



Leekes Creek Estuary

Seasonal Fish Surveys and Seagrass Assessment

Prepared for:

Department of National Parks, Sport and Racing

frc [environmental](#)

PO Box 2363, Wellington Point QLD 4160

Telephone: + 61 3286 3850

Facsimile: + 61 3821 7936

frc reference: 140803

Document Control Summary

Project No.: 140803
Status: Final Report
Project Director: John Thorogood
Project Manager: Craig Chargulaf
Title: Leekes Creek Estuary Seasonal Fish Survey and Seagrass Assessment
Project Team: C. Chargulaf, C. Conacher, M. Langridge, K. Maguire, T. Probst
Client: Department of National Parks, Sport and Racing
Client Contact: Rochelle Jupp
Date: 24 July 2015
Edition: 140803Riii
Checked by: Carol Conacher _____
Issued by: Craig Chargulaf _____

Distribution Record

Department of National Parks, Sport and Racing: 1 .pdf document

This work is copyright.

A person using frc environmental documents or data accepts the risk of:

- 1 Using the documents or data in electronic form without requesting and checking them for accuracy against the original signed hard copy version; and
- 2 Using the documents or data for any purpose not agreed to in writing by frc environmental.

Contents

Summary	i
1 Introduction and Objectives	1
2 Methods	3
2.1 Survey Timing	3
2.2 Site Conditions	3
2.3 Water Quality	4
2.4 Fauna	6
2.5 Seagrass and Macroalgae	12
3 Results	14
3.1 Water Quality	14
3.2 Fauna	14
3.3 Seagrass and Macroalgae	33
4 General Discussion and Conclusion	37
5 References	39

Appendix A Tide Heights and Times in Each Survey

Appendix B Fish Sites and Fishing Effort

Appendix C Crab Pot Sites and Effort

Appendix D Seagrass Transects

Appendix E Water Quality Results

Appendix F Fish Caught

Appendix G Anecdotal Fish Occurrence

Appendix H Crabs Caught

Appendix I Seagrass Community Composition and Distribution

Appendix J Raw Data

Tables

Table 2.1	Data collected in each survey.	3
Table 2.2	Queensland water quality guidelines for estuarine and enclosed coastal waters of the Central Coast region.	4
Table 3.1	Fish recorded in Leekes Creek estuary and adjacent bays in the surveys.	15
Table 3.2	Life history stages of fish identified in Leekes Creek estuary and adjacent bays.	22
Table 3.3	Crabs identified in Leekes Creek estuary and adjacent bays.	28
Table 3.4	Crab abundance, size class and sex ratio for crabs caught in crab pots and seine nets at each location.	31

Figures

Figure 2.1	A fyke net set along a natural drainage channel.	7
Figure 2.2	Seine netting in the mouth of Leekes Creek at low tide.	8
Figure 2.3	Cast netting on the foreshore of Leekes Beach.	9
Figure 2.4	Deploying a BRUV in Leekes Creek mouth at low tide.	10
Figure 2.5	Deploying a crab pot at the mouth of the estuary.	11
Figure 2.6	Deploying the tow sled for seagrass and macroalgae surveys.	13
Figure 3.1	Abundance of fish at each site in each survey.	20
Figure 3.2	Fish species richness at each site in each survey.	20
Figure 3.3	Fish eggs sampled in the mouth of Leekes Creek.	21
Figure 3.4	Fish eggs in the intertidal zone of the mouth of Leekes Creek.	21
Figure 3.5	Abundance of yellowfin bream in each survey.	24
Figure 3.6	Abundance of sea mullet in each survey.	25

Figure 3.7	Abundance of whiting in each survey.	25
Figure 3.8	Abundance of prawns in each survey.	26
Figure 3.9	Prawn (<i>Parapenaeopsis</i> sp.) caught in the mouth of Leekes Creek.	27
Figure 3.10	Abundance of crabs at each site in each survey.	30
Figure 3.11	Abundance of large crabs in each survey.	30
Figure 3.12	Attempted turtle nesting on Leekes Beach.	32
Figure 3.13	<i>Halodule uninervis</i> near Svendsson's Beach in November 2014.	33
Figure 3.14	Patches of <i>Halophila ovalis</i> near Svendsson's Beach in May 2015.	34
Figure 3.15	Sparse <i>Halodule uninervis</i> along the foreshore of Leekes Creek that was exposed at low tide in November 2014.	34
Figure 3.16	<i>Caulerpa</i> sp.	35
Figure 3.17	<i>Sargassum</i> sp.	36

Maps

Map 1.1	Location of Study Areas around Leekes Creek and Adjacent Bays.	2
Map 2.1	Location of Water Quality Sampling Sites.	5

Summary

This study was commissioned by the Queensland Parks and Wildlife Service as part of the Central Queensland declared Fish Habitat Area (FHA) Investigations Program, which is funded as part of Gladstone Ports Corporation's (GPC) Marine Fish Habitat Offsets Program (DNPRSR 2015). As part of the Investigations Program the fisheries values of sections of the Leekes Creek area, Great Keppel Island, were assessed to support the proposed inclusion of these areas into the FHA network. Additional funds were provided for this work by GPC through their Biodiversity Offsets Strategy.

The objectives of this study were to identify and inventory the seasonal use of habitats by fish and crabs of the Leekes Creek estuary, and to describe the seasonal distribution of seagrass and macroalgae communities in areas adjacent to the estuary. The results of these surveys were then used to assess the potential value of Leekes Creek as an FHA.

Water quality was typical of an estuarine environment (Montagna et al. 2013), with most parameters within Queensland Water Quality Guideline trigger values.

The benthic habitat directly downstream of Leekes Creek and in the adjacent bays was typically characterised by bare sand with some small areas of rubble. In the adjacent bays, there were also sparse patches of seagrass and macroalgae. The size and distribution of the patches varied between surveys.

The area supports a diverse range of marine fauna, including fish, crabs, prawns, dolphins, dugong, and turtles. Fifty-nine species of fish, 2 species of prawns, and 13 species of crab were recorded, including several species of commercial, recreational and indigenous importance. The highest abundance and highest diversity of fish were caught in May 2015, and a mass spawning event was recorded in November 2014 in Leekes Creek. Leekes Creek supports a diverse fish community and is likely to be an integral area for the breeding, migratory and foraging success of the species recorded.

The Leekes Creek estuary and adjacent bays supports a diverse marine community with ecological significance, including many fish and crabs that are of commercial, recreational and indigenous importance. The estuary may be a particularly important spawning area in the summer and an important migratory pathway for fish using offshore reefs. Overall, the area surveyed would be a significant addition to the State's network of declared Fish Habitat Areas

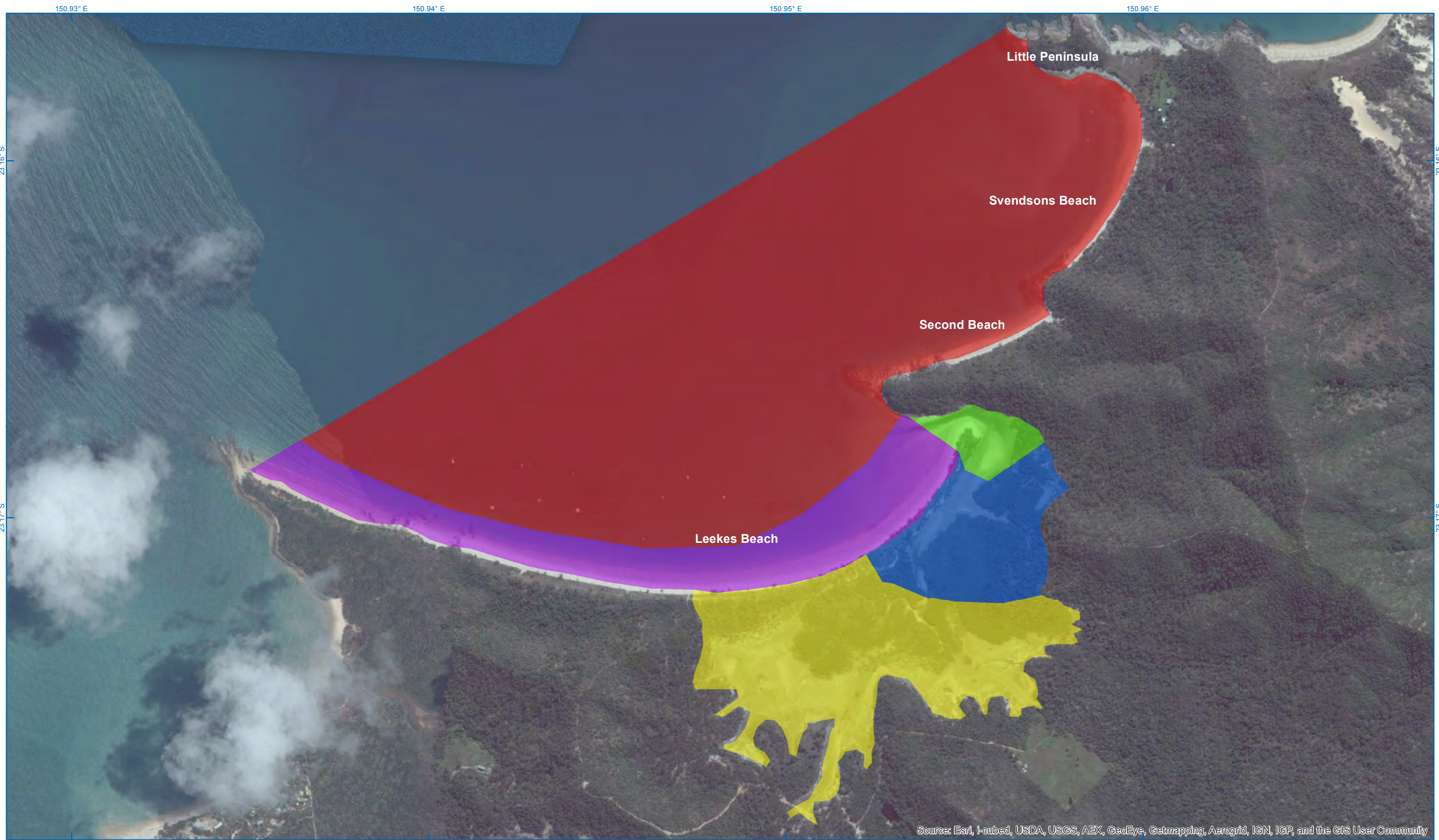
1 Introduction and Objectives

This study was commissioned by the Queensland Parks and Wildlife Service as part of the Central Queensland declared Fish Habitat Area (FHA) Investigations Program, which is funded as part of Gladstone Ports Corporation's (GPC) Marine Fish Habitat Offsets Program (DNPRSR 2015). As part of the Investigations Program the fisheries values of sections of the Leekes Creek area, Great Keppel Island, were assessed to support the proposed inclusion of these areas into the FHA network. Additional funds were provided for this work by GPC through their Biodiversity Offsets Strategy.

This study complements the initial Fisheries Resource Assessments (FRA) of the Leekes Creek estuary, which comprised three (frc environmental 2014), and also a snap shot habitat assessment of Leekes Creek estuary and adjacent inshore waters (frc environmental 2015).

Leekes Creek is an estuary on Great Keppel Island (23.17°S, 150.955°E) (Map 1.1). The island has an area of 14.5 km², and is in the Great Barrier Reef World Heritage Area, 15 km off the mainland coast. Great Keppel Island has a tidal range of approximately 4.0 m. Leekes Creek is lined with mangrove communities and the channels drain at low tide, with small pools of water remaining. Above tidal waters, the Leekes Creek area has been identified as significant habitat for terrestrial flora and fauna (Chenoweth EPLA 2011).

The objectives of this study were to identify and inventory the seasonal use of habitats by fish and crabs of the Leekes Creek estuary, and to describe the seasonal distribution of seagrass and macroalgae communities in the areas adjacent to the estuary. The results of these surveys were then used to assess the potential value of Leekes Creek as an FHA.



Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community



PO Box 2363
Wellington Point
Q 4160 Australia

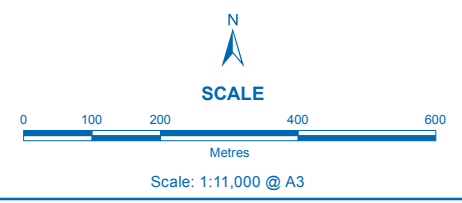
P 07 3286 3850
E info@frcenv.com.au
www.frcenv.com.au

Leekes Creek Estuary Fish Survey and Seagrass Assessment

Map 1.1: Location of Study Areas around Leekes Creek and Adjacent Bays

SOURCES
 © Copyright Commonwealth of Australia (Geoscience Australia) 2001, 2004, 2006
 © The State of Queensland (Department of Natural Resources and Mines) 2013
 © The State of Queensland (Department of Environment and Heritage Protection) 2013

- LEGEND**
Study Area
- Leekes Creek Foreshore
 - Leekes Creek Mouth
 - Leekes Creek Mid-Estuary
 - Leekes Creek Upper Estuary
 - Adjacent Bays

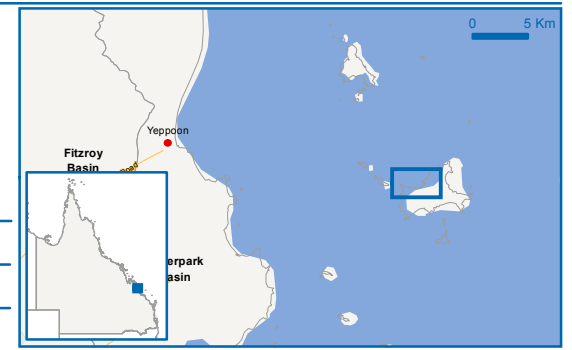


PROJECTION
 Coordinate System: GCS GDA 1994
 Datum: GDA 1994
 Units: Degree

DATE
2015-06-24

DRAWN BY
CAC

VERSION
01



Document Path: Y:\Projects\2014-140801_DNP\RSR_Leekes_Creek\Mapping\Workspaces\140801_Map1_study_area.mxd

2 Methods

2.1 Survey Timing

Water quality, fish and crabs, and seagrass / macroalgae were surveyed four times between February 2014 and May 2015 (Table 2.1).

Table 2.1 Data collected in each survey.

Survey Dates	Season	Water Quality	Fish and Crabs	Seagrass and Macroalgae
11–14 February 2014	Summer	✓	✓	✓
19–22 August 2014	Winter	✓	✓	✓
15–18 November 2014	Spring	✓	✓	✓
2–5 May 2015	Autumn	✓	✓	✓

Surveys in February 2014, August 2014 and May 2015 were only during the day. In November 2014, fish surveys were also conducted at night.

2.2 Site Conditions

In February 2014 and May 2015, the weather was fine and sunny with slight winds (<10 knots) in the afternoons. In August 2014, there was moderate rain (5–10 mm) and winds (10 knots), which constrained seagrass surveys to the inshore area. In November 2014, there were high winds (15 knots) in the late afternoons; however, this did not have an impact on the survey.

The tidal variation ranged from 2.3 to 3.6 m in February 2014, August 2014, and November 2014, and from 0.7 to 4.1 m in May 2015 (Appendix A).

2.3 Water Quality

Site Locations

Water quality was measured in situ at nine sites (Map 2.1) using a handheld Aquaread multi-parameter water quality meter, which was calibrated each day as per the *Queensland Monitoring and Sampling Manual 2009 – Version 2* (EHP 2013). The following data was recorded at each site:

- water temperature
- pH
- percent saturation of dissolved oxygen
- turbidity, and
- salinity.

Water quality was measured during an outgoing tide in February 2014, and during outgoing and incoming tides in August 2014, November 2014, and May 2015.

Data Analysis

Water quality was compared to the Queensland Water Quality Guideline values for estuarine and enclosed coastal waters of the Central Coast region (slightly to moderately disturbed waters) (Table 2.2).


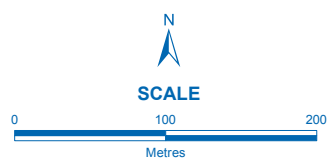

Table 2.2 Queensland water quality guidelines for estuarine and enclosed coastal waters of the Central Coast region.

Parameter	Unit	Guideline Value (GV)		
		Upper Estuarine	Mid-estuarine & Tidal Canals	Enclosed Coastal
temperature	°C	–	–	–
pH	pH units	7.0–8.4	7.0–8.4	8.0–8.4
dissolved oxygen	% saturation	70–100	85–100	90–100
turbidity	NTU	25	8	6
salinity	psu	–	–	–

– no trigger value



Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

 <p>PO Box 2363 Wellington Point Q 4160 Australia</p> <p>P 07 3286 3850 E info@frcenv.com.au www.frcenv.com.au</p>	<h3>Leekes Creek Estuary Fish Survey and Seagrass Assessment</h3> <hr/> <h4>Map 1.2: Location of Water Quality Sampling Sites</h4> <hr/> <p>SOURCES © Copyright Commonwealth of Australia (Geoscience Australia) 2001, 2004, 2006 © The State of Queensland (Department of Natural Resources and Mines) 2013 © The State of Queensland (Department of Environment and Heritage Protection) 2013</p>	<p>LEGEND</p> <ul style="list-style-type: none"> ● Water Quality Sampling Site 	<div style="text-align: center;">  <p>SCALE 0 100 200 Metres Scale: 1:5,000 @ A3</p> </div> <p>PROJECTION Coordinate System: GCS GDA 1994 Datum: GDA 1994 Units: Degree</p>	<div style="text-align: center;">  <p>0 5 Km</p> </div> <p>DATE 2015-06-24</p> <p>DRAWN BY CAC</p> <p>VERSION 01</p>
---	---	--	--	--

Document Path: Y:\Projects\2014-140801_DNP\RSR_Leekes_Creek\Mapping\Workspace\140801_Map1-2_WQ_sites.mxd

2.4 Fauna

Fauna surveys targeted fish, crabs and other macrocrustaceans (e.g. prawns) within the estuary of Leekes Creek estuary and in the adjacent bay. Survey sites are shown in Appendix B.

Sightings of fish, crabs and megafauna during the surveys were also included, as well as anecdotal sightings from local residents of the island.

Fish and Macrocrustacean Surveys

Data was collected using a combination of four techniques:

- fyke nets
- seine nets
- cast nets, and
- baited remote underwater videos (BRUVs).

The fishing effort for each method is presented in Appendix B.

Additional fish that were visually sighted or identified during the video transects for the seagrass surveys, were also noted.

Fyke Netting

Fyke nets are an effective gear type to capture fish and macrocrustaceans using mangrove habitats (Figure 2.1). Two double winged fyke nets were set in different habitat areas along the tidal reaches of Leekes Creek estuary and the adjacent bay (i.e. upper-estuary, mid-estuary, estuary mouth and foreshore of Leekes Beach).

At each location, the fyke nets were set approximately 50 m apart, with the cod end remaining in the water at all times of the tidal cycle. Fyke nets were placed at the entrance to natural inlets or drainage channels, with one wing of the fyke net angled along the shore line, and the other wing angled along the shoreline on the opposite side of the inlet / drainage channel. Where possible fyke nets were set across the creek itself to sample fish moving towards the creek mouth as the tide receded. Nets were checked at low tide, and the fish and macrocrustaceans that were caught were released downstream of the nets.

Figure 2.1

A fyke net set along a natural drainage channel.



Seine Netting

Seine nets were used within the residual pools of Leekes Creek estuary and along the foreshore of the adjacent bay at low tide (Figure 2.2). Replicate seines were completed in three different habitat zones:

- mid-estuary
- estuary mouth, and
- foreshore.

The seine net was dragged out in an U-shape from the bank into the direction of the prevailing current, and then brought into shore ensuring that the lead line remained on the bottom during the haul. The seine net was 120 m x 4 m with 60 mm mesh; however, the haul length was dependent on the site and available water.

Figure 2.2

Seine netting in the mouth of Leekes Creek at low tide.



Cast Netting

Cast nets were used in Leekes Creek and the adjoining bay to target fish species that were not caught in the seine or fyke nets (Figure 2.3). Cast netting specifically targeted pools and areas of deeper water in the estuary where fish were aggregating at low tide. Subsequent casts of the net were greater than 5 m apart. Cast nets were not used in areas where they might get snagged or where there was dense aquatic vegetation. The cast net was thrown off the side of the boat or from the shore, using a single net operator to minimise sampler bias and variation in technique.

Figure 2.3

Cast netting on the foreshore of Leekes Beach.



Baited Remote Underwater Videos

BRUVs, baited with pilchards, were deployed at a minimum of six sites in the estuary mouth and in the adjacent bays for a minimum of 30 minutes at each site (Figure 2.4). After 30 minutes, the BRUVs were retrieved and redeployed in another section of the study area.

Figure 2.4

Deploying a BRUV in Leekes Creek mouth at low tide.



Fish and Macrocrustacean Data Collection

Fish and macrocrustaceans caught in nets were placed in a large container filled with seawater and aerated to minimise mortality. Fish were then identified to species and photographed; macrocrustaceans were identified to family level and photographed. The first 20 individuals of each species (or family) were measured to total (or fork) length (± 1 cm). All fish and macrocrustaceans were subsequently returned to the environment from where they were caught.

Video footage from each BRUV was reviewed in the laboratory by an ecologist trained in marine fish identification. New fish species (i.e. not recorded during netting efforts) were added to the species inventory.

Crab Surveys

The abundance and species composition of crab assemblages were surveyed in accordance with the Department of Agriculture, Fisheries and Forestry (DAFF)

methodology outlined in the *Fisheries, Long Term Monitoring Program Sampling Protocol Mud Crab: (2008 onwards) Section 1* (Fisheries Queensland 2009). Replicate crab pots were set at 50 m intervals as close as possible to mangrove habitat in four key habitat areas (i.e. foreshore, mouth, mid-estuary and upper-estuary) (Appendix C, Figure 2.5). Crab pots were baited with mullet and set at least two hours before the late afternoon or night high tide. Pots were checked at least four hours after the morning low tide. Details of crab potting efforts are provided in Appendix C.

Figure 2.5

Deploying a crab pot at the mouth of the estuary.



For each sampling location the following details were recorded:

- catch location (i.e. foreshore, mouth, mid or upper estuary)
- deployment date and time, and
- retrieval time and date.

All crabs caught were:

- identified to species
- sexed
- measured
- photographed, and
- released at the site of capture.

Incidental Observations of Marine Megafauna

Marine megafauna observed while completing the fish, crab and seagrass surveys were recorded, along with the location and time of each sighting.

2.5 Seagrass and Macroalgae

Seagrass and macroalgae were surveyed in subtidal habitats of the adjacent bays from a boat using a remote video camera mounted on a tow sled (Figure 2.6). Transects were approximately 0.3–1 km long, with each transect running perpendicular to the shore (Appendix D). Successive transects were separated by approximately 200–400 m. The track was mapped using a GPS and linked to depth and other key characteristics of the habitat.

Video of benthic habitats was viewed ‘live’ on board the boat. Where seagrass meadows, macroalgae or other notable habitat features, such as rocky outcrops, were identified the following was recorded:

- the position using a GPS
- the time
- the water depth, and
- the species of seagrass or macroalgae present, and
- the density by visually estimating the percent cover of each species.

When seagrass or macroalgae was identified, additional transects and spot checks were undertaken in the area to establish the boundary of each patch. The above process was repeated each time seagrass or macroalgae (or other notable habitat) was found.

Figure 2.6

Deploying the tow sled for seagrass and macroalgae surveys.



Data Analysis and Mapping

All water depth data was converted to Australian Height Datum (AHD) to enable comparison between locations, using tide height data for the survey period and tidal plane information provided for Rosslyn Bay Boat Harbour by Maritime Safety Queensland.

The GPS positions of each survey point and the associated water depth and seagrass data, along with the track logs of all transect surveyed (including any additional survey points) were downloaded to Arc GIS.

This information was used to create a map depicting transects and points surveyed, the location of seagrass and the species composition of seagrass at each location.

3 Results

3.1 Water Quality

In each season, water temperature was typical of seawater temperatures, and was similar at each site in each survey (Appendix E).

The pH of Leekes Creek estuary varied between surveys, but was typically within the Queensland Water Quality Guideline values, with the exception of some sites in February 2014 and August 2014 (Appendix E). In February 2014, the pH was slightly below (more acidic than) the guidelines at three sites, one in the upper estuary and two off the foreshore, which was likely to be due to the high rainfall and freshwater inputs prior to this survey [206 mm from 1 to 10 February (BOM 2015)]. In August 2014, the pH was slightly above (more alkaline than) the guidelines at two sites, one in the upper estuary and one in the mid-estuary, on the outgoing tide. The differences were minor (≤ 0.3 NTU) and likely due to rainfall and run-off during the survey.

The percent saturation of dissolved oxygen varied between sites and between surveys (Appendix E). With the exception of November 2014, the percent saturation of dissolved oxygen was above the guidelines at some sites in each survey; however, there was no consistent pattern.

Turbidity predominantly complied with the guidelines, with the exception of the outgoing tide in February 2014 (Appendix E). Turbidity was typically highest in February 2014 and this was also likely to be related to the high rainfall and associated run-off prior to the survey.

Salinity was consistent between sites and surveys and typical of estuarine waters (Appendix E).

3.2 Fauna

Fish

Altogether, 2014 fish were caught or observed (e.g. from BRUV footage) in Leekes Creek estuary and in the adjacent bays, comprising 60 fish species from 41 families (Table 3.1). A photographic record of species is presented in Appendix F.

Table 3.1 Fish recorded in Leekes Creek estuary and adjacent bays in the surveys.

Family	Species	Common Name	Location Caught or Observed			
			Upper Estuary	Mid-estuary	Mouth	Foreshore
Ambassidae	<i>Ambassis marianus</i>	estuary perchlet	x	x	x	–
Atherinidae	<i>Atherinomorus endrachtensis</i>	Endracht hardyhead	x	–	–	–
Bothidae	<i>Bothus</i> sp.	flounder species	x	–	–	–
Caesionidae	<i>Caesio caerulea</i>	blue and gold fusilier	–	–	–	x
Carangidae	<i>Gnathanodon speciosus</i>	golden trevally	–	x	x	–
Carcharhinidae	<i>Negaprion acutidens</i>	lemon shark	x	–	–	–
Clupeidae	<i>Anodontostoma chacunda</i>	gizzard shad	–	–	x	–
Clupeidae	<i>Herklotsichthys castelnaui</i>	Castelnaud's herring	–	x	–	–
Clupeidae	<i>Herklotsichthys koningsbergeri</i>	Koningsberger's herring	x	–	–	–
Clupeidae	<i>Sardinella albella</i>	white sardine	–	–	–	x
Cynoglossidae	<i>Paraplagusia bilineata</i>	patterned tongue sole	–	–	–	x
Dasyatidae	<i>Pastinachus sephen</i>	cowtail stingray	–	x	–	–
Dasyatidae	<i>Taeniura lymma</i>	blue-spotted stingray	–	x	x	x
Drepanidae	<i>Drepane punctata</i>	sicklefish	–	x	–	–
Echeneidae	<i>Echeneis naucrates</i>	remora	–	–	–	x
Eleotridae	<i>Butis butis</i>	crimson-tipped gudgeon	x	x	–	–
Ephippidae	<i>Platax orbiculatus</i>	orbicular batfish	–	–	–	x

Family	Species	Common Name	Location Caught or Observed			
			Upper Estuary	Mid-estuary	Mouth	Foreshore
Gerreidae	<i>Gerres filamentosus</i>	thread-finned silver biddy	–	x	x	–
Gerreidae	<i>Gerres oyena</i>	common silver biddy	–	–	–	x
Ginglymostomatidae	<i>Nebrius ferrugineus</i>	tawny nurse shark	–	–	–	x
Gobiidae	<i>Favonigobius exquisitus</i>	exquisite sand goby	–	–	x	–
Gobiidae	<i>Glossogobius circumspectus</i>	flathead goby	x	–	–	–
Gobiidae	<i>Periophthalmus argentilineatus</i>	mudskipper	x	x	–	–
Haemulidae	<i>Plectorhinchus gibbosus</i>	brown sweetlip	–	–	x	–
Haemulidae	<i>Pomadasys kaakan</i>	spotted javelinfinch	–	–	x	x
Hemiramphidae	<i>Hemiramphus</i> sp.	garfish	x	x	x	–
Labridae	<i>Thalassoma lunare</i>	moon wrasse	–	–	–	x
Latidae	<i>Lates calcarifer</i>	barramundi	–	–	x	–
Leiognathidae	<i>Leiognathus equulus</i>	common ponyfish	–	–	x	x
Lutjanidae	<i>Lutjanus argentimaculatus</i>	mangrove jack	–	–	x	–
Lutjanidae	<i>Lutjanus russelli</i>	Moses perch	–	x	x	–
Monodactylidae	<i>Monodactylus argenteus</i>	diamondfish	–	x	–	–
Mugilidae	<i>Mugil cephalus</i>	sea mullet	x	x	x	x
Mullidae	<i>Parupeneus barberinus</i>	dash-dot goatfish	–	–	–	x
Mullidae	<i>Upeneus tragula</i>	freckled goatfish	–	–	x	–

Family	Species	Common Name	Location Caught or Observed			
			Upper Estuary	Mid-estuary	Mouth	Foreshore
Myliobatidae	<i>Manta birostris</i>	manta ray	–	–	–	x
Platycephalidae	<i>Inegocia japonica</i>	rusty flathead	–	–	x	–
Platycephalidae	<i>Platycephalus arenarius</i>	sand flathead	–	–	–	x
Platycephalidae	<i>Platycephalus endrachtensis</i>	bar-tailed flathead	–	–	–	x
Platycephalidae	<i>Platycephalus fuscus</i>	dusky flathead	–	–	x	–
Plotosiidae	<i>Plotosus lineatus</i>	striped catfish	–	–	x	–
Polynemidae	<i>Eleutheronema tetradactylum</i>	blue threadfin salmon	–	x	x	–
Pomacentridae	<i>Abudefduf vaigiensis</i>	sergeant major	–	–	–	x
Pomacentridae	<i>Parma oligolepis</i>	bigscale scalyfin	–	–	–	x
Pseudomugilidae	<i>Pseudomugil signifer</i>	Pacific blue-eye	x	x	–	–
Rhinobatidae	<i>Aptychotrema</i> sp.	shovelnose ray	–	x	x	x
Scatophagidae	<i>Selenotoca multifasciata</i>	striped butterflyfish	–	x	x	x
Serranidae	<i>Ephinephelus coioides</i>	estuary cod	–	x	x	–
Siganidae	<i>Siganus canaliculatus</i>	white-spotted spinefoot	–	–	x	–
Siganidae	<i>Siganus lineatus</i>	golden-lined spinefoot	–	x	–	–
Sillaginidae	<i>Sillago</i> sp.	whiting	x	x	x	–
Sparidae	<i>Acanthopagrus australis</i>	yellowfin bream	x	x	x	–
Sparidae	<i>Acanthopagrus pacificus</i>	black bream	x	x	x	–

Family	Species	Common Name	Location Caught or Observed			
			Upper Estuary	Mid-estuary	Mouth	Foreshore
Sphyraenidae	<i>Sphyraena jello</i>	pickhandle barracuda	–	x	x	x
Synanceiidae	<i>Synanceia horrida</i>	estuarine stonefish	–	–	x	–
Terapontidae	<i>Terapon jarbua</i>	crescent perch	x	–	x	–
Tetradontidae	<i>Arothron immaculatus</i>	immaculate pufferfish	–	–	x	–
Tetradontidae	<i>Arothron manilensis</i>	striped pufferfish	–	–	x	–
Tetradontidae	<i>Tetractenos hamiltoni</i>	common toadfish	x	x	x	–
Unknown	–	unidentifiable juvenile	–	x	–	–

x caught or observed
– not caught or observed

Abundance and species richness of fish were both highest in May 2015. Abundance was generally highest in the mid and upper-estuary, while species richness was generally highest at the mouth of Leekes Creek, and in the mid-estuary (Figure 3.1 and Figure 3.2).

Estuary perchlet (*Ambassis mariana*) was the most abundant species in each survey, except for February 2014, when no estuary perchlets were caught. In the remaining surveys estuary perchlet was commonest in the upper- and mid-estuary sections of Leekes Creek. Estuary perchlets are small, relatively short-lived species that commonly form large shoals. They are common prey for many larger carnivorous fish, including flathead and bream (Blaber 1986; Grant 1991), as such, large variations in abundance are expected. In February 2014, the most abundant species was the common ponyfish (*Leiognathus equulus*) and the Endracht hardyhead (*Atherinomorus endrachtensis*).

In each survey, the fish that were caught were dominated by adults (Table 3.2); however, the limitations of fishing methods (i.e. large mesh sizes) did not allow for the effective capture of juvenile fish. Juveniles were often seen in the mangrove root system at high tide, but were not caught. Intermediate life-history stages were caught in each survey in each section of the creek.

In November 2014, there was a mass-spawning event (of unknown species) in Leekes Creek, which left large masses of eggs in pools and natural depressions on the banks at low tide (Figure 3.3 and Figure 3.4).

Manta rays (*Manta birostris*) were sighted on 19 January 2015 and again on 5 May 2015 in Leekes Bay.

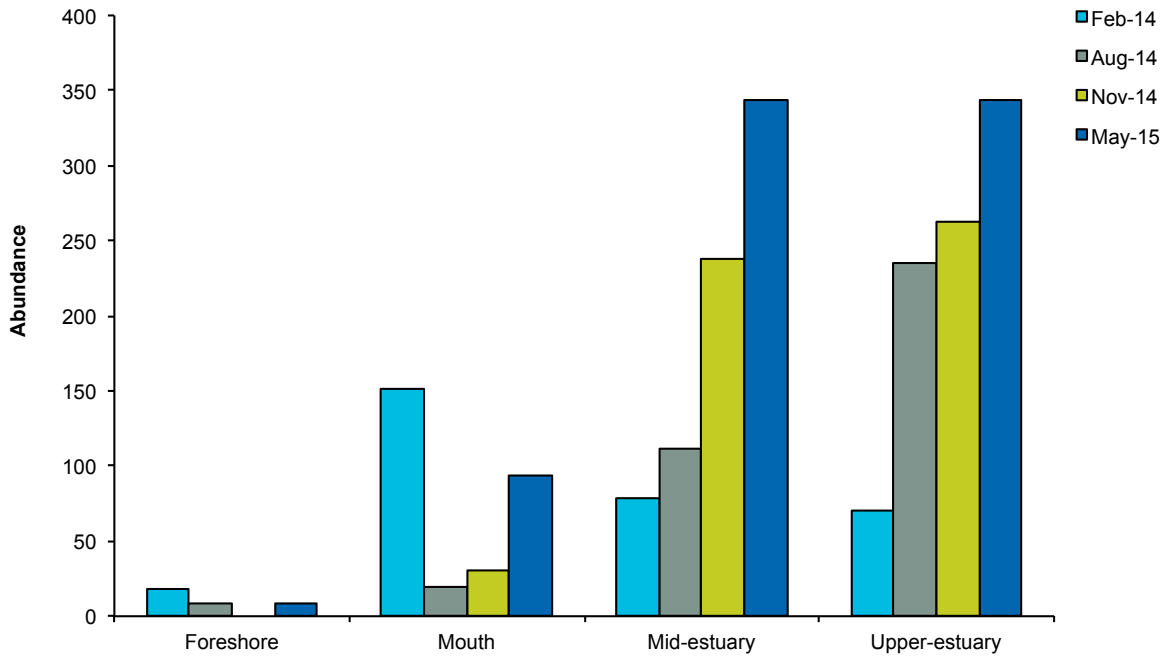


Figure 3.1 Abundance of fish at each site in each survey.

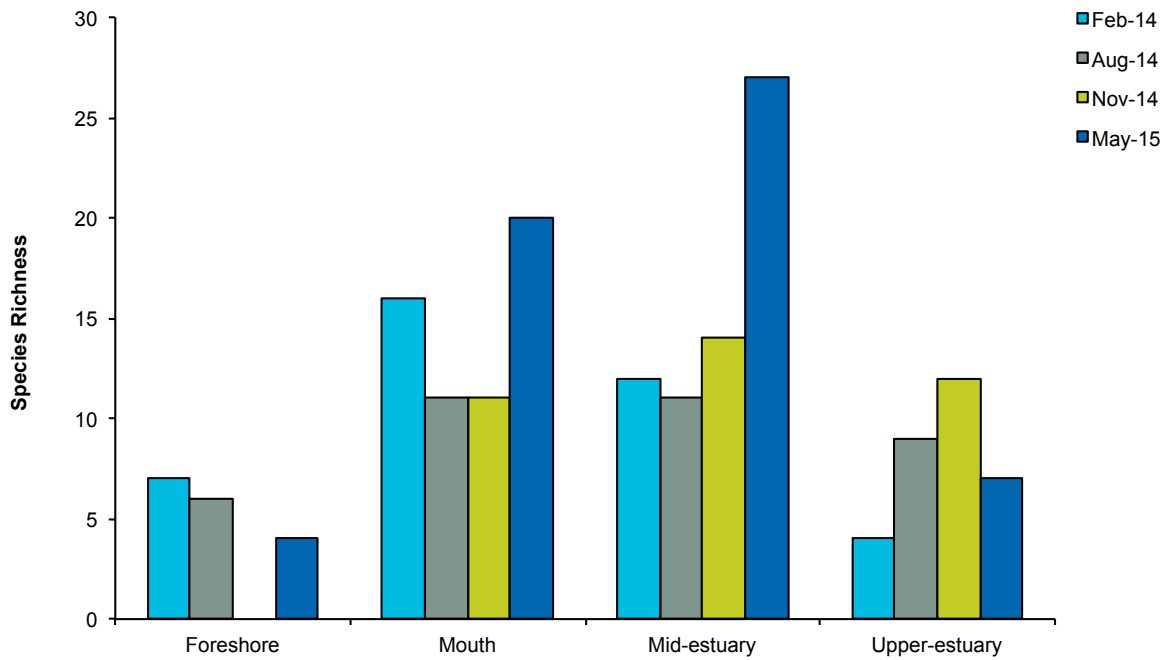


Figure 3.2 Fish species richness at each site in each survey.

Figure 3.3

Fish eggs sampled in the mouth of Leekes Creek.



Figure 3.4

Fish eggs in the intertidal zone of the mouth of Leekes Creek.



Table 3.2 Life history stages of fish identified in Leekes Creek estuary and adjacent bays.

Family	Species	Common Name	Size Range (mm)	Juveniles	Intermediates	Adults	Total Count
Ambassidae	<i>Ambassis marianus</i>	estuary perchlet	31–80	0	0	730	730
Atherinidae	<i>Atherinomorus endrachtensis</i>	Endracht hardyhead	9–88	46	98	0	144
Bothidae	<i>Bothus</i> sp.	flounder	48	1	0	0	1
Caesionidae	<i>Caesio caerulea</i>	blue and gold fusilier	–	–	–	–	–
Carangidae	<i>Gnathanodon speciosus</i>	golden trevally	132–180	0	8	0	8
Carcharhinidae	<i>Negaprion acutidens</i>	lemon shark	740	0	1	0	1
Clupeidae	<i>Anodontostoma chacunda</i>	gizzard shad	190–210	0	0	4	4
Clupeidae	<i>Herklotsichthys castelnaui</i>	Castelnau's herring	125–190	0	0	71	71
Clupeidae	<i>Herklotsichthys koningsbergeri</i>	Koningsberger's herring	40–195	0	10	25	35
Clupeidae	<i>Sardinella albella</i>	white sardine	90	0	0	1	1
Cynoglossidae	<i>Paraplagusia bilineata</i>	patterned tongue sole	230	0	0	1	1
Dasyatidae	<i>Pastinachus sephen</i>	cowtail stingray	350–600	0	1	1	2
Dasyatidae	<i>Taeniura lymma</i>	blue-spotted stingray	300	0	0	1	1
Drepanidae	<i>Drepane punctata</i>	sicklefish	11	0	1	0	1
Echeneidae	<i>Echeneis naucrates</i>	remora	–	–	–	–	–
Eleotridae	<i>Butis butis</i>	crimson-tipped gudgeon	90–100	0	0	2	2
Ehippidae	<i>Platax orbiculatus</i>	orbicular batfish	65	1	0	0	1
Gerreidae	<i>Gerres filamentosus</i>	thread-finned silver biddy	52–220	0	0	48	48
Gerreidae	<i>Gerres oyena</i>	common silver biddy	15–170	5	0	16	21
Ginglymostomatidae	<i>Nebrius ferrugineus</i>	tawny nurse shark	–	–	–	–	–
Gobiidae	<i>Favonigobius exquisitus</i>	exquisite sand goby	17–33	0	1	9	10
Gobiidae	<i>Glossogobius circumspectus</i>	flathead goby	70	0	0	1	1
Gobiidae	<i>Periophthalmus argentilineatus</i>	mudskipper	52	0	0	1	1 ^a
Haemulidae	<i>Plectorhinchus gibbosus</i>	brown sweetlip	110–144	0	2	0	2
Haemulidae	<i>Pomadasys kaakan</i>	spotted javelinfish	112–430	0	6	16	22
Hemiramphidae	<i>Hemiramphus</i> sp.	garfish	–	–	–	–	–
Labridae	<i>Thalassoma lunare</i>	moon wrasse	–	–	–	–	–
Latidae	<i>Lates calcarifer</i>	barramundi	650–770	0	0	2	2
Leiognathidae	<i>Leiognathus equulus</i>	common ponyfish	12–196	20	22	140	182
Lutjanidae	<i>Lutjanus argentimaculatus</i>	mangrove jack	305–320	0	0	3	3

Family	Species	Common Name	Size Range (mm)	Juveniles	Intermediates	Adults	Total Count
Lutjanidae	<i>Lutjanus russelli</i>	Moses perch	40–149	0	6	9	15
Monodactylidae	<i>Monodactylus argenteus</i>	diamondfish	80–83	0	2	0	2
Mugilidae	<i>Mugil cephalus</i>	sea mullet	20–274	30	35	63	128
Mullidae	<i>Parupeneus barberinus</i>	dash-dot goatfish	–	–	–	–	–
Mullidae	<i>Upeneus tragula</i>	freckled goatfish	106	0	0	1	1
Myliobatidae	<i>Manta birostris</i>	manta ray	–	–	–	2	2
Platycephalidae	<i>Inegocia japonica</i>	rusty flathead	470	0	0	1	1
Platycephalidae	<i>Platycephalus arenarius</i>	sand flathead	120	0	0	1	1
Platycephalidae	<i>Platycephalus endrachtensis</i>	bar-tailed flathead	230	0	0	1	1
Platycephalidae	<i>Platycephalus fuscus</i>	dusky flathead	291–300	0	2	0	2
Plotosiidae	<i>Plotosus lineatus</i>	striped catfish	130–200	0	0	172	172
Polynemidae	<i>Eleutheronema tetradactylum</i>	blue threadfin salmon	–	–	–	–	–
Pomacentridae	<i>Abudefduf vaigiensis</i>	sergeant major	–	–	–	–	–
Pomacentridae	<i>Parma oligolepis</i>	bigscale scalyfin	–	–	–	–	–
Pseudomugilidae	<i>Pseudomugil signifer</i>	Pacific blue-eye	23–50	0	33	60	93
Rhinobatidae	<i>Aptychotrema</i> sp.	shovelnose ray	400–580	3	5	0	8
Scatophagidae	<i>Selenotoca multifasciata</i>	striped butterfish	96–165	0	0	8	8
Serranidae	<i>Ephinephelus coioides</i>	estuary cod	89–341	8	1	0	9
Siganidae	<i>Siganus canaliculatus</i>	white-spotted spinefoot	87–189	0	6	24	30
Siganidae	<i>Siganus lineatus</i>	golden-lined spinefoot	72	0	1	0	1
Sillaginidae	<i>Sillago ciliata</i>	sand whiting	20–335	2	8	45	55
Sparidae	<i>Acanthopagrus australis</i>	yellowfin bream	21–256	1	13	51	65
Sparidae	<i>Acanthopagrus pacificus</i>	black bream	20–310	1	23	19	43
Sphyrnidae	<i>Sphyrna obtusata</i>	obtuse barracuda	350–550	0	0	2	2
Synanceiidae	<i>Synanceia horrida</i>	estuarine stonefish	145	0	0	1	1
Terapontidae	<i>Terapon jarbua</i>	crescent perch	27–103	2	24	1	27
Tetradontidae	<i>Arothron immaculatus</i>	immaculate pufferfish	68–170	0	0	14	14
Tetradontidae	<i>Arothron manilensis</i>	striped pufferfish	37–60	3	0	0	3
Tetradontidae	<i>Tetractenos hamiltoni</i>	common toadfish	55–140	0	4	6	10
Unknown	–	unidentifiable juvenile	25–28	3	0	0	3

– fish were either recorded on BRUV or sighted and could not be measured

^a numerous mudskippers were observed on the banks at low tide in the upper- and mid-estuary, but not caught

Several species of commercial, recreational and indigenous importance were recorded in Leekes Creek in each survey, including:

- barramundi (*Lates calcifer*)
- mangrove jack (*Lutjanus argentimaculatus*)
- sea mullet (*Mugil cephalus*)
- yellowfin bream (*Acanthopagrus australis*), and
- sand whiting (*Sillago ciliata*).

Yellowfin bream (*Acanthopagrus australis*), sea mullet (*Mugil cephalus*) and whiting (*Sillago* sp.) were most widely distributed in the estuary and were present in each survey (Figure 3.5 to Figure 3.7). Several species were only caught in one survey, for example Barramundi (*Lates calcifer*) were only caught in the November 2014 survey, while mangrove jack (*Lutjanus argentimaculatus*) was only caught in the August 2014 survey. This indicates that use of the creek may be seasonal for some species and usage is likely to be linked with either breeding or migratory cycles.

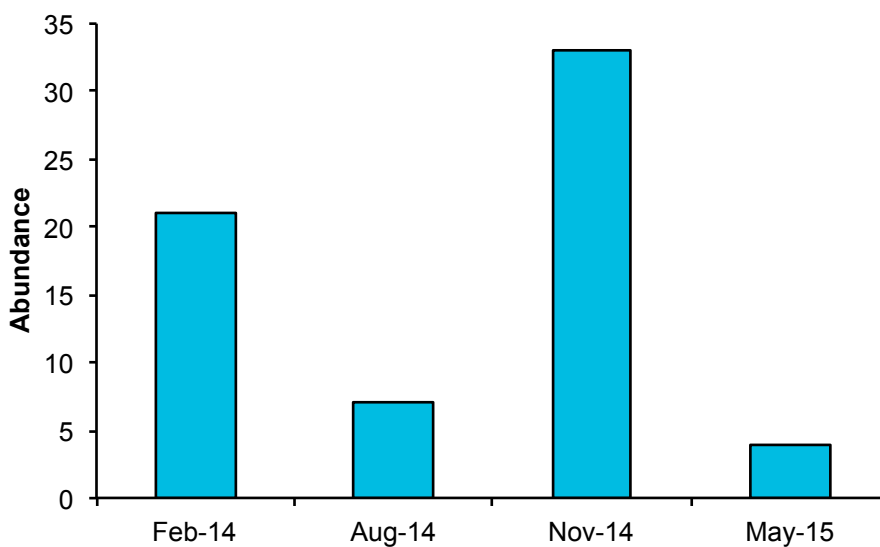


Figure 3.5 Abundance of yellowfin bream in each survey.

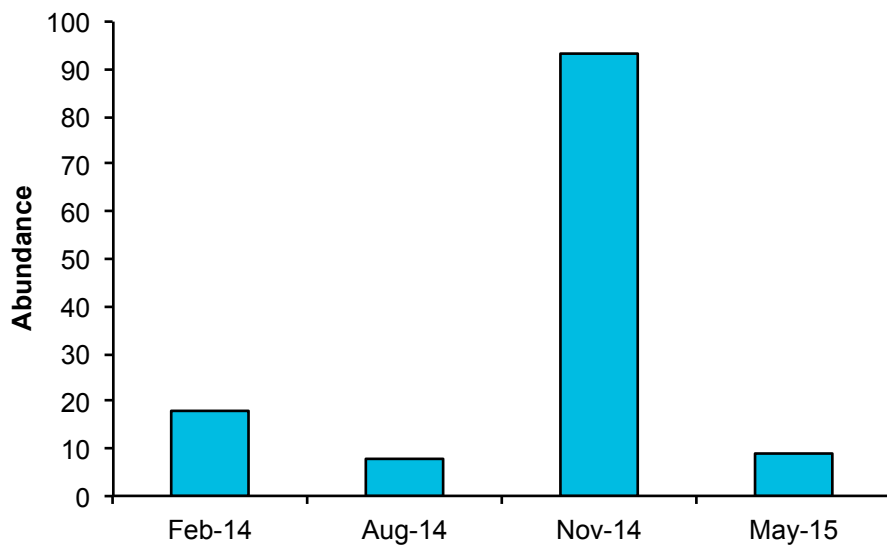


Figure 3.6 Abundance of sea mullet in each survey.

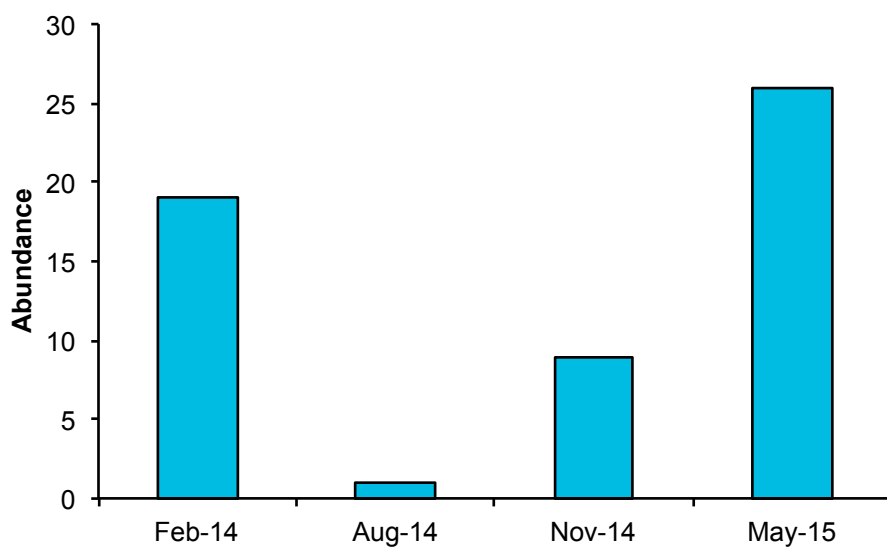


Figure 3.7 Abundance of whiting in each survey.

Anecdotal Fish Occurrence

Fish species known to occur in the Leekes Creek estuary and adjacent bays, as identified by local residents of Great Keppel Island (but that were not caught or recorded in the current surveys) are presented in Appendix G.

Macrocrustaceans

The only other macrocrustacean species caught in Leekes Creek were prawns. Approximately 1500 prawns (at least two species, *Parapenaeopsis* sp. (Figure 3.9) and an unidentified species) were caught, with the highest abundance of prawns in February 2014 (Figure 3.8). Prawns were caught in all sections of the creek, including the foreshore. The size of the prawns ranged from 12 to 90 mm, with the largest prawn recorded in May 2015. In each survey, smaller individuals dominated the prawn catch with little seasonal differences in life-history stages. Prawns are a key food source for fish and an important commercial fishery in Australia, and are likely to play an important role in the food web of Leekes Creek.

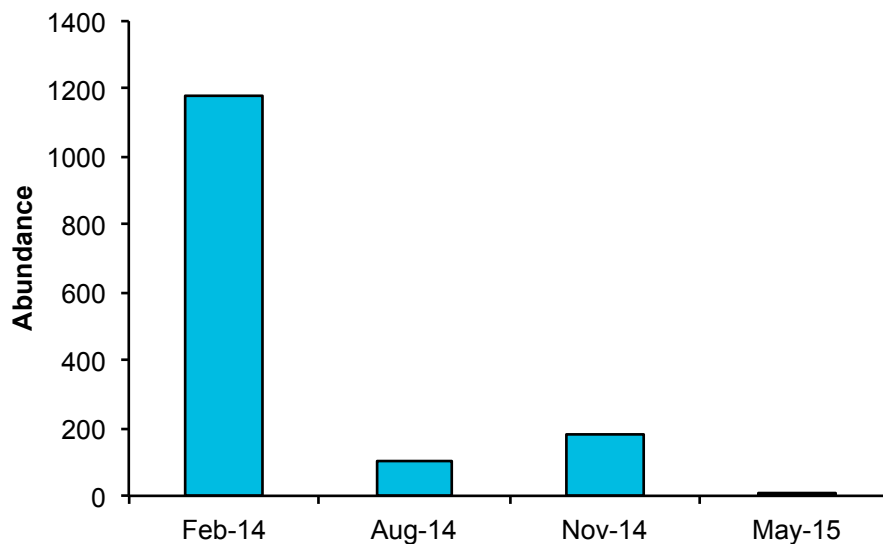


Figure 3.8 Abundance of prawns in each survey.

Figure 3.9

Prawn (*Parapenaeopsis* sp.)
caught in the mouth of Leekes
Creek.



Crabs

Thirteen species of crab from eight families were recorded in the surveys (Table 3.3 and Appendix H). The soldier crab (*Mictyris longicarpus*) was the most abundant species, and was observed foraging over intertidal sandy substrate at low tide. Other common crabs included:

- mud crabs
- blue swimmer crabs
- hermit crabs, and
- fiddler crabs.

Mud crabs and blue swimmer crabs, which were most abundant in the mid-estuary, are species of recreational, commercial and indigenous importance.

Table 3.3 Crabs identified in Leekes Creek estuary and adjacent bays.

Family	Species	Common Name
Calappidae	<i>Ashtoret granulosa</i>	armed crab
Diogenidae	<i>Diogenidae</i> sp.	hermit crab
Dotillidae	<i>Scopimera inflata</i>	sand bubbler crab
Grapsidae	<i>Goniopsis cruentata</i>	red mangrove crab
Grapsidae	<i>Pachygrapsus laevimanus</i>	shore crab
Menippidae	<i>Myomenippe fornasinii</i>	stone crab
Mictyridae	<i>Mictyris longicarpus</i>	soldier crab
Ocypodidae	<i>Ocypodidae</i> sp.	ghost crab
Ocypodidae	<i>Ocypode ceratophthalma</i>	ghost crab
Ocypodidae	<i>Uca</i> sp.	fiddler crab
Portunidae	<i>Portunus pelagicus</i>	blue swimmer crab
Portunidae	<i>Scylla serrata</i>	mud crab
Portunidae	<i>Thalamita crenata</i>	mangrove swimming crab

Crab Abundance and Size Classes

The relative abundance of crabs was highest in the mid-estuary in each survey, except in May 2015 (Figure 3.10). The relative abundance of larger crabs (i.e. excluding soldier crabs) in Leekes Creek was low in each survey, but highest in November 2014 (Figure 3.11).

There was a range of sizes for each species and the ratio of males to females varied with species (Table 3.4). No large mud crabs were caught, with the largest individual having a carapace length of 165 mm, where the maximum length for this species can be more than 250 mm (DAF 2012). Most mud crabs and blue swimmer crabs were caught in the mid-estuary, but were also recorded in the upper-estuary and mouth of the creek. In each survey, most of the crabs that were caught were adults and intermediates. One juvenile mud crab was caught in February 2014 and one in August 2014. No juvenile blue swimmer crabs were caught in Leekes Creek or the adjoining bay.

In February 2014 and May 2015, gravid female crabs were caught in Leekes Creek, including one mangrove swimming crab and one mud crab.

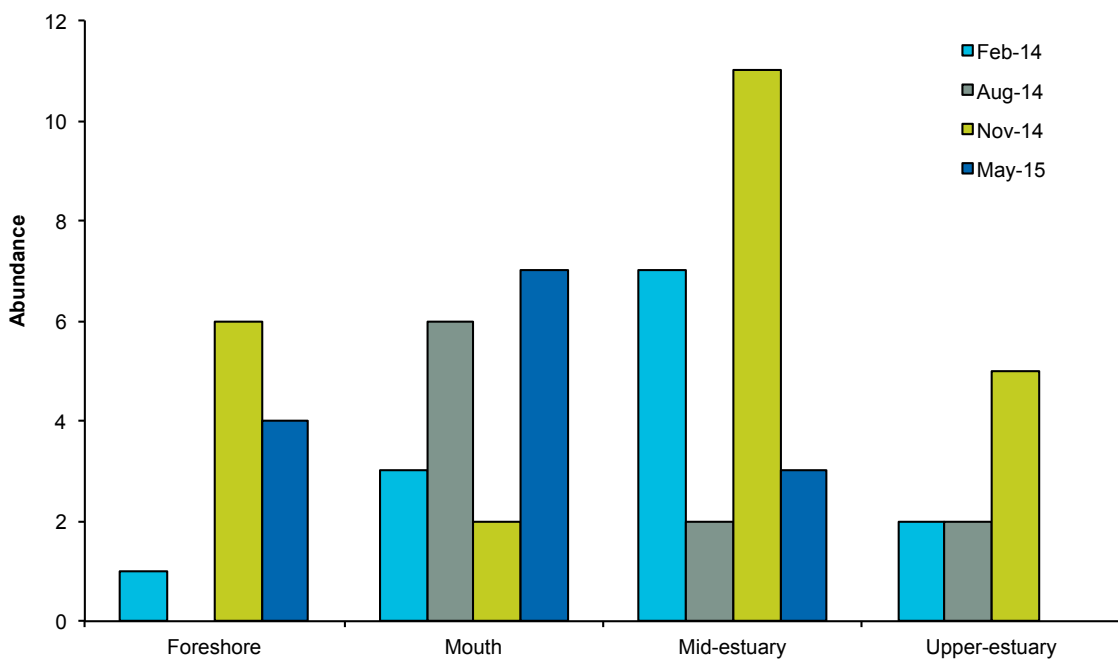


Figure 3.10 Abundance of crabs at each site in each survey.

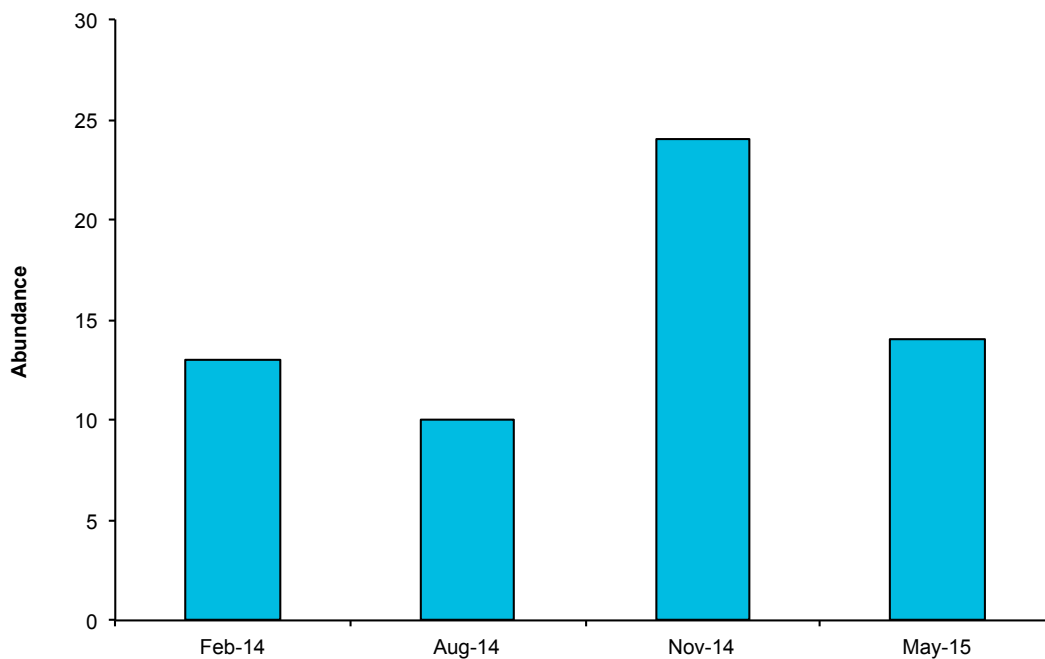


Figure 3.11 Abundance of large crabs in each survey.

Table 3.4 Crab abundance, size class and sex ratio for crabs caught in crab pots and seine nets at each location.

Species	Common Name	Abundance	Size Range (mm)	Sex Ratio (M:F)
Upper Estuary				
<i>Ocypode ceratophthalma</i>	ghost crab	2	10	0:2
Ocypodinae	ghost crab	1	10	0:1
<i>Pachygrapsus laevimanus</i>	shore crab	1	16	0:1
<i>Portunus pelagicus</i>	blue swimmer crab	3	12–68	1:2
<i>Scylla serrata</i>	mud crab	2	100–145	1:1
<i>Thalamita crenata</i>	mangrove swimming crab	1	50	1:0
Mid-estuary				
Diogenidae	hermit crab	4	–	–
<i>Myomenippe fornasinii</i>	stone crab	1	95	1:0
<i>Portunus pelagicus</i>	blue swimmer crab	7	40–160	5:2
<i>Scylla serrata</i>	mud crab	7	10–165	3:4
<i>Thalamita crenata</i>	mangrove swimming crab	5	40–75	2:3
<i>Uca</i> sp.	fiddler crab	1	2	1:0
Mouth				
<i>Ashtoret granulosa</i>	armed crab	1	30	1:0
Diogenidae	hermit crab	8	–	–
<i>Myomenippe fornasinii</i>	stone crab	2	90–150	1:1
<i>Ocypode ceratophthalma</i>	ghost crab	1	50	1:0
<i>Portunus pelagicus</i>	blue swimmer crab	4	100–150	2:2
<i>Scylla serrata</i>	mud crab	1	50	–
<i>Thalamita crenata</i>	mangrove swimming crab	1	40	0:1
Foreshore				
<i>Ashtoret granulosa</i>	armed crab	10	20–70	7:3
<i>Ocypode ceratophthalma</i>	horn-eyed ghost crab	1	40	1:0
<i>Portunus pelagicus</i>	blue swimmer crab	1	80	1:0

Marine Megafauna

Two species of dolphin were observed approximately 300 m offshore of Leekes Beach on 13 February 2014. Two Australian humpback dolphins (*Sousa sahalensis*) and one common dolphin (*Delphinus delphis*) were recorded. A common dolphin was also observed on 5 May 2015, midway between Putney Point and Leekes Point.

One dugong (*Dugong dugon*) was observed on 22 August 2014 approximately 400 m west of Leekes Creek mouth.

Green turtle (*Chelonia mydas*) tracks were observed on 25 November 2014; however, due to the erosion of the banks and zig-zag of the tracks, it was unlikely to have been a successful nesting (Figure 3.12). Anecdotal evidence also suggests flatback turtles (*Natator depressus*) nest on Leekes Beach (frc environmental 2012; C. Svendsen pers. comms. 20 February 2014), and that hawksbill turtles (*Eretmochelys imbricata*) and loggerhead turtles (*Caretta caretta*) forage in the adjacent bays (C. Svendsen pers. comm. 20 February 2014).

Figure 3.12

Attempted turtle nesting on
Leekes Beach.



3.3 Seagrass and Macroalgae

Seagrass and Macroalgae Distribution

Seagrass communities were sparse and low in density, with seagrass communities represented by two species, *Halodule uninervis* (Figure 3.13) and *Halophila ovalis* (Figure 3.14). The size, distribution and density of patches varied between each survey (Appendix I). Seagrass was most prevalent along Svendsen's Beach in each survey. Smaller patches were recorded offshore from Second Beach in August and November 2014 and throughout Leekes Beach. Seagrass was typically recorded in the 2 to 7 m depth range and was denser in the shallower areas. The area of seagrass was approximately 2.5 ha in February 2014, 7.3 ha in August 2014, 23 ha in November 2014 and 17.5 ha in May 2015.

frc environmental also surveyed seagrass along Leekes Beach in November 2010, January 2011 and April 2011. A small patch of sparse seagrass (<1 ha in area and <5% cover) was recorded near Putney Point in November 2010, but no seagrass was observed in 2011 (frc environmental 2012). The extent of seagrass in the area fluctuates between seasons and is typically dominated by a small morphology of *Halophila ovalis*. No previous surveys have been conducted along Svendsen Beach or Second Beach.

In each survey, the benthic habitat directly downstream of Leekes Creek and in the adjacent bay was typically bare sand with some small areas of rubble and debris. The highest density of seagrass in this region was recorded in the summer (November 2014), with a large patch exposed at low tide in the intertidal zone (Figure 3.15).

Figure 3.13

Halodule uninervis near
Svendsen's Beach in November
2014.



Figure 3.14

Patches of *Halophila ovalis* near Svendson's Beach in May 2015.



Figure 3.15

Sparse *Halodule uninervis* along the foreshore of Leekes Creek that was exposed at low tide in November 2014.



Seagrass and Macroalgae Community Composition

Seagrass communities comprised *Halophila uninervis* and *Halophila ovalis*. Macroalgae species included:

- *Caulerpa* sp. (Figure 3.16)
- *Halimeda* spp.
- *Laurencia* spp.
- *Hypnea* spp.
- *Padina* spp., and
- *Sargassum* sp. (Figure 3.17).

Macroalgae consisted of sparse clumps or individual patches on sand; no rocky outcrops or large beds of macroalgae were recorded.

Figure 3.16

Caulerpa sp.



Figure 3.17

Sargassum sp.



Benthic macroinvertebrates were also noted during the seagrass surveys, including:

- seastars (*Protoreaster* spp.)
- acorn worms (*Balanoglossus camosus*)
- sea cucumbers (*Holothuria* spp.), and
- razor clams (*Pinna bicolor*).

4 General Discussion and Conclusion

Water quality was typical of an estuarine environment (Montagna et al. 2013), with most parameters within Queensland Water Quality Guideline values. Water quality was consistent between surveys, with small differences related to weather conditions either before or during each survey. Water quality was mostly influenced by heavy rainfall and associated run-off from the island.

A diverse range of marine fauna, including fish, crabs, prawns, dolphins, dugong and turtles use the area. Fish and crustaceans included several species of commercial, recreational and indigenous importance. For several species, there was a direct seasonal pattern of use. Barramundi were only caught in November 2014, while mangrove jacks were only caught in August 2014. Barramundi use inshore marine waters as spawning grounds, and freshwater (e.g. creeks and rivers) and estuaries as juveniles and sub-adults (Russell & Garrett 1983; Manson et al. 2005). In areas remote from freshwater, purely marine populations may become established (Pender & Griffin 1996). Within estuaries barramundi use a range of habitats (e.g. mangroves, floodplains and tidal pools) (Russell & Garrett 1983). Other species, such as mangrove jack, have large coastal movements and migrate between offshore and estuarine environments, with smaller individuals (< 338 mm) typically being caught in estuaries (such as in this survey) (Russell & McDougall 2005). Smaller species, such as whiting and mullet, were caught in each survey and in various life-history stages, indicating that Leekes Creek is likely to be a foraging and nursery area.

Based on the results of these surveys, the area supports habitat considered to be of significant ecological value. Leekes Creek and adjoining bays support a diverse community of fish, prawns and crabs, several of which are of commercial, recreational and indigenous importance. Fish species recorded in the estuary were also recorded in the surrounding coral reefs and rocky headlands (frc environmental 2015), and the connectivity of these habitats may be important. The diversity and abundance of fish caught in Leekes Creek was high when compared to other intertidal, mangrove lined creeks in tropical Australia (Robertson & Duke 1987; Robertson & Duke 1990) as well as in Brazil (Castellanos-Galindo & Krumme 2014), Kenya (Mirera et al. 2010) and temperate Australia (Payne & Gillanders 2009). There was a variety of fish representing all levels of the trophic food web. As some species were found in only one season, Leekes Creek appears to be an area used for specific life stages (e.g. breeding or migration) indicating connectivity to offshore reefs and inshore coastal waters. Leekes Creek supports a diverse fish community and is likely to be an integral area for the breeding, migratory and foraging success of these species.

The catch of prawns within Leekes Creek was highly variable and dominated by juvenile life-history stages. The low abundance of large, adult prawns indicates that the estuary is likely to be a nursery ground, rather than a permanent estuarine population.

The low abundance and diversity of crabs indicates that Leekes Creek is unlikely to be an area of high importance to these populations. Both mud and sand crab populations can vary considerably between years, as recruitment is highly associated with environmental conditions, larval supply, settlement and survivorship (Butcher et al. 2014). Blue-swimmer crabs larval development is influenced by temperature with highest survival between 22.5 and 25°C (Bryars & Havenhand 2005). It is widely recognised that marine park and no-take zones can play a major role in increasing the population of mud crabs in a given area (Butcher et al. 2014). The declaration of Leekes Creek as a FHA, would likely lead to an increase in the crab populations that would benefit the productivity of the area.

The benthic habitat directly downstream of Leekes Creek and in the adjacent bay was typically characterised by bare sand with some small areas of rubble. In the adjacent bays, there were also sparse patches of seagrass and macroalgae. The size and distribution of the patches varied between surveys. Tropical seagrass meadows often have variable and cyclic patterns of abundance, that are influenced by long term weather patterns as well as flood and cyclone events (Waycott et al. 2004). Seagrass communities were dominated by *Halophila ovalis* and *Halodule uninervis*. These two species of seagrass are an important food source for dugongs (Marsh et al. 1982). These species are commonly ephemeral, are rapid colonisers that are often the first species to emerge after disturbances (Waycott et al. 2004). Flood events with excess sediment and nutrient loads have previously been associated with local declines of seagrasses in the Great Barrier Reef region (Schaffelke et al. 2005; Waycott et al. 2005; Johnson et al. 2011) and the cyclone in February 2015 would have also had an impact on the community prior to the May 2015 survey.

Overall, the area surveyed would be a significant addition to the State's network of declared Fish Habitat Areas

5 References

- Blaber, S.J.M., 1986, 'Feeding selectivity of a guild of piscivorous fish in mangrove areas of north-west Australia', *Australian Journal of Marine and Freshwater Research* 37: 329-336.
- BOM, 2015, Daily rainfall: Svendsen Beach, http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=136&p_display_type=dailyDataFile&p_startYear=&p_c=&p_stn_num=033260, accessed July 2015.
- Bryars, S.R. & Havenhand, J.N., 2005, 'Effects of constant and varying temperatures on the development of blue swimmer crab (*Portunus pelagicus*) larvae: Laboratory observations and field predictions for temperate coastal waters', *Journal of Experimental Marine Biology and Ecology* 329: 218-229.
- Butcher, P.A., Boulton, A.J., Macbeth, W.G. & Malcolm, H.A., 2014, 'Long-term effects of marine park zoning on giant mud crab *Scylla serrata* populations in three Australian estuaries', *Marine Ecology Progress Series* 508.
- Castellanos-Galindo, G.A. & Krumme, U., 2014, 'Long-term stability of tidal and diel-related patterns in mangrove creek fish assemblages in North Brazil', *Estuarine, Coastal and Shelf Science* 149: 264-272.
- Chenoweth EPLA, 2011, *Great Keppel Island Environmental Impact Statement Flora and Fauna Technical Report*, report prepared for Tower Holdings.
- DAF, 2012, *Mud crab (mangrove crab)*, <https://http://www.daf.qld.gov.au/fisheries/species-identification/inshore-estuarine-species/mud-crab>, accessed July 2015.
- DNPRSR, 2015, Declared Fish Habitat Area Investigations Program – Central Queensland, <http://www.nprsr.qld.gov.au/managing/habitat-areas/investigations-program-cq.html>, accessed July 2015.
- EHP, 2013. *Monitoring and Sampling Manual 2009 Environmental Protection (Water) Policy 2009 Version 2 September 2010 (July 2013 format edits)*. Department of Environment and Heritage Protection.
- Fisheries Queensland, 2009. *Fisheries Long Term Monitoring Program Sampling Protocol – Mud Crab (2008 onwards) Section 1*. Department of Employment, Economic Development and Innovation, Brisbane, Australia.

- frc environmental, 2012, *Great Keppel Island Resort Revitalisation EIS: Aquatic Ecology*, report prepared for Tower Holdings Pty Ltd.
- frc environmental, 2014, *Leekes Creek Estuary Fish Survey and Seagrass Assessment*, report prepared for Department of National Parks, Recreation, Sport and Racing.
- frc environmental, 2015, *Leekes Creek Estuary and Adjacent Inshore Waters Habitat Assessment*, report prepared for Department of National Parks, Sport and Racing.
- Grant, E.M., 1991, *Grant's Fishes of Australia*, E M Grant Pty Ltd, Redcliffe.
- Johnson, J.E., Brando, V.E., Devlin, M.J., Kennedy, K., McKenzie, L., Morris, S., Schaffelke, B., Thompson, A., Waterhouse, J. & Waycott, M., 2011, *Reef Rescue Marine Monitoring Program: 2009/2010 Synthesis Report*, report prepared for Report prepared by the Reef and Rainforest Research Centre Consortium of monitoring providers for the Great Barrier Reef Marine Park Authority, Reef and Rainforest Research Centre Limited.
- Manson, F.J., Loneragan, N.R., Skilleter, G.A. & Phinn, S.R., 2005, 'An evaluation of the evidence for linkages between mangroves and fisheries: a synthesis of the literature and identification of research directions', *Oceanography and Marine Biology: An Annual Review* 43: 483-513.
- Marsh, H., Channells, P.W., George, E.H. & Morissey, J., 1982, 'Analysis of stomach contents of dugong from Queensland', *Australian Wildlife Research* 9: 55-67.
- Mirera, D.O., Kairo, J.G., Kimani, E.N. & Waweru, F.K., 2010, 'A comparison between fish assemblages in mangrove forests and on intertidal flats at Ungwana Bay, Kenya', *African Journal of Aquatic Science* 35: 165-171.
- Montagna, P., Palmer, T. & Pollack, J., 2013, *Hydrological Changes and Estuarine Dynamics. 1st edition*, Springer-Verlag, New York.
- Payne, N.L. & Gillanders, B.M., 2009, 'Assemblages of fish along a mangrove-mudflat gradient in temperate Australia', *Marine and Freshwater Research* 60: 1-13.
- Pender, P.J. & Griffin, R.K., 1996, 'Habitat History of Barramundi *Lates calcarifer* in a North Australian River System Based on Barium and Strontium Levels in Scales', *Transactions of the American Fisheries Society* 125.

- Robertson, A.I. & Duke, N.C., 1987, 'Mangroves as nursery sites: comparisons of the abundance and species composition of fish and crustaceans in mangroves and other nearshore habitats in tropical Australia', *Marine Biology* 96: 193-205.
- Robertson, A.I. & Duke, N.C., 1990, 'Mangrove fish-communities in tropical Queensland, Australia: spatial and temporal patterns in densities, biomass and community structure', *Marine Biology* 104: 369-379.
- Russell, D. & McDougall, A.J., 2005, 'Movement and juvenile recruitment of mangrove jack, *Lutjanus argentimaculatus* (Forsskal), in northern Australia', *Marine and Freshwater Research* 56: 465-475.
- Russell, D.J. & Garrett, R.N., 1983, 'Use by juvenile barramundi, *Lates calcarifer* (Bloch), and other fishes of temporary upralittoral habitats in a tropical estuary in northern Australia', *Australian Journal of Marine and Freshwater Research* 34: 805-811.
- Schaffelke, B., Mellors, J. & Duke, N., 2005, 'Water quality in the Great Barrier Reef region: responses of mangrove, seagrass and macroalgal communities', *Marine Pollution Bulletin* 51: 279-296.
- Waycott, M., Longstaff, B.J. & Mellors, J., 2005, 'Seagrass population dynamics and water quality in the Great Barrier Reef region: A review and future research directions', *Marine Pollution Bulletin* 51: 343-350.
- Waycott, M., McMahon, K., Mellors, J., Calladine, A. & Kleine, D., 2004, *A Guide to Tropical Seagrasses of the Indo-West Pacific*.

Appendix A Tide Heights and Times in Each Survey

Table A.1 Tide heights and times each day in the February 2014 survey.

	11 February 2014		12 February 2014		13 February 2014		14 February 2014	
	Height (m)	Time	Height (m)	Time	Height (m)	Time	Height (m)	Time
Low	1.16	0106	1.03	0142	0.92	0213	0.85	0243
High	4.19	0716	4.32	0751	4.40	0823	4.44	0853
Low	1.21	1351	1.10	1422	1.02	1450	0.95	1517
High	3.57	1934	3.68	2008	3.83	2039	3.83	2109

Table A.2 Tide heights and times each day in the August 2014 survey.

	19 August 2014		20 August 2014		21 August 2014		22 August 2014	
	Height (m)	Time	Height (m)	Time	Height (m)	Time	Height (m)	Time
High	2.9	0435	3.0	0552	1.2	0047	1.0	0128
Low	1.3	1041	1.2	1154	3.2	0648	3.3	0733
High	3.5	1520	3.7	1821	1	1248	0.9	1331
Low	1.4	2354	–	–	3.8	1908	4.0	1947

Table A.3 Tide heights and times each day in the November 2014 survey.

	15 November 2014		16 November 2014		17 November 2014		18 November 2014	
	Height (m)	Time	Height (m)	Time	Height (m)	Time	Height (m)	Time
High	2.8	0345	3.0	0503	3.2	0554	1.0	1201
Low	1.8	0947	1.6	1054	1.4	1146	3.5	0634
High	3.3	0348	3.3	0453	3.4	0547	1.2	1231
Low	1.4	1023	1.2	1118	–	–	3.5	0633

Table A.4 Tide heights and times each day in the May 2015 survey.

	2 May 2015		3 May 2015		4 May 2015		5 May 2015	
	Height (m)	Time	Height (m)	Time	Height (m)	Time	Height (m)	Time
Low	1.0	0209	0.9	0243	0.9	0317	0.9	0353
High	3.8	0812	3.8	0845	3.7	0918	3.6	0952
Low	0.8	1411	0.7	1442	0.7	1514	0.8	1546
High	4.0	2036	4.1	2107	4.1	2138	4.1	2212

Appendix B Fish Sites and Fishing Effort

Map B.1 Location of Fishing Sites in February 2014





Source: Sri, Haubel, USDA, USGS, AEX, GeoEye, Earthstar, Imagery, IGN, Intermap, Inc, Swire, and the GIS User Community

 <p>PO Box 2363 Wellington Point Q 4108 Australia</p> <p>P 07 3286 3850 E info@frcenv.com.au www.frcenv.com.au</p>	<p>Leekes Creek Estuary Fish Survey and Seagrass Assessment</p> <p>Map B.1: Location of Fishing Sites</p> <p>SOURCES © Copyright Commonwealth of Australia (Geoscience Australia) 2001, 2004, 2008 © The State of Queensland (Department of Natural Resources and Mines) 2013 © The State of Queensland (Department of Environment and Heritage Protection) 2013</p>	<p>LEGEND</p> <p>Fishing Method</p> <ul style="list-style-type: none"> ● BRUVs ● Cast Net ● Fyke Net ● Seine Net 	<p>SCALE</p> <p>0 100 200 Metres</p> <p>Scale: 1:5,000 @ A3</p> <p>PROJECTION Coordinate System: GCS_GDA_1994 Datum: GDA 1994 Units: Degree</p>	<p>DATE 2015.06.24</p> <p>DRAWN BY CAC</p> <p>VERSION 01</p> 
---	--	---	---	---

Map B.3 Location of Fishing Sites in November 2014



 <p>PO Box 2363 Wellington Point Q 4108 Australia</p> <p>P 07 3286 3850 E info@frcenv.com.au www.frcenv.com.au</p>	<p>Leekes Creek Estuary Fish Survey and Seagrass Assessment</p> <p>Map B.3: Location of Fishing Sites in November 2014</p> <p>SOURCES © Copyright Commonwealth of Australia (Geoscience Australia) 2001, 2004, 2008 © The State of Queensland (Department of Natural Resources and Mines) 2013 © The State of Queensland (Department of Environment and Heritage Protection) 2013</p>	<p>LEGEND</p> <p>Folder/Path</p> <ul style="list-style-type: none"> ● BRUV's ● Cast net ● Fyke net ● Seine net 	<p>SCALE</p> <p>0 100 200 Metres</p> <p>Scale: 1:6,000 @ A3</p> <p>PROJECTION Coordinate System: GCS_GDA_1994 Datum: GDA 1994 Units: Degree</p>	<p>DATE 2015.06.24</p> <p>DRAWN BY CAC</p> <p>VERSION 01</p> 
---	---	---	---	---

Map B.4 Location of Fishing Sites in May 2015





 <p>PO Box 2363 Wellington Point Q 4106 Australia</p> <p>P 07 3298 3850 E info@frcenv.com.au www.frcenv.com.au</p>	<p align="center">Leekes Creek Estuary Fish Survey and Seagrass Assessment</p> <p align="center">Map B.4: Location of Fishing Sites in May 2015</p> <p>SOURCES © Copyright Commonwealth of Australia (Geoscience Australia) 2001, 2004, 2008 © The State of Queensland (Department of Natural Resources and Mines) 2013 © The State of Queensland (Department of Environment and Heritage Protection) 2013</p>	<p>LEGEND</p> <p>Folder/Path</p> <ul style="list-style-type: none"> ● BRUVs ● Cast net ● Fyke net ● Seine net 	<p align="center">N</p> <p align="center">SCALE</p> <p align="center">0 100 200 Metres</p> <p align="center">Scale: 1:6,000 @ A3</p> <p>PROJECTION Coordinate System: GCS_GDA_1994 Datum: GDA 1994 Units: Degree</p>	 <p>DATE 2015-06-24</p> <p>DRAWN BY CAC</p> <p>VERSION 01</p>
---	--	---	--	---

Table B.1 Fishing efforts in Leekes Creek estuary and adjacent bays in February 2014.

Date	Site	Method	Time In	Time Out	Incoming Tide	Outgoing Tide	Effort
2014-02-11	mouth	seine net	–	–	x		1 haul ^a
2014-02-11	mouth	cast net	–	–	x		3 casts ^b
2014-02-11	foreshore	cast net	–	–		x	3 casts ^b
2014-02-11	foreshore	cast net	–	–		x	3 casts ^b
2014-02-12	mid-estuary	fyke net	1030	1230		x	4 h ^c
2014-02-12	mouth	cast net	–	–	x		6 casts ^b
2014-02-12	upper estuary	fyke net	0930	1200		x	5 h ^c
2014-02-12	mid-estuary	seine net	–	–		x	1 haul ^a
2014-02-13	mouth	fyke net	1120	1415		x	5.8 h ^c
2014-02-13	foreshore	BRUV	1340	1440		x	1 h
2014-02-13	mouth	seine net	–	–	x		2 hauls ^a
2014-02-13	mouth	fyke net	1030	1310		x	5.34 h ^c
2014-02-13	foreshore	seine net	–	–	x		2 hauls ^a
2014-02-13	foreshore	BRUV	1445	1515	x		0.5 h
2014-02-14	foreshore	BRUV	0710	0740	x		0.5 h
2014-02-14	foreshore	BRUV	0840	0910	x		0.5 h
2014-02-14	foreshore	BRUV	1315	1345		x	0.5 h
2014-02-14	mouth	BRUV	1400	1430		x	0.5 h

^a seine nets are 60 m x 4 m with 60 mm mesh

^b cast nets are 10 m with 4 m diameter opening and 25 mm mesh

^c two double winged fyke nets with 5 m long wings, 1 m drop, 12 mm mesh and a 600 mm ring opening

^h hours

Table B.2 Fishing efforts in Leeques Creek estuary and adjacent bays in August 2014.

Date	Site	Method	Time In	Time Out	Incoming Tide	Outgoing Tide	Effort
2014-08-20	mid-estuary	cast net	–	–	x		10 casts ^b
2014-08-20	mouth	cast net	–	–	x		10 casts ^b
2014-08-20	foreshore	cast net	–	–	x		10 casts ^b
2014-08-20	mouth	seine net	–	–	x		1 haul ^a
2014-08-20	mid-estuary	seine net	–	–	x		1 haul ^a
2014-08-20	upper estuary	fyke net	1030	1410		x	83 h ^c
2014-08-20	mid-estuary	fyke net	1040	1420		x	83 h ^c
2014-08-21	mid-estuary	cast net	–	–		x	10 casts ^b
2014-08-21	upper estuary	cast net	–	–		x	10 casts ^b
2014-08-21	foreshore	BRUV	0940	1020		x	0.66 h
2014-08-21	foreshore	BRUV	1030	1110		x	0.66 h
2014-08-21	mouth	fyke net	1130	1630		x	5.8 h ^c
2014-08-21	foreshore	fyke net	1140	1640		x	5.8 h ^d

Date	Site	Method	Time In	Time Out	Incoming Tide	Outgoing Tide	Effort
2014-08-21	foreshore	seine net	–	–		x	2 hauls ^a
2014-08-21	mouth	seine net	–	–	x		2 hauls ^a
2014-08-21	mouth	BRUV	1430	1530		x	1 h
2014-08-21	foreshore	BRUV	1540	1640	x		1 h
2014-08-21	foreshore	BRUV	1330	1400		x	0.5 h
2014-08-21	foreshore	BRUV	1530	1630	x		1 h

^a seine nets are 60 m x 4 m with 60 mm mesh

^b cast nets are 10 m with 4 m diameter opening and 25 mm mesh

^c two double winged fyke nets with 5 m long wings, 1 m drop, 12 mm mesh and a 600 mm ring opening

^d one double winged fyke nets with 5 m long wings, 1 m drop, 12 mm mesh and a 600 mm ring opening

h hours

Table B.3 Fishing efforts in Leekes Creek estuary and adjacent bays in November 2014.

Date	Site	Method	Time In	Time Out	Incoming Tide	Outgoing Tide	Effort
2014-11-14	upper-estuary	fyke net	1800	0800 (2014-11-15)	x		28 h ^c
2014-11-14	foreshore	cast net	–	–	x		10 cast ^b
2014-11-15	mid-estuary	cast net	–	–		x	10 cast ^b
2014-11-15	mid-estuary	seine net	–	–	x		1 haul ^a
2014-11-15	mouth	fyke net	1000	1500	x		4 h ^c
2014-11-15	mouth	cast net	–	–	–	x	10 casts ^b
2014-11-15	upper estuary	cast net	–	–		x	10 casts ^b
2014-11-16	mid-estuary	fyke net	1130	0900 (2014-06-17)		x	43 h ^d
2014-11-16	mouth	seine net	–	–		x	2 hauls ^a
2014-11-16	foreshore	seine net	–	–	x		1 haul ^a
2014-11-16	mouth	BRUV	1330	1400		x	0.5 h
2014-11-16	foreshore	BRUV	1350	1420		x	0.5 h

Date	Site	Method	Time In	Time Out	Incoming Tide	Outgoing Tide	Effort
2014-11-17	foreshore	BRUV	1030	1115	x		0.75 h
2014-11-17	foreshore	BRUV	1100	1145	x		0.75 h
2014-11-17	foreshore	BRUV	1200	1230		x	0.5 h
2014-11-17	foreshore	BRUV	1245	1345		x	1 h

^a seine nets are 60 m x 4 m with 60 mm mesh

^b cast nets are 10 m with 4 m diameter opening and 25 mm mesh

^c two double winged fyke nets with 5 m long wings, 1 m drop, 12 mm mesh and a 600 mm ring opening

^d four double winged fyke nets with 5 m long wings, 1 m drop, 12 mm mesh and a 600 mm ring opening

h hours

Table B.4 Fishing efforts in Leekes Creek estuary and adjacent bays in May 2015.

Date	Site	Method	Time In	Time Out	Incoming Tide	Outgoing Tide	Effort
2015-05-02	mid-estuary	seine net	–	–	x		1 haul ^a
2015-05-02	mid-estuary	cast net	–	–	x		10 casts ^b
2015-05-02	upper estuary	fyke net	0900	1330		x	18 h ^c
2015-05-03	mid-estuary	fyke net	0845	1245		x	8 h ^d
2015-05-03	mouth	cast net	–	–		x	10 casts ^b
2015-05-03	foreshore	cast net	–	–		x	10 casts ^b
2015-05-05	mouth	fyke net	1000	1245		x	5.5 h ^d
2015-05-05	mouth	seine net	–	–	x		1 haul ^a
2015-05-05	foreshore	seine net	–	–	x		1 haul ^a
2015-05-05	upper estuary	cast net	–	–		x	10 casts ^b
2015-05-04	foreshore	BRUV	0800	0900	x		1 h
2015-05-04	foreshore	BRUV	0810	0910	x		1 h
2015-05-05	mouth	BRUV	0830	0930	x		1 h

Date	Site	Method	Time In	Time Out	Incoming Tide	Outgoing Tide	Effort
2015-05-05	foreshore	BRUV	0845	0945	x		1 h
2015-05-05	foreshore	BRUV	1015	1100		x	0.75 h
2015-05-05	foreshore	BRUV	1020	1105		x	0.75 h

^a seine nets are 60 m x 4 m with 60 mm mesh

^b cast nets are 10 m with 4 m diameter opening and 25 mm mesh

^c four double winged fyke nets with 5 m long wings, 1 m drop, 12 mm mesh and a 600 mm ring opening

^d two double winged fyke nets with 5 m long wings, 1 m drop, 12 mm mesh and a 600 mm ring opening

h hours

Appendix C Crab Pot Sites and Effort

Map C.1 Location of crab pots in February 2014



Map C.2 Location of crab pots in August 2014



Map C.3 Location of crab pots in November 2014



PO Box 2363
Wellington Point
Q 4106 Australia

P 07 3286 3850
E info@frcenv.com.au
www.frcenv.com.au

**Leekes Creek Estuary Fish Survey
and Seagrass Assessment**

Map C.3: Community Composition and Percent Cover of
Seagrass Communities in November 2014

SOURCES
© Copyright Commonwealth of Australia (Geoscience Australia) 2001, 2004, 2008
© The State of Queensland (Department of Natural Resources and Mines) 2013
© The State of Queensland (Department of Environment and Heritage Protection) 2013

LEGEND
● Crab Pot Location

SCALE
0 100 200 400
Metres
Scale: 1:8,000 @ A3

PROJECTION
Coordinate System: GCS_GDA_1994
Datum: GDA 1994
Units: Degree

DATE
2015.06.24
DRAWN BY
CAC
VERSION
01



Map C.4 Location of crab pots in May 2015



Table C.1 Crab pot effort in Leekes Creek estuary and foreshore in February 2014.

Method	Location	Date In	Time In	Date Out	Time Out	Effort
15 x crab pots	upper estuary	2014-02-11	1600	2014-02-12	1630	367.5 h
5 x crab pots	mid-estuary	2014-02-11	1630	2014-02-12	1700	122.5 h
13 x crab pots	mid-estuary	2014-02-12	1700	2014-02-13	1330	287 h
6 x crab pots	mouth	2014-02-12	1630	2014-02-14	1115	112.5 h
2 x crab pots	foreshore	2014-02-13	1700	2014-02-14	1100	36 h

h hours

Table C.2 Crab pot effort in Leekes Creek estuary and foreshore in August 2014.

Method	Location	Date In	Time In	Date Out	Time Out	Effort
15 x crab pots	upper estuary	2014-08-19	1600	2014-08-20	0800	240 h
15 x crab pots	mid-estuary	2014-08-20	1530	2014-08-21	0900	262.5 h
10 x pitfall traps	mid-estuary	2014-08-20	1145	2014-08-21	0945	220 h
5 x pitfall traps	mouth	2014-08-20	1345	2014-08-21	0945	200 h
9 x crab pots	mouth	2014-08-21	1300	2014-08-22	0800	171 h
2 x crab pots	foreshore	2014-08-21	1300	2014-08-22	0800	38 h

h hours

Table C.3 Crab pot effort in Leekes Creek estuary and foreshore in November 2014.

Method	Location	Date In	Time In	Date Out	Time Out	Effort
20 x crab pots	upper estuary	2014-11-15	1400	2014-11-16	0900	380 h
10 x pitfall traps	mid-estuary	2014-11-15	1100	2014-11-16	1100	240 h
20 x crab pots	mid-estuary	2014-11-16	1500	2014-11-17	0830	350 h
10 x pitfall traps	upper estuary	2014-11-16	1130	2014-11-17	1130	240 h
18 x crab pots	mouth	2014-11-17	1230	2014-11-18	0730	342 h
2 x crab pots	foreshore	2014-11-17	1230	2014-11-18	0730	38 h

h hours

Table C.4 Crab pot effort in Leekes Creek estuary and foreshore in May 2015.

Method	Location	Date In	Time In	Date Out	Time Out	Effort
20 x crab pots	mouth	2015-05-01	1330	2015-05-02	0815	375 h
18 x crab pots	upper estuary	2015-05-02	0900	2015-05-03	0900	432 h
2 x crab pots	foreshore	2015-05-02	0900	2015-05-03	0900	48 h
20 x crab pots	mid-estuary	2015-05-03	1000	2015-05-04	0830	450 h

h hours

Appendix D Seagrass Transects

Map D.1 Location of seagrass and macroalgae transects in February 2014.



Map D.2 Location of seagrass and macroalgae transects in August 2014.



Map D.3 Location of seagrass and macroalgae transects in November 2014.



Map D.4 Location of seagrass and macroalgae transects in May 2015.



Appendix E Water Quality Results

Table E.1 Water quality at each site on the outgoing tide in February 2014.

Parameter	Unit	Upper Estuary			Mid-estuary			Mouth			Foreshore		
		GV ¹	WQ1	WQ2	GV ²	WQ3	WQ4	WQ5	WQ6	WQ7	GV ³	WQ8	WQ9
temperature	°C	–	26.3	25.5	–	25.5	25.4	25.3	25.3	25.5	–	25.5	25.4
pH	pH units	7.0–8.4	6.5	7.1	7.0–8.4	7.4	7.5	7.5	7.6	7.7	8.0–8.4	7.7	7.7
dissolved oxygen	% saturation	70–100	109	96	85–100	95	94	93	94	95	90–100	100	101
turbidity	NTU	25	8	6	8	11	5	5	6	6	6	4	9
salinity	psu	–	ND	ND	NA	ND	ND	ND	ND	ND	NA	ND	ND

¹ QWQG upper estuarine guideline value

² QWQG mid estuarine guideline value

³ QWQG mid enclosed coastal guideline value

– Guideline values not available

ND - no data; salinity probe malfunctioning

Shading indicates value does not meet guideline values

Table E.2 Water quality at each site on the outgoing tide in August 2014.

Parameter	Unit	Upper Estuary			Mid-estuary			Mouth			Foreshore		
		GV	WQ1	WQ2	GV	WQ3	WQ4	WQ5	WQ6	WQ7	GV	WQ8	WQ9
temperature	°C	–	18.5	18.6	–	18.8	19	18.7	19	19.1	–	19.2	19.4
pH	pH units	7.0–8.4	8.4	8.6	7.0–8.4	8.7	8.3	8.2	8.3	8.3	8.0–8.4	8.3	8.2
dissolved oxygen	% saturation	70–100	103	110	85–100	115	117	113	119	121	90–100	121	123
turbidity	NTU	25	4	3	8	2	2	4	2	2	6	1	1
salinity	psu	–	40	39	–	38	38	36	37	36	–	36	35

– Guideline values not available

Shading indicates value does not meet guideline values

Table E.3 Water quality at each site on the incoming tide in August 2014.

Parameter	Unit	Upper Estuary			Mid-estuary			Mouth			Foreshore		
		GV	WQ1	WQ2	GV	WQ3	WQ4	WQ5	WQ6	WQ7	GV	WQ8	WQ9
temperature	°C	–	20.9	24	–	22.8	22.6	21.5	22.1	21.4	–	20.2	20.1
pH	pH units	7.0–8.4	8.2	8.1	7.0–8.4	8.2	8.2	8.2	8.2	8.3	8.0–8.4	8.2	8.2
dissolved oxygen	% saturation	70–100	126	128	85–100	130	92	124	123	120	90–100	123	124
turbidity	NTU	25	2	7	8	5	4	3	4	4	6	3	2
salinity	psu	–	35	42	–	38	39	38	35	32	–	30	29

– Guideline values not available

Shading indicates values does not meet guideline values

Table E.4 Water quality at each site on the outgoing tide in November 2014.

Parameter	Unit	Upper Estuary			Mid-estuary			Mouth			Foreshore		
		GV	WQ1	WQ2	GV	WQ3	WQ4	WQ5	WQ6	WQ7	GV	WQ8	WQ9
temperature	°C	–	22.5	22.5	–	22.4	22.1	22.7	22.9	22.9	–	23.5	23.7
pH	pH units	7.0–8.4	8.1	8.0	7.0–8.4	8.2	8.2	8.3	8.2	8.2	8.0–8.4	8.1	8.0
dissolved oxygen	% saturation	70–100	ND	ND	85–100	ND	92	ND	ND	ND	90–100	ND	ND
turbidity	NTU	25	5	4	8	4	4	8	5	4	6	3	2
salinity	psu	–	38	38	–	38	38	37	35	33	–	36	35

– Guideline values not available

ND - no data; dissolved oxygen probe malfunctioning

Shading indicates value does not meet guideline values

Table E.5 Water quality at each site on the incoming tide in November 2014.

Parameter	Unit	Upper Estuary			Mid-estuary			Mouth			Foreshore		
		GV	WQ1	WQ2	GV	WQ3	WQ4	WQ5	WQ6	WQ7	GV	WQ8	WQ9
temperature	°C	–	23.4	23.6	–	23.5	23.3	23.7	23.7	23.8	–	24	24.1
pH	pH units	7.0–8.4	8.0	8.0	7.0–8.4	8.2	8.2	8.3	8.2	8.1	8.0–8.4	8.0	8.0
dissolved oxygen	% saturation	70–100	ND	ND	85–100	ND	92	ND	ND	ND	90–100	ND	ND
turbidity	NTU	25	2	3	8	3	3	3	4	4	6	3	2
salinity	psu	–	39	40	–	38	37	36	36	35	–	36	35

Guideline values not available

ND - no data; dissolved oxygen probe malfunctioning

Shading indicates value does not meet guideline values

Table E.6 Water quality at each site on the outgoing tide in May 2015.

Parameter	Unit	Upper Estuary			Mid-estuary			Mouth			Foreshore		
		GV	WQ1	WQ2	GV	WQ3	WQ4	WQ5	WQ6	WQ7	GV	WQ8	WQ9
temperature	°C	–	23.4	23	–	22.7	22.9	22.9	22.9	23.2	–	23.2	23.4
pH	pH units	7.0–8.4	8.1	8.1	7.0–8.4	8.1	8.1	8.1	8.1	8.1	8.0–8.4	8.1	8.1
dissolved oxygen	% saturation	70–100	107	102	85–100	100	94	96	97	100	90–100	100	102
turbidity	NTU	25	3	7	8	3	3	5	3	6	6	3	2
salinity	psu	–	41	42	–	41	41	41	41	41	–	41	41

Guideline values not available

Shading indicates value does not meet guideline values

Table E.7 Water quality at each site on the incoming tide in May 2015.

Parameter	Unit	Upper Estuary			Mid-estuary				Mouth		Foreshore		
		GV	WQ1	WQ2	GV	WQ3	WQ4	WQ5	WQ6	WQ7	GV	WQ8	WQ9
temperature	°C	–	22.9	23.1	–	23	23.1	23.1	23.3	23.3	–	23.4	23.6
pH	pH units	7.0–8.4	8.1	8.1	7.0–8.4	8.1	8.1	8.1	8.1	8.1	8.0–8.4	8.1	8.1
dissolved oxygen	% saturation	70–100	100	100	85–100	101	102	100	102	102	90–100	102	103
turbidity	NTU	25	3	5	8	2	3	3	2	2	6	2	2
salinity	psu	–	42	41	–	41	41	41	41	41	–	41	41

Guideline values not available

Shading indicates value does not meet guideline values

Appendix F Fish Caught

Figure F.1

Estuary perchlet.



Figure F.2

Endracht hardyhead.



Figure F.3

Flounder species.



Figure F.4

Blue and gold fusilier.



Figure F.5

Golden trevally.



Figure F.6

Lemon shark.



Figure F.7

Castelnau's herring.



Figure F.8

Koningsberger's herring.



Figure F.9

White sardine.



Figure F.10

Patterned tongue sole.

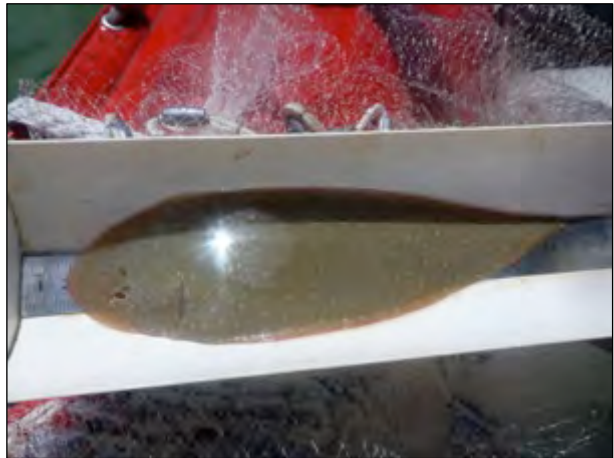


Figure F.11

Cowtail stingray.



Figure F.12

Blue-spotted stingray.



Figure F.13

Sicklefish.



Figure F.14

Remora.



Figure F.15

Crimson-tipped gudgeon.



Figure F.16

Orbicular batfish.



Figure F.17

Thread-finned silver biddy.



Figure F.18

Common silver biddy.



Figure F.19

Tawny nurse shark.



Figure F.20

Exquisite sand goby.



Figure F.21

Mudskipper.



Figure F.22

Brown sweetlip.



Figure F.23

Spotted javelinfinch.



Figure F.24

Barramundi.



Figure F.25

Common ponyfish.



Figure F.26

Mangrove jack.



Figure F.27

Moses perch.



Figure F.28

Diamondfish.



Figure F.29

Sea mullet.



Figure F.30

Dash-dot goatfish.



Figure F.31

Freckled goatfish.



Figure F.32

Sand flathead.



Figure F.33

Dusky flathead.



Figure F.34

Striped catfish.



Figure F.35

Pacific blue-eye.

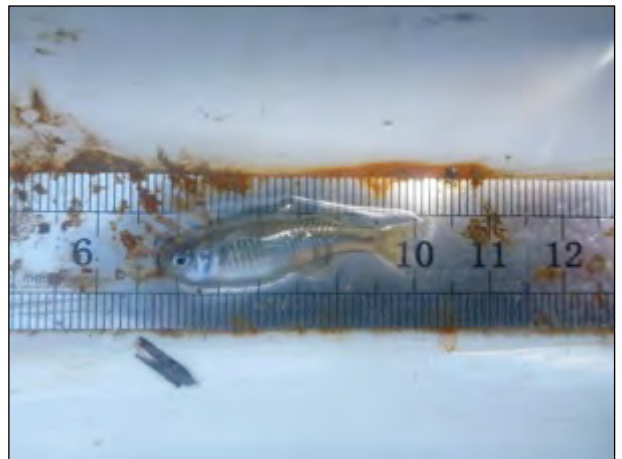


Figure F.36

Shovelnose ray.



Figure F.37

Stripped butterfish.



Figure F.38

Estuary cod.



Figure F.39

White-spotted spinefoot.



Figure F.40

Golden-lined spinefoot.



Figure F.41

Sand whiting.



Figure F.42

Yellowfin bream.



Figure F.43

Black bream.



Figure F.44

Pickhandle barracuda.



Figure F.45

Estuarine stonefish.



Figure F.46

Crescent perch.



Figure F.47

Immaculate pufferfish.



Figure F.48

Striped pufferfish.



Figure F.49

Common toadfish.



Appendix G Anecdotal Fish Occurrence

Table G.1 Fish species anecdotally recorded from Leekes Creek estuary and adjacent bays.

Family	Species	Common Name	Locations Reported to Occur	
			Estuary	Adjacent Bay
Albulidae	<i>Albula vulpes</i>	bonefish	–	x
Atherinidae	<i>Pranesus ogilbyi</i>	Ogilby's hardyhead	x	x
Belonidae	various	longtom	x	x
Brachaeluridae	<i>Brachaelurus waddi</i>	blind shark	x	x
Carangidae	<i>Alectis indica</i>	Indian threadfin	x	x
Carangidae	<i>Caranx sexfasciatus</i>	bigeye trevally	x	x
Carangidae	<i>Seriola lalandi</i>	yellowtail amberjack	–	x
Carangidae	<i>Trachinotus blochi</i>	snubnose pompano	x	x
Carangidae	<i>Trachinotus russelli</i>	large-spot dart	–	x
Carcharhinidae	<i>Carcharhinus obscurus</i>	dusky shark	x	x
Carcharhinidae	<i>Carcharhinus sorrah</i>	spot-tail shark	x	x
Carcharhinidae	<i>Galeocerdo cuvieri</i>	tiger shark	x	x
Chanidae	<i>Chanos chanos</i>	milkfish	x	x
Chirocentridae	<i>Chirocentrus dorab</i>	dorab wolf-herring	x	x
Dasyatidae	<i>Taeniura lymna</i>	ribbontail stingray	–	x
Ephippidae	<i>Platax pinnatus</i>	dusky batfish	–	x
Haemulidae	<i>Plectorhincus gibbosus</i>	Harry hotlips	x	x
Haemulidae	<i>Pomadasys argenteus</i>	silver grunt	x	x
Hemiramphidae	<i>Hyporhamphus australis</i>	eastern sea garfish	x	x
Hemiramphidae	<i>Hemiramphus robustus</i>	three-by-two garfish	–	x
Hemiscylliidae	<i>Hemiscyllium ocellatum</i>	epaulette shark	x	x
Latidae	<i>Lates calcarifer</i>	barramundi	x	x
Lethrinidae	<i>Lethrinus fletus</i>	grass emperor	–	x
Lutjanidae	<i>Lutjanus argentimaculatus</i>	mangrove red snapper	x	x
Lutjanidae	<i>Lutjanus carponotatus</i>	Spanish flag snapper	–	x
Monodactylidae	<i>Monodactylus argenteus</i>	silver moony	x	x
Mugilidae	<i>Liza</i> sp.	mullet	x	x
Mugilidae	<i>Myxus elongatus</i>	sand grey mullet	x	x
Myliobatidae	<i>Aetobatus narinari</i>	spotted eagle ray	–	x
Myliobatidae	<i>Manta alfredi</i>	manta ray	–	x
Orectolobidae	<i>Orectolobus ornatus</i>	ornate wobbegong	x	x

Family	Species	Common Name	Locations Reported to Occur	
			Estuary	Adjacent Bay
Paralichthyidae	<i>Pseudorhombus arsius</i>	largetooth flounder	x	x
Plotosidae	<i>Plotosus anguillaris</i>	striped eel catfish	x	x
Rachycentridae	<i>Rachycentron canadum</i>	cobia	–	x
Rhinobatidae	<i>Rhynchobatus djiddensis</i>	giant guitarfish	x	x
Rhinobatidae	<i>Glaucostegus typus</i>	giant shovelnose ray	x	x
Scombridae	<i>Cybiosarda elegans</i>	leaping bonito	–	x
Scombridae	<i>Cybium commersoni</i>	narrow-barred Spanish mackerel	–	x
Scombridae	<i>Euthynnus alletteratus</i>	little tunny	–	x
Scombridae	<i>Indocybium semifasciatum</i>	broad-barred king mackerel	–	x
Scombridae	<i>Sawara niphonia</i>	Japanese Spanish mackerel	–	x
Scombirdae	<i>Scomberoides lysan</i>	doublespotted queenfish	x	x
Scombridae	<i>Scomberomorus queenslandicus</i>	Queensland school mackerel	–	x
Serranidae	<i>Epinephelus merra</i>	honeycomb grouper	x	x
Serranidae	<i>Epinephelus tauvina</i>	greasy grouper	x	x
Serranidae	<i>Plectropoma maculatus</i>	spotted coral grouper	–	x
Sillaginidae	<i>Sillago maculata</i>	trumpeter whiting	x	x
Sphyraenidae	<i>Agriposphyraena barracuda</i>	great barracuda	–	x
Sphyraenidae	<i>Sphyraena obtusata</i>	obtuse barracuda	–	x
Sphyrnidae	<i>Sphyrna lewini</i>	scalloped hammerhead	x	x
Stegostomatidae	<i>Stegastoma fasciatum</i>	zebra shark	–	x
Synanceiidae	<i>Synanceia trachynis</i>	estuarine stonefish	x	–
Terapontidae	<i>Pelates quadrilineatus</i>	fourlined terapon	x	x
Tetradontidae	<i>Tetractenos hamiltoni</i>	toadfish	x	x
Uranoscopidae	<i>Ichthyoscopus lebeck</i>	longnosed stargazer	x	x

Source: C. Svendsen pers. comms. 2014

x observed

– not observed

Appendix H Crabs Caught

Figure H.1

Armed crab.



Figure H.2

Hermit crab species.



Figure H.3

Sand bubbler crab burrows.



Figure H.4

Red mangrove crab.



Figure H.5

Shore crab.



Figure H.6

Stone crab.



Figure H.7

Soldier crab.



Figure H.8

Ghost crab species 1.



Figure H.9

Ghost crab species 2.



Figure H.10

Fiddler crab.



Figure H.11

Blue swimmer crab.



Figure H.12

Mud crab.



Figure H.13

Mangrove swimming crab.



Appendix I Seagrass Community Composition and Distribution

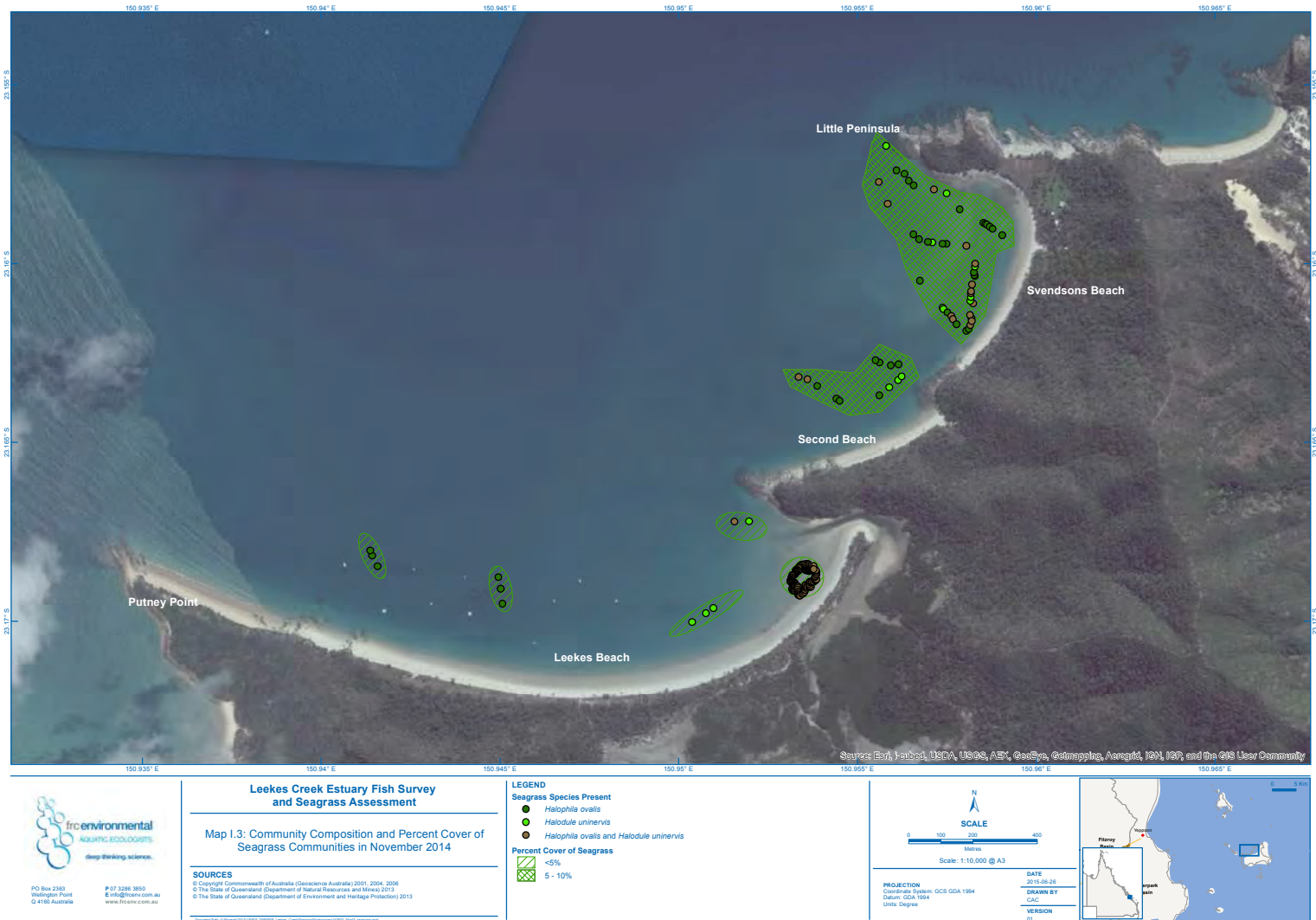
Map I.1 Seagrass community composition and distribution in February 2014.



Map I.2 Seagrass community composition and distribution in August 2014.



Map I.3 Seagrass community composition and distribution in November 2014.



Map I.4 Seagrass community composition and distribution in May 2015.



Appendix J Raw Data

Table J.1 Crab species caught in the Leekes Creek survey area.

Site	Date	Species	Sex	Carapace Width (mm)
Mid-estuary	11/02/14	<i>Scylla serrata</i>	m	165
Mid-estuary	11/02/14	<i>Scylla serrata</i>	f	22
Mid-estuary	11/02/14	<i>Thalamita crenata</i>	m	70
Mid-estuary	11/02/14	<i>Thalamita crenata</i>	f	50
Upper-estuary	11/02/14	<i>Thalamita crenata</i>	m	50
Upper-estuary	11/02/14	<i>Scylla serrata</i>	m	145
Mouth	13/02/14	<i>Portunus pelagicus</i>	m	150
Foreshore	11/02/14	<i>Portunus pelagicus</i>	m	80
Mid-estuary	12/02/14	<i>Thalamita crenata</i>	m	50
Mid-estuary	12/02/14	<i>Thalamita crenata</i>	f	40
Mouth	12/02/14	<i>Portunus pelagicus</i>	m	110
Mid-estuary	12/02/14	<i>Thalamita crenata</i>	f	55
Mouth	13/02/14	<i>Ashoret granulosa</i>	m	30
Foreshore	13/02/14	<i>Ocypode ceratophthalma</i>	m	40
Mid-estuary	21/08/15	<i>Scylla serrata</i>	m	10
Mid-estuary	21/08/15	<i>Uca sp.</i>	m	2
Mouth	22/08/15	Diogenidae	–	–
Mouth	22/08/15	<i>Ocypode ceratophthalma</i>	m	5
Upper-estuary	20/08/15	<i>Scylla serrata</i>	F	10
Upper-estuary	20/08/15	<i>Portunus pelagicus</i>	f	12
Upper-estuary	16/11/14	<i>Portunus pelagicus</i>	f	68
Upper-estuary	16/11/14	<i>Portunus pelagicus</i>	m	55
Upper-estuary	16/11/14	<i>Pachygrapsus laevimanus</i>	f	16
Upper-estuary	16/11/15	Ocypodinae	f	10
Mouth	16/11/15	<i>Portunus pelagicus</i>	f	100
Mouth	16/11/15	<i>Portunus pelagicus</i>	m	150
Foreshore	16/11/15	<i>Ashtoret granulosa</i>	m	70
Foreshore	16/11/15	<i>Ashtoret granulosa</i>	m	40
Foreshore	16/11/15	<i>Ashtoret granulosa</i>	m	40
Foreshore	16/11/15	<i>Ashtoret granulosa</i>	f	50
Foreshore	16/11/15	<i>Ashtoret granulosa</i>	m	40
Foreshore	16/11/15	<i>Ashtoret granulosa</i>	f	50
Mid-estuary	17/11/15	Diogenidae	–	–
Mid-estuary	17/11/15	<i>Portunus pelagicus</i>	m	160

Site	Date	Species	Sex	Carapace Width (mm)
Mid-estuary	17/11/15	<i>Portunus pelagicus</i>	f	65
Mid-estuary	17/11/15	<i>Portunus pelagicus</i>	f	75
Mid-estuary	17/11/15	<i>Myomenippe fornasinii</i>	m	95
Upper-estuary	17/11/15	<i>Ocypode ceratophthalma</i>	f	10
Upper-estuary	17/11/15	<i>Ocypode ceratophthalma</i>	f	10
Mid-estuary	18/11/15	<i>Scylla serrata</i>	m	50
Mid-estuary	18/11/15	<i>Scylla serrata</i>	f	60
Mid-estuary	18/11/15	Diogenidae	–	–
Mid-estuary	18/11/15	<i>Portunus pelagicus</i>	m	55
Mid-estuary	18/11/15	<i>Portunus pelagicus</i>	f	40
Mid-estuary	18/11/15	<i>Portunus pelagicus</i>	f	120
Foreshore	5/05/15	<i>Ashtoret granulosa</i>	f	40
Foreshore	5/05/15	<i>Ashtoret granulosa</i>	m	30
Foreshore	5/05/15	<i>Ashtoret granulosa</i>	m	50
Foreshore	5/05/15	<i>Ashtoret granulosa</i>	m	20
Mid-estuary	4/05/15	<i>Scylla serrata</i>	f	90
Mid-estuary	4/05/15	<i>Scylla serrata</i>	f	50
Mouth	2/05/15	<i>Myomenippe fornasinii</i>	f	15
Mouth	2/05/15	<i>Myomenippe fornasinii</i>	m	9
Mouth	2/05/15	<i>Scylla serrata</i>	unknown	5
Mouth	2/05/15	Diogenidae	–	–
Mid-estuary	3/05/15	<i>Portunus pelagicus</i>	f	60
Mouth	03/05/15	<i>Thalamita crenata</i>	f	40

Site	Date	Method	Species Name	Length of first 20 individuals																				Additional Count			Counts of Measured Fish	Total Count
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	A	I	J		
Leekes Creek Upper Estuary	12/02/14	Fyke B	<i>Atherinomorus endrachtensis</i>	48	39	50	44	40	45	40	45	46	44	40	43	46	45	44	41	42	42	42	48	0	46	0	20	66
Leekes Creek Upper Estuary	12/02/14	Fyke B	<i>Mugil cephalus</i>	70																						1	1	
Leekes Mid-Estuary	12/02/14	Fyke D	<i>Ephinephelus coioides</i>	142	102																					2	2	
Leekes Mid-Estuary	12/02/14	Fyke D	Family Penaeidae	32	25	30	32	36	28	31	36	33	25	30	29	29	27	37	36	35	30	31	35	157	0	0	20	177
Leekes Mid-Estuary	13/02/14	Fyke E	<i>Pseudomugil signifer</i>	30	34	32	28	30	31																	6	6	
Leekes Mid-Estuary	13/02/14	Fyke E	unidentifiable juvenile	27	28	25																				3	3	
Leekes Mid-Estuary	13/02/14	Fyke E	Family Penaeidae	29																						1	1	
Foreshore Leekes	13/02/14	Fyke F	<i>Gerres oyena</i>	30																						1	1	
Foreshore Leekes	13/02/14	Fyke G	<i>Gerres oyena</i>	35	32	35	32																			4	4	
Foreshore Leekes	13/02/14	Fyke G	<i>Arothron manilensis</i>	39																						1	1	
Foreshore Leekes	13/02/14	Fyke G	Family Penaeidae																							0	1000	
Leekes Creek Mouth	12/02/14	Seine 1	<i>Sillago ciliata</i>	238																						1	1	
Leekes Creek Mouth	12/02/14	Seine 1	<i>Selenotoca multifasciata</i>	96	135																					2	2	
Leekes Creek Mouth	12/02/14	Seine 1	<i>Mugil cephalus</i>	203	203	194	206																			4	4	
Leekes Creek Mouth	12/02/14	Seine 1	<i>Gerres filamentosus</i>	120	129	122																				3	3	
Leekes Creek Mouth	12/02/14	Seine 1	<i>Gnathanodon speciosus</i>	180																						1	1	
Leekes Creek Mouth	12/02/14	Seine 1	<i>Acanthopagrus australis</i>	124	182																					2	2	
Leekes Creek Mouth	12/02/14	Seine 1	<i>Siganus canaliculatus</i>	173																						1	1	
Leekes Creek Mouth	12/02/14	Seine 1	<i>Ephinephelus coioides</i>	195																						1	1	
Leekes Creek Mouth	13/02/14	Seine 1	<i>Leiognathus equulus</i>	139	144	146	145	155	138	150	150	149	146	146	145	141	146	154	139	144	137	146	136	7	0	0	20	27
Leekes Creek Mouth	13/02/14	Seine 1	<i>Gerres filamentosus</i>	109	100	95	119	121	100	93																7	7	
Leekes Creek Mouth	13/02/14	Seine 1	<i>Gerres filamentosus</i>	135																						1	1	
Leekes Mid-Estuary	12/02/14	Seine 2	<i>Sillago ciliata</i>	335	252	221	228	295	281	250	272	220	248	283	213	262	230	211	280	282						17	17	
Leekes Mid-Estuary	12/02/14	Seine 2	<i>Gerres filamentosus</i>	125	94	195	125	96	168	125	95	132	134	115	130	90	110	105	94	131	94	154	90	1	0	0	21	22

Site	Date	Method	Species Name	Length of first 20 individuals																				Additional Count			Counts of Measured Fish	Total Count		
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	A	I	J				
Foreshore Leekes	21/08/14	BRUV	<i>Ephinephelus coioides</i>																						1	0	0	0	1	
Leekes Mid-Estuary	21/08/14	Cast	<i>Tetractenos hamiltoni</i>	83																						0	0	0	1	
Leekes Mid-Estuary	21/08/14	Fyke	<i>Ambassis mariana</i>	70	73	77	79	60	60	64	63	63	70	77	72	68	69	68	72	80	78	62	73	39	0	0	0	20	59	
Leekes Mid-Estuary	21/08/14	Visual	<i>Selenotoca multifasciata</i>																					1	0	0	0	1		
Leekes Mid-Estuary	21/08/14	Visual	<i>Terapon jarbua</i>																					1	0	0	0	1		
Leekes Creek Upper Estuary	21/08/14	Cast	<i>Ambassis mariana</i>	60	61	66	68	66	63	63	62	70	72	77	78	77	60	65	63							0	0	0	16	16
Leekes Creek Upper Estuary	21/08/14	Cast	<i>Mugil cephalus</i>	92	90	82	80	89	91																0	0	0	6	6	
Leekes Creek Upper Estuary	21/08/14	Cast	<i>Leiognathus equulus</i>	70																					0	0	0	1	1	
Leekes Creek Upper Estuary	21/08/14	Cast	<i>Acanthopagrus pacificus</i>	95	90	109																			0	0	0	3	3	
Leekes Creek Upper Estuary	21/08/14	Cast	<i>Acanthopagrus australis</i>	130	135	128																			0	0	0	3	3	
Leekes Creek Upper Estuary	21/08/14	Cast	<i>Sillago ciliata</i>	98																					0	0	0	1	1	
Leekes Creek Upper Estuary	21/08/14	Cast	<i>Arothron manilensis</i>	60																					0	0	0	1	1	
Leekes Creek Upper Estuary	21/08/14	Pitfall	<i>Periophthalmus</i> sp.	52																					0	0	0	1	1	
Leekes Creek Upper Estuary	21/08/14	Cast	Prawn	32	24	31	32	29	29	27	28	26	29	29	33	32	28	31	30	27	25	24	22	0	80	0	0	20	100	
Leekes Creek Mouth	22/08/14	Seine	<i>Lutjanus argentimaculatus</i>	310	305	320																			0	0	0	3	3	
Leekes Creek Mouth	22/08/14	Seine	<i>Taeniura lymma</i>	300																					0	0	0	1	1	
Leekes Creek Mouth	22/08/14	Seine	<i>Acanthopagrus australis</i>	145																					0	0	0	1	1	
Leekes Creek Mouth	22/08/14	Seine	<i>Siganus canaliculatus</i>	100																					0	0	0	1	1	
Leekes Creek Mouth	22/08/14	Seine	<i>Acanthopagrus pacificus</i>	113																					0	0	0	1	1	
Leekes Creek Mouth	22/08/14	Seine	<i>Plectorhinchus gibbosus</i>	144																					0	0	0	1	1	

A adult
I intermediate
J juvenile

