Australian Government

Great Barrier Reef Marine Park Authority

Coastal Ecosystems Assessment Framework

Development of a framework for assessment of ecosystem services within the basins located in the Great Barrier Reef catchment with a focus on improving the health and resilience of the Great Barrier Reef

Coastal Ecosystems Assessment Framework

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Contents

1. Background

The Great Barrier Reef and the adjacent Great Barrier Reef catchment (the catchment) encompass a diverse and complex number of terrestrial, freshwater, estuarine and marine ecosystems. Those ecosystems are found within a variety of modified or unmodified states and provide a range of ecological services, forming a critical component of the ecosystem services provided to the Great Barrier Reef and reef users.

The ecological services provided include physical processes (such as sediment and water distribution and cycling), biogeochemical processes (such as nutrient and chemical cycling) and biological processes (such as habitat and food provisioning).

The *Great Barrier Reef Outlook Report 2009* (Outlook Report) identified various threats to the health and resilience of the Great Barrier Reef. The biggest threats identified were from coastal development, water quality and climate change. In response to the findings of the Outlook report, and to enable the assessment and prioritisation of issues for better management of coastal ecosystems, the Great Barrier Reef Marine Park Authority (GBRMPA) developed a framework for assessing the importance of coastal ecosystems.

The aim of this framework was to assess the ecological functions, the risks to these functions and the cumulative impacts at work across the catchment that are affecting the long-term health of the Great Barrier Reef in a holistic way. This information could then be used for natural resource management planning.

Analysis of the catchment was undertaken at different scales – catchment wide, natural resource management areas (NRM), basin scales and local scales. In developing this framework it was found that scale is important. As expected, more influencing factors – and consequently more pressures – are at work at the finer scales of analysis (such as at a basin scale). Optimal analysis for understanding the ecological services and reviewing the pressures on these services is best done at a basin or sub-basin scale.

This framework allows for a detective type approach, identifying the natural state, current modified state and the pressures and threats through current land use for a specific defined area. To ensure the methodology provides a robust and relevant framework for assessment, it was developed in partnership with the Queensland Department of Environment and Heritage Protection (DEHP) and the Queensland Wetlands Program.

The analysis of ecological services, pressures and threats used in this framework is based on the best currently available science, supported by a range of experts in a diverse range of study areas. These included terrestrial and marine ecologists, geologists, hydrologists, climate change experts, natural resource managers and representatives from all levels of government. Further engagement with local communities and those with extensive local knowledge assisted in refining the understanding of the holistic functions at work at the basin scale.

The outcomes from the application of this framework by GBRMPA can be found in the report *Informing the Outlook for Great Barrier Reef Coastal Ecosystems.* Supporting information such as vulnerability assessments for coastal ecosystems and species, workshop outcome reports and guiding information can also be found on the GBRMPA website at www.gbrmpa.gov.au. The information that follows details the processes used by GBRMPA in developing this framework.

2. Key terminology

Basins:	An extent or an area of land where surface water channels to a hydrological network and discharges at a single point i.e. river, stream, creek.
Coastal zone:	Area of coast as defined by the Queensland Coastal Plan 2011.
Coastal Ecosystem:	Inshore, coastal and adjacent catchment ecosystems that connect the land and sea and have the potential to influence the health and resilience of the Great Barrier Reef. For this framework this includes the Great Barrier Reef catchment and 10 per cent of the Reef waters seawards of the coastline
Ecological process	A collection of the underlying steps that ecosystems/organism conduct to achieve a physical, biological or biogeochemical outcome. For example, nutrient cycling is a biogeochemical process
Ecological service	The physical, biological and biogeochemical processes that ecosystems provide that assist to sustain the health and resilience of the Great Barrier Reef. For example, estuaries provide habitat (physical), provide food (biological) and cycle nitrogen (biogeochemical) which all contribute to the health of fish that frequent the reef, such as mangrove jack.
Ecosystem:	A dynamic complex of plant, animal and micro-organism communities and the non-living environment interacting as a functional unit. (source: Millennium Ecosystem Assessment 2005)
Ecosystem function:	The interactions between organisms and the physical environment, such as nutrient cycling, soil development and water budgeting.
Ecosystem services	The benefits people obtain from ecosystems
Inshore marine areas:	Ten per cent of the distance between the outer boundary of the Great Barrier Reef and mean low water on the mainland at the same latitude. An arbitrary boundary created for the purpose of this analysis.
Great Barrier Reef catchment	The 35 river basins in Queensland which drain into the Great Barrier Reef (table 1.1).
Natural Resource Management (NRM) regions:	A group of basins that are managed by non-government organisations (NRM bodies) within Queensland (table 2.1).
Natural Resource Management (NRM) bodies:	Non-government organisations that participate in and engage with community in the long-term care and use of soil, water, vegetation and the ecosystems they make up. There are six NRM groups operating in the catchment.
Non-remnant:	Vegetation that does not meet the criteria of 'remnant vegetation' (see Remnant vegetation)
Pre-clear:	Queensland government reconstruction of regional ecosystems to represent vegetation pre-European settlement.
Post-clear:	Queensland mapping of the state of regional ecosystems. For the purpose of our study, we have used 1999 and 2009 data.
Remnant vegetation:	Vegetation within a defined areas that meets all of the following criteria: • 50 per cent of the predominant canopy cover that would exist if the vegetation community were undisturbed • 70 per cent of the height of the predominant canopy that would exist if the vegetation community were undisturbed • composed of the same floristic species that would exist if the vegetation community were undisturbed.
Regional Ecosystem:	Regional ecosystems (REs) are remnant vegetation communities that are consistently associated with a particular combination of geology, land form and soil in a bioregion. The Queensland Herbarium has mapped the remnant extent of regional ecosystems for much of the state using a combination of satellite imagery, aerial photography and on-ground studies. Each regional ecosystem has been assigned a conservation status which is based on its current remnant extent (how much of it remains) in a bioregion. The exception is areas of Cape York (Lockhart basin) which have not been mapped.
Vulnerability:	The degree to which a system or species is susceptible to, or unable to cope with, adverse effects of pressures. Vulnerability is a function of the character, magnitude, and rate of variation or change to which a system or species is exposed, its sensitivity, and its adaptive capacity.

Table 2.1: Regional breakdown of the scale of assessments used to analyse coastal ecosystems and land use. (Refer to section four)

Great Barrier Reef catchment	NRM regions	Basins	Coastal zone as defined by Queensland State Coastal Management Plan 2011
	Cape York NRM region (managed by Cape York NRM group)	Jacky Jacky	
		Olive-Pascoe	
		Lockhart	
		Stewart	
		Normanby	
		Jeanie	
		Endeavour	
	Wet Tropics NRM region (managed by Terrain Pty Ltd)	Daintree	
		Mossman	
		Barron	
		Mulgrave-Russell	
		Johnstone	
		Tully	
		Murray	
		Herbert	
	Burdekin Dry Tropics NRM region (managed by NQ Dry Tropics)	Black	
		Ross	
		Haughton	
		Burdekin	
		Don	
	Mackay-Whitsunday NRM region (managed by Reef Catchments Pty Ltd)	Proserpine	
		O'Connell	
		Pioneer	
		Plane	
	Fitzroy NRM region (managed by Fitzroy Basin Association)	Styx	
		Shoalwater	
		Waterpark	
		Fitzroy	
		Calliope	
		Boyne	
	Burnett-Mary region (managed by Burnett Mary Regional Group)	Baffle	
		Kolan	
		Burnett	
		Burrum	
		Mary	

3. Method

This framework provides a holistic approach to assessing and understanding ecological services provided by coastal ecosystems, the pressures affecting them and the management regimes in place to protect them. The outcomes from application of this framework were used as the basis of the report *Informing the outlook for Great Barrier Reef coastal ecosystems* (figure 3.1).

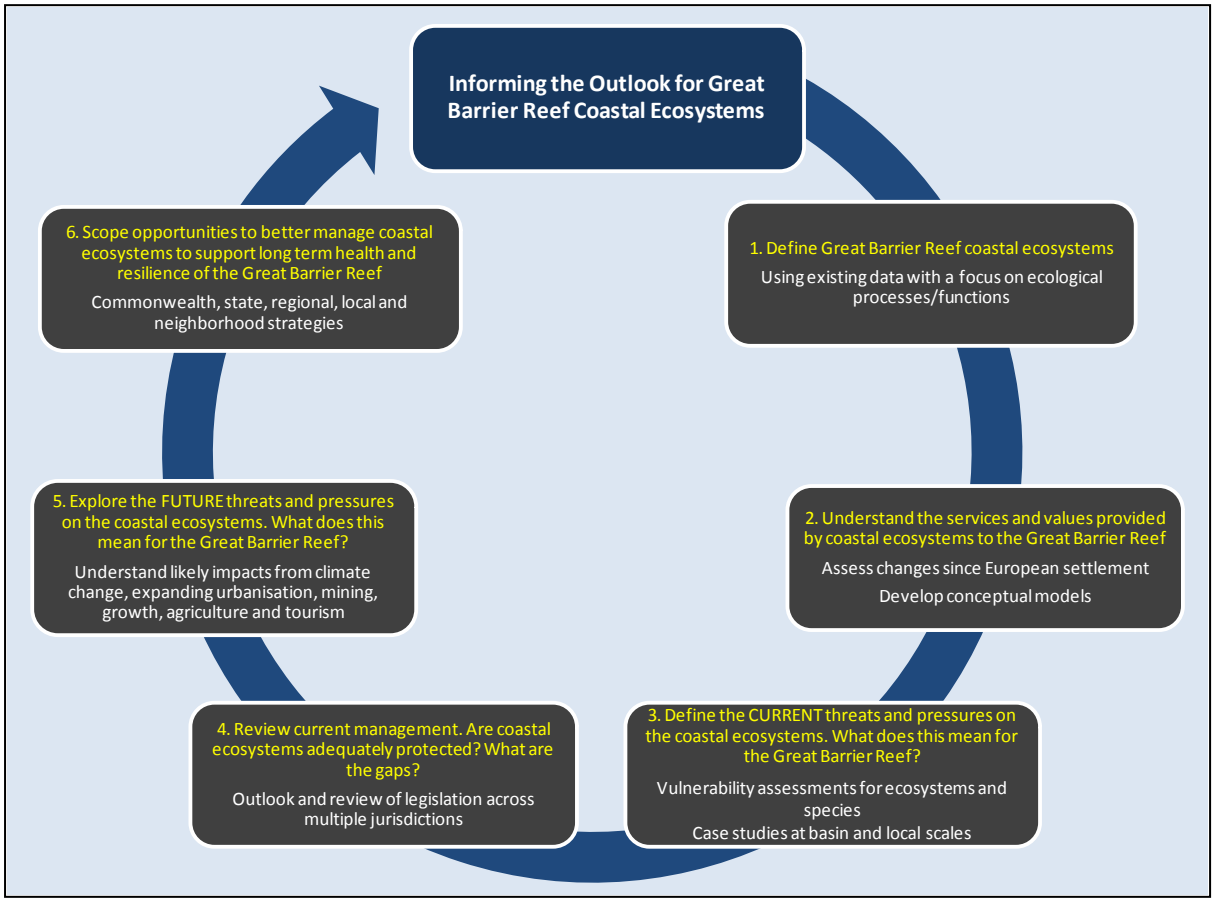

Figure 3.1: Summary of the processes followed in creating the report: *Informing the Outlook for Coastal Ecosystems*

The methods used involved utilising available data from a variety of sources (such as vegetation, soils, hydrology, climate, geology, groundwater and land use). The data is collated and analysed by environmental experts to create a series of visual tools to facilitate the understanding of ecological services occurring within the basin.

The analysis includes assessment of the ecological services provided to the adjacent marine area from both modified and unmodified ecosystems, the linkages between ecosystems within the basins that form the Great Barrier Reef Catchment, and how those ecological services provided by coastal ecosystems are affected when ecosystems have been modified or the linkages between those ecosystems have been broken.

3.1 Developing a base

Data used in the framework is freely available from the Queensland Government. This data was chosen as it provides a baseline and is updated when data becomes available. The methodology used to group the base data to inform the outlook for coastal ecosystems is detailed in the following sections. This methodology provides a process to compare and contrast future changes in coastal ecosystems and land use data.

Expert workshops and specialist reviews have been used to validate and support the framework.

3.1.1 Defining Great Barrier Reef Coastal Ecosystems

The Great Barrier Reef and adjacent catchment encompasses marine, coastal, floodplain, lowland and highland areas which each contain a variety of ecosystem types (figure 3.2). GBRMPA is particularly interested in understanding the ecological services provided by those ecosystems from the perspective of the Great Barrier Reef.

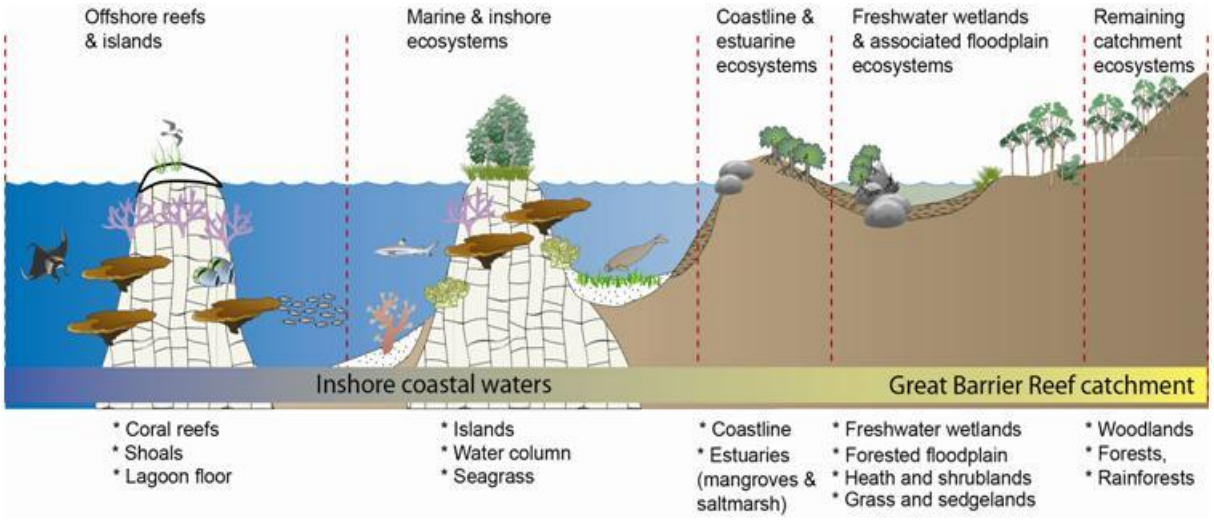

Figure 3.2: Broad landscape groupings showing coastal ecosystems

In order to facilitate this understanding, GBRMPA – in collaboration with DEHP – grouped regional ecosystems into fourteen coastal ecosystems (figure 3.3). The rationale and methodology used for mapping the Regional Ecosystems into coastal ecosystems can be found in appendix A–E. The mapping of terrestrial and marine ecosystems was processed independently with different data layers used (table 3.1).

3.1 List of data sets used by GBRMPA in basin assessments

Agency	Dataset	Year
GBRMPA	GBRMP Zoning	2009
	Marine Bioregions of GBRMP (non-reefal)	2005
	Marine Bioregions of GBRMP (reefal)	2005
Queensland Government	Regional Ecosystems of Queensland (Pre-clear)	2009 v6.0b
	Regional Ecosystems of Queensland (Remnant)	2009 v6.0b (collected in 2006)
	Queensland Wetlands Data – water bodies and wetland regional ecosystems	2009
	Digital Cadastre Boundary Database – (Tenure)	2011
	Queensland Landuse Mapping Project (QLUMP)	1990,1999, 2005, 2009
	Stream Ordered Rivers (Hydrology)	2009
	Queensland Coastal Plan including draft hazard erosion prone area, draft hazard sea level rise high risk of storm tide inundation, medium risk of storm tide inundation	2011
	Dams and Weirs	2002
	SEDNET Soils Data Set	2006
	Seagrass mapping and modelling	

CSIRO (joint dataset with other agencies	GBR Seabed Biodiversity site clusters	July 2007
	GBR Seabed Biodiversity assemblages	July 2007
Boundary datasets	Healthy Water Management Plan	
	Great Barrier Reef catchment boundary	
	Natural Resource Management region boundaries	
	Great Barrier Reef basins	
	Queensland Coastal Plan coastal zones	
	Queensland government floodplain mapping	
	GBRMPA inshore marine areas boundary	
James Cook University	Seagrass Model (Dryseason)	2007
	Seagrass Model (Wetseason)	2007

For each of the coastal ecosystems, a vulnerability assessment has been compiled. The purpose of the vulnerability assessments is to define each coastal ecosystem and document the vulnerabilities of coastal ecosystems to known pressures and the implications for the Great Barrier Reef. These vulnerability assessments were used to:

- document the major pressures and key sources of vulnerability for each coastal ecosystem
- document the ecological role and function of each ecosystem, grouping the ecosystem services provided, the interconnectivity of the ecosystems throughout the GBR catchment, and how these influence the health and resilience of the Great Barrier Reef
- identify present management tools and appropriate and practical management actions that could be taken to mitigate risk and enhance coastal ecosystem resilience for the long term benefit of the Great Barrier Reef
- identify gaps in management effectiveness, including deficiencies in legislation and policy, and those areas where additional research is required for making informed decisions.

The vulnerability assessments were prepared by GBRMPA based on the best available information on that coastal ecosystem. Each assessment was peer reviewed by natural resource managers and researchers with expertise within the particular ecosystem. They provide a key reference document that supports our understanding of the complex nature of interconnected coastal ecosystems, their functions and the influence they have on the Great Barrier Reef.

Vulnerability assessments for the coastal ecosystems are available at www.gbrmpa.gov.au and will be updated as new information becomes available.

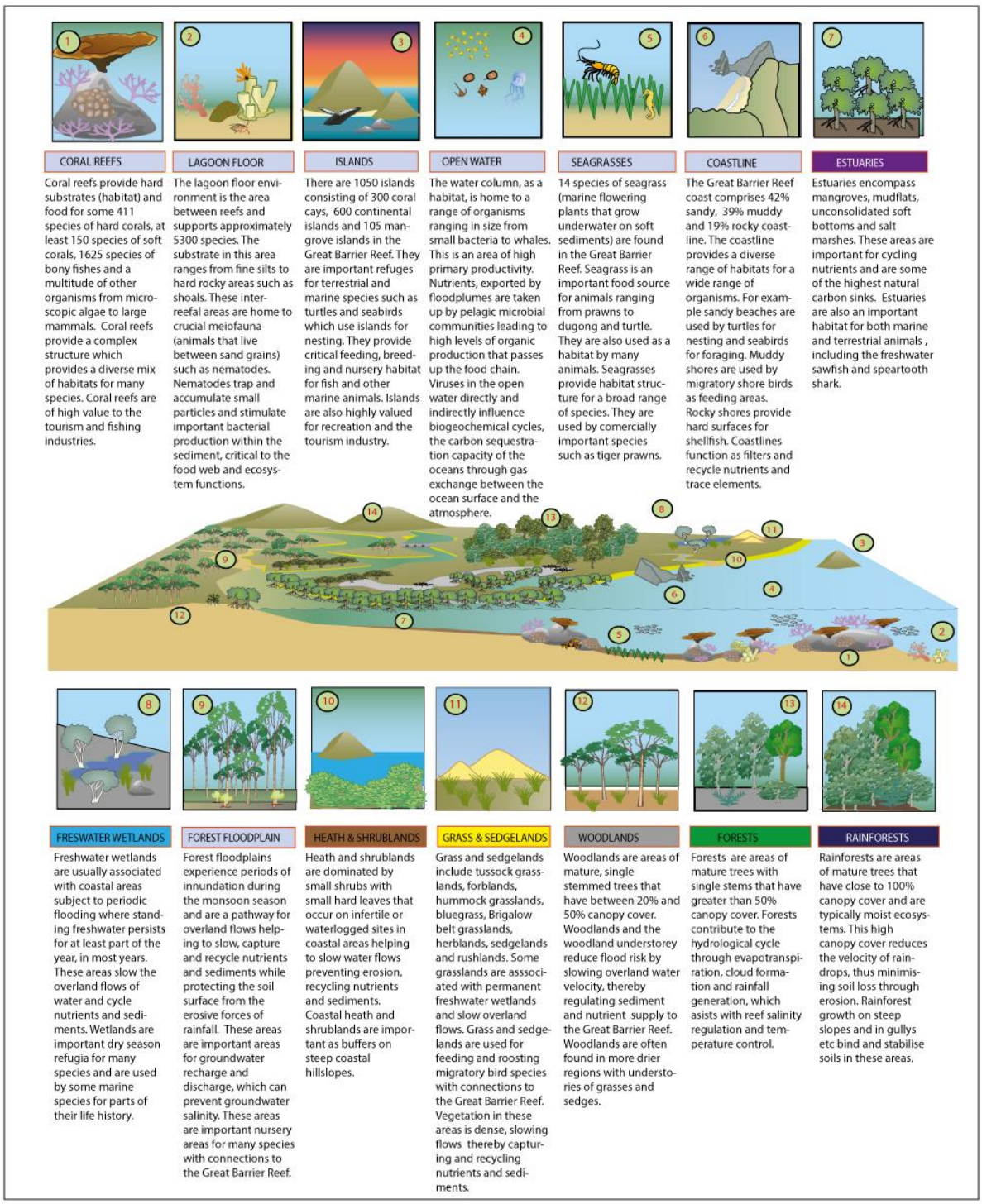

Figure 3.3: Coastal ecosystems as defined by GBRMPA.[1]

3.1.2 Terrestrial ecosystems

To enable categorisation and map based analysis of the terrestrial ecosystems, GBRMPA used existing data from the Queensland State Government (Queensland Herbarium and the DEHP).

The Queensland Herbarium has mapped Regional Ecosystems for much of the state over different time scales using a combination of satellite imagery, aerial photography and on-ground studies. The resulting spatial dataset titled Queensland's Regional Ecosystems, are based on vegetation communities that are consistently associated with a particular combination of geology, land form and soil within a designated bioregion. See below example.

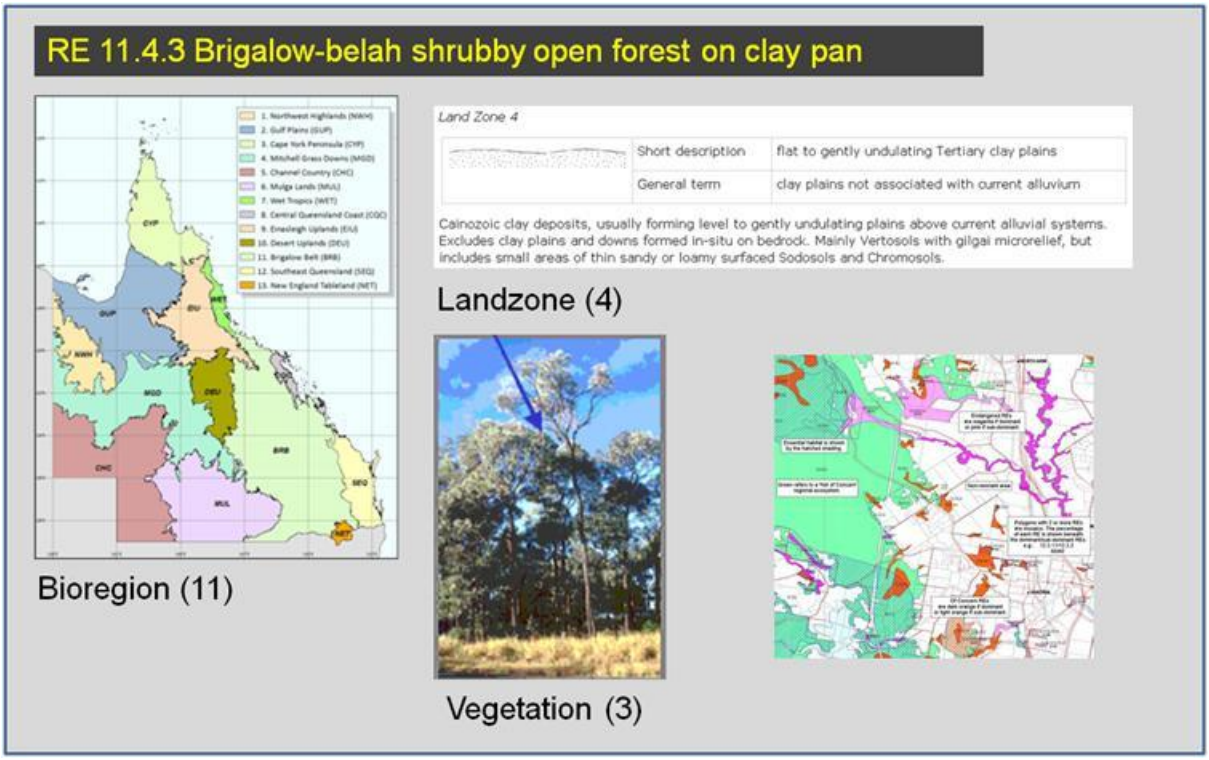

Figure 3.4: Example of the process for mapping Regional Ecosystem mapping. Regional Ecosystems are based on bioregion, land zones and vegetation characteristics. More information can be found at www.dehp.qld.gov.au

Due to the extent and area of the catchment, GBRMPA grouped the Regional Ecosystems into the coastal ecosystem categories based on broad functional groupings. These were then later validated with expert input (see section 3.2.2). These coastal ecosystems were then mapped at catchment, NRM and basin scales. An example of coastal ecosystem basin scale mapping is shown in figure 3.5.

3.1.3 Marine ecosystems

The marine bioregional mapping used geographic information systems (GIS) based tools and analytical methods to identify and map 70 bioregions (of which 30 were reef bioregions and 40 were non-reefal). This information forms the basis for the 2003 rezoning of the Great Barrier Reef.

Additional seagrass survey and modelling data (compiled by the former Queensland Department of Employment, Economic Development and Innovation and James Cook University) was used to define the marine groupings of the coastal ecosystems.

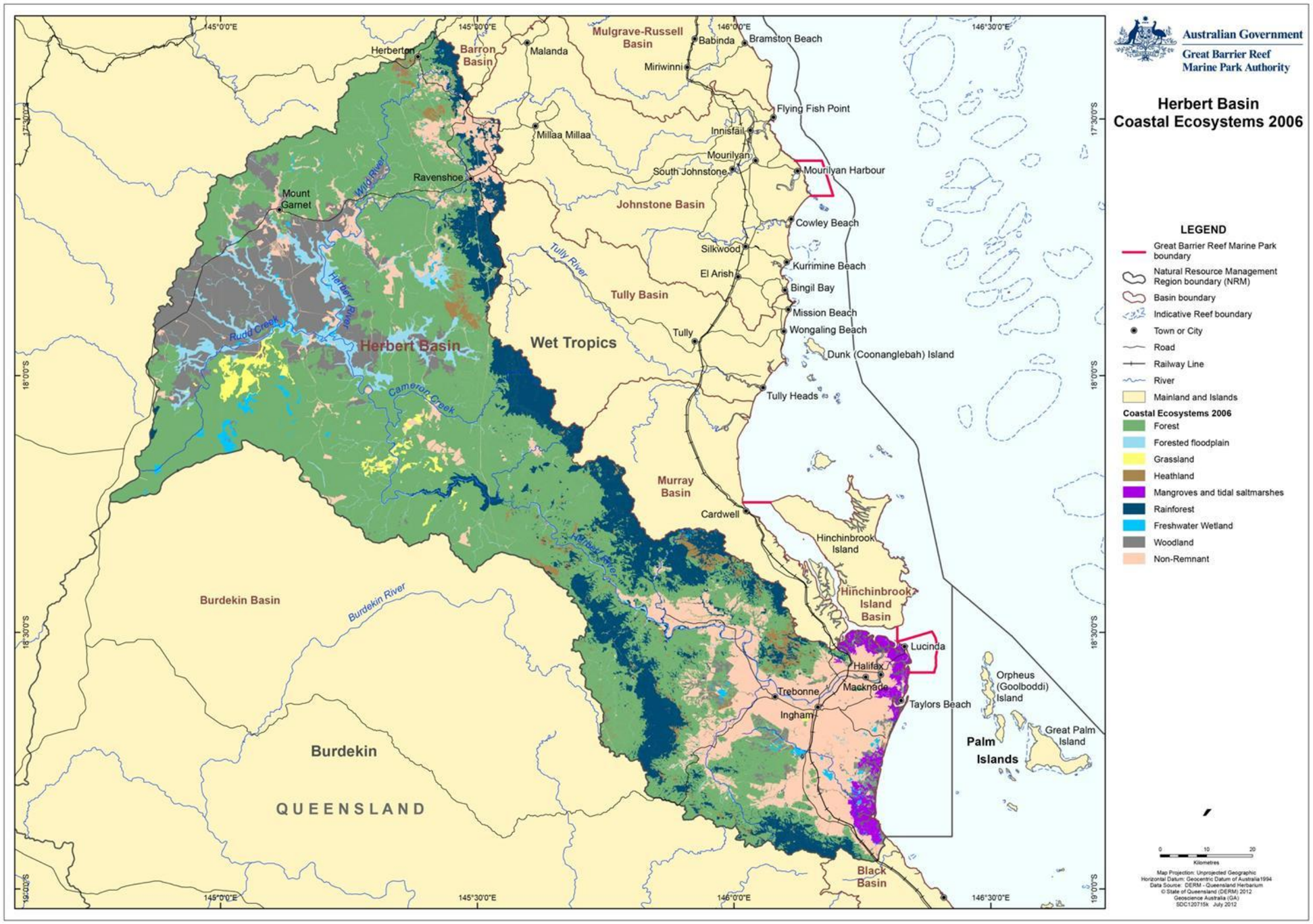

Figure 3.5: Map showing the current (post-clear) extent of coastal ecosystems within the Herbert River basin

3.2 Understanding the values and services provided by coastal ecosystems to the Great Barrier Reef at a basin scale.

The catchment in its current state is a mosaic of natural and modified ecosystems with a suite of values and services of importance. The processes used to understand these are outlined in the following sections with technical information on the spatial analysis in the appendix. This process (basin assessment) is summarised in figure 3.6.

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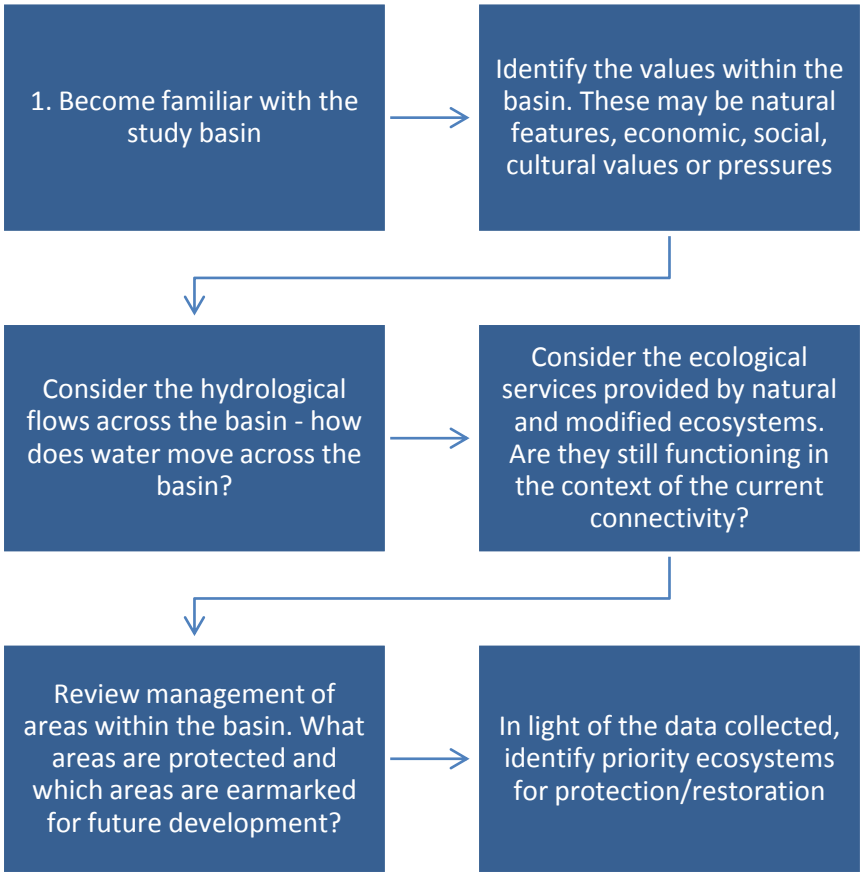


Figure 3.6: Summary of the processes for conducting a basin scale assessment

This process can be used at all scales, however for the purpose of our work we identified data collected at the basin scale. This provided a good snapshot of the ecosystems at a useable scale. For larger basins (for example Fitzroy and Burdekin basins), we conducted this work at a sub-basin scale.

Basins in our pilot were chosen to assess the capacity to apply findings to other basins in the catchment. Basins chosen represented a wet tropical basin, a dry tropical basin, an extensively grazed basin, an intensively farmed basin and a basin containing significant port and industry.

Once basins were selected, a desktop study was undertaken to collate information regarding the study basin. Information collected included demographics, history, geology, hydrology, settlement and development within the basin, traditional use, social and economic values, growth areas, climate and regional climate change predictions. This information was then provided, along with detailed basin maps of the data (section 3), to experts in a workshop. Information was then collected including basin values, ecological services, connectivity and the impacts of climate change.

3.2.1 Assessment of values at a basin scale

Purpose: To capture important 'values' within a study area.

Within each basin there are identifiable values (both natural and anthropogenic) that influence the way the basin functions, and how it is used.

The values may be identified as natural or anthropogenic. In addition, some may have social, economic and/or cultural values:

- areas of unique habitat (such as a coastal rainforest or a pristine wetland) (natural values)
- a dam or weir (anthropogenic, possibly with social and economic values)
- an industrial use or installation (anthropogenic, with economic values)
- urban development area (anthropogenic, with social and economic values)
- the presence of a particular species of flora or fauna (natural, with possible social, cultural and economic values)
- an area of significance to traditional owners or the community (natural, with cultural values)

Process: The list of potential assets is non-exhaustive and personal subjective judgment will be required with regard to the scale and degree to which values are recorded. An example of assets identified within the Herbert River basin during a mapping exercise is shown in figure 3.6. These assets were obtained in a workshop where scientists and people with good local knowledge were asked to place numbered markers on a map and to describe the assets they had identified and why they were considered important.

To assist this information gathering exercise, participants were provided with maps showing information such as land use, coastal ecosystem mapping, major rivers, streams and water bodies, as well allocations of towns, industry and development. This information can also be collected in the field and captured in a database for further analysis and mapping of values.

Table3.2: Example of database used for the collection of values within a basin. Other parameters, such as condition assessment data, can also be included.

Value	Description	Natural or Anthropogenic	GPS	Values	Description of other value
Goorganga plains wetland	Extensive wetland systems	Natural	001	Natural	Natural wetland and fish habitat
Goorganga plains wetland	Extensive wetland systems	Natural	001	Social	Popular recreational site
Goorganga plains wetland	Extensive wetland systems	Natural	001	Economic	Used by the tourism industry
Goorganga plains wetland	Extensive wetland systems	Natural	001	Economic	Source of barramundi for the inshore barramundi fishery
Goorganga plains wetland	Extensive wetland systems	Natural	001	Cultural	Significant site for local Traditional Owners

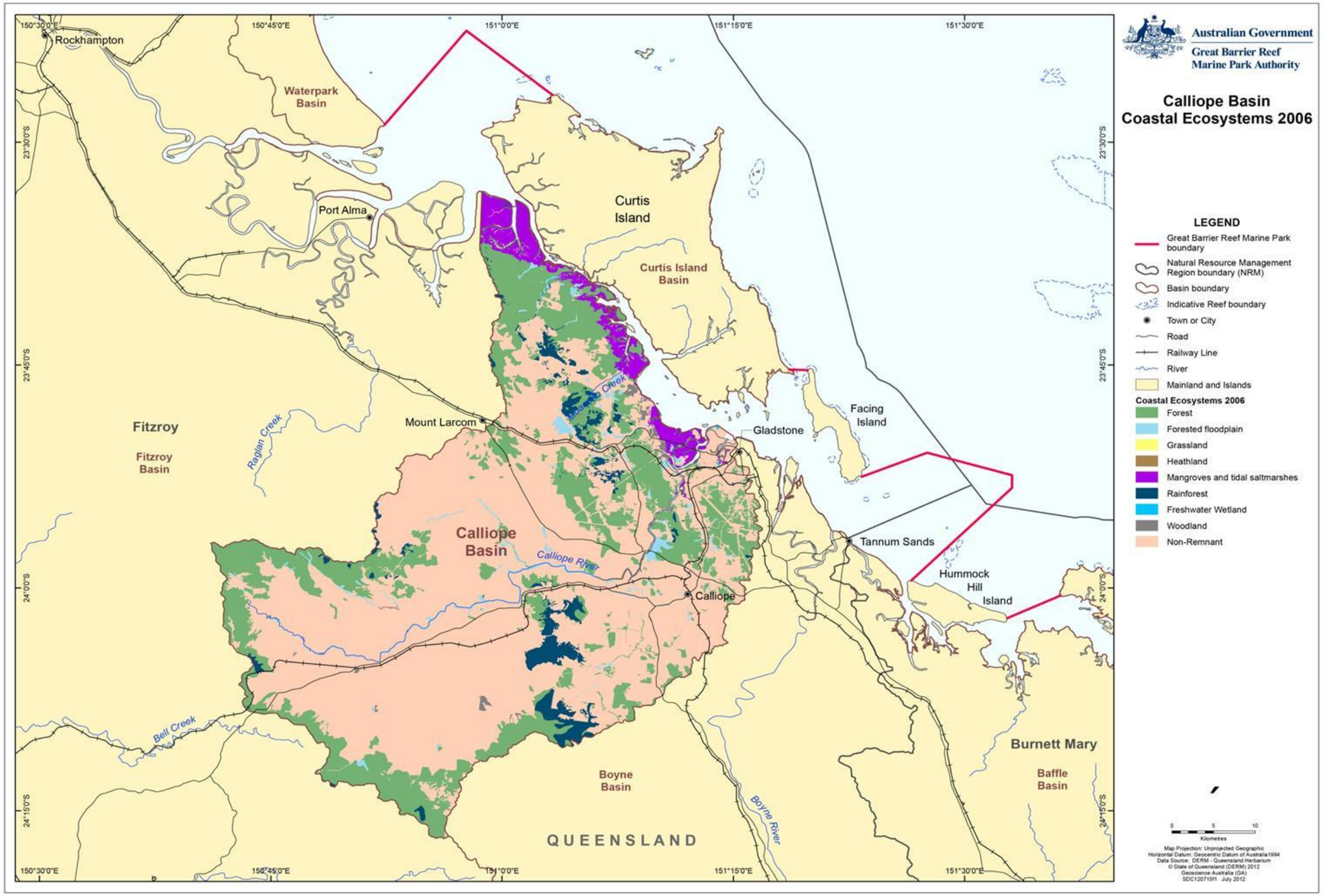


Figure 3.6: Values as identified by experts in an expert workshop for the Calliope basin

3.2.2 Ecological services at a basin scale

Purpose: To capture some of the ecological services provided by coastal ecosystems within the study area by reviewing selected processes, and considering how they benefit the Great Barrier Reef.

Ecological services provided by coastal ecosystems can be broadly grouped into physical, biological and biogeochemical processes. These ecological services may have intrinsic values (for example, local nutrient recycling) or wider values (for example, a forest floodplain may provide a nursery area for juvenile barramundi from coastal waters). Where an ecosystem has been modified, the ecological service may continue to be provided. However, generally the level of service or function provided will depend to the extent and degree to which the ecosystem has been modified.

Process: To assist with identifying ecological services provided by natural and modified ecosystems, a table showing the ecological services provided by natural and modified ecosystems is included (appendix F). This was used in conjunction with maps to capture basin scale services (for example, sites of groundwater recharge and areas susceptible to erosion).

In some more extreme cases the level of ecological service may be provided at a significantly reduced level or may even be nonexistent. For example ecosystems that have been converted from a natural ecosystem into cane land will continue to provide some ecological services (for example, sediment trapping at times) whereas at a mine site ecological services will likely be minimal.

The best way capture this information is to select one process and consider it across the basin landscape, while considering the post-clear vegetation and land use maps. Some maps may be more useful when considering particular processes. For example, land zone and topography will be relevant when considering some physical processes, such as sediment transport and cycling

3.2.3 Consider the flows – connectivity between ecosystems at a basin scale

Purpose: To identify the linkages between coastal ecosystems and the Great Barrier Reef, and how landscape modifications and land use may be altering the way water moves over and under the landscape.

Connectivity (connections between ecosystems) is important to consider in this process. How water moves across (or beneath) the basin will affect the ability of coastal ecosystems to remain healthy and function normally. Changes to topography (for example, laser levelling for agriculture) and water retention measures (for example, ponded pastures or dams) will influence the movement of water across a basin and affect downstream groundwater dependant ecosystems. Note that for some ecosystems, a lack of connectivity can be important too. Changes to connectivity can also affect the values identified in 3.2.1 or the services in 3.2.2.

Groundwater movement can be important for both terrestrial and marine coastal ecosystems. Groundwater movement is driven by the underlying geology, with greater water movement occurring in areas that contain more porous substrate. Groundwater discharges during the dry season are important for maintain aquatic refuges and aquatic ecological processes. Changes to floodplain flows can interfere with groundwater recharge and, as a result, reduce groundwater discharge and thus jeopardise groundwater dependant ecosystem health and aquatic processes and encourage salt water intrusion in the low-lying coastal areas.

Process: Stream order maps overlayed with elevation maps were used to determine how water moves across a basin (Figure 3.7). From these maps, important areas of groundwater recharge and discharge can often be identified. Groundwater movements were considered by using underlying geology supported by expert local knowledge.

After considering basin hydrology and connectivity, these were assessed against the values compiled in 3.2.1 and a selected process from 3.2.2. By selecting individual processes from 3.2.2 and following them across the basin, a greater understanding of the pressures, threats and subsequent consequences for the Great Barrier Reef can be identified.

Using this data, the processes were captured on the mapped basins (figure 3.8)

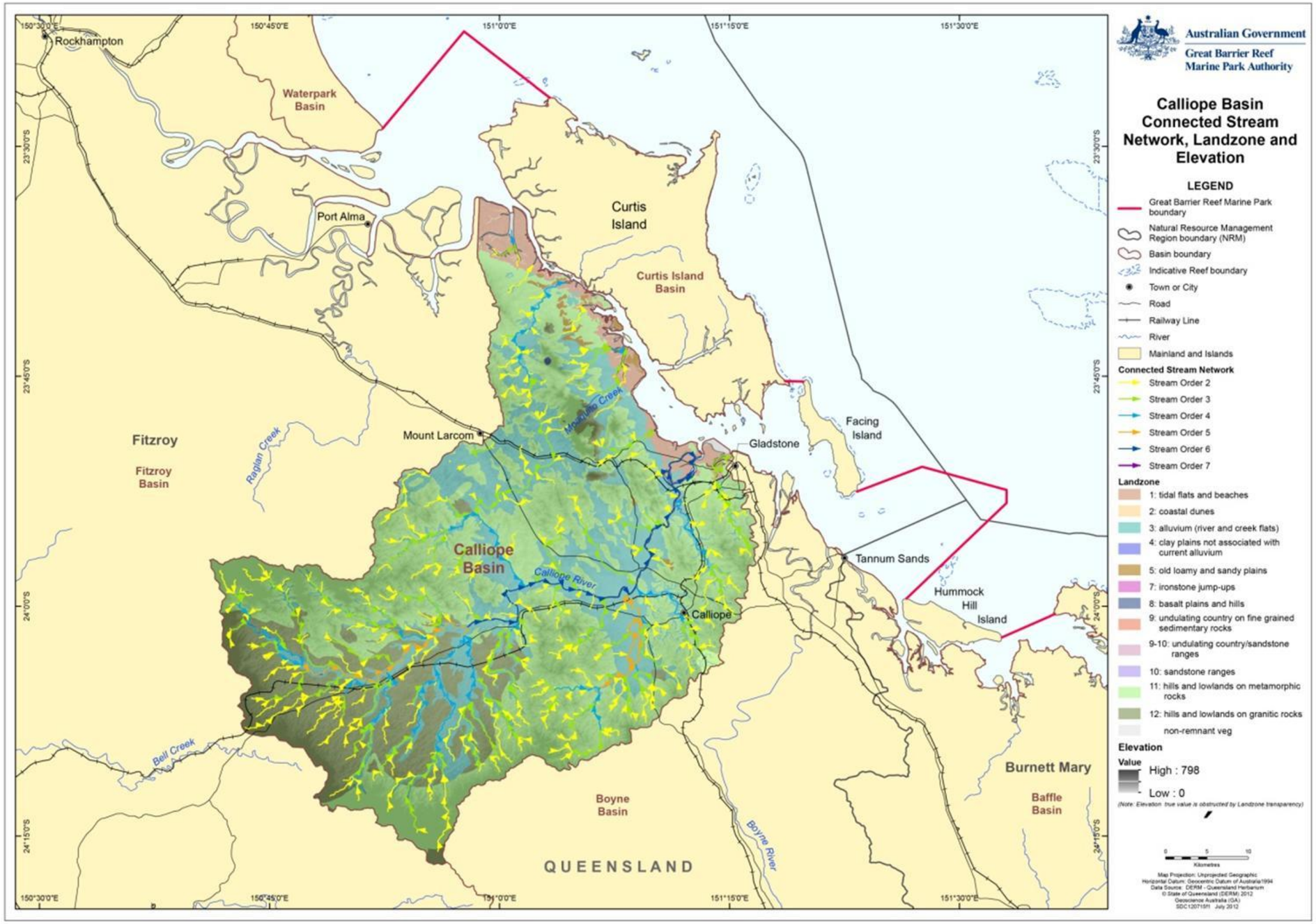


Figure 3.7: Example stream order map for analysis of hydrological flows in the Calliope Basin

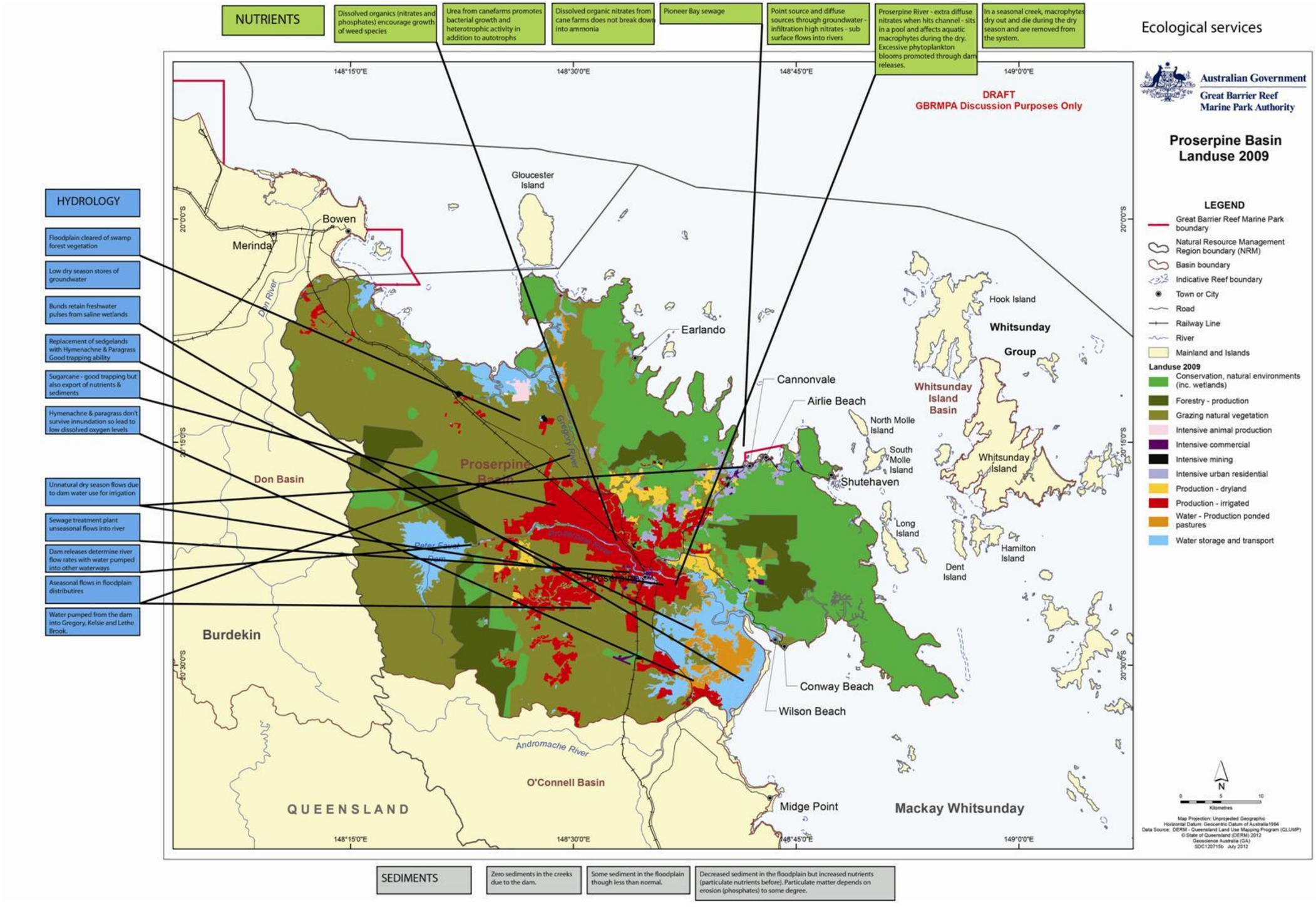


Figure 3.8: Ecological services (hydrology and regulation of nutrient and sediment regimes) overlaid on a map of the current land use for the Proserpine basin

3.2.4 Climate change

Purpose: To consider and identify how the predicted impacts from climate change (at a regional scale) will impact on the values, ecological services, the connectivity and ultimately the Great Barrier Reef, and identify possible management strategies.

Rising temperature and sea levels, ocean acidification, increases in storm severity and other predictions associated with climate change represent significant pressures on coastal ecosystems.

Process: GBRMPA considered it useful to explore the likely or potential effects of climate change on the services identified at a basin scale in an effort to understand 'what those changes mean for the values, services, connectivity and ultimately the Great Barrier Reef?'

This step was achieved by using the results from the assessment of the ecological services within the basin and considering how they were likely to change as a result of climate change.

The Queensland Coastal plan has mapped the following useful categories:

- Erosion prone areas
- Sea level rise
- Areas prone to storm surge.

This mapping and Queensland regional climate change predictions 2 (was applied to the data collected in section 3.2 to assess the effects of climate change on the study area basins (Figure 3.9).

Shorter sharper wet and longer dry season

Greater channel instability , erosion and transport capacity Flashier flow regime

Lower cover of vegetation polished base gullies

Less groundwater recharge

Greater overtopping of dam flushing of vegetation out of creeks and river

Vegetation shift from wetter to drier conditions - less rainforest melaleuca forests.

Fire regime more intensive and extensive

Reduced extent and quality of freshwater refugia

Increased instability of slopes cleared for development

More erosion prone areas in each bay

HYDROLOGY

Less freshwater refugia, shorter more intense rainfall

Lower dissolved oxygen will increase water stress

Greater decomposition and an increased in biological oxygen demand

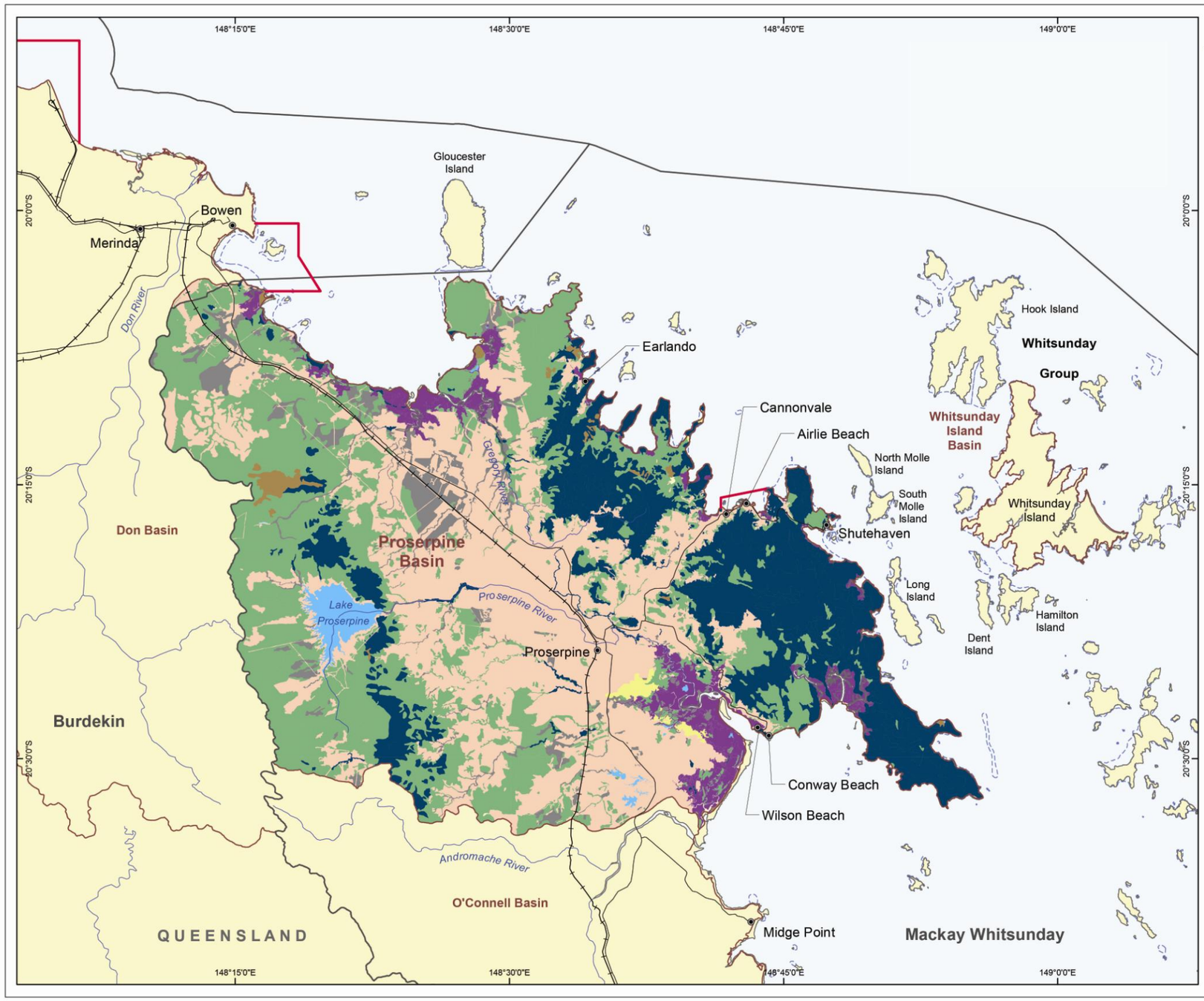
Hypersaline stress - movement of saltmarshes (except samphire)

Decrease in mangrove diversity

Greater vegetation water stress

Greater potential for changed fire regimes. Some fire sensitive communities which became water stressed could burn and therefore refugia extent and quality would decline. Less riparian vegetation

May be a reduction in para grassand hymenachne? Both are fire sensitive and there will be greater access for cattle if water levels drop



Australian Government
Great Barrier Reef Marine Park Authority

Proserpine Basin Coastal Ecosystems 2006

Climate Change impacts

LEGEND

- Great Barrier Reef Marine Park boundary
- Natural Resource Management Region boundary (NRM)
- Basin boundary
- Indicative Reef boundary
- Major Town
- Road
- Railway Line
- River
- Mainland and Islands

Coastal Ecosystems 2006

- Forest
- Forested floodplain
- Grassland
- Heathland
- Mangroves and tidal saltmarshes
- Rainforest
- Freshwater Wetland
- Woodland
- Non-Remnant

Worst case scenario - weed invasion

N

0 5 10
Kilometres

Map Projection: Unprojected Geographic
Horizontal Datum: Geocentric Datum of Australia1994
Data Source: DERM - Queensland Herbarium
© State of Queensland (DERM) 2012
Geoscience Australia (GA)
SDC120715d July 2012

Sea level rise/seawater innundation

Grazed floodplain is in the area of seawater innundation

Seawater increase will lead to a reduction in melaleucas, freshwater associated vegetation and macrophytes

Reduced diversity of mangroves (maybe slower growth species) samphire flats may expand

Tidal bundwalls innundated. These may be built higher. If they fail some sedgelands could be reestablished. What happens at the landwards margins? E.g. exotics vs natural revegetation Some potential for revegetation of saltmarshes

Figure 3.9: Climate change impacts on processes within the Proserpine basin

4. Bringing it all together

Many of the ecological services provided by catchment coastal ecosystems are vital to maintain the resilience and long-term health of the Great Barrier Reef. In order to provide effective protection to the ecosystems providing these services, it is necessary to have an understanding of the coastal ecosystems, the services that they provide and how they function as a whole.

Understanding ecological services is especially important given the catchment and the Great Barrier Reef are both under significant pressure as coastal populations grow. Population growth drives development by creating demand for residential development and associated supporting infrastructure and industry.

While development is unavoidable and plays an important role in economic growth and social structure, to ensure the growth is sustainable in the long-term, ecosystem services and ecological services need to be protected and maintained into the future. To achieve that goal, careful future strategic planning is required to recognise critical ecosystems and protect the values of coastal ecosystems.

This framework provides the methodology to facilitate the identification and understanding of those coastal ecosystems that are critical to the long-term health and resilience of the Great Barrier Reef.

Further information can be found on GBRMPA's website including:

- *Informing the Outlook for Coastal Ecosystems* report
- workshop proceedings from expert advisory workshops
- basin assessments for Herbert River basin, Ross River basin, Proserpine River basin, Styx River basin, Calliope River basin.
- vulnerability assessments for coastal ecosystems and species of concern.

4.1 Management

Purpose: To identify spatially the areas currently protected under legislation (such as the *Vegetation Management Act 1999*) in the study area, to identify areas that are planned for future development (State Development Areas, areas with prior development approvals).

Process: Through spatial analysis, coastal ecosystems currently protected can be mapped. Queensland Land Use Mapping Project (QLUMP) data contains information on the extent and distribution of national parks, conservation parks and state forests.

Protection is offered under the Vegetation Management Act. . This applies to all native vegetation except grasses and mangroves. Most protection is offered to remnant vegetation – vegetation that has either never been cleared or has regrown (to cover more than 50 per cent of the undisturbed predominant canopy, more than 70 per cent of the undisturbed height and is composed of species characteristic of the undisturbed predominant canopy). Regrowth of high value and regrowth around certain watercourses is regulated under 2009 amendments.

Regional Ecosystems are remnant vegetation assemblages grouped into bioregions. These are assigned a conservation status based on the extent within each bioregion (table 3.3).

Table 3.3 Conservation statuses of Regional Ecosystems

Conservation status	Metric
Endangered	Less than 10 per cent of pre-European extent remaining or 10–30 per cent remaining but less than 100km^2 in this bioregion.
Of Concern	Less than 30 per cent of pre-European extent remaining or more than 30 per cent remaining but less than 100km^2 in this bioregion.
Least Concern	More than 30 per cent of pre-European extent remaining and more than 100km^2.

Broadscale clearing and clearing of high value regrowth vegetation (uncleared since 1989) and some vegetation close to waterways in the catchment is now prohibited. However, in urban areas, these rules only applies to Endangered Regional Ecosystems. In some instances, urban areas may still allow clearing of Endangered Regional Ecosystems. Major industries like mining, transport, electricity and community infrastructure are exempt from the Vegetation Management Act.

The Commonwealth Government's Collaborative Australian Protected Areas Database (CAPAD) provides protected area data for Australia. Reserve types and areas for Queensland are shown in table 3.4.

Table 3.4: Conservation categories listed in the Collaborative Australian Protected Areas Database

Type	Number	*Area
Conservation Park	220	67,752
Coordinated Conservation Area	2	1,253
Forest Reserve	79	145,005
Indigenous Protected Area	5	218,010
National Park	286	7,776,105
National Park (Recovery)	19	29,192
National Park (Scientific)	9	53,189
National Park Aboriginal	5	274,636
Nature Refuge	374	2,059,672
NRS Addition - Gazettal in progress	20	297,491
Protected Area	2	51,574
Resources Reserve	43	353,376
Timber Reserve	9	177,933
Total	**1,073**	**11,505,188**

The *Queensland Fisheries Act 1994* prohibits the destruction, damage or disturbance of marine plants in all areas. They include mangroves, seagrass, saltcouch, algae, samphire (succulent) vegetation and adjacent plants, such as melaleuca (paper barks) and casuarina (coastal she-oaks).

5. Additional resources

Table 6.1: Sources of information that can be used for compiling background information on the basin

Reference material	Resources
GBRMPA Coastal Ecosystem workshop outputs Vulnerability Assessments Informing the outlook for Great Barrier Reef Coastal Ecosystems (report)	GBRMPA
Local values	Local government websites
Social values	Department of Local Government, Planning, Sports and Recreation
Traditional Owner values	GBRMPA
Climate, tides	Bureau of Meteorology – www.bom.gov.au
Economic values & forecasts	Department of Office of State Revenue
Coastal Ecosystem values	GBRMPA Vulnerability Assessments
Climate change	Queensland Department of Environment and Heritage Protection regional climate change forecast summaries www.ehp.qld.gov.au/climatechange/regional-summaries.html
Natural Resource Management	Cape York NRM Terrain NRM NQ Dry Tropics NRM Reef Catchments NRM Fitzroy NRM Burnett Mary NRM
Tourism – Great Barrier Reef	GBRMPA
Tourism – catchment	Queensland Tourism
Fisheries values	The Queensland Department of Agriculture, Fisheries and Forestry
Historical and heritage values	University of Queensland www.queenslandplaces.com.au
Wetlands	Queensland Department of the Environment and Resource Management – Wetland*info*
Receiving water information	Australian Centre for Tropical and Freshwater Research
Water Quality and land use management practices	Reef Water Quality Protection Plan

Climate information can be particularly important for the reason that many ecological processes are dependent on climatic cycles (for example, wet season rains) and can be obtained through the Bureau of Meteorology.

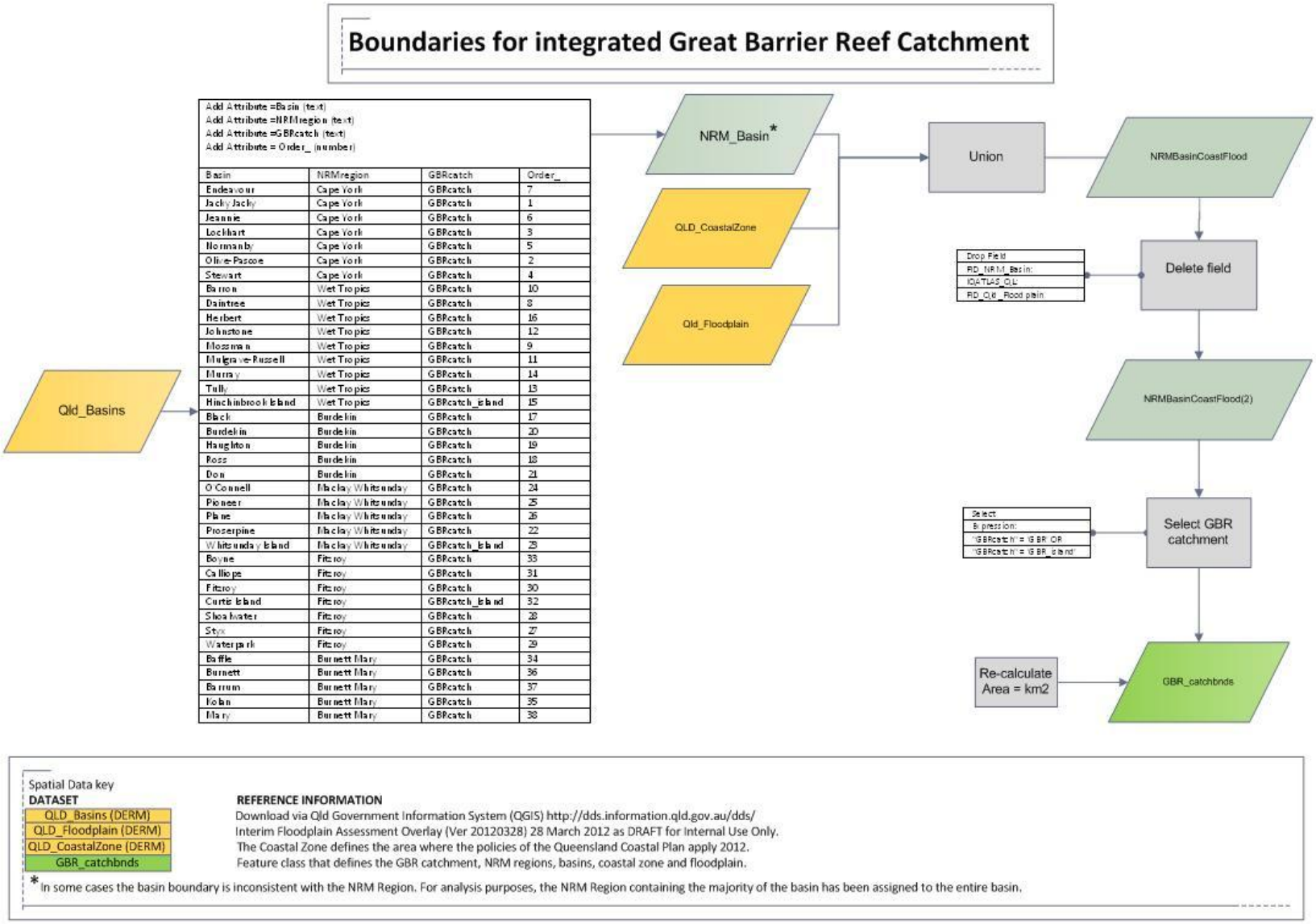
5.1 Spatial data

Data used in the compilation of maps supplied to workshop participants was obtained from a wide variety of sources (Table 6.2). The variation in data sources enabled a variety of maps to be produced which was useful in facilitating identification and understanding of the assets and processes within (and external to) the case study basins. Many of the layers used in creating this framework are available from GBRMPA at www.gbrmpa.gov.au

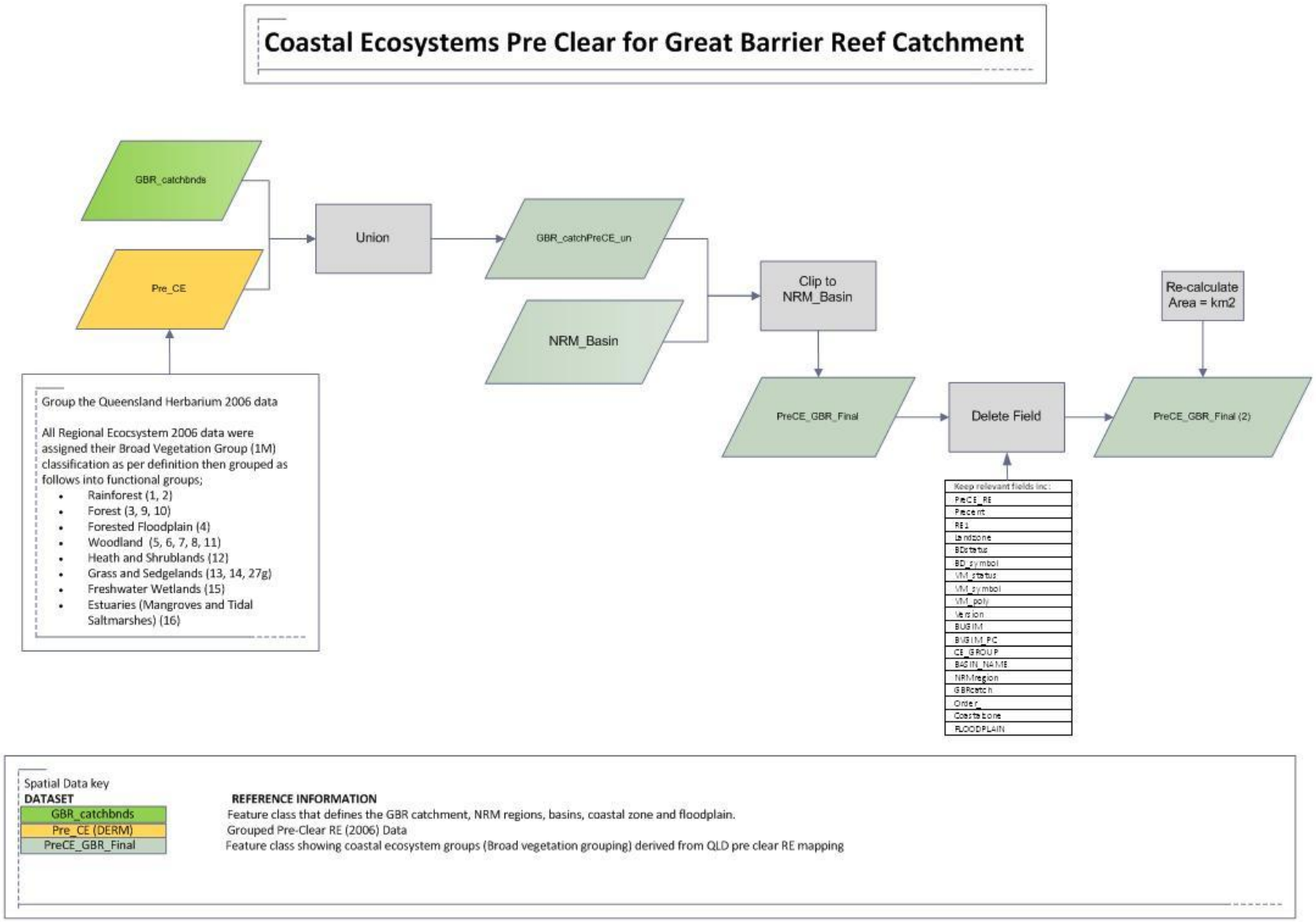
Table 6.2: Data sources used in developing the Basin Assessment Framework

Data provider	Coverage	Data set	Description	Data information
DERM	Mainland and islands	Regional Ecosystem Mapping (pre-clear)	Herbarium maps showing pre-clear vegetation	1940s
DERM	Mainland and Islands	Regional Ecosystem Mapping	Herbarium maps showing remaining and remnant vegetation	2004
DLGP	GBR catchment	QLUMP 1999, 2004, 2009	Land usage data	1999, 2004 (limited coverage), 2009
DERM	Mainland and Islands	Landzone data		
DERM	Mainland	Wetland mapping	Wetland trigger areas	
DERM	Mainland	Queensland Coastal Plan	Sea-level rise, storm surge and areas of High Ecological Value maps	
DERM	Mainland and Islands	Stream Order network	Streams grouped by stream order	
GBRMPA	GBRMP	Zoning plan	GBRMPA zoning	
GBRMPA	GBRMP	Marine Bioregions	Marine bioregions	
DEEDI	GBRMP	Seagrass mapping	Seagrass occurrence and modelled possible occurrence	
Geoscience Australia	Australia wide	Topography	Heights above mean sea level	
Geoscience Australia	Australia wide	Bathymetry	Seafloor topography	
	Mainland, Islands and GBRMP	NRM regions		
GBRMPA	GBRMP	Flood plume exposure areas	Flood plume exposure areas	
		State development areas		
Queensland reconstruction authority	Queensland	Floodplain areas	Floodplain areas of Queensland, flooded areas	2010, 2011 disaster maps
DERM	Queensland (parts)	Groundwater dependent ecosystems	Areas of groundwater activity based upon geology and expert input	2011

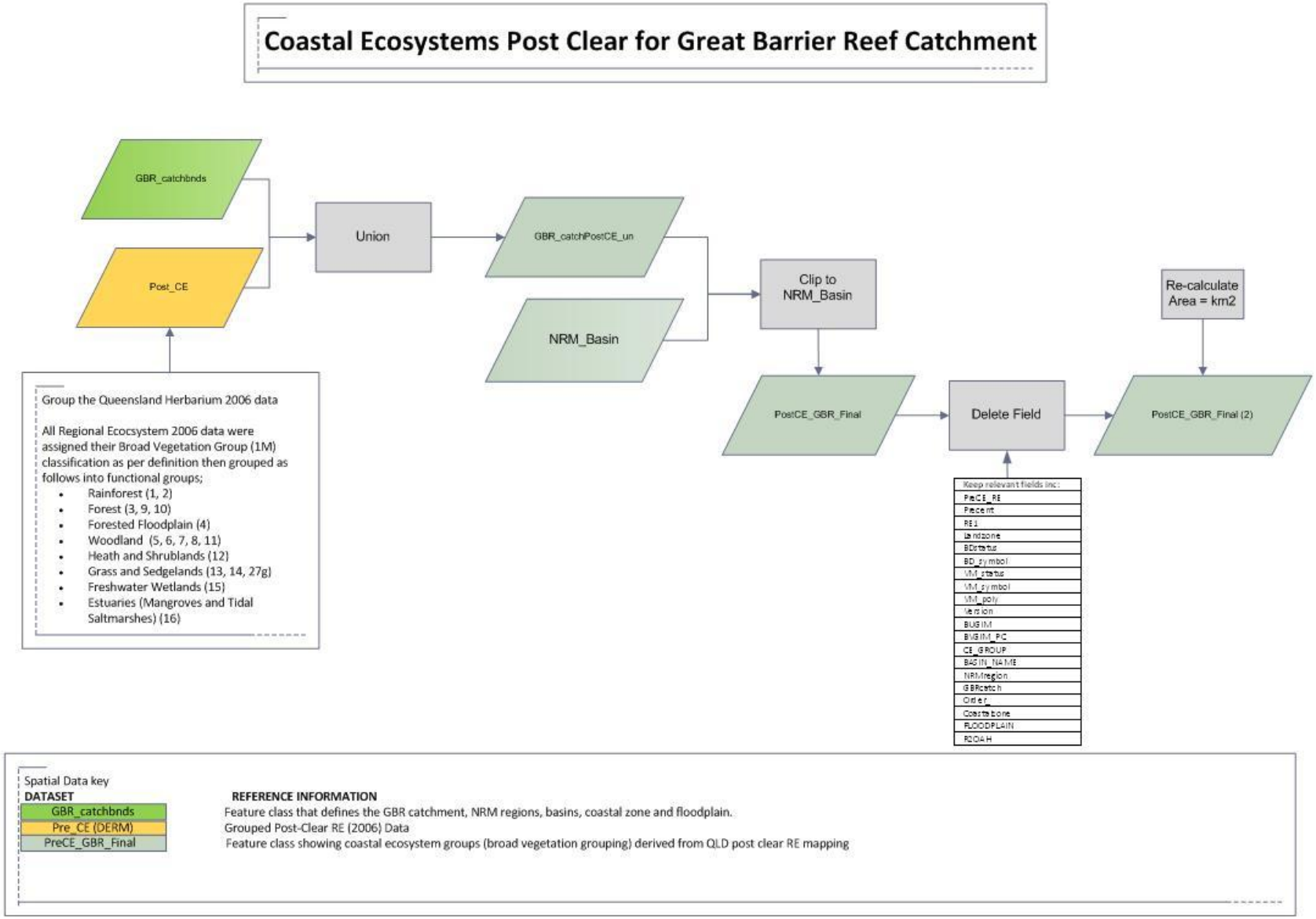
Appendix A – Process diagram for boundary dataset compilation



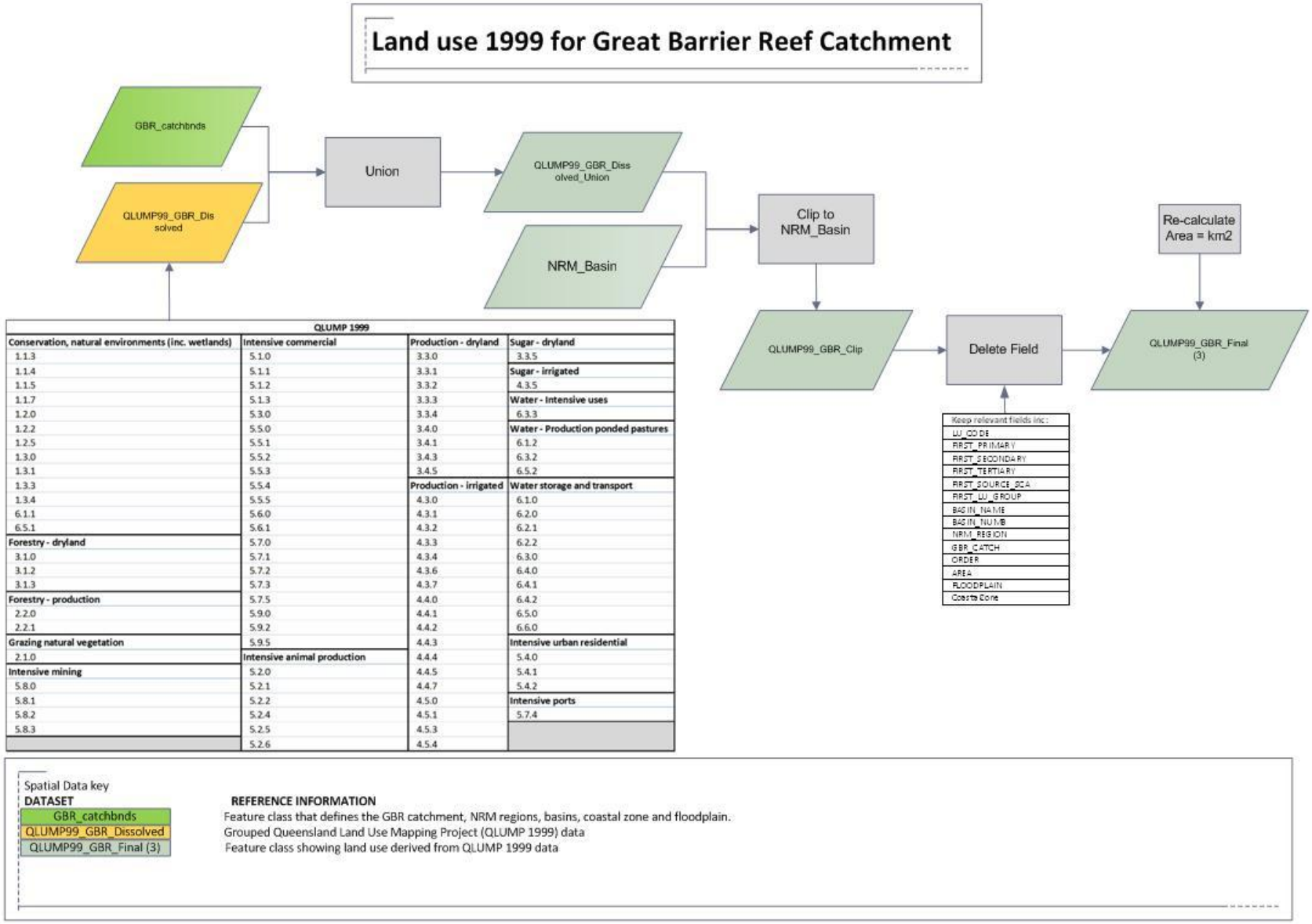
Appendix B – Process diagram for Coastal Ecosystems pre clear dataset compilation



Appendix C – Process diagram for Coastal Ecosystems post clear dataset compilation

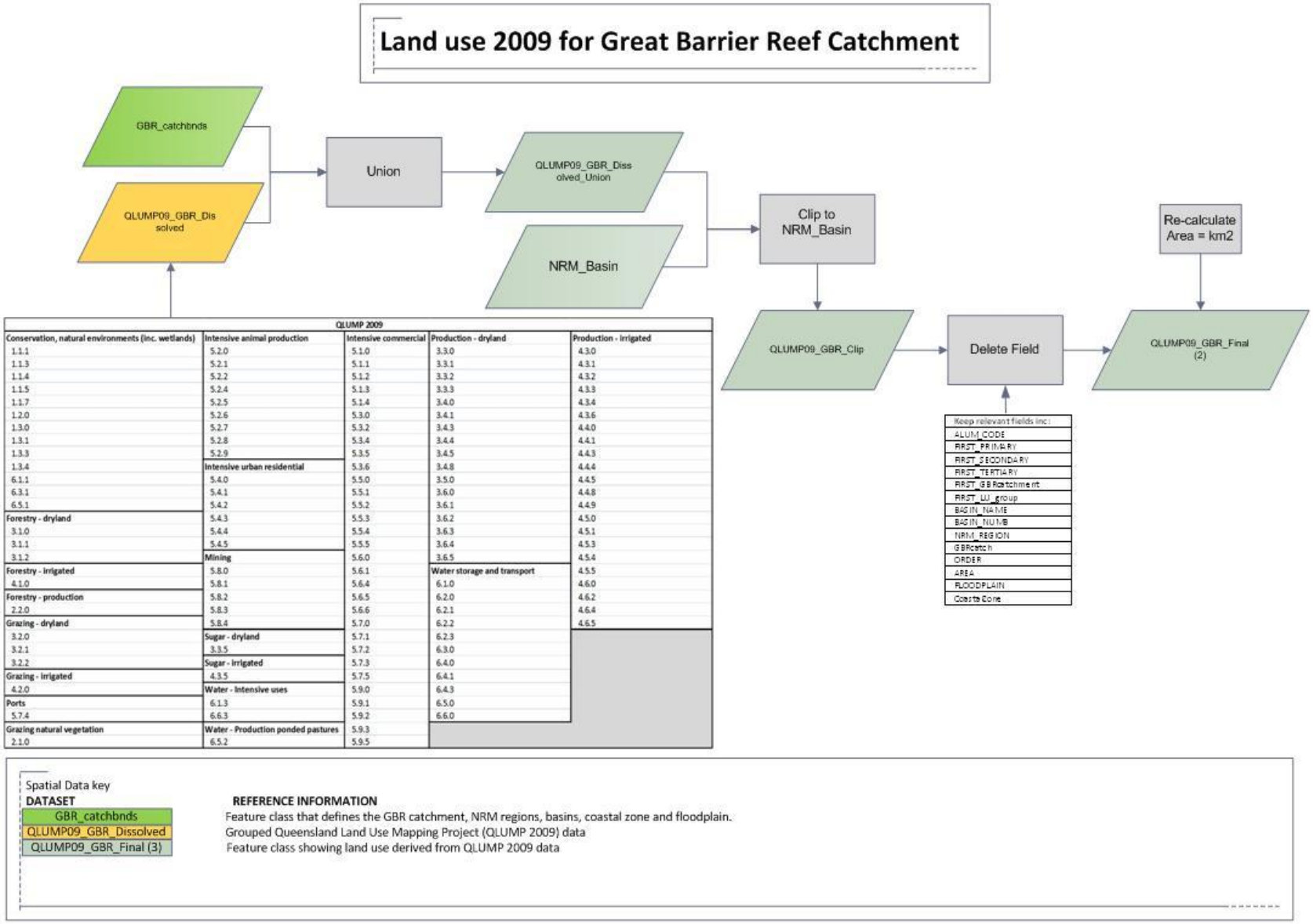


Appendix D – Process diagram for Land use 1999 dataset compilation



QLUMP 1999			
Conservation, natural environments (inc. wetlands)	**Intensive commercial**	**Production - dryland**	**Sugar - dryland**
1.1.3	5.1.0	3.3.0	3.3.5
1.1.4	5.1.1	3.3.1	**Sugar - irrigated**
1.1.5	5.1.2	3.3.2	4.3.5
1.1.7	5.1.3	3.3.3	**Water - Intensive uses**
1.2.0	5.3.0	3.3.4	6.3.3
1.2.2	5.5.0	3.4.0	**Water - Production ponded pastures**
1.2.5	5.5.1	3.4.1	6.1.2
1.3.0	5.5.2	3.4.3	6.3.2
1.3.1	5.5.3	3.4.5	6.5.2
1.3.3	5.5.4	**Production - irrigated**	**Water storage and transport**
1.3.4	5.5.5	4.3.0	6.1.0
6.1.1	5.6.0	4.3.1	6.2.0
6.5.1	5.6.1	4.3.2	6.2.1
Forestry - dryland	5.7.0	4.3.3	6.2.2
3.1.0	5.7.1	4.3.4	6.3.0
3.1.2	5.7.2	4.3.6	6.4.0
3.1.3	5.7.3	4.3.7	6.4.1
Forestry - production	5.7.5	4.4.0	6.4.2
2.2.0	5.9.0	4.4.1	6.5.0
2.2.1	5.9.2	4.4.2	6.6.0
Grazing natural vegetation	5.9.5	4.4.3	**Intensive urban residential**
2.1.0	**Intensive animal production**	4.4.4	5.4.0
Intensive mining	5.2.0	4.4.5	5.4.1
5.8.0	5.2.1	4.4.7	5.4.2
5.8.1	5.2.2	4.5.0	**Intensive ports**
5.8.2	5.2.4	4.5.1	5.7.4
5.8.3	5.2.5	4.5.3	
	5.2.6	4.5.4	

Appendix E – Process diagram for Land use 2009 dataset compilation



Appendix F – Processes for natural and modified ecosystems

Ecological service	Process	Forests & woodlands	Rainforests	Freshwater wetlands	Grassland and Sedgelands	Heath and shrublands	Forest floodplains	Estuaries	Coastline	Seagrass	Reef & Shoals	Lagoon floor	Water column	Groundwater Ecosystems	Irrigated agriculture	Non-irrigated agriculture	Dams & Weirs	Urban	Mining – operational o/cut	Forestry Plantation	Extensive agriculture	Ponded pastures
Physical processes- transport & mobilisation																						
Recharge/Discharge	Detains water			H			✓	MH						✓$_1$	M			L	M		H	
	Flood mitigation			✓	L		H	M						✓	N			L	X		X	
	Connects ecosystems			H			H	✓						H	L			L	N		L	
	Regulates water flow (groundwater, overland flows)	MH	H	H	L		✓	MH	✓	✓	H	L		H	M			L	L		M	
Sedimentation/ erosion	Traps sediment	MH	MH	H	L			H		M	M	MH	ML	N	M$_4$			L	M		H	
	Stabilises sediment from erosion	MH	M	✓	L	✓	✓	✓	H	M		✓		✓	M$_4$			H	N		H	
	Assimilates sediment	MH	H	H				✓	✓						M			L	N		H	
	Is a source of sediment	MH		M											L			L$_{11}$	M		L	
Deposition & mobilisation processes	Particulate deposition & transport (sed/nutr/chem. etc)			H										✓$_2$	L			L	L		H	
	Material deposition & transport (debris, DOM, rock etc)			H											L			L	L		L	
	Transports material for coastal processes			H											N			M	L			
Biogeochemical Processes – energy & nutrient dynamics																						
Production	Primary production	M	H	H				H	✓	H	✓	✓	H	N							M	
	Secondary production			✓				H	✓	H				✓$_3$							H	
Nutrient cycling (N, P)	Detains water, regulates flow of nutrients			H										✓							M$_{13}$	
	Source of (N,P)	M	H					H	L	M				✓							M	
	Cycles and uptakes nutrients			MH	✓	✓		H	L	M	L	H	H	✓							H	
	Regulates nutrient supply to the reef	M	H	M			H	H	L	M				✓							H	
Carbon cycling	Carbon source		H	H				H	L	M				✓							M	

	Sequesters carbon			H			✓	H	L	M	✓	H	L	✓							MH	
	Cycles carbon	H	H					H	L	M	L	H	H	✓							H	
Decomposition	Source of Dissolved Organic Matter		H	H				H						✓							L_{14}	
Oxidation-reduction	Biochar source	H																			X	
	Oxygenates water							✓	L			H	H	N							L	
	Oxygenates sediments							✓	L	M		✓		N							$✓_{15}$	
Regulation processes	pH regulation			H						M				✓							$✓_{15}$	
	PASS management			H				H													L	
	Salinity regulation																				$✓_{15}$	
	Hardness regulation			H																	$✓_{15}$	
	Regulates temperature		ML	✓			✓	✓	✓												L_{16}	
Chemicals/heavy metal modification	Biogeochemically modifies chemicals/heavy metals			H				✓		M	L			✓							X_{17}	
	Flocculates heavy metals			H				✓						✓							L	
Biological processes (processes that maintain animal/plant populations)																						
Survival/reproduction	Habitat/refugia for aquatic species with reef connections			H			✓	H	H	✓	H	M	L	N	L_5	L_5	L_8	L_{12}	N	N	L	M_{18}
	Habitat for terrestrial spp with connections to the reef			H							H			N	L	L	H_9	L	N	N	L	L_{19}
	Food source			✓			H	✓	✓	H		✓		N	N	N	M	L	N	L	M	L
	Habitat for ecologically important animals				✓		✓	H	L	H	H	✓			N	N	L_{10}	N	N	N	M	L_{19}
Dispersal/ migration/ regeneration	Replenishment of ecosystems – colonisation (source/sink)			H				H	M	H	H			N	N	N	L	N	N	N	M	L_{20}
	Pathway for migratory fish			H										N	N_6	N_6	L_8	N	N	N	$✓_{15}$	L_{21}
Pollination														N	L_7	L_7	N		N			
Recruitment	Habitat contributes significantly to recruitment			H			H	H	H	H	H				N	N	L	N	N	N	M	N

Capacity of natural and modified coastal ecosystems to provide ecological services for the Great Barrier Reef.

H – High capacity for this system to provide this service, M – medium capacity for this system to provide this service, L- low capacity for this system to provide this service, N – No capacity for this system to provide this service, X- Not applicable, ✓– service is provided but capacity unknown. Boxes with no data indicate a lack of information available. Note that the capacity shown for modified systems assumes periods of low hydrological flow. End-notes 1 – Capacity depends on hydraulic characteristics of the aquifer (porosity, permeability, storativity); 2- particulate transport occurs sometimes in subterranean systems; 3- secondary production is variable; 4- dependent upon crop cycle; 5- Habitat for crocodiles and turtles; 6- especially in channels, but is dependent on water quality; 7- depends upon crop; 8- only where fish passage mechanisms exist; 9- especially water & shorebirds; 10- particularly aquatic species (though may lack connectivity); 11- refers to new developments; 12- impoundments, ornamental lakes and stormwater channels; 13- hoof compaction of soil increases runoff; 14- particulate Organic Carbon is high, Dissolved is Low; 15- unchanged from natural ecosystem capacity; 16- relates more to extent of vegetation clearance of riparian zone; 17- contaminant; 18 – in the dry season amongst Hymenachne; 19- particularly for birds; 20- sink biologically as species move into areas but reduced water quality can affect badly; 21- subject to water quality and grazing regime