Assessment of Common Conservation Values—Intertidal and Subtidal Environs of the Baffle to Fitzroy Coast

Version 1.1

Queensland Government

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Cover Photo: Queensland government imagery

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Acronyms and abbreviations

ACA	Aquatic Conservation Assessment
AquaBAMM	Aquatic Biodiversity Assessment and Mapping Methodology
ASL	Above Sea Level
BAMM	Biodiversity Assessment and Mapping Methodology
BFC	Baffle to Fitzroy Coast
Bonn	Convention on the Conservation of Migratory Species of Wild Animals
BPA	Biodiversity Planning Assessment
CAMBA	China–Australia Migratory Bird Agreement
DIWA	Directory of Important Wetlands in Australia
DEHP	Department of Environment and Heritage Protection
DES	Department of Environment and Science
EAAF	East Asian-Australasian Flyway
EPBC	*Environment Protection and Biodiversity Conservation Act 1999*
IUCN	International Union for Conservation of Nature
JAMBA	Japan–Australia Migratory Bird Agreement
MSL	Mean sea level
NCA	*Nature Conservation Act 1992*
NP	National Park
QISC	Queensland Intertidal and Subtidal Ecosystem Classification Scheme
QWP	Queensland Wetland Program
QWS	Queensland Wetland System
QWSG	Queensland Wader Study Group
QWISBMP	Queensland Wetland Intertidal and Subtidal Benthic Mapping Program
Ramsar	Ramsar Convention on Wetlands
RE	Regional Ecosystem
ROKAMBA	Republic of Korea–Australia Migratory Bird Agreement

1 Introduction

The Department of Environment and Science (DES) has undertaken an assessment of common conservation values of the subtidal and intertidal environments extending from just south of the mouth of Baffle Creek to north of the Fitzroy River. The assessment is non-social, non-economic and tenure independent and is based upon a subset of the criteria employed by the Aquatic Biodiversity Assessment and Mapping Method (AquaBAMM; Clayton et al. 2006) and founded upon a wide body of national and international literature.

The current project was conducted as a subcomponent of the 'Queensland Intertidal and Subtidal Ecosystem Classification Scheme' (QISC) project which was developed under the Queensland Wetlands Program. The QISC was developed to provide a structured framework for classifying the intertidal and subtidal ecosystems of Queensland and surrounding waters using independent biophysical attributes. The framework could also apply to other parts of Australia.

QISC provides a logical process that harnesses the understanding of the factors that influence ecosystem types, allows for ecosystems to be described, and enables ecosystems to be identified based on biophysical attributes, at a range of different scales. This provides a common understanding and language of classification that will improve communication, ensure better integration, lead to more informed management outcomes, and provide the basis for any future mapping.

As part of the Queensland Wetland Program (QWP), this project was led by the Queensland Department of Environment and Science (DES in collaboration with the Queensland Department of Agriculture and Fisheries (DAF) and the Gladstone Ports Corporation (GPC). Other organisations involved included: Queensland universities, the Commonwealth Scientific and Industrial Research Organisation (CSIRO), the Great Barrier Reef Marine Park Authority (GBRMPA) and natural resource management (NRM) bodies.

The GPC provided financial assistance toward the development of this scheme as part of a fish habitat initiative required to meet fish habitat offsets associated with approved development conditions, with funding delivered through the Department of Agriculture and Fisheries (including part-funding under DAF 1498CQA-2 toward the Intertidal and Subtidal Habitat Mapping and Conservation Values Assessment for Central Queensland State Waters Project).

The assessment of common conservation values undertaken here utilised a combination of expert knowledge and existing data to derive relative ratings against a series of criteria for subtidal and intertidal spatial units within the study area. An expert elicitation process conducted via an ecology expert panel workshop was conducted in Gladstone from the 20th to 21st of June, 2018 and comprised of individuals with expertise in either local/general marine and estuarine dependent flora, fauna or ecology. Smaller workshops, in conjunction with out-of-panel consultation were also conducted during the course of this project. This report describes the findings and recommendations from the expert elicited and data driven diagnostic processes.

Several broad criteria were assessed including the diversity and richness of habitats and taxa, threatened species, ecosystems at risk and other special features including areas of ecological importance identified by experts. It was recommended that an overall conservation value not be applied and that the criteria be presented as standalone products for separate interrogation. The assessment is not a comprehensive analysis of estuarine and marine conservation values, rather the assessment is focused on a subset of common conservation criteria.

The spatial database which accompanies this report is a compiled ESRI file geodatabase containing spatial representations reflecting the criteria conservation ratings assessed. It also includes a marine/estuarine dependent taxa inventory summarising species records situated within each 2 km hexagon grid for general information purposes. The spatial products and the assessment summary report are designed to be used as a preliminary information source to aid in the identification of known areas considered of importance, not as a prioritisation mechanism. The overall study area is referred to in this report as the Baffle to Fitzroy Coast (BFC).

1.1 Study Area

The Baffle to Fitzroy Coast study area covers approximately 4380 km^2 most of which is located within the Shoalwater Coast marine bioregion (mesoscale), and a smaller portion in the south (from approximately Deepwater National Park south) situated in the Tweed-Moreton marine bioregion. The study area extends from the Fitzroy River mouth in the north to just south of Baffle Creek (Figure 1).

A number of large bays, extensive areas of adjoining estuarine systems, exposed and sheltered open stretches of beach and coastal islands occur throughout. Curtis Island, the largest offshore island in the study area, was incised from the mainland by a major geological fault (Yarrol Fault). The passage between Curtis and the mainland represents one of the few tidal passages in Australia.

A variety of intertidal and subtidal habitats are present which support a diversity of estuarine and marine dependent taxa, including a number of threatened and migratory species. For example, extensive seagrass meadows within the study area are important for dugongs *Dugong dugon* and several sea turtle species. The regions coral reefs also support a diversity of sub-tropical/temperate species. Close inshore coral communities tend to be of lower species richness and cover and dominated by sediment tolerant coral species, with exceptions, such as the Pancake Creek community which host taxa in an estuarine environment generally found offshore. Intact mangrove and saltmarsh communities providing critical nursery habitat for many taxa inclusive of recreational and commercial species (e.g. barramundi *Lates calcarifer* and mud crab *Scylla serrata*). They also provide suitable habitat for threatened species such as water mouse *Xeromys myoides*. Much of the regions intertidal areas boast nationally and internationally important roosting and foraging habitat for a range of threatened shorebird species including: eastern curlew *Numenius madagascariensis*, curlew sandpiper *Calidris ferruginea* and lesser sand plover *Charadrius mongolus* (Bamford et al. 2008; Choi et al. 2017).

Several national and state regulated or recognised areas overlay almost the entirety of the study area (refer to Table 1), emphasising its importance at the regional, state and national level. These include: the Great Barrier Reef World Heritage Area (covering approximately 82% of the study area) and accompanying Marine Park zones (covering 46% of study area), Directory of Important Wetlands (DOIW) (covering 36% of study area), declared fish habitat areas (covering 26% of study area) and Dugong Protection areas (covering 12% of study area) (see Figure 1). These areas are highly important for acknowledging and protecting vital intertidal, subtidal and marine biodiversity, habitats and ecosystem processes. Whilst not included as assessment criteria in their own right, they are considered as having inherent values of state/national significance by default.

A number of coastal land use pressures however apply to the study area. The Curtis Coast region is a major industrial hub and continues to be under high development pressures. The Port of Gladstone is Queensland's largest multi-commodity port and shipping port, the location of the world's largest Alumina refinery, and the world's fourth largest coal exporting terminal. On the southern end of Curtis Island, LNG processing facilities have been constructed. A wide variety of products are handled at the Port, including coal, bauxite, alumina, aluminium, cement and Liquefied Natural Gas (LNG). This presents a high risk of multiple pollutants, including metals, being released into the environment via wind, accidents or water discharges. Release of contaminates can affect water quality leading to negative impacts particularly on coral, seagrass and mudflat communities. Elevated nutrient levels can exert toxic effects on some seagrass species, and although seagrasses are able to bioaccumulate trace metals, this can lead to detrimental impacts on grazers such as turtles and dugongs. Similarly, excessive levels of nutrients and metals can be toxic to intertidal invertebrates, fish and symbiotic algae, on which corals rely upon (resulting in bleaching). Risk of algal blooms also present additional pressures.

Port traffic is concentrated between southern Curtis Island and the Mainland coast, coinciding with turtle and dugong movement. In the 2015 - 16 financial year, port traffic of over 1,800 vessels was recorded (cite: http://www.gpcl.com.au/operations/port-of-gladstone). Vessel strikes present an additional risk to marine megafauna, equivalent to by-catch via trawl fishery (Hazel and Gyuris 2006). High vessel traffic also presents an increased risk of oil spill. In January 2006, 25 tonnes of heavy fuel oil spilled into the Port of Gladstone from a breached hull of a bulk carrier ship (Melville et al. 2009).

Other ongoing threats include dredging, land reclamation, urban development, and climate change. Coastal development is likely to continue to place pressure on the intertidal systems in the future (Goudkamp & Chin 2006). Many river and creek catchments on the mainland, close to the coastal areas, including the mangrove and saltmarsh communities, have historically been cleared and drained for livestock grazing and coastal development (i.e. urban and industrial). Residential development is also proposed for Hummock Hill Island which has been largely undisturbed and shelters extensive tract of mangroves, claypan, estuarine waters, seagrass beds and a small coral community.

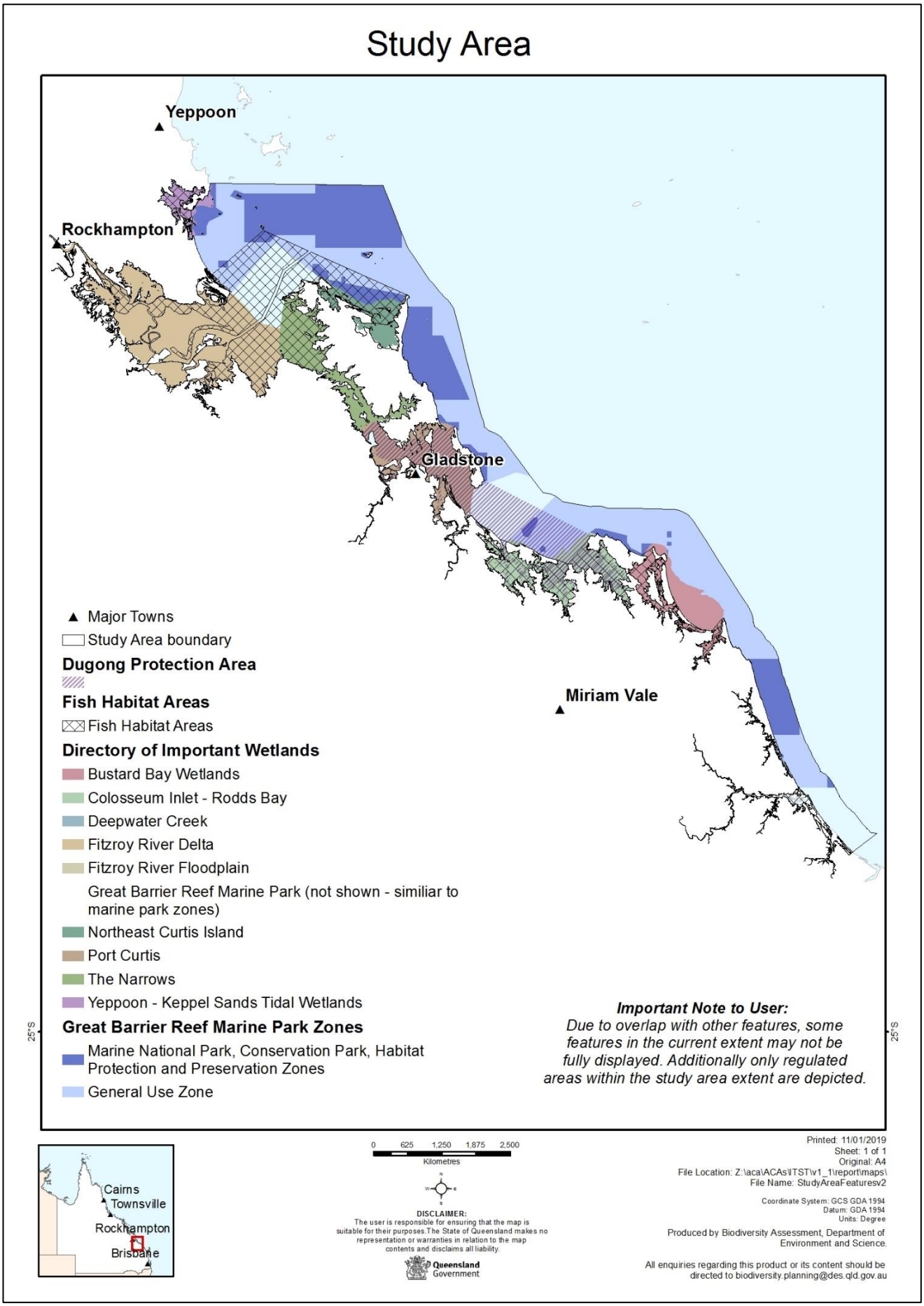


Figure 1: National and State recognised areas within the study area

Table 1: National and state recognised areas within the study area

Name	Locality	Type/Zone
World Heritage Areas *World Heritage Areas represent outstanding examples of the world's natural or cultural heritage. The World Heritage Committee oversees the listing these areas on behalf of the United Nations Educational, Scientific and Cultural Organisation (UNESCO). In Australia, World Heritage Areas are managed under the Environment Protection and Biodiversity Conservation Act 1999.*		
Great Barrier Reef World Heritage Area	Great Barrier Reef	World Natural Heritage
Marine Parks *Marine parks are established to protect tidal lands and waters and conserve the natural marine environment while allowing for its sustainable use. Marine parks are managed under the Marine Parks (Great Barrier Reef Coast) Zoning Plan 2004 and the Queensland Marine Parks Act 2004.*		
Great Barrier Reef Coast Marine Park	Bustard Bay	Marine National Park, Conservation Park, Habitat Protection and General Use zones
Great Barrier Reef Coast Marine Park	Bustard Head	Habitat Protection and General Use zones
Great Barrier Reef Coast Marine Park	Keppel/Corio Bays	Marine National Park, Preservation, Conservation Park, Habitat Protection and General Use zones
Great Barrier Reef Coast Marine Park	Rodds Bay	Habitat Protection and General Use zones
Great Barrier Reef Coast Marine Park	Rodds Harbour	General Use zone
Great Barrier Reef Coast Marine Park	Rodds Peninsula	Marine National Park, Conservation Park, Habitat Protection and General Use zones
Great Barrier Reef Coast Marine Park	Round Hill Creek	General Use zone
Great Barrier Reef Coast Marine Park	The Narrows	Habitat Protection zone
Fish Habitat Areas *A type of marine protected area which focuses on protecting natural fish habitats from alteration and degradation by strictly limiting development within and adjacent to the declared FHA, while allowing for continued community use and access. Managed under the Fisheries Act 1994.*		
Fish Habitat Area	Baffle Creek	Management level A
Fish Habitat Area	Seventeen Seventy-Round Hill	Management level A and B
Fish Habitat Area	Eurimbula	Management level A
Fish Habitat Area	Rodds Harbour	Management level A and B
Fish Habitat Area	Colosseum Inlet	Management level A and B
Fish Habitat Area	Dē-răl-lĭ (Calliope River)	Management level B
Fish Habitat Area	Fitzroy River (Rev.1)	Management level A
Fish Habitat Area	Cawarral Creek	Management level A
Dugong Protection Area *A system of dugong protection areas in the southern Great Barrier Reef and Hervey Bay regions to protect dugongs. Managed under the Fisheries Act 1994 and the Nature Conservation Act 1992.*		
Dugong Protection Area	Port of Gladstone - Rodds Bay	Dugong Protection Area B

Name	Locality	Type/Zone
Directory of Important Wetlands *A directory compiled with the cooperation of conservation agencies and other resource managers in all jurisdictions identifying nationally important wetlands.*		
Deepwater Creek	Deepwater Creek	N/A
Bustard Bay Wetlands	Bustard Bay Wetlands	N/A
Colosseum Inlet - Rodds Bay	Colosseum Inlet - Rodds Bay	N/A
Port Curtis	Port Curtis	N/A
The Narrows	The Narrows	N/A
Northeast Curtis Island	Northeast Curtis Island	N/A
Fitzroy River Delta	Fitzroy River Delta	N/A
Yeppoon - Keppel Sands Tidal Wetlands	Yeppoon - Keppel Sands Tidal Wetlands	N/A
Fitzroy River Floodplain	Fitzroy River Floodplain	N/A

1.2 Panel composition

The expert panel was comprised of the persons listed in Table 2. It includes individuals with expertise in the local aquatic dependent flora, fauna and ecology. Individuals who provided information outside of the workshop through smaller targeted expert workshops and/or out of panel consultation are also listed in Table 2.

Table 2: Composition and details of the expert panel

Name	Organisation	Expertise/Position	Ecology panel
Arnon Accad	Queensland Herbarium	Vegetation communities	Attended Ecology Panel
Mark Breitfuss	Epic Environmental	Director/ Principal Environmental Scientist. Expertise: Intertidal/ invertebrates	Smaller Workshop
Allan Briggs	BirdLife Capricornia	Birds	Out of panel
Ian Butler	CoraLogic Consulting	Coral reefs	Out of panel
Daniela Ceccarelli	Independent	Coral reefs	Out of panel
Chi-Yeung Jimmy Choi	University of Queensland	Shorebirds	Out of panel
Lyndon DeVantier	Independent	Corals	Out of panel
Melissa Dixon	Department of Agriculture and Fisheries	Principal Fisheries Resource Officer, Fisheries Assessment. Expertise: Fish habitat	Out of panel; Smaller workshop
Norm Duke	James Cook University - TropWATER	Mangroves	Attended Ecology Panel
Merrick Ekins	Queensland Museum	Manager - Sessile Marine Invertebrates. Expertise: Invertebrates	Smaller Workshop
Jeff Johnson	Queensland Museum	Fish	Out of panel
Nina Kaluza	Department of Environment and Science	Water mouse	Out of panel
Evanthia Karpouzli	Department of Environment and Science	Geographic Information Systems – Intertidal subtidal habitat mapping	Attended Ecology Panel
Peter Kind	Department of Agriculture and Fisheries	Principal Scientist, Fisheries Assessment. Expertise: Fisheries management, fish and stock status assessments	Out of panel; Smaller workshop
Adam Leavesley	Wildlife Unlimited	Shorebirds	Out of panel

Name	Organisation	Expertise/Position	Ecology panel
Col Limpus	Department of Environment and Science	Marine reptiles	Attended Ecology Panel
Dave Orgill	Queensland Parks and Wildlife Service	Marine conservation	Attended Ecology Panel
Cathie Page	Department of Environment and Science	Corals	Out of panel
Genevieve Phillips	Department of Agriculture and Fisheries	Senior Fisheries Resource Officer. Expertise: Fish	Smaller workshop
Darryl Potter	Queensland Museum	Biodiversity Collection Manager. Expertise: Invertebrates (esp. Molluscs and Crustaceans)	Smaller Workshop
Michael Rasheed	James Cook University	Principal Research Scientist, TropWATER. Seagrass ecology	Attended Ecology Panel
Julie Robins	Department of Agriculture and Fisheries	Fish	
Mike Ronan	Department of Environment and Science	Wetlands Manager. Expertise: Marine ecology	Attended Ecology Panel, Smaller workshops
Tim Ryan	Queensland Herbarium	Vegetation	Out of panel
Marcus Sheaves	James Cook University	Head of Marine Biology and Aquaculture. Expertise: Coastal wetlands, nearshore fishes, habitat relationships, nursery grounds	Attended Ecology Panel, Smaller workshops
Anjana Singh	Gladstone Ports Corporation Limited	Environmental Specialist	Attended Ecology Panel
Angus Thompson	Australian Institute of Marine Science	Corals	Out of panel
Cardon Wallace	Queensland Museum	Corals	Out of panel
Steven Whalan	Independent	Marine ecology	Attended Ecology Panel
Maria Zann	Department of Environment and Science	Project Manager, DES – QWP benthic habitat mapping	Attended Ecology Panel, Smaller workshops
Brad Zeller	Department of Agriculture and Fisheries	Senior Fisheries Scientist, Fisheries Assessment. Expertise: Fisheries management, fish and stock status assessments	Out of panel
Catherine Walsh	Department of Environment and Science	Support staff	
Shane Chemello	Department of Environment and Science	Support staff	
Stephen Trent	Department of Environment and Science	Support staff	

1.3 Workshop format

The role of the Expert Panel was to provide expert advice on values for the intertidal and subtidal habitats within the study area. The specific tasks undertaken by the panel included:

1. listing and identifying threatened and priority taxa within the study area
2. listing and identifying ecological communities at risk
3. identification of areas of particular biodiversity significance for species or communities (roosting, nesting, breeding, resting, nursery grounds, and migration paths)
4. identification of areas of significant intertidal and subtidal ecological value due to unique geomorphological, hydrological, or other reasons.

The expert panel workshop held in Gladstone from the 20-21st June 2018 used ArcGIS Desktop software to display datasets, such as species records and background topographic data, to help identify species, processes, and features of interest. Where possible, region specific data were sourced from technical reports and scientific publications.

Prior to attending the larger expert panel, participants were provided with background material including a Terms of Reference, relevant definitions, and taxon lists for flora and fauna recorded within the study area. Organisation and technical support for the panel was provided by Catherine Walsh, Shane Chemello and Stephen Trent.

1.4 Criteria assessed

The criteria assessed[1] included:

1. Habitat diversity – incorporates richness and the extent area of habitat types within a defined local area
2. Taxon richness (fauna) – richness of taxa within a defined local area
3. Threatened species richness (fauna) – richness of threatened taxa within a defined local area
4. Priority species richness (fauna) – richness of priority taxa within a defined local area
5. Ecosystems at risk – threatened ecological communities recognized at the National/State level or nominated by the panel
6. Special areas of ecological importance identified through expert panel process.

Unlike other ACAs conducted using the AquaBAMM, a simplified two-tiered approach (Measures -> Criteria) rather than Measures -> Indicators -> Criteria was used to calculate overall ratings for each criterion in the current study, primarily due to the direct translation of Measures to Criteria. Other ACAs incorporate multiple measures to calculate indicator scores, and multiple indicator scores to then calculate an overall criteria rating. Similarly, differential weightings of measures and indicators as applied in other ACAs was not used in the current assessment.

Consistent with the recommendation by the expert panel, as well as findings from other studies (Alluvium Consulting 2011), an overall prioritisation score based upon differential weighting of measures and criteria was not calculated. It was deemed more appropriate to present the criteria as standalone elements to be reviewed independently and relevant to the question at hand. Whilst an overall prioritisation score was not incorporated, a compiled rating reflective of the maximum value of any criterion is provided in the output spatial data, simply to draw attention to areas assessed as being of potential importance under one or more criteria.

The following sections detail the approach used to calculate measure values, measure scores, and the overall criteria ratings and resultant outputs. Table 3 lists the measure values and scores used to determine overall criteria ratings.

[1] Following consultation with experts and due largely to limited available information with respect to marine/estuarine flora records, it was determined that flora values and their conservation value was more appropriately addressed at the community level through criteria 4, 5 and 6. As such, richness mapping applications under criteria 2, 3 and 4 are relevant only to fauna taxa.

Table 3: Assessment Measures and Criteria

Criteria	Measure value	Measure score	Criteria Rating
Criterion 1: Habitat Diversity	C1M1DA: Dominant habitat diversity – Simpson's diversity index	C1M1NSS: Grid cells within the near shore zone with a value of >0, quantiled to produce a score between 1 to 4. Cells with a value of 0 assigned a score of 0.	Mean of the two measure scores (for the near shore and distant to shore zones) used to assign an overall rating of: 0 = No diversity within the local area) to 4 = Very high diversity within the local area.
		C1M1DSS: Grid cells within the distant to shore zone with a value of >0, quantiled to produce a score between 1 to 4. Cells with a value of 0 assigned a score of 0	
	C1M2DA: Broad habitat diversity – Simpson's diversity index	C1M2NSS: Grid cells within the near shore zone and with a value of >0, quantiled to produce a score between 1 to 4. Cells with a value of 0 assigned a score of 0	
		C1M2DSS: Grid cells within the distant to shore zone with a value of >0, quantiled to produce a score between1 – 4. Cells with a value of 0 assigned a score of 0	
Criterion 2: Taxon Richness	C2M1DA: Aves richness index	C2M1S: Grid cells with a value of >0, quantiled to produce a score between 1 to 4. Cells with a value of 0 assigned a score of 0.	Maximum score derived from any the five measure scores used to assign an overall rating for that grid cell: 0 = No richness/no data to 4 = Very high known richness.
	C2M2DA: Fish, sharks, skate and rays richness index	C2M2S: Grid cells with a value of >0, quantiled to produce a score between 1 to 4. Cells with a value of 0 assigned a score of 0. Stratified by high and low broad survey effort zones.	
	C2M3DA: Mammal, reptile richness index	C2M3S: Grid cells with a value of >0, quantiled to produce a score between 1 to 4. Cells with a value of 0 assigned a score of 0.	
	C2M4DA: Anthozoa richness index	C2M4S: Grid cells with a value of >0, quantiled to produce a score between 1 to 4. Cells with a value of 0 assigned a score of 0.	
	C2M5DA: Other invertebrate richness index	C2M5S: Grid cells with a value of >0, quantiled to produce a score between 1 to 4. Cells with a value of 0 assigned a score of 0. Stratified by high and low broad survey effort zones.	
Criterion 3: Threatened Species Richness	C3M1DA: Threatened taxa richness index	C3M1S: Grid cells with a value of >0, quantiled to produce a score between 1 to 4. Cells with a value of 0 assigned a score of 0.	Measure score for each grid cell used to assign the overall criteria rating for that grid cell: 0 = No richness/no data to 4 = Very high known richness.
Criterion 4: Priority Species Richness	C4M1DA: Priority taxa richness index	C4M1S: Grid cells with a value of >0, quantiled to produce a score between 1 to 4. Cells with a value of 0 assigned a score of 0.	Measure score for each grid cell used to assign the overall criteria rating for that grid cell: 0 = No richness/no data to 4 = Very high known richness.
Criterion 5: Ecosystems (ecological communities) at Risk	->	C5M1S: Categorical rating – assigned a score between 0 – 4.	Measure score for each ecological community used to assign the overall criteria rating for that grid cell: 0 = Not nominated by the panel to 4 = Very high risk.
Criterion 6: Special Features	->	C6M1S: Categorical rating – assigned a score between 0 – 4.	Measure score for each panel identified special area used to assign the overall criteria rating: 0 = Not nominated by the panel to 4 = Very high ecological value.

2 Criterion 1 - Habitat Diversity

The number and size of marine/estuarine ecosystems present in an area provides an indication of habitat complexity. Areas of high ecosystem diversity indicate greater representation of multiple ecosystems and the accompanying ecotones that are present.

Habitat complexity is influenced by the structure, composition and dynamics of ecological communities that in turn are a reflection of various abiotic factors, e.g. substrate, water quality/nutrient levels, depth and currents. In general, areas of high habitat complexity have an overall greater richness of taxa, particularly if structural complexity within these habitat types is also high (e.g. coral reefs). Areas possessing a high taxa richness also provide an indication of highly dynamic and productive environments, such as ecotonal boundaries.

2.1 Approach

To derive a representation of habitat diversity, a preliminary version (received the 29th August 2018) of the QWISBMP mapping was used to develop two suites of base spatial units. The first was derived from finer scale habitat types identified in the mapping (hereafter referred to as the dominant habitat type), and the second, from broad habitat groupings which were created for the purpose of the current assessment. At the finer scale (dominant habitat types), 57 habitats were present within the study area, which were subsequently grouped into 12 broader categories as indicated in Table 4

Table 4. Habitat Types and Broad Habitat Groupings

Habitat Code	Dominant Habitat Type	Broad Habitat Group
Intertidal Habitats		
1	Grass-herb-sedge (undifferentiated)	Intertidal grass-herb-sedge-other succulent
2	Grass	Intertidal grass-herb-sedge-other succulent
3	Succulent with herb	Intertidal grass-herb-sedge-other succulent
4	Sedge	Intertidal grass-herb-sedge-other succulent
5	Mangroves and other trees (undifferentiated)	Intertidal mangroves and other trees & shrubs
6	Ceriops	Intertidal mangroves and other trees & shrubs
7	Rhizophora	Intertidal mangroves and other trees & shrubs
8	Avicennia	Intertidal mangroves and other trees & shrubs
9	Mixed mangroves	Intertidal mangroves and other trees & shrubs
10	Other trees and shrubs	Intertidal mangroves and other trees & shrubs
11	Ovoid seagrass	Intertidal seagrass
12	Strap (wide) seagrass	Intertidal seagrass
13	Strap (narrow) seagrass	Intertidal seagrass
15	Other seagrass	Intertidal seagrass
16	Other algae (macrophytes)	Intertidal algae
17	Bare areas above MSL (i.e. Saltpan with or without microphytobenthos)	Intertidal unconsolidated substrate
20	Molluscs inc. oysters w/ barnacles	*Split into two broad habitat types based upon consolidation field:* Intertidal unconsolidated substrate & Intertidal consolidated substrate
21	Intertidal coral	Intertidal coral
22	Other biota (flora and fauna)	*Split into two broad habitat types based upon consolidation field:* Intertidal unconsolidated substrate & Intertidal consolidated substrate
23	Consolidated - high energy	Intertidal consolidated substrate
24	Consolidated - low energy	Intertidal consolidated substrate
26	Low energy intermediate consolidation	Intertidal unconsolidated substrate
27	Above MSL unconsolidated mud (claypan/saltpan)	Intertidal unconsolidated substrate
28	Below MSL unconsolidated mud (mudflat/bank) - high energy	Intertidal unconsolidated substrate

Habitat Code	Dominant Habitat Type	Broad Habitat Group
29	Below MSL unconsolidated mud (mudflat/bank) - low energy	Intertidal unconsolidated substrate
30	High energy sand	Intertidal unconsolidated substrate
31	Low energy sand	Intertidal unconsolidated substrate
32	High energy gravel	Intertidal unconsolidated substrate
33	Low energy gravel	Intertidal unconsolidated substrate
34	High energy boulders	Intertidal consolidated substrate
35	Low energy boulders	Intertidal consolidated substrate
40	Unconsolidated - unknown texture - HIGH ENERGY	Intertidal unconsolidated substrate
41	Unconsolidated - unknown texture - LOW ENERGY	Intertidal unconsolidated substrate
Subtidal Habitats		
45	Seagrass ovoid - shallow water	Subtidal seagrass
46	Seagrass ovoid (intermittent)- deep water	Subtidal seagrass
48	Seagrass wide strap	Subtidal seagrass
49	Seagrass narrow strap	Subtidal seagrass
50	Seagrass fern-like	Subtidal seagrass
54	Algae erect calcareous	Subtidal algae
55	Algae erect macrophytic	Subtidal algae
62	Other habitat forming biota	Subtidal unconsolidated substrate
65	Molluscs on intermediate or unknown substrate consolidation	Subtidal unconsolidated substrate
66	Hard (undifferentiated) coral - consolidated, shallow to deep	Subtidal coral
70	Hard (undifferentiated) coral - not consolidated, shallow to deep	Subtidal coral
90	Undifferentiated coral on consolidated - shallow to deep	Subtidal coral
94	Undifferentiated coral not on consolidated - shallow to deep	Subtidal coral
99	Soft coral not on unconsolidated	Subtidal coral
100	Consolidated/intermediate calcareous reef (i.e. coral platform)	Subtidal consolidated substrate
101	Consolidated/intermediate non-calcareous (i.e. rocky reef or coffee rock)	Subtidal consolidated substrate
102	Mud - high energy	Subtidal unconsolidated substrate
103	Mud - low energy	Subtidal unconsolidated substrate
104	Sand - high energy	Subtidal unconsolidated substrate
105	Sand - low energy	Subtidal unconsolidated substrate
106	Gravel - high energy	Subtidal unconsolidated substrate
107	Gravel - low energy	Subtidal unconsolidated substrate
108	Boulders	Subtidal consolidated substrate
109	Other unconsolidated substrate	Subtidal unconsolidated substrate

Two sets of spatial units were created reflective of:

1. discrete contiguous areas representing the 57 dominant habitat types present
2. discrete contiguous areas representing the 12 broad habitat groupings.

The two outputs were used as base inputs for assessing habitat diversity within a given extent. Representations of the two scales of spatial units are shown in Figure 2.

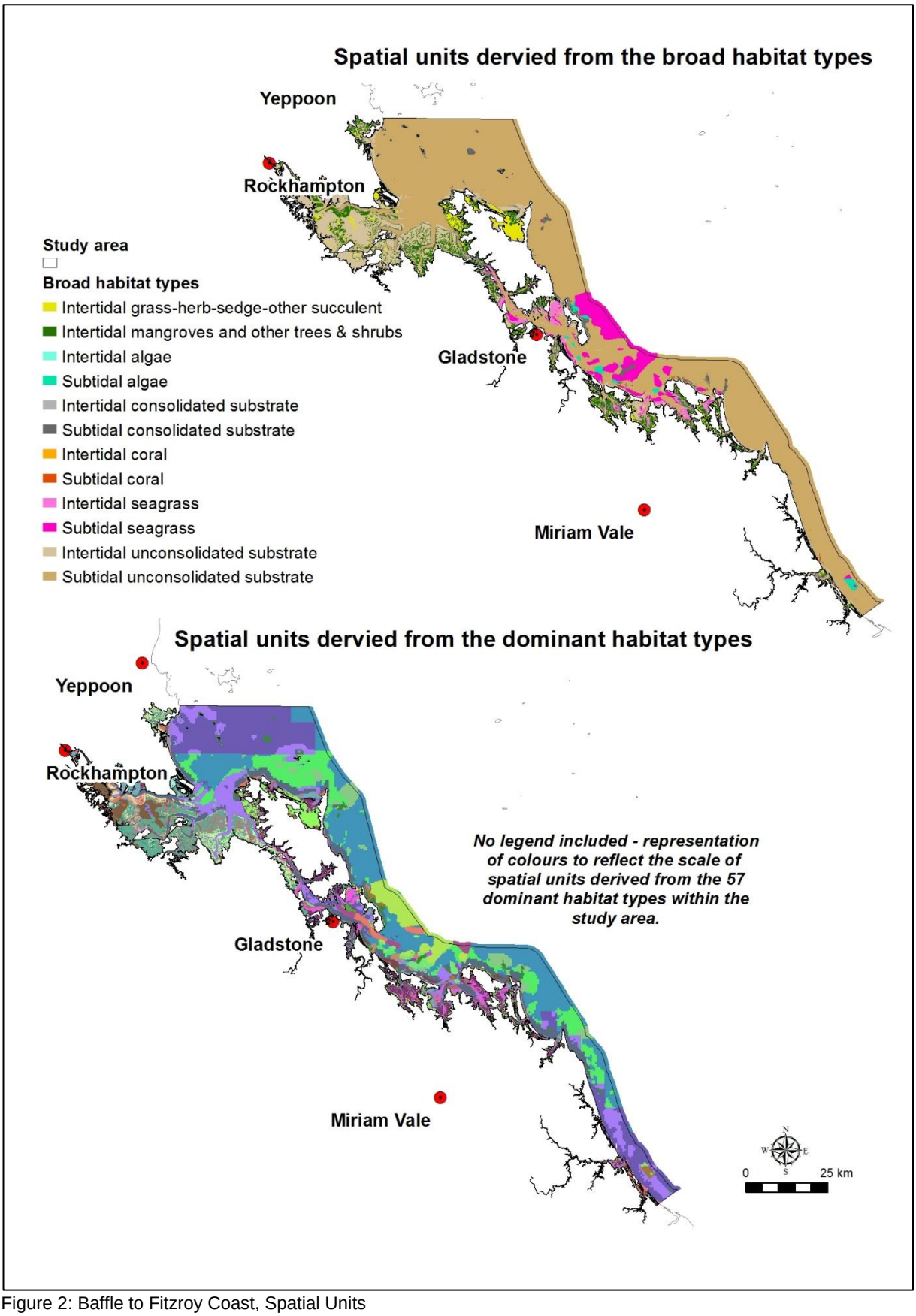


Figure 2: Baffle to Fitzroy Coast, Spatial Units

A modified Simpsons Diversity Index (EHP 2014) was adopted to account for the number of habitat types and the extent of area occupied by each habitat type present within a hexagon grid (2 km short diagonal) clipped to the study area. Ecosystem diversity is commonly classified using concepts of 'richness' and 'evenness'. Richness refers to the number of different ecosystems, while evenness refers to their relative abundance. Simpson's Diversity Index is a commonly used measure of estimating diversity that incorporates both. The index calculates a value between 0 and 1, with higher scores representing areas of greater habitat and ecotone richness and extent representation. Habitat diversity for each grid cell was calculated using the following modified formula:

$$SDI = 1 - \sum_{i=1}^{m} P_i^2$$

Where

$$P_i = \frac{\text{Area of the spatial unit } i}{\text{Total area}}$$

m = number of spatial units.

The above process was applied twice to produce habitat diversity outputs for both the dominant and broad habitat type spatial units.

2.1.1 Stratification

It was observed that the scale of habitat mapping in the draft QWISBMP mapping varied between near shore/intertidal environments, with finer scale mapping, compared to offshore/subtidal environments. Reasons for this are likely due to:

- the limited extent area of the intertidal zone enforcing smaller discrete habitat polygons, comparative to the subtidal environment
- subtidal areas based upon the adopted modified habitat typology, will inherently contain larger homogenous areas for some habitat types (e.g. areas of high energy unconsolidated sand)
- a high degree of variation in habitats present at the transition zone between the subtidal and terrestrial environment
- map scale limitations in the draft QSIC dataset (i.e. representative of the difficulties and limitations associated with accurately and comprehensively identifying distinct habitat types, especially in the subtidal environment).

To minimise the issues described above, the habitat diversity index outputs were stratified into two zones including "Near shore" and "Distant to shore". The near shore zone included all hexagon grid cells which partly or fully intersected intertidal areas adjacent to the mainland and major islands. The remainder of spatial units were allocated to the "Distant to shore" category.

2.1.2 Assignment of relative ratings

For both the dominant and broad type spatial unit habitat diversity outputs, a quantile approach was adopted in order to assign relative measure scores stratified within "Near shore and "Distant to shore" zones. For example, all hexagon grid cells with a calculated dominant habitat diversity index of 0 in the "Near shore" zone were assigned a value of 0, i.e. "No diversity". For all remaining hexagon grid cells:

- the highest ranked 10% of cells were assigned a score of 4 (Very high diversity within the local area)
- the subsequent ranked 10-30% interval a score of 3 (High diversity within the local area)
- the subsequent ranked 30-60% interval a score of 2 (Medium diversity within the local area)
- the remaining hexagon cells a score of 1 (Low diversity within the local area).

This process was repeated using the broad habitat diversity index output in the "Near shore" zone, and then similarly, for both habitat diversity outputs in the "Distant to shore" zones.

To produce an overall generalised habitat diversity criteria rating, the stratified calculated habitat diversity scores for the dominant and broad habitat types was averaged, so that each grid cell was again assigned a value: 0 - No

diversity within the local area [2]; 1 – Low diversity within the local area; 2 – Medium diversity within the local area; 3 – High diversity within the local area; and 4 - Very high diversity within the local area. The following section presents the outputs of the calculated relative habitat diversity scores derived from dominant and broad spatial units, and the compiled output (the overall criteria rating).

2.2 Habitat diversity results

Results from the combined habitat diversity calculations indicated 9% of the study area as being of Very high habitat diversity, 15% as having High habitat diversity, 24% as having Medium habitat diversity, 32% as having Low habitat diversity and 20% as having No habitat diversity. Figure 3 shows the habitat diversity measure score results based upon the dominant habitat type, broad habitat type and Figure 4, the overall habitat diversity rating for each hexagon grid cell.

[2] Some level of true habitat diversity is inherent in all grid cells within the study area. The statement "No diversity within the local area", applies to instances where only a single currently mapped habitat type was present within a 2km grid cell and is relevant only to the scale, complexity and accuracy of the underlying base data (i.e. habitat mapping and typology). Application of finer scale mapping and/or different habitat classifications would result in a different habitat diversity calculation and result.

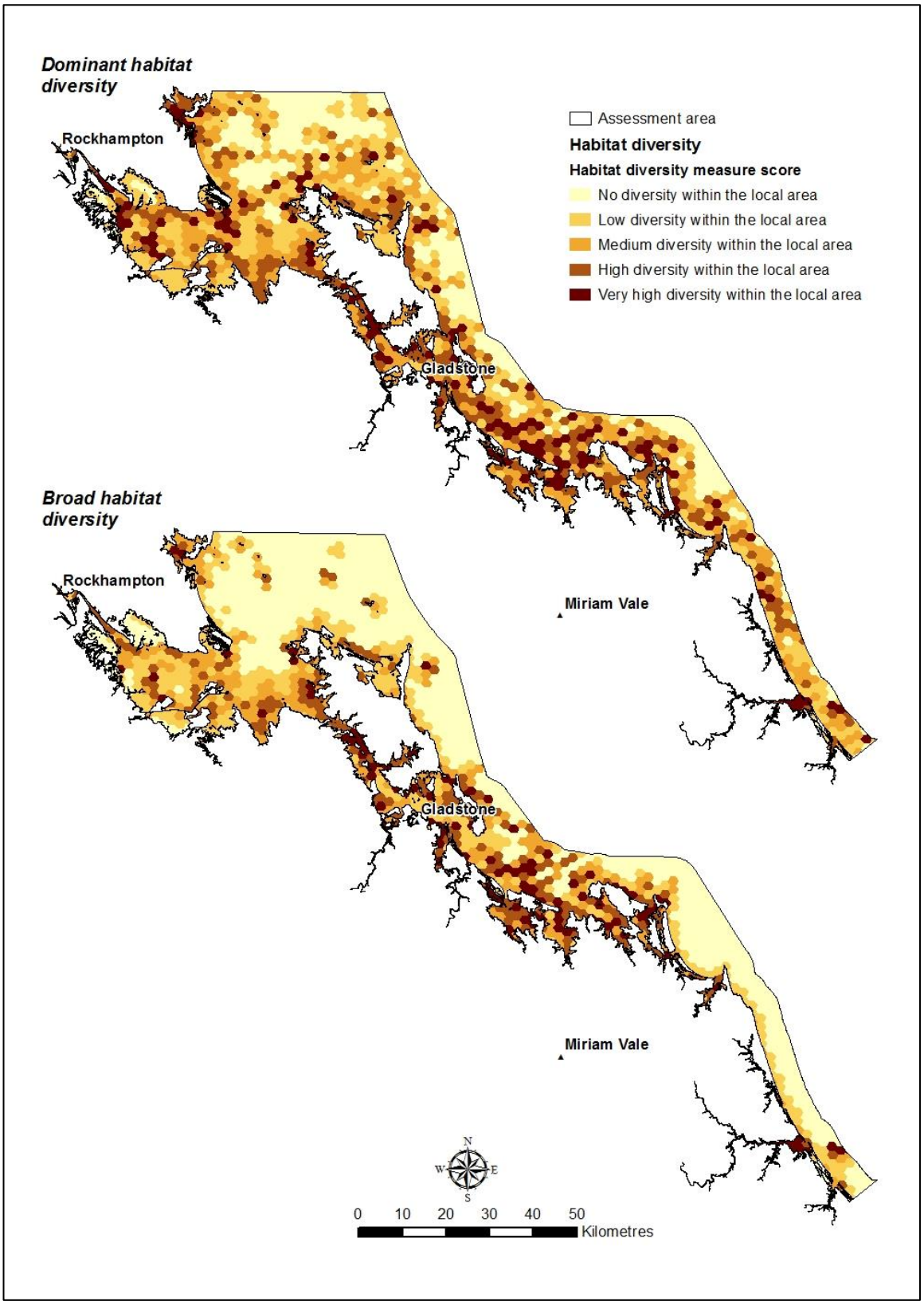


Figure 3: Baffle to Fitzroy coast marine/estuarine dominant and broad habitat diversity

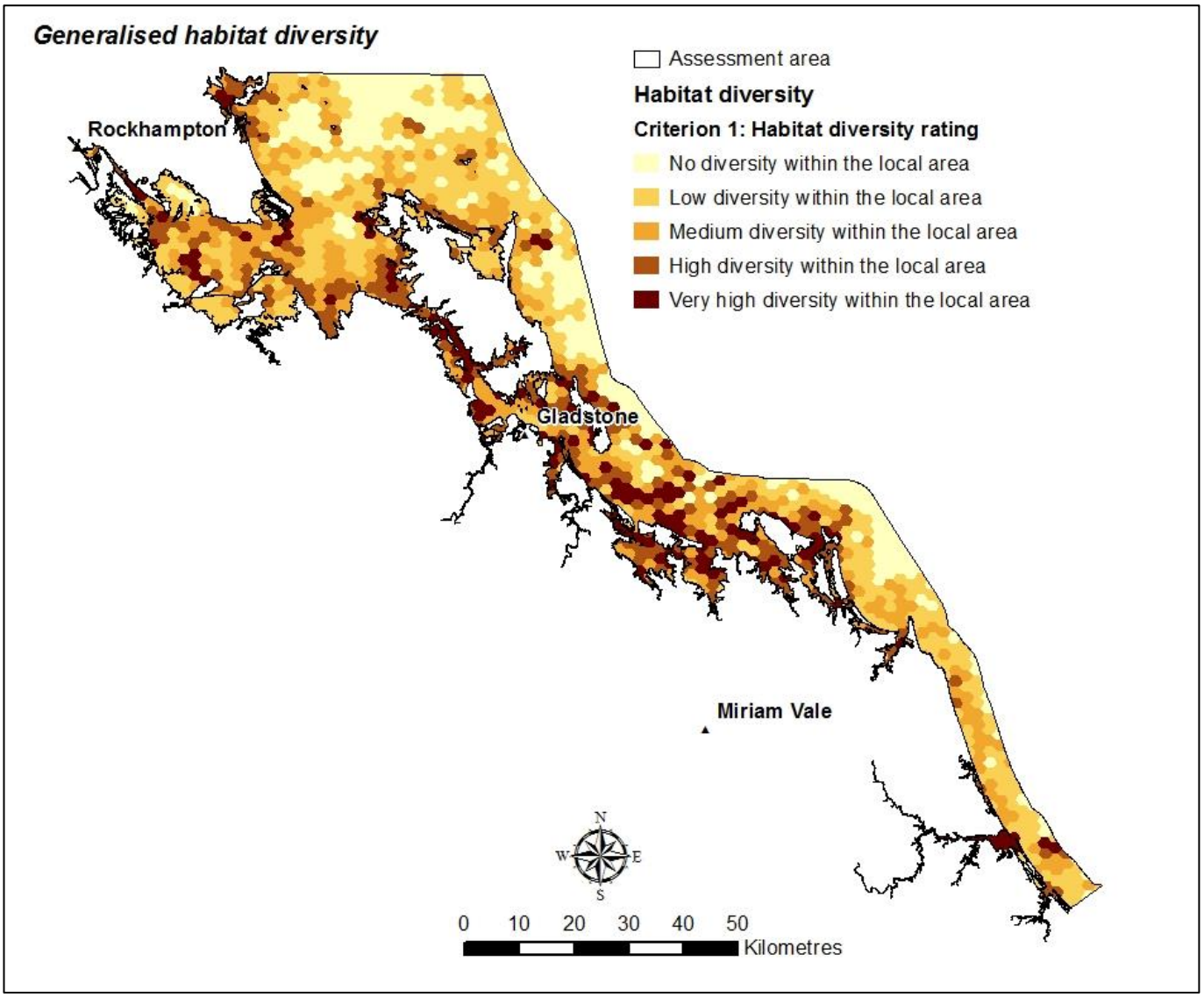


Figure 4: Baffle to Fitzroy coast marine/estuarine generalised habitat diversity

3 Criterion 2 –Taxon Richness (Fauna)

To estimate general fauna taxa richness across the study area, indexes were calculated for five broad taxonomic groups based upon the presence of marine or estuarine dependent species. Marine or estuarine dependent species were defined as:

> *Species that are adapted to and dependent on living in marine/estuarine environments for at least part of their life cycle and are found either within or immediately adjoining a marine or estuarine wetland.*

The five broad taxonomic groups included, 1. Aves, 2. Fish (inclusive of sharks, rays and skates) 3. Mammals and reptiles, 4. Anthozoa (corals, gorgonians and anemones) and 5. Other invertebrates. Richness mapping for the earlier three broad taxonomic groups was conducted at the species level, whilst for the taxonomic groups "Anthozoa" and "Other invertebrates", at the level of family.

Due to inherent inequivalent levels of survey effort for the two broad taxonomic groups "Fish" and "Other invertebrates", the study area was stratified into two broad zones of survey effort based upon sampled site locations for each group. As such, the mapped taxa richness ratings assigned to grid cells and presented in Sections 3.5 and 3.6 are only relative to each other within the same survey effort zone.

3.1 Approach

Approximately 400,000 native marine and estuarine taxa records were compiled and vetted so that only relatively recent records (1975 or later) with spatial accuracies of less than or equal to 2,000m were retained. Of these records, those which were attributed as the same species, with the same geographical coordinates (decimal degrees, four decimal places) and the same record accuracy were considered duplicate records, and only a single record for each set of duplicates retained. Post vetting, approximately 63,500 records were retained.

A 2km hexagon grid consistent with that used for the purpose of Section 3 above (Habitat Diversity) was produced and which covered the entirety of the study area. For each list of species/families relevant to the broad taxonomic group, records were buffered by their spatial accuracy and intersected with the hexagon grid cells. The probability that a species/family occurs within a grid cell was calculated based upon the extent overlap of a buffered record(s) for that species/family with the grid cell. Finally, the sum of the probability for all relevant species/family in a taxonomic group that occurred within the grid cell was calculated to produce a relative taxa richness index score for all grid cells. The formula below summarises the method by which grid cell taxa richness was calculated:

$$P = \sum_{x=1}^{m} (1-Ax)$$

Where *P* is the sum of probabilities associated with each species/family within a broad taxonomic group occurring within a grid cell, taking into account record spatial uncertainty. *Ax* is the probability of the event that all records for species/family *x* would occur outside of the grid cell of interest. *1- Ax* provides the probability that at least one record for species/family *x* occurs within the grid cell of interest (i.e. the opposite of the event that all records for a species/family are located outside of the grid cell of interest). *m* is the total number of species/family.

To calculate *Ax*, for record buffers which intersected grid cells of interest, the proportion area for each record buffer outside of the grid cell of interest was first calculated. Then, the subsequent proportions multiplied to provide an overall probability score.

$$Ax = a1 \times a2 \times ai$$

Where *ai* is the probability for each record of species/family *x*, that record *i* falls outside of the grid cell of interest.

Finally, for each broad taxonomic group, the value *P* was calculated for all grid cells across the study area to produce a relative taxa richness index measure, with greater values representative of the likelihood of greater numbers of species/family known to be present.

3.1.1 Stratification

Due to the unequal levels of geographic survey effort for the two taxonomic groups "Fish" and "Other Invertebrates", two zones of sampling intensity were defined for each based upon a density analysis of sampled sites for the target taxa.

Specifically, a 1,000m grid (consistent with the average record accuracy of approximately +/- 500m) was overlaid across the study area so that each grid cell that contained one or more records from the broad taxonomic group,

was considered as ‘sampled’ and assigned a value of 1. All remaining cells within the study area were assigned a value of 0. A kernel density analysis (ESRI ArcGIS version 10.4, default search radius) was performed to produce a continuous grid representative of generalised broad survey effort. To reduce the down weighting of cells located at the study area margins (i.e. outside of which sampled locations could not occur), the output was adjusted by the weighted number of cells present within the neighbourhood around each cell. Jenks natural breaks (Jenks 1967) was then used to identify two broad zones of survey effort for the both taxonomic groups across the region. The estimated relative levels of generalised broad survey effort and the “High” survey effort zones for the two taxonomic groups are depicted in Figure 5.

Due to what was considered more consistent levels of survey effort across the study area, stratification was not applied for the taxonomic groups “Aves” and “Mammals & /reptiles”. Similarly, as the records associated with the taxonomic group “Anthozoa” were largely composed of coral taxa and it was considered that some survey effort at the majority of the shallow reefs within the study area had occurred, stratification of the results was similarly not applied for this group.

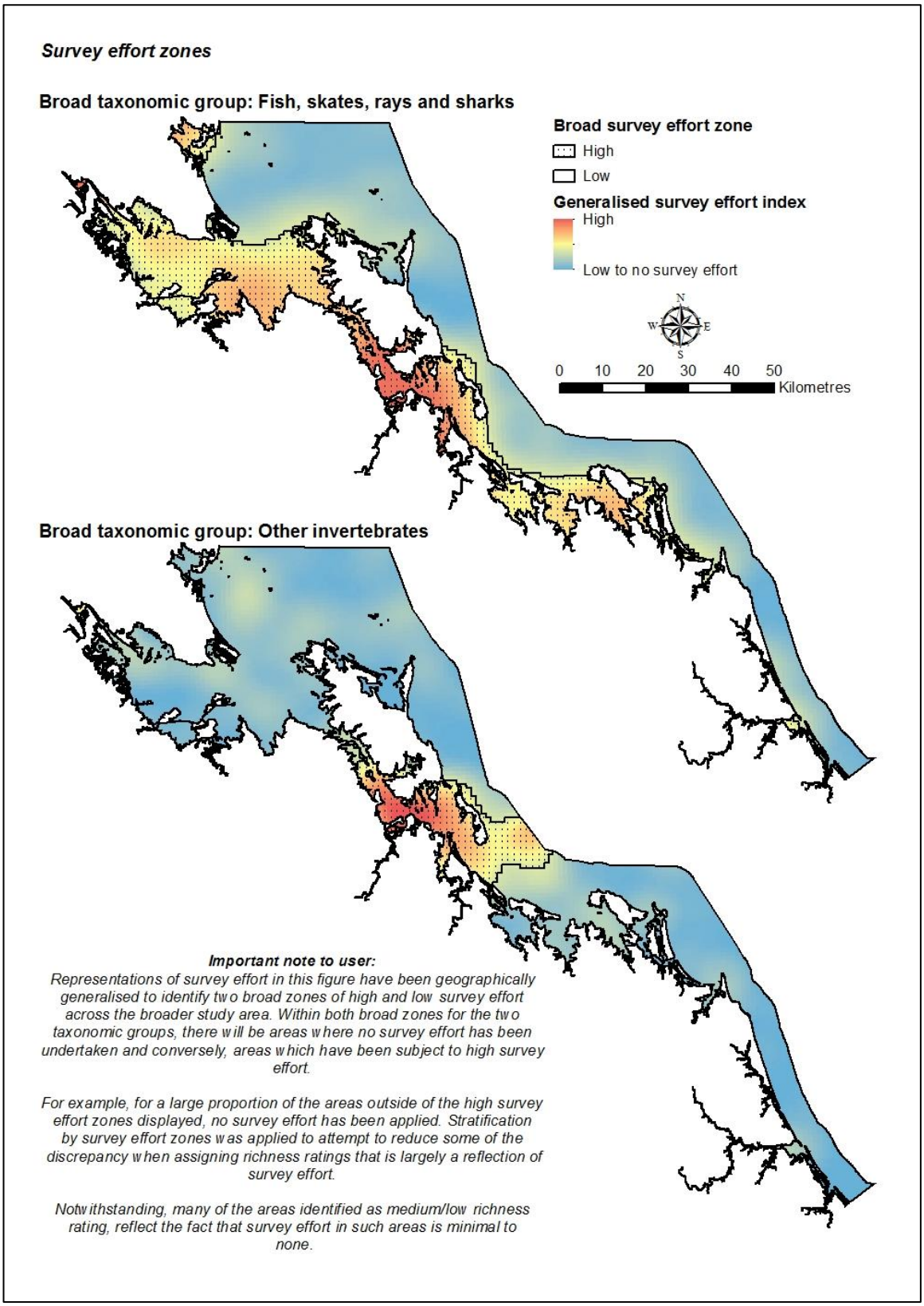


Figure 5: Broad zones of survey effort

3.1.2 Assignment of relative ratings

For each of the taxonomic groups, a quantile approach was adopted to assign relative measure scores. All hexagon grid cells with a calculated richness index measure value of 0 were assigned a measure score of 0 - “No richness/no information”. For all remaining hexagon grid cells:

- the highest ranked 10% of cells were assigned a measure score of 4, or analogous to “Very high relative richness known for that taxonomic group within the local area”
- the subsequently ranked 10-30% a measure score of 3 (High relative richness known within the local area)
- the subsequently ranked 30-60% a measure score of 2 (Medium relative richness known within the local area)
- the remaining hexagon cells a measure score of 1 (Low relative richness known).

For the two taxonomic groups, “Fish” and “Other Invertebrates”, richness measure scores are comparative only to other hexagon grid cells within the same zone of broad survey effort. For all other broad taxonomic groups measure scores are relative to all cells across the study area.

A overall generalised taxon richness score (criteria rating) integrating measure scores for the above taxonomic groups was calculated by adopting the maximum measure score from any of the five groups for each hexagon grid cell and is presented in Section 3.7, representative of the overall criteria rating.

3.2 Avian taxa richness results

Based upon compiled records, 95 native marine/estuarine dependent avian species were identified relevant to the study area. Figure 6 below displays the results of avian richness mapping assessment across the study area in terms of the relative richness index and associated measure scores.

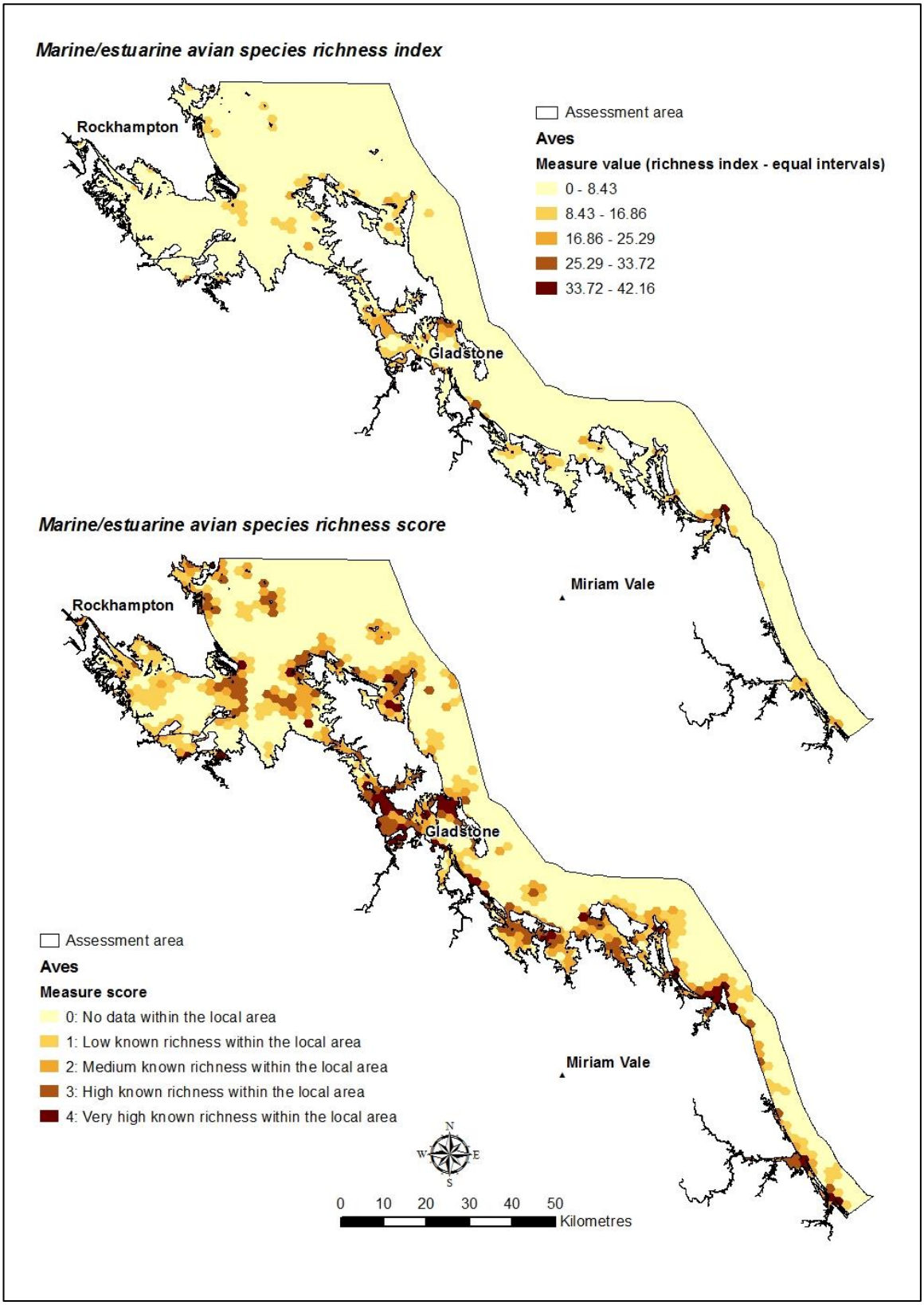


Figure 6: Marine/estuarine avian species richness

3.3 Fish, sharks, rays and skates taxa richness results

Based upon compiled records, 513 native marine/estuarine fish, sharks, rays and skates species were identified relevant to the study area.

Figure 7 below displays the results of the fish, sharks, rays and skates richness mapping assessment across the study area in terms of the relative richness index and associated measure score. As discussed under Section 3.1.2, richness ratings of hexagons are only relevant to other hexagons within the same survey effort zone.

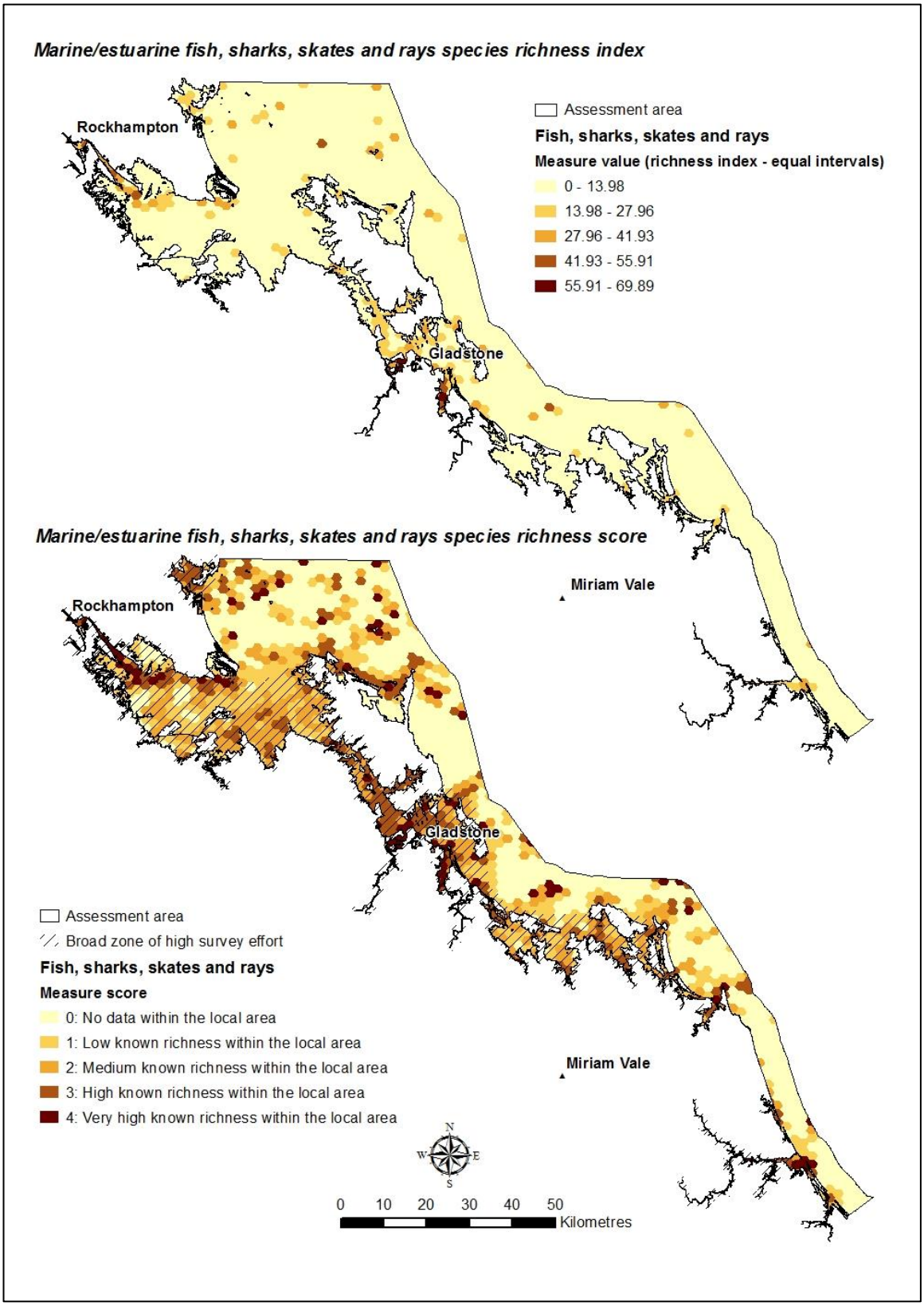


Figure 7: Marine/estuarine fish, sharks, skates and rays species richness

3.4 Mammal and reptile taxa richness results

Based upon compiled records, 26 native marine/estuarine species of mammal and reptile were identified relevant to the study area. Figure 8 below displays the results of the mammal and reptile richness mapping assessment across the study area in terms of the relative richness index and associated measure score.

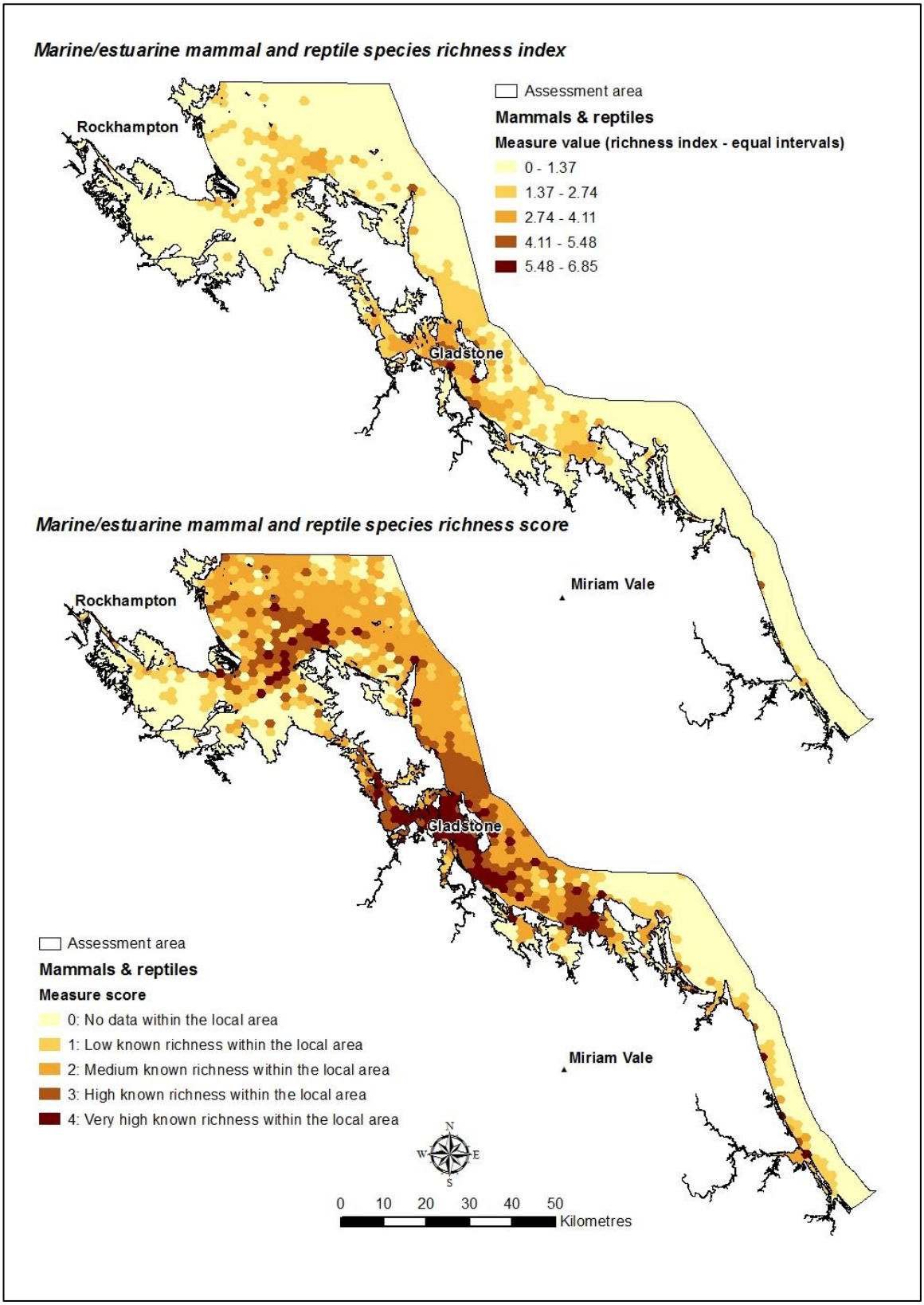


Figure 8: Marine/estuarine mammal and reptile richness

3.5 Anthozoa taxa richness results

Based upon compiled records, 44 native marine/estuarine Anthozoa families were identified relevant to the study area. Figure 9 below displays the results of the Anthozoa richness mapping assessment across the study area in terms of the relative richness index and associated measure score.

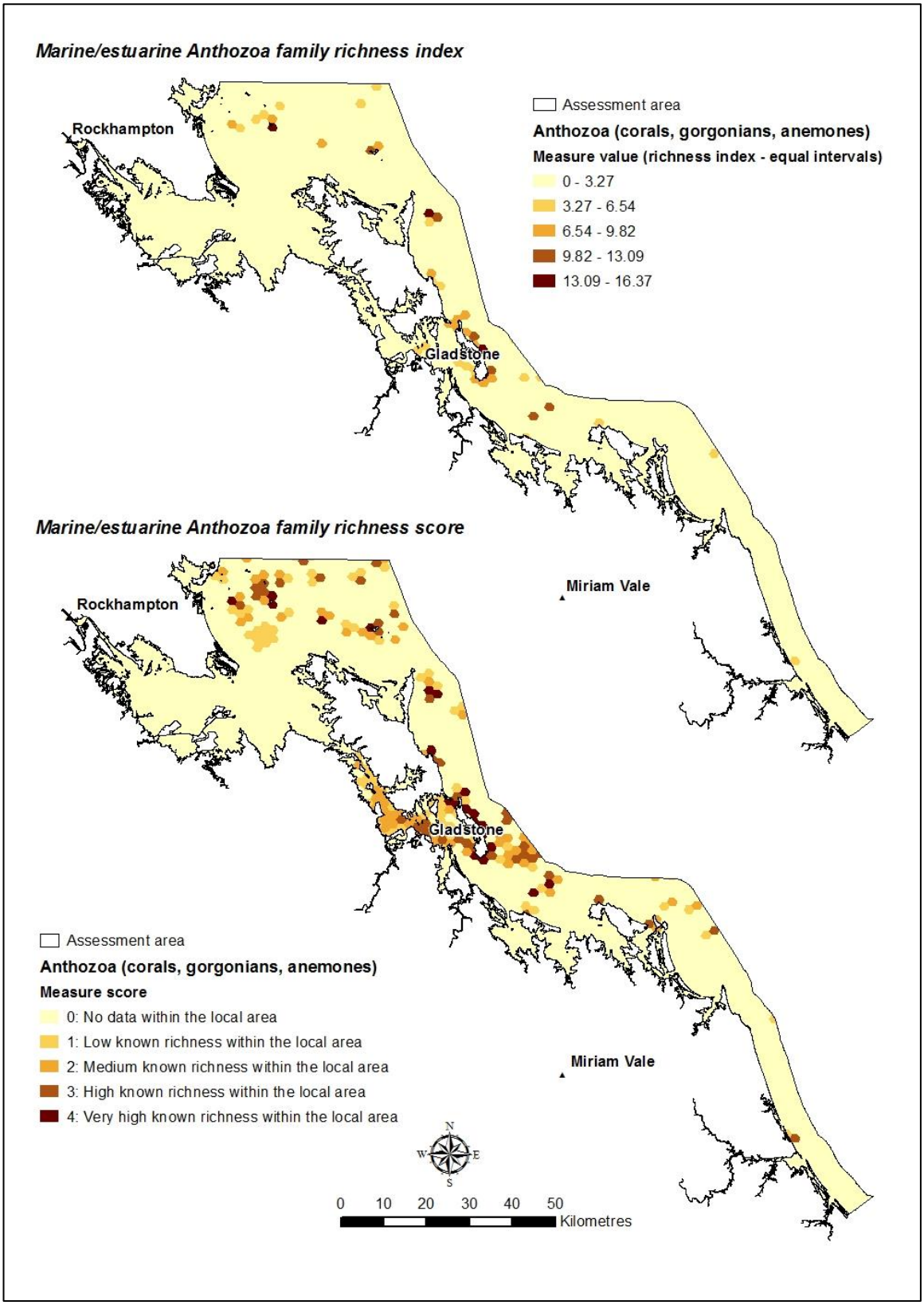


Figure 9: Marine/estuarine Anthozoa family richness

3.6 Other invertebrate taxa richness results

Based upon compiled records, 459 native marine/estuarine invertebrate families (exclusive of the class Anthozoa) were identified relevant to the study area. Figure 10 below displays the results of the other invertebrate richness mapping assessment across the study area in terms of the relative richness index and associated measure score. As discussed under Section 3.1.2, richness ratings of hexagons are only relevant to other hexagons within the same survey effort zone.

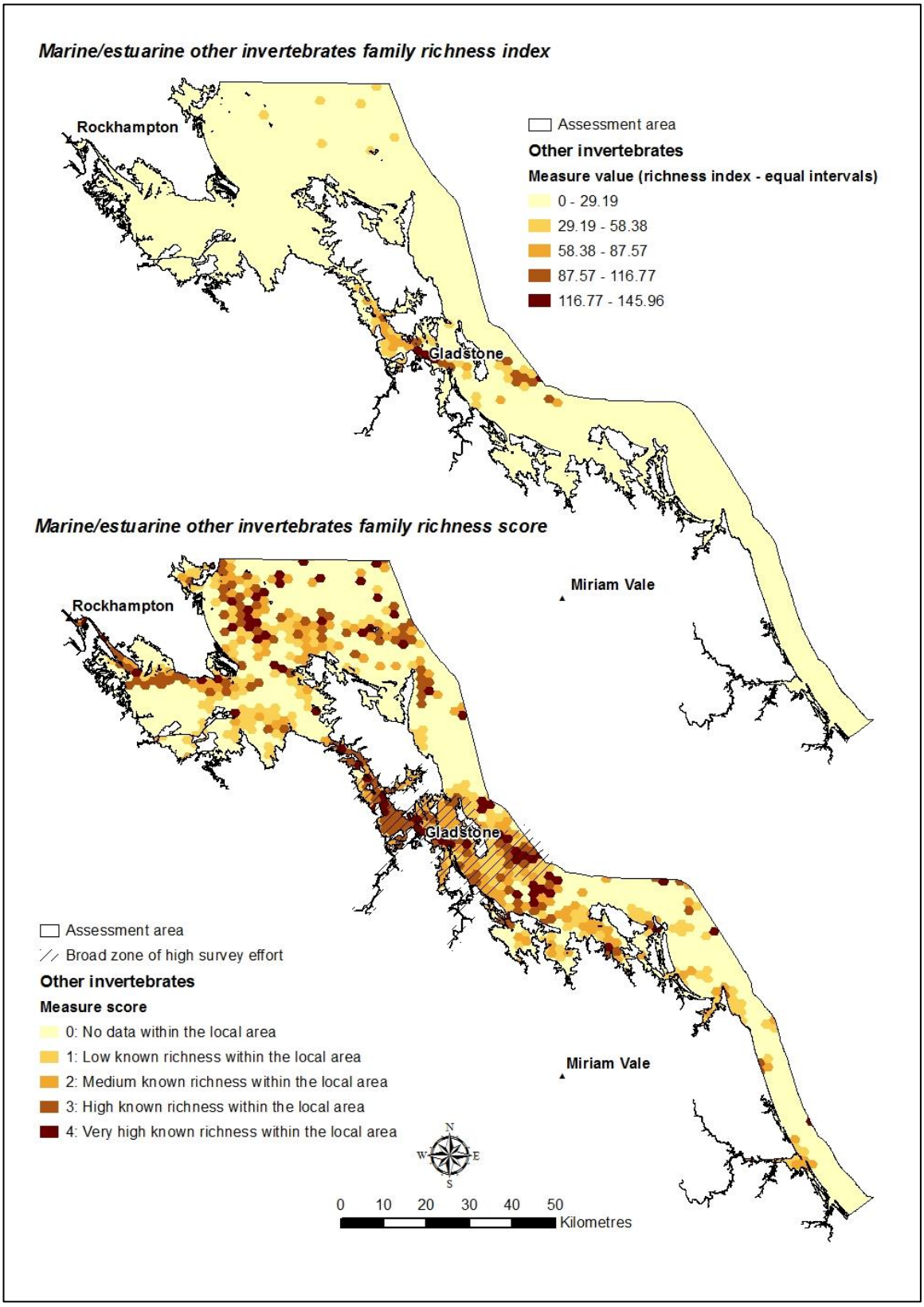


Figure 10: Marine/estuarine other invertebrate species richness

3.7 Overall generalised taxon richness results

Figure 11 displays the overall generalised taxon richness ratings developed by combining the five taxa scores displayed in Sections 3.2 - 3.6 for which richness mapping was performed. The overall criterion richness rating assigned to each hexagon, reflects the maximum rating value present of any of the taxa groups.

Based upon the compiled taxa richness output, 17% of the study area was categorised as Very high known richness for one or more taxa groups, 25% as high known richness, 30% as medium known richness, 16% as low known richness and 12% of the study area had no data present.

The spatial database which accompanies this report, includes a species inventory summarising taxa records situated within each 2km hexagon grid for general information purposes.

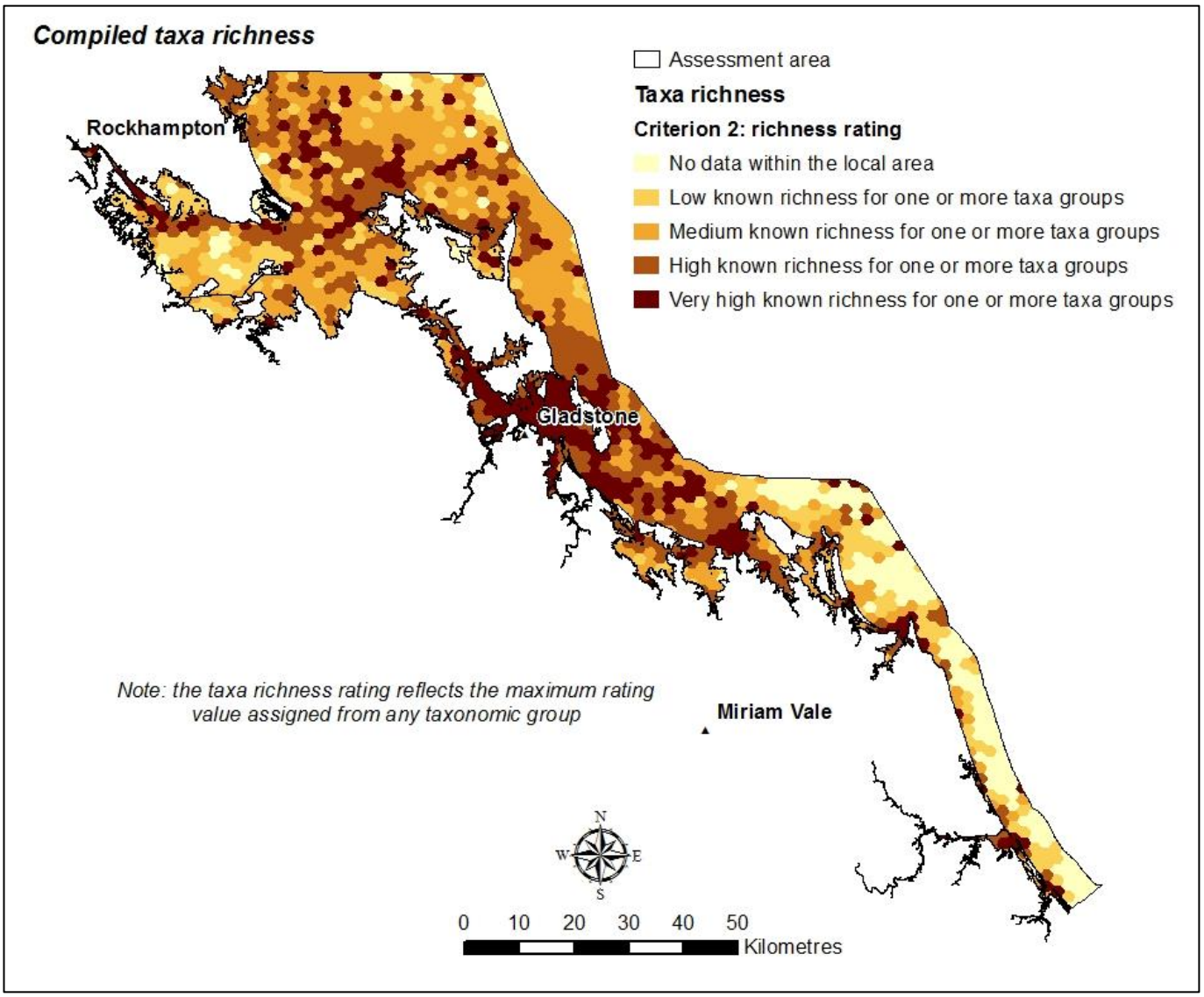


Figure 11: Baffle to Fitzroy Coast - Compiled taxa richness

4 Criterion 3 - Threatened Species Richness (Fauna)

Threatened species are those listed as Critically Endangered, Endangered, Vulnerable or Near threatened under Queensland or Commonwealth legislation. The panel reviewed lists of threatened species based upon records as to whether they occurred, or were highly likely to occur within the study area. Only species judged to be dependent on marine or estuarine environments and scheduled as near threatened, vulnerable, endangered, or critically endangered under the Queensland *Nature Conservation Act 1992* or the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* were considered.

4.1 Approach

The same approach as outlined under Section 3.1 was used to produce an estimate of threatened taxa richness across the study area. However, threatened taxa were not separated into broad taxonomic groups, rather, assessed as a single entity. Threatened taxa consisted primarily of mammals, reptiles and aves, for which it was considered that more consistent levels of broad geographic survey effort (comparative to other invertebrates and fish) had been applied across the study area. Consequently, the survey effort zones discussed in Section 3.1.1 were not used to stratify output values.

4.1.1 Assignment of relative ratings

A quantile approach was adopted to assign relative ratings. All hexagon grid cells with a calculated richness index measure score of 0 were assigned a measure score of 0 - “No data within the local area”. For all remaining hexagon grid cells:

- the highest ranked 10% of cells were assigned a measure score of 4, or analogous to “Very high relative richness known for that taxonomic group within the local area”
- the subsequent ranked 10-30% interval a measure score of 3 (High relative richness known within the local area)
- the subsequent ranked 30-60% interval a measure score of 2 (Medium relative richness known within the local area)
- the remaining hexagon cells a measure score of 1 (Low relative richness known).

Table 5 lists the threatened taxa confirmed by the panel as occurring within the study area, whilst Figure 12 provides a visual representation of threatened taxa richness across the study area.

4.2 Threatened species richness results

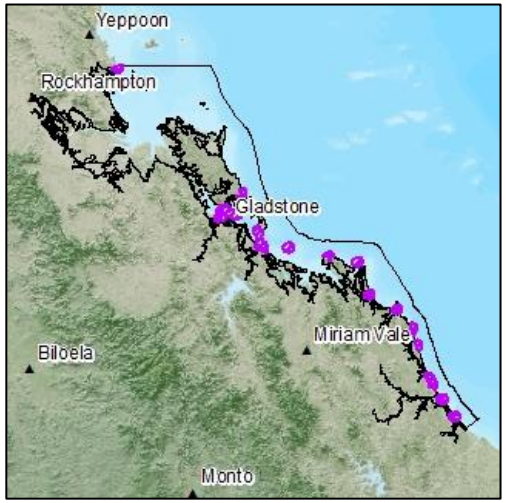
There were 28 threatened taxa identified including, 1 invertebrate and 27 vertebrates (fish, reptiles, birds and mammals). The proceeding table lists marine/estuarine threatened species confirmed by experts as occurring/or considered likely to occur in the study area. The shaded distributions depicted in the table are based upon generalised buffers around point records (unless otherwise stated) and are included for indicative purposes only (refer to the previous Section 3.1 with respect to record vetting rules applied for the purpose of this assessment). It is important to note that in many instances limitations associated with survey bias and/or limited survey effort may cause the depicted distributions to be substantially under-represented.

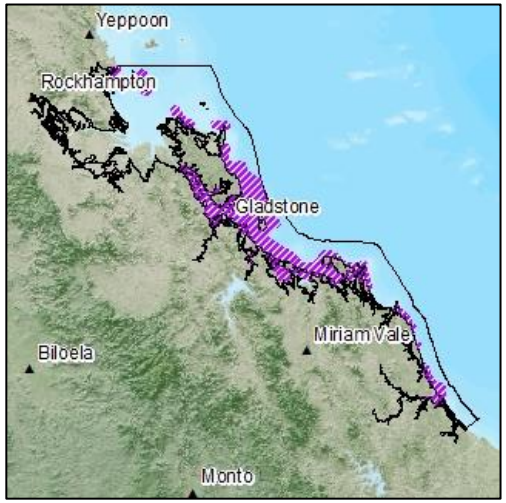
Table 5. Marine/estuarine threatened fauna taxa

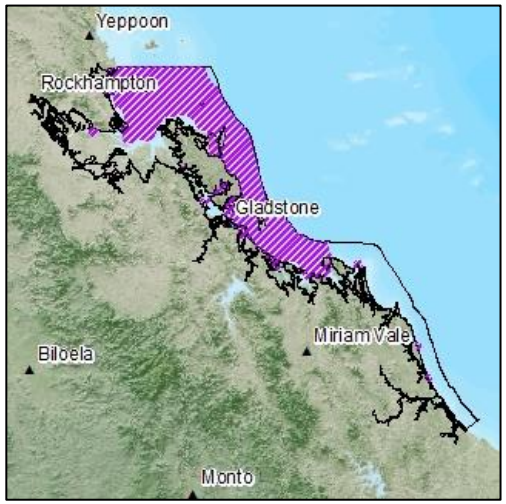
Scientific name (Common name)	NCA[1]	EPBC[2]	Migratory[3]	Brief description/Panel comments
Invertebrate				
Acrodipsas illidgei (Illidge's Ant-blue) *(No records in the study area, considered likely to occur, not mapped)*	V			*Acrodipsas illidgei* prefers mangrove habitats associated with freshwater outflow, and adjacent *Allocasuarina* spp. and *Corymbia* spp. dominated open forests and woodlands (Beale & Zalucki 1995; Braby 2004). The main known threat is habitat loss from urban development and possibly impacts from insecticide use related to sandfly and mosquito control (Dunn et al. 1994). The panel noted that the species has been found at the following confirmed sites just south of the study area: Mary River Heads, Beaver Rock and Maaroom in the Mary River Region. Whilst there has been no confirmed sightings within the study area, suitable habitat is present and it was considered likely that adequate surveys have simply not been conducted.
Fish, sharks, rays and skates				

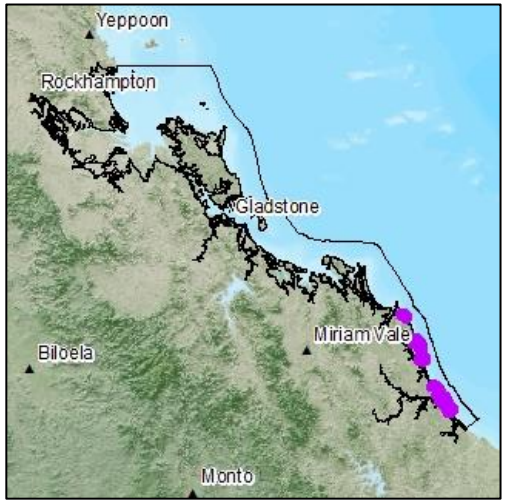
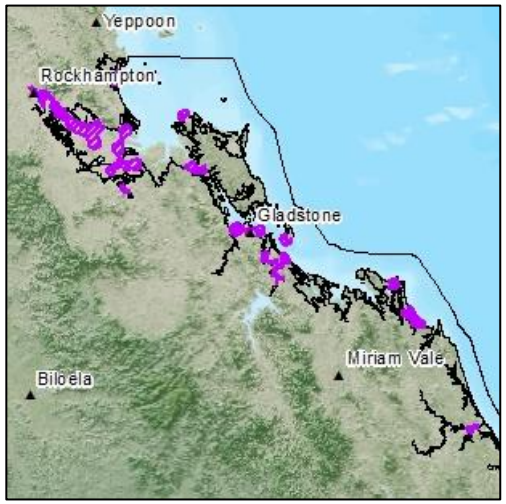
Scientific name (Common name)	NCA[1]	EPBC[2]	Migratory[3]	Brief description/Panel comments
Carcharias taurus (grey nurse shark) *(No records in the study area, considered likely to occur, not mapped)*	E	CE		This species is found in warm temperate inshore waters in southern Queensland, and is associated with particular headlands and consolidated rock crops. The main threats include commercial and recreational fishing, shark finning, shark control measures and ecotourism activities (DoE 2018d). The most northerly validated occurrences on the Qld east coast have been in 2000 & 2013 at Wolf Rock [approx. 25.9 S lat., 153.2 E, long.] (Atlas of Living Australia occurrence download at *https://biocache.ala.org.au/occurrences/search?q=lsid%3Aurn%3Alsid%3Abiodiversity.org.au%3Aafd.taxon%3A0c3e2403-05c4-4a43-8019-30e6d657a283* accessed on Wed Jan 09 12:51:27 AEDT 2019), and as Shark Control Program bycatch in 2007, 2008 and 2017 at Rainbow Beach [approx. 25.9 S lat., 153.1 E, long.] (https://www.daf.qld.gov.au/business-priorities/fisheries/shark-control-program/catch-numbers accessed 9 Jan 2019). While these locations are outside the southern extent of the study area, the species is a known inhabitant of temperate and tropical coastal waters and undertakes northward movements during winter associated with breeding (Last and Stevens 2009).

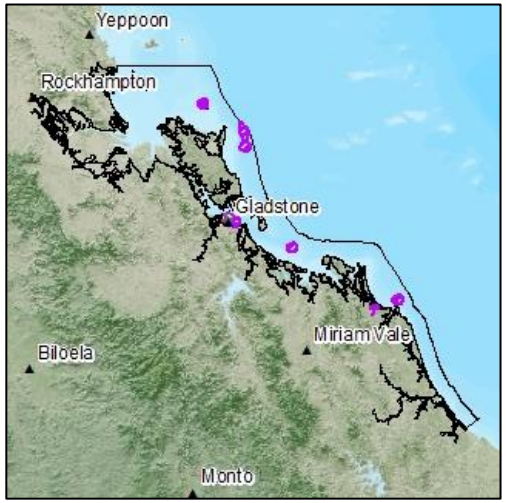
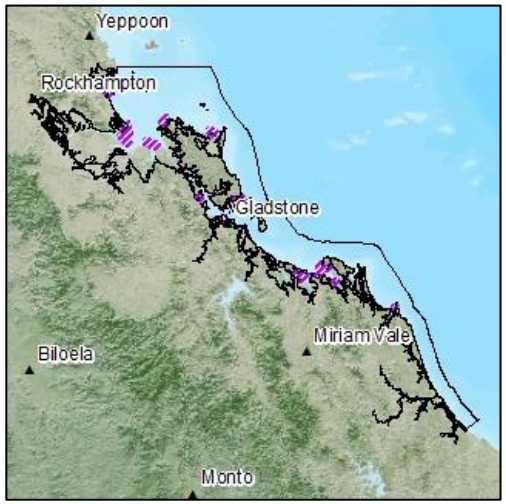
Scientific name (Common name)	NCA[1]	EPBC[2]	Migratory[3]	Brief description/Panel comments
Hemitrygon/Dasyatis fluviorum (estuary stingray) 	NT			This species inhabits estuarine habitats, including tidal edges of mudflats and sandbars, mangrove-fringed upper estuaries and lower freshwater reaches. During low tides, they can also be found in areas with subtidal seagrass. The estuary stingray plays an important ecological role as a bioturbator, being an exclusive bottom-dwelling species which consumes a variety of benthic invertebrates (Last & Stevens 2009). Commercial and recreational fishing and potentially habitat loss due to land reclamation are considered some of the primary reasons for decline (Pogonoski et al. 2002). Occurring within coastal waters of central and southern Qld (https://bie.ala.org.au/species/37035008#tab_recordsView), the species is a known bycatch of the banana prawn fishery targeted by beam and otter trawling in and adjacent to major east coast estuaries including the Fitzroy, Calliope and Boyne Rivers and nearby Burnett River to the south. Three recent ecological risk assessments of the east coast trawl fishery, considered that: • with a higher likelihood of interaction with the East Coast Trawl Fishery relative to other east coast fisheries, the species for the foreseeable future was at *intermediate to low risk* of becoming overfished by otter trawling within the GBRMP (Pears et al. 2012); • at *intermediate risk* of becoming overfished by beam trawling and otter trawling south of the GBRMP (Jacobsen et al. 2018); and • at *low risk* of being overfished by inshore otter trawling south of the GBRMP (Campbell et al. 2017). Notwithstanding, when on a precautionary basis uncertainty around this species sustainable instantaneous rate of mortality is considered, there is no more than a *medium risk* that overfishing may be occurring, while the population is being maintained at a sustainable level (*ibid*.), i.e. the population is considered resilient to depletion at the current fishing level.
Rhincodon typus (whale shark)		V		Recorded sighting, however, not linked to any particular habitat (QLD Museum). In Australia, the Whale Shark is known from NSW, Queensland, Northern Territory, Western Australia and occasionally Victoria and South Australia, but it is most commonly seen in waters off northern Western Australia, Northern Territory and Queensland (Compagno 1984; Last & Stevens 2009).
Reptile				

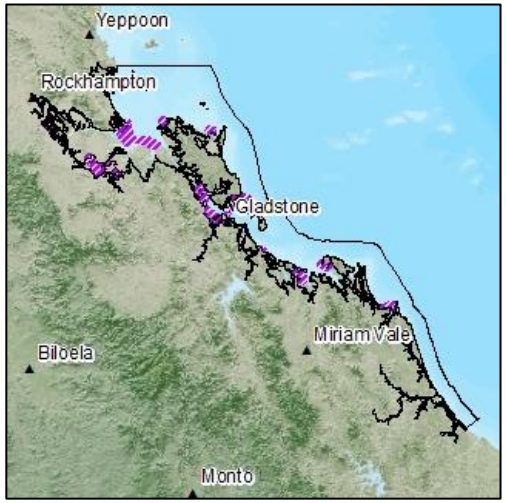
Scientific name (Common name)	NCA[1]	EPBC[2]	Migratory[3]	Brief description/Panel comments
Caretta caretta (loggerhead turtle) 	E	E	Bonn	Within the study area, major breeding sites for this species are located along the coast around Port Curtis and the southern GBR. Loggerhead turtle nests above the high tide mark. When hatchlings enter the ocean, they swim out perpendicular to the wave fronts, and can actively swim for approximately 3 days until they reach deep water, and then drift on the Eastern Australian current. This species migrates to South America to grow and reach adulthood, and return after approximately 16 years where they settle and stay within the area close to where they were born. Very common on coral reefs and rocky shores, as well as in subtidal areas with soft sediment bottoms. *Caretta caretta* primarily feeds on molluscs and crabs in the sub-tidal areas, and will also consume seagrass and algae (Limpus et al. 2001). In some areas, they will chase mobile food resources such as beds of molluscs at certain maturity. Known threats to the species include accidental drowning in fishing/trawling nets, direct mortality due to marine pollution, boat-strike, egg predation from feral animals, and habitat degradation (e.g. seagrass beds and nesting beaches (Limpus 2008). The panel noted it is known to be commonly trawled in the area immediately offshore from the Gladstone Port. For more information on sea turtle nesting areas, refer to special area decision BFC_EC_06 in Table 9.

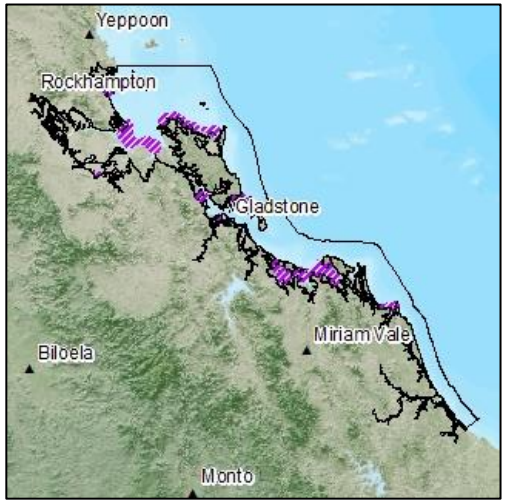
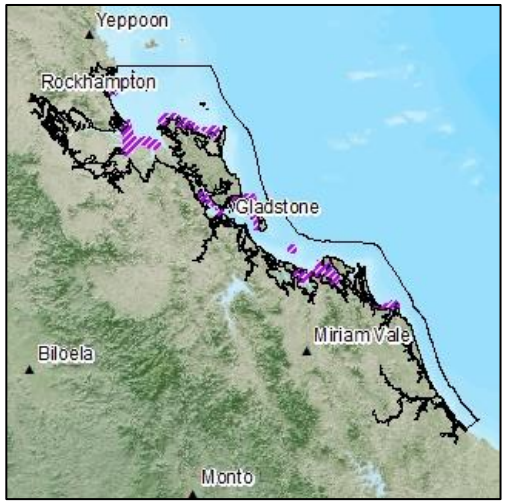
Scientific name (Common name)	NCA[1]	EPBC[2]	Migratory[3]	Brief description/Panel comments
Chelonia mydas (green turtle) 	V	V	Bonn	Within the study area, the species occurs on rocky reef, seagrass and algae beds, and coral reef feeding habitat. When hatchlings enter the ocean, they swim out perpendicular to the wave fronts, and actively swim for approximately 3 days until they reach deep water, where they drift on the Eastern Australian current. At 8 years of age the species will return and settle in coastal habitat, where it spends its adult life in the area. Clusters of individuals occur in areas such as Pelican Banks and Rodds Bay, where they move up the estuaries and consume mangrove (*Avicennia* sp.) seeds. In the North channel, they are known to occur on the rocky reef habitat where they feed on filamentous and macro algae. They have also been observed basking on banks at Chinaman Island and South End. *Chelonia mydas* extensively utilises the Calliope and Boyne River systems where there is significant outflow (e.g. 150 individuals recorded in 2011 in a health assessment by QPWS). Additionally, they have been observed as far upstream as the Bruce highway crossing. The panel noted that the species is more regularly observed on the seagrass meadows between Tannum Sands and Hummock Hill Island. Preliminary information suggests South Trees has the best concentration of immature *C. mydas* within the whole Port. Tracking research into their feeding habits suggest that Pelican Banks may not be as important as previously considered, and more than half their time is spent outside of the Gladstone Port. The vast majority of individuals reside within the local area, however, they seem to travel substantially further. It is uncertain whether they are targeting low density seagrass patches between corals. Known threats to the species include accidental drowning in fishing/trawling nets, direct mortality due to marine pollution, boat-strike, egg predation from feral animals, and habitat degradation, e.g. seagrass beds and nesting beaches (Limpus 2007a). The panel also noted that there are records of wild dogs dragging basking individuals above the high tide mark and killing them. For more information on sea turtle nesting areas, refer to special area decision BFC_EC_06 in Table 9.

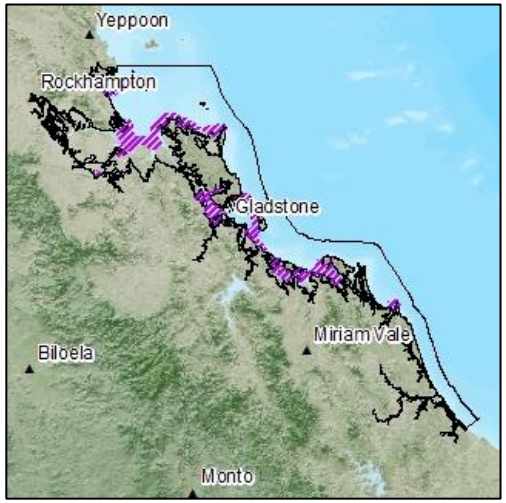
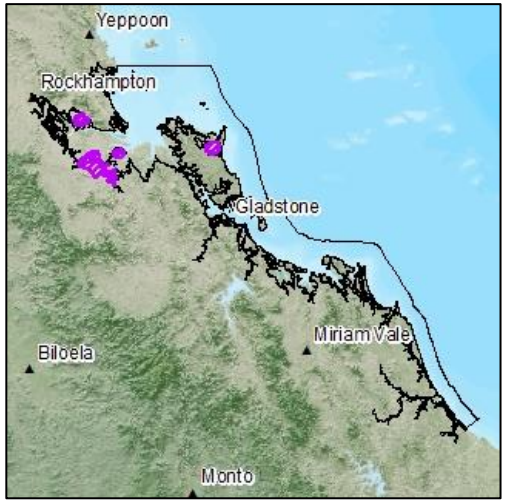
Scientific name (Common name)	NCA[1]	EPBC[2]	Migratory[3]	Brief description/Panel comments
Eretmochelys imbricata (hawksbill turtle) 	E	V	Bonn	This species favours tropical coastal waters and is primarily found in coral and rocky reef habitats. Its diet includes benthic and soft-bodied invertebrates, bubble corals, sponges and tunicates. *Eretmochelys imbricata* is not known to breed within the study area, immature individuals arrive, mature to adulthood then migrate to Vanuatu to breed. The panel noted that there does not appear to be any concentration of individuals, just a dispersed distribution. Within the study area, it is one of the least captured species in the open Port area, as it likely favours small reef patches. Known threats to the species include accidental drowning in fishing/trawling nets, direct mortality due to marine pollution, boat-strike, egg predation from feral animals, and habitat degradation, e.g. seagrass beds and nesting beaches (Limpus 2009a). For more information on sea turtle nesting areas, refer to special area decision BFC_EC_06 in Table 9.
Natator depressus (flatback turtle) 	V	V	Bonn	The flatback turtle occurs in shallow, turbid tropical inshore waters (coast and bays) over soft-bottomed habitats away from reefs. The species consumes seagrass and algae, as well as a variety of soft-bodied benthic invertebrates in soft sediment habitats. This includes sea pens, soft corals, sea cucumbers and jellyfish. However, they do not feed whilst laying eggs, and are capable of travelling up to 180km in the two weeks during this time. *Natator depressus* maintain planktonic feeding present in convergence lines and wind drifts, and they do not undergo deep sea migration like other sea turtle species. Instead, they remain on the continental shelf and inshore waters inside the GBR. They nest above the high tide mark, and Peak Island is considered to be the most important breeding site (Limpus 2007b; Pople et al. 2016). Known threats to the species include accidental drowning in fishing/trawling nets, direct mortality due to marine pollution, boat-strike, egg predation from feral animals, and habitat degradation (e.g. seagrass beds and nesting beaches (Limpus 2007b). The panel noted that this is the second most captured sea turtle in trawlers from bycatch studies. There is also a risk posed to the breeding area adjacent to Gladstone Port due to it being situated in a high traffic area. For more information on sea turtle nesting areas, refer to special area decision BFC_EC_06 in Table 9.

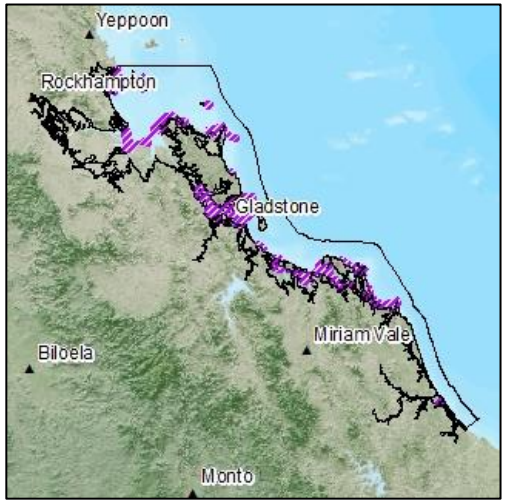
Scientific name (Common name)	NCA[1]	EPBC[2]	Migratory[3]	Brief description/Panel comments
Dermochelys coriacea (leatherback turtle) 	E	E	Bonn	This species prefers sub-tropical and temperate seas and from a hatchling stage it is generally more pelagic/oceanic, spending time in both deep waters and over the continental shelf. It primarily forages on the surface in bays, estuaries and mouths of tidal rivers, feeding on large gelatinous prey such as jellyfish and plankton (Cogger 2000; Limpus 2009). The panel noted that *Dermochelys coriacea* is thought to be potentially extinct in regards to nesting within the study area, as there has been no nesting records in eastern Australia for the last 20 years. Known threats to the species include accidental drowning in fishing gear, direct mortality due to marine pollution, egg predation from feral animals, and habitat degradation, e.g. seagrass beds and nesting beaches (Limpus 2009b). For more information on sea turtle nesting areas, refer to special area decision BFC_EC_06 in Table 9.
Crocodylus porosus (estuarine crocodile) 	V		Bonn	*Crocodylus porosus* is an apex predator, primarily inhabiting estuaries and major river systems, billabongs, swamps and occasionally found in open sea. Its broad diet includes fish, reptiles, birds, mammals and crustaceans (Cogger 2000). The seasonal movements of males and females can be up to 87km and are capable of long-distance travel of several hundred kilometres using surface currents (Campbell et al. 2010). Known threats to the species include drowning in fishing nets, destruction of riparian breeding habitat and illegal shooting (McDonald 2000).
Bird				

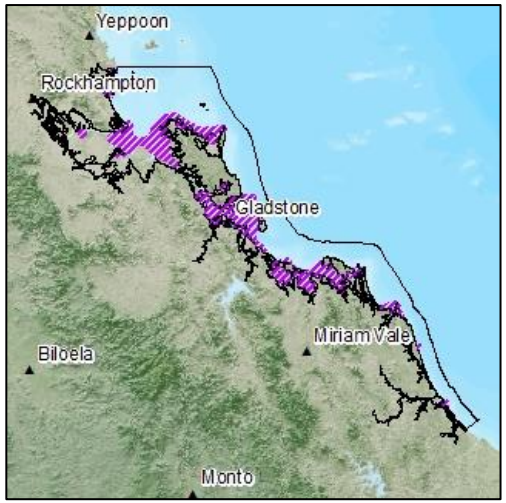
Scientific name (Common name)	NCA[1]	EPBC[2]	Migratory[3]	Brief description/Panel comments
Ardenna pacifica (wedge-tailed shearwater) 	V		JAMBA	This pelagic species can be found over oceanic waters except when at colonies. Its diet includes fish, crustaceans and insects. The breeding season is variable, nesting in burrows in colonies on offshore islands or atolls. The panel noted that within the study area, this is a species that is rarely observed however, it breeds in large numbers on offshore islands such as North West, Heron and Lady Musgrave (outside of the study area). Approximately 150,000 pairs were reported on North West island in 2017. Some of the above information was extracted from the IUCN database on the 16/11/18 (https://www.iucnredlist.org).
Calidris canutus (red knot) 	E	E	Bonn, CAMBA, JAMBA, ROKAMBA	This species has a global distribution and breeds in the northern hemisphere, undertaking migrations along the East Asian-Australasian Flyway to overwinter in Australasia, where it spends the majority of its non-breeding period. In Australia, *Calidris canutus* primarily feed and roost on intertidal mudflats, sandflats and sandy beaches of sheltered coasts (DoE 2018b). Their diet includes bivalves, gastropods, worms and crustaceans. Threats to the species include habitat destruction and degradation, disturbance from humans and dogs in shared zones (e.g. beaches), pollution and contamination, and impacts from climate change (Bamford et al. 2008; DoE 2018b). Red knot is a non-resident of the Curtis Coast area. Unlike other migratory shorebird species, red knots use this area as a stopover site on their way to non-breeding destinations further south (Choi et al. 2017). Cattle Point on the Fitzroy River Delta is a crucial feeding ground for the species, as this location has a superabundance of bivalves (main prey item). Other important areas for the species include North Curtis Island and Rodds Peninsula.

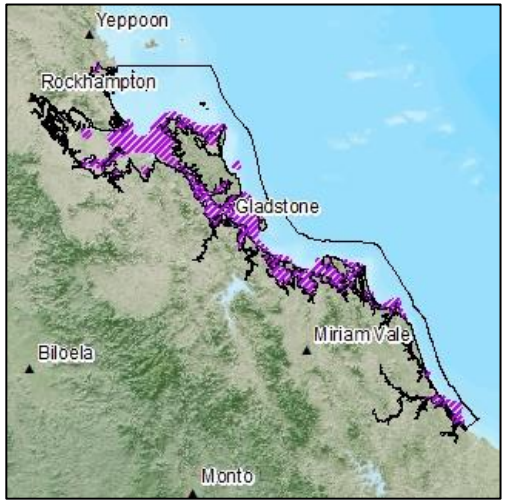
Scientific name (Common name)	NCA[1]	EPBC[2]	Migratory[3]	Brief description/Panel comments
Calidris ferruginea (curlew sandpiper) 	E	CE	Bonn, CAMBA, JAMBA, ROKAMBA	This species occurs mostly along coastlines and has records from all states in Australia. In Queensland, there are scattered records in the Gulf of Carpentaria and widespread records south of Cairns. A migratory species, it breeds in the Russian Artic in June-July and spends its non-breeding season in the Southern Hemisphere. Curlew sandpipers feed on marine invertebrates, e.g. worms, molluscs, crustaceans, in shallow waters of intertidal mudflats during low tide. They are also known to use non-tidal habitats such as lakes and swamps near the coast, as well as artificial sites such as saltworks and sewage plants. Often roosting near feeding sites, they congregate in open areas with damp substrate (e.g. sand spit, islet or beach) during high tide. Known threats to the species includes habitat loss as a result of coastal development, land reclamation and changes to water regimes. In addition, severe population declines of approximately 76% over the last 20 years are primarily attributed to habitat loss and human disturbance in Australia and stop-over sites along the flyway (Department of the Environment 2015). Another major threat is disturbance by humans and dogs in shared zones such as beaches (Lilleyman 2016). Curlew sandpiper is a non-resident of the Curtis Coast area, which acts as a stopover site rather than a final non-breeding ground for the species. Curlew sandpipers were most commonly recorded in the Fitzroy Delta and Cheetham Salt Works during ERMP surveys (Wildlife Unlimited 2012-2018). The panel noted that it is also occasionally recorded at Kinka Wetlands.

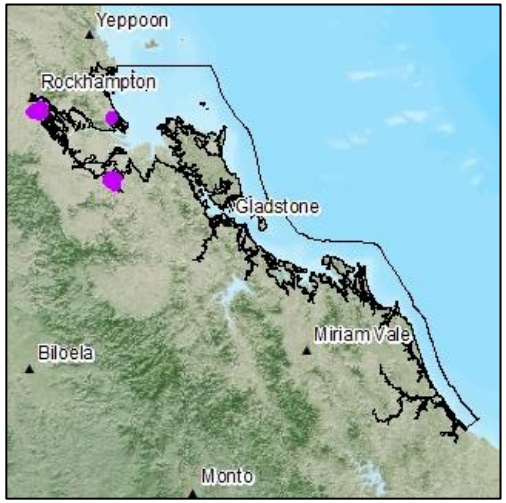
Scientific name (Common name)	NCA[1]	EPBC[2]	Migratory[3]	Brief description/Panel comments
Calidris tenuirostris (great knot) 	E	CE	Bonn, CAMBA, JAMBA, ROKAMBA	This migratory species occurs along coastlines throughout Australia, although they are less common in south-west Australia, South Australia, Victoria and Tasmania. It breeds in the Russian Artic and spends its non-breeding season in the Southern Hemisphere. This species prefers sheltered coastal environments such as inlets, bays or harbours and is also known to utilise exposed reefs or rock platforms, shorelines with mangrove vegetation and artificial swamps. Like many shorebirds, Great Knots often roost near feeding sites which mainly include intertidal mudflats and claypans (Higgins & Davies 1996). Great Knots feed primarily on bivalves, but will also consume gastropods, crustaceans and other invertebrates in shallow waters of intertidal mudflats during low tide. Threats to the species includes habitat loss, human disturbance, pollution and contamination, and impacts from climate change (Higgins & Davies 1996; DoE 2018c). Great Knot is a non-resident of the Curtis Coast area, using the area as its final non-breeding destination. Cattle Point on the Fitzroy River Delta is a crucial feeding ground for the species, as this location has a superabundance of bivalves (main prey item) (Choi et al. 2017). Other important areas for the species include North Curtis and Mundoolin Rocks. Curtis Coast supports an average of 725 individuals over the last 7 years of ERMP surveys (Wildlife Unlimited 2012-2018). This number represents 0.2% of the EAAF population (total = 375,000) (Bamford et al. 2008), and may be considered of national significance.
Charadrius leschenaultii (greater sand plover) 	V	V	Bonn, CAMBA, JAMBA, ROKAMBA	This migratory species occurs mostly along coastlines and has records from all states in Australia. It breeds in northern Mongolia, north-west China and northern Siberia, and spends its non-breeding season in the Southern Hemisphere. In Queensland, it is widespread along the entire length of the eastern coast during the non-breeding season. Greater sand plover inhabits littoral and estuarine habitats such as sheltered sandy or muddy beaches with large intertidal mudflats or sandbanks, sandy estuarine lagoons, as well as inshore reefs. Occasionally recorded on saltworks and brackish swamps near the coast. Their diet includes worms, crustaceans, insects and molluscs. Known threats to the species includes habitat loss as a result of coastal development, land reclamation and changes to water regimes, and disturbance of individuals caused by humans and dogs in shared zones (e.g. roosting/feeding sites) (DoE 2018e). Greater sand plover is a non-resident of the Curtis Coast region, using the area as its final non-breeding destination. The species were most commonly recorded at North Curtis and Fitzroy Estuary during ERMP surveys, and supported an average of approximately 607 individuals across the Curtis Coast region (Wildlife Unlimited 2012-2018). This number represents 0.6% of the EAAF population (total = 110,000) (Bamford et al. 2008), and may be considered of national significance.

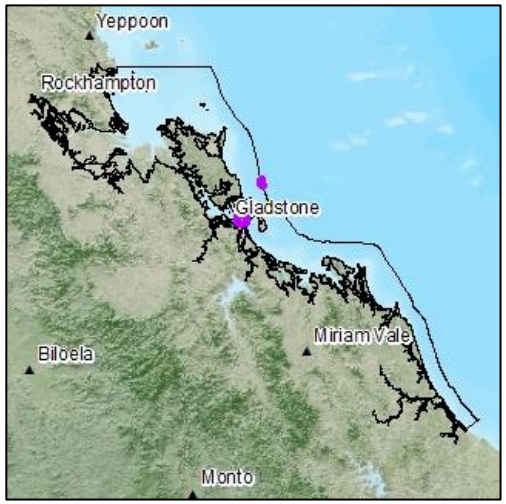
Scientific name (Common name)	NCA[1]	EPBC[2]	Migratory[3]	Brief description/Panel comments
Charadrius mongolus (lesser sand plover) 	E	E	Bonn, CAMBA, JAMBA, ROKAMBA	This migratory species occurs mostly along coastlines and has records from all states in Australia. It breeds in eastern Siberia, including far eastern Russia and Mongolia, and spends its non-breeding season in the Southern Hemisphere. In Queensland, it is widespread along the entire length of the eastern coast during the non-breeding season. Lesser sand plover inhabits littoral and estuarine habitats such as extensive intertidal sandflats and mudflats in estuaries, sheltered bays, and occasionally coral reefs and sandy beaches. Their diet includes worms, crustaceans, insects and bivalves. Known threats to the species includes habitat loss as a result of coastal development, land reclamation, changes to water regimes, and disturbance by humans and dogs in shared zones (e.g. roosting/feeding sites) (DoE 2018f). Lesser sand plover is a non-resident of the Curtis Coast region, using the area as both a stopover site and a non-breeding destination. Lesser Sand Plovers were mostly commonly recorded at Fitzroy Estuary and North Curtis during ERMP surveys, and supported an average of 595 individuals across the Curtis Coast region (Wildlife Unlimited 2012-2018). This number represents 0.4% of the EAAF population (140,000) (Bamford et al. 2008), and may be considered of national significance.
Epthianura crocea macgregori (yellow chat - Capricorn subsp.) 	E	CE		This subspecies is distributed in the coastal lowlands of the central Queensland coast, between St Lawrence wetlands south to Curtis Island and the Fitzroy River delta floodplain. The current estimated population is approximately 300 individuals (Houston & Melzer 2007). Within its very limited distribution, known isolated populations are on Curtis Island, Twelve Mile Creek on the Fitzroy Delta, Fitzroy Vale (property on the Fitzroy River) and at several properties at Torilla (near Shoalwater Bay). It inhabits swampy grassland and wetlands characterised by mosaics of marine couch, water couch, sedges and rushes. Also occurs on marine plains dominated by saline herbland and supratidal saltmarsh within a network of braided, sometimes tidally influenced, drainage lines. Artificial saltpans and wetlands can be used as alternative habitat, such as the Port Alma saltworks. Their diet includes a wide range of invertebrates, e.g. beetles, ants, spiders and flies. Potential threats to Yellow Chat (Capricorn subsp.) include habitat destruction and degradation due to wetland modification, industrial development and impacts from grazing animals e.g. cattle and feral pigs, climate change impacts and predation from introduced predators (Houston & Melzer 2007).

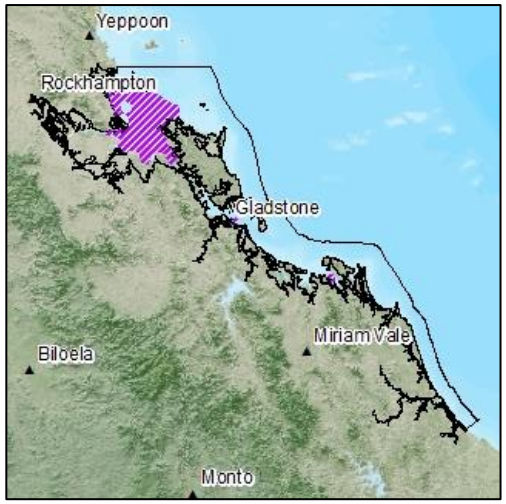
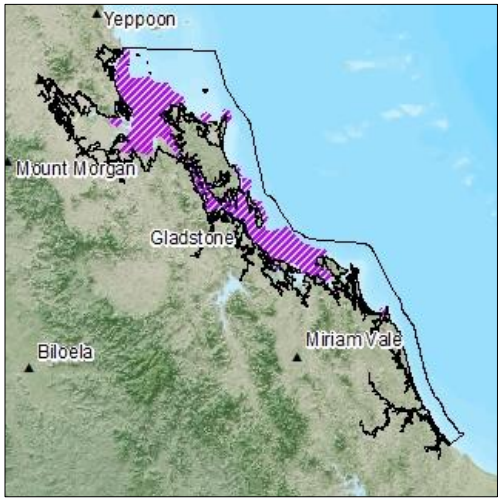
Scientific name (Common name)	NCA[1]	EPBC[2]	Migratory[3]	Brief description/Panel comments
Esacus magnirostris (beach stone-curlew) 	V			In Queensland, this resident shorebird species occurs along the entire length of the coastline as well as on offshore islands. It can be found in in a variety of beach and littoral habitats on muddy, rocky, sandy and coral substrates, often near river mouths and mangrove-backed areas Its diet includes crabs and other marine invertebrates. Threats to the species include nesting failure due to human disturbance, egg-collecting, habitat loss and predation by introduced predators (Marchant & Higgins 1993). Beach stone-curlews were sighted regularly at annual surveys for the Gladstone Ports Corporation's Ecosystem Research and Monitoring Program. Sightings coincide with areas identified as significant for migratory shorebirds (BF_EC_21 – 27). However, a high concentration of sightings occur at claypans and saltpans in the Port of Gladstone, between the Western Basin Reclamation Area and Friend Point, and on Curtis Island near Laird Point and LNG plants. Another concentration of sightings occur along the shore from Bustard Bay Lookout to the mouth of Eurimbula Creek. Within the study area, breeding pairs have been noted at Australia Pacific LNG saltpan on Curtis Island (1 pair) and Eurimbula Beach near Jenny Lind Creek (2 pairs).

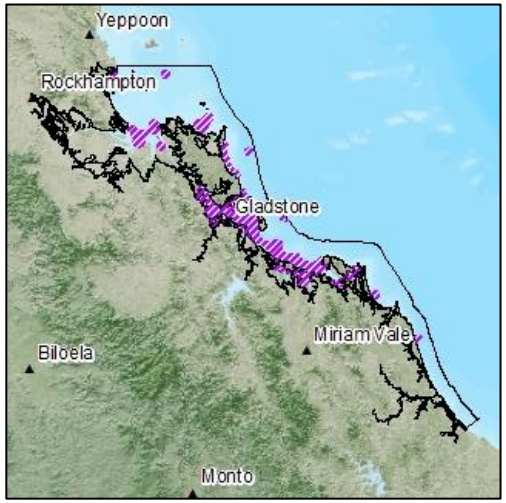
Scientific name (Common name)	NCA[1]	EPBC[2]	Migratory[3]	Brief description/Panel comments
Limosa lapponica baueri (Bar-tailed godwit - western Alaskan) 	V	V	Bonn, CAMBA, JAMBA, ROKAMBA	The bar-tailed godwit (western Alaskan) is a large migratory shorebird. The two subspecies in the East Asian – Australasian Flyway (EAAF), *L. l. baueri* and *L. l. menzbieri*, are distinguishable morphologically in the field (Wilson et al. 2007; Choi et al. 2015). This species occurs mostly along coastlines and has records from all states in Australia. In Queensland, it is widespread along the entire length of the eastern coast during the non-breeding season. The species breeds in north-east Siberia and western Alaska during the boreal summer. It occurs predominately in coastal habitats including estuaries, mudflats, large intertidal sandflats, sandy beaches, as well as sewage farms and saltworks in coastal areas (Higgins & Davies 1996). Its diet consists of molluscs, crustaceans, worms and insects. *Limosa lapponica baueri* forages on exposed soft mud or exposed substrates near the edge of water or in shallow water on claypans, intertidal flats, banks and beaches (Higgins & Davies 1996). Known threats to the species includes habitat loss as a result of coastal development, land reclamation and changes to water regimes, and disturbance of individuals caused by humans and dogs in shared zones, e.g. roosting/feeding sites (DoE 2018g). Significant loss of habitat in Yellow Sea a key area along the East Asian – Australasian Flyway flyaway. Bar-tailed godwit is a non-resident of the Curtis Coast region, utilising the area as its non-breeding destination. Curtis Coast supports a consistent number of Bar-tailed Godwits, with an average of 2,783 individuals over the past 7 years (Wildlife Unlimited 2012-2018). This number is 0.9% of the EAAF population estimate (total = 325,000) (Bamford et al. 2008), and may be considered of national significance. Bar-tailed Godwits were mostly commonly recorded at North Curtis and Mundoolin Rocks during ERMP surveys (Wildlife Unlimited 2012-2018).
Macronectes giganteus (southern giant-petrel) *(No records in the study area, considered likely to occur)*	E	E	Bonn	Usually found in southern seas in Antarctica and subtropical zones, and is a moderately common to rare non-breeding visitor to Queensland (Marchant & Higgins 1990). Prefers open seas and coastal waters foraging on birds, fish, crustaceans, cephalopods and carrion. Threats to the species include deaths due to longline fishing, ingestion of or entanglement in marine pollution, and disturbance to nesting colonies by humans and feral herbivores (Marchant & Higgins 1990; Patterson et al. 2008).

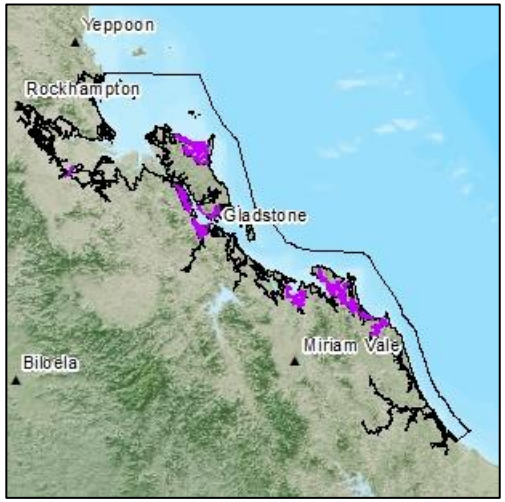
Scientific name (Common name)	NCA[1]	EPBC[2]	Migratory[3]	Brief description/Panel comments
Numenius madagascariensis (eastern curlew) 	E	CE	Bonn, CAMBA, JAMBA, ROKAMBA	This species occurs mostly along coastlines and has records from all states in Australia. In Queensland, it is widespread along the entire length of the eastern coast during the non-breeding season. The species breeds in eastern Russian and north-east China. It can be found on sandflats, claypans, intertidal flats near mangroves and estuaries/creeks, and occasionally on sandy beaches and coral reefs (Higgins & Davies 1996). The species consumes small molluscs, crabs, burrowing shrimps (e.g. ghost shrimp), worms and occasionally fish and insects. It forages close to the water on soft sandy or mud substrates, preferring broad flats (Higgins & Davies 1996). Potential threats to the species include habitat loss as a result of coastal development, land reclamation and changes to water regimes, and disturbance of individuals caused by humans and dogs in shared zones, e.g. roosting/feeding sites. In addition, the panel noted that human disturbance on mainland beaches have seen a steady decline in sightings of this species. Eastern curlew is a non-resident of the Curtis Coast area, using the area as its final non-breeding destination. This species has experienced severe declines across the flyway, at approximately 81.4% over 30 years - equal to the loss of three generations (Garnett et al. 2011). An average of 780 individuals have been recorded in the Curtis Coast region over the past 7 years of ERMP surveys, and was most commonly recorded at Port Curtis and Mundoolin Rocks (Wildlife Unlimited 2012-2018). This number represents 2% of the EAAF estimated population (total = 38,000) (Bamford et al. 2008), making Curtis Coast an internationally significant non-breeding ground for this taxon.

Scientific name (Common name)	NCA[1]	EPBC[2]	Migratory[3]	Brief description/Panel comments
Rostratula australis (Australian painted snipe) 	V	E		*Rostratula australis* occurs along the eastern coast from South Australia to Queensland, and in northern Western Australia and Northern Territory (Marchant & Higgins 1993). Favoured habitat includes shallow permanent and ephemeral swamps, lake margins and water meadows with sedges/rushes, short grass and areas with lignum and chenopods present. It is also known to use intertidal and saltmarsh areas, samphire flats, and waterlogged grasslands with scattered trees. Their diet includes earthworms, molluscs, small crustaceans, seeds and insects. This cryptic species is nomadic and possibly a latitudinal migrant, dispersing according to the local conditions (Black et al. 2010). Potential threats to the species include hunting and habitat loss through drainage and trampling/over-grazing by livestock of suitable wetland habitat (Marchant & Higgins 1993). The panel noted that a group of 23 individuals were observed on Murray Lagoon in June 2013 after good rainfall. Small groups of Australian painted snipe have also been observed on the edges of freshwater lagoons and ephemeral water bodies in grassland, on coastal cattle properties such as Balnagowan and Fitzroy Vale.
Sternula nereis exsul (fairy tern - New Caledonian) 	E			In Queensland, this subspecies has been recorded from Cape York south to Fraser Island (Garnett et al. 2011). One sighting exists at the mouth of Baffle Creek. Fairy tern utilise a variety of habitats including offshore, estuarine or lacustrine islands, wetlands, beaches and spits. They nest above the high water mark often in clear view of the water and on sites where the substrate is sandy and the vegetation low and sparse. Fairy terns feed almost entirely on fish. Plant material, crustaceans and gastropods may be digested, possible from the stomachs of fish. Known threats include disturbance by humans, dogs and vehicles, predation by introduced mammals, pollution, weed encroachment, irregular water management and high salinity which can lead to the collapse of prey fish (Higgins & Davies 1996).

Scientific name (Common name)	NCA[1]	EPBC[2]	Migratory[3]	Brief description/Panel comments
Mammal				
Megaptera novaeangliae (humpback whale) 	V	V	Bonn	This exclusively marine species has a worldwide distribution. In Queensland, it has been reported from waters between 12° - 29° S. It prefers warm shallow waters (i.e. <100m) when birthing and mating, and Hervey Bay to the south of the study area, is a known resting area (DoE 1997; DEH 2005). While the species is becoming more common following the cessation of hunting, some of the potential threats include disturbance from boat traffic, pollution impacts, mortality due to accidental boat strikes, entanglement in shark nets, and reduced food supply, e.g. fish and krill, as a result of commercial fishing activities (DEH 2005).

Scientific name (Common name)	NCA[1]	EPBC[2]	Migratory[3]	Brief description/Panel comments
Orcaella heinsohni (Australian snubfin dolphin) 	V		Bonn	This species has been recorded across northern Australia from Western Australia, east across the Northern Territory and south along the Queensland coast to the Fitzroy River, and occasionally to the Brisbane River (Cagnazzi 2013). It can be found in shallow coastal waters, as well as muddy and brackish waters particularly near creek and river mouths. Its diet includes fish, cephalopods and crustaceans (Cagnazzi 2013). Potential threats include mortality due to by-catch from commercial fishing activities and shark nets, boat strikes, degradation of inshore and riverine habitat due to pollution in areas close to agricultural, industrial and urban areas, and prey depletion from inshore commercial and recreational fishing activities (Parra & Marsh 2001; Cagnazzi et al. 2013). The panel noted that the most southerly resident population of *Orcaella heinsohni* in Queensland occurs in the Port Alma/Keppel Bay area, near Rockhampton. Sightings of the species south of Port Alma are rare, with occasional observations in the western basins and Calliope River.
Sousa sahulensis (Australian humpback dolphin) 	V		Bonn	This species has been recorded across northern Australia from Western Australia, east across the Northern Territory and south along the east coast to the central coast of New South Wales (Jefferson & Rosenbaum 2014). It can be found in shallow inshore waters, often at the mouths of estuaries and in tidal channels, including dredged channels. It occasionally occurs offshore but usually in association with relatively sheltered, shallow reef or island habitats (Menkhorst & Knight 2001; Cagnazzi 2013; Jefferson & Rosenbaum 2014). Their diet includes a variety of fish, molluscs, crustaceans and some squid (Menkhorst & Knight 2001). Potential threats include mortality due to by-catch from commercial fishing activities and shark nets, boat strikes, degradation of inshore and riverine habitat due to pollution in areas close to agricultural, industrial and urban areas, and prey depletion from inshore commercial and recreational fishing activities (Parra & Marsh 2001; Cagnazzi et al. 2013). The panel noted that although Australian humpback dolphins have been recorded up to 55km offshore on the northern GBR, they are primarily found within 20km of the coast. Key localities for the species in Queensland include Moreton Bay, the Great Sandy Strait, Port Curtis, Port Alma-Keppel Bay, Shoalwater Bay, Mackay-Whitsundays, Townsville-Hinchinbrook and Bathurst Bay.

Scientific name (Common name)	NCA[1]	EPBC[2]	Migratory[3]	Brief description/Panel comments
Dugong dugon (dugong)  	V		Bonn	This species occurs in coastal waters from Shark Bay in Western Australia, east across northern Australia and south along the Queensland coast to Moreton Bay in south-east Queensland (Heinsohn 2008). Occasionally it extends further south on both east and west coasts. Dugongs prefer shallow warm tropical and subtropical waters that are generally calm and in locations with extensive seagrass meadows, usually in wide protected bays and channels with fringing mangroves (Heinsohn 2008). Its diet is primarily comprised of leaves and rhizomes of a range of seagrass species, and will also consume marine algae and benthic macro-invertebrates (Marsh et al. 1982). Known threats to the species includes the depletion and degradation of seagrass beds as a result of increased sedimentation and/or disturbance from prawn trawling activities and poor catchment management (land clearing, agricultural practices, mining), and unsustainable hunting. Other threats include mortality due to fish nets, boat-strike and anti-shark measures (Heinsohn 2008). The panel noted that dugongs are very important species in this region. Within the study area, their feeding behaviour in intertidal areas indicate that they utilise all the seagrass patches from the Narrows to Rodds Bay, and dugong scat is known to disperse seagrass species. They are very mobile species and can travel extensively to utilise of all the species of seagrass recorded in the area. Dugongs mainly feed on coastal seagrass (i.e. shallower than 10m), with some seagrass areas more important than others. Deep water seagrass may be used only occasionally, yet it still considered important as it is utilised seasonally and their increased fecundity may be associated by the events of blooming of deep water seagrass. Data from StrandNet indicate that when seagrass patches disappeared, there were no dugongs or boat-strikes recorded, and it is presumed dugongs leave the area. The panel noted that dugongs will avoid vessel movement, and may have learnt to avoid shallow seagrass beds adjacent to shipping routes or recreational boats. Seagrass patches in Gladstone are highly important areas as they are the only major area of seagrasses between Hervey Bay and Shoalwater Bay. Recent tracking of individuals shows migrations from Hervey Bay and Shoalwater Bay, going past Baffle River and stopping in the Gladstone area.

Scientific name (Common name)	NCA[1]	EPBC[2]	Migratory[3]	Brief description/Panel comments
Xeromys myoides (water mouse)  *Distribution derived from DES habitat model where habitat type = core habitat.*	V	V		This species has widely separated populations from the Northern Territory, and scattered locations along the Queensland coast between Cairns and Coomera River in SEQ (Woinarski et al. 2000; Gynther 2011). It inhabits a range of coastal environs including mangrove forests, sedgeland, saline grassland and wet heath and swamps near drainage lines. It feeds almost exclusively on crabs, and is also known to consume flatworms, bivalves and freshwater invertebrates (Van Dyck 1997). Known threats to the species include the loss, degradation and fragmentation of coastal habitat from foreshore development and drainage of swamps, as well as impacts from recreational vehicles and trampling by feral herbivores, reduced water quality and altered hydrology impacting on food supplies and intertidal vegetation (Gynther 2011).

[1] NCA—Queensland Nature Conservation Act *1992*: E = endangered, V = vulnerable, NT = near threatened, LC = least concern.

[2] EPBC—Commonwealth Environment Protection and Biodiversity Conservation Act *1999*: Ex= extinct, CE = critically endangered, E = endangered, V = vulnerable.

[3]The migratory convention under which the species is listed: Bonn Convention (Bonn), JAMBA, CAMBA, ROKAMBA.

Figure 12 provides a spatial representation of the threatened taxa relative richness index and associated criterion rating based upon compiled records within the study area. Approximately 7% of the study area was categorised as Very high known richness, 15% as High known richness, 31% as Medium known richness, 18% as Low known richness and 29% of the study area had No data present.

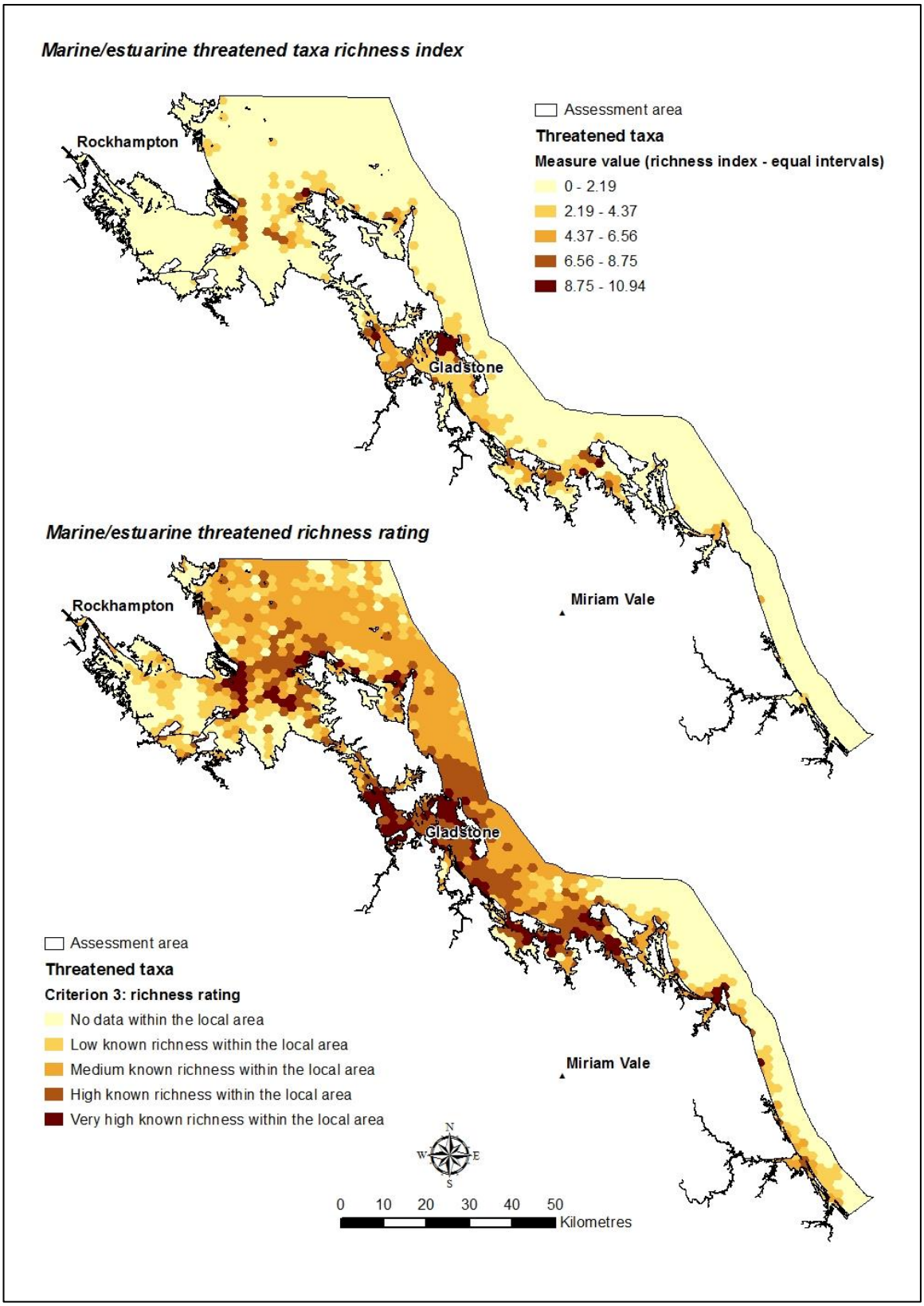


Figure 12: Marine/estuarine threatened species taxa richness

5 Criterion 4 – Priority Species Richness (Fauna)

In addition to listed threatened taxa, the panel deliberated on marine and estuarine dependent flora and fauna species within the study area to identify priority taxa. For the purpose of this assessment, priority taxa were defined as those not listed as Critically Endangered, Endangered, Vulnerable or Near threatened under Queensland or Commonwealth legislation, but were considered significant within the study region as they exhibit one or more of the following attributes:

1. Taxa at risk (non-climate change related) - Taxa that, from a regional perspective, are under threat and consequently have had significant population and/or range declines based on scientific evidence and/or expert opinion.
2. Taxa vulnerable to impacts of climate change - Species that are considered to be adversely affected by the predicted changes in climate, e.g. increasing temperatures, sea level rise and increasing frequency of extreme weather events (drought, flood & cyclones). Species can only be listed under this reason if there is sufficient knowledge of species' biology and its interaction with climate that would support an assessed impact under climate change scenarios.
3. Keystone species - a plant or animal that plays a unique and crucial role in the way an ecosystem functions. Without keystone species, the ecosystem would be negatively impacted.
4. Critical species - a species essential to the viability of a threatened or priority species.
5. Species with narrowly restricted ranges.
6. Disjunct species - species which occur as isolated, restricted, and disjunct populations (two or more groups that are related but considerably separated from each other geographically).

Emphasis was placed on those taxa considered at risk under attributes 1 or 2.

5.1 Approach

The same approach as outlined in Section 3.1 was used to produce an estimate of priority species taxa richness across the study area. However, as per Section 4.1 relating to threatened taxa, priority species were not separated into broad taxonomic groups, rather, assessed as a single group. Similarly, no stratification was applied to the final richness ratings.

5.1.1 Assignment of relative ratings

A quantile approach was adopted to assign relative ratings. All hexagon grid cells with a calculated richness index value of 0 were assigned a measure score of 0 - "No richness/no information". For all remaining hexagon grid cells:

- the highest ranked 10% of cells were assigned a measure score of 4, or analogous to "Very high relative richness known for that taxonomic group within the local area"
- the subsequent ranked 10-30% interval a measure score of 3 (High relative richness known within the local area)
- the subsequent ranked 30-60% interval a measure score of 2 (Medium relative richness known within the local area)
- the remaining hexagon cells a measure score of 1 (Low relative richness known).

Table 6 lists the priority species nominated by the panel, whilst Figure 13 provides a visual representation of priority taxa richness across the study area.

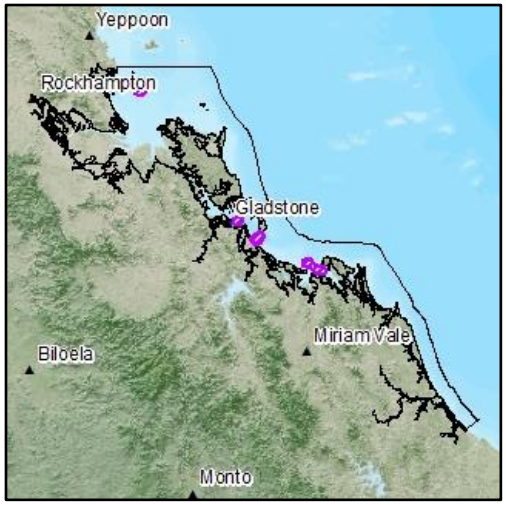
5.2 Priority species richness results

The panel identified 24 priority taxa relevant to the study area (refer to Table 6). Of these, 20 were invertebrates (crustaceans and mollusc) and 4 were vertebrates (fish, reptiles and birds). The following table lists marine/estuarine priority species identified by the panel as occurring in the study area. Please note, that the distributions depicted are based upon generalised point buffer records (unless otherwise noted) and are included for indicative display purposes only.

Table 6. Priority fauna taxa

Scientific name	Priority attribute[1]	Migratory [2]	Description
Invertebrate			
Acropora aculeus (staghorn stony coral) 	1, 2		This species is found on shallow reefs on upper reef slopes and lagoons and occurs across a broad depth range. Whilst widespread, it is uncommon throughout its range and categorised Vulnerable under the IUCN. Globally, the species is particularly susceptible to bleaching, disease, crown-of-thorns starfish predation, storms, harvesting for aquarium trade, and extensive reduction of coral reef habitat due to a combination of threats. Specific population trends are unknown, but population reduction can be inferred from declines in habitat quality based on the combined estimates of both destroyed reefs and reefs at the critical stage of degradation within its range (Wilkinson 2004). Its threat susceptibility increases the likelihood of being lost within one generation in the future from reefs at a critical stage. Therefore, the estimated habitat degradation and loss of 37% over three generation lengths (30 years) is the best inference of population reduction and meets the threshold for Vulnerable under Criterion A4ce. It will be important to reassess this species in 10 years' time given predicted threats from climate change and ocean acidification. The above information was extracted from the IUCN database on the 5/11/18 (https://www.iucnredlist.org).
Acropora bushyensis (staghorn coral) *No records available*	6		The species occurs on shallow reef flats and in reef lagoons (0-5 m) predominately along continental or island coastlines, rather than on patch reefs. In Eastern Australia, it occurs in sub-tropical latitudes, in coastal shoals, rocky reefs and on some cay-bearing reefs offshore, but is rarely seen on middle and outer reefs of the Great Barrier Reef (Wallace 1999). It is considered as being Of Least Concern under the IUCN. The above information was extracted from the IUCN database on the 5/11/18 (https://www.iucnredlist.org). The panel noted this species is disjunct.

Scientific name	Priority attribute[1]	Migratory [2]	Description
Acropora multiacuta (staghorn stony coral) 	1, 2		Occurring in shallow, tropical reef environments in wave washed lagoon margins, subtidally on submerged reef tops, ledges in walls, and rocky slopes; it is often found in indentations or crevices in the reef surface (Wallace 1999) at depths from 3-15 m. Whilst widespread, the species is rare throughout and categorised as Vulnerable under the IUCN. Where this species does occur, groups of colonies can be found suggesting that there is a form of localized recruitment involved. It is particularly susceptible to bleaching, disease, crown-of-thorns starfish predation, storms and extensive reduction of coral reef habitat due to a combination of threats. Specific population trends are unknown but population reduction can be inferred from declines in habitat quality based on the combined estimates of both destroyed reefs and reefs at the critical stage of degradation within its range (Wilkinson 2004). Its threat susceptibility increases the likelihood of being lost within one generation in the future from reefs at a critical stage. Therefore, the estimated habitat degradation and loss of 40% over three generation lengths (30 years) is the best inference of population reduction and meets the threshold for Vulnerable under Criterion A4ce. It will be important to reassess this species in 10 years' time given predicted threats from climate change and ocean acidification. The above information was extracted from the IUCN database on the 5/11/18 (https://www.iucnredlist.org).
Acropora solitaryensis (staghorn stony coral) 	1, 2		This species is found in shallow, tropical reef environments as well as on rocky foreshores in subtropical locations. It occurs subtidally on reef slopes and walls and submerged reefs at depths between 5-25 m (Wallace 1999). Whilst widespread, the species is considered to be common at subtropical locations, and is rare elsewhere, and is categorised as Vulnerable under the IUCN. On a global scale, it is particularly susceptible to threatening processes such as bleaching, disease, crown-of-thorns starfish predation, storms and extensive reduction of coral reef habitat due to a combination of threats. Specific population trends are unknown, but population reduction can be inferred from declines in habitat quality based on the combined estimates of both destroyed reefs and reefs at the critical stage of degradation within its range (Wilkinson 2004). Its threat susceptibility increases the likelihood of being lost within one generation in the future from reefs at a critical stage. Therefore, the estimated habitat degradation and loss of 38% over three generation lengths (30 years) is the best inference of population reduction and meets the threshold for Vulnerable under Criterion A4ce. It will be important to reassess this species in 10 years' time given predicted threats from climate change and ocean acidification. The above information was extracted from the IUCN database on the 5/11/18 (https://www.iucnredlist.org). The panel noted it has a limited range in Australia and is a disjunct species.

Scientific name	Priority attribute[1]	Migratory [2]	Description
Cymbiola complexa nielseni (volute) 	1, 6		The subspecies is a live-bearing marine gastropod which is restricted to rubble areas along coral reefs. It is known to occur offshore in the southern Great Barrier Reef area and the panel noted it is possibly nearshore and definitely in the study area. There is much genetic variation within the species. Threats to the species include shell collectors and trawler operations. It is currently presumed extinct around Heron Island.
Decatopecten strangei (scallop) 	1, 2		The panel suggested that the scallop, *Decatopecten strangei,* is declining off Gladstone and Bustard Head. It is known to respond to the upwelling, and potentially occurs around the paleo channels due to the currents off Gladstone. There is limited information available with regard to their larvae and breeding sites.

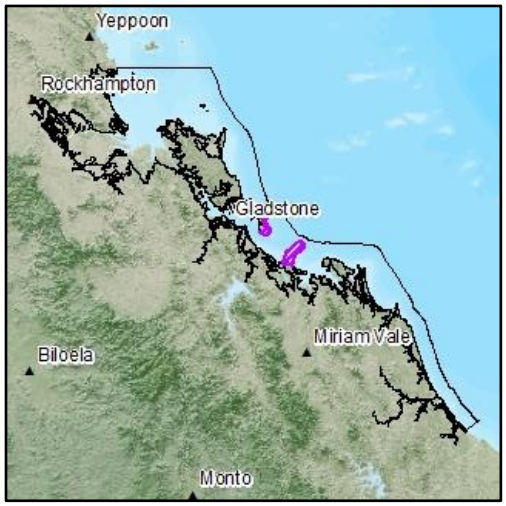
Scientific name	Priority attribute[1]	Migratory [2]	Description
Duncanopsammia axifuga (whisker coral/stony coral) 	1, 2		Usually occurs in water to 30 m deep, and attaches to a solid substrate often in areas where soft sand predominates. This species often forms small creeping colonies or low clumps in which the corallites are united at their bases by coenosteum (Wood 1983). Whilst the species is widespread, it has a disjunct range and is considered rare and categorised as Near Threatened under the IUCN. Specific population trends are unknown but population reduction can be inferred from estimated habitat loss (Wilkinson 2004). Estimated habitat loss of 23% from reefs already destroyed within its range is the best inference of population reduction since it may survive in coral reefs already at the critical stage of degradation (Wilkinson 2004). This inference of population reduction over three generation lengths (30 years) does not meet the threshold of a threat category. However, since this population reduction estimate is close to a threatened threshold, and because this species is moderately susceptible to a number of threats, it is likely to be one of the species lost on some reefs currently at the critical stage of degradation and therefore is Near Threatened. Predicted threats from climate change and ocean acidification make it important to reassess this species in 10 years or sooner, particularly if the species is actually observed to disappear from reefs currently at the critical stage of reef degradation. The above information was extracted from the IUCN database on the 5/11/18 (https://www.iucnredlist.org).

Scientific name	Priority attribute[1]	Migratory [2]	Description
Turbinaria peltata (stony coral)  *Map derived from ALA records only*	1, 2		Occurring in shallow waters on sandy reef flats and deep sandy reef bases, the species forms plates of over 1 m and can be found in depths between 0.5-25 m. This species is widespread and common throughout its range. However, it is heavily harvested for the aquarium trade and has suffered extensive reduction of coral reef habitat due to a combination of threats, and is categorised as Vulnerable under the IUCN. Specific population trends are unknown but population reduction can be inferred from declines in habitat quality based on the combined estimates of both destroyed reefs and reefs at the critical stage of degradation within its range (Wilkinson 2004). Its threat susceptibility increases the likelihood of being lost within one generation in the future from reefs at a critical stage. Therefore, the estimated habitat degradation and loss of 36% over three generation lengths (30 years) is the best inference of population reduction and meets the threshold for Vulnerable under Criterion A4cd. It will be important to reassess this species in 10 years' time given predicted threats from climate change and ocean acidification. The above information was extracted from the IUCN database on the 15/11/18 (https://www.iucnredlist.org).

Scientific name	Priority attribute[1]	Migratory [2]	Description
Favia rosaria (moon coral/stony coral)  *Map derived from ALA records only*	1, 2		This species occurs in shallow reef slopes and also in lagoons at depths of up to 20 m. It has a relatively small range and is considered uncommon, and is categorised as Vulnerable under the IUCN. It is susceptible to bleaching and disease due to a more restricted depth range, and collected for the aquarium trade. Extensive reduction of coral reef habitat has occurred in the region due to a combination of threats. Specific population trends are unknown but population reduction can be inferred from declines in habitat quality based on the combined estimates of both destroyed reefs and reefs at the critical stage of degradation within its range (Wilkinson 2004). Its threat susceptibility increases the likelihood of being lost within one generation in the future from reefs at a critical stage. Therefore, the estimated habitat degradation and loss of 36% over three generation lengths (30 years) is the best inference of population reduction and meets the threshold for Vulnerable under Criterion A4c. It will be important to reassess this species in 10 years' time given predicted threats from climate change and ocean acidification. The above information was extracted from the IUCN database on the 5/11/18 (https://www.iucnredlist.org).

Scientific name	Priority attribute[1]	Migratory [2]	Description
Homophyllia bowerbanki (stony coral) 	1, 2		This species is found in a wide range of reef environments, and does well in turbid waters where it can occur in depths of up to 20 m. The most important known threat for this species is extensive reduction of coral reef habitat due to a combination of threats, however, this species is also moderately susceptible to bleaching, and is categorised as Vulnerable under the IUCN. Specific population trends are unknown but population reduction can be inferred from estimated habitat loss (Wilkinson 2004). It is widespread and common throughout its range and is therefore likely to be more resilient to habitat loss and reef degradation because of an assumed large effective population size that is highly connected and/or stable with enhanced genetic variability. The estimated habitat loss of 19% from reefs already destroyed within its range is the best inference of population reduction since it may survive in coral reefs already at the critical stage of degradation (Wilkinson 2004). This inference of population reduction over three generation lengths (30 years) does not meet the threshold of a threat category. However, since this population reduction estimate is close to a threatened threshold, and because this species is moderately susceptible to a number of threats, it is likely to be one of the species lost on some reefs currently at the critical stage of degradation and therefore is Near Threatened. Predicted threats from climate change and ocean acidification make it important to reassess this species in 10 years or sooner, particularly if the species is actually observed to disappear from reefs currently at the critical stage of reef degradation. The above information was extracted from the IUCN database on the 15/11/18 (https://www.iucnredlist.org).

Scientific name	Priority attribute[1]	Migratory [2]	Description
Micromussa lordhowensis (stony coral) 	1, 2, 6		This species is found in shallow reef environments, especially in subtropical localities to depths of up to 30 m. It is widespread and uncommon throughout its range and is categorised as Near Threatened under the IUCN. The species is likely to be more resilient to habitat loss and reef degradation because of an assumed large effective population size that is highly connected and/or stable with enhanced genetic variability. Specific population trends are unknown but population reduction can be inferred from estimated habitat loss (Wilkinson 2004). Estimated habitat loss of 19% from reefs already destroyed within its range is the best inference of population reduction since it may survive in coral reefs already at the critical stage of degradation (Wilkinson 2004). This inference of population reduction over three generation lengths (30 years) does not meet the threshold of a threat category. However, since this population reduction estimate is close to a threatened threshold, and because this species is moderately susceptible to a number of threats, it is likely to be one of the species lost on some reefs currently at the critical stage of degradation and therefore is Near Threatened. Predicted threats from climate change and ocean acidification make it important to reassess this species in 10 years or sooner, particularly if the species is actually observed to disappear from reefs currently at the critical stage of reef degradation. The above information was extracted from the IUCN database on the 14/11/18 (https://www.iucnredlist.org). The panel noted that this stony coral is uncommon where it occurs and similarly within the study area it is rare and disjunct.

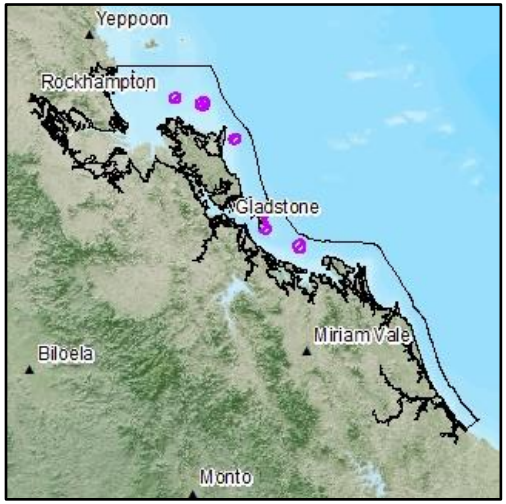
Scientific name	Priority attribute[1]	Migratory [2]	Description
Montipora capricornis (staghorn stony coral) 	1, 2		This species occurs in shallow, tropical reef environments and is found mostly in lagoons to a depth of at least 20 m. This species is widespread and uncommon throughout its range, and is categorised as Vulnerable under the IUCN. However, it is particularly susceptible to threatening processes which include: bleaching, disease, crown-of-thorns starfish predation, and extensive reduction of coral reef habitat due to a combination of threats. Specific population trends are unknown but population reduction can be inferred from declines in habitat quality based on the combined estimates of both destroyed reefs and reefs at the critical stage of degradation within its range (Wilkinson 2004). Its threat susceptibility increases the likelihood of being lost within one generation in the future from reefs at a critical stage. Therefore, the estimated habitat degradation and loss of 36% over three generation lengths (30 years) is the best inference of population reduction and meets the threshold for Vulnerable under Criterion A4ce. It will be important to reassess this species in 10 years time because of predicted threats from climate change and ocean acidification. The above information was extracted from the IUCN database on the 14/11/18 (https://www.iucnredlist.org).
Moseleya latistellata (stony coral) 	1, 2		This species occurs in shallow, tropical reef environments where it can be found on the back and foreslope of the reef and in lagoons to 10 m in depth. Colonies are generally small, consisting of one or several corallites, and are often unattached (Wood 1983). It is not a widespread species and is considered uncommon throughout its range, and is categorised as Vulnerable under the IUCN. It is susceptible to bleaching and disease due to a narrow depth range and has suffered extensive reduction of coral reef habitat due to a combination of threats. Specific population trends are unknown but population reduction can be inferred from declines in habitat quality based on the combined estimates of both destroyed reefs and reefs at the critical stage of degradation within its range (Wilkinson 2004). Its threat susceptibility increases the likelihood of being lost within one generation in the future from reefs at a critical stage. Therefore, the estimated habitat degradation and loss of 41% over three generation lengths (30 years) is the best inference of population reduction and meets the threshold for Vulnerable under Criterion A4c. It will be important to reassess this species in 10 years time because of predicted threats from climate change and ocean acidification. The above information was extracted from the IUCN database on the 14/11/18 (https://www.iucnredlist.org).

Scientific name	Priority attribute[1]	Migratory [2]	Description
Porites nigrescens (stony coral) *No records available*			A branching coral species common on lower reef slopes and lagoons. It is found in tropical waters to depths of up to 30 m. While there are no known threats to the species, the most important potential threat is the extensive reduction of coral reef habitat due to a combination of threats. Similar to the related species, *P. cylindrical*, it may also be susceptible to bleaching and harvesting for the aquarium trade. The above information was extracted from the following links on the 15/11/18: https://www.iucnredlist.org https://coral.aims.gov.au/factsheet.jsp?speciesCode=0323
Turbinaria mesenterina (stony coral) 	1, 2		This taxon is common in shallow turbid environments to a depth of up to 20 m. Whilst this species is widespread and common throughout its range, it is collected and harvested for the aquarium trade and has suffered extensive reduction of coral reef habitat due to a combination of threats, and is categorised as Vulnerable under the IUCN. Specific population trends are unknown but population reduction can be inferred from declines in habitat quality based on the combined estimates of both destroyed reefs and reefs at the critical stage of degradation within its range (Wilkinson 2004). Its threat susceptibility increases the likelihood of being lost within one generation in the future from reefs at a critical stage. Therefore, the estimated habitat degradation and loss of 36% over three generation lengths (30 years) is the best inference of population reduction and meets the threshold for Vulnerable under Criterion A4cd. It will be important to reassess this species in 10 years time because of predicted threats from climate change and ocean acidification. The above information was extracted from the IUCN database on the 14/11/18 (https://www.iucnredlist.org).

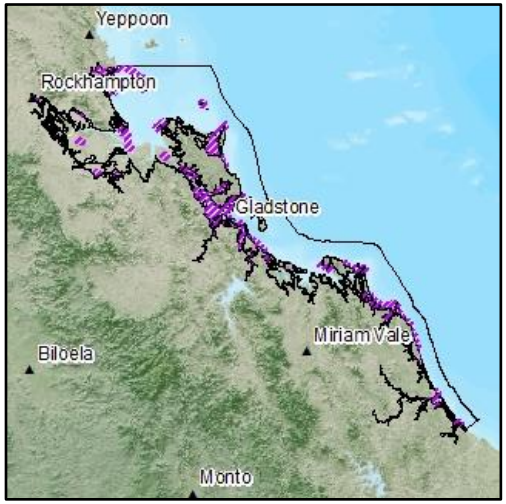
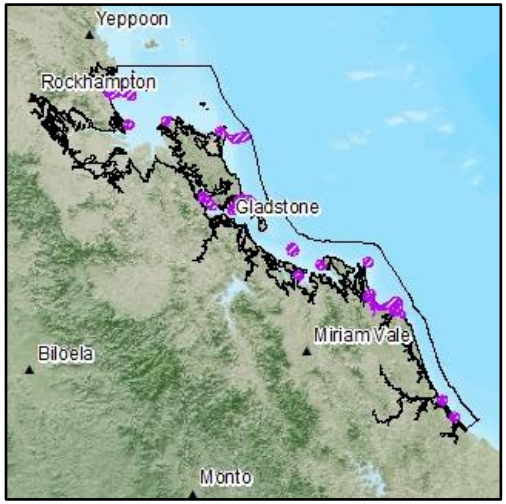
Scientific name	Priority attribute[1]	Migratory [2]	Description
Turbinaria patula (stony coral) 	1, 2		This species is found on inshore reefs and shallow rocky foreshores of subtropical locations. They form plates of over 1 m in diameter and can be found from 7-20 m. This species is widespread and uncommon throughout its range, and is categorised as Vulnerable under the IUCN. It is particularly susceptible to bleaching, disease, and extensive reduction of coral reef habitat due to a combination of threats. Specific population trends are unknown but population reduction can be inferred from declines in habitat quality based on the combined estimates of both destroyed reefs and reefs at the critical stage of degradation within its range (Wilkinson 2004). Its threat susceptibility increases the likelihood of being lost within one generation in the future from reefs at a critical stage. Therefore, the estimated habitat degradation and loss of 36% over three generation lengths (30 years) is the best inference of population reduction and meets the threshold for Vulnerable under Criterion A4c. It will be important to reassess this species in 10 years time because of predicted threats from climate change and ocean acidification. The above information was extracted from the IUCN database on the 15/11/18 (https://www.iucnredlist.org).
Turbinaria reniformis (stony coral) 	1, 2		This taxon forms plates of over 1 m in diameter and may form large stands on fringing reefs where the water is turbid between depths of 2-15 m. This species is widespread and sometimes common throughout its range, and is categorised as Vulnerable under the IUCN. It is susceptible to bleaching and disease due to a more restricted depth range, and extensive reduction of coral reef habitat due to a combination of threats. Specific population trends are unknown but population reduction can be inferred from declines in habitat quality based on the combined estimates of both destroyed reefs and reefs at the critical stage of degradation within its range (Wilkinson 2004). Its threat susceptibility increases the likelihood of being lost within one generation in the future from reefs at a critical stage. Therefore, the estimated habitat degradation and loss of 36% over three generation lengths (30 years) is the best inference of population reduction and meets the threshold for Vulnerable under Criterion A4c. It will be important to reassess this species in 10 years time because of predicted threats from climate change and ocean acidification. The above information was extracted from the IUCN database on the 14/11/18 (https://www.iucnredlist.org).

Scientific name	Priority attribute[1]	Migratory [2]	Description
Entacmaea quadricolor (bubbletip anemone)  *Map derived from ALA records only*	2, 6		This species is widespread throughout tropical waters, where it can grow to depths of up to 200 m and is known to host many species of anemonefish (https://en.wikipedia.org/wiki/Bubble-tip_anemone). Whilst widespread, the panel noted that the species occurs as disjunct populations, has been affected from bleaching over part of the southern Great Barrier Reef, and is potentially vulnerable to impacts associated with climate change.
Isognomon ephippium (saddle tree oyster) *No records available*	1, 3		Saddle tree oyster has been identified as a keystone species, forming big beds by establishing themselves on rocks and other hard substrates in brackish and marine environments. They are restricted to estuaries and mangrove area, and the larvae will settle as a settlement cue. Within the study area, it is an important species for the local indigenous people and a tributary of Baffle Creek has been referred to as Oyster Creek. It has also been observed in Littabella Creek. The panel noted that the species is in some form of decline and populations have been identified as being at risk from poor water quality due to land use and overfishing. Additionally, it is not well studied and it is unknown whether they comprise the one species or a few.

Scientific name	Priority attribute[1]	Migratory [2]	Description
Tubuca seismella (fiddler crab) 	1, 6 Southern range limit		The fiddler crab is distributed from north-west to north-east Australia and has been identified as the most cryptic of the numerous *Uca* species found across the continent (Von Hagen & Jones 1989). It is known to be common and has restricted habitat requirements, only occurring on large river banks with steep-sloping, firm mud banks. The panel noted that its southern range limit is the Mary River, however, Von Hagen & Jones (1989) report that the species is also found on the banks of the Brisbane River. Within the study area, the panel also determined that it is found in the red zone in the intertidal mapping, close to lowest astronomical tide.
Fish			

Scientific name	Priority attribute[1]	Migratory [2]	Description
Chaetodontoplus duboulayi (Scribbled Angelfish) 	1		This species occurs in shallow coastal and continental shelf coral reefs, most commonly on open flat areas or over rock and coral-covered substrates (G.R. Allen pers. comm. 2006). It feeds on sponges and tunicates, and usually forms pairs or small groups (Pyle 2001). Its preferred habitat includes sponge garden and rubble areas along fringing coral reefs at depths of 5-20m, particularly in the southern parts of its distribution. Categorised as Least Concern under the IUCN in view of its relatively wide distribution, large overall population, collection for the aquarium fish trade is not globally impacting the population, and there are no other potential major threats. Extracted from the IUCN database on the 14/11/18 (https://www.iucnredlist.org). However, within the study area, the panel considered the species as possibly being at risk due to being targeted for the aquarium industry and given restricted suitable habitat types present, thereby facilitating easy targeting. As part of the *Queensland Sustainable Fisheries Strategy 2017-2027*, ecological risk assessments are now being developed for all marine aquarium fish species (including the scribbled angelfish). All key fisheries including the Marine Aquarium Fish fishery and the Coral Fishery will be managed by harvest strategies, developed by stakeholder based working groups. The harvest strategies will be informed by an expanded biological monitoring program and ecological risk assessments (ERA) being developed for all fisheries. The ERA program is assessing fishing related risks to target and non-target species, protected species and the environment. One of the outcomes from these assessments, will aid in identifying species at potential risk.
Reptile			

Scientific name	Priority attribute[1]	Migratory [2]	Description
Varanus semiremex (rusty monitor) 	1,2,6 (southern range limit)		In Queensland, *Varanus semiremex* is distributed from Cape York south to Tannum Sands (Tremul 2017). It occurs in coastal and estuarine mangrove habitat where it shelters in hollow limbs or occasionally under loose bark. This solitary species is both arboreal and terrestrial, being most active at low tide and rarely enters water to swim. The diet includes crustaceans and occasionally invertebrates, fish, and terrestrial vertebrates such as small reptiles and rodents (Borsboom 2006; Tremul 2017). There are no known threats to rusty monitor however some of the suspected threats include poisoning from cane toad ingestion, feral cat predation, global warming impacts and loss of habitat due to coastal development (Burnett 1997; QPWS 2001; EHP 2016). Within the study area, the species is at its southern range limit and is at risk from habitat loss as a result of industrial development across the region.
Bird			

Scientific name	Priority attribute[1]	Migratory [2]	Description
Haliaeetus leucogaster (white-bellied sea-eagle) 	1		White-bellied sea-eagle is a large-sized bird of prey which occurs along the coastline of mainland Australia and Tasmania, as well as offshore islands and inland areas, particularly in eastern Australia (DoE 2018h). It is found in a wide range of coastal habitats and terrestrial wetlands, usually characterised by large open water expanses such as lakes, swamps, the ocean and larger rivers (Marchant & Higgins 1993). The species consumes a range of vertebrate prey including fish, birds, mammals, reptiles, as well as crustaceans and carrion is also known to be eaten (Marchant & Higgins 1993). The main threats include habitat loss as a result of coastal development and nest disturbance caused by human activity (Dennis & Lashmar 1996). The panel noted that within the study area, white-bellied sea-eagle has been recorded in the upper harbour of Port Curtis.
Sternula albifrons (little tern) 	1	Bonn, CAMBA	Little tern is found along all coasts of northern and eastern Australia, and along most of the coast in Queensland (Higgins & Davies 1996). Habitat for the species includes coastal environs usually < 1.5km from the shore including sheltered seas, lagoons, tidal creeks/estuaries and bays, and occasionally offshore islands and cays. Within sheltered areas it is known to roost on exposed sandspits. The diet includes a variety of small fish as well as crustaceans, worms and molluscs. Main threats to the species includes egg and chick mortality from anthropogenic disturbance, i.e. walkers and vehicles, and a range of predators, and the disturbance and loss nesting and roosting sites as a result of coastal development (Higgins & Davies 1996). Within the study area, a roosting population is known from around Middle Island where it is subject to a high degree of disturbance from tour operators. As such, the panel have identified that this population is at risk primarily due to disturbance of a key breeding area through human-induced factors (i.e. tourism activities).

[1] The priority number is the priority attributes exhibited by each species.

[2]The migratory convention under which the species is listed: Bonn Convention (Bonn), JAMBA, CAMBA, ROKAMBA.

Figure 12 provides a spatial representation of priority taxa richness index (measure value) and associated criterion rating based upon compiled records within the study area.

Approximately, 2% of the study area was categorised as very high known richness, 3% as high known richness, 6% as medium known richness, 8% as low known richness and 82% of the study area had no data present to calculate a richness score.

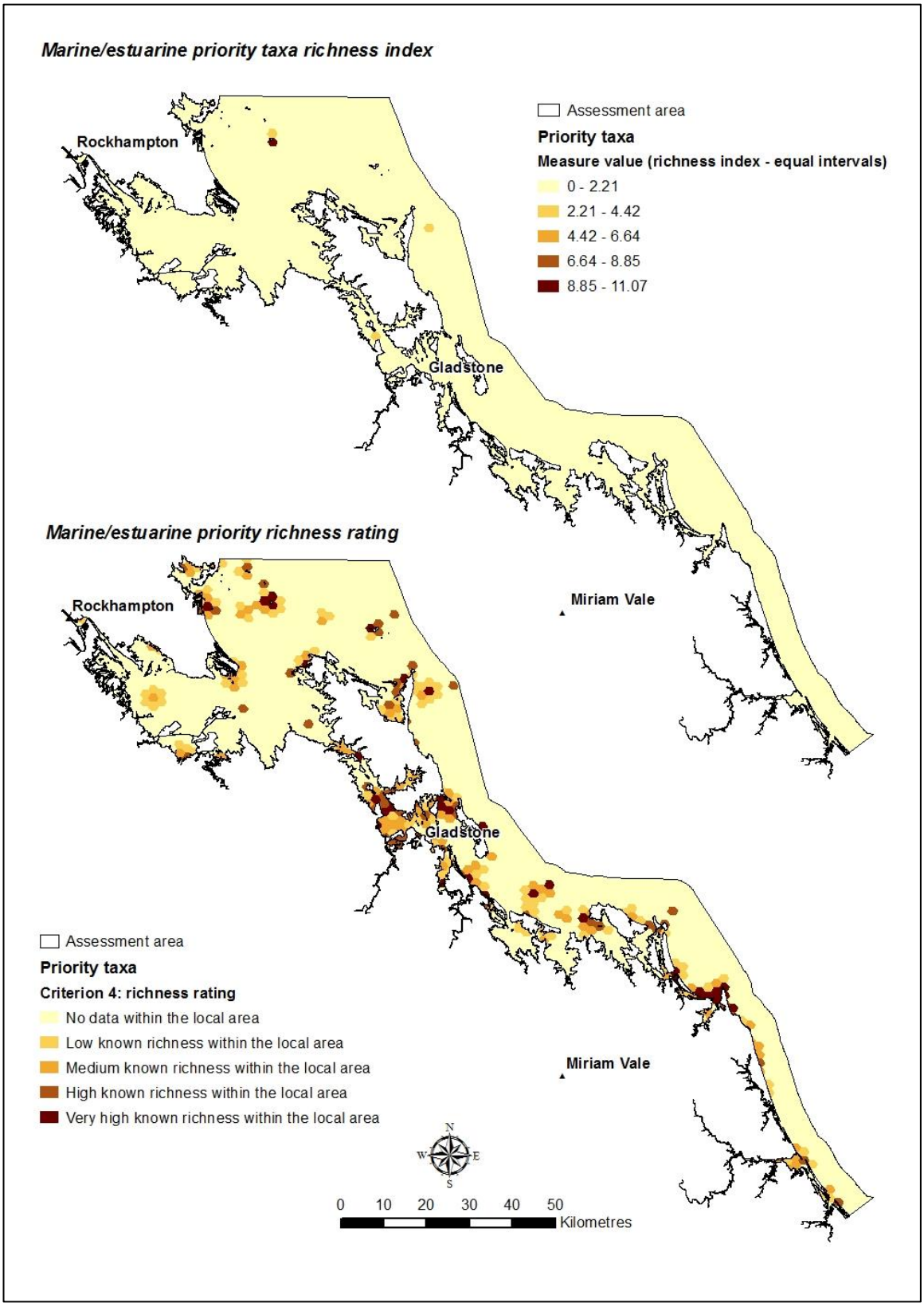


Figure 13 Marine/estuarine priority species richness

6 Criterion 5 - Ecological Communities At Risk

The panel identified marine and/or estuarine ecological communities at risk. At risk communities, included those:

- listed as Critically Endangered, Endangered, Vulnerable, or Of Concern under either the EPBC or NCA (as current at the time at which this report was produced)
- other communities identified through the expert panel considered to be at risk due to anthropogenic related activities/impacts.

Nb. whilst not directly incorporated within this criterion, many of the species that form part of the listed threatened ecological communities (Table 7) or panel nominated at risk ecosystems (Table 8) are referred to as 'marine plants'. Queensland legislation applies to protection of 'marine plants' as defined under Section 8 of the Fisheries Act 1994 *(Meaning of marine plant). Marine plants defined in the* Fisheries Act 1994 *include mangroves, seagrass, saltcouch, samphires and algae, and plants growing on or adjacent to tidal lands. All marine plants, regardless of whether they are alive or dead or whether they grow on freehold, leasehold or unallocated State lands, are protected due to their importance in providing food and shelter for fish.*

6.1 Approach

Distributions for each of the panel nominated communities known to occur within the study area were derived from one or both of the following source datasets:

- a draft version (extracted the 29th August 2018) of the Queensland Wetland Intertidal and Subtidal Benthic Mapping Program
- the Queensland Herbarium's Regional Ecosystem Mapping (version 11).

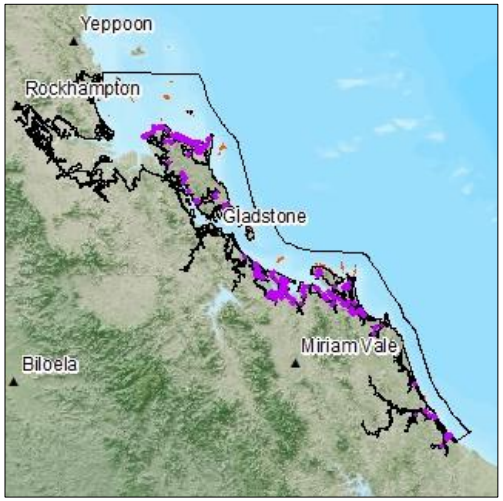
A description of the specific ecosystems/habitat types used to depict an Ecological community at risk, is included in the preceding tables.

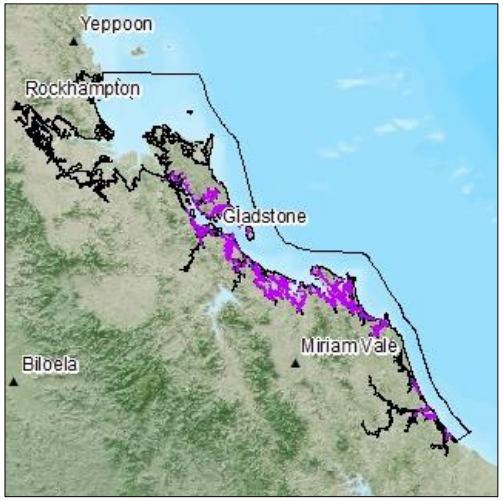
The resultant outputs were compiled into a single product, assigned an "At risk" rating (measure score 1 to 4 which directly translated to the criteria rating of "Low known risk" to "Very high risk". Where more than one nominated ecological community overlapped with another, the highest "At risk rating" was assigned. Table 7 and Table 8 provide descriptions of the individual communities identified by the panel and Figure 14 shows a spatial representation of the compiled product respectively.

6.2 Listed threatened ecological communities

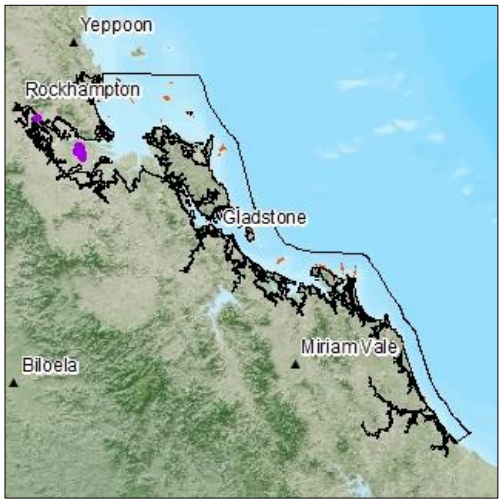
Table 7 lists marine/estuarine threatened ecological communities/ecosystems as identified under the EPBC or as listed in the Queensland Herbarium's regional ecosystem description database (at the time at which this report was produced) and confirmed by the panel as occurring within the study area.

Table 7. Listed threatened ecological communities

Community	Description	EPBC	Biodiversity Status	Criteria Rating
BFC_AREC_01: *Casuarina glauca* woodland on margins of marine clay plains  *Extent area derived from the Draft Queensland Herbarium Regional ecosystem Mapping version 11 (vegetation community 12.1.1).*	*Casuarina glauca* (regional ecosystem 12.1.1) open forest to low open woodland. Occurs on margins of Quaternary estuarine deposits. (*Information extracted from the Regional Ecosystem Description Database, Queensland Herbarium 2018*) This regional ecosystem type corresponds to the nationally threatened ecological community "Coastal Swamp Oak (*Casuarina glauca*) Forest of New South Wales and South East Queensland ecological community".	Endangered	Of concern	Very high risk

Community	Description	EPBC	Biodiversity Status	Criteria Rating
BFC_AREC_02: Saltpan vegetation including grassland, herbland and sedgeland on marine clay plains  *Extent area derived from the QWISBMP draft mapping (habitat type: intertidal grass-herb-sedge-other succulent) and the Draft Queensland Herbarium Regional ecosystem Mapping version 11 (vegetation community 12.1.2).*	Saltpan vegetation comprising *Sporobolus virginicus* grassland and samphire herbland. Grasses including *Zoysia macrantha* subsp. *macrantha* sometimes present in upper portions of tidal flats. Includes saline or brackish sedgelands. Usually occurs on hypersaline Quaternary estuarine deposits. Marine plains/tidal flats. (*Information extracted from the Regional Ecosystem Description Database, Queensland Herbarium 2018*) This regional ecosystem type corresponds to the nationally threatened ecological community “Subtropical and Temperate Coastal Saltmarsh”.	Vulnerable	No concern at present	High risk

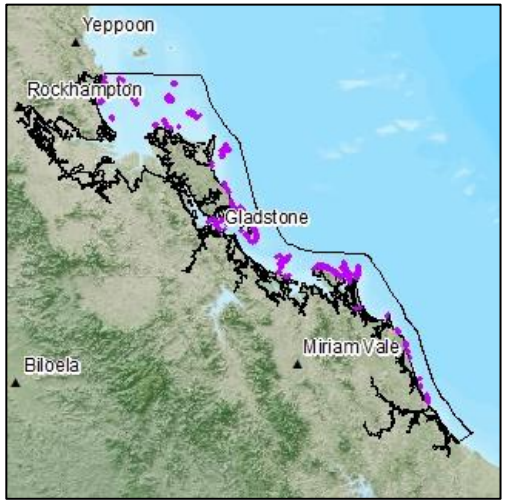
Community	Description	EPBC	Biodiversity Status	Criteria Rating
BFC_AREC_03: *Melaleuca* spp. and/or *Eucalyptus tereticornis* and/or *Corymbia tessellaris* woodland with a ground stratum of salt tolerant grasses and sedges, usually in a narrow zone adjoining tidal ecosystems  *Extent area derived from the Draft Queensland Herbarium Regional ecosystem Mapping version 11 (vegetation community 8.1.5).*	Regional ecosystem 8.1.5 - *Melaleuca* spp. and/or *Eucalyptus tereticornis* and/or *Corymbia tessellaris* low open woodland to open forest (to open shrubland) (2-20m tall). Canopy dominants are very variable, ranging from dense stands of *Melaleuca quinquenervia* or *M. leucadendra*, to more open stands of *Melaleuca* spp. and/or eucalypt species. *Acacia* spp. such as *A. leptocarpa* and *A. holosericea* may be present. Mangrove species may also occur in clumps or scattered in low numbers. Some sites have a sparse (to isolated plants) secondary tree or shrub layer consisting of one or several of *Acacia* spp., *Pandanus* spp., mangrove spp., *Melaleuca* spp. *Myoporum acuminatum*, *Clerodendrum inerme*, Gahnia *sieberiana*, *Phragmites australis*, *Banksia* spp., and sometimes pioneering rainforest spp. There is usually a mid-dense to dense ground layer (often interspersed with large bare areas of saline silts), most often dominated by *Sporobolus virginicus*, *Baumea juncea* or *Acrostichum speciosum*. Other dominants may include *Vincetoxicum carnosum*, *Baumea rubiginosa*, *Eleocharis dulcis* and *Paspalum vaginatum*. Other typical associated species are *Imperata cylindrica*, *Phragmites* spp., *Eriochloa procera*, *Gymnanthera oblonga*, *Juncus kraussii*, *Ceratopteris thalictroides* and *Cyperus javanicus*. Narrow tidal and supratidal flats landward of and adjoining tidal regional ecosystems on lowlands. Sometimes occurs over broader low-lying, tidally influenced plains. Geologies mapped include Qm (Quaternary coastal mud, silt and minor evaporites), Qhe/m (Holocene mud, sandy mud, muddy sand and minor gravel), Qhcm (Holocene mud and sandy mud), Qhct (Holocene silt, mud and sand) and Qhe/s (Holocene sand, muddy sand, mud and minor gravel). (*Information extracted from the Regional Ecosystem Description Database, Queensland Herbarium 2018*)	-	Endangered	Very high risk

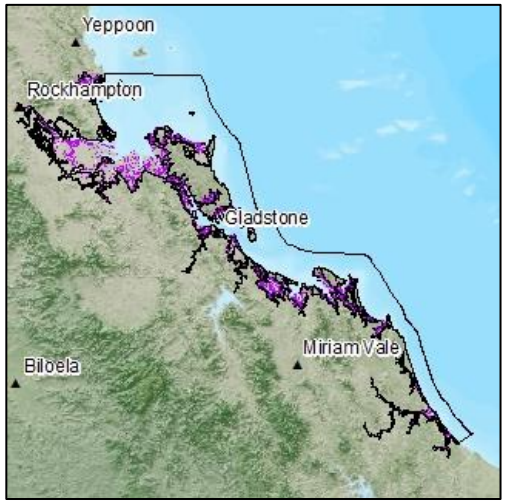
Community	Description	EPBC	Biodiversity Status	Criteria Rating
BFC_AREC_04: Sedgelands on marine clay plains  *Extent area derived from the Draft Queensland Herbarium Regional ecosystem Mapping version 11 (vegetation community 11.1.3).*	Regional ecosystem 11.1.3: Sedgelands to grasslands on Quaternary estuarine deposits. Sedgeland dominated by a range of sedges and grasses which include *Eleocharis philippinensis*, *Cyperus alopecuroides*, *C. scariosus* and *C. iria* and the grasses *Sporobolus virginicus* and *Paspalum vaginatum*. Other typical species in shallower margins include *Fimbristylis ferruginea*, *Phyla nodiflora* and *Cyperus polystachyos* var. *polystachyos*. Occasional twiners such as *Vincetoxicum carnosum* may be present. Occurs in depressions on Quaternary estuarine deposits which are brackish to saline. These are may be seasonally inundated with fresh water, but dry out completely before the next season's rain. (*Information extracted from the Regional Ecosystem Description Database, Queensland Herbarium 2018*)	-	Of concern	High risk

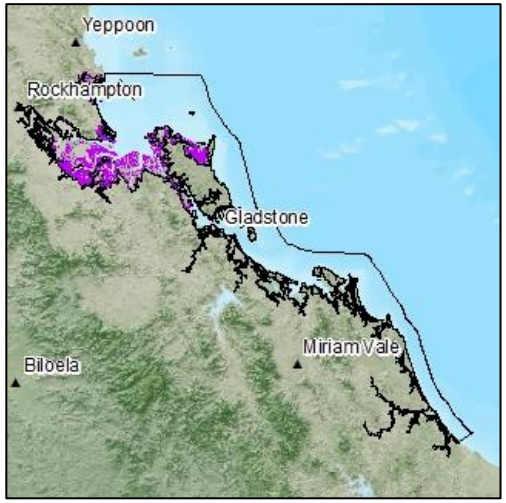
6.3 Other at risk ecosystems (identified by the panel)

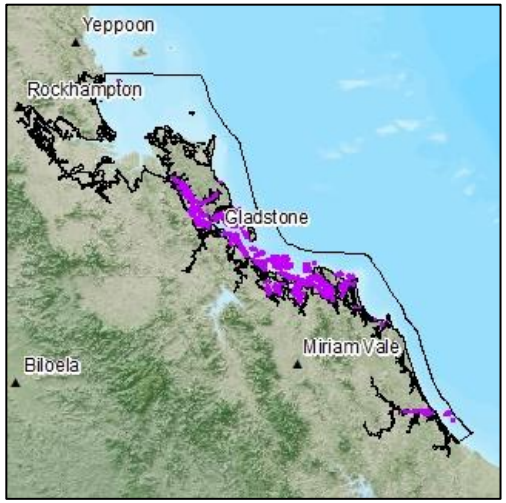
Table 8 lists other marine/estuarine threatened ecological communities not identified in Table 7 above, however, which were considered by the panel as being at risk and occurring within the study area.

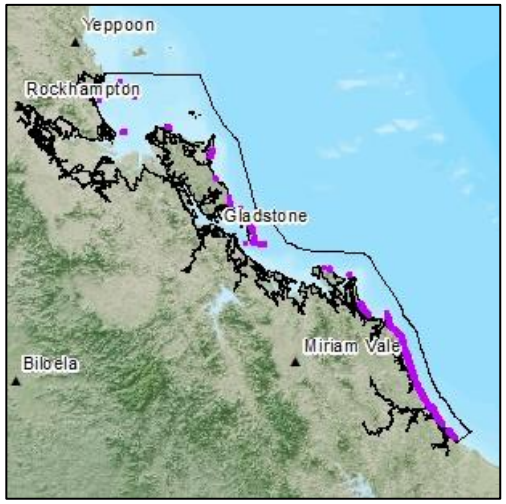
Table 8. Other panel nominated at risk ecosystems

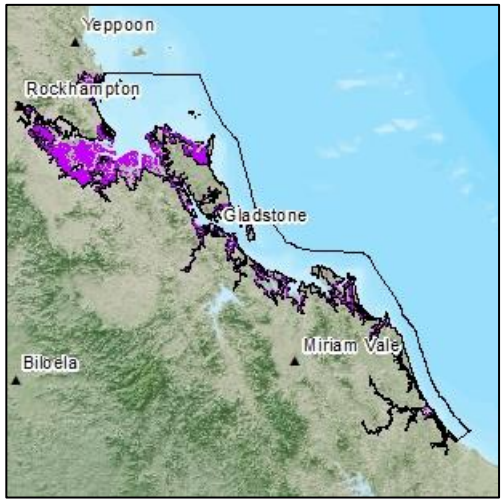
Community	Description	Criteria Rating
BFC_AREC_05: Nearshore coral dominated ecosystems  *Extent area derived from the QWISBMP draft mapping where the habitat type related to coral.*	Coral reef systems dominated by branching corals in the shallow subtidal and intertidal zones are more vulnerable compared to other forms such as submassives and massives from events which result in increased turbidity, freshwater and nutrient plumes. Similarly, cyclonic and large storm events tend to impact these communities more severely. The top 2 m of *Acropora* spp. in the Keppel reefs were killed by bleaching in 2006 and freshwater flows during the December 2011 and 2013 floods, whilst surveys suggests that in thermal and bleaching impacted reefs off Cairns, *Acropora* spp. tend to be the most significantly affected. In contrast, whilst more easily impacted from stochastic events, branching corals tend to recover more rapidly compared to submassives and massives that require substantially longer periods of time. Potentially, increasing sea temperatures in coming decades coupled with a strong East Australian Current and long-shore drift may enhance coral recruitment from reefs to the north, with an increase in species richness locally. However, the longer-term maintenance of diversity of these systems may be offset due to impacts associated with increased frequency of storm events, associated freshwater nutrient and sediment plumes, changes to water temperature and sea level rise, further coupled with other anthropogenic pressures (i.e. dredging). As such, the panel considered that all coral-dominated areas may be subject to further degradation increasing the importance of prioritising such areas for conservation.	High risk

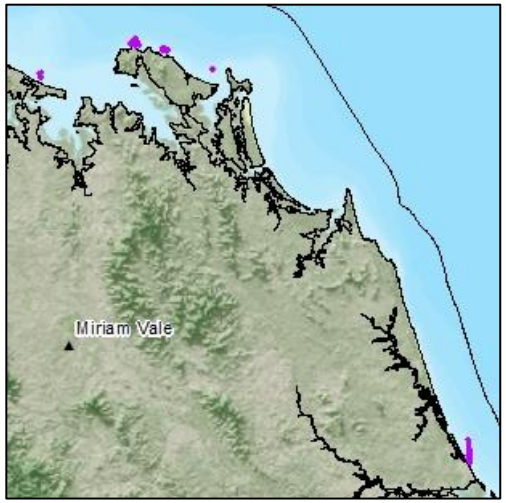
BFC_AREC_06: Mangrove communities  *Extent area derived from the QWISBMP draft mapping where the habitat type related to mangroves.*	Mangrove communities are an important component of the intertidal and estuarine environment providing a range of ecosystem services in terms of the provision of a buffer between the terrestrial and marine environment, bank stabilisation, and are integral to biological productivity and food webs in coastal waters, whilst also providing critical nursery habitat. A relatively resilient ecosystem comparative to other inshore communities (i.e. such as intertidal/shallow seagrass more susceptible to stochastic events), anthropogenic and changing climate patterns are and will likely continue to impact detrimentally (Goudkamp & Chin 2006). Increasing pressure from cyclones, freshwater incursion and an increased frequency and duration of such events will potentially result in the dieback of old growth communities in frequently impacted areas. Anthropogenic activities including reclamation of land and infilling for industrial and urban development in locations such as Gladstone, as well as indirect impacts from increased boat traffic and wake, have resulted in the direct loss of areas, whilst also impacting in other areas on the ability of such systems to recover. Continued cumulative pressures can affect the rate and success of recovery of such communities following disturbance events. As per other intertidal environments, seal level rise poses a potential risk, however, with the movement of the intertidal zone inland, it is expected than new areas will be suitable for colonisation (unless impeded by natural or human barriers and/or other cumulative pressures reduce their ability to establish).	Low risk

BFC_AREC_07: Saltmarsh (non-listed EPBC/QLD Biodiversity Status community)  *Extent area derived from the QWISBMP draft mapping (habitat type: Intertidal grass-herb-sedge-other succulent) and the Queensland Herbarium Regional ecosystem Mapping version 11 (vegetation communities 11.1.1, 11.1.2 and 12.1.2 north of 23° 37').*	A particularly vulnerable ecosystem, susceptible to compaction from vehicle and cattle, which impact on in-ground fauna and flora. Feral species, such as pigs can also impact severely. Successful removal/eradication program of cattle and pigs from Curtis Island has resulted in an altered system of the Marine Grass plains. Cattle grazing along the mainland component of the narrows is still an issue. In addition, extensive areas of this community have been impacted through hydrological modification by the construction of bundwalls and pondage systems and/or conversion to salt evaporation ponds (Queensland Herbarium 2018). The system is also at potential risk from climate change, especially in areas where limited retreat is available. Other impacts to the community have arisen from recent infrastructure and industry related activities around the Gladstone area, resulting in substantial losses of this community. Within the study area, this community corresponds to regional ecosystem 11.1.1, 11.1.2 and occurrences of 12.1.2 north of approximately 23° 37'.	Medium risk

BFC_AREC_08: Intertidal and shallow coastal seagrass meadows  *Extent area derived from the QWISBMP draft mapping to 10m depth (habitat types included Intertidal and subtidal seagrass communities)*	Seagrass communities play a crucial role as a nursery habitat for many species of fish and marine invertebrates and are a critical resource for a number of threatened marine fauna. Intertidal and shallow coastal seagrass meadows were considered by the panel to be vulnerable to increased turbidity, nutrient and pesticide loads arising from increasing storm intensity, flooding events and anthropogenic activities. Increasing frequency of such events, and long term resilience of such communities is of significant concern. Often situated more distant to the mainland coast and associated anthropogenic impacts, deeper seagrass meadows, tend to be less impacted, and/or recover more quickly from such events, provided water quality recovers.	Medium risk

BFC_AREC_09: High energy beaches  *Extent area derived from the QWISBMP draft mapping where habitat type: equates to intertidal high energy sand (30) on unconsolidated substrate)*	With an increased frequency of large storm events expected, the panel raised the concern that many exposed high energy beaches may be subject to more frequent and longer duration erosion processes resulting in the loss of dunal systems and/or in some instances, the beaches themselves. This may impact directly via the loss of suitable habitat on many species of turtles and shorebirds which utilise these areas for nesting, feeding and resting. Additionally, the likelihood of disturbance events occurring during nesting or egg incubation is increased which in turn can directly result in greater hatchling mortality rates. Substantial reductions in turtle hatchling rates have been observed at Mon Repos during large inundation/storm events which coincided with nesting. The increased continued frequency of such events may impact on population demographics for dependent species over time.	Medium risk

BFC_AREC_10: Mudflats & saltpans  *Extent area derived from the QWISBMP draft mapping where habitat types reflected "above MSL unconsolidated mud (claypan/saltpan)" or "bare areas above MSL (i.e. saltpan with or without microphytobenthos)" on unconsolidated, or intertidal grass/herb sedge communities.*	Mudflats and saltpans are significant depositional landforms which form from the downdrift of sediment sources from river mouths where they are exposed to wave energy and tidal currents (Whiteway et al. 2014). These natural processes can occur not only over seasons but decades. Mudflats may also form when there is a large barrier such as a barrage or dam within large river systems. Important and coastal-restricted vegetation communities grow in these areas, such as RE 8.1.3 (*Sporobolus virginicus* tussock grassland on marine sediments). Mudflats are globally under threat of loss, degradation and fragmentation from coastal development (Murray et al. 2019). Other pressures include sea-level rise, soil erosion and altered sediment flux (Syvitski et al. 2005; Passeri et al. 2015). For example, increased nutrient runoff from urbanisation or mining can impact on invertebrate diversity and abundance, and in turn the threatened shorebird species which feed on them. Severe declines in migratory shorebirds are attributed to the loss of mudflats, and can be compounded by high site fidelity for roosting and feeding (Clemens et al. 2014). Recent work by Choi et al. (2017) suggest that Curtis Coast mudflats are at carrying capacity as foraging grounds, and further loss of habitat will lead to declines due to high site fidelity. Refer also to decisions BFC_AREC_2, BFC_AREC_4 and BFC_AREC_7 – components of this broader community, however which were assigned higher criteria ratings.	Low risk

BFC_AREC_11: Soft coral / reefal garden dominated communities  *Extent area derived from the QWISBMP draft mapping (habitat type = soft coral)*	Sessile organisms without a hard outer covering, octocorals form the second most common group of macrobenthic animals in the Great Barrier Reef after hard corals. They provide habitat for a number of marine taxa, including a number of dependent species. Whilst not as well studied as hard corals and largely unknown, surveys indicate taxonomic richness increases along a southerly to northerly gradient and from shallow to moderate water depths. It is suggested that the observed increase in richness in moderate depths is related to water clarity and sediment. Taxonomic composition within an area similarly appears to be related to environmental conditions including turbidity, light availability and water currents. Reduced water quality reduces richness, with only tolerant species persisting (Fabricius 2018). Although some species may recolonise more quickly than their hard coral cousins, soft corals are similarly considered to be susceptible to bleaching following freshwater flows.	High risk
BFC_AREC_12: Encrusting sponge communities (mapping not available)	Cryptic taxa that provide ecosystem services including photosynthetic production of nutrients and energy that drive coral reef ecosystems, as well as filtering waste products and toxins from other animals and plants on the reef, and recycling calcium carbonate back into the reef system (Queensland Museum 2018). Within the study area, they form important heterogeneous communities with relatively high levels of 'apparent endemism'. These communities and their heterogeneity are influenced by a range of factors such as light, depth, quality of substrate and water quality (Hooper & Ekins 2004). The main threat includes impacts from trawling. Substantial areas of hard benthic substrate where trawling has been limited are likely to still contain communities of sponges.	Medium risk

6.4 Compiled At Risk Ecosystem conservation ratings

Figure 14 represents the overall generalised at risk ecosystems ratings. In instances where more than one “At risk” community is attributed to a spatial unit, the highest rating is assigned.

Approximately 0.5% of the study area was occupied by an ecosystem types considered to be at Very high risk, 3% as High risk, 12% as Medium risk and 12% at Low risk, with the remainder of the study area occupied by ecosystems not identified through the expert panel, or listed under legislation as being “At risk”.

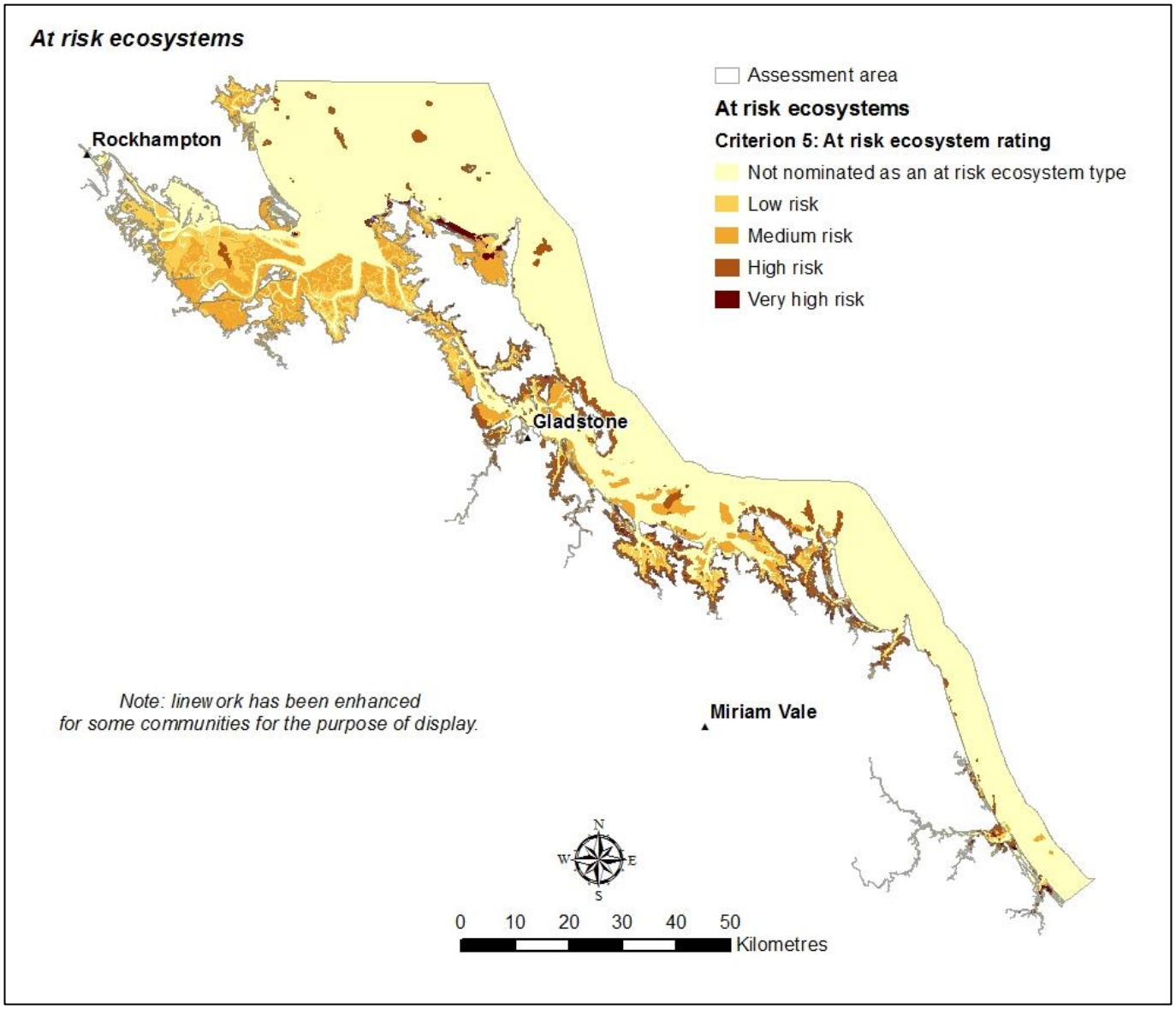


Figure 14: At risk ecosystems category status

7 Criterion 6 - Special Features

In addition to threatened species, priority species and at risk ecosystems, the panel identified other outstanding or notable ecological special features relevant to the study area. Each special feature was assigned a conservation rating between 1 (Low) and 4 (Very High) for one or more particular measures (sub-criterion for which an area could be nominated). The individual measures for which a special area might be nominated included:

- Measure 6.1 - Ecological areas important for species breeding
- Measure 6.2 - Ecological areas important for species feeding
- Measure 6.3 - Ecological areas important for species movement
- Measure 6.4 - Ecological areas important for species resting
- Measure 6.5 - Ecological areas important as nurseries
- Measure 6.6 - Other areas considered of ecological importance by the panel (e.g. resultant from distinct hydrological, geomorphic, or other factor).

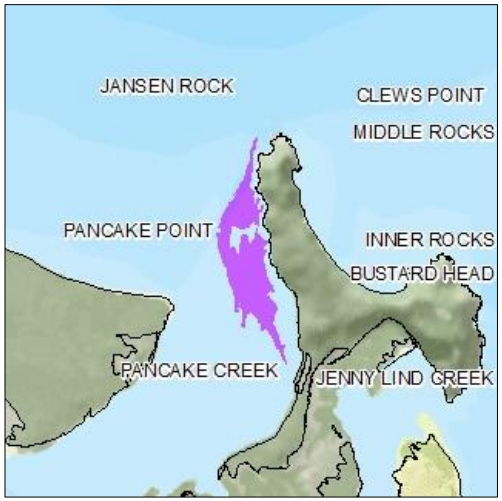
7.1 Approach

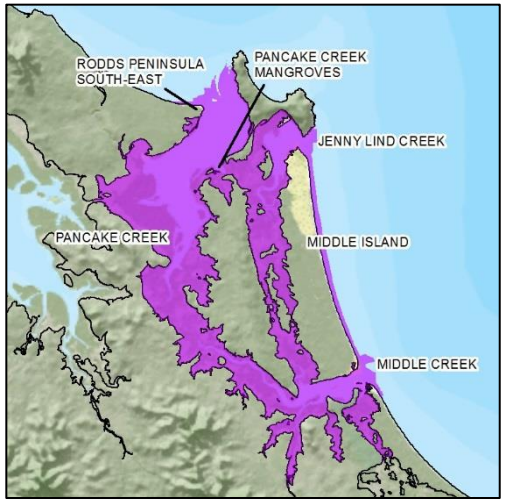
Decisions that were unable to be implemented due to a lack of data or unconfirmed values are indicated as "Not Implemented" in the special feature tables. The final criterion score was the maximum of any of the individual measures.

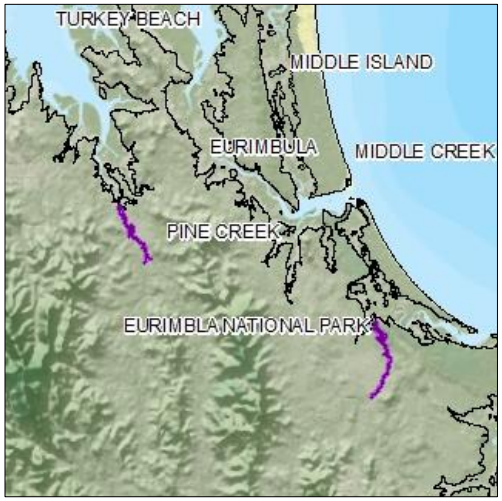
7.2 Special Features

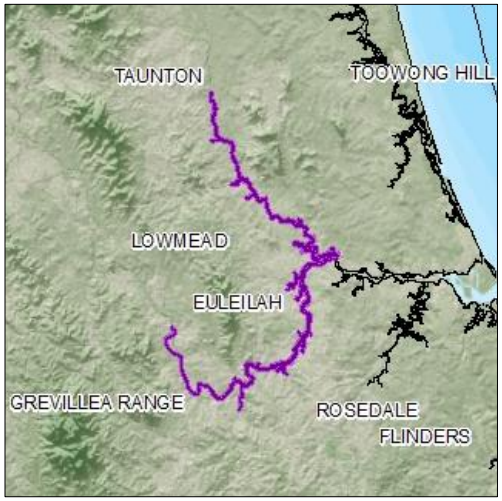
The Baffle to Fitzroy Coast special areas identified by experts are listed in Table 9.

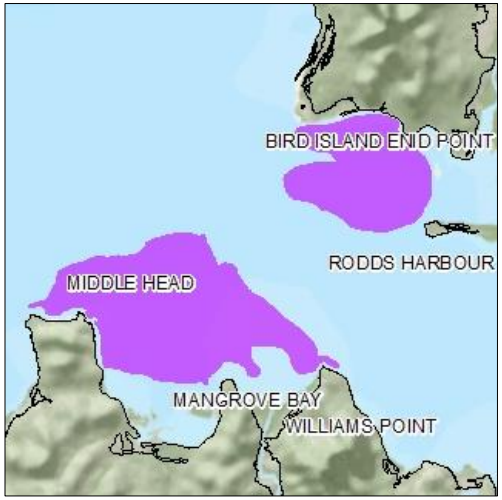
Table 9. Intertidal and subtidal special features and their values

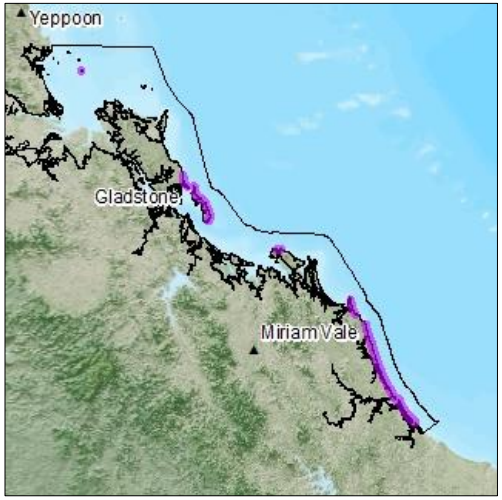
Special Feature Name	Description	Measure: Score (Rating)
BF_EC_01: Pancake Creek – estuarine coral reef 	A small unique system incorporating intertidal and subtidal coral and rock reefs situated at the entrance of Pancake Creek and extending into the estuary. The mouth of Pancake Creek forms the northern entrance of a C shaped estuarine system, which excises Middle Island before exiting at its southern seaward opening (the mouth of Middle Creek). Due to the small, yet intact vegetated catchment with comparatively minimal freshwater hydrological inputs, a short system length and extensive tidal flushing (resultant from two seaward openings), limited nutrient and sediment input occurs sustaining a relatively clear water system that facilitates coral growth. Comparative to many other inshore coral reefs in the study area, these unique hydrological conditions potentially imbue a refugial value to this system. Significant reef build up has occurred (Butler 2018), possibly in part as a result from the level of protection from oceanic conditions**.** Species of corals are present that are usually found offshore. Branching stony corals are the predominant form of the approximately 20 species of corals that have been recorded within and around Pancake Creek area (including but not limited to *Acropora aculeus*, *A. cerealis*, *A. digitifera*, *A. intermedia*, *A. latistella*, *A. millepora*, *A. muricata*, *A. nasuta*, *A. sarmentosa*, *A. secale*, *A. valida* and *A. yongei*).	6.6: 4 (Very high) *presence of a estuarine coral reef system and diversity of coral taxa in an inshore estuarine environment, inclusive of species generally found offshore*

Special Feature Name	Description	Measure: Score (Rating)
BF_EC_02: Pancake Creek, Middle island and Jenny Lind estuary systems  	This special feature encompasses the connected Pancake, Middle and Jenny Lind Creek estuarine systems, the earlier two of which form the main C shaped estuarine passage open to the sea at both its northern and southern extents. The Jenny Lind System connects directly to the pancake/middle creek system during larger high tide events. Whilst some minor localised impacts are present (arising from recreational camping, fishing, guided tourism charter activities, as well as the historical construction of a large causeway across middle creek), there is minimal current anthropogenic disturbance. As a result, the intertidal and subtidal estuarine ecosystems (inclusive of mangroves, saltmarsh, mudflats, saltpans, rockbars, rock and coral reef systems) are considered in excellent natural condition. Additionally, as mentioned under BF_EC_01, the small intact vegetated catchment, short system length and extensive tidal flushing, minimise impacts that arise in larger less intact systems due to freshwater events carrying high nutrient and sediment loads. It is thought that groundwater seepage behind the dunes supports important habitat for the threatened species *Xeromys myoides* (Water Mouse – Vulnerable under the EPBC and NCA) and extensive areas of habitat are present within the area. According to Queensland Wader Study Group surveys in 2006-2007, this system also supports 3,700 shorebirds of 16 species. Rodds Peninsula south-east recorded the largest proportion, with 1,496 shorebirds of 10 species. Pancake Creek mangroves recorded 532 individuals and Middle Island eastern beach recorded 609 individuals (Milton & Harding 2007). This included almost 1.5% of the EAAF population of Grey-tailed Tattler, 3% of the Australian population of Whimbrel (*Numenius phaeopus*) and 2.1% of the endangered Australian population of Lesser Sand Plover (*Charadrius mongolus*) (Milton & Harding 2007). At least two breeding pairs of the vulnerable Beach Stone-curlew (*Esacus magnirostris*) currently use this area for feeding and roosting.	6.1: 3 (High) *important breeding site* 6.2: 4 (Very high) *important feeding site* 6.4: 4 (Very high) *important roosting site* 6.6: 4 (Very high) *unique hydrological features with ecosystems considered in excellent natural condition*

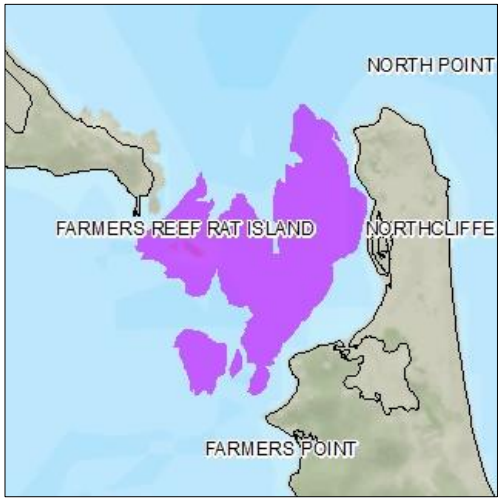
Special Feature Name	Description	Measure: Score (Rating)
BF_EC_03: Upstream estuary transition zone - Worthington and Eurimbula  	Commences upstream of the mangrove expanses, the upper estuarine sections of Worthington and Eurimbula extend through low adjoining hills with only a narrow estuarine riparian vegetated fringe present. Comparative to systems such as Deepwater/Blackwater where constructed barriers have resulted in the removal of a substantial extent of high quality nursery habitat, these systems occur in intact catchments, and are considered in excellent condition with natural connectivity. Whilst no anthropogenic modified barriers are present, rock bars form natural breaks resulting in separated pools with slightly reduced connectivity and a dissolved oxygen content not sufficient to support large biomasses of instream fauna. The pools and habitat however, act as important nursery grounds dominated by juveniles of mangrove jack (*Lutjanus argentimaculatus*), bream and other species.	6.5: 4 (Very high) *important nurseries*

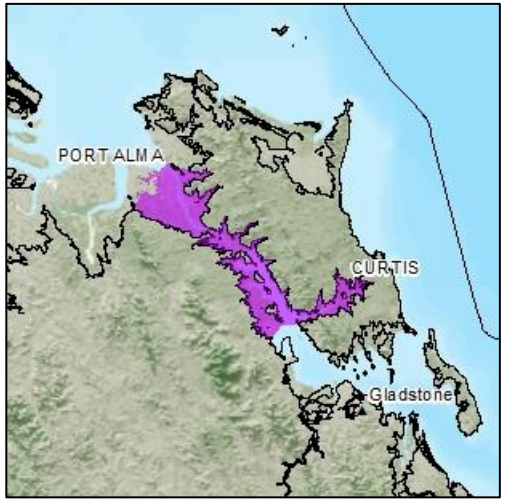
Special Feature Name	Description	Measure: Score (Rating)
BF_EC_04: Upstream estuarine extent - Baffle 	The Baffle is representative of a comparatively “pristine” estuarine system with minimal human impacts on hydrologic flow. Unlike the majority of such systems along the Queensland east coast, no weirs or dams have been constructed impeding or altering natural flows, or impacting on instream connectivity. Upstream areas of the baffle encompass a diversity of habitats including sand bars, narrow creeks, rock bars and outcrops which in turn support important nursery, feeding and spawning grounds for a variety of species with good connectivity between freshwater and marine environs.	6. 5: 4 (Very high) *important nurseries* 6.6: 4 (Very high) *unique hydrological features with minimal impacts to hydrologic flow impeding natural movement*

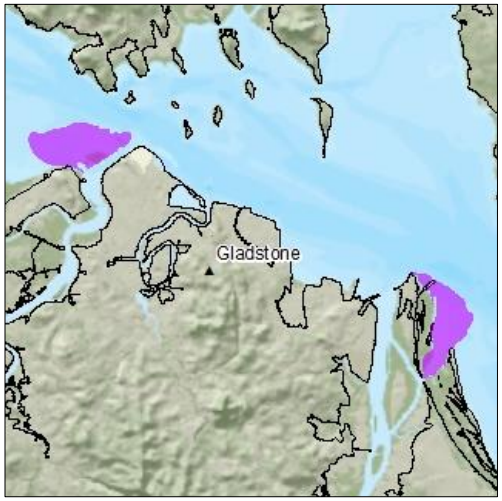
Special Feature Name	Description	Measure: Score (Rating)
BF_EC_05: Rodds Bay seagrass 	Areas of intertidal to subtidal seagrass meadows situated at the northern and southern entrance of Rodd's Bay. Whilst considered an important foraging area for Green turtles (observed along the deeper edges), the presence of consistent feeding trails suggests that the areas are of particular importance for Dugong.	6.2: 4 (Very high) *important feeding site*

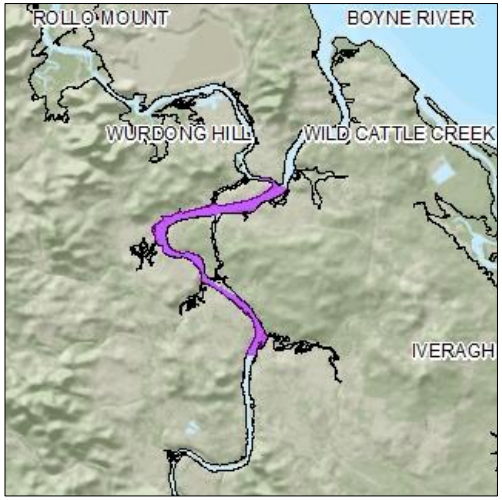
BFC_EC_06: Significant turtle nesting beaches 	High density nesting is usually associated with beaches that have greater stability under high intensity storms. Whilst nesting occurs above the high-water mark, increased frequency of storm surge and accelerated beach erosion processes as a result of climate change, will likely impact nesting populations now and in the future. At Mon Repos, Cyclone David (January 1976) resulted in 70- 80 % of nests lost in a single season. Changes in sand temperature are also considered paramount to successful hatchling rates and sex determination. Loggerhead hatchlings at and south of sunshine coast are dominated by males for example, whilst at the northern extent, hatchling sex is skewed towards females. It is uncertain as to how species and nesting distributions will respond to long term climatic change, especially if major human population's centres coincide with future suitable environmental ranges. Within the study area, mainland beaches and adjacent islands support nesting populations for species of Flatback (*Natator depressus*), Loggerhead (*Caretta caretta*), and also incidental areas for Greens (*Chelonia mydas*). Although no nesting has been recorded in the past 20 years, historical nesting occurrences of the leatherback turtle (*Dermochelys coriacea*) have also been recorded within the study area. South of Bustard Head, predominantly Loggerhead nesting occurs on mainland beaches with a sporadic occurrence of Flatbacks and Greens, whilst to the north through to Townsville, mainland beaches are dominated by Flatback nesting. Outer barrier islands are Green and Loggerhead dominated, with the exception of the continental islands (Percy group), which support both Flatback and Green nesting (outside of area). One of the top five regional breeding areas of loggerheads in the South pacific includes nesting beaches from the sunshine coast, north to Bustard Head. Within this area, the mainland Woongarra coast and Wreck Rock area contain the highest aggregation of nesting beaches (Limpus et al. 2013). It is estimated that 10-20% of breeding for the South Pacific population occurs in the stretch 22km south from Red rock beach to Deepwater. Beach's south of this area support smaller numbers. With respect to the Eastern Australian Flatback genetic stock, Peak Island (Keppels) is considered one of the most important nesting sites, whilst Medium density nesting populations are present along Southend Beach (Curtis Island) and Ocean Beach (Facing island). Surprisingly, other than Southend Beach, very little nesting occurs along other beaches of Curtis. Low density Flatback turtle nesting occurs on beaches south to the Woongarra Coast (the southerly nesting distribution for the species in eastern Australia) (Pople et al. 2016).	6.1: 4 (Very high) *important nesting site*

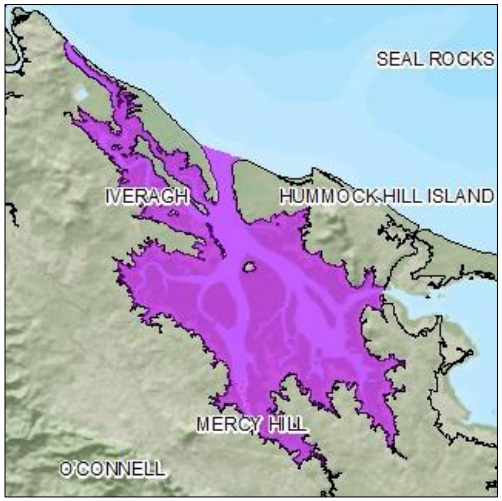
Special Feature Name	Description	Measure: Score (Rating)
BFC_EC_07: Pelican Banks 	This feature encompasses intertidal to subtidal seagrass meadows and adjoining mangrove communities at the margin. The pelican banks reflects the largest area of productive and continuous cover high density *Zostera capricorni* within the Gladstone area. The area is a key dispersal point of propagules, upon which the long term harbour population is reliant. Experiments using exclusion cages have resulted in large differences in seagrass biomass and the area is considered important feeding habitat for the dugong and green turtle. Tracking studies show that dugong spend a lot of time at East Quoin (area of seagrass and corals). High densities of stingray feeding tracks occur and a diversity of species are present (eagle, spotted, cow tail, mangrove ray etc). The dense area of seagrass also plays an important role as nurseries for fishery and prawn species. The ecotone of the mangrove edges and seagrass beds allow small green turtles to feed on the algae on the mangroves and *Avicennia* propagules and *Rhizophora* growing shoots, whilst larger individuals are found predominantly on the flats resulting in differentiation in the size of greens and where they feed. This area overlaps with near-shore intertidal mudflats used by migratory shorebirds for feeding and roosting, refer to BF_EC_25.	6.1: 4 (Very high) *important breeding site - seagrass dispersal* 6.2: 4 (Very high) *important feeding site* 6.5: 4 (Very high) *important nursery site*

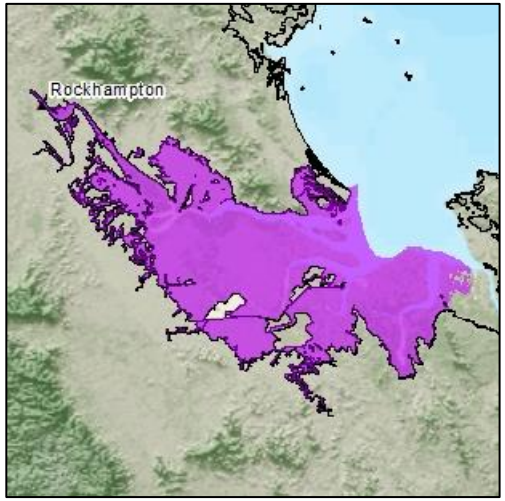
Special Feature Name	Description	Measure: Score (Rating)
BFC_EC_08: Gladstone North Entrance, Facing Island, Rat and Farmers Reefs 	Located at the North entrance of the Gladstone Harbour, incorporating intertidal, subtidal rocky and coral reef areas interspersed by areas of subtidal seagrass. Subject to significant tidal flows (greater than 4 m) due to channelling and shallow waters between Curtis and Facing Islands, the area is regularly flushed and dosed with clearer water during high tides. As a result and comparative to other areas containing corals/seagrass in the harbour, it is less impacted from flooding and sediment/nutrient plumes and may provide a refugial role within the harbour during and post recovery of such events. Findings from a survey conducted by BMT WBM (2009), indicated that the reefs located in the North passage and western side of facing island had comparatively high coral cover dominated by sediment tolerant heterotrophs (i.e. species not entirely reliant on light). Over 20 species of corals have been recorded within the area, including *Petrophyllia (Archohelia) rediviva* (Wells & Alderslade 1979) a rare ahermatypic (lacking zooxanthellae) hard coral, which previous to its discovery in 1975 were known only from fossil records of the West Indies and Central and North America. The species is also targeted by collectors. Hard coral genera recorded in the area include *Acropora*, *Cyphastrea*, *Favites*, *Goniastrea*, *Goniopora*, *Montipora*, *Moseleya*, *Pocillopora*, *Porites* and *Turbinaria*.	6.6: 4 (Very high) *inshore reef with comparatively high coral cover, presence of unique species*

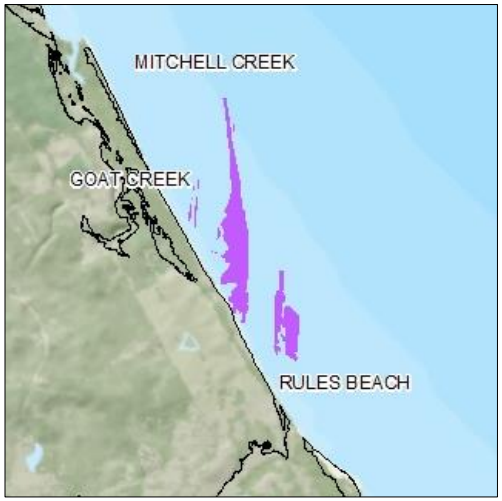
Special Feature Name	Description	Measure: Score (Rating)
BFC_EC_09: The Narrows 	Identified as a nationally important wetland, the passage between Curtis island and the mainland, is one of a handful of tidal passages in Australia and follows the alignment of the major north-south Yarrol fault zone. The interesting geomorphology of the area, complex tidal flows and water movement patterns result in a number of unique habitats. Encompassed by a relatively low flat topography, the passage forms a connection between two very different areas of Keppel Bay and Gladstone Port, and facilitates an important inshore movement corridor. Incorporating a variety of habitats ranging from subtidal aquatic beds, reefs and estuarine waters to extensive intertidal flats of sand, mud and salt marsh and mangrove systems, the area supports habitat for a number of marine and estuarine dependent species. Excellent examples of extensive and intact mangrove communities are present, two species of which (*Xylocarpus australasicus* and *Bruguiera exaristata*) are at or close to the southern limits of their range. Intertidal habitat support the federally and state listed vulnerable Water Mouse (*Xeromys myoides*). Seagrass beds provide habitat for a variety of fish and invertebrate taxa and are feeding grounds for *Dugong dugon*. The Australian endemic snubfin dolphin (*Orcaella heinsohni*) and the Australian Humpback dolphin (*Sousa sahulensis*) both utilise the passage. Four species of Marine turtle (Green, Flatback, Leatherback and Hawksbill) are present, and although uncommon, the estuarine crocodile has also been recorded (Blackman et al. 1999). Friend Point claypan and associated intertidal mudflat in the south-east can support between 50 – 300 migratory shorebirds including threatened species such as Eastern Curlew (*Numenius madagascariensis*) and Great Knot (*Calidris tenuirostris*). Beach Stone-curlews (*Esacus magnirostris*) have also been sighted here. However, shorebird numbers are much lower in comparison to other sites in the Curtis Coast. Shorebirds may also use the nearby Passage and Wiggins island as alternative roosts and feeding sites.	6.3: 4 (Very high) *important movement passage* 6.6: 3 (High) *one of a few true tidal passages formed as a result of the Yarrol fault. Diversity of habitats.*

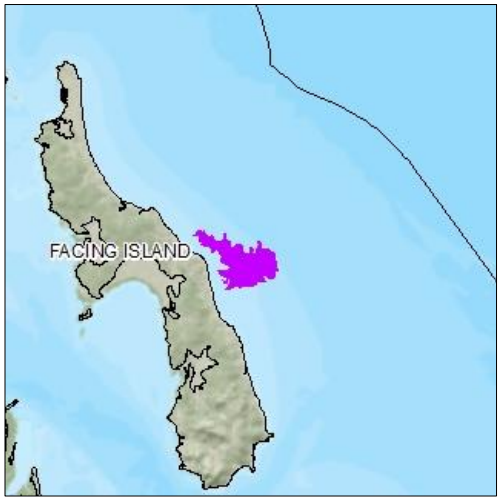
Special Feature Name	Description	Measure: Score (Rating)
BFC_EC_10: Wiggins Island and South Trees intertidal flats 	The special area encompasses the Wiggins Island and South Trees intertidal flats (and associated small areas of mangrove at Wiggins Island). These intertidal seagrass beds (*Zostera capricorni* and *Halophila ovalis* dominated meadows on soft mud banks), whilst of moderate seagrass density, reasonable areas of algae cover are also present. Concentrations of green turtles have been noted to occur at both areas and within the surrounding channels. Significant outflow from river systems such as at the mouth of the South Trees, Boyne and Calliope appear to hold high concentrations of green turtles. It was suggested that based upon surveys, the mouth of the South Trees may host the highest concentration of immature greens within the entire port. High density dugong feeding trails have been observed at both sites (Thomas et al. 2009). Intertidal mudflats surrounding Wiggins Island and two claypans at the mouth of Calliope River are used by a small number (< 100) of migratory shorebirds for feeding and roosting. Beach Stone-curlews (*Esacus magnirostris*) have also been recorded to use this area. Mangroves on Wiggins island have been utilised by the nationally vulnerable Grey Headed Flying Fox (*Pteropus poliocephalus*) as a roost site, although population counts have declined since the 1990s.	6.2: 3 (High) *important feeding site*

Special Feature Name	Description	Measure: Score (Rating)
BFC_EC_11: Boyne River riffle zones 	This feature is comprised of a series of riffle zones with gravel bottoms, separated by rock bars and deeper and shallow pools. It is thought that high diversity and productivity in these riffle zones with respect to algae is targeted as a feeding resource by green turtles. Individuals have been observed upstream as far as the Boyne Highway.	6.2: 3 (High) *important feeding site*

Special Feature Name	Description	Measure: Score (Rating)
BFC_EC_12: Colosseum Inlet  	Recognised both as a listed Nationally Important Wetland and a declared Fish Habitat Area, the Colosseum Inlet encompasses extensive areas of mangroves, samphire and clay pan, estuarine waters and deltaic sandbars, intertidal seagrass beds and a small coral community off the south end of Wild Cattle Island. Wild Cattle and Hummock Hill islands' shelter extensive intact expanses of mangroves with *Avicennia*, *Excoecaria*, *Rhizophora*, *Ceriops* and *Aegialitis* species present. Mangroves exhibit distinct banding with an *Avicennia* fringe at the seaward extent, followed by Rhizophora zone (main zone) and then a *Ceriops* zone before transitioning to saltmarsh with a final *Ceriops* zone at the landward extent. Recognised as being of substantial importance as a nursery habitat for commercial, recreational and Indigenous fisheries (barramundi, blue salmon, bream, estuary cod, flathead, grey mackerel, grunter, jewfish, king salmon, mangrove jack, queenfish, sea mullet, school mackerel, whiting, banana prawns, endeavour prawns, king prawns, mud crabs). (https://parks.des.qld.gov.au/managing/area-summaries/colosseum.html) Other notable fauna species observed in the area includes *Dugong dugon*, and a number of trans equatorial wading bird species (JAMBA and CAMBA) utilise the extensive intertidal feeding grounds.	6.1: 4 (Very high) *important breeding area - mangroves* 6.5: 3 (High) *important nursery site*

Special Feature Name	Description	Measure: Score (Rating)
BFC_EC_13: Fitzroy Delta 	The Fitzroy Delta, a declared Fish Habitat Area and recognised as a nationally important wetland system incorporates a coastal delta and floodplain environment situated at the terminus of the largest river system in Queensland. Ecosystems present include estuarine water bodies, lagoons, mangrove, saltpan and saltmarsh communities, through to semi-permanent and permanent freshwater palustrine and lacustrine wetland systems. The lagoon systems and other wetlands communities provide important ecosystem functions in terms of nursery habitat, and feeding for a range of invertebrate, fish and bird taxa. This area is recognised as a Key Biodiversity Area by BirdLife International, where a number of conservation significant migratory birds utilise the lagoons, mudflats and other wetland communities for feeding. Permanency of the freshwater and saline lagoons is largely dependent upon their depth, and the frequency of connection to the estuarine system. Connections during larger tidal and flood events allow recruitment of juvenile fish to nursery areas and conversely, more mature juveniles to move back into the estuarine/riverine system. Timing of the connections is therefore important with respect to a taxa's life cycle stage. In contrast, the shallower saline pool systems and those subject to longer periods between connections are at greater risk of drying/evaporating, and become hypersaline as water levels recede. As these systems approach collapse, in pool taxa become more aggregated, and susceptible to predation providing an important feeding resource for many species of shorebird. Notable shorebird examples include the lesser sand plover *Charadrius mongolus*, greater sand plover *C. leschenaultii*, bar-tailed godwit *Limosa lapponica baueri*, eastern curlew *Numenius madagascariensis*, great knot *Calidris tenuirostris*, red knot *C. canutus* and curlew sandpiper *C. ferruginea*. A minimum of approximately 50 waterbird species utilise the area including Australasian bittern *Botaurus poiciloptilus*. Small populations of the endangered Capricorn yellow chat *Epthianura crocea macregori* also occur in areas of suitable habitat. (ref: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW&doiw_refcodelist=QLD012)	6.2: 3 (High) *important feeding site* 6.5: 4 (Very high) *important nursery site* 6.6: 4 (Very high) *unique lagoon system*

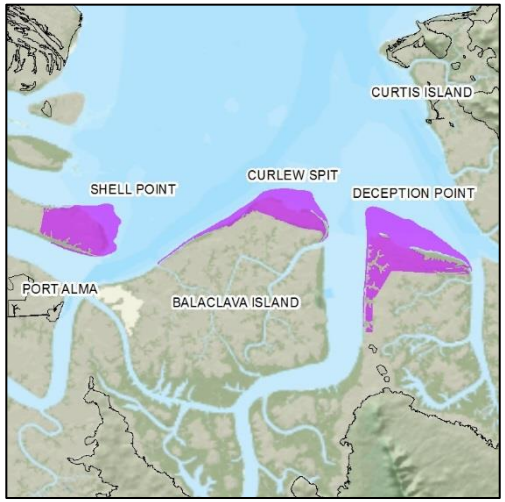
Special Feature Name	Description	Measure: Score (Rating)
BFC_EC_14: Finger Reef (Stringer's Reef)  	A seaward extension of the underlying Elliott Sandstone at Rules Beach supports a small area of inshore (intertidal and subtidal) coral reef with unusual octocorallians (soft corals, gorgonians and sea fans) present and a high relative abundance of other benthos, inclusive of sponges and colonial ascidians. Whilst recent surveys suggest coral cover is generally quite low, previous surveys have purported much higher abundances (Butler 2018). Terrestrial run-off and a high energy exposed environment prevents reef build up and taxa are directly attached to the rocky substrate (Butler, 2018). Based upon compiled species records, soft coral genera include, *Lobophyton*, *Dendronephthya*, *Sarcophyton* and *Xenia*, whilst examples of hard coral genera present include *Porites*, *Psammocora* and *Goniopora*.	6.6: 3 (High) *interesting geomorphic structure that supports coral community with unusual octocorallians.*
15: Fitzroy River Palaeochannel *Not implemented*	The Fitzroy River Palaeochannel is representative of one of the outstanding universal values for which the Great Barrier Reef Word Heritage Area was declared. In the last Glacial Maximum lowstand, the Fitzroy River extended across the entire shelf. The Paelochannel, represents a well preserved and interesting geomorphological structure that contains a record of historical climatic events through depositional processes, and contributes to on-going processes, including a possible mechanism for cross shelf sediment transportation, a pathway for cooler bodies of water, and in providing connection between ground water aquifers from the terrestrial to marine environment via discharged springs, termed "Wonky holes" (Whiteway et al. 2014). *Decision not implemented as the remnant Paleo channel visible on bathymetry data occurs just outside of the study area. Retained for information purposes.*	

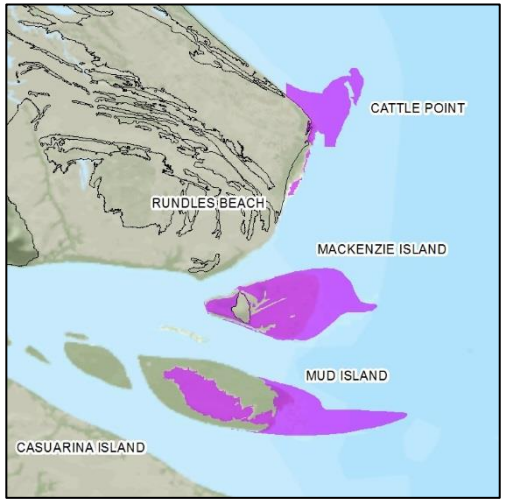
Special Feature Name	Description	Measure: Score (Rating)
BFC_EC_16: Sable Chief Rocks Reef 	Fringing reefs extend along a large portion of the east coastline of Facing Island. From a survey undertaken by Sea Research (2012), Sable Chief Rocks Reef had the highest hard coral cover (approximately 30% of the substratum), and was the only site dominated by Acroporidae of the fringing coral reefs sampled. Within the area depicted, stony coral species from at least 16 genera have been recorded (inclusive of *Acropora*, *Agaricia*, *Alveopora*, *Anacropora*, *Cyphastrea*, *Favia*, *Favites*, *Goniastrea*, *Goniopora*, *Montipora*, *Platygyra*, *Pocillopora, Porites, Turbinaria,* and unknown genera from the Mussidae (Lobophylliidae) and Siderastreidae families). Whilst having reasonably high macroalgae cover, soft coral cover was found to be low. A desktop assessment undertaken by (Gibbs 2013) suggested that, of the eastern fringing reefs surveyed adjoining facing island, Sable Chief Rock Reef likely had the highest resilience to anthropogenic impacts resulting from increased turbidity and water quality, was of the highest ecological value and the reef most representative of the greater bioregion. Accordingly, Sable Chief Rock Reef was considered as being of the highest priority of the eastern facing island reefs in terms ensuring protection measures.	6.6: 3 (High) *high coral diversity and cover*

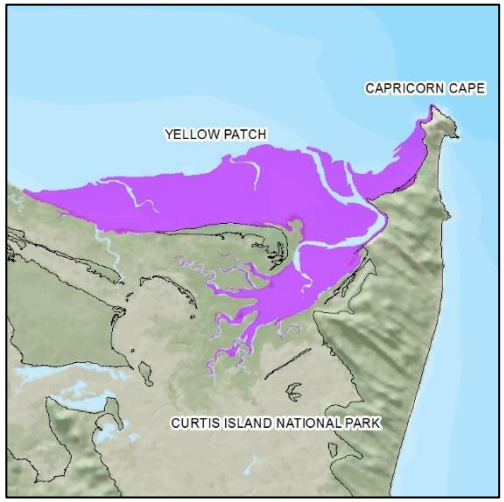
Special Feature Name	Description	Measure: Score (Rating)
BF_EC_17: Rundle Reef 	Located approximately 4 km offshore from Curtis Island, a small area of rock outcrop surrounded by fringing reef that supports a healthy coral community. A comparatively high diversity of hard coral species have been recorded at the site, with a survey by Ayling et al. (2013) identifying approximately 50 species of hard coral and which covered approximately 40% of the substratum. Surveys at the site indicate that coral communities are dominated by Acroporidae, with generally less than 5% cover representative of other hard coral families Dendrophylliidae, Faviidae and Poritidae. Soft coral and sponge cover is low (Ayling et al. 2013). The reef was identified as being of ecological value due to both high levels of cover and resilience (Gibbs 2014) - largely attributed due to the reefs distance from the mainland and the associated detrimental impacts arising from both Port Curtis and the Fitzroy systems. Also suggested as a potentially important larval source for inshore reefs within the area, especially during recovery following disturbance events (Gibbs 2014).	6.6: 3 (High) *high coral diversity and cover*
18: Jabiru Shoal *Not implemented*	The jabiru shoals, representative of an uncommon habitat type within the study area, is located approximately 8 km WNW of Hummocky Island, the Jabiru Shoals incorporates a series of rises at depths of approximately 8-10 m. *Decision not implemented – insufficient information with respect to values.*	

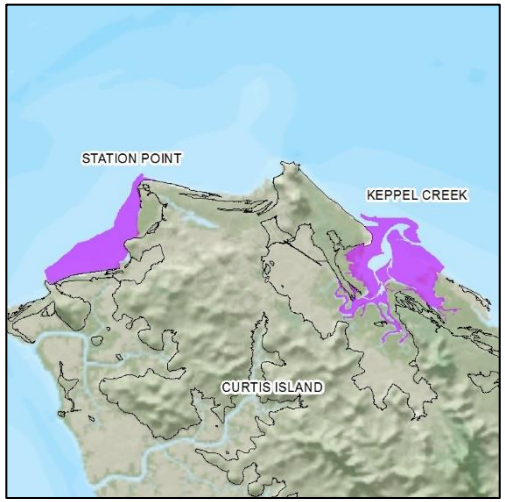
Special Feature Name	Description	Measure: Score (Rating)
BF_EC_19: Hummocky Island 	A rocky outcrop situated north of Curtis Island supporting fringing coral reefs. Based upon surveys undertaken by Ayling et al. (2013), the reefs are dominated by stony corals of Staghorn (acroporid) and *Turbinaria* corals in the family Dendrophylliidae. Soft corals are also relatively common especially *Sarcophyton* and *Sinularia* species and *Junceela* sea whips. Approximately 40 species of coral have been recorded at the site of which, approximately 25-30 species are hard coral forms (including species of *Acanthastrea*, *Acropora*, *Coscinaraea*, *Cyphastrea*, *Echinophyllia*, *Favia*, *Favites*, *Goniopora*, *Hydnophora*, *Montipora*, *Platygyra*, *Pocillopora*, *Porites*, *Psammocora*, and *Turbinaria* genera) and approximately 10 species of soft coral. Algae cover was noted as being low, as were sponges, ascidians and hydroids. Similar to reefs in Keppel area and Rundle reef to the south east, given the distance from the mainland and potential impacts to water quality arising from large disturbance events, the fringing reefs of Hummock Hill Island likely have a higher inherent resilience comparative to those closer inshore.	6.6: 3 (High) *high coral diversity and cover*

Special Feature Name	Description	Measure: Score (Rating)
BFC_EC_20: Peak, Wedge and Divided Islands 	Peak, Wedge and Divided Islands represent shallow water mid-shelf island fringing reefs, of which few occur within the study area. Whilst a survey at Peak Island indicated low hard coral cover comparative to other reefs within the region, Peak and Pelican Islands (to the north of Wedge Island, just outside the study area) were found to have coral communities with high representation of sediment and nutrient tolerant genera such as *Psammocora* and *Hydnophora* (BMT WBM 2013). The particular composition of the coral community observed at Peak Island implies a level of resilience (Gibbs 2014) to water quality impacts arising from plumes from the Fitzroy system. Divided and Wedge Islands are located between Pelican and Peak Islands, though closer to shore than Peak. The study by Gibbs (2014) attributed Peak as being of only moderate ecological value (based upon the extent coral cover, the speed of calcification, the importance to coral reef stability and coral water quality sensitivity).	6.6: 3 (High) *fringing reefs, few present in the study area*

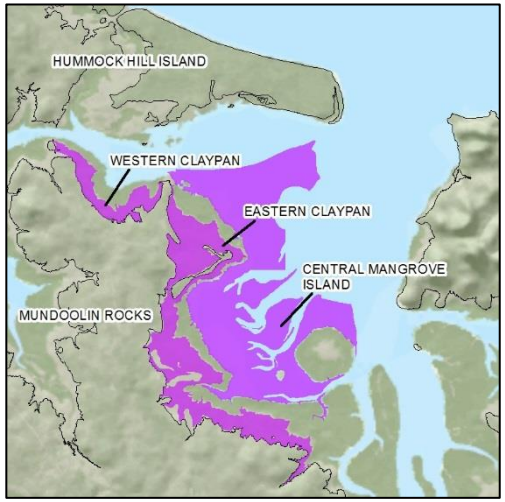
Special Feature Name	Description	Measure: Score (Rating)
BFC_EC_21: Significant shorebird roosting and feeding sites of the Fitzroy estuary  	The Fitzroy Estuary region supports a substantial proportion of the total shorebird population in Curtis Coast. The region consistently records over 1,000 individuals per survey and supports a variety of migratory species in the East-Asian Australasian Flyway. Key sites include: Shell Point: This site supports the highest number for the Fitzroy Estuary, with a total of 13 shorebird species recorded here (Wildlife Unlimited 2012-2018). Endangered species include Lesser Sand Plover (*Charadrius mongolus*), Great Knot (*Calidris tenuirostris*) and Curlew Sandpiper (*Calidris ferruginea*). Numbers of Lesser Sand Plovers are particularly high at this site (IMEMS 2013). Curlew Spit: This site supports 15 species of migratory shorebirds species (Wildlife Unlimited 2018), with over 1,000 individuals per survey recorded for both high tide (roosting) and low tide (feeding) (GHD 2011 a,b,c,d). It supports a significant number of vulnerable and endangered species including: Eastern Curlew (*Numenius madagascariensis*), Lesser Sand Plover (*Charadrius mongolus*), Bar-tailed Godwit (*Limosa lapponica baueri*) and Greater Sand Plover (*Charadrius leschenaultia*) (IMEMS 2013). Deception Point: This site has a total of 12 migratory shorebird species, and consistently records >500 individuals per survey (Wildlife Unlimited 2012-2018). It supports a significant number of vulnerable and threatened species including: Eastern Curlew (*Numenius madagascariensis*), Lesser Sand Plover (*Charadrius mongolus*) and Greater Sand Plover (*Charadrius leschenaultia*) (IMEMS 2013).	6.2: 4 (Very high) *important feeding site* 6.4: 4 (Very high) *important roosting site*

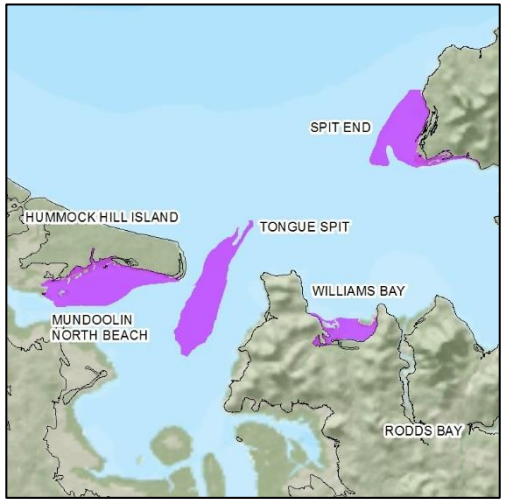
Special Feature Name	Description	Measure: Score (Rating)
BFC_EC_22: Other important shorebird roosting and feeding Sites of the Fitzroy estuary  	Other important shorebird intertidal flats and claypans are located in the north-west section of the Fitzroy Estuary. While shorebird numbers are lower here, they serve as part of the greater complex of roosting and feeding sites in the Fitzroy Estuary. Cattle Point: One of the largest exposed mudflat in the region with a high abundance of invertebrates. Its upper shore is dominated by small bivalves (more abundant than anywhere in Curtis Coast), providing an important resource for bivalve specialists such as the endangered Great Knot (*Calidris tenuirostris*) and Red Knot (*Calidris canutus*) (Choi et al. 2017). Shorebirds also roost here in high tide, choosing to feed on exposed mudflats in the north and roosting near Rundle beach in the south. It has recorded a total of 15 species, and also supports a significant number of Lesser Sand Plovers (*Charadrius mongolus*) and Bar-tailed Godwits (*Limosa lapponica baueri*) (IMEMS 2013). Mackenzie Island: This site has recorded a total of 11 species and supports a significant number of Lesser Sand Plover (*Charadrius mongolus*) and Eastern Curlew (*Numenius madagascariensis*) (IMEMS 2013). Other Vulnerable and Endangered species recorded include: Bar-tailed Godwit (*Limosa lapponica baueri*), Greater Sand Plover (*Charadrius leschenaultia*) and Great Knot (*Calidris tenuirostris*). Shorebirds have been observed to use this site as an alternative roost when disturbed at Cattle Point. Mud Island: This site has recorded a total of nine migratory shorebirds species. The eastern claypan and mangroves are most often used for roosting, due to their proximity to the intertidal mudflat for feeding at low tide. Bar-tailed Godwit (*Limosa lapponica baueri*) and Eastern Curlew (*Numenius madagascariensis*) are the most frequently recorded species.	6.2: 3 (High) *important feeding site* 6.4: 3 (High) *important roosting site*

Special Feature Name	Description	Measure: Score (Rating)
BFC_EC_23: Significant shorebird roosting and feeding Sites of North Curtis 	The Yellow Patch Estuary supports the largest number of shorebirds in the Curtis Coast region, with over 5,000 individuals recorded on a single survey (IMEMS 2013) and consistently >1,000 individuals in recent years (Wildlife Unlimited 2013-2018). The offshore sandbar in the north is a unique geomorphic feature that provides roosting ground for a large number of shorebirds. It is exposed further in low tide, acting as a feeding area also. Shorebirds are recorded to a lesser extent at Mud Bay and Yellow Patch mangroves at the mouth of the estuary further south. Nineteen migratory shorebird species have been recorded at Yellow Patch Sandbar, which support a significant number of vulnerable and endangered species such as Eastern Curlew (*Numenius madagascariensis*), Lesser Sand Plover (*Charadrius mongolus*) and Bar-tailed Godwit (*Limosa lapponica baueri*) (IMEMS 2013). This site previously supported >1% of the EAAF population of Whimbrels (*Numenius phaeopus*) (IMEMS 2013).	6.2: 4 (Very high) *important feeding site* 6.4: 4 (Very high) *important roosting site*

Special Feature Name	Description	Measure: Score (Rating)
BFC_EC_24: Other important shorebird roosting and feeding sites of North Curtis 	Other important shorebird roosting and feeding sites in North Curtis include Station Point and Keppel Creek. Both sites have recorded over 500 individuals per survey (Wildlife Unlimited 2012-2018), with high tide roosts immediately adjacent to large intertidal flats for feeding. Prey availability and roosting numbers are lower than Yellow Patch (BF_EC_23), but may be used as alternative sites in this region.	6.2: 3 (High) *important feeding site* 6.4: 3 (High) *important roosting site*

Special Feature Name	Description	Measure: Score (Rating)
BFC_EC_25: Significant shorebird roosting and feeding Sites of Port Curtis  	The Pelican Banks intertidal mudflat is one of the largest exposed mudflats in the Curtis Coast area, at greater than 1 km wide on most low tides (Choi et al. 2017). Over 1,000 individuals have been recorded foraging at low tide (GHD 2011 a,b,c,d; SES 2011; SES 2012) and roosting at claypans to the north-west (Wildlife Unlimited 2013-2018). Fourteen migratory shorebird species have been recorded here (Wildlife Unlimited 2018), including a significant number of endangered species such as Eastern Curlew (*Numenius madagascariensis*), Bar-tailed Godwit (*Limosa lapponica baueri*) and Great Knot (*Calidris tenuirostris*) (IMEMS 2013). The Pelican Banks mudflat and claypan supports the majority of birds in this complex. The western Facing Island mudflat is used by the same flock of shorebirds found on Pelican Banks as an alternate site. Both sites are highly abundant in polychaete worms (Choi et al. 2017). During low tide, shorebirds spread across the Pelican Banks mudflat and have been observed to fly across the narrow channel to feed on Facing Island. The Facing Island claypan further south is also used as an alternative roost in this complex, but numbers are lower here (maximum 332 individuals recorded) (Wildlife Unlimited 2018). The Pelican Banks-Facing Island region has the highest overall prey availability in Curtis Coast (Choi et al. 2017).	6.2: 4 (Very high) *important feeding site* 6.4: 4 (Very high) *important roosting site*

Special Feature Name	Description	Measure: Score (Rating)
BFC_EC_26: Significant shorebird roosting and feeding sites of Mundoolin-Colosseum  	The Mundoolin Rocks eastern claypan records the highest number of roosting shorebirds for the Mundoolin-Colosseum-Rodds Peninsula region. Over 1,000 individuals have been recorded at high tide surveys with 15 migratory shorebird species found here (IMEMS 2013; Wildlife Unlimited 2013-2018). Endangered species such as Eastern Curlew (*Numenius madagascariensis*) and Bar-tailed Godwit (*Limosa lapponica baueri*) have been recorded in significant numbers here (IMEMS 2013). The Mundoolin eastern claypan acts as a primary roost in this region however, the western claypan and central mangrove island are also used as alternative roosts. The intertidal mudflat adjacent to the eastern claypan is used for feeding and is abundant in polychaete worms (Choi et al. 2017).	6.2: 4 (Very high) *important feeding site* 6.4: 4 (Very high) *important roosting site*

Special Feature Name	Description	Measure: Score (Rating)
BFC_EC_27: Other important shorebird roosting and feeding areas of Mundoolin-Colosseum-Rodds Peninsula  	Surrounding claypans and intertidal flats in Mundoolin North Beach, Tongue Spit, Williams Bay and Spit End are used as part of the same complex of roosting and feeding sites as BFC_EC_26. Choi et al. (2017) recorded shorebird movement throughout these sites however, numbers are lower here. Historically, Mundoolin North Beach supported the highest number of shorebirds in the region (19 species, maximum 1,211 individuals recorded) (IMEMS 2013). Shorebird numbers have dropped substantially in recent surveys, and now records 12 species and a maximum of 251 individuals in the past 7 years (Wildlife Unlimited 2018). Spit End on Rodds Peninsula carries the largest abundance of Brachyuran (crabs) for the Curtis Coast region, a preferred prey type for Eastern Curlews (*Numenius madagascariensis*), Whimbrels (*Numenius phaeopus*) and Terek Sandpipers (*Xenus cinereus*) (Choi et al. 2017).	6.2: 3 (High) *important feeding site* 6.4: 3 (High) *important roosting site*

[3] Conservation rating between 1 (Low) and 4 (Very High).

7.3 Compiled special area results

The panel identified approximately 23% of the study area as being occupied by ecosystem/features considered to be of 'Very High' ecological value and 1% as being of 'High' ecological value and the remainder of the study area occupied by ecosystems/features not identified by the expert panel.

Figure 15 represents the compiled product reflecting panel nominated special areas and associated ratings. In instances where more than one special feature is attributed to a spatial unit, the highest category was assigned.

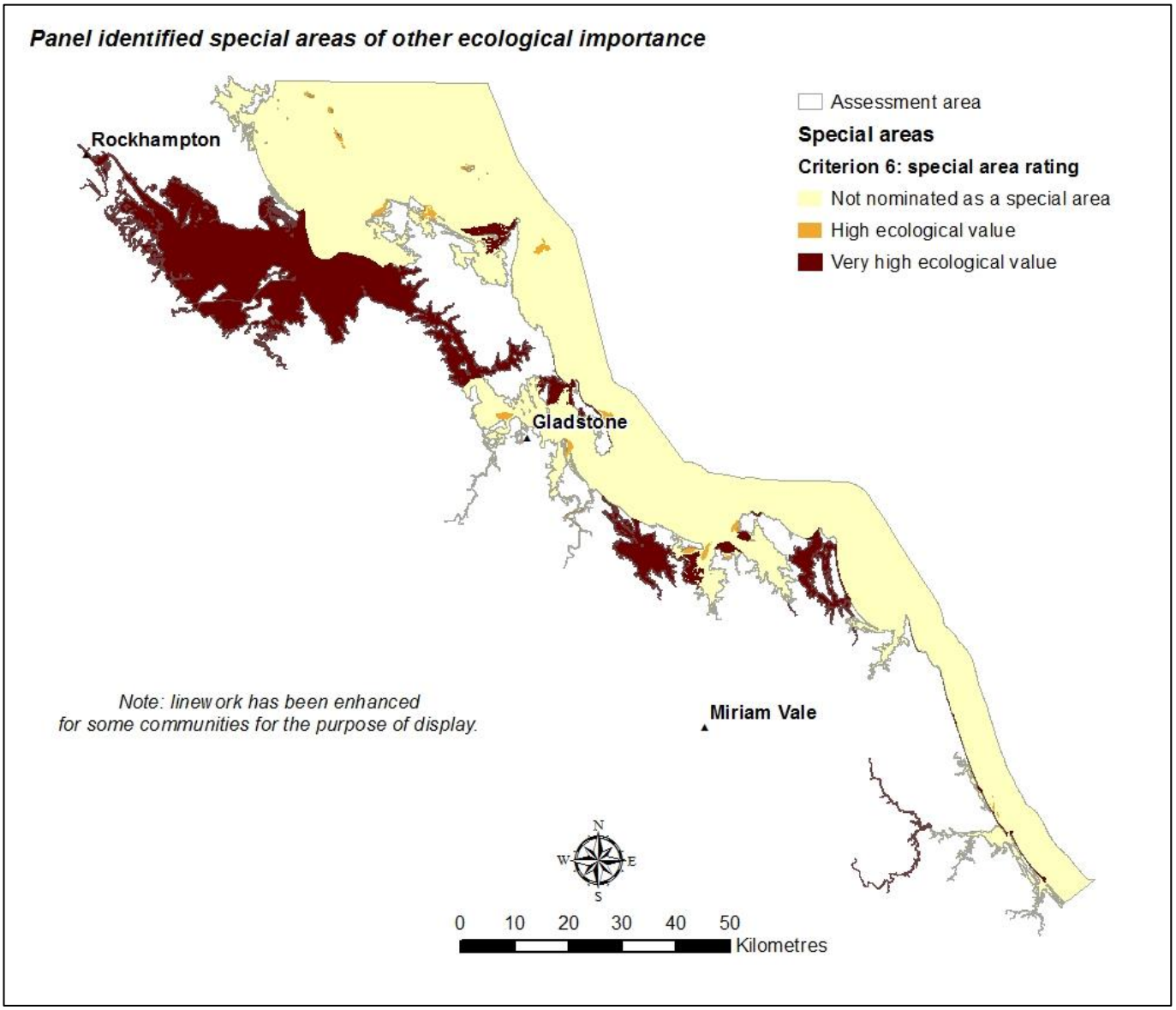


Figure 15: Panel identified special areas of other ecological importance

8 Discussion

This report describes the methods and results for an assessment of common conservation values applied to the subtidal and intertidal environments extending from just south of the mouth of Baffle Creek to north of the Fitzroy River. Ongoing industrial and coastal land use pressures continue to apply to the study area, and the long term viability of habitats and associated taxa depends upon appropriate management plans and actions which reduce or negate environmental harm. The work presented here is intended to provide a preliminary information platform and method to assist decision making processes, subject to the limitations described.

8.1 Limitations

The expert panel and authors highlighted several constraints to be considered when interpreting assessment results, based upon the criteria and approach used. These are typical across most broad conservation assessments and relate largely to the availability and completeness of input data.

The panel noted that substantial knowledge gaps exist with respect to certain taxa groups and communities, their ecology, distribution, abundance, rarity and vulnerability. With respect to Criteria 2, 3 and 4 (Taxa Richness, Threatened Taxa and Priority Taxa respectively) the accuracy of the richness scores presented here is affected by the availability of comprehensive taxa records obtained through systematic survey effort. Examination of the input data highlighted spatial variability in the application of survey effort across the study area. Compliance for the Gladstone Ports Corporation's Western Basin Dredging and Disposal project for example, initiated the Ecosystem Research and Monitoring Program which provided a high degree of information for selected areas. As a result, reasonable levels of survey effort occur over parts of the study area, whilst for other areas, limited to no effort has occurred.

Certain taxa groups are also inherently subject to higher levels of survey effort due to public and political interest, accessibility with respect to the environments they utilise, and the cost and difficulty associated with undertaking taxa specific targeted surveys. Migratory and resident shorebirds have been subject to a higher level of effort due to public interest, international agreements, and greater accessibility to the environments where they occur. Likewise, more detailed research has been conducted by independent experts on threatened taxa/communities such as turtles, dolphins, dugongs and coral communities. Conversely, for many taxonomic groups of invertebrates, scientific knowledge and survey effort across the study area is limited. As such the resulting maps and species lists presented in this report provide only a representation of current 'knowledge'.

The panel also noted that marine/estuarine environments are highly dynamic, subject to both gradual environmental change and stochastic events. Temporal surveys of seagrass/coral community structure indicate that the abundance of individuals and community compositions fluctuate as a result of environmental conditions. Many of the compiled records are collected from sites which may have only been surveyed on one or two occasions and provide a snapshot in time, rather than a long term reflection of the community/ecosystem generally present.

With respect to record compilation, the adequacy of Criteria 2, 3 and 4 (Taxa Richness, Threatened Taxa and Priority Taxa Respectively) are also dependent upon the comprehensiveness of the data sources reviewed. Whilst the current assessment undertook a wide ranging review in terms of available sources, other sources may not have been identified and thus utilised in the course of this study. All records, irrespective of whether they were associated with breeding, resting, feeding sites, or simply of an individual traversing from one site to another, were retained. Thus, high richness should not necessarily be construed as a reflection of dependency of species on an area in terms of direct habitat utilisation.

The completeness of Criteria 4, 5 and 6, in terms of comprehensively identifying priority taxa, at risk ecosystems and other special areas of ecological importance, is largely reliant upon the range of experts who could contribute to the expert panel process. Whilst there are significant knowledge gaps in regards to some taxon groups and communities, additional experts with knowledge of other taxa and communities, and/or other parts of the study area, may have resulted in the identification of additional species, at risk communities and/or areas of ecological importance.

Issues of scale associated with base mapping may also impact on the consistency of the results. This study used a draft version of the QWISBMP benthic habitat mapping as the basis for estimating habitat diversity, identifying at risk ecosystems and delineating special features. This mapping has since been subject to further refinement. By necessity of available information, QWISBMP utilises numerous base inputs mapped at various scales to spatially delineate habitat units. Consequently the scale of mapping within the product varies and this similarly impacts relevant criteria outputs in the current assessment.

A further issue raised with respect to Criterion 1 (Habitat Diversity), was it did not account for inherent habitat complexity within habitat types. The panel noted that high diversity and productivity are more likely on reefs with a variety of coral growth forms and greater structural complexity, rather than where dominated by a particular coral

species or group (e.g. such as branching *Acropora* spp.). In addition, one of the habitat diversity measures was reliant upon the ranked dominant habitat type present within an area, and did not account for the fact that co-habitat types may be present resulting in greater heterogeneity. Addressing these elements in future reviews, will provide a more accurate representation.

As with other conservation assessments, the categorisation of results into classes (i.e. Very high, High, Medium, Low) is subjective. The manner in which criteria have been independently rated to provide a measure and subsequent criteria scores, with the exception of Criterion 5 (At Risk Ecosystems) and 6 (Special Areas), consisted of assigning scores of Very High through to Low based upon quantiling areas for all grid cell units for which data was available. Thus, thresholds used to assign rating values of Very high to Low, are not ecologically defined and are intended to provide a relative representation only.

Lastly, this assessment is not intended to replace the need for further survey effort or expert elicitation, rather, to provide a preliminary information platform to aid decision making when used in conjunction with other information sources. As mentioned in Chapter 1, the majority of the study area is captured under state, federal or international instruments including the Great Barrier Reef World Heritage Area, State Marine Parks, declared fish habitat areas, and nationally important wetlands. Whilst potentially not captured as special areas by the panel - by default, such areas should be considered of being of very high/state significance.

8.2 Recommendations

Further investigation to identify and incorporate additional criteria relevant to the marine/estuarine environment such as condition, system connectivity, ecosystem productivity, abundance and biomass, and to capture the interdependencies between and within ecosystems and taxon groups, will facilitate development of a more robust and comprehensive assessment. Greater understanding of the associations and dependences between certain taxa groups and the ecosystems they utilise, coupled with greater survey effort, will assist in appraising individual ecosystem contribution and importance.

Unfortunately, data coverage resulting from comprehensive surveys, especially given the difficulties and costs of undertaking such within the marine environment, is unlikely to be available in the immediate future. Therefore, increased application and reliance of modelling approaches which quantify patterns in seabed biodiversity, habitat and environmental conditions, may provide better consistency and representation in the interim. For example, Pitcher et al (2017) undertook a broad assessment of seabed biodiversity across the continental shelf of the Great Barrier Reef World Heritage Area, part of which examined the use of biophysical data as environmental correlates of biodiversity and benthic communities. Availability of fine scale seabed mapping, such as produced through the QSIC, may facilitate similar inferential approaches.

In addition, the QISC provides an essential framework comparable to the Queensland Herbarium's regional ecosystem mapping, critical to the conservation of Queensland's terrestrial and fringing marine/estuarine vegetation communities. Expansion of the project to other areas to identify discrete areas of marine/estuarine habitat, coupled with improved data made available through broader application and technological advancements (i.e. remote sensing innovations), will enable determination of ecosystem rarity, community diversity, local area complexity, aid in identifying systems at risk, as well as assist in targeting research. Incorporation of such components will result in the development of a more robust and representative marine/subtidal environ conservation values assessment.

8.3 Summary

The current assessment represents the first time that a broad scale delineation of common conservation criteria has been applied to the intertidal and subtidal environs of Queensland. The assessment identifies areas of potential importance through use of available data and application of taxa richness mapping relevant to broad taxa groupings, the presence of listed threatened species, and other species considered at risk by experts. In addition, the assessment identifies and delineates panel confirmed/nominated threatened/at risk ecological communities and additional areas identified of special ecological importance. The use of expert elicited information is an essential component to this conservation assessment and increases the assessment comprehensiveness through infilling of data/knowledge gaps that arise from the reliance upon known records alone.

An additional spatial output, not presented in this report, is the development of a preliminary species inventory derived from multiple sources encompassing approximately 400,000 native marine and estuarine taxa records. The inventory has been applied at a 2km hexagon grid scale, enabling generation of species lists within a local area and which can be expanded upon in the future as further information becomes available.

Detailed content relating to taxa/ecosystem ecology, distribution and the values they encompass has been incorporated in the report to provide context and justification as to the reasons for inclusion. The spatial outputs in conjunction with the taxa and community descriptions presented in this report, provide a compiled information

source not previously available for the area. Interrogation of these outputs enables the prompt acquisition of information relevant to an area of interest, essential to effective conservation planning and management activities.

References

Alluvium Consulting (2011). *Framework for the assessment of river and wetland health: findings from the trials and options for uptake*, Waterlines report, National Water Commission, Canberra.

Ayling, A.M., Ayling, A.L. & Ceccarelli, D.M. (2013). Changes in Benthic communities on Fringing Coral Reefs around Facing Island: August 2013. Prepared for Gladstone Ports Corporation.

Bamford, M., Watkins, D., Bancroft, W., Tischler, G. & Wahl, J. (2008). Migratory shorebirds of the East Asian — Australasian flyway: population estimates and internationally important sites, Wetlands International — Oceania, Canberra.

Beale, J.P. & Zalucki, M.P. (1995). Status and distribution of *Acrodipsas illidgei* (Waterhouse and Lyell) (Lepidoptera: Lycaenidae) at Redland Bay, southeastern Queensland, and a new plant-association record. *Journal of Australian Entomological Society*, **34**: 163-168.

Black, R., Houston, W. & Jaensch, R. (2010). Evidence of regular seasonal migration by Australian Painted Snipe to the Queensland tropics in autumn and winter. *The Stilt*, **58**: 1-9.

Blackman, J.G., Perry, T.W., Ford, G.I., Craven, S.A., Gardiner, S.J. & De Lai, R.J. (1999). Characteristics of important wetlands in Queensland. Environmental Protection Agency, Queensland.

BMT WBM (2009). Port Curtis Reef Assessment. Report prepared for Queensland Gas Corporation. December 2009.

BMT WBM (2013). Central Queensland corals and associated benthos: Monitoring review and gap analysis. April 2013. Prepared for the Gladstone Ports Corporation.

Borsboom, A. (2006). Nomination to re-classify the rare Varanus semiremex to both 'near threatened' and 'of least concern' under the Nature Conservation Act 1992. Environmental Protection Agency, Brisbane.

Braby, M.F. (2004). The Complete Field Guide to Butterflies of Australia. CSIRO Publishing: Collingwood, Victoria.

Burnett, S. (1997). Colonizing Cane Toads cause population declines in native predators: reliable anecdotal information and management implications. *Pacific Conservation Biology*, **3**: 65-72.

Cagnazzi, D. (2013). Review of Coastal Dolphins in central Queensland, particularly Port Curtis and Port Alma regions. Report to Gladstone Port Corporation.

Cagnazzi, D., Parra, G.J., Westley, S. & Harrison, P.L. (2013). At the heart of the industrial boom: Australian Snubfin Dolphins in the Capricorn Coast, Queensland, need urgent conservation action. *PLoS ONE*, **8**(2): e56729. Doi:10.1371/journal.pone.0056729.

Campbell, M.J., Courtney, A.J., Wang, N., McLennan, M.F., and Zhou, S. (2017). Estimating the impacts of management changes on bycatch reduction and sustainability of high-risk bycatch species in the Queensland East Coast Otter Trawl Fishery: FRDC Final Report Project number 2015/014. Brisbane, Queensland.

Campbell, H.A., Watts, M.E., Sullivan, S., Read, M.A., Choukroun, S., Irwin, S.R. & Franklin, C.E. (2010). Estuarine crocodiles ride surface currents to facilitate long-distance travel. *Journal of Animal Ecology*, **79**: 955-964.

Choi, C.Y, P.F. Battley, M.A. Potter, K.G. Rogers & Z. Ma. (2015). The importance of Yalu Jiang coastal wetland in the north Yellow Sea to Bar-tailed Godwits Limosa lapponica and Great Knots Calidris tenuirostris during northward migration. Bird Conservation International 25, 53-70.

Choi C.-Y., Coleman, J., Klaassen, M., Moffitt, D.J., Rogers, D., Skilleter, G., & Fuller, R.A. (2017). Final Report: Migratory Shorebird Monitoring – Understanding Ecological Impact (CA12000284). Report produced for the Ecosystem Research and Monitoring Program Advisory Panel as part of GPC's Ecosystem Research and Monitoring Program.

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

Cogger, H. G. (2000). Reptiles and Amphibians of Australia. Reed Books: Port Melbourne.

Dennis, T.E. & Lashmar, A.F.C. (1996). Distribution and abundance of White-bellied Sea-Eagles in South Australia. *Corella*, **20**: 93-102.

Department of Environment (DoE) (1997). Conservation and management of whales and dolphins in Queensland 1997-2001. Department of Environment: Brisbane.

Department of Environment and Heritage (DEH) (2005). Humpback whale recovery plan 2005-2010. Department of Environment and Heritage: Canberra.

Department of the Environment (2015). Conservation Advice *Calidris ferruginea* curlew sandpiper. Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/856-conservation-advice.pdf. Accessed 10 December 2018.

Department of the Environment (2018a). *Carcharias taurus* (east coast population) in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed 15 November 2018.

Department of the Environment (2018b). *Calidris canutus* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed 16 November 2018.

Department of the Environment (2018c). *Calidris tenuirostris* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed 30 November 2018.

Department of the Environment (2018d). *Carcharias taurus* (east coast population) in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed 15 November 2018.

Department of the Environment (2018e). *Charadrius leschenaultii* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed 16 November 2018.

Department of the Environment (2018f). *Charadrius mongolus* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed 16 November 2018.

Department of the Environment (2018g). *Limosa lapponica baueri* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed 19 November 2018.

Department of the Environment (2018h). *Haliaeetus leucogaster* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed 21 November 2018.

Duke, N.C. & Mackenzie, J. (2016). Southern GBR Coastal Habitat Archive and Monitoring Program (S-GBR CHAMP): Progress Report December 2016. Report to the National Environmental Science Programme. Reef and Rainforest Research Centre Limited. TropWATER Centre, James Cook University, Townsville, 68p.

Dunn, K.L., Kitching, R.L. & Dexter, E.M. (1994). The Conservation Status of Australian Butterflies. A report to Australian National Parks and Wildlife Service, Canberra.

EHP (2014), Biodiversity Assessment and Mapping Methodology. Version 2.2. Department of Environment and Heritage Protection, Brisbane.

Fabricius, K. (2018). Soft corals of the Great Barrier Reef. Available from: https://eatlas.org.au/content/soft-corals-great-barrier-reef, accessed 14 November 2018.

Garnett, S., Szabo, J. & Dutson, G. (2011). The Action Plan for Australian Birds 2010. CSIRO Publishing, Collingwood.

Gibbs, B. (2014). Gladstone Coral Desktop Study - Desktop Study of the Distribution and Ecological Value of Corals and Coral Reef in the Gladstone Region and Wider Bioregion. Gladstone Ports Corporation Limited.

GHD (2011a). Report for Migratory Shorebird Monitoring Port Curtis to Port Alma: Survey One – January. Report produced for the Ecosystem Research and Monitoring Program Advisory Panel as part of Gladstone Ports Corporation's Ecosystem Research and Monitoring Program.

GHD (2011b). Report for Migratory Shorebird Monitoring Port Curtis to Port Alma: Survey Two – March 2011. Report produced for the Ecosystem Research and Monitoring Program Advisory Panel as part of Gladstone Ports Corporation's Ecosystem Research and Monitoring Program.

GHD (2011c). Report for Migratory Shorebird Monitoring Port Curtis to Port Alma: Survey Three – March 2011. Report produced for the Ecosystem Research and Monitoring Program Advisory Panel as part of Gladstone Ports Corporation's Ecosystem Research and Monitoring Program.

GHD (2011d). Report for Migratory Shorebird Monitoring Port Curtis to Port Alma: Survey Four – November 2011. Report produced for the Ecosystem Research and Monitoring Program Advisory Panel as part of Gladstone Ports Corporation's Ecosystem Research and Monitoring Program.

Goudkamp, K. & Chin, A. (2006). 'Mangroves and Saltmarshes' in Chin. A, (ed) The State of the Great Barrier Reef On-line, Great Barrier Reef Marine Park Authority, Townsville. Available from: http://www.gbrmpa.gov.au/publications/sort/mangroves_saltmarshes, accessed 19 November 2018.

Gynther, I.C. (2011). Distribution and ecology of the water mouse *Xeromys myoides* on Bribie Island, south-eastern Queensland. *Proceedings of the Royal Society of Queensland*, **117**: 275-296.

Heinsohn, G.E. (2008). Dugong *Dugong dugon* (Muller, 1776). In: The Mammals of Australia. (Eds Van Dyck, S. & Strahan, R.), pp. 711-713. New Holland: Chatswood, NSW.

Higgins, P.J. & Davies, S.J.J.F. (Eds) (1996). Handbook of Australian, New Zealand & Antarctic Birds, Volume 3, Snipe to Pigeons. Oxford University Press: Melbourne.

Hooper, J.N.A. & Ekins, M. 2004 (published online 2009). Collation and validation of museum collection databases related to the distribution of marine sponges in northern Australia. (ISBN 978-0-9805692-5-4) Technical Reports of the Queensland Museum 002: 1-224.

Houston, W. & Melzer, A. (2007). Yellow chat (Dawson subspecies) *Epthianura crocea macgregori* recovery plan. Report to Department of the Environment and Water Resources, Canberra. Queensland Parks and Wildlife Service: Brisbane.

IMEMS Pty Ltd (2013). Migratory Shorebird Monitoring Review: Consultancy Agreement CA120022. Gladstone Ports Corporation, Gladstone.

Jacobsen, I., Zeller, B., Dunning, M., Garland, A., Courtney, A., & Jebreen, E. (2018). An Ecological Risk Assessment of the Southern Queensland East Coast Trawl Fishery & River and Inshore Beam Trawl Fishery. Queensland Government, Department of Agriculture and Fisheries.

Jefferson, T.A. & Rosenbaum, H.C. (2014). Taxonomic revision of the humpback dolphins (*Sousa* spp.), and description of a new species from Australia. *Marine Mammal Science,* **30**: 1494-1541.

Jenks, G.F. (1967). The Data Model Concept in Statistical Mapping. International Yearbook of Cartography 7: 186–190

Last, P.R. & Stevens, J.D. (2009). Sharks and Rays of Australia. Second edition. CSIRO: Melbourne.

Lilleyman, A. (2016). Report on potential impacts from disturbance to migratory shorebirds in Darwin: Defence Housing Australia - Lee Point Master-planned Urban Development. Report to EcOz Environmental Consultants, Darwin.

Limpus, C.J. (2007a). A Biological Review of Australian Marine Turtles. 2. Green Turtle *Chelonia mydas* (Linnaeus). Freshwater and Marine Sciences Unit, Environmental Protection Agency: Brisbane.

Limpus, C.J. (2007b). A Biological Review of Australian Marine Turtles. 5. Flatback Turtle *Natator depressus* (Garman). Freshwater and Marine Sciences Unit, Queensland Environmental Protection Agency: Brisbane.

Limpus, C.J. (2008). A Biological Review of Australian Marine Turtles. 1. Loggerhead Turtle *Caretta caretta* (Linnaeus). Freshwater and Marine Sciences Unit, Environmental Protection Agency: Brisbane.

Limpus, C.J. (2009a). A Biological Review of Australian Marine Turtles. 3. Hawksbill Turtle, *Eretmochelys imbricata* (Linnaeus). Freshwater and Marine Sciences Unit, Environmental Protection Agency: Brisbane.

Limpus, C.J. (2009b). A Biological Review of Australian Marine Turtles. 6. Leatherback Turtle, *Dermochelys coriacea* (Vandelli). Freshwater and Marine Sciences Unit, Environmental Protection Agency: Brisbane.

Limpus, C.J., de Villiers, D.L., de Villiers, M.A., Limpus, D.J. & Read, M.A. (2001). The loggerhead turtle, *Caretta caretta* in Queensland: feeding ecology in warm temperate waters. Memoirs of the Queensland Museum 46, 631-645.

Limpus C.J., Parmenter C.J. & Chaloupka M. (2013). Monitoring of Coastal Sea Turtles: Gap Analysis 1. Loggerhead turtles, Caretta caretta, in the Port Curtis and Port Alma Region. Report produced for the Ecosystem Research and Monitoring Program Advisory Panel as part of Gladstone Ports Corporation's Ecosystem Research and Monitoring Program.

Marchant, S. & Higgins, P.J. (Eds) (1990). Handbook of Australian, New Zealand & Antarctic Birds, Volume 1, Ratites to Ducks, Part A: Ratites to Petrels. Oxford University Press: Melbourne.

Marchant, S. & Higgins, P.J. (Eds) (1993). Handbook of Australian, New Zealand & Antarctic Birds, Volume 2, Raptors to Lapwings. Oxford University Press: Melbourne.

Marsh, H., Channells, P.W., Heinsohn, G.E. & Morrissey, J. (1982). Analysis of stomach contents of dugongs from Queensland. *Australian Wildlife Research,* **9**: 55-67.

McDonald, K.R. (2000). 'Crocodiles'. In: *Wildlife of Tropical North Queensland*. (Ed. Ryan, M.), Queensland Museum: Brisbane, pp. 200-201.

Menkhorst, P. & Knight, F. (2001). A Field Guide to the Mammals of Australia. Oxford University Press: South Melbourne.

Milton, D. & Harding S. (2007). Shorebirds of the Burnett Coast: surveys of critical high tide roosts. Queensland Wader Study Group, Brisbane.

Murray, N.J., Phinn, S.R., DeWitt, M., Ferrari, R., Johnston, R., Lyons, M.B., Clinton, N., Thau, D. & Fuller, R.A. (2019). The global distribution and trajectory of tidal flats. *Nature*, **565**: 222-225.

Parra, G.J. & Marsh, H. (2001). Conservation of Inshore Dolphins in Australia's Northern Waters. Report on the Coast and Clean Seas Program; James Cook University: Townsville.

Passeri, D.L., Hagen, S.C., Medeiros, S.C., Bilskie, M.V., Alizad, K. & Wang, D. (2015). The dynamic effects of sea level rise on low-gradient coastal landscapes: A review. *Earth's Future*, **3**: 159-181.

Patterson, D.L., Woehler, E.J., Croxall, J.P., Poncet, S., Peter, H.-U., Hunter, S. & Fraser, W.R. (2008). Breeding distribution and population status of the Northern giant petrel *Macronectes halli* and the Southern giant petrel *M. giganteus*. *Marine Ornithology*, **36**: 15-124.

Pears, R.J., Morison, A.K., Jebreen, E.J., Dunning, M.C., Pitcher, C.R., Courtney, A.J., Houlden, B. & Jacobsen, I.P. (2012). Ecological risk assessment of the East Coast Otter Trawl Fishery in the Great Barrier Reef Marine Park: Technical report, Great Barrier Reef Marine Park Authority, Townsville.

Pitcher, C.R., Doherty, P., Arnold, P., Hooper, J., Gribble, N., Bartlett, C., Browne, M., Campbell, N., Cannard, T., Cappo, M., Carini, G., Chalmers, S., Cheers, S., Chetwynd, D., Colefax, A., Coles, R., Cook, S., Davie, P., De'ath, G., Devereux, D., Done, B., Donovan, T., Ehrke, B., Ellis, N., Ericson, G., Fellegara, I., Forcey, K., Furey, M., Gledhill, D., Good, N., Gordon, S., Haywood, M., Hendriks, P., Jacobsen, I., Johnson, J., Jones, M., Kinninmoth, S., Kistle, S., Last, P., Leite, A., Marks, S., McLeod, I., Oczkowicz, S., Robinson, M., Rose, C., Seabright, D., Sheils, J., Sherlock, M., Skelton, P., Smith, D., Smith, G., Speare, P., Stowar, M., Strickland, C., Van der Geest, C., Venables, W., Walsh, C., Wassenberg, T., Welna, A., Yearsley, G. (2007). Seabed Biodiversity on the Continental Shelf of the Great Barrier Reef World Heritage Area. AIMS/CSIRO/QM/QDPI CRC Reef Research Task Final Report. 320 pp.

Pogonoski, J.J., Pollard, D.A. & Paxton, J.R. (2002). Conservation Overview and Action Plan for Australian Threatened and Potentially Threatened Marine and Estuarine Fishes. Environment Australia: Canberra.

Pople, L., Reinhold, L. & Limpus, C.J. (2016). Marine Turtle Nesting Population: Peak Island Flatback Turtles, 2015-2016 breeding season. Brisbane: Department of Environment and Heritage Protection, Queensland Government. Report produced for the Ecosystem Research and Monitoring Program Advisory Panel as part of Gladstone Ports Corporation's Ecosystem Research and Monitoring Program.

Pyle, R. (2001). Pomacanthidae: Angelfishes. In: K.E. Carpenter and V.H. Niem (eds), FAO species identification guide for fishery purposes. The living marine resources of the Western Central Pacific. Bony fishes part 3 (Menidae to Pomacentridae), pp. 3266-3286. FAO, Rome, Italy.

QPWS (2001). *Varanus semiremex* Rusty Monitor. Species Management Profile, Species Management Manual Vol. 2. Queensland Parks & Wildlife Service, Forest Management: Brisbane.

Queensland Herbarium (2018) Regional Ecosystem Description Database (REDD). Version 11 (December 2018) (DES: Brisbane).

Queensland Museum (2018). *Sponges*. Queensland Government. Available from: http://www.qm.qld.gov.au/Find+out+about/Animals+of+Queensland/Sea+Life/Sponges#.W-vFOv5lJxE, accessed 14 November 2018.

Sandpiper Ecological Surveys (SES) (2011). Gladstone Ports Corporation Report for Migratory Shorebird Monitoring Port Curtis to Port Alma Survey One – January. GHD on behalf of the Gladstone Prots Corporation

Sandpiper Ecological Surveys (SES) (2012). Gladstone Ports Corporation Migratory Shorebird Monitoring – Survey 1 and 2, Year 2 (Jan/Feb 2012). Report prepared on behalf of Gladstone Ports Corporation Limited.

Sea Research (2012). The Impact of Dredge Spoil Dumping on Fringing Coral Reefs Around Facing Island. Prepared for Gladstone Ports Corporation.

Syvitski, J.P.M., Vörösmarty, C.J., Kettner, A.J. & Green P. (2005). Impact of Humans on the Flux of Terrestrial Sediment to the Global Coastal Ocean. *Science*, **308**: 376-380.

Tremul, P.R. (2017). Field observations provide an insight into the ecology of the Rusty Monitor (*Varanus semiremex*) in South-eastern Queensland, Australia. *Memoirs of the Queensland Museum*, **60**: 77-89.

Van Dyck, S. (1997). *Xeromys myoides* Thomas, 1889 (Rodentia: Muridae) in mangrove communities of North Stradbroke Island, southeast Queensland. *Memoirs of the Queensland Museum*, **42**: 337-366.

Von Hagen, H.O. & Jones, D.S. (1989). The fiddler crabs (Ocypodidae: *Uca*) of Darwin, Northern Territory, Australia. *Beagle: Records of the Museums and Art Galleries of the Northern Territory*, **6**: 55-68.

Wallace, C.C. (1999). Staghorn Corals of the World: a revision of the coral genus *Acropora*. CSIRO, Collingwood.

Wells, J. W. & Alderslade, P.N. (1979). The scleractinian coral Archohella living on the coastal shores of Queensland. Australia. *Records of the Australian Museum*, **32**(5): 211–216.

Whiteway, T., Smithers, S., Potter, A. & Brooke, B. (2014). Geological and geomorphological features of Outstanding Universal Value in the Great Barrier Reef World Heritage Area. Record 2014/02. Geoscience Australia, Canberra. http://dx.doi.org/10.11636/Record.2014.002.

Wildlife Unlimited (2012). Gladstone Ports Corporation Report for Migratory Shorebird Monitoring Port Curtis and the Curtis Coast August 2012. Report produced for the Ecosystem Research and Monitoring Program Advisory Panel as part of Gladstone Ports Corporation's Ecosystem Research and Monitoring Program.

Wildlife Unlimited (2013). Gladstone Ports Corporation Report for Migratory Shorebird Monitoring Port Curtis and the Curtis Coast Annual Summer Survey - 2013. Report produced for the Ecosystem Research and Monitoring Program Advisory Panel as part of Gladstone Ports Corporation's Ecosystem Research and Monitoring Program.

Wildlife Unlimited (2014). Gladstone Ports Corporation Report for Migratory Shorebird Monitoring Port Curtis and the Curtis Coast Annual Summer Survey - 2014. Report produced for the Ecosystem Research and Monitoring Program Advisory Panel as part of Gladstone Ports Corporation's Ecosystem Research and Monitoring Program.

Wildlife Unlimited (2015). Gladstone Ports Corporation Report for Migratory Shorebird Monitoring Port Curtis and the Curtis Coast Annual Summer Survey - 2015. Report produced for the Ecosystem Research and Monitoring Program Advisory Panel as part of Gladstone Ports Corporation's Ecosystem Research and Monitoring Program.

Wildlife Unlimited (2016). Gladstone Ports Corporation Report for Migratory Shorebird Monitoring Port Curtis and the Curtis Coast Annual Summer Survey - 2016. Report produced for the Ecosystem Research and Monitoring Program Advisory Panel as part of Gladstone Ports Corporation's Ecosystem Research and Monitoring Program.

Wildlife Unlimited (2017). Gladstone Ports Corporation Report for Migratory Shorebird Monitoring Port Curtis and the Curtis Coast Annual Summer Survey - 2017. Report produced for the Ecosystem Research and Monitoring Program Advisory Panel as part of Gladstone Ports Corporation's Ecosystem Research and Monitoring Program.

Wildlife Unlimited (2018). Gladstone Ports Corporation Report for Migratory Shorebird Monitoring Port Curtis and the Curtis Coast Annual Summer Survey - 2018. Report produced for the Ecosystem Research and Monitoring Program Advisory Panel as part of Gladstone Ports Corporation's Ecosystem Research and Monitoring Program.

Wilkinson, C. (2004). Status of coral reefs of the world: 2004. Australian Institute of Marine Science, Townsville, Queensland, Australia.

Wilson, J.R., S. Nebel & C.D.T. Minton. (2007). Migration ecology and morphometrics of two Bar-tailed Godwit populations in Australia. Emu 107, 262–274.

Woinarski, J.C.Z., Brennan, K., Dee, A., Njudumul, J., Guthayguthay, P. & Horner, P. (2000). Further records of the false water-rat *Xeromys myoides* from coastal Northern Territory. *Australian Mammalogy*, **21**: 221-223.

Wood, E.M. (1983). Reef Corals of the World: Biology and Field Guide. T.F.H. Publications Inc., Ltd., Hong Kong.