NATURAL VALUES AND RESOURCE USE IN THE LIMMEN BIGHT REGION

KEEP TOP END COASTS HEALTHY

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Keep Top End Coasts Healthy Alliance

Keep Top End Coasts Healthy is an alliance of environment groups including the Australian Marine Conservation Society, the Pew Charitable Trusts and the Environment Centre of the Northern Territory.

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Main - Limmen River. Photo: David Hancock

Inset (L-R): Green Turtle, Recreational fishing is an important leisure activity in the NT, Dugong. Photos: Australian Marine Conservation Society.

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KEY FINDINGS

This report by the Centre for Conservation Geography (CCG) aims to provide information to stakeholders, the public and decision makers on the natural values - marine and coastal bioregions, mammals, birds, fish and reptiles; and resource uses - commercial and recreational fishing, mining, tourism and water extraction - in the Limmen Bight Region during the Limmen Bight Marine Park management planning process.

The preparation of a park management plan was a key 2016 election commitment of the Gunner Government.

NATURAL VALUES OF THE LIMMEN BIGHT REGION

The Limmen Bight Marine Park is found in the Limmen Bight Region, which straddles Northern Territory and Commonwealth waters in the southwestern corner of the Gulf of Carpentaria. The region's natural values include:

- near-pristine tropical waters;
- the Territory's most important dugong population;
- the Territory's second-largest intertidal flats;
- important seabird and waterbird colonies;
- tens of thousands of visiting migratory shorebirds;
- five species of marine turtles, with nesting sites and foraging areas;
- a Site of Conservation Significance;
- a nationally important wetland;
- an Important Bird and Biodiversity Area;
- at least 100 species of fish.

RESOURCE USE AND THREATS IN THE LIMMEN BIGHT REGION

The main resource uses currently in the Limmen Bight Region and the Limmen Bight Marine Park area:

- commercial fisheries for prawns, mud crabs and barramundi;
- recreational fishing, and fishing tourism, largely targeting barramundi and mud crabs;
- iron ore and mineral sands mining in the catchment of the Roper River.

Future regional resource uses could include an expansion of iron ore mining, the development of hydraulic fracturing (fracking) in the Roper River catchment, and the potential development of seabed mining in the Limmen Bight Region. A moratorium on seabed mining currently exists across the Northern Territory, but applications that still exist were made to mine the seabed of the Limmen Bight Region and the Limmen Bight Marine Park prior to its proclamation.

The threats facing the Limmen Bight Region include those associated with the above resource uses and also invasive species, marine debris and climate change (rising sea levels and sea and air temperatures; ocean acidification; increased storm intensity; mangrove dieback).

There are a number of resource use activities that are incompatible with the values of the Limmen Bight Region and the Limmen Bight Marine Park. They should be excluded from the marine park and restricted or well managed in the remainder of the region.

Resource use activities incompatible with the Limmen Bight Marine Park are seabed mining; bottom trawling; gillnetting; dredging; pipelines and barges used to transfer iron ore; transhipment of iron ore. Land use activities beyond the boundaries of the marine park, which should be restricted or avoided to

prevent harm to it and the broader Limmen Bight Region, include alteration of river flows and groundwater levels; hydraulic fracturing (fracking); intensive stock grazing; and land clearance.

FOUR AREAS OF HIGH CONSERVATION VALUE

This report has identified four areas of high conservation value that are inside or adjacent to the Limmen Bight Marine Park. They are:

- Roper River estuary and mouth;
- Limmen Bight River estuary and mouth;
- marine park waters surrounding Maria Island;
- seagrass meadows in the marine park's south-eastern waters.

Details on each area are provided in the section, "Four areas of high conservation value".

INTRODUCTION

This report by the Centre for Conservation Geography (CCG) aims to provide information to stakeholders, the public and decision makers on the natural values - marine and coastal bioregions, mammals, birds fish and reptiles; and resource uses - commercial and recreational fishing, mining, tourism and water extraction - in the Limmen Bight Region during the Limmen Bight Marine Park management planning process.

The preparation of a park management plan was a key 2016 election commitment of the Gunner Government.

For some species and ecological communities, and for commercial and recreational use, data from the broader Limmen Bight Region has been used in this report because research within Limmen Bight Marine Park has been limited.

GOVERNMENT POLICY COMMITMENTS

The Limmen Bight Region is found in the south-west corner of the Gulf of Carpentaria. Limmen Bight Marine Park, which stretches offshore from the mouth of the Roper River in the north to Wuraliwuntya Creek in the south, was established in 2012. During the 2016 Territory election, the then Labor Opposition made the following commitments for the park's future management:

"Invest $400,000 to develop a comprehensive plan of management for Limmen Bight Marine Park.

In 2012, Territory Labor created the Limmen Bight Marine Park, but under the CLP the park stalled – left uncompleted and at risk from damaging seabed mining. By the end of 2019 a Territory Labor Government will complete Limmen Bight Marine Park by finalising sensible, science-based and well consulted management arrangements. Labor will:

- Ensure adequate funding to conduct a comprehensive consultation process, ongoing management and fair fisheries structural adjustment;
- Ensure a ban on seabed mining in the park – seabed mining is not compatible with a healthy marine environment in such a sensitive area;
- Seek to create ongoing employment opportunities for local Traditional Owners via cooperative management and coordination with Labor's Indigenous rangers support initiatives;
- Identify opportunities for sustainable and well managed tourism in the region through a properly consultative process;
- Develop the management arrangements in accordance with formal and accepted processes under the Aboriginal Land Rights Act and Native Title Act;
- Develop a best practice monitoring and evaluation framework in cooperation with Traditional Owners and other stakeholders"[1].

According to local MP for Barkly, Gerry McCarthy, "Labor's plan will provide an innovative model of marine management which protects biodiversity, respects indigenous culture, safeguards lifestyle and creates sustainable jobs. Only Labor can get it right and protect Limmen Bight"[2].

The Limmen Bight Marine Park management planning process is now underway and is being coordinated by the Northern Territory Parks and Wildlife Commission. This CCG report is aimed at providing useful background information for the process.

THE LIMMEN BIGHT REGION

TRADITIONAL OWNERS AND INDIGENOUS RANGER GROUPS

The Limmen Bight Region, which is found between Groote Eylandt in the north and the Sir Edward Pellew Group of islands in the south, is part of the traditional lands of the Marra, Yanyuwa, Alawa and Wandarrang peoples.

There are two Aboriginal Land Trusts in the Limmen Bight Region: Arnhem Land and the Marra (see Figure 1). Most of the region's shoreline is Aboriginal freehold land.

The trusts are statutory bodies under the *Aboriginal Land Rights Act 1976*. The trust holds the title to land returned to Traditional Owners and performs certain functions under the direction of the Northern Land Council (NLC). The coastal boundary of the Arnhem Land trust runs north from the Roper River mouth, the Marra trust stretches between the mouths of the Roper and Limmen Bight rivers.

The Yugul Mangi Land and Sea Management Corporation, which manages a land area of 20,000 km^2 in the Roper River basin, was established in 2008, although Yugul Mangi rangers have been operating since 2002 when a group of women from Ngukurr began working on local land management issues funded under the Community Employment and Development Program. The Yugul Mangi Women Rangers were joined by a local group of men in 2007. The corporation and its rangers, who operate out of Ngukurr, carry out a number of activities including:

- fire management: annual fire management planning with on-ground burning, foot-walk burning and aerial controlled burning;
- weed management: Mimosa *Mimosa pigra* and Parkinsonia *Parkinsonia aculeata* are the two main weeds;
- feral animal management: horses; pigs; buffaloes; cats; cane toads; and big-headed ants are the main problems;
- sea country: ghost net collection, monitoring seagrass beds and turtle nesting sites and surveillance of illegal fishing;
- managing sites of significance: sacred sites, art sites.

Two other Ranger groups in the western Gulf who also have sea and river patrol capacity are Numbulwar Numburindi Amalahgayag Injung Rangers and Li-anthawirriyarra Sea Rangers.

The Numbulwar Numburindi Amalahgayag Injung Rangers were established more than ten years ago and manage 3,200 km^2 of land and sea country. Their fee-for-service contracts include wildlife surveys, fire management and biosecurity patrols for Top End Biowatch. The group has one of the highest numbers of women engaged in the NLC's Working on Country program.

The Li-anthawirriyarra Sea Rangers are employed by the Mabunji Aboriginal Resource Indigenous Corporation. The group is based in Borroloola and largely focussed on the Pellew Islands, but they also have satellite bases on the upper reaches of the Limmen Bight River and near the Roper River mouth. Their work includes the management of dugong and turtle populations and control of feral populations.

While threatening activities can impact cultural values, this report is focussed on the Limmen Bight Region's natural values and resource uses.

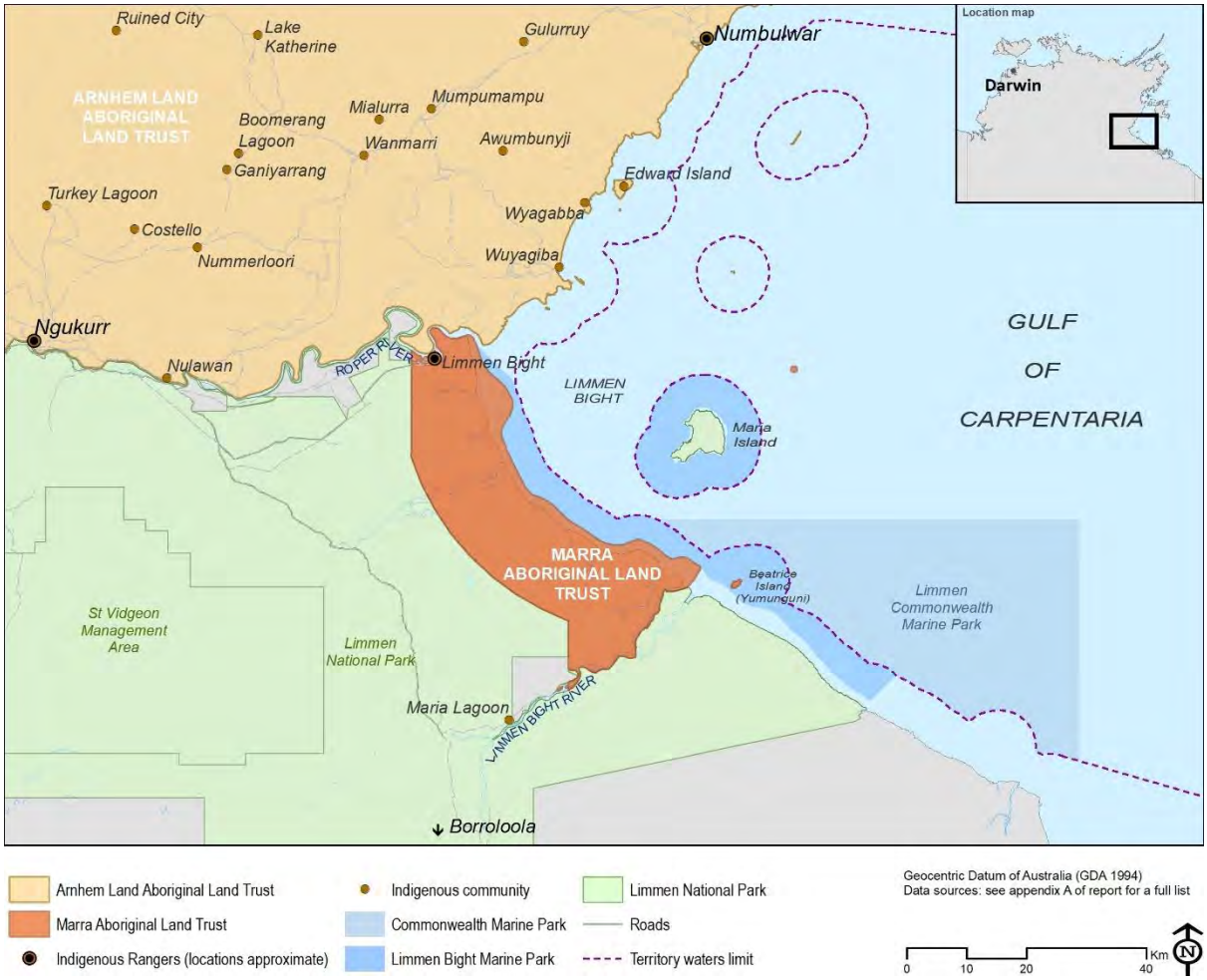

Figure 1. ABORIGINAL LAND TRUSTS AND LIMMEN BIGHT REGIONAL GEOGRAPHY

GEOGRAPHY

Dutch explorer Abel Tasman named Limmen Bight after one of the ships used in his 1644 exploration of the northern Australian coast.

The region's climate is tropical, with the wet season generating most of the flows of the main rivers, flooding the coastal plain with freshwater and discharging nutrients into Limmen Bight. The tidal range of Limmen Bight is mesotidal, with the change from high to low tide between two and four metres. Combined with a shallow seabed, this creates the Territory's second-largest area of intertidal flats when exposed at low tide. The Roper and Limmen Bight rivers are the region's two largest, but the smaller Rosie Creek, Spillen Creek, Nayarnpi Creek and Towns River also discharge into Limmen Bight.

The main town in the Limmen Bight Region is Ngukurr (1,149 at 2016 census) is situated on the Roper River, about 120 km from its mouth at Port Roper. Borroloola (871 at 2016 census) is located on the McArthur River 100 km to the south-east and outside the region identified for this report (see Figure 3 for the region's main geographical features). A number of small outstations are also found in the region, and commercial fishing camps have been established on the Roper and Limmen Bight rivers.

The waters of the Limmen Bight Region and the marine park can be accessed by boat via boat ramps at Borroloola, Ngukurr, Tomato Island, Bing Bong and the mouths of the Roper and Limmen Bight rivers, or directly from the Gulf of Carpentaria.

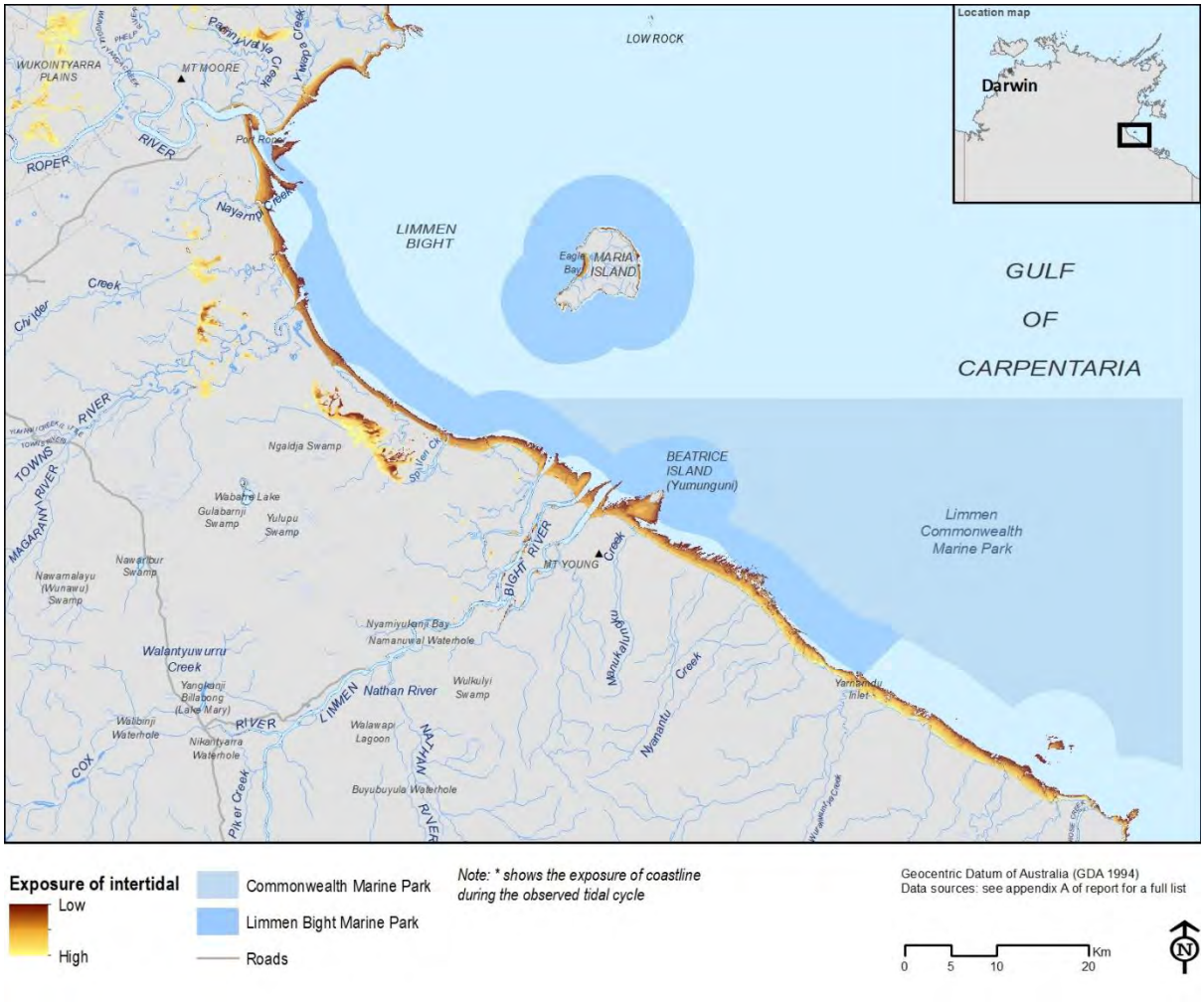

Figure 2. GEOGRAPHIC FEATURES OF LIMMEN BIGHT

LIMMEN BIGHT MARINE PARK

Limmen Bight Marine Park snakes its way along Limmen Bight's southern shore and is one of two marine parks proclaimed in Northern Territory waters, the other Garig Gunak Barlu Marine Park surrounding the Cobourg Peninsula.

Covering 884 km^2 in total, Limmen Bight Marine Park stretches south-easterly from the mouth of the Roper River to Wuraliwuntya Creek and includes a separate area (277 km^2) of Territory waters around Maria Island (Kurrululinya). The park extends from the low tide mark and out to the edge of Northern Territory waters. Figure 2 shows how the tidal extent varies across the marine park.

The land of Maria Island, 39 km^2 in area, is part of the terrestrial Limmen National Park (see Figure 1), which on the mainland covers more than 9,000 km^2 and is one of Australia's largest. The Commonwealth's Limmen Marine Park (399 km^2) runs along the eastern half of the Limmen Bight Marine Park and extends from 10 km west of Beatrice Island and then east to offshore from Wadere Point, near the mouth of Rosie Creek.

NATURAL VALUES OF THE LIMMEN BIGHT REGION

Local MP for Barkly, Gerry McCarthy, described the Limmen Bight Marine Park as:

"A special part of the Gulf, rich in marine life, including extensive seagrass beds and mangrove forests supporting commercial and recreational fishing, and the Territory's largest population of dugongs, as well as dolphins and turtles. Limmen Bight is iconic for Territory anglers, for its catches of mud crabs, barramundi, reef fish and prawns. However, this important area like many others along our coast is faced with new and concerning pressures including seabed mining and extensive mangrove die-off"[3].

Limmen Bight Marine Park is a special part of the Top End and Territory waters and shares many of its natural values with the broader Limmen Bight Region and the Gulf of Carpentaria. Here those shared values are discussed and mapped.

MARINE AND COASTAL BIOREGIONS AND A KEY ECOLOGICAL FEATURE

PELLEW MARINE BIOREGION

The Pellew marine bioregion (see Figure 3) is characterised by a low shoreline with extensive mudflats and rocky islands, and the Limmen Bight Marine Park and the Limmen Commonwealth Marine Park are fully contained within it. The Territory's largest dugong population, important seabird rookeries on offshore islands, and foraging areas for thousands of migratory shorebirds are found in the Pellew bioregion. Seagrasses cover much of the seabed in nearshore waters.

GULF COASTAL PLAIN BIOREGION

The Gulf Coastal Plain bioregion (Figure 3) extends along the coast and inland for 80 km from the mouth of the Roper River to roughly the Queensland border. This bioregion is an undulating plain with scattered low and steep hills and rivers, such as the Roper River, that meander through extensive flood plains. The Limmen Bight River has formed a large coastal delta at its mouth.

Eucalypt woodlands with a grassy understorey dominant the inland parts of the bioregion, whereas closer to the shoreline there are saline tidal flats with samphire shrubland bordered by tall grass, as well as mangrove forests and patches of rainforest. Land subject to inundation and saline coastal flats are common, while a narrow band of foreshore flats follows the entire shoreline. Mangroves are found in the mouths of the Roper and Limmen Bight rivers and along the banks of creeks.

Six estuaries are found along the coast: Limmen Bight, Roper and Towns rivers, Nayarnpi and Spillen creeks, and an unidentified estuary. The Roper River is the only tide-dominated estuary found in the bioregion, whereas the Limmen Bight River, Nayarnpi Creek and Towns River are all river-dominated estuaries with tide-dominated deltas.

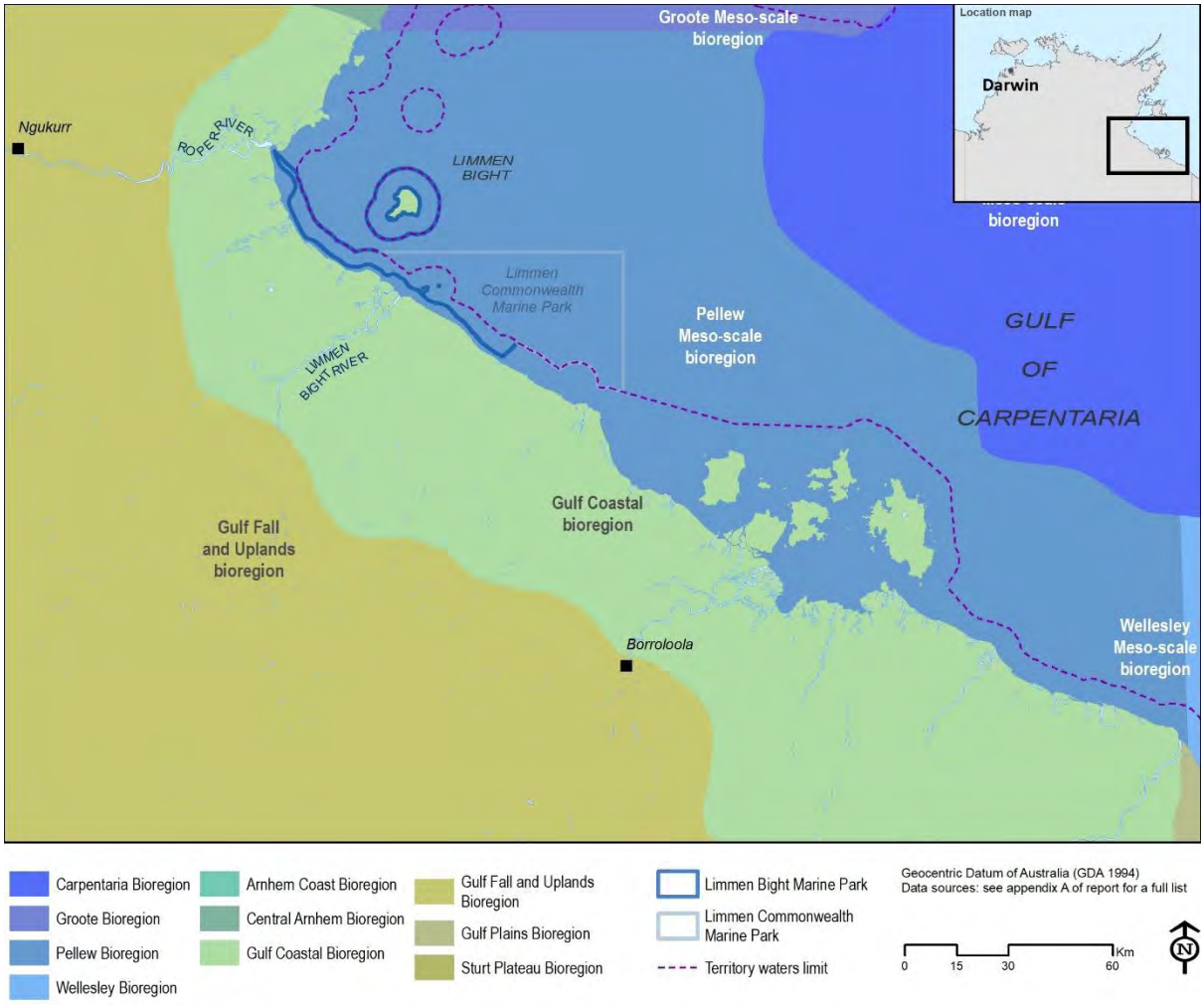

Figure 3. BIOREGIONS IN AND NEAR THE LIMMEN BIGHT REGION

A KEY ECOLOGICAL FEATURE: GULF OF CARPENTARIA COASTAL ZONE

Limmen Bight Marine Park is found within the Key Ecological Feature of the Gulf of Carpentaria Coastal Zone. The major values of the zone identified in the Commonwealth's planning process for the North Marine Bioregion[4] are:

- higher productivity and more diverse and abundant biota than elsewhere in the North Marine Bioregion;
- near pristine and supports many protected species such as marine turtles, dugongs and sawfish
- intact ecosystem processes and connectivity;
- river flows are mostly uninterrupted by artificial barriers;
- healthy, diverse estuarine and coastal ecosystems support many species that move between shallow coastal and offshore waters
- species found include olive ridley, green, hawksbill and loggerhead marine turtles, 16 species of sea snake, colonial and solitary seabirds (e.g. terns, frigatebirds, white bellied sea eagles, osprey, brown boobies), dugongs, dolphins, and aggregations of fish and sharks (freshwater and green sawfish, syngnathids, rare rays and other elasmobranchs).

SITE OF CONSERVATION SIGNIFICANCE

The importance of the terrestrial and marine components of the Limmen Bight Region have been recognised in the Limmen Bight and Associated Coastal Plains Site of Conservation Significance (see Figure 4). The site includes the waters of Limmen Bight, Low Rock and Sandy, Maria and Beatrice islands, and the coastal floodplains of the Roper (Wukointyarra Plains), Limmen Bight and Towns rivers. The site also supports eight species that are listed as threatened at either the national or Territory level (in brackets the national status is first followed by the Territory status):

- Australian bustard *Ardeotis australis* (-/Vulnerable);
- masked owl *Tyto novaehollandiae kimberli* (Vulnerable/Vulnerable);
- partridge pigeon *Geophaps smithii* (Vulnerable/Vulnerable);
- northern hopping-mouse *Notomys aquilo* (Vulnerable/Vulnerable);
- flatback turtle *Natator depressus* (Vulnerable/Data Deficient);
- green turtle *Chelonia mydas* (Vulnerable /Least Concern);
- hawksbill turtle *Eretmochelys imbricata* (Vulnerable/Data Deficient);
- olive ridley turtle *Lepidochelys olivacea* (Endangered/Data Deficient).

The Territory's former Department of Natural Resources, Environment, the Arts and Sport said of the site:

"The extensive intertidal mudflats of Limmen Bight are among the most important areas for migratory shorebirds in the NT. They support large aggregations of waders, including more than 1% of the world's Grey-tailed Tattlers and Great Knot, and significant numbers of at least two other species. Off-shore islands support large colonies of nesting seabirds and provide important nesting sites for Green and Flatback turtles. Three waterbird colonies have been reported in the Site and large numbers of waterbirds use the seasonal floodplains. Eight threatened species are reported from this Site including four marine turtles, three birds, and one mammal"[5].

"This site has not been formally assessed against Ramsar criteria but is likely to satisfy at least waterbird based criteria (criterion 5: important waterbird aggregation site with >20 000 waterbirds; criterion 6: regularly supports >1% of the individuals in a population) for listing as a wetland of international importance under the Ramsar Convention"[6].

IMPORTANT BIRD AND BIODIVERSITY AREA

The terrestrial areas of the Limmen Bight Region, including the tidal flats, have been recognised as an Important Bird and Biodiversity Area (see Figure 4) by Birdlife International. It supports more than 1% of the global population of grey-tailed tattler, great knot and white-headed stilt, and is one of the most important areas for shorebirds in the Territory. The great knot and grey tailed tattler, along with the chestnut rail are Important Bird Area trigger species, and there are also significant numbers of black-tailed godwit and at least 11 waterbird/seabird breeding rookeries[7].

NATIONALLY IMPORTANT WETLAND

The Limmen Bight (Port Roper) Tidal Wetland System was included in the Directory of Important Wetlands in Australia, satisfying all six listing criteria[8]:

- It is a good example of a wetland type occurring within a biogeographic region in Australia;
- It is a wetland which plays an important ecological or hydrological role in the natural functioning of a major wetland system/complex;
- It is a wetland which is important as the habitat for animal taxa at a vulnerable stage in their life cycles, or provides a refuge when adverse conditions such as drought prevail;
- The wetland supports 1% or more of the national populations of any native plant or animal taxa;
- The wetland supports native plant or animal taxa or communities which are considered endangered or vulnerable at the national level;
- The wetland is of outstanding historical or cultural significance.

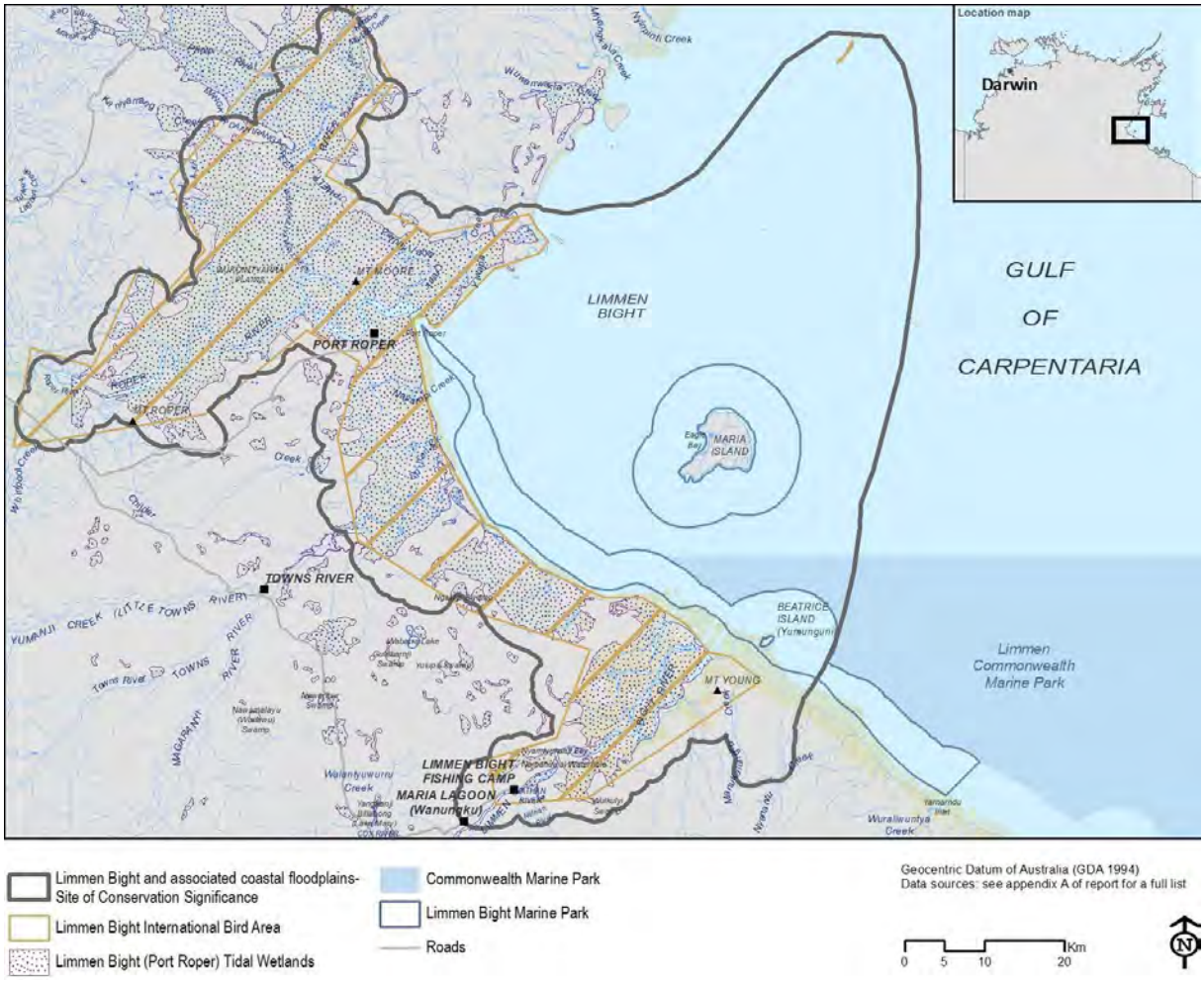

Figure 4. LIMMEN BIGHT SITE OF CONSERVATION SIGNIFICANCE, IMPORTANT BIRD AREA AND NATIONALLY IMPORTANT WETLANDS

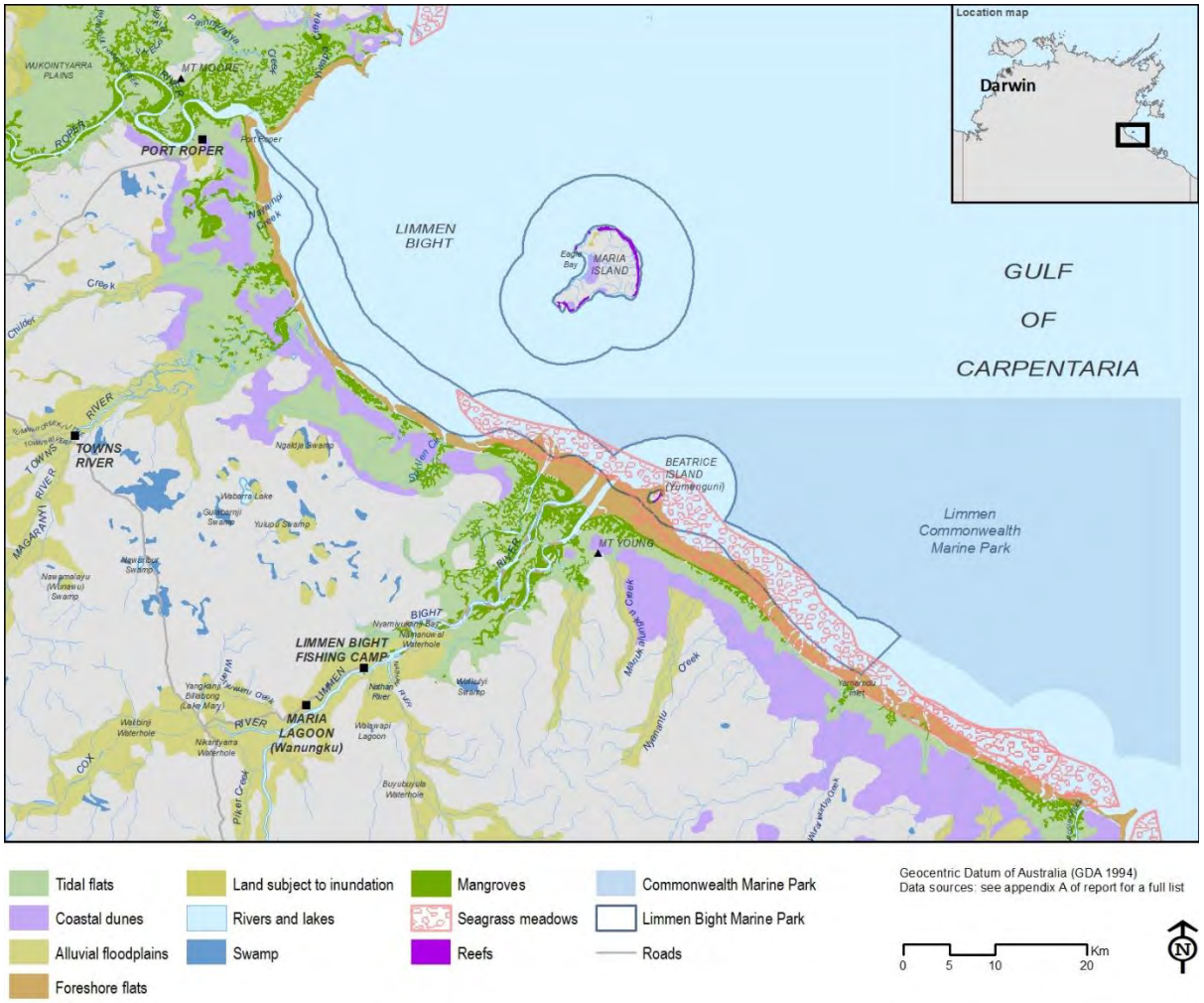

Figure 5. Coastal COMMUNITIES IN THE LIMMEN BIGHT REGION

MANGROVES

Mangroves dominate the shoreline, estuaries and creek banks of the Limmen Bight Region (see Figure 5). Although not within the Limmen Bight Marine Park boundaries, mangroves are directly connected to a number of its marine species, including commercially and recreationally targeted fish such as barramundi. The Limmen Bight Region has at least 19 species of mangroves[9].

REEFS

Figure 5 reveals that reefs are rare in the Limmen Bight Region, only found along the northern and southern shorelines of Maria Island, on the eastern side of Beatrice Island, and as an outcrop between the mainland and Beatrice Island. The two islands are outcrops of dolostone, shale and sandstone rocks that are also found in bands on the mainland to the north and south.

In its 2012 report on the values of the Limmen Bight Marine Park, the NT Parks and Wildlife Service referred to coral reefs as 'sparse', but no other public data on coral reefs within the Limmen Bight Region has been found during the preparation of this report. However, there has been research by Harris et al. (2008) on coral reefs nearby to the north-east:

"Multibeam sonar mapping, drill cores and underwater video data have confirmed the existence of a previously unknown coral reef province in the Gulf of Carpentaria, Australia. Seven reefs, comprised of coral limestone that support living corals have been mapped so far and as many as 50 other reefs may exist in the region"[10].

Harris et al. (2008) also reported that there were 140 km^2 of coral reefs in the Gulf of Carpentaria, mainly emergent reefs along the Wessel Islands, Groote Eylandt and the west coast.

SEAGRASS MEADOWS

Seagrass meadows are extensive along the southern shoreline of the Limmen Bight Region (see Figure 5 and Figure 6), in particular between Spillen and Rosie creeks to the east of the Limmen Bight River mouth. They cover a large part of the marine park's eastern half.

Eight seagrass species have been identified in the Limmen Bight Region: Cymodocea serrulata, Cymodocea rotundata, Enhalus acoroides, Halodule uninervis, Halophila ovalis, Halophila spinulosa, Syringodium isoetifolium, and Thalassia hemprichii[11].

Seagrass meadows are critical feeding habitats for dugong and marine turtles, as well as providing nurseries for commercially and recreationally targeted fish in their juvenile stages. They also hold significant stores of blue carbon, provide protection for the shoreline and are a source of materials for weaving. Mapping over time has shown significant spatial variations in the region's seagrasses.

MUDFLATS AND SANDFLATS

The tidal range in the south-west corner of the Gulf of Carpentaria ranges from 2-4 metres, creating vast mudflats and sandflats on the gently sloping seabed. The coastal floodplains and intertidal and foreshore flats of the Roper and Limmen Bight rivers (Figure 5) dominate the hinterland of the Limmen Bight shoreline, while there are extensive mud and sand/mud intertidal flats at low tide. The intertidal flats merge with saline flats along much of the shoreline, interrupted by patches of mangroves and rainforest. Intertidal mudflats and sandflats are largely within the Marra Aboriginal Land Trust but are also found inside the marine park.

DUGONGS

The Gulf of Carpentaria is viewed as one of the most important areas for dugong in Australia and the world (the 2007 population estimate for the entire Gulf was approximately 12,500[12]), while the Limmen Bight Region supports the Territory's largest population.

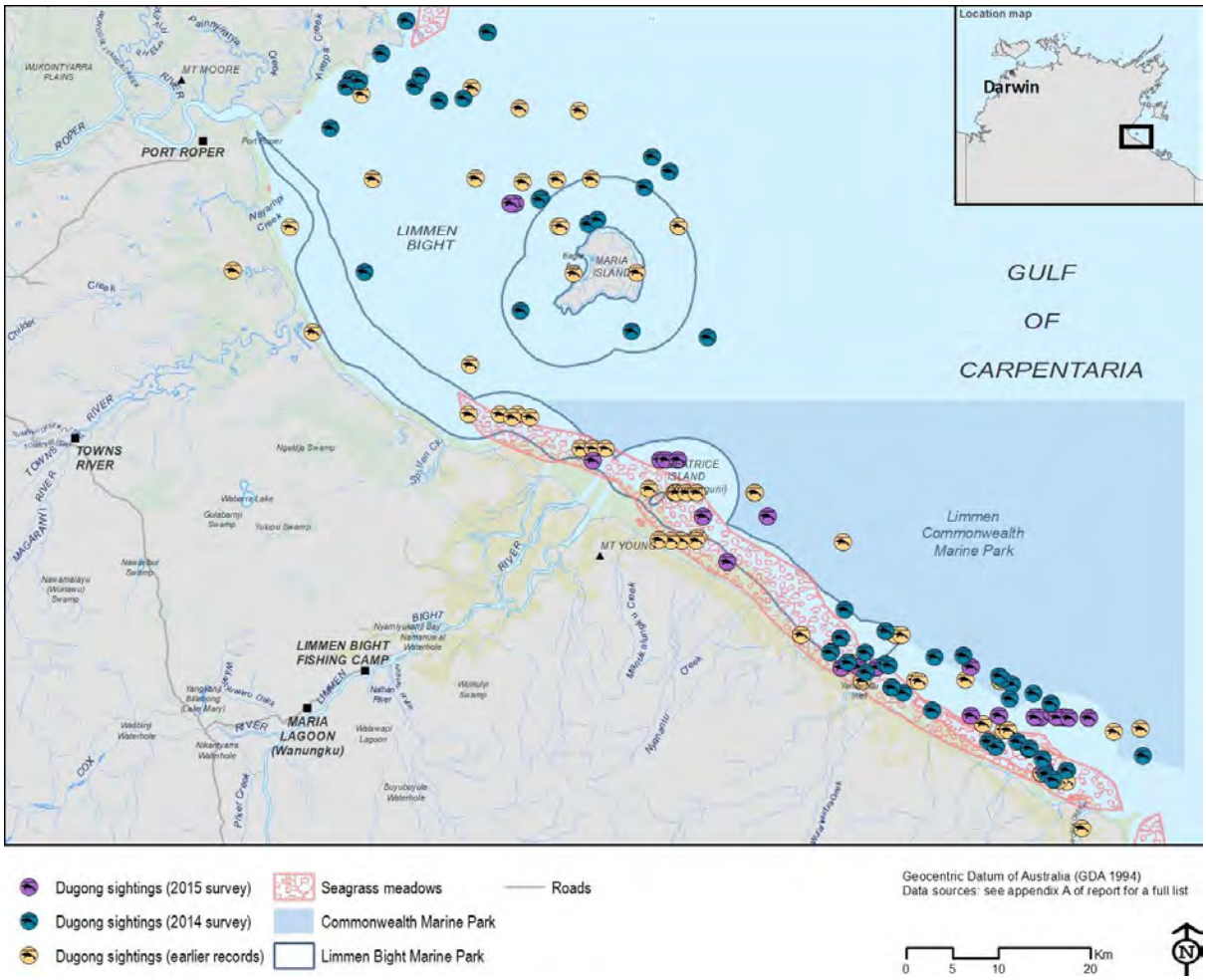

Figure 6. SEAGRASS MEADOWS AND DUGONG SIGHTINGS IN THE LIMMEN BIGHT REGION

In 2007, aerial surveys[13] estimated the dugong numbers between the Sir Edward Pellew Islands group and Groote Eylandt at 3,863. In a 2014 survey[14], the Limmen Bight Region recorded the highest dugong densities. Again in 2015 an aerial survey showed that dugong populations in the Gulf of Carpentaria remained stable[15]. The concentration of dugong sightings in seagrass meadows in Figure 6 indicates the importance of that habitat to the species. The main threats to dugongs are loss of habitat and entanglement in fishing gear.

DOLPHINS

Figure 7 provides distribution data for three dolphin species in the Limmen Bight Region (five have been recorded in the region). Dolphins are seen throughout the Limmen Bight region, but there appears to be a concentration in the waters surrounding and north of Maria Island. The 2014 aerial survey of dugongs[16] recorded sightings of Australian snubfin dolphins and one unidentified dolphin inside or near the Limmen Bight Marine Park, which contains suitable habitat for them and Indo-Pacific humpback dolphins.

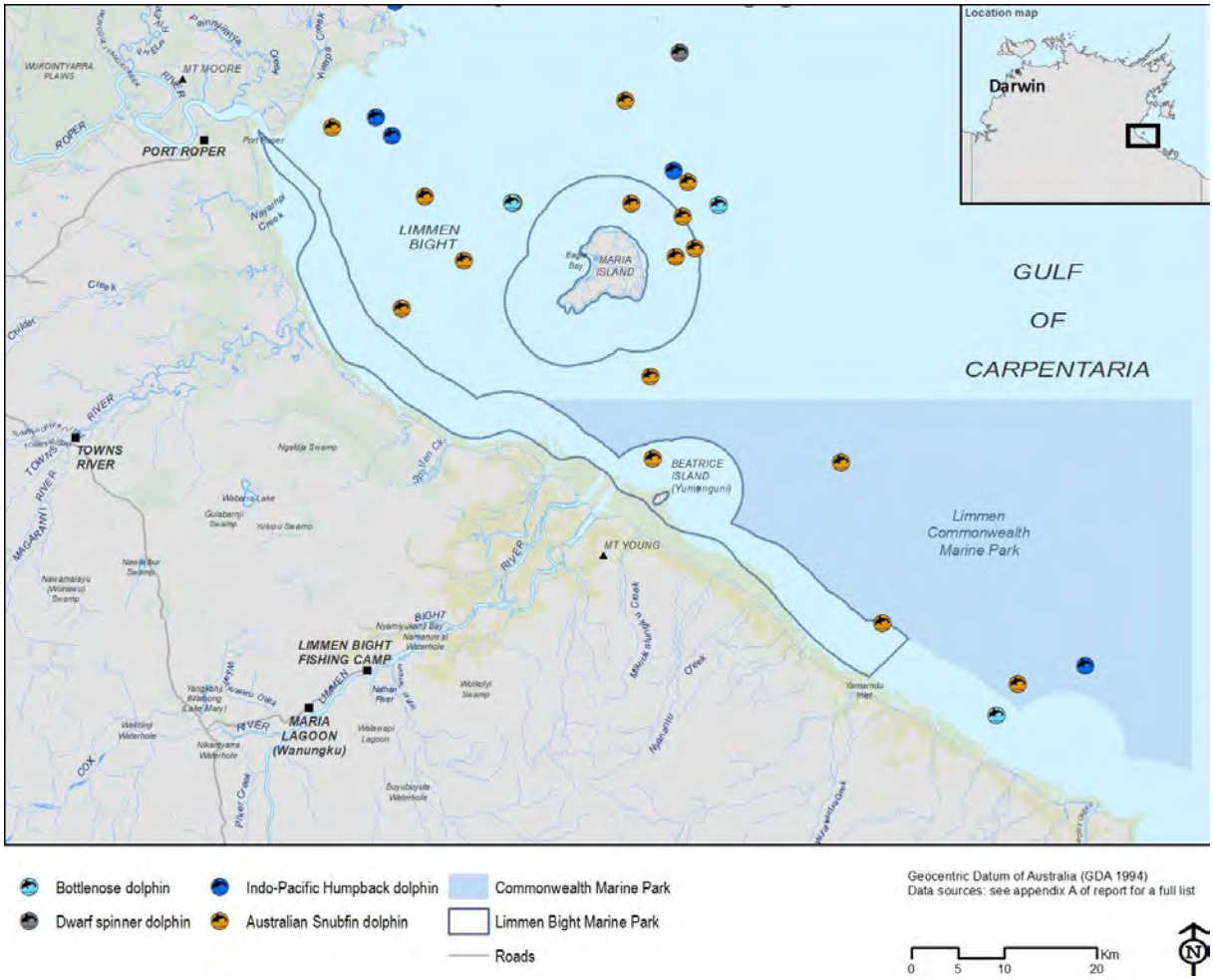

Figure 7. DOLPHIN SIGHTINGS IN THE LIMMEN BIGHT REGION

MARINE TURTLES

Marine turtles forage throughout the Limmen Bight Region's waters but due to the muddy shoreline and few sandy beaches, nesting sites are limited to Maria and Sandy islands and the upper reaches of some creeks.

The flatback, green, hawksbill and olive ridley turtles feed in the waters of the Limmen Bight Marine Park, while flatback turtles nest on Maria Island and several sandy beaches along the mainland shoreline. The main threats for marine turtles are habitat loss and entanglement in operational and discarded fishing gear.

Figure 8 summarises aerial sightings and recorded nesting sites and tracks of marine turtles in the Limmen Bight Region. Aerial sightings are concentrated between Limmen Bight River and Rosie Creek, where most seagrass meadows are found. Five flatback turtle nesting sites were reported along the shoreline from Towns River to Spillen Creek, and on the south-western shoreline of Maria Island.

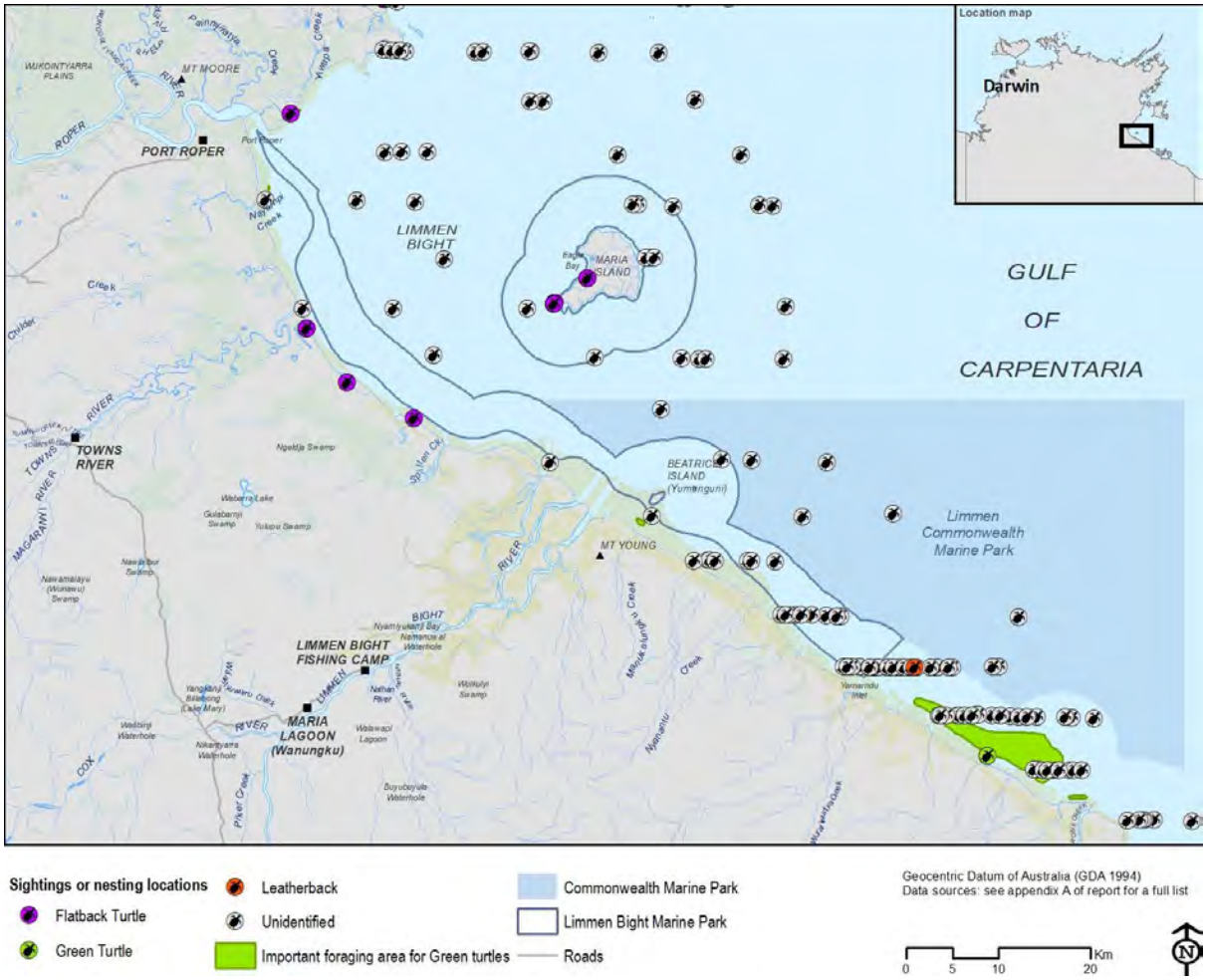

Figure 8. TURTLE SIGHTINGS AND BIOLOGICALLY IMPORTANT AREAS IN THE LIMMEN BIGHT REGION

Chatto and Baker (2008)[17] surveyed turtle nesting sites in the Northern Territory from 1991 to 2004. The Limmen Bight Region, enclosed within the Pellew bioregion, was surveyed 49 times between 1993 and 2004. They found that:

"The Pellew Bioregion is another bioregion that is very important for marine turtle nesting, particularly on the islands. All species that normally nest in the NT were recorded nesting in this bioregion but the Flatback Turtle and the Green Turtle were the most often recorded".

However, in a 200 km section of the coast between Nyinpinti Point and Bing Bong, most turtle nesting (of flatback and green) was on beaches north of the Roper River, north of the Limmen Bight River and north of Bing Bong. Chatto and Baker concluded that the coastal section "is a low priority area for turtles and high priority area for waterbirds and waders, which consequently received most of the attention during the surveys". In the coastal section containing Maria Island, the researchers found flatback turtle nesting sites in high numbers on its eastern and southern shores.

SEABIRDS, SHOREBIRDS AND WATER BIRDS

The best available data on seabirds, shorebirds and waterbirds in the Limmen Bight Region are from aerial and ground surveys conducted by Ray Chatto of the Northern Territory Parks and Wildlife Commission during the 1990s and early 2000s. Figure 9 maps seabird and waterbird colonies in the region based on these reports (new surveys are urgently required to better inform the management of the Limmen Bight Region and the Limmen Bight Marine Park in relation to seabirds, shorebirds and waterbirds).

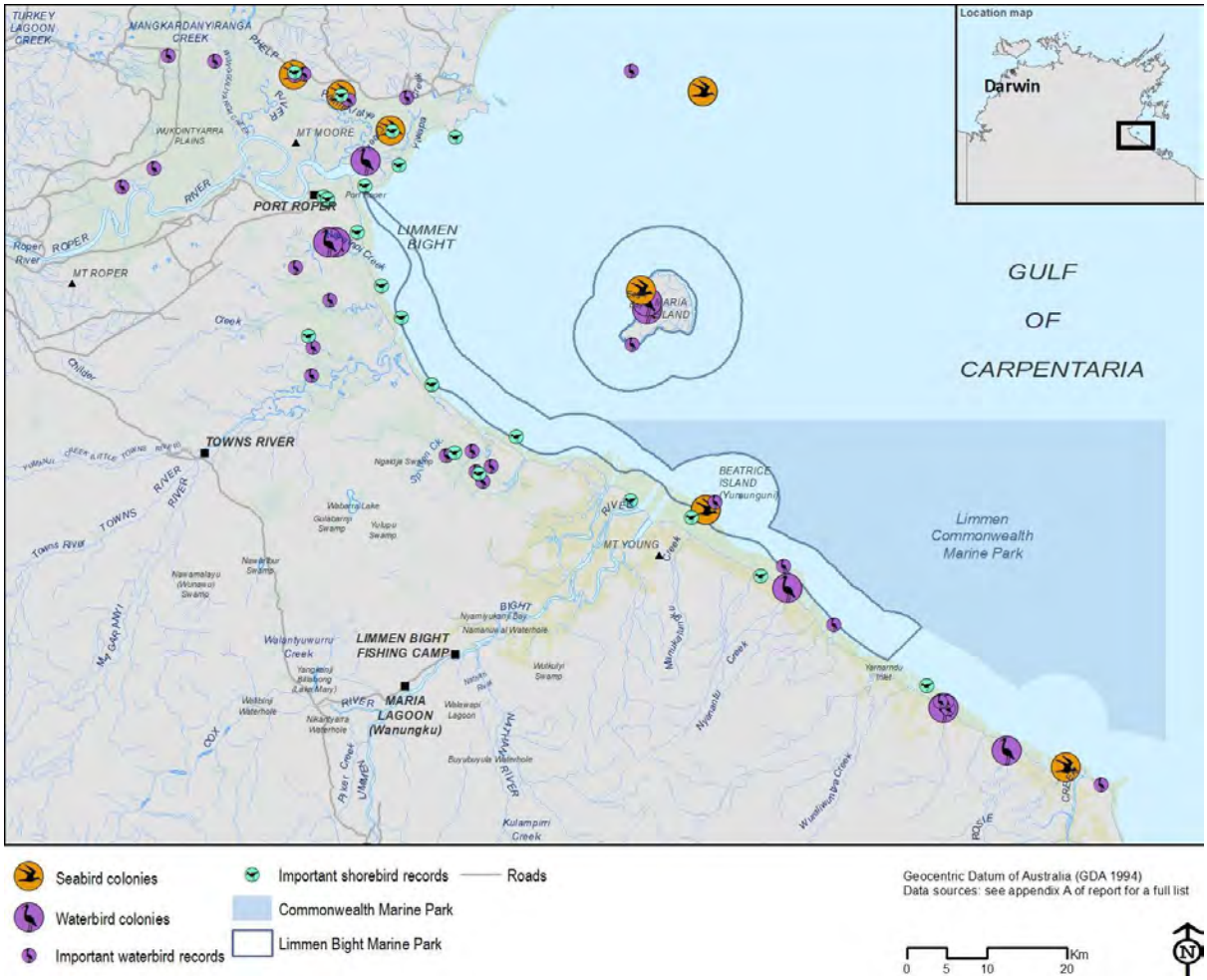

Figure 9. SEABIRD AND WATERBIRD COLONIES AND IMPORTANT RECORDS

SEABIRDS

For the surveys of seabirds, the distributions of which are more localised, Chatto (2001)[18] focussed on individual colonies (147 along the Territory coastline) rather than the broader areas used for the waterbird and shorebird surveys- seabirds are scattered over far wider areas. In the Limmen Bight Region, Chatto identified four seabird colonies: Maria Island, Low Rock (between Groote Eylandt and the Roper River mouth), Sand Spit Island and the beach west of the mouth of Rosie Creek.

Maria Island, which is 20 km from the mainland shore, hosts one of the Territory's largest silver gull colonies and the surrounding marine waters are one of their important foraging areas. The osprey and the white-bellied sea eagle are also known to breed on the island, while the eastern side is "well used for seabird roosting and the island has reasonable numbers of shorebirds", according to Chatto (2001), who

also believed that the island had suitable habitat for breeding by little tern, black-naped/roseate tern and the pied cormorant.

Low Rock is a small island outcrop of sand, coral rubble and rock that hosts a high number of seabird species including crested, lesser crested (only known breeding colony in the Territory), black naped, roseate and bridled terns and is one of the Top End's most significant colonies, with the size of the colony estimated to be from 10,000 to 30,000 birds. It is also one of two internationally significant seabird colonies in the Limmen Bight Region, the other 25 km north on Sandy Island (mainly crested tern).

Sand Spit Island is a narrow 500-metre strip of sand joined to the mainland at very low tides and which hosts a significant Top End little tern colony. The pied oystercatcher also breeds on this partially vegetated island, as does the silver gull, which preys on tern eggs and chicks. Just west of the mouth of Rosie Creek, another long and narrow sand island hosts significant breeding colonies of little tern, silver gulls and pied oystercatchers as well as red capped plovers.

The bioregional planning process for the North Marine Region identified a number of threats of potential concern to seabirds[19]. For terns, the main species group found in the Limmen Bight Region, these threats were climate change (rises in sea level and sea surface temperatures, and ocean acidification); marine debris, human disturbance, including burleying by recreational fishers, and invasive species.

SHOREBIRDS

The extensive intertidal mudflats in the Limmen Bight Region support internationally significant numbers of migratory shorebirds and are one of the Territory's most important areas for them.

In his surveys of shorebirds[20] during which he recorded 20 species of migratory birds, Chatto (2003) found the most common between the Roper River and Bing Bong, and including Maria Island, were the red knot (one flock had 1500 birds), great knot, red-necked stint, red-capped plover, lesser and greater sand plovers and the grey-tailed tattler. Other shorebird species recorded were common greenshank, eastern curlew, bar-tailed and black-tailed godwit, ruddy turnstone, pied oystercatcher, grey plover, whimbrel and the curlew, marsh, sharp-tailed, terek and broad-billed sandpipers. The highest numbers for single surveys exceeded 38,000 shorebirds around the Roper River and up to 11,000 birds east of the Limmen Bight River. The tidal flats on the northern and southern sides of the Roper River mouth contained the most aggregation sites.

During the surveys, the recorded numbers of broad-billed sandpiper, lesser sand plover and grey-tailed tattler were all greater than 1% of their Australian population sizes, an international threshold of significance.

WATERBIRDS

Of 38 waterbird species recorded between the Roper and Limmen Bight rivers by Chatto (2006)[21], the most abundant was the black-winged stilt, and then the magpie goose, four egret species and the red-necked avocet, Australian pelican, glossy ibis and grey teal. Fewer waterbirds were recorded east of the Limmen Bight River, with the most abundant being grey teal, pied cormorant, black-winged stilt and egret species, while the black-necked stork was widespread.

Figure 9 maps eight waterbird colonies in the Limmen Bight Region: two on Maria Island, three near the Roper River mouth, and three to the east of the Limmen Bight River (another is found on Low Rock). These host Australian white ibis, nankeen night heron, little, great and intermediate egrets, pied heron, little and pied cormorants and large numbers of visiting waterbirds during the wet season.

The highest numbers of waterbirds recorded in a single survey was on the wetlands and coast of the Roper River floodplain. There Chatto recorded 17,000 but he believed this could have reached 20,000, a similar figure for wetlands of the Towns River and those north of the Limmen Bight River. The Roper River is also a major breeding area for brolga.

FISH

More than 100 fish species have been recorded in the estuarine and marine areas of Limmen Bight. These include at least three species of pipefish, the large-toothed sawfish, the bull shark and the freshwater whipray.

SYNGNATHIDS

Blue-spotted pipefish, the short-keel pipefish and the beady pipefish have been recorded in Limmen Bight. Each is listed on the *Environment Protection and Biodiversity Conservation Act*. The threats of potential concern for syngnathids in the North Marine Bioregional planning process[22] were physical habitat modification by dredging and fishing gear (active and derelict). For some Territory species, bycatch from commercial fishing was another potential concern.

SAWFISH

The large-toothed sawfish (formerly freshwater sawfish) has been recorded in the coastal habitats and lower reaches of creeks and rivers in the Limmen Bight Region. The threats of concern for sawfish, identified in the planning process for the North Marine Bioregion, include extraction by illegal and unregulated fishing, as bycatch from commercial and recreational fishing, and changes in hydrological regimes due to land-based developments and climate change[23]. Of potential concern were rises in sea level (inundation or erosion of habitats; increased salinity; loss of mangroves) and sea surface temperatures (changes in metabolism, behaviour and movement, as well as reduced respiratory function resulting from lower dissolved oxygen levels), marine debris and contaminants.

SEA SNAKES

Sixteen species of sea snakes have been recorded in the Gulf of Carpentaria's coastal zone[24]. Sea snakes have a highly specialised diet feeding on a small number of benthic fish species and breed once a year. Fry, Milton and Wassenberg[25] found that slow reproduction and small clutch sizes made sea snakes potentially vulnerable. The North Marine Bioregional planning process identified climate change (sea level and sea surface temperature increases, and ocean acidification), habitat modification through dredging, and bycatch as of potential concern, while bycatch was of concern for several sea snake species[26].

RESOURCE USES IN THE LIMMEN BIGHT REGION

For many years the marine resources of the Limmen Bight Region and the yet to be operationalised Limmen Bight Marine Park have been used by commercial and recreational fishers targeting prawns, barramundi, mud crabs and other species. Cattle grazing on pastoral leases in the region's catchment has in the past been a major activity. More recently, there has been a growing interest in the mining of the Limmen Bight Region's catchment, which would involve the barging and transhipping of ores very close to the marine park's boundary and increase demand for surface and groundwater extraction, and seabed mining throughout the park and the region. Separately and together these resource uses pose a threat to water quality, marine life and the natural values of the Limmen Bight Marine Park. Climate change is another.

COMMERCIAL FISHING

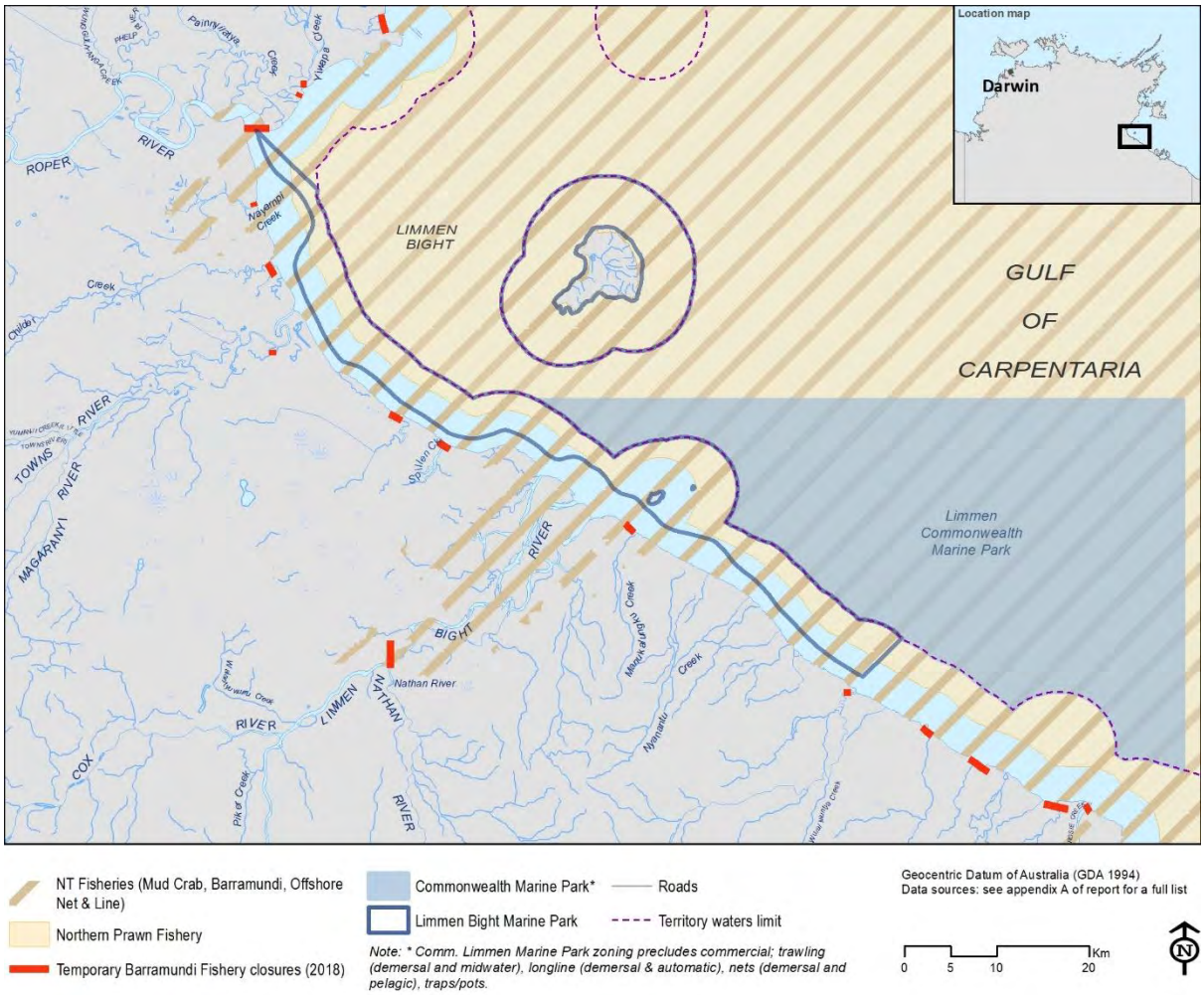

Figure 10. COMMERCIAL FISHING IN LIMMEN BIGHT

There is limited data available on commercial fishing in the Limmen Bight Region (with the exception of prawn fishery catches and interactions with threatened species). The data that does exist is old and has limited regional coverage, while fisheries, such as for barramundi, have had no formal stock assessments.

Although the Territory-wide number of licences are known for the Barramundi (14 licences), Mud Crab (49 licences), Offshore Net and Line (17 licences) and Northern Prawn (52 licensed boats that fish out to the edge of Australia's Exclusive Economic Zone) fisheries, it is unclear just how many licensed commercial fishers operate regularly within the Limmen Bight Region and Limmen Bight Marine Park. Information from fisheries with less than five active operators cannot be released without consent and hence is not publicly available.

MUD CRAB FISHERY

The Northern Territory Mud Crab Fishery is divided into two zones, with the Western Gulf of Carpentaria Zone representing 70% of Territory harvests[27] (the other zone occupies the remainder of Territory waters).

The Northern Territory's Mud Crab Fishery uses crab traps in coastal estuaries and on mudflats to target the giant mud crab (99% of catch). At the time of the Limmen Bight Marine Park's creation in 2012, the NT Seafood Council estimated that 20% of the Territory mud crab catch came from inside the park[28], while *ABC News* reported that:

"One third of the Territory's mud crab licenses are operated within the proposed 80,000 hectare site. License holder Sherwood Thorbjornsen says last year almost one third of the total catch came from the same area. 'There's no place that we can go to use 16 licenses"'[29].

Mud crab catches are higher in wetter years; since 2013 lower than average rainfall has seen catches decline. Mud crab catches in the Gulf zone peaked at 1000 t in 2002, whereas in 2015 they were closer to 50 t (mostly from Limmen Bight and waters north of Groote Eylandt). Catches increased in 2017:

"Based on historical patterns in catch [the catch to the end of August represented two thirds of the annual catch], we expect the 2017 harvest in the Gulf to be around 180 tonnes, up from 50 tonnes last year"[30]...and "catches in the Roper region were expected to be 60 tonnes, up from just 3 tonnes last year"[31].

Figure 10 shows the area of the Limmen Bight Region that mud crab fishers can access. Based on the above *ABC News* report, 16 licensed mud crab fishers could be operating within the marine park (although at the time of the park's creation, the NT Seafood Council estimated at least eight licensed fishers[32]). However, as Figure 2 reveals, the region's intertidal mudflats may not occur within the marine park. Although the marine park's offshore waters may be used by spawning female crabs releasing eggs (some have been found to travel 95 km) and by mud crab larvae:

"Adult mud crabs generally inhabit muddy estuaries and enclosures in mangrove ecosystems and tidal flats that are influenced by tidal waters, juveniles reside in the upper intertidal and remain there during low tide"[33].

The number of licensed fishers operating within the marine park, and their total catch, is a major knowledge gap that needs addressing.

According to the 2015 Key Northern Territory Fish Stocks Report:

"While environmental factors do appear to have a significant impact on Giant Mud Crab recruitment, it is possible that intermittent overfishing of the Western GoC stock has occurred in recent years and that overfishing did take place in 2015"[34].

A Fisheries Research and Development Corporation (FRDC) report[35] determined that the Mud Crab Fishery in the Western Gulf of Carpentaria Zone was transitional depleting, which means that it is a deteriorating stock i.e. crab biomass is not yet recruitment overfished, but fishing pressure is too high and moving the stock in the direction of becoming recruitment overfished. This was also the assessment in the 2017 *Management framework for the Northern Territory Mud Crab Fishery*[36].

Mud crab traps interact with threatened species, and escape vents are now mandatory for wire traps used by commercial fishers but optional for recreational fishers. Discard rates of undersized mud crabs can be as high as 70% of the total catch in some areas according to the FRDC report. There was no estimate of the mortality rate of discarded mud crabs, however:

"Mud Crabs sometimes lose limbs when caught in or removed from traps; the injury rate is related to the style of trap used. Although limb loss appears to have little impact on the short-term survivorship of 'Mud Crabs', repeated limb damage may potentially compromise their growth and/or reproductive success (based on observations of other crab species)"[37].

The Management Framework for the Northern Territory Mud Crab Fishery 2017[38] noted four ecological risks from the fishery:

- sustainability of the target species in the Gulf of Carpentaria;
- terrestrial impact from construction and use of temporary land-based camps by commercial fishers;
- environmental conditions that impact recruitment to the fishery;
- the potential for runoff from development to impact water quality.

BARRAMUNDI FISHERY

The Northern Territory Barramundi Fishery uses gillnets of up to 1000 metres in length (combined) to catch barramundi (king threadfin is a by-product) in Territory waters. At the time of the Limmen Bight Marine Park's declaration in March 2012, the number of barramundi licence holders reported fishing in the park ranged from two[39] to eight[40].

Figure 10 shows that there are 17 Barramundi Fishery closures in the Limmen Bight region but all are outside the marine park's boundary. The closures, which prohibit commercial harvesting of barramundi in those areas, include the mouths of the Roper River, Nayarnpi and Rosie creeks, and the upper reaches of the Limmen Bight River. Enhancing opportunities for recreational fishing for barramundi is one of the objectives of the closures. They can also reduce the impacts of gillnetting on other marine life. The 2015 *Key Northern Territory Fish Stocks Report*[41] indicated that the most common threatened species interactions in the Barramundi Fishery involve saltwater crocodiles (<50 interactions per year), along with largetooth sawfish, green sawfish, turtles and dugongs (<10 per year).

Due to the presence of threatened species in the Limmen Bight Marine Park, and the potential for their interaction with gillnets, gillnetting is incompatible with park values.

The management plan zone for the adjoining Commonwealth Limmen Marine Park is Habitat Protection Zone, which prohibits demersal and pelagic nets. To ensure consistency between the adjoining parks, the use of gillnets should be prohibited in the Limmen Bight Marine Park.

OFFSHORE NET AND LINE FISHERY

The Offshore Net and Line Fishery covers Territory, Queensland and Commonwealth waters in the Gulf of Carpentaria, with management shared between the Territory and Queensland agencies. Blacktip reef sharks and grey mackerel are the main species targeted, but black jewfish, Spanish mackerel, longtail tuna and black pomfret, and hammerhead, bull, tiger, pigeye, lemon and winghead sharks and dusky whalers, are also taken. The fishery uses demersal or pelagic longlines and pelagic nets, with the longlines reaching up to 15 km in length and the nets 2 km.

In 2015 the catch in the Northern Territory component of the fishery was only 4 tonnes (80-95% of the harvest occurs in Queensland waters). Data on the catch within the Limmen Bight Region and the Limmen Bight Marine Park are unavailable, although the 2015 stock status report[42] indicates that black

jewfish were harvested in the Limmen Bight Region and possibly the marine park. Grey mackerel were also harvested in the region but not from inside the park.

The Offshore Net and Line Fishery interacts with turtles, dolphins and other threatened species. Although the numbers of reported interactions in the commercial logbooks are low, the impact on threatened species populations is unknown.

The Australian Marine Conservation Society's *Sustainable Seafood Guide* says of the fishery:

"The NT fishery that catches grey mackerel also targets a number of shark species, such as blacktip, spot-tailed and scalloped hammerhead shark, often with no stock assessments for high-risk species. The NT fishery has recorded increasing catches of shark in recent years. The lack of knowledge about shark abundances combined with increasing fishing pressure is particularly concerning as shark species are generally long-lived, are slow to mature and produce few young; this means shark populations are highly vulnerable to population depletions as a result of fishing activity. Sharks are also apex predators that are essential to the maintenance of healthy marine food webs. In both QLD fisheries, a number of threatened species are caught as bycatch in gillnets set to catch grey mackerel, including green, loggerhead, flatback and leatherback turtles, dugongs, sawfish and a number of shark species, including hammerhead sharks. There is an independent observer program in NT, but the amount of observer coverage is low"[43].

Due to the fishery's interactions with turtles, dolphins and other threatened species, and the uncertainty over the size of fish stocks and the levels of fishing pressure and bycatch, commercial netting is incompatible with the values of the Limmen Bight Marine Park.

The management plan zone for the adjoining Commonwealth Limmen Marine Park is Habitat Protection Zone, which prohibits demersal longlines and pelagic nets. To ensure consistency between the adjoining parks, the use of demersal longlines and pelagic nets should be prohibited in the Limmen Bight Marine Park.

NORTHERN PRAWN FISHERY

The Northern Prawn Fishery is the Territory's most valuable, with the majority of its catch in Territory and Commonwealth waters (it extends to the boundary of Australia's Exclusive Economic Zone) taken from the Groote and Limmen Bight statistical areas that cover the Limmen Bight Region (they are two of 15 statistical areas across the fishery). The Limmen Bight Region is almost wholly in the Limmen Bight statistical area.

Tiger, banana and endeavour prawns are targeted by the fishery using otter trawls with two, three or four nets that must have turtle excluder and bycatch reduction devices fitted. Waters within two nautical miles of the shoreline of the Limmen Bight Region are closed to prawn trawling, which leaves available one nautical mile of Territory waters inside the marine park waters (including off Maria Island).

In 2017, the Limmen Bight statistical area had the third-highest catch of banana prawns with 721 t (they were 78 t in 2016)[44], whereas for tiger prawns the Groote statistical area had the highest catch (371 t; 591 t in 2016 and 1,386 t in 2015) and Limmen Bight the second highest (350 t; 422 t in 2016). It is unknown what tonnages are harvested from within the Limmen Bight Marine Park.

Tables 1 and 2 list the fisheries interactions with threatened species: turtles, dugong, syngnathids and sea snakes. Table 1 shows that from 2008 to 2017, the fishery had 33,336 interactions with turtles and sea snakes within the Groote and Limmen Bight statistical areas[45]. Most of the interactions were with sea snakes. Across the two areas, 26,624 sea snakes were released alive and 3,324 perished. Another 39 were released injured. For turtles, 209 were released alive and 7 perished. Table 2 shows that interactions with syngnathids and sawfish between 2015 and 2017 numbered 551[46]. Across the two statistical areas there were 276 sawfish released and 97 perished. For syngnathids, 64 were released and 144 perished.

Due to the habitat impacts of bottom trawling, and the fishery's interaction with turtles, sea snakes, dugongs and syngnathids, bottom trawling is incompatible with the values of the Limmen Bight Marine Park.

The management plan zone for the adjoining Commonwealth Limmen Marine Park is Habitat Protection Zone, which prohibits demersal and midwater trawling. To ensure consistency between the adjoining parks, trawling should be prohibited in the Limmen Bight Marine Park.

OTHER COMMERCIAL FISHERIES

The Trepang, Aquarium and Spanish Mackerel fisheries may also harvest fish in the Limmen Bight Region and potentially the Limmen Bight Marine Park.

The Trepang Fishery is based on the hand collection of sandfish *Holothuria scabra* by divers in Territory waters. With only six licences, publicly available data on catches are limited. In 2015, no catches were reported from the Limmen Bight Region. The Territory's Aquarium Fishery is a relatively small one, with 11 licences in the Territory harvesting freshwater and marine plant and animal species. Diving, hand collection and cast and scoop nets are the main methods. Most marine species are harvested within 100 km from Nhulunbuy and Darwin. The 2015 stock status report indicates that Spanish mackerel were harvested in the Limmen Bight Region during that year but not inside the marine park[47].

Table 1 THREATENED SPECIES (TURTLES AND SNAKES) INTERACTIONS IN THE NORTHERN PRAWN FISHERY 2008-2017

SUBREGION/IMPACT	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	TOTAL
GROOTE											
Turtles released alive	1	8	2	4	19	12	15	29	5	23	118
Turtles perished	0	0	0	0	0	1	0	0	0	0	1
Turtles released injured	0	0	0	0	0	0	0	0	0	0	0
Condition unknown	0	0	0	0	0	0	0	0	0	0	0
Snakes released alive	1030	1310	2345	1198	1576	1165	1477	2360	2080	2375	16916
Snakes perished	105	85	179	94	127	184	173	520	664	675	2806
Snakes released injured	5	1	26	21	14	11	2	2	3	0	85
Condition unknown	49	24	192	149	98	219	207	775	3	0	1716
LIMMEN BIGHT											
Turtles released alive	2	11	10	1	5	19	11	7	14	11	91
Turtles perished	0	3	0	0	2	0	0	0	0	1	6
Turtles released injured	0	0	0	0	0	0	0	0	0	0	0
Condition unknown	0	0	0	0	0	0	0	0	0	0	0
Snakes released alive	1879	839	1162	621	642	1048	750	540	930	1297	9708
Snakes perished	193	56	164	89	81	131	128	103	279	198	1422
Snakes released injured	22	0	7	10	5	6	3	0	1	0	54
Condition unknown	51	31	74	1	5	187	43	21	0	0	413
TOTAL	3337	2368	4161	2188	2574	2983	2809	4357	3979	4580	33336

Table 2. THREATENED SPECIES INTERACTIONS (SAWFISH AND SYNGNATHIDS) IN THE NORTHERN PRAWN FISHERY 2015-2017

SUBREGION/IMPACT	2015	2016	2017	TOTAL
GROOTE				
Sawfish released	55	42	57	154
Sawfish perished	25	31	23	79
Syngnathid released	36	4	10	50
Syngnathid perished	61	16	16	93
Syngnathid released injured	0	0	0	0
Syngnathid condition unknown	0	0	0	0
LIMMEN BIGHT				
Sawfish released	22	30	70	122
Sawfish perished	2	8	8	18
Syngnathid released	7	1	6	14
Syngnathid perished	9	10	2	21
Syngnathid released injured	0	0	0	0
Syngnathid condition unknown	0	0	0	0
TOTAL	217	142	192	551

RECREATIONAL FISHING

Recreational fishers target barramundi, other fish and mud crabs in the estuaries and along the Roper and Limmen Bight rivers.

Data on recreational fisher catches in the Northern Territory, and the Limmen Bight Region, are severely limited. For example, Territory-wide estimates of annual recreational harvest of mud crabs have been 42 t in 1998[48], 66 t in 2000[49] and 24 t in 2009[50]. The infrequency of such surveys may in part be addressed by the introduction of the recreational fishing diary program and more regular surveys.

The lack of data on recreational fishing creates uncertainty, so the *Recreational Fishing Development Plan 2012-2022*[51] recommended increased 'fisheries research and data collection on key recreational species' and 'comprehensive five-yearly surveys, ongoing monitoring of key areas and targeted surveys'. The plan also recommended the following strategies and actions:

- ensure that recreational fishing controls protect stock sustainability, by taking into account species' abundance, biological characteristics and levels of fishing pressure;
- ensure fisheries management measures are proactive and anticipative of increasing recreational fishing activity and impacts;
- ensure fish are protected at vulnerable stages of their life cycle, such as juvenile fish and spawning aggregations;
- improve fish handling and release techniques to minimise mortality of released fish;
- targeted management of fishing hot spots; identify important fish habitats, nursery areas and spawning aggregation sites that may require additional specific management measures[52].

Recreational fishing is not without its impacts:

'With the increasing number of recreational fishers in the Northern Territory and advancement in fishing technology, it is likely that some fish stocks in more populated areas are being fished at or near their sustainable limits. Continuing increases in fishing pressure may lead to low quality fisheries based on small-sized recruits, and fish stocks declining or even collapsing if proactive management is not adopted. This may impact on fishing quality and lifestyle values and also regional tourism centres and local economies. There is limited data available on the status of many recreationally significant fish stocks in Territory waters. Inadequate information heightens the need for precautionary fishery management measures…'[53].

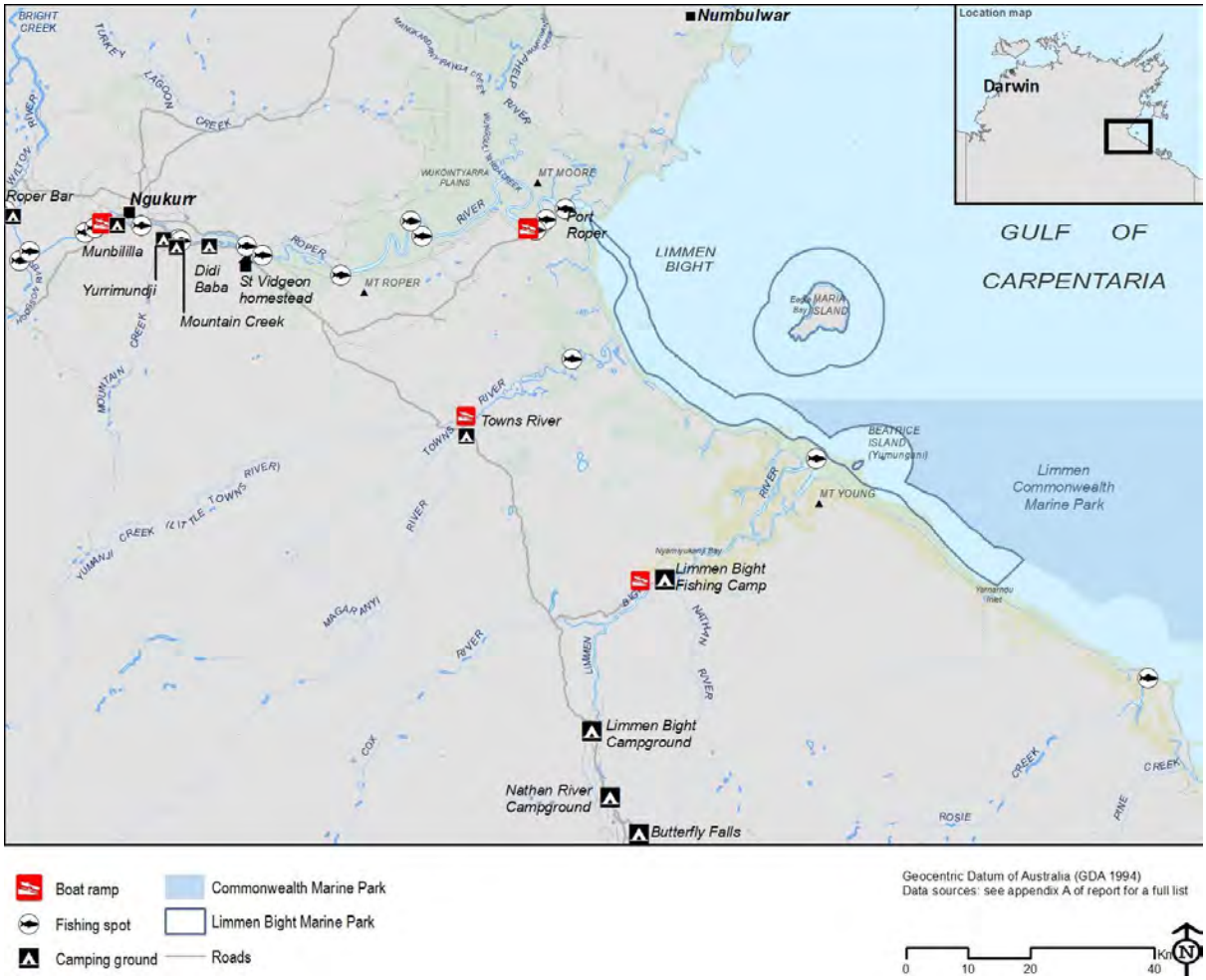

Figure 11. RECREATIONAL FISHING IN THE LIMMEN BIGHT REGION

In the last recreational fisher survey in 2009-2010, the number of days fished in Limmen Bight amounted to 7% of the total days fished in the Territory. The remoteness of the Limmen Bight region and the relative lack of infrastructure (seasonal 4WD tracks, fishing camps with limited facilities and only six boat ramps on the Roper and Limmen Bight rivers - see Figure 11) currently restricts recreational fisher numbers.

The Amateur Fishermen's Association NT welcomed the declaration of the Limmen Bight Marine Park in March 2012, described by the then Minister for Parks and Wildlife as a 'recreational fishing friendly Marine Park'[54].

The region's near-pristine waters (and remoteness) are strong attractors for recreational fishers who are not just looking to catch fish but to also seek an outdoors experience, interact with the natural environment, and have an adventure. A marine park that limits incompatible commercial fishing, such as bottom trawling, and promotes recreational fishing may encourage more visits from recreational fishers.

An expansion of recreational fishing activity and associated support infrastructure may be part of the Limmen Bight Region's future economic development. This could see safe all-weather roads, more boat ramps that allow reasonable access, and improvements to camping sites and telecommunications. Increased fisher numbers, expanded services in local communities and local management/ranger opportunities may flow from this. For example, in 2016 the Territory Minister for Transport announced an upgrade of the Roper Highway with new bridges and realignments:

"The Roper Highway is a key road in the Northern Territory road network, linking cattle stations to domestic and international markets as well as access to the East Arnhem tourism region and to the mineral rich Roper Gulf region. During the wet season, the crossings are prone to flooding, making the highway impassable for a significant portion of the year. Mr Chandler said the project will improve access to the local communities, such as the Ngukurr and Numbulwar communities by reducing closure time at the crossings during the wet season"[55].

Developments like these will need to be well managed to ensure that the region's values are not degraded.

TOURISM

Tourists are attracted to the Limmen Bight Region because of its natural beauty, cultural richness, remoteness and to camp and fish along its rivers. But regional tourism data is extremely limited.

The Limmen Bight Region is part of the Katherine tourism region, which up until 2014 had been experiencing a steady decline in interstate, intrastate and international overnight visitors. However, since 2014 the number of intrastate visitors has been increasing, while interstate visitors have grown in numbers since 2015, and those from overseas since 2016. How many of those tourists are coming to the Limmen Bight Region is unclear. The only data available are the average annual overnight visitor numbers for the Gulf Statistical Area (SA2)[56], which extends from north of Groote Eylandt to the Queensland border. From 2015-2017, the annual average was 22,000. However, it has also been reported that the Limmen National Park alone receives 15,000 visitors each year[57], which may include day visitors.

The various natural values of the region, which have been described earlier in this report, are regionally, nationally and internationally significant values that the Territory Government's approach to tourism promotion emphasises. In the Gunner Government's Healthy Environment, Strong Economy policy, the Territory's "unique natural environment is one of our greatest assets" and offers this as a key point of difference compared to other tourism destinations in Australia and globally.

The Territory's Tourism Vision 2020 describes the Territory's competitive strength as being "based on its unique nature, culture and outback experiences". Aquatic wildlife is number one on the list of top Australian experiences for all international tourists visiting Australia[58], while currently more than 80% of international visitors to the Top End seek out nature-based activities, making the Territory's marine and coastal environment a critical tourism asset[59]. The Territory's marine and coastal environment contains abundant aquatic wildlife including crocodiles, turtles, dugong, coastal dolphins, seabirds, sharks and sawfish.

When it declared the Limmen National Park and Limmen Bight Marine Park, the Territory Government in 2012 "hoped the combination of special rock formations, savannahs, dolphins and turtles will prove be major tourist drawcards for the parks"[60]. The protection, management and promotion of the Limmen Bight Marine Park will provide the Gunner Government with an opportunity to take advantage of these strengths.

Some tourism operators are already doing this. The Savannah Way Green Trail, which links Broome to Cairns, is one collaborative tourism promotion that may bring more tourists to the Limmen Bight Region and the Limmen Bight Marine Park. It showcases "responsible tourism" across northern Australia:

"A sustainable approach to the management of tourism, providing more enjoyable experiences for tourists through connecting with local people and communities. Travellers can discover significant conservation activity, sustainable land uses, local history, cultural values, native flora and fauna along the Savannah Way from Cairns to Broome"[61].

Ngukurr, the Roper Bar, Limmen National Park and Borroloola are along the green trail. Limmen Bight Marine Park could become another destination once a management plan is in place.

One tourist operator that already focuses on the natural values of the region is the Lorella Station Wilderness Park. It is operated by the holders of the Lorella Springs pastoral lease, is twice the size of the ACT and:

"Part of a virtually untouched one million acre cattle station located 180 kilometres along the road between Borroloola and Roper Bar, 29 km north of the Savannah Way. This huge, remote property offers a retreat of solitude and serenity with 25 kilometres of coastline, plus waterways, wetlands and swamps, rock formations and mountain ranges, chasms and gorges, numerous water holes and natural springs and a variety of wildlife"[62].

With the region destined for improved roads and other infrastructure, the result of government programs and mining operations, the number of tourists visiting the region will likely increase. When announcing an upgrade of the Roper Highway with new bridges and realignments in 2016, the Territory Minister for Transport said that:

"Traffic on the Roper Highway has increased at six per cent a year over the past decade and these flood immunity works will deliver the much needed infrastructure to benefit remote Indigenous communities as well as help to build a prosperous economy"[63].

A tourism strategy that accentuates the promotion and protection of the region's natural and cultural values will be essential.

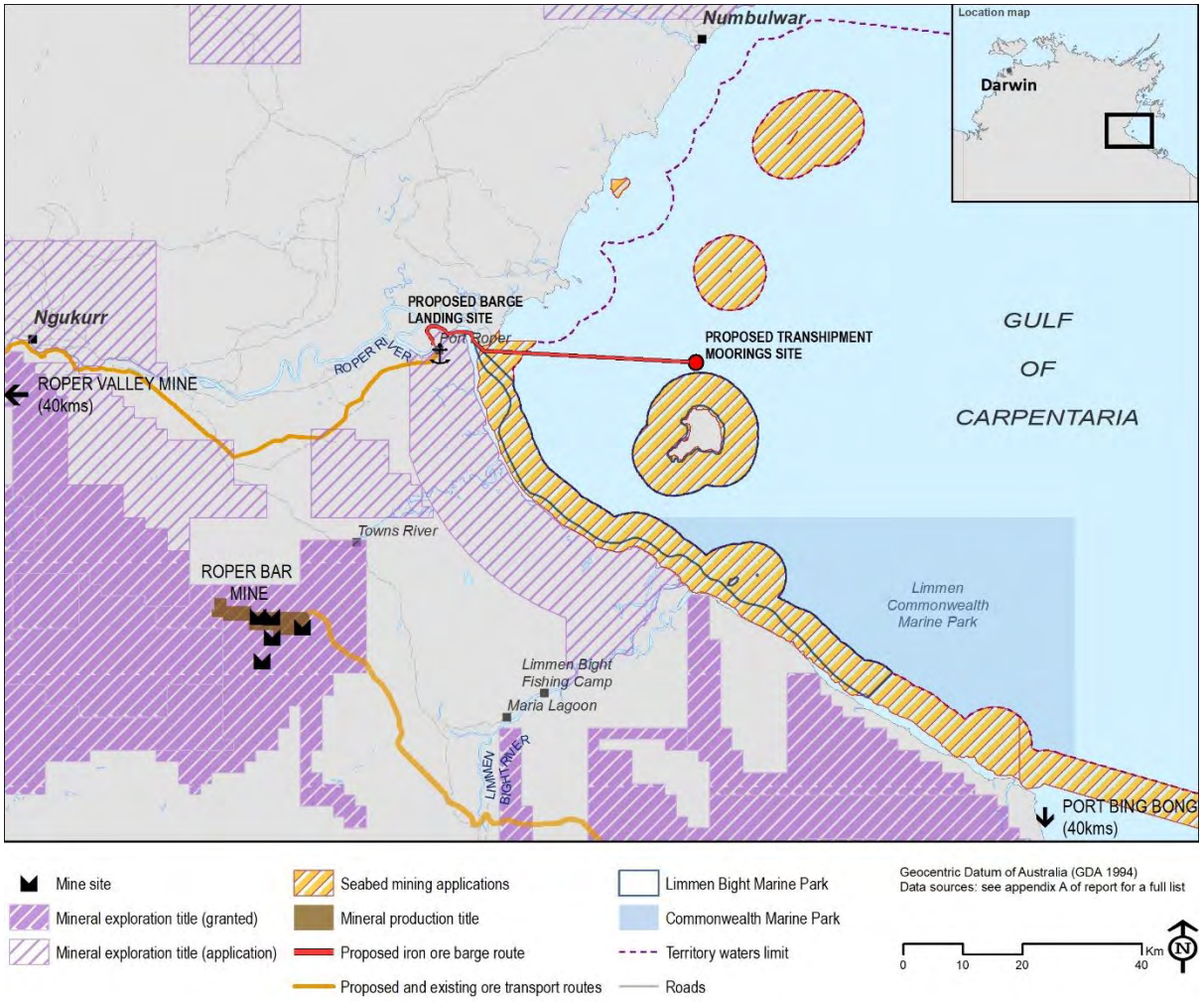

Figure 12. MINERALS MINING APPLICATIONS & PRODUCTION IN LIMMEN BIGHT REGION

LAND-BASED MINING

There are currently two iron ore mining projects in the Limmen Bight Region. Although both were mothballed after the crash in iron ore prices in 2014, under new owners the Roper Bar iron ore mine is again operational (although yet to produce ore), while the Roper Valley mine is seeking approvals to operate.

A mineral-sands mine is operational in the Mataranka area, while there is also considerable exploration activity in the catchment of the Limmen Bight Region, and the upper reaches of the Roper River catchment are not included in planned reservations from hydraulic fracturing (fracking).

ROPER BAR IRON ORE

The Roper Bar iron ore mine was reopened by its new owner Britmar (Aust) in 2018. Once the mine begins production, the iron ore will be trucked to the Bing Bong port for export.

The prior owner of the Roper Bar mine, Western Desert Resources (WDR), was fined in the federal court in 2016 for the illegal clearing of native vegetation to construct a road through the Lorella Springs pastoral lease without approval:

"The Department's investigation revealed that WDR knowingly cleared land and began road construction associated with a mining venture prior to the approval being granted. Unregulated actions like this can put the flora and fauna protected under national environment law at great risk. Between July and December of 2012 WDR illegally cleared approximately 80 km of vegetation to build a haul road between a planned iron ore mine in the Roper Bar region and Bing Bong Point port"[64].

Rhett Walker, the leaseholder of Lorella Springs, said of the road in an *ABC Rural* special report in 2016:

'"Much of the land cleared for the mine's haul road is on Lorella Springs. It cuts right through the middle of Lorella," he said. "The first time I went through I was absolutely shattered. After nearly 28 years in this country, and considering our place and protecting it, the first time I went through and they had big chains and it was just ripped apart." He says many of his visitors don't understand why the road is there"'[65].

And now with the imminent restart of mining, Rhett Walker recalled the impact of iron-ore road transport:

'"Within a few months there was a bitumen road running through my property [with] haul trucks running every nine minutes," Mr Walker said. "There was red dirt and dust for a few hundred metres either side of the road and I had to warn every single [visitor] not to get hit by a road train. Lorella is a million-acre property and I market it as one of the most remote places on earth, but the road, when it went through seven years ago, cut a big section of it in half," he said. "By it being cut it means that inevitably more and more this section of the land will be open and traffic will keep using it more and more, and it is something that I can't control"'[66].

Along with the road, the operation of the Bing Bong port and its generation of iron ore dust has also caused concerns. On one visit to the port site, the then head of the Amateur Fishermen's Association of the NT (AFANT), Craig Ingram, said in a statement, which was accompanied by photos illustrating the dust issue:

"On a recent trip to the Roper/Mcarthur area I had the opportunity to visit a couple of the NT's mines that AFANT was heavily involved with during the approval process, while we understand that the very nature of the mining activity is that there will be some impact on the environment the following photos show a level of impact that AFANT believes is totally unacceptable. The attached photos show the windblown dust from the Western Desert Resources loading facility at Bing Bong, we fully acknowledge that iron ore dust is less of a threat than other minerals but this is not an acceptable situation in a sensitive coastal environment"[67].

Marra clan elder, Grace Daniels, has also expressed concerns about the prospect of an iron ore dust problem recurring with the reopening of the Roper Bar mine. When interviewed by the ABC's NT Country Hour she was reported as saying:

'"We don't want our animals to be red [from iron ore dust] like they were at Bing Bong," she said. "I felt really sad and cried when I heard from my family at Borroloola that everything [near Bing Bong] was red, the bird, the saltwater fish, everything. So we don't want any more ports to be put anywhere"'[68].

In the same ABC report, Limmen Bight commercial fisher, Steven Barrett, was quoted as saying:

'"I have seen it at Bing Bong port that [the iron ore dust] has settled on the sea bottom where they have dredged, and when the tug boats were going out they had to go slow because they had a big red trail behind them. So what damage it is doing to the sea bottom, I wouldn't really know but it wouldn't be doing any good for dugongs, turtles and fish"'[69].

Several years earlier WDR proposed the construction of a buried pipeline to transport the ore as slurry across proposed national park lands, the Marra Aboriginal Land Trust, the Limmen Bight seabed and to a barge loading facility off Maria Island, and from there loaded onto ships for export. This too was opposed by Traditional Owners, environment groups and recreational fishers and was abandoned by the company.

Roper Valley Iron Ore

The Roper Valley Iron Ore project owned by Northern Territory Iron Ore p/l is located west of Ngukurr and currently comprises several sample pits across multiple production and exploration titles. The proposed mine expansion includes the annual removal of 2GL of water from the Roper River, the building of a 400-metre-long dam wall in the upper reaches of the Hodgson River, surface water collection and potential groundwater extraction. The mining project also includes the trucking of six million tonnes of iron ore each year along 235 km of public roads to a barge loading facility to be built at Port Roper near the mouth of the Roper River. From there the iron ore would be barged 15 km down the Roper River and then 40 km across Limmen Bight to Panamax ships of up to 75,000 tonnes waiting at three mooring sites north of Maria Island. Some Traditional Owners, recreational fishers and environment groups are opposing the proposal. The President of AFANT has said:

'"The Roper is one of the most pristine rivers we have in the Northern Territory, it's one of those places where you have a very good opportunity to catch a trophy-sized barra, and for them to disrupt that by having barges going in and out of the mouth, it may disperse or destroy some of the habitat that barra rely on. I am getting phone calls from people who live in the area or work in and around the Roper area who say they are concerned about the impacts [the mine] is going to have"'[70].

The Limmen Bight (Port Roper) Tidal Wetland System, in which the barge facility would be located, comprises estuaries, intertidal mudflats and saline coastal flats, the second-largest in the Territory, covering 185,000 ha., and is a good example of tidal wetlands with high freshwater inflows. Further:

"The Tidal Wetlands System is a major migration stop-over area for shorebirds (especially godwits and knots), and one of the most important coastal sites in the Northern Territory in terms of shorebird numbers, especially the Port Roper mudflats. The seagrass beds are a major breeding area for prawns and an important feeding area for Dugong and the Green Turtle. Medium densities of the Saltwater Crocodile (*Crocodylus porosus*) occur in the Roper River estuary and, overall, the area of suitable nesting habitat for C. porosus is extensive on the Roper River System. Marine turtles use nest sites on offshore islands"[71].

Australian Ilmenite Resources

Further inland but within the Roper River catchment, the Australian Ilmenite Resources open cut mineral sands mine near Mataranka has been in production since 2013, with an expected life of 50 years. The company has approval to pump up to 1.65 GL of water from the Roper River, which it transports south to the mine in a 12-kilometre pipeline. Open cut mining can cause erosion and sedimentation, expose areas to weed invasion, impact landscape function, reduce water quality and alter drainage. The company plans to rehabilitate the mined areas with native and introduced grasses to create a perennial grass rangeland[72].

The Borroloola Project

Exploration in the region is being undertaken by Sandfire Resources NL, MMG Ltd, Pacifico and West Rock Resources Ltd as part of Borroloola Project. The project area covers 9659 km^2 between Cape Crawford and the Roper River mouth and includes parts of the Lorella Springs pastoral lease.

Sandfire Resources NL believes the region to be prospective for base metals, sedimentary manganese and iron ore and now has 28 granted exploration licences, one mining lease and three exploration licence applications (as at 2016). Half of the Borroloola Project's area is now overlain by the Limmen National Park and, according to the company's 2016 management plan[73], exploration will not occur within that park or Limmen Bight Marine Park. One of the exploration licence applications covers the Marra Aboriginal Land Trust.

Exploration of this type can have localised environmental impacts that require rehabilitation, but it is the subsequent mining operations and the construction of associated infrastructure that can impact the environment more broadly. It is unclear whether the explorations will eventually lead to mining proposals.

HYDRAULIC FRACTURING (FRACKING)

In April 2018 the Gunner Government announced the lifting of the 2016 moratorium on onshore hydraulic fracturing (fracking). However, under s9 of the Petroleum Act, parts of the Territory are planned for reservation from such mining. These planned reservations include the waters of the western side of Limmen Bight, the catchments of the Limmen Bight and Towns rivers, and downstream parts of the Roper River and Rosie Creek catchments. Petroleum exploration licences have been granted for the upstream sections of the Roper River and Rosie Creek catchments, which are not planned reservations from fracking.

Fracking can impact surface and groundwater resources through water extraction for use in the fracking operations and potential contamination by waste water and chemicals. The Roper River has one of the largest catchments in the Katherine region but more than 90% of its runoff occurs in the wet season (November to May), while "Natural groundwater discharge plays a vital role in providing water to maintain dry season flow to the iconic Mataranka Hot Springs and surface flows in the Roper River and tributaries throughout the dry season"[74].

The cumulative impacts of multiple water extraction projects to support the mining sector have potential to impact the values of the Limmen Bight Marine Park and require further study.

SEABED MINING

Before a Territory-wide moratorium on seabed mining was declared by the Northern Territory Government in March 2012, and which has been extended to 2021, applications for seabed mining licences already covered the entire Limmen Bight Marine Park, including the waters around Maria Island (see Figure 12). These applications were made in May 2010 by NTM Gold Ltd (formerly Northern Manganese Limited).

Seabed mining involves the dredging of seabed habitats, the removal of minerals and then the dumping of the tailings as spoil. Its impacts can include:

- removal of seabed habitats and the plants and animals within them;
- seawater contamination by nutrients and toxins;
- increased turbidity reducing light penetration for seagrass photosynthesis;
- removal of fish breeding and nursery areas;
- vessel interactions with threatened species;
- reduced natural productivity;
- smothering of habitats beneath spoil (tailings) dumps.

At the 2016 Territory election, Territory Labor committed to the completion of a management plan for the Limmen Bight Marine Park that would "Ensure a ban on seabed mining in the park – seabed mining is not compatible with a healthy marine environment in such a sensitive area", which was reiterated by local MP, Gerry McCarthy:

"Limmen Bight is iconic for Territory anglers, for its catches of mud crabs, barramundi, reef fish and prawns. However, this important area like many others along our coast is faced with new and concerning pressures including seabed mining and extensive mangrove die-off"[75].

The management plan zone for the adjoining Commonwealth Limmen Marine Park is Habitat Protection Zone, which prohibits all mining operations (other than laying of pipelines).

OTHER THREATS

MARINE DEBRIS

Marine debris, often in the form of ghost nets, is a serious issue in the Gulf of Carpentaria. Limpus (2009)[76] estimated that many hundreds of turtles were each year drowned in derelict fishing nets. For example, 4000 nets were washed ashore during Cyclone Abigail in 2001 and contained around 400 dead turtles[77]. More recently, research by CSIRO and Ghostnets Australia, revealed in the 2016 Senate Environment and Communications References Committee report, *Toxic tide: the threat of marine plastic pollution in Australia*, showed that of:

"…approximately 9000 nets intercepted in the Gulf of Carpentaria, it was estimated that at least 15,000 turtles had been entangled. The study examined the types of nets present in the Gulf of Carpentaria and found that large gills nets have particularly high catch rates of turtles. The study also concluded that given the number of nets that wash ashore in the region, the estimated number of entangled turtles can be extended to approximately 20,000 turtles"[78].

Nets and other plastics are also known to harm seabirds such as shearwaters, terns and petrels. According to the marine bioregional plan for the North marine region[79]:

"In northern Australia, debris have entangled sharks, cetaceans, large piscivorous fishes and turtles. Much of the marine debris found along the northern Australian coastline, including derelict fishing nets, is believed to be of foreign origin. Northern Australia is especially vulnerable to marine debris given the proximity of intensive legal and illegal fishing operations, difficulties in surveillance and enforcement of existing management arrangements, and ocean circulation patterns that are likely to concentrate floating debris before dumping it on coastlines and beaches"[80].

Kiessling (2003) identified Groote Eylandt, its adjacent mainland and the Pellew Islands as some of the hotspots for marine debris in the Territory, with plastics representing from 50-90% of all items reported in northern Australia[81]. In one survey at Groote Eylandt in 1997-1998, Kiessling reported that there were 1140 items collected weighing 61,806 kg. Of those items, 1026 were plastic and 812 were sourced from fishing activities (land-sourced items represented around 10% of the items)[82].

From a survey of marine debris at Cape Arnhem, Kiessling (2003) reported that of the 21% of items of known manufacturing origin, 87% were of South-east Asian origin.

Griffin (2008) reported that:

"Many derelict fishing nets are found in the Gulf of Carpentaria, on the eastern side from Cape York to south of Weipa during the Wet Season, when the north west monsoon blows, and on the western side from Cape Arnhem to Groote Eylandt during the Dry Season when the south-east trade winds blow. Derelict fishing nets are a small fraction by number of debris items, but a large fraction by weight. A few are Australian prawn nets but most are of Taiwanese, Japanese or Indonesian manufacture"[83].

Wilcox and Hardestay (2013) estimated that ghost nets were washing up on to Gulf of Carpentaria shores:

"…at densities reaching up to three tonnes/km, among the highest in the world. We don't know where more than half the nets come from, but of the nets we can identify, most come from fisheries in neighbouring Asian countries. About 4% come from Australia"[84].

Their research also found that:

"Ghostfishing for turtles is concentrated in an area along the eastern margin of the Gulf and in a wide section in the southwest extending up the west coast. Most ghostnets enter the Gulf from the northwest and move clockwise along its shores"[85].

More recent research reported in 2018 has revealed that marine debris washing onto the beaches of northern Australia had doubled in the past decade[86]. At the 11 beaches monitored, up to three tonnes of

marine debris along each kilometre were found, with Cape Arnhem recording the highest levels. In an *ABC Radio Darwin* report, Blue Douglas, a resident of northeast Arnhem Land, described the beach scene:

"The beach was literally littered with plastic baskets, cigarette lighters, bottles in particular — shampoo bottles, oil bottles — and the sad thing is about a lot of these things, when you pick them up, they've obviously been punctured in some way to ensure that when they're thrown off the side of the boat they sink," he said. "A lot of the oil bottles, the caps, there's been holes punctured in them, the shampoo bottles have had a slice put through the centre of them. There were empty steel gas cylinders — which I've never seen in past years — which surprised me".

The researchers believe that foreign fishing vessels are the source of much of the debris. Between 2000 and 2012, the number of foreign fishing vessels in Australia's border regions increased from 9000 to 37,000[87].

The Senate Environment and Communications References Committee also reported that:

"The Northern Territory Seafood Council stated that lost or discarded fishing gear from fishing activities by foreign fishing operations is of increasing concern to industry. In particular, enormous nets of predominantly Taiwanese manufacture and longline gear used by numerous fisheries to the north of Australia, or by illegal fishers in Australian waters, are pushed by the prevailing winds and currents into Australian waters".

Ghost net collection is a major activity for Indigenous ranger groups in the Gulf of Carpentaria.

INVASIVE SPECIES

Feral animals including horses and buffaloes are widespread on the land of the Limmen Bight Region. Horses and buffalo trample the wetlands and compress the mud, create swim channels that allow saltwater to intrude on freshwater habitats, crush turtle eggs, overgraze native plants such as water lilies and encourage the spread of weeds. Along with damage to the natural environment, habitat degradation reduces important food resources – turtles, fish, water lilies – for Indigenous communities.

Released in coastal Queensland in 1935, by 1995 the cane toad had spread to the Roper River Valley. The toad poison is lethal for predators.

Parthenium weed (a Weed of National Significance) and three high-priority weeds, southern sandspur, coffee senna and puncture vine are recorded from the Limmen Bight and Associated Coastal Plains Site of Conservation Significance.

If the transhipping activities of the Roper River Iron Ore mine were given approval, the risk of invasive marine species introductions in the Limmen Bight Marine Park would increase.

During the implementation of the National System for the Prevention and Management of Marine Pest Incursions, the Australian Government has stated that:

"Over 250 introduced marine plants and animals have hitch-hiked to Australian waters on vessels of all types from yachts to commercial ships. Some have displaced our native species from their habitats, changing our coastal areas and damaging our fishing, aquaculture and tourism industries"[88].

CLIMATE CHANGE

Rises in sea level and air and sea surface temperatures, and increased intensity of storms and cyclones, will have significant impacts on the Limmen Bight Region.

The recent mass dieback of mangroves in the Gulf of Carpentaria during the 2015-2016 summer affected 1,000 km from the Roper River to Karumba in Queensland, with 7,400 ha or about 6% of the Gulf's

mangrove forests dying. Research scientists identified the likely causes were drought, higher sea and air temperatures and a lowering of sea level caused by El Nino. According to the scientists:

"We don't yet know what role human-caused climate change played in these particular weather events or El Nino. But the unprecedented extent of the dieback, the confluence of extreme climate events and the coincidence with the bleaching of the Great Barrier Reef mean the role of climate change will be of critical interest in the global response to mangrove decline"[89].

In the summer of 2017-18, a coral bleaching events struck the coral reefs in the waters of Gang Gurak Barlu National Park. In January 2018, sea surface temperatures between Papua New Guinea and the Northern Territory were at what the National Oceanic and Atmospheric Administration in the US calls Alert Level 2 – its highest alert for the risk of bleaching and subsequent coral death[90]. This was not the first coral bleaching observed in the Territory, with another occurring in the 2015-16 summer off Arnhem Land[91]. Although the coral reefs found in the Limmen Bight region are limited in area, they are important habitats for a variety of marine life.

The six main climate-change impacts in the Limmen Bight Region will be:

- sea level rise: reducing the area of seagrasses and mangroves and leading to changes in ecosystem structures, processes and connectivity, including fish and crustaceans that move between inshore and offshore areas, while also causing saltwater intrusion of freshwater wetlands;
- sea surface temperature increases: reducing fish and prawn nursery habitats, such as seagrasses and mangroves, impacting on the distribution and abundance of zooplankton and fish, and undermining coral reefs in the region;
- ocean acidification: impacting shell-formation in echinoderms, crustaceans and molluscs;
- air temperature rises: increasing heat stress on mangroves and other coastal habitats;
- increased storm intensity: damaging seagrasses and mangroves and increasing sedimentation.

CUMULATIVE IMPACTS

Each of the resource uses (and climate change) described above have the potential to impact the natural values of the Limmen Bight Region and the Limmen Bight Marine Park. Taken alone, they may be considered to have a localised or minor impact, but when considered together and over a time frame that includes past, present and future resource use, the cumulative impact may be significant. The consideration of such cumulative impacts, supported by scientific research, must be a vital element of marine and coastal spatial planning and also the preparation of marine park management plans.

FOUR AREAS OF HIGH CONSERVATION VALUE

This report has identified four marine and coastal areas of high conservation value in the Limmen Bight Region. The four areas are mapped in Figure 13 and are:

1. Roper River estuary and mouth;
2. Limmen Bight River estuary and mouth;
3. marine park waters surrounding Maria Island;
4. seagrass meadows in the marine park's south-eastern waters.

Each one includes parts of the Limmen Bight Marine Park. Commercial fishing, seabed mining, and iron ore barging, transhipment and industrial development are resource use activities that are incompatible with the protection of these four significant areas.

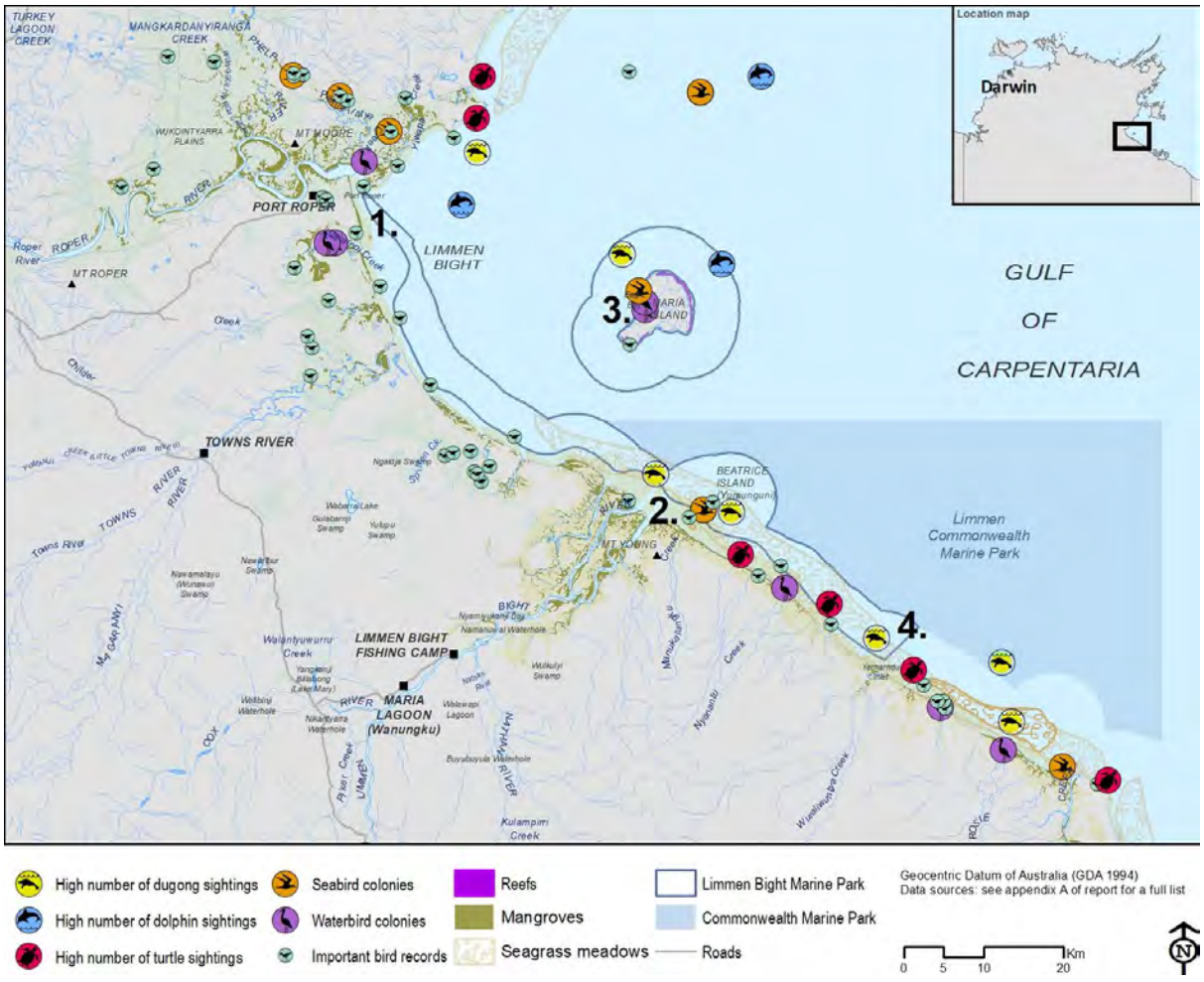

Figure 13. AREAS OF HIGH CONSERVATION VALUE

ROPER RIVER ESTUARY AND MOUTH

The Roper River estuary and mouth have:

- the only tide-dominated estuary in the Pellew bioregion and listed in the Directory of Important Wetlands in Australia, having satisfied all six listing criteria;
- coastal wetlands that support three significant waterbird colonies and many thousands of visiting waterbirds;
- extensive tidal flats (second-largest area of tidal flats in the Territory) that attract tens of thousands of migratory shorebirds;
- 13 species of mangrove;
- intertidal seagrass meadows that are important breeding areas for prawns and feeding areas for marine turtles and dugongs;
- medium densities of the saltwater crocodile and suitable nesting habitat[92];
- a major breeding area for brolga;
- records of large-toothed sawfish, whipray and bull shark;
- barramundi spawning area critical for Roper River fish populations.

LIMMEN BIGHT RIVER ESTUARY AND MOUTH

This is a river-dominated estuary with a tide-dominated delta and is:

- a popular dugong feeding area;
- a biologically important area for green turtle (foraging);
- a regionally important seabird breeding area on Beatrice Island (Yumunguni), along with a waterbird colony;
- a place for flatback turtle nesting sites;
- host to two waterbird colonies;
- part of a nationally important wetland site and a Site of Conservation Significance;
- possible barramundi spawning area.

MARINE PARK WATERS SURROUNDING MARIA ISLAND

Maria Island has:

- almost all of the mapped reefs within the Pellew Bioregion;
- a key nesting site and biologically important area for flatback turtles;
- waterbird and seabird colonies (crested terns, lesser crested terns and roseate terns);
- high numbers of dugong and dolphin sightings in the surrounding waters;
- part of a Site of Conservation Significance.

SEAGRASS BEDS IN THE MARINE PARK'S SOUTH-EASTERN WATERS

The south-eastern seagrass beds are:

- one of the largest mapped seagrass beds in the Pellew Bioregion;
- one of the top 4 dugong feeding sites in Australia, with densities greater than 5 per km[93];
- an area with high numbers of turtle sightings.

CONCLUSIONS

The Limmen Bight Region contains near-pristine tropical waters that supports the Territory's most important dugong population, five species of marine turtles, a number of seabird and waterbird colonies and thousands of visiting migratory shorebirds attracted by the Territory's second-largest intertidal flats.

The natural values of the Limmen Bight region have been recognised as a Site of Conservation Significance, a nationally important wetland (Directory of Important Wetlands in Australia) an Important Bird Area and an Important Biodiversity Area.

The main resource uses currently in the Limmen Bight Region and the Limmen Bight Marine Park are:

- commercial fisheries for prawns, mud crabs and barramundi;
- recreational fishing, and fishing tourism, largely targeting barramundi and mud crabs
- iron ore and mineral sands mining in the catchment of the Roper River.

Future regional resource uses could include an expansion of iron ore mining, the development of hydraulic fracturing (fracking) in the Roper River catchment, and the potential development of seabed mining in the Limmen Bight Region. A moratorium on seabed mining currently exists across the Northern Territory, but applications were made to mine the seabed of the Limmen Bight Region and the Limmen Bight Marine Park prior to its proclamation.

The threats facing the Limmen Bight Region include those associated with the above resource uses and also invasive species, marine debris and climate change (rising sea levels and sea and air temperatures; ocean acidification; increased storm intensity).

There are a number of resource use activities that are incompatible with the values of the Limmen Bight Region and the Limmen Bight Marine Park. They should be excluded from the marine park and restricted or well managed in the remainder of the region.

Resource use activities incompatible with the Limmen Bight Marine Park are seabed mining; bottom trawling; gillnetting; dredging; industrial activities associated with iron ore mining including pipeline construction and the barging and transhipment of iron ore. Land use activities beyond the boundaries of the marine park, and which should be restricted or avoided to prevent harm to it and the broader Limmen Bight Region, include alteration of river flows and groundwater levels; hydraulic fracturing (fracking); intensive cattle grazing; and land clearance.

This report has identified four areas of high conservation value:

- Roper River estuary and mouth;
- Limmen Bight River estuary and mouth;
- marine park waters surrounding Maria Island;
- seagrass meadows in the marine park's south-eastern waters.

Each one includes important values of the Limmen Bight Marine Park. Commercial fishing, seabed mining, and iron ore barging, transhipment and infrastructure development are resource use activities that are incompatible with the protection of these four significant areas.

The Limmen Bight Region is a highly significant part of the Northern Territory's coasts and seas. The proclamation of the Limmen Bight Marine Park gives due recognition to the region's natural values and their significance. The preparation of the park's management plan provides the Gunner Government with the opportunity to safeguard these values while also allowing ecologically sustainable use.

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APPENDIX A: DATA SOURCES

Figure	Data	Attribution
ALL	Roads	GEODATA TOPO 250K Series 3. Commonwealth of Australia (Geoscience Australia). Available from: http://www.ga.gov.au
ALL	Localities	NT Place Names Dataset. Department of Infrastructure, Planning and Logistics, Northern Territory Government
ALL	Rivers and lakes	GEODATA TOPO 250K Series 3. Commonwealth of Australia (Geoscience Australia). Available from: http://www.ga.gov.au
ALL	Coastline	GEODATA COAST 100K 2004. Commonwealth of Australia (Geoscience Australia). Available from: http://www.ga.gov.au/metadata-gateway/metadata/record/61395/
ALL	Territory waters boundary	Australian Maritime Boundaries (AMB). Commonwealth of Australia (Geoscience Australia). Available from: http://www.ga.gov.au/search/index.html#/
ALL	Commonwealth Marine Park	Australian Marine Parks. Australian Marine Parks. © Commonwealth of Australia, Australian Government Department of the Environment and Energy, 2018. Available from: https://www.environment.gov.au/fed/
ALL	Limmen National Park and Marine Park	Northern Territory Parks and Reserves. Department of Land Resource Management, Northern Territory Government. Available from: http://www.lands.nt.gov.au/land-info/ntlis
1	Aboriginal Lands Trust	Department of Lands, Planning and the Environment, Government of Northern Territory.
1	Indigenous Community	NT Place Names Dataset. Department of Infrastructure, Planning and Logistics, Northern Territory Government
2	Intertidal Extent	Intertidal Extents Model (25m) ITEM v1 2016, © Commonwealth of Australia, Geoscience Australia. Available at http://www.ga.gov.au/interactive-maps/#/theme/earthobservation/map/intertidal
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4	Mangroves	Mangroves of the Northern Territory, 1:100,000 (2002) Department of Environment and Natural Resources, Northern Territory Government

Figure	Data	Attribution
5	Dugong sightings 2015	Groom R, Dunshea G and Griffiths A (2015), The distribution and abundance of Dugong and other marine megafauna in the Gulf of Carpentaria, Northern Territory, November 2014. Department of Land Resource Management; Flora and Fauna Division, Berrimah
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6	Dolphin sightings	Groom R, Dunshea G and Griffiths A (2015), The distribution and abundance of Dugong and other marine megafauna in the Gulf of Carpentaria, Northern Territory, November 2014. Department of Land Resource Management; Flora and Fauna Division, Berrimah
6	Dolphin sightings	Groom RA, Dunshea GJ, Griffiths AD, and Mackarous K (2017). *The distribution and abundance of Dugong and other marine megafauna in Northern Territory, November 2015*. Department of Environment and Natural Resources, Darwin
7	Turtle sightings	Groom R, Dunshea G and Griffiths A (2015), The distribution and abundance of Dugong and other marine megafauna in the Gulf of Carpentaria, Northern Territory, November 2014. Department of Land Resource Management; Flora and Fauna Division, Berrimah
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7	Important foraging area for Green Turtles	Biologically Important Areas of Regionally Significant Marine Species. © Commonwealth of Australia, Australian Government Department of the Environment and Energy, 2015.
8	Seabird colonies	Seabird Colonies of the Northern Territory (2009), Department of Environment and Natural Resources. Northern Territory Government
8	Waterbird colonies	Waterbird Colonies of the Northern Territory (2009), Department of Environment and Natural Resources. Northern Territory Government
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Healthy mangroves. Photo: Glenn Walker

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