CAIRNS SHIPPING DEVELOPMENT PROJECT

Revised Draft Environmental Impact Statement

APPENDIX AN: Additional Baseline Studies Marine Ecology Report (2017)

BMT WBM

Cairns Shipping Development EIS – Additional Studies – Marine Ecology Baseline Report

Reference: R.B22074.008.01.Add_Marine_Ecol_Baseline.docx
Date: June 2017
Confidential

Document Control Sheet

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	Title:	Cairns Shipping Development EIS – Additional Studies – Marine Ecology Baseline Report
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Synopsis:	This technical report provides the results of additional baseline studies describing the marine ecology and sensitive receptors of addition areas potentially affected by the revised Cairns Shipping Development EIS.	

REVISION/CHECKING HISTORY

Revision Number	Date	Checked by		Issued by	
0	8th May 2017	CMJ		BMG	
1	5th June 2017	CMJ		BMG	

DISTRIBUTION

Destination	Revision										
	0	1	2	3	4	5	6	7	8	9	10
Ports North	PDF	PDF									
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1 Introduction

This report presents the findings of the additional marine ecology baseline studies for the revised Cairns Shipping Development (CSD) Environmental Impact Statement (EIS). The recalibrated CSD EIS included the land placement options at either the Northern Sands site or East Trinity, where several sub-options were under consideration. Once the Northern Sands site became the preferred option, macroinvertebrate and fish surveys were ceased at the East Trinity site and Trinity Inlet. A material placement site at Tingira Street is also intended to hold stiff clays, which will not be pumped or dewatered.

With the EIS considering land placement options, further ecological assessments were required to adequately describe areas potentially affected by placement activities, tailwater discharges, and dredge pump-out. The study area was comprised of Hills Creek, Firewood Creek, Trinity Inlet, and the Barron River estuary (hereafter referred to as the estuarine waterways) and offshore pump-out location near Richters Creek offshore from the northern beaches area (Figure 1-1).

The baseline marine ecology program was comprised of the following components:

- Subtidal habitat surveys at locations in Trinity Inlet (no longer considered for potential dredge pump-out) using single-beam acoustic backscatter, underwater video (drop-camera), and remote seagrass sampling (raking) offshore from the northern beaches
- Side-scan sonar habitat surveys of the Barron River and pump-out location offshore from Richters Creek
- A single dry season survey of commercially and recreationally significant fish and crab species at sites in East Trinity and Trinity Inlet
- Wet and dry season surveys of fish and crab species in the Barron River
- Assessments of benthic macroinvertebrate communities within the estuarine waterways (Trinity Inlet, East Trinity), the potential dredge pump-out location (offshore from Richters Creek), and at the proposed maintenance dredging DMPA.
- An assessment of bank and riparian condition along Hills Creek, Firewood Creek, and the Barron River. Note that the baseline (assessment of vegetation both terrestrial and wetlands) is part of Chapter B8 – Terrestrial Ecology. The assessment of riparian vegetation undertaken in the present study was intended to provide background information on aquatic habitat condition and potential sensitivities to changes in water quality conditions.

1.1 Site History and Context

1.1.1 East Trinity

The East Trinity site consists of a large wetland complex that is transitioning from a highly degraded acid lake into a modified intertidal wetland. Tidal influence was removed from the site in the early 1970s when a bund wall and tide gates were installed in an attempt to grow sugar cane on the land. The combined loss of tidal regime and earthworks that disturbed acid sulfate generating soils resulted in the production of an estimated 70,000 tons of sulfuric acid over 20 years. The change in pH and salinity inside the bund led to *Melaleuca leucadendra* and other acid tolerant species colonising the site and widespread vegetation dieback in areas where the pH was too acidic.

The state government acquired the site in 2000 and began remediation from the mid 2000's. Tide gates were used to dampen the tidal signal and neutralise acidity by adding soluble lime during select incoming tide phases. The return to a tidal state with more neutral pH has led to large areas of *Melaleuca* dieback, ponding, and recolonization by mangrove trees and mangrove ferns. Land neighbouring the site is used primarily for growing sugarcane and bananas and the higher elevation land to the east is remnant forest.

The site is currently off limits to the public, but numerous fishers and crabbers access the area by parking cars and boats outside the gates and walking along the bund, or by carrying smaller vessels over the bund. Large crocodiles are abundant within the site which does not fall into the Crocodile Management B zone, unlike Cairns and the Northern Beaches. Large or "problem" crocodiles are actively removed from the Management zone B.

1.1.2 Barron River and Delta

The Barron River is a highly modified system; the major factors influencing its water quality and ecology include alterations to its catchment (particularly in the lower reaches), flow regulation further upstream of the project, and fishing regime.

Tinaroo Dam has regulated flow to the downstream reaches of the Barron River since 1958, with the Barron Gorge Hydroelectric power station regulating flow since 1968. The power station has little effect on wet season flows, but does affect the volume of dry season flow. Dry season environmental flows from the power station and Tinaroo Dam are prescribed per day according to the Resource Operation Plan. Minimum daily flow volumes are based on water levels in Tinaroo Dam; therefore, the operation of the water infrastructure acts to reduce the amplitude of freshwater flows, but increase duration to a point. Once dam level reach critical levels, environmental flows are ceased.

The catchment surrounding the lower Barron River is heavily modified and only a thin strip of native riparian vegetation remains over much of its length. The immediate floodplain catchment has been cleared since the late 1800s when Chinese settlers began growing sugar cane, fruit, and rice. Thus, the natural properties of most of the floodplain wetland (including the ability to improve water quality and buffer flood events) have been highly modified for over a century. Present-day land use immediately surrounding the Barron River consists of cane farming, residential, sand extraction, waste disposal, airport land, and mangrove forest. The void at Northern Sands, which is proposed to serve as a dredged material placement area (DMPA), is the result of sand extraction. During extreme flood events it has connectivity to the Barron River, but is otherwise isolated.

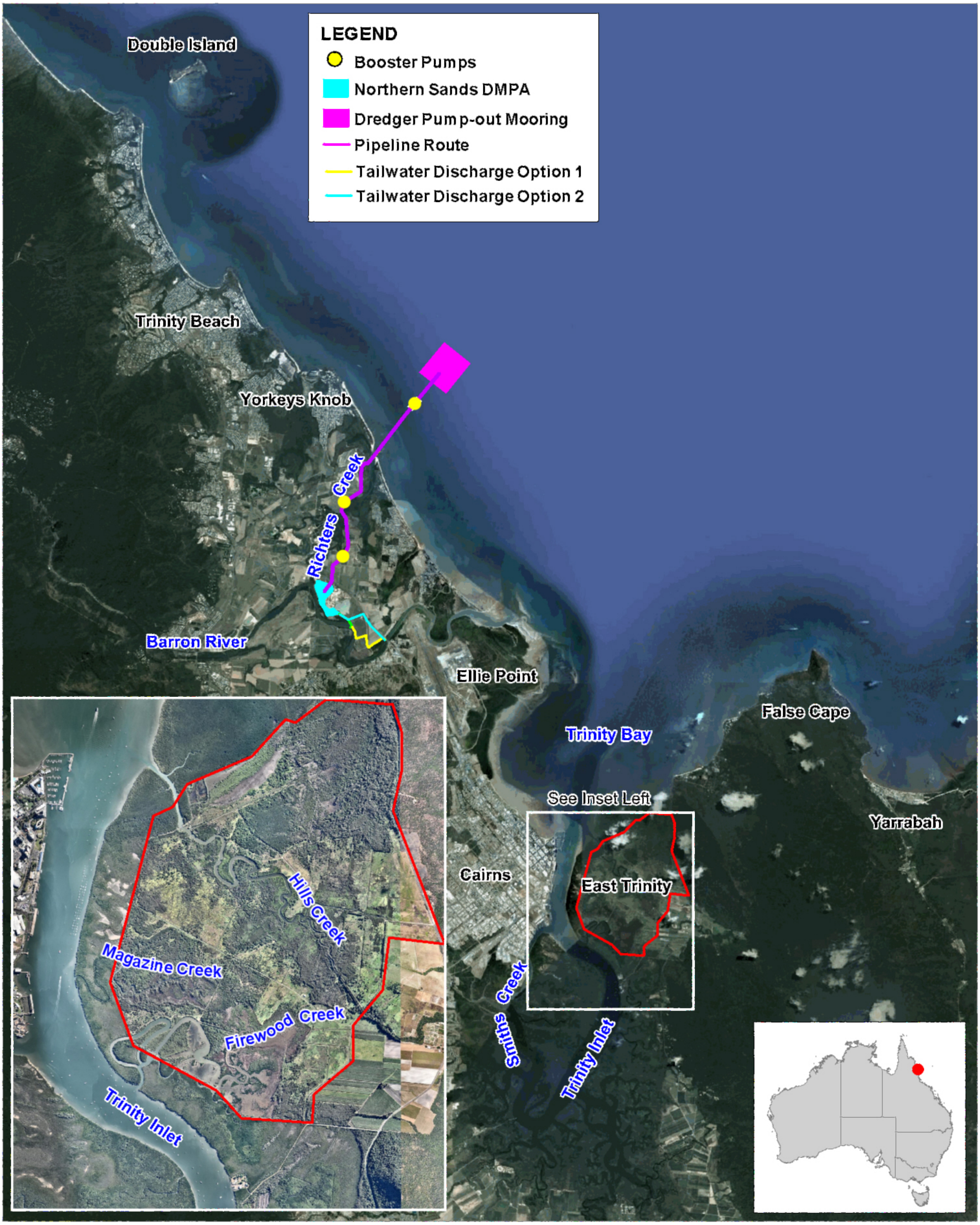
Prior to 1939, the Barron River mouth opened into Trinity Inlet further south, towards Ellie Point. The previous Barron River mouth was more confined than the present day location and provided passage for ships carrying produce to Cairns. The present opening is opening is extremely shallow, dynamic, and unconfined.

Commercial netting in the Barron River was ceased entirely in November 2015, when the Trinity Bay Zone closure was brought into effect. The area between False Cape and the northern tip of Trinity Beach, south to Trinity Inlet was closed to all forms of net fishing at this time. This replaced the small seasonally closed area consisting of a 500 m radius around the mouth of the Barron River from November to February. Recreation fishing effort is substantial as land-based and boat-based angling occurs throughout the system. Certain areas such as the jetties, bridges, creek mouths, open beaches and the Barron River mouth have high recreational fisher utilisation, with anglers present at these features most days of the year.

1.2 Study Aim and Objectives

The broad aim of this study was to collect and update baseline marine ecology data to understand the key ecological components and sensitive receptors in areas potentially affected by the revised CSD EIS. The specific objectives were to:

- Characterise benthic habitats in the estuarine waterways and the offshore pump-out location
- Describe spatial patterns in the composition, abundance and richness of estuarine fauna (fish, crabs, macro-infauna, macro-epibenthos)
- Describe the general characteristics and condition of fringing intertidal habitats to complement fauna assessments
- Determine the key sensitive marine ecological receptors in the estuarine waterways and offshore pump-out location and their potential sensitivities to disturbances resulting from the Project.



Title: **Locality Plan**

Figure: 1-1

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BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

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1.3 Terms of Reference/EIS Guidelines

This marine ecology baseline study addresses the requirements contained in the State Terms of Reference (TOR) and the Commonwealth EIS Guidelines developed for the CSD EIS.

The relevant sections of these documents include:

- Section 5.4.1 (Sensitive Environmental Areas) of the State TOR.
- Section 5.9 (Existing Environment) of the Commonwealth EIS Guidelines.

This marine ecology baseline seeks to describe the main features of the existing environment not described in the original CSD EIS and update information that has become available since the original CSD EIS.

2 Methodology

2.1 Timing of Field Work

The preferred land disposal site was not known at the start of the data collection campaign, so a series of preliminary ecological, hydrodynamic, engineering assessments were conducted to highlight the potential advantages and ecological sensitivities of various sites. Once the Northern Sand site was established as the intended land disposal site, ecological data collection at East Trinity and Trinity Inlet was ceased. Therefore, fish, crustacean and macroinvertebrate data is available for dry and wet seasons at the Barron River, but only dry season data is available for East Trinity and Trinity Inlet.

The following describes the timing of collection each of the marine ecological datasets:

Barron River

- Bathymetric data: July 29th, 2016
- Riparian health assessment: July 29th, 2016
- Dry season fishing and macroinvertebrate survey: between July 30th and August 5th, 2016
- Wet season fishing and macroinvertebrate survey: March 7th to 9th, 2017
- Side-scan acoustic data collection: March 9th, 2017

Trinity Inlet

- Dry season fishing and macroinvertebrate survey between July 30th and August 5th, 2016
- Single-beam acoustic mapping and ground truthing: August 6th to 8th 2016

East Trinity

- Bathymetric data: July 27th to 28th 2016
- Riparian health assessment: July 27th to 28th 2016
- Dry season fishing and macroinvertebrate survey between July 30th and August 5th, 2016

Offshore from Richters Creek and Northern Beaches

- Seagrass rake transects at northern beaches August 2nd 2016
- Side-scan sonar survey offshore from Richters Creek: September 22nd 2016

Proposed Maintenance Dredging DMPA

- Benthic macroinvertebrates: August 2nd 2016

2.2 Equipment and Methods

2.2.1 Acoustic Data Collection

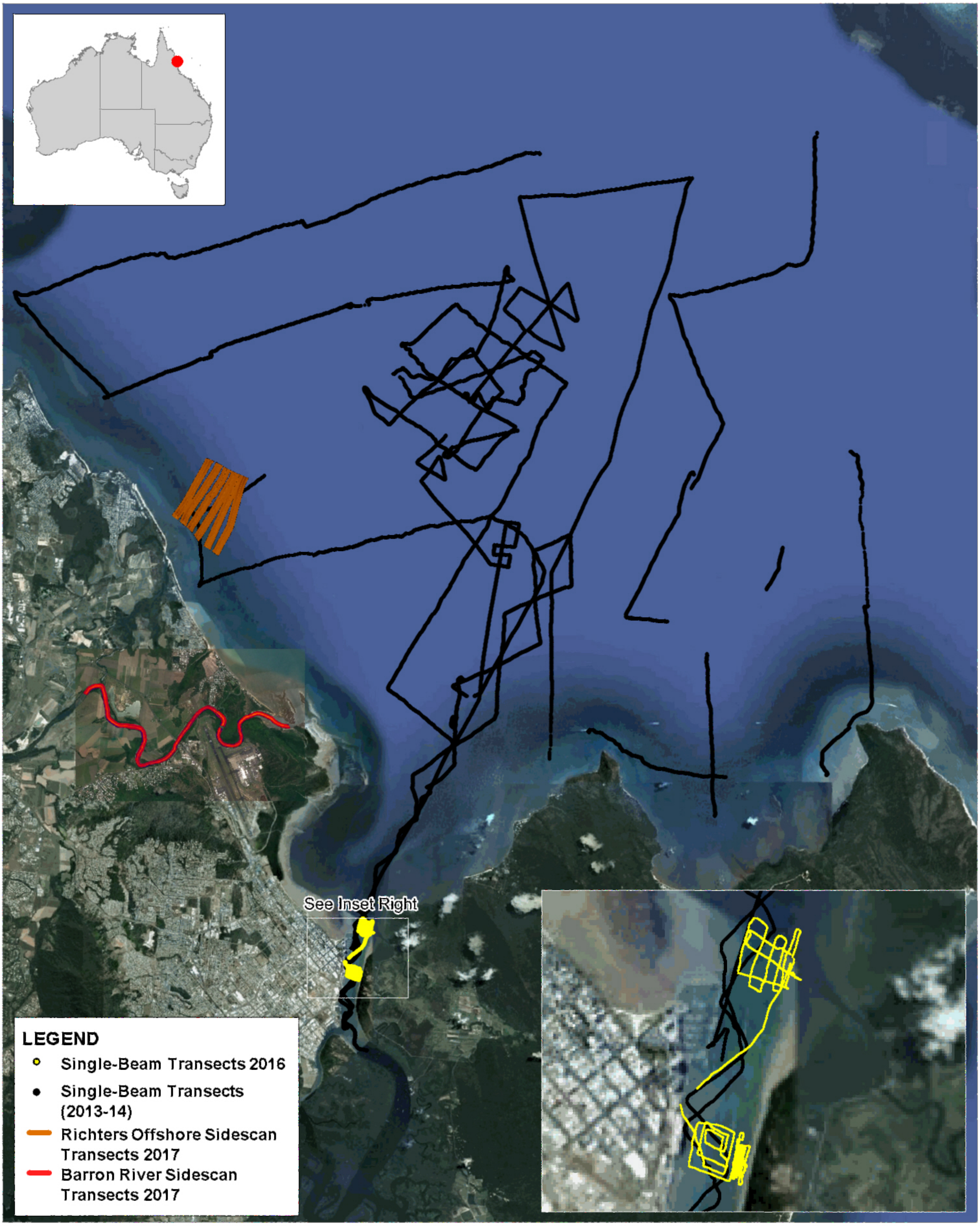
Acoustic data were collected from four focal areas within the wider extent of the areas surveyed in 2013 and 2014 (Figure 2-1). New areas of single-beam data collection are shown in yellow, and new areas of side-scan data are shown in red. These new areas represented potential dredger pump-out locations, near the mouth of Hills Creek, Magazine Creek, and Richters Creek, and the potential impact area of the Barron River estuary..

Collected backscatter data from a single-beam 200 KHz echo-sounder was processed using the same methods used for the previously collected datasets. A commercially surveyed 4.5 m vessel was used to collect acoustic data in Trinity Inlet and the Barron River, amongst the confines of moored vessels and other obstructions in shallow waters. Side-scan acoustic data offshore from the Richters Creek mouth was collected from MV *Viking.*

Conditions within Trinity Inlet were calm, whereas strong south-east winds and 1-1.5 m sea were running during the survey offshore from Richters Creek. These conditions rendered the offshore single-beam backscatter unusable; hence, only the side-scan sonar only is presented here. A small section of rocky substrate on the western edge of Trinity Inlet was used to ground-truth the signal for hard substrate in the single-beam acoustic dataset.

2.2.2 Sides-scan Sonar Data Processing

Benthic habitats were mosaicked using a 450kHz Side Scan Sonar (SSS) systems with a swath width of up to 300 meters. Acoustic data from the SSS were captured and processed using the Scanline 2.1 software. The raw acoustic data were stored in real-time on laptop computers and backup copies of the acoustic data were created each day during data acquisition. Side-scan data was converted to XTF files and mosaicked using Sonarwiz 6. A combination of manual and automated bottom tracking was used to remove the nadir and the program’s automated gain control was used to normalise the brightness. Mosaics were presented over background imagery in MapInfo 12.



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Accoustic Transects 2016

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2.2.3 Drop Camera and Seagrass Assessments

Drop camera assessments were made at 21 sites (yellow) as shown in Figure 2-2. At each site a high-definition underwater video camera with 1800 lumen accessory lights and a live surface feed was used to take video imagery of the sea floor.

High turbidity at the northern beaches prevented the use of underwater video camera. Physical point (rake method; Rodusky *et al*. 2005) sampling was therefore carried out by dragging a weighted rake behind the vessel along a 20 m transect at each of the 21 sites shown in green in Figure 2-2.

2.2.4 Fish and Portunidae Crab Surveys

Fishing surveys were timed to capture flooding and ebbing tides (where possible) in each waterway. Fish and crab surveys were conducted at 12 sites (purple) as shown in Figure 2-2. Sites in Trinity Inlet were positioned such that they could be used to investigate longitudinal gradients in assemblages within Trinity Inlet and the estuarine waterways. For example, sites TRIN2 and TRIN4 were used as Trinity Inlet sites and downstream sites for Firewood Creek and Hills Creek.

Site selection was based on (i) targeting representative habitats in each waterway; (ii) logistical considerations and accessibility; and (iii) health and safety considerations. For example, one of the sites in Hills Creek was re-positioned after a 3 m crocodile persisted within the area.

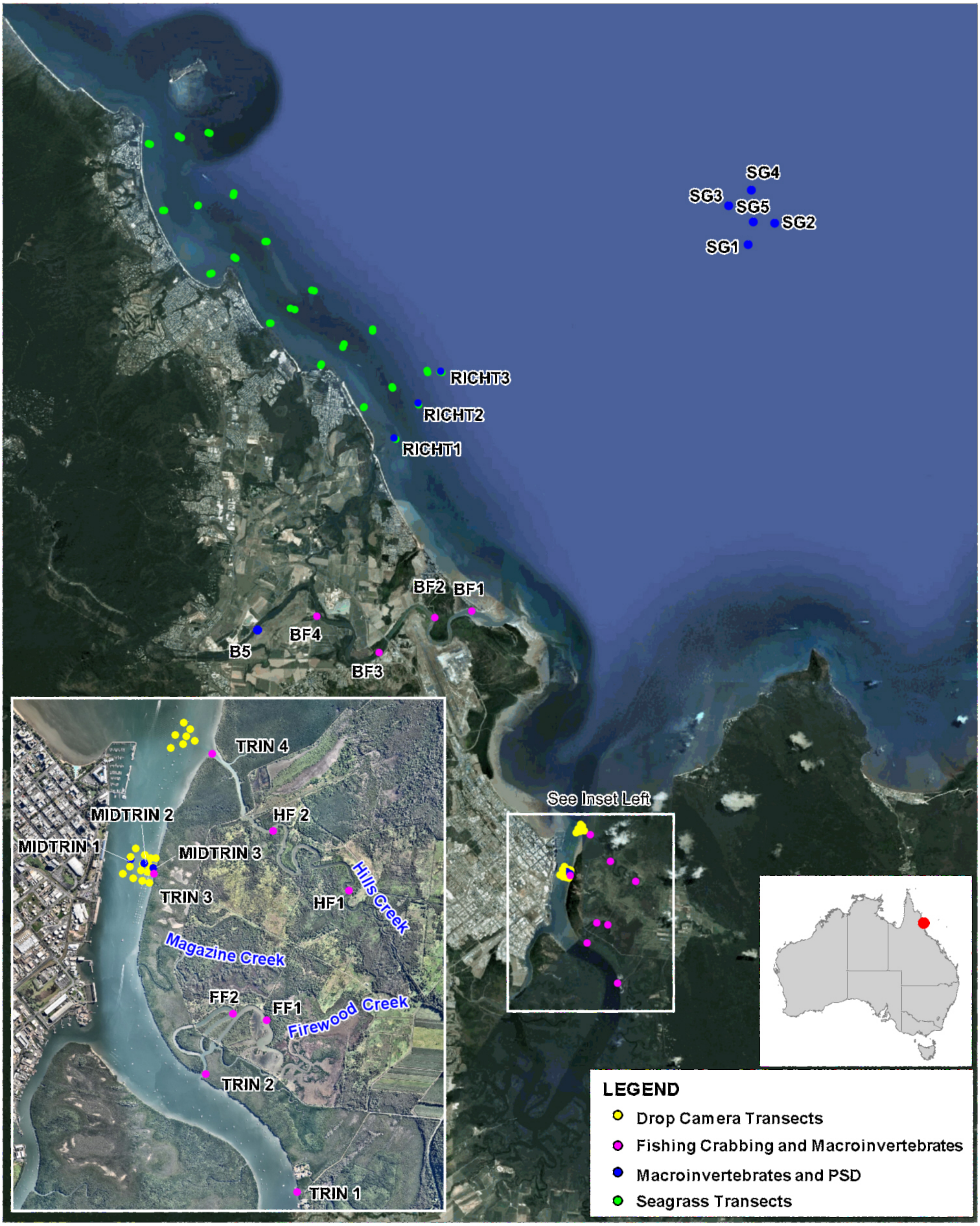
At each site the following methods were used (all during day light hours for health/safety reasons):

- 25 m long gill net with 25 mm mesh (2 hr soak time)
- 25 m long gill net with 75 mm mesh (2 hr soak time)
- 2 m drop cast net (10 shots)
- 10 x collapsible bait traps tied to the shoreline
- 5 x 50cm crab pots.

All sites received the same effort except site BF1 in the dry season, where three crab pots were temporarily lost when they were shifted by the incoming spring tide. Crab pot catch was scaled to crabs per pot per hour to allow comparisons among sites. Also, baited traps were not deployed at BF1 due to lack of anchoring points and strong tidal currents. All species were counted, measured and returned to the water. The sex of portunid crabs (i.e. mud crabs and sand crabs) was also recorded.

2.2.5 Macroinvertebrate and PSD Sampling

A small van Veen grab (0.028 m^2 gape) was used to collect macroinvertebrates and benthic substrate samples at a total of 23 sites (shown in purple and blue in Figure 2-2). At each site, three replicate grabs were taken and sieved through a 0.5 mm screen. The Mid-Trinity sites were averaged to provide one location (Trin 3), giving a total of 21 sites overall. An additional grab was also taken at each location for the laboratory analysis particle size distribution (PSD).



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Marine Ecology Sampling Sites

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Riparian Assessment Sites

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2.2.6 Riparian and Bank Condition Assessment

Photos and observations regarding the dominant riparian cover, community composition, canopy health, and bank profile were taken at points along each waterway, shown in orange in Figure 2-3.

2.3 Data Quality

2.3.1.1 Quality Assurance Procedures

Quality Assurance (QA) during monitoring involved:

- Proper training and supervision of field staff. The team was comprised of two qualified marine ecologists, led by senior marine scientist Dr Conor Jones.
- Use and maintenance of appropriate sampling equipment.
- Sample containers were clearly and accurately labelled and a log of collected samples was maintained and updated.
- Chain of custody forms were maintained and included with samples.
- Data validation included cross check by a second scientist after entry into the database.

2.3.1.2 Quality Control (QC) Procedures

Single-beam Acoustic Data Collection

The following quality control procedures were implemented during data processing:

- Depth picks less than 1 m were filtered to remove misclassifications related to inaccurate depth readings.
- During survey, depth readings were constantly monitored to ensure that there were no actual soundings below 1 m.
- Notes were made during capture of crossing any propeller wash, potential reef, or areas of rough surface conditions
- Classifications below 90% confidence were not used in this assessment.

Quester Tangent Corporation (QTC) suggests that single-beam hydro-acoustic habitat classification should not occur when pitch or roll exceeds 10 degrees. While only habitat classifications greater than 90% confidence were used in this assessment, confidence filtering cannot remove the effects that pitch and roll have on changing the shape of the signal return from oblique returns from a rolling vessel. In this regard, the hydro-acoustic dataset collected at Richters Creek was not considered of appropriate quality to assess sediment types and is not presented. The presence of hard returns (reefs) and determination of sediment type was investigated using side-scan sonar during a subsequent instrument service trip.

3 Results

3.1 Single-Beam Acoustic Data

The cleaned and filtered dataset consisted of 7,613 hydro-acoustic records, which fell into five classes as shown below in Figure 3-1 (two-dimensional ordination along the most significant principal components from clustering). Ground validation surveys indicate that these classes consist of the following:

- Class 1 sediments (dark blue) consisted largely of sands, occasionally with shell grit
- Class 2 sediments (light blue) consisted of muddy sands often with shell grit
- Class 3 sediments (green) consisted of sandy mud, occasionally with shell grit
- Class 4 sediments (brown) were mud with shell grit
- Class 5 sediments (pink) were rock, reef or gravel.

These classes can be seen grading from left to right across the ordination in Figure 3-1.

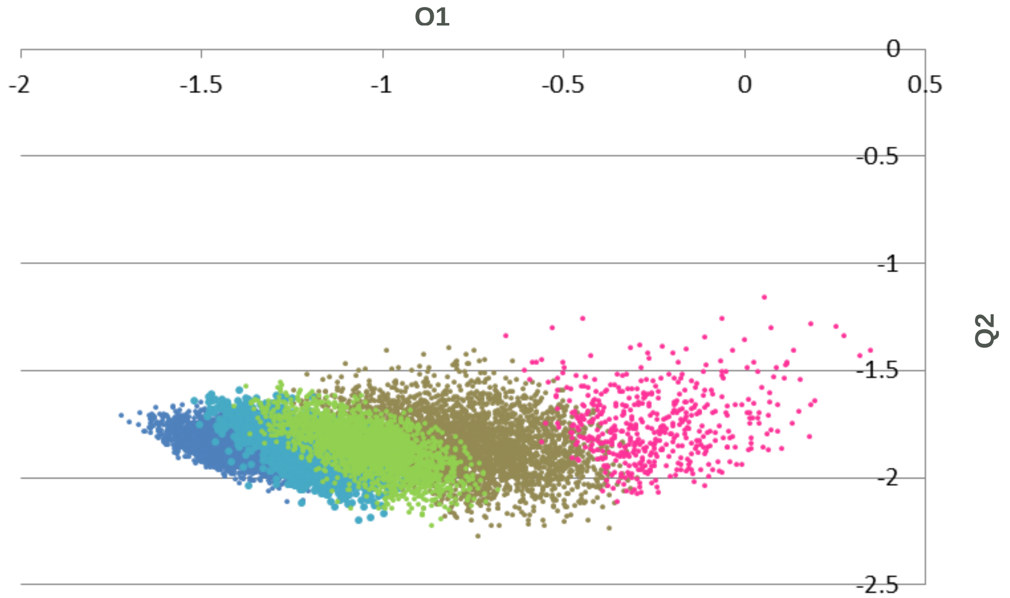
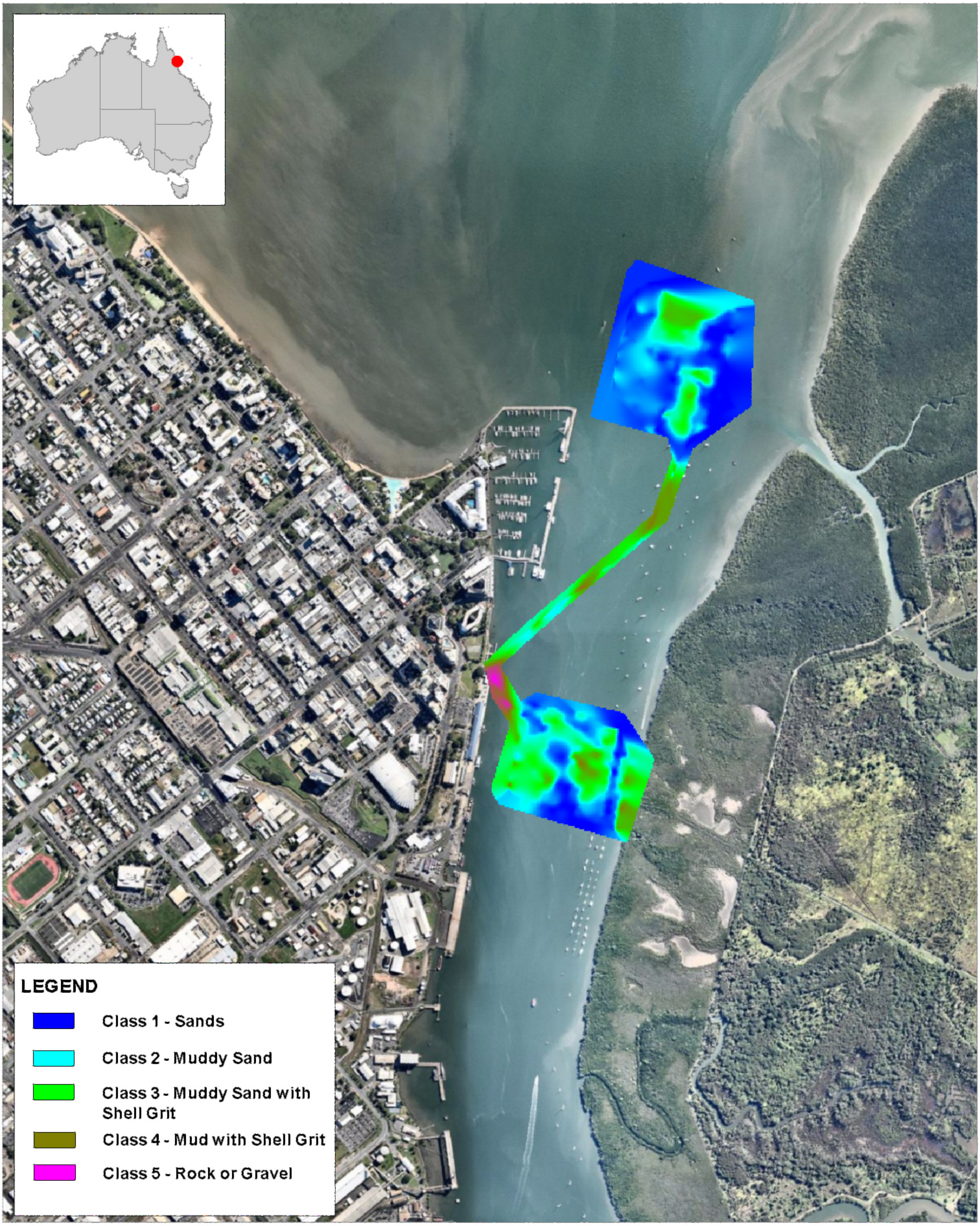


Figure 3-1 Two-dimensional ordination of the five hydro-acoustic classes (1, 2, 3, 4 and 5) against two principal components Q1 and Q2

The distribution of these substrate classes is shown in Figure 3-2. Subtidal habitat mapping at the north of the mouth of Magazine Creek shows a muddy shoreline against the eastern extent of the survey area. Sandy sediments prevail beneath the permanent moorings, with mixtures of sandy and muddy substrates with shell grit along the survey area. No significant reefs or hard substrates were observed here.



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Interpolated 200 kHz single-beam acoustic mapping results

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Rocky substrates were located on the eastern extent of the survey area against the edge of the berthing pockets. At the mouth of Hills Creek there was a mixture of sandy and muddy substrates with shell grit. There were more sands than muds at the mouth of Hills Creek.

3.2 Side-scan Sonar

Side-scan sonar imagery of the sea bed offshore from Richters Creek shows a sandy shoreline with becoming muddier (with shell grit) with distance offshore (Figure 3-3). In the inshore area nearest to the mouth of Richters Creek the area was dominated by brighter more reflective sands associated with sand accumulation and wave energy at the sandbar that has formed offshore from the Richters Creek mouth. Immediately beyond this sandbar, there were some mud channels seen as darker areas amongst the brighter, more reflective sands.

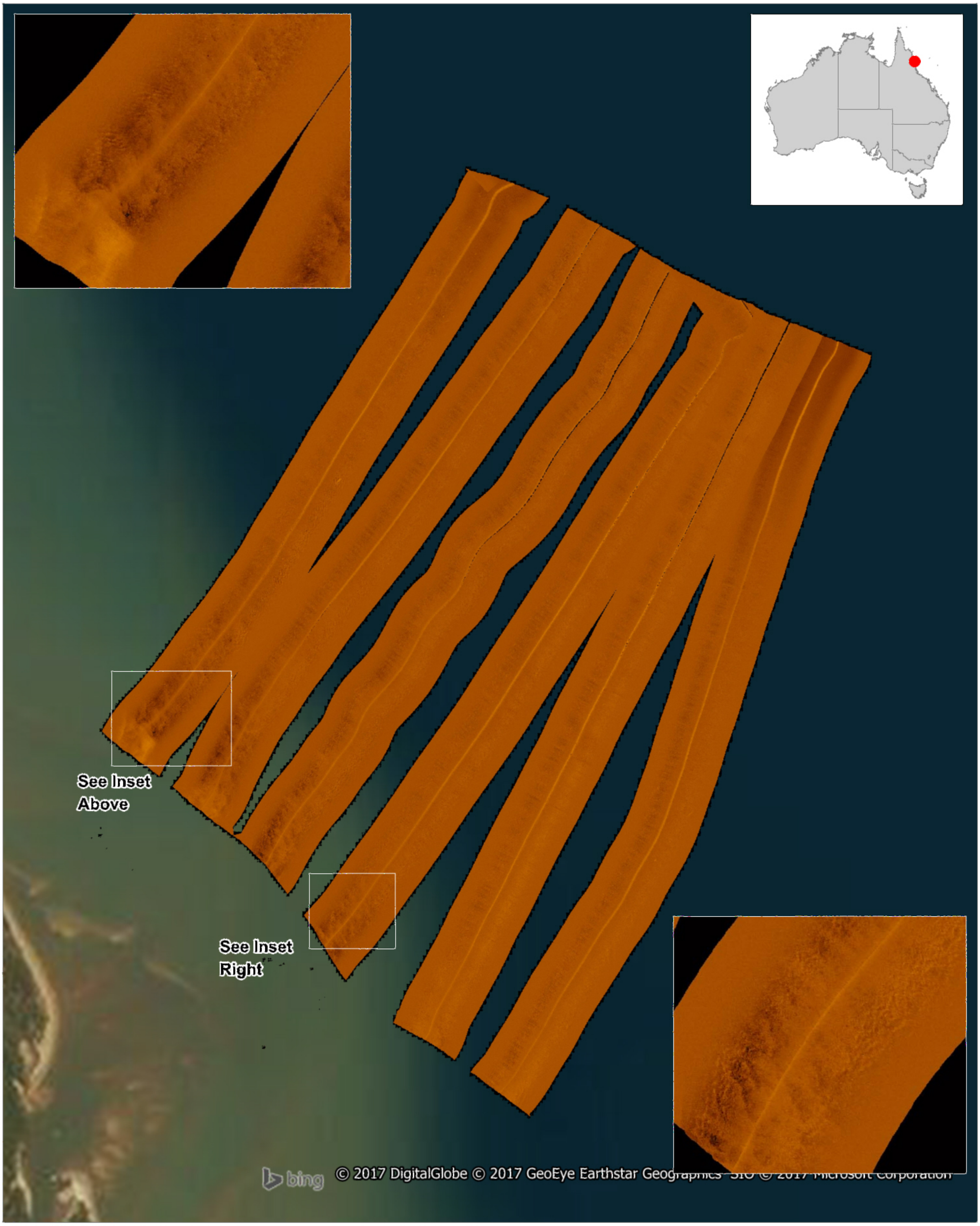
With the exception of these mud channels, the reflectivity of the signal tended to decrease with distance offshore, as sediments became muddier and water became deeper. Small sand ripples can be observed over the top of larger sand berms on the insets shown in Figure 3-3. No reefs or hard substrates were observed in any of the survey lines around the pump-out offshore from Richters Creek.

The side-scan imagery of the Barron River showed a variety of sub-tidal and intertidal habitats from the mouth to the beyond the confluence with Richters Creek (Figure 3-4). Starting upstream, inset 1 shows a large submerged tree on the downstream right bank (DRB) near a large bend in the river, just upstream of the confluence with Richters Creek. This bend represents the deepest section of the downstream surveyed reach at over 7 m below AHD (Figure 3-5). At the confluence with Richters Creek, just downstream of this bend, there are several large rocky outcrops and the downstream left bank (DLB) opposite the northern section of the Northern Sands void is lined with rock and concrete.

The straight stretch of river directly west of the void is relatively shallow (Figure 3-5), and both banks have gradual profiles. The next bend of the river that follows the Northern Sands void is heavily armoured on the DRB with materials of opportunity including boulders, concrete, and steel. The straight section of river (near inset 2 on Figure 3-4) contains several very large sand bars, with a sunken barge located mid-way along this stretch.

This pattern of river morphology continues to the bend shown on inset 3; with large sand banks present mid reach along the straights and rocky hard habitats present along the outside meanders (Figure 3-5). These large mid-channel sand banks along the straight sections of bank were not present downstream of inset 3. Accretion appears instead along the river edges along the straight sections, or along the inside meanders (Figure 3-4, Figure 3-5).

Inset 4 on Figure 3-4 shows the presence of two sets of pylons, one which is a popular structure for land-based fishers, and another more upstream structure, which is not visible from the surface. Between these two structures are a series of rock piles along the DRB which continue upstream to the bend shown in inset 3.



Title:

Sidescan mosaic offshore from Richters Creek

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LEGEND

Title:
Sidescan mosaic of the Barron River

Figure:
3-4

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0 450 900m
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LEGEND

Depth (m AHD)

-9 -6 -4 -3 -2 -1 0

Title:

Bathymetry of the Barron River and Richters Creek

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The long straight section downstream of Inset 4 contains several pylons structures associated with the highway bridge and airport landing lights, otherwise it appears to be muddy and relatively featureless. There are several rock piles along the outside meander of the DLB, and a large amount of rocky habitat associated with a boat ramp on the Barron River Esplanade. There are also several large items of debris located mid-channel, possibly the remains of a wreck.

There is extensive accretion on the inside meander opposite the creek that runs to Machan's Beach. As this meander progresses into the second last meander, directly north of the airport, the outside meander is heavily armoured with rock. This rocky layer continues down, well into the subtidal region and is visible in inset 5 on Figure 3-4.

The final stretch of the Barron is relatively featureless, apart from several shipwrecks, and debris piles shown inset 6 on Figure 3-4. The mouth of the Barron is made up of large shallow sandbanks with occasional woody debris from fallen trees on the shoreline (see Section 3.8).

3.3 Seagrass Communities

3.3.1 Regional Seagrass Overview

While a total of seven species of seagrass have been recorded in the study area (Coles et al. 1992; Rasheed et al. 2013) only five species were present in the 2015 annual monitoring conducted by JCU TropWATER (York et al., 2016). Species present included *Zostera muelleri, Halodule uninervis, Halophila decipiens, Halophila ovalis,* and *Cymodocea serrulata*.

Survey effort conducted by the TropWater is shown in Figure 3-6, is focused on distinct regular monitoring meadows, and does not extend into the northern beaches area, and does not extend into the northern beaches area. Additional survey effort in offshore from Richters Creek to Double Island was conducted by BMT WBM to extend survey cover over the relevant project area (Figure 3-7).

3.3.2 Temporal Changes in Seagrass

Since 2001, staff from JCU – TropWATER (formerly of the Department of Forestry and Fisheries) have undertaken seagrass meadow surveys on an annual basis, representing 15 years of monitoring data over the Trinity Bay and Trinity Inlet regions of the study area. Surveys area have been conducted at the same time of year to prevent seasonal variability confounding long-term trends.

The past 15 years of monitoring has shown great variation in the distribution, extent, biomass and density of seagrass assemblages (Figure 3-8). The most recent survey (York et al. 2016) showed a general improvement in seagrass cover and biomass compared to 2014; however, cover and biomass were still very low compared to pre-2009 conditions (Figure 3-8). The reduction in cover and biomass between 2009 and 2010 sampling episodes coincided with above average rainfall associated with 2010/11 La Niña events and Tropical Cyclone Yasi. It is likely that these conditions reduced the light available for seagrasses causing dieback, as broad-scale reductions in seagrass cover were observed throughout Queensland (McKenzie et al 2012).

As per previous monitoring, the most well developed shallow water meadows were located along the foreshores on both sides of Trinity Bay. The changes in extent that have occurred in in these meadows are shown in Figure 3-9 and Figure 3-10. Between 2014 and 2015 there has been a substantial increase in meadow extent in front of the Cairns Esplanade and much more moderate increase in cover near False Cape. Meadow 34 near the Cairns Esplanade, was composed of dense *H. uninervis* along its eastern margin and light *C. serrulata* with *H. uninervis* along the western (landward) border. Most of the meadows south-west of False Cape were composed of light-cover aggregated patches of *H. uninervis,* with the meadows situated just north of East Trinity consisting of light *C. serrulata* with *H. uninervis.*

Temporal changes in seagrass meadows at the southern end of Trinity Inlet are shown in Figure 3-11. The extent of these meadows reduced most recently between 2014 and 2015, reflecting some of the lowest cover that has been observed in the last 10 years.

Seed bank monitoring of meadows within in Cairns harbour suggests that the total seed density in 2015 was low, and that much of the recovery between 2014 and 2015 has been observed near the Esplanade was due to vegetative expansion of existing fragments or patches, rather than recolonization from seeds (York et al. 2016).

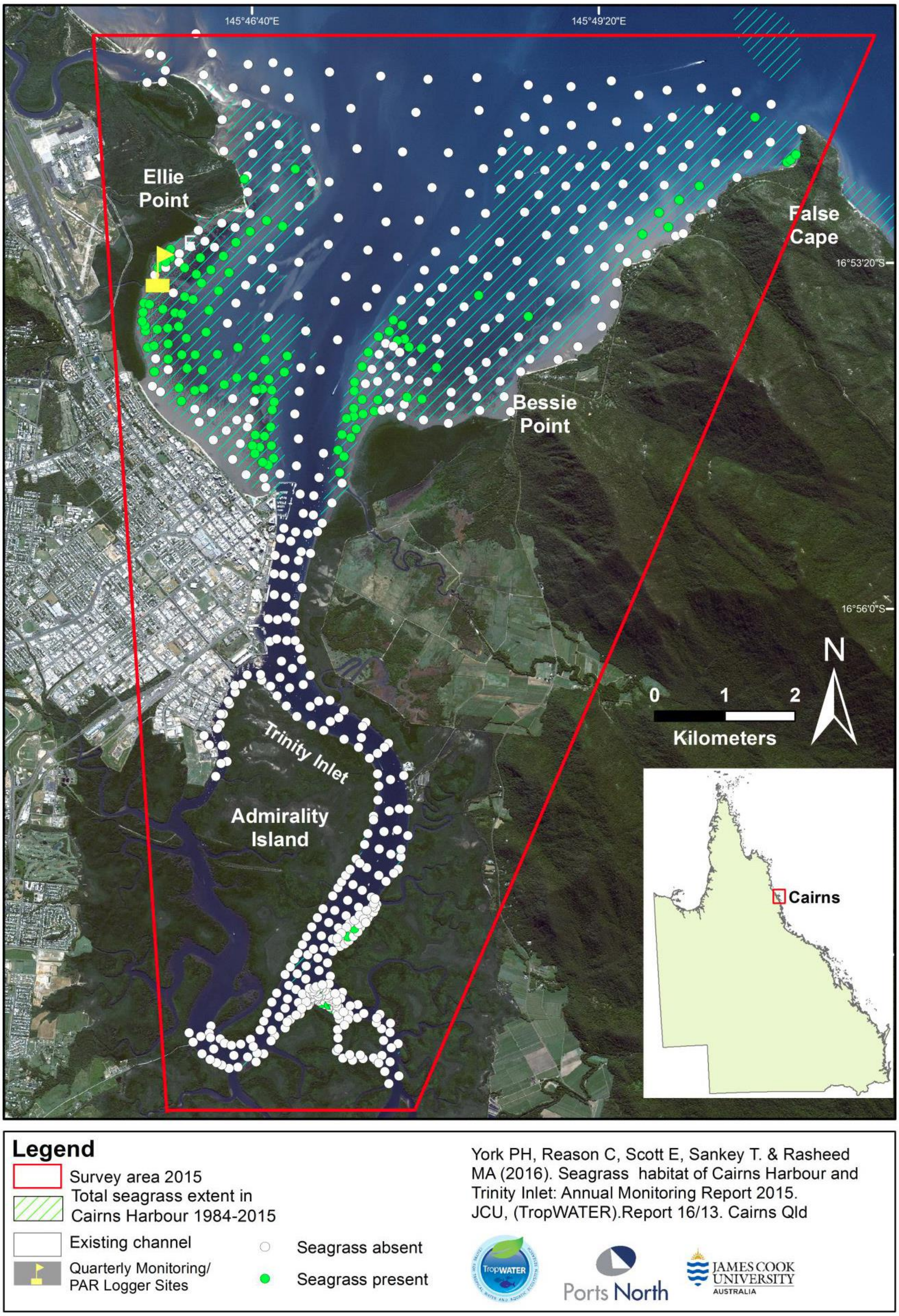
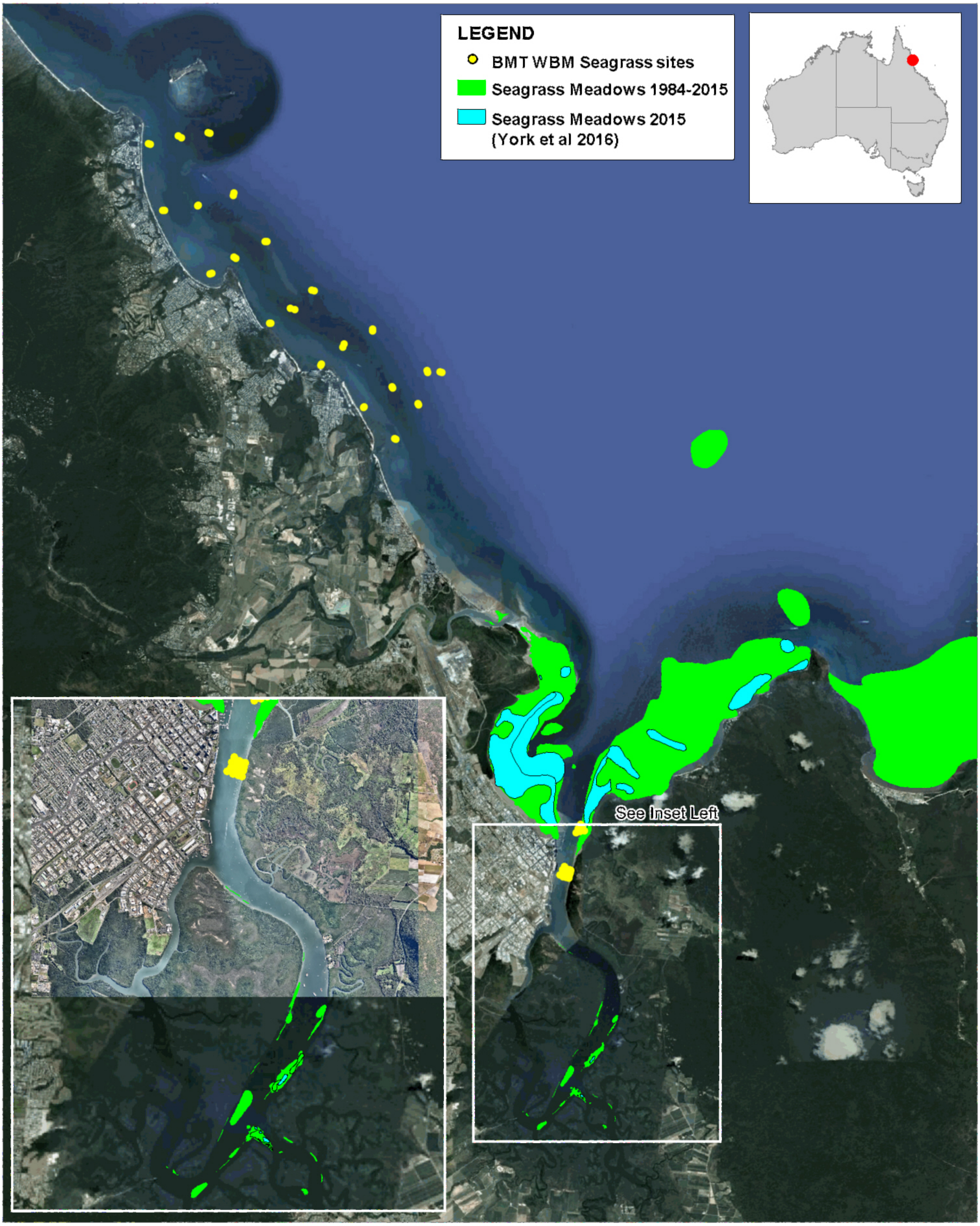


Figure 3-6 2015 seagrass distribution in Cairns Harbour (York et al. 2016)



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2015 and maximal seagrass distribution

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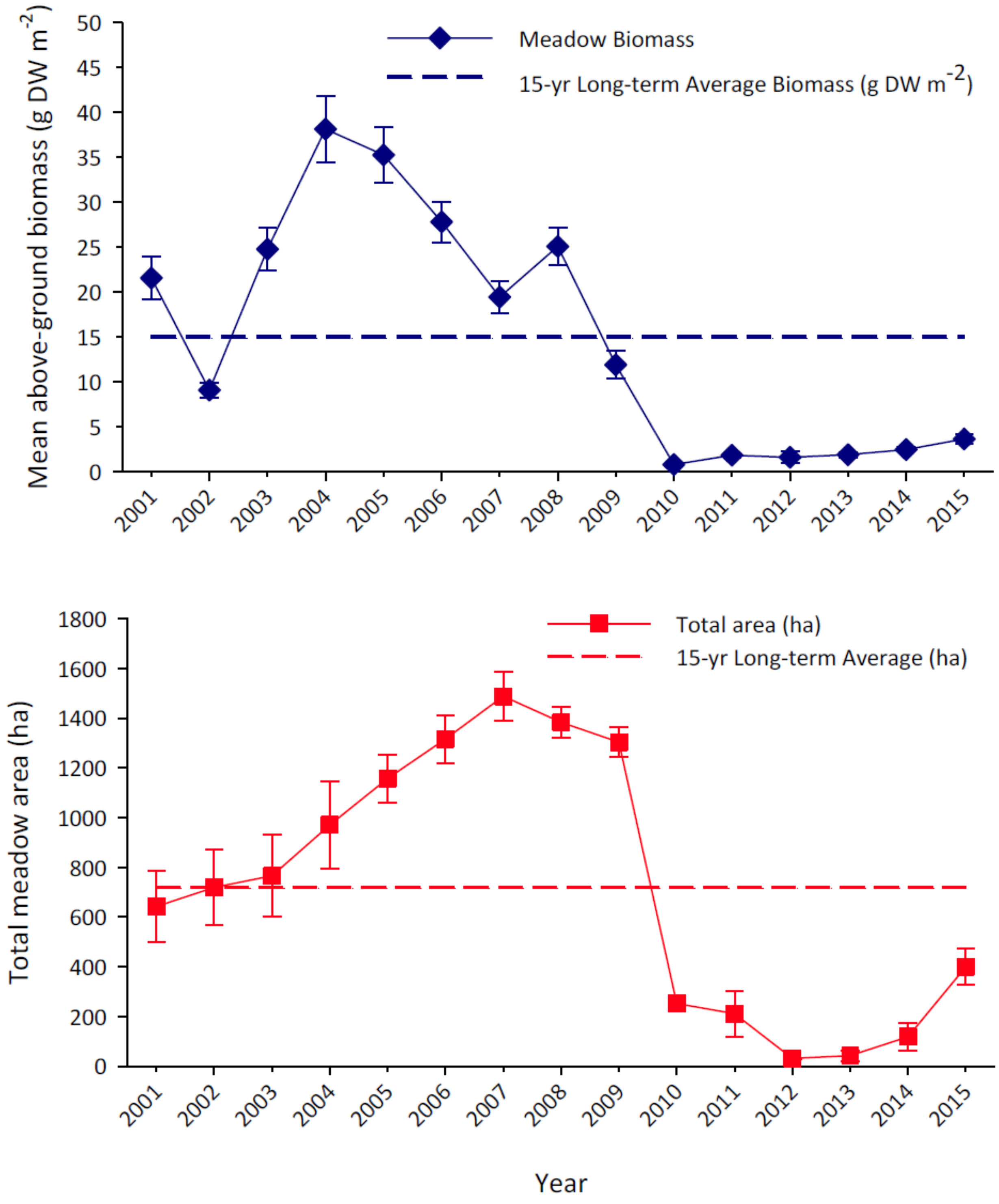

Figure 3-8 Seagrass biomass (above) and cover (below) for the Cairns region between 2001 and 2015 (York et al. 2016)

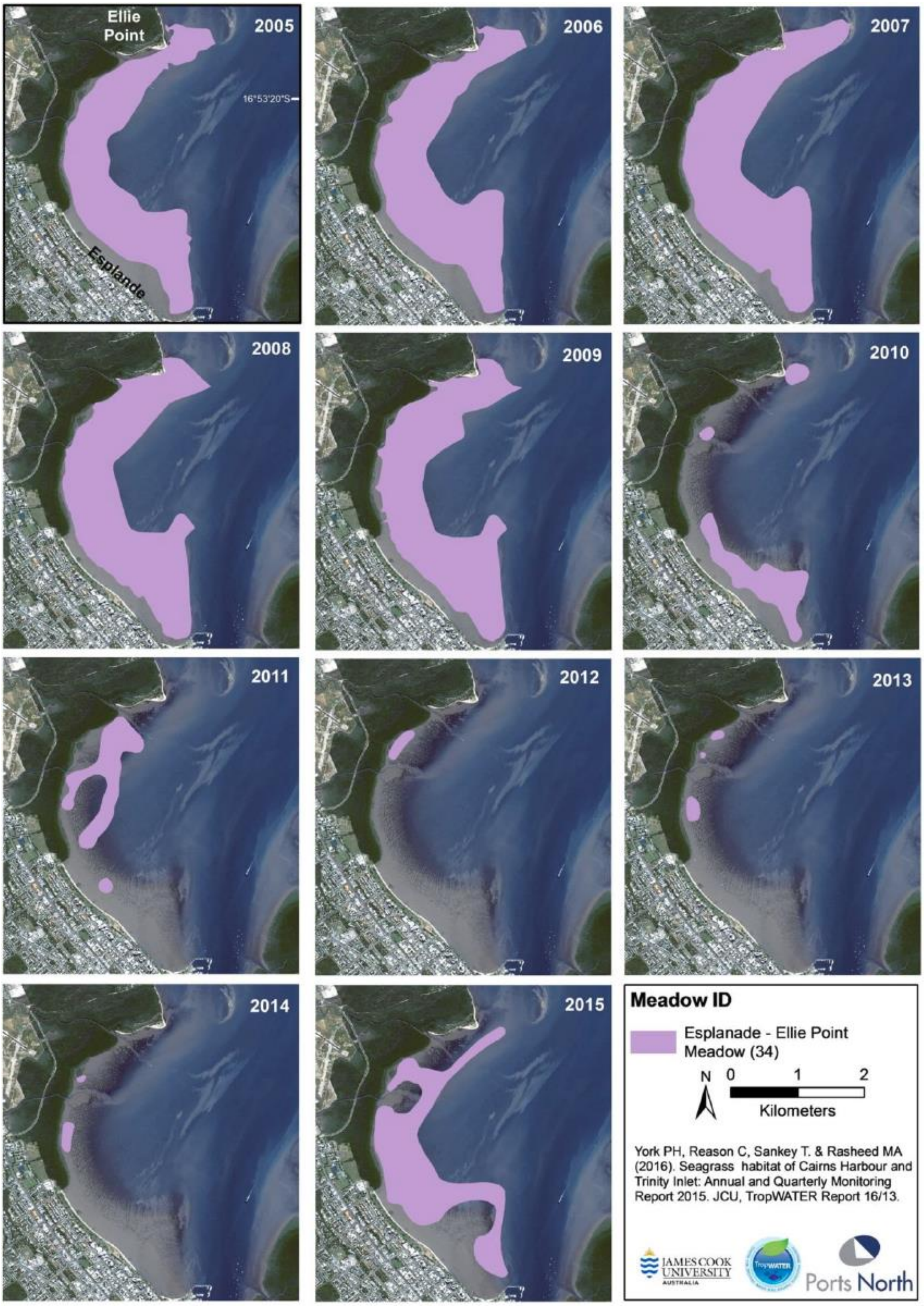

Figure 3-9 Changes in seagrass meadow extent between 2005 and 2015 for the Cairns Esplanade and Ellie point (York et al 2016)

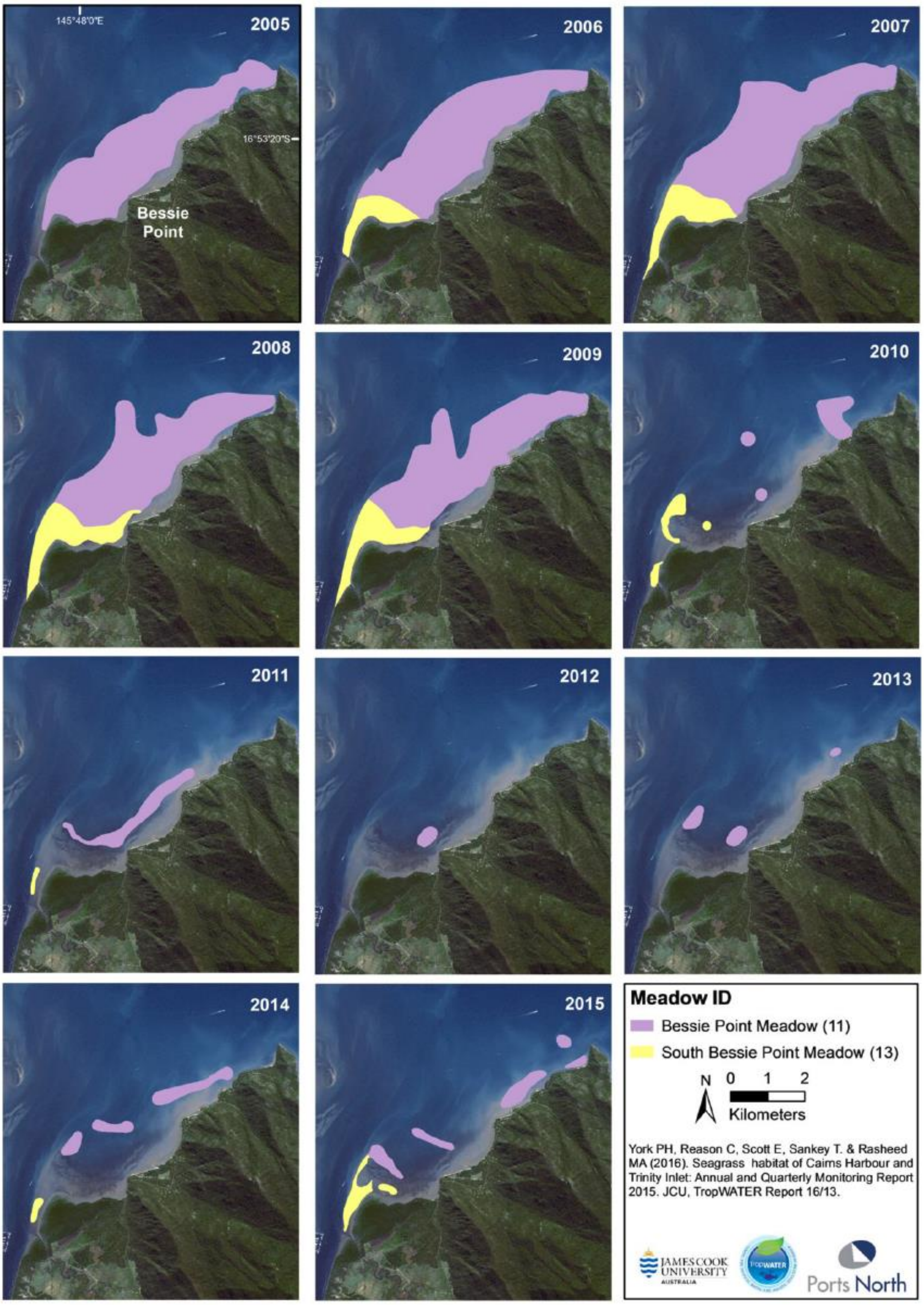

Figure 3-10 Changes in seagrass meadow extent between 2005 and 2015 for meadows south-west of False Cape (York et al 2016)

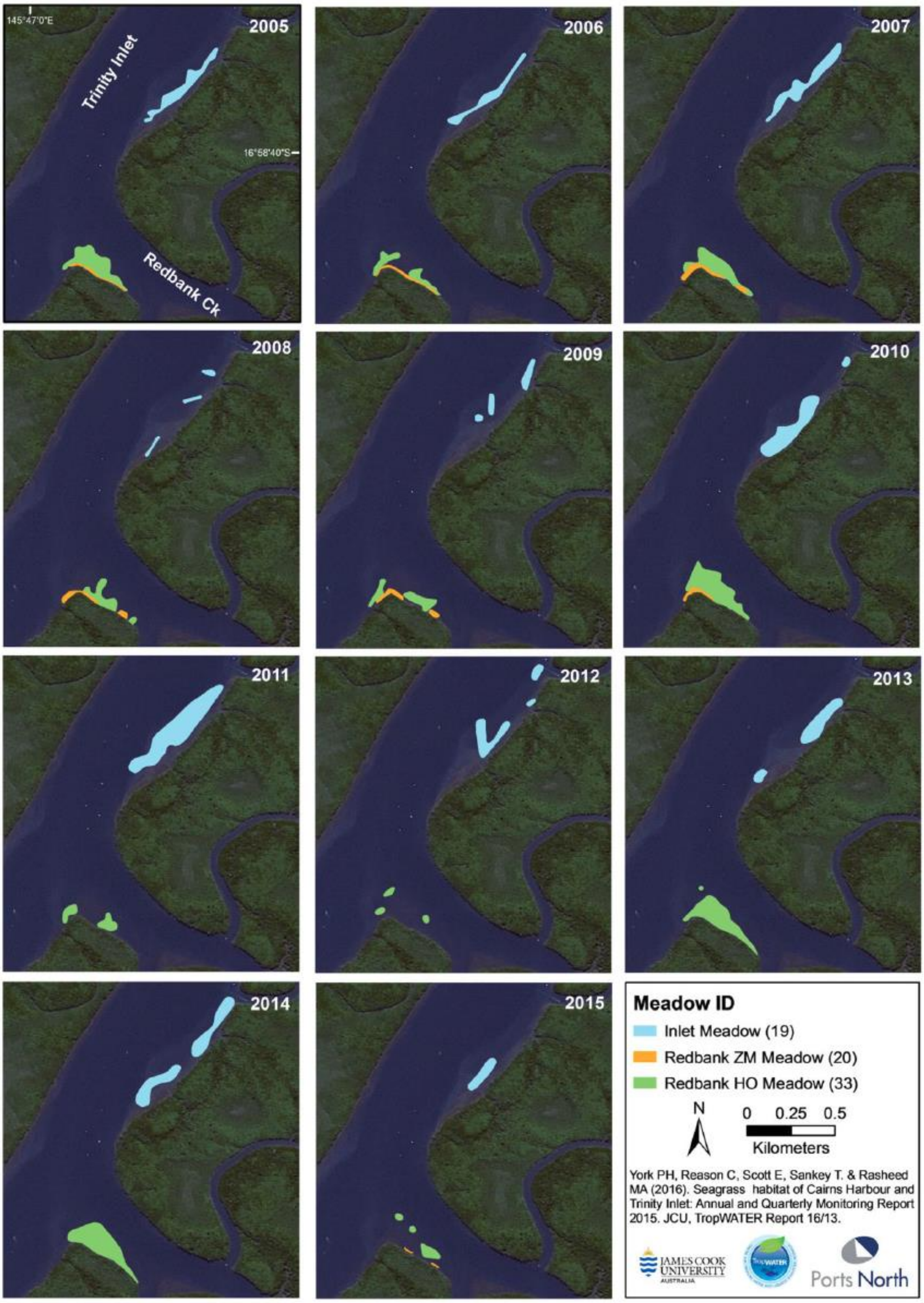

Figure 3-11 Changes in seagrass meadow extent between 2005 and 2015 for meadows in southern Trinity Inlet (York et al 2016)

3.3.3 Additional Seagrass Assessments by BMT WBM

No seagrass was observed at any of the drop-camera points in Trinity Inlet, which was consistent with the results of York et al., (2016). Similar to previous broad-scale surveys, no seagrass meadows were observed along any of the transects conducted along the northern beaches. However, seagrass was incidentally recorded at two estuarine waterway sites:

- Trinity Inlet (TRIN3) – seagrass was recorded in a gill net deployed in the lower intertidal/ upper subtidal zone at Magazine Creek. Leaves were small and damaged, but the sample was identified as *Halophila ovalis.* It is possible that this fragment was wrack, and not attached to the seafloor.
- Firewood Creek (site FF2) – *Halophila ovalis* was recorded in a benthic grab sample at site FF2, which was located inside the East Trinity bund. It is likely that *H. ovalis* is present over much of the shallow, calmer parts of East Trinity.

Figure 3-12 Seagrass (*Halophila ovalis*) incidentally recorded at Magazine Creek (TRIN3)

Figure 3-13 Seagrass (*H. ovalis*) from a benthic grab in Firewood Creek (FF2)

3.4 Epibenthos Communities

Additional surveys of epibenthos communities at Trinity Inlet opposite the Cairns Marina were very sparse with only the occasional sponge and stinging hydroid observed. Communities at the mouth of Hills Creek were similarly sparse. These results are similar to that of McKenna et al (2013) who found that the epibenthos within Trinity Inlet was dominated by bare substrates. Offshore from Richters Creek, epibenthos densities varied from bare substrate to low-density benthic communities.

The data indicate the following:

- Habitats over most of Trinity Inlet and along the dredge pump-out alignment from the mouth of Richters Creek do not contain hard substrates or abundant epibenthic communities.
- Seagrass was extremely sparse in central Trinity Inlet, and outside of its mapped distribution it probably only exists periodically when conditions are optimal, and as thin margins within the lower intertidal/ upper subtidal zone.

3.5 Fishing and Crabbing Data

3.5.1 Overview

A total of 1,119 fish belonging to approximately 42 morpho-species were caught across the 12 sites (Table 3-1). The entire catch was comprised of native species, and none of these are considered threatened. The most abundant species collected were small planktivores including as Castelnau's herring (*Herlotsichthys castelnaui*), and the gizzard shad (*Anodontosoma chacunda*). Sea mullet (*Mugil cephalus*) ponyfish (*Leiognathus equulus*) and the northern whiting (*Sillago sihama*) were the next most abundantly collected taxa. The largest specimens collected consisted of dusky flathead (*Platycephalus fuscus* 485 mm), queenfish (*Scomberoides tala*, 473 and 445 mm), shield-headed catfish (*Plicofollis nella* 390 – 460 mm) (Valamugil buchanani 405 mm) and giant trevally (*Caranx ignobilis* 400 mm). Photos of notable captures are shown in Figure 3-14.

3.5.2 Fish Richness and Abundance

Diverse and abundant fish communities were observed within Trinity Inlet, Barron River, Hills Creek and Firewood Creek. During the dry season event, fish abundance tended to increase with distance downstream in all estuarine waterways[1] (Figure 3-15), but there were no clear spatial gradients in species richness in either season (Figure 3-16).

[1] note that site numbering with respect to the downstream gradient differs at the Barron River

Table 3-1 Species of fish collected from East Trinity, Trinity Inlet, and the Barron River

Scientific Name	Common Name	BF1	BF2	BF3	BF4	FF1	FF2	HF1	HF2 DRY	TRIN1 SEASON	TRIN2	TRIN3	TRIN4	BF1	BF2 WET	BF3 SEASON	BF4	Total
		Barron River			Firewood			Hills Creek		Trinity Inlet				Barron River				
Scientific Name	**Common Name**	**BF1**	**BF2**	**BF3**	**BF4**	**FF1**	**FF2**	**HF1**	**HF2**	**TRIN1**	**TRIN2**	**TRIN3**	**TRIN4**	**BF1**	**BF2**	**BF3**	**BF4**	**Total**
Acanthopagrus pacificus	pikey bream															1		**1**
Ambassis interrupta	longspine glassfish	2					1		1									
Anodontosoma chacunda	gizzard shad		14	11	4	3	24		6	2	8	36	28	33	12	7	1	**189**
Apogon hyalosoma	mangrove cardinalfish		1															**1**
Batrachomoeus trispinosus	three-spine frogfish			1														**1**
Butis amboinensis	olive flathead gudgeon		1				2											**3**
Caranx ignobilis	giant trevally				1		1											**2**
Caranx sp4	juvenile trevally						1											**1**
Caranx sp5	juvenile trevally						1											**1**
Chelon macrolepis	largescale mullet		1						2					1	2		9	**15**
Clupeidae 2	herring	6	1				1					2	3			9		**22**
Clupeidae 3	sprat (juvenile)		1									2						**3**
Cyanoglossus sp	tongue sole		1															**1**
Eleotridae juvenile	juvenile gudgeon		1													1		**2**
Epinephelus coioides	estuary cod														1			**1**
Gerres filamentosus	threadfin silverbiddy										1			1				**2**
Gerres oyena	blacktip silverbiddy								1							1		**2**
Herlotsichthys castelnaui	Castelnau's herring	343	82		1	16	10		2	14	26	11	50		34	12	3	**604**
		Barron River			**Firewood**			**Hills Creek**		**Trinity Inlet**				**Barron River**				
Leiognathus equulus	common ponyfish	10	3	1	6		1	6			8	12	3	2	1	3		**56**
Lethrinidae juvenile	juvenile lethrinid										1							**1**
Liza subviridis	greenback mullet															1		**1**
Lutjanus johnii	golden snapper	1																**1**
Mugil cephalus	sea mullet	1	19	1				3			2	2	3	10	2		3	**46**
Mesopristes argenteus	silver grunter															3		**3**
Neoarius graeffei	salmon catfish			2												1		**3**
Nibea solado	silver jewfish	2													5			**7**
Platycephalus fuscus	dusky flathead										1							**1**
Platycephalus indicus	bar-tailed flathead	1												2				**3**
Plicofollis nella	shieldhead catfish			1												12		**13**
Pomadasys kaakan	javelin grunter			1	1									2	1	7		**12**
Pseudomugil signifer	Pacific blue-eye					4												**4**
Pseudorhombus arsius	largetooth flounder		1															**1**

Scientific Name	Common Name	BF1	BF2	BF3	BF4	FF1	FF2	HF1	HF2 DRY	TRIN1 SEASON	TRIN2	TRIN3	TRIN4	BF1	BF2 WET	BF3 SEASON	BF4	Total
Scomberoides lysan	barred queenfish													1				**1**
Scomberoides tala	barred queenfish				1					1		1					1	**4**
Scomberomorus sp.	juvenile mackerel														1	1		**2**
Secutor rucornis	pugnose ponyfish						1					1			1	1		**4**
Selentoca multifasciata	striped scat													4				**4**
Signaus guttatus	orange-spotted rabbitfish						2											**2**
Sillago sihama	northern whiting	57	3								2		8	2				**72**
		Barron River			**Firewood**			**Hills Creek**		**Trinity Inlet**				**Barron River**				
Sygnathidae	juvenile pipefish		1															**1**
Toxotes jaculatrix	banded archerfish				1		15		4								1	**21**
Valamugil buchanani	blue-tail mullet											1						**1**
	Richness	**9**	**14**	**7**	**7**	**3**	**12**	**2**	**6**	**3**	**8**	**9**	**6**	**10**	**10**	**14**	**6**	**41**
	Abundance	**423**	**130**	**18**	**15**	**23**	**60**	**9**	**16**	**17**	**49**	**68**	**95**	**58**	**60**	**60**	**18**	**1119**

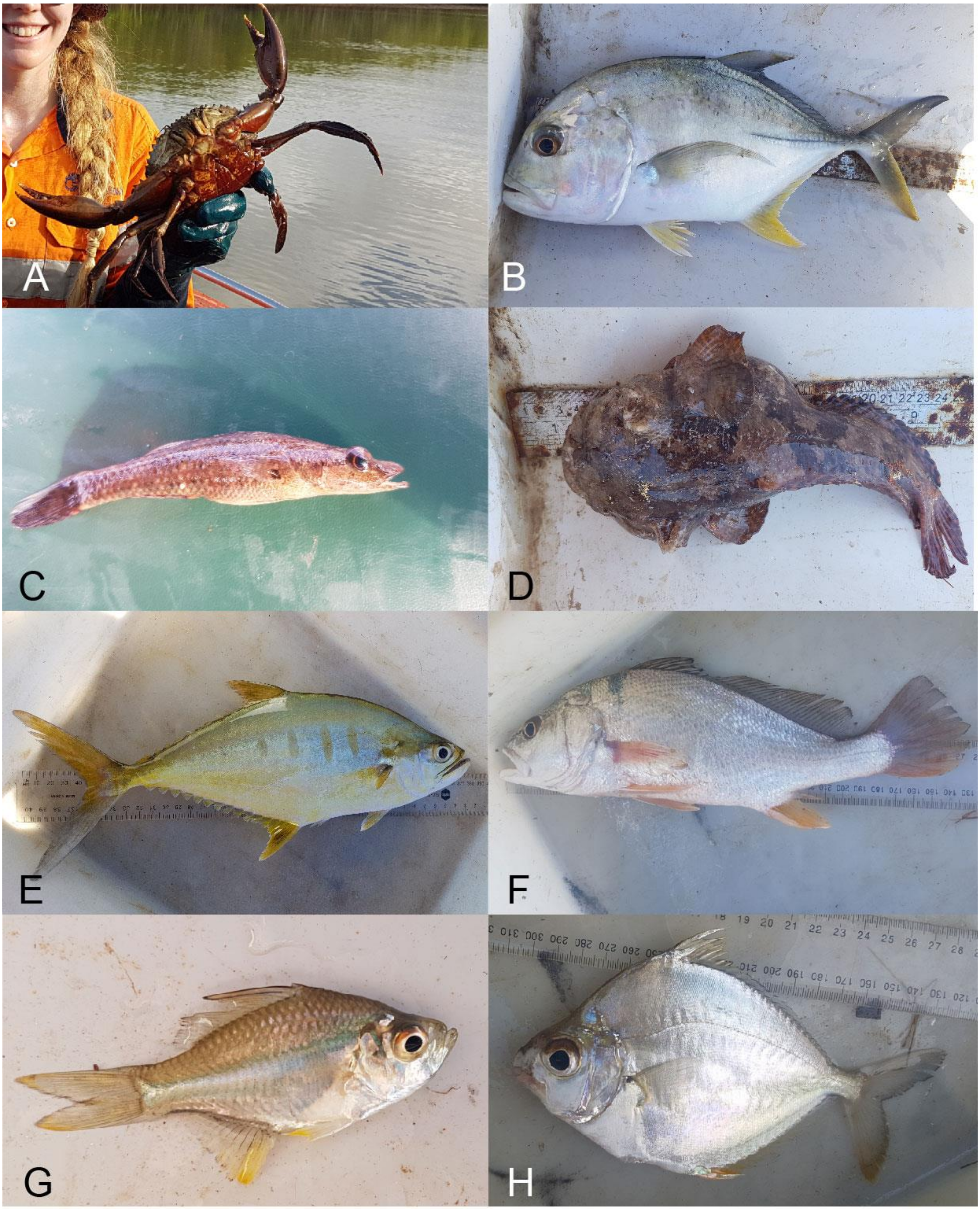

Figure 3-14 Photos of selected specimens: mud crab, *Scylla serrata* (A); giant trevally, *Caranx ignobilis* (B), olive flathead gudgeon *Butis amboinensis* (C); threespine frogfish, *Batrachomoeus trispinosus* (D); queenfish, *Scomberoides tala* (E); silver jewfish, *Nibea solado* (F); estuarine glassfish, *Ambassis interrupta* (G); common ponyfish, *Leiognathus equulus* (H)

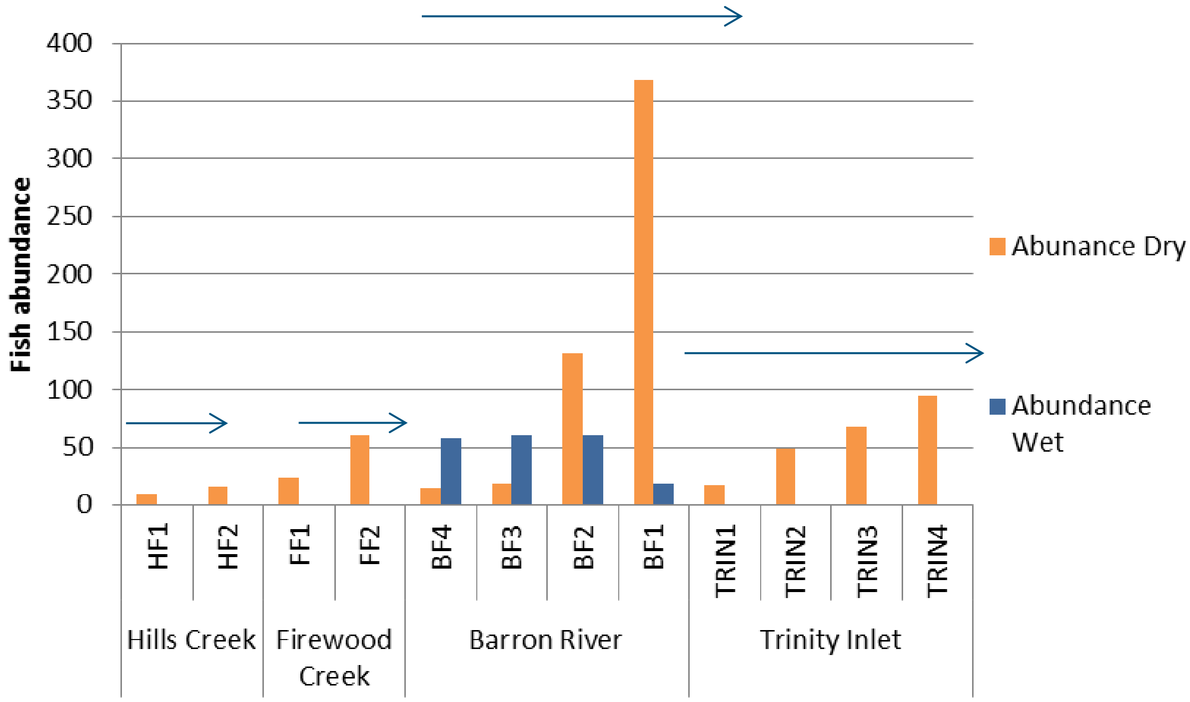

Figure 3-15 Total fish abundance at each of the sites within each waterway (arrows indicate site gradient towards the sea)

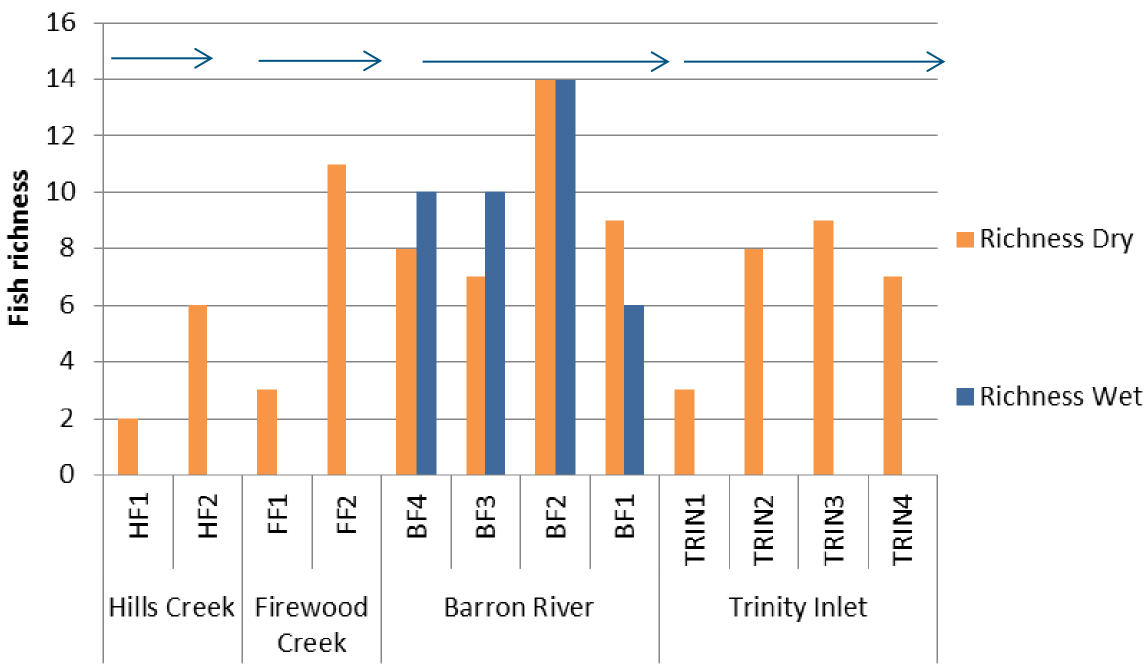

Figure 3-16 Species richness at each of the sites within each waterway (arrows indicate site gradient towards the sea)

During the dry season, Hills Creek had low catches (abundance) but species richness was within the range recorded in other waterways. The bunded parts of Hills Creek (HF1, HF2) contained fewer species and individuals than the site located downstream at the confluence of Hills Creek and Trinity Inlet (TRIN4). This spatial gradient was not observed at Firewood Creek, where the most abundant and richest catches were made inside the bund at FF2, which was higher than the downstream site located at the confluence of Firewood Creek and Trinity Inlet (TRIN2). The riparian vegetation at FF2 was in reasonably good condition, unlike that surrounding site FF1 where a major disturbance to the riparian zone was still evident. Site FF1 had the lowest fish species richness and abundance of all sites in Firewood Creek.

Barron River had consistently high species richness across sites over both seasons, whereas abundance increased markedly with distance downstream during the dry season. During the wet season abundance was similar throughout the system, except for at site BF1, which had relatively low abundance and richness. The highest richness was observed at site BF2 in both seasons, and the very high abundance at BF1 in the dry season (369 fish), was mostly due to a large catch of herring.

3.5.3 Portunid Crabs

Mud crabs (*Scylla serrata*) generally dominated catches in Trinity Inlet and East Trinity, whereas sand crabs (*Portunus pelagicus*) dominated catches in the downstream reaches of the Barron River. Only two mud crabs were collected in the whole of the Barron River during the dry season, while a further four crabs were captured from the Barron in the wet season.

High abundances of crabs were recorded at site BF1 on the Barron River (sand crabs), and Firewood Creek sites (FF2 and TRIN2) which had high catches of mud crabs.

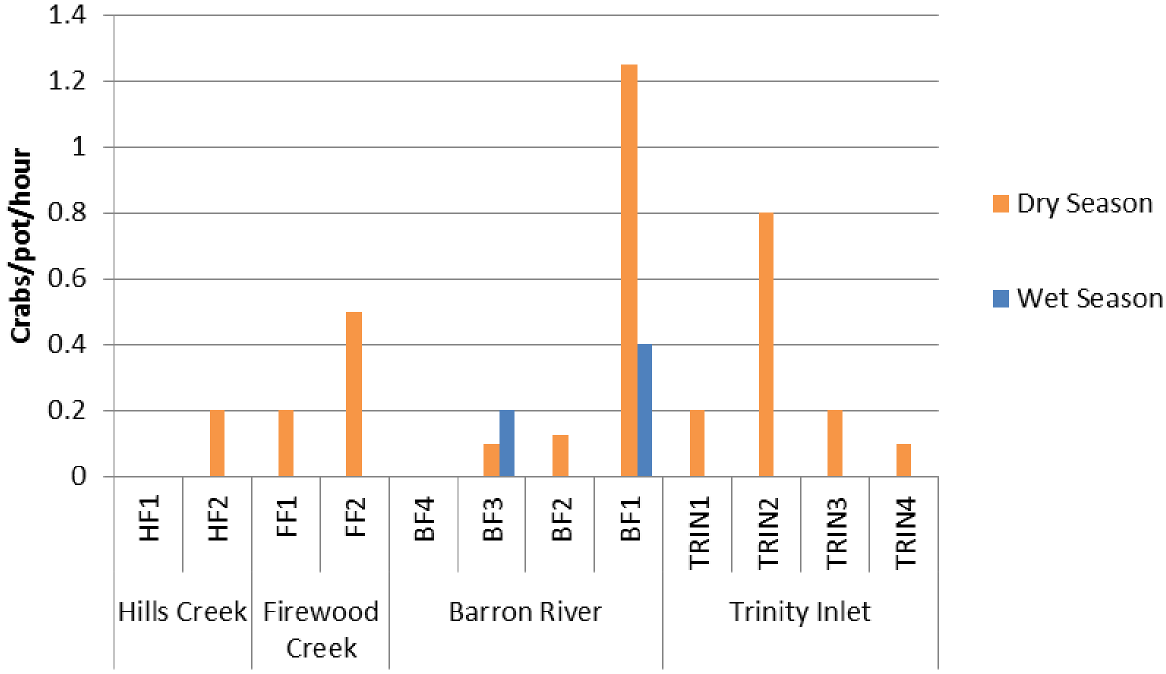

Figure 3-17 Crab catch per unit effort (crabs/ pot/ hr)

During the dry season at East Trinity, mud crab catches also varied upstream and downstream of the bund. Mud crabs upstream of the bund were larger (both males and females) than in downstream areas, and were predominantly male compared to predominantly female downstream (Figure 3-18, Figure 3-19, Figure 3-20). This suggests either habitat partitioning by sex and age, or possibly an effect of fishing pressure (noting that no crabbing occurs upstream of the bund, except in the vicinity of the tide gates).

For the water quality aspect of the this EIS, six weekly service trips were conducted over 12 months to Trinity Inlet, Hills and Firewood Creeks and the Barron River. Fishing and crabbing was observed at public access sites on every trip, suggesting that recreational fishing and crabbing effort is continuous and highly concentrated in certain locations such as tide gates, creek mouths, and jetties. Given the high effort observed throughout the year, and differences in size and sex ratio of mud crabs between public access and restricted areas, it is likely that recreational take is a significant process affecting mud crab density and sex ratio in the region.

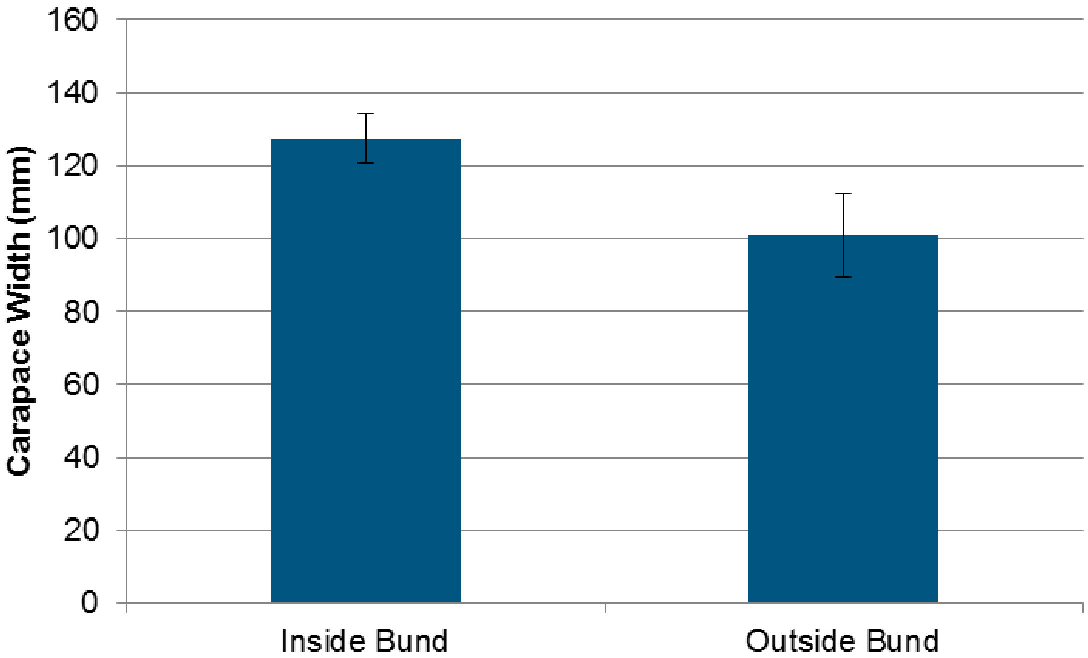

Figure 3-18 Differences in mean carapace width (± SE) for mud crabs inside and outside of the bund wall at East Trinity

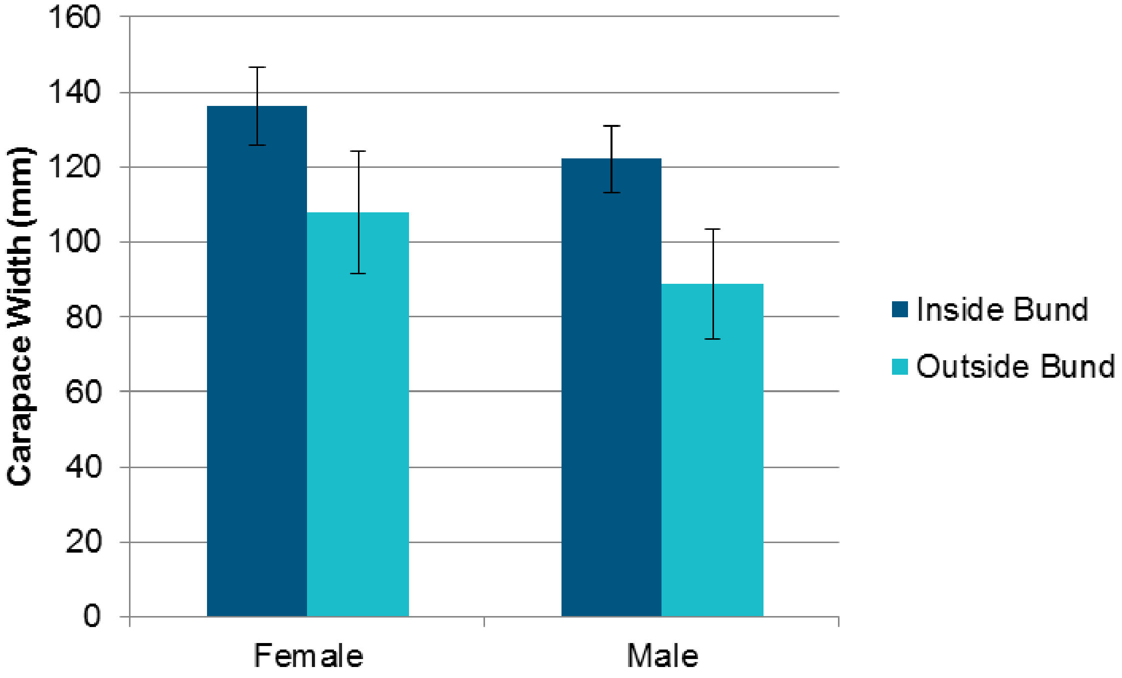

Figure 3-19 Differences in mean carapace width (± SE) partitioned by sex inside and outside of the bund wall at East Trinity

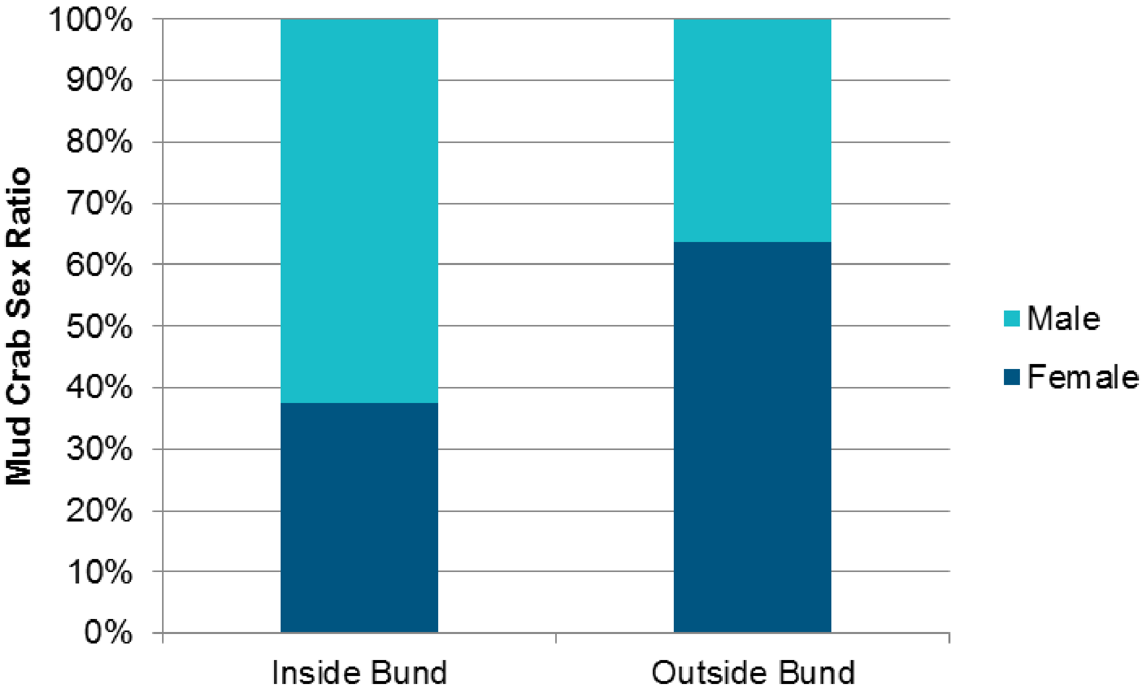

Figure 3-20 Sex ratios for mud crab catches inside and outside of the bund wall at East Trinity

3.6 Commercial Catch of Fish and Shellfish

Commercial fish catch data (DAFF 2017) for the H16 grid covering the study area shows that there has great variability through time in both net (Figure 3-21) and line fisheries (Figure 3-28). Figure 3-27 and Figure 3-28 show temporal changes in the catch of major species contributing these fisheries, as described in the original CSD EIS. The study area comprises approximately 25 percent of grid H16, which runs from south of Cape Grafton to Port Douglas. Net fishery data shows that the total catches from H16 have been generally declining since 2012. It should be noted that data are not available for instances where there are less than 5 licence holders.

The observed reduction in catch generally coincides with the buy-back and of a number of commercial licenses. The effects of the Trinity Bay net closure are difficult to determine, as data is generally deficient for the period beyond 2012 or 2014 for different species.

Catch per unit effort (CPUE) for the major species groups shown in Figure 3-21 (expressed as kg/day) does appear to be trending upwards since 1999, suggesting that effort reductions have potentially acted to increase biomass of the net fisheries.

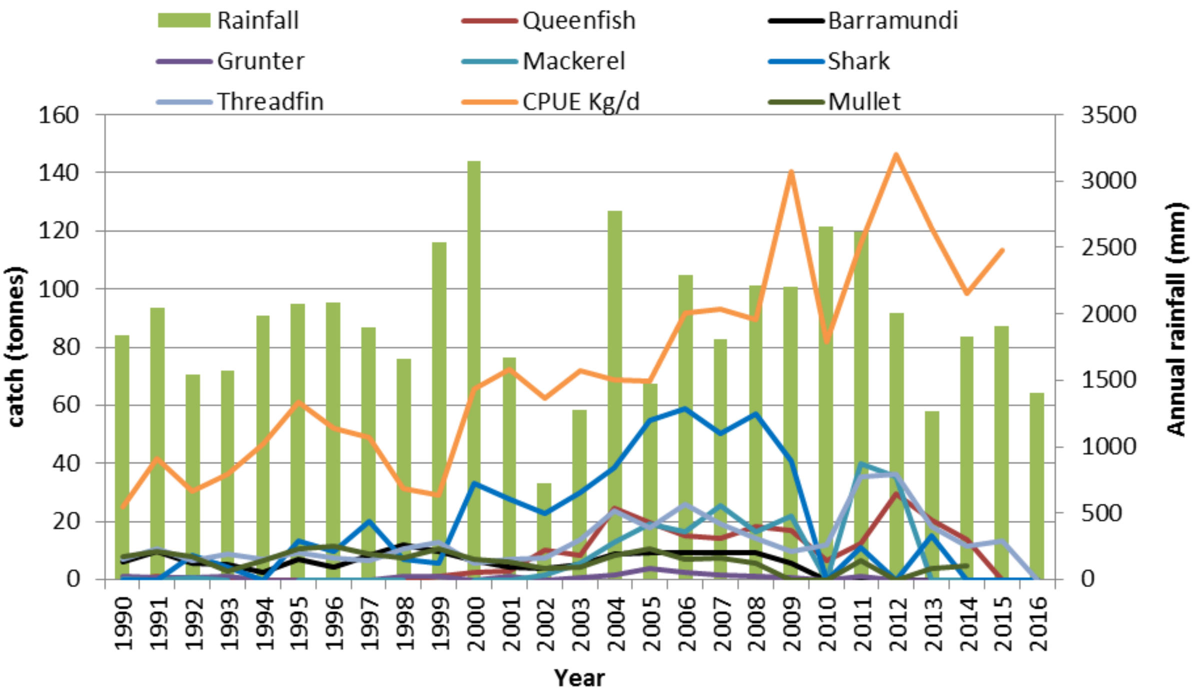

Figure 3-21 Commercial catch of the primary species contributing to the net fishery, annual rainfall (mm) and catch per unit effort (kg/d)

For the line fishery, catch data of major species or species are sporadically available through the time series as data is available for periods where there are greater than 5 licence holders (Figure 3-28). Spanish mackerel is the only species which has consistent catch records available in the line fishery over the entire time period. Total catch and CPUE for Spanish mackerel show a quasi-cyclical pattern with peaks in catch appearing every 4-6 years. CPUE of the major line fishing species appears to be down trending through time.

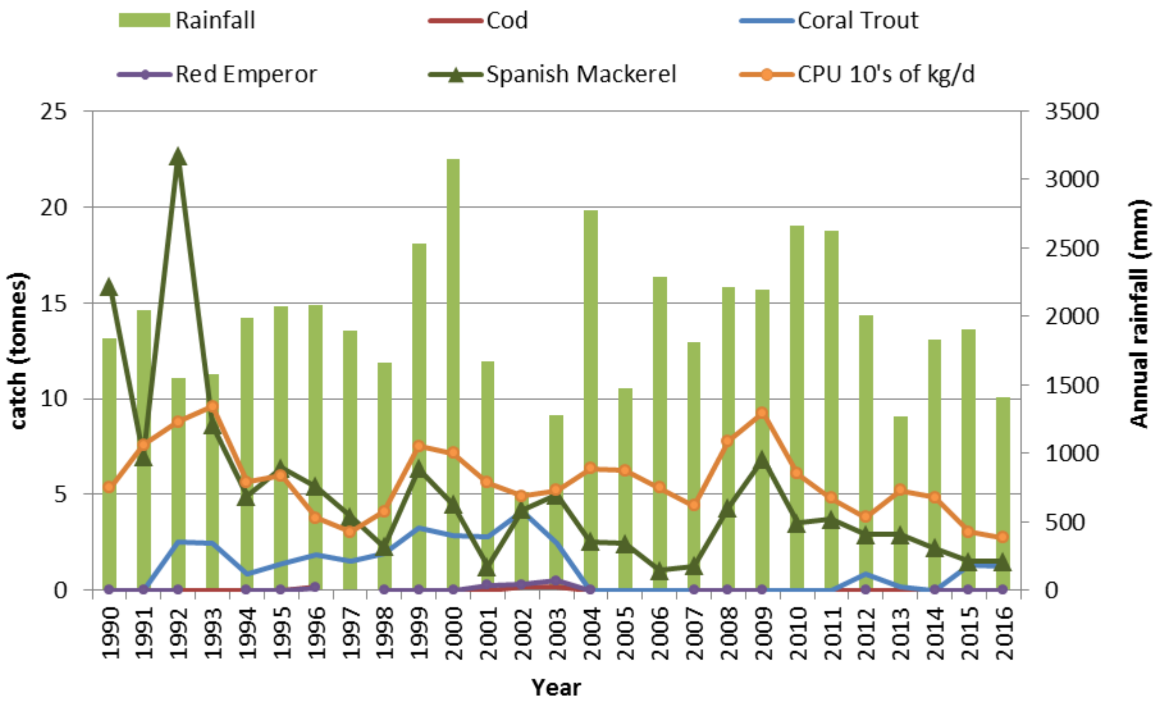

Figure 3-22 Commercial catch of the primary species contributing to the line fishery, annual rainfall (mm) and catch per unit effort (10's of kg/d)

The reported commercial catch of mud crabs shows relatively stable effort through time, with the total number of licences falling below five in 2013 and 2015 (Figure 3-23). There are two distinct peaks in CPUE, occurring in 1991 and 2009. Since 2009, CPUE and total catch appear to have steadily fallen to a low point, comparable with CPUE in the mid-1990s (where data is available).

The catches of squid, scallops, and blue swimmer crab (Figure 3-24) have been highly variable through 26 year time period, with large gaps in data due to several periods where there were less than 5 licence holders. Catches of bugs have been reported over the entire time period, with high and variable catches up until 2001, followed by relatively low and more stable catch rates to 2016. While catch rates of bugs appear to be down-trending CPUE appears relatively stable.

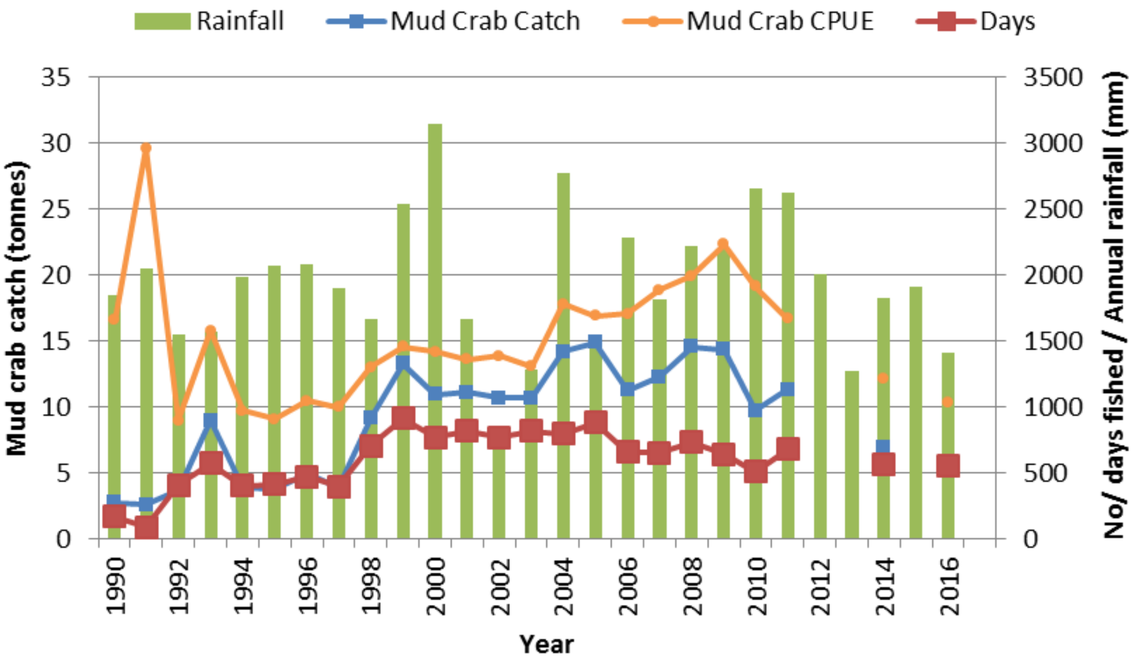

Figure 3-23 Commercial catch of mud crabs, annual rainfall (mm) and catch per unit effort (kg/d)

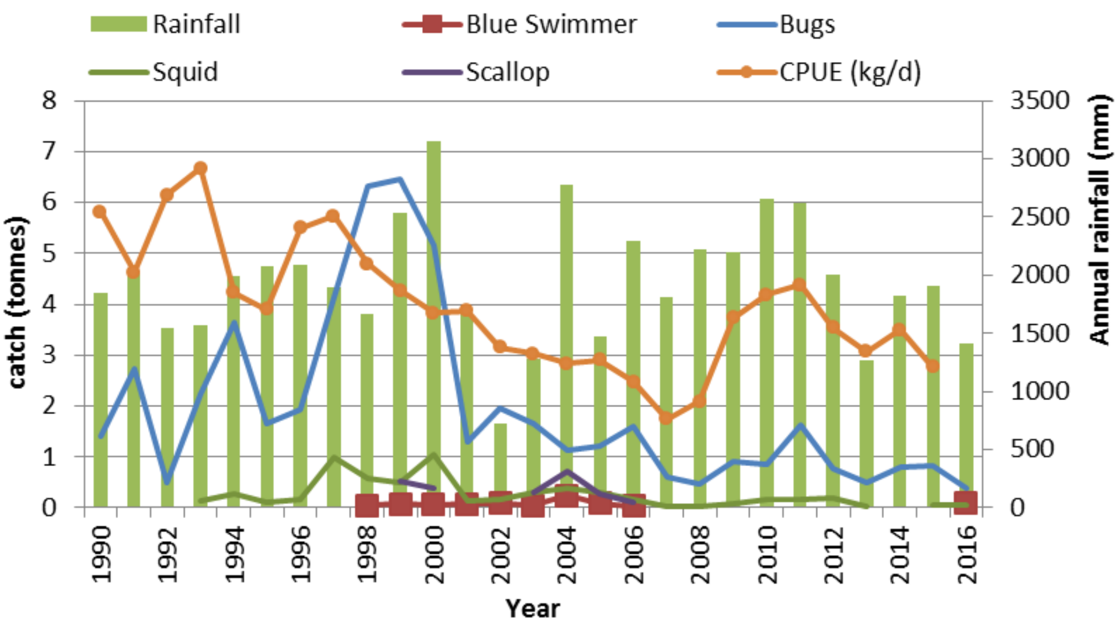

Figure 3-24 Commercial catch of squid, blue simmer crabs, scallops, bugs (tonnes), annual rainfall (mm) and catch per unit effort (kg/d)

BMT WBM

The catch prawns and total commercial catch for all methods in grid H16 are shown in Figure 3-25 against annual rainfall. Prawn is a major contributor to total catch, particularly prior to 2001. There was a reasonably strong positive association between prawn catch and annual rainfall. While total catch for all species has generally declined since 2006, the catch of prawns has remained relatively steady since 2001. CPUE for prawns has also been steady through this period.

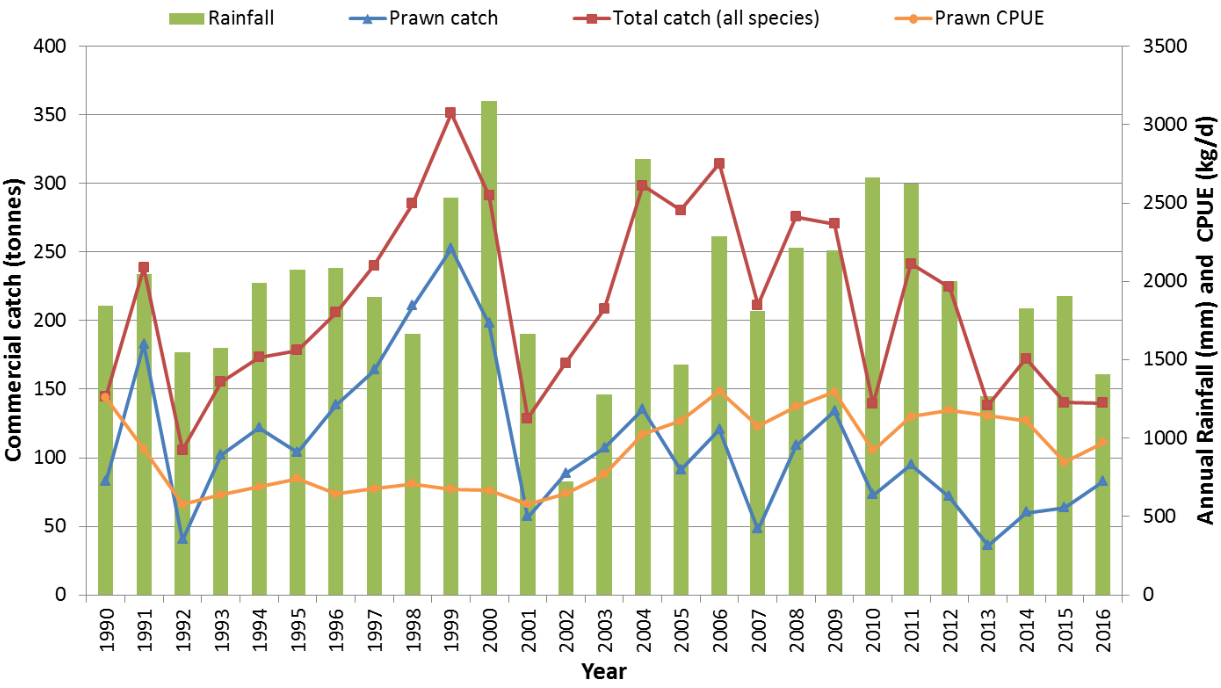

Figure 3-25 Commercial catch of prawns, total commercial catch, prawn CPUE (kg/d) and annual rainfall (mm).

3.7 Infauna Communities

A total 125 macroinvertebrate families were recorded from the 21 sites sampled in the dry season of 2016. During the wet season (March 2017), a total of 87 macroinvertebrate families were recorded from 8 sites investigated. The macroinvertebrate fauna reported in the dry season was numerically dominated by mytilid bivalves (particularly *Xenostrobus secures*), representing approximately 22% of the catch (Figure 3-26). This was due largely to very large numbers of the bivalve collected from site BF4 on the Barron River. Specimens of nereid polychaete worms were the next most abundant taxon collected, accounting for 18% of the catch. Other abundant taxa were bristle worms (Terebellida) families (Ampharetidae and Sternaspidae), which together accounted for 9% of the catch, spionid polychaetes (marine worms), amphipods and apseudid crustaceans.

During the wet season, the macroinvertebrate fauna was dominated by Apseudidae (small shrimp-like crustaceans), which accounted for 81% of the catch. Apseudids are frequently very abundant over soft sediments in shallow to very deep waters. Other abundant fauna taxa were nematodes (round worm), bivalves (clams, mussels and scallops), Zooanthidae (coral-like animals) and

Amphipoda (crustaceans). The Barron River sites were by far the most abundant sites for macroinvertebrates, but this varied greatly from the dry season to the wet season. Upstream sites BF5 and BF4 were much more abundant in the dry season, while there was much greater abundance at more downstream sites BF2 and BF3 in the wet season. It is possible that greater abundance in the downstream and offshore locations is the result of greater river flow, which acts as a disturbance in the wet season. A similar pattern was observed in the previous EIS.

In terms of species richness, Site TRIN2 in Trinity Inlet recorded the highest mean number of species during the dry season. High richness here was primarily driven by several types of amphipods that accounted for 21% of the catch. During the wet season, site RICHT1 offshore from Richters Creek had greatest mean number of species that was dominated by *Apseudes* spp (Apseudidae), which represented 26% of the catch. Site RICHT1 was also the most seasonally variable site for richness; during the dry season in 2016 it also had the reported the lowest average number of species. Such high variability in richness is likely due to the stability of bed habitat, as this site has the most wave exposure of all the sites investigated, being located at the mouth of Richters Creek.

For taxonomic diversity (Shannon's H') site TRIN2 in Trinity Inlet had the highest diversity, in the dry season, while site RICHT1 recorded the highest diversity in the wet season. The least diverse sites in the dry and wet seasons were BF5 and BF3, respectively. On the Barron River.

In general, most sites had similar levels of diversity, with the Barron Rivers sites being less diverse than surrounding sites. This appeared to be driven largely by sporadically high abundance and low species richness in the Barron River. Of all of the waterways considered, the Barron River has the largest catchment area and experiences the greatest freshwater flow. It is likely that these pulsed turbidity and freshwater events act as important drivers of abundance, diversity, and richness, and contribute to the spatial and temporal variability observed at these sites.

Multivariate analysis of the wet and dry season community data was presented graphically using a non-metric multidimensional scaling plot (nMDS), which shows the average of each site replicate. Sites were classed into positions, three broad categories based on their sampling location: Mouth (mouth of a channel), Channel and Offshore. Mouth sites were on the junction between waterways, channel sites were within confined channels of waterways, and offshore sites included sites in Trinity Bay (Figure 3-27).

The stress value (>0.2) of the nMDS plot indicates that the patterns observed are difficult to resolve clearly in two dimensions, and any patterns should be interpreted cautiously. A range of different data transformations, averaging and taxonomic clustering did not improve stress levels of these ordinations, suggesting that there was little clear separation of communities across sites or temporal scales. Despite this, offshore sites SG1 to SG5 and RICHT1 to RICHT3 clustered to the right of the plot, suggesting that the macroinvertebrate assemblage at these sites are more similar to one another than other sites in the mouth of a channels and in channel. These offshore sites were dominated by tanaid crustaceans (tanaid 3), Bivalvia (bivalve 10) and amphipods (*Cheiriphotis* sp 2).

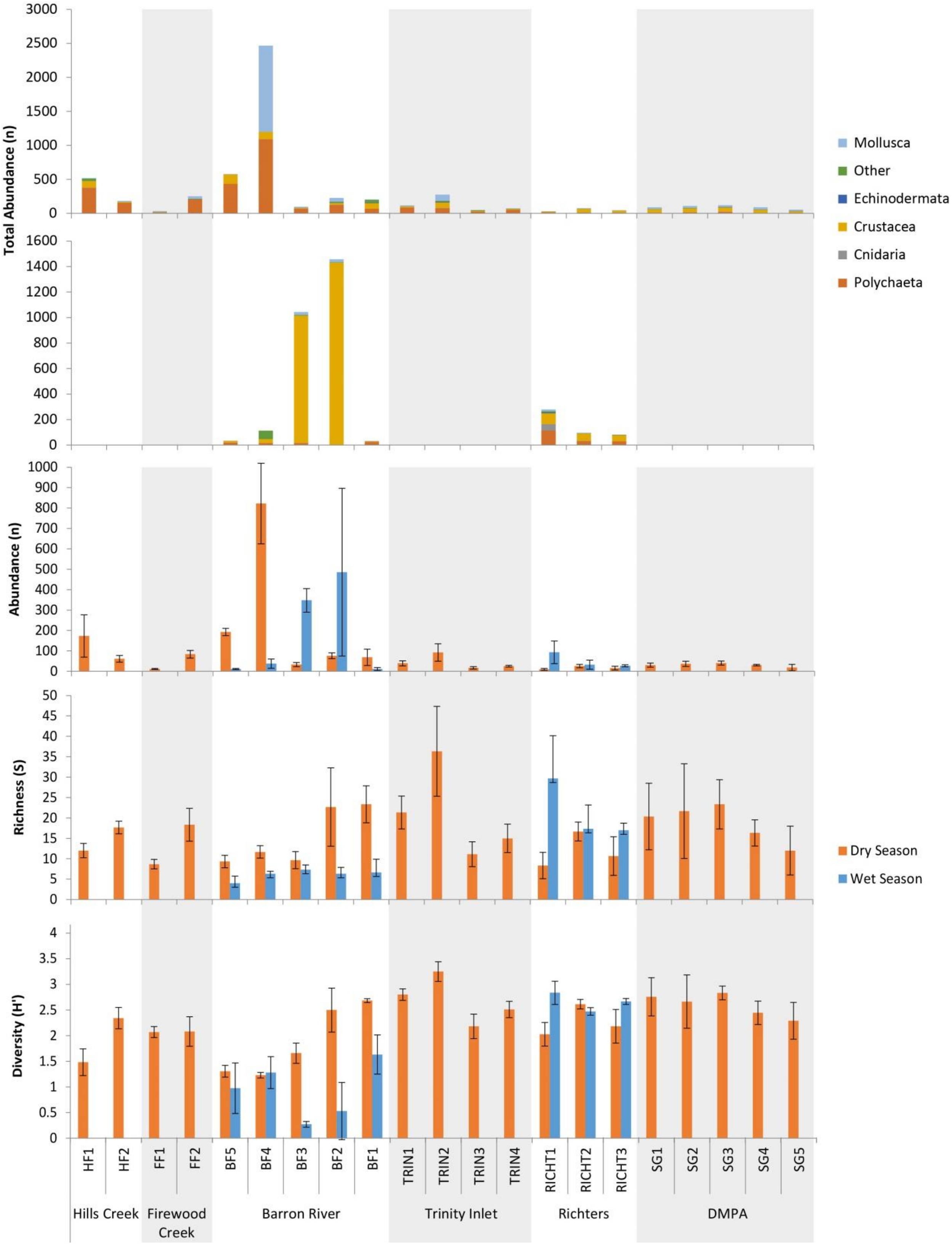

Figure 3-26 From top to bottom, differences in macroinvertebrate total abundance (dry season); total abundance (wet season); mean abundance (n); mean richness (S); and mean diversity (H')

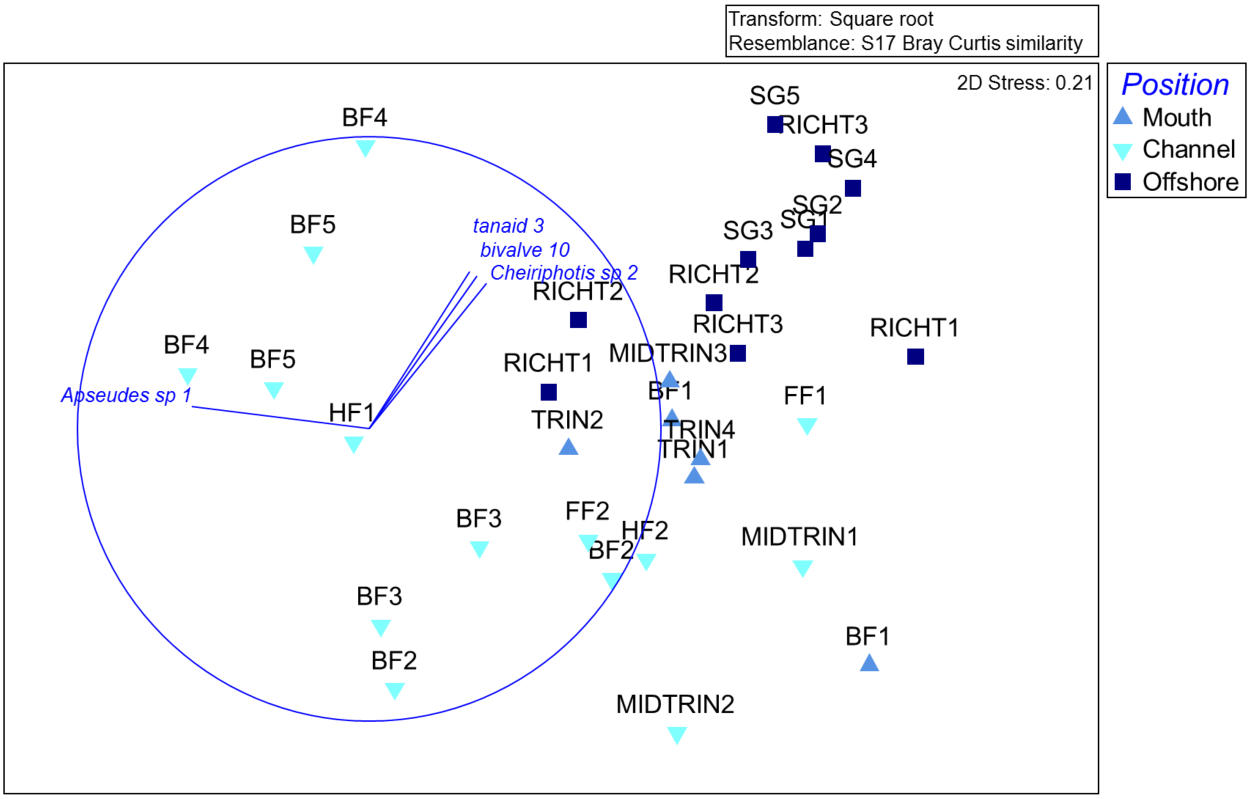

Figure 3-27 nMDS plot of infauna communities

Particle size data for each of the infauna locations shows that the Barron River and Trinity Inlet sites had the largest fractions of coarse sediment, particularly gravel. The Richters Creek offshore sites and DPMPA sites had the highest proportion of fines (silt and clay). Site RICHT1 offshore 1 was the only exception, where a significant proportion (>30%) of gravel was present.

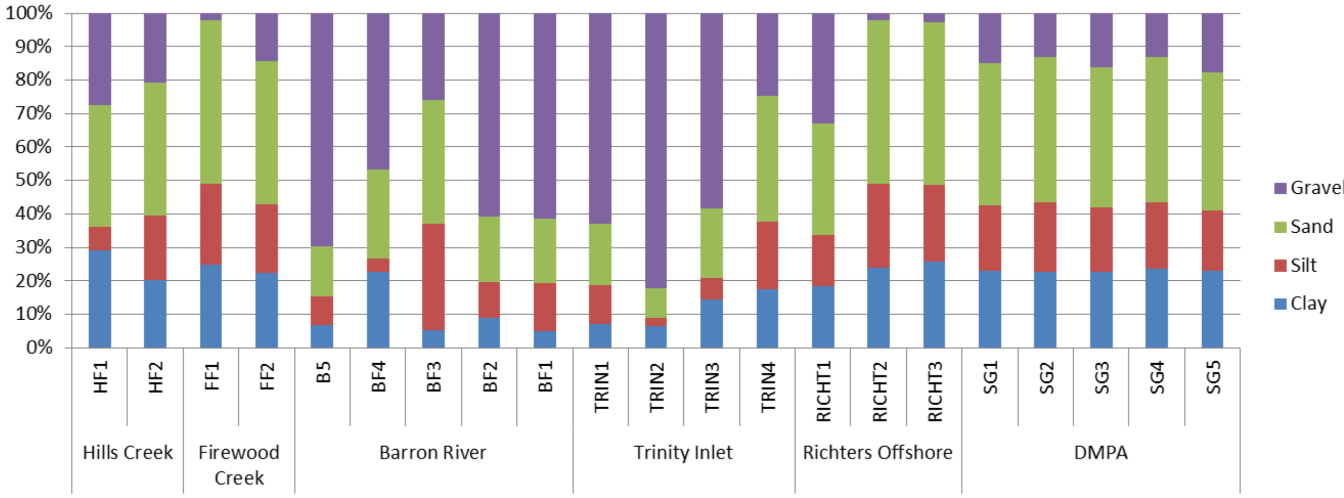

Figure 3-28 Particle size distributions for each of the infauna sites during the dry season

3.8 Riparian and Bank Condition Assessment

The mouth of the Barron River had large amounts of accreted and re-worked sand, with sections showing obvious accretion while others appeared to be actively eroding. Erosion was evident particularly along the southern shore of the Barron near the mouth (Figure 3-29), and frequently along the outside meanders of each river bend. Some fallen trees along the northern (DLB) bank also suggested that this shoreline had recently eroded (Figure 3-29).

In the lower estuary (upstream of the river mouth), the mangroves *Bruguiera* and *Rhizophora* dominated on the outside of eroding meander bends (Figure 3-30), whereas *Avicennia* and *Sonneratia* dominated on the inside accreting. meanders and straight sections of the river (Figure 3-30). There were several sections of bank showing major disturbances to riparian vegetation, along the DLB in particular. There was a large pile of bricks and concrete on the DLB near the mouth (Figure 3-31).

Near the airport, the DRB (on the airport side) had series of major bank stabilisations in the form of rock armour at the base of the mangroves on the outside meander. Recruiting mangroves were observed growing in gaps in the armour. The DLB opposite the airport was a gentle sloping bank with an intact mangrove fringe. The DLB tended to show some erosion near the creek entrance to Machans Beach, where the pneumatophore root raft was visible and steep at low tide.

The riparian zone was in relatively good condition throughout the lower and mid-sections of the Barron River, where it was composed of mangrove vegetation (Figure 3-31). Occasional dead and fallen trees were present along the actively eroding outside meanders of the Barron River, but no areas of dieback were observed.

Figure 3-29 Eroding shoreline near the mouth of the Barron River, the downstream right bank, (southern bank) (above); and downstream left bank (northern bank) (below).

Figure 3-30 Dense *Sonneratia* near the mouth of the Barron River on the downstream right bank (above); *Bruguiera* dominating an outside meander in a downstream reach of the Barron River (below)

Figure 3-31 Armouring of the left bank with materials of opportunity in the downstream reaches (above); healthy mixed mangrove community in the mid section of the Barron River, DLB (below)

Figure 3-32 *Avicennia* and *Sonneratia* dominating a straight section of river (above); Melaleuca and other salt-sensitive species growing near the high water mark upstream from the Bruce Highway (below)

At the first bend upstream of the Bruce Highway Bridge, pockets of non-mangrove riparian habitat began to become more prevalent in the riparian fringe (Figure 3-32). At this bend, the downstream right bank has a large number of *Melaleuca* and other less marine tolerant species growing down towards the high water mark.

From the Bruce Highway Bridge to Northern Sands the proportion of mangroves in the riparian fringe becomes progressively less (Figure 3-33), to the point where mangroves are no longer present upstream of the Northern Sands void. Bank condition along the outside meanders in the vicinity of the Northern Sands void is often highly disturbed, with most outside meanders being stabilised by materials of opportunity including concrete, building materials, and car bodies, on both sides of the river.

Figure 3-33 A mixture of *Hibiscus* and occasional mangrove in the riparian community opposite Northern Sands

Upstream of the Northern Sands site are mixtures of non-remnant, highly disturbed vegetation fringing agricultural lands and several other fringing wetland communities including the endangered fringing riverine wetland community 7.3.23a (Figure 3-34). Disturbances from cattle are most prominent along the DRB in the reach upstream of the Northern Sands void. Fringing wetland communities appear in good health with very tall (>30 m) canopies in places (Figure 3-34).

Figure 3-34 Highly disturbed riparian zone on the downstream right bank, upstream of the Northern Sands site Fringing wetland community 7.3.23a to the right of screen near the most upstream extent of the survey

4 Summary

This section outlines key findings from the additional marine ecology field studies.

4.1 Existing Values/Resources

The existing marine/aquatic ecological features of waters adjacent to the potential land placement site and dredging impacts in Trinity Inlet are summarised as follows:

- Seagrass meadows in 2015 have made some recovery in Cairns Harbour since the last time they were surveyed in 2014. These meadows are relatively remote from the Barron River mouth. Some incidental records of seagrass were recorded in benthic grabs inside the bund in East Trinity reserve. No seagrass was recorded along the dredge pump-out pipeline at Richters Creek or on transects at the northern beaches.
- Diverse and abundant fish assemblages were observed within the Barron River, Trinity Inlet, Hills Creek and Firewood Creek. No non-native, invasive, or threatened fish or macro-crustaceans were collected in the study area.
- There were some downstream gradients in fish abundance observed during the dry season, but not during the wet season or for species richness.
- There was some evidence of recreational/ commercial depletion in mud crab catches, based on comparisons between protected and public access areas. Mud crabs outside of public access waterways were larger (both males and females) and were predominantly male.
- Fish and crab assemblages in all estuarine waterways were comprised mostly of marine and estuarine species that are tolerant of brief episodic reductions in salinity. Pacific Blue-eye were recorded in Firewood Creek, and while considered a ‘freshwater’ species, they are tolerant of a wide range of salinity (fresh to full sea water) conditions and are commonly recorded in mangrove forests.
- Trends in commercial catch show a general reduction in effort and catch associated with licence-holder buy-back and the closure of net fishing grounds over much of the study area. These changes to effort have coincided with increased catch per unit effort (CPUE) in the net fishery, while structural changes to other fisheries remain unclear given the recent timespan and a lack of data.
- Macroinvertebrate infauna communities in the Barron River were highly variable in space and time. Increasing richness and abundance with distance downstream in the wet season is consistent with freshwater flow acting as a disturbance. Bed stability was also implicated in affecting the richness and abundance of infauna.
- Crocodiles were abundant in East Trinity and occasionally influenced sampling site placement. No crocodiles were observed in the Barron River and this is likely due to the active removal program associated with the Crocodile Management Plan B zoning.

- Acoustic habitat mapping showed there were no reefs or hard substrates offshore from the mouth of Richters Creek, but substantial rocky habitats, wrecks, and debris are found throughout the Barron River
- The structure of riparian vegetation communities in the lower reaches of the Barron River varied on different sections of meander bends. Red mangrove (*Rhizophora)* tended to dominate on the outside meander bends, whereas grey mangrove (*Avicennia)* and mangrove apple (*Sonneratia alba)* tended to dominate on the inside meanders.
- A change in riparian vegetation community structure occurred upstream of the Bruce Highway Bridge, with *Melaleuca* and *Hibiscus* becoming more prevalent amongst the mangroves. This change in community structure most likely reflects reduced tidal influence and greater freshwater input in these upstream reaches. No extensive areas of recent or historic dieback were observed.

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