

Towed Camera Marine Habitat Mapping Survey NT Power and Water Corporation – East Point Aquatic Life Reserve

Technical Report

Prepared for URS Australia Pty Ltd

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Prepared by Geo Oceans Pty Ltd

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Executive Summary

- This survey accurately describes the distribution of marine habitats near the proposed East Point Outfall Works pipeline location and surrounding East Point Aquatic Life Reserve habitats.
- The majority of benthic habitats along the proposed pipeline alignment are mobile sand substrates with low abundance of epibenthos and have low ecological importance.
- Areas to the south of the alignment includes shallow reefs dominated by macroalgae and small patches of hard coral and deeper reefs dominated filter feeder communities.
- This survey did not record the presence (greater than 1% cover) of seagrass communities including at the sites that were repeated from previous surveys that recorded seagrass. However, seagrass was recorded along the proposed pipeline alignment in previous surveys.
- The seagrass in this area is sparse, patchy and ephemeral and will be difficult to monitor but is likely to recover and recolonize suitable sand substrates after any disturbance.

1 Introduction

Geo Oceans was commissioned by URS Australia Pty. Ltd. (URS) to conduct a marine habitat mapping survey for the Northern Territory (NT) Power and Water Corporation (PWC) in and around the East Point Aquatic Life Reserve (EPALR) within Darwin Harbour.

A towed camera method was used to collect seafloor habitat point data and classify benthic habitat types in areas of interest around the PWC's proposed East Point Outfall Works project (Ludmilla Outfall Upgrade) and the EPALR. An intertidal survey was undertaken at East Point to map the intertidal zones during low tide. Marine habitat maps were then created from the point data and existing data using Geographical Information System (GIS) software.

This technical report describes the methodologies used for field data collection and map production and presents the habitat maps created from this survey.

1.1 Background

Power and Water Corporation (PWC) have proposed the Larrakeyah Outfall Closure Plan. This plan includes the closure of the Larrakeyah outfall and the upgrade of the Ludmilla outfall pipeline (East Point Outfall Works).

PWC commissioned GHD Pty. Ltd. (GHD) to undertake a benthic marine habitat survey of the East Point survey area (GHD, 2009a) and a bathymetric survey of the Larrakeyah outfall (GHD, 2009b). The GHD marine habitat surveys concentrated on areas adjacent to the proposed East Point Outfall location, at reference sites established during survey work in 2007 (GHD, 2007) and around Darwin Harbour at the EPALR, South Shell Island and Weed Reef.

PWC and URS conducted intertidal walking surveys at spring-low tides taking still images, GPS locations and notes describing seagrass on the lower intertidal (littoral) sand flats (PWC, 2011). The geo-referenced images of seagrass were provided to Geo Oceans by URS for processing and inclusion in this report.

Marine habitat surveys were undertaken in Darwin Harbour by BMT WBM (2010) and Geo Oceans (2011). Geo Oceans were engaged by the NT Department of Lands and Planning (DLP) to collate all existing benthic habitat data available in Darwin Harbour (Geo Oceans, 2012) using methodologies consistent with habitat maps submitted by INPEX for the Ichthys LNG Development Project Environmental Impact Statement (INPEX, 2011).

Detailed bathymetry data was collected throughout Darwin Harbour, including near East Point (GHD, 2009b), the inner harbour extending out of the Harbour approximately 15km north east of East Point (NRETAS, 2011) and in the East and Middle Arm of Darwin Harbour (IX Survey, 2010).

1.2 Objectives

The aim of this survey was to collect marine habitat data and create habitat distribution maps for the EPALR and the area surrounding the proposed East Point Outfall Works.

2 Method

2.1 Field Logistics

Towed camera and intertidal surveys were conducted from 3 to 6 May 2012. The towed camera survey was undertaken aboard a 17.5 m monohull vessel ('MV Mystified') chartered to URS by Broadsword Marine Contractors during a neap tide period to provide the best available water currents, visibility and tidal rise and fall conditions. The intertidal survey was performed by walking at low tide on 6 May 2012.

Table 1. Tide times during the Survey.

2/05/12		3/05/12		4/05/12		5/05/12		6/05/12	
Time	Height	Time	Height	Time	Height	Time	Height	Time	Height
0217	5.13	0336	5.72	0436	6.38	0530	6.98	0620	7.45
0829	3.08	0947	2.84	1045	2.53	1133	2.27	1216	2.10
1445	5.81	1544	6.16	1630	6.53	1712	6.86	1750	7.09
2130	2.66	2223	2.00	2309	1.34	2353	0.78	-	-

2.2 Field Program Sampling Design

The sampling program was designed prior to the field survey using existing habitat data (Geo Oceans, 2011 and GHD 2007) (

Figure 1), bathymetry data (GHD 2009b and NRETAS, 2011) and high-resolution satellite imagery. The sampling design involved spatial stratification to target (1) areas of particular interest and (2) areas identified as data poor.

The survey area included subtidal and intertidal waters around East Point. The areas of interest included:

- The East Point Aquatic Life Reserve;
- The proposed Ludmilla Outfall pipeline alignment and outfall locations;
- Areas with previous seagrass data (GHD, 2009a and Geo Oceans, 2011); and
- The intertidal areas at East Point.

2.2.1 Towed Camera Survey

During the survey, 73 towed camera transects and an intertidal walk were conducted over 4 days of field operations. The towed camera transects ranged in length from 50 m to greater than 200 m. Areas of particular interest were surveyed in more detail with longer transect lengths (e.g 1.4 km transect along the route of the proposed pipeline). Where possible, the towed camera survey transects were orientated orthogonal to depth gradients or habitat boundaries. However, due to the strong tidal currents in Darwin Harbour and in consultation with the vessel master, the orientation of some transects were modified to accommodate safe vessel positioning and control.

The start locations for each towed camera transect are displayed in Figure 2 and

Appendix 1.

2.2.2 Intertidal Survey

The intertidal survey was conducted by two marine scientists (field personnel) walking between the upper to lower-mid littoral intertidal zones at low-tide. Field personnel described the intertidal habitats by recording geo-referenced habitat data and taking written notes and still images along (walking) transects and locations where profile images could be captured of large areas of habitats (e.g. lookouts). Still images were taken to describe habitat distributions, substrate types ('profile' images) and the composition of epibenthic communities ('biota' images).

The location of each image taken during the intertidal survey is shown in Figure 2, Figure 3 and Appendix 2.

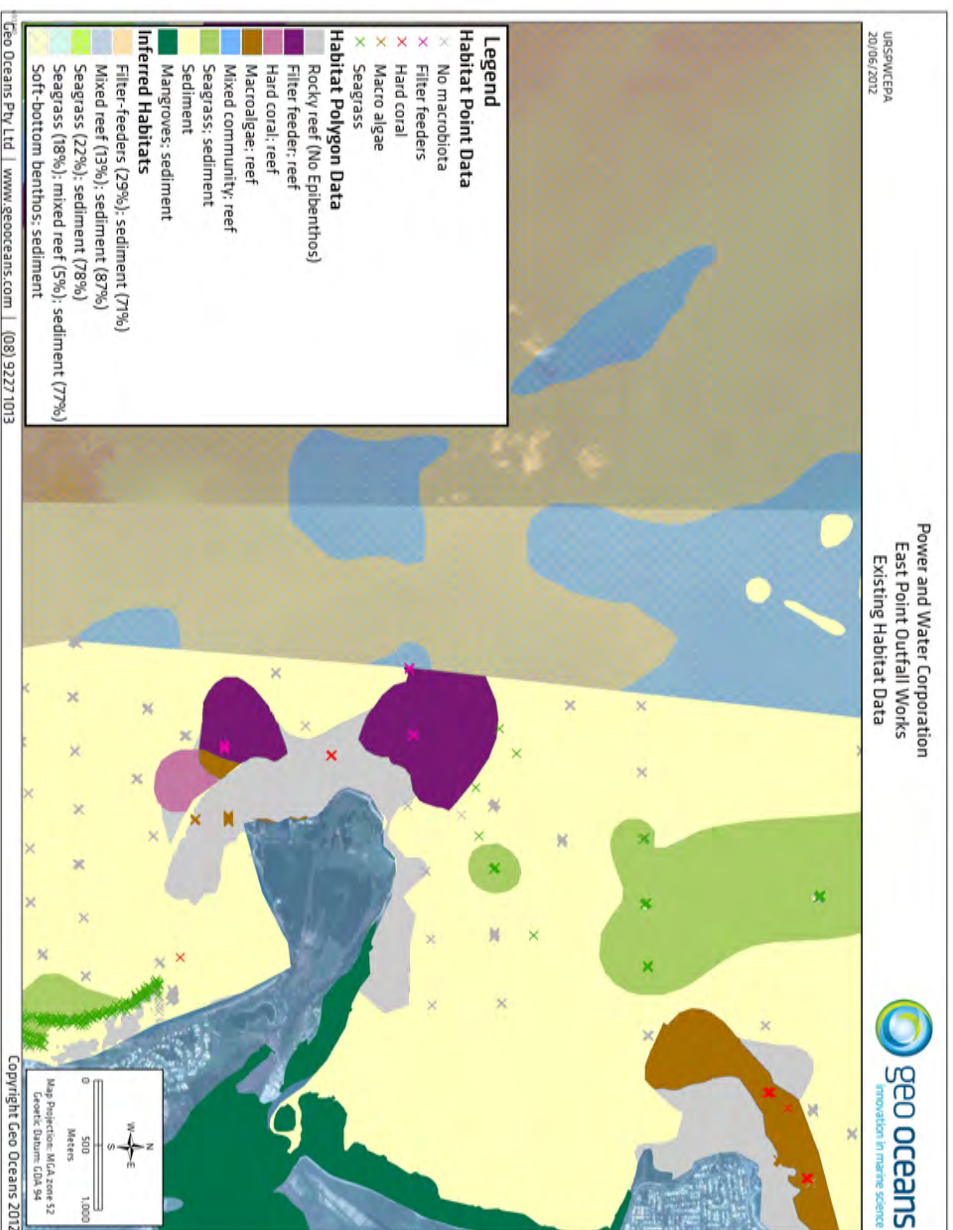


Figure 1. Existing habitat data (Geo Oceans, 2011).

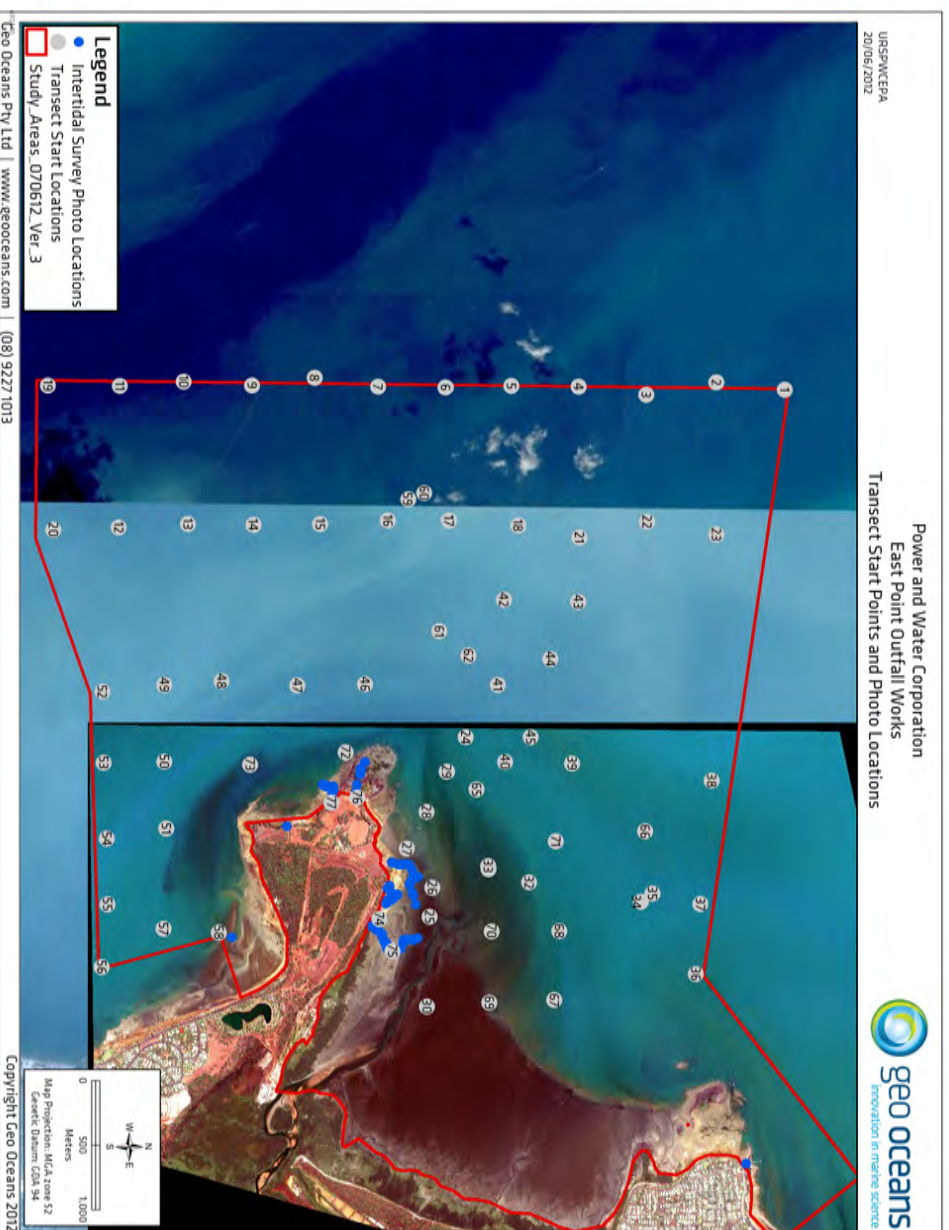


Figure 2. Towed camera survey transect start locations and survey area.



Figure 3. Intertidal survey area showing numbered image locations (image thumbnails attached in Appendix 7).

2.3 Towed Camera Survey Equipment

2.3.1 Topside Control Unit

The towed camera system was powered and controlled by a GO Visions™ Topside Control Unit (TCU) and vessel mounted laptop computer. The TCU encoded Global Positioning System (GPS) data to audio and video tracks of the video footage. The TCU streamed video footage and data to a laptop computer and hard drive video recorder (in real-time) for recording and video analysis. The video footage was captured on a hard drive video recorder at a resolution of 720 x 576 (lines) at 30 frames per second, displayed and assessed by a video analyst (Figure 4). The GPS data were streamed to the laptop using the GO Visions™ Habitat Assessment Software.

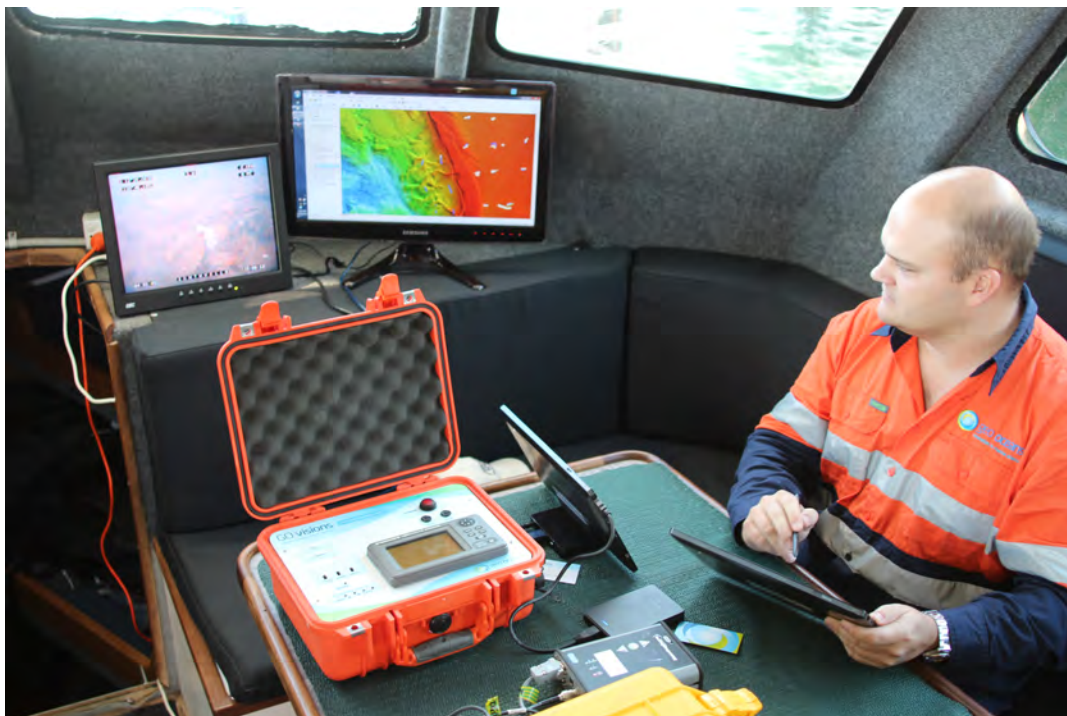


Figure 4. GO Visions™ TCU data capture system and data display screens being operated on vessel “MV Mystified”.

2.3.2 Towed Camera System

The towed camera system includes a high-resolution, low light (0.1 lux) video camera. The video camera was mounted on a 45° forward angle in a towed frame (Figure 5). The camera was towed approximately 50 cm above the seafloor to capture an image approximately 30 cm wide. The hydrodynamic design of the towed camera frame minimises friction with and consequent drag forces from the water. This reduces camera lag behind the vessel and the spatial positioning error between the GPS receiver on the vessel and the subsurface camera. The video camera is connected to the TCU via an umbilical cable that transmits data from and power to the camera. Two 550 watt LED lights are mounted on the camera frame on

a 45° forward angle to improve image resolution in low light environments. Two fixed lasers, mounted in parallel to the camera frame and calibrated to a set distance (20 cm) between beams, provide scale calibration to video footage.

The towed camera system includes a Digital Single Lens Reflex (Digital SLR) still camera with a 24 mm lens housed within an underwater pod and mounted at 180° (facing directly down) to the substrate.



Figure 5. GO Visions™ towed camera system prior to deployment on vessel “MV Mystified”.

2.3.3 Spatial Positioning

The GPS position (latitude and longitude) coordinates were acquired using a Hemisphere R110 differential GPS (DGPS) unit with an accuracy of 0.6 m with 95% confidence. The GPS antennae was positioned slightly aft of the towed camera’s surface tow point. To reduce the towed camera frame’s drag, the vessel was operated at slow speeds (less than 1 km.h⁻¹) to minimise the camera’s spatial position error relative to the DGPS antennae.

A Tritech Altimeter transducer was fitted to the towed camera frame. The altimeter measures and transmits the distance between it and the seafloor in real-time and allows the camera operator to tow the camera at a constant distance (approximately 0.5 m to 1 m) above the seafloor.

2.4 Intertidal Survey Equipment

2.4.1 Backpack Control Unit

A Samsung Slate PC was used to operate the GO Visions™ software for recording geo-referenced intertidal habitat observations (Figure 6). GPS data were streamed to the Samsung Slate and interfaced to the GO Visions™ software. Waypoints and geo-referenced observation notes were recorded within the GO Visions™ software for each still image (photograph) taken during the survey.

2.4.2 DSLR Camera

A Canon 18 megapixel Digital SLR camera fitted with a 24 mm wide-angle lens was used to capture images of intertidal habitats, flora and fauna. The images were geo-referenced by linking the timestamp on the image metadata with the timestamp of the GPS track data collected by GO Visions™ software.

2.4.3 Spatial Positioning

The GPS position (latitude and longitude) coordinates were acquired using a Hemisphere R110 differential GPS (DGPS) unit with an accuracy of 0.6 m with 95% confidence. The GPS and antennae were carried in a Backpack Control Unit (BCU) worn by GO Visions™ software field personnel.

2.5 Habitat Classification

2.5.1 Towed Camera Video Data Analysis

Geo Oceans' customised Visual Basic software program (GO Visions™) allows video analysis and habitat classification trained marine scientists to assign and record habitat data in real-time (i.e. as the video is recorded). The habitat data ('Habitat Point' data) recorded using the software includes percent cover of five different subtidal 'Biota Classes' as defined in the subtidal habitat classification scheme in Appendix 3 (i.e. 'Hard Coral', 'Soft Coral', 'Filter Feeders', 'Macroalgae' and 'Seagrass'). Substrate categorisation ('Substrate Types' such as 'Reef' and 'Sand'), biota counts and modifiers (e.g. sediment particle size, substrate profile and biota taxonomic information) are also recorded. Appendix 8 lists the Habitat Point data attributes captured and geo-referenced using the GO Visions™ software.

Global Positioning System data were received at one-second intervals, encoded to the video and recorded in a database table along with the biota and substrate attributes assigned using the GO Visions™ software.

2.5.2 Intertidal Survey Data Analysis

Intertidal habitat observations were classified *in-situ* by Geo Oceans' GO Visions™ software trained field personnel. Geo-referenced visual observations, waypoints and notes were recorded in real-time i.e. as the observations and still images were taken in the field. For each image GO Visions™ software captured geo-referenced waypoints, camera bearing, number, type, littoral zone and notes. A summary of still image waypoint data is provided in Appendix 2.

Habitat Point data records include percent cover of five different Biota Classes ('Oysters', 'Macroalgae', 'Seagrass', 'Mangroves' and 'Coastal Trees'), two different

Substrate Types ('Reef' and 'Sand'), littoral zones, biota counts and modifiers (e.g. sediment particle size, substrate profile and biota taxonomic information). These are defined in the intertidal habitat classification scheme in Appendix 4. Appendix 8 lists the habitat point data attributes that were captured and geo-referenced using the GO Visions™ software. Global Positioning System data were received at 1-second intervals and recorded in a database table along with the biota and substrate attributes assigned using the GO Visions™ software.



Figure 6. Geo Oceans' field personnel using GO Visions™ software and Backpack Control Unit.

2.5.3 Habitat Classification Scheme

Benthic habitats were classified according to the Geo Oceans hierarchical habitat classification scheme (Appendices 3 and 4) adapted from an Australian intertidal and subtidal benthic habitat classification scheme (Mount *et al.*, 2007). The habitat classification scheme uses a hierarchical decision process to define benthic habitats. It has been used on other benthic habitat mapping surveys in Darwin Harbour (Geo Oceans, 2011) including the DLP's previous habitat mapping project (Geo Oceans, 2012).

2.5.4 Data Checking

Video data were error checked in a Microsoft Access database for blank fields and erroneous GPS coordinates and habitat classifications. The data were converted into a GIS shapefile (as point data) and displayed in ArcGIS (version 10.1). Habitat data were symbolised to show presence and absence of the Biota Classes and percent cover values. The point data were reviewed for habitat classifications that

were inconsistent with surrounding point and existing habitat data. If point data were considered invalid, video footage was reanalysed using the same methods as the real-time analysis method described above.

2.5.5 Habitat Point Data Classification

Individual Habitat Point data were analysed in a Microsoft Access database using queries to define broad habitat ('Community Class') and substrate classes ('Substrate Class').

The Community Class field was classified using the presence and absence data for each Biota Class observed for each point in the Habitat Point data. The decision rules (thresholds) for presence and absence of each Biota Class were based on percent cover estimates from Habitat Point data. Thresholds for presence and absence were consistent with those used to define habitat classes in Geo Oceans (2011). Table 2 shows thresholds for defining Biota Class 'presence'.

The Substrate Class field was classified using reef percent cover estimates in the habitat point data. Decision rules to define substrate classes are provided in Table 3.

Table 2 Community Class 'presence' thresholds.

Littoral Zone	Community Class	Biota Class percent cover
Subtidal	Hard Coral	> 5%
	Soft Coral	> 5%
	Filter feeder	> 10%
	Macroalgae	> 10%
	Seagrass	> 1%
Intertidal	Mangrove	> 5%
	Oysters	> 5%
	Macroalgae	> 5%
	Turf algae	> 5%
	No Epibenthos	No Community Classes present

Table 3. Substrate Class decision rules.

Substrate Class	Reef percent cover
Reef	> 50%
Sand and Reef	10% to 50%
Sand	< 10%

2.6 Habitat Map

2.6.1 Delineating Marine Habitat Boundaries (Polygons)

Marine habitat boundaries were delineated using a manual 'digitisation' process in ArcGIS to create polygons ('Marine Habitat Polygons'). Habitat boundaries were

defined by tracing the bathymetric contours and characteristics (i.e. slope and rugosity) in existing bathymetry data (IX Survey, 2010; NRETAS, 2011b) and WorldView (2 m multi-spectral) satellite imagery. The existing habitat data (Geo Oceans, 2011) and the habitat point data collected during this survey were used to guide the manual digitisation.

2.6.2 Classifying Habitat Polygons

Habitat Point data inside each Marine Habitat Polygon were reclassified in ArcGIS using the 'Spatial Intercept' tool. The reclassified Habitat Point data were processed in Microsoft Excel using 'Pivot Table' queries. Pivot Tables were used to calculate the Habitat Polygon average percent cover for each Biota Class and Reef Cover, and Bioturbation counts.

Marine Habitat Polygons were classified with 3 habitat attributes: 'Community Classification', 'Substrate Classification' and 'Bioturbation Classification'.

Community Classification attribute fields were classified using Habitat Point data average percent cover Biota Class. Biota Class composition percent cover thresholds used to define dominance and co-dominance for each polygon are shown in Table 4.

Table 4. Community Classification decision rules.

Community Classification	Example	Biota Class composition
Dominated by Biota Class	Hard coral	Biota Class is >90% composition of total biota
Dominant Biota Class with other biota classes present	Hard coral with Filter Feeder	Dominant Biota Class <90% with other biota 10 to 30% composition of total biota
Co-dominant Biota Classes (and)	Filter Feeder and Macroalgae	Co-dominant Biota Classes >30% composition of total biota

Substrate Classification attribute fields were classified using Habitat Point data average percent Reef Cover to define Substrate Classification. Reef Cover thresholds used to define Substrate Classification are shown in Table 5. A sediment profile modifier was used to separate the Sand Substrate classification. The sediment profile modifier was classified using the bathymetry data to identify polygons with high profile sand 'waves'.

Table 5. Substrate Classification decision rules

Substrate Classification	Reef Cover	Modifier
Reef	> 50%	
Sand and Reef	10% to 50%	
Sand	< 10%	Low profile Waves

Bioturbation Classification attribute fields were classified using the Habitat Point

data Bioturbation data. The Bioturbation data included qualitative estimates (levels) of sediment reworking activity i.e. None, Low, Medium and High (defined in Appendix 3). The occurrence (counts) of each bioturbation level was compared. The bioturbation level with the highest number of counts in each polygon was used to define the Bioturbation Classification.

2.7 Quality Assurance and Control (QA/QC) Summary

All tasks undertaken by Geo Oceans for this project agreed with Geo Oceans management systems.

In summary, QA/QC procedures were developed and implemented for:

- Field procedures;
- Technical communications and field briefings;
- Equipment testing and operation;
- Video analyses; and
- Data handling, storage, backup and security.

In addition to the QA/QC procedures discussed within the methods sections above, specific QA/QC records included:

- Towed video transect field sheets; and
- Raw and analysed data files with in-built QA/QC checks.

2.8 Metadata

This report provides details of the data collection and analysis methods used. The metadata for each spatial dataset are provided in Appendix 8.

3 Results

In total, the survey captured 23,171 records of habitat point data with the towed camera and intertidal surveys capturing 15,798 and 7,377 rows of data respectively.

Weather conditions during towed camera field operations were calm and tidal currents low, allowing consistent towing speed. Water visibility was 2 m to 4 m and all footage was suitable for analysis. Still images classified biota to level 3 in the habitat classification scheme (Appendices 3 and 4). Figure 8 to Figure 13 show examples of still images used to identify biota to a lower taxonomic classification. Data captured during the towed camera survey had a spatial error of less than 5 m.

The intertidal survey captured 139 geo-referenced still images (Appendix 2) and habitat observations that were used to describe intertidal habitats at East Point and Night Cliff. Data captured during the intertidal survey had a spatial error of less than 0.6 m.

Habitat point data, existing habitat and bathymetry data and Worldview satellite images were used to create a spatially accurate map of marine benthic habitats in the survey areas (Figure 13 and Figure 14). Habitat polygons were classified using reef cover and bioturbation classes (Appendix 5) and biota cover (Appendix 6) from habitat point data inside each polygon.

Table 6 and Table 7 show the area of each habitat polygon and the community, substrate and bioturbation.

Figure 15 shows the distribution of marine habitats in the survey area relative the current and proposed pipeline alignments.

The majority (68% or 2,219 ha) of the survey area consisted of habitats with no epibenthos on sandy substrates with no bioturbation (41% or 1,187 ha). Three large sand waves were observed as distinct features from the bathymetry data and were mapped in the survey area. One sand wave was mapped in the area at the western end of the proposed pipeline alignment. The sand waves were typically composed of coarse (gravel) sediments with no bioturbation and were up to 5 m high.

The exposed reef substrates deeper than -1 m (LAT) were dominated by aphototrophic filter feeder communities consisting mainly of gorgonian fans, sea whips, soft corals, hydroids and sponges. These deeper subtidal reefs cover a large area of the reef that extends west from East Point and south of the proposed pipeline alignment. However, in some sections, the proposed pipeline alignment is less than 100m from the reef. The shallow reef substrates (less than -1 m LAT) near East Point and Night Cliff were dominated by macroalgae communities mixed with sparse hard corals.

Hard coral dominated (greater than 10%) communities were found on a reef slope on the north eastern side of East Point, approximately 400 m south of the proposed pipeline alignment. These hard coral communities were mixed with filter feeders and sparse (less than 5%) macroalgae. The hard coral communities were dominated by Faviid, Pectiniid and Dendrophyllid corals with *Acropora* spp. corals present in low abundance.

No seagrass greater than 1% cover was recorded as present. However, very sparse

(less than 1%) seagrass (*Halodule* sp.) was recorded on one transect north of East Point (transect 67) in an area where seagrass was previously recorded (Figure 16) (Geo Oceans, 2011). The seagrass recorded in previous surveys was sparse and patchy and was dominated by *Halophila* sp. and *Halodule* sp.,

The intertidal habitats consisted of sand and reef substrates with the dominant communities correlated with height altitude (above LAT). The lower littoral reefs were typically dominated by macroalgae (10% to 19% cover) with sparse hard coral (less than 3% cover). The common macroalgae recorded on these reefs was *Halimeda* sp., *Caulerpa* sp., *Dictyopteris* sp. and *Padina* sp. with others from the Phaeophyta (brown algae) and Rhodophyta (red algae). Gastropods, mussels, oysters and barnacles were the most common fauna recorded on the intertidal reefs throughout the lower and mid-littoral zones. Crabs and holothurians were also recorded on the reefs. The sand habitats in the mid to lower littoral zones did not support any epibenthos but some patches had high bioturbation with evidence of burrowing infauna.

Mangroves were present in both dense and sparse patches on the east and north east sides of East Point in the mid to upper littoral zones. Similar mangrove habitats were recorded at Night Cliff and small patches were recorded on the east and south sides of East Point.

The majority of the proposed pipeline alignment, extending from the existing outfall location, covered sand substrate with low-profile sand ripples (less than 10 cm high) and no bioturbation. The intertidal areas near the existing pipeline alignment were predominantly low profile reef dominated by rock oysters and sand with no epibenthos. Mangrove habitats were mapped higher in the mid to upper littoral zones to the east of the pipeline alignment but not in direct alignment.



Figure 7. Still camera image of seagrass (*Halodule* sp.) with filamentous green algae growing on blades.

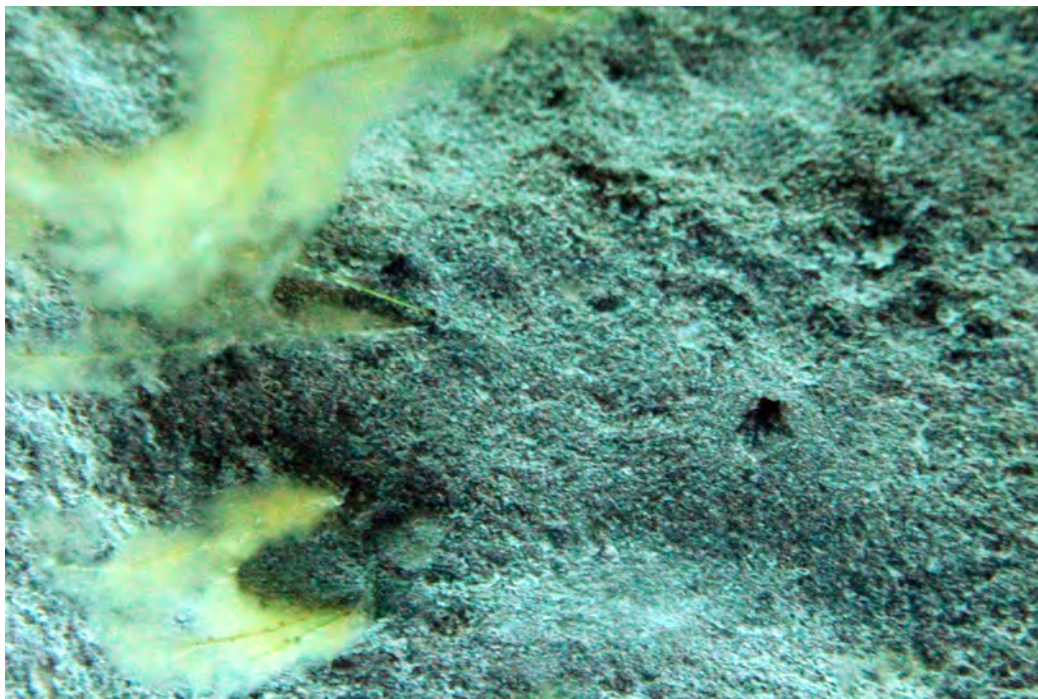


Figure 8. Still camera image close up of seagrass (*Halodule* sp.) with filamentous algae growing on blades.

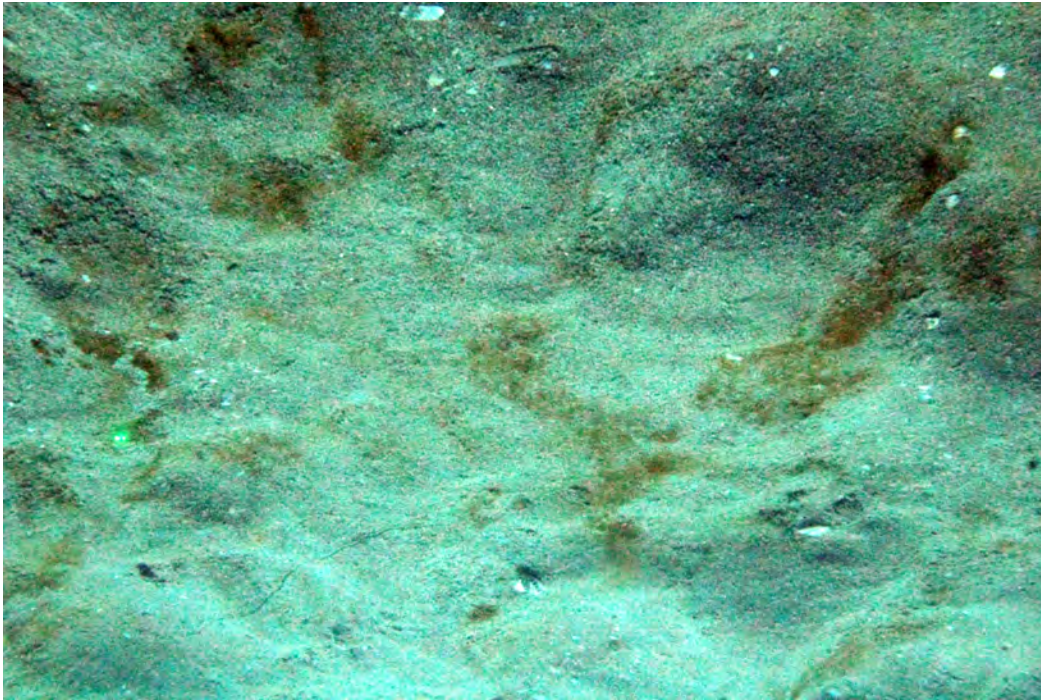


Figure 9. Still camera image of sand with microphytobenthos present.



Figure 10. Still camera image of filter feeders (sponges).



Figure 11. Still camera image of hard coral (*Duncanopsammia* sp.) in top right of frame.



Figure 12. Still camera image of various hard corals.

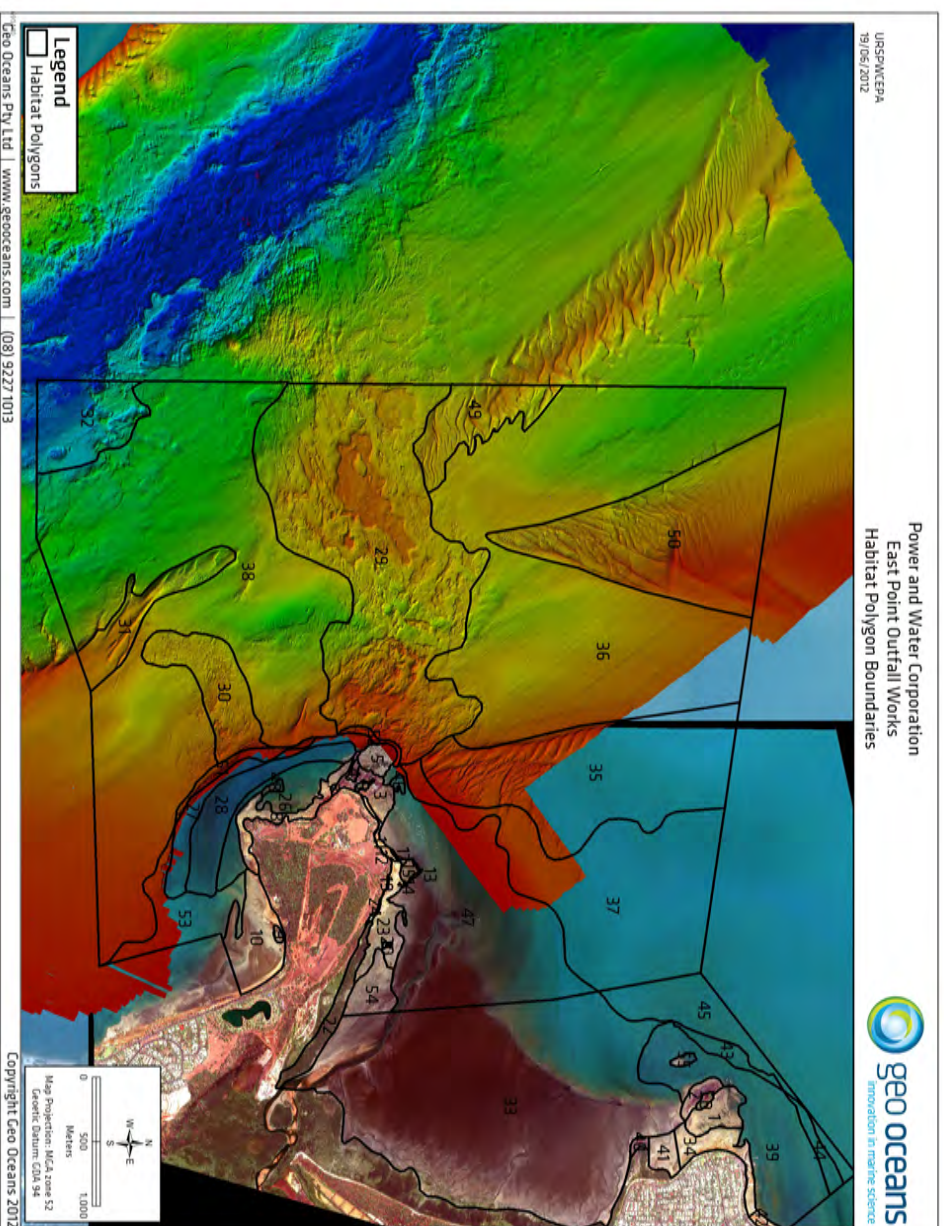


Figure 13. Digitised habitat polygons using existing bathymetry data (Red +1m; Green -20m LAT depth) showing Polygon ID.

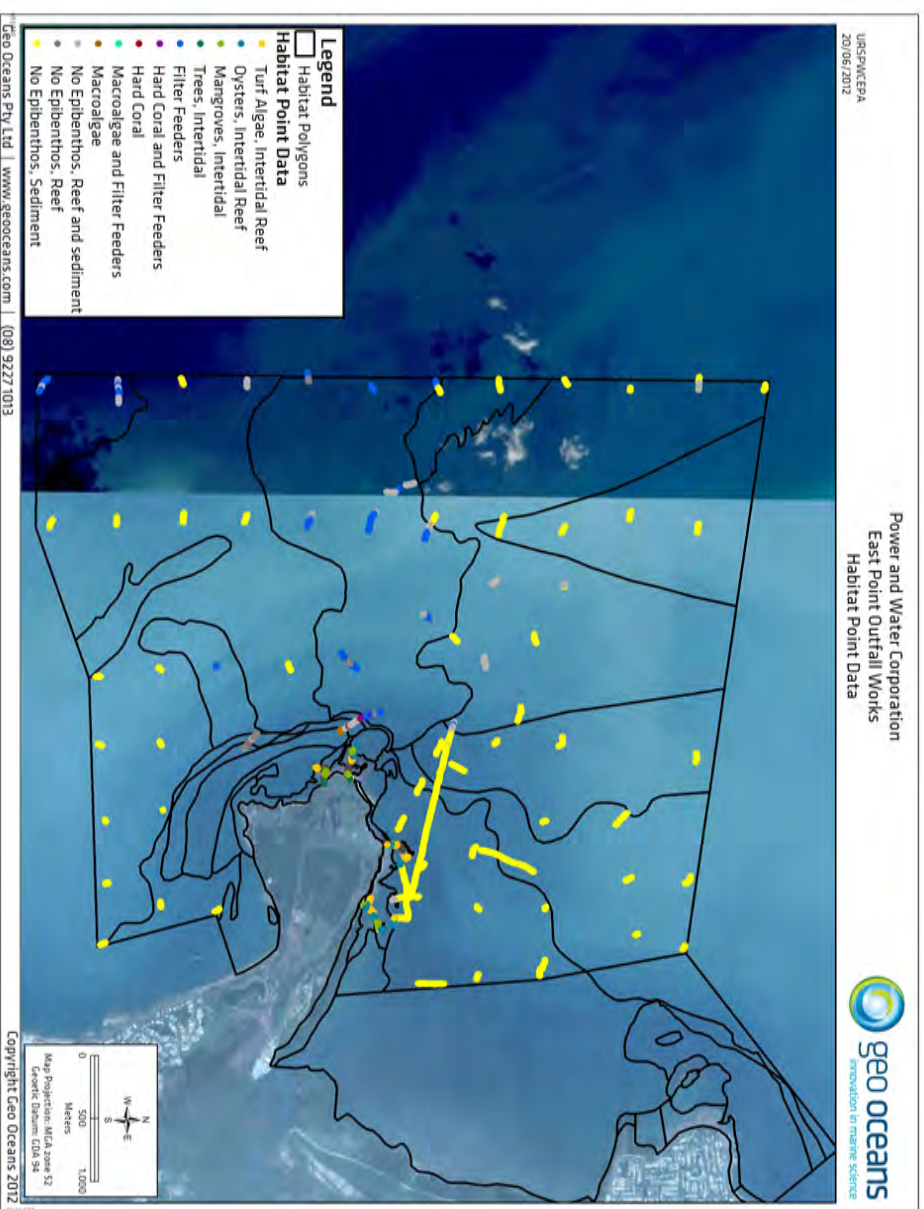


Figure 14. Habitat Point data collected during the towed camera and intertidal surveys and Habitat Polygons

Table 6. Marine Habitat Polygon data (GDA 94, MGA zone 52).

Polygon ID	Eastings	Northing	Community	Substrate	Littoral Zone	Bioturbation	Verified	Area (ha)
0	8630495.565	699804.3023	Mangrove	Sand and Reef	Intertidal	Unverified	Unverified	1.014623
1	8630593.021	699898.5716	Oyster and Turf	Reef	Intertidal	Unverified	Unverified	10.824042
2	8630452.391	699759.4096	Oyster and Turf	Reef	Intertidal	Unverified	Unverified	4.164723
3	8627895.951	697396.4018	No epibenthos	Reef	Intertidal	None	Verified	8.498853
4	8627768.009	697249.3339	Mangrove and Oyster	Reef	Intertidal	None	Verified	0.913529
5	8627953.083	697147.066	Oyster and Turf	Reef	Intertidal	None	Verified	5.644428
6	8627839.252	697358.6438	Mangrove	Sand and Reef	Intertidal	None	Verified	0.677779
7	8627606.55	697373.6354	Mangrove	Reef	Intertidal	None	Verified	0.136674
8	8627199.002	697582.8127	No epibenthos	Sand and Reef	Intertidal	Low	Verified	12.576875
9	8627179.576	698515.6606	Mangrove	Sand and Reef	Intertidal	Unverified	Unverified	0.70961
10	8626993.238	698543.889	No epibenthos	Sand	Intertidal	Unverified	Unverified	27.329248
11	8627968.029	697736.5847	No epibenthos	Reef	Intertidal	None	Verified	2.045965
12	8628081.704	697891.9819	No epibenthos	Sand	Intertidal	Unverified	Unverified	0.147983
13	8628251.097	698017.2452	Oyster and Turf	Reef	Intertidal	None	Verified	0.301706
14	8628180.298	698111.9762	Oyster and Turf	Reef	Intertidal	None	Verified	0.124321
15	8628189.523	698018.3773	No epibenthos	Reef	Intertidal	None	Verified	1.607273
17	8628150.38	697948.8128	Turf	Reef	Intertidal	None	Verified	0.153309
19	8628025.3	698124.8796	No epibenthos	Sand and Reef	Intertidal	Unverified	Unverified	0.144995
20	8628022.941	698593.654	Mangrove and Oyster	Reef	Intertidal	None	Verified	0.230236
21	8628123.096	698126.0056	Oyster and Turf	Reef	Intertidal	Unverified	Unverified	0.019871
22	8627573.625	699150.9348	Mangrove and Oyster	Reef	Intertidal	None	Verified	13.239278
23	8628010.783	698449.9527	Oyster and Turf	Reef	Intertidal	None	Verified	13.79669
24	8627922.3	698356.9725	No epibenthos	Sand and Reef	Intertidal	Unverified	Unverified	0.3705
26	8627151.23	697544.3274	Macroalgae with hard coral	Sand and Reef	Intertidal	Unverified	Unverified	23.031506
27	8626784.423	697544.2665	Macroalgae with hard coral	Sand and Reef	Intertidal	Low	Verified	19.866863

Polygon ID	Easting	Northing	Community	Substrate	Littoral Zone	Bioturbation	Verified	Area (ha)
28	8626885.483	697558.944	Macroalgae with hard coral	Sand and Reef	Intertidal	Low	Verified	33.788625
29	8627918.703	695548.7886	Filter feeders	Sand and Reef	Subtidal	Low	Verified	319.294881
30	8626670.306	696590.9286	Filter feeders	Sand and Reef	Intertidal	None	Verified	42.181523
31	8626141.015	696015.8125	No epibenthos	Sand Wave	Subtidal	Unverified	Unverified	32.601336
32	8625665.42	694526.4116	Filter feeders	Sand and Reef	Subtidal	None	Verified	48.08985
33	8628911.045	699808.4226	No epibenthos	Sand	Intertidal	None	Verified	363.860113
34	8630596.377	700209.8583	No epibenthos	Reef	Intertidal	None	Unverified	13.575827
35	8629646.261	697264.984	No epibenthos	Sand	Subtidal	None	Verified	169.045326
36	8629582.869	695641.7166	No epibenthos	Sand	Subtidal	None	Verified	443.390738
37	8629778.233	698152.0832	No epibenthos	Sand	Subtidal	Medium	Verified	176.384788
38	8626421.923	696044.4839	No epibenthos	Sand	Subtidal	Low	Verified	511.190678
39	8630830.994	699989.4426	Macroalgae with hard coral	Sand and Reef	Intertidal	None	Verified	77.097927
40	8629984.734	700143.71	Oyster and Turf	Reef	Intertidal	Unverified	Unverified	1.335544
41	8630179.954	700216.5499	No epibenthos	Sand and Reef	Intertidal	Unverified	Unverified	6.369459
42	8630974.664	700767.0767	No epibenthos	Sand	Intertidal	Unverified	Unverified	2.322496
43	8630664.288	699433.0813	Macroalgae with hard coral	Sand and Reef	Subtidal	Unverified	Unverified	7.687794
44	8631385.377	700189.1426	No epibenthos	Sand	Intertidal	Unverified	Unverified	6.729752
45	8630488.056	699237.1377	No epibenthos	Sand	Subtidal	None	Verified	41.896238
46	8628113.775	697343.4214	Macroalgae with hard coral	Reef	Intertidal	Unverified	Unverified	1.092006
47	8628652.671	698382.7263	No epibenthos	Sand	Intertidal	None	Verified	168.870971
48	8627145.38	697374.8833	Macroalgae with hard coral	Sand and Reef	Intertidal	Unverified	Unverified	1.103705
49	8628706.776	694527.9505	No epibenthos	Sand Wave	Subtidal	None	Verified	41.449758
50	8630254.715	695392.6603	No epibenthos	Sand Wave	Subtidal	None	Verified	154.932175
51	8626865.209	697213.2836	Sparse Mixed Epibiota	Reef	Subtidal	None	Verified	7.71039
52	8627921.012	697000.2024	Hard coral and filter feeders	Reef	Intertidal	Low	Verified	2.514896
53	8626451.871	698345.9261	No epibenthos	Sand	Intertidal	High	Verified	33.317403
54	8627915.027	698947.0247	Oyster and Turf	Sand and Reef	Intertidal	Unverified	Unverified	12.506621
55	8630330.912	699489.7955	Oyster and Turf	Reef	Intertidal	Unverified	Unverified	1.349455

Table 7. Marine Habitat Polygon areas.

Community	Substrate	Bioturbation	Area (ha)
Filter feeders	Sand and Reef		409.6
			409.6
		Low	319.3
		None	90.3
Hard coral and filter feeders	Reef		2.5
			2.5
Macroalgae with hard coral	Reef	Low	2.5
			163.7
			1.1
		Unverified	1.1
	Sand and Reef		162.6
		Low	53.7
		None	77.1
		Unverified	31.8
			2.5
Mangrove	Reef		0.1
			0.1
		None	0.1
			0.1
	Sand and Reef		2.4
		None	0.7
		Unverified	1.7
			1.7
Mangrove and Oyster	Reef		14.4
			14.4
		None	14.4
			14.4
No epibenthos	Reef		2218.7
			25.7

Community	Substrate	Bioturbation	Area (ha)
	Sand	None	25.7
			1944.5
		High	33.3
		Low	511.2
		Medium	176.4
		None	1187.1
		Unverified	36.5
	Sand and Reef		19.5
		Low	12.6
		Unverified	6.9
	Sand Wave		229.0
		None	196.4
Unverified		32.6	
Oyster and Turf		50.1	
	Reef		37.6
		None	19.9
		Unverified	17.7
	Sand and Reef		12.5
		Unverified	12.5
Sparse Mixed Epibiota		7.7	
	Reef		7.7
		None	7.7
Turf		0.2	
	Reef		0.2
		None	0.2
TOTAL SURVEY AREAS			8607.8

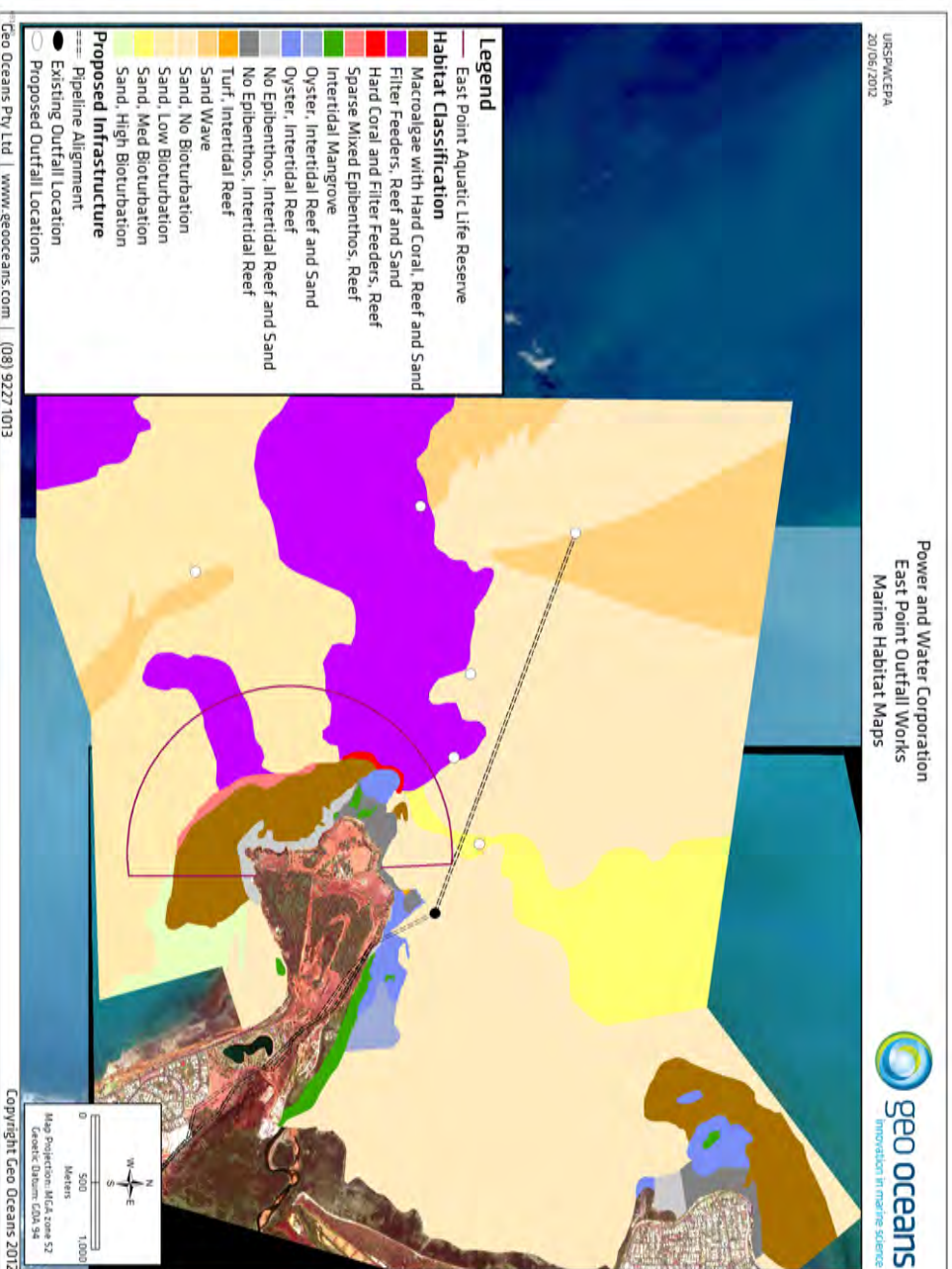


Figure 15. Marine Habitat Polygon classifications for the subtidal and intertidal zones of the EPALR including proposed site for East Point Outfall Works project.

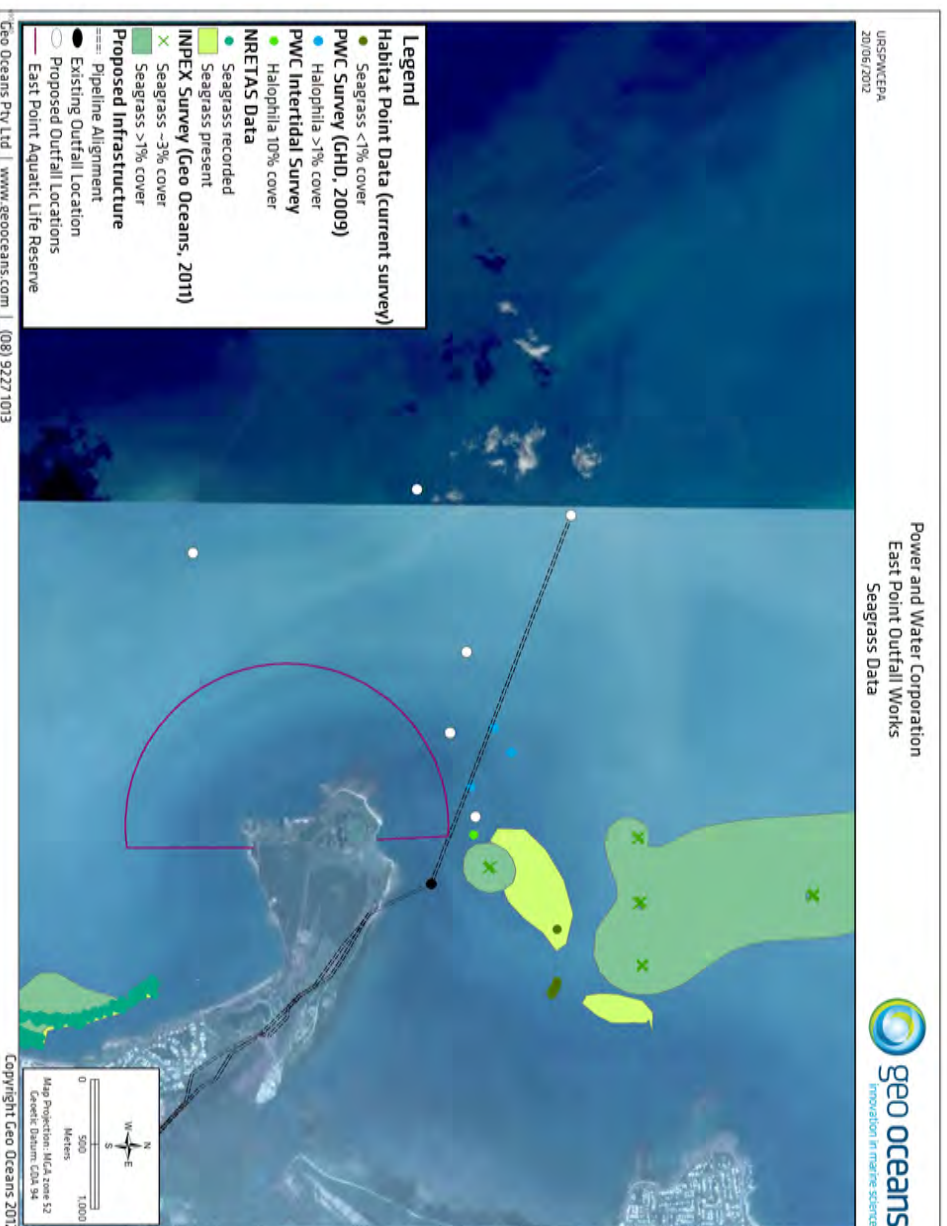


Figure 16. Seagrass data recorded near the proposed pipeline alignment. Note the seagrass data recorded during this survey was very sparse (less than 1% cover) and was not mapped as 'present'.

4 Discussion

The maps produced in this project provide an accurate representation of the distribution of marine habitats in waters surrounding the proposed East Point Outfall Works development. The methods used to classify the marine habitats were consistent with previous marine habitat surveys undertaken in Darwin harbour and, consequently, the habitat point and distribution data can be collated with existing data.

The proposed pipeline alignment covered marine habitats consisting of sand with no bioturbation. The abundance and diversity of these sand habitats is low compared to other reference sites in the Darwin Harbour region (GHD, 2007; 2009a). The proposed pipeline alignment crosses small patches of reef habitats with sparse (less than 10% cover) of filter feeder communities but these communities are abundant throughout Darwin Harbour (Geo Oceans, 2011). The lack of reef structure along the proposed pipeline alignment combined with the high tidal currents results in large areas of mobile sand waves. This significantly reduces the possibility epibenthic colonisation by flora and fauna.

The pipeline alignment crosses approximately 100 m north of a reef slope dominated by hard coral and filter feeder communities in the shallow sub-tidal waters on the north-east section of East Point. A large area of reef habitat dominated by filter feeder communities extends to the west of East Point, south of the proposed pipeline alignment. The existing pipeline alignment crosses intertidal platform reefs dominated by rock oysters and other intertidal fauna and flora. Mangroves are located approximately 50 m east of the alignment, but not in the direct path.

This survey did not record any seagrass along the pipeline alignment but small patches of very sparse (less than 1% cover) seagrass covered in epiphytes were recorded near the existing outfall north of East Point. Patches of seagrass were previously recorded (GHD, 2009a) along the proposed pipeline alignment and in the near-by sheltered bays of Fannie Bay and Casuarina Beach (Geo Oceans, 2011; NRETAS, 2011b and PWC, 2011). These seagrass communities were dominated by *Halodule* spp. (e.g. *Halodule uninervis*) and *Halophila* spp. (e.g. *Halophila decipiens*) and a *Syringodium* sp. (Geo Oceans, 2011 and GHD, 2009a). The majority of the seagrass was found in the lower littoral intertidal zone between 0 to +1 LAT, but sparse communities extended out to -3m LAT into the sub-tidal zone (Geo Oceans, 2011). The current survey did not record seagrass present (greater than 1% cover) in the survey area including at the same locations as recorded in previous surveys. The seagrass in this area is sparse, patchy, and ephemeral and the abundance varies greatly over time, making it difficult to monitor.

5 Conclusion

The proposed pipeline alignment covers areas of mobile sand substrates with low diversity and abundance of epibenthos and consequently low ecological importance. The area to the south of the proposed pipeline alignment, including the large filter feeder dominated reefs and the macroalgae and hard coral habitats in the shallow waters inside the East Point Aquatic Life Reserve, have much higher ecological importance. The East Point Aquatic Life Reserve is adjacent to the proposed pipeline.

This survey did not record the presence (greater than 1% cover) of seagrass communities including at the sites that were repeated from previous surveys that did record seagrass. The seagrass in this area is sparse, patchy and ephemeral and will be difficult to monitor.

6 References

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Appendix 1: Towed Camera Survey Transect Summary.

Transect ID	Timestamp	Distance (m)	Analyst Name	Start		End		Average Biota Cover (%)							
				Latitude	Longitude	Latitude	Longitude	MA	SG	HC	SC	FF			
1	03/05/2012 09:08:48	61	Ben Brayford	-12.37717083	130.78698317	-12.37723200	130.78753250	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	03/05/2012 09:19:15	113	Ben Brayford	-12.38195717	130.78648150	-12.38195150	130.78752417	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0
3	03/05/2012 09:27:57	22	Ben Brayford	-12.38685867	130.78740700	-12.38686133	130.78761100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	03/05/2012 09:37:17	50	Ben Brayford	-12.39157783	130.78684083	-12.39134667	130.78723817	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
5	03/05/2012 09:45:59	93	Ben Brayford	-12.39629233	130.78683617	-12.39616050	130.78769167	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
6	03/05/2012 09:56:23	107	Ben Brayford	-12.40085617	130.78697967	-12.40046167	130.78794500	0.0	0.0	0.3	0.0	10.0	0.0	0.0	0.0
7	03/05/2012 10:06:27	94	Ben Brayford	-12.40558050	130.78694617	-12.40524950	130.78776367	1.3	0.0	0.0	0.0	39.5	0.0	0.0	0.0
8	03/05/2012 10:14:47	87	Ben Brayford	-12.41001850	130.78633200	-12.40993600	130.78713783	0.0	0.0	0.0	0.0	15.6	0.0	0.0	0.0
9	03/05/2012 10:23:33	69	Ben Brayford	-12.41437383	130.78693383	-12.41436017	130.78760983	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0
10	03/05/2012 10:31:07	82	Ben Brayford	-12.41917783	130.78668817	-12.41891600	130.78741083	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0
11	03/05/2012 10:45:12	191	Ben Brayford	-12.42362750	130.78707750	-12.42355300	130.78878367	0.0	0.0	0.0	0.0	18.2	0.0	0.0	0.0
12	03/05/2012 10:56:32	60	Ben Brayford	-12.42364717	130.79709833	-12.42366850	130.79765600	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0
13	03/05/2012 11:04:20	74	Ben Brayford	-12.41881583	130.79679350	-12.41887700	130.79749617	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0
14	03/05/2012 11:11:46	74	Ben Brayford	-12.41422083	130.79682250	-12.41449050	130.79746083	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0
15	03/05/2012 11:19:10	112	Ben Brayford	-12.40955950	130.79674367	-12.40997150	130.79768783	1.7	0.0	0.0	0.0	11.1	0.0	0.0	0.0
16	03/05/2012 11:28:36	184	Nick Veitch	-12.40483717	130.79646467	-12.40559717	130.79814517	3.0	0.0	1.4	0.0	19.5	0.0	0.0	0.0
17	03/05/2012 11:39:01	254	Nick Veitch	-12.40056850	130.79644433	-12.40155033	130.79867017	0.0	0.0	0.0	0.0	6.2	0.0	0.0	0.0
18	03/05/2012 11:48:49	168	Nick Veitch	-12.39575200	130.79675217	-12.39628900	130.79829117	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	03/05/2012 12:45:50	126	Ben Brayford	-12.42865050	130.78703533	-12.42931533	130.78803700	0.0	0.0	0.0	0.0	26.4	0.0	0.0	0.0
20	03/05/2012 12:55:23	68	Ben Brayford	-12.42821217	130.79728750	-12.42846350	130.79787050	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0
21	03/05/2012 13:13:23	60	Ben Brayford	-12.39146117	130.79756800	-12.39172217	130.79806183	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	03/05/2012 13:20:43	68	Ben Brayford	-12.38673900	130.79642150	-12.38685833	130.79704367	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	03/05/2012 13:27:16	70	Ben Brayford	-12.38187967	130.79730733	-12.38197850	130.79795850	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Transect ID	Timestamp	Distance (m)	Analyst Name	Start		End		Average Biota Cover (%)				
				Latitude	Longitude	Latitude	Longitude	MA	SG	HC	SC	FF
24	03/05/2012 14:30:35	1442	Ben Brayford	-12.39992317	130.81183017	-12.40238367	130.82473667	0.0	0.0	0.0	0.0	0.6
25	03/05/2012 14:51:42	217	Ben Brayford	-12.40172367	130.82462583	-12.40366100	130.82492517	0.0	0.0	0.0	0.0	0.0
26	03/05/2012 15:03:09	34	James Brook	-12.40153783	130.82256183	-12.40174417	130.82260283	0.0	0.0	0.0	0.0	0.0
27	03/05/2012 15:21:56	105	Ben Brayford	-12.40334183	130.81977817	-12.40288067	130.81891033	0.0	0.0	0.0	0.0	0.0
28	03/05/2012 15:28:06	112	Ben Brayford	-12.40198867	130.81715250	-12.40156767	130.81617250	0.0	0.0	0.0	0.0	0.0
29	03/05/2012 15:34:17	108	Ben Brayford	-12.40060817	130.81428933	-12.40020500	130.8133733	0.0	0.0	0.0	0.0	0.0
30	03/05/2012 15:55:37	215	Ben Brayford	-12.40187367	130.83100600	-12.39992817	130.83099917	0.0	0.0	0.0	0.0	0.0
31	03/05/2012 16:13:58	315	Ben Brayford	-12.39765083	130.82120750	-12.39495233	130.82216950	0.0	0.0	0.0	0.0	0.0
32	03/05/2012 16:36:46	157	Ben Brayford	-12.39481383	130.82211517	-12.39357217	130.82280650	0.0	0.0	0.0	0.0	0.0
33	03/05/2012 16:47:15	80	Ben Brayford	-12.39768600	130.82099350	-12.39797667	130.82166733	0.0	0.0	0.0	0.0	0.0
34	04/05/2012 08:34:04	59	Ben Brayford	-12.38698667	130.82343517	-12.38650867	130.82316800	0.0	0.0	0.0	0.0	0.0
35	04/05/2012 08:48:29	487	Ben Brayford	-12.38617467	130.82285750	-12.38603267	130.82726867	0.0	0.0	0.0	0.0	0.0
36	04/05/2012 09:05:56	70	Ben Brayford	-12.38311117	130.82855667	-12.38265783	130.8281533	0.0	0.0	0.0	0.0	0.5
37	04/05/2012 09:15:46	82	Ben Brayford	-12.38281650	130.82356483	-12.38228233	130.82302967	0.0	0.0	0.0	0.0	0.0
38	04/05/2012 09:31:26	79	Ben Brayford	-12.38208717	130.81478033	-12.38195017	130.81406167	0.0	0.0	0.0	0.0	0.0
39	04/05/2012 09:43:29	83	Ben Brayford	-12.39186383	130.81364783	-12.39157267	130.81294417	0.0	0.0	0.0	0.0	0.0
40	14/05/2012 14:56:12	51	James Brook	-12.39654367	130.81357817	-12.39623267	130.81322817	0.0	0.0	0.0	0.0	0.0
41	04/05/2012 10:17:30	107	Ben Brayford	-12.39709550	130.80809167	-12.39721367	130.80711250	0.0	0.0	0.0	0.0	3.0
42	04/05/2012 10:28:29	73	Ben Brayford	-12.39671650	130.80204900	-12.39631300	130.80151600	0.0	0.0	0.0	0.0	0.5
43	04/05/2012 10:39:24	44	Ben Brayford	-12.39152183	130.80213833	-12.39148083	130.80173083	0.0	0.0	0.0	0.0	0.3
44	08/05/2012 12:26:07	75	James Brook	-12.39343183	130.80623133	-12.39362333	130.80548967	0.0	0.0	0.0	0.0	0.0
45	08/05/2012 12:30:56	113	James Brook	-12.39476267	130.81179067	-12.39457600	130.81077083	0.0	0.0	0.0	0.0	0.0
46	08/05/2012 12:42:25	180	James Brook	-12.40633417	130.80811750	-12.40746083	130.80692500	0.0	0.0	0.0	0.0	38.3
47	08/05/2012 12:54:37	55	James Brook	-12.41108600	130.80821517	-12.41126450	130.80773867	0.0	0.0	0.0	0.0	1.8
48	08/05/2012 12:58:05	11	James Brook	-12.41637200	130.80797150	-12.41646283	130.80793117	0.0	0.0	0.0	0.0	21.4
49	08/05/2012 13:03:27	29	James Brook	-12.42037800	130.80825550	-12.42058400	130.80808933	0.0	0.0	0.0	0.0	0.5
50	08/05/2012 17:06:12	27	James Brook	-12.42033967	130.81372050	-12.42044483	130.81350017	0.0	0.0	0.0	0.0	1.7

Transect ID	Timestamp	Distance (m)	Analyst Name	Start		End		Average Biota Cover (%)				
				Latitude	Longitude	Latitude	Longitude	MA	SG	HC	SC	FF
51	08/05/2012 13:13:37	2	James Brook	-12.42018100	130.81847267	-12.42018117	130.81847400	0.0	0.0	0.0	0.0	0.0
52	08/05/2012 13:16:41	40	James Brook	-12.42471733	130.80876617	-12.42507633	130.80878150	0.0	0.0	0.0	0.0	0.3
53	08/05/2012 13:26:05	36	James Brook	-12.42458683	130.81381233	-12.42488017	130.81368433	0.0	0.0	0.0	0.0	0.0
54	08/05/2012 13:31:32	18	James Brook	-12.42433267	130.81921200	-12.42426983	130.81936000	0.0	0.0	0.0	0.0	0.0
55	08/05/2012 13:38:07	21	James Brook	-12.42424467	130.82389517	-12.42409533	130.82378517	0.0	0.0	0.0	0.0	0.0
56	08/05/2012 13:42:13	46	James Brook	-12.42463467	130.82835183	-12.42426083	130.82818150	0.0	0.0	0.0	0.0	0.0
57	08/05/2012 13:46:05	44	James Brook	-12.42032667	130.82556467	-12.42032417	130.82517533	0.0	0.0	0.0	0.0	0.0
58	08/05/2012 13:48:52	43	James Brook	-12.41644150	130.82585100	-12.41610067	130.82565917	0.0	0.0	0.0	0.0	0.0
59	08/05/2012 13:52:39	101	James Brook	-12.40340417	130.79493633	-12.40428517	130.79515050	0.0	0.0	0.0	0.0	9.7
60	08/05/2012 13:56:03	70	James Brook	-12.40230933	130.79448083	-12.40292800	130.79461950	0.0	0.0	0.0	0.0	1.6
61	08/05/2012 14:02:43	52	James Brook	-12.40117467	130.80430933	-12.40157400	130.80406300	0.0	0.0	0.0	0.0	22.1
62	08/05/2012 14:07:02	57	James Brook	-12.39915483	130.80602617	-12.39949083	130.80563450	0.0	0.0	0.0	0.0	0.5
65	04/05/2012 15:40:31	122	Ben Brayford	-12.39854600	130.81553767	-12.39951433	130.81497083	0.0	0.0	0.0	0.0	0.0
66	04/05/2012 15:57:43	142	Ben Brayford	-12.38672067	130.81844167	-12.38768583	130.81930733	0.0	0.0	0.0	0.0	0.0
67	04/05/2012 16:19:56	139	Ben Brayford	-12.39299867	130.83046133	-12.39270817	130.82920700	0.0	0.4	0.0	0.0	0.0
68	04/05/2012 16:29:12	22	Ben Brayford	-12.39268917	130.82555683	-12.39265217	130.82535617	0.0	0.0	0.0	0.0	0.0
69	04/05/2012 16:38:59	42	Ben Brayford	-12.39754133	130.83069317	-12.39746783	130.83029950	0.0	0.0	0.0	0.0	0.0
70	04/05/2012 16:48:00	37	Ben Brayford	-12.39741317	130.82564167	-12.39759883	130.82536483	0.0	0.0	0.0	0.0	0.0
71	04/05/2012 16:59:02	32	Ben Brayford	-12.39296733	130.81918633	-12.39270317	130.81907217	0.0	0.0	0.0	0.0	0.0
72	04/05/2012 17:27:32	378	Ben Brayford	-12.40766517	130.81295717	-12.40460867	130.81126383	2.9	0.0	3.8	0.0	6.3
73	14/05/2012 15:52:35	150	James Brook	-12.41434667	130.81389933	-12.41347850	130.81284733	0.0	0.0	2.1	0.0	0.5

Appendix 2: Intertidal Survey Transect and Waypoint Summary.

Transect ID	Timestamp	Distance (m)	Analyst Name	Start		End	
				Latitude	Longitude	Latitude	Longitude
74	05/05/2012 10:08:09	264	Nick Veitch	-12.40523350	130.82481383	-12.40430800	130.82709417
75	05/05/2012 11:10:33	689	Nick Veitch	-12.40430850	130.82709000	-12.40411133	130.82083717
76	05/05/2012 12:48:04	280	Nick Veitch	-12.40682133	130.81616333	-12.40631467	130.81364350
77	06/05/2012 11:12:20	155	Ben Brayford	-12.40863050	130.81654717	-12.40915817	130.81532133

Intertidal survey Waypoint Summary.

Waypoint Number	Date	Latitude	Longitude	Still Image Number	Littoral zone	Bearing	Image Type	Observations
1	050512	-12.40453867	130.82242467	2112	Upper-mid littoral	e	Profile	profile
2	050512	-12.40454983	130.82243600	2113	Mid littoral	e	Profile	profile
3	050512	-12.40454917	130.82244183	2114	Supra littoral	w	Profile	profile
4	050512	-12.40454467	130.82250267	2115	Upper-mid littoral			mangrove
5	050512	-12.40467650	130.82263100	2116	Upper littoral	w	Habitat	trees
6	050512	-12.40439783	130.82296917	2117	Mid littoral		Habitat	crab
7	050512	-12.40426683	130.82304583	2118	Mid littoral	w	Habitat	mangrove
8	050512	-12.40422450	130.82304067	2119	Mid littoral	e	Habitat	Oysters
9	050512	-12.40419683	130.82308750	2120	Mid littoral	w	Habitat	Chiton
10	050512	-12.40419150	130.82310833	2121	Mid littoral	s	Profile	profile
11	050512	-12.40419217	130.82310800	2122	Mid littoral	e	Habitat	Oysters
12	050512	-12.40401100	130.82302400	2123	Mid littoral	w	Habitat	Oysters
13	050512	-12.40401050	130.82302483	2124	Mid littoral	e	Habitat	crab

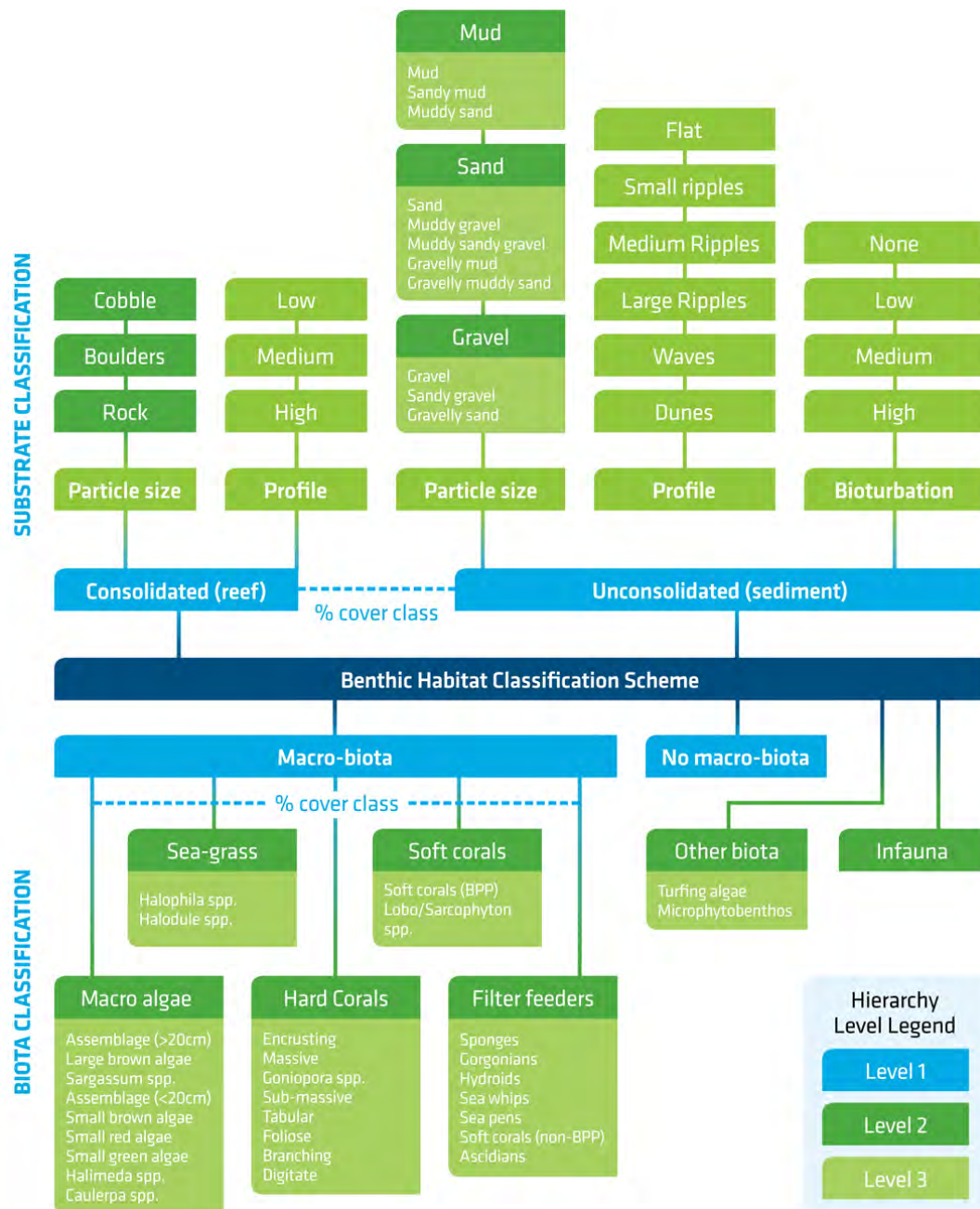
Waypoint Number	Date	Latitude	Longitude	Still Image Number	Littoral zone	Bearing	Image Type	Observations
14	050512	-12.40401317	130.82302333	2125	Mid littoral	sw	Habitat	turf algae
15	050512	-12.40397800	130.82305833	2126	Mid littoral	se	Habitat	Turf algae
16	050512	-12.40420700	130.82327750	2127	Lower littoral		Habitat	Gastropods
17	050512	-12.40421867	130.82327967	2128	Lower littoral	se	Profile	profile
18	050512	-12.40421867	130.82327983	2129	Lower littoral	se	Profile	profile
19	050512	-12.40422667	130.82328367	2129	Lower littoral	w	Profile	profile
20	050512	-12.40525850	130.82486067	2130	Mid littoral	e	Habitat	Gastropods
21	050512	-12.40426850	130.82331517	2130	Lower littoral	w	Profile	profile
22	050512	-12.40446150	130.82345900	2131	Mid littoral	ne	Habitat	Sand ripples
23	050512	-12.40467283	130.82344717	2133	Mid littoral	se	Profile	profile
24	050512	-12.40465767	130.82349400	2134	Mid littoral		Habitat	worm holes
25	050512	-12.40522700	130.82479117	2135	Mid littoral	w	Habitat	oysters
26	050512	-12.40524083	130.82481817	2136	Mid littoral	e	Profile	profile
27	050512	-12.40525700	130.82483833	2137	Mid littoral	e	Habitat	turf algae
28	050512	-12.40533933	130.82507917	2139	Mid littoral		Habitat	
29	050512	-12.40536983	130.82520467	2140	Mid littoral		Habitat	crab
30	050512	-12.40548733	130.82526283	2142	Mid littoral	s	Habitat	Oysters
31	050512	-12.40561050	130.82532900	2143	Mid littoral	sw	Habitat	Mangrove
32	050512	-12.40568550	130.82532400	2144	Mid littoral	ne	Habitat	mangroves
33	050512	-12.40573950	130.82528917	2145	Upper-mid littoral	s	Habitat	Mangrove
34	050512	-12.40549283	130.82553450	2146	Mid littoral	w	Profile	profile
35	050512	-12.40547017	130.82555050	2147	Mid littoral		Habitat	chiton, oyster and turf algae
36	050512	-12.40528250	130.82564250	2148	Mid littoral	e	Habitat	Oysters
37	050512	-12.40515417	130.82576933	2150	Mid littoral	n	Habitat	Macro algae
38	050512	-12.40503633	130.82584333	2151	Mid littoral		Habitat	Oysters
39	050512	-12.40501833	130.82608217	2152	Mid littoral	e	Habitat	Oysters
40	050512	-12.40490867	130.82631783	2153	Mid littoral		Habitat	barnacle, pliable barnacles

Waypoint Number	Date	Latitude	Longitude	Still Image Number	Littoral zone	Bearing	Image Type	Observations
41	050512	-12.40482150	130.82639800	2154	Mid littoral	n	Habitat	mangroves profile
42	050512	-12.40475367	130.82658200	2155	Mid littoral		Habitat	crab
43	050512	-12.40474683	130.82658633	2156	Mid littoral	n	Habitat	mangrove
44	050512	-12.40468933	130.82661617	2157	Mid littoral	n	Habitat	Mangrove
45	050512	-12.40466617	130.82690483	2158	Mid littoral	n	Profile	profile
46	050512	-12.40466800	130.82690417	2159	Mid littoral	ne	Habitat	Gastropods
47	050512	-12.40451317	130.82710483	2160	2161	ml	Habitat	crab
48	050512	-12.40431133	130.82708650	2162	Mid littoral	w	Profile	profile
49	050512	-12.40411100	130.82712650	2163	Mid littoral		Habitat	Macro algae
50	050512	-12.40372717	130.82692017	2164	Mid littoral	e	Profile	profile
51	050512	-12.40373633	130.82692100	2165	Mid littoral	w	Profile	profile
52	050512	-12.40357367	130.82648450	2168	Mid littoral	e	Habitat	Oysters
53	050512	-12.40351533	130.82624000	2169	Lower littoral	s	Profile	profile
54	050512	-12.40316183	130.82623517	2170	Lower littoral	n	Profile	profile
55	050512	-12.40314833	130.82623133	2171	Lower littoral	n	Habitat	cyanobacteria
56	050512	-12.40288350	130.82626683	2172	Lower littoral	e	Profile	profile
57	050512	-12.40254150	130.82614133	2173	Lower littoral		Habitat	cyanobacteria
58	050512	-12.40269100	130.82374700	2174	Lower littoral	w	Profile	Outfall
59	050512	-12.40269467	130.82373433	2175	Lower littoral	e	Profile	profile
60	050512	-12.40285850	130.82311383	2176	Lower littoral	w	Habitat	Sand
61	050512	-12.40294717	130.82288467	2177	Lower littoral	n	Profile	Outfall
62	050512	-12.40315117	130.82235233	2179	Lower littoral	nw	Profile	profile
63	050512	-12.40307917	130.82216650	2180	Mid littoral		Habitat	chiton
64	050512	-12.40303633	130.82208417	2181	Mid littoral	e	Habitat	Sponge
65	050512	-12.40292483	130.82197933	2182	Mid littoral	nw	Profile	Outfall
66	050512	-12.40292150	130.82197300	2183	Mid littoral		Habitat	Macro algae
67	050512	-12.40262517	130.82182550	2184	Mid littoral		Habitat	Macro algae

Waypoint Number	Date	Latitude	Longitude	Still Image Number	Littoral zone	Bearing	Image Type	Observations
68	050512	-12.40262533	130.82182500	2185	Lower littoral		Habitat	
69	050512	-12.40254483	130.82178117	2186	Lower littoral	n	Habitat	Macro algae
70	050512	-12.40286850	130.82165217	2187	Lower littoral	sw	Profile	profile
71	050512	-12.40297117	130.82131333	2188	Lower littoral		Habitat	Gastropods
72	050512	-12.40311917	130.82097133	2189	Mid littoral	sw	Habitat	wader bird
73	050512	-12.40336917	130.82085917	2190	Mid littoral	s	Profile	profile
74	050512	-12.40362483	130.82092283	2191	Mid littoral	s	Profile	Rock pool
75	050512	-12.40362933	130.82091600	2192	Mid littoral		Habitat	Coral
76	050512	-12.40376450	130.82088033	2193	Mid littoral	sw	Profile	profile
77	050512	-12.40393817	130.82092183	2194	Mid littoral		Habitat	
78	050512	-12.40428417	130.82081733	2196	Supra littoral	e	Habitat	Trees
79	050512	-12.40439767	130.82076533	2197	Supra littoral	w	Profile	profile
80	050512	-12.40682533	130.81617083	2198	Supra littoral	w	Profile	profile
81	050512	-12.40691717	130.81576833	2199	Mid littoral	ne	Habitat	Mangrove
82	050512	-12.40687017	130.81528067	2200	Mid littoral	e	Profile	Rock pool
83	050512	-12.40664667	130.81452050	2201	Mid littoral	n	Habitat	
84	050512	-12.40657850	130.81422050	2202	Mid littoral	n	Profile	Rock pool
85	050512	-12.40662217	130.81415017	2203	Mid littoral	sw	Profile	profile
86	050512	-12.40630200	130.81364533	2204	Mid littoral	n	Habitat	Holothurian
87	060512	-12.41172900	130.81825217	2221	Supra littoral	no	Habitat	
88	060512	-12.40863200	130.81654750	2222	Supra littoral	n	Profile	profile
89	060512	-12.40864250	130.81653517	2223	Supra littoral	w	Profile	profile
90	060512	-12.40858400	130.81590167	2224	Mid littoral	nw	Habitat	Mangrove
91	060512	-12.40848650	130.81567400	2225	Mid littoral	w	Profile	Rock pool
92	060512	-12.40850633	130.81539017	2226	Mid littoral	w	Habitat	
93	060512	-12.40851033	130.81538683	2227	Mid littoral	w	Habitat	Oysters
94	060512	-12.40891650	130.81541300	2228	Upper littoral	se	Profile	Rock pool

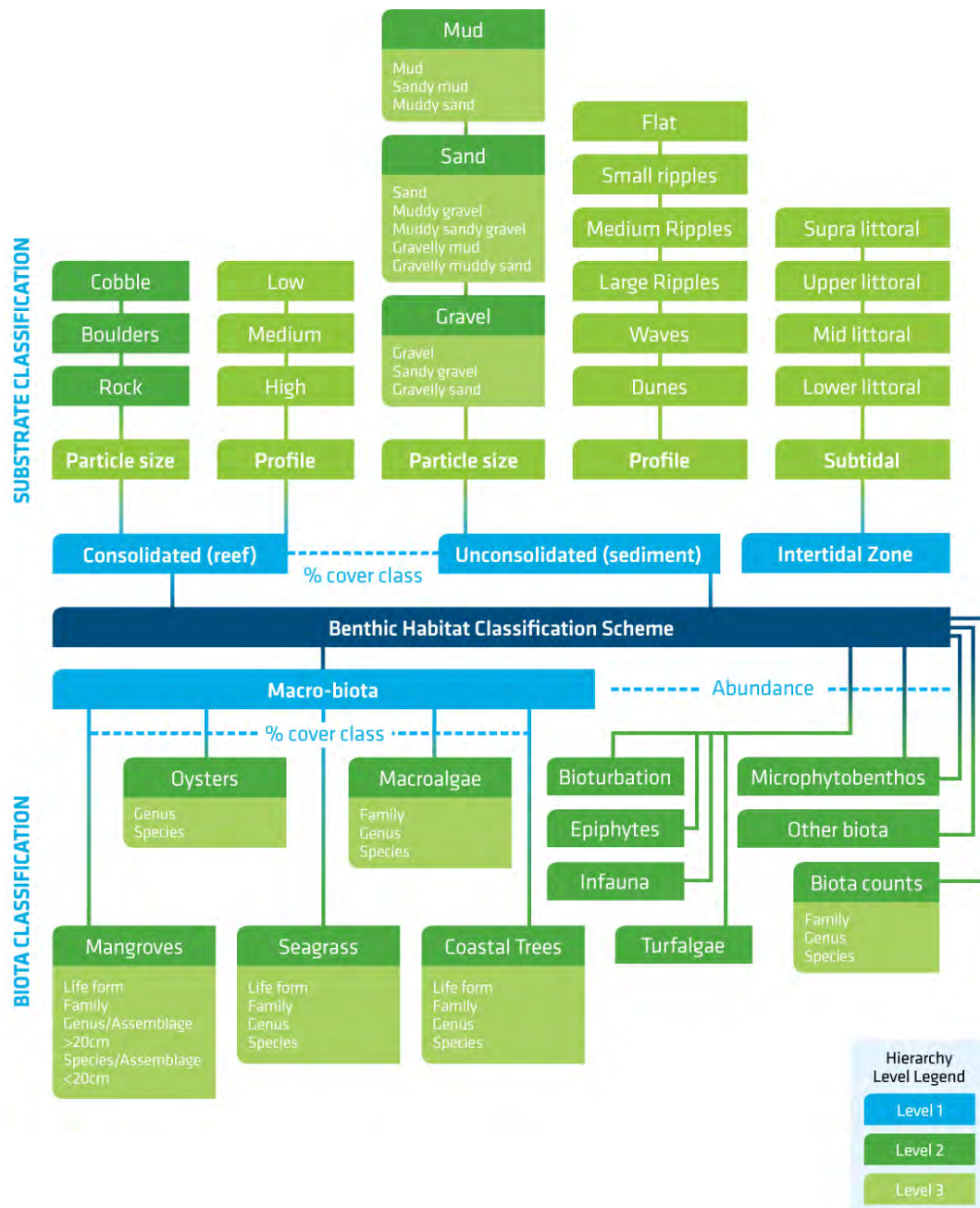
Waypoint Number	Date	Latitude	Longitude	Still Image Number	Littoral zone	Bearing	Image Type	Observations
95	060512	-12.40913567	130.81537083	2233	Mid littoral	e	Habitat	Rock pool
96	060512	-12.40925183	130.81526533	2234	Mid littoral	n	Habitat	barnacle
97	060512	-12.40918133	130.81532150	2237	Mid littoral	n	Habitat	
98	060512	-12.40916317	130.81532033	2239	Mid littoral		Habitat	chiton
99	060512	-12.40914517	130.81532450	2240	Mid littoral	s	Habitat	limpet
100	060512	-12.40915733	130.81531450	2241	Mid littoral		Habitat	barnacle
101	060512	-12.40915233	130.81531917	2244	Mid littoral		Habitat	oyster
102	050512	-12.40372517	130.82691900	2166 and 2167	Mid littoral	w	Profile	profile
103	060512	-12.40896883	130.81534967	2229 2233	Upper littoral	n w s	Profile	profile
104	060512	-12.40915417	130.81531767	2243 and 2245	Mid littoral		Habitat	chiton
111	160612	12.37861110	130.84366667	823	Supra littoral	s	Profile	
112	160612	12.37861110	130.84366667	824	Supra littoral	e s e	Profile	
113	160612	-12.44083333	130.83650000	826	Upper littoral	w	Habitat	Mangrove
114	160612	12.37944444	130.84194444	827	Supra littoral	nw	Habitat	Mangrove
115	160612	12.37944444	130.84194444	828	Upper littoral	ws w	Profile	
116	160612	12.37944444	130.84194444	829	Upper littoral	ssw	Profile	
117	160612	12.37944444	130.84194444	830	Upper littoral	s	Habitat	Mangrove
118	160612	-12.37950000	130.84200000	831	Supra littoral	w	Profile	

Appendix 3: Geo Oceans' Subtidal Habitat Classification Scheme.



Note: in this report 'Macro-biota' is referred to as 'Epibenthos'

Appendix 4: Geo Oceans' Intertidal Habitat Classification Scheme



Appendix 5: Geo Oceans' Substrate Polygon Classification Data.

Polygon ID#	Count of Bioturbation:		None		Low		Medium		High		Bioturbation Classification
	Substrate Classification	Reef Cover	Count	Total	Count	Total	Count	Total	Count	Total	
0	Sand and Reef	-	-	-	-	-	-	-	-	-	Unverified
1	Reef	-	-	-	-	-	-	-	-	-	Unverified
2	Reef	-	-	-	-	-	-	-	-	-	Unverified
3	Reef	81%	349	87%	0	0%	0	0%	0	0%	None
4	Reef	70%	60	100%	0	0%	0	0%	0	0%	None
5	Reef	70%	30	100%	0	0%	0	0%	0	0%	None
6	Sand and Reef	24%	4	100%	0	0%	0	0%	0	0%	None
7	Reef	74%	-	0%	0	0%	0	0%	0	0%	None
8	Reef	95%	-	0%	21	100%	0	0%	0	0%	Low
9	Sand and Reef	-	-	-	-	-	-	-	-	-	Unverified
10	Sand	-	-	-	-	-	-	-	-	-	Unverified
11	Reef	100%	-	0%	0	0%	0	0%	0	0%	None
12	Sand	-	-	-	-	-	-	-	-	-	Unverified
13	Reef	88%	10	100%	0	0%	0	0%	0	0%	None
14	Reef	77%	33	100%	0	0%	0	0%	0	0%	None
15	Reef	56%	397	96%	2	0%	0	0%	0	0%	None
17	Reef	85%	340	92%	0	0%	0	0%	0	0%	None
19	Sand and Reef	-	-	-	-	-	-	-	-	-	Unverified
20	Reef	77%	102	100%	0	0%	0	0%	0	0%	None
21	Reef	-	-	-	-	-	-	-	-	-	Unverified
22	Reef	64%	99	100%	0	0%	0	0%	0	0%	None
23	Reef	77%	326	100%	0	0%	0	0%	0	0%	None
24	Sand and Reef	-	-	-	-	-	-	-	-	-	Unverified
26	Sand and Reef	-	-	-	-	-	-	-	-	-	Unverified
27	Sand and Reef	42%	116	35%	219	65%	0	0%	0	0%	Low
28	Sand and Reef	41%	74	45%	89	55%	0	0%	0	0%	Low
29	Sand and Reef	45%	1117	60%	754	40%	0	0%	0	0%	Low
30	Sand and Reef	44%	83	100%	0	0%	0	0%	0	0%	None
31	Sand Wave	-	-	-	-	-	-	-	-	-	Unverified
32	Sand and Reef	36%	439	100%	0	0%	0	0%	0	0%	None

Polygon ID#	Count of Bioturbation:		None		Low		Medium		High		Bioturbation Classification
	Substrate Classification	Reef Cover	Count	Total	Count	Total	Count	Total	Count	Total	
33	Sand	0%	32	100%	0	0%	0	0%	0	0%	None
34	Reef	-	-	-	-	-	-	-	-	-	None
35	Sand	0%	1411	69%	478	23%	151	7%	0	0%	None
36	Sand	4%	1372	77%	362	20%	0	0%	0	0%	None
37	Sand	0%	421	22%	718	0%	741	0%	53	3%	Medium
38	Sand	0%	760	34%	781	35%	219	10%	459	21%	Low
39	Sand and Reef	46%	201	100%	0	0%	0	0%	0	0%	None
40	Reef	-	-	-	-	-	-	-	-	-	Unverified
41	Sand and Reef	-	-	-	-	-	-	-	-	-	Unverified
42	Sand	-	-	-	-	-	-	-	-	-	Unverified
43	Sand and Reef	-	-	-	-	-	-	-	-	-	Unverified
44	Sand	-	-	-	-	-	-	-	-	-	Unverified
45	Sand	0%	18	100%	0	0%	0	0%	0	0%	None
46	Reef	-	-	-	-	-	-	-	-	-	Unverified
47	Sand	0%	2720	53%	1701	33%	261	5%	0	0%	None
48	Reef	-	-	-	-	-	-	-	-	-	Unverified
49	Sand	0%	176	92%	16	8%	0	0%	0	0%	None
50	Sand Wave	0%	396	86%	67	14%	0	0%	0	0%	None
51	Reef	68%	188	100%	0	0%	0	0%	0	0%	None
52	Reef	55%	-	0%	120	100%	0	0%	0	0%	Low
53	Sand	0%	-	0%	0	0%	0	0%	273	100%	High
54	Sand and Reef	-	-	-	-	-	-	-	-	-	Unverified
55	Reef	-	-	-	-	-	-	-	-	-	Unverified

Note: The Bioturbation 'Total' field is the proportion of the bioturbation class counts of the total counts for the polygon.

Appendix 6: Geo Oceans' Habitat Polygon Classification Data.

Polygon ID	Community Class	Macroalgae		Seagrass		Soft Coral		Hard Coral		Filter Feeders		Mangroves		Oysters		Turf Algae		Total Biota Cover	Tidal Zone	Verified/Inferred Polygon ID No# (note 1)
		Cover	Total	Cover	Total	Cover	Total	Cover	Total	Cover	Total	Cover	Total	Cover	Total	Cover	Total			
0	Mangrove	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Intertidal	6
1	Oyster and Turf	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Intertidal	23
2	Oyster and Turf	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Intertidal	23
3	No epibenthos	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	3%	11%	0%	0%	3%	Intertidal	Verified
4	Mangrove and Oyster	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	15%	41%	19%	51%	3%	8%	37%	Intertidal	Verified
5	Oyster and Turf	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%	3%	9%	12%	61%	85%	72%	Intertidal	Verified
6	Mangrove	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	11%	100%	0%	0%	0%	0%	11%	Intertidal	Verified
7	Mangrove	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	23%	100%	0%	0%	0%	0%	23%	Intertidal	Verified
8	No epibenthos	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%	31%	1%	23%	3%	46%	6%	Intertidal	Verified
9	Mangrove	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Intertidal	6
10	No epibenthos	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Intertidal	33
11	No epibenthos	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	Intertidal	Verified
12	No epibenthos	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Intertidal	33
13	Oyster and Turf	3%	3%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	6%	9%	66%	88%	75%	Intertidal	Verified
14	Oyster and Turf	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	33%	47%	38%	53%	71%	Intertidal	Verified
15	No epibenthos	1%	19%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	3%	5%	78%	7%	Intertidal	Verified
17	Turf	1%	3%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%	23%	96%	24%	Intertidal	Verified
19	No epibenthos	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Intertidal	33
20	Mangrove and Oyster	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	27%	74%	8%	20%	2%	6%	37%	Intertidal	Verified
21	Oyster and Turf	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Intertidal	13
22	Mangrove and Oyster	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	52%	63%	7%	9%	23%	28%	82%	Intertidal	Verified
23	Oyster and Turf	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	3%	16%	41%	23%	57%	40%	Intertidal	Verified

Polygon ID	Community Class	Macroalgae		Seagrass		Soft Coral		Hard Coral		Filter Feeders		Mangroves		Oysters		Turf Algae		Total Biota Cover	Tidal Zone	Verified/Inferred Polygon ID No# (note 1)
		Cover	Total	Cover	Total	Cover	Total	Cover	Total	Cover	Total	Cover	Total	Cover	Total	Cover	Total			
24	No epibenthos	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Intertidal	33
26	Macroalgae with hard coral	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Intertidal	33
27	Macroalgae with hard coral	10%	76%	0%	0%	0%	0%	3%	24%	0%	0%	0%	0%	0%	0%	0%	0%	13%	Intertidal	Verified
28	Macroalgae with hard coral	19%	85%	0%	0%	0%	0%	3%	13%	0%	2%	0%	0%	0%	0%	0%	0%	22%	Intertidal	Verified
29	Filter feeders	1%	2%	0%	0%	0%	0%	1%	2%	21%	95%	0%	0%	0%	0%	0%	0%	22%	Subtidal	Verified
30	Filter feeders	0%	0%	0%	0%	0%	0%	0%	0%	25%	100%	0%	0%	0%	0%	0%	0%	25%	Subtidal	Verified
31	No epibenthos	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Subtidal	50
32	Filter feeders	0%	0%	0%	0%	0%	0%	0%	0%	21%	100%	0%	0%	0%	0%	0%	0%	21%	Subtidal	Verified
33	No epibenthos	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	Intertidal	Verified
34	No epibenthos	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Intertidal	33
35	No epibenthos	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	Subtidal	Verified
36	No epibenthos	0%	0%	0%	0%	0%	0%	0%	0%	1%	100%	0%	0%	0%	0%	0%	0%	1%	Subtidal	Verified
37	No epibenthos	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	Subtidal	Verified
38	No epibenthos	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	Subtidal	Verified
39	Macroalgae with hard coral	13%	86%	0%	0%	0%	0%	2%	14%	0%	0%	0%	0%	0%	0%	0%	0%	15%	Intertidal	Verified
40	Oyster and Turf	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Intertidal	5
41	No epibenthos	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Intertidal	33
42	No epibenthos	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Intertidal	33
43	Macroalgae with hard coral	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Subtidal	33
44	No epibenthos	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Intertidal	44
45	No epibenthos	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	Subtidal	Verified
46	Macroalgae with hard coral	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Intertidal	39
47	No epibenthos	0%	6%	0%	84%	0%	0%	0%	0%	0%	10%	0%	0%	0%	0%	0%	0%	0%	Intertidal	Verified
48	Macroalgae with hard coral	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Intertidal	39
49	No epibenthos	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	Subtidal	Verified
50	No epibenthos	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	Subtidal	Verified
51	Sparse Mixed Epibiota	2%	22%	0%	0%	0%	0%	2%	83%	1%	17%	0%	0%	0%	0%	0%	0%	5%	Subtidal	Verified
52	Hard coral and filter feeders	0%	2%	0%	0%	0%	0%	10%	60%	7%	38%	0%	0%	0%	0%	0%	0%	17%	Intertidal	Verified

Polygon ID	Community Class	Macroalgae		Seagrass		Soft Coral		Hard Coral		Filter Feeders		Mangroves		Oysters		Turf Algae		Total Biota Cover	Tidal Zone	Verified/Inferred Polygon ID No# (note 1)
		Cover	Total	Cover	Total	Cover	Total	Cover	Total	Cover	Total	Cover	Total	Cover	Total	Cover	Total			
53	No epibenthos	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	Intertidal	Verified
54	Oyster and Turf	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Intertidal	5
55	Oyster and Turf	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Intertidal	5

Note 1: Polygons listed as "Verified" have been ground truthed. Polygons listed with an "Inferred Polygon ID No#" have been inferred based on the listed Polygon ID number.

Note 2: The 'Total' field is the biota proportion of the 'Total Biota Cover'.

Appendix 7: Intertidal Survey Still Image Thumbnails



Profile image in Upper-mid littoral zone facing east (image 2112, WP 1)



Profile image in Supra-Littoral zone facing west (image 2114, WP 3)



Habitat image in Mid-littoral zone facing east showing oysters (Image 2122, WP 11)



Habitat image in Mid-littoral zone facing west showing oyster beds (image 2123, WP 12)



Habitat image in Mid-littoral zone facing south west showing turf algae (image 2125, WP 14)



Habitat image in Mid-littoral zone facing east showing turf algae (image 2137, WP 27)



Habitat image in Mid-littoral zone facing south east showing turf algae (image 2126, WP 15)



Habitat image in Mid-littoral zone facing north east showing mangrove trees (image 2144, WP 32)



Habitat image in Mid-littoral zone facing north showing macro-algae (image 2150, WP 37)



Habitat image in Mid-littoral zone showing oysters (image 2151, WP 38)



Habitat image in Mid-littoral zone facing east showing oyster bed with mangrove trees in background (image 2152, WP 39)



Habitat image in Mid-littoral zone showing barnacles (image 2153, WP 40)



Habitat image in Mid-littoral zone facing north showing mangroves trees (WP 43)



Profile image in Mid-littoral zone facing north (image 2158, WP 45)



Habitat image in Mid-littoral zone facing north east showing gastropods (WP 46)



Habitat image in Mid-littoral zone facing east showing oyster bed (image 2168, WP 52)



Habitat image 2163 in Mid-littoral zone showing macro-algae (image 2163, WP 49)



Habitat image in Lower-littoral zone showing cyanobacteria (image 2173, WP 57)



Profile image in Lower-littoral zone facing north west (image 2179, WP 62)



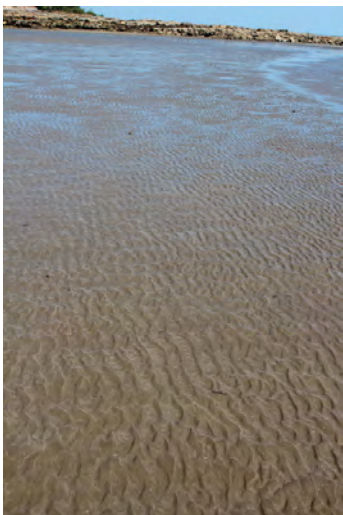
Habitat image in Mid-littoral zone showing chiton (image 2180, WP 63)



Profile image in Mid-littoral zone facing north west (image 2182, WP 65)



Profile image in Lower-littoral zone facing south west (image 2187, WP 70)



Habitat image in Lower-littoral zone facing west showing sand (image 2176, WP 60)



Profile image in Mid-littoral zone facing south showing a rock pool (image 2191, WP 74)



Profile image in Supra-littoral zone facing west (image 2197, WP 79)



Habitat image in Mid-littoral zone facing north east showing mangroves (image 2199, WP 81)



Habitat image in Lower-littoral zone showing gastropods (image 2188, WP 71)



Profile image in Mid-littoral zone facing north showing rock pool (image 2202, WP 84)



Habitat image in Supra-littoral zone facing east showing trees (image 2196, WP 78)



Habitat image in Mid-littoral zone facing north showing holothurian (image 2204, WP 86)



Profile image in Mid-littoral zone facing east showing rock pool (image 2200, WP 82)



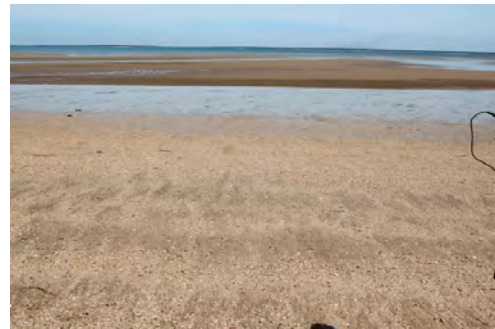
Profile image in Supra-littoral zone facing north (image 2221, WP 87)



Habitat image in Mid-littoral zone facing north west showing mangroves (image 2224, WP 90)



Habitat image in Mid-littoral zone showing chiton (image 2239, WP 98)



Profile image in Lower-littoral zone facing south west (image 2278, WP 111)



Habitat image in Lower-littoral zone facing north- west (image 2285, WP 112)



Profile image in Supra-littoral zone facing east south south (image 824, WP 114)



Habitat image in Upper-littoral zone facing west showing mangroves (image 826, WP 115)



Profile image in Upper -littoral zone facing south south west (image 829, WP 118)



Habitat image in Upper-littoral zone facing north west showing mangroves (image 827, WP 116)



Profile image in Supra-littoral zone facing west (image 831, WP 120)



Profile image in Upper -littoral zone facing west south west (image 828, WP 117)

Appendix 8: Metadata.

Field data collection date: 3 May to 6 May 2012

Field data collection global positioning system datum: WGS 84

Towed Camera Transect Summary Attributes

Field name	Description	Type
ProjectNam	Project name	Text
Subregion	Location	Text
Transect	Transect number	Number
Start (WGS 84)	Transect Start Point Latitude	Number
	Transect Start Point Longitude	Number
End Location (WGS 84)	Transect End Point Latitude	Number
	Transect End Point Longitude	Number
Start (MGA zone 52)	Transect Start Point Easting	Number
	Transect Start Point Northing	Number
End (MGA zone 52)	Transect End Point Easting	Number
	Transect End Point Northing	Number
Distance	Transect distance	Number
AnalystNam	Name of video analyst	Text
Timestamp	Date of data collection	Date
MA	Average Macroalgae cover on transect	Double
SG	Average Seagrass cover on transect	Double
HC	Average Hard coral cover on transect	Double
SC	Average Soft coral cover on transect	Double
FF	Average Filter feeder cover on transect	Double

Habitat Point Data Attribute

Field	Description (decision rules)	Data type
ProjectNam	Project name	Text
Subregion	Location	Text
TransectID	Transect number	Number
FrameID	Data frame ID	Number
UTime	UTC Time of capture	Number
LatDegrees	Latitude (DD) WGS 84	Number
LonDegrees	Longitude (DD) WGS 84	Number
Easting	Easting (meters) MGA zone 52	Number
Northing	Northing (meters) MGA zone 52	Number
TransectDi	Distance along transect	Number
ReefCover	Reef percent cover (0; 1-20%; 21-60%; 61-80%; 81-99%; 100%)	Number
ReefCoverV	Reef percent cover value from qualitative estimate ranges	Number
ReefStruct	Reef particle size (Cobble = 64 – 256mm; Boulders = >256mm; Rock = unbroken)	Text

Field	Description (decision rules)	Data type
ReefProfil	Reef profile (Platform = <1m; 1-4m; >4m over 5m)	Text
SedStruct	Sediment particle size	Text
SedProfile	Sediment profile (No profile = <1cm; 1-10cm; 10-50cm; >50cm)	Text
SubstrateD	Substrate description (Reef = ReefV > 60; Sand and Reef = ReefV 1 to 60; Sand = ReefV <1)	Text
Bioturbati	Qualitative estimate of bioturbation (None, low, medium or high)	Text
ClassMAVal	Macroalgae percent cover (None; <1%; 1-5%; 5-10%; 10-20%; 20-40%; 40-60%; 60-80%; >80%)	Number
ClassMAPre	Macroalgae present (1) or absent (0) (Present at > 10% cover)	Number
ClassSASpp	Small Macroalgae (<20cm) taxonomies and morphologies	Text
ClassCASpp	Canopy Macroalgae (>20cm) taxonomies and morphologies	Text
ClassSGVal	Seagrass percent cover (None; <1%; 1-5%; 5-10%; 10-20%; 20-40%; 40-60%; 60-80%; >80%)	Number
ClassSGPre	Seagrass present (1) or absent (0) (Present at > 1% cover)	Number
ClassSGSpp	Seagrass taxonomy and morphologies	Text
ClassCoralVal	Coral percent cover (None; <1%; 1-5%; 5-10%; 10-20%; 20-40%; 40-60%; 60-80%; >80%)	Number
ClassCorPre	Coral present (1) or absent (0). Present at > 5% cover	Number
ClassCorSpp	Coral taxonomies and morphologies	Text
ClassSCVal	Soft coral percent cover (None; <1%; 1-5%; 5-10%; 10-20%; 20-40%; 40-60%; 60-80%; >80%)	Number
ClassSCPre	Softcoral present (1) or absent (0) (Present at > 5% cover)	Number
ClassSCSpp	Soft coral taxonomies and morphologies	Text
ClassFFVa	Filter feeder percent cover (None; <1%; 1-5%; 5-10%; 10-20%; 20-40%; 40-60%; 60-80%; >80%)	Number
ClassFFPr	Filter feeder present (1) or absent (0) (Present at > 10% cover)	Number
ClassFFSpp	Filter feeder taxonomies and morphologies	Text
Class OystersVa	Oyster percent cover (None; <1%; 1-5%; 5-10%; 10-20%; 20-40%; 40-60%; 60-80%; >80%)	Number
Class MangroveVa	Mangrove percent cover (None; <1%; 1-5%; 5-10%; 10-20%; 20-40%; 40-60%; 60-80%; >80%)	Number
Class Turf Va	Turf algae percent cover (None; <1%; 1-5%; 5-10%; 10-20%; 20-40%; 40-60%; 60-80%; >80%)	Number
HabitatDes	Defined by combinations of biota classes present	Text
Epiphytes	Epiphyte load (None, low, medium, high)	Text
Turf algae	Turf algae cover (None, low, medium, high)	Text
P/A biota	Records of other biota present	Text
Biota counts	Counts up to 4 biota classes (+1; +4; -1)	Number

Habitat Map Polygons (Subtidal and Intertidal) Attributes

Field	Description	Data type
Polygon_ID	Polygon ID number	Number
Shape	Feature class	Text
Littoral_Z	Subtidal or Intertidal	Text
Easting	Easting (MGA zone 52)	Double

Northing	Northing (MGA zone 52)	Double
Community_	Habitat classification (classified by Geo Oceans Habitat Point Data)	Text
Substrate_	Substrate classification (classified by Geo Oceans Habitat Point Data)	Text
Bioturbati	Bioturbation classification	Text
Area	Area of habitat (Ha)	Double
Verified	Verified - Habitat Point Data present; Unverified - Habitat Point Data absent	Text

Intertidal Survey Waypoint Data Attributes

Field	Description	Data type
ProjectID	Project ID	Text
UDate	Date of data collection	Text
LatDegrees	Latitude	Number
LonDegrees	Longitude	Number
Image number	Photograph number	Number
Littoral zone	Intertidal zone (Low – neap low and spring low; Mid – neap high and neap low; Upper – spring high and neap high; Supra – above spring high affected by splash)	Text
Bearing	Direction photographer was facing when the image was captured	Text
Type	Type of image I.e. Habitat, Profile	Text
Observations	Observations and notes taken by field staff (e.g. species, substrate)	Text