CAIRNS SHIPPING DEVELOPMENT PROJECT

Revised Draft Environmental Impact Statement

APPENDIX P: Marine Ecology Baseline Report (2016)

Cairns Shipping Development EIS - Marine Ecology Baseline Report

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BMT WBM Pty Ltd
Level 8, 200 Creek Street
Brisbane Qld 4000
Australia
PO Box 203, Spring Hill 4004

Tel: +61 7 3831 6744
Fax: + 61 7 3832 3627

ABN 54 010 830 421

www.bmtwbm.com.au

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Title:	Cairns Shipping Development EIS - Marine Ecology Baseline Report
Project Manager:	Greg Fisk
Author:	Conor Jones, Darren Richardson
Client:	Ports North / FCG
Client Contact:	David Finney
Client Reference:	

Synopsis: This preliminary report summarises the existing environmental value and potential threats associated with land-based placement and tailwater discharge in Trinity Inlet, East Trinity (Firewood and Hills Creeks), and the Barron River. Mitigation opportunities and limitations of the study are discussed.

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Key Findings and Implications for Stage 1C

This section outlines key findings from the marine ecology baseline study. The section identifies key marine/aquatic ecological issues that need to be considered in the selection of potential land placement sites for dredged material.

Existing Values/Resources

The existing marine/aquatic ecological features of waters adjacent to potential land placement sites are summarised as follows:

East Trinity

- Diverse and abundant fish assemblages were observed within Hills Creek and Firewood Creek. No non-native, invasive, or threatened fish or macro-crustaceans were collected in the study area.
- Waters upstream of the bund on Hills Creek had fewer species and individuals than areas downstream at the junction with Trinity Inlet. This was inconsistent with spatial patterns at Firewood Creek where the highest fish catch (abundance) and species richness was recorded in upstream areas (i.e. inside the bund at FF2).
- 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. 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).
- Fish and crab assemblages in both Firewood and Hills Creeks 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.
- Riparian vegetation communities at Hills Creek appeared to be in a more advanced state of recovery than Firewood Creek, and had a more defined channel and fewer ponded areas. Large parts of Firewood Creek were shallow and ponded with few living mangroves. During prolonged sunny and windy periods, it is possible that warm hypersaline conditions may eventuate in Firewood Creek.
- Live *Melaleuca* was more abundant in upstream environments than downstream in both creeks. Dead *Melaleuca* logs were abundant in both creeks, providing fish habitat and a source of energy to estuarine ecosystems.
- Near the limit of navigability in Hills Creek the vegetation changes rapidly to include more *Pandanus*, mangrove lily *Crinum pedunculatum* and live *Melaleuca,* suggesting a greater freshwater influence. No such changes were observed in the parts of Firewood Creek that were visited; however, meanders in the north-west section of the bunded Firewood Creek had much more intact riparian communities than those in its south-east.
- Incidental records of seagrass were recorded in benthic grabs inside the bund on Firewood Creek (FF2). This same site had high fish catches of fish and mangroves were in good condition.

- Crocodiles were abundant in Hills Creek, which influenced sampling site placement. Fewer crocodiles were observed in Firewood Creek than Hills Creek.

Trinity Inlet

- Rich and abundant fish communities were recorded within Trinity Inlet, again with both metrics increasing with distance downstream. The main Trinity Inlet channel, excluding creek mouths, had low crab catches. Crab species captured were mostly non-commercial species.
- Within the Trinity Inlet sites, the highest catches of fish and crabs were made at the mouths of Hills, Magazine, and Firewood Creeks. This is likely due to subtidal microhabitats along the main parts of Trinity Inlet being less developed, and creek mouths offering important fish passage between creeks and the inlet.
- At the mouth of Magazine Creek, Trinity Inlet had a muddy shoreline with a thin fringe of sparse seagrass in the upper subtidal/lower intertidal region. Sandy sediments prevail beneath the permanent moorings, with mixtures of sandy and muddy substrates with shell grit along the dredge pump-out alignment. No significant reefs or hard substrates were recorded.
- A similar pattern in habitat structure was observed at the mouth of Hills Creek, except there were no incidental records or observations of seagrass beds.
- Potential seagrass habitat (i.e. shallow subtidal waters) was not well developed at Coconut Shipyard. This site had a steep bank profile that dropped to ~4 m within close proximity of the shore.
- Crocodiles were less frequently observed in Trinity Inlet than they were inside the bund, with only two crocodile sightings at site TRIN1 near the Coconut Shipyards.

Barron River and Northern Beaches

- Sites located in the downstream reaches of the Barron River generally had higher catches of fish and crabs than other sites, but species richness was highest at the major creek entrance at site BF2.
- There were differences in crab catches along the Barron River; the sandy downstream environments had high sand crab catches, whereas upstream environments had higher catches of mud crabs. This pattern most likely reflects differences in habitat preferences of these species.
- Fish assemblages were comprised of marine and estuarine species, including sites in the upstream reaches of the Barron River. Most species would have adaptations that allow them to cope with temporary reductions in salinity, as occurs during rain events. No freshwater species that are intolerant of saline conditions were recorded.
- 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.

- No seagrass was recorded along the dredger pump-out at Richters Creek or on transects at the northern beaches.
- Subtidal habitat mapping offshore from Richters Creek shows a sandy shoreline becoming muddy with shell grit with distance offshore. Some “hard reads” (gravel or reefs) were recorded, which are likely to be vessel motion-induced sampling errors caused by high seas during the hydro-acoustic survey. Validation surveys will be carried out during the next water quality instrument servicing trip to assess these potentially erroneous data.
- No crocodiles were observed in the Barron River.

Threats

Potential threats to estuarine and marine biodiversity values associated with land placement are as follows:

East Trinity

- Tailwater discharge into Firewood Creek and/or Hills Creek inside the bund may alter surface and groundwater levels. Mangroves (and the burrowing fauna that control mangrove health) and *Melaleuca* are sensitive to long-term changes in water levels, and changes to hydrology that disrupt wetting and drying cycles could lead to plant stress and possibly mortality.
- Increases in turbidity within the bund may reduce light availability to seagrass communities inside the bund. Seagrass meadow extent within the bund has not been mapped to date and would require further assessment if this option is to be further considered.
- *Melaleuca* and mangrove species at the tidal limit are sensitive to extended periods of high salinity. Discharges of saline waters could therefore lead to stress and mortality of salt sensitive species, depending on management of the location, intensity, frequency and duration of tailwater discharges.
- Tailwater discharge into Firewood Creek downstream of the bund would be less likely to cause hydrology impacts (level and salinity) due to a lack of containment. The bund creates a very large tidal impediment (and lag) and acts to pond water.
- It is expected that most fish and invertebrate species would be tolerant of seawater salinities. The higher salinity in tailwater may provide more suitable habitat conditions for marine species, which could result in temporary changes to fauna community structure within the mixing zone of tailwater discharges.
- Seagrass meadows at the mouth of Magazine Creek were very sparse and comprised of pioneer species. The extent and resilience of these meadows (i.e. seed banks, seed sources) has not been examined to date. It is expected that any seagrass in the Magazine Creek dredger pump-out footprint would be temporarily lost, but would recolonise here if habitat conditions are re-instated i.e. depth, sediments, turbidity. No seagrass was observed at the potential pump out site at the entrance to Hills Creek.

Barron River and Northern Beaches

- Tailwater discharges of saline water to the Barron River upstream of Bruce Highway Bridge could adversely impact on brackish water, salt sensitive riparian vegetation species (e.g. *Melaleuca* and *Hibiscus)*. It is possible that vegetation stress and dieback could occur in the mixing zone, depending on the location, intensity, frequency and duration of tailwater discharges.

- Increased salinity in the central reaches of the Barron River (upstream of the Bruce Highway) may result in changes in fish communities, which could result in temporary changes to fauna community structure within the mixing zone of tailwater discharges.
- There is some uncertainty regarding whether hard substrates occur in the vicinity of the dredger pump-out, due to vessel motion-induced sampling errors caused by high seas during the survey. However, this area has naturally highly turbid waters and mobile sediments, and on this basis it is considered unlikely that this area supports species and habitats that are highly sensitive to sediments (e.g. reef building corals). No seagrass has been recorded at this location, and habitat conditions (high water depths, high turbidity, mobile sediments) are considered for sub-optimal for meadow development.

Mitigation Opportunities

Recommended mitigation measures include:

East Trinity and Trinity Inlet

- Discharge of tailwater downstream of the bunded areas, or in Trinity Inlet directly, would likely provide for better mixing and would be less likely to cause water level changes than discharge into the bunded area. This would also likely result in fewer salinity impacts to several salt-sensitive species that live in the bunded area. On this basis, a discharge point located downstream of the bunded area is preferred from an aquatic biodiversity perspective.
- Management actions (e.g. flap gates, ebb-tide discharges etc.) may be required to ensure that the dispersion of saline tailwater waters during flood-tides does not result in long term increases in salinity within upstream environments. This will need to be balanced against the need to maintain appropriate hydrological and water quality regimes, as well as fish passage, within upstream environments.

Barron River and Northern Beaches

- Tailwater should be discharged as far downstream towards the river mouth as practicable to minimise the potential for impacts to aquatic biodiversity values in upstream estuarine environments, noting the riparian assessment indicated a change to more freshwater species upstream of the Bruce Highway Bridge.
- Tailwater discharge during ebbing tides may also assist in reducing the extent of saline water penetrating upstream.

Constraints / Limitations

- Benthic macroinvertebrate samples have not been processed to date.
- Sonar-based habitat mapping results were affected by rough weather conditions during the survey, and there is some uncertainty regarding whether hard substrates occur at the dredge pump-out site on the northern beaches.
- Aquatic fauna communities show great variability over a range of time-scales, and this one-off study provides a single snap-shot in time of community characteristics.
- The baseline (assessment of vegetation both terrestrial and wetlands) is not part of the scope of BMT WBM. The assessment of riparian vegetation undertaken in the present study is intended to provide

background information on aquatic habitat condition and potential sensitivities to changes in water quality conditions.

Contents

List of Figures

1 Introduction

This report presents the preliminary findings of the marine ecology baseline study for the recalibrated Cairns Shipping Development (CSD) Environmental Impact Statement (EIS).

The recalibrated CSD EIS now includes the following two land placement options:

- Northern Sands
- East Trinity (where three sub-options are under consideration).

With the EIS now considering land placement options, further ecological assessments were required to adequately describe areas potentially affected by 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 in the northern beaches area.

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

- Subtidal habitat surveys at potential dredger pump-out locations using sonar (back-scatter), underwater video (drop-camera), and remote seagrass sampling
- A single snap-shot survey of commercially and recreationally significant fish and crab species at sites in the estuarine waterways
- Assessments of benthic macroinvertebrate communities within the estuarine waterways and potential dredger pump-out locations (in Trinity Bay at the mouth of Richters Creek for Northern Sands, and at Trinity Inlet for East Trinity sites).
- 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 not part of the scope of BMT WBM, the assessment of riparian vegetation undertaken in the present study is intended to provide background information on aquatic habitat condition and potential sensitivities to changes in water quality conditions.

1.1 Study Aim and Objectives

The broad aim of this study is to collect baseline marine ecology data to inform the preparation of the 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.

1.2 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.

2 Methodology

2.1 Timing of Field Work

Riparian condition assessments occurred during the collection of bathymetric data as a part of the coastal modelling component from July 27 to 29 for Hills and Firewood Creeks and on August 2 2016 near Richters Creek. Hydro-acoustic backscatter data (to examine benthic habitats) were collected from Trinity Inlet on August 6, 2016 at the entrances to Magazine and Hills Creeks and from the mouth of Richters Creek on August 8, 2016.

Fishing surveys were conducted over 6 days between July 30 and August 5, 2016 and were timed to capture flooding and ebbing tides (where possible) in each waterway. Macroinvertebrate samples were collected during fishing assessments and on August 5 at Magazine Creek, and August 8, 2016 along the pump-out alignment at Richters Creek. Drop-camera and remote seagrass sampling was conducted at the same time in these locations.

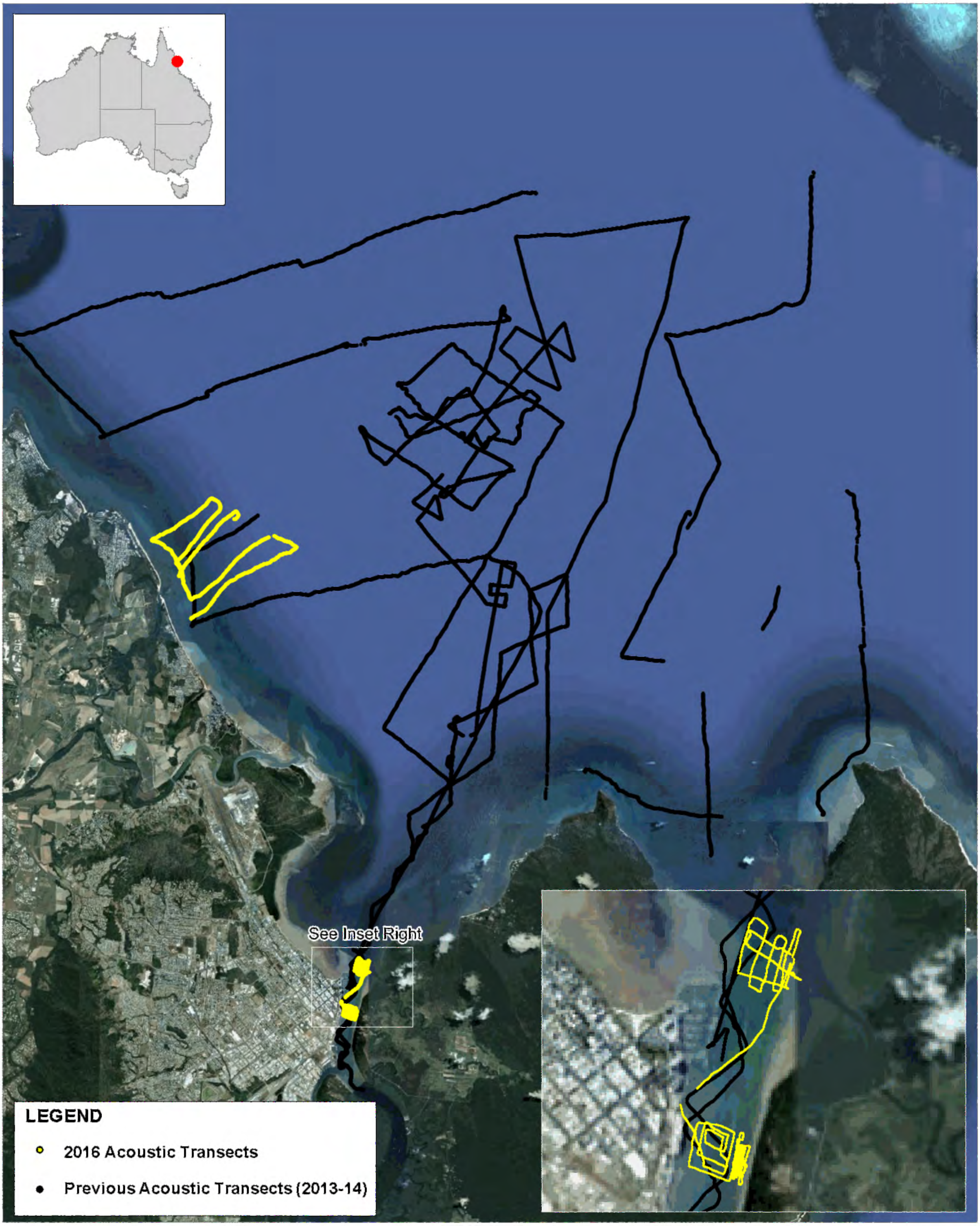
2.2 Equipment and Methods

2.2.1 Acoustic Data Collection

Acoustic data were collected from three focal areas within the wider extent of the areas surveyed in 2013 and 2014 (Figure 2-1). New areas of data collection are shown in yellow. These represented potential dredger pump-out locations near the mouth of Hills Creek, Magazine Creek, and Richters Creek.

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 polycraft vessel was used to collect data in Trinity Inlet, amongst the confines of moored vessels and in shallow waters. Hydro-acoustic data at 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 of Richters Creek. A small section of rocky substrate on the western edge of Trinity Inlet was used to validate the signal for hard substrates.



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2.2.2 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; see Rodusky et al. 2005[1]) sampling was therefore carried out by dragging a rake behind the vessel along a 20 m transect at each 21 sites shown in green in Figure 2-2.

2.2.3 Fish and Portunidae Crab Surveys

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 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 Portunidae crabs (i.e. mud crabs and sand crabs) was also recorded.

2.2.4 Macroinvertebrate and PSD Sampling

A small van Veen grab (0.028 m^2 gape) was used to collect macroinvertebrates and benthic substrate samples at 18 sites including each of the fishing sites and six additional sites along the Magazine Creek pump-out alignment and the Richters Creek pump-out alignment (shown in blue in Figure 2-2). At each site, three replicate grabs were taken and sieved through a 0.5 mm screen.

An additional grab was also taken at each location for the laboratory analysis particle size distribution (PSD).

[1] Rodusky AJ, Sharfstein B, East TL, Maki RP (2005) A comparison of three methods to collect submerged aquatic vegetation in a shallow lake. Environmental Monitoring and Assessment 110, 87-97.

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2.2.5 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

Hydro-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 is not considered of appropriate quality to assess sediment types and will be checked for hard returns (reefs) using side-scan sonar during a subsequent instrument service trip.

3 Findings

3.1 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.

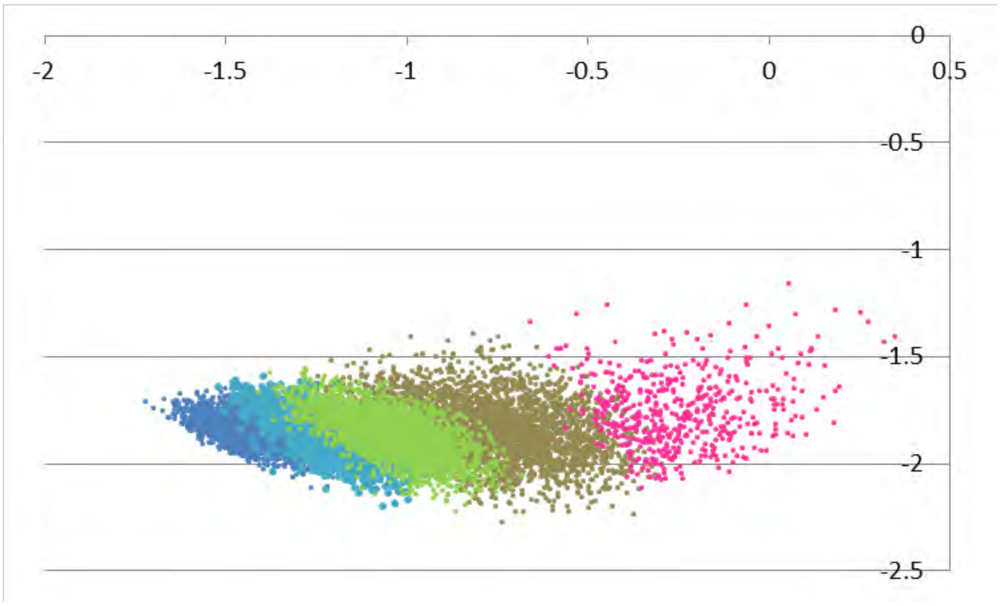
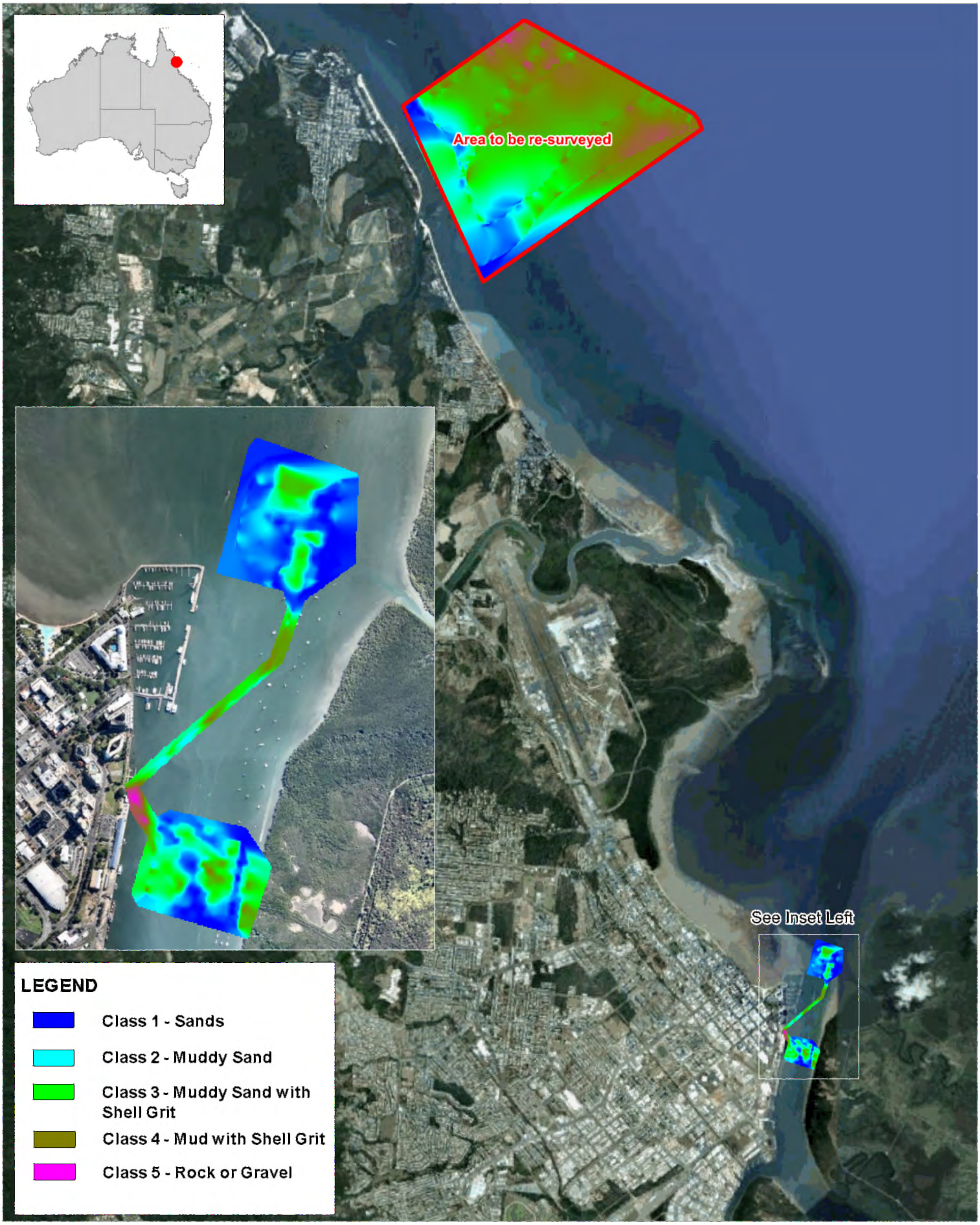


Figure 3-1 Two-dimensional ordination of the five hydro-acoustic classes (1, 2, 3, 4 and 5)

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



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Subtidal habitat mapping offshore from Richters Creek shows a sandy shoreline becoming muddier (with shell grit) with distance offshore. Some “hard reads” (gravel or reefs) were recorded, but these are likely to be artefacts of rough survey conditions, and need to be re-surveyed under better conditions.

3.2 Drop Camera and Seagrass Assessments

No seagrass meadows were observed at any of the drop-camera or physical point (rake) assessment sites.

Seagrass was incidentally recorded at two estuarine waterway sites:

- Magazine Creek (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 tentatively identified as *Halophila ovalis.*
- Firewood Creek (site FF2) – *Halophila ovalis* was recorded in a benthic grab sample at site FF2, which was located inside the bund.

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

Figure 3-4 Seagrass (*H. ovalis*) from a benthic grab in Firewood Creek (FF2)

Epibenthos communities at the Magazine Creek entrance to Trinity inlet were very sparse with only the occasional sponge and stinging hydroid observed. Communities at the mouth of Hills Creek were similarly sparse.

The data indicate the following:

- Habitats beneath the dredger pump-out locations in Trinity inlet do not contain reef or abundant epifauna communities.
- Seagrass was extremely sparse and probably only exists as a thin margin in the eastern margin of Trinity Inlet within the lower intertidal/ upper subtidal zone.
- The dredger pump-out location at Richters Creek is unlikely to be constrained by seagrass or reefs, but the presence of reefs will be further examined in subsequent trips to verify this.

3.3 Fishing and Crabbing Data

3.3.1 Overview

A total of 870 fish belonging to approximately 39 morpho-species were caught across the 12 sites. The entire catch was comprised of native species, and none of these are considered threatened.

Species list TBC

3.3.2 Fish Richness and Abundance

Diverse and abundant fish communities were observed within Trinity Inlet, Barron River, Hills Creek and Firewood Creek. Fish abundance tended to increase with distance downstream in all estuarine waterways[2] (Figure 3-5), but there were no clear spatial gradients in species richness (Figure 3-6).

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

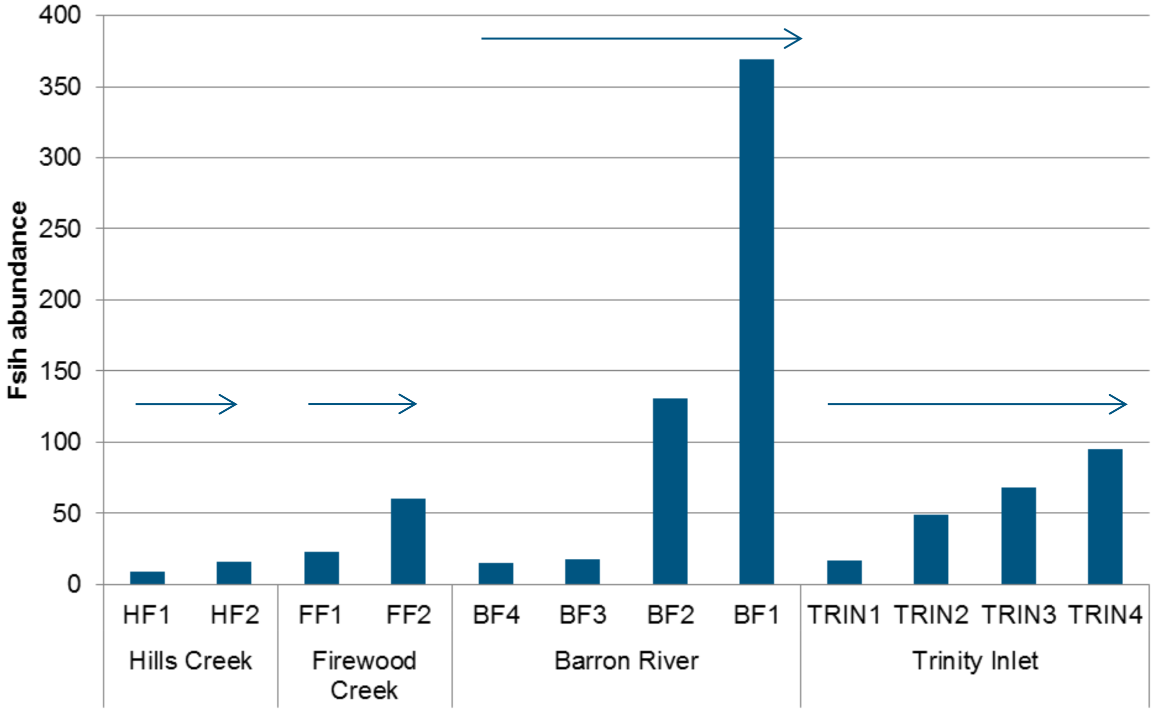

Figure 3-5 Total fish abundance at each of the sites within each waterway (arrows indicate site gradient towards the sea)

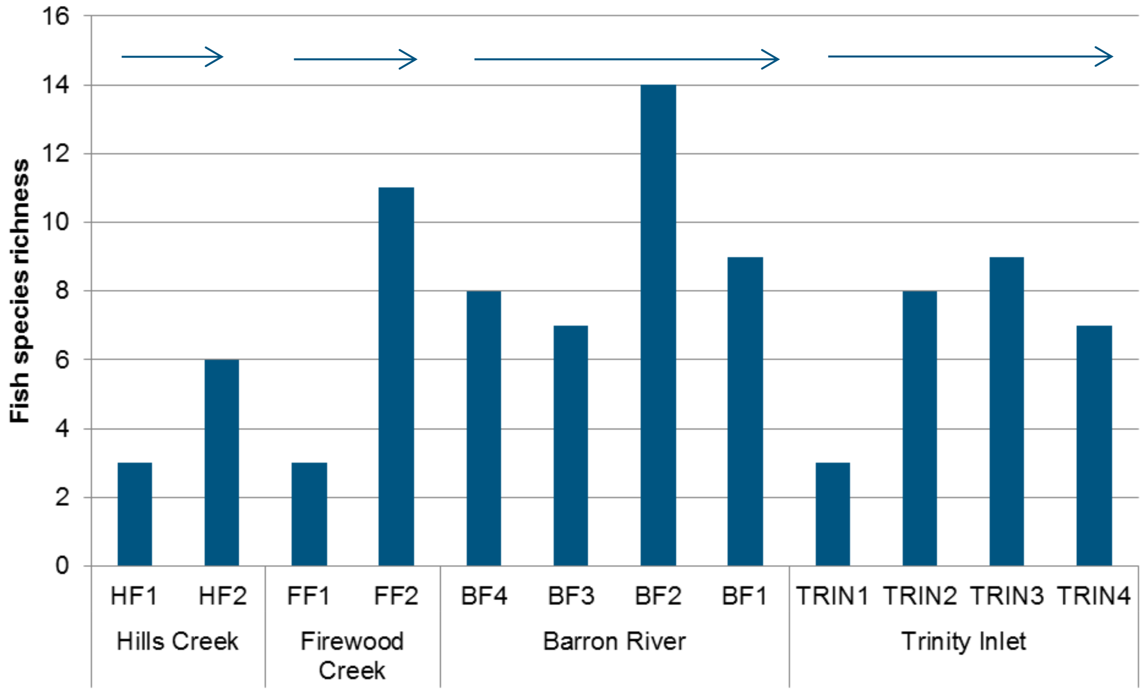

Figure 3-6 Species richness at each of the sites within each waterway (arrows indicate site gradient towards the sea)

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, whereas abundance increased markedly with distance downstream. The highest richness was observed at site BF2, and the high abundance at BF1 (369 fish) was mostly due to a large catch of herring.

3.3.3 Portunidae 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.

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.

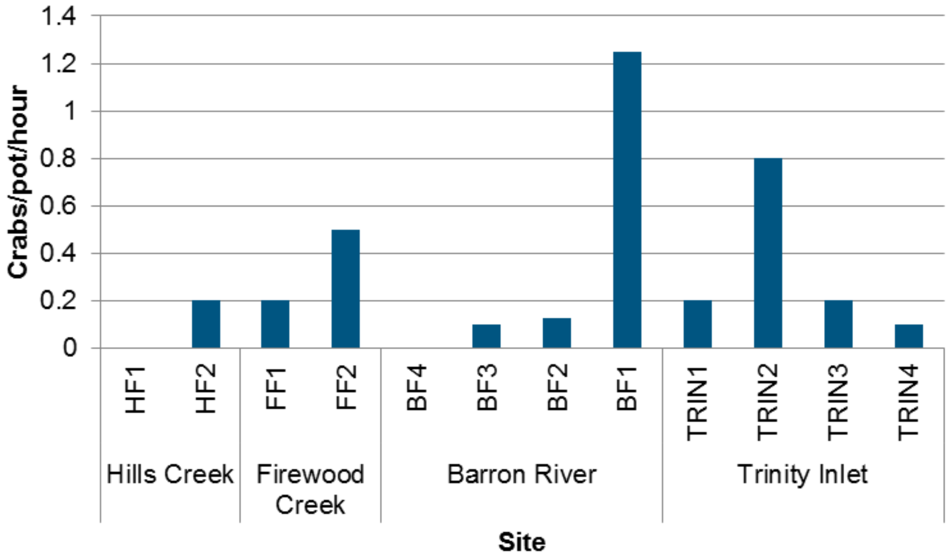

Figure 3-7 Crab catch per unit effort (crabs/ pot/ hr)

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 3-8, Figure 3-9, Figure 3-10). 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).

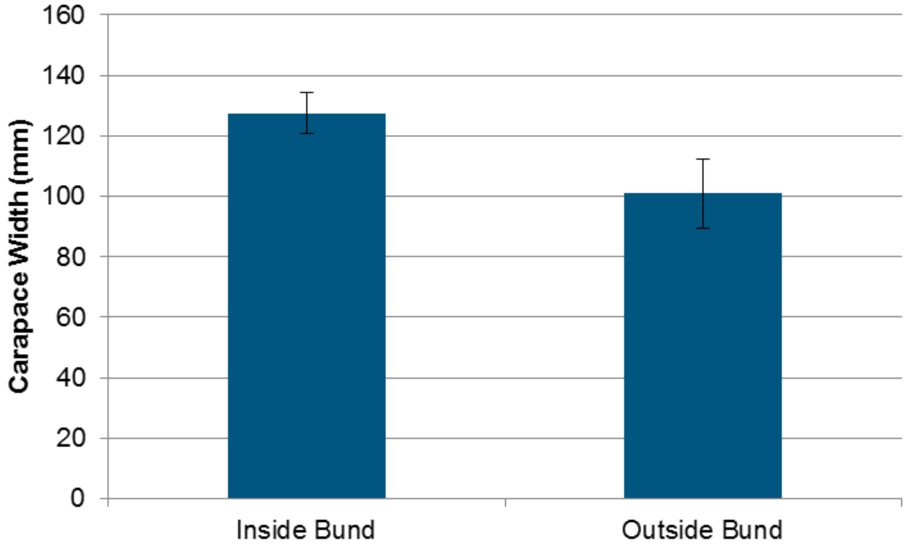

Figure 3-8 Differences in mean carapace width (± SE) for mud crabs inside and outside of the bund wall at East Trinity

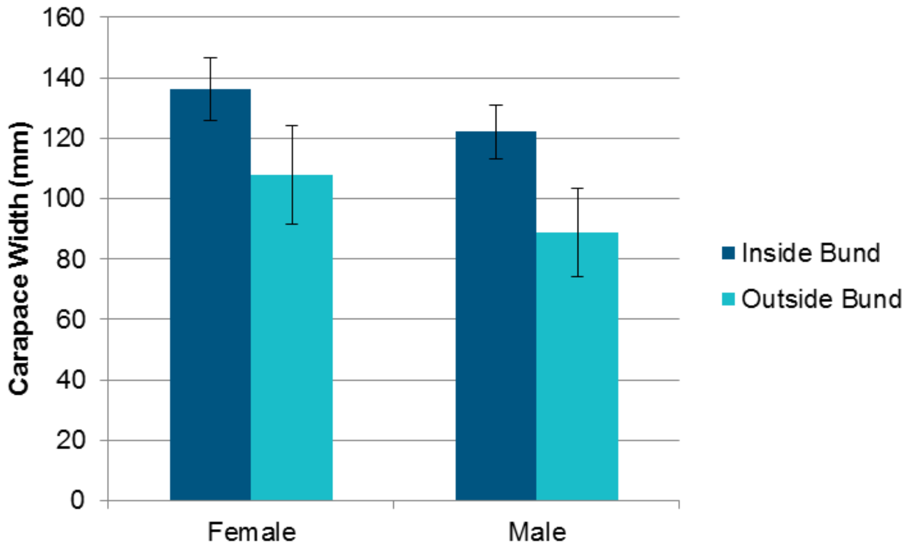

Figure 3-9 Differences in mean carapace width (± SE) partitioned by sex inside and outside of the bund wall at East Trinity

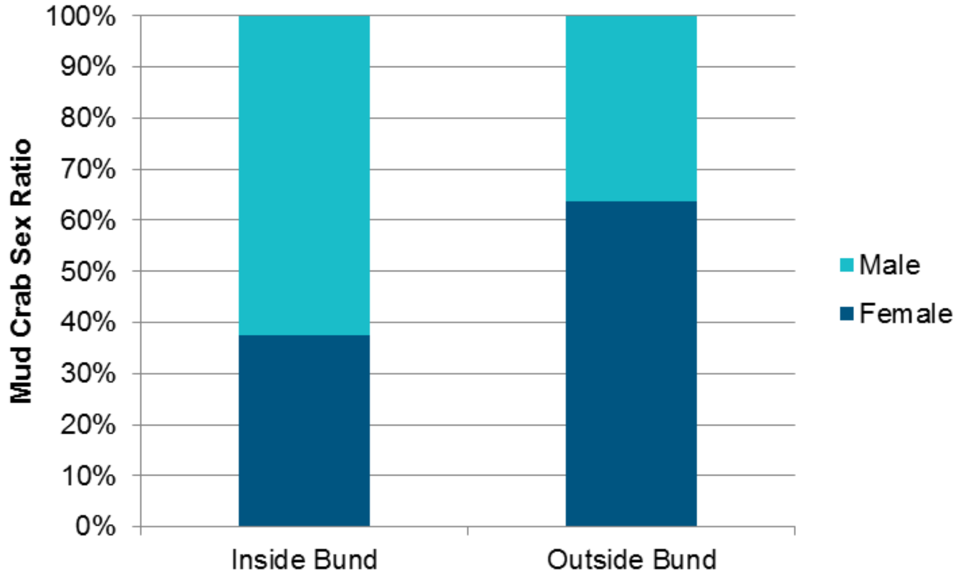

Figure 3-10 Sex ratios for mud crab catches inside and outside of the bund wall at East Trinity

3.4 Macroinvertebrate and PSD Data

Data not yet available

3.5 Riparian and Bank Condition Assessment

3.5.1 Firewood Creek

Outside of the bund the mangrove vegetation was typically dominated by red mangrove (*Rhizophora)* with occasional *Sonneratia alba* (Figure 3-11) particularly on accreting inside meanders where connectivity has been completely cut off by the bund. Vegetation communities were typically in good condition with the exception of those against the bund wall which were in poor condition but in a recovery state (Figure 3-11).

Figure 3-11 *Rhizophora* and *Sonneratia* in good condition downstream of the bund on Firewood Creek (left); and small *Rhizophora* and *Osbornia* growing on the bund wall (right)

Riparian communities inside the bund of Firewood Creek varied greatly in condition. The inundated area consisted of a complicated chain of fragmented oxbows, often connected by narrow tie-channels, and shallow ponded areas. The south-eastern sector of the bunded area within Firewood Creek was in a highly disturbed condition. This sector was mostly comprised of ponded open water with dead *Melaleuca* snags and isolated (regrowth) mangroves (mostly *Rhizophora* and *Aegiceras corniculatum*) (Figure 3-12). Riparian vegetation was in better condition towards the north-west sector of the bunded area, and was dominated by *Avicennia marina* (Figure 3-12).

The extent of channel definition within each section of waterway appeared to be directly related to the completeness and development of the riparian zone, and the level of tidal connectivity. Ponded areas with poor riparian vegetation had poorly defined channels, while section of waterway that had dense riparian vegetation tended to have a deeper, more defined channel. The upper reaches of Firewood Creek quickly became too shallow to navigate; therefore, the assessment of Firewood Creek did not extend as far upstream as it did into Hills Creek. A distinct change in vegetation from mangrove to less saline tolerant species was not observed in the surveyed extent of Firewood Creek.

Figure 3-12 *Rhizophora* and *Aegiceras* re-colonising ponded regions in the south-eastern sector of Firewood Creek (left); and dense *Avicennia marina* dominating the riparian zone in the north-west sector of the bund (right)

3.5.2 Hills Creek

Hills Creek consists of a linear channel, unlike Firewood Creek which consisted of a series of fragmented oxbows and ponded areas. The riparian zone in Hills Creek was generally better condition than it was in Firewood Creek, but dieback was still present in places upstream of the bund. Near the limit of upstream navigability, riparian vegetation was largely dominated by live *Melaleuca* and *Pandanus* (Figure 3-13), as is typical in brackish water upper estuarine environments.

The riparian vegetation in the middle and lower reaches of Hills Creek was dominated by mangroves *Rhizophora, Bruguiera, Aegiceras*, and occasional *Sonneratia* (Figure 3-13; Figure 3-14). This change in community structure and vegetation health reflects the greater tidal influence compared to upstream environments.

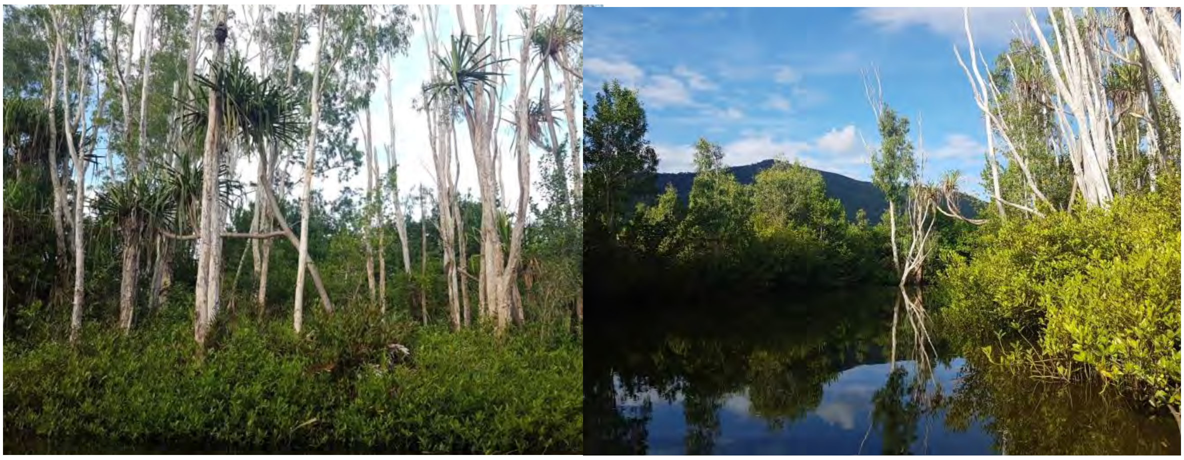

Figure 3-13 *Pandanus*, *Melaleuca* and mangrove holly in the upper estuary of Hills Creek (Left); *Aegiceras, Avicennia* and *Heritiera* in the middle reaches of Hills Creek (right)

Figure 3-14 Mangroves in good condition downstream of the bund on Hills Creek

3.5.3 Barron River

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. Erosions was evident particularly along the southern shore of the Barron near the mouth (Figure 3-15), and frequently along the outside meanders of each river bend.

In the lower estuary (upstream of the river mouth), the mangroves *Bruguiera* and *Rhizophora* dominated on the outside of eroding meander bends (Figure 3-15), whereas *Avicennia* and *Sonneratia* dominated on the inside accreting meanders and straight sections of the river (Figure 3-16). There were several sections of bank showing major disturbances to riparian vegetation, along the downstream left bank in particular.

Near the airport, the downstream right bank (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.

Figure 3-15 Eroding shoreline near the mouth of the Barron River (above); *Bruguiera* dominating an outside meander in a downstream reach of the Barron River (below)

The riparian zone was in relatively good condition throughout the lower and mid-sections of the Barron River. Occasional dead and fallen trees were present along the actively eroding outside meanders of the Barron River, but no areas of dieback were observed.

At the first bend upstream of the Bruce Highway Bridge, pockets of non-mangrove riparian habitat begin to become more prevalent in the riparian fringe. 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.

Figure 3-16 *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)

From the Bruce Highway Bridge to Northern Sands the proportion of mangroves in the riparian fringe becomes progressively less (Figure 3-17), to the point where mangroves are no longer present upstream of the Northern Sands site.

Figure 3-17 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 communities (7.3.23a).

Figure 3-18 Highly disturbed riparian zone on the downstream left bank, upstream of the Northern Sands site

Figure 3-19 Fringing wetland community 7.3.23a to the right of screen near the most upstream extent of the survey

Appendix A Laboratory Data

Laboratory Data

TBC

BMT WBM Bangalow
6/20 Byron Street, Bangalow 2479
Tel +61 2 6687 0466 Fax +61 2 66870422
Email bmtwbm@bmtwbm.com.au
Web www.bmtwbm.com.au

BMT WBM Brisbane
Level 8, 200 Creek Street, Brisbane 4000
PO Box 203, Spring Hill QLD 4004
Tel +61 7 3831 6744 Fax +61 7 3832 3627
Email bmtwbm@bmtwbm.com.au
Web www.bmtwbm.com.au

BMT WBM Denver
8200 S. Akron Street, #B120
Centennial, Denver Colorado 80112 USA
Tel +1 303 792 9814 Fax +1 303 792 9742
Email denver@bmtwbm.com
Web www.bmtwbm.com

BMT WBM London
International House, 1st Floor
St Katharine's Way, London E1W 1AY
Email london@bmtwbm.co.uk
Web www.bmtwbm.com

BMT WBM Mackay
PO Box 4447, Mackay QLD 4740
Tel +61 7 4953 5144 Fax +61 7 4953 5132
Email mackay@bmtwbm.com.au
Web www.bmtwbm.com.au

BMT WBM Melbourne
Level 5, 99 King Street, Melbourne 3000
PO Box 604, Collins Street West VIC 8007
Tel +61 3 8620 6100 Fax +61 3 8620 6105
Email melbourne@bmtwbm.com.au
Web www.bmtwbm.com.au

BMT WBM Newcastle
126 Belford Street, Broadmeadow 2292
PO Box 266, Broadmeadow NSW 2292
Tel +61 2 4940 8882 Fax +61 2 4940 8887
Email newcastle@bmtwbm.com.au
Web www.bmtwbm.com.au

BMT WBM Perth
Level 3, 20 Parkland Road, Osborne, WA 6017
PO Box 1027, Innaloo WA 6918
Tel +61 8 9328 2029 Fax +61 8 9486 7588
Email perth@bmtwbm.com.au
Web www.bmtwbm.com.au

BMT WBM Sydney
Level 1, 256-258 Norton Street, Leichhardt 2040
PO Box 194, Leichhardt NSW 2040
Tel +61 2 8987 2900 Fax +61 2 8987 2999
Email sydney@bmtwbm.com.au
Web www.bmtwbm.com.au

BMT WBM Vancouver
Suite 401, 611 Alexander Street
Vancouver British Columbia V6A 1E1 Canada
Tel +1 604 683 5777 Fax +1 604 608 3232
Email vancouver@bmtwbm.com
Web www.bmtwbm.com