Photo: Jim Tait

Australian Government

Great Barrier Reef
Marine Park Authority

Don Basin Assessment

Burdekin Dry Tropics NRM Region

Assessment of ecological functions within the Don basin focusing on understanding and improving the health and resilience of the Great Barrier Reef

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EXECUTIVE SUMMARY

Context

A healthy and resilient Great Barrier Reef World Heritage Area (the World Heritage Area) is reliant upon the ecological integrity of the adjacent Great Barrier Reef catchment and its coastal ecosystems.

The Don basin provides habitat for many important marine, estuarine, freshwater and terrestrial species with lifecycles that have connections to the World Heritage Area. The coastal ecosystems in the basin also provide a range of ecological functions that support the health and resilience of the marine environment.

Within the marine environment, coastal waters provide high value marine areas including around islands and inshore coral reefs. To protect representations of these areas, there are many coastal and inshore Marine National Park Zones adjacent to this basin.

This Report is part of a series of similar reports investigating the nature, condition, connectivity and management of coastal ecosystems within basins that form the catchment of the World Heritage Area. The purpose of this Report on the Don basin is to:

- Review coastal ecosystems in the basin, assess their state and consider the pressures that they are facing now, and into the future.
- Understand the connections between coastal ecosystems and the World Heritage Area, and how changes to these connections are impacting on the ecological functions they provide to the Marine Park.
- Empower communities and stakeholders by providing information that can support on-ground actions.

Maps shown in this basin assessment were derived from a range of data sources, and should only be used as a guide.

The Don basin

The Don basin is located south of Ayr and to the north east of Airlie Beach and is bounded by the Clarke Range to the south east. It covers some 373,412 hectares. When compared to other basins in the catchment, the Don basin is one of the lesser impacted basins. Approximately 10 per cent of the Don basin is afforded protection through National Parks, Conservation Parks and Protected Areas with around 25 per cent of the coastal zone protected. As a result some inshore marine ecosystems such as seagrass, are in a relatively good state (refer section 2.3).

Key issues

The Don basin has significant natural assets and is home to (and used by) many important marine, estuarine, freshwater and terrestrial species with connections to the Great Barrier Reef World Heritage Area (World Heritage Area). There are many coastal and inshore Marine National Park Zones adjacent to this basin. The high levels of productivity generated from extensive wetland systems in this region support highly valuable commercial fisheries (trawl, line and inshore fin fish) and high value recreational fisheries. This basin also represents one of the few examples of a relatively healthy basin. The basin estuaries make up four and a half per cent of the extent of estuaries in the Great Barrier Reef catchment (the catchment). This amounts to an estimated $4 million worth of annual recreational and commercial fisheries catch*.

Although limited, water quality monitoring of the inshore marine environment reveals no significant detrimental impacts from this basin on the World Heritage Area. Adjacent to Bowen however, Stone Island (Figure 1) shows signs of a decline in health which reportedly occurred over the last 20-30 years.

Figure 1: Stone Island's fringing coral reef was described by Saville-Kent in 1893 as an outstanding example of a fringing coral reef[1]

Around 32 per cent of the Don basin vegetation is non-remnant (cleared) and a further 48 per cent of the remaining natural areas are currently used for grazing. Most of this clearing occurred on leasehold land under government policies aimed at promoting economic development in the 1950s and continued until the early 1990s.[2] Only 10 per cent is currently protected (for example in National Parks) from development (however weeds and feral pigs are still having an impact in these areas). Most protection is afforded to Cape Upstart with 72 per cent of the coastal zone and 43 per cent of the floodplain currently protected.

Proposals to supply water from the Burdekin Dam to allow the expansion of irrigated cropping to the Don basin are proposed. If this occurs, it is likely that this basin will experience the same degree of impacts with groundwater, nutrients and pesticides as currently experienced in the lower Burdekin floodplain. This will have a significant and widespread impact on the World Heritage Area and Matters of National Environmental Significance defined under the *EPBC Act 1999*.

Expansion of the Port of Abbot Point into a multi-purpose port facility to support Queensland North's heavy industry sectors (which include an alumina refinery, aluminium smelter, iron and steel making, nickel refinery, shale oil exports, liquefied natural gas exports, coke, chloralkali plant and power station) has been identified by the Queensland Government as critical to economic growth in north and central Queensland. The construction period for the Multi-Cargo Facility is expected to span 3-4 years with an approximate cost of $6.2 billion. Conceptual development options for a suitable wharf/berthing facility have been developed (Figure 2).[3,4] This expansion will require a major capital dredging campaign involving the relocation of approximately 3,000,000 m^3 of sediment[5], which could have detrimental impacts on surrounding seagrass and coral reef ecosystems.

Figure 2: Image (left) depicts the current Abbot Point Coal terminal, while image (right) depicts the proposed expansion of terminals

*This figure was derived from the annual catch in the Great Barrier Reef of fish and invertebrate species that use estuaries for part or all of their life histories. This amounted to approximately $20,000 per square kilometre of estuary (assuming all estuaries are equally productive and using Gross Value of Production figures from the east coast inshore finfish fishery, mud crab fishery and other trawl fishery).[6,7,8]

Potential management actions

This report has been developed as a baseline for the Don basin. In order to ensure that the basin is best represented, consideration of additional finer scale data, local knowledge and information will further enhance this assessment.

Ensuring the long-term health of the Reef requires greater protection of, and restoration of important ecological processes and functions provided by Fitzroy basin coastal ecosystems. Actions that would increase protection and restore processes and function include:

1. Greater protection, restoration and management of remnant and riparian vegetation in the floodplain.
2. Greater protection, restoration and management of freshwater wetlands which have been reduced from 5307 hectares to 2965 hectares.
3. Restore connectivity of streams, rivers and waterways to improve fish passage.
4. Improve connectivity between remnant coastal ecosystems, with preference to the freshwater wetlands and associated floodplain ecosystems.
5. Manage modified coastal ecosystems to provide ecological functions and values that support the health of the World Heritage Area through the continued improvement in land management practices such as Reef Plan best practice initiatives for agriculture.
6. Limit the development of irrigated cropping in the basin to prevent the problems that are occurring in other basins (refer to the Haughton basin assessment) from impacting this area.

INTRODUCTION

Background

The Great Barrier Reef Marine Park (Marine Park) covers an area of approximately 348,000 km^2 and extends from Cape York in the north to Bundaberg in the south. The Great Barrier Reef World Heritage Area was accepted in 1981 for inclusion in the World Heritage List, meeting all four of the natural heritage criteria (aesthetics and natural phenomena; geological processes and significant geomorphic features representing major stages of earth's history; ecological and biological processes; and habitats for the conservation of biological diversity, including threatened species). The World Heritage Area includes additional areas outside of the Marine Park. The World Heritage Area extends from the low water mark on the Queensland coast to up to 250 km offshore past the edge of the continental shelf and includes coastal and island ecosystems, as well as some port and tidal areas, outside of the Marine Park.

The adjacent Great Barrier Reef catchment encompasses an area of 424,000 km^2 with all water flowing from the catchment into the World Heritage Area. The catchment contains a diverse range of terrestrial, freshwater and estuarine ecosystems. These coastal ecosystems include rainforests, forests, woodlands, forested floodplains, freshwater wetlands, heath and shrublands, grass and sedgelands, and estuaries.

Coastal ecosystems support the health and resilience of the World Heritage Area. The ecological functions provided by coastal ecosystems 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).

This report assesses the Don basin's current land use, remaining extent and pressures on coastal ecosystems, and how this basin supports and maintains the health and resilience of the World Heritage Area.

Purpose

The purpose of a basin assessment is to assess at the landscape scale the ecological functions, the risks to these functions and the cumulative impacts that are affecting the long-term health of the World Heritage Area. The focus area for this report is the Don basin, which includes ecosystems extending from the inshore areas of the Marine Park to the upper extent of the Don basin. The information collected, collated and analysed provides a rapid summary of the state of the basin's ecological assets and highlights pressures and threats, ecological condition, and the social response to threats and pressures that are influencing the health of the World Heritage Area. More influencing factors – and consequently more pressures – are at work at finer scales of analysis and should be considered when planning or managing these areas.

The Great Barrier Reef catchment is made up of thirty-five basins draining directly into the World Heritage Area, as shown in Table 1.

Table 1: Basins in the Great Barrier Reef catchment

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)	Jacky Jacky	
		Olive-Pascoe	
		Lockhart	
		Stewart	
		Normanby	
		Jeanie	
		Endeavour	
	Wet Tropics NRM region (managed by Terrain)	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)	Proserpine	
		O'Connell	
		Pioneer	
		Plane	
	Fitzroy NRM region (managed by Fitzroy Basin Association)	Styx	
		Shoalwater	
		Waterpark	
		Fitzroy	
		Calliope	
		Boyne	
	Burnett-Mary NRM region (managed by Burnett Mary Regional Group)	Baffle	
		Kolan	
		Burnett	
		Burrum	
		Mary	

Methodology

The methods underpinning this basin assessment are detailed in the Coastal Ecosystems Assessment Framework[9], a tool developed in partnership with the Queensland Government (available at www.gbrmpa.gov.au). The Coastal Ecosystems Assessment Framework was developed and used as the basis of the *Informing the Outlook for Great Barrier Reef coastal ecosystems*[10] report, and provides a holistic approach to assessing and understanding ecological functions provided by coastal ecosystems and the pressures affecting them.

The catchment in its current state is a mosaic of natural and modified ecosystems with a suite of values and services of importance to the World Heritage Area. The methodology used to understand the values and services provided by natural and modified coastal ecosystems are outlined in the Coastal Ecosystem Assessment Framework[9] and have been used as a basis to assess the Don basin assessment. Figure 3 below describes the methodology used to rapidly assess the ecological functions and values to conduct the Don basin assessment.

Figure 3: Summary of the methodology for conducting a rapid basin scale assessment

Stakeholder engagement and verification of assessment information has been crucial to the development of this basin assessment. Building on the information collected and collated for the *Informing the Outlook for coastal ecosystems*[11] report, the methodology for preparing this Report incorporated the following steps:

1. Local experts were consulted to identify areas of interest to visit in the field as part of a ‘rapid assessment’.
2. Research was conducted on the basin using available information.
3. Sites of interest were identified using coastal ecosystem maps and Google earth (GPS identification for sites to be visited for field work).
4. Collaboration with local stakeholders (i.e. consultants, natural resource management bodies, local land owners) helped to verify the issues affecting the basin, as well as additional field sites.
5. Field investigations were conducted, using the field site assessment template forms (Appendix B) to capture site locations and reference photos at basin sites (Figure 4).
6. GPS coordinates from field assessments were imported into Google earth to assist with report preparation.
7. Preliminary basin assessments were compiled to facilitate stakeholder input.
8. Workshops were conducted to bring stakeholders together to present information and incorporate feedback into the basin assessment.
9. Draft basin assessments were prepared as a basis to further stakeholder input.
10. Basin assessment finalised and published.

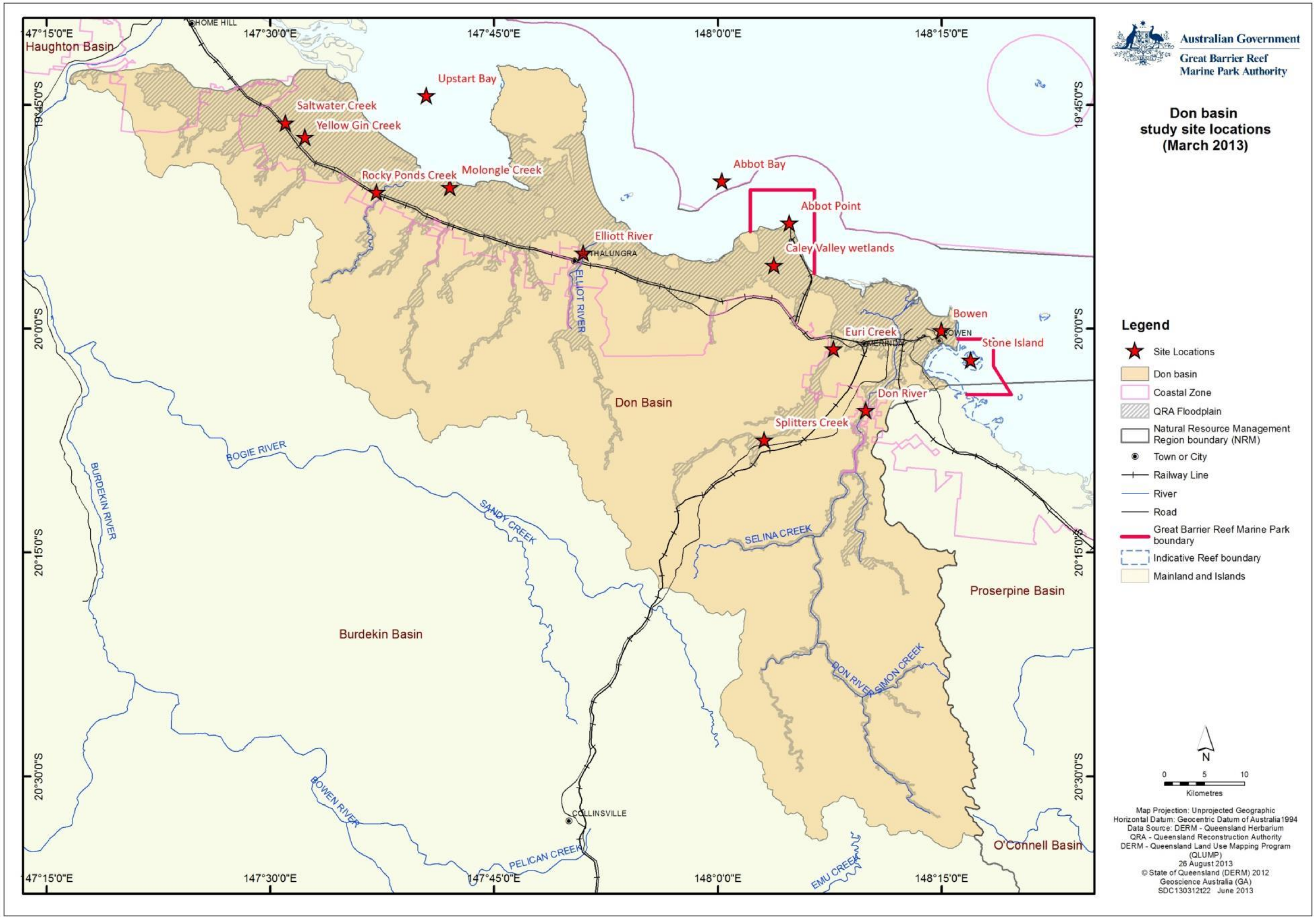


Figure 4: Key study sites for the Don basin assessment

PART A: VALUES OF THE GREAT BARRIER REEF REGION – DON BASIN

Chapter 1: Don basin – background to changes affecting matters of national environmental significance

1.1 Background and history of the Don basin

The Don basin is located south of Ayr and to the north east of Airlie beach (between latitude 19º 30" S and 20º 30" S) and bounded by the Clarke Range to the south east (Figure 1.1.1). It is the southernmost basin within the Burdekin Natural Resource Management (NRM) Region and is managed by the NQ Dry Tropics NRM body. Mean annual rainfall ranges from 1000 mm to 1600 mm across the basin with an average of 482,000 ML/year of run-off.[12] The major streams in the basin are the Don River, Elliott River, Rocky Ponds Creek, Yellow Jin Creek, Saltwater Creek and Euri Creek.

Figure 1.1.1: Location map of the Don basin within the Great Barrier Reef catchment

Bowen sits at the mouth of the Don River and is the largest population centre in the basin. The local economy is based principally on mining and agriculture.

The Don basin has a long history of agriculture and port development (Table 1.1.1) The Don River's alluvial plain provides fertile soil that supports a prosperous farming industry. Horticulture and beef cattle grazing are the main activities. The area sown for vegetables (4800 hectares) is the largest area of all survey basins. Much of the lower catchment has been cleared and used for irrigated crops such as tomatoes, capsicums, melons and beans.[13]

Just north of Bowen is the Abbot Point coal loading port. Coal mined inland of Bowen in Collinsville and other towns in the Bowen basin is brought by rail to a deepwater pier to be loaded on bulk carriers. Coal is exported mainly to China and India.

Stone Island, within the Bowen (Dungeness) port waters was described by William Saville Kent in1890 as a beautiful fringing reef. Recent photographic comparisons show that this reef has changed markedly over time.[1,14,15] Figure 1.1.2 shows the difference in coral cover and assemblage structure at Stone Island over 100 years.

Figure 1.1.2: Comparison photographs of the fringing reef surrounding Stone Island off Bowen a) fringing reef in 1893 and b) fringing reef in 1994

The coral reefs around Bowen have several shipwrecks, including the SS Gothenburg which sank in 1875 with a loss of more than 100 lives. Numerous relics of Bowen's history, from the Aboriginal past onwards, are on display at the Bowen Historical Society's museum.

Point and non-point sources of pollution within the catchment area include the commercial shipment port at Abbot Point, commercial fishery port facilities, recreational marine use and its associated marinas and harbours, sewage release from the town of Bowen, 4 large scale marine prawn farming sites, and coke and salt works. The Port of Abbot Point is located 25 km north-west of Bowen. The port consists of coal stockpiling facilities, loading facilities for the export of coal and a jetty with a conveyor connecting to two offshore berths and two ship loaders 2.8 km offshore. Coal is the only commodity exported from this port facility. A summary of historical events in the Don basin is shown in Table 1.1.1.[10]

Table 1.1.1: Historical timeline for the Don basin

Year	Event
1770	Captain James Cook named Cape Gloucester on his voyage of exploration up the Australian coast. The 'cape' turned out to be Gloucester Island which dominates the view from Bowen's eastern beaches.
1860	The Queensland Government commissioned a coastal exploratory party to investigate possible harbours beyond Rockhampton. The town of Bowen was established on the Port Denison Harbour and was proclaimed in April 1861, becoming the first township north of Rockhampton.
1865	Bowen's European population exceeded 1000 people as the port allowed supplies to be transported to new outback stations. Its merchants established a trading depot at the village of Dalrymple on the upper Burdekin, to alleviate the effect of seasonal isolation of Bowen from its hinterland during floods.
1865/66	A jetty with a tramway was built at Port Denison.
1869	Bowen was connected by telegraph to Townsville (founded as a potential new port in 1864). By the end of the 1860s Bowen had the Bowen Sugar Company and small cotton-growing industry. The sugar company failed due to insufficient rainfall and the end of the American civil war ended Australia's market for cotton.
1880s	A meatworks was opened on Poole Island, but failed within a few years.
	A second attempt at a meatworks succeeded at Merinda, 8 km west of Bowen.
1902	Bowen and the Wangaratta divisional board formed a joint venture for a tramway, hoping to capture sugar trade from Proserpine. The Bowen-Proserpine tramway, with government assistance, was opened in 1910 and incorporated into the North Coast line in 1918. Bowen's population in the early 1900s was around 1000 - close to the number in 1865. The harbour was rated as one of the best on the east coast, secure in all weathers. Dredging was needed to maintain depth around the pier.
1913	The North Coast railway and Burdekin River Bridge between Bowen and Townsville was completed. Better access allowed Merinda meatworks a larger share of the cattle industry.
1915	Exploratory boreholes at Pelican Creek were revisited. Private explorations indicated a complex web of coal deposits. The coal deposits were the foundation of Collinsville, 90 km to the south-west, which was linked to Bowen by rail in 1922.
	Bowen's climate proved ideal for growing mangoes and vegetables, particularly tomatoes for a lucrative southern market. Commercial fisheries harvested prawns, mud crabs and reef fish.
1925	An evaporative saltworks comprising 1700 hectares of solar ponds, west of the town, was established.
1970s	Cattle numbers exceed 250,000. Horticulture absorbed more of the rural work force and tomato cropping doubled. Melons, cucumber and capsicum were grown in increasing quantities.
mid-1980s	The Port Dennison pier was the hub of the coal trade until a purpose-built port was opened at Abbot Point, north of Bowen. The original port now caters for fishing boats, while the cruising yacht club occupies the harbour between the pier and the Flagstaff Hill Lookout on Point Dalrymple.
1993	In 1993 Bowen shire had 230,000 beef cattle, nearly 3000 pigs and grew 55,500 tonnes of tomatoes.
1995	The fruit and vegetable industry expanded around Queens Beach and is Bowen's agricultural centre. The main crops of tomatoes, capsicum, beans, sweet corn, rockmelons and cucumber, numbering over 7.75 million cartons.
1997	The Borthwicks meatworks at Merinda, 8 km west of Bowen, were closed in 1997.
2002	Total production of all vegetables was over 155,000 tonnes, grown on 6800ha, primarily around the township and Gumlu. Mango plantations produced 5250 tonnes.

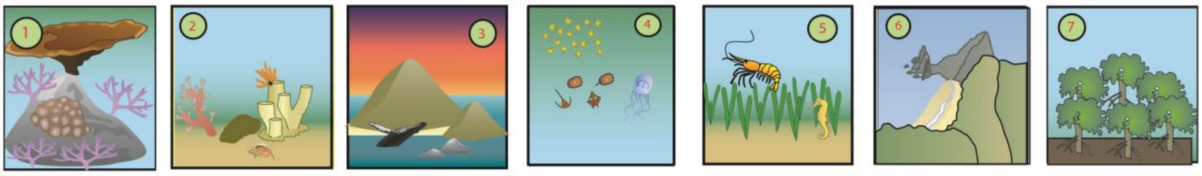
The Great Barrier Reef is used by both recreational and commercial operators. There is a significant number of commercial tourism operators operating in this region, predominantly servicing the many islands in the Whitsundays region and operating tours based from Airlie Beach.

Chapter 2: Values and their current condition and trend

The values that are considered in this report include:

- Inshore marine ecosystems that underpin the outstanding universal value of the World Heritage Area (such as coral reefs, seagrasses and associated species).
- Terrestrial, freshwater and estuarine coastal ecosystems that provide ecological functions to the World Heritage Area and other matters of national environmental significance.

A conceptual model of these ecosystems and the services they provide is shown in Figure 2.1. The ecosystems examined in this report also provide habitat for a range of other matters of national environmental significance. The matters of national environmental significance in the Don basin are outlined in Section 2.1 below and the values and their elements that underpin matters of national environmental significance for the Don basin and adjacent waters are shown in Appendix C.



CORAL REEFS

Coral reefs provide hard substrates (habitat) and food for some 411 species of hard corals, at least 150 species of soft corals, 1625 species of bony fishes and a multitude of other organisms from microscopic algae to large mammals. Coral reefs provide a complex structure which provides a diverse mix of habitats for many species. Coral reefs are of high value to the tourism and fishing industries.

LAGOON FLOOR

The lagoon floor environment is the area in between reefs and supports approximately 5300 species. The substrate in this area ranges from fine silts to hard rocky areas such as shoals. These interreefal areas are home to crucial meiofauna (animals that live between sand grains) such as nematodes. Nematodes trap and accumulate small particles and stimulate important bacterial production within the sediment. This is critical to the food web and ecosystem functions.

ISLANDS

There are 1050 islands consisting of 300 coral cays, 600 continental islands and 105 mangrove islands in the Great Barrier Reef. They are important refuges for terrestrial and marine species such as turtles and seabirds which use islands for nesting. They provide critical feeding, breeding and nursery habitat for fish and other marine animals. Islands are also highly valued for recreation and the tourism industry.

OPEN WATER

The water column, as a habitat, is home to a range of organisms ranging in size from small bacteria to whales. This is an area of high primary productivity. Nutrients exported by floodplumes are taken up by pelagic microbial communities, leading to high levels of organic production that passes up the food chain. Viruses in the open water directly and indirectly influence biogeochemical cycles and the carbon sequestration capacity of the oceans through gas exchange between the ocean surface and the atmosphere.

SEAGRASSES

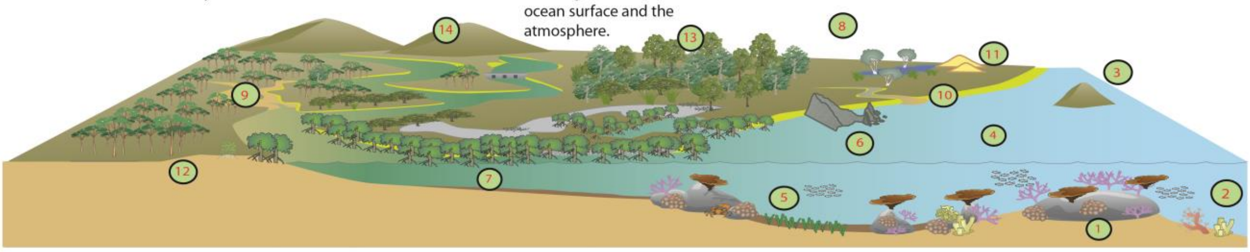
14 species of seagrass (marine flowering plants that grow underwater on soft sediments) are found in the Great Barrier Reef. Seagrass is an important food source for animals ranging from prawns to dugong and turtle. They are also used as a habitat by many animals. Seagrasses provide habitat structure for a broad range of species. They are used by comercially important species such as tiger prawns.

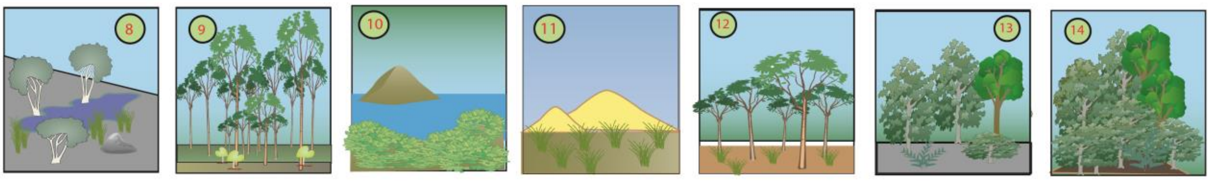
COASTLINE

The Great Barrier Reef coast comprises 42% sandy, 39% muddy and 19% rocky coastline. The coastline provides a diverse range of habitats for a wide range of organisms. For example sandy beaches are used by turtles for nesting and seabirds for foraging. Muddy shores are used by migratory shore birds as feeding areas. Rocky shores provide hard surfaces for shellfish. Coastlines function as filters and recycle nutrients and trace elements.

ESTUARIES

Estuaries encompass mangroves, mudflats, unconsolidated soft bottoms and salt marshes. These areas are important for cycling nutrients and are some of the highest natural carbon sinks. Estuaries are also an important habitat for both marine and terrestrial animals , including the freshwater sawfish and speartooth shark.





FRESHWATER WETLANDS

Freshwater wetlands are usually associated with coastal areas subject to periodic flooding where standing freshwater persists for at least part of the year, in most years. These areas slow the overland flows of water and cycle nutrients and sediments. Wetlands are important dry season refugia for many species and are used by some marine species for parts of their life history.

FOREST FLOODPLAIN

Forest floodplains experience periods of inundation during the monsoon season and are a pathway for overland flows helping to slow, capture and recycle nutrients and sediments while protecting the soil surface from the erosive forces of rainfall. These areas are important areas for groundwater recharge and discharge, which can prevent groundwater salinity. These areas are important nursery areas for many species with connections to the Great Barrier Reef.

HEATH & SHRUBLANDS

Heath and shrublands are dominated by small shrubs with small hard leaves that occur on infertile or waterlogged sites in coastal areas, helping to slow water flows, preventing erosion, and recycling nutrients and sediments. Coastal heath and shrublands are important as buffers on steep coastal hillslopes.

GRASS & SEDGELANDS

Grass and sedgelands include tussock grasslands, forblands, hummock grasslands, bluegrass, Brigalow belt grasslands, herblands, sedgelands and rushlands. Some grasslands are asssociated with permanent freshwater wetlands and slow overland flows. Grass and sedgelands are used for feeding and roosting migratory bird species with connections to the Great Barrier Reef. Vegetation in these areas is dense, slowing flows thereby capturing and recycling nutrients and sediments.

WOODLANDS

Woodlands are areas of mature, single stemmed trees that have between 20% and 50% canopy cover. Woodlands and the woodland understorey reduce flood risk by slowing overland water velocity, thereby regulating sediment and nutrient supply to the Great Barrier Reef. Woodlands are often found in drier regions with understories of grasses and sedges.

FORESTS

Forests are areas of mature trees with single stems that have greater than 50% canopy cover. Forests contribute to the hydrological cycle through evapotranspiration, cloud formation and rainfall generation, which asists with reef salinity regulation and temperature control.

RAINFORESTS

Rainforests are areas of mature trees that have close to 100% canopy cover and are typically moist ecosystems. This high canopy cover reduces the velocity of raindrops, thus minimising soil loss through erosion. Rainforest growth on steep slopes and in gullys etc bind and stabilise soils in these areas.

Figure 2.1: Conceptual model for categorizing the Great Barrier Reef coastal, catchment and inshore ecosystems and assessing the ecological functions and services of those ecosystems to the cumulative impacts of development

2.1 Matters of National Environmental Significance in the basin

Under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), actions that have, or are likely to have, a significant impact on a matter of national environmental significance require referral to the Australian Government Environment Minister. The Minister will decide whether assessment and approval may be required under the EPBC Act. There are eight matters of national environmental significance protected under the EPBC Act. These are:

- World heritage properties
- National heritage places
- Wetlands of international importance (listed under the Ramsar Convention)
- Listed threatened species and ecological communities
- Migratory species protected under international agreements
- Commonwealth marine areas
- The Marine Park
- Nuclear actions (including uranium mines).

There are also a number of species that are not listed under the EPBC Act, including the snubfin dolphin which is of concern because of its limited home range.

World heritage properties

The Great Barrier Reef was inscribed in the World Heritage List in 1981 and meets all four natural criteria. Parts of the Don basin and all of the adjacent marine areas fall within the World Heritage Area.

National heritage properties

The EPBC Act provides for the listing of natural, historic or Indigenous places that are of outstanding national heritage value. Within the Don basin only the Great Barrier Reef is listed as a National Heritage Property (for its natural values).

Wetlands of international importance (declared Ramsar wetlands)

There are no listed wetlands of international importance within the Don basin.

Listed threatened species and ecological communities

Six species of birds, one species of frog, six species of mammal, nine species of plant, seven species of reptiles and one species of cycad have been identified as listed threatened species within the Don basin and adjacent waters (Appendix D)

Ecological communities

There are three critically endangered ecological communities that occur within the Don basin. These are the:

- Brigalow (*Acacia harpophylla* dominant and codominant)
- Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions

- Broad leaf tea-tree (*Melaleuca viridiflora*) woodlands in high rainfall coastal north Queensland.

Listed migratory species

The EPBC Act lists migratory species which includes those species listed in the:

- Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention)
- China-Australia Migratory Bird Agreement (CAMBA)
- Japan-Australia Migratory Bird Agreement (JAMBA).

The wetlands in this region represent important habitat for migratory bird species with the adjacent marine waters providing important habitat and transport corridors for many migratory marine species. There are 37 migratory species listed in the Don basin consisting of: 28 species of bird, two species of marine mammals and seven species of reptiles. These are listed in Appendix E.

The Great Barrier Reef Marine Park

The Marine Park is recognised as a matter of national environmental significance under the EPBC Act to enhance the management and protection of the ecosystems in the Great Barrier Reef Region. The *Great Barrier Reef Marine Park Zoning Plan 2003* (the Zoning Plan) is the overarching plan that provides for a range of ecologically sustainable recreational, commercial and research opportunities, and for the continuation of traditional activities. Each zone has different rules for the activities that are allowed, prohibited, and those that require permission. Zones may also place restrictions on how some activities are conducted.

Other protected areas and values in the basin

Although not matters of national environmental significance, there are other areas within the Don basin that have intrinsic values and may also have significance for the long-term health and resilience of the World Heritage Area. These include Dugong Protection Areas, Nationally Important Wetlands, National Parks, Conservation Parks, Fish Habitat Areas and Nature Refuges.

Dugong Protection Areas

Dugong Protection Areas A and B occur in the coastal waters of the Don basin. Zone 'A' Dugong Protection Areas include significant dugong habitats in the southern Great Barrier Reef. These are mapped, along with Nationally Important Wetlands, Conservation Parks, National Parks, Forest Reserves, Nature Reserves and Fish Habitat Protection areas in Figure 2.2.1.

In these areas, the use of offshore set, foreshore set and drift nets are prohibited. The use of river set nets is allowed with modifications in Zone 'A' Dugong Protection Areas. Other netting practices such as ring, seine, tunnel and set pocket netting, which are not considered to pose a serious threat to dugong, are unaffected.

In Zone 'B' Dugong Protection Areas mesh netting practices are allowed to continue, but with more rigorous safeguards and restrictions than before. Zone 'B' Dugong Protection Areas have been shown to contain about 22 per cent of dugongs in the southern Great Barrier Reef. These measures are being kept under review to ensure protection of dugongs in these areas.

Nationally Important Wetlands (Directory of Important Wetlands in Australia)

The Directory of Important Wetlands in Australia identifies nationally important wetlands and provides information on their values providing a valuable tool for management and conservation. Nationally important wetlands in the Don basin include:

- Abbot Point - Caley Valley
- Burdekin Delta
- Great Barrier Reef Marine Park
- Southern Upstart Bay.

These are mapped, along with Conservation Parks, National Parks, Forest Reserves, Nature Reserves and Fish Habitat Protection areas in Figure 2.2.1.

Conservation Parks, National Parks and Forest Reserves

There are five protected areas consisting of National Parks, Conservation Parks, state forests and forest reserves under Queensland state legislation in the area (Figure 2.2.1). These cover approximately ten per cent of the basin and include:

- Abbot Bay Resources Reserve
- Cape Upstart National Park
- Mount Abbot National Park (Scientific)
- Mount Aberdeen National Park
- Don State Forest.

Fish Habitat Areas

Declared fish habitat areas (FHA) are areas protected under the *Fisheries Act 1994* (Qld) against physical disturbance associated with coastal development and are selected on the basis of their respective values. The Burdekin FHA is the only FHA adjacent to the Don basin (Table 2.2.1, Figure 2.2.1).

Table 2.2.1: Fish Habitat Area (FHA) in the Don basin

FHA	Location	Habitat Values	Fisheries Values
Burdekin FHA	Cape Bowling Green to Cape Upstart, Upstart Bay and the Burdekin delta, 10 km East of Ayr and Home Hill and is approximately 91,985 ha in size.	Extensive mangrove communities containing approximately 20 mangrove species, dominated by *Rhizophora, Avicennia* and *Ceriops* species and *Xylocarpus mekongensis* Dense seagrass meadows – at least eight species of seagrass recorded Extensive saltpans.	The fisheries values are predominantly commercial, recreational and subsistence fishing. The main fish species caught in this area are barramundi, grunter, flathead, mullet, salmon, mackerel and shark. Whiting, mangrove jack, queenfish, bream, dart, trevally and jewfish are also caught on a commercial basis. Banana and tiger prawns are caught in areas along the coast. Mud crabs are caught frequently in all tidal areas.

Nature refuges

A nature refuge is a class of protected area under the Nature Conservation Act 1992 that acknowledges a commitment to manage and preserve land with significant conservation values while allowing compatible and sustainable land uses to continue. Although a nature refuge agreement may be entered into voluntarily a nature refuge agreement is legally binding. There are four nature refuges in the Don basin (Figure 2.2.1) consisting of:

- Aberdeen Nature Refuge
- Flagstone Nature Refuge
- Homehaven Nature Refuge
- Mount Pleasant Nature Refuge.

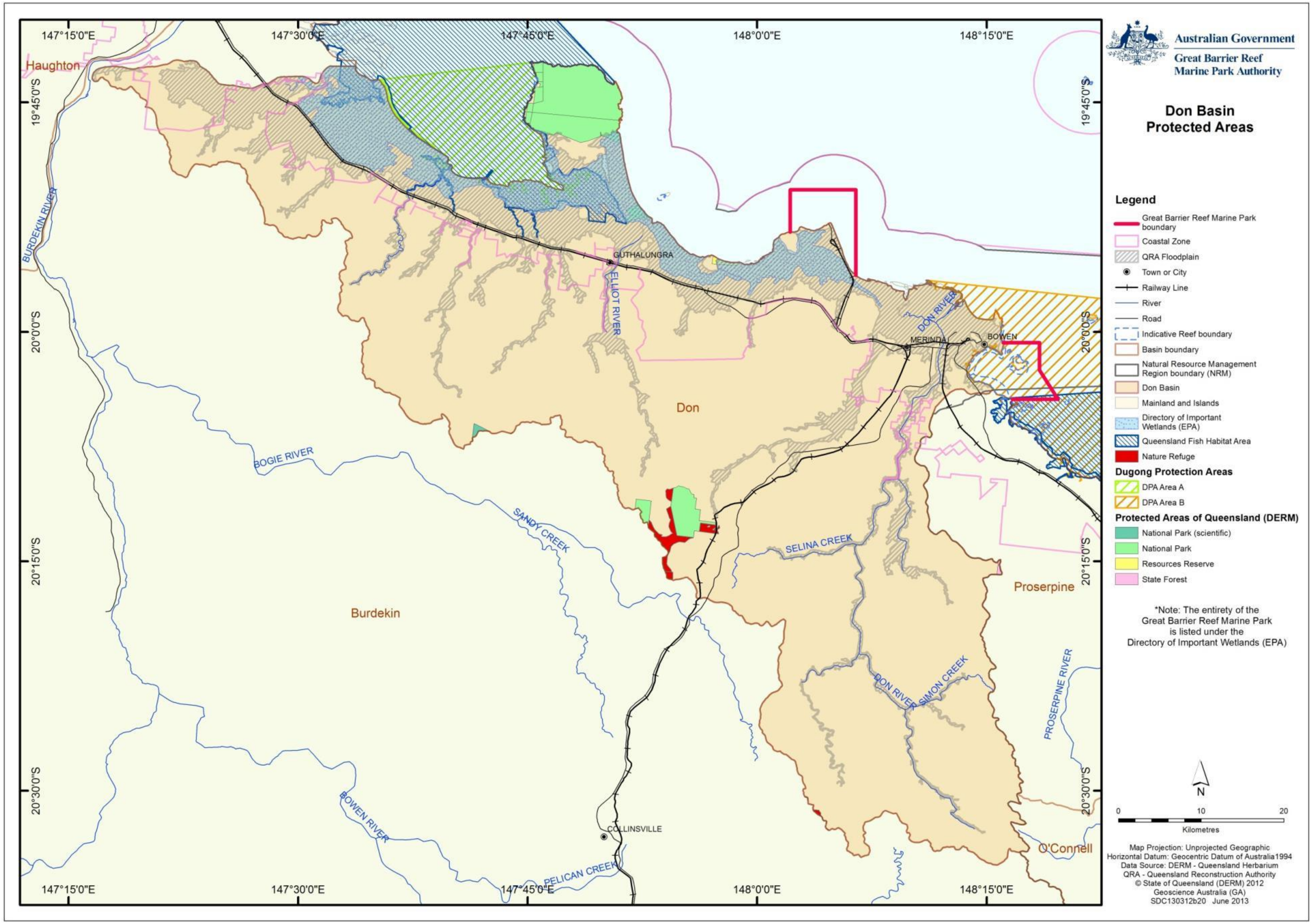


Figure 2.2.1: This map shows the spatial extent of some values in the Don basin that may underpin matters of national environmental significance, including World Heritage Properties, National Heritage Properties, Ramsar wetlands, Nationally Important wetlands, National Parks, Conservation Parks, forest reserves, Fish Habitat Areas, and Nature Refuges

2.3 Coastal ecosystems

The Great Barrier Reef inshore ecosystems are made up of many complex components, including estuarine and marine ecosystems such as mangroves, seagrasses and inshore coral reefs, which are closely linked to adjacent coastal ecosystems. These include coastal freshwater wetlands, coastlines and forested floodplains (Figure 2.3.1). These coastal ecosystems are interconnected and reliant on one another for their ongoing health and resilience. Species that form part of the amazing biodiversity of the Marine Park live in and move between these ecosystems throughout their life cycles.

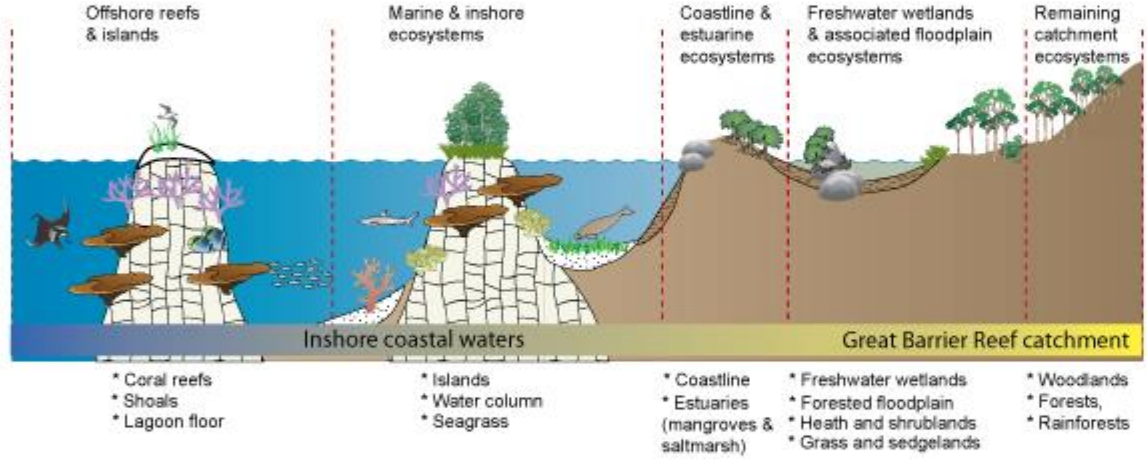


Figure 2.3.1 Broad groupings of coastal ecosystems illustrating the general level of importance for the ongoing health and resilience of the Great Barrier Reef

Coastal ecosystems are not easily separated and defined, as functionally they are all connected one way or another. Each component provides specific ecological functions that together make up and support the health and resilience of the ecosystem as a whole.

Inshore marine coastal ecosystems

The inshore coastal waters adjacent to the Don basin are home to a range of marine flora and fauna, many of which are of conservation concern.[16,17,18,19,20] Green and loggerhead turtles use these waters for foraging, humpback whales migrate close to the coast, and the area is a significant sea snake habitat.[21]

Figure 2.3.2 shows the reefal and non-reefal bioregions in the area that were used as the basis for the Great Barrier Reef Marine Park Authority Zoning Plan. Figure 2.3.3 shows the Marine Park Zoning Plan.

Flood plumes from the Don and adjacent basins in the Burdekin region have been shown to reach beyond the Great Barrier Reef. At risk of exposure to one or more water quality concerns (sediments, nutrients or pesticides) are 271 coral reefs (covering an area of 2080km^2) and 89 seagrass beds (covering an area of 586km^2).[22]

The area surrounding Abbot Point has been reported as being important habitat for turtles, dugong and dolphins. Dugongs are reported to be found in moderate numbers foraging in seagrass meadows adjacent to the port. The Indo-Pacific humpback dolphin (*Sousa chinensis)* and the snubfin dolphin (*Orcaella heinsohni*) have also reportedly been observed in the Port area, and in the surrounding shallow coastal bays, harbours and estuaries.

Turtles (including green (*Chelonia mydas*) and the flatback (*Natator depressus*) turtles) are recorded in the area with numbers reportedly peaking in the nesting period (November – February). The beaches surrounding Abbot Point (and adjacent areas such as Cape Upstart and Camp Island) are reportedly known to support low density nesting for green and flatback turtles.[17]

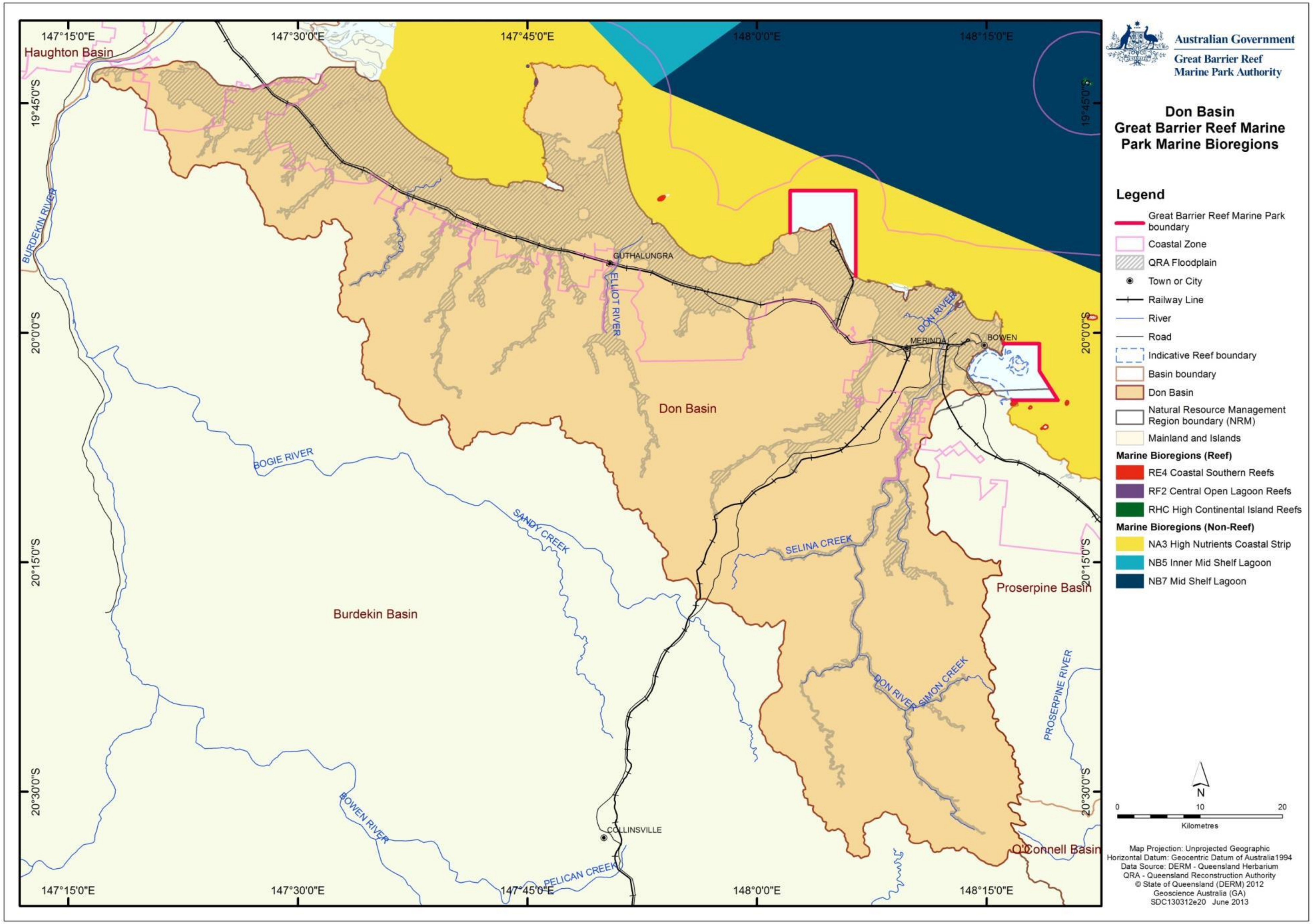


Figure 2.3.2: Marine bioregions adjacent to the Don basin

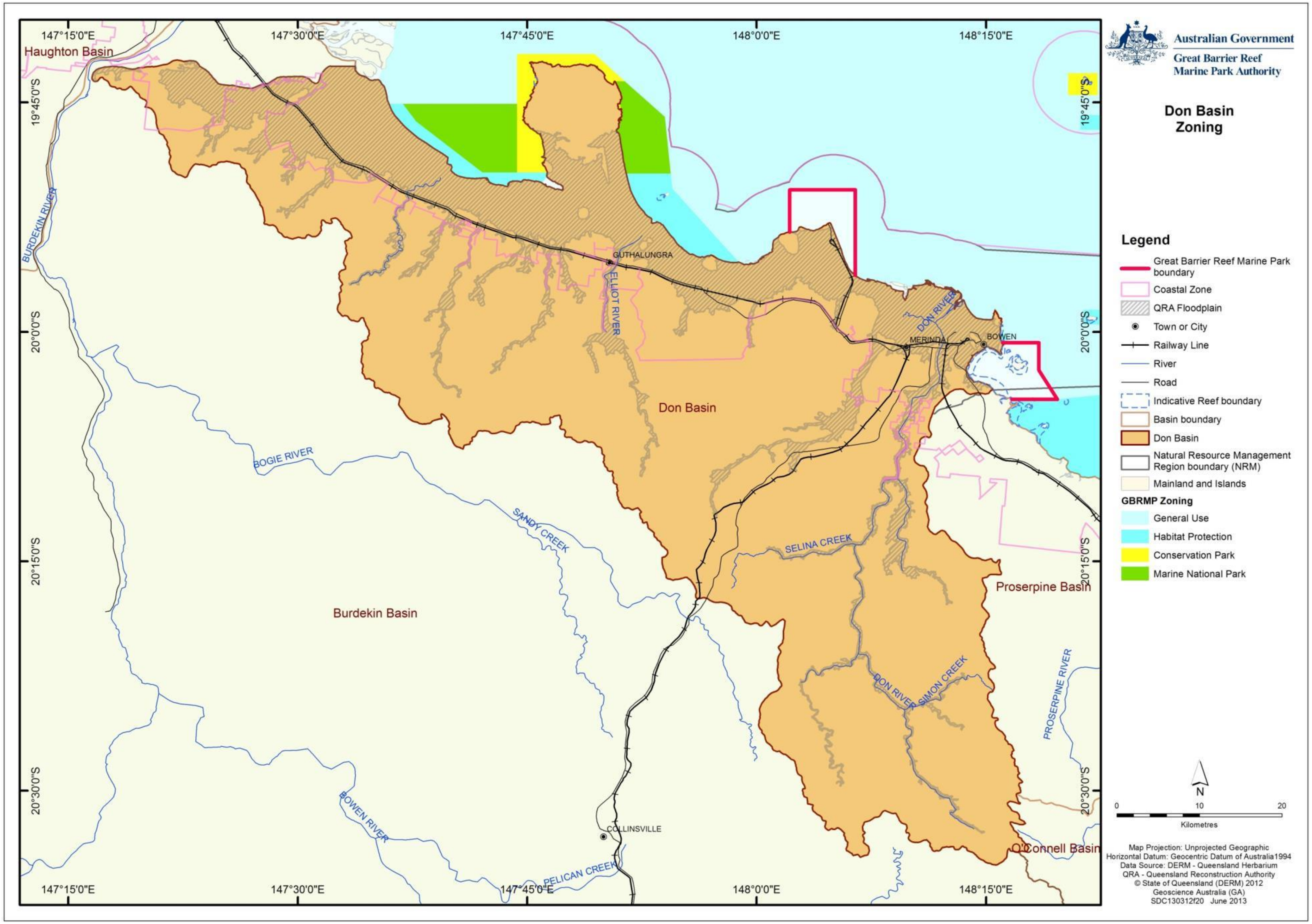


Figure 2.3.3: Zoning within the Marine Park adjacent to the Don basin

Marine fauna survey observations in the area have found a number of other species including sea snakes, leopard sharks and manta rays and concluded that the use of the region by dolphins, dugongs and turtles for foraging, indicates this area is an important feeding area at a local scale.

The reported sighting of Humpback whales in corresponding seasonal migration patterns for breeding and calving (August 2008 and September 2008) has been suggested as indicative that the Abbot Point area is used as a resting and possible calf feeding area and important refuge environment.

One hundred and thirty two species of fish from 51 families have been reported to be found from the Abbot Point area including: pelagic species such as mackerel and marlin, reefal species such as coral trout and parrotfish and benthic species such as flatheads, and dragonets, mangrove jack, snapper, whiting and mackerel.

A marine benthic study conducted at 300 sites at Abbot Point found five species of coral (soft corals, sea pens and hard coral) at 41 sites in very low densities (>10 per cent cover) and in medium/low density at two of those sites. The benthic habitats of the Port of Abbot Point are reported as exclusively soft substrate, comprising mainly of sands and fine silty material.[18,20]

There is no long-term seagrass monitoring program occurring within the Don basin. Ad hoc seagrass mapping has been undertaken by the Queensland Government since 1988 and is summarised in Figure 2.3.4. Predicative models for deep water seagrass show that deepwater seagrass is likely to occur north of the Don basin.

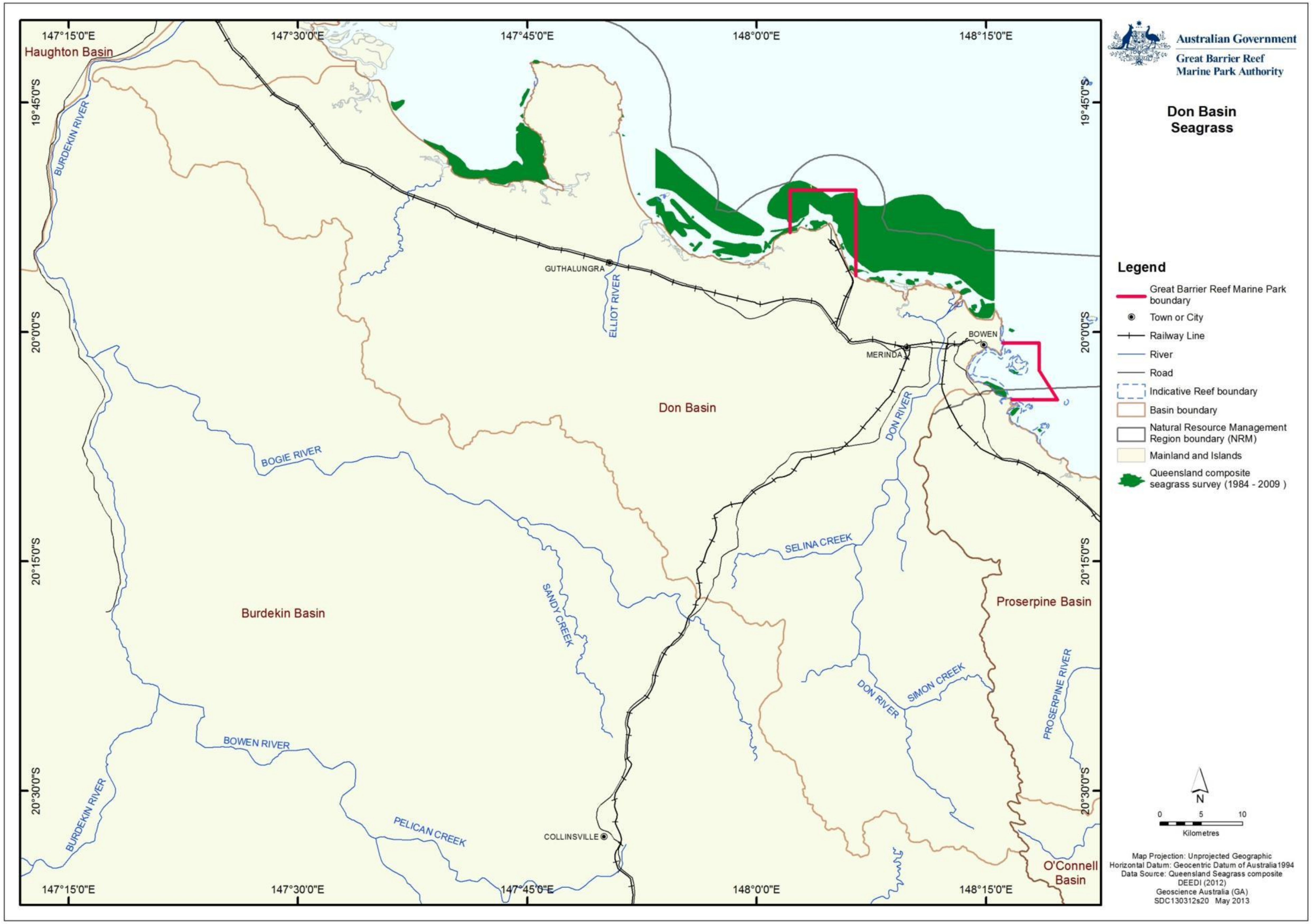


Figure 2.3.4 This map shows the extent of mapped seagrass (inshore) and deepwater seagrass probability for the Don basin

There has been very little monitoring or studies of coral extent, diversity and recruitment in coastal waters of the Don basin. The Historical Photographs Project (GBRMPA) compared historical with current (at the time of the project) photos of coral reef-flats in order to determine gross shifts in benthic community structure.[14] Both Stone Island (Figure.1.1.2) and Bramston Reef (located offshore of Bowen) showed evidence of significant changes in their reef-flat communities.

General comparisons could be made with the historical photographs of Bramston Reef, which showed a large abundance of massive coral colonies such as *Porites* and faviids and tabular/corymbose colonies of *Acropora spp*. The photographs taken in the early 1990s showed that no *Acropora spp.* were present and the majority of faviid colonies were dead and covered with algae and/or mud and those still alive were comparatively smaller (< 15 cm diameter). Large colonies and micro-atolls of *Porites* as well as large amounts of coral rubble were found in the photos from the early 1990s.

General comparisons could also only be made between the Stone Island photographs (Figure 1.1.2), which showed a decline in reef-flat composition. The historical photos taken between the 1890s and 1915 showed extensive hard coral cover including colonies of plating, corymbose and caespitose Acropora and many massive coral colonies. A cyclone in 1918 reportedly destroyed the reef; however local residents say that the reef-flat was healthy 20-30 years ago. The photos taken in the early 1990s showed a lack of Acropora colonies and few massive coral colonies. The surface of the reef-flat was covered in a mixture of coral rubble and algae.[1,14]

Changes to coastal ecosystems

Coastal ecosystems in the Don basin have been substantially modified or cleared. Significant changes include:

- Broadscale clearing of forests, woodlands and grass and sedgelands leading to elevated discharges of soils into the World Heritage Area.
- Introduction of pasture grasses that have changed the flora biodiversity and the fire regime. These African and South American grasses burn hotter causing significant changes to biodiversity and lead to loss of soils.
- Introduction of grazing on natural vegetation on the fragile upland goldfields soils increasing the impact of erosion on the downstream areas further adding to the sediment load.
- Broadscale changes to overland and underground hydrology through groundwater extraction for irrigation.

Although these changes can potentially have negative consequences for coastal ecosystems, the condition of aquatic coastal ecosystems was generally in good condition at the time of this assessment. Despite the close proximity of some wetlands to areas of intensive cropping, their condition was generally good. This is likely an outcome of good irrigation practices stemming from limited groundwater supplies.

In pre-European times, the Don basin was dominated by grass and sedgelands, forests and woodlands (Figure 2.3.5, Table 2.3.2). Since European settlement, these areas have been thinned for grazing in the upper basin and cleared for dryland production in the coastal basin areas (Figure 2.3.6).

Aquifer groundwater is the only source of irrigation water in much of the Don basin as there are no major dams or weirs (with the exception of the northern part, which receives irrigation water from the Burdekin Dam). Saltwater intrusion is an issue in much of this basin. Some irrigation water is pumped from the Burdekin for properties in the far northern part of the basin.

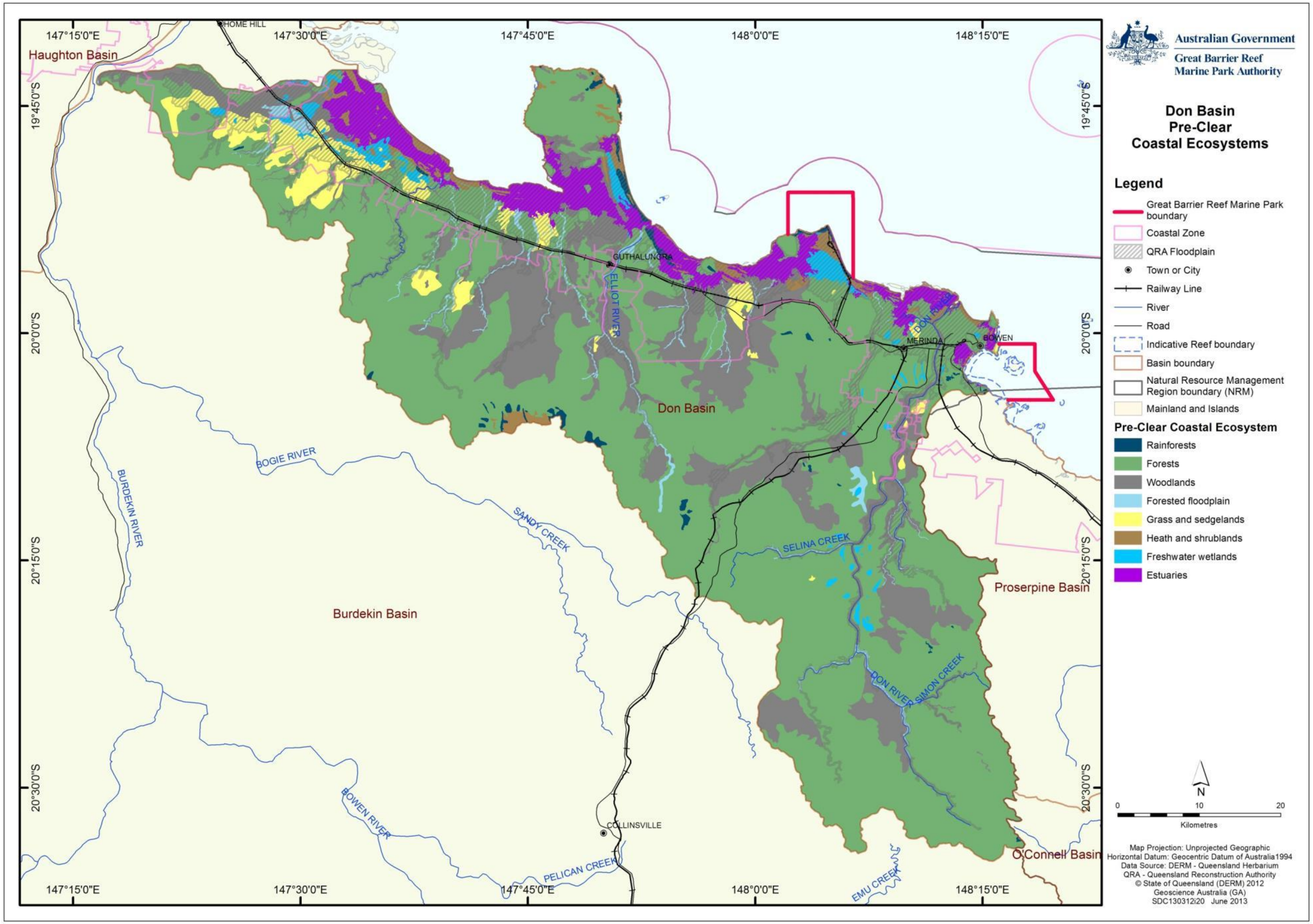


Figure 2.3.5: This map shows the pre-clear coastal ecosystems in the Don Basin

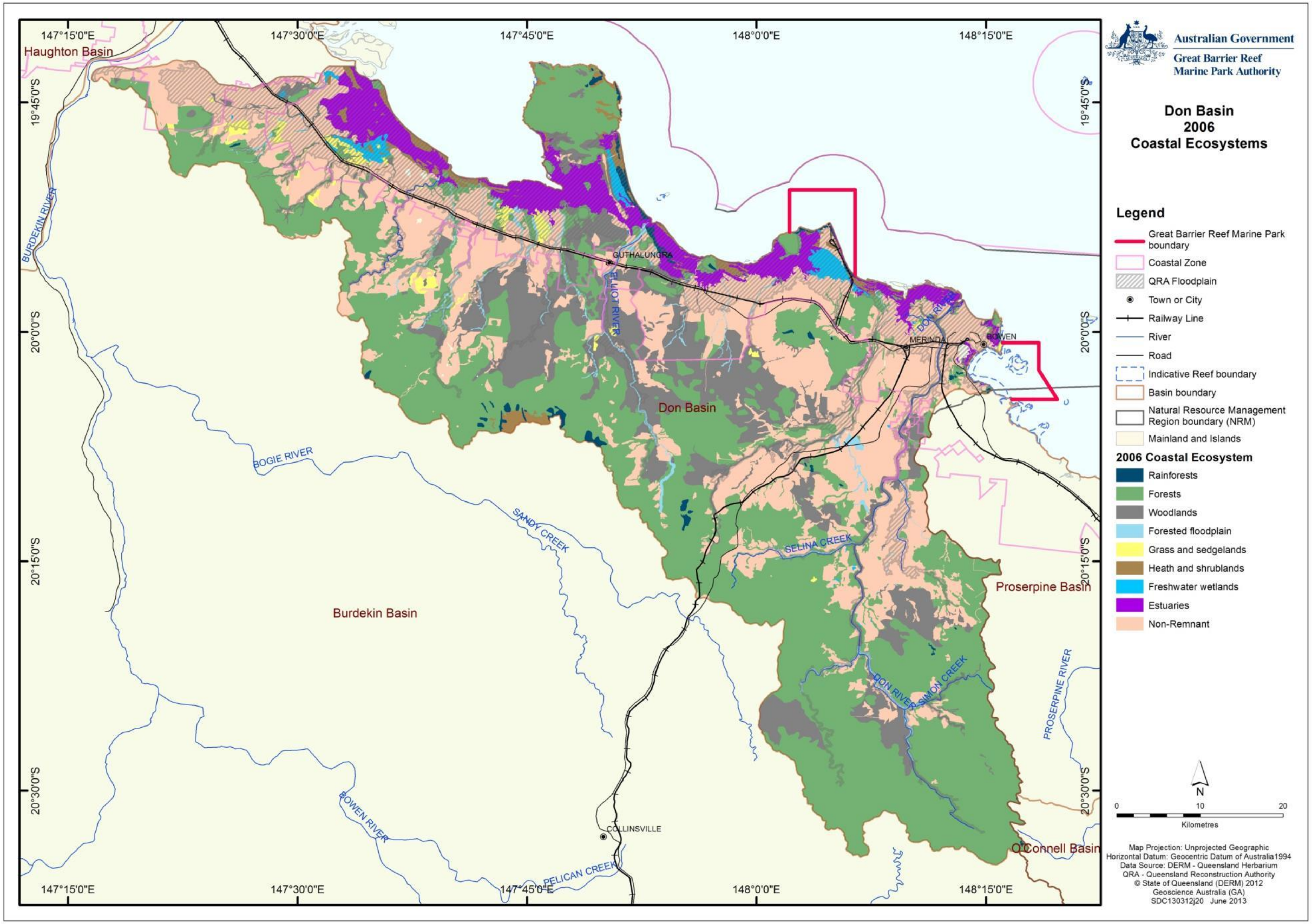


Figure 2.3.6: This map shows the post clear coastal ecosystem assemblages in the Don basin (derived from 2006 Queensland Government Regional Ecosystem data)

The alluvial plains in the northern part of the Don basin (Rocky Ponds Creek, Elliot River to Abbot Point) have better soils and are smaller properties that can readily switch between grazing and horticulture. The lack of irrigation in this area is currently restricting horticultural expansion. This has assisted in maintaining good water quality through reduced run-off. Based on field observations, Salty Creek northwards (part of the lower Burdekin floodplain) has supplemented flows from the Burdekin Irrigation scheme. This area is experiencing weed infestation and declining wetland health in some areas.

The changes to coastal ecosystems (Table 2.3.2) show that the greatest proportion of losses in terrestrial biodiversity has occurred to grass and sedgelands, woodlands and freshwater wetlands.

Table 2.3.2: Area (ha) of pre-clear and post-clear coastal ecosystems based upon Queensland Government Regional Ecosystem mapping within the entire Don Basin

	Ecosystem	Pre-clear	2006	2009	% remaining
	Rainforests	2,639	2,524	2,524	96
	Forests	245,872	162,317	162,275	66
	Woodlands	71,934	53,771	53,745	75
	Forested floodplain	6,542	5,145	5,128	78
	Grass and sedgelands	14,074	3,391	3,354	24
	Heath and shrublands	6,331	4,847	4,820	76
	Freshwater wetlands	5,307	2,965	2,965	56
	Estuaries	20,320	19,203	19,203	95
	Non Remnant	0	118,392	118,541	N/A
	Not Mapped	394	859	859	N/A

Coastline and estuarine coastal ecosystems

The majority of estuarine ecosystems remain intact within the Don basin. The current health of these ecosystems has not been assessed since a study on the condition of estuaries within the Don basin was completed in 1998 as part of the Australian Estuarine Database Survey. Results for some of the estuaries within the Don are shown in Table 2.3.3

Table 2.3.3: Summary of estuarine condition statistics as part of the Australian Esturaine Database Survey 1998 for the Don basin

Name of estuary	Class	Sub-class	Condition
Don River	River Dominated	Tide-Dominated Delta	Modified
Euri Creek	River Dominated	Tide-Dominated Delta	Near Pristine
Branch Creek	Tide Dominated	Tidal Flat/Creek	Near Pristine
Elliot River	River Dominated	Tide-Dominated Delta	Near Pristine
Nobbies Inlet	Wave Dominated	Strandplain	Near Pristine
Rocky Ponds Creek	Wave Dominated	Strandplain	Near Pristine

Most of the estuaries tested in 1998 were listed as near pristine, however not all of the major estuaries within the Don basin were sampled during this study. Molongle Creek is located near Cape Upstart and is a popular launching place for recreational fishers to access the Great Barrier Reef Marine Park and fishing huts on the Eastern side of Cape Upstart. It was not assessed as part of the condition assessment in 1998. The mouth of the estuary is highly modified and continues to be altered with heavy machinery as was observed in the October 2012 field assessment by Great Barrier Reef Marine Park Authority (Figure 2.3.7). The modified estuary mouth serves as a harbour to allow users to access the boat ramps in all weather.

Figure 2.3.7: Modified estuary at Molongle Creek in the Don basin

The Don River estuary was listed as modified in the 1998 survey and this was still the case in fieldwork undertaken in October 2012. Extensive modifications have occurred to maintain the integrity of the estuary banks to minimise erosion and overbank flooding of the adjacent Queens Beach community (Figure 2.3.8). Although this system has been extensively modified there were signs of reasonable biodiversity as juvenile mangrove jack were observed in the estuary using the rock wall as a protective habitat. Large stands of healthy mangroves were observed growing within the Don River estuary. Coastal ecosystems mapping for the Don River show the extent of mangroves beginning in the centre of the Don River and continuing North West where they merge with the mangroves of the Euri Creek estuary. Although the Queens Beach side of the Don River estuary is now modified by urban areas, the extent of mangroves have not altered substantially from their pre-European state. Historically, the areas of Queens Beach were heath and shrubland, not mangroves.

Figure 2.3.8: Mouth of the Don River showing estuarine modifications for flood proofing along the bank adjacent to Queens Beach

The Caley Valley wetland estuary supports a diversity of vegetation (Figure 2.3.9). Several mangrove species including dense grey mangrove (*Avicennia marina*), spotted mangrove (*Rhizophora stylosa*) and yellow mangrove (*Ceriops tagal*) are found mainly within channels on the western side of the wetland.[23]

Figure 2.3.9: Wetland vegetation (samphire) at Caley Valley wetland

Freshwater wetlands and associated floodplain coastal ecosystems

Freshwater wetlands across the Don basin have been reduced to approximately 55 per cent of the pre-European extent in the entire basin. The mapped extent of freshwater wetlands often underestimates losses, especially in those wetlands that are infrequently inundated. Ephemeral wetlands are the ones most vulnerable to being lost or degraded. They are also often the ones that provide connections for species movement within catchments and within the Great Barrier Reef World Heritage Area.

Many otherwise intact wetlands are suffering a range of health problems associated with loss of connectivity, sediment and nutrient overload and weed infestations. The loss of function therefore may be much greater than changes in extent might imply.

The Queensland and Australian governments, through the Queensland Wetlands Program have mapped wetlands within the Don basin at a finer scale than the current regional ecosystem mapping. The extent and classification types of wetlands within the Don basin are shown in Table 2.3.4.

Table 2.3.4: Queensland Wetlands Program data for the freshwater and estuarine wetlands of the Don basin

System as defined by Queensland Wetlands Program	Area (km²)	Wetlands area (%)	Total area of basin (%)
Artificial and highly modified	6.99	2.2	0.2
Estuarine	183.32	56.6	4.9
Lacustrine	0.18	0.1	0.0
Palustrine	41.93	12.9	1.1
Riverine	91.69	28.3	2.5
Total	324.11	100.0	8.7

Overall measures of extent can also mask significant basin scale losses of wetland functions in specific locations, especially in the coastal floodplain where up to 80 per cent of freshwater wetlands have been lost in some basins.

The northern part of the Don basin is effectively part of the Burdekin Delta. The Northern part of the Don basin would once have received overbank flows from the Burdekin in flood however bank modifications along the Burdekin have changed the natural flows. The northern part of the Don also receives irrigation water from the Burdekin Dam.

Use of non-supplemented groundwater for irrigation in this region has resulted in wise water use and minimal run-off of nutrients into adjacent wetlands. The wetland below is bounded by irrigated agriculture.

Saltwater Creek in the Northern Don basin has changed from seasonal flows to year round flows. This has led to the proliferation of grasses and sedges that take advantage of the year round flows. Management programs have improved the condition of Saltwater Creek beneath the Bruce Highway Bridge (Figure 2.3.10).

Figure 2.3.10: Saltwater Creek on the border of the Burdekin and Don basins a) 1970 healthy open water lagoon b) 1999 chocked with Salvinia and Hymenachme weeds c) 2012 reduction in weeds with an appearance of some open water habitat (photos: Jim Tait)

Upstream of this Creek, the Inkerman wetlands are high value wetlands and partnerships under the Reef Guardian Farmer program are helping to maintain the condition of these wetlands. Downstream, the impacts of the a-seasonal freshwater flows were not assessed and condition is unknown.

Well managed grazing properties, like Wadjunga property in the northern Don basin on the lower floodplain, allow for healthy freshwater wetlands with open water habitat and minimal impacts from introduced pasture. Ponded pastures generally impact negatively on coastal ecosystems however at the Wadjunga property some bunds are creating healthy freshwater wetlands adjacent to pastoral areas (Figure 2.3.11).

Figure 2.3.11: Healthy freshwater wetlands in Yellow Jin Creek, Wadjunga property

The Caley Valley Wetland is located north west of Bowen adjacent to Abbot Point. It extends approximately 18 kilometres from Mount Curlewis in the west to Euri Creek in the east and about six kilometres from Bald Hill in the north to Caley Valley homestead in the south.

The wetland contains permanent water, along with a wide range of wetland habitats which provide important food resources and sheltered roosting and breeding sites for waterbirds. The significance of the site is recognised through listing on the National Directory of wetlands and reportedly meets criteria for identifying wetlands of international importance under the Ramsar Convention.

The wetland environment includes a large fresh and brackish water wetland impounded within an artificial impoundment along with subtidal and intertidal marine and estuarine environments.

The western edge of the wetland is tidally influenced. During high rains in the wet season fresh and brackish water moves westwards from the wetland into Curlewis bay. The natural tidal pattern and drainage from the site has been influenced by the construction of a causeway between Caley Valley Homestead and Mount Luce. Mount Stuart Creek flows under the northern end of the causeway which restricts the movement of water between the site and Curlewis Bay. The causeway has been piped at several spots however the natural flow of saltwater to the eastern side of the wetland has been modified.

Various EPBC migratory species are found at the site (including the Black-necked stork, cotton pygmy-goose) along with a range of EPBC listed threatened species.

Forested coastal ecosystems

Terrestrial coastal ecosystems within the Don basin maintain much of their pre-European extent with over 70 per cent of both rainforests and woodlands remaining. Forests have the highest amount of modification with only 66 per cent of the pre-European extent remaining. Grazing in much of the upper Don basin occurs on the upland and sloping areas of the basin, in and around forest ecosystems. This has resulted in large quantities of coarse sand entering the Don River, primarily from gully erosion. This sand has built up to the point where it has caused flooding in lowland coastal areas. Mechanical sand extraction occurs within the Don River to reduce the effects of flooding on the adjacent community (Figure 2.3.12). Further permits for sand extraction have recently been approved which may assist in restoring ecological processes, such as deep pool refugia for fish species with connections to the Reef.

Figure 2.3.12: Don River approximately upstream from the Bruce Highway Bridge a) sand extraction on the Northern bank of the river b) sand extraction detail

The Queensland Government has assigned regional ecosystems a conservation status which is based on its current remnant extent (how much of it remains) in a bioregion. Regional ecosystems were originally defined by Sattler and Williams (1999)[24] as vegetation communities in a bioregion that are consistently associated with a particular combination of geology, landform and soil. Vegetation that is classified as endangered is afforded most protection in Queensland; however some industries such as mining, transport, electricity and community infrastructure may be exempt. Lesser protection is afforded by the other categories. These have been mapped for the Don basin (Figure 2.3.13). Information on regional ecosystem information provides the basis for the development of coastal ecosystem functional groups identified in the Coastal Ecosystem Assessment Framework.[9] However regional ecosystem conservation classification is based on terrestrial distribution, and do not assess their functional linkage to the World Heritage Area. Regional ecosystem conservation classifications most likely do not protect coastal ecosystems most important to maintaining the health and resilience of the World Heritage Area.

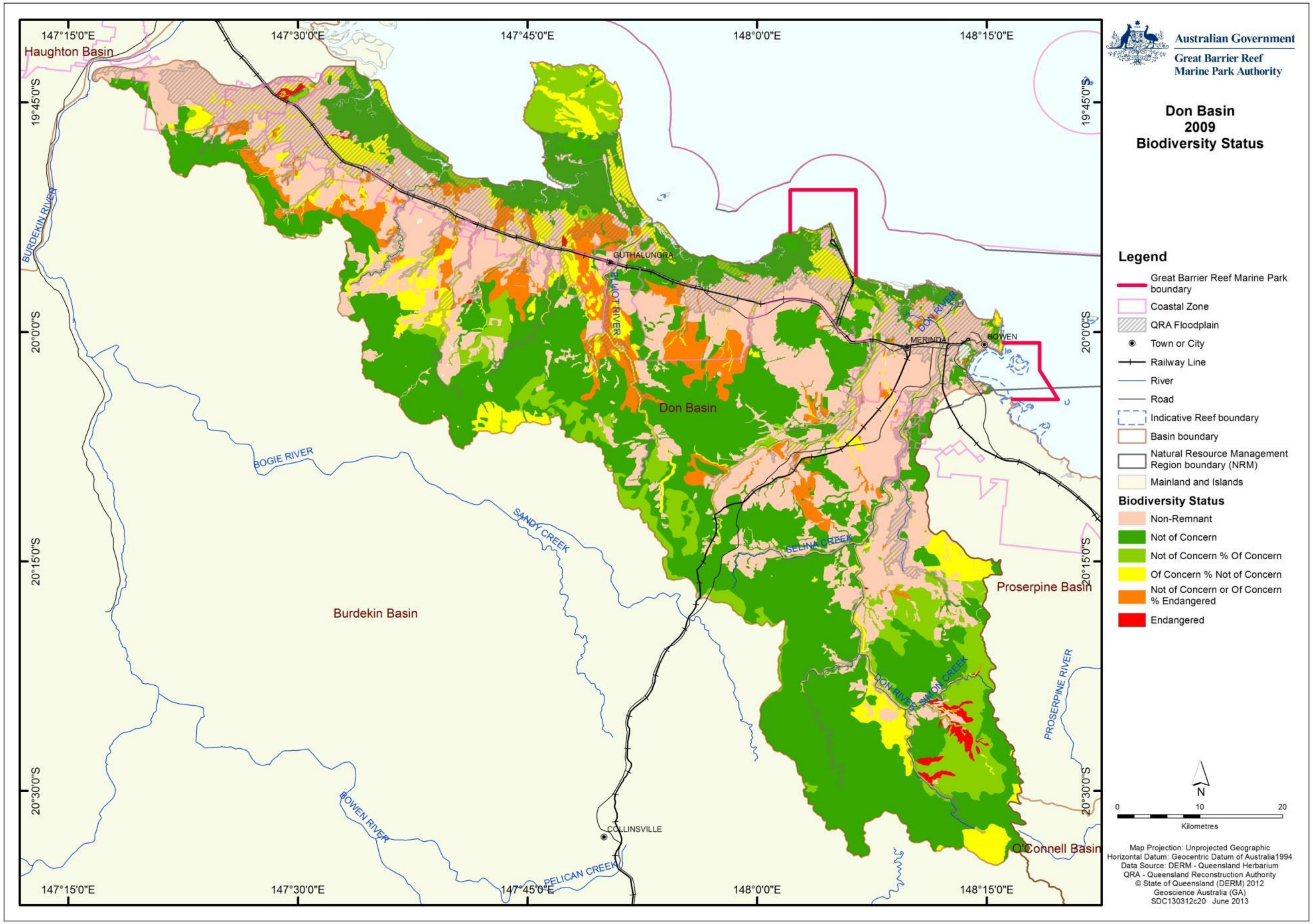


Figure 2.3.13: Regional ecosystem conservation status for the Don basin

2.4 Ecosystem processes

The condition of ecosystem processes in the Don basin varies both spatially and temporally. Areas that have been highly modified from the natural coastal ecosystems that were once there show the greatest degree of change in processes. For example, rivers that have been modified into water distribution channels offer limited capacity for biological processes for fish species such as reproduction, dispersal, recruitment and migration and are often nutrient enriched.

Appendix F contains a list of coastal ecosystems and some of the ecological processes they deliver for the health and resilience of the World Heritage Area. All rivers within the Don basin are in generally good condition and are some of the healthiest in the catchment. They provide most of the same ecosystems services as they did before European settlement.

Physical processes

Physical processes are the processes that transport and mobilise elements such as water, sediments and minerals. They include groundwater recharge/discharge, sedimentation/erosion of soils and deposition and mobilisation processes. All coastal ecosystems provide these services, some more than others. Declines in delivery of physical processes that retain sediments are generally reflected by an increase in total suspended solids.

Within the Don basin there are no significant dams or other barriers that impact on physical processes. The Don River itself is experiencing a build-up of sand (Figure 2.4.1) and sand extraction is occurring in the middle reaches of the river. This sand is likely to be a result of erosion from grazing of forested ecosystems in the middle and upper reaches of the Don River.

Further west Splitters Creek (which runs into the Caley Valley wetlands) is in good condition apart from some upstream adjacent grazing of natural areas. There may be some increased sediment loads due to grazing, however intact coastal ecosystems provide a buffer between basin land use and inshore marine ecosystems of the Great Barrier Reef World Heritage Area.

Figure 2.4.1: Sand build up in the lower Don River (left) and extraction occurring further upstream

Biogeochemical processes

Biogeochemical processes revolve around energy and nutrient dynamics. Biogeochemical processes include production, nutrient cycling, carbon cycling, decomposition, oxidation-reduction, regulation processes and chemical/heavy metal modification. Wetland and associated floodplain ecosystems offer the greatest capacity for maintaining biogeochemical processes as these ecosystems slow the flow of water and allow the processes to occur. During large flood events biogeochemical processes in coastal ecosystems often do not occur as water flows at high volume and velocity directly into inshore coastal waters. In more developed basins, the volume of nutrients is often higher as a result of fertiliser use and point source discharges. These processes then generally occur in the inshore coastal waters. Table 2.4.1 outlines the nutrient forms and their availability for biogeochemical processes.

Table 2.4.1: Forms of nutrients and their impact on the aquatic environment

Term	Description/source	Impact on aquatic environment
Particulate organic matter	Large particles of organic matter (e.g. dead plants and animals) that get broken down by decomposers into smaller dissolved organic matter.	Not available for uptake by plants and animals.
Dissolved organic matter (DOM)	Large molecules of organic matter (nitrogen, carbon, phosphorus etc.) produced as a result of decomposition.	Not biologically available until broken down by bacteria.
Dissolved inorganic matter	By-product of bacterial decomposition of DOM or applied in this form as fertilisers.	Nutrients such as nitrogen and phosphorus are freely available in this form for uptake by cyanobacteria, plants and animals.

Elevated nutrients in inshore coastal waters indicate that the coastal ecosystems are not able to regulate the biogeochemical processes. This is likely due to elevated inorganic nutrients from agricultural and urban sources which often discharge directly into waterways. The lack of biogeochemical processes is also expected to be higher in the northern part of the Don basin, where irrigated cropping occurs and there is a higher level of water containing nutrients entering the inshore marine environment.

In the areas where healthy coastal ecosystems remain intact and are in locations where very few impacts are occurring, the biogeochemical processes listed above are occurring as expected.

Biological processes

Biological processes are the processes that maintain animal and plant populations. These include survival/reproduction mechanisms, dispersal/migration/regeneration, pollination and recruitment. Wetland and associated floodplain ecosystems offer the greatest capacity for maintaining biological processes.

Freshwater wetlands have declined by 45 per cent and this will have resulted in an associated decline in biological processes in the Don basin. Estuaries have only declined slightly, so biological processes provided by these coastal ecosystems remain relatively close to natural state, except in areas where modifications have occurred (for example closer to Bowen).

Molongle Creek in the northern part of the Don basin has some stream modifications in the lower reaches which may impact on the biological services provided. Much of the riparian mangrove cover has been removed by heavy machinery which has reduced the habitat for in-stream flora and fauna.

2.5 Connectivity

Aquatic ecosystem connectivity refers to how ecosystem components are linked, whether through air, water or by land. Disruptions to connectivity between different areas where fish breed and grow, can lead to a reduction in population resilience, or even localised extinctions. Figure 2.5.1 shows the sub-basin waterways that are part of the Don basin. Figure 2.5.2 shows the stream orders (classification system where waterways are given an ‘order’ according to the number of additional tributaries associated with each waterway combined with land zones and elevation). These tools were used to rapidly assess connectivity.

The major streams of the Don basin are Rocky Ponds and Molongle creeks at the northern end of the basin flow into Upstart Bay, an area of significant seagrass diversity. These systems have good in-stream and overland connectivity in most parts.

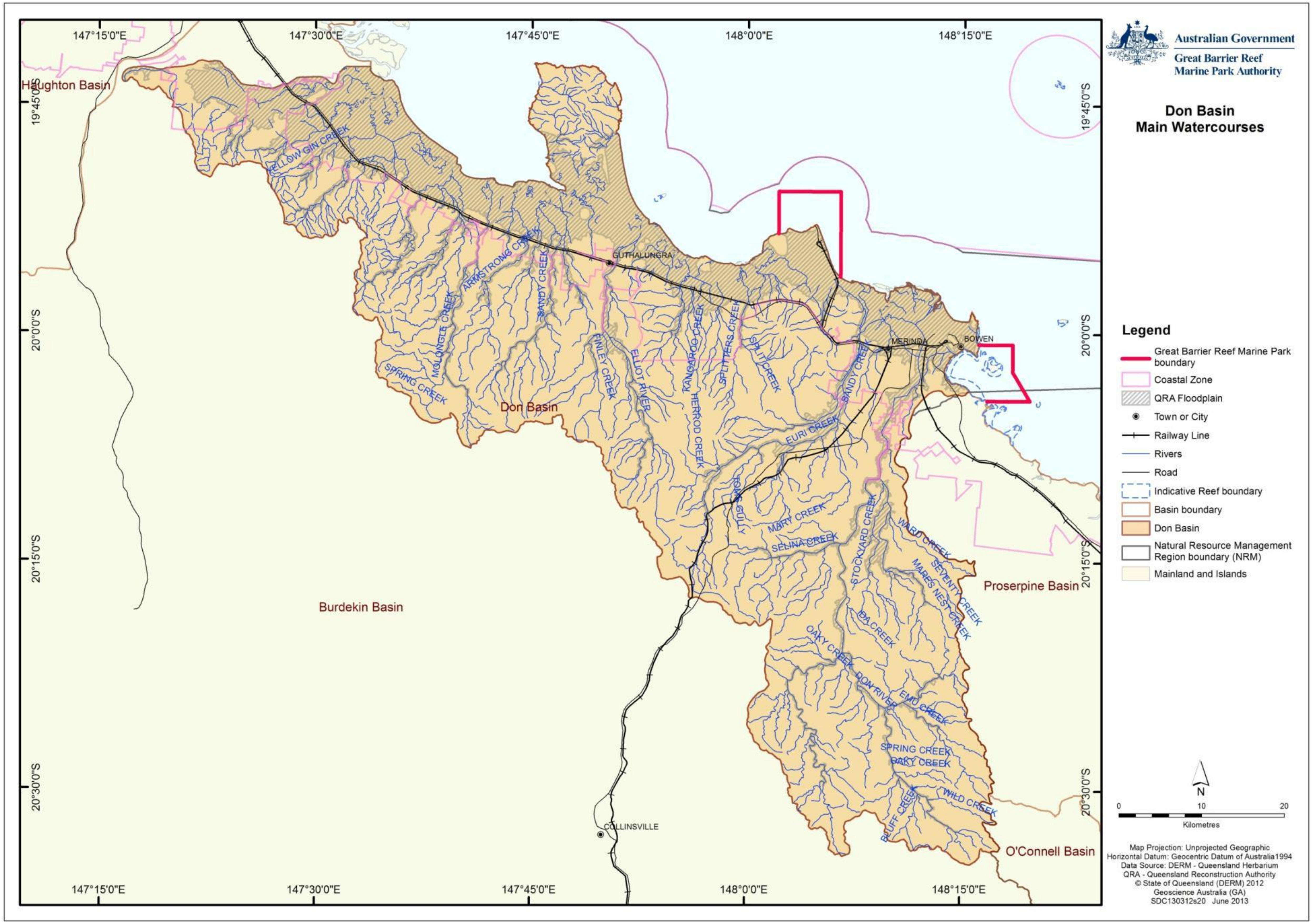


Figure 2.5.1: Major waterways in the Don basin considered in this assessment

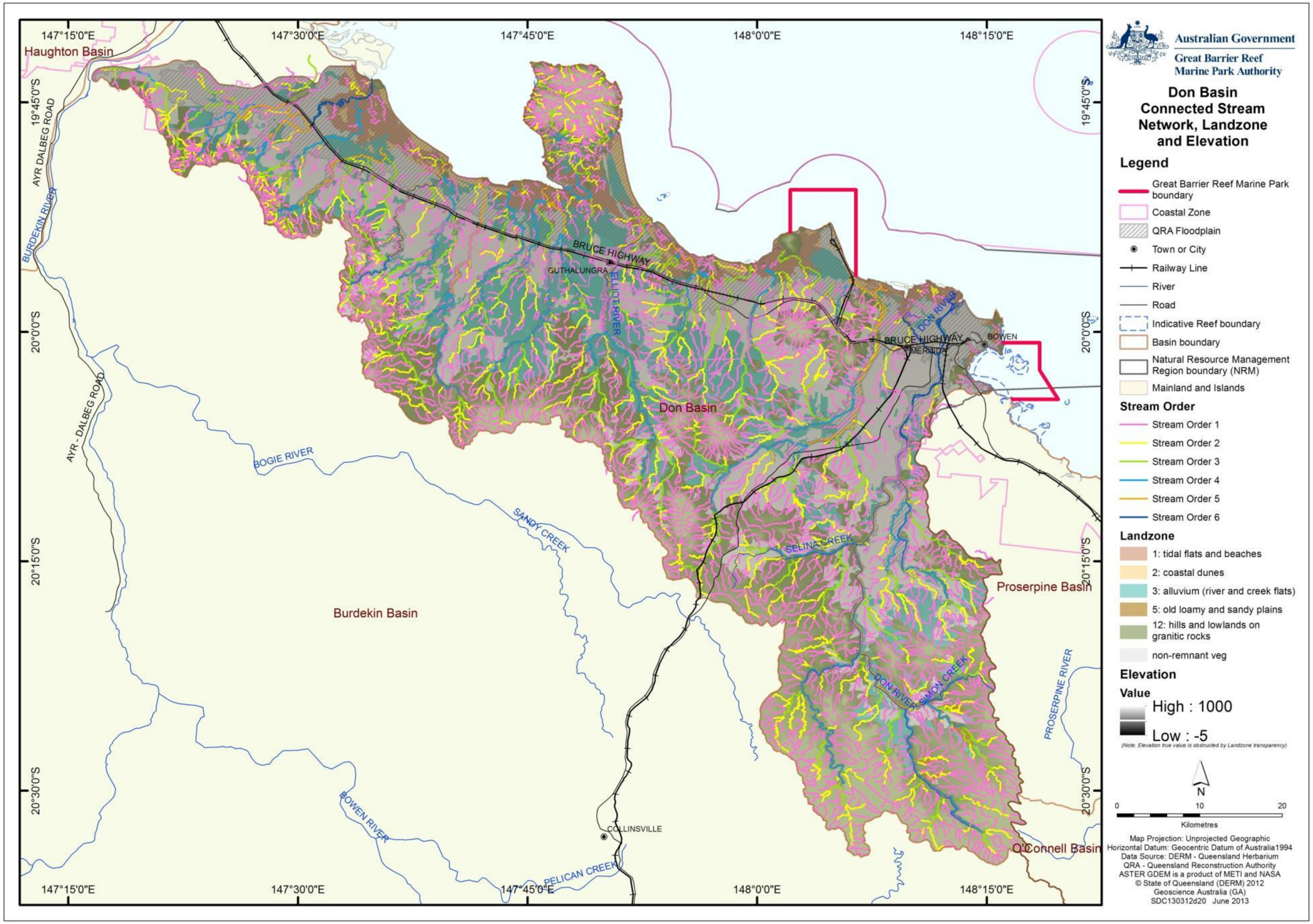


Figure 2.5.2: Stream order and elevation map showing the floodplain in the Don basin

Surface hydrology

The Don basin (with all of the smaller waterways) is relatively well connected with few man-made obstructions present in any major waterway. Unlike adjacent basins, the Don River has no major dams or weirs. Although there are no major man-made obstructions there are substantial sand chokes in many of the rivers including the Don River, Euri Creek and the Elliot River. These are likely as a result of soil loss and erosion.

The main barriers to overland flows within the Don basin are the railway lines (Figure 2.5.3) running across the basin to the Port of Abbot Point and the Bruce Highway running between Bowen and Home Hill. Proposed developments at Abbot Point will increase the number of barriers present within the basin if not managed properly.

Figure 2.5.3: The railway line running north-south acts as a barrier to connectivity in many places

Groundwater hydrology

There is intensive groundwater use in this region for grazing and horticulture. Significant soil erosion on the river delta and flats has been caused predominantly from horticulture, while grazing lands have isolated severe gully erosion in cleared areas, resulting in major stream modifications in the catchment.[5] There is little knowledge of the land use impacts on stream flow and limited records of the quantity of water extracted from the main stream and overland flow by water harvesting.

The Bowen irrigation area, situated in the heart of the Don River delta, is one of the largest horticultural areas in the dry tropics region of Queensland.[25] Major groundwater management issues include the expansion of irrigation, particularly in the inland floodplain areas, which has increased groundwater demand and the potential for contamination by agrochemicals or nutrients.[25]

The Don River basin is located in the North East Coast Drainage division and the Don River is the principle drainage of the Groundwater Management Unit (GMU), draining the catchment in a northerly direction.[12] Saltwater intrusion is a major issue for the Don River GMU, the Euri and Menilden creeks.

Rocky Ponds Creek has some water extraction to recharge ring tanks which are used for irrigating horticulture (Figure 2.5.4). Water extraction primarily occurs adjacent to the Bruce Highway north of Gumlu. Downstream of the water extraction, Rocky Ponds Creek is generally healthy with substantial remnant mangroves. Although there is some ponded pastures, cattle grazing and horticulture adjacent to the creek, the extensive intact coastal ecosystems maintain their provision of services to the Great Barrier Reef World Heritage Area.

Figure 2.5.4: Ring tank supplied by water extracted from Rocky Ponds Creek, used to irrigate adjacent agricultural land

Chapter 3: Impacts on the values

3.1 Drivers of change

The primary drivers of change for the Don basin are climate change, economic and population growth.

Climate Change

The Queensland Government has carried out extensive mapping of coastal areas projected to be at risk based on climate change predictions up until the year 2070. The maps they produced factor in climate change impacts including sea-level rise of 30 centimetres and a 10 per cent increase in the maximum potential intensity of cyclones and associated storm surge at-risk areas and erosion prone areas.[26]

Information on climate change impacts is based on the most recent report from the Intergovernmental Panel on Climate Change (IPCC) – the international scientific authority on climate change. Property scale and area-based coastal hazard maps are available at http://www.ehp.gov.au/coastal/management/maps/index.html. Table 3.1.1 shows the regional climate change predictions for Central Queensland in relation to temperature, rainfall, evaporation and extreme events.

Woodlands and forests in the Don basin will likely be affected by invasive vegetation, changed fire regimes and extreme weather events that will become more commonplace as a result of climate change. Coastal wetland ecosystems will be impacted by sea-level rise, extreme weather events and changes in the water balance and hydrology.[27]

Table 3.1.1: The regional climate change predictions for the Whitsunday, Hinterland and Mackay region for temperature, rainfall, evaporation and extreme events

Element	Prediction
Temperature	Average annual temperature in the WHM region has increased 03^{o} C over the last decade (from 22.7^{o}C to 23.0^{o}C). Projections indicate an increase of up to 4.2^{o}C by 2070, leading to annual temperatures well beyond those experienced over the last 50 years. By 2070, Mackay may have 12 times the number of days over 35^{o}C (increasing from an average of one per year to an average of 12 per year by 2070).
Rainfall	Average annual rainfall in the last decade fell nearly 14 per cent compared with the previous 30 years. This is generally consistent with natural variability experienced over the last 110 years, which makes it difficult to detect any influence of climate change at this stage. Models have projected a range of rainfall changes from an annual increase of 17 per cent to a decrease of 35 per cent by 2070. The "best estimate" of a projected rainfall change shows a decrease under all emissions scenarios.
Evaporation	Projections indicate annual potential evaporation could increase 7-15 per cent by 2070.
Extreme events	The 1-in-100-year storm tide event is projected to increase by 36 cm in Mackay and 31 cm at Airlie Beach if certain conditions eventuate. These conditions are a 30 cm sea-level rise, a 10 per cent increase in cyclone intensity and frequency, as well as a 130 km shift southwards in cyclone tracks.

Economic Growth

Economic growth is driving the proposed port expansion project for Abbot Point which will generate more employment opportunities and promote expansions of some local industries. Based on observations elsewhere, a likely expansion in urban development and industry will occur in conjunction with the port expansion.

There is a large local tourism industry which supports the township of Bowen. Bowen is known by locals and statewide visitors for its beautiful beaches (Figure 3.1.1). There are many resorts located around the coast of Bowen ranging from caravan parks to four star accommodations. During holiday periods most of the accommodation at the Bowen beaches is booked out.

Figure 3.1.1: The township of Bowen is a popular place for tourists. Resorts can be found in a number of bays around the headland including Rose Bay

Population Growth

The Don basin has low population densities, particularly outside of Bowen. The population is expected to grow during the construction of Abbot Point. The population has grown slightly but overall the effects of mining inland of Bowen on population growth has been minimal.

3.2 Activities and impacts

Historically the major land use in the Don basin was grazing and horticulture. These continue to be the primary land use with figures remaining fairly constant between 1999 and 2009 (Table 3.2.1, Figures 3.2.1 and 3.2.2). Most of the current extent of horticulture is irrigated however supply is limited to groundwater extraction unlike neighbouring basins that can source water from large rivers and purpose built dams. As a result, the ecological impacts from irrigated horticulture in the Don basin are far less than neighbouring basins. There has been a considerable increase in marsh and wetlands production within the basin which has doubled between 1999 and 2009.

The Don basin supports a range of aquaculture activities, including prawn, crab and barramundi farming. A planned expansion of the Abbot Point coal terminal is also underway.

Table 3.2.1: Land use data for the Don basin for 1999 and 2009. Areas shown in hectares

	Don basin land use (ha)	1999	2009
	Conservation, natural environments (inc. wetlands)	45,734	37,012
	Forestry - production	222	62
	Grazing natural vegetation	293,194	299,849
	Intensive animal production	24	73
	Intensive commercial	3,686	1,011
	Intensive mining	331	369
	Intensive urban residential	812	1,854
	Production - dryland	79	135
	Production - irrigated	18,190	17,395
	Water - production ponded pastures	5,812	11,885
	Water storage and transport	4,460	3,179
	Not Mapped	868	587
	Total Area (h)	373,412	373,412

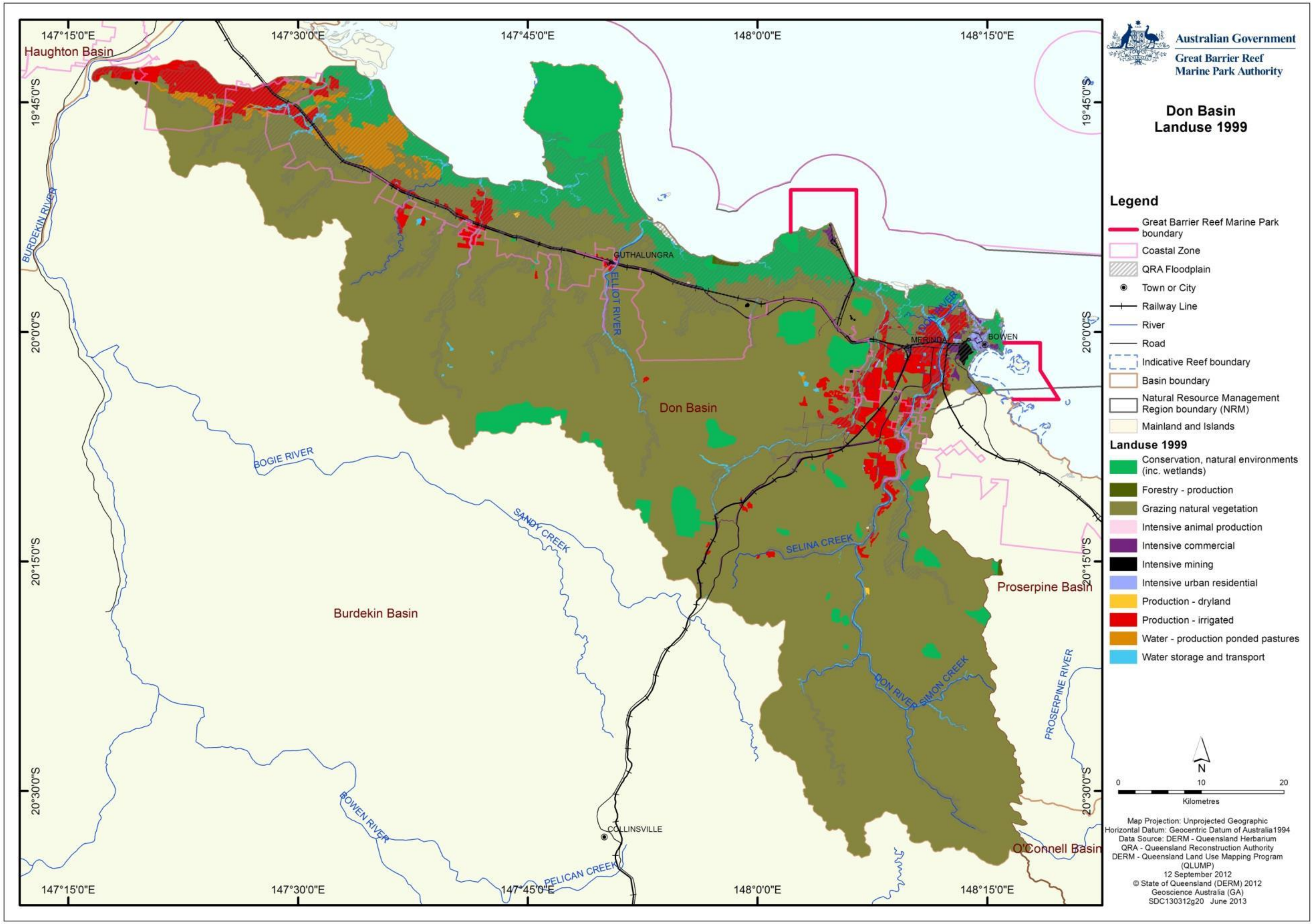


Figure 3.2.1: Map of land use for the Don Basin based on 1999 QLUMP data

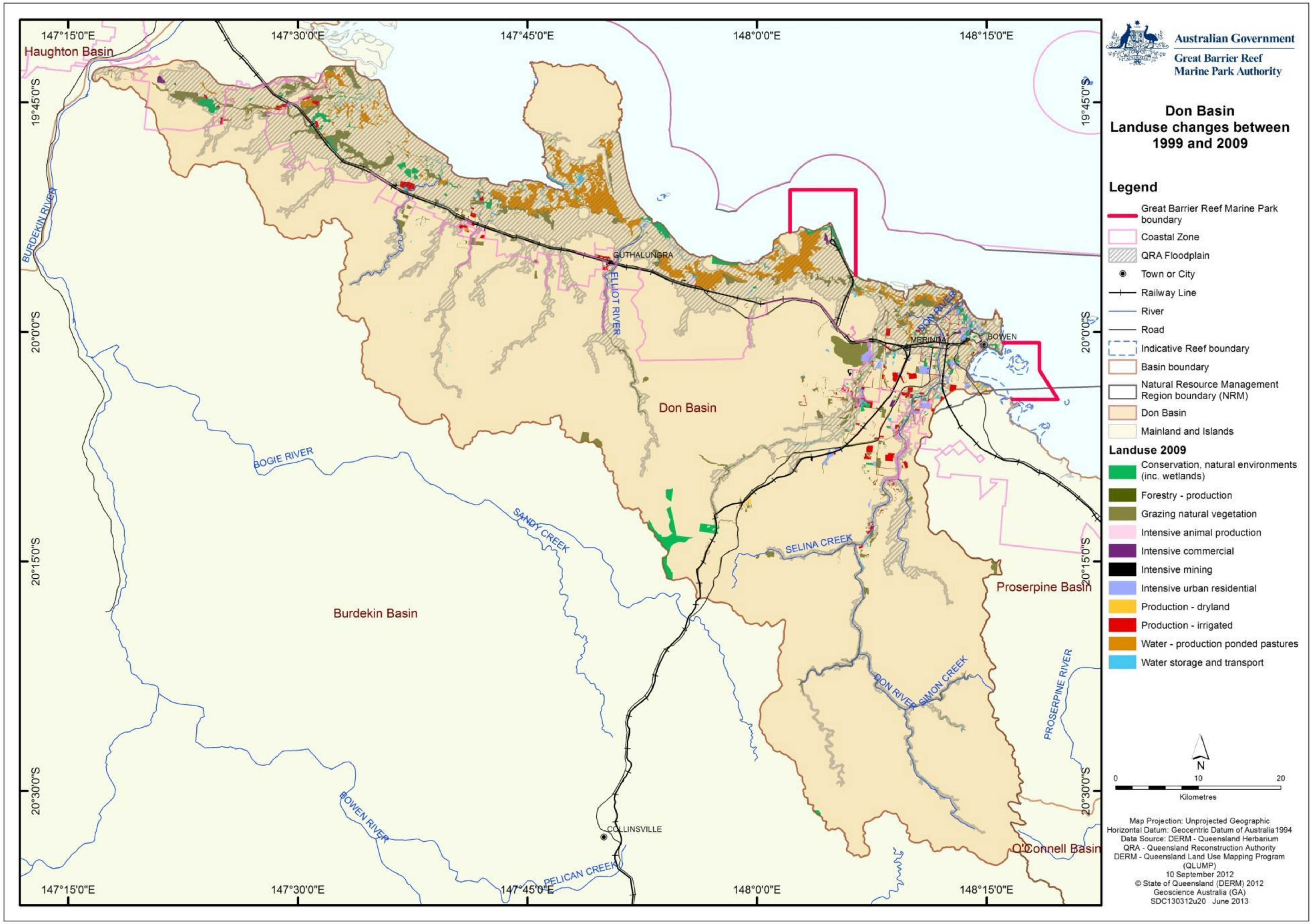


Figure 3.2.2: Map showing areas of changed land use in the Don basin based on 1999 and 2009 QLUMP data. Note that the water – ponded pastures mapping was refined in 2009 and does not reflect an actual change to this land use

Land use within the coastal zone

Land use adjacent to the coast (the coastal zone) can have the greatest impact on the Great Barrier Reef inshore waters. The coastal zone includes Queensland's coastal waters (which extend three nautical miles out to sea), coastal islands and land below 10 metres Australian Height Datum or within five kilometres of the coastline, whichever is greater. The land use occurring within the coastal zone for 1999 and 2009 is shown in Table 3.2.2. Approximately 25 per cent of the coastal zone is within protected areas and another 50 per cent is grazed natural areas. Around ten per cent of the coastal zone contains irrigated production, mostly sugar. Within the coastal zone, the dominant land use is grazing.

Table 3.2.2 Major land use categories for the Don basin coastal zone in 1999 and 2009 based on Queensland Land Use Mapping Program data. Areas shown in hectares

	Don Coastal Zone land use (ha)	**1999**	**2009**
	Conservation, natural environments (inc. wetlands)	35,067	26,529
	Forestry - production	160	0
	Grazing natural vegetation	50,125	53,543
	Intensive animal production	18	63
	Intensive commercial	2,328	953
	Intensive mining	305	313
	Intensive urban residential	765	1,498
	Production - dryland	30	102
	Production - irrigated	10,478	10,353
	Water - production ponded pastures	5,268	11,727
	Water storage and transport	2,233	1,978
	Not Mapped	868	586

3.3 Actual and potential impacts from key activities

Based on analysis of coastal ecosystems and land use mapping, the main impacts to the World Heritage Area from land use in the Don basin is primarily associated with land cleared for grazing and agricultural use. There is however some potential future developments (such as the Abbot Point expansion and associated infrastructure) may have further impacts on coastal ecosystems and on the World Heritage Area.

Forestry

There is very little forestry within the Don basin. Forestry reduced from 222 hectares in 1999 to 62 hectares in 2009. Of this, 160 hectares within the coastal zone in 1999 has now been included into surrounding protected areas. The remaining extent of forestry is unlikely to pose any significant threat to the World Heritage Area.

Grazing natural vegetation

Dryland grazing within natural areas is the major land use (almost 300,000 hectares) within the upper parts of the basin as well as some of the coastal areas. Non-native pasture grasses introduced for grazing have become a problem in some areas. These South American and African grasses generate extremely hot fires which can kill otherwise fire tolerant native trees. Managed grazing can be used in affected areas to mitigate the fire risk (Figure 3.3.1).

Figure 3.3.1: Introduced grasses along a creek line where cattle are excluded pose a fire risk for native trees, as evident by scorched dead trees in the background

Over-grazing of land often leads to erosion, especially bank/gully erosion (Figure 3.3.2) which contributes to increasing sediment loads being discharged into the World Heritage Area.

Figure 3.3.2: Bank erosion observed in an upland tributary of the Don River

Intensive animal production

There is an aquaculture facility in the Don basin coastal zone approximately 40 km north-west of Bowen which produces black prawns. This farm is located on saltpans and channels have been constructed that have resulted in the bunding of an area and exclusion of tidal ingress into a large area of adjacent saltpan.

Intensive commercial

There are two main pockets of intensive commercial activity within the basin. The majority of commercial infrastructure is associated with the township of Bowen but there is also a large amount of commercial infrastructure associated with the Abbot Point coal loading facility.

There is currently an approval to expand the Abbot Point port development (Table 3.3.1). [28] The construction and operation of a new rail line from Goonyella Riverside Mine Complex to the Port of Abbot Point near Bowen. The rail link is expected to transport approximately 60 million tonnes per annum of coal for export. It would be approximately 250-290 km in length and in the order of 1700 hectares may be disturbed during construction. The Marine Park is in close proximity to the northern end of the rail line. Three threatened ecological communities, 34 listed threatened species and 43 migratory species have been identified for the area covered by this project. The referral under the EPBC Act 1999 concluded that the project is likely to have significant impacts and should be assessed as a controlled action.

Table 3.3.1: Details of the Port of Abbot Point

No. of Ports	Trading Ports	Cargo	Number of berths		Number of vessel visits (per annum)	Coal export capacity (million tonnes/year)
			Current	*Proposed additional*	*Current*	*Current*
2	Port of Abbot Point	Coal	2	6	190	50

Ports, port infrastructure and associated shipping can all potentially contribute to the input of a range of heavy metals (from antifoulant paints for example), hydrocarbons and other pollutants into the marine environment. Shipping movements are also a potential risk to the World Heritage Area and its flora and fauna. For more information on this risk and water quality information refer to Appendix G. An environmental management plan has been published by North Queensland Bulk Ports Corporation Limited in 2010 providing an assessment of the environment surrounding the Port of Abbot Point.[18]

Intensive Mining

There has been a small increase in mining within the basin. There is a salt farm near the Bowen CBD which accounts for all the intensive mining within the basin, however there is a large amount of infrastructure associated with mining in the adjacent Burdekin basin at Collinsville. The mining at Collinsville is transported by rail through the Don basin and exported from the Port of Abbot Point (Figure 3.3.3).

Figure 3.3.3: Coal machinery at the Port of Abbot Point

Intensive Urban Residential

The major urban residential areas are Bowen, Merinda and Guthalungra. Bowen comes under the Whitsunday Shire council which promotes water sensitive urban design in new developments and is also currently a Reef Guardian council. The Bowen urban footprint is likely to expand as a result of the development of the Port at Abbot Point. Any urban expansion will be likely to impact on the adjacent coastal waters and should employ water sensitive urban design principles.

Production – dryland

There is only one square kilometre of dryland production - a small scale horticulture farm. This is unlikely to have any significant impact on the World Heritage Area.

Production – irrigated

Irrigated production represents the second largest land use in the Don basin and includes sugar cane and crops such as tomatoes (Figure 3.3.4). The extent of irrigated production is limited by water supply, with irrigated croppers using either ring tanks (water storage dams filled from streams) or bore irrigation. A proposal to supply water from the Burdekin Dam (if approved) would open up the region to widespread irrigated production. Impacts from this irrigation could potentially be on par with those experienced in the lower Burdekin floodplain (refer to the Haughton basin assessment) and may have catastrophic impacts on the adjacent marine environment.

Figure 3.3.4: Irrigated tomatoes grown in the Don basin

During the field assessment in December 2012 large areas of clearing of the fertile floodplain were observed in preparation for cropping (Figure 3.3.5). At this stage topsoil is vulnerable to erosion.

Figure 3.3.5: Extensive clearing of land in preparation for cropping

Unlike the Haughton basin to the north, the lack of water infrastructure has led to low levels of water use. This practice results in much less run-off, and therefore less nutrients, sediment and pesticide delivery into adjacent waterways and ultimately the World Heritage Area. During field observations healthy deep water pools were observed in streams located adjacent to cane fields (Figure 3.3.6). In theory, these properties would only contribute these elements to the waterways during periods of heavy rainfall or flooding.

Figure 3.3.6: A small stream adjacent to a cane field with a diverse range of submerged and emergent aquatic plants and native fish

Water-marsh/wetland production

Marsh wetland production is a dominant land use within the coastal areas of the Don basin. Between 1999 and 2009 wetland marsh production has doubled mostly through recognition in more recent land use mapping, changing from water storage within the coastal zone to marsh/wetland production.

There is evidence of bunding in the lower floodplain which is aimed at increasing the area of land suitable for cattle grazing. The area around Yellow Jin Creek and Wunjunga property was investigated as part of a field survey in October 2012 and large areas of salt pan were observed to be bunded. Figure 3.3.7 shows a classic bund wall with saltpan vegetation on the right and pasture grass on the left suitable for cattle grazing. These bundwalls, when located close to the tidal interface, can reduce inshore productivity. Away from the coastal zone, these bundwalls can sometimes serve as wetlands, replenishing groundwater and providing habitat for birds.

Figure 3.3.7: Bund wall (ponded pasture) at Wunjunga (photo: Jim Tait)

Water– intensive use and water–storage and treatment

All of the smaller town centres in the Don basin are currently unsewered. Table 3.3.2 outlines the status of wastewater treatment in the main urban centres in the Don basin.

Table 3.3.2: Status of wastewater treatment in the Don basin

Urban centre	Wastewater treatment
Bowen	Unknown
Guthalungra	Unsewered
Gumlu	Unsewered

PART B: OUTCOMES OF BASIN ASSESSMENT

Chapter 4: Projected condition of Great Barrier Reef catchment values

4.1 Summary of current state of coastal ecosystems

Coastal ecosystems in the Don basin have been modified. During the 1960s to 1980s, the Brigalow Scheme promoted widespread clearing of vegetation and encouraged agricultural development. Coastal ecosystems most affected were forests, woodlands, grass and sedgelands, heath and shrublands, forested floodplains and freshwater wetlands (Table 4.1.1). In the coastal zone, estuaries (saltmarsh, saltpan) in some areas have been bunded for the purposes of ponded pastures.

Table 4.1.1: Percentage of remaining coastal ecosystems in the Don basin, Don basin coastal zone and the Don basin floodplain. Orange cells indicate areas with 10-30 per cent remaining; yellow 31-50 per cent and green greater than 50 per cent. Note these figures provide no information about ecosystem condition or functionality

Percentage remaining of coastal ecosystems in the Don basin	Rainforests	Forests	Woodlands	Forested floodplain	Grass and sedgelands	Heath and shrublands	Freshwater wetlands	Estuaries
Basin wide	96	66	75	78	24	76	56	95
Floodplain	92	31	53	73	28	73	68	95
Coastal Zone	92	41	61	68	22	73	65	95

Overall, the remaining coastal ecosystems within the Don basin are in relatively good condition. This assessment is based upon:

- Much of the basin is under grazing regimes which, if managed to best practice, will minimise any impacts on the World Heritage Area.
- There are no major dams or weirs on any of the waterways within the Don basin to impede connectivity. There are however some impediments to flow caused by sand chokes in some of the rivers most likely as a result of legacy issues from historic land clearing and poor grazing management. Rivers affected include the Don River and Euri Creek.
- The condition of wetlands visited in this basin assessment showed that the wetlands (even those bounded by production land) were in good overall condition. This is likely influenced by the limited availability of water for irrigation which promotes sustainable use and recycling, and limits the extent of agriculture.
- Some of the waterways visited showed signs of management activities focused on restoring ecosystem health. Saltwater Creek in the north of the Don basin for example (Figure 2.3.10) showed evidence of recent spraying of emergent weeds.

Between 2006 and 2009, 139 hectares of coastal ecosystems were modified: 32 hectares of forest, 26 hectares of woodlands, 17 hectares of forested floodplain, 37 hectares of grass and sedgelands and 27 hectares of heath and shrublands. The current state of coastal ecosystems in the Don basin is summarised in Table 4.1.2.

Table 4.1.2: Summary of the current state of coastal ecosystems in the Don basin

Coastal ecosystem	Current condition
Rainforests	Status is good.
Forests	Heavily impacted with 66 per cent remaining, much of which is used for grazing. Only 41 per cent of forests on the floodplain and 31 per cent of forests in the coastal zone remain.
Woodlands	Reduced in extent by 25 per cent with much of the remainder under grazing regimes. Greater losses in the floodplain and coastal zone.
Forested floodplain	Reduced in extent by 21 per cent. Areas surrounding remaining forested floodplains have been modified. Condition not assessed.
Grass and sedgelands	Extensively modified with only 24 per cent remaining. Remnant grass and sedgelands impacted by water from irrigation and land modification. 22 per cent loss in the floodplain and 28 per cent loss in the coastal zone.
Heath and shrublands	Reduced in extent by 24 per cent. Most remnant heath and shrublands are buffered by other remnant coastal ecosystems or protected areas.
Freshwater wetlands	Almost half of the Don basin wetlands have been modified. Remaining wetlands assessed appear to be in a reasonable condition.
Estuaries	Mangrove systems are mostly intact and in near pristine condition. Saltmarsh/saltpans have been modified with bund walls for ponded pastures are not reflected in these figures.

4.2 Outline of key current and likely future pressures and impacts on coastal ecosystems in the Don basin

Table 4.2.1 provides a brief summary of the current pressures and future outlook for coastal ecosystems in the Don basin. There are two activities that will likely impact on the health and resilience of coastal ecosystems in the Don basin into the future. These are the Abbot Point expansion and potential irrigation from the Burdekin Dam.

The Abbot Point expansion has received approval and construction has commenced. This work is likely to lead to a short term increase in the demand for residential dwellings.

The water for Bowen project proposed an open irrigation channel to provide water to the Don basin. The project was abandoned in 2011 due to lack of financial viability. If this project were to proceed, there is a significant risk of declining water quality as a result of run-off from irrigated production.

Table 4.2.1: Summary of the current pressures and future outlook for coastal ecosystems in the Don basin

Pressure	Current status (1999-2009)	Description	Future outlook	Description
Urban development	Increase	Urban residential increased by 128% (approximately 100% for the coastal zone) between 1999 and 2009.	Increase	Urban centres are expected to increase further with the Abbot Point coal terminal expansion.
Port development	No change	No data	Increase	Major expansion proposed for Abbot Point.
Agriculture (production)	Decrease	Agriculture production (dryland and irrigated) has declined by 6% between 1999 and 2009.	No significant change expected	Agricultural production is currently restricted by the availability of water. Unlikely to expand significantly unless water infrastructure is improved.
Irrigation infrastructure	No change	No additional water infrastructure.	Uncertain	Water for Bowen pipeline cancelled due to lack of financial viability. Agricultural production is currently restricted by the availability of water. Unlikely to expand significantly.
Grazing	Increase	Grazing has increased by 2% between 1999 and 2009.	Uncertain	Subject to market demands.
Introduced weed species	Uncertain	Weeds are well established throughout the basin.	Uncertain	Ongoing control programs for weed management in place however climate change impacts are uncertain and may encourage proliferation of some weed species. Expansion of irrigation infrastructure may increase extent of aquatic and terrestrial weeds.
Climate Change	Uncertain	Not assessed.	Increase	Increasing intensity of episodic events, droughts and

Pressure	Current status (1999-2009)	Description	Future outlook	Description
				changes in rainfall patterns all likely to impact on coastal ecosystems.
Vegetation removal	Minimal change	The introduction of the *Vegetation Management Act 1999* provided a regulatory framework for broad-scale land clearing across Queensland. Since its introduction, the rate of vegetation clearance in the basin has significantly declined.	Uncertain	Amendments proposed for the *Vegetation Management Act 1999.*

Vegetation removal

The introduction of the *Vegetation Management Act 1999* and the *Sustainable Planning Act 2009* now regulates vegetation clearing on approximately 95 per cent of Queensland by triggering assessment and applying penalties for non-approved clearing. The *Vegetation Management Act 1999* also provides mapping of areas of conservation significance through Regional Ecosystems. Regrowth vegetation (especially riparian) is provided some protection. However, this legislation does not provide protection to mangroves, grasses, non-woody vegetation or plants within some grassland ecosystems. Marine plants such as mangroves, saltmarsh and saltcouch are provided protection under the *Queensland Fisheries Act 1994*. Other legislation also applies depending on the location of the vegetation and the tenure of the land.

Climate change

The impacts of climate change will vary across the basin, with the highest threats to low-lying coastal areas and the floodplain. Future development planning needs to map and consider the risks of sea-level rise, storm surge and flooding before allowing for further development in the coastal zone and floodplain. The interaction of rising sea temperatures and ocean acidification will exacerbate the impacts from catchment run-off on inshore coral reef ecosystems.

Future high temperatures as a consequence of climate change will likely see a decline in intertidal, coastal and estuarine seagrass meadows in the World Heritage Area.[29] Ocean acidification as a result of increasing CO_2 on the other hand is expected to enhance seagrass production.[30]

Agriculture/grazing

The Reef Water Quality Protection Plan (Reef Plan) is a collaborative program of coordinated projects and partnerships designed to improve the quality of water on the Great Barrier Reef though improved land management in the Great Barrier Reef catchment. The plan is a joint Australian and Queensland Government initiative that specifically focuses on non-point-source pollution. This is where irrigation or rainfall carries pollutants such as sediments, nutrients and pesticides into waterways and the reef lagoon. Reef Plan sets targets for water quality and land management improvement, and identifies actions to improve the quality of water entering the reef. Initially established in 2003, the plan was updated in 2009.

Reef Rescue initiatives have been implemented in the Don River basin include grazing grants to promote better soil health, controls for gully and stream bank erosion, improve water quality through riparian fencing and spreading of waters to exclude stock from creeks and rivers. Water quality improvement grants are also attainable for growers that use effective chemical application rates, reduce off-farm run-off, and apply fertiliser in a precise manner to promote better soil health.

The Burdekin Bowen Integrated Floodplain Management Advisory Committee Inc. (BBIFMAC) promotes an integrated, strategic and community-driven approach to the management of natural resources within these regions. BBIFMAC supports the sustainable development of primary industries and the local economy for the long-term benefit of present and future generations through running, supporting and collaborating on various projects.

BBIFMAC has addressed concern regarding the current state of the Don River and engaged with the North Queensland Dry Tropics (NQ Dry Tropics) NRM group to address the problems faced by the Don River and to become involved with remedial actions.

4.3 Current and likely future impacts on coastal ecosystems and likely resultant impacts on the World Heritage Area

The Don basin has changed, and any management actions to improve the condition of the adjacent World Heritage Area need to consider this system as a whole. The key current and likely future impacts on coastal ecosystems and likely resultant impacts on the World Heritage Area are summarised in Table 4.3.1

The future prospects for the Don basin are largely dependent on the ability of natural resource managers to manage the balance between land and water use, and ecosystem health. If well managed, the potential to improve the health and resilience of wetland, estuarine and inshore coastal marine ecosystems (and the industries they support) are significant. Failure to address these problems will, however, continue to impact on coastal ecosystems and the species they support.

The Reef Water Quality Protection Plan (Reef Plan) is a collaborative program of coordinated projects and partnerships designed to improve the quality of water in the World Heritage Area though improved land management in Great Barrier Reef catchments. Reef Plan is a joint Australian and Queensland Government initiative that specifically focuses on non-point-source pollution. This is where irrigation or rainfall carries pollutants such as sediments, nutrients and pesticides into waterways and the Reef lagoon. Reef Plan sets targets for water quality and land management improvement, and identifies actions to improve the quality of water entering the World Heritage Area. Initially established in 2003, Reef Plan was updated in 2009 and 2013.

Table 4.3.1: Key current impacts and likely future impacts in the Don basin and the likely consequences for the World Heritage Area

Current impacts on Coastal Ecosystems	Trend 1999-2009	Current likely impacts as a result on the World Heritage Area	Future likely impacts on Coastal Ecosystems	Future likely impacts on the World Heritage Area
Broadscale clearing of coastal ecosystems for agriculture, urban or industry	Rates of clearing have declined as a result of the *Vegetation Management Act 1999.*	Loss of ecological process and connectivity, replacement of some ecological processes depending on the nature of the modified system.	Coastal ecosystems unlikely to be returned to their former state, however no further losses expected.	No change likely to occur.
Farm run-off	Improvements as a result of increasing rates of Best Management Practice uptake.	Improvements to water quality expected, although delayed due to lag effects. Changes in land use will not be obvious for a few years.	Dependant on extent of new horticulture and uptake of best management practice.	Water quality expected to improve over time.
Groundwater changes	Increasing salinity occurring in the basin.	Potential decline in biological and biogeochemical processes, changes to connectivity.	Over extraction of groundwater may lead to increases in salinity and loss of dry season refugia in waterways.	As for current impacts.
Stream/river bank erosion	Increasing as a result of extreme weather events. Legacy issues from historical clearing.	Increased in suspended sediments and turbidity in coastal waters; increase in sediment (sand) build up in waterways.	Management actions (e.g. Reef Plan) underway to restore riparian areas.	Likely to improve under uptake of Best Management Practice and restoration projects.
Declining water quality	Improvements in recent years.	Decline in inshore ecosystem health and resilience.	Likely to improve as a result of management actions targeted at improving water quality.	Improvements expected but will take time to take effect.
Barriers to fish migrations	Sand has built up in the Don River. No dams or weirs in this basin.	Reduction/loss of connectivity and fish passage.		As for current impacts.
Introduced terrestrial weeds	Established throughout the basin (mostly in modified landscapes).	Introduced grasses generate hotter fires that can destroy forest canopies and expose soil which can be eroded, especially when fires occur late in the dry season.	Eradication to date has been ineffective and many grasses are still used for pasture. Strategic basin scale management actions are needed to manage and control.	Likely to lead to increases in erosion and therefore more suspended sediments in the World Heritage Area unless management actions implemented.

Current impacts on Coastal Ecosystems	Trend 1999-2009	Current likely impacts as a result on the World Heritage Area	Future likely impacts on Coastal Ecosystems	Future likely impacts on the World Heritage Area
Changed overland hydrology	Most development/modification has occurred on the floodplain and coastal zone.	Changes to connectivity and water retention which has impacted on all ecological processes.	Development continues to occur on the floodplain and coastal zone	Likely decline in water quality and aquatic biodiversity in the World Heritage Area
Ponded pasture/wetland production	It became illegal to establish new ponded pastures in the coastal zone in 2001 (policy for development and use of ponded pasture).	Loss of connectivity and declines in fish productivity, blackwater, and the potential release of acid sulphate soils.	Plans to modify ponded pastures to improve ecosystem health	Improved productivity, ecosystem health and resilience

Seagrass

Coastal seagrass meadows are at greatest risk from impacts from the Don basin (predominantly water quality). Given recent seagrass losses[31] and the extensive seagrass meadows adjacent to this basin, this basin may be of high importance in long-term conservation planning for seagrass and seagrass associated species (such as dugong).

Water quality

The condition of coastal ecosystems, the ecosystem processes they provide and connectivity within the Don basin will reflect in water quality values that in turn determine the long-term health and resilience of the World Heritage Area. Water quality in this instance is used as a proxy for integrity of the basin. The Great Barrier Reef Outlook Report identified declining water quality as one of the greatest threats to the long-term health and resilience of the Great Barrier Reef. As a result, substantial investments have been made to improve land based practices with the goal of halting the decline in water quality.

Water quality sampling in the Don basin in the past has been limited. From the available water quality data (Table 4.3.2) some pesticides and herbicides have been detected, although most have been within water quality guidelines. The main pesticides of interest are herbicides, in particular residual herbicides that inhibit photosynthesis, referred to as PSII herbicides (for example atrazine, diuron). Pesticides, even at low concentrations, are a significant cause for concern. Of particular concern is the potential for compounding effects that these chemicals have on the health of the inshore reef ecosystem, especially when delivered with other water quality pollutants during flood events.[32]

There are no inshore marine monitoring programs for water quality or reef health adjacent to the Don basin.

Table 4.3.2: Pesticides/herbicides detected in ad hoc water samples taken from the Don basin

Element detected	Sampling date	Location	Is this within guideline values?
Atrazine	2006 flow event	Don River	Below ANZECC guidelines
Hexazinone	2006 flow event	Don River	Below ANZECC guidelines
Desethyl atrazine	2006 flow event	Don River	Below ANZECC guidelines
Hexazinone	2006/2007	Don River	Below ANZECC guidelines
Metolachlor	2006/2007	Don River	One sample exceeded ANZECC guideline
Hexazinone	January 24 2007	Euri Creek	Below ANZECC guidelines

The water quality discharged from the Don basin into inshore waters of the World Heritage Area varies between the sub-basins and changes seasonally. Higher concentrations are generally detected in the wet season compared to the dry season when flood plumes transport pesticides from the sub-basins into the marine environment. Herbicides that inhibit photosynthesis, in particular diuron, were frequently detected in inshore waters of the Great Barrier Reef. At times these herbicides were found up to 15 kilometres from the shore at concentrations that, when considered together, have the potential to affect marine organisms, such as seagrass and corals.

Most exceedences of water quality guideline values occur during episodic flood events and may last from a period of days to weeks. The level of nutrients, sediments, pesticides and herbicides carried into inshore coastal waters at these times will vary according to the land use occurring within the sub-basin. The impacts on the World Heritage Area will also vary depending on the water quality, the size of the flood plumes, the flow duration, levels of mixing with coastal marine waters and the exposure time of organisms to the plume water.

Figure 4.3.1 provides an example of the relationships between pressures, state and impact from increased pollutants being delivered to the Great Barrier Reef.[33] Note that these sequential impacts are linked primarily to nutrient loading scenarios, and do not define the cumulative impacts from increasing temperature and nutrients, or from other pollutants such as suspended sediment and pesticides. Recent work[34,35,36] indicates that the combined impacts of rising temperatures and increasing nutrients, particularly dissolved inorganic nitrogen (DIN), will result in reduced resilience of coral reefs to recover from more frequent bleaching events.[33]

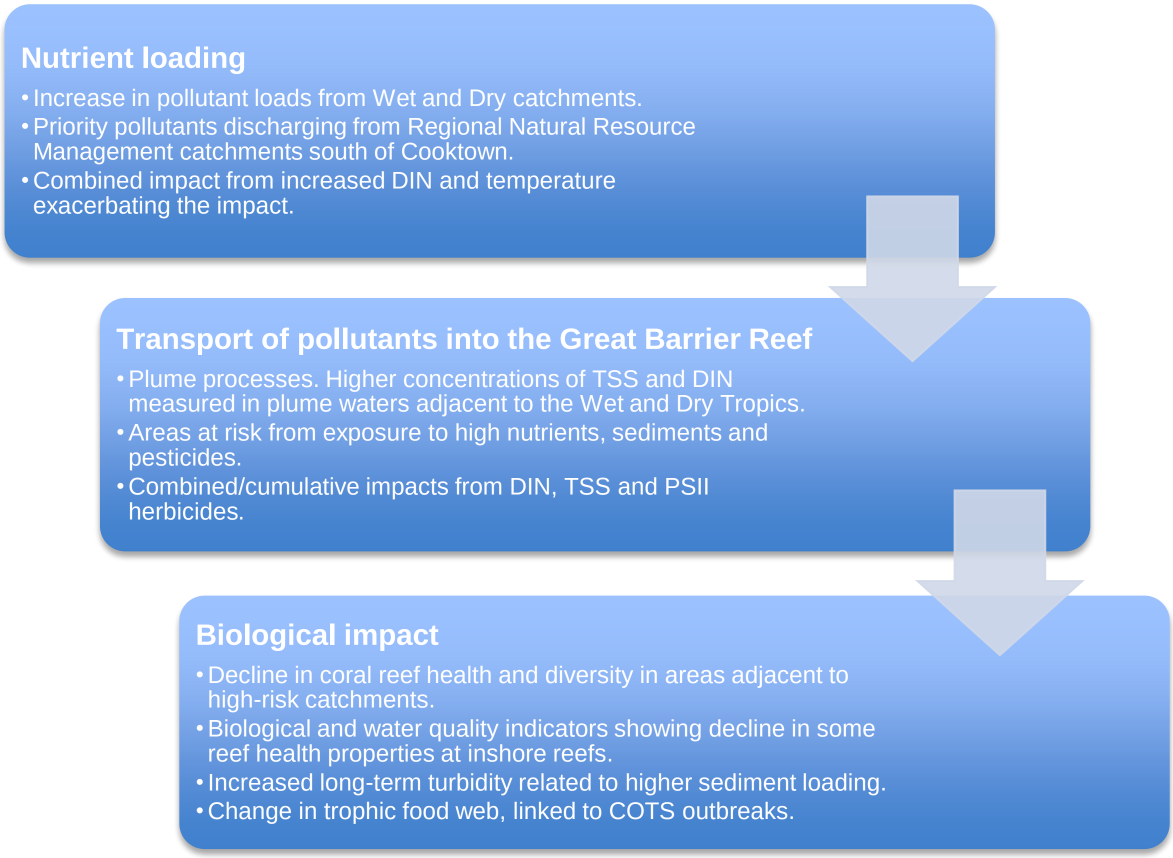


Figure 4.3.1: Pathway from nutrient enrichment to biological impact from total suspended solids (TSS); dissolved inorganic nitrogen (DIN); photosynthesis inhibiting herbicides (PSII); and crown-of-thorns starfish (COTS)

The impacts of increasing sediments and nutrients on coral reefs (Figure 4.3.2) and seagrass (Figure 4.3.3) include shading, reduced resilience and reduced recruitment.[33]

Abundances of a range of other reef associated organisms have also been shown to change along the water quality gradient.[33]

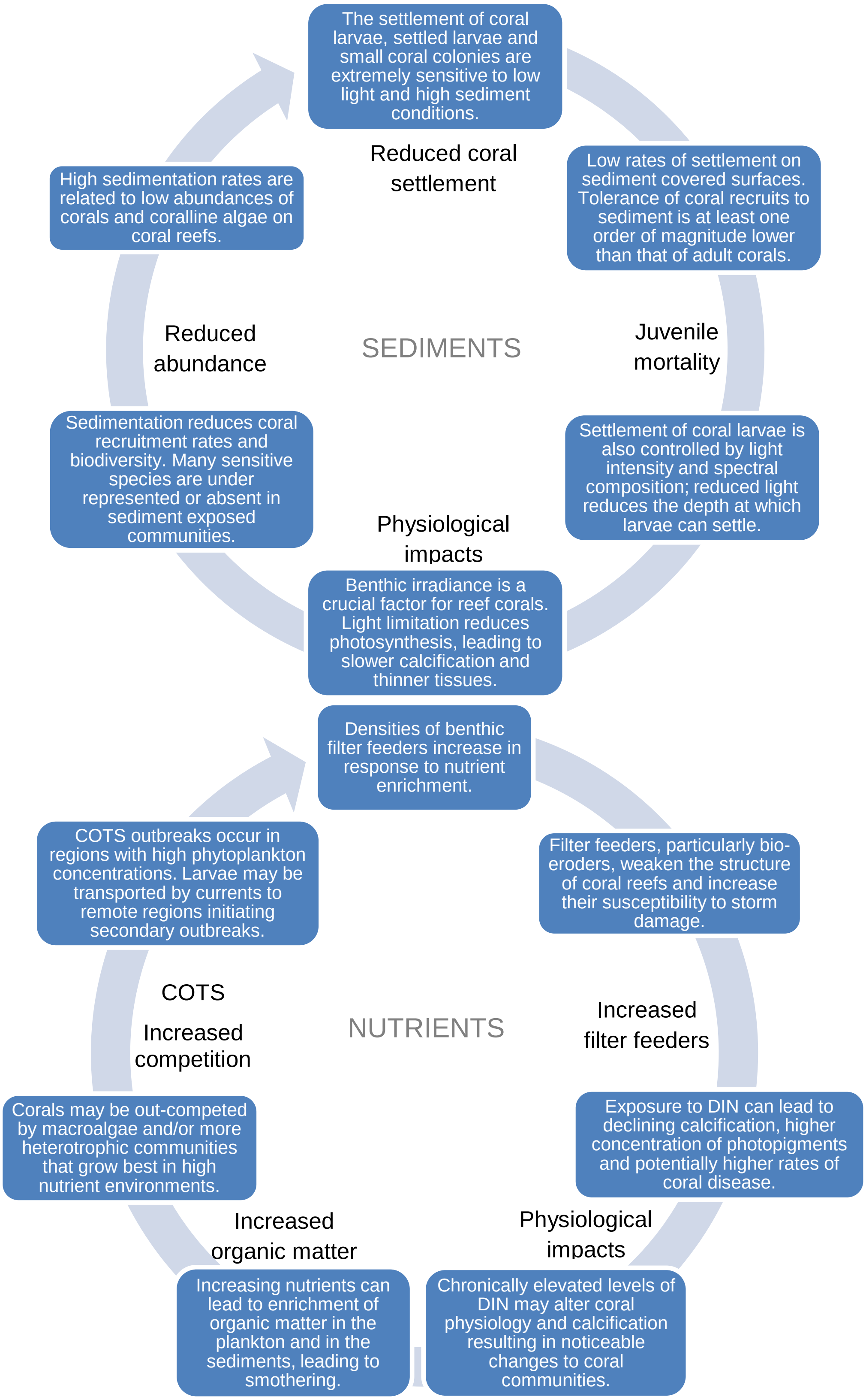
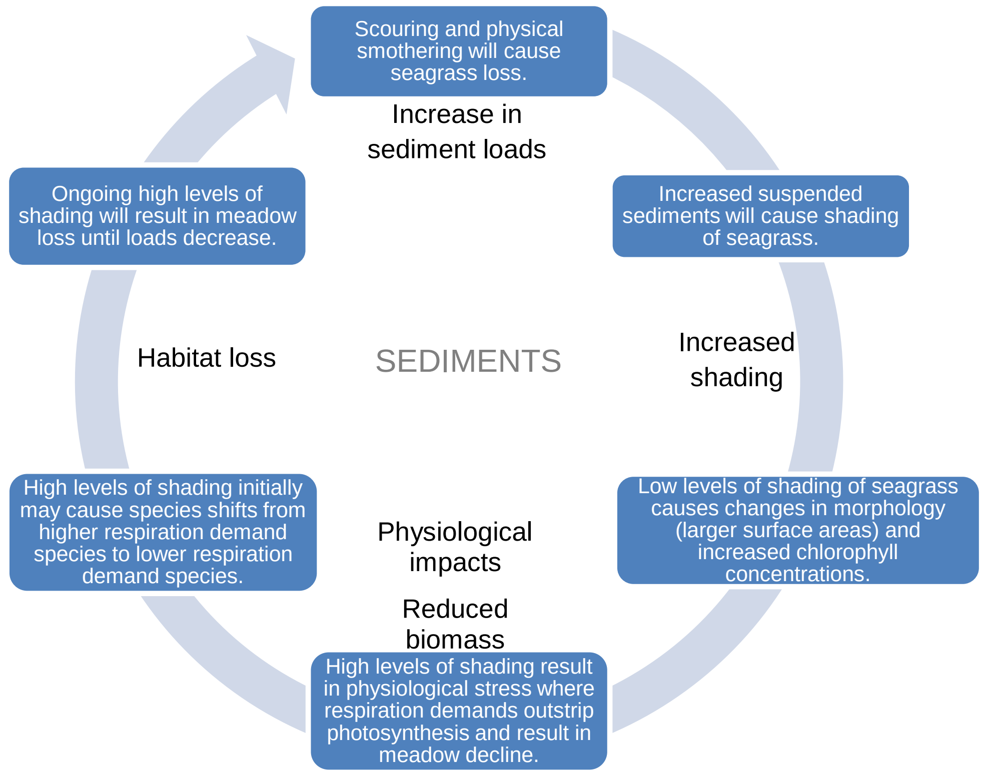


Figure 4.3.2: Potential and known impacts of increasing nutrients and sediments on coral reefs[33]



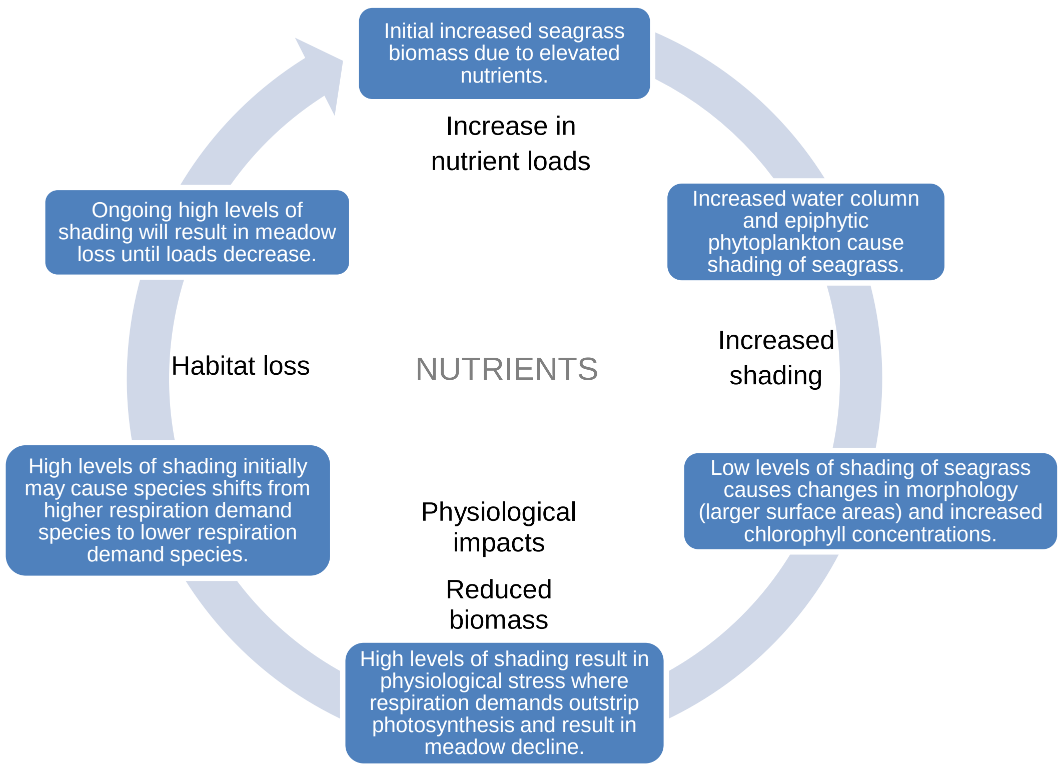


Figure 4.3.3: Potential and known impacts of increasing nutrients and sediments on seagrass beds[33]

The current best estimates of modelled loads leaving the Don River basin are provided in Table 4.3.3. The estimated loads have increased substantially from pre-development values. After the implementation of the Reef Rescue program in 2008, an improvement in load values was observed for most water quality parameters. For example, modelled suspended sediment export values from the Don River basin (Table 4.3.3) showed that the total export in 2008/2009 (330,000 t/yr) had increased almost 3-fold compared to pre-development loads (119,000 t/yr). However, after the implementation of the Reef Rescue program (2009/2010) values decreased to 327,000 t/yr, which is a 1.2 per cent improvement. Improvements for DON, DIP and DOP loads have not yet been observed. For further water quality information and associated impacts see Appendix G.

Table 4.3.3: Best estimates of modelled total pre-development values, current values and anthropogenic changes in water quality parameters. Reef Rescue values represent the values after the commencement of the Reef Rescue Program and Reef Rescue change represents the improvement (%) after implementation

	Pre-development	Current (2008/2009)	Current (2009/2010)	Anthropogenic Increase	Reef Rescue (2009/2010)	Reef Rescue change (%)	Total change (%)
TSS (kt/yr)	119	330	327	211	328	0.6	1.2
DIN (t/yr)	23	70	69	48	69	3.6	3.6
DON (kt/yr)	97	172	172	76	172	0	0
PN (t/yr)	181	443	438	262	440	1.1	1.9
TN (t/yr)	300	686	679	386	681	1.2	1.7
PSII (kg/yr)	0	69	66	69	66	3.9	3.9
DIP (t/yr)	8	16	16	7	0	0	0
DOP (t/yr)	8	14	14	6	0	0	0
PP (t/yr)	58	146	144	88	145	1.0	1.7
TP (t/yr)	74	176	175	102	175	0.9	1.5

4.4 Priorities for conservation and restoration

Coastal ecosystems located in the floodplain and coastal zone are those that have experienced the greatest losses and those most at risk in the future. Future conservation measures should include protection of these ecosystems from further loss and impacts and restoration efforts should focus on these areas. These areas are also the areas at greatest risk from flooding, storm and climate change impacts. High value infrastructure, such as residential and industrial development, should be avoided in these areas. Current infrastructure in these areas needs to be constructed and managed to current best practice.

As with much of the catchment, many of the issues affecting the health and resilience of the Marine Park adjacent to this basin stem from legacy issues such as broadscale vegetation clearing. Current legislation should prevent recurrence of many of these issues however management actions to recognise and rectify these problems are rare. Riverbank erosion is still occurring due to upstream channelisation, clearing, loss of riparian vegetation and weed species all of which reduce habitat for native species with connections to the Reef. While the rate of loss has been reducing over the last decade, riparian vegetation continues to decrease.[37,38]

Coastal ecosystems outside of these zones should be retained where possible.

Coastal zone

Coastal ecosystems in the coastal zone generally have the closest connections to the World Heritage Area and generally have a higher capacity to provide physical, biological and biogeochemical processes for the World Heritage Area. Some coastal ecosystems in the coastal zone also fall within the World Heritage Area. The coastal zone is also the area at greatest risk from the impacts of climate change. Actions that could be taken to reduce pressure on the coastal zone in the Don basin include:

- Limit further loss of remaining coastal ecosystems.
- Increased protection provided to remaining coastal ecosystems.
- Restore riparian corridors in this area to a standard that provides effective ecological functions. Any re-vegetation should include species adapted for future climate scenarios.
- Improve agricultural practices to current best practice standards and identify new practices where needed.
- Limit further intensive development in the coastal zone, particularly in intact areas. This will not only reduce environmental impacts, but may also reduce the risk of economic impacts resulting from future climate change, as scenarios predict that the coastal zone will be at greatest risk from sea-level rise and storm surge.
- Consistent with Queensland planning provisions, future urban developments that cannot be sited outside of the coastal zone should be constructed to current best practice, employing principles such as water sensitive urban design, gross pollutant traps and tertiary sewage treatment.
- Introduction of a comprehensive water quality and seagrass monitoring program to ensure long-term health and resilience of seagrass in the area.

Floodplain

Floodplains support particularly rich coastal ecosystems, especially in terms of diversity and abundance. These areas are important for the physical, biological and biogeochemical processes they provide for the long-term health and resilience of the World Heritage Area. Actions that can be taken to reduce pressure on the floodplain include:

- Limit further loss of remaining coastal ecosystems.
- Increased protection afforded to remaining coastal ecosystems.
- Restore riparian corridors in this area to a standard that provides effective ecological functions. Any revegetation should consider the appropriateness of using species adapted for future climate scenarios.
- Improve connectivity between remnant coastal ecosystems within the floodplain.

- Improve agricultural practices to current best practice standards and identify new practices where needed.
- Limit further intensive development in the floodplain. This will not only reduce environmental impacts, but may also reduce the risk of economic impacts resulting from future climate change, as scenarios predict that the floodplain will be at increased risk from flooding.
- Future urban developments that cannot be sited outside of the floodplain should be constructed to current best practice to minimise the impact of floodplain processes, employing principles such as water sensitive urban design, gross pollutant traps and tertiary sewage treatment.

Riparian zones and waterways

Riparian vegetation provides important physical, biological and biogeochemical processes essential for the long-term health and resilience of the World Heritage Area. Riparian vegetation slows water velocity and provides areas of nutrient cycling, fish habitat and pathways for fish passage and connectivity across the basin. Actions that can be taken to reduce pressure on the riparian zones include:

- Restore riparian corridors to a standard that provides effective ecological functions. Any revegetation should consider the appropriateness of using species adapted for future climate scenarios and should consider adjacent land use.
- Seek to protect or reinstate in-stream habitat to improve flow regulation and fish habitat structure.
- Introduced grass species that are compromising the health and resilience of the waterways should be controlled through appropriate means, including innovative alternatives such as controlled grazing regimes.
- Limit further construction of dams and weirs in this basin where they might impact on coastal ecosystems or the Marine Park.
- Further development adjacent to waterways should not increase point and non-point source pollutants entering waterways.

Wetlands

Wetlands provide habitat for many species with connections to the World Heritage Area and are often referred to as the ‘kidneys of the Reef’. Wetlands provide important physical, biological and biogeochemical processes that support the long-term health and resilience of the World Heritage Area. Actions that can be taken to reduce pressure on wetlands include:

- Limit further loss of wetlands.
- Improve connectivity between wetlands and the World Heritage Area, including maintaining or restoring environmental flows where appropriate.
- Increase protection of remaining wetlands.
- Restore wetlands where possible.
- Control and manage introduced species that compromise wetland health.

Other areas

Areas outside of the coastal zone and floodplain still provide some physical, biological and biogeochemical processes to the World Heritage Area. Actions that can be taken include:

- Appropriate restoration of riparian corridors to a standard that provides effective ecological functions.
- Encourage best practice management of agricultural activities, particularly in areas where riparian buffers are minimal or non-existent.
- Plan and manage new land use to have no net impact on the World Heritage Area values.

4.5 Potential management actions

This report has been developed as a baseline for the Don basin. In order to ensure that the basin is best represented, consideration of additional finer scale data, local knowledge and information will further enhance this assessment.

Ensuring the long-term health and resilience of the World Heritage Area requires greater protection of, and restoration of important ecological processes and functions provided by the Don basin coastal ecosystems. Actions that would increase protection and restore processes and function include:

1. Greater protection, restoration and management of remnant and riparian vegetation in the floodplain.
2. Greater protection, restoration and management of freshwater wetlands which have been reduced from 5307 hectares to 2965 hectares.
3. Restore connectivity of streams, rivers and waterways to improve fish passage.
4. Improve connectivity between remnant coastal ecosystems, with preference to the freshwater wetlands and associated floodplain ecosystems.
5. Manage modified coastal ecosystems to provide ecological functions and values that support the health of the World Heritage Area through the continued improvement in land management practices such as Reef Plan best practice initiatives for agriculture.
6. Limit the development of irrigated cropping in the basin to prevent the problems that are occurring in other basins (refer to the Haughton basin assessment) from impacting this area.

4.6 Knowledge gaps

The following knowledge gaps have been identified for the Don basin:

- Groundwater flows and groundwater dependent ecosystems have not been assessed for this basin.
- Water quality data is limited for this basin, which is of concern given the area contains many anthropogenic point and non-point sources of pollution. There are currently no long-term monitoring programs for the Don River catchment. Random and opportunistic monitoring has taken place on occasion during recent years. The pesticides that are largely used in the Don region have been identified and it has been proposed that longer term monitoring of loads will expand into the Don River region in the future.[39] Lewis and Glendenning (2009) assessed pesticide usage within key crops of the Bowen district, as well as emerging industries (cotton) in the wider Bowen/lower Burdekin regions for their risk of offsite movement and potential toxicity using the Pesticide Impact Rating Index (PIRI) semi-quantitative mode.[40,41]

This study highlighted the pesticides that should be focused on for monitoring programs, and includes atrazine (herbicide), S-metolachlor (herbicide), and chlorothalonil (fungicide). There are no studies to date examining the occurrence or impacts of micropollutants such as microplastics, heavy metals and pharmaceutical wastes in the Don Creek basin, and this is a research need.

- Impacts of water quality on inshore marine ecosystems.
- Implications of agricultural chemicals on the marine environment.
- Effectiveness of current marine monitoring sites. Current sites in this basin are limited to locations that provide ease of access and do not necessarily reflect monitoring at specific river mouths. Integrated monitoring of in-stream and river mouth water quality and ecosystem health would provide more pertinent information on the ability of remaining coastal ecosystems to provide services to maintain the health and resilience of the Great Barrier Reef.
- Freshwater water quality monitoring.

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Appendix A – Key Terminology used in this report

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. Defined by Queensland Government and may include many sub-basins.
Coastal zone:	Area of coast as defined by the *Coastal Protection and Management Act 1995* (Queensland)
Coastal Ecosystem:	Marine, estuarine, freshwater and terrestrial ecosystems that connect the land and sea and have the potential to influence the health and resilience of the Great Barrier Reef. For this study, this includes the Great Barrier Reef catchment and 10% of the Reef waters seawards of the coastline.
Ecosystem:	A dynamic complex of plant, animal and micro-organism communities and the non-living environment interacting as a functional unit. Source: Millenium Ecosystem Assessment 2005.[42]
Ecosystem function:	The interactions between organisms and the physical environment, such as nutrient cycling, soil development and water budgeting.
Inshore marine areas:	Include (but not limited to) those areas extending up to 20 km offshore from the coast and which correspond to enclosed coastal and open coastal water bodies as described in the *Water Quality Guidelines for the Great Barrier Reef Marine Park (2010)*.[43]
Great Barrier Reef catchment (catchment):	The 35 river basins in Queensland which drain into the Great Barrier Reef (Table 1).
Natural Resource Management (NRM) regions:	A group of basins managed by non-government organisations (NRM bodies) within Queensland (Table 1).
Natural Resource Management (NRM) bodies:	Non-government organisations focused on environmental and sustainable agriculture programs and activities.
Non Remnant:	Vegetation that does not meet the criteria of remnant vegetation as defined under the Vegetation Management Act 1999.
Pre-clear:	Queensland Government reconstruction of regional ecosystems to represent vegetation pre-European settlement.
Post-clear:	Queensland Government mapping of the state of regional ecosystems that occurred in 1999 and 2009.
Remnant vegetation:	Vegetation that meets all of 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 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. Some areas of Cape York have not been mapped.
Sub-basin	Smaller catchment area situated within a basin.
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.

Date	Basin Name	Latitude (-18.861499)	Camera No	Photo No

Appendix B – Field assessment template

Time	Way Point	Longitude (145.865234)	Photo no.
Team Members			
Experts			
Site Name			
Site Description			
Site Condition (circle): Excellent Good Average Poor Very poor Unknown			
Coastal Ecosystems: Coral Reef Open Water Lagoon Floor Seagrass Coastline Estuaries Freshwater Wetlands Mangroves Saltmarshes Heath and Shrublands Grass and sedgelands Forested Floodplain Woodlands Forests Rainforests			
Condition: intact fragmented cleared other			
Landuse: **Conservation and natural environments** (inc wetlands), **Forestry:** dryland or irrigated plantation, **Grazing:** dryland, irrigates or natural vegetation **Intensive:** commercial, mining, animal production, urban residential **Production:** dryland or dryland sugar, Production forestry, **Water:** marsh wetland production or intensive use, water storage and treatment, uncertain			
Direct Impacts (threats):			
Direct Impacts (threats):			
Indirect Impacts / Threats:			
MNES or threatened species			
Other Information			

Appendix C – Values and their elements that underpin matters of national environmental significance

Values and their elements that underpin matters of environmental significance	Matters of national environmental significance (MNES)						
	World Heritage Properties	National heritage places	Wetlands of international importance	Listed threatened species and ecological communities	Listed migratory species	Commonwealth marine areas	Great Barrier Reef Marine Park
Biodiversity - Habitats							
Islands	✓	✓				✓	✓
Beaches and coastlines	✓	✓				✓	✓
Mangroves	✓	✓				✓	✓
Seagrass meadows	✓	✓				✓	✓
Coral reefs (<30m)	✓	✓				✓	✓
Mesophotic (deep water) corals	✓	✓				✓	✓
Lagoon floor	✓	✓				✓	✓
Shoals	✓	✓				✓	✓
Halimeda banks	✓	✓				✓	✓
Continental slope	✓	✓				✓	✓
Open waters	✓	✓				✓	✓
Saltmarshes	✓	✓	✓			✓	✓
Freshwater wetlands	✓	✓	✓			✓	✓
Forest floodplain	✓	✓				✓	✓
Heath and shrublands	✓	✓				✓	✓
Grass and sedgelands	✓	✓	✓			✓	✓
Woodlands	✓	✓				✓	✓
Forests	✓	✓				✓	✓
Rainforests	✓	✓		✓		✓	✓
Biodiversity - Species							
Dune & saltmarsh plants	✓	✓					
Mangroves	✓	✓				✓	✓
Seagrasses	✓	✓				✓	✓
Macroalgae	✓	✓				✓	✓
Benthic microalgae	✓	✓				✓	✓
Corals	✓	✓				✓	✓
Seahorses and allies	✓	✓				✓	✓
Other invertebrates	✓	✓				✓	✓
Plankton and microbes	✓	✓				✓	✓
Bony fish	✓	✓				✓	✓
Sharks and rays	✓	✓		✓	✓	✓	✓
Sea snakes	✓	✓				✓	✓
Marine turtles	✓	✓		✓	✓	✓	✓
Estuarine crocodile	✓	✓			✓	✓	✓

Values and their elements that underpin matters of environmental significance	Matters of national environmental significance (MNES)						
	World Heritage Properties	National heritage places	Wetlands of international importance	Listed threatened species and ecological communities	Listed migratory species	Commonwealth marine areas	Great Barrier Reef Marine Park
Seabirds	✓	✓		✓	✓	✓	✓
Shorebirds	✓	✓		✓	✓	✓	✓
Whales	✓	✓		✓	✓	✓	✓
Dolphins	✓	✓			✓	✓	✓
Dugongs	✓	✓				✓	✓
Ecosystem Processes – Physical processes							
Ocean currents	✓	✓				✓	✓
Cyclones & wind	✓	✓				✓	✓
Freshwater inflow	✓	✓				✓	✓
Sedimentation	✓	✓	✓			✓	✓
Sediment re-suspension	✓	✓				✓	✓
Sea level	✓	✓				✓	✓
Sea temperature	✓	✓				✓	✓
Light	✓	✓				✓	✓
Aquatic connectivity	✓	✓	✓				
Ecosystem Processes – Geomorphological processes							
To be determined (SEWPaC advice)							
Ecosystem Processes – Chemical processes							
Nutrient cycling	✓	✓	✓			✓	✓
Pesticide accumulation	✓	✓	✓			✓	✓
Ocean acidity	✓	✓				✓	✓
Ocean salinity	✓	✓				✓	✓
Ecosystem Processes – Ecological processes							
Microbial processes	✓	✓				✓	✓
Particle feeding	✓	✓				✓	✓
Primary production	✓	✓	✓			✓	✓
Herbivory	✓	✓				✓	✓
Predation	✓	✓				✓	✓
Symbiosis	✓	✓				✓	✓
Bioturbation	✓	✓				✓	✓
Reef building	✓	✓				✓	✓
Competition	✓	✓				✓	✓
Ecological connectivity	✓	✓	✓			✓	✓
Recruitment	✓	✓	✓			✓	✓
Heritage – Outstanding Universal Value							
Superlative natural phenomena, exceptional natural beauty and aesthetic importance (Criterion VII)	✓	✓					
Geological processes and geomorphic	✓	✓					

Values and their elements that underpin matters of environmental significance	Matters of national environmental significance (MNES)						
	World Heritage Properties	National heritage places	Wetlands of international importance	Listed threatened species and ecological communities	Listed migratory species	Commonwealth marine areas	Great Barrier Reef Marine Park
features (Criterion VII)							
Ecological and biological processes (Criterion IX) See Ecosystem Processes	✓	✓					
Natural habitats for conservation of biodiversity (Criterion X) See Biodiversity - Habitats	✓	✓					
Integrity	✓	✓					
Heritage – Natural							
See Biodiversity and Ecosystem Processes above							
Heritage – Indigenous							
Cultural practices, observances and customs						✓	✓
Sacred sites, sites of significance, places for cultural tradition						✓	✓
Stories, song lines and marine totems	✓	✓				✓	✓
Indigenous structures, tools and archeaology	✓	✓				✓	✓
Places of historic significance - Indigenous						✓	✓
Places of aesthetic value - Indigenous						✓	✓
Heritage – Non-Indigenous							
Places of historic significance – historic shipwrecks						✓	✓
Places of historic significance - World War II features and sites						✓	✓
Places of historic significance - lighthouses						✓	✓
Places of historic significance – other						✓	✓
Places of scientific significance (research stations, expedition sites)						✓	✓
Places of aesthetic value See OUV - Criterion VII	✓	✓				✓	✓
Places of social significance – iconic sites						✓	✓
Community benefits derived from the Great Barrier Reef Region							
Income	✓	✓				✓	✓
Employment	✓	✓				✓	✓
Understanding and appreciation	✓	✓				✓	✓
Enjoyment						✓	✓
Access to Reef resources						✓	✓
Personal attachment						✓	✓
Social relationships						✓	✓

Values and their elements that underpin matters of environmental significance	Matters of national environmental significance (MNES)						
	World Heritage Properties	National heritage places	Wetlands of international importance	Listed threatened species and ecological communities	Listed migratory species	Commonwealth marine areas	Great Barrier Reef Marine Park
Health benefits						✓	✓

Appendix D – Threatened species of the Don basin

Birds

Erythrotriorchis radiatus
Fregetta grallaria grallaria
Geophaps scripta scripta
Neochmia ruficauda ruficauda
Poephila cincta cincta
Rostratula benghalensis (sensu lato)

Frogs

Taudactylus eungellensis

Mammals

Dasyurus hallucatus
Megaptera novaeangliae
Phascolarctos cinereus (combined populations of QLD, NSW and the ACT)
Rhinolophus philippinensis (large form)
Saccolaimus saccolaimus nudicluniatus
Xeromys myoides

Other

Cycas ophiolitica

Plants

Aristida granitica
Croton magneticus
Eucalyptus raveretiana
Leucopogon cuspidatus
Omphalea celata
Ozothamnus eriocephalus
Streblus pendulinus
Taeniophyllum muelleri
Tylophora williamsii

Reptiles

Caretta caretta
Chelonia mydas
Delma labialis
Dermochelys coriacea
Eretmochelys imbricata
Lepidochelys olivacea
Natator depressus

Appendix E – Migratory species of the Don basin

Aves (Birds)
Bar-tailed Godwit
Black-faced Monarch
Black-tailed Godwit
Cattle Egret
Curlew Sandpiper
Eastern Curlew
Fork-tailed Swift
Great Egret, White Egret
Great Knot
Greater Sand Plover, Large Sand Plover
Grey-tailed Tattler
Lesser Sand Plover, Mongolian Plover
Little Curlew, Little Whimbrel
Marsh Sandpiper, Little Greenshank
Pacific Golden Plover
Painted Snipe
Red Knot, Knot
Red-necked Stint
Ruddy Turnstone
Rufous Fantail
Sanderling
Sarus Crane
Satin Flycatcher
Sharp-tailed Sandpiper
Spectacled Monarch
Whimbrel
White-bellied Sea-Eagle
White-throated Needletail
Mammalia (Mammals)
Dugong
Humpback Whale
Reptilia (Reptiles)
Flatback Turtle
Green Turtle
Hawksbill Turtle
Leatherback Turtle, Leathery Turtle, Lute Turtle
Loggerhead Turtle
Olive Ridley Turtle, Pacific Ridley Turtle
Salt-water Crocodile, Estuarine Crocodile

Appendix F – Ecological processes

Ecological processes of natural coastal ecosystems linked to the health and resilience of the Great Barrier Reef. Islands have been excluded as they vary considerably between island types.

Process	Ecological Service	Coral Reefs	Lagoon floor	Open water	Seagrass	Coastline	Estuaries	Freshwater wetlands	Forest floodplain	Heath and shrublands	Grass and sedgelands	Woodlands	Forests	Rainforests
	Physical processes- transport and mobilisation													
Recharge/discharge	Detains water						MH	H	✓					
	Flood mitigation						M	✓	H		L			
	Connects ecosystems						✓	H	H					
	Regulates water flow (groundwater, overland flows)	H	L		✓	✓	MH	H	✓		L	MH	MH	H
Sedimentation/ erosion	Traps sediment	M	MH	ML	M		H	H			L	MH	MH	MH
	Stabilises sediment from erosion		✓		M	H	✓	✓	✓	✓	L	MH	MH	M
	Assimilates sediment					✓	✓	H				MH	MH	H
	Is a source of sediment							M				MH	MH	
Deposition and mobilisation processes	Particulate deposition & transport (sed/nutr/chem. etc.)							H						
	Material deposition & transport (debris, DOM, rock etc.)							H						
	Transports material for coastal processes							H						
	Biogeochemical Processes – energy and nutrient dynamics													
Production	Primary production	✓	✓	H	H	✓	H	H				M	M	H
	Secondary production				H	✓	H	✓						
Nutrient cycling (N, P)	Detains water, regulates flow of nutrients							H						
	Source of (N,P)				M	L	H					M	M	H
	Cycles and uptakes nutrients	L	H	H	M	L	H	MH		✓	✓			
	Regulates nutrient supply to the reef				M	L	H	M	H			M	M	H
Carbon cycling	Carbon source				M	L	H	H						H

	Sequesters carbon	✓	H	L	M	L	H	H	✓					
	Cycles carbon	L	H	H	M	L	H					H	H	H
Decomposition	Source of Dissolved Organic Matter						H	H						H
Oxidation-reduction	Biochar source											H	H	
	Oxygenates water		H	H		L	✓							
	Oxygenates sediments		✓		M	L	✓							
Regulation processes	pH regulation				M			H						
	PASS management						H	H						
	Salinity regulation													
	Hardness regulation							H						
	Regulates temperature					✓	✓	✓	✓					ML
Chemicals/heavy metal modification	Biogeochemically modifies chemicals/heavy metals	L			M		✓	H						
	Flocculates heavy metals						✓	H						
Biological processes (processes that maintain animal/plant populations)														
Survival/reproduction	Habitat/refugia for aquatic species with reef connections	H	M	L	✓	H	H	H		✓				
	Habitat for terrestrial species with connections to the reef	H						H						
	Food source		✓		H	✓	✓	✓		H				
	Habitat for ecologically important animals	H	✓		H	L	H			✓	✓			
Dispersal/ migration/ regeneration	Replenishment of ecosystems – colonisation (source/sink)	H			H	M	H	H						
	Pathway for migratory fish							H						
Pollination														
Recruitment	Habitat contributes significantly to recruitment	H			H	H	H	H		H				

Capacity of natural coastal ecosystems to provide ecological functions for the Great Barrier Reef[44]

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.

Ecological processes of modified systems linked to the health and resilience of the Great Barrier Reef. Islands have been excluded as they vary considerably between island types.

Process	Ecological Service	Groundwater Ecosystems	Irrigated agriculture	Non-irrigated agriculture	Dams & Weirs	Urban	Mining – operational open cut	Forestry Plantation	Extensive agriculture	Ponded pastures
	Physical processes- transport & mobilisation									
Recharge/Discharge	Detains water	✓[1]	M			L	M		H	
	Flood mitigation	✓	N			L	X		X	
	Connects ecosystems	H	L			L	N		L	
	Regulates water flow (groundwater, overland flows)	H	M			L	L		M	
Sedimentation/ erosion	Traps sediment	N	M[4]			L	M		H	
	Stabilises sediment from erosion	✓	M[4]			H	N		H	
	Assimilates sediment		M			L	N		H	
	Is a source of sediment		L			L[11]	M		L	
Deposition & mobilisation processes	Particulate deposition & transport (sed/nutr/chem. etc.)	✓[2]	L			L	L		H	
	Material deposition & transport (debris, DOM, rock etc.)		L			L	L		L	
	Transports material for coastal processes		N			M	L			
	Biogeochemical Processes – energy & nutrient dynamics									
Production	Primary production	N							M	
	Secondary production	✓[3]							H	
Nutrient cycling (N, P)	Detains water, regulates flow of nutrients	✓							M[13]	
	Source of (N,P)	✓							M	
	Cycles and uptakes nutrients	✓							H	
	Regulates nutrient supply to the reef	✓							H	
Carbon cycling	Carbon source	✓							M	
	Sequesters carbon	✓							MH	
	Cycles carbon	✓							H	
Decomposition	Source of Dissolved Organic Matter	✓							L[14]	
Oxidation-reduction	Biochar source								X	
	Oxygenates water	N							L	
	Oxygenates sediments	N							✓[15]	

Process	Ecological Service	Groundwater Ecosystems	Irrigated agriculture	Non-irrigated agriculture	Dams & Weirs	Urban	Mining – operational open cut	Forestry Plantation	Extensive agriculture	Ponded pastures
Regulation processes	pH regulation	✓							✓$_{15}$	
	PASS management								L	
	Salinity regulation								✓$_{15}$	
	Hardness regulation								✓$_{15}$	
	Regulates temperature								L_{16}	
Chemicals/heavy metal modification	Biogeochemically modifies chemicals/heavy metals	✓							X_{17}	
	Flocculates heavy metals	✓							L	
	Biological processes (processes that maintain animal/plant populations)									
Survival/reproduction	Habitat/refugia for aquatic species with reef connections	N	L_5	L_5	L_8	L_{12}	N	N	L	M_{18}
	Habitat for terrestrial species with connections to the reef	N	L	L	H_9	L	N	N	L	L_{19}
	Food source	N	N	N	M	L	N	L	M	L
	Habitat for ecologically important animals		N	N	L_{10}	N	N	N	M	L_{19}
Dispersal/ migration/ regeneration	Replenishment of ecosystems – colonisation (source/sink)	N	N	N	L	N	N	N	M	L_{20}
	Pathway for migratory fish	-	N_6	N_6	L_8	N	N	N	✓$_{15}$	L_{21}
Pollination		-	L_7	L_7	N		N			
Recruitment	Habitat contributes significantly to recruitment		N	N	L	N	N	N	M	N

Capacity of natural coastal ecosystems to provide ecological functions for the Great Barrier Reef[44]

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); 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 run-off; 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.

Appendix G – Water quality report for the Don basin

Don basin (provided by TropWATER)

Summary

The Don River basin has been subject to land use changes for horticulture and grazing lands and intensive groundwater use for irrigation, which has resulted in significant soil erosion. Expansion of irrigation has resulted in major groundwater issues in this area, as well as the risk of increased water contamination by agrochemicals and nutrients. Monitoring during high flow events have shown residues of herbicides including atrazine and hexazinone, both of which were below ANZECC guidelines. There are currently no long-term programs monitoring water quality in this basin. Observed ecological changes include the loss of wetlands and riparian vegetation as well as noticeable reductions in coral cover. Land use changes are highly likely to occur in the Don River basin. Changes include the Water for Bowen project, which involves the construction of a pipeline/channel that will transport water for use in irrigated croplands and to support industrial and urban users. Additionally, the proposed expansion of the Port of Abbot Point will severely impact the coastal marine environment.

1. Introduction

The Don River basin is located in the lower Burdekin region in northern Queensland. Major streams within the basin include the Don River, Elliott River, Molongle Creek and Euri Creek. The area experiences a dry tropical climate with an annual rainfall across the catchment of approximately 1000-1600 mm and an average of 482,000 ML/yr of run-off.[1] Approximately 75 per cent of the rainfall occurs from December to March, with frequent flooding often attributed to cyclonic events.[1]

The dominant land use (Fig. 1) consists of grazing (3695 km^2), followed by protected areas (100 km^2), horticulture (63 km^2), sugarcane (47 km^2) and state forests and timber reserves (< 1 km^2). Approximately 92 per cent of the catchment has been cleared, with only 3 per cent remaining as protected land. The largest settlement in the area is Bowen, with a population of 10,260. Smaller settlements include the Elliot River fishing settlement, Molongle Creek, Gumlu, Guthalungra and Wunjunga.

Point and non-point sources of pollution within the catchment area include a commercial shipment port (Abbot Point), commercial fishery port facilities, recreational marine use and its associated marinas and harbours, sewage release from the town of Bowen, 4 large scale marine prawn farming sites, and coke and salt works. The Port of Abbot Point is located 25 km north-west of Bowen. The port consists of coal stockpiling facilities, loading facilities for the export of coal and a jetty with a conveyor connecting to two offshore berths and two ship loaders 2.8 km offshore. Coal is the only commodity exported from this port facility.

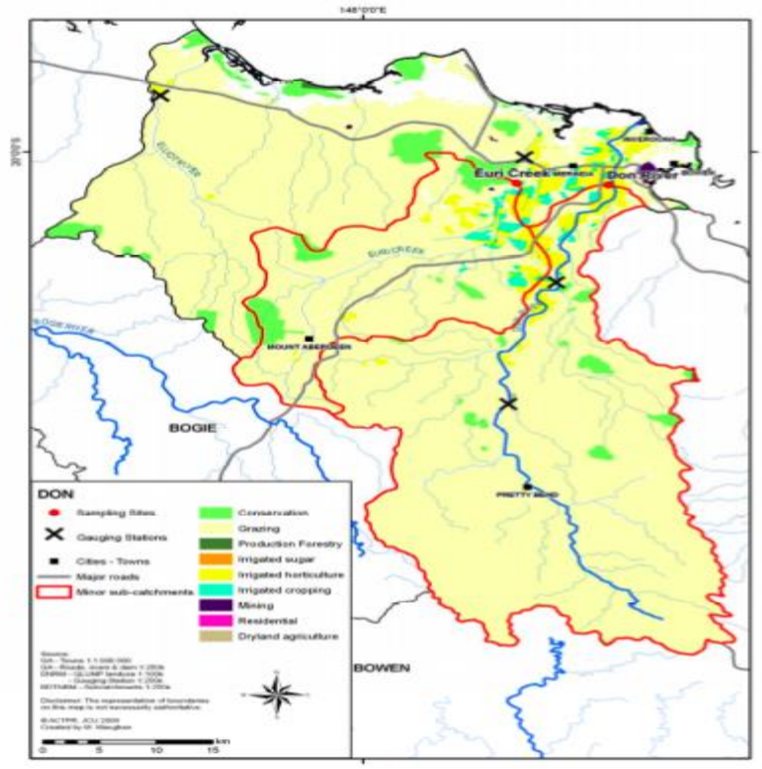

Figure 1: Land use in within the Don River catchment

2. Hydrology and drainage

There is intensive groundwater use in this region for grazing and horticulture. Significant soil erosion on the river delta and flats has been caused predominantly from horticulture, while grazing lands have isolated severe gully erosion in cleared areas, resulting in major stream modifications in the catchment.[2] There is little knowledge of the land use impacts on stream flow and limited records of the quantity of water extracted from the main stream and overland flow by water harvesting.

The Bowen irrigation area, situated in the heart of the Don River delta, is one of the largest horticultural areas in the dry tropics region of Queensland.[3] Major groundwater management issues include the expansion of irrigation, particularly in the inland floodplain areas, which has increased groundwater demand and the potential for contamination by agrochemicals or nutrients.[3]

The Don River basin is located in the North East Coast Drainage division and the Don River is the principle drainage of the Groundwater Management Unit (GMU), draining the catchment in a northerly direction.[4] Saltwater intrusion is a major issue for the Don River GMU, the Euri and Menilden creeks.

3. Basin water quality

a) Water quality

1) Status of monitoring in basin and rivers

There are currently no long-term monitoring programs for the Don River catchment. Random and opportunistic monitoring has taken place on occasion during recent years. The pesticides that are largely used in the Don region have been identified and it has been proposed that longer term monitoring of loads will expand into the Don River region in the future.[5]

Lewis and Glendenning (2009)[6] assessed pesticide usage within key crops of the Bowen district, as well as emerging industries (cotton) in the wider Bowen/lower Burdekin regions for their risk of offsite movement and potential toxicity using the Pesticide Impact Rating Index (PIRI) semi-quantitative model.[7] This study highlighted the pesticides that should be focused on for monitoring programs, and includes atrazine (herbicide), S-metolachlor (herbicide), and chlorothalonil (fungicide).

2) Water quality data

Five samples were collected during the 2006 flow events monitored by Lewis et al. (2007).[8] Results revealed two herbicide residues including atrazine (0.02 to 0.22 µg/L 5 of 5) and hexazinone (<0.01 to 0.06 µg/L 3 of 5), while desethyl atrazine was detected (0.01 µg/L) in one sample. Atrazine concentrations peaked during the second larger flow event in April, while hexazinone concentrations peaked with the first smaller event in January. Both herbicides were well below the ANZECC guidelines and their values suggest these herbicides are of low significance in this catchment, however future monitoring is necessary to determine if any pesticides pose a significant threat to this region.[8]

Three water samples were analysed from the flow events during the 2006/2007 water year. Hexazinone (<0.01 to 0.03 µg/L: 2 of 3) and metolachlor (<0.1 to 0.1 µg/L: 1 of 3) pesticide residues were detected (Lewis et al. 2007). One sample of metolachlor exceeded the ANZECC (2000) low reliability guideline (0.02 µg/L), while atrazine was not detected in the 2006/2007 samples.

Opportunistic samples collected approximately 2 days after peak flows from Euri Creek, Molongle Creek and the Elliot River (waning flow January 24, 2007) revealed hexazinone residues (0.02 µg/L) at Euri Creek, while no pesticide residues were detected from Molongle Creek and Elliot River samples.[8]

Due to financial constraints insecticides from horticulture were not analysed in this study, and in general, only a limited suite of pesticides have been looked at. Increased specific pesticide monitoring to target run-off from horticulture-dominated land uses is encouraged.

b) Ecological effects of water quality and hydrological changes in basin

An image-base Tropical Rapid Assessment of Riparian Condition (iTRARC) analysis found a large decrease (from good to relatively poor) in the condition of wetlands within the basin.[9]

This change was attributed to an increased number of gaps in the riparian corridor along all stream sizes and floodplain clearing, in addition to an increase in gullying/scalding within the catchment.

4. Coastal water quality

a) Water quality

1) Status of monitoring in coastal areas

Very little monitoring of coastal waters within the Don River catchment is currently being conducted. This is of concern since the area contains many anthropogenic sources of point and non-point sources of pollution (see introduction). Monitoring of turtles and dugongs occurs within waters offshore of the Don River basin; however water quality measurements are not currently collected in these programs.

2) Water quality data

The spatial distribution of various water quality variables were predicted and mapped across 6 regions and 3 cross-shelf (coastal, inner shelf and outer shelf) positions in the Great Barrier Reef using measurements from 1985-2006.[10] The values predicted for the Burdekin are provided in Table 1. All variables decreased with increased distance from the coast with the exception of Secchi depth, which increased at more offshore sites. Compared to the other 5 analysed regions (Cape York, Mackay Whitsunday, Fitzroy, Burnett Mary, and Wet Tropics), the Burdekin contained: the lowest Secchi depth (3.7m), the lowest coastal and lowest offshore chlorophyll *a* values. SS and PN values were highest and cross-shelf changes most pronounced from the Burdekin to Port Douglas. Highest coastal values of PN were found between the Burdekin and Hinchinbrook Island. PP values were highest and cross shelf changes most pronounced between the Whitsundays and Cairns (i.e. in the Burdekin and Wet Tropics). TDN and TDP values were second highest and highest in the Burdekin, respectively. Total nitrogen (TN) and particulate phosphorus (PP) values were second highest and highest in the Burdekin, respectively, with the greatest cross-shelf changes measured in the Burdekin region for both variables.

Table 1: Mean annual values of water quality variables predicted in 3 cross-shelf regions of the Burdekin region

Variable	Coastal	Inner Shelf	Outer Shelf	Across all zones
Secchi depth (m)	3.7 ± 0.6	13.3 ± 0.6	18.7 ± 0.8	15.7 ± 0.7
Chl a (μg L^{-1})	0.9 ± 0.07	0.5 ± 0.04	0.3 ± 0.04	0.4 ± 0.04
SS (mg L^{-1})	5.5 ± 0.4	2.5 ± 0.2	0.9 ± 0.1	1.9 ± 0.2
PN (μmol L^{-1})	2.6 ± 0.2	1.9 ± 0.1	1.4 ± 0.1	1.6 ± 0.1
PP (μmol L^{-1})	0.18 ± 0.01	0.10 ± 0.01	0.07 ± 0.01	0.09 ± 0.01
TDN (μmol L^{-1})	6.7 ± 0.3	5.8 ± 0.3	4.9 ± 0.3	5.4 ± 0.3
TDP (μmol L^{-1})	0.39 ± 0.04	0.33 ± 0.03	0.18 ± 0.03	0.24 ± 0.03
TN (μmol L^{-1})	8.7 ± 0.5	7.4 ± 0.4	7.2 ± 0.6	7.5 ± 0.5
TP (μmol L^{-1})	0.59 ± 0.06	0.46 ± 0.04	0.33 ± 0.06	0.39 ± 0.05

Sampling of flood plumes in the Great Barrier Reef is conducted as part of the Reef Rescue Marine Monitoring Program within Reef Plan. Flood plumes associated with the Burdekin region were monitored during the 2011 wet season[11], however plumes associated with rivers north and south of Cape Bowling Green (where the Don River is released) were monitored while rivers within the bay, such as the Don River, were not.

An assessment of in shore ecosystems exposed to different categories of surface pollutants within the Burdekin region (Table 2) showed a total of 2,079.82 km^2 of coral reefs and 586.05 km^2 of seagrass beds are exposed to PSII, TSS and DIN.[11]

Table 2: Number and area of exposed coral reefs and seagrass beds to surface pollutants in the Burdekin region.

Exposure			Coral reefs		Seagrass beds	
PSII	**TSS**	**DIN**	**Num.**	**Km^2**	**Num.**	**Km^2**
0.00	0.00	0.00	0	0.00	0	0.0.0
0.06	0.36	0.14	13	20.30	0	0.00
0.13	0.72	0.28	126	1,266.17	0	0.00
0.19	1.07	0.41	39	533.38	0	0.00
0.25	1.43	0.55	13	205.96	3	0.29
0.32	1.79	0.69	80	54.01	86	585.76
				2,079.82		**586.05**

Source:[11]

The current best estimates of modelled loads leaving the Don River catchment are provided in Table 3. The estimated loads have increased substantially from pre-development values. Dissolved organic phosphorus (DOP) and dissolved inorganic phosphorus (DIP) has increased the least (6 t/yr and 7 t/yr, respectively) since pre-development, while total nitrogen (386 t/yr) and particulate nitrogen (262 t/yr) have increased the most. After the implementation of the Reef Rescue program in 2008 an improvement in load values was observed for TSS, DIN, PN, TN, PSII herbicides, PP and TP. For example, modelled suspended sediment export values from the Don River basin (Table 3) showed that the total export in 2008/2009 (330,000 t/yr) had increased almost 3-fold compared to pre-development loads (119,000 t/yr). However, after the implementation of the Reef Rescue program (2009/2010) values decreased to 327,000 t/yr, which is a 1.2 per cent improvement. Improvements for DON, DIP and DOP loads have not yet been observed.

Table 3: Best estimates of modelled total pre-development values, current values, and anthropogenic changes in water quality parameters. Reef Rescue values represent the values after the commencement of the Reef Rescue program and Reef Rescue change represents the improvement (%) after implementation

	Pre-development	Current (2008/2009)	Current (2009/2010)	Anthropogenic Increase	Reef Rescue (2009/2010)	Reef Rescue change (%)	Total change (%)
TSS (kt/yr)	119	330	327	211	328	0.6	1.2
DIN (t/yr)	23	70	69	48	69	3.6	3.6
DON (kt/yr)	97	172	172	76	172	0	0
PN (t/yr)	181	443	438	262	440	1.1	1.9
TN (t/yr)	300	686	679	386	681	1.2	1.7
PSII (kg/yr)	0	69	66	69	66	3.9	3.9
DIP (t/yr)	8	16	16	7	0	0	0
DOP (t/yr)	8	14	14	6	0	0	0
PP (t/yr)	58	146	144	88	145	1.0	1.7
TP (t/yr)	74	176	175	102	175	0.9	1.5

Source: Report Card 2 (in press)[12]

b) Ecological effects of water quality and hydrological changes in coastal areas

The Don River is discharged in close proximity to Edgecumbe Bay (south of Bowen), where turtle fibropapillomatosis, a form of herpes virus, has been found within 50 per cent of juvenile green turtles surveyed compared to 10 per cent elsewhere (Dr. Ellen Arial Per. Comm).The virus results in tumor-like lesions (Fig. 2) on soft tissue surfaces such as the tail, flippers, eyelids and corneas, as well as organs such as the lungs.[13] Although some turtles recover, the tumors can disrupt organ function resulting in death (Dr. Ellen Arial Per. Comm). Additionally, since the tumors on the eyes reduce vision, the turtles are unable to escape predators and are hindered from observing prey, resulting in starvation and death. The illness appears localized within a centralized region of Edgecumbe Bay (Brisk Bay) and it remains unclear whether these turtles are entering the bay with the virus or are acquiring it while settled within the bay (Dr. Ellen Arial Pers. Comm). Studies are currently being undertaken by scientists at JCU in partnership with the World Wildlife Fund (WWF). Research will be addressing questions regarding turtle immunology, recovery time of ill turtles, and behavioural changes in turtles with the virus, as well as virus profile modelling. Additionally, tagging experiments will allow scientists to monitor the migration of turtles in hopes of determining where the animals are becoming infected.

Figure 2: Fibropapilloma lesions on green sea turtles (*Chelonia mydas*) from Australia (a) and Florida (b)(Source a) Magnetic Times b) Mote Marine Laboratory)

The Historical Photographs Project of the Great Barrier Reef Marine Park Authority compared historical with current (at the time of the project) photos of coral reef-flats in order to determine gross shifts in benthic community structure.[14] Although this method is considered crude, it is possible to make general comparisons. Both Stone Island (Fig. 3) and Bramston Reef (located offshore of Bowen) showed evidence of significant changes in their reef-flat communities.

General comparisons could be made with the historical photographs of Bramston Reef, which showed a large abundance of massive coral colonies such as *Porites* and faviids and tabular/corymbose colonies of *Acropora* spp. The photographs taken in the early 1990s showed that no *Acropora* spp were present and the majority of faviid colonies were dead and covered with algae and/or mud and those still alive were comparatively smaller (< 15 cm diameter). Large colonies and micro-atolls of *Porites* as well as large amounts of coral rubble were found in the photos from the early 1990s.

General comparisons could also only be made between the Stone Island photographs (Fig. 3), which showed a decline in reef-flat composition. The historical photos taken between the 1890s and 1915 showed extensive hard coral cover including colonies of plating, corymbose and caespitose *Acropora* and many massive coral colonies. A cyclone in 1918 reportedly destroyed the reef; however local residents say that the reef-flat was healthy 20-30 years ago. The photos taken in the early 1990s showed a lack of *Acropora* colonies and few massive coral colonies. The surface of the reef-flat was covered in a mixture of coral rubble and algae.

Figure 3: Photographs of the reef-flat at Stone Island taken in the early 1890s (a) and in the early 1990s (b). Source: a)[15] b)[14]

5. Additional pollutants

Potential chemical substances within the Don River catchment include heavy metals and metalloids, which can enter the marine environment through natural weathering processes as well as anthropogenic activities. In the case of the Don River catchment, sources of heavy metals and metalloids may include agricultural run-off of pesticides, leaching of antifoulant paints from ship vessels, leaching of trace levels present in coal particles and corrosion of marine metals.[16]

Organotin compounds are potent toxins, a property that has resulted in organotin use in a range of biocides including vessel antifoulants.[17] Tributyltin (TBT) based antifoulant paints have been used on vessels in Australia since the early 1970s and was banned on vessels < 25 m in Eastern Australian states in 1989 due to growing evidence of its detrimental impacts on the marine environment.[17] Although TBT was banned in 2008, only 34 of the 168 states within the International Maritime Organization (IMO) ratified to the agreement set by The International Convention on the Control of Harmful Antifouling Systems for Ships. TBT remains a threat to the marine environment.

Copper (Cu) is also used as an antifoulant and is a main biocide in Cu based paints commonly used on small boats, in addition to being an additive to TBT-based paints.[17] TBT quickly kills organisms such as mussels, algae and barnacles, which naturally attach themselves to hard surfaces including ship hulls, however is also leached into the marine environment. TBT and heavy metals can be found in sediments as paint flakes from ships dissolve into the water and stay solubilized or attach to particulate matter that will settle out. Heavy metals are potentially toxic to marine organisms[18], while TBT has been considered as the most toxic substance deliberately introduced to the marine environment.[19] TBT is responsible for imposex in dog-whelks[20,21] and shell deformations in oysters[22]. Both TBT and heavy metals accumulate in organisms and food chains and eventually reach humans through fish consumption.[23,24,25] TBT and heavy metals are persistent pollutants, and can remain stored in sediments for many years, re-entering the food chain when the sea bottom is disturbed by passing vessels in shallow areas, ports or by storms and dredging activities.

Monitoring of surface sediments is conducted on a somewhat regular basis along various transects within the Abbot Point port limits such as surrounding the berth and within the dumped dredge spoil.[16] To date, monitored values of heavy metals have measured below the National Ocean Disposal Guidelines for Dredged Material (NODGDM) screening levels and the guidelines for the Assessment and Management of Contaminated Land in Queensland (Department of Environment (DoE) 1998) Environmental Investigation Levels (EILs). However, in 2007, TBT levels were found to exceed the NODGDM screening level (5µg Sn/g).

Another potential source of pollution in the coastal area of the Don River basin is coal. Coal contains polycyclic aromatic hydrocarbons (PAHs), which can be toxic and carcinogenic to a variety of species. Information is limited and the effects of PAHs on many marine organisms have not yet been examined. Coal can enter the environment via a variety of mechanisms such as the natural erosion of coal seams, and during various stages of coal processing such as disposal of colliery waste, wind and water erosion of coal stockpiles, and accidental spillage.[26] Once in the marine environment, coal particulates are dispersed via currents throughout coastal ecosystems.[27] In Australia coal particulates have been found in sediments traps as far as the continental shelf break.[28] The behaviour and distribution of particulate coal in tropical waters is largely unknown, however exposure to marine organisms is likely to increase as loading volumes and shipping increases. It is therefore imperative that more research is done to investigate the potential effects of coal on key tropical organisms.

Expansion of the Port of Abbot Point into a mulit-purpose port facility to support Queensland north’s heavy industry sectors (which include an alumina refinery, aluminium smelter, iron and steel making, nickel refinery, shale oil exports, liquefied natural gas exports, coke, chloralkali plant and power station) has been identified by the Queensland Government as critical to economic growth in north and central Queensland. The construction of new terminals has been proposed, which will require a major capital dredging campaign involving the relocation of approximately 3,000,000 m^3 of sediment.[29] Dumping and re-suspension of sediments could have detrimental impacts on surrounding seagrass and coral reef ecosystems.

Figure 4: Current Abbot Point Coal terminal Source: a)[30]

6. Management

a) In basin for basin

The Burdekin Bowen Integrated Floodplain Management Advisory Committee Inc. (BBIFMAC) promotes an integrated, strategic and community-driven approach to the management of natural resources within these regions. BBIFMAC supports the sustainable development of primary industries and the local economy for the long term benefit of present and future generations through running, supporting and collaborating on various projects. The area covered by the committee is the floodplains in the Bowen and Burdekin shires, the lower catchments of the Bogie, Don, Elliot, Burdekin and Haughton rivers.

BBIFMAC has addressed concern regarding the current state of the Don River and engaged with the North Queensland Dry Tropics (NQDT) in winter 2011 to discuss the problems faced by the Don River and to become involved with remedial actions.

b) In basin for Great Barrier Reef

Reef Rescue initiatives have been implemented in the Don River catchment that include grazing grants to promote better soil health, control gully and stream bank erosion, improve water quality through riparian fencing and spreading of waters to exclude stock from creeks and rivers. Water quality improvement grants are also attainable for growers that use effective chemical application rates, reduce off-farm run-off, and apply fertiliser in a precise manner to promote better soil health.

7. Potential future land use changes

Land use changes within the Don River basin are highly likely due to the Water for Bowen project and expansions at the Port of Abbot Point (J. Brodie Personal Communication). The Water for Bowen project, a 415 million dollar endeavor, was proposed in order to transport 60,000 ML of water per annum 150 km from Clare Weir on the Burdekin River south, down the coastal plain to Bowen and surrounding areas.[31] An additional 20 km pipeline will run to Abbot Point.[31] The proposal relies on existing water in the Burdekin Falls Dam, however an increase in the size of the Burdekin Falls Dam would improve the possibility of the channel being built (J. Brodie Personal Communication). The water transported through the channel and pipeline would be used for irrigation cropping in the area between Coastal Plain, Home Hill and Bowen, including Gumlu and Guthalungra. The area available for increased irrigation is tens of thousands of hectares. The original proposal envisaged more than half of the transported water to be used to support industrial (port, alumina refinery) and urban users in Bowen and the remainder would go to irrigate existing horticulture, which could expand crops of tomatoes, capsicums, mangos, sugarcane or even less likely, cotton.[32] The project is currently on hold because it is not financially viable; however this could change in the future since water is required for port activities.

There is also a possibility of increased coastal aquaculture, which could alter coastal foreshore, estuarine, mangrove, salt marsh, marine and other aquatic environments.[32] Environmental impacts associated with aquaculture are water pollution, pest species, strain placed on wild fish populations for feeding and brooding, as well as the culling of natural predators.[32]

The expansion of the Port of Abbot Point is almost certain to proceed. The current export capacity from Terminal 1 (T1) is 50 Mtpa.[33] The expansion of three major terminals (TO, T2, T3) is currently being facilitated and is in pre-feasibility and feasibility phases.[33] T2 and T3 proponents are currently in a framework agreement with North Queensland Bulk Ports and it is planned that T3 will export 60 Mtpa and a new 500 km rail line from the mine to the port will be built.[33] The first exports from T3 are planned for 2015. Additionally, an expansion of the existing T1 by 35 Mpta and an additional 2 offshore berths has been proposed. The final commitments by proponents will depend on their ability to secure environmental approvals under the Federal EPBC Act.[33]

8. Knowledge gaps

Information regarding the water quality status of the Don River basin is currently very limited. There are currently no long-term monitoring programs within stream and coastal areas in the Don River basin, and therefore there is limited historical and current data that can be used to make appropriate management decisions. Flood plumes originating from the Don River basin are currently not monitored by any long-term programs. Little is known regarding the impacts of current land uses on stream flow and there are limited records quantifying water extraction from the main waterways and overland flow from water harvesting. There is also a large knowledge gap relating to the occurrence and effects of micropollutants in this area. There is limited information on the effects of coal dust on marine organisms and to the best of our knowledge there is no monitoring of litter, microplastics, pharmaceutical wastes or TBT in the Don River basin.

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