





7 Survey Results

7.1 Intertidal habitats

Three principal intertidal BCH types were recorded at Heron Point; Fine sand, Pavement reef and Pavement reef with macroalgae (Table 1, Figure 11). Within the lower-littoral zone occasional hard and soft corals were also present within the Pavement reef with macroalgae habitat.

Table 1 Intertidal habitats identified during survey

BCH TYPE	DESCRIPTION	PHOTOGRAPH
Fine sand	Fine sand within upper littoral zone (Soldier crabs [<i>Mictyris</i> sp.] present in some locations)	
Pavement reef	Unvegetated pavement reef within the upper littoral zone	
Reef with macroalgae	Pavement reef within the mid-littoral zone with mud veneer and sparse macroalgae (<i>Sargassum</i> sp.) Squirting octopus (<i>Abdopus</i> sp.) in centre of photo.	

BCH TYPE	DESCRIPTION	PHOTOGRAPH
	Pavement reef within the lower-littoral zone with macroalgae (<i>Halimeda</i> sp., <i>Padina</i> sp., <i>Sargassum</i> sp.) and occasional hard corals (<i>Turbinaria</i> spp.) and soft corals (<i>Lobophytum</i> spp.)	




Each of these BCH types is well represented along the south-western shore of Exmouth Gulf, beyond the survey area, and all are widespread throughout the tropical/sub-tropical coasts of north-west Australia.


The mangroves along the south-western end of Exmouth Gulf are described in the EPA's Guidance Statement 1 (EPA 2001) as 'Area 1: Bay of Rest' and are classified as being of 'Very High' importance. For Guideline 1 areas, the EPA expects that 'no development should take place that would adversely affect the mangrove habitat, the ecological function of these areas and the maintenance of ecological processes which sustain the mangrove habitats'. It was also noted that 'Proponents should be aware that where developments are proposed in these areas the EPA will adopt a presumption against finding the proposals environmentally acceptable' (EPA 2001).

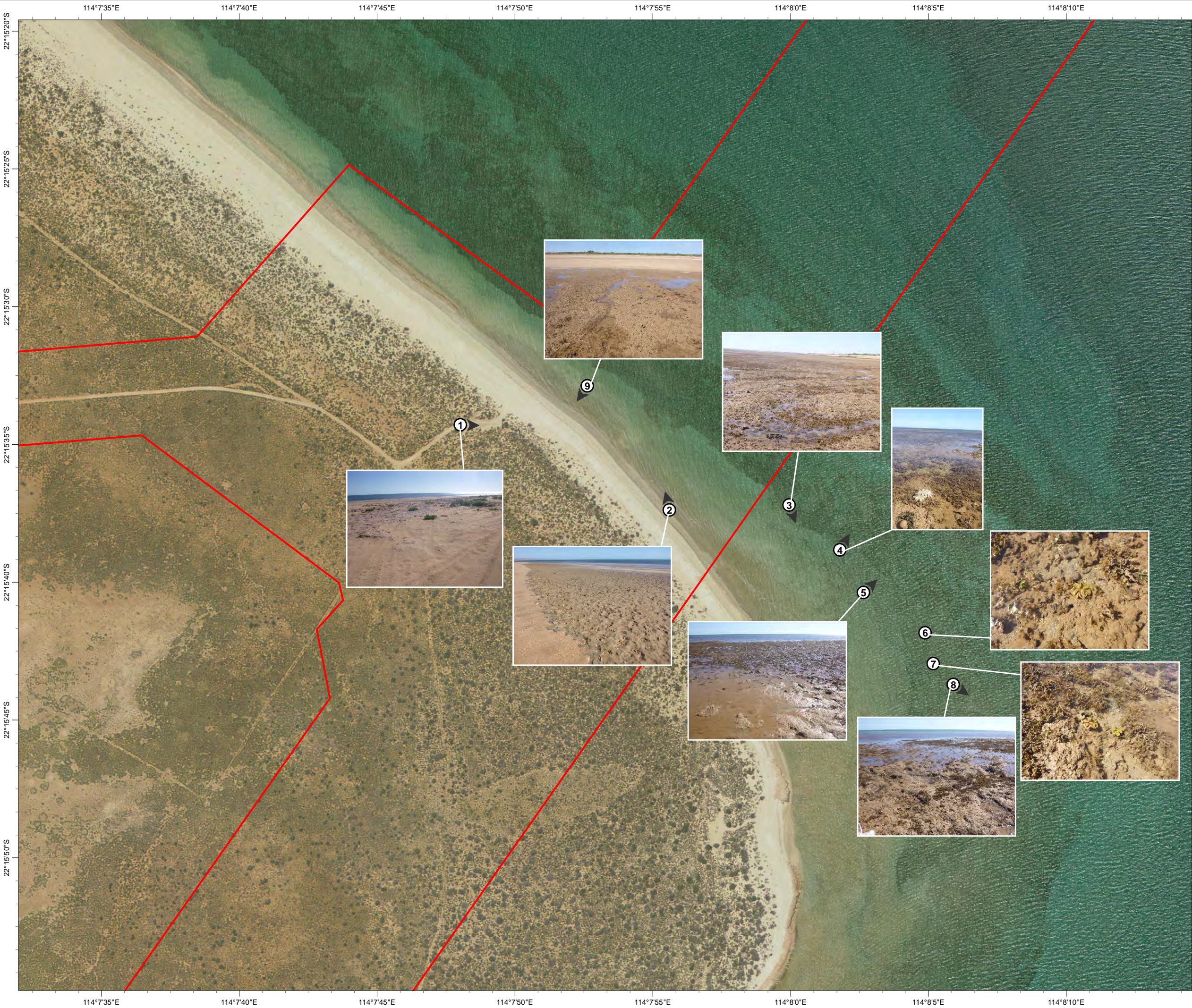
The mangal at Gales Bay (to the south of the Bay of Rest) has "a seaward zone of mature *Rhizophora* (to 4-5 m) succeeded by a central zone of mature *Avicennia* forest and woodland, and, in some areas, mixed *Rhizophora* and *Avicennia*. The landward side grades into thickets of *Avicennia* with occasional *Ceriops*" (CALM 1994).

Within the Bay of Rest several mangrove communities were recorded (Table 2, Figure 12).

Table 2 Mangrove habitats identified during survey at the Bay of Rest

BCH TYPE	DESCRIPTION	PHOTOGRAPH
Grey Mangrove (<i>Avicennia marina</i>)	Isolated mangroves in upper littoral zone	
Stilted Mangrove (<i>Rhizophora stylosa</i>)	Isolated Stilted Mangroves in upper littoral zone	
Club mangrove (<i>Aegialitis annulata</i>)	Isolated Club Mangroves within upper littoral	

BCH TYPE	DESCRIPTION	PHOTOGRAPH
Grey Mangrove (<i>Avicennia marina</i>)	Moderate density Grey Mangrove band within upper and mid-littoral zone	
Stilted Mangrove (<i>Rhizophora stylosa</i>)	Stilted Mangroves at offshore extent of mangrove habitats	



Legend

Project Envelope (August 2017)

Intertidal Photograph Locations

- LOCALITY MAP SOURCED FROM LANDGATE 2006

- DPAW MANAGED LANDS SOURCED DPAW 2016

- HERITAGE SITES SOURCED DAA 2015

- NATIONALLY IMPORTANT WETLANDS SOURCED DEE 2016

- IMAGERY SOURCED FROM LANDSAT7

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Subsea 7
Bundle Site, Learmonth

Environmental Baseline Studies

Figure 11

Photograph Locations

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K:\Projects\9.0 APP\2061 Subsea 7 - Environmental Approvals\Figures\Environmental Baseline Studies\2061 Figure 11 - Photograph Locations.mxd



- Legend**
- Survey Track
 - Photo Point (June 2017)

- LOCALITY MAP SOURCED FROM LANDGATE 2006
- PROJECT ENVELOPE SOURCED 360 ENVIRONMENTAL 2017
- ROADS SOURCED MRWA 2012
- PROPOSED ACCESS ROAD SOURCED SUBSEA7 2017
- SITE LAYOUT SOURCED SUBSEA7 2017
- BUNDLE TOW ROUTE SOURCED SUBSEA7 2017
- IMAGERY SOURCED FROM LANDGATE 2013
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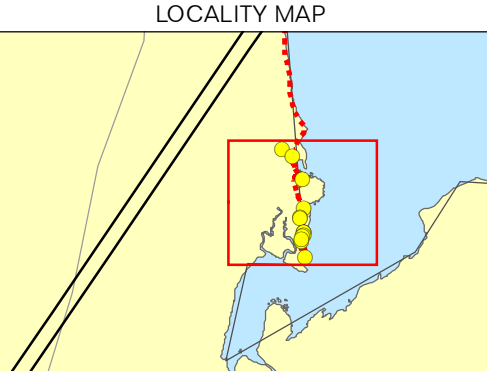
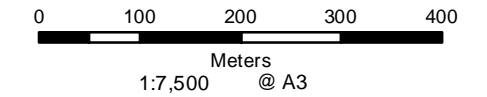
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Subsea 7
Bundle Site, Learmonth

Learmonth Habitat Surveys

Figure 12
Bay of Rest Mangroves Inspection -
Track and Photographs


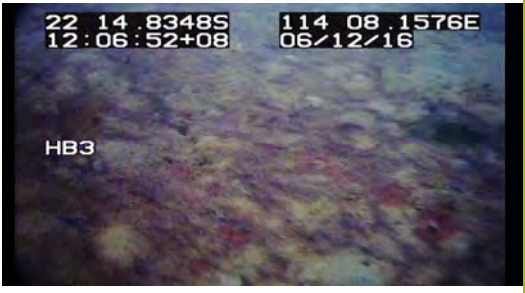
7.2 Subtidal habitats

7.2.1 Heron Point



Five principal subtidal BCH types were recorded; Soft sediment, Soft sediment with turf algae, Soft sediment with filter feeders, Reef with macroalgae and Reef with macroalgae and filter feeders (Table 3, Figure 13, Figure 14). The Soft sediment habitat was found to be unvegetated, beyond the isolated areas supporting up to 50% cover of turf algae/microphytobenthos (MPB)¹ at sites HB3 and HA23 (Figure 13) but showed signs of significant bioturbation, with many holes and mounds visible.

In areas with a presumed underlying hard substrate, particularly at sites HA13 and HA16, a varying abundance of filter feeders was recorded. Inshore areas of reef habitat exhibited a varying cover of macroalgae and filter feeders (e.g. sites HA1, HA6 and HB14) (Figure 13).

Table 3 Subtidal habitats identified during survey

BCH TYPE	DESCRIPTION	PHOTOGRAPH
Soft sediment	Mud and sand dominated habitats with sparse turf algae	
Soft sediment with turf algae	Mud and sand dominated habitats with turf algae/microphytobenthos (MPB)	

¹ MPB consists of unicellular eukaryotic algae and cyanobacteria that grow within the upper several millimeters of illuminated sediments, typically appearing only as a subtle brownish or greenish shading (MacIntyre et al. 1996), although some mat-forming species are more clearly visible.

BCH TYPE	DESCRIPTION	PHOTOGRAPH
Soft sediment with filter feeders	Soft sediment veneer overlying low relief reef. Sparse cover of filter feeders (sponges and soft corals)	
Reef with macroalgae	Low relief reef with macroalgae (brown)	
Reef with macroalgae and filter feeders	Low relief reef with macroalgae (brown) and filter feeders (sponges, soft corals, hard corals) Note the numerous Foraminifera (white dots)	



Legend

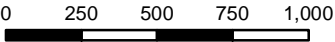
- Survey area
- Subtidal substrate types
 - Reef
 - Reef and soft sediment
 - Soft sediment

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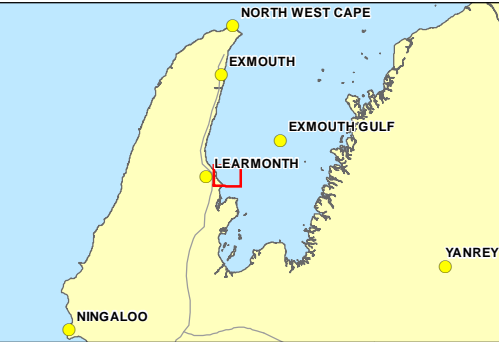
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LOCALITY MAP



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**Subsea 7
NW Bundle Site**

Environmental Baseline Studies

**Figure 13
Substrate Types Recorded**



Legend

Survey area

Macroalgae/turf algae cover %

- 0
- 1 - 10
- 11 - 25
- 25 - 50

Filter feeders count/10m

- 0
- 1 - 10
- 11 - 25
- 26 - 50

Hard coral count/10m

- 0
- 1 - 3
- 4 - 6

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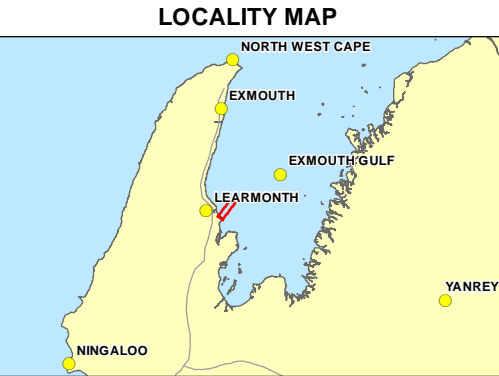
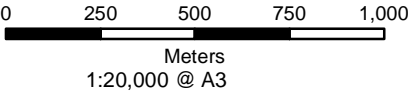
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**Subsea 7
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Environmental Baseline Studies

Figure 14
Subtidal Habitat Types



Legend

Survey area

Subtidal survey transect

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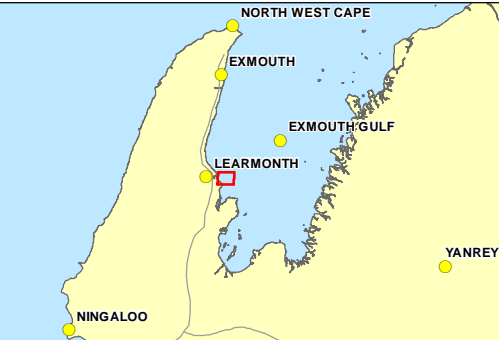
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**Subsea 7
NW Bundle Site**

Environmental Baseline Studies

Figure 15
**Multibeam and Subtidal
Survey Transects (0-1m)**

Based on the habitat recorded along the subtidal video transects and the backscatter data obtained during the multibeam survey (Figure 15), the habitat map as presented in Figure 11 has been developed. The extent of each BCH type is presented in Table 4.

Table 4 Coverage of each BCH type within the Heron Point area


BCH TYPE	AREA (HA)
Intertidal Habitats	
Fine sand	4.7
Pavement reef	3.1
Subtidal Habitats	
Soft sediment	521.9
Soft sediment with turf algae	6.2
Soft sediment with filter feeders	6.7
Reef with macroalgae	20.9
Reef with macroalgae and filter feeders	38.8
Total	602.3


7.2.2 Local Assessment Unit

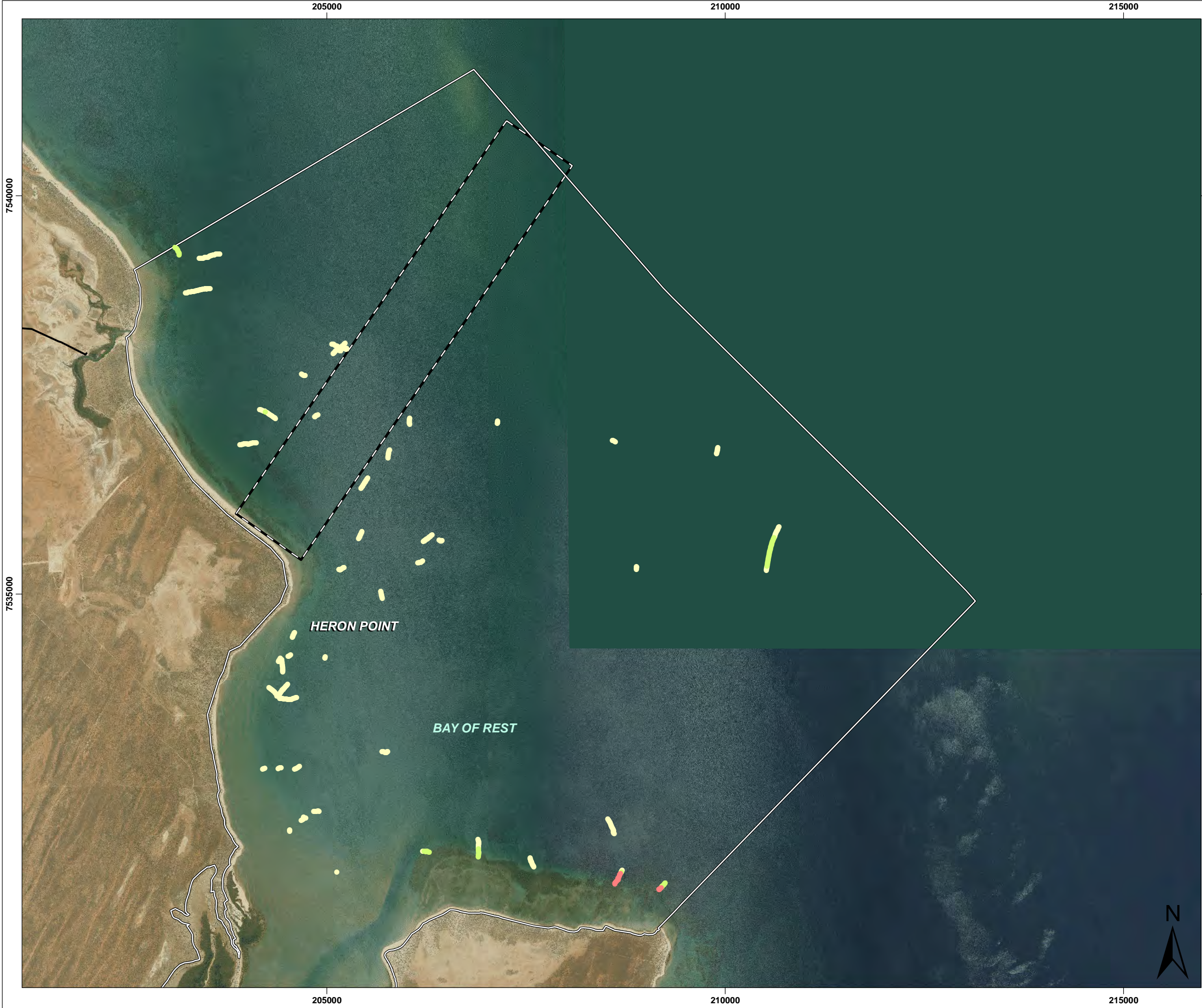
Five principal subtidal BCH types were recorded across the LAU; Soft sediment, Soft sediment with sparse seagrass, Soft sediment with filter feeders, Reef with macroalgae and Reef with filter feeders (Table 5, Figure 16, Figure 17).

Sparse seagrass (*Halodule uninervis* and patchy *Halophila ovalis*) was recorded in one area at densities ranging from 2% (trace) to 15% (Figure 18).






Table 5 Subtidal habitats identified within wider LAU

BCH TYPE	DESCRIPTION	PHOTOGRAPH
Soft sediment	Mud and sand dominated habitats (Site HA8)	
Soft sediment with sparse seagrass	Mud and sand dominated habitats with sparse <i>H. uninervis</i> and <i>H. ovalis</i> (Site AS6c).	
Soft sediment with filter feeders	Soft sediment veneer overlying low relief reef. Sparse cover of filter feeders (sponges, soft corals and, in some areas, hard corals) (Site AS34)	
Reef with macroalgae	Low relief reef with macroalgae (brown) (Site AS17b)	

BCH TYPE	DESCRIPTION	PHOTOGRAPH
Reef with filter feeders	Low relief reef with filter feeders (sponges, soft corals, hard corals) (Site Schofield Shoal)	



Legend

-  Local Assessment Unit
-  December 2016 survey area
- Substrate types
 -  Reef
 -  Sand/reef
 -  Sand

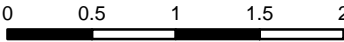
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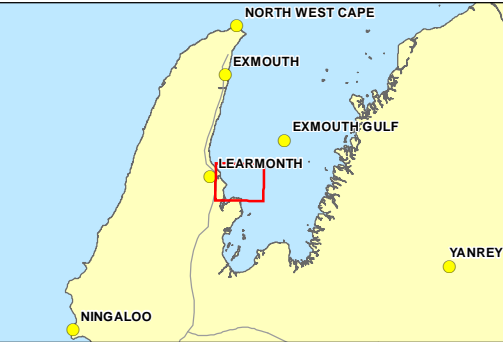
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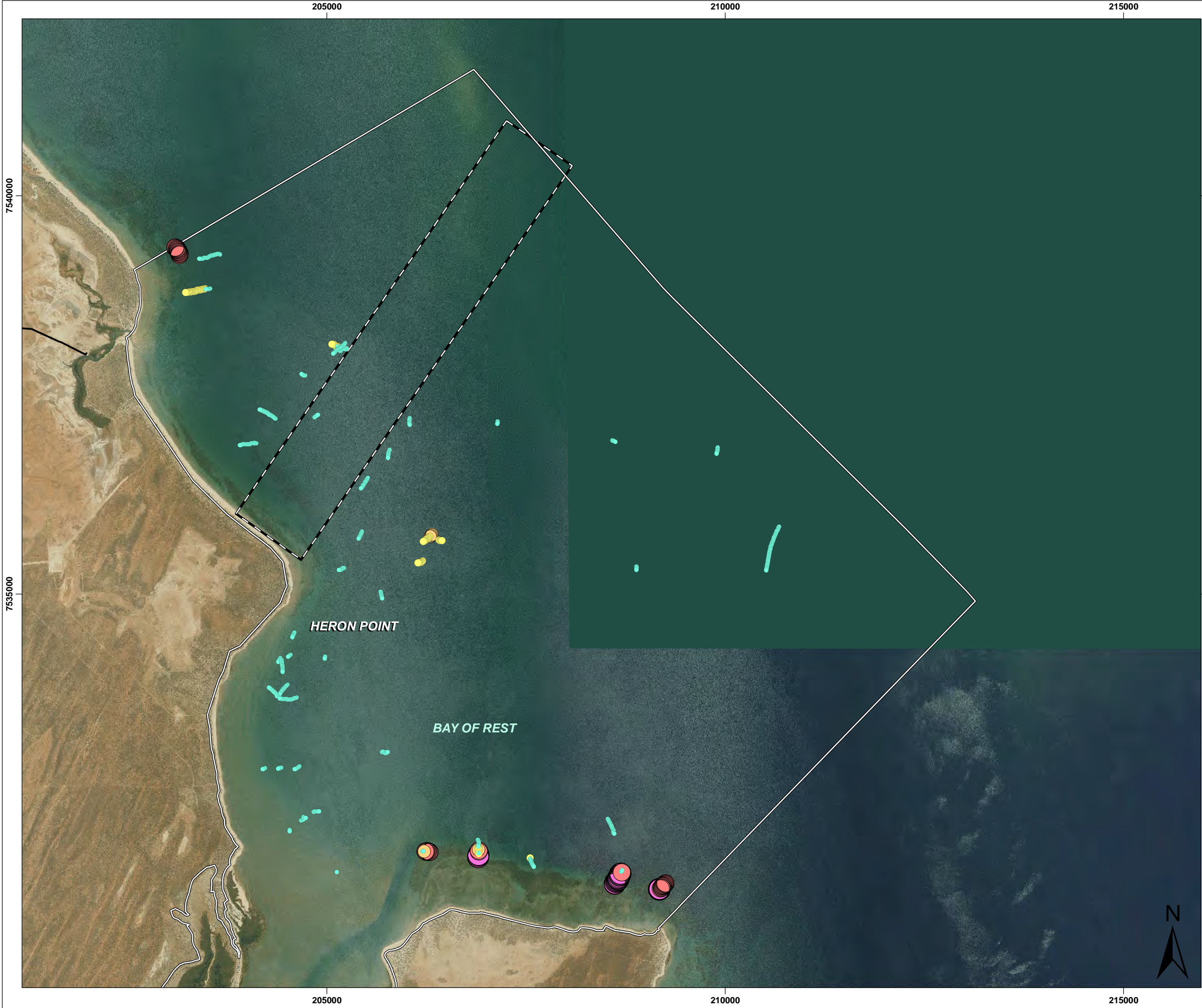
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Learmonth Bundles Site

Environmental Baseline Studies

Figure 16
Substrate Types



Legend

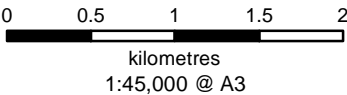
- Local Assessment Unit
- December 2016 survey area
- Macroalgae/turf algae cover %
 - 0
 - 1 - 10
 - 11 - 25
 - 26 - 50
 - 51 - 75

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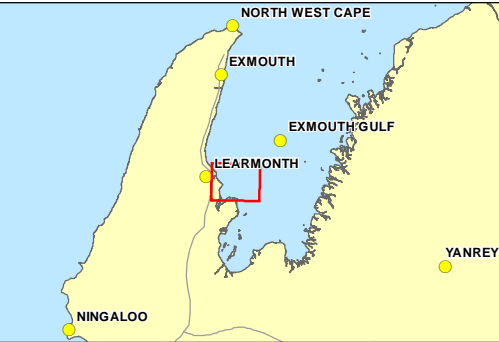
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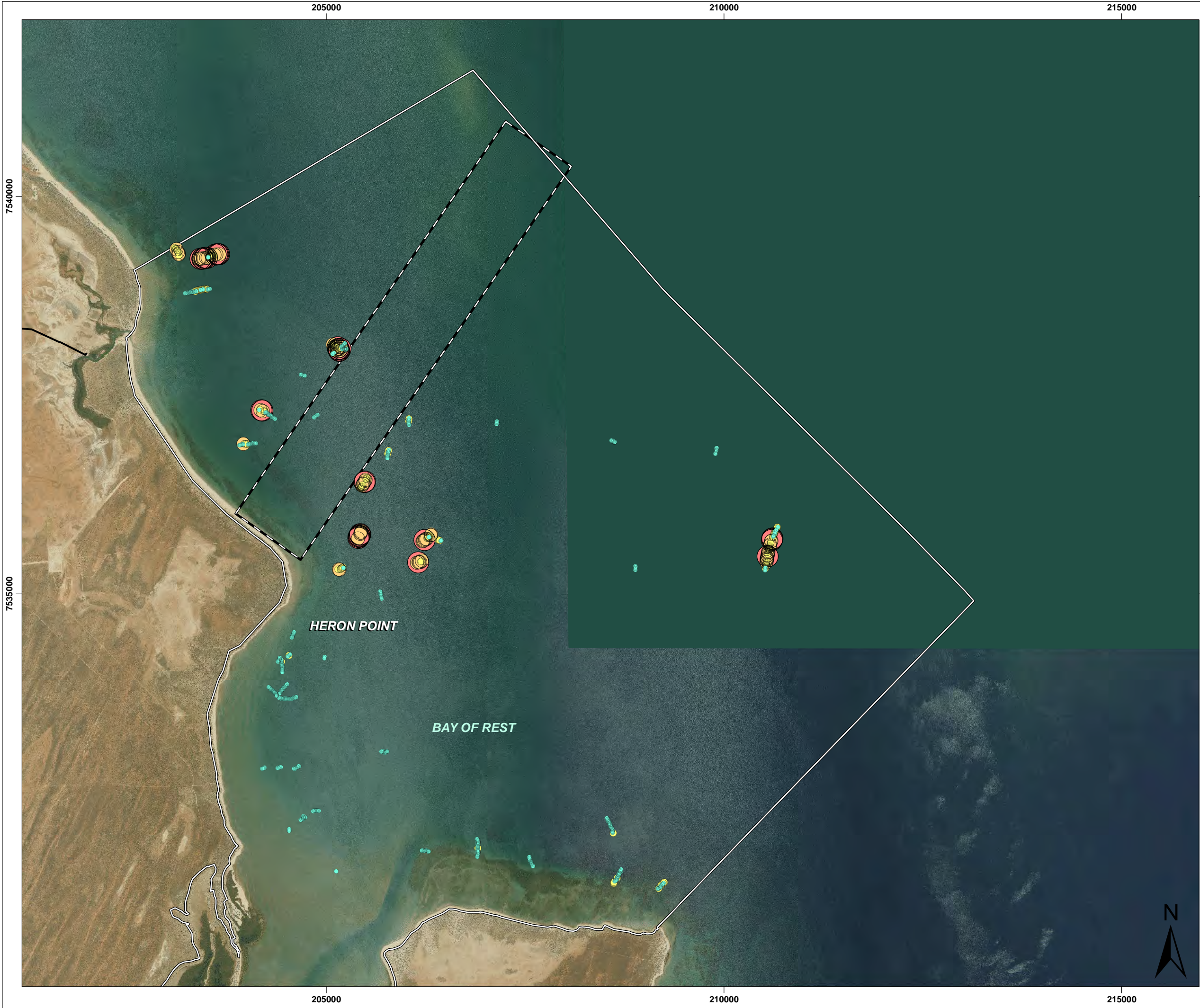


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Environmental Baseline Studies

Figure 17a
Subtidal Habitat Types
Macroalgae/Turf Algae Cover %



Legend

-  Local Assessment Unit
-  December 2016 survey area
- Filter Feeders (Count/20s)
 -  0
 -  1 - 10
 -  11 - 25
 -  26 - 51

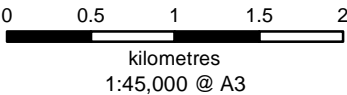
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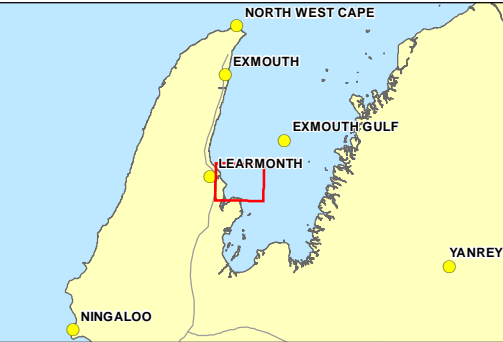
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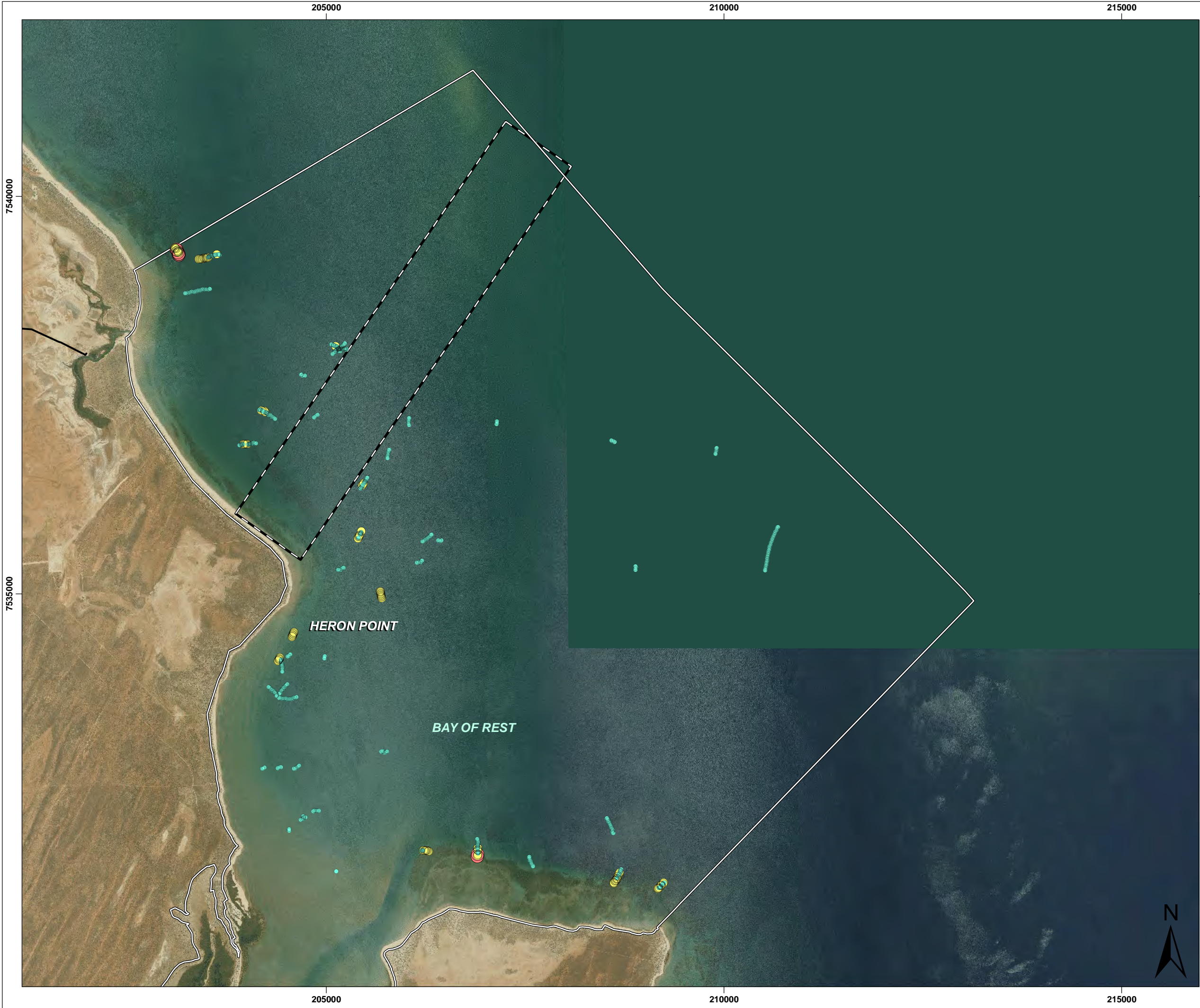


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Learmonth Bundles Site

Environmental Baseline Studies

Figure 17b
Subtidal Habitat Types
Filter Feeders (Count/20s)



Legend

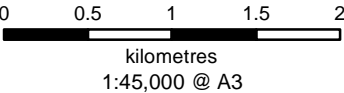
- Local Assessment Unit
- December 2016 survey area
- Hard Coral (Count/20s)
 - 0
 - 1 - 10
 - 11 - 23

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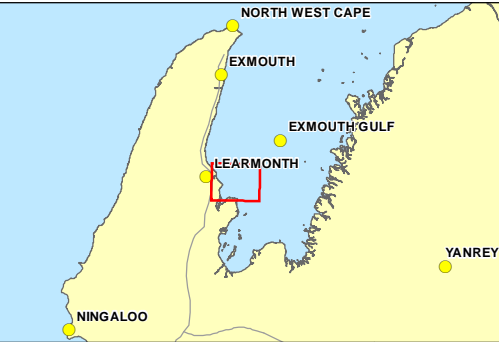
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LOCALITY MAP



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Learmonth Bundles Site

Environmental Baseline Studies

Figure 17c
Subtidal Habitat Types
Hard Coral (Count/20s)



Legend

-  Local Assessment Unit
-  December 2016 survey area
- Seagrass cover %
 -  0
 -  1 - 3
 -  4 - 6
 -  7 - 10
 -  11 - 15

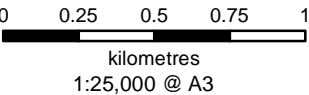
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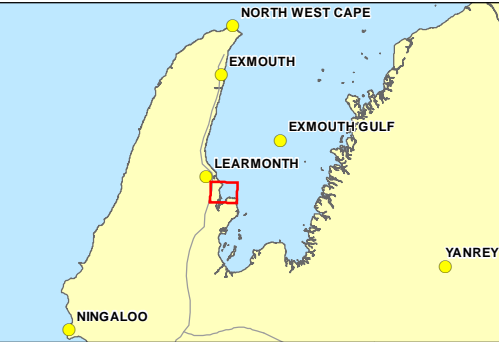
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LOCALITY MAP



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Learmonth Bundle Site

Environmental Baseline Studies

Figure 17d
Subtidal Habitat Types
Seagrass Cover %

7.2.3 Soft sediment infauna communities

The infaunal community structure was investigated by examination of the individual and species numbers recorded within each sample (univariate analysis) and by the use of multivariate analysis methods through use of PRIMER 5.0 software (Clarke & Warwick 2014).

Multivariate methods measure the similarity coefficients between samples. Hierarchical clustering (CLUSTER) was used to assess the similarity of sites based on the faunal components. The procedure generates a dendrogram indicating the relationships between sites based on a similarity matrix.

The greatest number of species (27) and individuals (80) were recorded from site IS-2 (Table 6, Appendix C). Site IS-12 returned the highest species diversity (5.96) followed by site IS-2 (5.93) (Table 6).

Table 6 Univariate analysis results for infauna samples

SAMPLE SITE	SPECIES RICHNESS	ABUNDANCE (NUMBER OF INDIVIDUALS)	SPECIES DIVERSITY (
IS-1	24	51	5.85
IS-2	27	80	5.93
IS-4	16	42	4.01
IS-5	19	28	5.40
IS-7	12	24	3.46
IS-8	10	17	3.18
IS-10	19	49	4.63
IS-11	19	31	5.24
IS-12	23	40	5.96
SEA-G	15	28	4.20

Note: Highest two values under each measure highlighted in bold.

Multi-Dimensional Scaling (MDS) analysis and dendrogram (Figure 18) indicates that no site was clearly different from the rest, nor was any sites particularly similar to each other. The inshore sites at Heron Point (IS-1 and IS-2) were around 38% similar and sites IS-7 and IS-11 (both ~3.5 km offshore) were approximately 60% similar. The site with sparse seagrass cover (SEA-G) was least similar to any other site.

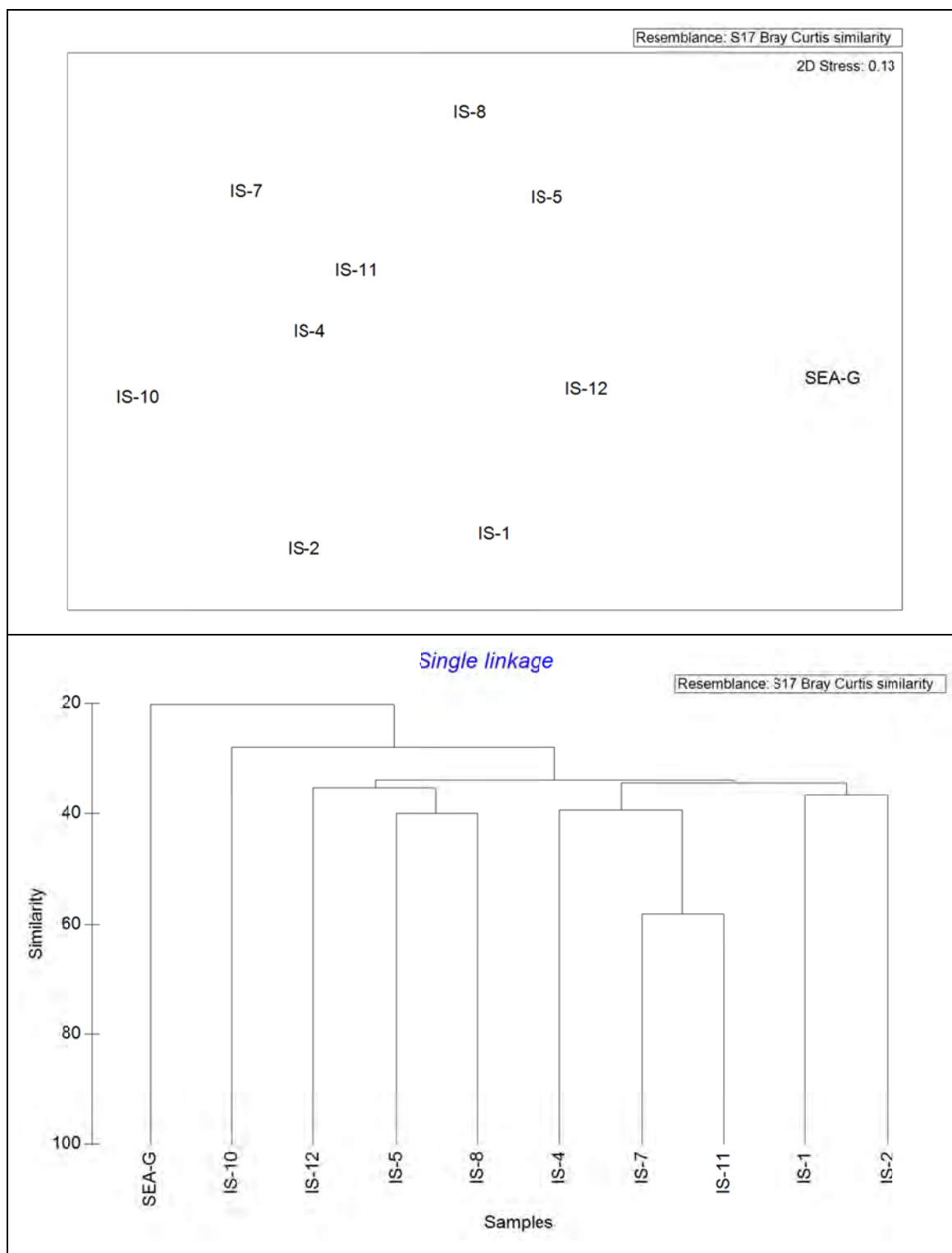


Figure 18 Infauna community MDS plot (top) and Dendrogram (bottom)

The sample from SEA-G was set apart from the rest due to the presence of four species not recorded from other sites:

- *Sigalionidae* 1 (polychaete worm);
- *Streblosoma* sp.1 (polychaete worm);
- *Dosina* sp.1 (bivalve mollusc); and
- *Modiolus* sp.1 (bivalve mollusc).

The most abundant species were *Sipuncula* sp. (unsegmented worm), *Ampleliscidae* sp. (amphidod [shrimp]) and *Spionidae* 2 (polychaete worm) (Plate 1).

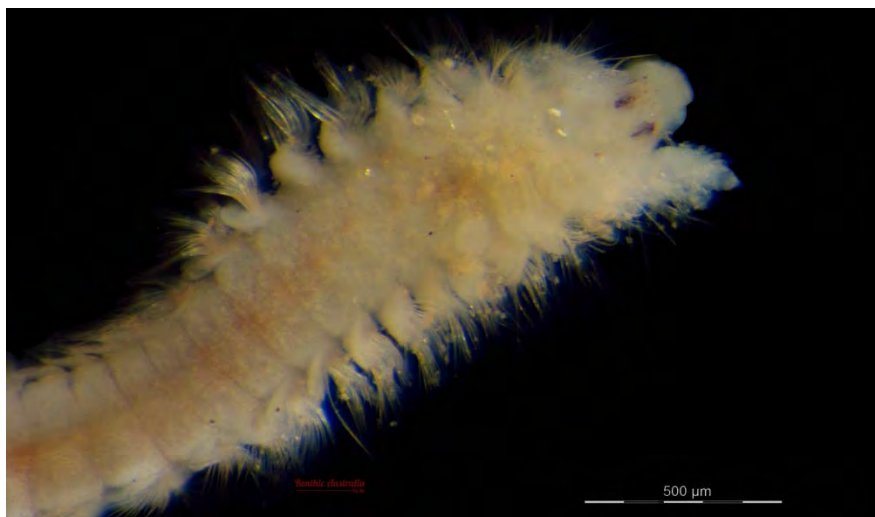


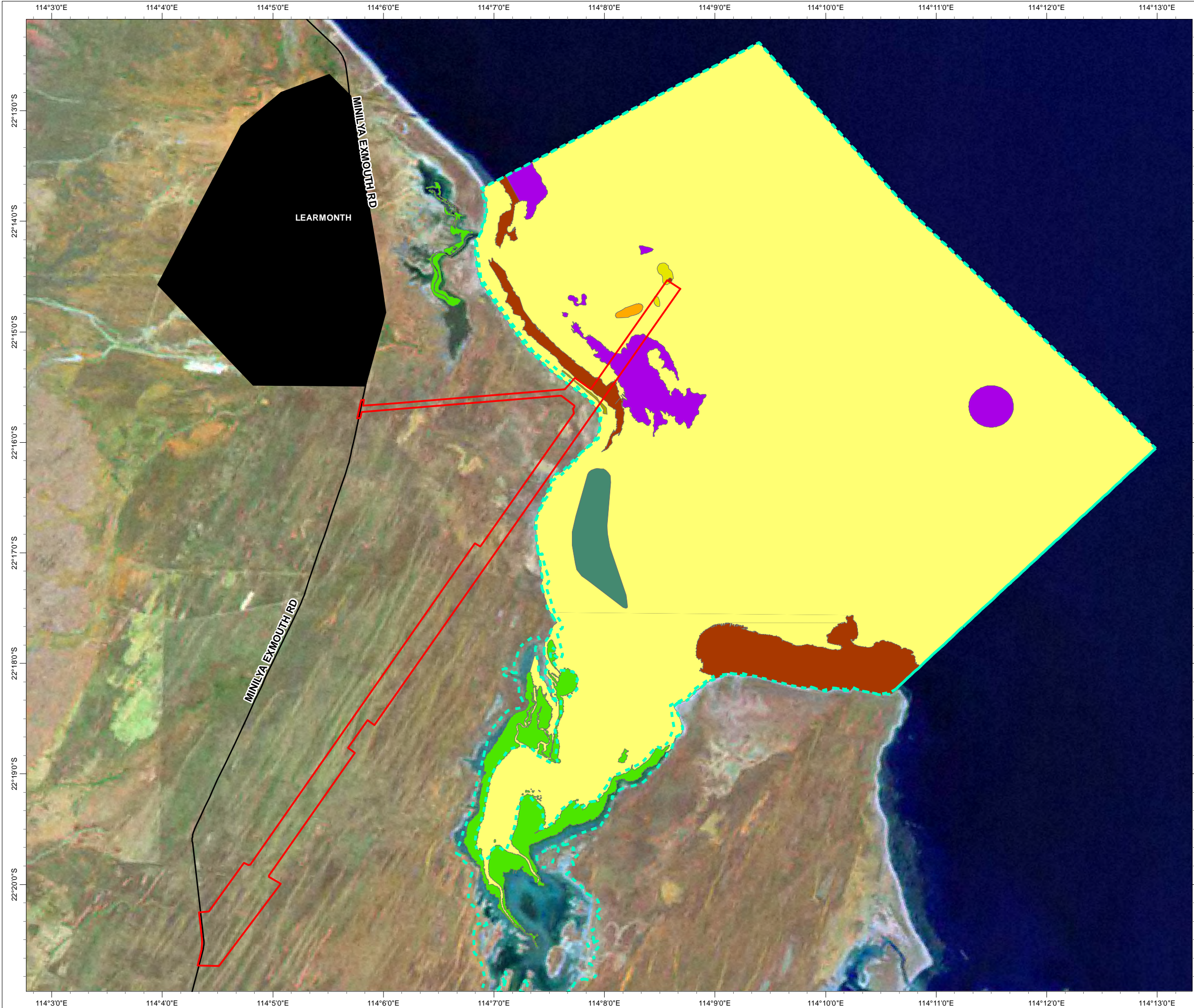
Plate 1 *Sipuncula* sp., *Ampheliscidae* sp. and *Spionidae* 2

8 Habitat Mapping

Based on the subtidal habitat recorded along the video transects, the backscatter data obtained during the multibeam survey (Figure 15) and the analysis of available aerial photography, the habitat map as presented in Figure 19 has been developed. The extent of each BCH type is presented in Table 7.

Table 7 Coverage of each BCH type within the LAU

BCH TYPE	AREA (HA)
Mangrove	259.2
Soft sediment	6880.9
Soft sediment with turf algae	6.2
Soft sediment with filter feeders	6.7
Soft sediment with sparse seagrass	108.7
Reef with macroalgae	345.0
Reef with macroalgae and filter feeders	201.7
Total	7808.4



Legend

Project Envelope (August 2017)

Local Assessment Unit

Habitat Map

Soft sediment

Soft sediment with turf algae

Soft sediment with filter feeders

Seagrass

Pavement reef

Reef with macroalgae

Reef with macroalgae and filter feeders

Mangrove

- LOCALITY MAP SOURCED FROM LANDGATE 2006

- PROJECT ENVELOPE SOURCED 360 ENVIRONMENTAL 2016

- ROADS SOURCED MRWA 2012

- IMAGERY SOURCED FROM LANDSAT7

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PREPARED FOR

subsea 7

SLIP ENABLER

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS

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LOCALITY MAP

PROJECT NO			DATE
2061			14/08/2017
HORIZONTAL DATUM AND PROJECTION			
GCS GDA 1994			
CREATED	CHECKED	APPROVED	REVISION
JA	SS	SS	0

Subsea 7

Bundle Site, Learmonth

Habitat Surveys Report

Figure 19

Habitat Map

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9 Initial impact assessment

9.1 Historic impacts to BCH within the LAU

EPA 2016c advises that the approach to determine cumulative losses within a defined LAU includes determining the spatial extent of benthic communities and habitats:

- prior to all human-induced disturbance;
- existing and approved at the time of the proposal; and
- remaining after implementation of the proposal.

Likely sources, and the likely extent/degree, of historic impacts to BCH within the proposed LAU, are discussed below.

No major resource or infrastructure projects have occurred within the LAU.

The Exmouth Gulf Prawn Managed Fishery has impacted on some shallow water areas (less than 12 m in depth) containing sponge habitats, but the trawling has focused in the deeper central and north-western sectors of Exmouth Gulf since the 1980s (DoF 2015, Figure 2).

Given the lack of infrastructure development within the LAU, and time since prawn trawling within the shallow areas within the LAU which have the potential to support benthic primary producer habitat (BPPH) or filter feeders, it is considered that no historic losses of BCH have occurred.

9.2 Potential future impacts to BCH within the LAU

Based on the habitat recorded along the subtidal video transects, the backscatter data obtained during the multibeam survey and available aerial imagery, the habitat map as presented in Figure 10 has been developed.

EPA (2016c) recommends that the amount of BCH likely to be lost within the LAU following the implementation of a project should be determined.

Potential impacts to BCH could occur as a result of direct disturbance during the construction of the Bundle Track, as a result of disturbance of the seabed beyond the Bundle Track during a Bundle launch, and due to locally elevated water column turbidity immediately adjacent to where the seabed is disturbed during Bundle Launch.

The Bundle launchway crosses the beach and extends into the shallow subtidal area, and will facilitate the launch of each Bundle. To launch a Bundle, the offshore end of the Bundle is connected to a tug (the 'Leading Tug') via a long tow wire. The tug then slowly (≤ 5 knots) heads offshore, pulling the Bundle along the rail track and into the ocean. The onshore end of the Bundle is connected to another wire which is slowly paid out from an onshore winch, until the Bundle reaches sufficient water depth for connection to another tug (the 'Trailing Tug'). The Bundle rolls down the rail track, which extends across the beach and into the shallow subtidal area. The towheads on either end of the Bundle are likely to drag along the seabed until a seawater depth of approximately 6 m is reached, at which point the Bundle and towheads will float just below the sea surface. At Learmonth this point is reached within 1,500 m of the shoreline.

Worst-case potential losses of BCH have been calculated based on a 100 m wide disturbance footprint. This is considered highly conservative (worst case) given the Bundle Launchway will be 20 m wide. Table 8 indicates the proportional losses of each BCH type within the LAU based on this scenario.

Table 8 Coverage of each BCH type within the LAU

BCH TYPE	AREA IN LAU	AREA IN ENVELOPE	AREA WITHIN 50M BUFFER OF LAUNCHWAY	PERCENTAGE LOSS
		HA		%
Mangrove	259.2	0.0	0.0	0.0
Soft sediment	6880.9	38.6	12.8	0.2
Soft sediment with turf algae	6.2	0.0	0.0	0.0
Soft sediment with filter feeders	6.7	1.6	0.5	7.5
Soft sediment with sparse seagrass	108.7	0.0	0.0	0.0
Reef with macroalgae	345.0	6.6	2.2	0.6
Reef with macroalgae and filter feeders	201.7	15.5	7.0	3.5
Total	7808.4	62.3	22.5	

9.3 Consequences for biological diversity and ecological integrity

EPA (2016c) recommends that “proponents should evaluate and discuss the potential consequences (i.e. impacts and risks) their proposal will and could have on ecological integrity and biological diversity at local and regional scales, taking into account:

- the predicted cumulative irreversible losses of BCH;
- the likely severity and duration of shorter-term (reversible) impacts of the proposal on BCH, and
- the local and regional values and distributions of the affected BCH.”

Benthic primary producer habitats (functional ecological communities that inhabit the seabed within which algae, seagrass, mangroves, corals or mixtures of these groups are prominent components) play important roles in maintaining the integrity of marine ecosystems and the supply of ecological services. There is strong evidence that the

presence of benthic primary producer habitat is important for the maintenance of biodiversity through provision of structurally complex and diverse habitat, provision of refuge, and increased food supply (EPA 2009).

As defined by the EPA, “Ecosystem integrity is considered in terms of structure (e.g. the biodiversity, biomass and abundance of biota) and function (e.g. food chains and nutrient cycles)” (EPA 2000).

Habitat structure varies from the two-dimensional habitats of unvegetated soft sediment areas to the complex three-dimensional habitat available on reefs, with the latter offering more ecological ‘niches’ for colonisation by macroalgae and fauna.

Habitat function includes the following:

- Primary production: a measure of the growth rates and therefore potential contribution to food webs of the main groups of aquatic plants on the seabed (benthic primary production);
- Secondary production: a measure of the growth rates of invertebrates;
- Water filtering capacity: a measure of the rate at which particulate organic matter (phytoplankton, zooplankton, detritus) in the water column is removed by filter-feeding organisms (e.g. bivalves, sponges, soft corals); and
- Biogeochemical cycling: an estimate of the rate at which biologically significant materials (in this case nitrogen) are converted from inorganic forms into organic forms (nitrogen cycling by plants), or cycled within the sediments (e.g. as represented by the degree of sediment bioturbation by invertebrates, as this affects sediment oxygen levels that in turn affect nitrogen cycling within sediments).

For the purposes of an initial assessment of the potential impacts to biological diversity and ecological integrity, the maximum cumulative loss of each habitat type have been considered. Where a loss of less than 1% of a particular habitat type is predicted, it has been assumed that the risk of a significant impact to the biological diversity or ecological integrity is unlikely. This is based on the previous guidance from the EPA that, for areas defined as ‘High Protection Areas’, which included areas recommended for inclusion in WA’s marine reserve system (i.e. ‘Wilson Report areas, CALM 1994), a cumulative loss threshold of 1% be applied. This guidance suggests that losses of less than 1% are considered unlikely to significantly affect the ecological integrity of the wider ecosystem.

Where a loss of more than 1% of a particular habitat type is predicted (i.e. for the BCH types; Soft sediment with filter feeders and Reef with macroalgae and filter feeders), further analysis of the potential impacts to biological diversity and ecological integrity will be completed and presented within the relevant environmental assessment documentation.

10 Discussion

The survey area covered the proposed bundle launch route, with a subsequent survey to map BCH throughout the LAU (defined in consultation with the OEPA).

Off Heron Point, intertidal habitats were visually inspected on a low spring tide on 5 December 2016. A towed underwater video survey was undertaken of the subtidal habitats in the period 6-9 December 2016, aiming to capture the period of peak seagrass biomass. A total of 47 towed video transects were conducted in the survey area offshore of Heron Point. Three intertidal habitat types and four subtidal habitat types were recorded within the survey area. Unvegetated soft sediment was the dominant habitat type (86.7%) with macroalgae and filter feeder-dominated reef habitats also present, all of which commonly occur within the shallow coastal waters of tropical north-west Australia.

Further survey of BCH within the LAU was undertaken between 30 May and 2 June 2017. Five principal subtidal BCH types were recorded; Soft sediment, Soft sediment with sparse seagrass, Soft sediment with filter feeders, Reef with macroalgae and Reef with filter feeders. Sparse seagrass (*Halodule uninervis* and patchy *Halophila ovalis*) was recorded in one area at densities ranging from 2% (trace) to 15%.

Within the Bay of Rest several mangrove species were recorded; Grey Mangrove (*Avicennia marina*), Stilted Mangrove (*Rhizophora stylosa*) and the Club mangrove (*Aegialitis annulata*).

The infaunal community structure was also investigated by the collection and analysis of Van Veen grab samples of soft sediment. The greatest number of species recorded in any sample was 27 and the highest number of individuals was 80. Multi-Dimensional Scaling (MDS) analysis and a dendrogram indicated that no site was clearly different from the rest, nor was any sites particularly similar to each other. The inshore sites at Heron Point (IS-1 and IS-2) were around 38% similar and sites IS-7 and IS-11 (both ~3.5 km offshore) were approximately 60% similar. The site with sparse seagrass cover (SEA-G) was least similar to any other site.

Worst-case potential losses of BCH have been calculated based on a 100 m wide disturbance footprint. The proportional losses of each BCH type within the LAU based on this scenario range from 0% (no loss) for mangroves, seagrass and turf algae, to 7.5% for soft sediment with filter feeders.

The BCH types identified are all likely to be well represented elsewhere in Exmouth Gulf, although surveys have generally been limited to those targeting seagrass habitats, or those undertaken in support of other infrastructure projects.

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