significant threat to one ecosystem in the Connors Range (8.3.13).
Pistia stratiotes	Water lettuce		Major problem particularly in slow moving backwaters and around weirs.

Scientific name	Common name	Habitat	Comments
Salvinia molesta	Salvinia		A problem particularly in dry times as it builds up significantly.
Urochloa mutica	Para grass	Semi-aquatic[2]	Coastal weed that can create ponded pastures. In the absence of grazing it smothers wetlands reducing the diversity of birds and fish.
Acacia nilotica	Prickly acacia		
Acanthocereus tetragonus	Sword pear		Has a significant impact on Brigalow wetlands where it outcompetes natives and reduces habitat suitability.
Agave americana			
Agave americana var. americana			
Agave americana var. americana cv. Marginata			
Agave sisalana	Sisal hemp		
Agave vivipara var. vivipara			
Anredera cordifolia	Madeira vine		
Aristolochia elegans	Calico-flower		Impacts on the Birdwing butterfly (*Ornithoptera priamus*).
Bryophyllum delagoense			
Bryophyllum pinnatum	Resurrection plant		Infestations in Marlborough Creek.
Caesalpinia decapetala	Wait-a-while		Thrives in wet places occurring along Granite Creek.
Cardiospermum grandiflorum	Heart seed vine		
Cardiospermum halicacabum			
Cardiospermum halicacabum var. halicacabum			
Cascabela thevetia	Yellow oleander		Infestations are becoming a problem.
Catharanthus roseus	Pink periwinkle		No significant impact observed yet although but may become a problem in the future.
Cryptostegia grandiflora	Rubber vine		Presence can be used as an indicator of poor condition.
Duranta erecta	Duranta		
Eugenia uniflora	Brazilian cherry tree		Mainly found in urban areas.
Furcraea foetida			
Gmelina elliptica	Badhara bush		
Haematoxylum campechianum	Logwood tree		Highly invasive of some ecosystems around Mackay and across the Fitzroy River floodplain.
Harrisia martini			
Harrisia pomanensis			
Harrisia tortuosa			
Ipomoea cairica			
Ipomoea indica	Blue morning-glory		

Scientific name	Common name	Habitat	Comments
Jatropha gossypiifolia			Highly invasive, declared weed, widespread around Styx River catchment and Alton Downs.
Lantana camara			
Lantana camara cv. Gol Gol			
Lantana montevidensis	Creeping lantana		
Leonotis nepetifolia	Lions tail		
Leucaena leucocephala			
Leucaena leucocephala subsp. glabrata			
Leucaena leucocephala subsp. leucocephala			
Lippia alba var. alba			
Macfadyena unguis-cati	Cat's claw creeper		Significant weed of coastal areas.
Macroptilium atropurpureum	Siratro		Smothers native plants growing on creek banks.
Macrotyloma axillare var. axillare			Has potential to become a weed.
Macrotyloma uniflorum			Has potential to become a weed.
Macrotyloma uniflorum var. stenocarpum			Has potential to become a weed.
Macrotyloma uniflorum var. uniflorum			Has potential to become a weed.
Mangifera indica	Mango		Has become a problem around Mackay.
Megathyrsus maximus			This species generates significant fuel loads that can carry hot fires which cause damage to native ecosystems.
Megathyrsus maximus var. coloratus			This species generates significant fuel loads that can carry hot fires which cause damage to native ecosystems.
Megathyrsus maximus var. maximus			This species generates significant fuel loads that can carry hot fires which cause damage to native ecosystems.
Megathyrsus maximus var. maximus cv. Hamil			This species generates significant fuel loads that can carry hot fires which cause damage to native ecosystems.
Megathyrsus maximus var. pubiglumis			This species generates significant fuel loads that can carry hot fires which cause damage to native ecosystems.
Melinis minutiflora	Molasses grass		
Opuntia aurantiaca	Tiger pear		
Opuntia leucotricha			
Opuntia streptacantha	Cardona pear		
Opuntia stricta			
Opuntia tomentosa	Velvety tree pear		
Parkinsonia aculeata	Jerusalem thorn		
Parthenium hysterophorus	Parthenium weed		
Pennisetum ciliare	Buffel grass		
Pinus caribaea	Caribbean pine		
Pinus elliottii	Slash pine		

Scientific name	Common name	Habitat	Comments
Praxelis clematidea			
Prosopis glandulosa var. glandulosa			
Prosopis pallida			
Psidium guajava	Guava		
Psidium guineense	Cherry guava		
Ricinus communis	Castor oil bush		Grows in beds and banks of streams, and may possibly be wetland dependant.
Rivina humilis			Inhibits regeneration of native species particularly in scrub areas.
Schinus terebinthifolius	Broad leaved pepper		
Senna occidentalis	Coffee senna		
Sorghum halepense	Johnson grass		
Sphagneticola trilobata			Thrives around urban areas.
Synedrellopsis grisebachii			Problem weed in the Boyne and Calliope River catchments.
Syzygium cumini			Started to occur on floodplains.
Tecoma stans	Tecoma		
Tecoma stans var. stans			
Tecoma stans var. velutina			
Thunbergia grandiflora	Sky flower		
Thunbergia laurifolia			
Xanthium occidentale	Noogoora burr		
Ziziphus mauritiana	Indian jujube		

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

1. *Queensland Herbarium list of wetland species (contact Bruce Wilson)*
2. *Clayton, P.C., Fielder, D.F., Howell, S. and Hill, C.J. 2006. Aquatic biodiversity assessment and mapping method (AquaBAMM): a conservation values assessment tool with trial application in the Burnett River catchment. Queensland Environmental Protection Agency, Brisbane.*

7 Priority ecosystems and special features

The panel identified several non-riverine priority ecosystems/special features in the Fitzroy section of the GBR catchment (Table 6). These were identified for their aquatic and riparian flora values. Where special features nominated by the aquatic flora expert panel were also considered to have additional values (e.g. fauna, ecology) values by the aquatic fauna or wetland ecology expert panels, the special area were implemented as a wetland ecology special feature.

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 and special features, and their values

Decisions listed 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.

Priority ecosystem/ special feature	Values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Regional ecosystems 8.3.4 & 11.3.27	These regional ecosystems contain significant habitat values that are under threat from threatening processes such as physical alteration/ destruction and invasion by hymenachne. Note: This priority ecosystem decision applies to the following catchments: Calliope, Comet, Dawson, Fitzroy, Isaac, Mackenzie, Misc Other Islands, Nogoa, O’Connell, Pioneer, Plane, Proserpine, Shoalwater, Styx and Waterpark.	Calliope	ca_nr_fl_01	5.2.1	3
Regional ecosystems 8.3.4 & 11.3.27	These regional ecosystems contain significant habitat values that are under threat from threatening processes such as physical alteration/ destruction and invasion by hymenachne. Note: This priority ecosystem decision applies to the following catchments: Calliope, Comet, Dawson, Fitzroy, Isaac, Mackenzie, Misc Other Islands, Nogoa, O’Connell, Pioneer, Plane, Proserpine, Shoalwater, Styx and Waterpark.	Comet	ct_nr_fl_01	5.2.1	3
Mound springs of boggo mosses	These mound springs contain endemic, rare and threatened species. Note: Springs were implemented in this version (1.3) of this Aquatic Conservation Assessment but not the previous version (1.2).	Dawson	dn_nr_fl_01	6.3.1	4

Priority ecosystem/ special feature	Values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Regional ecosystems 8.3.4 & 11.3.27	These regional ecosystems contain significant habitat values that are under threat from threatening processes such as physical alteration/ destruction and invasion by hymenachne. Note: This priority ecosystem decision applies to the following catchments: Calliope, Comet, Dawson, Fitzroy, Isaac, Mackenzie, Misc Other Islands, Nogoa, O'Connell, Pioneer, Plane, Proserpine, Shoalwater, Styx and Waterpark.	Dawson	dn_nr_fl_02	5.2.1	3
Regional ecosystems 8.3.4 & 11.3.27	These regional ecosystems contain significant habitat values that are under threat from threatening processes such as physical alteration/ destruction and invasion by hymenachne. Note: This priority ecosystem decision applies to the following catchments: Calliope, Comet, Dawson, Fitzroy, Isaac, Mackenzie, Misc Other Islands, Nogoa, O'Connell, Pioneer, Plane, Proserpine, Shoalwater, Styx and Waterpark.	Fitzroy	fi_nr_fl_01	5.2.1	3
Blue Gum on Alluvial Floodplains/ delta land system (Regional ecosystems 11.3.4 and 11.3.4a)	Rare (riparian) ecosystem. Note: This decision also applies to the Fitzroy catchment. However, this decision has not been implemented in this assessment because further investigation into its implementation is required in this area.	Fitzroy	NA	5.2.1	4
Regional Ecosystems 8.3.4 & 11.3.27	These regional ecosystems contain significant habitat values that are under threat from threatening processes such as physical alteration/ destruction and invasion by hymenachne. Note: This priority ecosystem decision applies to the following catchments: Calliope, Comet, Dawson, Fitzroy, Isaac, Mackenzie, Misc Other Islands, Nogoa, O'Connell, Pioneer, Plane, Proserpine, Shoalwater, Styx and Waterpark.	Isaac	is_nr_fl_01	5.2.1	3
Kaiuroo Reserve	The Kaiuroo Reserve contains a disjunct population of the rare species *Eleocharis blakeana* as well as large melaleuca sp. remnants.	Mackenzie	ma_nr_fl_01	6.3.1	3

Priority ecosystem/ special feature	Values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Regional ecosystems 8.3.4 & 11.3.27	These regional ecosystems contain significant habitat values that are under threat from threatening processes such as physical alteration/ destruction and invasion by hymenachne. Note: This priority ecosystem decision applies to the following catchments: Calliope, Comet, Dawson, Fitzroy, Isaac, Mackenzie, Misc Other Islands, Nogoa, O'Connell, Pioneer, Plane, Proserpine, Shoalwater, Styx and Waterpark.	Mackenzie	ma_nr_fl_02	5.2.1	3
Blue Gum on Alluvial Floodplains/ delta land system (Regional ecosystems 11.3.4 and 11.3.4a)	Rare (riparian) ecosystem. Note: This decision also applies to the Fitzroy catchment. However, this decision has not been implemented in this assessment because further investigation into its implementation is required in this area.	Mackenzie	NA	5.2.1	4
Townsend Island to Corio Bay sandplain swamps	This area is mostly contained within defence lands or national park and has excellent water quality. The site contains a high diversity of sedges, is at the northern most limit of the broad-leaved tea-tree (*Eucalyptus robusta*) and contains coastal sandy swamps including sinkholes in the dunes.	Misc Other Islands	oi_nr_fl_02	6.3.1	4
Regional Ecosystems 8.3.4 & 11.3.27	These regional ecosystems contain significant habitat values that are under threat from threatening processes such as physical alteration/ destruction and invasion by hymenachne. Note: This priority ecosystem decision applies to the following catchments: Calliope, Comet, Dawson, Fitzroy, Isaac, Mackenzie, Misc Other Islands, Nogoa, O'Connell, Pioneer, Plane, Proserpine, Shoalwater, Styx and Waterpark.	Misc Other Islands	oi_nr_fl_03	5.2.1	3
Regional ecosystems 8.3.4 & 11.3.27	Significant habitat values, subject to These regional ecosystems contain significant habitat values that are under threat from threatening processes such as physical alteration/ destruction and invasion by hymenachne. Note: This priority ecosystem decision applies to the following catchments: Calliope, Comet, Dawson, Fitzroy, Isaac, Mackenzie, Misc Other Islands, Nogoa, O'Connell, Pioneer, Plane, Proserpine, Shoalwater, Styx and Waterpark.	Nogoa	no_nr_fl_01	5.2.1	3

Priority ecosystem/ special feature	Values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Slade Point/ Andergrove	This area is a large complex of estuarine and freshwater treeless and paperbark wetlands that includes small remnants of the highly endangered grassland regional ecosystem 8.3.12, and the of concern regional ecosystem 8.2.7a which also has a biodiversity status of endangered. The area also has unusually extensive and tall stands of the broad-leaved tea-tree *(Melaleuca leucadendra*). Note: This decision straddles the O'Connell and Pioneer study areas. The Pioneer component of this decision is covered by decision number pi_nr_fl_01.	O'Connell	oc_nr_fl_01	6.3.1	3
Regional ecosystems 8.3.4 & 11.3.27	Significant habitat values, subject to These regional ecosystems contain significant habitat values that are under threat from threatening processes such as physical alteration/ destruction and invasion by hymenachne. Note: This priority ecosystem decision applies to the following catchments: Calliope, Comet, Dawson, Fitzroy, Isaac, Mackenzie, Misc Other Islands, Nogoa, O'Connell, Pioneer, Plane, Proserpine, Shoalwater, Styx and Waterpark.	O'Connell	oc_nr_fl_02	5.2.1	3
Regional ecosystem 8.2.11	This endangered regional ecosystem is often found adjacent to saltpan wetlands. It contains significant habitat values due to it's highly nectivorous nature and therefore is important as food resource. Note: This priority ecosystem decision also applies to the following catchments: Plane, Proserpine and Waterpark.	O'Connell	oc_nr_fl_03	5.2.1	4
Slade Point/ Andergrove	This area is a large complex of estuarine and freshwater treeless and paperbark wetlands that includes small remnants of the highly endangered grassland regional ecosystem 8.3.12, and the of concern regional ecosystem 8.2.7a which also has a biodiversity status of endangered. The area also has unusually extensive and tall stands of the broad-leaved tea-tree *(Melaleuca leucadendra*). Note: This decision straddles the O'Connell and Pioneer study areas. The O'Connell component of this decision is covered by decision number oc_nr_fl_01.	Pioneer	pi_nr_fl_01	6.3.1	3

Priority ecosystem/ special feature	Values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Regional ecosystems 8.3.4 & 11.3.27	Significant habitat values, subject to These regional ecosystems contain significant habitat values that are under threat from threatening processes such as physical alteration/ destruction and invasion by hymenachne. Note: This priority ecosystem decision applies to the following catchments: Calliope, Comet, Dawson, Fitzroy, Isaac, Mackenzie, Misc Other Islands, Nogoa, O'Connell, Pioneer, Plane, Proserpine, Shoalwater, Styx and Waterpark.	Pioneer	pi_nr_fl_02	5.2.1	3
The freshwater swamps at Dudgeon Point	The freshwater swamps at Dudgeon Point and McEwans Beach are possibly the most diverse natural freshwater plant communities between Shoal Point and Salonika Beach. The vegetation associated with wetlands has very high value for wildlife refugia consisting of regional ecosystems 8.2.6a, 8.2.11, 8.2.1; 8.3.13a, 8.1.2 and 8.3.13a.	Plane	pl_nr_fl_01	6.3.3	4
Regional ecosystem 8.2.11	This endangered regional ecosystem is often found adjacent to saltpan wetlands. It contains significant habitat values due to it's highly nectivorous nature and therefore is important as food resource. Note: This priority ecosystem decision also applies to the following catchments: O'Connell, Proserpine and Waterpark.	Plane	pl_nr_fl_02	5.2.1	4
Regional ecosystems 8.3.4 & 11.3.27	These regional ecosystems contain significant habitat values that are under threat from threatening processes such as physical alteration/ destruction and invasion by hymenachne. Note: This priority ecosystem decision applies to the following catchments: Calliope, Comet, Dawson, Fitzroy, Isaac, Mackenzie, Misc Other Islands, Nogoa, O'Connell, Pioneer, Plane, Proserpine, Shoalwater, Styx and Waterpark.	Plane	pl_nr_fl_03	5.2.1	3
Regional ecosystem 8.2.11	This endangered regional ecosystem is often found adjacent to saltpan wetlands. It contains significant habitat values due to it's highly nectivorous nature and therefore is important as food resource. Note: This priority ecosystem decision also applies to the following catchments: O'Connell, Plane and Waterpark.	Proserpine	pr_nr_fl_01	5.2.1	4

Priority ecosystem/ special feature	Values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Regional ecosystems 8.3.4 & 11.3.27	These regional ecosystems contain significant habitat values that are under threat from threatening processes such as physical alteration/ destruction and invasion by hymenachne. <u>Note</u>: This priority ecosystem decision applies to the following catchments: Calliope, Comet, Dawson, Fitzroy, Isaac, Mackenzie, Misc Other Islands, Nogoa, O'Connell, Pioneer, Plane, Proserpine, Shoalwater, Styx and Waterpark.	Proserpine	pr_nr_fl_02	5.2.1	3
Regional ecosystems 8.3.4 & 11.3.27	These regional ecosystems contain significant habitat values that are under threat from threatening processes such as physical alteration/ destruction and invasion by hymenachne. <u>Note</u>: This priority ecosystem decision applies to the following catchments: Calliope, Comet, Dawson, Fitzroy, Isaac, Mackenzie, Misc Other Islands, Nogoa, O'Connell, Pioneer, Plane, Proserpine, Shoalwater, Styx and Waterpark.	Shoalwater	sh_nr_fl_01	5.2.1	3
Wetland complex west of St Lawrence	This wetland contains sedge swamps and areas of unmapped *Melaleuca* woodland.	Styx	st_nr_fl_01	6.3.1	3
Regional ecosystems 8.3.4 & 11.3.27	These regional ecosystems contain significant habitat values that are under threat from threatening processes such as physical alteration/ destruction and invasion by hymenachne. <u>Note</u>: This priority ecosystem decision applies to the following catchments: Calliope, Comet, Dawson, Fitzroy, Isaac, Mackenzie, Misc Other Islands, Nogoa, O'Connell, Pioneer, Plane, Proserpine, Shoalwater, Styx and Waterpark.	Styx	st_nr_fl_02	5.2.1	3
Townsend Island to Corio Bay sandplain swamps	This area is mostly contained within defence lands or national park and has excellent water quality. The site contains a high diversity of sedges, is at the northern most limit of the broad-leaved tea-tree (*Eucalyptus robusta*) and contains coastal sandy swamps including sinkholes in the dunes.	Waterpark	wa_nr_fl_01	6.3.1	4

Priority ecosystem/ special feature	Values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Regional ecosystem 8.2.11	This endangered regional ecosystem is often found adjacent to saltpan wetlands. It contains significant habitat values due to it's highly nectivorous nature and therefore is important as food resource. <u>Note</u>: This priority ecosystem decision also applies to the following catchments: O'Connell, Plane and Proserpine.	Waterpark	wa_nr_fl_02	5.2.1	4
Regional ecosystems 8.3.4 & 11.3.27	These regional ecosystems contain significant habitat values that are under threat from threatening processes such as physical alteration/ destruction and invasion by hymenachne. <u>Note</u>: This priority ecosystem decision applies to the following catchments: Calliope, Comet, Dawson, Fitzroy, Isaac, Mackenzie, Misc Other Islands, Nogoa, O'Connell, Pioneer, Plane, Proserpine, Shoalwater, Styx and Waterpark.	Waterpark	wa_nr_fl_03	5.2.1	3
Keppel Sands Conservation Park	Large area of *Livistona decora*. <u>Note</u>: This decision could not be implemented due to lack of non-riverine wetland mapping in this area.	Waterpark	wa_nr_fl_04	6.3.1	3
Reed bed and sedgeland communities	Critical habitat (e.g. gavial swamp). <u>Note</u>: This decision has not been implemented in this assessment as further investigation is required prior to its implementation.	Various	NA	5.2.1	3
Eleocharis dulcis (bulkuru) closed sedgelands (regional ecosystems 11.1.3 and 11.3.27d)	Community that used to occur from Herbert to Fitzroy. It provides key resources and breeding habitat for a range of waterfowl such as brolgas and magpie geese. It is currently threatened by development, being a preferred landform setting for ponded pasture development (bunding). <u>Note</u>: This decision has not been implemented in this assessment because further investigation into its implementation is required.	Various	NA	5.2.1	3
Regional ecosystem 8.3.12 (ecosystems containing *Hemarthria uncinata*)	This endangered grassland ecosystem has limited distribution and has been extensively cleared/altered. <u>Note</u>: This decision was not implemented in this assessment as it was not considered to be a wetland related decision.	Various	NA	5.2.1	3

Priority ecosystem/ special feature	Values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Regional ecosystem 8.3.14	This endangered regional ecosystem is a naturally rare narrow upland wetland ecosystem where most remaining examples are degraded by weeds. Its original floristic composition is currently unknown. It is currently under threat from weed invasion caused by adjacent clearing and cattle grazing. Note: This decision could not be implemented as the base mapping showed no non-riverine wetlands in these areas.	Various	NA	5.2.1	3
Regional ecosystem 8.3.2	This regional ecosystem habitat is subject to threatening process. Note: This decision was not implemented in this assessment as it was not considered to be a wetland related decision.	Various	NA	5.2.1	3

Attachments

Attachment A – GBR catchment study area

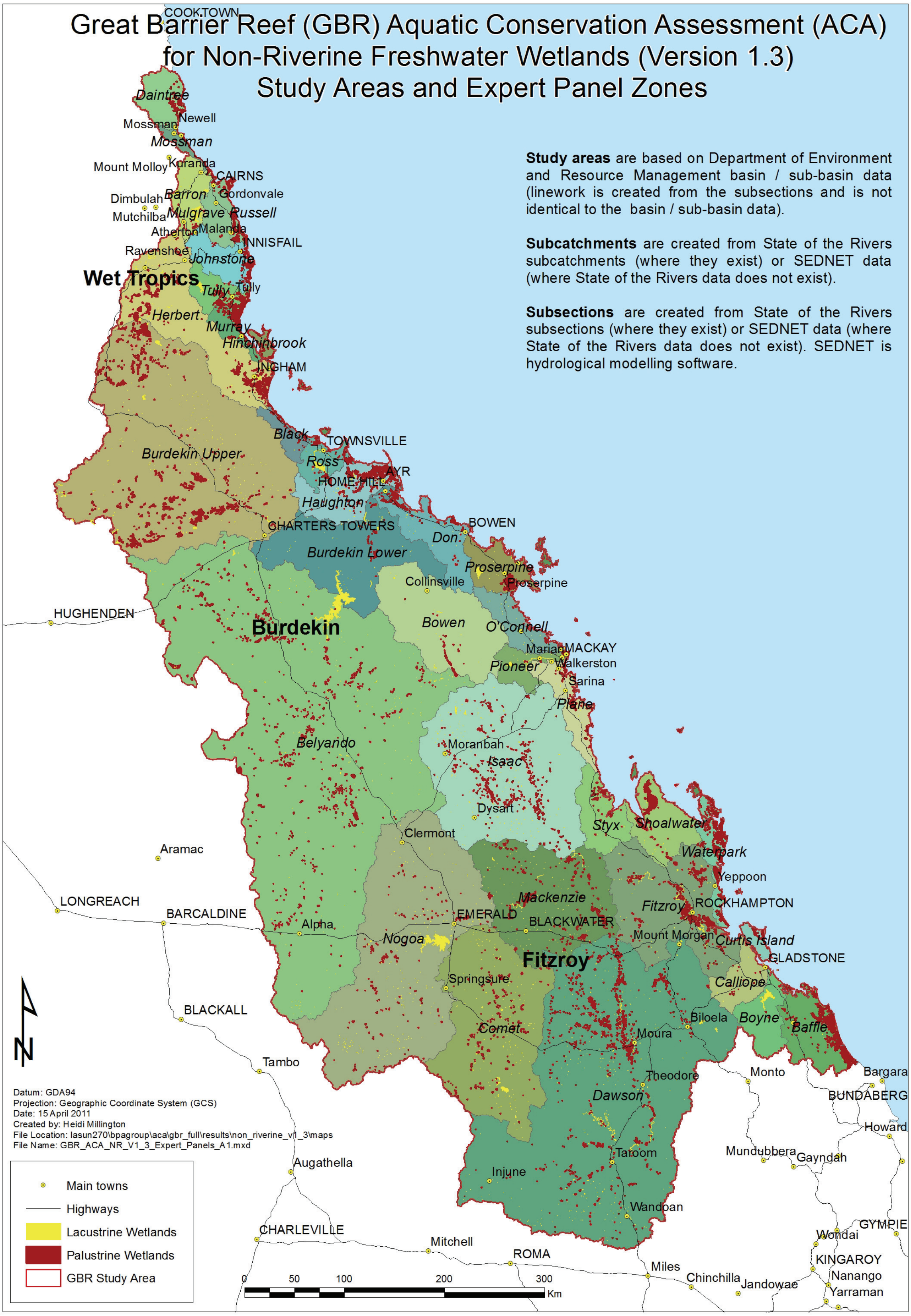

Figure 2 GBR catchment study area

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 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 of the GBR catchment. Experience in the identification and assessment of riverine and non-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 aquatic flora expert panel was established to provide expert advice on priority species, special features and/ or ecosystems that are of ecological significance to both the riverine and non-riverine wetlands of the GBR catchment. The panel consisted of professionals with expertise relating to aquatic flora and floristic communities.

The tasks undertaken by the panel included, but without limitation, 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 – Fitzroy catchment descriptions

Boyne catchment

The Boyne catchment is found to the south of Gladstone and includes the townships of Nagoorin, Ubobo, Boyne Island, Tannum Sands and Benaraby. The Boyne River and its tributaries are the major streams in the area. The Boyne is highly regulated by the large Awoonga Dam that supplies water to Gladstone and to the power station on Callide Creek in the Dawson catchment to the west. The headwaters of the Boyne drain from Kroombit Tops, Castletower, Bulberin and Dawes National Parks and these upper reaches are surrounded by high ecological value (HEV) habitat. The Boyne catchment is largely within the south-east Queensland (SEQ) bioregion.

Calliope catchment

The Calliope catchment is located to the north and west of Gladstone. Most of the catchment is within the Brigalow Belt bioregion. It includes the Calliope and its tributaries and some small coastal creeks such as Boat and Manduran creeks. The Calliope River is one of few east coast rivers that are not regulated by a dam or weir and good ecological connectivity is maintained from its source to its estuary. Its freshwater reaches are relatively natural. However, its estuary flows through several major industrial sites including a power station that releases cooling water into its lower reaches.

Most of the catchments' freshwaters are surrounded by grazing lands. Townships within the catchment include Gladstone, Calliope and Mount Larcom.

Comet catchment

The Comet sub-catchment of the Fitzroy is located west of the Great Dividing Range largely to the south and east of Emerald. Townships in the sub-catchment include Rolleston, Springsure and Comet. The major river system is the Comet and its tributaries such as Orion and Humboldt creeks.

This sub-catchment originates in the Carnarvon and Expedition Ranges and flows across a relatively flat floodplain into the Mackenzie River. The catchment is flatter and the streams less steep than any others in the Fitzroy catchment.

The catchment has levees and water harvesting infrastructure and the Comet Weir is found near its confluence with the Mackenzie. Several large perched lakes including Lake Nugga Nugga occur in its headwaters. The major industry of the sub-catchment is grazing but significant coal mines and cropping also occur in the sub-catchment.

Curtis Island

The Curtis Island catchment contains few freshwater streams but has significant non-riverine wetlands. These are of particular value in that they generally have good connectivity to estuarine systems. Most of the catchment's wetlands are surrounded by grazing lands or are within the Curtis Island National Park and Curtis Island Conservation Park.

Dawson catchment

The Dawson sub-catchment is the largest of the Fitzroy sub-catchments. Its sources include the Carnarvon Range to the south, the Expedition Range and Blackdown Tableland to the west and the Kroombit and Mount Morgan ranges to the east. The Dawson has several major tributaries including the Don and Dee rivers, Callide, Mimosa, Palm Tree, Juandah, Eurombah and Injune creeks.

Townships within the sub-catchment include Injune, Wandoan, Taroom, Theodore, Moura, Baralaba, Biloela, Mount Morgan and Duaringa. There is extensive grazing throughout the catchment as well as irrigated and dry-land cropping. There are several large coal mines and coal seam methane gas production is a significant and growing land use in the area that impacts on water flows.

The Dawson sub-catchment has a number of dams and weirs including the Glebe, Orange Creek, Gyranda, Theodore, Moura and Neville Hewitt weirs on the Dawson and Kroombit and Callide dams on the Callide Creek system. There are also dams on the Dee River near Mount Morgan to provide water for the township and others to contain contaminated water runoff from the Mount Morgan Mine tailings. Water is also flood harvested from the Dawson into offstream storage at Moura. Water is also pumped over the range from the Awoonga Dam on the Boyne River into Callide Dam.

The Dawson Valley tends to be relatively flat and the river frequently splits into anabranches and oxbow lakes in some places. The river intersects a number of sandstone gorges, notably the Nathan Gorge near Taroom and has complex groundwater links that produce unusual mound springs in some areas.

Most of the flows in the Dawson occur in summer but its southern catchments may also receive significant winter rains in some years.

Fitzroy sub-catchment

The Fitzroy sub-catchment receives its waters from the Mackenzie and Dawson rivers. It also receives significant inflows from Marlborough, Neerkol and Alligator creeks. The area also includes smaller Fitzroy delta streams including Raglan Creek.

In terms of area, grazing is the predominant land use. However, there are industrial developments close to the river including two large meatworks and the Stanwell Power Station. The Fitzroy River estuary flows through the city of Rockhampton and the townships of Marlborough, Yaamba, Westwood, Bajool and Raglan.

The Fitzroy is highly regulated as a result of upstream dams and weirs, Eden Bann Weir and the Fitzroy Barrage that prevents tidal saltwaters from moving upstream. Eden Bann Weir provides water for Stanwell Power Station and the barrage provides water for Rockhampton and the Capricorn Coast. Raglan Creek is an almost perennial stream that flows into the Fitzroy Delta.

There are several large offstream wetlands through the Fitzroy Delta including Woolwash, Yeppen, Frogmore, Crescent, Nankin, Serpentine and Gracemere lagoons.

Isaac catchment

The Isaac-Connors sub-catchment of the Fitzroy is located west of the Great Dividing Range roughly from west of Sarina to west of Marlborough. Townships in the sub-catchment include Nebo and Moranbah.

This sub-catchment provides most of the flow that reaches the Fitzroy Estuary. This is particularly so of the Connors River whose tributaries originate in the wet Clarke Connors Range to the west of Mackay and Sarina. The western side receives much less rain than the rest of the catchment and consequently flows in the upper Isaac River are much smaller. The lower Isaac and Connors rivers become split into complex multi-channels and anabranches that can become separated lagoons during the dry season.

Grazing is the predominant land use in the catchment but there are a significant number of coal mines particularly to the west. This catchment is currently less regulated than any of the other Fitzroy sub-catchments with only small dams occurring in the upper Isaac River e.g. Burton Gorge Dam. There are significant quantities of water pumped from the Burdekin catchment into the catchment to supply the needs of coal mining.

The Dipperu National Park (scientific) is the only park within the Isaac Connors sub-catchment.

Mackenzie catchment

The Mackenzie sub-catchment of the Fitzroy receives flows from the Nogoa, Comet and Isaac rivers. The catchment extends downstream to the confluence with the Dawson River after which it becomes the Fitzroy. Townships in the sub-catchment include Middlemount, Blackwater and Dingo.

Grazing is the predominant land use in the catchment but there are a significant number of coal mines and irrigated and dry-land cropping are also important. The catchment is highly regulated with flows being controlled through Bingegang, Bedford and Tartrus weirs as well as a number of water harvesting operations.

Most of the upper catchment flows through a single channel. However, at the confluence with the Isaac River the river has several large floodplain waterholes such as Lake Mary on its floodplain that may become river channels during floods.

There is one National Park—Taunton National Park—and several state forests within the sub-catchment.

Nogoa catchment

The Nogoa sub-catchment of the Fitzroy is located west of the Great Dividing Range largely to the west of Emerald. Townships in the sub-catchment include Emerald, Rubyvale, Sapphire, Clermont and Capella. The major river system is the Nogoa and its tributaries such as Theresa and Crinum creeks.

This sub-catchment originates between Carnarvon Range and Clermont and shares its origins with the Burdekin, Burnett and Murray Darling systems. It is totally landlocked and flows into the Mackenzie River system. Grazing is the predominant land use in the catchment but there are a significant number of coal mines and cropping is important in the Emerald irrigation area. The catchment is highly regulated downstream of the large Fairbairn Dam near Emerald with several small weirs and the Theresa Creek Dam also regulating flows.

There is one national park—Carnarvon National Park—at the south-western corner of the subcatchment and a number of large state forests such as Kettle and Fairbairn State Forests.

O’Connell catchment

The O’Connell catchment is located to the south of Proserpine and north of Mackay. It forms part of the Central Queensland Coast bioregion.

Despite its name, this catchment actually comprises small coastal catchments including the Andromache and O’Connell rivers and several smaller creeks including Murray, Constant and Blackrock creeks.

Townships in the area include Bloomsbury, Calen, Kuttabul and Seaforth. The major industries of the area include tourism, cane growing, cattle grazing and fishing.

The O'Connell catchment has a tropical climate with a pronounced wet season between December and March. The streams tend to be relatively short and fast flowing from rainforest headwaters across a highly modified coastal plain extensively developed for sugar cane growing.

Pioneer catchment

The Pioneer catchment is located on the east coast flowing through the city of Mackay. It forms part of the Central Queensland Coast bioregion.

This catchment includes the Pioneer River and its tributaries such as Cattle, Finch Hatton, Teemburra, Blacks and Black Waterhole creeks. The Pioneer River is highly regulated with a major dam (Teemburra Dam) and a series of weirs (Marian, Mirani and Dumbleton). Water is also diverted through a series of creeks to be utilised in the Pioneer Valley Irrigation Scheme and also pumped to the nearby Kinchant Dam which is the major storage for the Eton Irrigation Scheme in the Plane Creek catchment.

The headwaters of the catchment rise in high conservation value rainforest and then flow across a highly modified coastal plain through the city of Mackay.

Townships in the area include Mackay, Marian, Mirani and Pinnacle. The major industries of the area include tourism, cane growing, cattle grazing, forestry (including plantations), and fishing. Most of the headwaters of the Pioneer rise in national parks, such as the Eungella National Park, or state forest (including Crediton State Forest).

The Proserpine catchment has a tropical climate with a pronounced wet season between December and March.

Plane catchment

The Plane catchment is located on the east coast of Queensland, to the south of Mackay. It forms part of the Central Queensland Coast bioregion. Despite its name, this catchment is actually several small coastal catchments including Bakers, Sandy, Alligator, Plane, Rocky Dam, Marion, Carmilla, West Hill and Clairview creeks.

Townships within the catchment include Sarina, Koumala, Carmila and Clairview. The northern streams form part of the Eton Irrigation Scheme supplying water for irrigated cane growing. Water from the Pioneer River is flood harvested and transferred into these streams in part through the large offstream storage Kinchant Dam. Plane Creek has a series of small weirs regulating its flows. Streams tend to be less regulated and modified in the southern parts of the catchment.

The Plane catchment has a tropical climate with a pronounced wet season between December and March. The streams tend to be relatively short and fast flowing from rainforest headwaters. In the north they flow across a highly modified coastal plain extensively developed for sugar cane growing.

Southern streams largely rise in state forests such as the West Hill and Kelvin State Forest. Cape Palmerston National Park is found on the coast within the catchment.

Proserpine catchment

The Proserpine catchment is located on the east coast, to the south of Bowen and north of Mackay. It forms part of the Central Queensland Coast bioregion.

Despite its name, this catchment is actually several small coastal catchments including the Proserpine and Gregory rivers and smaller creeks such as Repulse Creek, and it includes the world-recognised wetlands of Goorganga Plain. Streams in the area tend to be short and fast flowing usually with headwaters in rainforest.

Repulse Creek is one of few streams almost entirely enclosed in protected area (predominantly Conway National Park). In contrast the Proserpine River is highly regulated with a major storage (Peter Faust Dam) in its headwaters. Water is released from this dam through a series of stream diversions to facilitate irrigated sugar cane growing.

Townships in the area include Proserpine, Airlie Beach Dingo Beach and Midge Point. The major industries of the area include tourism, cane growing, cattle grazing, forestry (including plantations), and fishing. There are also major national parks including the Whitsunday Islands and Conway National Park.

The Proserpine catchment has a tropical climate with a pronounced wet season between December and March.

Shoalwater catchment

The Shoalwater catchment is located to the north of Rockhampton and south of Mackay. It forms part of the Brigalow Belt and Central Queensland Coast bioregions. It is largely bounded by the western coast of Shoalwater Bay and the shores of Stanage Bay. It includes the small streams flowing into Stanage Bay such as Herbert and Wadallah creeks, and includes the settlement of Stanage Bay.

There are extensive non-riverine wetlands in the vicinity of the Torilla Plains and Glenprairie to the east and west of Stanage Bay. The major modification to local water regime is the construction of extensive levees to stop saltwater intrusion. These have modified a number of estuarine wetlands to become extensive freshwater palustrine areas.

The Shoalwater catchment has a tropical to subtropical climate with a pronounced wet season between December and March. It represents a transitional zone between the steep fast streams to the north and the long slow-flowing streams of the Fitzroy Basin. Streams are less steep and slower flowing than those further north.

Styx River catchment

The Styx catchment is located on the east coast of Queensland, to the north of Rockhampton and south of Mackay. It forms part of the Brigalow Belt North bioregion. The major streams in this small catchment are the Styx River and St Lawrence Creek. Locations within the catchment include St Lawrence and Ogmore. St Lawrence Creek is regulated by a small weir.

The Styx catchment has a tropical climate with a pronounced wet season between December and March. It represents a transitional zone between the steep fast streams to the north and the long slow-flowing streams of the Fitzroy Basin. Streams are less steep and slower flowing than those further north. The highly dispersive soils of the area make the streams naturally more turbid.

The major industries in the area are cattle grazing and fishing with some horticulture and plantation forestry in the north.

Two small state forests (Glencoe and Mt Buffalo) and a small conservation park (Newport) exist in the catchment.

Waterpark catchment

The Waterpark catchment is located to the north-east of Rockhampton. It forms part of the Brigalow Belt and Central Queensland Coast bioregions. It includes the Shoalwater Bay

Military Training Area south to the mouth of the Fitzroy River. The northern section from the mouth of Waterpark Creek is one of the least disturbed catchment areas in Queensland with only infrequent use in relatively small areas. It is closely managed as part of the Shoalwater Bay Military Training Area, the Byfield National Park and Byfield State Forest with limited access and largely natural remnant vegetation.

The largest stream in the area is Waterpark Creek, which rises from sand dunes in the north and flows south and then east into Corio Bay almost exclusively through protected areas. Its water quality and source from within sand dunes makes it unique within the Fitzroy study area. Within Shoalwater Bay, there are several small streams including Shoalwater Creek and a large wetland complex (Dismal Swamp) but no large rivers. Further south creeks such as Coorooman Creek have much more disturbed catchments. The acid Wallum wetlands of the Dismal Swamp area are very unusual within the central Fitzroy area.

The area includes the townships of Yeppoon, Emu Park and Keppel Sands.

Attachment D – Criteria, indicators and measures for the GBR catchment

The criteria, indicators and measures (CIM) list outlines the CIM that were implemented as part of the non-riverine Aquatic Conservation Assessment (ACA) using AquaBAMM of the freshwater wetlands of the GBR catchment.

The list has been developed from a default list of CIM that may be considered when an Aquatic Conservation Assessment (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. AquaBAMM does allow addition or deletion of indicators and/or measures for each ACA when its assessment parameters are set. However, 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 GBR catchment

Criteria & indicators	Measures	
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
1.4 Hydrological modification	1.4.5	Hydrological disturbance/modification of the wetland (e.g. as determined through DERM wetland mapping and classification)
2 Naturalness catchment		
2.1 Exotic flora/fauna	2.1.1	Presence of exotic terrestrial plants in the assessment unit
2.2 Riparian disturbance	2.2.5	Per cent area of remnant vegetation relative to preclear extent within buffered non-riverine wetland: 500 m buffer for wetlands >= 8Ha, 200 m buffer for smaller wetlands
2.3 Catchment disturbance	2.3.1	Per cent "agricultural" land-use area (i.e. cropping and horticulture)
	2.3.2	Per cent "grazing" land-use area
	2.3.3	Per cent "vegetation" land-use area (i.e. native veg + regrowth)
	2.3.4	Per cent "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	3.1.2	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
3.3 Habitat	3.3.2	Richness of wetland types within the local catchment (e.g. SOR sub-section)
	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[1], EPBC Act[2]

Criteria & indicators	Measures	
	4.1.2	Presence of rare or threatened aquatic ecosystem dependent flora species – NC Act[1], EPBC Act[2]
4.2 Communities/ assemblages	4.2.1	Conservation status of wetland Regional Ecosystems – Herbarium biodiversity status, NC Act[1], EPBC Act[2]
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)
	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[3]/CAMBA[4] 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)
8 Representativeness		
8.1 Wetland protection	8.1.1	The per cent area of each wetland habitat type within protected areas
	8.1.2	The per cent 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*
8.2 Wetland uniqueness	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)
	8.2.2	The relative abundance of the wetland management group to which the wetland habitat belongs within the subcatchment or estuarine/marine zone (management groups ranked least common to most common)
	8.2.3	The size of each wetland habitat relative to others of its management group within the catchment or study area
	8.2.4	The size of each wetland habitat relative to others of its management group within a subcatchment (or estuarine zone)
	8.2.5	Wetland habitat representative of the study area – identified by expert opinion
	8.2.6	The size of each wetland habitat relative to others of its 'type' within the catchment or study area

1 NC Act – *Nature Conservation Act 1992* (Queensland legislation)
[2] EPBC Act – *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth legislation)
[3] JAMBA – Japan-Australia Migratory Bird Agreement
[4] CAMBA – China-Australia Migratory Bird Agreement

References

Clayton, P.D., Fielder, D.P., Barratt, P.J. and Hill, C.J. (2008). Aquatic Conservation Assessments (ACA), using AquaBAMM, for freshwater wetlands of the Baffle Creek catchment. Published by the Environmental Protection Agency, Brisbane.

Attachment H GBR catchments ACA – Aquatic fauna expert panel report (Fitzroy region)

An Aquatic Conservation Assessment for the non-riverine wetlands of the Great Barrier Reef catchment

Aquatic fauna
Expert panel report

(Version 1.3)

Fitzroy region

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Acronyms and abbreviations

ACA	Aquatic Conservation Assessment
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
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
GBR	Great Barrier Reef
GIS	Geographic information system
HEV	High ecological value (under a water quality improvement plan)
JAMBA	Japan-Australia Migratory Birds Agreement
NC Act	*Nature Conservation Act 1992*
Ramsar	Ramsar Convention on Wetlands
RE	Regional ecosystem

1 Introduction

The Department of Environment and Resource Management (DERM) conducted an Aquatic Conservation Assessment (ACA) for the non-riverine wetlands in the Great Barrier Reef (GBR) catchment using the Aquatic Biodiversity Assessment and Mapping Method (AquaBAMM; Clayton *et al*. 2006). The ACA relied upon 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 GBR catchment.

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 GBR catchment is made up of 35 individual catchments from the Daintree River north of Cairns, to Baffle Creek south of Gladstone. DERM applied AquaBAMM separately to the non-riverine (palustrine and lacustrine) and riverine wetlands within each of the 35 GBR catchments. In effect, there are 70 ACAs for the entire GBR catchment—covering non-riverine and riverine wetlands. A map of the GBR catchment showing each study area is provided in Attachment A.

A series of nine expert panels were conducted to address aquatic fauna, aquatic and riparian flora, and wetland ecology for the GBR catchments. The non-riverine and riverine wetlands were covered in combined workshops. The panels, held in Cairns, Townsville and Rockhampton during November and December 2008, involved invited experts with expertise in aquatic fauna, aquatic and riparian flora and/or wetland ecology in the Wet Tropics, Burdekin and Fitzroy sections of the GBR catchment.

This report documents the findings and recommendations of the aquatic fauna expert panel for the Fitzroy region held in Rockhampton on Wednesday 10 December, 2008. This report presents supporting information and panel input that only addresses the non-riverine wetland systems. The riverine component has been addressed in a separate report. Terms of reference for the aquatic fauna expert panel are provided in Attachment B.

2 Method

2.1 Study area

The Fitzroy section of the GBR catchment is a vast and extremely varied area. It ranges from the high rainfall, short fast streams surrounded by rainforest on the Whitsunday coast to the slow, turbid meandering floodplain streams of the Fitzroy catchment. It encompasses parts of three bioregions, supports Ramsar listed wetlands and its waters impact on the southern and central GBR. It includes iconic sandstone gorges in places like the Carnarvon Ranges to perched lakes in the upper Comet sub-catchment to world recognised wetland complexes such as the Goorganga Plains as well as waterfalls, cascades and torrents in the rainforests of the Whitsundays.

The Fitzroy catchment itself is the largest eastward flowing system in Australia only exceeded in total flow Australia wide, by the Murray–Darling system. The area includes two catchments (Waterpark Creek and Repulse Creek) that are almost entirely surrounded by protected areas. Other catchments are highly modified with a number of rivers heavily regulated by dams, weirs and irrigation development.

The climate of the area is also highly variable. It ranges from distinctly tropical in the north to subtropical in the south. Rainfall is distinctly seasonal with a pronounced wet season from December to March but the amount of rain that falls is amongst the most variable in the world. Between 1976 and 2008, wet season flow to the mouth of the Fitzroy varied from around 349,677 megalitres to 22,903,390 megalitres. Much of the aquatic ecology of the area is driven by variable boom and bust cycles and is consequently amongst the most resilient anywhere.

The largest land use in terms of area is cattle grazing, however extensive cropping and intensive cultivation of sugar cane is also very important. The area also contributes a huge quantity of coal that is vital to the Queensland and Australian economy.

It is not possible to adequately give an overview of such a vast and varied area, so a brief description of the 17 catchment areas is provided in Attachment C. This attachment should be considered when interpreting the contents of this report.

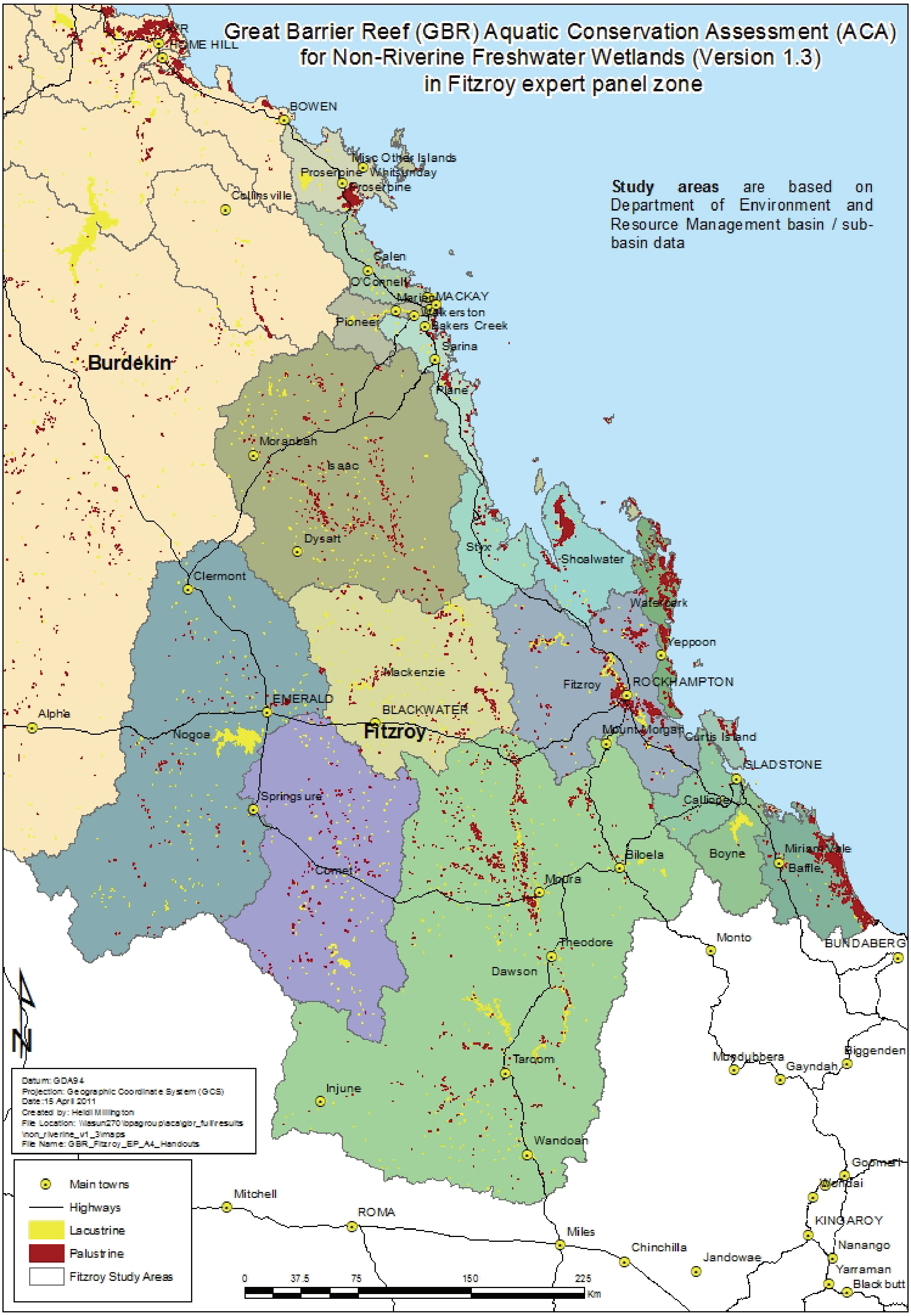

Figure 1 Fitzroy section of the GBR catchment (incorporating 17 individual catchments)

2.2 Panel composition

The expert panel (the panel) comprised invited persons (Table 1) familiar with aquatic fauna in the Fitzroy section of the GBR Catchment.

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
Jim Tait	Ecologist, Ecoconcern Pty Ltd	Wetland ecology and management
John Platten	Principal Biodiversity Planning Officer, Department of Environment and Resource Management	Biodiversity planning, aquatic ecology and water quality
Pam Malysek	Greening Australia	Turtles
Roger Jaensch	Senior Programme Officer, Wetlands International	Wetland ecology and management, birds
Shaun Pobar	District Advisor, Department of Primary Industries and Fisheries	Fish and aquatic fauna
Steve Elson	Principal Planning Officer, Department of Environment and Resource Management	Biodiversity planning
Thomas Espinoza	Project Leader, Aquatic Ecosystem Programme, Department of Environment and Resource Management	Fish and aquatic fauna

Heidi Millington and Steven Howell provided administrative and technical support for the workshop which was facilitated by Selena Inglis.

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 GBR catchment was also sourced from various technical reports.

3 Rare and threatened fauna

The panel identified seven ‘rare’, eight ‘vulnerable’, three ‘endangered’ and two ‘critically endangered’ fauna taxa in the Fitzroy section of the GBR catchment (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 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**	**Comments**
Adclarkia dawsonensis	Boggomoss snail	CE[2]	
Adelotus brevis	Tusked frog	V[1]	
Crinia tinnula[#]	Wallum froglet	V[1]	Found in Baffle Creek catchment acid swamps, usually non-riverine.
Crocodylus porosus	Estuarine crocodile	V[1]	
Cyclorana verrucosa	Rough collared frog	R[1]	
Denisonia maculata	Ornamental snake	V[1,2]	
Ephippiorhynchus asiaticus	Black-necked stork	R[1]	
Epthianura crocea	Yellow chat	V[1]	
Epthianura crocea macgregori	Yellow chat (Capricorn subsp.)	E[1], CE[2]	Limited distribution, habitat threatened.
Erythrotriorchis radiatus	Red goshawk	E[1], V[2]	
Lewinia pectoralis	Lewin's rail	R[1]	
Litoria revelata	Whirring treefrog	R[1]	
Neochmia phaeton phaeton	Crimson finch	LC[1]	Previous status was listed as V[1]. Status is now LC[1]. To be reviewed for potential priority species inclusion at subsequent ACA updates as the limited habitat that remains is highly impacted by exotic pastures.
Neochmia ruficauda ruficauda	Star finch	E[1,2]	
Nettapus coromandelianus	Cotton pygmy-goose	R[1]	Habitat has been extensively modified and range has become restricted.
Pseudomugil mellis	Honey blue eye	V[1,2]	
Rostratula australis	Australian painted snipe	V[1,2]	Habitat and feeding grounds have been extensively modified. Reduction in population is cause for concern.
Sternula albifrons	Little tern	E[1]	Uses lakes sometimes.
Stictonetta naevosa	Freckled duck	R[1]	
Tadorna radjah	Radjah shelduck	R[1]	

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

[#] *Crinia tinnula data is based on habitat distribution model*

1. Queensland *Nature Conservation Act 1992 (E – Endangered, V – Vulnerable, R – Rare, LC – Least Concern)*
2. *Environment Protection and Biodiversity Conservation Act 1999 (CE – Critically Endangered; E – Endangered, V – Vulnerable; EX - Extinct)*

4 Priority fauna

The panel deliberated on all aquatic-dependent fauna species within the Fitzroy section of the GBR catchment to identify ‘priority fauna’ (excluding the rare or threatened species listed in Table 2). The panel agreed to a definition of a priority species: namely, 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 (>1 per cent for waterbirds, >75 per cent other species) occurs in the waterbody (see Ramsar criterion 6 for waterbirds).

4.1 Priority species

The panel identified nine priority fauna species associated with non-riverine wetlands (Table 3). These species were included in ‘Criterion 5 Priority species and ecosystems’ (5.1.2). Point records were buffered using their precision to identify the spatial units having a priority species present. A spatial unit with one or more of these species present 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	Priority number[1]	Comments
Hephaestus fuliginosus	Sooty grunter	4	Threatened by loss of habitat.
Lates calcarifer	Barramundi	3, 6	Migratory species that has experience a significant reduction in its already naturally restricted distribution due to habitat modification.
Megalops cyprinoides	Oxeye herring/tarpon	3, 6	Migratory species that has experienced a significant reduction in its distribution and has a naturally restricted distribution in the study area. Its habitat is also under threat.
Mugil cephalus	Sea mullet	3, 6	Migratory species that has experienced a significant reduction in its distribution and has a naturally restricted distribution in the study area. Its habitat is also under threat.
Myxus petardi	Pinkeye mullet	3, 6	Migratory species that has experienced a significant reduction in its distribution and has a naturally restricted distribution in the study area. Its habitat is also under threat.
Ophiocara porocephala	Spangled gudgeon	3	Small population that has experienced a significant reduction in its distribution and has a naturally restricted distribution in the study area.
Scleropages leichardti	Southern saratoga	1, 7	Endemic to the study area this species’ entire breeding population occurs within wetlands.

Scientific name	Common name	Priority number[1]	Comments
Scortum hillii	Leathery grunter	1, 4, 7	Endemic to the study area this species' entire breeding population occurs within wetlands. The small population is also threatened by loss of habitat.
Strongylura krefftii	Freshwater longtom	2,4	Experienced a serious population decline and is further threatened by loss of habitat.

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

1. The priority numbers are the values that a species must exhibit to be a priority species as listed in dot points above Table 3.

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) or the Convention on the Conservation of Migratory Species of Wild Animals (CMS) as priority fauna. A total of 15 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 and a four 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). Sourced from Japan-Australia Migratory Bird Agreement (JAMBA), China-Australia Migratory Bird Agreement (CAMBA), and the Convention on the Conservation of Migratory Species of Wild Animals (CMS) at <www.environment.gov.au/biodiversity/migratory/waterbirds/index>.

Scientific name	Common name	Agreements/ conventions	Comments
Ardea ibis	Cattle egret	CAMBA[1], JAMBA[2], CMS[3]	Waterbird that uses the freshwater wetlands in the Fitzroy region that is truly migratory according to the CMS[3], also known to migrate to New Zealand.
Ardea modesta	Eastern great egret	CAMBA[1], JAMBA[2]	Also known or believed to migrate in large numbers to New Guinea and/or Indonesia.
Arenaria interpres	Ruddy turnstone	CAMBA[1], JAMBA[2], CMS[3]	
Calidris acuminata	Sharp-tailed sandpiper	CAMBA[1], JAMBA[2], CMS[3]	Waterbird that uses the freshwater wetlands in the Fitzroy region that is truly migratory according to the CMS[3].
Charadrius bicinctus	Double-banded plover	CMS[3]	Known to migrate to New Zealand.
Chlidonias leucopterus	White-winged black tern	CAMBA[1], JAMBA[2], CMS[3]	Waterbird that uses the freshwater wetlands in the Fitzroy region that is truly migratory according to the CMS[3].
Gallinago hardwickii	Latham's snipe	CAMBA[1], JAMBA[2], CMS[3]	Waterbird that uses the freshwater wetlands in the Fitzroy region that is truly migratory according to the CMS[3].
Glareola maldivarum	Oriental pratincole	CAMBA[1], JAMBA[2]	
Limosa limosa	Black-tailed godwit	CAMBA[1], JAMBA[2], CMS[3]	Waterbird that uses the freshwater wetlands in the Fitzroy region that is truly migratory according to the CMS[3].
Numenius minutus	Little curlew	CAMBA[1], JAMBA[2], CMS[3]	Waterbird that uses the freshwater wetlands in the Fitzroy region that is truly migratory according to the CMS[3]. Uncommon in region.
Plegadis falcinellus	Glossy Ibis	CAMBA[1], CMS[3]	

Scientific name	Common name	Agreements/ conventions	Comments
Pluvialis fulva	Pacific golden plover	CAMBA[1], JAMBA[2], CMS[3]	
Rostratula australis	Australian painted snipe	CAMBA[1]	Habitat loss has reduced numbers and range.
Tringa stagnatilis	Marsh sandpiper	CAMBA[1], JAMBA[2], CMS[3]	Waterbird that uses the freshwater wetlands in the Fitzroy region that is truly migratory according to the CMS[3], known to migrate to South East Asia.
Xenus cinereus	Terek sandpiper	CAMBA[1], JAMBA[2], CMS[3]	Known to migrate to North-East Asia.

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

1 *China-Australia Migratory Birds Agreement (CAMBA)*
2 *Japan-Australia Migratory Birds Agreement (JAMBA)*
3 *Convention on the Conservation of Migratory Species of Wild Animals (CMS) also known as the "Bonn Convention"*

5 Species richness

Species richness (i.e. total number of species) was scored for each class (amphibians – frogs, fish, reptiles, and birds – waterbirds) of fauna, stratified using 150 m above sea level (asl) for the Baffle study area (see the Fitzroy ecology expert panel report for more information on stratification). 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.

5.1 Fish richness

There were 47 native fish species identified in the non-riverine wetlands of the Fitzroy section of the GBR catchment. A further six species were considered to be alien to the region. Table 5 lists fish species that were used under 'Criteria 3 Diversity and richness' (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	Comments
Amniataba percoides	Barred grunter	LC[1]	
Anguilla obscura	Pacific shortfin eel	LC[1]	Shortfin and longfin eel are easily misidentified. Shortfin eel is primarily found in habitats close to the coast.
Anguilla reinhardtii	Longfin eel	LC[1]	Shortfin and longfin eel are easily misidentified. Longfin eel is found throughout the study area.
Anguilla sp.	Freshwater eel sp.	LC[1]	
Arius graeffei	Blue catfish	LC[1]	Found throughout the study area.
Arrhamphus sclerolepis	Snubnose garfish	LC[1]	
Craterocephalus stercusmuscarum	Flyspecked hardyhead	LC[1]	
Giurus margaritacea	Snakehead gudgeon	LC[1]	
Glossamia aprion	Mouth almighty	LC[1]	
Hephaestus fuliginosus	Sooty grunter	LC[1]	Native in northern catchments.
Hypseleotris compressa	Empire gudgeon	LC[1]	
Hypseleotris galii	Firetail gudgeon	LC[1]	
Hypseleotris klunzingeri	Western carp gudgeon	LC[1]	
Hypseleotris sp.	Gudgeon sp.	LC[1]	
Hypseleotris sp. A	Midgley's carp gudgeon	LC[1]	
Lates calcarifer	Barramundi	LC[1]	
Leiopotherapon unicolor	Spangled perch	LC[1]	Found throughout the study area.
Megalops cyprinoides	Oxeye herring/tarpon	LC[1]	
Melanotaenia duboulayi	Crimson spotted rainbowfish	LC[1]	
Melanotaenia sp.	Rainbowfish sp.	LC[1]	
Melanotaenia splendida	Eastern rainbowfish	LC[1]	
Mogurnda adspersa	Southern purple spotted gudgeon	LC[1]	
Mogurnda sp.	Gudgeon sp.	LC[1]	

Scientific name	Common name	Status	Comments
Mordacia mordax	Short-headed lamprey	LC[1]	
Mugil cephalus	Sea mullet	LC[1]	
Myxus petardi	Pinkeye mullet	LC[1]	
Nematalosa erebi	Bony bream	LC[1]	Excellent indicator of water quality as it is the first species to be affected by poor water quality resulting in a fish kill. Currently absent from Yeppen Lagoon.
Neosilurus ater	Black catfish	LC[1]	
Neosilurus hyrtlii	Hyrtl's catfish	LC[1]	Common throughout the study area.
Neosilurus sp.	Eel-tailed catfish	LC[1]	
Notesthes robusta	Bullrout	LC[1]	
Ophiocara porocephala	Spangled gudgeon	LC[1]	
Oxyeleotris lineolata	Sleepy cod	LC[1]	
Philypnodon grandiceps	Flathead gudgeon	LC[1]	
Philypnodon macrostomus	Dwarf flathead gudgeon	LC[1]	
Philypnodon sp.	Gudgeon sp.	LC[1]	
Porochilus rendahli	Rendahl's catfish	LC[1]	
Pseudogobius sp.	Goby sp.	LC[1]	
Pseudomugil mellis	Honey blue eye	V[1,2]	
Pseudomugil signifer	Pacific blue eye	LC[1]	
Redigobius bikolanus	Speckled goby	LC[1]	
Retropinna semoni	Australian smelt	LC[1]	Occurs in baffle but is not common north of there.
Rhadinocentrus ornatus	Ornate rainbowfish	LC[1]	Reliable records from Shoalwater Bay.
Scleropages leichardti	Southern saratoga	LC[1]	
Scortum hillii	Leathery grunter	LC[1]	Not commonly found on the coast.
Strongylura krefftii	Freshwater longtom	LC[1]	Population fluctuates markedly. It is found in Awonga Dam, Calliope and Callide River catchments.
Tandanus tandanus	Freshwater catfish	LC[1]	

- *recent records (>1975) and records with precision (<2000 m) only*
1. Queensland *Nature Conservation Act 1992 (E – Endangered, V – Vulnerable, R – Rare, LC – Least Concern)*
2. *Environment Protection and Biodiversity Conservation Act 1999 (EX – Extinct, CE – Critically Endangered, E – Endangered, V – Vulnerable)*

5.2 Reptile richness

There were ten native reptile species identified in the non-riverine wetlands of the Fitzroy section of the GBR catchment. 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	Comments
Chelodina longicollis	Eastern snake-necked turtle	LC[1]	
Chelodina sp.	Turtle sp.	LC[1]	This taxa suspected to be *Chelodina longicollis.*

Scientific name	Common name	Status	Comments
Crocodylus porosus	Estuarine crocodile	V[1]	
Denisonia maculata	Ornamental snake	V[1,2]	
Emydura macquarii krefftii	Krefft's river turtle	LC[1]	
Eulamprus quoyii	Eastern water skink	LC[1]	
Hemiaspis signata	Black-bellied swamp snake	LC[1]	Largely non-riverine as it prefers swampy areas with frogs as a food source.
Macrochelodina expansa	Broad-shelled river turtle	LC[1]	
Physignathus lesueurii	Eastern water dragon	LC[1]	
Tropidonophis mairii	Freshwater snake	LC[1]	

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

1. Queensland *Nature Conservation Act 1992 (E – Endangered, V – Vulnerable, R – Rare, LC – Least Concern)*
2. *Environment Protection and Biodiversity Conservation Act 1999 (EX – Extinct, CE – Critically Endangered, E – Endangered, V – Vulnerable)*

5.3 Waterbird richness

There were 82 native waterbird species identified in the non-riverine wetlands of the Fitzroy section of the GBR catchment. Table 7 lists the wetlands-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	Comments
Acrocephalus australis	Australian reed-warbler	LC[1]	
Amaurornis cinerea	White-browed crake	LC[1]	
Amaurornis moluccana	Pale-vented bush-hen	LC[1]	
Anas castanea	Chestnut teal	LC[1]	
Anas gracilis	Grey teal	LC[1]	
Anas rhynchotis	Australasian shoveler	LC[1]	
Anas superciliosa	Pacific black duck	LC[1]	
Anhinga melanogaster	Australasian darter	LC[1]	
Anseranas semipalmata	Magpie goose	LC[1]	
Ardea ibis	Cattle egret	LC[1]	
Ardea intermedia	Intermediate egret	LC[1]	
Ardea modesta	Eastern great egret	LC[1]	
Ardea pacifica	White-necked heron	LC[1]	
Ardea sumatrana	Great-billed heron	LC[1]	
Arenaria interpres	Ruddy turnstone	LC[1]	
Aythya australis	Hardhead	LC[1]	
Calidris acuminata	Sharp-tailed sandpiper	LC[1]	Waterbird that uses the freshwater wetlands in the Fitzroy region that is truly migratory according to the CMS[3].
Ceyx azureus	Azure kingfisher	LC[1]	
Ceyx pusilla	Little kingfisher	LC[1]	
Charadrius bicinctus	Double-banded plover	LC[1]	Known to migrate to New Zealand.
Chenonetta jubata	Australian wood duck	LC[1]	
Chlidonias hybrida	Whiskered tern	LC[1]	Verified as freshwater living.

Scientific name	Common name	Status	Comments
Chlidonias leucopterus	White-winged black tern	LC[1]	Verified as freshwater living.
Chroicocephalus novaehollandiae	Silver gull	LC[1]	Verified as freshwater living.
Circus approximans	Swamp harrier	LC[1]	
Cygnus atratus	Black swan	LC[1]	
Dendrocygna arcuata	Wandering whistling-duck	LC[1]	
Dendrocygna eytoni	Plumed whistling-duck	LC[1]	
Egretta garzetta	Little egret	LC[1]	
Egretta novaehollandiae	White-faced heron	LC[1]	
Ephippiorhynchus asiaticus	Black-necked stork	R[1]	
Epthianura crocea	Yellow chat	V[1]	Thought to be a misidentification and has been grouped with *Epthianura crocea macgregori.*
Epthianura crocea macgregori	Yellow chat (Dawson subspecies)	E[1], CE[2]	This is the only subspecies of yellow chat in the study area.
Erythrogonys cinctus	Red-kneed dotterel	LC[1]	
Erythrotriorchis radiatus	Red goshawk	E[1], V[2]	
Fulica atra	Eurasian coot	LC[1]	
Gallinago hardwickii	Latham's snipe	LC[1]	
Gallinula tenebrosa	Dusky moorhen	LC[1]	
Gallirallus philippensis	Buff-banded rail	LC[1]	
Gelochelidon nilotica	Gull-billed tern	LC[1]	Verified as freshwater living.
Glareola maldivarum	Oriental pratincole	LC[1]	
Grus rubicunda	Brolga	LC[1]	
Himantopus himantopus	Black-winged stilt	LC[1]	
Hydroprogne caspia	Caspian tern	LC[1]	Verified as freshwater living.
Irediparra gallinacea	Comb-crested jacana	LC[1]	
Ixobrychus dubius	Australian little bittern	LC[1]	
Ixobrychus flavicollis	Black bittern	LC[1]	
Lewinia pectoralis	Lewin's rail	R[1]	
Limosa limosa	Black-tailed godwit	LC[1]	Waterbird that uses the freshwater wetlands in the Fitzroy region that is truly migratory according to the CMS[3].
Malacorhynchus membranaceus	Pink-eared duck	LC[1]	
Megalurus gramineus	Little grassbird	LC[1]	
Microcarbo melanoleucos	Little pied cormorant	LC[1]	
Neochmia phaeton phaeton	Crimson finch	LC[1]	Previously identified as V[1]. Status is now LC[1]. The limited habitat that remains is highly impacted by exotic pastures.
Neochmia ruficauda ruficauda	Star finch	E[1,2]	
Nettapus coromandelianus	Cotton pygmy-goose	R[1]	
Nettapus pulchellus	Green pygmy-goose	LC[1]	
Numenius minutus	Little curlew		Waterbird that uses the freshwater wetlands in the Fitzroy region that is truly migratory according to the CMS[3], less common in region.

Scientific name	Common name	Status	Comments
Pelecanus conspicillatus	Australian pelican	LC[1]	
Phalacrocorax carbo	Great cormorant	LC[1]	
Phalacrocorax sulcirostris	Little black cormorant	LC[1]	
Phalacrocorax varius	Pied cormorant	LC[1]	
Platalea flavipes	Yellow-billed spoonbill	LC[1]	
Platalea regia	Royal spoonbill	LC[1]	
Plegadis falcinellus	Glossy ibis	LC[1]	
Pluvialis fulva	Pacific golden plover	LC[1]	
Podiceps cristatus	Great crested grebe	LC[1]	
Poliocephalus poliocephalus	Hoary-headed grebe	LC[1]	
Porphyrio porphyrio	Purple swamphen	LC[1]	
Porzana fluminea	Australian spotted crake	LC[1]	
Porzana pusilla	Baillon's crake	LC[1]	
Porzana tabuensis	Spotless crake	LC[1]	
Rostratula australis	Australian painted snipe	V[1,2]	
Sternula albifrons	Little tern	E[1]	Uses lakes sometimes.
Stictonetta naevosa	Freckled duck	R[1]	
Tachybaptus novaehollandiae	Australasian grebe	LC[1]	
Tadorna radjah	Radjah shelduck	R[1]	
Threskiornis molucca	Australian white ibis	LC[1]	
Threskiornis spinicollis	Straw-necked ibis	LC[1]	
Tribonyx ventralis	Black-tailed native-hen	LC[1]	
Tringa stagnatilis	Marsh sandpiper	LC[1]	
Vanellus miles	Masked lapwing	LC[1]	
Xenus cinereus	Terek sandpiper	LC[1]	Known to migrate to North-East Asia.

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

1. Queensland *Nature Conservation Act 1992 (E – Endangered, V – Vulnerable, R – Rare, LC – Least Concern)*
2. *Environment Protection and Biodiversity Conservation Act 1999 (EX – Extinct, CE – Critically Endangered, E – Endangered, V – Vulnerable)*

5.4 Frog richness

There were eight species of amphibians identified in the non-riverine wetlands of the Fitzroy section of the GBR catchment. 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 measure (3.1.1 and 3.1.6).

Scientific name	Common name	Status	Comment
Adelotus brevis	Tusked frog	V[1]	Restricted within the region to Kroombit Tops and Blackdown Tableland. Its main threats are disease (chytridiomycosis) and habitat alteration by introduced pigs, cattle and horses. There has been an apparent decline in numbers.
Crinia tinnula[#]	Wallum froglet	V[1]	Non-riverine species found in acid swamps of the Baffle Creek catchment.
Cyclorana verrucosa	Rough collared frog	R[1]	
Limnodynastes salmini	Salmon striped frog	LC[1]	Possible population decline.

Scientific name	Common name	Status	Comment
Litoria chloris	Orange eyed treefrog	LC[1]	Apparent population decline in upland sites.
Litoria revelata	Whirring treefrog	R[1]	
Mixophyes fasciolatus	Great barred frog	LC[1]	Within the region it is restricted to Kroombit Tops.
Pseudophryne raveni	Copper backed broodfrog	LC[1]	Within the region it is restricted to Kroombit Tops.

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

[#] *Crinia tinnula data is based on habitat distribution model*

1. Queensland *Nature Conservation Act 1992 (E – Endangered, V – Vulnerable, R – Rare, LC – Least Concern)*

5.5 Mammal richness

There were four species of mammal identified in the non-riverine wetlands of the Fitzroy section of the GBR catchment. Table 9 lists mammal species that were 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	Comments
Ornithorhynchus anatinus	Platypus	LC[1]	Common species which thrives even in disturbed habitats.
Myotis macropus	Large-footed myotis	LC[1]	Fishing bat
Hydromys chrysogaster	Water rat/ white tailed water rat	LC[1]	
Rattus lutreolus	Swamp rat	LC[1]	

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

1. Queensland *Nature Conservation Act 1992 (E – Endangered, V – Vulnerable, R – Rare, LC – Least Concern)*

5.6 Macroinvertebrate richness

There was only one species of macroinvertebrates identified in the non-riverine wetlands of the Fitzroy section of the GBR catchment. Table 10 lists the macroinvertebrate species that was 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	Comments
Adclarkia dawsonensis	Boggomoss snail	CE[1]	

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

1. *Environment Protection and Biodiversity Conservation Act 1999 (CE – Critically Endangered, E – Endangered, V – Vulnerable)*

6 Exotic fauna

Six fish, one crustacean and twelve vertebrate species were nominated by the panel (Table 11) as exotic wetland fauna. Some species identified by the panel were considered to only be exotic in certain areas of the Fitzroy region despite being a native species. This was mainly due to translocations or introductions upstream of natural instream barriers. The presence of aquatic exotic fauna species was recorded under 'Criterion 1 Naturalness (aquatic)' (1.1.1).

Table 11 Alien fauna

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

Scientific name	Common name	Comments
Anas platyrhynchos	Northern mallard	
Anser anser	Greylag (domestic) goose	
Bos indicus	Zebu	
Bos sp.	Cattle	
Cairina moschata	Muscovy duck	
Carassius auratus	Goldfish	Common throughout the Fitzroy River catchments. Uncertain of its impact. Primarily a riverine species.
Cherax quadricarinatus	Redclaw crayfish	Translocated native taxa that is likely to be replacing other indigenous *Cherax* species. It is common in most dams including Fairburn Dam, and the Callide and Nogoa Rivers as well as Theresa Creek.
Felis catus	Cat	Widespread throughout the study area.
Gambusia holbrooki	Mosquitofish	Widespread throughout the study area.
Hemidactylus frenatus	House gecko	
Pavo cristatus	Indian peafowl	
Poecilia reticulata	Guppy	
Rattus norvegicus	Brown rat	
Rattus rattus	Black rat	
Rhinella marina	Cane toad	Widespread throughout the study area.
Sus scrofa	Pig	
Xiphophorus helleri	Swordtail	Mainly found close to towns, especially Gladstone, as it is usually a fish tank escapee.
Xiphophorus maculatus	Platy	Mainly found close to towns as it is usually a fish tank escapee.
Tilapia mariae	Spotted tilapia	

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

7 Special features

The panel identified several non-riverine special features in the Fitzroy section of the GBR catchment (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 Table 12 was given a score equal to the conservation rating.

Table 12 Identified priority ecosystems and special features, and their values

Decisions 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.

Special feature	**Identified values**	**Catchment**	**Decision implementation number**	**Criteria/ indicator/ measure**	**Conservation rating (1-4)**
Baffle off stream lagoons	These off stream lagoons provide important dry season refugia for many species of fish including barramundi (*Lates calcarifer*), mangrove jack (*Lutjanus argentimaculatus*), sea mullet (*Mugil cephalus*) and the long-finned eel (*Anguilla reinhardtii*). These waterholes have been mapped and sampled although there are others that haven't been identified which would serve the same purpose. <u>Note</u>: This decision has not been implemented in this assessment because further investigation into its implementation is required.	Baffle	ba_nr_fa_01_not_implemented	6.3.1	
Eleocharis equisetina swamp at the base of Granite Creek State Forest near Miriam Vale	This area has high wildlife refugia values. <u>Note</u>: This decision is a flora decision in the Southeast Queensland Biodiversity Planning Assessment (decision number seqn_fl_31).	Baffle	ba_nr_fa_02	6.3.1	3
Brown Lake	This lake has similar value to the Pink Lily lagoons and Nugga Nugga. The lake is ephemeral but when wet it provides good habitat for many birds.	Comet	ct_nr_fa_01	6.3.1	3
Shoal Point	The wetlands near Shoal Point provide good fish habitat, good connectivity and good fish passage. The Orphanage Swamp wetlands contained within this area contains pockets of good fish habitat but there is connectivity issues associated with low bunds.	O'Connell	oc_nr_fa_01	6.3.1	3
Iwasaki Wetlands	The Iwasaki wetlands provide important waterbird habitat and nursery area for fish. Although the site covers a larger area than its natural extent (due to bunding) it is still fairly natural.	Waterpark	wa_nr_fa_01	6.3.1	4

Special feature	Identified values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Wetlands along coast near mouth of Fitzroy	The Pleistocene dune swales in this area provide good waterbird and fish habitat. The area has a history of clearing for grazing but is in good condition now. The area supports significant barramundi (*Lates calcarifer*) populations.	Waterpark	wa_nr_fa_02	6.1.1 6.3.1	3

Attachments

Attachment A – GBR catchment study area

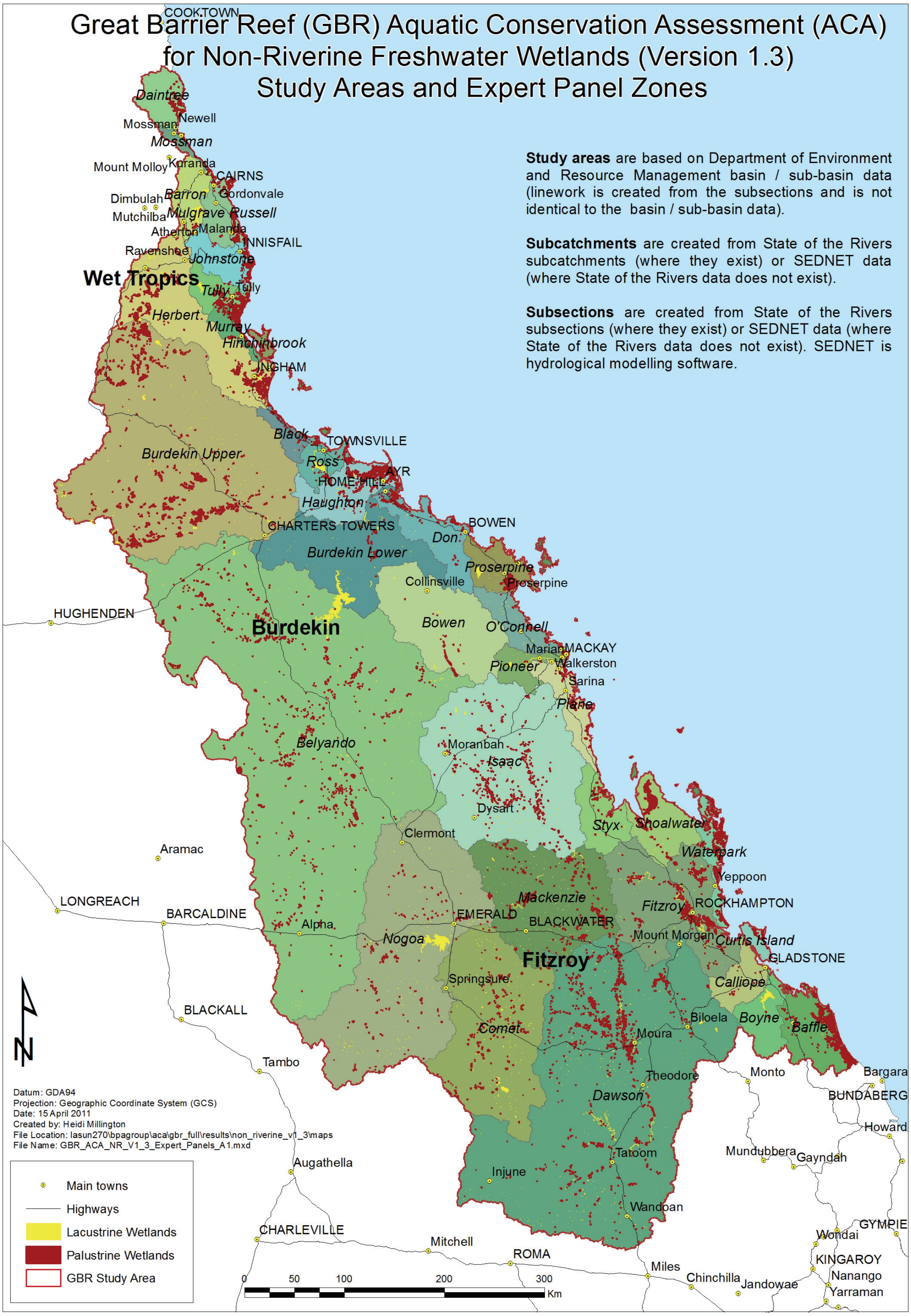

Figure 2 GBR catchment study area

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 gain information for 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 of the GBR catchment. Experience in the identification and assessment of riverine and non-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 riverine and non-riverine wetlands of the GBR catchment. The panel consisted of professionals with expertise relating to aquatic fauna values.

The tasks undertaken by the panel included, but without limitation, 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 – Fitzroy catchment descriptions

Boyne catchment

The Boyne catchment is found to the south of Gladstone and includes the townships of Nagoorin, Ubobo, Boyne Island, Tannum Sands and Benaraby. The Boyne River and its tributaries are the major streams in the area. The Boyne is highly regulated by the large Awoonga Dam that supplies water to Gladstone and to the power station on Callide Creek in the Dawson catchment to the west. The headwaters of the Boyne drain from Kroombit Tops, Castletower, Bulberin and Dawes National Parks and these upper reaches are surrounded by high ecological value (HEV) habitat. The Boyne catchment is largely within the south-east Queensland (SEQ) bioregion.

Calliope catchment

The Calliope catchment is located to the north and west of Gladstone. Most of the catchment is within the Brigalow Belt bioregion. It includes the Calliope and its tributaries and some small coastal creeks such as Boat and Manduran creeks. The Calliope River is one of the few east coast rivers that are not regulated by a dam or weir and good ecological connectivity is maintained from its source to its estuary. Its freshwater reaches are relatively natural. However, its estuary flows through several major industrial sites including a power station that releases cooling water into its lower reaches.

Most of the catchments' freshwaters are surrounded by grazing lands. Townships within the catchment include Gladstone, Calliope and Mount Larcom.

Comet catchment

The Comet sub-catchment of the Fitzroy is located west of the Great Dividing Range largely to the south and east of Emerald. Townships in the sub-catchment include Rolleston, Springsure and Comet. The major river system is the Comet and its tributaries such as Orion and Humboldt creeks.

This sub-catchment originates in the Carnarvon and Expedition Ranges and flows across a relatively flat floodplain into the Mackenzie River. The catchment is flatter and the streams less steep than any others in the Fitzroy catchment.

The catchment has levees and water harvesting infrastructure and the Comet Weir is found near its confluence with the Mackenzie. Several large perched lakes including Lake Nugga Nugga occur in its headwaters. The major industry of the sub-catchment is grazing but significant coal mines and cropping also occur in the sub-catchment.

Curtis Island

The Curtis Island catchment contains few freshwater streams but has significant non-riverine wetlands. These are of particular value in that they generally have good connectivity to estuarine systems. Most of the catchment's wetlands are surrounded by grazing lands or are within the Curtis Island National Park and Curtis Island Conservation Park.

Dawson catchment

The Dawson sub-catchment is the largest of the Fitzroy sub-catchments. Its sources include the Carnarvon Range to the south, the Expedition Range and Blackdown Tableland to the west and the Kroombit and Mount Morgan ranges to the east. The Dawson has several major tributaries including the Don and Dee rivers, Callide, Mimosa, Palm Tree, Juandah, Eurombah and Injune creeks.

Townships within the sub-catchment include Injune, Wandoan, Taroom, Theodore, Moura, Baralaba, Biloela, Mount Morgan and Duaringa. There is extensive grazing throughout the catchment as well as irrigated and dry-land cropping. There are several large coal mines and coal seam methane gas production is a significant and growing land use in the area that impacts on water flows.

The Dawson sub-catchment has a number of dams and weirs including the Glebe, Orange Creek, Gyranda, Theodore, Moura and Neville Hewitt weirs on the Dawson and Kroombit and Callide dams on the Callide Creek system. There are also dams on the Dee River near Mount Morgan to provide water for the township and others to contain contaminated water runoff from the Mount Morgan Mine tailings. Water is also flood harvested from the Dawson into offstream storage at Moura. Water is also pumped over the range from the Awoonga Dam on the Boyne River into Callide Dam.

The Dawson Valley tends to be relatively flat and the river frequently splits into anabranches and oxbow lakes in some places. The river intersects a number of sandstone gorges, notably the Nathan Gorge near Taroom and has complex groundwater links that produce unusual mound springs in some areas.

Most of the flows in the Dawson occur in summer but its southern catchments may also receive significant winter rains in some years.

Fitzroy sub-catchment

The Fitzroy sub-catchment receives its waters from the Mackenzie and Dawson rivers. It also receives significant inflows from Marlborough, Neerkol and Alligator creeks. The area also includes smaller Fitzroy delta streams including Raglan Creek.

In terms of area, grazing is the predominant land use. However, there are industrial developments close to the river including two large meatworks and the Stanwell Power Station. The Fitzroy River estuary flows through the city of Rockhampton and the townships of Marlborough, Yaamba, Westwood, Bajool and Raglan.

The Fitzroy is highly regulated as a result of upstream dams and weirs, Eden Bann Weir and the Fitzroy Barrage that prevents tidal saltwaters from moving upstream. Eden Bann Weir provides water for Stanwell Power Station and the barrage provides water for Rockhampton and the Capricorn Coast. Raglan Creek is an almost perennial stream that flows into the Fitzroy Delta.

There are several large offstream wetlands through the Fitzroy Delta including Woolwash, Yeppen, Frogmore, Crescent, Nankin, Serpentine and Gracemere lagoons.

Isaac catchment

The Isaac-Connors sub-catchment of the Fitzroy is located west of the Great Dividing Range roughly from west of Sarina to west of Marlborough. Townships in the sub-catchment include Nebo and Moranbah.

This sub-catchment provides most of the flow that reaches the Fitzroy Estuary. This is particularly so of the Connors River whose tributaries originate in the wet Clarke Connors Range to the west of Mackay and Sarina. The western side receives much less rain than the rest of the catchment and consequently flows in the upper Isaac River are much smaller. The lower Isaac and Connors rivers become split into complex multi-channels and anabranches that can become separated lagoons during the dry season.

Grazing is the predominant land use in the catchment but there are a significant number of coal mines particularly to the west. This catchment is currently less regulated than any of the other Fitzroy sub-catchments with only small dams occurring in the upper Isaac River e.g. Burton Gorge Dam. There are significant quantities of water pumped from the Burdekin catchment into the catchment to supply the needs of coal mining.

The Dipperu National Park (scientific) is the only park within the Isaac Connors sub-catchment.

Mackenzie catchment

The Mackenzie sub-catchment of the Fitzroy receives flows from the Nogoa, Comet and Isaac rivers. The catchment extends downstream to the confluence with the Dawson River after which it becomes the Fitzroy. Townships in the sub-catchment include Middlemount, Blackwater and Dingo.

Grazing is the predominant land use in the catchment but there are a significant number of coal mines and irrigated and dry-land cropping are also important. The catchment is highly regulated with flows being controlled through Bingegang, Bedford and Tartrus weirs as well as a number of water harvesting operations.

Most of the upper catchment flows through a single channel. However, at the confluence with the Isaac River the river has several large floodplain waterholes such as Lake Mary on its floodplain that may become river channels during floods.

There is one National Park—Taunton National Park—and several state forests within the sub-catchment.

Nogoa catchment

The Nogoa sub-catchment of the Fitzroy is located west of the Great Dividing Range largely to the west of Emerald. Townships in the sub-catchment include Emerald, Rubyvale, Sapphire, Clermont and Capella. The major river system is the Nogoa and its tributaries such as Theresa and Crinum creeks.

This sub-catchment originates between Carnarvon Range and Clermont and shares its origins with the Burdekin, Burnett and Murray Darling systems. It is totally landlocked and flows into the Mackenzie River system. Grazing is the predominant land use in the catchment but there are a significant number of coal mines and cropping is important in the Emerald irrigation area. The catchment is highly regulated downstream of the large Fairbairn Dam near Emerald with several small weirs and the Theresa Creek Dam also regulating flows.

There is one national park—Carnarvon National Park—at the south-western corner of the subcatchment and a number of large state forests such as Kettle and Fairbairn State Forests.

O'Connell catchment

The O'Connell catchment is located to the south of Proserpine and north of Mackay. It forms part of the Central Queensland Coast bioregion.

Despite its name, this catchment actually comprises small coastal catchments including the Andromache and O'Connell rivers and several smaller creeks including Murray, Constant and Blackrock creeks.

Townships in the area include Bloomsbury, Calen, Kuttabul and Seaforth. The major industries of the area include tourism, cane growing, cattle grazing and fishing.

The O'Connell catchment has a tropical climate with a pronounced wet season between December and March. The streams tend to be relatively short and fast flowing from rainforest headwaters across a highly modified coastal plain extensively developed for sugar cane growing.

Pioneer catchment

The Pioneer catchment is located on the east coast flowing through the city of Mackay. It forms part of the Central Queensland Coast bioregion.

This catchment includes the Pioneer River and its tributaries such as Cattle, Finch Hatton, Teemburra, Blacks and Black Waterhole creeks. The Pioneer River is highly regulated with a major dam (Teemburra Dam) and a series of weirs (Marian, Mirani and Dumbleton). Water is also diverted through a series of creeks to be utilised in the Pioneer Valley Irrigation Scheme and also pumped to the nearby Kinchant Dam which is the major storage for the Eton Irrigation Scheme in the Plane Creek catchment.

The headwaters of the catchment rise in high conservation value rainforest and then flow across a highly modified coastal plain through the city of Mackay.

Townships in the area include Mackay, Marian, Mirani and Pinnacle. The major industries of the area include tourism, cane growing, cattle grazing, forestry (including plantations), and fishing. Most of the headwaters of the Pioneer rise in national parks, such as the Eungella National Park, or state forest (including Crediton State Forest).

The Proserpine catchment has a tropical climate with a pronounced wet season between December and March.

Plane catchment

The Plane catchment is located on the east coast of Queensland, to the south of Mackay. It forms part of the Central Queensland Coast bioregion. Despite its name, this catchment is actually several small coastal catchments including Bakers, Sandy, Alligator, Plane, Rocky Dam, Marion, Carmilla, West Hill and Clairview creeks.

Townships within the catchment include Sarina, Koumala, Carmila and Clairview. The northern streams form part of the Eton Irrigation Scheme supplying water for irrigated cane growing. Water from the Pioneer River is flood harvested and transferred into these streams in part through the large offstream storage Kinchant Dam. Plane Creek has a series of small weirs regulating its flows. Streams tend to be less regulated and modified in the southern parts of the catchment.

The Plane catchment has a tropical climate with a pronounced wet season between December and March. The streams tend to be relatively short and fast flowing from rainforest headwaters. In the north they flow across a highly modified coastal plain extensively developed for sugar cane growing.

Southern streams largely rise in state forests such as the West Hill and Kelvin State Forest. Cape Palmerston National Park is found on the coast within the catchment.

Proserpine catchment

The Proserpine catchment is located on the east coast, to the south of Bowen and north of Mackay. It forms part of the Central Queensland Coast bioregion.

Despite its name, this catchment is actually several small coastal catchments including the Proserpine and Gregory rivers and smaller creeks such as Repulse Creek, and it includes the world-recognised wetlands of Goorganga Plain. Streams in the area tend to be short and fast flowing usually with headwaters in rainforest.

Repulse Creek is one of few streams almost entirely enclosed in protected area (predominantly Conway National Park). In contrast the Proserpine River is highly regulated with a major storage (Peter Faust Dam) in its headwaters. Water is released from this dam through a series of stream diversions to facilitate irrigated sugar cane growing.

Townships in the area include Proserpine, Airlie Beach Dingo Beach and Midge Point. The major industries of the area include tourism, cane growing, cattle grazing, forestry (including plantations), and fishing. There are also major national parks including the Whitsunday Islands and Conway National Park.

The Proserpine catchment has a tropical climate with a pronounced wet season between December and March.

Shoalwater catchment

The Shoalwater catchment is located to the north of Rockhampton and south of Mackay. It forms part of the Brigalow Belt and Central Queensland Coast bioregions. It is largely bounded by the western coast of Shoalwater Bay and the shores of Stanage Bay. It includes the small streams flowing into Stanage Bay such as Herbert and Wadallah creeks, and includes the settlement of Stanage Bay.

There are extensive non-riverine wetlands in the vicinity of the Torilla Plains and Glenprairie to the east and west of Stanage Bay. The major modification to local water regime is the construction of extensive levees to stop saltwater intrusion. These have modified a number of estuarine wetlands to become extensive freshwater palustrine areas.

The Shoalwater catchment has a tropical to subtropical climate with a pronounced wet season between December and March. It represents a transitional zone between the steep fast streams to the north and the long slow-flowing streams of the Fitzroy Basin. Streams are less steep and slower flowing than those further north.

Styx River catchment

The Styx catchment is located on the east coast of Queensland, to the north of Rockhampton and south of Mackay. It forms part of the Brigalow Belt North bioregion. The major streams in this small catchment are the Styx River and St Lawrence Creek. Locations within the catchment include St Lawrence and Ogmore. St Lawrence Creek is regulated by a small weir.

The Styx catchment has a tropical climate with a pronounced wet season between December and March. It represents a transitional zone between the steep fast streams to the north and the long slow-flowing streams of the Fitzroy Basin. Streams are less steep and slower flowing than those further north. The highly dispersive soils of the area make the streams naturally more turbid.

The major industries in the area are cattle grazing and fishing with some horticulture and plantation forestry in the north.

Two small state forests (Glencoe and Mt Buffalo) and a small conservation park (Newport) exist in the catchment.

Waterpark catchment

The Waterpark catchment is located to the north-east of Rockhampton. It forms part of the Brigalow Belt and Central Queensland Coast bioregions. It includes the Shoalwater Bay Military Training Area south to the mouth of the Fitzroy River. The northern section from the mouth of Waterpark Creek is one of the least disturbed catchment areas in Queensland with only infrequent use in relatively small areas. It is closely managed as part of the Shoalwater Bay Military Training Area, the Byfield National Park and Byfield State Forest with limited access and largely natural remnant vegetation.

The largest stream in the area is Waterpark Creek, which rises from sand dunes in the north and flows south and then east into Corio Bay almost exclusively through protected areas. Its water quality and source from within sand dunes makes it unique within the Fitzroy study area. Within Shoalwater Bay, there are several small streams including Shoalwater Creek and a large wetland complex (Dismal Swamp) but no large rivers. Further south creeks such as Coorooman Creek have much more disturbed catchments. The acid Wallum wetlands of the Dismal Swamp area are very unusual within the central Fitzroy area.

The area includes the townships of Yeppoon, Emu Park and Keppel Sands.

Attachment D – Criteria, indicators and measures for the GBR catchment

The criteria, indicators and measures (CIM) list outlines the CIM that were implemented as part of the non-riverine Aquatic Conservation Assessment (ACA) using AquaBAMM of the freshwater wetlands of the GBR catchment.

The list has been developed from a default list of CIM that may be considered when an Aquatic Conservation Assessment (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. AquaBAMM does allow addition or deletion of indicators and/or measures for each ACA when its assessment parameters are set. However, 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 13 CIM list for the GBR catchment

Criteria & indicators	Measures	
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
1.4 Hydrological modification	1.4.5	Hydrological disturbance/modification of the wetland (e.g. as determined through DERM wetland mapping and classification)
2 Naturalness catchment		
2.1 Exotic flora/fauna	2.1.1	Presence of exotic terrestrial plants in the assessment unit
2.2 Riparian disturbance	2.2.5	Per cent area of remnant vegetation relative to preclear extent within buffered non-riverine wetland: 500 m buffer for wetlands >= 8Ha, 200 m buffer for smaller wetlands
2.3 Catchment disturbance	2.3.1	Per cent "agricultural" land-use area (i.e. cropping and horticulture)
	2.3.2	Per cent "grazing" land-use area
	2.3.3	Per cent "vegetation" land-use area (i.e. native veg + regrowth)
	2.3.4	Per cent "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	3.1.2	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
3.3 Habitat	3.3.2	Richness of wetland types within the local catchment (e.g. SOR sub-section)
	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[1], EPBC Act[2]
	4.1.2	Presence of rare or threatened aquatic ecosystem dependent flora species – NC Act[1], EPBC Act[2]

Criteria & indicators	Measures	
4.2 Communities/ assemblages	4.2.1	Conservation status of wetland Regional Ecosystems – Herbarium biodiversity status, NC Act[1], EPBC Act[2]
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)
	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[3]/CAMBA[4] 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)
8 Representativeness		
8.1 Wetland protection	8.1.1	The per cent area of each wetland habitat type within protected areas
	8.1.2	The per cent 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*
8.2 Wetland uniqueness	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)
	8.2.2	The relative abundance of the wetland management group to which the wetland habitat belongs within the subcatchment or estuarine/marine zone (management groups ranked least common to most common)
	8.2.3	The size of each wetland habitat relative to others of its management group within the catchment or study area
	8.2.4	The size of each wetland habitat relative to others of its management group within a subcatchment (or estuarine zone)
	8.2.5	Wetland habitat representative of the study area – identified by expert opinion
	8.2.6	The size of each wetland habitat relative to others of its 'type' within the catchment or study area

[1] NC Act – *Nature Conservation Act 1992* (Queensland legislation)
[2] EPBC Act – *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth legislation)
[3] JAMBA – Japan-Australia Migratory Bird Agreement
[4] CAMBA – China-Australia Migratory Bird Agreement

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Attachment I GBR catchments ACA – Aquatic ecology expert panel report (Fitzroy region)

Queensland Government

An Aquatic Conservation Assessment for the non-riverine wetlands of the Great Barrier Reef catchment

Wetland ecology Expert panel report

(Version 1.3)

Fitzroy region

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Acronyms and abbreviations

ACA	Aquatic Conservation Assessment
ASL	Above sea level
BPA	Biodiversity Planning Assessment
DERM	Department of Environment and Resource Management
DIWA	Directory of Important Wetlands
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
GBR	Great Barrier Reef
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

1 Introduction

The Department of Environment and Resource Management (DERM) conducted an Aquatic Conservation Assessment (ACA) for the non-riverine wetlands in the Great Barrier Reef (GBR) catchment using the Aquatic Biodiversity Assessment and Mapping Method (AquaBAMM; Clayton *et al*. 2006). The ACA relied upon 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 GBR catchment.

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 GBR catchment is made up of 35 individual catchments from the Daintree River north of Cairns, to Baffle Creek south of Gladstone. DERM applied AquaBAMM separately to the non-riverine (palustrine and lacustrine) and riverine wetlands within each of the 35 GBR catchments. In effect, there are 70 ACAs for the entire GBR catchment—covering non-riverine and riverine wetlands. A map of the GBR catchment showing each study area is provided in Attachment A.

A series of nine expert panels were conducted to address aquatic fauna, aquatic and riparian flora, and wetland ecology for the GBR catchments. The non-riverine and riverine wetlands were covered in combined workshops. The panels, held in Cairns, Townsville and Rockhampton during November and December 2008, involved invited experts with expertise in aquatic fauna, aquatic and riparian flora and/or wetland ecology in the Wet Tropics, Burdekin and Fitzroy sections of the GBR catchment.

This report documents the findings and recommendations of the wetland ecology expert panel for the Fitzroy region held in Rockhampton on Thursday 21 December 2008. This report presents supporting information and panel input that only addresses the non-riverine wetland systems. The riverine component has been addressed in a separate report. Terms of reference for the wetland ecology expert panel are provided in Attachment B.

2 Method

2.1 Study area

The Fitzroy section of the GBR catchment is a vast and extremely varied area. It ranges from the high rainfall, short fast streams surrounded by rainforest on the Whitsunday coast to the slow, turbid meandering floodplain streams of the Fitzroy catchment. It encompasses parts of three bioregions, supports Ramsar listed wetlands and its waters impact on the southern and central GBR. It includes iconic sandstone gorges in places like the Carnarvon Ranges to perched lakes in the upper Comet sub-catchment to world recognised wetland complexes such as the Goorganga Plains as well as waterfalls, cascades and torrents in the rainforests of the Whitsundays.

The Fitzroy catchment itself is the largest eastward flowing system in Australia and only exceeded in total flow Australia wide, by the Murray-Darling system. The area includes two catchments (Waterpark Creek and Repulse Creek) that are almost entirely surrounded by protected. Other catchments are highly modified with a number of rivers heavily regulated by dams, weirs and irrigation development.

The climate of the area is also highly variable. It ranges from distinctly tropical in the north to subtropical in the south. Rainfall is distinctly seasonal with a pronounced wet season from December to March but the amount of rain that falls is amongst the most variable in the world. Between 1976 and 2008, wet season flow to the mouth of the Fitzroy varied from around 349,677 megalitres to 22,903,390 megalitres. Much of the aquatic ecology of the area is driven by variable boom and bust cycles and is consequently amongst the most resilient anywhere.

The largest land use in terms of area is cattle grazing, however extensive cropping and intensive cultivation of sugar cane is also very important. The area also contributes a huge quantity of coal that is vital to the Queensland and Australian economy.

It is not possible to adequately give an overview of such a vast and varied area, so a brief description of the 17 catchment areas is provided in Attachment C. This attachment should be considered when interpreting the contents of this report.

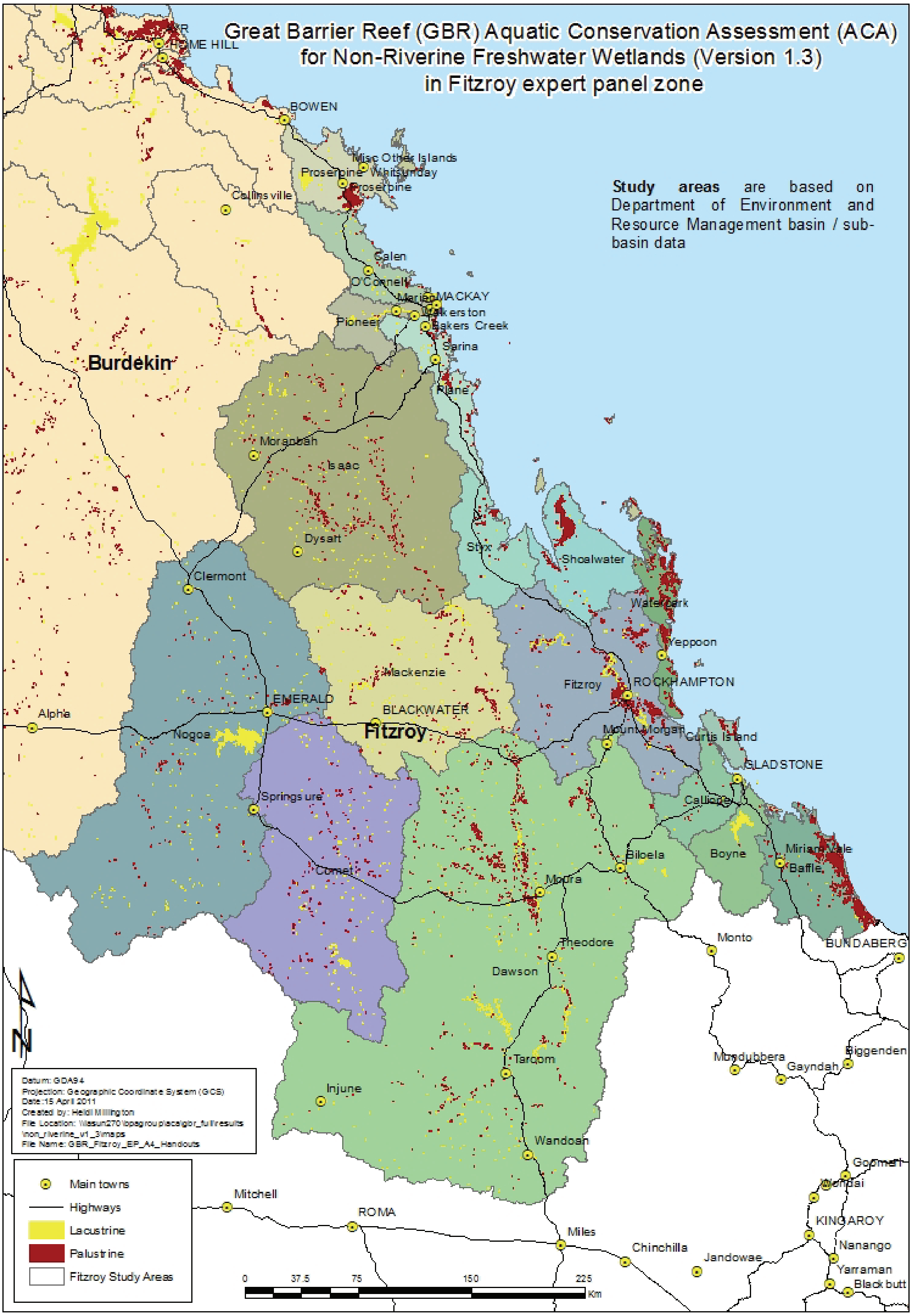

Figure 1 Fitzroy section of the GBR catchment (incorporating 17 individual catchments)

2.2 Panel composition

The expert panel (the panel) comprised invited persons (Table 1) familiar with non-riverine and riverine wetland ecology, including fish, macroinvertebrates, water quality, hydrology, geomorphology and vegetation, in the Fitzroy section of the GBR catchment.

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
Jeanette Kemp	Principal Botanist, Department of Environment and Resource Management	Native and exotic flora
Jim Tait	Ecologist, Ecoconcern Pty Ltd	Wetland ecology and management
John McCabe	Senior Extension Officer, Nature Refuges, Department of Environment and Resource Management	Waterbirds, flora, and landscape restoration
John Platten	Principal Biodiversity Planning Officer, Department of Environment and Resource Management	Biodiversity planning, aquatic ecology and water quality
Leo Duivenvoorden	Senior Lecturer/ Researcher, Central Queensland University	Aquatic and semi-aquatic plants.
Nick Cuff	Principal Botanist, Queensland Herbarium, Department of Environment and Resource Management	Botany and regional ecosystem assessment
Steve Elson	Principal Planning Officer, Department of Environment and Resource Management	Biodiversity planning
Thomas Espinoza	Project Leader, Aquatic Ecosystem Programme, Department of Environment and Resource Management	Fish and aquatic fauna

Selena Inglis, Heidi Millington and Steven Howell 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 GBR catchment was also sourced from various technical reports.

3 Special features

The panel identified several priority ecosystems/special features in the Fitzroy section of the GBR catchment (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 considered to have additional values (e.g. geomorphological or hydrological) were implemented as wetland ecology special features.

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 priority ecosystems and special features

Decisions 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.

Special feature	**Identified values**	**Catchment**	**Decision implementation number**	**Criteria/ indicator/ measure**	**Conservation rating (1-4)**
Deep Water area dunes	Acid wetlands in wallum areas close to the coast (land zone two) provide important habitat for acid tolerant species. These areas are unique in the Baffle catchment. <u>Note</u>: This decision was also included in the riverine ACA assessment (decision number ba_r_ec_01). See the Fitzroy riverine report for more details.	Baffle	ba_nr_ec_01	6.1.1	4
Jack's Lagoon	Jack's Lagoon, which is found near Ulangool Homestead near the confluence of Granite Creek and Baffle Creek, is known fish habitat. This value is largely due to its connectedness to the river and its size.	Baffle	ba_nr_ec_02	6.3.1	3
Wet heaths	These wet heaths provide significant habitat which have intact and unique hydrological regimes. They occur on the back side of the dunes system having perched water levels thought to also be influenced by fluctuating groundwater and seepage.	Baffle	ba_nr_ec_03	6.4.1	4
Springs on Futter Creek on Braeside property	Unique flora values in bottom of the springs such as palm trees and ferns, good contribution to base flows, provide significant contribution to water quality. <u>Note</u>: There are no springs mapped in the Queensland Wetlands Mapping V2.0 in this area. Nor are there any lacustrine or palustrine wetlands mapped in this area.	Calliope	ca_nr_ec_01_not_implemented	6.3.1 6.4.1	3
Monduran Creek	Monduran Creek is an important barramundi (*Lates calcarifer*) and other fish nursery area. <u>Note</u>: This decision was also included in the riverine ACA assessment (decision number ca_r_ec_02). See the Fitzroy riverine report for more details.	Calliope	ca_nr_ec_02	6.3.1	2

Special feature	Identified values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Lake Nugga Nugga	Lake Nugga Nugga is listed as a wetland of national significance because of its significance for waterbirds. It is an ephemeral system that has geomorphic values of interest habitat for numerous macrophytes. <u>Note</u>: This decision was also a fauna decision under the Brigalow Belt Biodiversity Planning Assessment (decision number brbs_fa_56).	Comet	ct_nr_ec_01	6.1.1 6.3.1	4
Consuelo Creek wetlands	The Consuelo Creek wetlands contain sandstone geomorphology, good water quality and are important as drought refugia. The area supports extensive *Eleocharis* swamps and is habitat for *Livistona nitida*. There are rare and threatened species recorded from the area and high waterbird diversity. It is also the southern most habitat of the cotton pygmy goose (*Nettapus coromandelianus*).	Comet	ct_nr_ec_02	6.1.1 6.3.1	3
North Curtis (western edge of parabolic dunes)	This area is an interface between dunes and marine plain wetlands including rainforest on the dunes abutting marine plain swamps. The area provides good yellow chat (*Epthianura crocea macgregori*) habitat and generally very diverse particularly in the zone between rainforest and *Melaleuca* forest. All wetlands here have fish values including barramundi (*Lates calcarifer*) habitat and are thought to be important lowland frog habitat. Wetlands in between the dunes contain freshwater and support *Melaleuca* swamp ecosystems. <u>Note</u>: This decision could not be implemented as the base mapping showed no non-riverine wetlands in these areas.	Curtis Island	ci_nr_ec_01_not_implemented	6.1.1 6.3.1	4
Palm Tree and Robinson Creeks	The wetlands in this area contain sandstone geomorphology that provides good habitat for *Livistona nitida* and supports extensive *Eleocharis* swamps. The area contains rare and threatened species and a high waterbird diversity including magpie geese (*Anseranas semipalmata*) and cotton pygmy geese (*Nettapus coromandelianus*). <u>Note</u>: This decision was also included in the riverine ACA assessment (decision number dn_r_ec_01). See the Fitzroy riverine report for more details.	Dawson	dn_nr_ec_01	6.1.1 6.3.1	4
Callide Creek/Lake Victoria	This area has unique hydrological values including being a natural sump/perched lake which is uncommon in the region. The site has been likened to a brigalow gilgai that is permanent.	Dawson	dn_nr_ec_02	6.4.1	3
Dee/Don wetlands	The Dee/Don wetlands are within semi cleared blue gum grazing country where the Dee and the Don meander together through multichannels. The area includes imbedded lakes and sedge systems, extensively connect during very wet times providing good connectivity between channels. The area is thought to support about 20 macroinvertebrate taxa and about 12 – 15 aquatic flora species.	Dawson	dn_nr_ec_03	6.3.1	3

Special feature	Identified values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Headlow Basin & Creek	This area contains remnants of regional ecosystem 8.3.13a and includes Serpentine Lagoon, Lake Mary and Green Lake. It is geomorophologically and hydrologically unique having a high water table and a basin area that floods out regularly and picks up backwater floodwater off the Fitzroy River. The water also often builds up and overflows into Alligator Creek. The creek has been stocked with barramundi (*Lates calcarifer*) because fish passage has been impeded by a barrage. The area is also important for waterbirds despite being quite modified. Note: This decision was also included in the riverine ACA assessment (decision number fi_r_ec_01). See the Fitzroy riverine report for more details.	Fitzroy	fi_nr_ec_01	6.3.1	4
Fitzroy Floodplain	The Fitzroy Floodplain is listed separately on the Directory of Important Wetlands (DIWA) from the Fitzroy Delta. The floodplain contains deep water lagoon systems and is a very important nursery habitat for fish. The area has unique geomorphology and is one of the least modified large floodplains on the eastern seaboard. Other areas like this have been cleared for agriculture. The area provides good waterbird habitat with over 30,000 waterbirds recorded here in a recent survey (as part of the national waterbird inventory). Note: This decision was also included in the riverine ACA assessment (decision number fi_r_ec_02). See the Fitzroy riverine report for more details.	Fitzroy	fi_nr_ec_02	6.1.1 6.3.1	4
Fitzroy Delta (freshwater component)	The Fitzroy Delta is listed separately on the DIWA from the Fitzroy Floodplain. The area has large sedge swamps, very important nursery habitat for fish as well as good waterbird habitat. Note: This decision was also included in the riverine ACA assessment (decision number fi_r_ec_03). See the Fitzroy riverine report for more details.	Fitzroy	fi_nr_ec_03	6.3.1	4
Denison Creek and Funnel Creek	The long, deep waterholes with paperbarks in this area support large numbers of platypus (*Ornithorhynchus anatinus*) and a mixture of fish species. Note: This decision was also included in the riverine ACA assessment (decision number is_r_ec_02). See the Fitzroy riverine report for more details.	Isaac	is_nr_ec_01	6.3.1	4

Special feature	Identified values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Lake Elphinstone	This site has unique geomorphology and is a good example of a sub-coastal lake that provides important habitat in the Fitzroy region. The lake provides important waterbird habitat and has repeated seasonal cyanobacteria blooms. It is on the registry of wetlands of national importance. The headwaters of the catchment often dry out and studies have indicated the presence of macroinvertebrates. The lake has unique water quality values including high toxin levels and possibly sediments that contain natural levels of phosphorus and nitrogen contributed to by the surrounding land uses.	Isaac	is_nr_ec_02	6.1.1 6.3.1	3
Isaac River where it joins Mackenzie River down to Coolmaringa	This site has unique geomorphology and provides good habitat for saratoga. <u>Note</u>: This decision was also included in the riverine ACA assessment (decision number ma_r_ec_01). See the Fitzroy riverine report for more details.	Mackenzie	ma_nr_ec_01	6.1.1 6.3.1	4
Marion, West Hill & Basin Creeks	The wetlands in this area support a diversity of fish and provide good habitat for diadromous fish in particular. This area includes a large stand of the endangered regional ecosystem 8.3.11 at Notch Point as well as coastal swamps at Cape Palmerston that contains a large intact example of the endangered regional ecosystem 8.3.4 and significant examples of the highly restricted regional ecosystem 8.2.11. <u>Note</u>: This decision was also included in the riverine ACA assessment (decision number pl_r_ec_01). See the Fitzroy riverine report for more details.	Plane	pl_nr_ec_01	6.3.1	4
Goorganga Plain	Though heavily weed invaded in places, this wetland complex remains the largest naturally treeless plain that has not been converted to cultivation in the northern high rainfall coasts (Wet Tropics and Central Queensland Coast bioregions). It contains the best and largest example of intact native sorghum-dominated grassland in the central Queensland coast bioregion and contains some of the last stands of the endangered regional ecosystem 8.3.11. The area includes a range of wetland types with good connectivity between estuarine to riverine to non-riverine wetlands. There are both wooded and non-wooded wetlands and the biggest area of regional ecosystem 8.3.12 in the region. The site also provides good waterbird habitat, is one of the largest crocodile breeding sites south of Hinchinbrook and is important for fish. It has unique hydrological values including good hydrological persistence and although it is mainly non-riverine it also has minor stream segments running through it that are important.	Proserpine	pr_nr_ec_01	6.1.1 6.3.1	4

Special feature	Identified values	Catchment	Decision implementation number	Criteria/ indicator/ measure	Conservation rating (1-4)
Glennprarie	Overall the Glennprarie is a good wetland complex with significant reed beds that provide excellent waterbird habitat and is a known habitat of the yellow chat (*Epthianura crocea macgregori*). It has been mismanaged in the past and contains a fish tidal exclusion barrier.	Shoalwater	sh_nr_ec_01	6.3.1	3
Torilla Plain	The Torilla Plain is a large wetland complex that includes a range of different wetland types with good connectivity between estuarine to riverine to non-riverine wetlands. It is the least disturbed wetland on the coast south of the cape. Freshwater and saline water flow both ways into the wetland which contains both wooded and non-wooded wetlands and the largest area of regional ecosystem 11.3.27 and its various subtypes. The area supports extensive areas of good condition grass sedge wetland and is a hot spot for biodiversity. The site provides good waterbird habitat with 30,000 to 40,000 waterbirds observed during the wet season. Yellow chats (*Epthianura crocea macgregori*) and an array of other waterbirds thrive in the area despite some parts being slightly modified.	Shoalwater	sh_nr_ec_02	6.3.1	4
Bar plains	The bar plains contain endangered vine forest regional ecosystems and provides habitat for the endangered yellow chat (*Epthianura crocea macgregori*) as well as shorebird roost sites on adjacent sand bars.	Styx	st_nr_ec_01	6.3.1	3
Waterpark Creek catchment	This area is derived from coastal sands and granite and has unique drainage. It has a very low pH of about 5.5 with clear deep pools and contains excellent water quality. There are large numbers of mullet (*Myxus petardi*) and tarpon (*Megalops cyprinoides*) and the area may provide habitat for jungle perch (*Kuhlia rupestris*) as well. The area supports alluvial rainforest and palm swamps and feather palm rainforest as well as rare and threatened species such as *Sowerbaea, Phaius australis* and the endemic byfield fern (*Bowenia serrulata*). Note: This decision was also included in the riverine ACA assessment (decision number wa_r_ec_01). See the Fitzroy riverine report for more details.	Waterpark	wa_nr_ec_01	6.3.1 6.4.1	4
Mound springs	Mound springs Note: Time was not available to consider this decision outside of “dn_nr_fl_01”.	Various	NA	6.4.1	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 for the non-riverine wetlands of the GBR catchment. After some time discussing connectivity for non-riverine wetlands, the panel members agreed that connectivity Criterion 7 be turned off for the GBR non-riverine ACA due to issues associated with its implementation (including method and resources). The following sections detail discussions from the panel regarding the implementation of non-riverine connectivity in the Burdekin section of the GBR catchment and possible options for future investigation.

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 the 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).

4.2 Applying principles for measuring connectivity

The practicalities of measuring connectivity in both riverine and non-riverine environments 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. 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 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.

One suggestion was to use aerial photography showing one in five year flood events to identify the connectivity of wetland systems in conjunction with the wetland mapping. This analysis would identify the extent of connectivity for non-riverine wetlands and enable thresholds to be developed for when particular non-riverine wetlands are connected to a riverine wetland. It was however identified that this would become an issue for those wetlands that do not rely on flood events, such as those that are groundwater fed or fed from seepage areas. In addition to this, there is difficulty in obtaining the hydrological data and having the

satellite imagery to interpret the connectivity. There would also be a significant investment of time and resources to undertake an assessment such as this.

4.4 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 Wet Tropics and Burdekin panels recommended assigning a three to an area with hydrological estuarine connectivity and a four to an area that has freshwater wetlands and hydrological estuarine and/or biological connectivity. Whilst this approach has merit, issues associated with its implementation (including method and resources) meant that it could not be implemented in this assessment. This approach will be considered for future investigation and implementation.

5 Stratification

Study area stratification for application to relevant measures of AquaBAMM is a user decision and is not mandatory for 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. Stratification is unwarranted for measure datasets where there is an equal probability of scoring across a range of values throughout the study area. To date, the use of strata in completed ACAs has been limited to 150 m above seal level (asl) for coastal flowing catchments and 400 m ASL for catchments west of the Great Dividing Range in the Murray-Darling Basin.

Stratification was considered by the panel and it was recommended that is was not necessary to stratify any of the study areas within the Fitzroy. After further investigation post panel, and to maintain consistency with other ACAs, it was decided to adopt the stratification of 150 m ASL for the Baffle study area only (as used in the recently released Baffle ACA).

6 Weighting of measures

The panel members that attended the nine 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 weight.
2. Weight the other measures within each indicator compared to the weighting of 10 assigned in the first step.
3. Different measures may have the same weight (i.e. all measures could be weighted 10).
4. Some indicators only have one measure and have already been given a weighting of 10.
5. Don't weight a measure 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 all three expert panel zones within the Great Barrier Reef study area, rather than average the weights for each zone or study area.

The final weights for each measure were then applied in the AquaBAMM assessment (Table 3). The measure number in Table 3 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 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 3 The average weights for each measure

Maximum score is 10; total number of participants was approximately 20.

Criteria & indicators	Measures		Weighting
1 Naturalness aquatic			
1.1 Exotic flora/fauna	1.1.1	Presence of 'alien' fish species within the wetland	7.6
	1.1.2	Presence of exotic aquatic and semi-aquatic plants within the wetland	9.9
	1.1.3	Presence of exotic invertebrate fauna within the wetland	5.9
	1.1.4	Presence of feral/exotic vertebrate fauna (other than fish) within the wetland	7.2
1.4 Hydrological modification	1.4.5	Hydrological disturbance/modification of the wetland (e.g. as determined through DERM wetland mapping and classification)	9.9
2 Naturalness catchment			
2.1 Exotic flora/fauna	2.1.1	Presence of exotic terrestrial plants in the assessment unit	10
2.2 Riparian disturbance	2.2.5	Per cent area of remnant vegetation relative to pre-clearing extent within buffered non-riverine wetland: 500 m buffer for wetlands >= 8Ha, 200 m buffer for smaller wetlands	10

Criteria & indicators	Measures		Weighting
2.3 Catchment disturbance	2.3.1	Per cent "agricultural" land-use area (i.e. cropping and horticulture)	8.9
	2.3.2	Per cent "grazing" land-use area	7.7
	2.3.3	Per cent "vegetation" land-use area (i.e. native veg + regrowth)	9.1
	2.3.4	Per cent "settlement" land-use area (i.e. towns, cities, etc)	8.8
2.4 Flow modification	2.4.1	Farm storage (overland flow harvesting, floodplain ring tanks, gully dams) calculated by surface area	9.0
3 Diversity and richness			
3.1 Species	3.1.2	Richness of native fish	9.8
	3.1.3	Richness of native aquatic dependent reptiles	8.2
	3.1.4	Richness of native waterbirds	8.8
	3.1.5	Richness of native aquatic plants	9.5
	3.1.6	Richness of native amphibians (non-riverine wetland breeders)	8.8
	3.1.7	Richness of native aquatic dependent mammals	7.8
3.2 Communities/ assemblages	3.2.1	Richness of macroinvertebrate taxa	9.2
3.3 Habitat	3.3.2	Richness of wetland types within the local catchment (e.g. SOR[1] sub-section)	9.4
	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 – NC Act[2], EPBC Act[3]	9.8
	4.1.2	Presence of rare or threatened aquatic ecosystem dependent flora species – NC Act[2], EPBC Act[3]	9.8
4.2 Communities/ assemblages	4.2.1	Conservation status of wetland Regional Ecosystems – Herbarium biodiversity status, NC Act[2], EPBC Act[3]	10
5 Priority species and ecosystems			
5.1 Species	5.1.1	Presence of aquatic ecosystem dependent 'priority' fauna species (expert panel list/discussion or other lists such as ASFB, WWF, etc)	9.6
	5.1.2	Presence of aquatic ecosystem dependent 'priority' flora species	9.7
	5.1.3	Habitat for, or presence of, migratory species (expert panel list/discussion and/or JAMBA[4] / CAMBA[5] agreement lists and/or Bonn Convention)	8.9
	5.1.4	Habitat for significant numbers of waterbirds	8.7
5.2 Ecosystems	5.2.1	Presence of 'priority' aquatic ecosystem	10
6 Special features			
6.1 Geomorphic features	6.1.1	Presence of distinct, unique or special geomorphic features	10
6.2 Ecological processes	6.2.1	Presence of (or requirement for) distinct, unique or special ecological processes	10
6.3 Habitat	6.3.1	Presence of distinct, unique or special habitat (including habitat that functions as refugia or other critical purpose)	9.4
	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	8.1
	6.3.3	Ecologically significant wetlands identified through expert opinion and/or documented study	9.1
6.4 Hydrological	6.4.1	Presence of distinct, unique or special hydrological regimes (e.g. spring fed stream, ephemeral stream, boggomoss)	10
8 Representativeness			
8.1 Wetland protection	8.1.1	The per cent area of each wetland habitat type within Protected Areas	10

Criteria & indicators	Measures		Weighting
	8.1.2	The per cent 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*	8.9
8.2 Wetland uniqueness	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)	8.5
	8.2.2	The relative abundance of the wetland management group to which the wetland habitat belongs within the subcatchment or estuarine/marine zone (management groups ranked least common to most common)	8.8
	8.2.3	The size of each wetland habitat relative to others of its management group within the catchment or study area	7.6
	8.2.4	The size of each wetland habitat relative to others of its management group within a subcatchment (or estuarine zone)	7.9
	8.2.5	Wetland habitat representative of the study area – identified by expert opinion	9.4
	8.2.6	The size of each wetland habitat relative to others of its 'type' within the catchment or study area	8.0

[1] SOR – State of the Rivers
[2] NC Act – Nature Conservation Act 1992 (Queensland legislation)
[3] EPBC Act – Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth legislation)
[4] JAMBA – Japan Australia Migratory Bird Agreement
[5] CAMBA – China Australia Migratory Bird Agreement

7 Ranking of indicators

The panel members that attended the nine workshops 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 1 which is the highest ranking.
2. Rank the other indicators within each criterion relative to the ranking of 1 assigned in the first step.
3. Different indicators may have the same ranking (i.e. all indicators may be ranked 1).
4. Don't rank an indicator 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 all three expert panel zones within the GBR study area, rather than average the ranks for each zone or study area.

The final ranks for each indicator were then applied in the AquaBAMM assessment (Table 4).

Table 4 The average rank for each indicator.

Maximum rank is 1; total number of participants was approximately 20.

Indicator	Description	Ranking
1 Naturalness aquatic		
1.1	Exotic flora/fauna	2
1.4	Hydrological modification	1
2 Naturalness catchment		
2.1	Exotic flora/fauna	3
2.2	Riparian disturbance	3
2.3	Catchment disturbance	1
2.4	Flow modification	2
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	2
4.2	Communities/ assemblages	1
5 Priority species and ecosystems		
5.1	Species	2
5.2	Ecosystems	1
6 Special features		
6.1	Geomorphic features	3
6.2	Ecological processes	2
6.3	Habitat	1
6.4	Hydrological	3
8 Representativeness		
8.1	Wetland protection	2
8.2	Wetland uniqueness	1

Attachments

Attachment A – GBR catchment study area

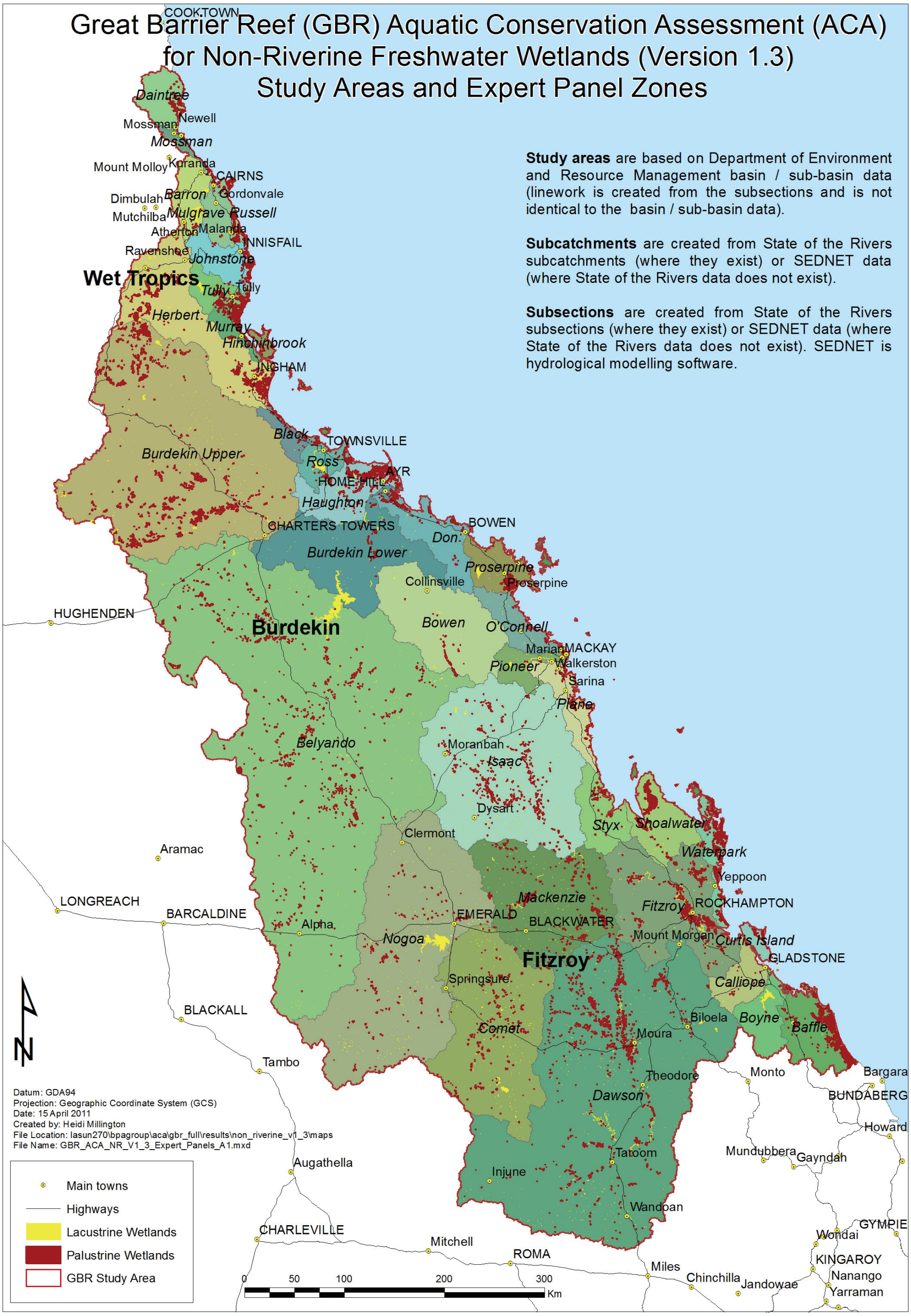

Figure 2 GBR catchment study area

Attachment B – Terms of reference (wetland ecology 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 gain information for 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 of the GBR catchment. Experience in the identification and assessment of riverine and non-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 riverine and non-riverine wetlands of the GBR. The panel consisted of professionals in fields of expertise relating to riverine and wetland ecology, water quality, geomorphology, fisheries and hydrological processes.

The tasks undertaken by the panel included, but without limitation, 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.
- weight measures relative to their importance for an indicator.
- rank indicators relative to their importance for a criterion.

Attachment C – Fitzroy catchment descriptions

Boyne catchment

The Boyne catchment is found to the south of Gladstone and includes the townships of Nagoorin, Ubobo, Boyne Island, Tannum Sands and Benaraby. The Boyne River and its tributaries are the major streams in the area. The Boyne is highly regulated by the large Awoonga Dam that supplies water to Gladstone and to the power station on Callide Creek in the Dawson catchment to the west. The headwaters of the Boyne drain from Kroombit Tops, Castletower, Bulberin and Dawes National Parks and these upper reaches are surrounded by high ecological value (HEV) habitat. The Boyne catchment is largely within the south-east Queensland (SEQ) bioregion.

Calliope catchment

The Calliope catchment is located to the north and west of Gladstone. Most of the catchment is within the Brigalow Belt bioregion. It includes the Calliope and its tributaries and some small coastal creeks such as Boat and Manduran creeks. The Calliope River is one of the few east coast rivers that are not regulated by a dam or weir and good ecological connectivity is maintained from its source to its estuary. Its freshwater reaches are relatively natural. However, its estuary flows through several major industrial sites including a power station that releases cooling water into its lower reaches.

Most of the catchments' freshwaters are surrounded by grazing lands. Townships within the catchment include Gladstone, Calliope and Mount Larcom.

Comet catchment

The Comet sub-catchment of the Fitzroy is located west of the Great Dividing Range largely to the south and east of Emerald. Townships in the sub-catchment include Rolleston, Springsure and Comet. The major river system is the Comet and its tributaries such as Orion and Humboldt creeks.

This sub-catchment originates in the Carnarvon and Expedition Ranges and flows across a relatively flat floodplain into the Mackenzie River. The catchment is flatter and the streams less steep than any others in the Fitzroy catchment.

The catchment has levees and water harvesting infrastructure and the Comet Weir is found near its confluence with the Mackenzie. Several large perched lakes including Lake Nugga Nugga occur in its headwaters. The major industry of the sub-catchment is grazing but significant coal mines and cropping also occur in the sub-catchment.

Curtis Island

The Curtis Island catchment contains few freshwater streams but has significant non-riverine wetlands. These are of particular value in that they generally have good connectivity to estuarine systems. Most of the catchment's wetlands are surrounded by grazing lands or are within the Curtis Island National Park and Curtis Island Conservation Park.

Dawson catchment

The Dawson sub-catchment is the largest of the Fitzroy sub-catchments. Its sources include the Carnarvon Range to the south, the Expedition Range and Blackdown Tableland to the west and the Kroombit and Mount Morgan ranges to the east. The Dawson has several major tributaries including the Don and Dee rivers, Callide, Mimosa, Palm Tree, Juandah, Eurombah and Injune creeks.

Townships within the sub-catchment include Injune, Wandoan, Taroom, Theodore, Moura, Baralaba, Biloela, Mount Morgan and Duaringa. There is extensive grazing throughout the catchment as well as irrigated and dry-land cropping. There are several large coal mines and coal seam methane gas production is a significant and growing land use in the area that impacts on water flows.

The Dawson sub-catchment has a number of dams and weirs including the Glebe, Orange Creek, Gyranda, Theodore, Moura and Neville Hewitt weirs on the Dawson and Kroombit and Callide dams on the Callide Creek system. There are also dams on the Dee River near Mount Morgan to provide water for the township and others to contain contaminated water runoff from the Mount Morgan Mine tailings. Water is also flood harvested from the Dawson into offstream storage at Moura. Water is also pumped over the range from the Awoonga Dam on the Boyne River into Callide Dam.

The Dawson Valley tends to be relatively flat and the river frequently splits into anabranches and oxbow lakes in some places. The river intersects a number of sandstone gorges, notably the Nathan Gorge near Taroom and has complex groundwater links that produce unusual mound springs in some areas.

Most of the flows in the Dawson occur in summer but its southern catchments may also receive significant winter rains in some years.

Fitzroy sub-catchment

The Fitzroy sub-catchment receives its waters from the Mackenzie and Dawson rivers. It also receives significant inflows from Marlborough, Neerkol and Alligator creeks. The area also includes smaller Fitzroy delta streams including Raglan Creek.

In terms of area, grazing is the predominant land use. However, there are industrial developments close to the river including two large meatworks and the Stanwell Power Station. The Fitzroy River estuary flows through the city of Rockhampton and the townships of Marlborough, Yaamba, Westwood, Bajool and Raglan.

The Fitzroy is highly regulated as a result of upstream dams and weirs, Eden Bann Weir and the Fitzroy Barrage that prevents tidal saltwaters from moving upstream. Eden Bann Weir provides water for Stanwell Power Station and the barrage provides water for Rockhampton and the Capricorn Coast. Raglan Creek is an almost perennial stream that flows into the Fitzroy Delta.

There are several large offstream wetlands through the Fitzroy Delta including Woolwash, Yeppen, Frogmore, Crescent, Nankin, Serpentine and Gracemere lagoons.

Isaac catchment

The Isaac-Connors sub-catchment of the Fitzroy is located west of the Great Dividing Range roughly from west of Sarina to west of Marlborough. Townships in the sub-catchment include Nebo and Moranbah.

This sub-catchment provides most of the flow that reaches the Fitzroy Estuary. This is particularly so of the Connors River whose tributaries originate in the wet Clarke Connors Range to the west of Mackay and Sarina. The western side receives much less rain than the rest of the catchment and consequently flows in the upper Isaac River are much smaller. The lower Isaac and Connors rivers become split into complex multi-channels and anabranches that can become separated lagoons during the dry season.

Grazing is the predominant land use in the catchment but there are a significant number of coal mines particularly to the west. This catchment is currently less regulated than any of the other Fitzroy sub-catchments with only small dams occurring in the upper Isaac River e.g. Burton Gorge Dam. There are significant quantities of water pumped from the Burdekin catchment into the catchment to supply the needs of coal mining.

The Dipperu National Park (scientific) is the only park within the Isaac Connors sub-catchment.

Mackenzie catchment

The Mackenzie sub-catchment of the Fitzroy receives flows from the Nogoa, Comet and Isaac rivers. The catchment extends downstream to the confluence with the Dawson River after which it becomes the Fitzroy. Townships in the sub-catchment include Middlemount, Blackwater and Dingo.

Grazing is the predominant land use in the catchment but there are a significant number of coal mines and irrigated and dry-land cropping are also important. The catchment is highly regulated with flows being controlled through Bingegang, Bedford and Tartrus weirs as well as a number of water harvesting operations.

Most of the upper catchment flows through a single channel. However, at the confluence with the Isaac River the river has several large floodplain waterholes such as Lake Mary on its floodplain that may become river channels during floods.

There is one National Park—Taunton National Park—and several state forests within the sub-catchment.

Nogoa catchment

The Nogoa sub-catchment of the Fitzroy is located west of the Great Dividing Range largely to the west of Emerald. Townships in the sub-catchment include Emerald, Rubyvale, Sapphire, Clermont and Capella. The major river system is the Nogoa and its tributaries such as Theresa and Crinum creeks.

This sub-catchment originates between Carnarvon Range and Clermont and shares its origins with the Burdekin, Burnett and Murray Darling systems. It is totally landlocked and flows into the Mackenzie River system. Grazing is the predominant land use in the catchment but there are a significant number of coal mines and cropping is important in the Emerald irrigation area. The catchment is highly regulated downstream of the large Fairbairn Dam near Emerald with several small weirs and the Theresa Creek Dam also regulating flows.

There is one national park—Carnarvon National Park—at the south-western corner of the subcatchment and a number of large state forests such as Kettle and Fairbairn State Forests.

O'Connell catchment

The O'Connell catchment is located to the south of Proserpine and north of Mackay. It forms part of the Central Queensland Coast bioregion.

Despite its name, this catchment actually comprises small coastal catchments including the Andromache and O'Connell rivers and several smaller creeks including Murray, Constant and Blackrock creeks.

Townships in the area include Bloomsbury, Calen, Kuttabul and Seaforth. The major industries of the area include tourism, cane growing, cattle grazing and fishing.

The O'Connell catchment has a tropical climate with a pronounced wet season between December and March. The streams tend to be relatively short and fast flowing from rainforest headwaters across a highly modified coastal plain extensively developed for sugar cane growing.

Pioneer catchment

The Pioneer catchment is located on the east coast flowing through the city of Mackay. It forms part of the Central Queensland Coast bioregion.

This catchment includes the Pioneer River and its tributaries such as Cattle, Finch Hatton, Teemburra, Blacks and Black Waterhole creeks. The Pioneer River is highly regulated with a major dam (Teemburra Dam) and a series of weirs (Marian, Mirani and Dumbleton). Water is also diverted through a series of creeks to be utilised in the Pioneer Valley Irrigation Scheme and also pumped to the nearby Kinchant Dam which is the major storage for the Eton Irrigation Scheme in the Plane Creek catchment.

The headwaters of the catchment rise in high conservation value rainforest and then flow across a highly modified coastal plain through the city of Mackay.

Townships in the area include Mackay, Marian, Mirani and Pinnacle. The major industries of the area include tourism, cane growing, cattle grazing, forestry (including plantations), and fishing. Most of the headwaters of the Pioneer rise in national parks, such as the Eungella National Park, or state forest (including Crediton State Forest).

The Proserpine catchment has a tropical climate with a pronounced wet season between December and March.

Plane catchment

The Plane catchment is located on the east coast of Queensland, to the south of Mackay. It forms part of the Central Queensland Coast bioregion. Despite its name, this catchment is actually several small coastal catchments including Bakers, Sandy, Alligator, Plane, Rocky Dam, Marion, Carmilla, West Hill and Clairview creeks.

Townships within the catchment include Sarina, Koumala, Carmila and Clairview. The northern streams form part of the Eton Irrigation Scheme supplying water for irrigated cane growing. Water from the Pioneer River is flood harvested and transferred into these streams in part through the large offstream storage Kinchant Dam. Plane Creek has a series of small weirs regulating its flows. Streams tend to be less regulated and modified in the southern parts of the catchment.

The Plane catchment has a tropical climate with a pronounced wet season between December and March. The streams tend to be relatively short and fast flowing from rainforest headwaters. In the north they flow across a highly modified coastal plain extensively developed for sugar cane growing.

Southern streams largely rise in state forests such as the West Hill and Kelvin State Forest. Cape Palmerston National Park is found on the coast within the catchment.

Proserpine catchment

The Proserpine catchment is located on the east coast, to the south of Bowen and north of Mackay. It forms part of the Central Queensland Coast bioregion.

Despite its name, this catchment is actually several small coastal catchments including the Proserpine and Gregory rivers and smaller creeks such as Repulse Creek, and it includes the world-recognised wetlands of Goorganga Plain. Streams in the area tend to be short and fast flowing usually with headwaters in rainforest.

Repulse Creek is one of few streams almost entirely enclosed in protected area (predominantly Conway National Park). In contrast the Proserpine River is highly regulated with a major storage (Peter Faust Dam) in its headwaters. Water is released from this dam through a series of stream diversions to facilitate irrigated sugar cane growing.

Townships in the area include Proserpine, Airlie Beach Dingo Beach and Midge Point. The major industries of the area include tourism, cane growing, cattle grazing, forestry (including plantations), and fishing. There are also major national parks including the Whitsunday Islands and Conway National Park.

The Proserpine catchment has a tropical climate with a pronounced wet season between December and March.

Shoalwater catchment

The Shoalwater catchment is located to the north of Rockhampton and south of Mackay. It forms part of the Brigalow Belt and Central Queensland Coast bioregions. It is largely bounded by the western coast of Shoalwater Bay and the shores of Stanage Bay. It includes the small streams flowing into Stanage Bay such as Herbert and Wadallah creeks, and includes the settlement of Stanage Bay.

There are extensive non-riverine wetlands in the vicinity of the Torilla Plains and Glenprairie to the east and west of Stanage Bay. The major modification to local water regime is the construction of extensive levees to stop saltwater intrusion. These have modified a number of estuarine wetlands to become extensive freshwater palustrine areas.

The Shoalwater catchment has a tropical to subtropical climate with a pronounced wet season between December and March. It represents a transitional zone between the steep fast streams to the north and the long slow-flowing streams of the Fitzroy Basin. Streams are less steep and slower flowing than those further north.

Styx River catchment

The Styx catchment is located on the east coast of Queensland, to the north of Rockhampton and south of Mackay. It forms part of the Brigalow Belt North bioregion. The major streams in this small catchment are the Styx River and St Lawrence Creek. Locations within the catchment include St Lawrence and Ogmore. St Lawrence Creek is regulated by a small weir.

The Styx catchment has a tropical climate with a pronounced wet season between December and March. It represents a transitional zone between the steep fast streams to the north and the long slow-flowing streams of the Fitzroy Basin. Streams are less steep and slower flowing than those further north. The highly dispersive soils of the area make the streams naturally more turbid.

The major industries in the area are cattle grazing and fishing with some horticulture and plantation forestry in the north.

Two small state forests (Glencoe and Mt Buffalo) and a small conservation park (Newport) exist in the catchment.

Waterpark catchment

The Waterpark catchment is located to the north-east of Rockhampton. It forms part of the Brigalow Belt and Central Queensland Coast bioregions. It includes the Shoalwater Bay Military Training Area south to the mouth of the Fitzroy River. The northern section from the mouth of Waterpark Creek is one of the least disturbed catchment areas in Queensland with only infrequent use in relatively small areas. It is closely managed as part of the Shoalwater Bay Military Training Area, the Byfield National Park and Byfield State Forest with limited access and largely natural remnant vegetation.

The largest stream in the area is Waterpark Creek, which rises from sand dunes in the north and flows south and then east into Corio Bay almost exclusively through protected areas. Its water quality and source from within sand dunes makes it unique within the Fitzroy study area. Within Shoalwater Bay, there are several small streams including Shoalwater Creek and a large wetland complex (Dismal Swamp) but no large rivers. Further south creeks such as Coorooman Creek have much more disturbed catchments. The acid Wallum wetlands of the Dismal Swamp area are very unusual within the central Fitzroy area.

The area includes the townships of Yeppoon, Emu Park and Keppel Sands.

Attachment D – Criteria, indicators and measures for the GBR catchment

The criteria, indicators and measures (CIM) list outlines the CIM that were implemented as part of the non-riverine Aquatic Conservation Assessment (ACA) using AquaBAMM of the freshwater wetlands of the GBR catchment.

The list has been developed from a default list of CIM that may be considered when an Aquatic Conservation Assessment (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. AquaBAMM does allow addition or deletion of indicators and/or measures for each ACA when its assessment parameters are set. However, 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 5 CIM list for the GBR catchment

Criteria & indicators	Measures	
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
1.4 Hydrological modification	1.4.5	Hydrological disturbance/modification of the wetland (e.g. as determined through DERM wetland mapping and classification)
2 Naturalness catchment		
2.1 Exotic flora/fauna	2.1.1	Presence of exotic terrestrial plants in the assessment unit
2.2 Riparian disturbance	2.2.5	Per cent area of remnant vegetation relative to preclear extent within buffered non-riverine wetland: 500 m buffer for wetlands >= 8Ha, 200 m buffer for smaller wetlands
2.3 Catchment disturbance	2.3.1	Per cent "agricultural" land-use area (i.e. cropping and horticulture)
	2.3.2	Per cent "grazing" land-use area
	2.3.3	Per cent "vegetation" land-use area (i.e. native veg + regrowth)
	2.3.4	Per cent "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	3.1.2	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
3.3 Habitat	3.3.2	Richness of wetland types within the local catchment (e.g. SOR sub-section)
	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[1], EPBC Act[2]
	4.1.2	Presence of rare or threatened aquatic ecosystem dependent flora species – NC Act[1], EPBC Act[2]

Criteria & indicators	Measures	
4.2 Communities/ assemblages	4.2.1	Conservation status of wetland Regional Ecosystems – Herbarium biodiversity status, NC Act[1], EPBC Act[2]
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)
	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[3]/CAMBA[4] 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)
8 Representativeness		
8.1 Wetland protection	8.1.1	The per cent area of each wetland habitat type within protected areas
	8.1.2	The per cent 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*
8.2 Wetland uniqueness	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)
	8.2.2	The relative abundance of the wetland management group to which the wetland habitat belongs within the subcatchment or estuarine/marine zone (management groups ranked least common to most common)
	8.2.3	The size of each wetland habitat relative to others of its management group within the catchment or study area
	8.2.4	The size of each wetland habitat relative to others of its management group within a subcatchment (or estuarine zone)
	8.2.5	Wetland habitat representative of the study area – identified by expert opinion
	8.2.6	The size of each wetland habitat relative to others of its 'type' within the catchment or study area

[1] NC Act – *Nature Conservation Act 1992* (Queensland legislation)
[2] EPBC Act – *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth legislation)
[3] JAMBA – Japan-Australia Migratory Bird Agreement
[4] CAMBA – China-Australia Migratory Bird Agreement

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