Marine Parks

Australian Government
Great Barrier Reef Marine Park Authority

Queensland Government

SITE ASSESSMENT OF DAMAGE REPORT

Australian Border Force vessel Roebuck Bay - Henry Reef (12-053)

INCIDENT NAME	Roebuck Bay grounding at Henry Reef (12-053)		
DETAILS	Roebuck Bay – Australian Border Force vessel		
INCIDENT DATE	Day: Saturday	Date: 30-Sep-17	Time:~0030
SAD Date	Day: Saturday, Sunday, Monday and Tuesday	Date: 21 to 24 October 2017	Time: 0900 to 1530
Author **Editorial Assistance**	Incident Response Coordinator GBRMPA Manager Operations Support		
Investigator	Senior Investigator		
Snr Ranger	Senior Ranger QPWS Far Northern Great Barrier Reef		
SAD Officers	Incident Response Coordinator GBRMPA Marine Parks Inspector QPWS Far Northern GBR Marine Parks Inspector QPWS Far Northern GBR		

1. EXECUTIVE SUMMARY

Just after midnight on the 30th of September 2017, the Australian Border Force vessel *Roebuck Bay* ran aground on Henry Reef (12-053), located in the Far Northern Management Sector of the Great Barrier Reef Marine Park. The vessel was salvaged by the Australian Maritime Safety Authority contracted Emergency Towage Vessel *Coral Knight* during the early evening of the same day. No fuels were reported spilt from the vessel during the incident.

Henry Reef is characterised as a mid-shelf reef remote from major sources of human impacts. It supports a rich and relatively undisturbed ecosystem characterised by abundant marine life and high species diversity, average live benthic cover at Henry Reef is 47.2 per cent. The north-western reef flat of Henry Reef in the vicinity of the 'Roebuck Bay' grounding site was dominated by 'Live Coral Rock' and the coral communities were characterised by digitate *Acropora* sp. There was some indication of impacts of the coral bleaching events of 2016 and/or 2017. The nearest offshore bleaching surveys were undertaken in the vicinity of Five Reefs (11-232) in 2016,

where estimates of bleaching mortality varied between 10 per cent and 50 per cent (GBRMPA, 2017).

> Staff from the Great Barrier Reef Marine Park Authority and Queensland Parks and Wildlife Service on board the *MV Reef Ranger* undertook a post-salvage damage assessment of the site on 21, 22, 23 and 24 October 2017.

The maximum extent of physical reef damage was within an area of 990 m^2 on the north-western aspect of Henry Reef. Of the 81 randomly selected photoquadrats within the maximum extent of damage, the mean damage was 33.0 per cent representing 327.9 m^2 of the 990 m^2.

Average live coral cover within the maximum extent of damage was 7.9 per cent, compared to 14.7 per cent live coral in control photoquadrats. This represents a halving of Live Coral as a result of the vessel grounding.

The damage footprint areas of gouging into the reef matrix were consistent with powered movement across the reef flat.

Within the damaged area, five pieces of what was interpreted to be propeller fragments (termed ‘Type A’ metal) were collected as evidence exhibits. Across the remainder of the damaged area, four pieces of aluminium (termed ‘Type B’ metal) were collected as evidence exhibits and a nally crate full of aluminium was collected to remove debris from the site.

A small amount of antifouling was observed on site and four samples were taken as evidence exhibits during the survey.

At the completion of the survey, two hours were dedicated to picking up debris and undertaking site remediation. During this time, more than 50 live coral colonies, in 14 patches, totally approximately 8 m^2 were turned over and settled into the reef matrix. Given the potential for high wave energies on this outer reef, no estimation of potential return to pre-impact ecologically functional state can be given, as the next significant weather event is likely to mobilise all the damaged coral fragments.

2. INCIDENT BACKGROUND

At 0025 on Saturday 30 September, Australian Border Force vessel *Roebuck Bay* (38m LOA, 126 tonnes) ran aground on Henry Reef (12-053), 33 nautical miles north-east of Cape Weymouth - Great Barrier Reef. The vessel reported "two compartments flooded and no injuries to the 11 crew on board. Initial damage assessment for *Roebuck Bay* was as follows; forward void significant tears in hull, gash 75cm x 10cm either side of keel with hull plating folded into hull near the bulk head with the fresh water void. Fresh water void tear approximately 45cm x 30cm x 30cm (triangular tear) at bulk head between fresh water void and forward void, two plate incursions port side of keel, 20 cm cracks in hull, starboard side of keel x2 crack about 25cm long, one punched approximately 2cm diameter all near the common bulkhead of fresh water void and forward void."

Roebuck Bay was towed off Henry Reef (12-053) during the early evening of the same day by the Emergency Towage Vessel (ETV) *Coral Knight*. In this process *Roebuck Bay*'s 250 kg anchor and approximately 150 m of anchor chain were left on the reef.

Roebuck Bay was towed stern-first back to Cairns by ETV *Coral Knight*, arriving approximately 1200 on 4 October 2017.

Queensland Parks and Wildlife Service (QPWS) Marine Park Inspectors and a Great Barrier Reef Marine Park Authority Incident Response Coordinator, undertook a site assessment of damage at Henry Reef between 21 October and 24 October 2017, inclusive.

3. SITE ASSESSMENT OF DAMAGE METHOD

A survey of Henry Reef (12-053) was undertaken over four days with the following objectives (see Site Assessment of Damage Request for further detail – Appendix 1):

1. Determine the spatial extent of damage; GPS positions, length, width and depth of any observed damage
2. Determine the nature of damage and attribute possible causes based on observations
3. Collect spatially (GPS) referenced imagery, foreign objects from within and adjacent to the ground site

The survey was conducted on snorkel between 21 October and 24 October 2017, inclusive.

An initial orientation was undertaken on the 21 October 2017. A series of waypoints were taken to mark features of significance; including 'Roebuck Bay's' anchor which remained after salvage of the vessel, a number of marks along the anchor chain, 'Alpha' a mark at the southern end of inferred north-south initial impact line and

‘Bravo’ a mark at the northern end of the inferred north-south initial impact line (Figure 1).

The perimeter of damage was marked using a series of surface floats and pink string line to demark the maximum extent of damage. The perimeter was GPS tracked and the area was calculated via the Garmin 78sc GPS’ area function (Figure 1).

A 50 metre tape measure was laid along the north-south impact scar (heading 000 degrees) this was designated Transect Alpha-Bravo and a 50 m tape was laid along the axis of the anchor chain (heading 280 degrees), this east-west transect was designated Transect 4.

Using the north-south Transect Alpha-Bravo as a reference, 50 metre tapes were laid perpendicularly at 10 metre intervals to produce a “fishbone”. Each east-west transect started outside the damage, traversed the impact area and ended outside the damage area; each end of these transects were recorded as waypoints and designated A to H (Figure 2). A stylised representation of the site using the designations in this report is presented in Figure 3.

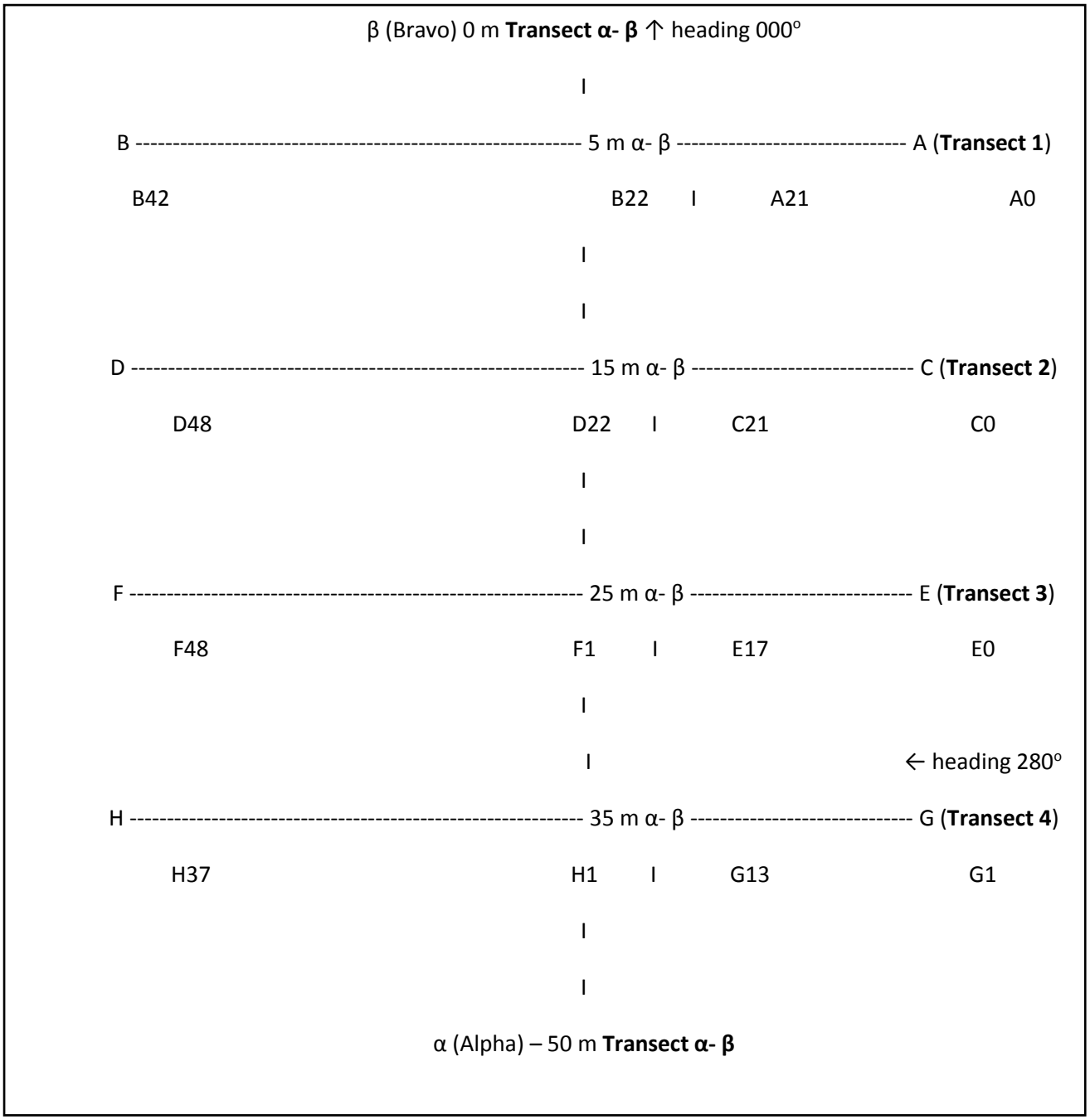

Figure 3: Stylised representation of the site set up for the Henry Reef (12-053) Site Assessment of Damage.

Spatially referenced video transects were run along each side of the north-south reference Transect Alpha-Bravo and on either side of the 10 metre east-west Transects 1 to 4 (Figure 4).

Video Transect	Transect (Fig 1)	From	To	Direction	Tape to
1	Transect α- β	Bravo	Alpha	South	Right
2	Transect α- β	Alpha	Bravo	North	Right
3	Transect 4	H	G	ESE	Right
4	Transect 4	G	H	WNW	Right
5	Transect 3	E	F	WNW	Right
6	Transect 3	F	E	ESE	Right
10	Perimeter	Anchor	Anchor	Anti-clockwise	Stringline
11	126 m^2 scar	Bravo	Charlie	SW	Nil
12	Transect 2	D	C	ESE	Right
13	Transect 2	C	D	WNW	Right
14	Transect 1	B	A	East	Right
15	Transect 1	A	B	West	Right

Figure 4: Henry Reef (12-053) Site Assessment of Damage Video Transect Orientation.

Three spatially referenced Reef Health and Impact Surveys (RHIS) were undertaken within the maximum extent of damage (impact) and six control RHIS were undertaken outside the perimeter of damage (control) -3 east and 3 west of the impact site (Figure 1).

Photoquadrats (1 m^2) were taken using a GoPro Hero 4 set to wide-angle on medium setting, along Transects 1 to 4 at 1 metre intervals (quadrat was flipped end over end) (see Appendix 2 for representative photoquadrats). The percentage of the categories of hard coral, soft coral, macroalgae, old rubble, new rubble, sand, old rock and new rock (taken to include, reef rock surfaces exposed by removal of the upper strata together with dislodged colonies of live hard and soft corals – unlikely to survive long-term because of impact of ongoing movement by waves and currents), were recorded.

The photographs were referred to when analysing coral cover and damage comparison between impact and control areas. A total of 81 quadrats were recorded outside the maximum extent of damage (control) and 110 quadrats were recorded within the maximum extent of damage (impact). For comparison between equivalent groups, 81 randomly selected quadrats from within the impact zone selected to find their average and standard deviation to be compared to the 81 control quadrats.

For the purpose of comparison between control quadrats and quadrats within the maximum extent of physical reef damage the follow categories were pooled:

Live Coral = Hard Coral plus Soft Coral

Old Rock = Old Rock

Damage = New Rock plus New Rubble

Within this report descriptive statistics will be reported as sample mean plus or minus the standard deviation of the sample mean (using n-1) as a percentage, in the form mean ± standard deviation, e.g. 12.3 ± 4.5 per cent.

Length, breadth and depth measurements were taken of significant gouges observed on the northern aspect of the damage footprint, together with geo-referenced photographs.

Geo-referenced samples of antifouling paint and metal debris were collected from within the damage perimeter.

A site clean-up; collection of additional debris (not spatially referenced) and remediation of overturned coral colonies was undertaken.

A transcription of all GPS waypoint data can be found at Appendix 3. Field data sheets for photoquadrats, for reef health and impact surveys and daily in-water field notes were also collated.

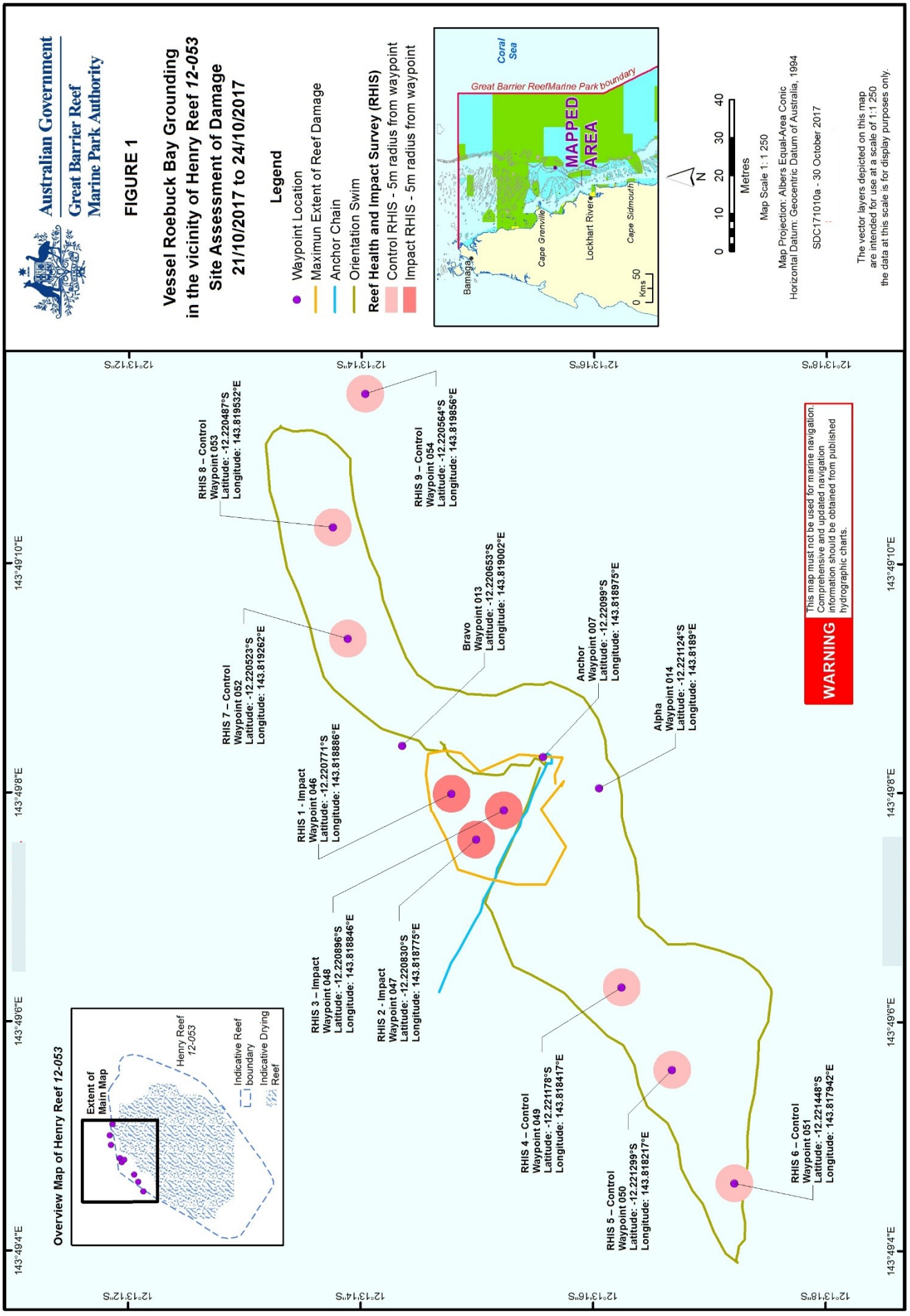
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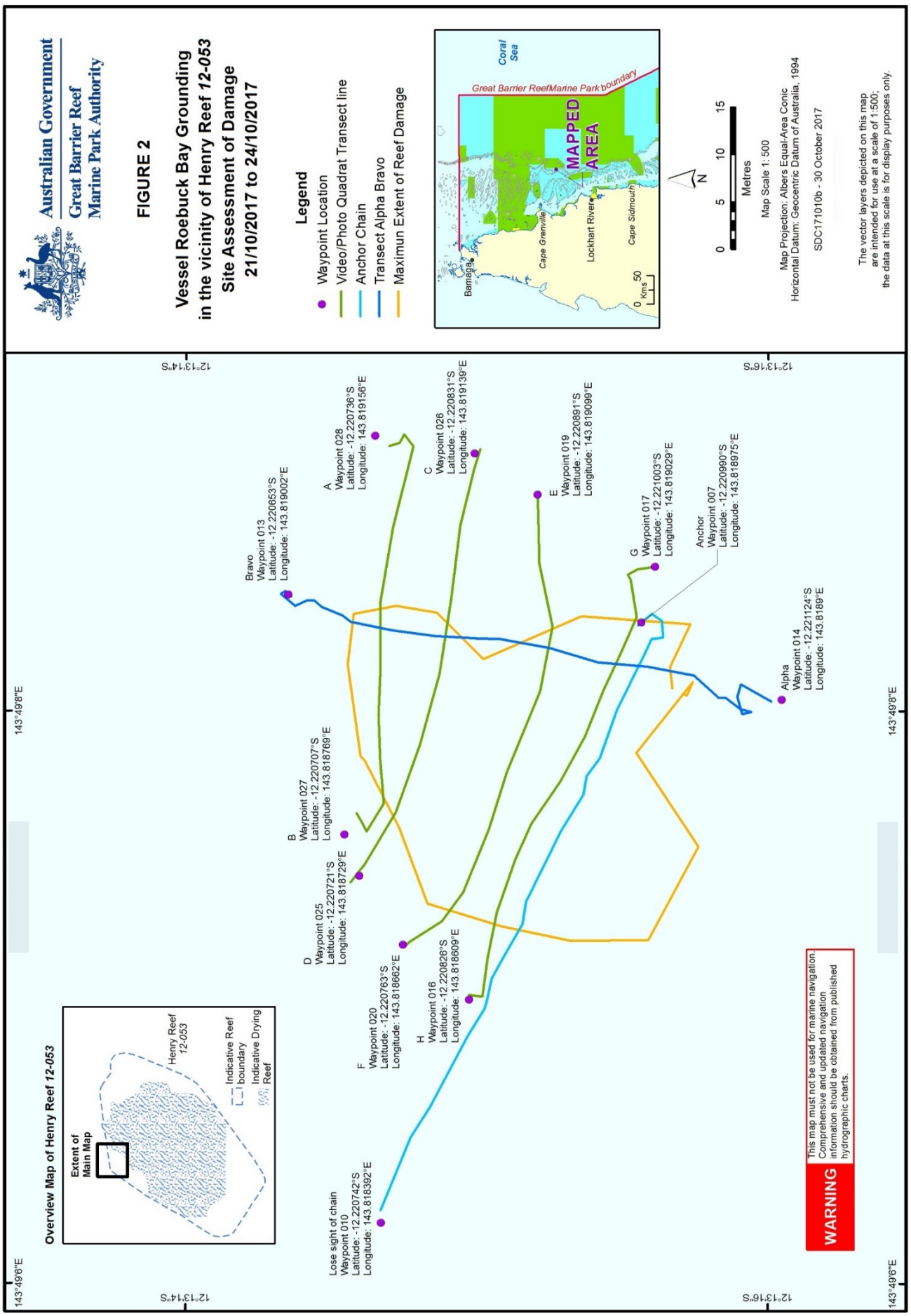
FIGURE 1
Vessel Roebuck Bay Grounding
in the vicinity of Henry Reef 12-053
Site Assessment of Damage
21/10/2017 to 24/10/2017
Legend
Waypoint Location
Maximun Extent of Reef Damage
Anchor Chain
Orientation Swim
Reef Health and Impact Survey (RHIS)
Control RHIS - 5m radius from waypoint
Impact RHIS - 5m radius from waypoint
Coral Sea
Great Barrier ReefMarine Park boundary
MAPPED AREA
Bamaga
Cape Grenville
Lockhart River
Cape Sidmouth
0 50 Kms
N
0 10 20 30 40
Metres
Map Scale 1: 1 250
Map Projection: Albers Equal-Area Conic
Horizontal Datum: Geocentric Datum of Australia, 1994
SDC171010a - 30 October 2017
The vector layers depicted on this map are intended for use at a scale of 1:1 250 the data at this scale is for display purposes only.
Overview Map of Henry Reef 12-053
Extent of Main Map
Henry Reef 12-053
Indicative Reef boundary
Indicative Drying Reef
RHIS 8 – Control
Waypoint 053
Latitude: -12.220487°S
Longitude: 143.819532°E
RHIS 9 – Control
Waypoint 054
Latitude: -12.220564°S
Longitude: 143.819856°E
RHIS 7 – Control
Waypoint 052
Latitude: -12.220523°S
Longitude: 143.819262°E
Bravo
Waypoint 013
Latitude: -12.220653°S
Longitude: 143.819002°E
Anchor
Waypoint 007
Latitude: -12.22099°S
Longitude: 143.818975°E
Alpha
Waypoint 014
Latitude: -12.221124°S
Longitude: 143.8189°E
RHIS 1 - Impact
Waypoint 046
Latitude: -12.220771°S
Longitude: 143.818886°E
RHIS 3 – Impact
Waypoint 048
Latitude: -12.220896°S
Longitude: 143.818846°E
RHIS 2 - Impact
Waypoint 047
Latitude: -12.220830°S
Longitude: 143.818775°E
RHIS 4 – Control
Waypoint 049
Latitude: -12.221178°S
Longitude: 143.818417°E
RHIS 5 – Control
Waypoint 050
Latitude: -12.221299°S
Longitude: 143.818217°E
RHIS 6 – Control
Waypoint 051
Latitude: -12.221448°S
Longitude: 143.817942°E
WARNING
This map must not be used for marine navigation. Comprehensive and updated navigation information should be obtained from published hydrographic charts.
143°49'4"E
143°49'6"E
143°49'8"E
143°49'10"E
12°13'12"S
12°13'14"S
12°13'16"S
12°13'18"S


Australian Government
Great Barrier Reef Marine Park Authority
FIGURE 2
Vessel Roebuck Bay Grounding in the vicinity of Henry Reef 12-053
Site Assessment of Damage
21/10/2017 to 24/10/2017
Legend
Waypoint Location
Video/Photo Quadrat Transect line
Anchor Chain
Transect Alpha Bravo
Maximun Extent of Reef Damage
Coral Sea
Great Barrier Reef Marine Park boundary
MAPPED AREA
Bamaga
Cape Grenville
Lockhart River
Cape Sidmouth
0 Kms 50
N
0 5 10 15
Metres
Map Scale 1: 500
Map Projection: Albers Equal-Area Conic
Horizontal Datum: Geocentric Datum of Australia, 1994
SDC171010b - 30 October 2017
The vector layers depicted on this map are intended for use at a scale of 1:500; the data at this scale is for display purposes only.
Overview Map of Henry Reef 12-053
Extent of Main Map
Henry Reef 12-053
Indicative Reef boundary
Indicative Drying Reef
WARNING
This map must not be used for marine navigation. Comprehensive and updated navigation information should be obtained from published hydrographic charts.
143°49'6"E
143°49'8"E
12°13'14"S
12°13'16"S
Lose sight of chain
Waypoint 010
Latitude: -12.220742°S
Longitude: 143.818392°E
F
Waypoint 020
Latitude: -12.220763°S
Longitude: 143.818662°E
D
Waypoint 025
Latitude: -12.220721°S
Longitude: 143.818729°E
B
Waypoint 027
Latitude: -12.220707°S
Longitude: 143.818769°E
Bravo
Waypoint 013
Latitude: -12.220653°S
Longitude: 143.819002°E
H
Waypoint 016
Latitude: -12.220826°S
Longitude: 143.818609°E
A
Waypoint 028
Latitude: -12.220736°S
Longitude: 143.819156°E
C
Waypoint 026
Latitude: -12.220831°S
Longitude: 143.819139°E
E
Waypoint 019
Latitude: -12.220891°S
Longitude: 143.819099°E
G
Waypoint 017
Latitude: -12.221003°S
Longitude: 143.819029°E
Anchor
Waypoint 007
Latitude: -12.220990°S
Longitude: 143.818975°E
Alpha
Waypoint 014
Latitude: -12.221124°S
Longitude: 143.8189°E

4. PHYSICAL SITE DESCRIPTION

Henry Reef (12-053) is characterised as a Far Northern Outer Mid-shelf Reef (Kerrigan *et al*. 2010) typical of coral reefs with hard under layer of consolidated dead coral matrix, with live coral colonies growing on top.

Reef Health and Impact Survey (RHIS) were undertaken using the standard RHIS Program protocols, all 9 RHIS sites were away from the impact areas. The average live coral cover was 44.2 ± 20.5 per cent (mean ± standard deviation), with a diversity of coral growth forms depending on depth and aspect and a macro algae cover of 3.0 ± 6.4 per cent. This represents an average live benthic cover (live coral and macro algae) of 47.2 ± 23.0 per cent.

On the western aspects of Henry Reef in the vicinity of the *Roebuck Bay* grounding site, the reef rises sharply out of 20 to 30 metres water depth, and in places the reef has a shallow shelf at approximately 5 to 8 metres. At or about Lowest Astronomical Tide (LAT) the reef gently slopes up across a reef flat to the reef crest on the eastern flank. The reef flat was undulating with numerous depressions and ridge areas. The north-western reef flat of Henry Reef in the vicinity of the *Roebuck Bay* grounding site was dominated by 'live rock' and the coral communities were characterised by digitate *Acropora* sp (Figure 5).

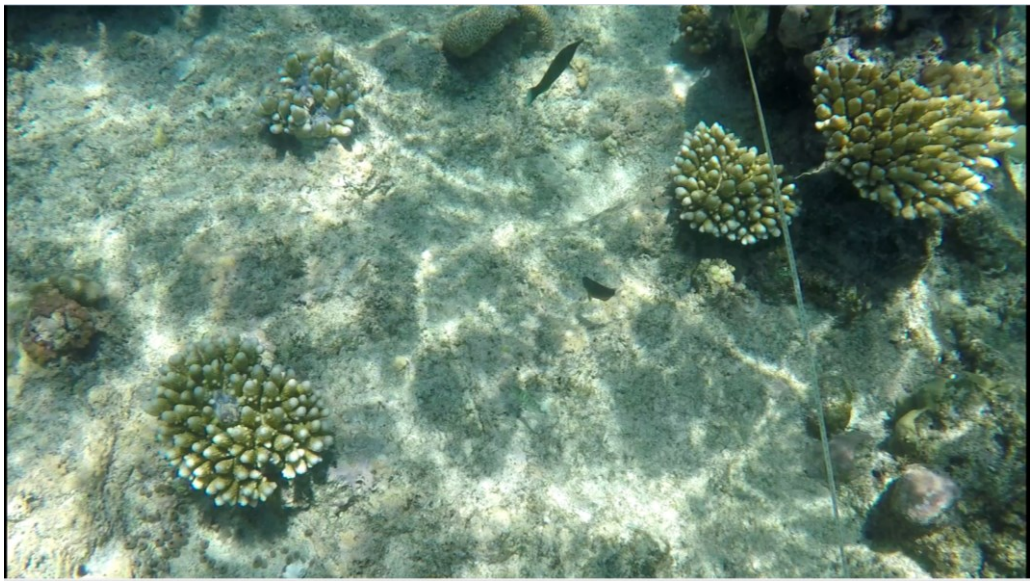


Figure 5 Benthos dominated by live coral rock and digitate *Acropora sp*: Screen grab for Video Transect 2 Wpt 26 to Wpt 25.

Two estimates of benthic community composition were used during the Henry Reef Site Assessment of Damage – 1 square metre photoquadrats and Reef Health and Impact Survey (RHIS – 78 m^2). These two tools provided a similar estimate of live coral cover ('hard coral' and 'soft corals') and undamaged live coral rock ('old rock' from quadrats and 'live coral rock' from RHIS) in control sites (Figure 6).

At control sites, photoquadrat live coral cover averaged 14.7 ± 1.6 per cent and RHIS indicated live coral cover in control areas was 17.8 ± 4.7 per cent.

The photoquadrats estimated undamaged live coral rock ('old rock') to be 74.8 ± 2.16 per cent and RHIS estimated that undamaged 'live coral rock' constitutes 74.0 ± 6.3 per cent of the benthic cover in control sites.

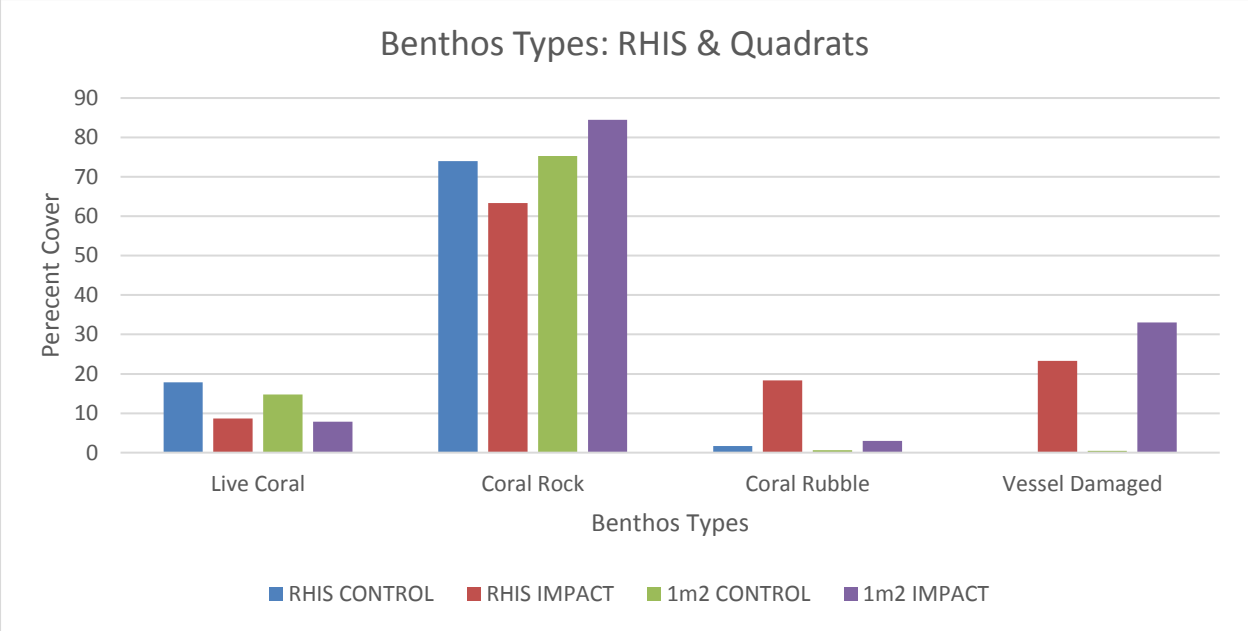


Figure 6 Percent benthos cover – comparison between RHIS and quadrat methods.

The higher coral rubble estimate from the RHIS Impact sites can be attributed to classification difference between the two methods as undertaken at Henry Reef. RHIS classified "coral rubble" as any coral fragments that could be mobilised by wave action, while the photoquadrat method classified "coral rubble" as coral fragments less than "cobble" size (<~64 mm). As a result, there was a potential miss-match between the two methods.

Using the RHIS method it was found to be difficult to dis-entangle the percentage of "recently dead" that was attributable to vessel damage and there was no ability to differentiate between naturally occurring coral rubble and live coral rock from coral rubble and live coral rock created as a result of vessel impacts. As such, RHIS data were not used for descriptive damage statistics within Section 5: Description of Damage.

There was no evidence of recent coral bleaching or coral disease and only limited predation present in the control sites. However, the high percentage cover of live rock in control sites is likely as a result of coral mortality associated with the 2016 and 2017 bleaching events and subsequent conversion of live coral to live coral rock.

The Great Barrier Reef Marine Park Authority's report into the 2016 coral bleaching event (GBRMPA, 2017), identified that offshore reefs in the Far Northern

Management Area experienced mortality of 10 per cent to 50 per cent, mostly in shallow habitats in waters <10 metres deep. While a direct causation cannot be attributed, the low coral cover and high live coral rock cover in the vicinity of the grounding site can be at least partially attributed to the coral mortality associated with that event.

5. DESCRIPTION OF DAMAGE

Site Assessment of Damage Categories:

- ***Extreme Damage:*** *substratum crushed and compacted, all benthos destroyed*
- ***Severe Damage****: substratum gouged, fractured or broken, most benthos impacted*
- ***Moderate Damage:*** *substratum undamaged, over-turned/fractured colonies*
- ***Low Damage:*** *broken branches/portions of colonies*
- ***Undamaged****: no impact associated with vessel grounding.*

Photoquadrats only were used for description of damage in this section. For the purpose of comparison between control quadrats and quadrats within the maximum extent of physical reef damage the follow categories were pooled:

Live Coral = Hard Coral and Soft Coral

Live Coral Rock = Old Rock

Damage = New Rock and New Rubble

Roebuck Bay's anchor and more than 80 metres of anchor chain remained on Henry Reef (12-053) at the time of undertaking this site assessment of damage. Given the anchor and anchor chain lay over live coral and living coral rock, further damage to the reef is possible during salvage of these. Any additional damage to Henry Reef associated with the removal of the anchor and anchor chain is not reported here. The site assessment of damage records only the damage caused by the vessel hull and any damage caused by the remaining anchor and chain to coral communities has not been assessed.

The anchor was the high point of the impact site, estimated to be 0.3 to 0.5 m higher than the reef damage in the vicinity of Bravo; and 0.2 to 0.7 m higher than reef damage adjacent to where the anchor chain dropped off the reef flat.

The maximum extent of physical reef damage was within an area of 990 m^2 on the north-western aspect of Henry Reef (Figure 1), as measured using the GPS' area function.

The observed damage was roughly triangular in dimension, with reef damage recorded between 3.9 m and 39.5 m (35.6 m) along Transect Alpha-Bravo and between 4.0 m and 41.3 m (37.3 m) along Transect 4 (Figure 2 and Figure 3).

Of the 81 randomly selected photoquadrats within the maximum extent of damage, the mean damage (new rock plus new rubble) was 33.0 ± 36.0 per cent representing 327.9 m^2 of the 990m^2. While only 0.4 ± 2.0 per cent of control photoquadrat area was Damage (Figure 7).

It is noted that five quadrats recorded as "controls" had damage associated with the vessel grounding. It was not evident that any of this damage had originated within these quadrats and it is inferred that the material was broken off the reef at another location and deposited. These quadrats were all within five metres of boundary of the maximum extent of damage. Four of the five were on Transect 1 between A6 and A14, these quadrats were adjacent to the commencement of the scars associated with propeller and rudder damage – see below. It is inferred that lateral movement of the vessel from Transect Alpha-Bravo to the south west may have moved this loose material to the north east.

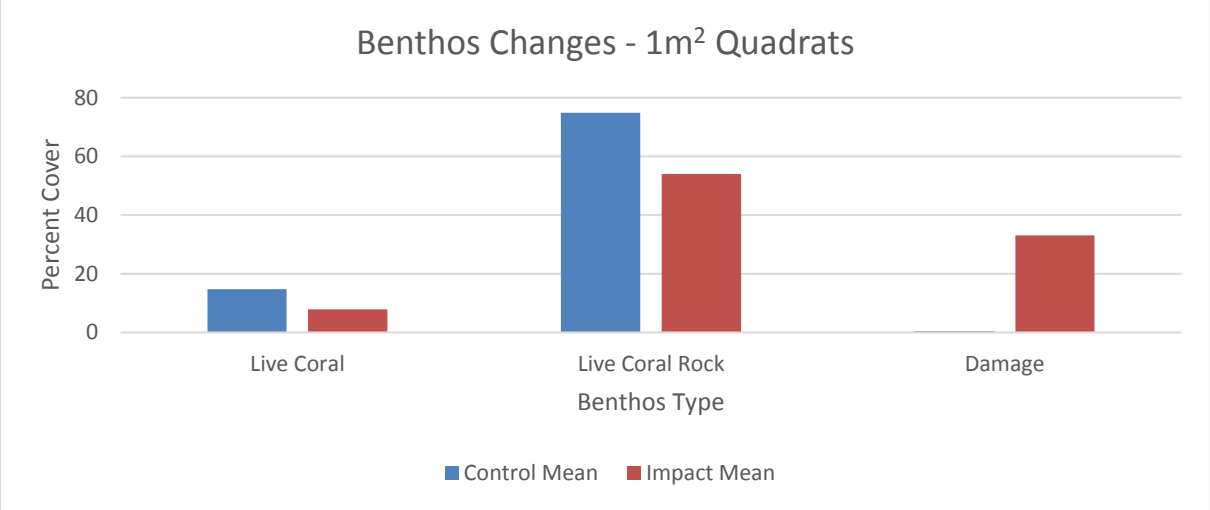


Figure 7: Changes in benthic cover as a result of vessel damage as recorded for 1m^2 quadrats, Henry Reef site assessment of damage.

Average live coral cover within the maximum extent of damage was 7.9 ± 9.2 per cent, compared to 14.7 ± 15.1 per cent live coral in control photoquadrats. This represents a halving of live coral as a result of the vessel grounding.

The mean live coral rock within the maximum extent of damage was 54.0 ± 34.7 per cent compared to 74.8 ± 19.5 per cent live coral rock in control photoquadrats. This represents a 25 per cent reduction in live coral rock as a result of the vessel grounding.

Within the damaged area adjacent to the northern boundary of the damage footprint, pieces of "Type A metal" were observed (Figure 8). These Type A metal pieces are interpreted to be broken fragments of the vessel's propeller (Figure 9).

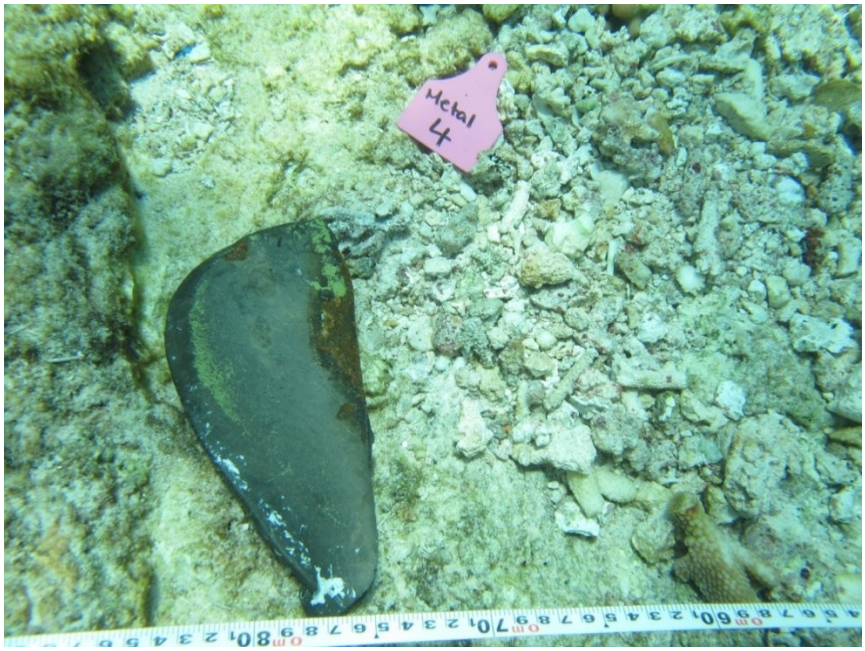


Figure 9 Metal fragment 4: “Type A” metal fragment collected 23 October 2017.

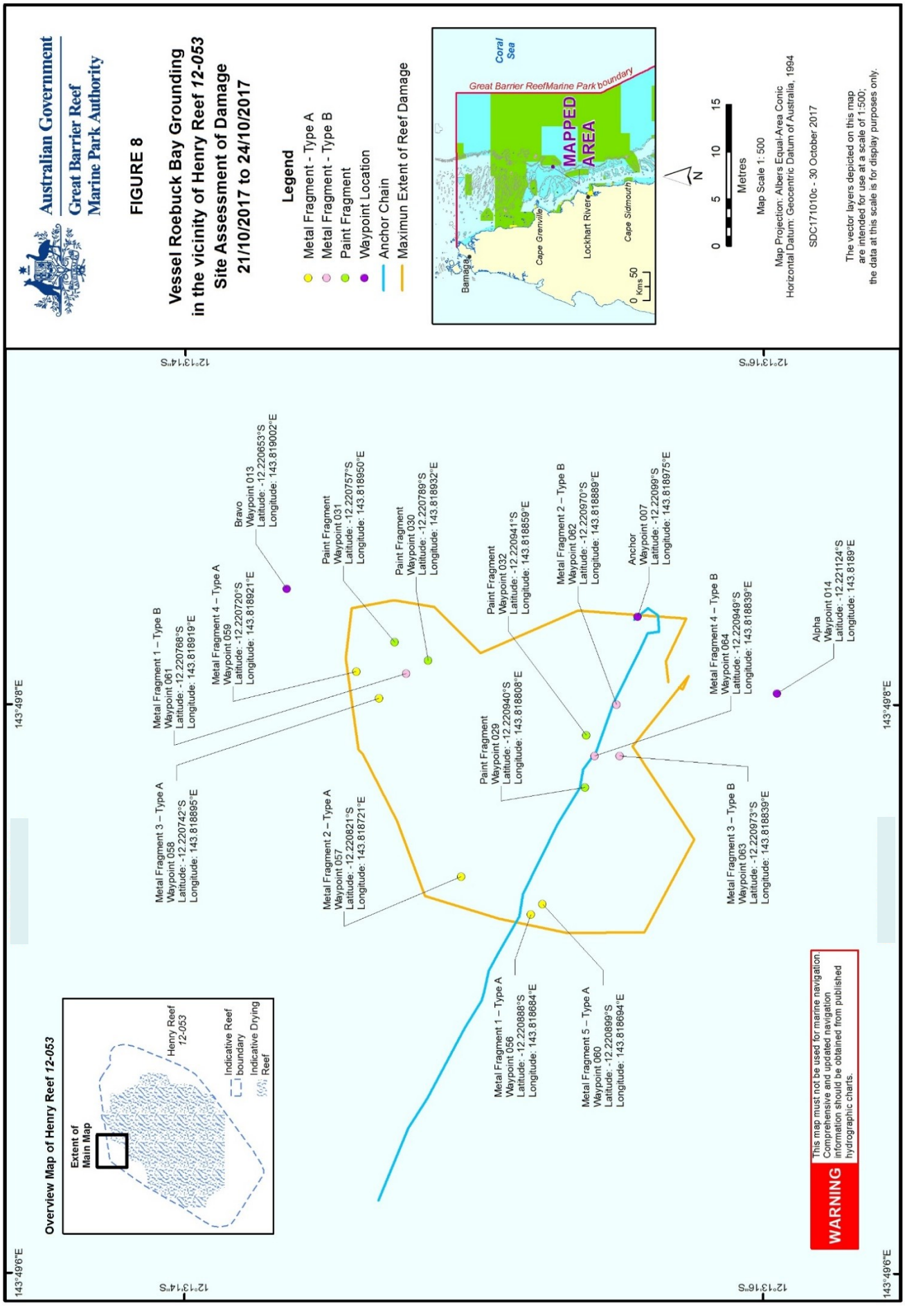

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FIGURE 8
Vessel Roebuck Bay Grounding in the vicinity of Henry Reef 12-053
Site Assessment of Damage
21/10/2017 to 24/10/2017
Legend
Metal Fragment - Type A
Metal Fragment - Type B
Paint Fragment
Waypoint Location
Anchor Chain
Maximun Extent of Reef Damage
Coral Sea
Great Barrier ReefMarine Park boundary
MAPPED AREA
Broome
Cape Grenville
Lockhart River
Cape Sidmouth
0 50 Kms
N
0 5 10 15
Metres
Map Scale 1: 500
Map Projection: Albers Equal-Area Conic
Horizontal Datum: Geocentric Datum of Australia, 1994
SDC171010c - 30 October 2017
The vector layers depicted on this map are intended for use at a scale of 1:500; the data at this scale is for display purposes only.
143°49'6"E
143°49'8"E
12°13'14"S
12°13'16"S
Overview Map of Henry Reef 12-053
Extent of Main Map
Henry Reef 12-053
Indicative Reef boundary
Indicative Drying Reef
Metal Fragment 1 – Type B
Waypoint 061
Latitude: -12.220768°S
Longitude: 143.818919°E
Metal Fragment 4 – Type A
Waypoint 059
Latitude: -12.220720°S
Longitude: 143.818921°E
Bravo
Waypoint 013
Latitude: -12.220653°S
Longitude: 143.819002°E
Paint Fragment
Waypoint 031
Latitude: -12.220757°S
Longitude: 143.818950°E
Paint Fragment
Waypoint 030
Latitude: -12.220789°S
Longitude: 143.818932°E
Metal Fragment 3 – Type A
Waypoint 058
Latitude: -12.220742°S
Longitude: 143.818895°E
Paint Fragment
Waypoint 032
Latitude: -12.220941°S
Longitude: 143.818859°E
Metal Fragment 2 – Type B
Waypoint 062
Latitude: -12.220970°S
Longitude: 143.818889°E
Anchor
Waypoint 007
Latitude: -12.22099°S
Longitude: 143.818975°E
Metal Fragment 2 – Type A
Waypoint 057
Latitude: -12.220821°S
Longitude: 143.818721°E
Paint Fragment
Waypoint 029
Latitude: -12.220940°S
Longitude: 143.818808°E
Metal Fragment 4 – Type B
Waypoint 064
Latitude: -12.220949°S
Longitude: 143.818839°E
Alpha
Waypoint 014
Latitude: -12.221124°S
Longitude: 143.8189°E
Metal Fragment 3 – Type B
Waypoint 063
Latitude: -12.220973°S
Longitude: 143.818839°E
Metal Fragment 1 – Type A
Waypoint 056
Latitude: -12.220888°S
Longitude: 143.818684°E
Metal Fragment 5 – Type A
Waypoint 060
Latitude: -12.220899°S
Longitude: 143.818694°E
WARNING
This map must not be used for marine navigation. Comprehensive and updated navigation information should be obtained from published hydrographic charts.

Across the remainder of the damaged area four pieces of “Type B” metal presumed to be aluminium hull fragments were collected as exhibits (Figure 10) and a nally crate full of this Type B metal was collected to remove debris from the site.

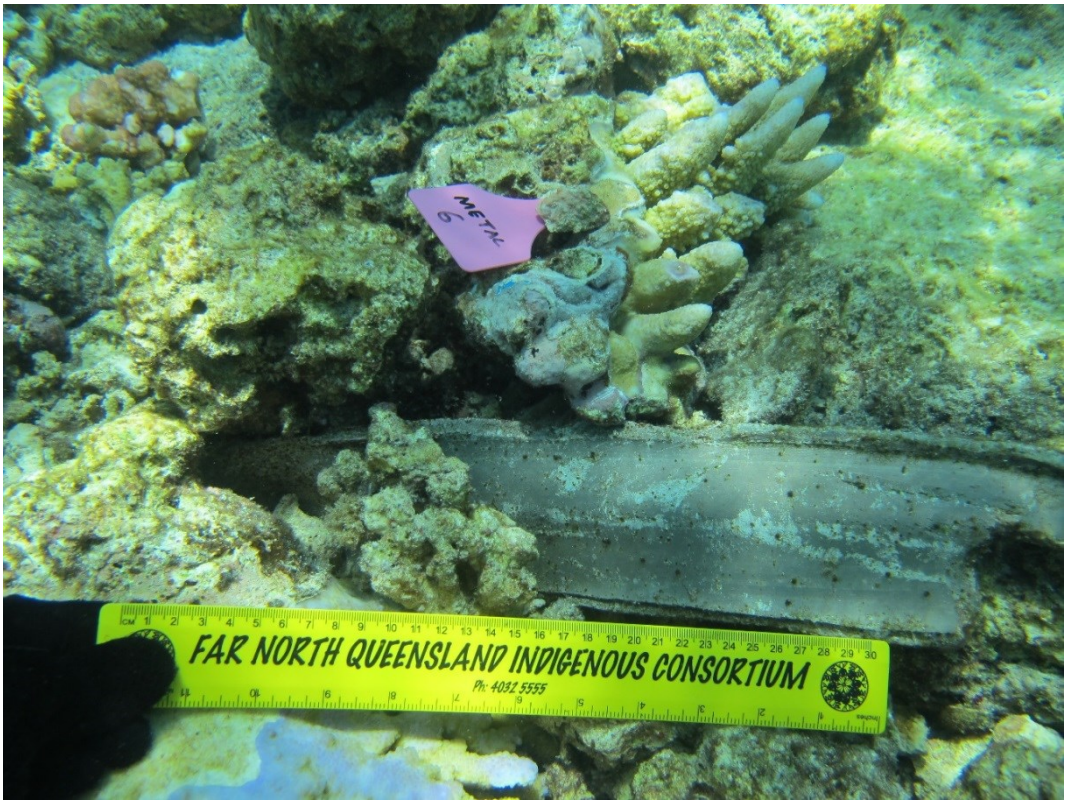


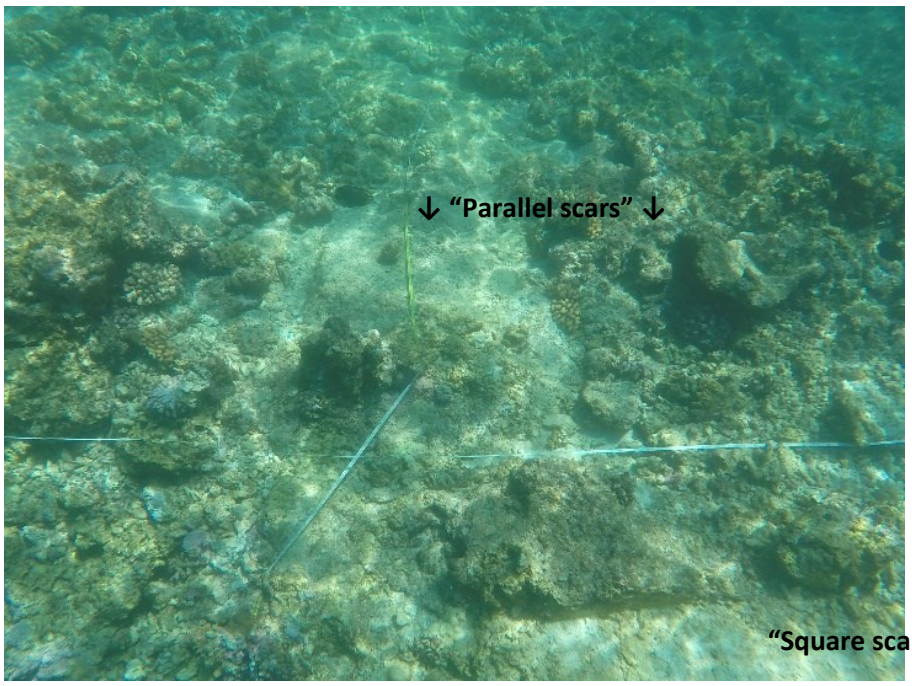
Figure 10 Metal fragment 6: Type B metal fragment collected 23 October 2017.

Within the damage footprint there were two main areas of moderate to severe damage. These were traced with the GPS using the area function, the scar along the northern extremity of damage that included all of the “Type A” metal fragments was measured as 126 m^2 and an area of damage adjacent to the anchor was measured as 58 m^2. These two areas account for about half of the overall 330 m^2 of damage estimated within the maximum extent. The 126 m^2 scar was further described by measurement and photographs:

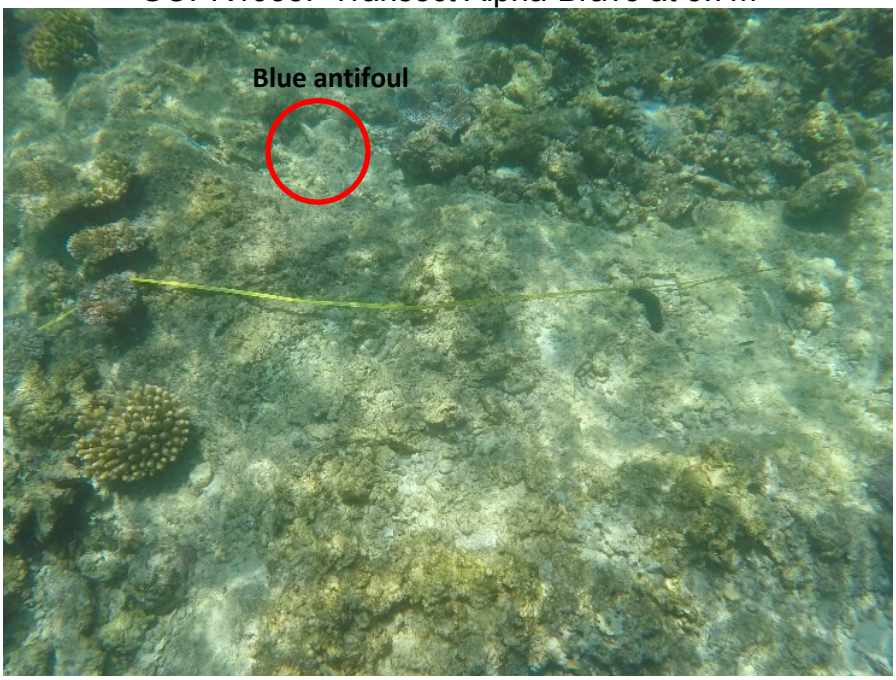
Within the north-eastern corner of the damage area (adjacent to Bravo) there was severe damage – extending from 5.7 m (Wpt 34 – Photo GOPR1955) to 12.7 m (Wpt 35 – GOPR1957) along Transect Alpha-Bravo (Figure 11). This area of damage was characterised by linear features running north-south, being two parallel scars approximately 950 mm apart depicted in GOPR1955 are more clearly visible in Figure 12, a screen grab from Video Transect 1 (see Figure 4, table of video transects).

The presence of these marks, and the height deferential between Bravo and Alpha would indicate that the vessel approached Henry Reef on a roughly southerly heading (reciprocal of 000) – corresponding to the vessel movement from Bravo in the direction of Alpha.

A second component of the 126 m^2 scar arced to the west of this inferred initial grounding site gouging into the reef matrix, consistent with powered movement across the reef flat. A 50 m tape was laid along the centre of the gouging, with the zero in the vicinity of the anchor chain and crossing the Transect Bravo-Alpha transect at 43 m. Two, roughly parallel scars were evident for approximately 12 m (45 m to 33 m along scar arc) - the scars had a clear impact area defined by broken fragments of a dark Type A metal and deep gouges to the live coral rock. These scars are interpreted as lateral movement of the aft of the vessel in an arc, from north-east to south-west (from Transect Alpha-Bravo to toward the anchor chain).



GOPR1955: Transect Alpha-Bravo at 5.7m



GOPR1957: Transect Alpha-Bravo at 12.7m

Figure 11 Severe reef damage adjacent to Bravo.

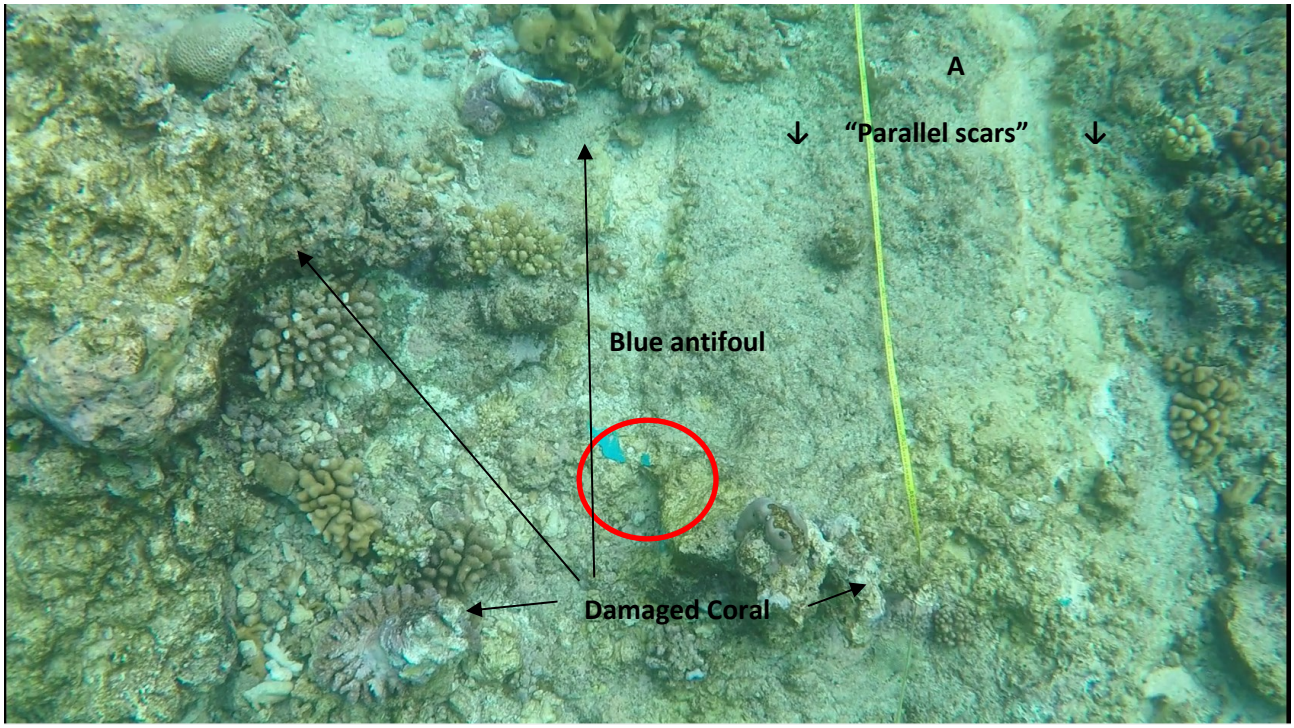


Figure 12 Still image extracted from Video Transect 1 (GoPR1715: 0:25sec); parallel scars running north-south. Evident within the image is: A – parallel scars; B - antifouling paint; C – damaged coral

The scars are evident on Video Transect 15 (GoPR1894) between 19.0 m and 31.0 m (12 m) – Figure 13.

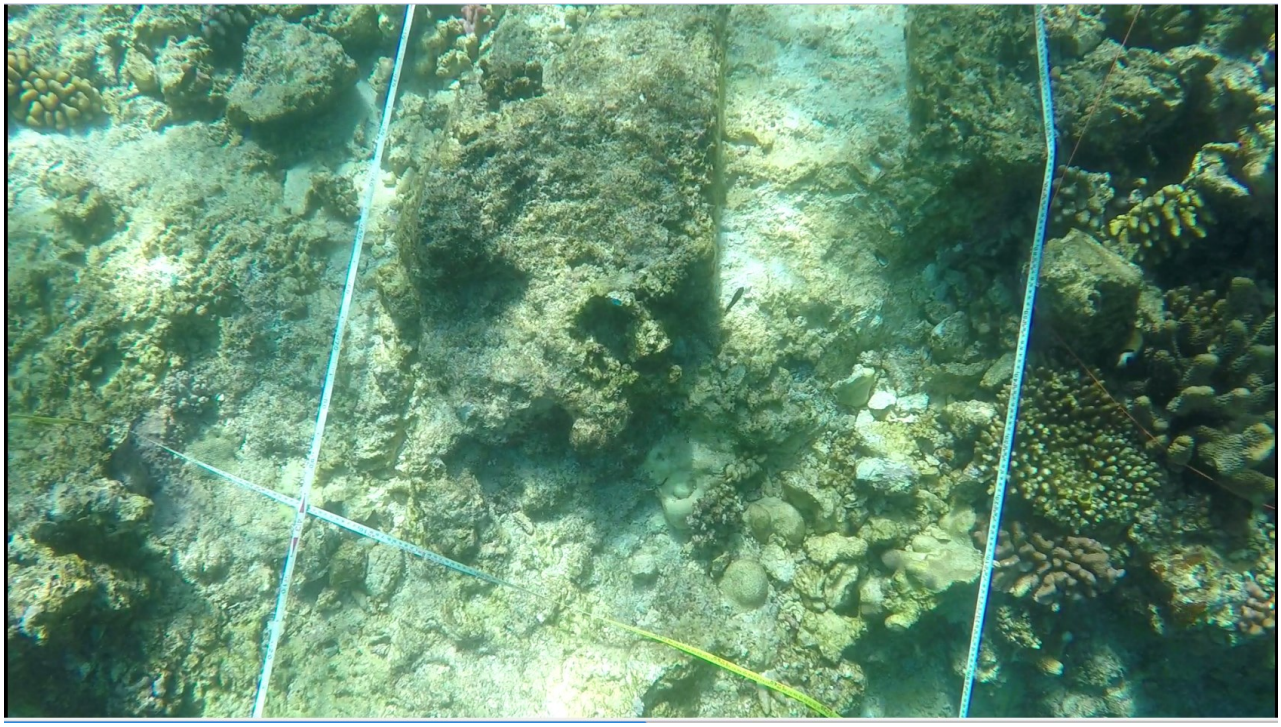


Figure 13 Still image extracted from Video Transect 15 (GoPR1894: 0:47sec) showing on the right (north/aft) A - the 300 mm "square scar" and on the left the (southern/forward) B - "irregular scar", separated by a ridge of lesser impacted reef matrix approximately 400 mm wide.

At five-metre intervals along the tape, the dimensions of the scar were measured using a rigid pole to determine the approximate level of undamaged coral structure and a plastic ruler to measure the depth from the apparent reef matrix height to the bottom of the centre scar line. Photos IMG_0067 to 0097 (taken using a Canon G11) show the measurement at these points. An example of these images is depicted in Figure 14.

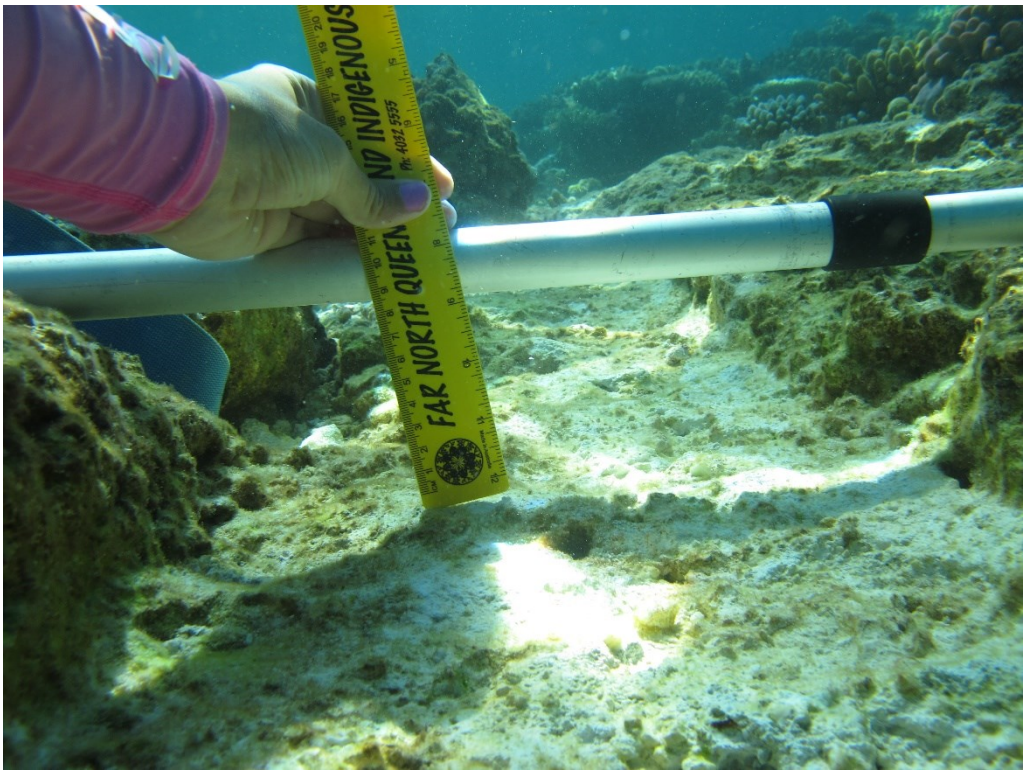


Figure 14 IMG_0090 – Officer taking measurement of scar depth of “square scar”.

The southern scar was irregular in the depth it was gouged into the reef matrix (mean 116 ± 51 mm, see Figure 15) and irregular in relation to the amount of coral debris which had fallen into the depression. The northern scar was a uniform 300 mm in width and while its depth was only measurable in 2 locations, it was slightly shallower (mean 103 ± 17 mm).

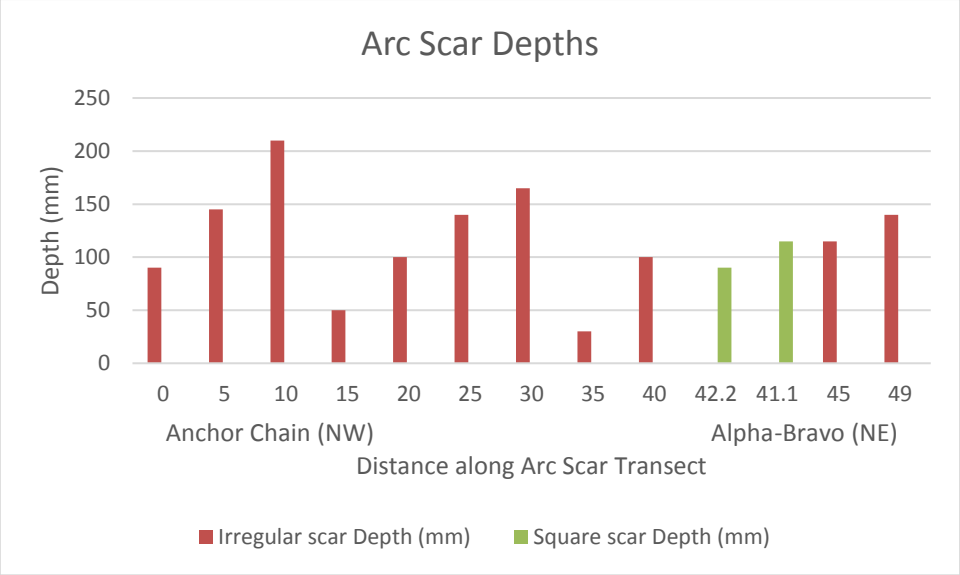


Figure 15 Aft scar depths.

A second set of measurements of distance between internal gouges on the "irregular scar" were taken after reviewing the depth observations. These were variable, ranging from gouges 90 mm long and 67 mm apart to 60 mm long and 33 mm apart (Figure 16).

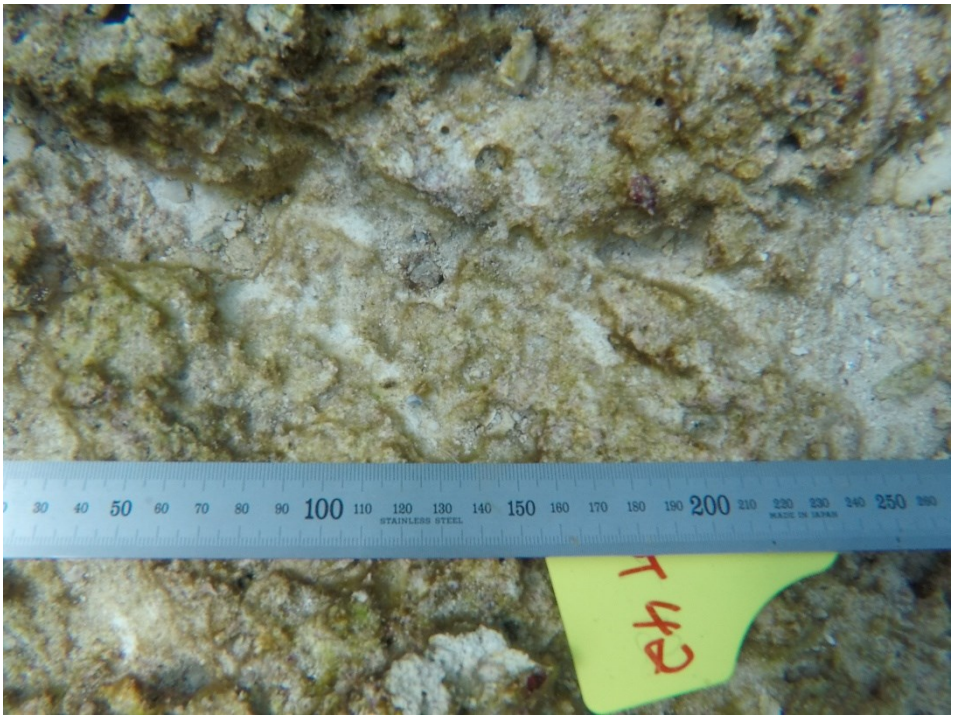


Figure 16 Close up of the "irregular scar" – Waypoint 42 – GoPR1995)

No significant damage to the reef matrix was observed. That is there was no damage to the reef matrix that would lead to further and ongoing impacts to local reef stability

– all observed damage was to live coral, reef rock or gouging impacts to the reef matrix.

No coral bleaching or disease was noted at any of the sites, with only minor animal predation observed at some sites.

Only a small amount of antifouling was observed on site and 4 samples were taken as evidence exhibits during the survey. Figures 17 to 23 depict the process of paint sample collection, processing and storage.

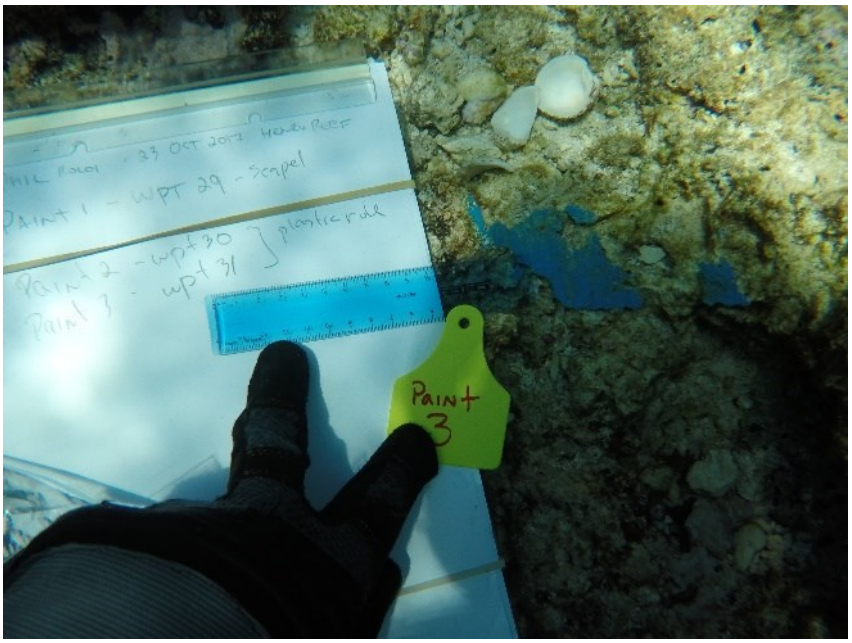
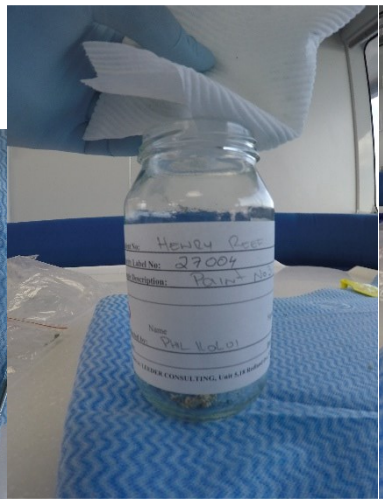


Figure 17 GoPR1946 – Paint sample 3 in situ

Figure 18 GoPR1950 – Paint sample 3 following collection with a Teflon wand placed into a sandwich bag with the waypoint cattle tag.

Figure 19 GoPR1972) - Paint sample 3 in sandwich bag and cattle tag on board the main vessel.

Figure 20 GoPR1973 – Paint sample 3 emptied onto drying paper with a cloth backing.



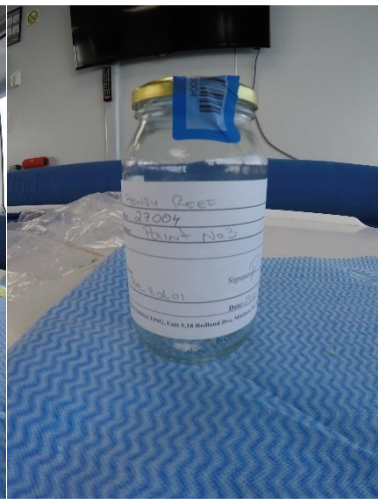


Figure 21 GoPR1976 **Figure 22** GoPR1979 **Figure 23** GoPR1980

Figure 21 – Drying sample and glass jar with security tag.

Figure 22 - Emptying paint fragments into the glass jar.

Figure 23 - Sealed jar with security sticker over the lid.

At the completion of the survey, two hours were dedicated to picking up debris and undertaking site remediation. During this time, more than 50 live coral colonies, in 14 patches, totally approximately 8 m^2 were turned over and settled into the reef matrix. Given the potential for high wave energies on this reef, no estimation of potential return to pre-impact ecologically-functional state can be given, as the next significant weather event is likely to mobilise all the damaged coral fragments.

6. RECOVERY PROSPECTS FOR THE REEF AND REMEDIATION OPTIONS

The coral debris (New Rock and New Rubble) associated with the grounding is currently mostly contained within the maximum extent of damage. However, due to the location of the site on the northern western aspect of Henry Reef (12-053), and constant swell experienced in the slight sea conditions while on site - the debris has the potential to be dispersed further across the reef flat over time or with significant northerly weather (as is often experienced in the summer months in the Far Northern Section). This may cause further damage to coral communities on the reef flat and more broadly across the reef.

The control sites demonstrate that the reef prior to damage would have been in a healthy condition, although with only moderate coral cover. The recovery of the site will depend primarily on the stabilisation of the substrate for recruitment. The broken coral fragments and any remaining metal debris will take some time to stabilise and form a solid platform suitable for successful recruitment or will continue to remain mobile until they wash off the reef flat into an area of lower wave energy.

The amount of visible antifouling paint was minimal, however given the toxic nature of this paint any amount present either smeared onto the reef matrix or as flakes within the rubble will affect the long term potential for recruitment at this site. Removal of paint and coral debris should be a priority to minimise the length of time to return the site to an ecologically functional state.

Using past experience from observations of cyclone and vessel damage, algal growth that had already begun to cover the exposed substrate and coral debris will continue over the next one to two years. Long term stabilisation of coral debris is unlikely to occur in this location, given the almost constant swell at the site. Small coral colonies may be observed within two to five years; however, their long-term prognosis will be reliant upon either stabilisation or removal of coral debris, as the next significant weather event is likely to mobilise all the damaged coral fragments.

As such, it is recommended that the following additional remedial action be undertaken:

1. Remove the anchor from the site as soon as practicable with care to minimise further coral damage;
2. Remove any further metal debris and antifouling paint from the site; which should then be removed and disposed of at a licenced mainland waste facility;
3. Stabilise mobile coral debris at the site by placing it in a location on the reef that is less likely to be affected by weather and swell. This may expose additional antifouling paint which should then be removed and disposed of at a licenced mainland waste facility.

On completion of these works it would be expected that the impact site would be able to naturally regenerate to an ecologically functional state similar to that of the control sites within five to seven years.

7. REFERENCES

Great Barrier Reef Marine Park Authority 2017, *Final report: 2016 coral bleaching event on the Great Barrier Reef*, GBRMPA, Townsville

Kerrigan, B., D. Breen, G. De'ath, J. Day, L. Fernandes, R. Partridge, and K. Dobbs. 2010. Classifying the biodiversity of the Great Barrier Reef World Heritage Area. Technical 124 report on the classification phase of the Representative Areas Program. Great Barrier Reef Marine Park Authority, Townsville.

Appendix 1: Site Assessment of Damage Request

Checklist for Site Assessment of Damage in the Great Barrier Reef

	Site assessment checklist	Level 1	Level 2	Level 3
Off site information	Aerial photo of site organised eg: by Boarder Protection Command/FOT or consider charter flight	Y	Y	Y
	Location data from google earth, satellite images, aircraft, other vessels and witnesses organised	Y	Y	Y
On site location and identification recorded	GPS of site location	Y	Y	Y
	Description and sketch of location eg: relative to reefs, islands, navigation markers	Y	Y	Y
	Notes and photos of surface features including visual guides to the location	Y	Y	Y
	Notes and photos of vessel that caused damage if present	Y	Y	Y
Measurements taken	Area of damaged site	Y	Y	Y
	Depth of damaged site	Y	Y	Y
	Sketch of damaged area	Y	Y	Y
	GPS linked drawing of site	Y	Y	Y
	Measurements of broken coral colonies		Y	Y
Descriptions recorded	Overview description of damage to site and individual coral colonies or other biota	Y	Y	Y
	Brief description of adjacent undamaged substrate including type and cover	Y	Y	Y
Samples collected	Pieces of wreckage or articles spilled from vessel collected and secured	Y	Y	Y
	Paint samples from substrate secured	Y	Y	Y
	Sediment samples			Y
	Hard substrate samples			Y
Photos taken	Above water of damage	Y	Y	Y
	Underwater of damage	Y	Y	Y
	Underwater of adjacent undamaged sites	Y	Y	Y
Video taken	Above water of damage		Y?	Y
	Underwater of damaged sites		Y?	Y
	Underwater of adjacent undamaged sites		Y?	Y
Photo/ Video transects	Underwater of damaged site		Y	Y
	Underwater of adjacent undamaged sites		Y	Y
Detailed data collected	Note possible high value biota		Y	Y
	Transects of damaged & undamaged sites		Y?	Y
	Quadrats of damaged & undamaged sites		Y?	Y
	RHIS or descriptions of undamaged sites	Y?	Y	Y
	Identification of high value biota	Y?	Y	Y
Data analysis	Video transects analysed			Y
Sites marked	Sites marked for future monitoring	Y?	Y	Y
Witnesses	Potential witnesses identified	Y	Y	Y
Notes	Notes signed and dated. Evidence secure	Y	Y	Y
Report	Report reviewed	Y	Y	Y external

FORM101: SITE ASSESSMENT OF DAMAGE REQUEST

INCIDENT NAME	**ABFC Roebuck Bay (VNZJ) grounding at Henry Reef (12-053)**		
INCIDENT DATE	**Day:** Saturday	**Date:** 30 September 2017	**Time:**0048
Author (requesting officer)	Incident Response Coordinator		
Investigator	Snr Investigator, GBRMPA		
Snr Ranger	Snr Ranger Far North Management Unit		
SAD Officer	Incident Response Coordinator Queensland Parks and Wildlife Rangers		
Likely SAD level	Level 2	Modified RHIS + Line intercept and/or quadrate transects + samples of antifouling if visible + permanently mark the site (optional)	

RECOMMENDED EQUIPEMENT (please read remainder of the plan to check you have all necessary equipment – your help making this list more complete would be appreciated!)

50 m Tapes	A minimum of 1, but possibly up to 5 to allow tapes to be laid along scaring and measurements taken both horizontally and vertically
GPS and tow boards	A minimum of 2 – in case one floods or is otherwise corrupted
1 m or 50 cm quadrats	To allow for quadrat sampling
Underwater camera **SD cards**	A minimum of 1, but 2 or more is recommended. To allow underwater images, please us scaling bar or other object of consistent size in each image **NOTE ensure GPS and camera times are synchronised** **Minimum of 2 SD cards for each camera** – note before leaving port fit the SD card and take a photo to ensure data records.
Water proof note paper and RHIS sheets	Collection of data – ensure you have enough before leaving port.

4. INCIDENT DESCRIPTION (AS CURRENTLY REPORTED):

INCIDENT DESCRIPTION
Sitrep 1 30/09/17 0300 - Advice received from RCC that non reporting customs vessel has run aground on Henry Reef. 11 POB. RCC and Cairns VTS have been dealing with this incident. Three vessels are inbound to assist. Toll Firefly has left the DSA to provide immediate assistance, and following are the Coral Knight, and Cape Fourcroy. Sitrep 2 30/09 0600 - Master has confirmed that two compartments are compromised. Should be able to safely tow the vessel UNLESS it sustains further damage when coming off the reef. RCC is still monitoring the situation. Sitrep 3 30/1315hrs Sep 2017 - ACV Cape Inscription identified as being in location with the ACV Roebuck Bay aground at Henry Reef. ReefVTS does not have VHF coverage of the incident location and is unable to confirm the intentions of the vessels. RCC advised by phone. Sitrep 4 30/12457hrs Sep 2017 - Toll Firefly had departed the location. 30/1727hrs Sep 2017 - Coral Knight identified on TIM as being in location with the ACV Roebuck Bay, RCC called and advised. RCC mentioned that assessments will be conducted and attempts made to recover the ACV Roebuck Bay at approximately 1900hrs this evening. 1. AT 300800UTC SEP 17 JRCC AUSTRALIA PASSED INCIDENT COORDINATION FOR THE RESPONSE TO THE GROUNDING OF ABFC ROEBUCK BAY TO AUSTRALIAN BORDER FORCE. 2. AT 300310UTC SEP 17 THE BARGE TOLL FIREFLY/VJN3664 WAS RELEASED AFTER THE ARRIVAL ONSCENE OF THE ADV CAPE INSCRIPTION. THE EMERGENCY TOWAGE VESSEL CORAL KNIGHT ARRIVED ONSCENE AT 300730UTC SEP 17. 3. ABFC ROEBUCK BAY WAS REFLOATED ON HIGH TIDE WITH THE ASSISTANCE OF THE CORAL KNIGHT AT APPROXIMATELY 300940UTC SEP 17. 4. ABFC ROEBUCK BAY IS NOW ALONGSIDE CORAL KNIGHT WITH ENGINEERING STAFF FROM BOTH VESSELS CONDUCTING DAMAGE ASSESSMENT. 5. INTENTIONS AT THIS TIME ARE TO AWAIT UNTIL DAYLIGHT 01 OCT 17 FOR ENGINEERING STAFF TO CONDUCT FURTHER DAMAGE ASSESSMENT WITH THE ULTIMATE INTENTION OF TOWING ROEBUCK BAY TO CAIRNS IF SAFE TO DO SO. ABFC Roebuck Bay ran aground on Henry Reef, 33nm North East of Cape Weymouth - Great Barrier Reef. The vessel reported two compartments flooded and no injuries to the 11 crew on board. Initial Damage assessment for Roebuck Bay was as follows; * Forward void significant tears in hull, gash 75cm x 10cm either side of keel with hull plating folded into hull near the bulk head with the fresh water void. * Fresh water void tear approx. 45cm x 30cm x 30cm (triangular tear) at bulk head between fresh water void and forward void, two plate incursions port side of keel, 20 cm cracks in hull, Stb side of keel x2 crack about 25cm long, one puncher approx. 2cm diameter all near the common bulkhead of fresh water void and forward void. ABFC Roebuck Bay was towed back to Cairns aft first arriving approximately 1200 on 4 October 2017.

INCIDENT LOCATION

LATITUDE	12.220833 S 12° 13.250'S	LONGITUDE	143.8190° E 143° 49.140'E

LOCATION DESCRIPTION

- Far Northern Section
- Henry Reef: 12-053
- Habitat Protection Zone:
- Approximately 33 nm NE of Cape Weymouth

5. PLOT INCIDENT LOCATION ON A CHART OR MAP

6. DETERMINE TYPE OF INCIDENT

Grounding

7. INCIDENT INFORMATION

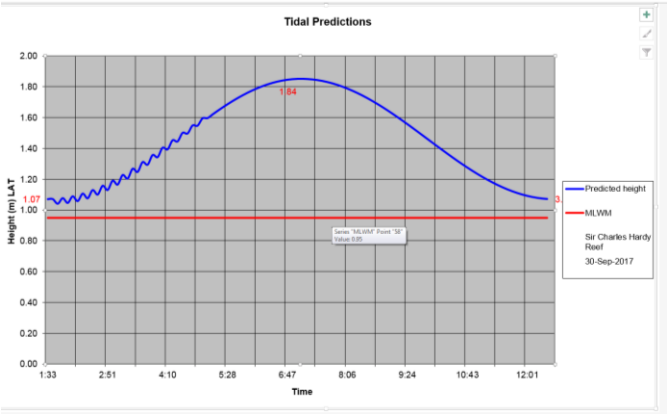
Has a vessel grounding, collision or sinking incident occurred?

Vessel TYPE (s) involved	• Australian Border Force Cutter "Roebuck Bay" (ACV 10)
	• Fishing Symbols: FFWF
	• Built: 1969
	• Constructions: wooden
	• LOA: 38.2 metres
	• Activity: Patrol Vessel
	• Ancillary vessels: 2 dories
	• Vessels Specification (generic for Bay Class):
	  ○ Beam: 7.2 m
	  ○ Draft: 2.4 m
	  ○ Gross Tonnage: 134 T
	  ○ Diesel Fuel: TBA metric tonnes
	  ○ Unleaded Fuel: TBA metric tonnes
	ACV10 Roebuck Bay was removed from Henry Reef (12-053) at approximately 1940 on the eventing of 30 December 2014. After being aground for approximately 14 hours. Crew reports:
	Initial Damage assessment for Roebuck Bay was as follows; * Forward void significant tears in hull, gash 75cm x 10cm either side of keel with hull plating folded into hull near the bulk head with the fresh water void. * Fresh water void tear approx. 45cm x 30cm x 30cm (triangular tear) at bulk head between fresh water void and forward void, two plate incursions port side of keel, 20 cm cracks in hull, Stb side of keel x2 crack about 25cm long, one puncher approx. 2cm diameter all near the common bulkhead of fresh water void and forward void.

Resources affected and any likely Impacts	From aerial imagery provided by MBC, it is estimated that the impact scar is likely to exist in the location of where the vessel came to rest. Note that the images above were taken while the vessel was aground – additional impact may have occurred while attempting to re-float. There appears to be a sediment halo to the eastern (port side) of the scar – it is unclear the exact nature of this impact, but will be worth investigating propeller impacts in the vicinity of the aft of the scar. The apparent nature of the coral in this location is low growth forms, the apparent nature of the damage is damage to coral colonies and some gouging of the reef matrix, although the major "scar" immediately aft of the vessel appears to be at least partially a natural break in coral cover. There has been no reported spill of diesel or unleaded fuel, therefore there is not likely to be petroleum pollution related resource impacts. The vessel is greater than 25 m and was built post 1999 (sunset date for zero TBT use on Australian vessels over 25 m), it is unlikely that TBT based antifoulants had been applied. No details have been obtained about the actual antifoulants used on the vessel – if paint is observed, it should be mapped and samples taken if possible. It is likely to be high in Copper and Zinc and other compounds which are harmful to corals and other marine organisms. LIKELY IMPACTS Damage to habitat as a result of grounding event. Damage to habitat as a result of salvage attempts. Damage to biota due to antifoulants (including a potential medium term halo effect out to 10s of metres)
Preliminary spill risk assessment	Vessel now removed, no oil spill reported

8. SITE CONDITIONS AT TIME OF DAMAGE:

TIDE: Using Sir Charles Hardy as datum - 27 minutes after Leggatt Reef; approximately same heights



	Tide Height	Tide Time
High Tide (29/9)	2.38 m	1904
Low Tide (30/9)	1.07 m	0143
High Tide	1.85 m	0705
Low Tide	1.04 m	1248
Mean Low Water	0.95 m	
Range	1.04 m	

Tide in the week 21 to 25 October potentially range from 0.7 m to 2.39 m (range 1.7 m) on 21st to 1.21 m to 1.98 m (range 0.77 m) on the 25th.

9. SITE ASSESSMENT OF DAMAGE PLAN:

Any changes or decisions made in relation to the Site Assessment of Damage Plan deemed necessary by the officers on site should be made in consideration of the Purpose of the SAD (modifications for purposes of safety or impact of tide or available period work are probable).

	Site orientation imagery
Things to look out for	**1.** Search the reef crest for the initial grounding site: a. Can any indication that the vessel was underway/drifting be observed? b. Is there any indication of attempted self salvage? c. What damage can be observed associated with the deployment of the anchor? d. Is there any indication of anchor scaring in deeper water that may indicate the vessel damaged corals off the reef crest during initial impact or salvage?? **2.** The general direction of the main scar, indications of where the propeller may have been engaged **3.** Ensure adequate “control” transects, preferably either side of the main scar

REMINDER: ensure that GPS and camera times are synchronised to allow positioning of images.

SITE ASSESSMENT OF DAMAGE METHOD	
Purpose	To undertake a systematic assessment of the vessel grounding site, to provide information to support the investigation of the grounding; including nature and scale of damage sustained and potential sequence of events.
Objectives	**4.** Determine the spatial extent of damage; GPS positions, length, width and depth of any observed damage **5.** Determine the nature of damage and attribute possible causes based on observations **6.** Collect spatially (GPS) referenced imagery, foreign objects from within and adjacent to the ground site
Tasks	**1.** Undertake a orientating snorkel/dive around the site, towing a GPS in track mode: - Mark and record waypoints and take notes of major features of the site - What you are looking for here is the maximum extent of damage associated with the grounding including damage that may have been caused during salvage. It may be that there are "patches of damage", you can identify these by start-end waypoints, but the primary purpose it to ensure that ALL damage associated with grounding is recorded – this **may** require a swim of 100s of metres away from reported grounding. **2.** Map the significant damage scars using GPS: - GPS mark start and end points of the scar - Lay tapes (10m/50m or multiple tapes) along the length of the scaring - Measure the length and width of the scar **3.** Sketch a plan of the damage site, making relevant notes to identify type of damage, foreign objects etc identified in 2. DAMAGE ESTIMATES - consider the time you have available and undertake A or B or A & B and C: (If using a control transect, select a location of habitat undamaged by the grounding that is of similar depth profile, orientation and distance from reef crest as the main scar) *A.* "LEVEL 1" **(rapid assessment – standard RHIS)** *This technique utilises the standard 5 m radius RHIS circle, but may underestimate the damage associated with a grounding because the circle includes impacted and non-impacted habitat.* - Undertake a minimum of 1 RHIS centred on the main axis of the scar, undertake an additional RHIS in accordance with Table 1 - Undertake this same number of RHIS as you have taken above along a selected control transect, centroids separated by a minimum of 15 m – the control transect should be wholly outside the impact zone (see 1 above) – where possible two control transects should be selected either side of the impact zone in "similar habitat" ie reef flat, reef slope etc *B.* Level 1 (rapid assessment - modified RHIS) *"an experimental survey technique" – This technique has not been a part of standard SAD training but utilises a modified RHIS circle radius to ensure only impact OR control are recorded for each replicate.* ***This will require greater level of thought when calculating percentages – it MUST be clearly recorded on the datasheet that a non-5m RHIS was completed.*** *Without detailed analysis, this technique would appear to provide a more accurate impact assessment.* - Consider the dimensions of the impact scar - what is the largest circle that can fit inside the scar? SET this ad the radius of a the modified

RHIS circle and undertake a minimum of 1 mRHIS centred on the main axis of the scar, undertake an additional mRHIS in accordance with

	STD RHIS (5 m radius) Minimum distance b/w centres 15 m		Modified RHIS (# m radius)
	Linear (scar length)	Area (scar area)	Area Only
1	0 m to 15 m	0 m^2 to 300 m^2	0 m^2 to 4∏r^2
2	15 m to 25 m	300 m^2 to 750 m^2	4∏r^2 to 10∏r^2
3	25-50	750 m^2 to 1200 m^2	9∏r^2 to 15∏r^2
4	50+	1200 m^2 +	16∏r^2

Table 3

Table 1: RHIS sample numbers

- LEVEL 2 (additional techniques) If time allows, using the 50 m tape along the long axis of the scar and undertake a "Fish Bone" assessment (measure width of damage in both directions of scar at 1, 2 or 5 m intervals), makes notes in relation to damage category, including "no visible damage"
    - ELSE as a "rapid assessment" make an estimate of the width of the scar at a minimum of 5 m intervals.

C. **(high rigor data collection)** Estimate the percentage of coral cover, coral damage and other major benthos types within the main scar and a control transect, using:
    - Quadrats AND
    - Photo Quadrats

(take photos of the quadrates including tape for spatial reference for later verification of percentages)

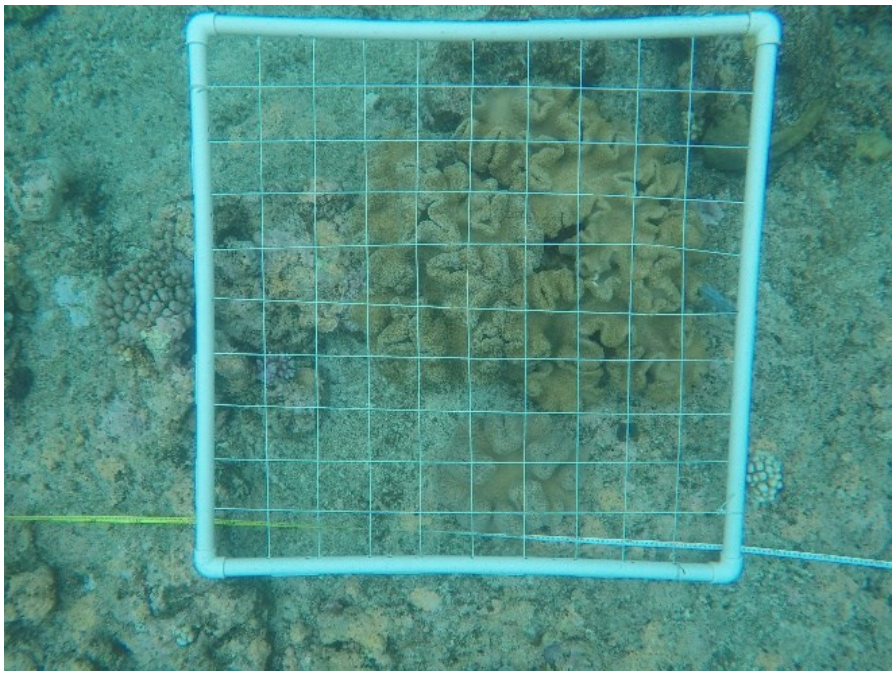
    - Note the estimated damage classification within the scar:
        - Cat 1: substrate crushed, all live coral destroyed
        - Cat 2: substrate gouged. Fractured or broken, most live coral damaged
        - Cat 3: substrate undamaged. Some live coral damaged.
        - No visible damage.

D. **(depth of damage assessment)** Using 50 m tapes laid out previously for reference, measure depth along main scar line:
    - At a minimum "Relative depth" (not water depth but depth of the damage – depth from undamaged to depth of scar) at 5 m intervals, but preferably at sites of significant damage OR at 1, 2 or 5 m intervals
    - If possible record the "Absolute depth" of depth of water above scar AND depth of water above live coral, as a proxy for amount of coral removed/damaged
        - If depth below current sea-level and time are recorded, a depth relative to LAT can be determined in analysis

4. Take GPS referenced photographs of the site and major features:
- Take notes in relation to any observations or indications through damage to coral, reef etc that may show directions of travel, or sequence of damage.
- Of particular interest from the aerial photography are the two areas of apparent prop washed sand. What are your thoughts on these areas?
- Immediately aft of where the vessel lay, there appears to be a "natural" gap in the coral. Photograph and notes associated with this feature would be appreciated.
- Any indication of damage of anchors, booms or dories would be of

	interest. **5.** Collect as GPS referenced evidence, any foreign objects pieces of timber, copper nails, steel pieces, paint flakes and smears etc that maybe left behind (Vessel has a steel shoe on keel) - Note you may wish to use flagging tape to make these items (tie to nearby coral) when you first see them (while undertaking Tasks 1, 3 or 4) to come back and collect **6.** Take any other measurements that you consider relevant to achieving the Purpose of this Site Assessment of Damage. **7.** When all data/exhibits are collected and you are satisfied with the evidence collected, make a determination of what if any remedial actions can be taken in the time available to you. - Ensure that you take a GPS referenced before and after photograph of each action - Consider removing flaked or smeared antifouling using dive knife and placing into a plastic bag for disposal (ensure that sample has been collected for evidentiary purposes) - Consider collecting broken corals. Given the likely exposure of this site to strong tidal currents, this live coral should be placed (dropped over the side if not safe to place) at depth of > 5 m and possibly > 10 m. What you are trying to do here is minimise further damage to corals from fragments rolling around live coral. If you consider the are no suitable receiving sites, dispose of coral as waste.

Appendix 2: Representative quadrates with notes on observations.



Arm A: Quadrat A1 (GoPR1898) – Control depicts 42 per cent soft coral and 57 per cent Old Rock

Arm A: Quadrat A20 (GoPR1918) – Impact depicts 16 per cent Hard Coral, 11 per cent Old Rock and 71 per cent New Rock. There is a small amount, less than 10 cm^2, of antifouling paint evident in the top left quarter of A20.

Figure 13 Arm B: B37 - Control B22 – Impact

Figure 13 depicts quadrat B22 (GoPR1920) – 88 per cent New Rock, a small smeared area of blue antifouling paint is present in the lower centre of this quadrat. B37 (GoPR1935) – 15 per cent Hard Coral and 84 per cent Old Rock is typical of the un-impacted reef as it drops off the reef flat into the upper reef slope on the north western aspects of Henry Reef.

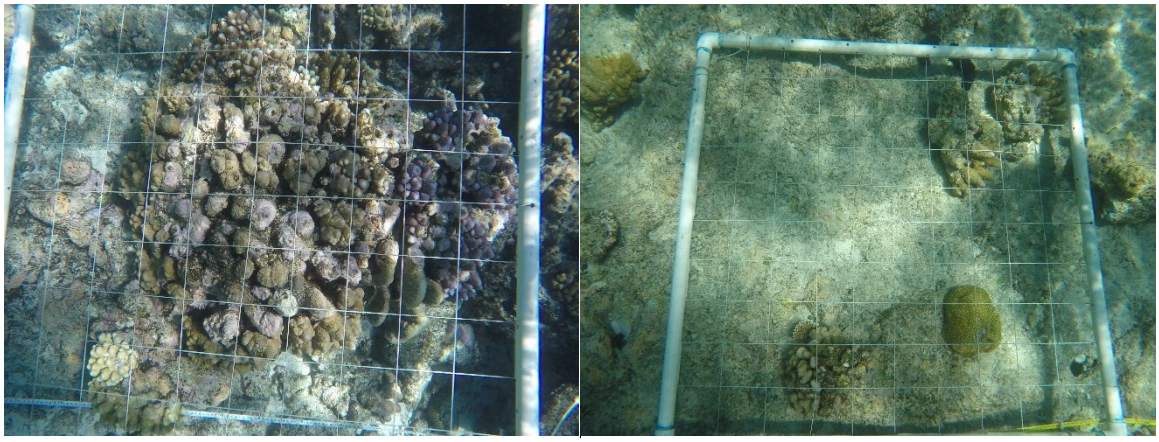


Figure 14 Arm C: C2 – Control C19 - Impact

Figure 14 depicts quadrat C2 (GoPR1847) – 33 per cent Live Coral and 65 per cent Old Rock and C19 (GoPR1864) – 4 per centLive Coral (hard + soft coral), 86 per cent Old Rock and 11 per cent New Rock; of note in this is image is the area of “New Rock” in the upper right quadrant. At the time of the Site Assessment of Damage (22 October 2017), the upper surfaces were alive, however the underside had bleached and tissue was undergoing necrosis.

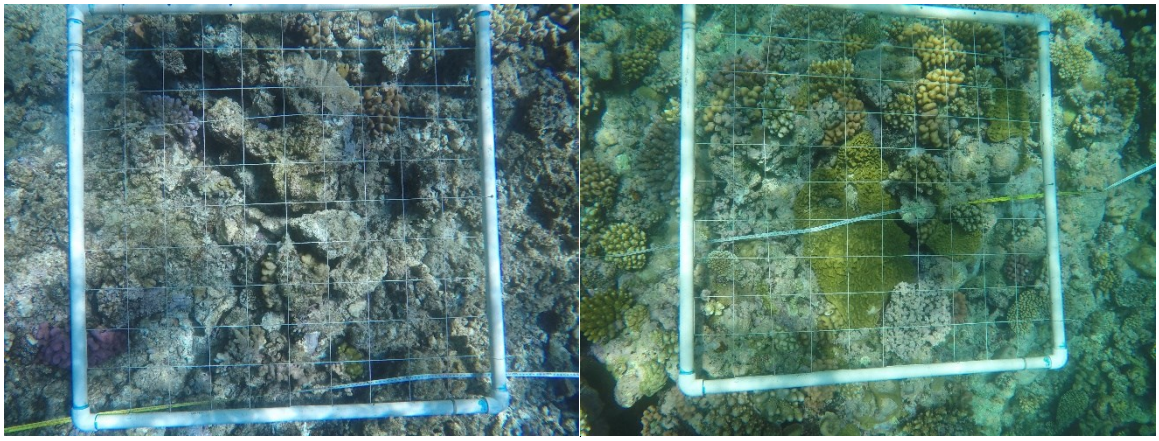


Figure 15 Arm D: D32 Impact D46 - Control

Figure 15 depicts D32 (GoPr1876) – 2 per cent Live Coral and 94 per cent New Rock, this quadrat was dominated by 10 cm to 30 cm diameter chunks of damaged coral. D46 (GoPr1890) depicts 31 per cent Live Coral and 67 per cent Old Rock. A single colony of soft coral in the centre of the quadrat comprises half the live coral cover.

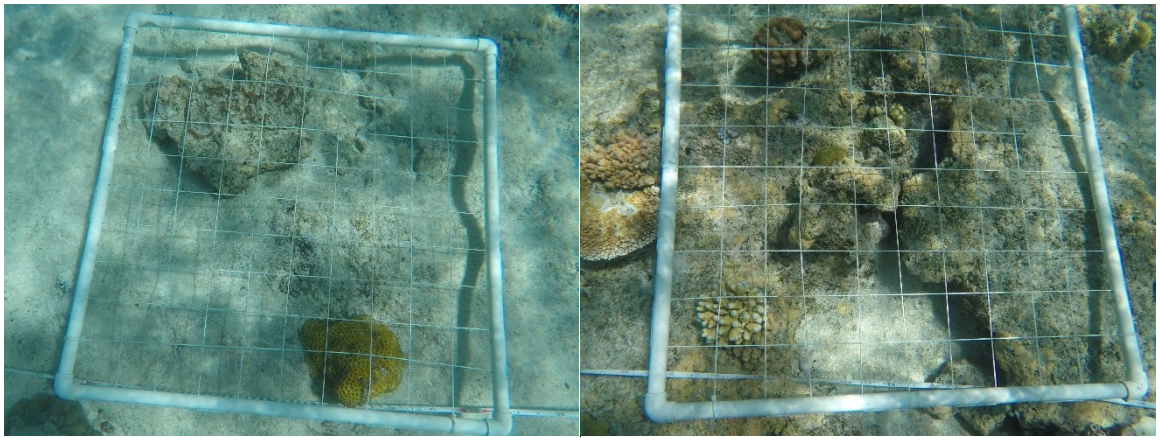


Figure 16 Arm E: E12 Control E15 - Impact

Figure 16 depicts E12 (GoPr1731) – 79 per cent Old Rock and 14 per cent New Rock – although this quadrate was initially identified to be outside the maximum extent of damage, the large Damaged coral fragment in the upper left corner of the quadrat is interpreted to be a piece of live coral rock somehow moved they vessel either in the process of grounding or in the process of attempted salvage. E15 (GoPR1728) – 11 per cent Live Coral and 81 per cent Old Rock, although within the maximum extent of damage exhibits no observed vessel induced impacts.

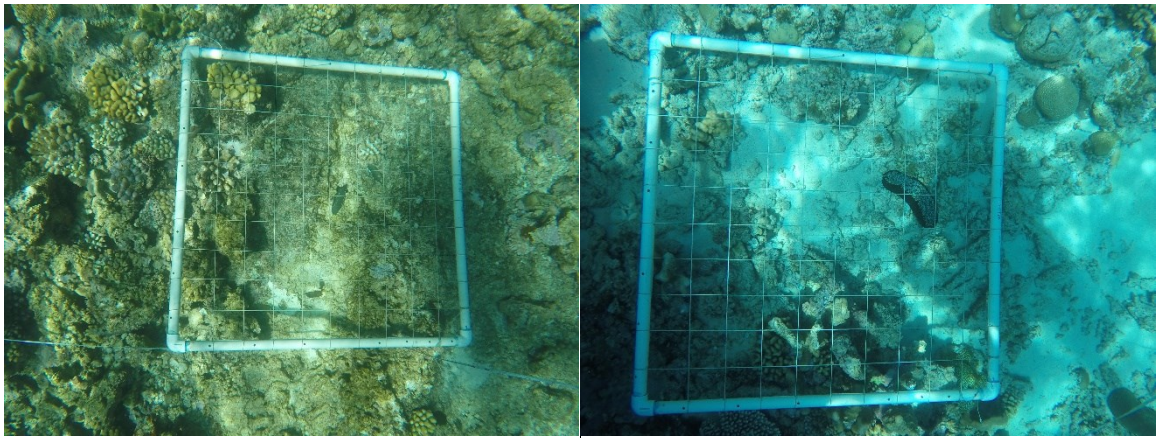


Figure 17 Arm F: F23 Impact F30 - Control

Figure 17 depicts F23 (GoPr1779) – 5 per cent Live Coral, 30 Old Rock and 65 per cent New Rock, of note in this image are the four (4) pieces of Type A metal along the central vertical axis of the quadrat and the associated “irregular scar”. F30 (GoPr1786) – 5 per cent Live Coral, 71 per cent Sand and 24 per cent Old Rock is typical of the shallow shelf on the north western aspect of Henry Reef, this location was in a small gutter between sections of reef flat.

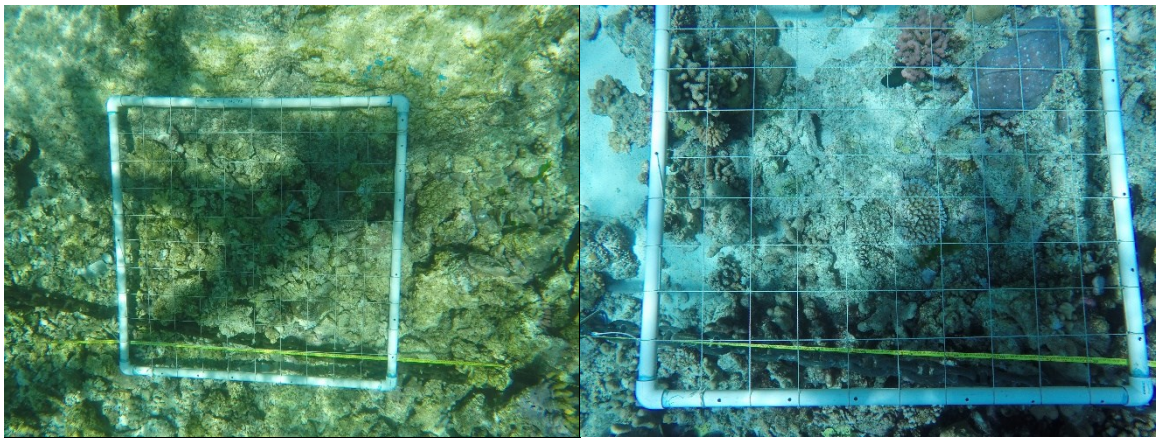


Figure 18 Arm H: H22 Impact H36 - Control

Figure 18 depicts H22 (GoPR1822) – 13 per cent Old Rock and 87 per cent New Rock, this quadrat is dominated by New Rock with a small flake of blue antifouling paint in the centre right of the image and H36 (GoPR1836) – 10 Live Coral and 81 per cent Old Rock.

Figure 19 Arm G: G3 Control G6 - Impact

Figure 19 depicts G3 (GoPR1790) – 97 per cent Old Rock and G6 (GoPR1793) – 5 per cent Live Coral, 81 per cent Old Rock and 13 per cent New Rock. Of note in the centre of the image is a loop of chain and New Rock sitting on top of the chain.

APPENDIX 3: GPS Waypoints

WAY POINTS: IRC Garmin 78sc: GDA94

WPT	Field Description	Lat	Long
Wpt 1	Anchor – start SAD area check	-12.22100	143.81897
Wpt 2	Gouge & change GPS case	-12.22075	143.81902
Wpt 3	Start SAD area (restart)	-12.22076	143.81897
Wpt 4	Eastern turn	-12.22035	143.81976
Wpt 5	Western turn	-12.22145	143.81776
Wpt 6	Chain – where Dater II linked on	-12.22085	143.81862
Wpt 7	Anchor	-12.22099	143.81897
Wpt 8	Chain – where Dater II linked on	-12.22085	143.81863
Wpt 9	Drop-off – chain into deep water	-12.22079	143.81850
Wpt 10	Loose sight of chain	-12.22074	143.81839
Wpt 11	Start perimeter swim	-12.22102	143.81889
Wpt 12	End perimeter swim	-12.22103	143.81891
Wpt 13	Bravo – start Vid 1 (0m)	-12.22065	143.81900
Wpt 14	Alpha – end Vid 1 & start Vid 2 (50m)	-12.22112	143.81889
Wpt 15	Bravo – end Vid 2 (0m)	-12.22066	143.81898
Wpt 16	Start Vid 3 (50m) – 35 m transect (G&H)	-12.22083	143.81860
Wpt 17	End Vid 3 & start Vid 4 (0m)	-12.22100	143.81903
Wpt 18	End Vid 4 (50)	-12.22077	143.81850
Wpt 19	Start Vid 5 & End Vid (0m) – 25 m transect (E&F)	-12.22089	143.81909
Wpt 20	End Vid 5 & Start Vid 6 (50 m)	-12.22076	143.81866
Wpt 21	Start Vid 10 – perimeter	-12.22103	143.81897
Wpt 22	End Vid 10 – perimeter	-12.22101	143.81897
Wpt 23	Start Vid 11 – aft scar	-12.22073	143.81902
Wpt 24	End Vid 11 – aft scar	-12.22096	143.81868
Wpt 25	Start Vid 12 & End Vid 13 – 15m transect (D-C)	-12.22072	143.81873
Wpt 26	End Vid 12 & Start Vid 13 – 15m transect (C-D)	-12.22083	143.81914
Wpt 27	Start Vid 14 & End Vid 15 – 5m transect (B-A)	-12.22071	143.81877
Wpt 28	End Vid 14 & Start Vid 15 – 5m transect (A-B)	-12.22074	143.81915
Wpt 29	Paint 1	-12.22094	143.81880
Wpt 30	Paint 2	-12.22079	143.81894
Wpt 31	Paint 3	-12.22076	143.81895
Wpt 32	Paint 4	-12.22094	143.81886
Wpt 33	Photo 60 (GOPR1955)	-12.22074	143.81879
Wpt 34	Start of damage Bravo (5.70m on tape) Photo 61 (GOPR1956)	-12.22074	143.81897
Wpt 35	Photo 62 (GOPR1957)	-12.22081	143.81895
Wpt 36	Photo 63 (GOPR1958)	-12.22089	143.81895
Wpt 37	End damage Alpha	-12.22102	143.81892
Wpt 38	Start damage chain	-12.22103	143.81897
Wpt 39	End Damage Charlie	-12.22090	143.81873
Wpt 40	Start severe damage perimeter	-12.22090	143.81873
Wpt 41	End severe damage perimeter	-12.22089	143.81871
Wpt 42	Propeller scar measurement – Photo GOPR1995	-12.22071	143.81886
Wpt 43	Propeller scar measurement – Photo GOPR1996	-12.22072	143.81894

WAY POINTS: IRC Garmin 68sc: WGA84

WPT	Field Description	Lat	Long
Wpt 046	RHIS 1 - Impact	-12.220771	143.818886
Wpt 047	RHIS 2 - Impact	-12.220830	143.818775
Wpt 048	RHIS 3 – Impact	-12.220896	1 43.818846
Wpt 049	RHIS 4 – Control	-12.221178	143.818417
Wpt 050	RHIS 5 – Control	-12.221299	143.818217
Wpt 051	RHIS 6 – Control	-12.221448	143.817942
Wpt 052	RHIS 7 – Control	-12.220523	143.819262
Wpt 053	RHIS 8 – Control	-12.220487	143.819532
Wpt 054	RHIS 9 – Control	-12.220564	143.819856

WAY POINTS: IRC Garmin 68sc: WGA84

WPT	Field Description	Lat	Long
Wpt 055	Rectangular Scar	-12.220917	143.818709
Wpt 056	Metal Fragment 1 – Type A	-12.220888	143.818684
Wpt 057	Metal Fragment 2 – Type A	-12.220821	143.818721
Wpt 058	Metal Fragment 3 – Type A	-12.220742	143.818895
Wpt 059	Metal Fragment 4 – Type A	-12.220720	143.818921
Wpt 060	Metal Fragment 5 – Type A	-12.220899	143.818694
Wpt 061	Metal Fragment 1 – Type B	-12.220768	143.818919
Wpt 062	Metal Fragment 2 – Type B	-12.220970	143.818889
Wpt 063	Metal Fragment 3 – Type B	-12.220973	143.818839
Wpt 064	Metal Fragment 4 – Type B	-12.220949	143.818839