Douglas Shoal Remediation Project Environmental Monitoring: Baseline Survey 1 – Preliminary Fieldwork Report

Reference: R.B23282.005.03.Preliminary Report Baseline Survey 1.docx
Date: December 2019

Published by the Great Barrier Reef Marine Park Authority

ISBN 9780648721574

This document was prepared by BMT Commercial Australia Pty Ltd for consideration by the Great Barrier Reef Marine Park Authority (the Authority) as part of the Douglas Shoal Environmental Remediation Project, and has been made available by the Authority on the understanding that users exercise their own skill and care with respect to its use. The contents do not represent Australian Government policy. Publication of this document does not indicate a commitment to a particular course of action.

A catalogue record for this publication is available from the National Library of Australia

This publication should be cited as:

Jones, C. and Brassil, W. 2019, *Douglas Shoal remediation project: environmental monitoring: baseline survey 1 – preliminary fieldwork report.* Prepared by BMT Commercial Australia Pty Ltd for the Great Barrier Reef Marine Park Authority, Townsville, Australia.

Comments and questions regarding this document are welcome and should be addressed to:

Australian Government
Great Barrier Reef
Marine Park Authority

Great Barrier Reef Marine Park Authority
2–68 Flinders Street
PO Box 1379
Townsville QLD 4810, Australia

Phone: (07) 4750 0700
Fax: (07) 4772 6093
Email: info@gbrmpa.gov.au
www.gbrmpa.gov.au

Executive Summary

In April 2010, the bulk carrier Shen Neng 1 grounded on Douglas Shoal in the Capricorn Bunker region of the Great Barrier Reef Marine Park. The carrier remained on the reef for 10 days before it was salvaged, producing the largest grounding scar (42 ha) in the marine park to date. The Great Barrier Reef Marine Park Authority (GBRMPA) established the Douglas Shoal Remediation Project (the project) in late 2016 with funds from a court settlement associated with the grounding incident.

BMT were engaged by GBRMPA to undertake Stream 3. Stream 3 will involve the collection of field data in multiple baseline surveys, a water quality survey during remediation, and multiple post-remediation surveys at Douglas Shoal, with the overall goal to:

"Assess the extent to which the remediation project has been effective at supporting natural recovery, including considering whether the project's activities have negatively impacted natural recovery on Douglas Shoal."

The surveys will follow a Before After Control Impact (BACI) style study design (with 'before' being before remediation works), with two 'before' and two 'after' surveys. The BACI design involves sampling at impacted locations (Douglas Shoal), near field controls (also at Douglas Shoal but outside of the impacted area), and control sites (Haberfield Shoal).

BMT undertook the first "before" baseline survey between 3-10 October 2019 (Trip 1) and 2-9 November (Trip 2). The survey was split up into two field trips aiming to take advantage of the neap tide windows and to temporally separate fishing and baited remote camera activities from in-water work to lessen the chances of interactions with sharks. The neap tide windows suitable for data collection were approximately 5-6 days in length.

The first trip was surface based and included data collection methodology intended to survey water based contaminants, fish communities, epibenthic cover, and contaminants within fish tissue. These involved the use of Baited Remote Underwater Video (BRUV), towed camera, water sampling equipment and line fishing.

The second trip was diver based and included data collection methodology intended to survey sediment based contaminants, contaminants within invertebrate and algal tissue, and visual change over time at highly impacted areas. This involved divers collecting sediment, algal and invertebrate tissue, and using stereo GoPros to create 3D models.

No preliminary results are available as yet, but they will be released to GBRMPA as they become available.

Contents

List of Figures

List of Tables

1 Background

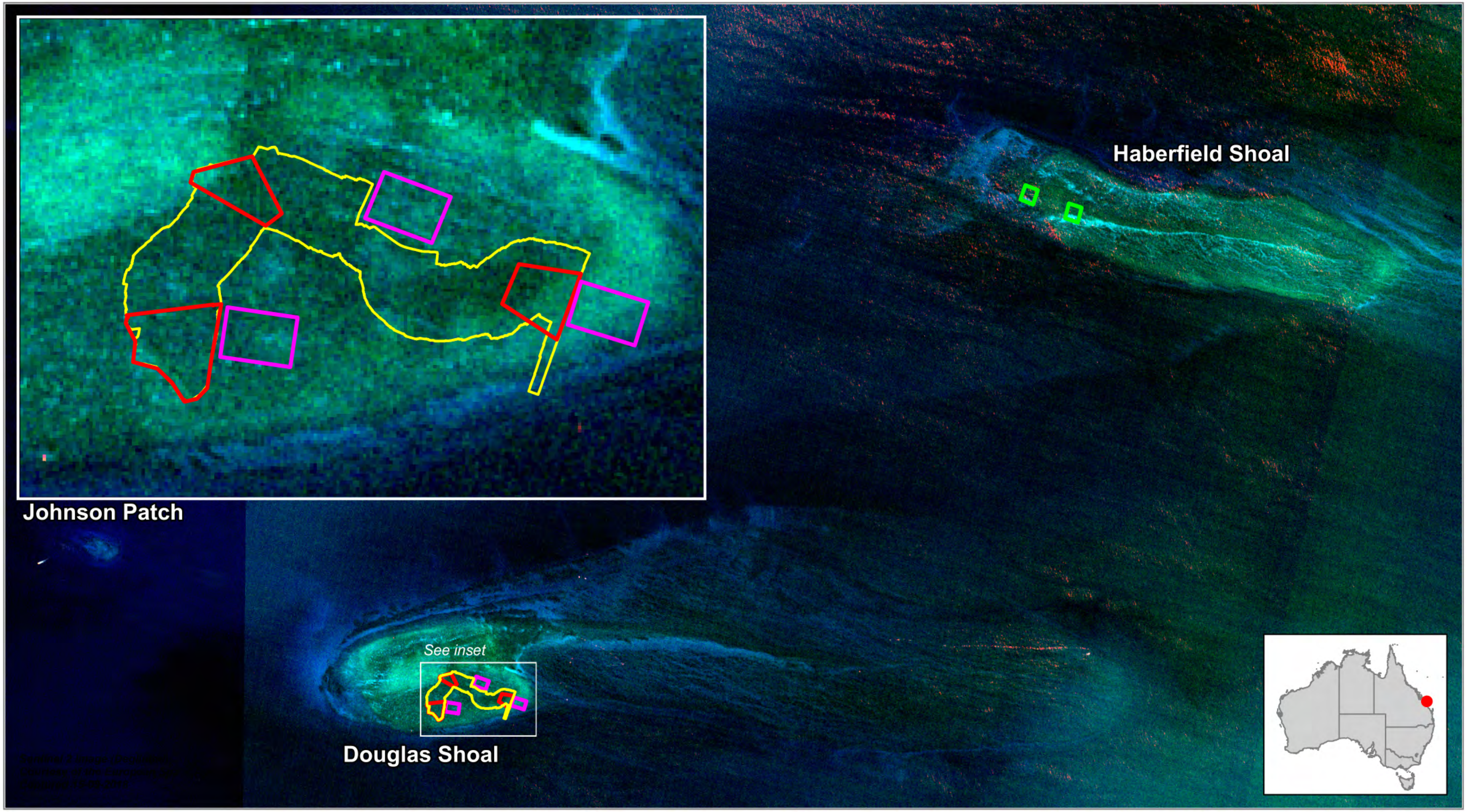
In April 2010, the bulk carrier Shen Neng 1 grounded on Douglas Shoal in the Capricorn Bunker region of the Great Barrier Reef Marine Park. The carrier remained on the reef for 10 days before it was salvaged, producing the largest grounding scar (42 ha) in the marine park to date. The Great Barrier Reef Marine Park Authority (GBRMPA) established the Douglas Shoal Remediation Project (the project) in late 2016 with funds from a court settlement associated with the grounding incident.

The primary desired outcome for the project is that remediation activities support natural recovery at Douglas Shoal. GBRMPA has divided the remediation into three streams of work:

- Stream 1: Planning and Project Management services for the project.
- Stream 2: Remediation and compliance monitoring.
- Stream 3: Physical, chemical and biological environmental monitoring of remediation works at Douglas Shoal.

BMT were engaged by GBRMPA to undertake Stream 3. Stream 3 will involve the collection of field data in multiple baseline surveys, a water quality survey during remediation, and multiple post-remediation surveys at Douglas Shoal.

This report provides a summary of the fieldwork conducted as a part of BMT's first baseline survey in October and November of 2019. The first trip (October) involved vessel-based sampling, while all in-water work was conducted in November 2019.



LEGEND

Grounding Footprint

Test Locations to be Remediated

Near-field Test Locations (Not Remediated)

Regional Reference Locations

Title:

Monitoring Locations

Figure: **1-1**

Rev: **A**

N

0 300 600m
Approx.Scale

0 1.5 3km
Approx. scale

BMT
www.bmt.org

Filepath: I:\B23282_I_JLB_Douglas Shoal Remediation Monitoring BT\DRG\ECO_008_190710_Monitoring_locations.WOR

1.1 Objectives

The overall objective of the surveys is to:

"Assess the extent to which the remediation project has been effective at supporting natural recovery, including considering whether the project's activities have negatively impacted natural recovery on Douglas Shoal."

The objectives of the first baseline survey were to:

- Create a snapshot of Douglas Shoal as it stands prior to any remediation work being conducted, in order to understand the effect of the remediation on the health of the shoal and its communities.
- Confirm levels of contamination present at the highly impacted sites across Douglas Shoal.
- Inform GBRMPA in understanding the remediation effort required, which will assist in creating the request for tender for stream 2 work.

1.2 Scope

Fieldwork was carried out in accordance with the approved Sampling and Analysis Plan (SAP) and the Health Safety Environment Quality (HSEQ) Plan.

The First baseline survey was broken down into two field trips aiming to take advantage of the neap tide windows and to temporally separate fishing and baited remote camera activities from in-water work to lessen the chances of interactions with sharks. Douglas Shoal experiences large tidal planes with over 3 m of tidal exchange during spring tides. Its exposure to the east and proximity to the Capricorn Channel often leads to strong currents and large swells. These conditions make in-water data collection difficult if not impossible over much of the year. The neap tide windows suitable for data collection were approximately 5-6 days in length.

The two trips were conducted between 3-10 October 2019 (Trip 1) and 2-9 November (Trip 2). Trip 1 focused on surface-based data collection and Trip 2 was diver based.

1.3 Report Structure

This report presents a preliminary summary of the two field trips to Douglas and Haberfield Shoals as part of the pre-remediation baseline survey. The report addresses each trip separately with the surface-based sampling trip first and the diver-based trip second. The following aspects are included:

- Daily logs for weather conditions, work tasks and person-hours worked
- Personnel involved in each trip, their roles and responsibilities
- Vessel information
- Summary of sampling/surveys conducted
- Methodology used in each component of the survey/sampling and any deviations that were required from the planned methodology in the SAP.
- Daily logs for weather conditions

- Opportunistic observations that may be relevant for the Project
- Observations on human visitation (commercial fishing, recreational fishing, low-level flights, etc)
- Lessons learned, issues or incidents experienced and opportunities for future improvement
- Preliminary/selected photographs and Geographic Information System (GIS) files collected during fieldwork

2 Field Trip Details

2.1 Trip 1 October 2019

2.1.1 Daily Activity

Table 2-1 Daily activities and weather conditions on first sampling trip

Day	Date	Time	Daily Activity	Weather Conditions
1	Wednesday 2/10/2019	7:00am	QLD team mobilises from Brisbane, WA team mobilises from Perth	N/A
2	Thursday 3/10/2019	8:00am	Pack boat and finalise equipment preparation	Clear, 20kt South Easterly wind, 23°c, Swell 2m
		2:00pm	Steam to North West Island	
3	Friday 4/10/2019	6:45am	Steam to Douglas Shoal	Fine, 10-15kt South Easterly wind, 24°c, 1.5-2m swell
		8:30am	Drop Camera Douglas Shoal Sites	
		4:00pm	Steam back to North West Island	
4	Saturday 5/10/2019	6:45am	Steam to Haberfield Shoal	Fine, 10kt North Easterly wind, 23°c, 0.8m North Easterly swell
		8:25am	Deploy drop camera Haberfield Shoal Sites	
		11:22am	BRUVs Haberfield Sites	
		3:29pm	Sediment at Haberfield Shoal Site	
		4:00pm	Return to North West Island	
5	Sunday 6/10/2019	6:30am	Steam North West Island to Douglas Shoal	Fine with scattered cloud, 5-10kt North Easterly wind, 25°c, <1m North Easterly swell
		7:50am	Deploy BRUVs at Douglas Shoal Sites and begin fishing Douglas Shoal	
		4:45pm	Complete BRUVs and Fishing at Douglas Shoal; steam back to North West Island	
6	Monday 7/10/2019	6:45am	Steam to Douglas Shoal	Fine, 0-10kt North Easterly wind, 26°c, 1-1.5m North Easterly swell
		7:40am	BRUVs at Douglas Shoal Sites	
		10:55am	Collect BRUVs and Steam to Haberfield Shoal	
		11:51am	BRUV and fishing at Haberfield Shoal sites	
		3:51pm	Sediment at Haberfield Shoal Site	
		4:00pm	Return to North West Island from Haberfield Shoal	
7	Tuesday	8:02am	Begin water sampling at Douglas Shoal Sites	Fine with scattered cloud, 10-17kt

Day	Date	Time	Daily Activity	Weather Conditions
	8/10/2019	11:47am	Steam for Haberfield Shoal	Northerly winds, 25°c, Swell 1.5-2m North Easterly.
		12:41pm	Water sampling Haberfield Shoal	
		2:00pm	Steam for North West Island, as weather is turning bad.	
8	Wednesday 9/10/2019	5:30am	Marine wind warning issued overnight. Skipper turns boat and heads back to Gladstone WA team mobilises back to Perth	Cloudy, 20-25kt North Easterly winds, Swell increasing to 2.5m
9	Thursday	7:00am	QLD team mobilises back to Brisbane	N/A

2.1.2 Vessels and Personnel

The vessel ‘Wild Blue’ was used for the first sampling trip. Wild Blue is a twin engine 17m single hull fibreglass vessel, equipped with a 5m inflatable dinghy. The vessel can support eight persons and two crew. The vessel also has a winch that runs from an A-frame directly off the centre of the stern, making it ideal for the operation of heavy equipment.

Figure 2-1 Wild Blue at dock in Gladstone

Figure 2-2 Wild Blue at Anchor North West Island

Three BMT personnel and two client representatives from GBRMPA were involved with the first sampling trip. The vessel also had two crew; a skipper and a deck hand.

Table 2-2 Personnel, Roles and Responsibilities

Role	Company	Responsibility
Field Technical Lead	BMT	Trip lead: ensure vessel operations adhere to SAP. Plan and coordinate daily activities, assist with sample preparation, data backup.
Field Assistant	BMT	Assist technical and field lead with daily activities to execute SAP and HSC plan to a high standard.
HSE and Logistics Lead	BMT	HSC lead and trip 2IC: ensure vessel operations adhere to HSC plan, lead daily toolboxes, assist field lead with daily activities. Logistics Lead: pack, test and prepare all gear for trip.
Client Representative and Auditor	GBRMPA	Audit elements of BMT sampling trip and provide comments and feedback from the perspective of the client. Assist with field sampling activities under the direction of BMT staff.

Role	Company	Responsibility
Client Representative	GBRMPA	Provide comments and feedback from the perspective of the client. Assist with field sampling activities under the direction of BMT staff.
Skipper	Rob Benn Holdings	Master the vessel and ensure that all vessel movements and anchorings are executed safely according to the vessel SMS, and BMT sampling analysis plan, and HSE documentation. Prepare meals.
Deck Hand	Rob Benn Holdings	Assist Master with watches, berthing, galley work, and assist with daily sampling activities under the direction of BMT staff.

2.1.3 Summary of Sampling

The first sampling trip was dedicated to surface sampling methodologies and was therefore primarily focused on camera deployments, water and fish tissue samples. Figure 2-3 below gives an indication of the types and numbers of samples that we collected during the first sampling trip. All samples in Figure 2-3 were collected on the first trip with the exception of:

- Sediment samples (two samples were collected on the first trip at site "I")
- The five algal and five invertebrate tissue samples at each location
- 3D Mosaics

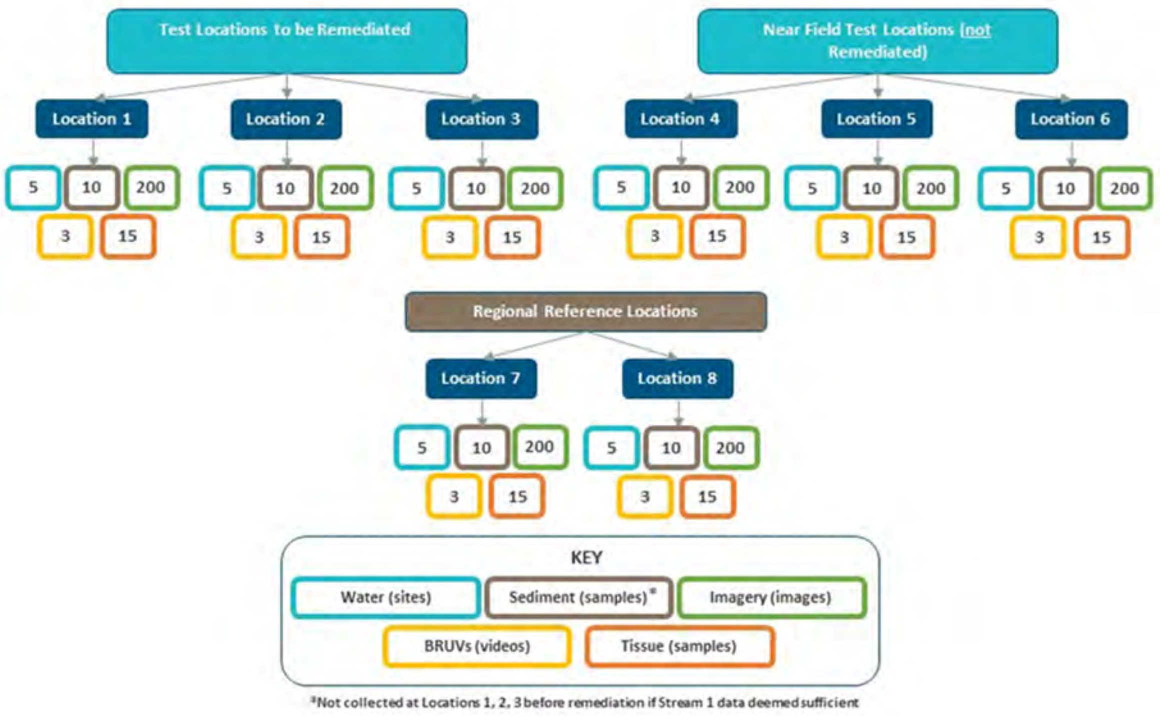


Figure 2-3 Sampling summary of both trips

2.1.3.1 BRUV

Baited Remote Underwater Video (BRUV) was used to collect information on the fish communities at three sites per location at Douglas Shoal and Haberfield Shoal. Three BRUV cameras (stereo BRUVs) capturing 1080p HD video were deployed for a 1 hour period at three sites simultaneously within each location. Cameras were separated by 70 cm and baited with approximately 1 kg of pilchards. The stereo-camera unit was mounted to a 25 kg flat-based steel frame with a surface float.

The process of BRUV sampling is described below.

- BRUVs were set up on back deck of boat, with cameras on and bait bag filled. The BRUV was attached to winch
- The skipper followed provided GPS heading until stern of vessel was on top of the site
- Cameras started and “calibration claps” were conducted
- BRUVs were lifted with winch and lowered to deployment position on duck board under direction of two personnel.
- The BRUV was lowered into the water, the winch shackle was removed and the BRUV was hand-lowered by two personnel
- A third person used a live-feed camera to direct the descent of BRUV, in order to avoid any contact with corals
- Once on the seafloor, A mark of the location was recorded on the DGPS, the BRUV line was thrown away from boat and skipper was notified
- BRUVs were left in the water for 1 hour
- BRUV float lines were collected using a boat hook over the side of the vessel
- Two personnel hauled the BRUV off the sea floor to approximately 1m from the surface
- The winch was then connected to the float line and is used to raise the BRUV onto the deck
- Cameras were checked for total recording and then stopped
- Cameras and bait in bait bag were changed over for the next deployment
- Videos were backed up onto two external hard drives each evening

Actual positioning varied from planned positioning due to the need to make sure BRUV did not land on living coral. Actual positioning is displayed in Figure 2-6.

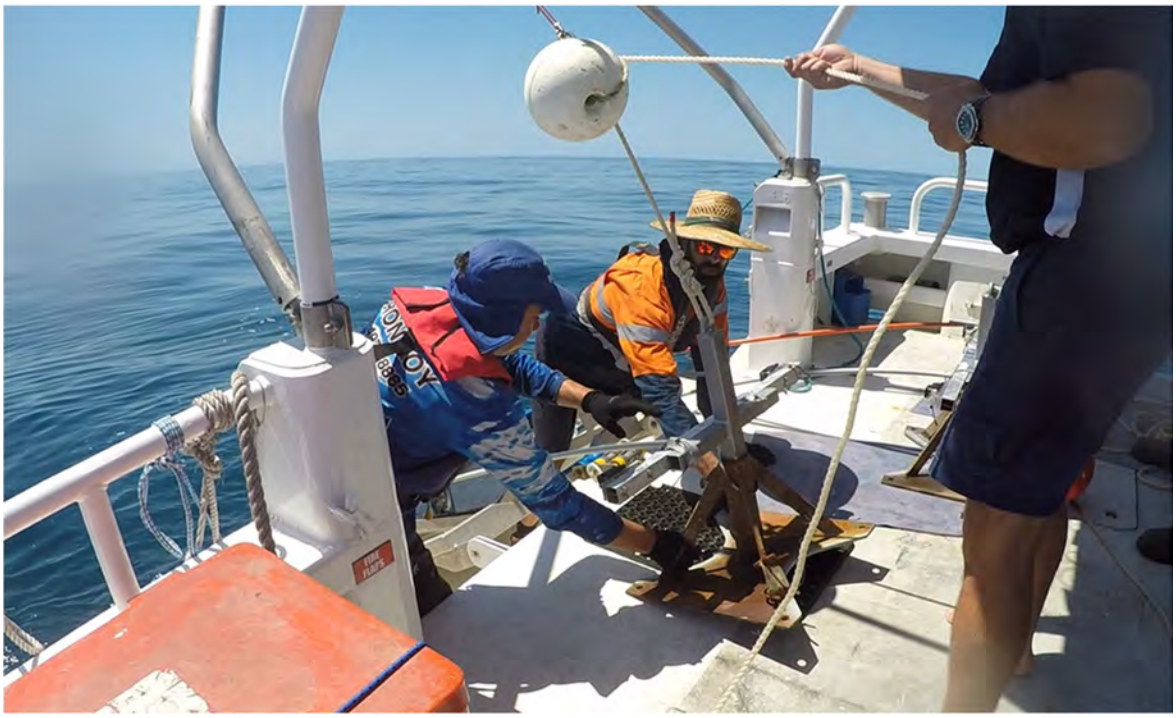
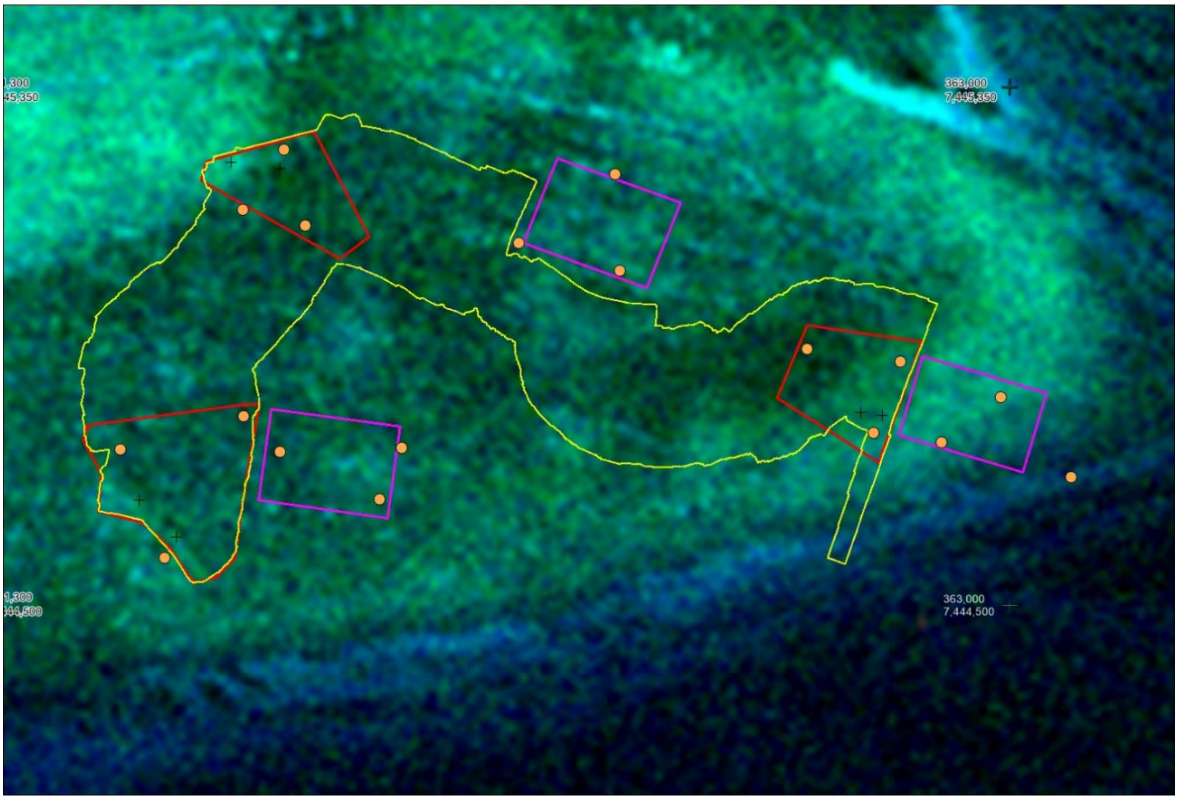


Figure 2-4 BRUV being deployed from back deck of Wild Blue

Figure 2-5 Scientist using live camera feed to direct lowering of BRUV to avoid contact with corals



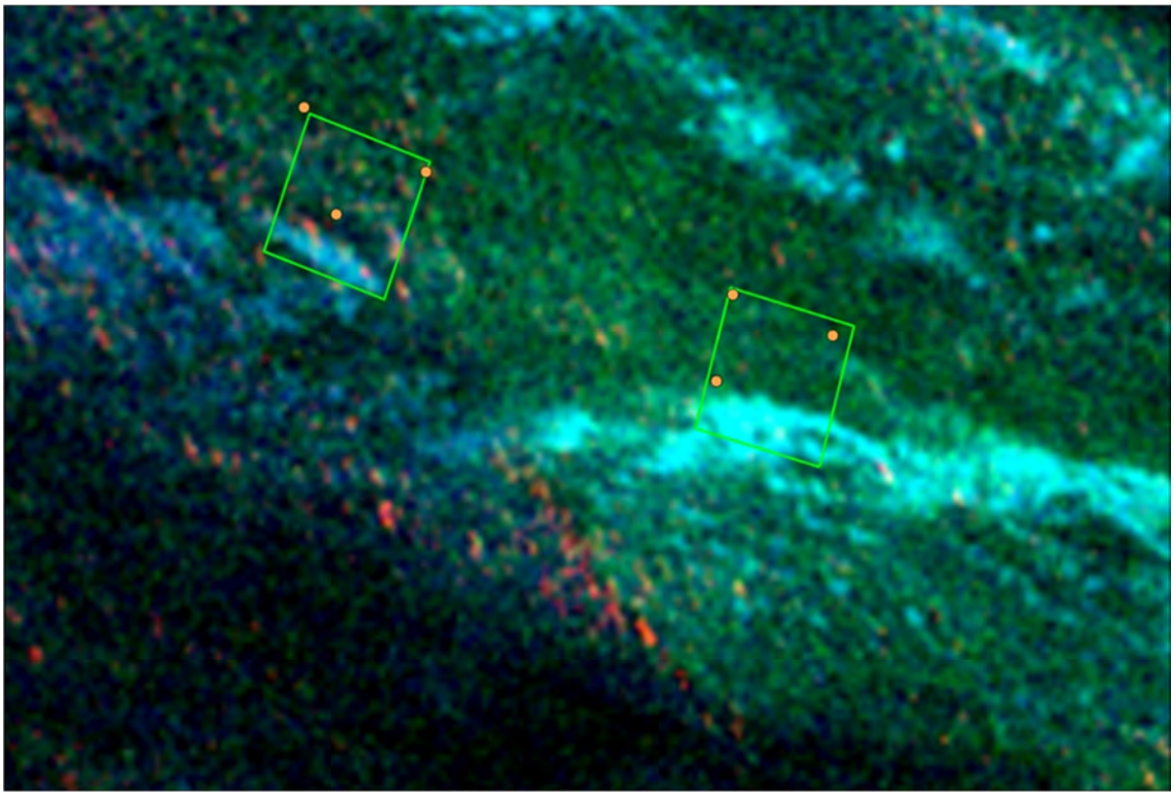


Figure 2-6 BRUV sites at Douglas (above) and Haberfield Shoals (below)

2.1.3.2 Towed Camera

The towed camera array (consisting of remote downward-facing cameras attached to a winged stabilisation device and weighted by a 25kg winged downrigger) was deployed from the rear of the vessel using the winch. Imagery of the seafloor was taken using a GoPro on 1 second intervals, guided by a forward-facing live feed camera. Tows were conducted in an up and back “S” pattern with consecutive lines being approximately 20 metres apart.

The procedure for towed camera sampling is described below

- All devices were time synchronised to the DGPS
- GoPro and live feed cameras were prepared on the rear deck of the vessel and the array was hitched to the winch; the GoPro was turned on
- DGPS tracking of the boat was activated
- Two personnel lifted the camera and weight and lowered it into the water as boat was idling forward.
- The winch took up the strain of the array and was then lowered (and subsequently controlled) by third person who was watching the live feed on a screen.
- The skipper followed plotted course to achieve a complete coverage over all the transect lines
- The camera was raised and lowered on turns to maintain a safe operating height from the seafloor and prevent snagging
- At the end of each transect the winch was retracted and camera was brought to surface as vessel slowed to an idle forward
- Two personnel retrieved the array from the water and lowered it onto the back deck
- The cameras were stopped and data backed up onto two hard drives

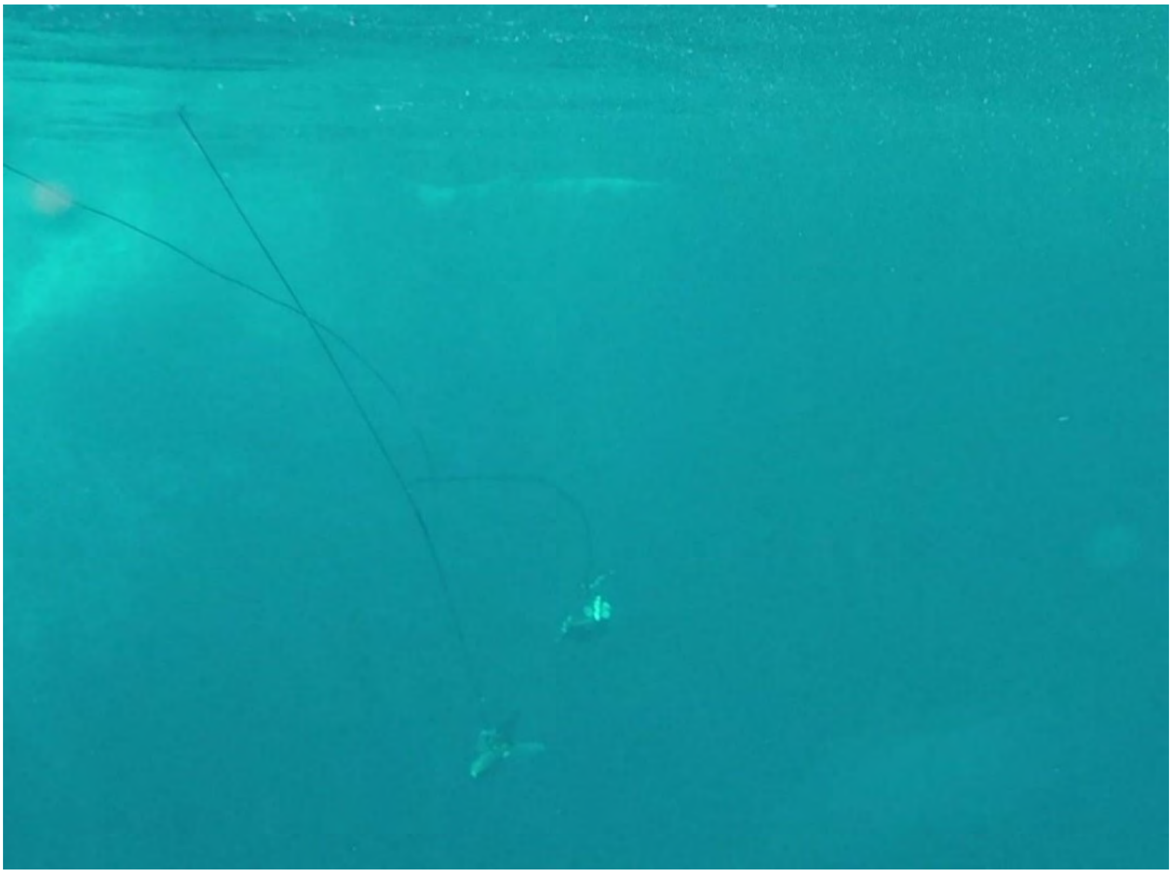


Figure 2-7 Towed camera array in operation

Figure 2-8 Scientist watching live camera feed and controlling height of glide above seafloor with the winch

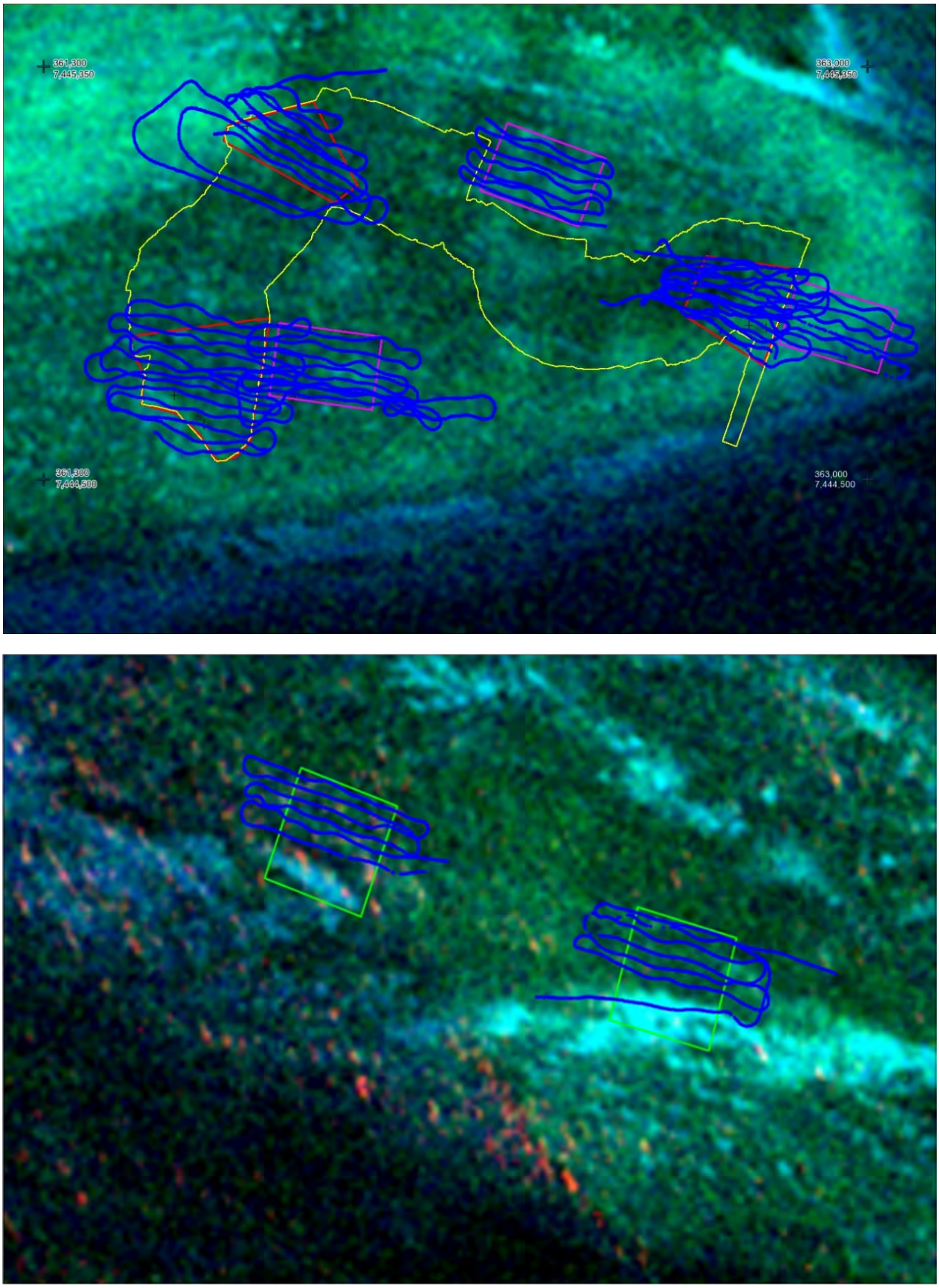


Figure 2-9 Towed camera transects at Douglas (above) and Haberfield Shoals (below)

2.1.3.3 Tissue Sampling

Fish were collected using a hook and line from within the boundaries of each location. Five fish samples were analysed per location. Samples consisted of a limited number of common species dominated by red-throated emperor, Venus tusk fish. and iodine bream. A sample of the muscle tissue of the fish was collected and placed on ice for analysis by the laboratory. The procedure for tissue sampling is detailed below.

- Fishing lines were prepared and baited. Two poles and two hand lines were utilised in this sampling trip.
- The skipper drove the vessel to the up current point of the sampling location then shut off engines. The vessel was allowed to drift with the current until the downstream edge of the sampling location, where the skipper would call for lines in, restart the engine and move the boat back up to the top of the sampling area.
- Once in position, confirmation that the engine had been stopped was given by the skipper and all available personnel, bar one (the processor), would drop the lines overboard aiming to fish approximately 1 metre from the sea floor.
- When a fish was hooked the fish would be reeled to the surface and retrieved by another person with a catch net or placed directly in a pre-cleaned fish tub, washed with Decon-90.
- The hook was then removed from the fish's mouth and the fish was killed by pithing.
- Notes of the location, time, size, weight, type and health of the fish were recorded. Photos were also taken.
- The sides of the fish were removed using a stainless-steel fishing knife and the skeleton discarded.
- A 200g sample of muscle tissue was placed into a zip lock bag and labelled before being placed on ice.
- Cutting boards, knives, and fish tubs were washed in Decon-90 and rinsed in sea water.

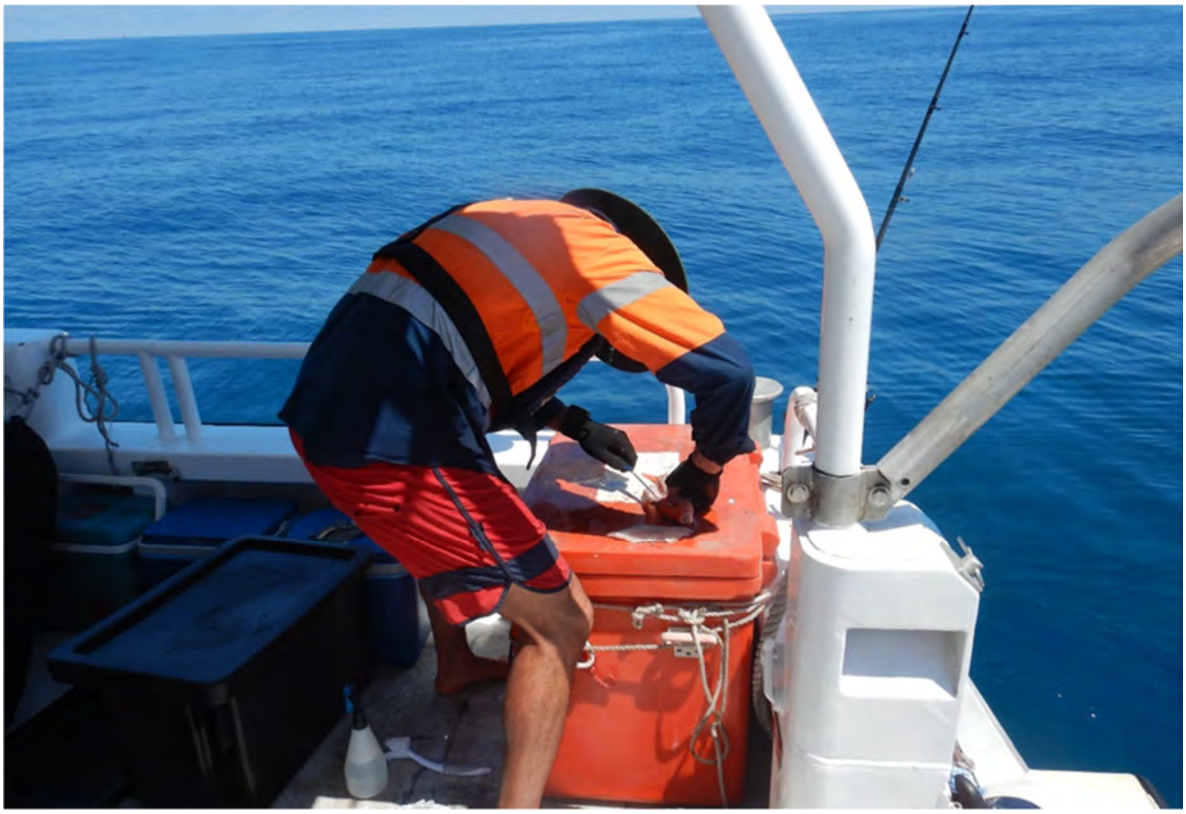


Figure 2-10 Scientist removing the sides of the fish for tissue samples

Figure 2-11 Tusk Fish caught at Douglas Shoal

Figure 2-12 Fishing from back deck of Wild Blue

2.1.3.4 Water Sampling

Site-based water quality sampling and *in-situ* measurements involved the collection of five replicate samples from each location 1 m above the seafloor. This was achieved using a van Dorn Sampler from 5 replicate casts taken haphazardly within each of the locations.

The water samples were taken by a scientist wearing protective gloves, while a dedicated water sampler handling syringes, water, and bottles wore nitrile gloves. Nitrile glove changes occurred between locations. Apparatuses were initially washed in Decon-90 then triple rinsed between replicates. Dissolved metal samples were filtered through a 0.45μm membrane. The time, date, sample number and location were recorded before refrigeration and storage of the sample.

The procedure for water sampling is described below.

- The Van Dorn Sampler was prepared on the rear deck of the vessel. The inside of the sampler was rinsed with Decon-90 and a weight was attached to the device with a 1 m rope.
- The skipper drove the vessel to the up current point of the sampling location then shut off the engines. The vessel was allowed to drift with the current until the downstream edge of the sampling location, where the skipper would restart the engines and move the boat back up to the top of the sampling area.
- After the engines were shut off the Van Dorn sampler was lowered over the side of the boat to a meter above the seafloor.
- The messenger weight was then released down the line and the sampler activated.
- The sampler was retrieved, and designated laboratory-supplied sample containers were filled directly from the sampler by a scientist wearing nitrile gloves. Bottles were labelled and placed on ice.

- A GPS mark was taken at each sampling location. Time and sample numbers were also recorded.
- At each location of a sample, a YSI Pro DSS water quality meter was lowered to a similar depth as the sampler while collecting a profile of water quality data. The data collected included pH, electrical conductivity, salinity, turbidity, temperature and dissolved oxygen.

Figure 2-13 Two scientists water-sampling using a Van Dorn sampler

Figure 2-14 GBRMPA officer assisting with the water quality sampling

2.1.3.5 Sediment Sampling

Only two sediment samples were taken using a large stainless steel Van Veen grab at one Haberfield Shoal location. All sediment sampling was planned to be conducted on the second sampling trip using a team of divers. These two samples were taken while waiting for the BRUVs to complete their time recording at the site. The Van Veen grab was rinsed with Decon-90 before collecting each sample. The procedure for sediment sampling from the vessel is stated below:

- The van Veen Grab was washed with Decon-90 and set up on the back deck of the vessel.
- An appropriate area for grabbing was identified by personnel on board.
- The winch connected to the grab and hoisted into the water. The weight of grab was held by one person as the rope was pulled through the winch to allow faster lowering of the grab.
- Once appropriate length of rope was pulled through winch, it was lowered at a constant rate by a person on duck board wearing protective gloves.
- Once the grab hit the bottom, the person on duckboard pulled the rope quickly and lifted the grab to close the jaws. The winch was then used to pull the grab to the surface.

- A GPS mark is taken at the location.
- Once on the surface, the grab was handled by two personnel and lowered into a decontaminated Nally bin, where it is opened and the sediment is released.
- The grab is removed and decontaminated prior to the next sampling.
- Sediment is scooped into glass jars provided by the lab by a scientist wearing nitrile gloves.
- the samples wer labelled and placed on ice.

2.1.4 Preliminary Observations

Preliminary observations from the first trip were limited by the fact that all working personnel were surface based. It was noted that there were no noticeable differences in the speed of catching the fish between any of the sites. The size of the fish was variable across all sites.

One large tiger shark was noted both from surface observations and from BRUV footage at site A. The shark was actively moving between two of the three BRUV locations. The shark was not aggressive. It acted in a curious manner and eventually, after circling one BRUV a few times, “nosed” the bait bag before swimming away.

BRUV and towed camera data are yet to be analysed so no further comments can be made regarding this data.

Other biota observations were limited to Noddy Terns, which were numerous at both sites. There was also a large amount of Trichodesmium at both sites.

Multiple sightings of green sea turtles were noted at both locations, as well as between the sites and North West Island.

Only one other vessel was sighted during the whole trip to Douglas and Haberfield Shoals. It was a small privately-owned, recreational fishing vessel, which was seen on Sunday 6/10/19. It remained onsite for most of the day.

2.2 Trip 2 November 2019

2.2.1 Daily Activity

Diver-based sediment and biota collections were conducted over a nine day period between Saturday 2 November and Sunday 10 November, 2019 (including mobilisation and demobilisation) Summary information for daily activities are provided in Table 2-3

Table 2-3 Summary of Daily Activities for Diver-based Sampling

Day	Date	Activities	Weather
1	Saturday 02/11/2019	BMT mobilises from Brisbane and Perth to Yeppoon	E winds 15-18 knots, Swell 1.8-2.2 m E
2	Sunday 03/11/2019	Vessel inductions, OHS inductions, equipment check. Depart Yeppoon 10:00 and arrive at North West Island 19:00.	E winds 10-15 knots, Swell 1.5-2.0 m E
3	Monday 04/11/2019	Depart Northwest Island 05:30. Undertake diver-based sediment, invertebrate, and algal collections at Douglas Shoal. Depart Douglas Shoal at 16:00, arrive at Tryon Island at 18:00. Data backup and QA check.	NE winds 10-12 knots, Swell 1.5-1.8 m E
4	Tuesday 05/11/2019	Depart Tryon Island 05:30. Undertake diver-based sediment, invertebrate, and algal collections at Douglas Shoal. Depart Douglas Shoal at 16:15, arrive at North West Island at 18:15. Data backup and QA check.	W winds 5 knots becoming light and variable, Swell 0.8-1.2m E
5	Wednesday 06/11/2019	Weather stand-down until 12:00 departure from Northwest Island. Undertake diver-based mosaic, sediment, invertebrate, and algal collections at Douglas Shoal. Depart Douglas Shoal at 17:15, arrive at Tryon Island at 19:00. Data backup and QA check.	SE winds 15-22 knots easing to 8-10 knot E, Swell 1.2-1.5 m SE
7	Thursday 07/11/2019	Depart Tryon Island 05:30. Undertake diver-based sediment, invertebrate, algal collections and mosaics at Douglas Shoal. Depart Douglas Shoal for Haberfield shoal at 13:00, arriving at 14:00. Undertake diver-based sediment, invertebrate, and algal collections at Haberfield Shoal. Depart Haberfield Shoal at 16:30, arriving at Tryon Island at 18:30. Data backup and QA check.	Variable winds 5 knots increasing to N 12 knots, Swell 1.0-1.2m E
8	Friday 08/11/2019	Weather stand-down. Data backup and QA check	N winds 13-15 knots, increasing to 30 knots, Swell 1.5-2.0 m N
9	Saturday 09/11/2019	Depart Tryon Island 09:00 for Haberfield Shoal. Undertake diver-based sediment, invertebrate, algal collections and mosaics at Haberfield Shoal. Depart Haberfield Shoal for Douglas Shoal at 14:00, arriving at 15:00. Undertake diver-based sediment, invertebrate, and algal collections at Douglas Shoal. Depart Douglas Shoal at 16:30 for Yeppoon. Equipment pack up and arrival at Emu Park at 00:30.	W winds 12 knots becoming light and variable, Swell 1.5-1.8 N, easing to 0.8
10	Sunday 10/11/2019	Demobilise to Brisbane and Perth from Yeppoon.	NA

2.2.2 Vessels and Personnel

The 17 m vessel twin engine single propeller “Adori” was used as a live-aboard charter for the diver-based sampling trip. The vessel can accommodate 8 passengers plus two crew (Master and deckhand), and has a 4 m aluminium tender (which was not used).

Figure 2-15 MV Adori

Roles and personnel for the diver-based sampling trip are described in Table 2-4

Table 2-4 Personnel, Roles and Responsibilities

Role	Company	Responsibility
Field Lead and acting HSE manager / ADAS Diver	BMT	Trip lead: ensure vessel operations adhere to HSE plan and SAP. Plan and coordinate daily activities, lead daily toolboxes, conduct diving under the direction of the ADAS supervisors, assist with sample preparation, data backup.
ADAS Dive Supervisor 1	BMT	Organise and execute diving plans under the direction of the trip lead. Set diving roster, maintain surface communications. Work in the wheelhouse for close coordination with vessel master. Ensure diving work is conducted safely and to the standard of AS2299.1. Conduct diving under the direction of the second ADAS supervisor.
ADAS Dive Supervisor 2	BMT	Execute diving plans under the direction of the trip lead when primary supervisor is diving. Maintain surface communications. Work in the wheelhouse for close coordination with vessel master. Ensure diving work is conducted safely and to the standard of AS2299.1. Conduct diving under the direction of the primary ADAS supervisor.

Role	Company	Responsibility
ADAS Diver	BMT	Conduct diving under the direction of the ADAS supervisors, assist with sample preparation and QA checks.
ADAS Diver	BMT	Conduct diving under the direction of the ADAS supervisors, assist with sample preparation and QA checks.
Master	Adori Charters	Master the vessel and ensure that all vessel movements and anchoring's are executed safely according to the vessel SMS, and BMT sampling analysis plan, and HSE documentation. Prepare meals.
Deck Hand	Adori Charters	Assist Master with watches, berthing, galley work, and perform SCUBA tank fills.

2.2.3 Summary of Sampling

Daily toolbox meetings were conducted during breakfast while steaming to site. These meetings discussed the weather forecast, plans for the day, tide times and amplitudes, and other logistics such as tank fills, transit between sites, communications, and lessons learnt.

2.2.3.1 Sediment Sampling

The typical daily operation for sediment and diver-based tissue sampling involved the following:

- The dive supervisor's timekeeping device was synchronised to UTC time prior to any operations. All sampling times and dates were recorded in AEST and UTC.
- The diver was readied and given instructions regarding the selection of sediments and biota for sampling, and the likely direction of the dive as a drift through the site location.
- The diver's path was traced utilising a tethered GPS on the diver float. At the point of sample collection, the diver notified the dive supervisor with an in-water comms kit, shortened his tether, thereby conducting line signals to describe the type of sample collected. The time of sample and positioning against the tethered GPS (giving an expected position within 10 m of true position) was recorded. Line signals were given to confirm in-water communications which were sometimes difficult to establish from diver to surface.
- Each sample was photographed approximately 1 m from the substrate, with a 50 cm scale bar in view. Samples were collected by divers using a hand trowel and placed into a PVC collection tube. The penetration depth was made against a trowel and photographed.
- Opportunistic photographs of the seafloor habitat were made at some notable sites where current was low.
- Upon surfacing, the sample was emptied into a stainless steel container, photographed and logged, homogenised, and divided into jars. All sampling apparatuses were sprayed with Decon-90 prior to being packaged into the catch bag.
- The distribution of sediment samples at Douglas and Haberfield Shoals is shown in Figure 2-17

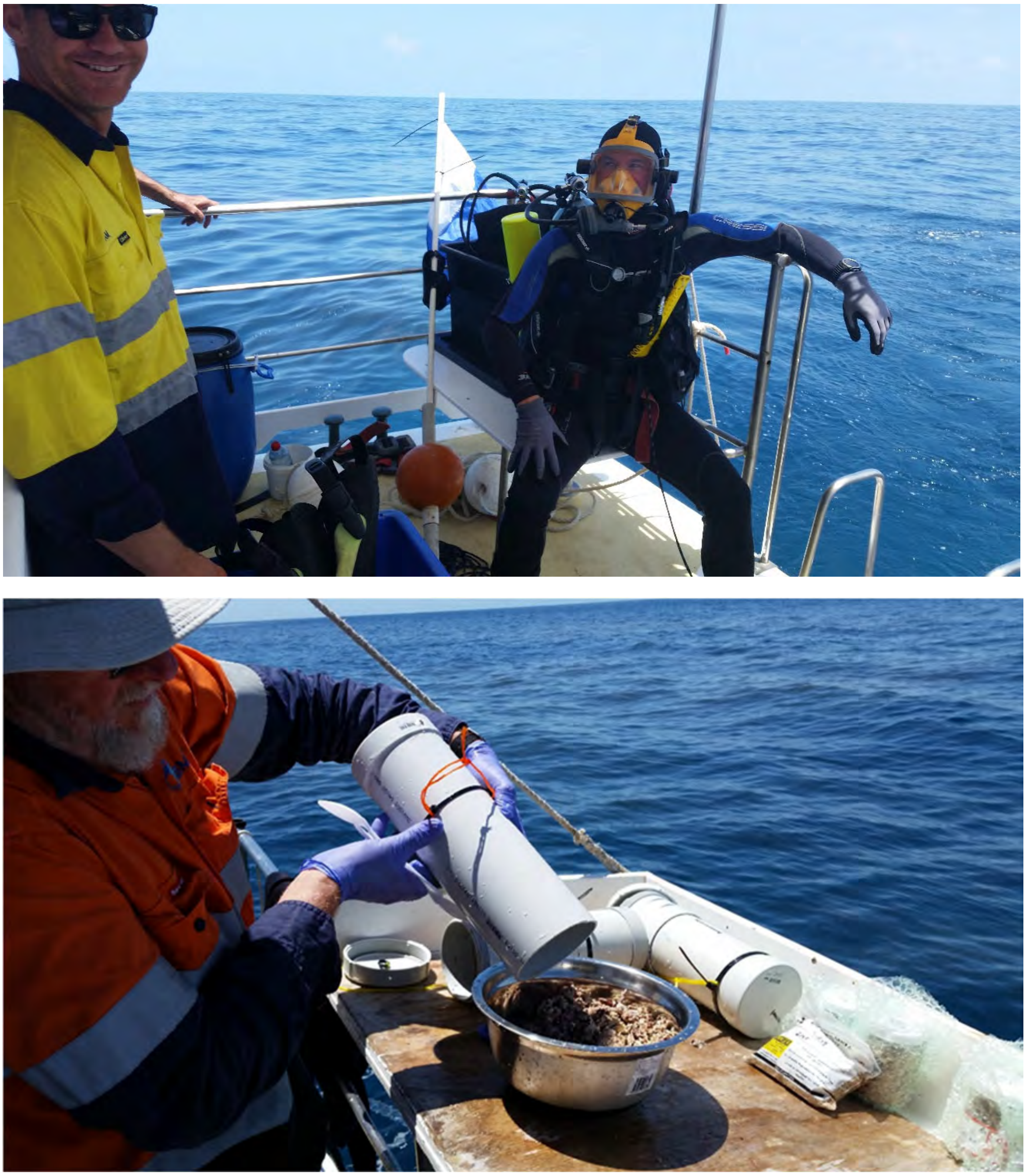


Figure 2-16 Diver and attendant preparing to dive (above); processing a sediment core (below)

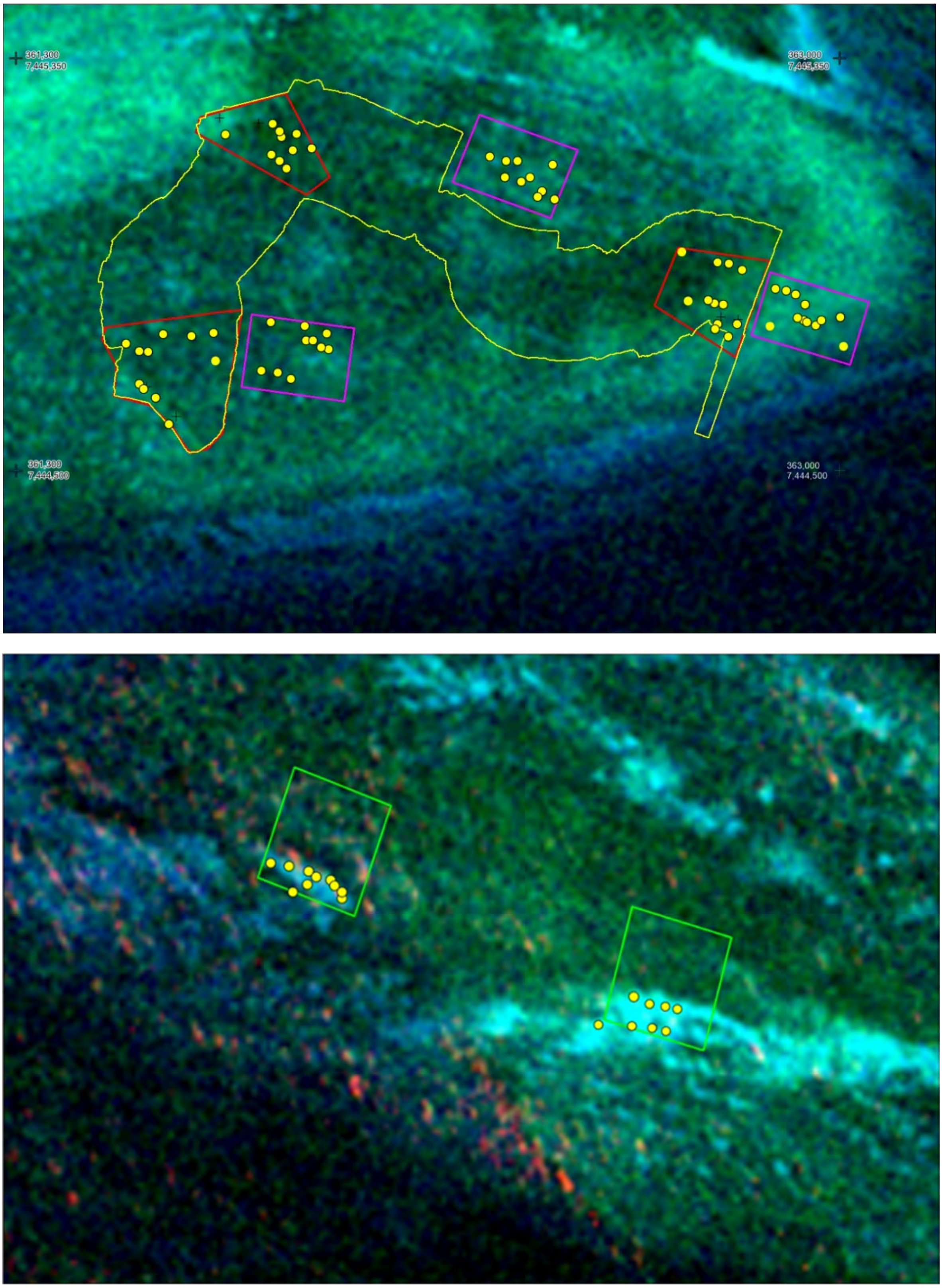


Figure 2-17 Sediment sample sites at Douglas (above) and Haberfield Shoals (below)

2.2.3.2 *Biota Tissue Sampling*

Biota sampling was conducted at the same time as sediment sampling, and biota sites occasionally coincided with sediment sites. Daily operations were similar to sediment collections with the following additional details:

- 40 algal samples were collected (five sites in each of the eight locations). *Dictyopteris* sp. was sampled every time because this was common in the impact areas as well as non-impacted and reference areas.
- 40 ascidian samples were collected (five sites in each of the eight locations). Samples resembling *Polycarpa* sp. were sampled every time because this taxon was relatively common in the impact areas as well as non-impacted and reference areas.
- Each specimen was placed into a calico bag. At the point of sample collection, the diver notified the dive supervisor with an in-water comms kit, shortened his tether conducting line signals to describe the form of sample collected. The time of sample and positioning against the tethered GPS (giving an expected position within 10 m of true position) were recorded. Line signals were given to confirm in-water coms which were sometimes difficult to establish from diver to surface.
- Upon surfacing, the sample was photographed and bagged. All sampling apparatuses were sprayed with Decon-90 prior to being packaged into the catch bag.

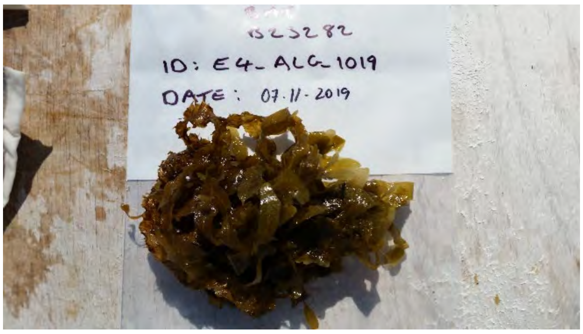



Figure 2-18 Ascidians *cf Polycarpa* (left) and algae (*Dictyopteris* sp.)

The distribution of biota samples at Douglas and Haberfield Shoals are shown in Figure 2-18.

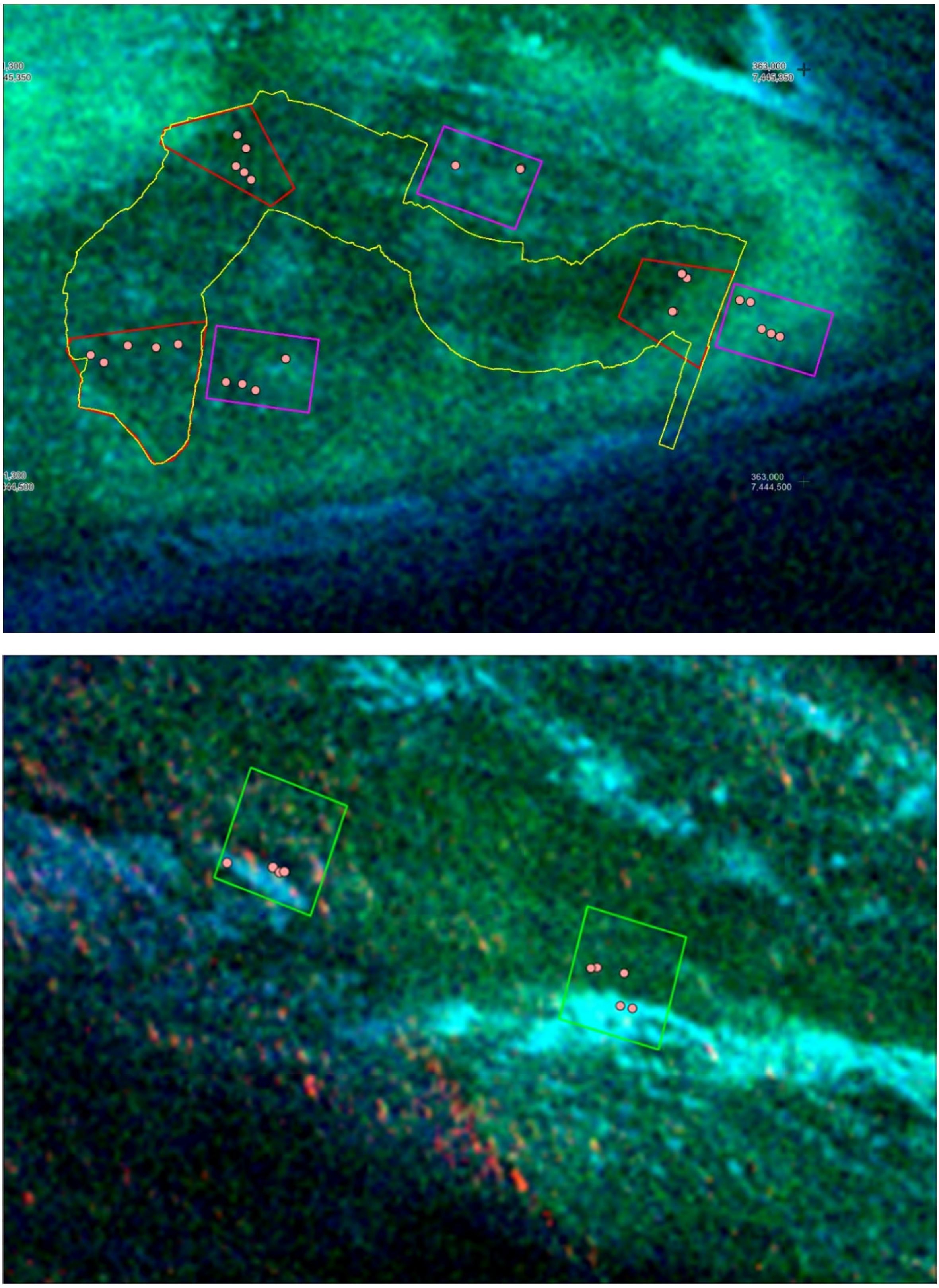


Figure 2-19 Biota sample sites at Douglas (above) and Haberfield Shoals (below)

2.2.3.3 3D Mosaics

Imagery to develop 3D models was collected inside the test locations at areas of the highest level of impact to provide a visual comparison of seafloor changes that may occur before and after remediation (Figure 2-20). At each location 400-500 photos were collected from a pair of synchronised wide-angle cameras giving a total of 800-1000 images per mosaic. Algal canopies were reasonably workable, and it is expected that most of the six 3D models and orthomosaics will be generated successfully. Models were approximately 10x10m and have been located over four tiles from the 5 m reference grid. The same locations will be visited before and after the remediation process.

The centroid of the site was marked using a DGPS, with the closest shot within 10 cm, and the farthest shot at approximately 1 m from the site centroid. The diver descended the shot and placed a series of markers. Half-face masks were used during mosaic generation to reduce diver fatigue (reduce re-breathing in full face masks) due to extra exertion required for this activity.

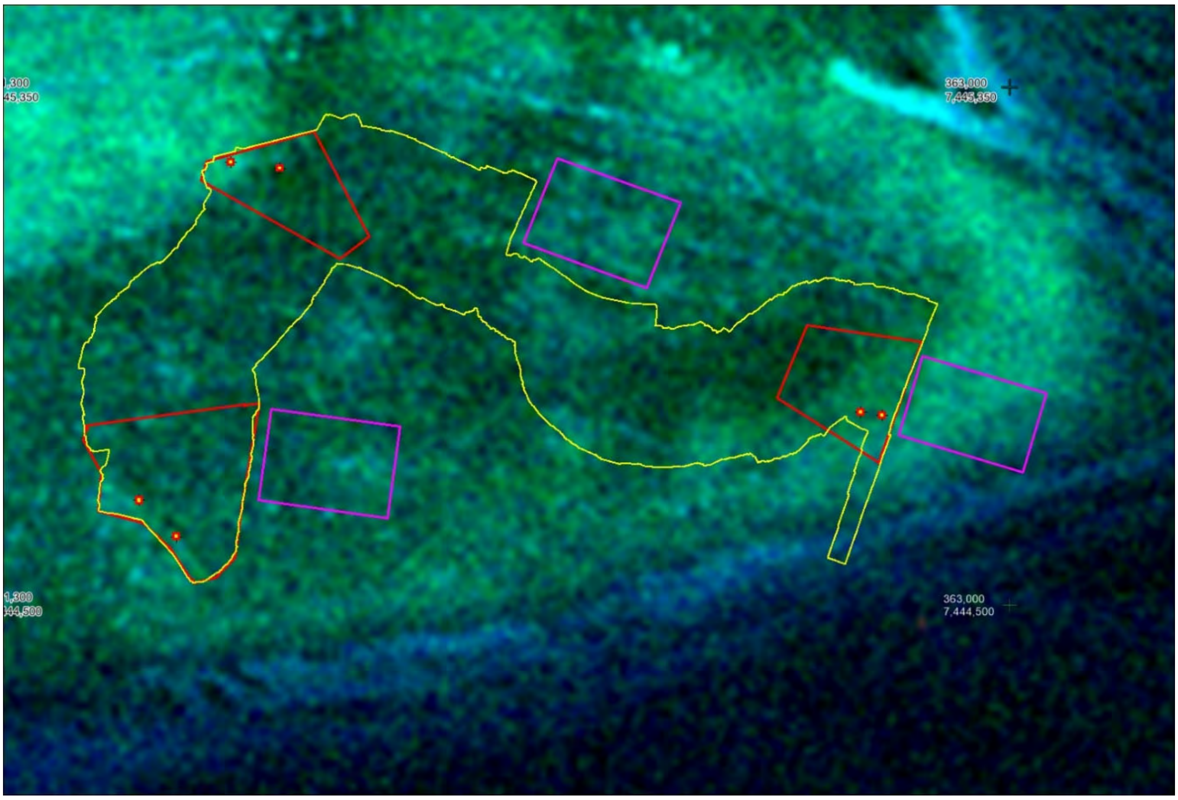
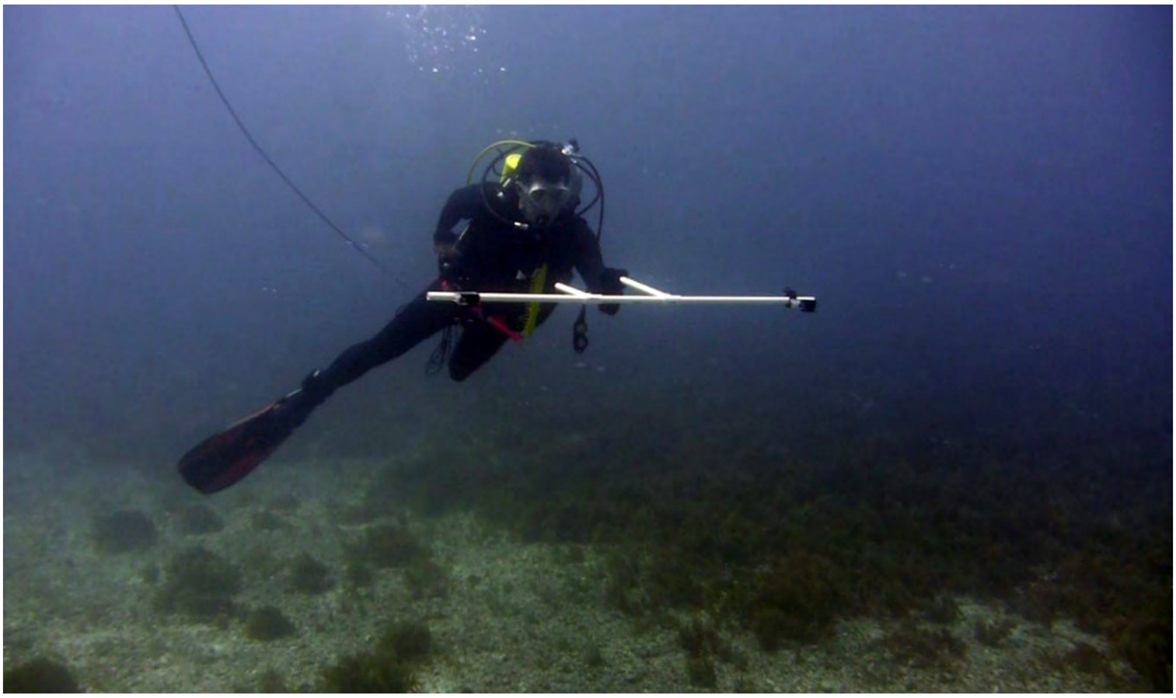


Figure 2-20 3D Mosaic sites at Douglas Shoal



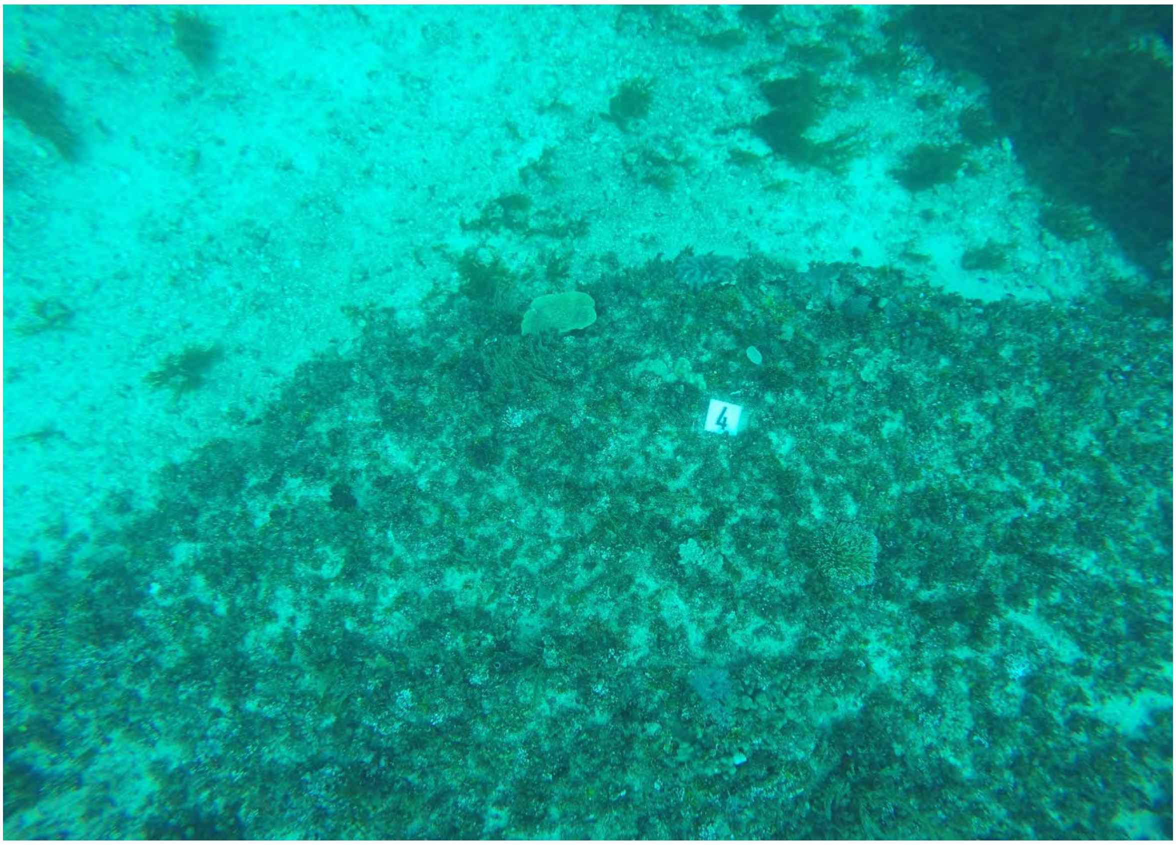


Figure 2-21 Diver collecting mosaic imagery at Location E (above); sample mosaic imagery (below)

2.2.4 Preliminary Observations

The following biota observations were noted on the diver-based trip.

- 30+ sea snakes
- 2 x manta rays
- 3 x green turtles
- Mutton birds
- Noddy terns
- 3 x spinner dolphins

3 Lessons Learnt

3.1 Weather and Sea State

East to south-east winds have the most potential to negatively influence sea state. Based on BMT's required activities, operational conditions from this quadrant rely on wind speeds less than 10 knots, depending on tide. Wind speeds from other directions (N, NW, W and SW) can be workable in 15-17 knots under certain tidal conditions. Unworkable sea state can exist in calm conditions after previous periods of high wind speed. Again, the ESE quadrant generates the most carry-over swell conditions, while high wind velocities from the N, NW, W, and SW can generate unworkable sea states, but these can attenuate to workable conditions within hours under favourable conditions.

3.2 Aggressive Marine Life

Although large tiger sharks were observed on BRUVs, no sharks were observed during in-water operations. Divers were wearing electronic shark protection at all times and had additional electronic protection within reach. Temporal separation of fishing and baited camera work, in combination with electronic shark protection appears to be an effective means of reducing encounters with sharks. Several large remoras were observed during diving work, but sharks were never in visual range. It is likely that sharks were present but kept to a distance greater than visibility conditions at the time (10-15 m).

In additional to HSEQ procedures, a multi-rotor drone was taken to trial aerial inspections of dive sites for large sharks prior to diver entry; however this drone was not used due to concerns with landing obstructions (vessel mast and stabilisers), as well as continual vessel movement. The failsafe on multi-rotor drones when something goes wrong or communications are lost, is to return to the take-off point and land. However, due to the live-boating approach and continuous movement of the vessel, the take-off and land points are never the same. This was deemed too risky in the event of an emergency landing. Lastly, *Trichodesmium* blooms and some coral spawn created very poor visibility in the upper two metres of the water column, making surface-based assessments of shark presence impossible much of the time.

3.3 Backup Equipment

Gear redundancy was generally good, One BRUV was flooded and exchanged and a tow camera system was crashed and repaired. Our redundant tethered cameras were not required but a second lead bomb array could have been required if the crashed bomb system could not be repaired. Fully redundant tow systems including lead down-rigging will be included in subsequent campaigns.

BRUV design will be improved in subsequent campaigns to improve housing strength and ability to withstand impacts (sharks and vessel interaction), and tethers improved to reduce chances of flooding. All new housings will be depth checked to ensure proper functioning prior to the next campaign to minimise unnecessary re-deployments.

3.4 Towed Camera

Major lessons learned from the towed camera exercise include needing to reduce tow speed as low as practical to improve photo quality, altering equipment to improve camera sensor capabilities, and improvements to lighting. While most images are useable for point-count analysis, greater detail of smaller (<10cm) coral colonies could be improved by adjusting the above. Sea-state also affects data quality, with tows into the sea-state being slower, but more affected vertically by waves. Tows with the sea-state (generally heading west) tended to be faster but less affected by waves and attitude. Towing during elevated sea state can create conditions where the camera is too close or too far from the bed depending on vessel position on the wave crest or trough. Subsequent camera work will utilise better lighting, filtering and camera sensors to improve the number and quality of useable images.

The tow camera became snagged on the reef during one of the passes around site C where an elevation change was coupled with deceleration during a turn off a transect line. Future prevention of such incidents was prevented by raising the array substantially prior to turning.

3.5 Mosaic

Due to the exertion required in maintaining a swim pattern against current and swell, diving on a half-face mask allowed more bottom time and less air consumption. Mosaic dives were conducted with line signalling with divers using half-face masks to increase bottom time. Surface to diver communications during this form of data collection are minimal due to a lack of required positioning and (no specimen collection) relatively small work area.

Mosaics were generated successfully at all six sites. Mosaic quality is affected by the density of large algae which is mobilised by tides and surges across the shoal. Improvements in mosaic quality can be made through collecting imagery with better sensors and filters. Improvements in photo stitching in dense macroalgae can be achieved by adding tie points. However, this requires some trimming of the macroalgae in order to make each tie-point visible to the camera.

3.6 Site Nomenclature

During the first site trip, GBRMPA identified that there is greater need for clarity around site nomenclature so as to not cause confusion in relation to site nomenclature used at Douglas Shoal by other contractors. There is not perfect spatial alignment between the sites used by us and Stream 1 (e.g. our ‘site x’ may only cover part of the Stream 2 ‘site x’). We also include additional sites not covered by Stream 2. Further, past works have also previously been conducted on site, before the commencement of the Douglas Shoal Remediation project.

In agreement with GBRMPA, all site names used by Stream 3 Environmental Monitoring will be prefixed by an ‘M’ for clarity.

3.7 Revisions of SAP and HSEQ Documentation

On return from the first trip, Stream 3 SAP and HSEQ documentation were revised to reflect some lessons learned and deviations from the original SAP, namely:

- Holothurians were not present in sufficient numbers at Douglas Shoal for collection of tissue samples. Ascidians were deemed to be readily available as a substitute invertebrate for tissue collection, and the SAP document updated accordingly prior to collection of ascidians.

- HSEQ procedures were reviewed and revised to further minimise the risk of serious injury or fatality from shark attack. This included introducing measures around recreational swimming and snorkelling.
- HSEQ procedures were revised to provide more discretion to the Dive Supervisor as to the preparation of Stand-by Divers (i.e. at what point a Stand-by Diver is to fully kitted up ready for entry to water). The Dive Supervisor can them take into account multiple considerations, such as diving risk and surface conditions.
- HSEQ procedures were revised to ease some PPE stipulations, including: closed in shoes not required at all times except when working with heavy equipment; and hats not required outdoors if working under cover.

These amendments were subsequently approved by GBRMPA, prior to deployment for the second trip.

4 Preliminary Findings

Data has yet to be analysed, so no preliminary findings exist. Significant preliminary findings will be reported to GBRMPA as they become available.

Appendix A Field Notes

Publication note: Appendix A has not been published

BMT has a proven record in addressing today's engineering and environmental issues.

Our dedication to developing innovative approaches and solutions enhances our ability to meet our client's most challenging needs.

Brisbane
Level 8, 200 Creek Street
Brisbane Queensland 4000
PO Box 203 Spring Hill Queensland 4004
Australia
Tel +61 7 3831 6744
Fax +61 7 3832 3627
Email brisbane@bmtglobal.com

Melbourne
Level 5, 99 King Street
Melbourne Victoria 3000
Australia
Tel +61 3 8620 6100
Fax +61 3 8620 6105
Email melbourne@bmtglobal.com

Newcastle
126 Belford Street
Broadmeadow New South Wales 2292
PO Box 266 Broadmeadow
New South Wales 2292
Australia
Tel +61 2 4940 8882
Fax +61 2 4940 8887
Email newcastle@bmtglobal.com

Adelaide
5 Hackney Road
Hackney Adelaide South Australia 5069
Australia
Tel +61 8 8614 3400
Email info@bmtdt.com.au

Northern Rivers
Suite 5
20 Byron Street
Bangalow New South Wales 2479
Australia
Tel +61 2 6687 0466
Fax +61 2 6687 0422
Email northernrivers@bmtglobal.com

Sydney
Suite G2, 13-15 Smail Street
Ultimo Sydney New South Wales 2007
Australia
Tel +61 2 8960 7755
Fax +61 2 8960 7745
Email sydney@bmtglobal.com

Perth
Level 4
20 Parkland Road
Osborne Park Western Australia 6017
PO Box 2305 Churchlands Western Australia 6018
Australia
Tel +61 8 6163 4900
Email wa@bmtglobal.com

London
Zig Zag Building, 70 Victoria Street
Westminster
London, SW1E 6SQ
UK
Tel +44 (0) 20 8090 1566
Email london@bmtglobal.com

Leeds
Platform
New Station Street
Leeds, LS1 4JB
UK
Tel: +44 (0) 113 328 2366
Email environment.env@bmtglobal.com

Aberdeen
11 Bon Accord Crescent
Aberdeen, AB11 6DE
UK
Tel: +44 (0) 1224 414 200
Email aberdeen@bmtglobal.com

Asia Pacific
Indonesia Office
Perkantoran Hijau Arkadia
Tower C, P Floor
Jl: T.B. Simatupang Kav.88
Jakarta, 12520
Indonesia
Tel: +62 21 782 7639
Email asiapacific@bmtglobal.com

Alexandria
4401 Ford Avenue, Suite 1000
Alexandria, VA 22302
USA
Tel: +1 703 920 7070
Email inquiries@dandp.com