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BMT

Douglas Shoal Remediation Project Environmental Monitoring: Baseline Survey 2 – Preliminary Fieldwork Report

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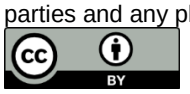

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Executive Summary

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 involves 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 performed the first pre-remediation survey in spring 2019, while this second "before" baseline survey was conducted between 9-14 April 2020 (Trip 1) and 16-21 April (Trip 2). The survey was split up into two field trips aiming utilise a neap tide window and favourable weather conditions. The neap tide window suitable for data collection was approximately 9-10 days in length.

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

The second trip was both diver-based and a continuation of the surface-based methodology from the previous trip. On this trip the diving was temporally separated from BRUV and fishing work, such that diving was completed before the commencement of any activities involving placing bait into the water. The diver-based work included sample collection to survey contaminants within invertebrate and algal tissue.

Few preliminary results are available as yet, but they will be released to GBRMPA as they become available.

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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:

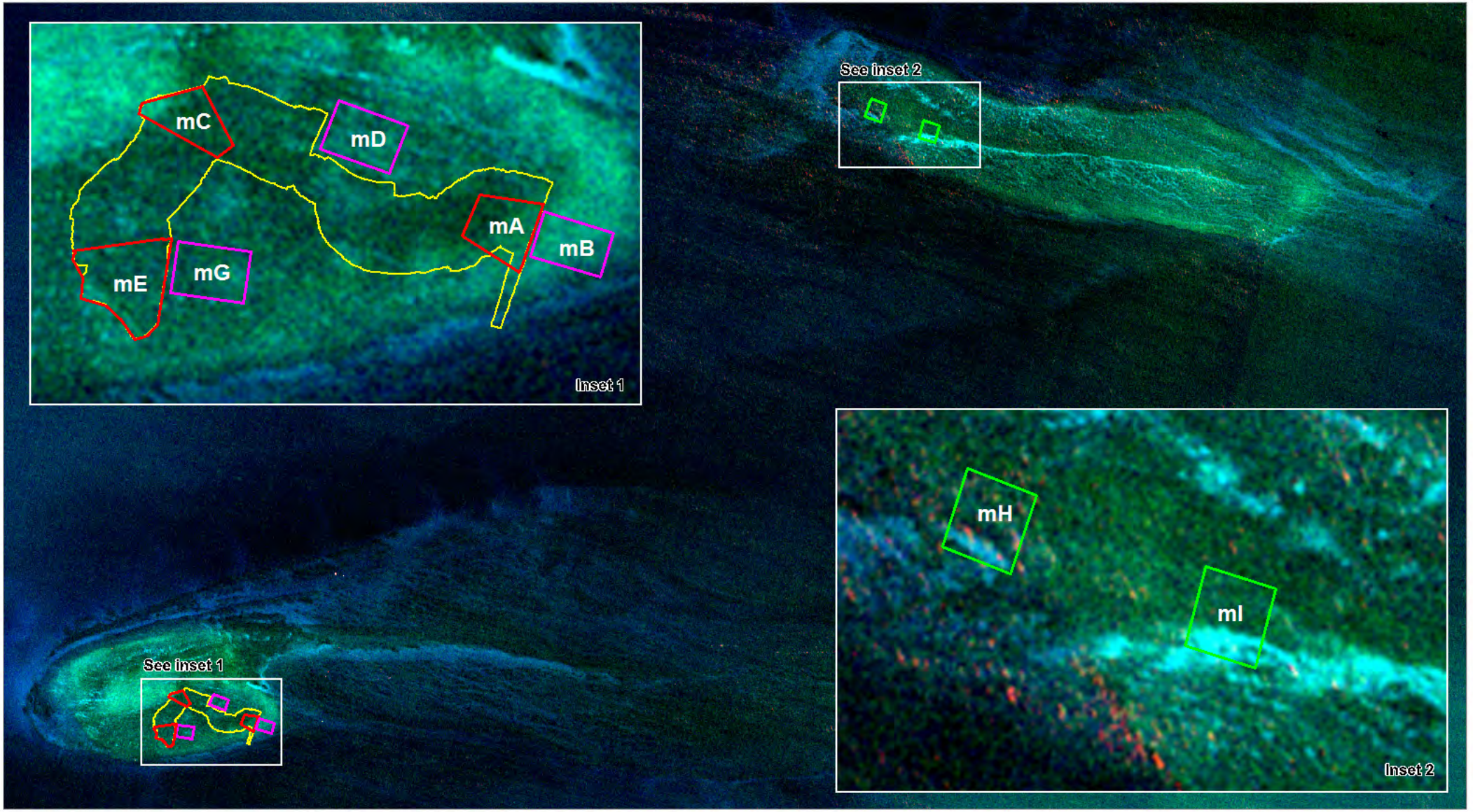
- Stream 1: Planning and Project Management services for the project
- Stream 2: Remediation and compliance monitoring
- Stream 3: Physical, chemical and biological environmental monitoring of remediation works at Douglas Shoal.

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

The first baseline survey was completed in the spring of 2019. This report provides a summary of the fieldwork conducted as a part of BMT's second baseline survey conducted in April of 2020. Two trips were conducted during the Autumn 2020 campaign; the first trip comprised entirely of vessel-based sampling, while all in-water (diving) work and the remainder of the surface work was conducted on the second trip.

Sampling basically consisted of towed video transects, baited remote underwater video (BRUV) deployments, and the collection of tissue samples for contamination from biota including reef fish, macroalgae, and ascidians. Each of these activities was conducted with similar levels of effort and replication at each of 8 monitoring locations depicted in Figure 1-1.

Stream 3 monitoring locations are prefixed with a lowercase m to prevent confusion with remediation sites, as these areas are similar but subtly different. Locations at Haberfield Shoal serve as regional references, while remediation prioritisation sites E and F are considered collectively in this SAP as location mE, given the similar nature of impact, proximity and adjacency.



LEGEND

- Grounding Footprint

Monitoring Locations

- Regional Reference Locations
- Near-field Test Locations (Not Remediated)
- Test Locations to be Remediated

Title:

Monitoring Location Nomenclature

Figure: 1-1

Rev: A

BMT endeavours to ensure that the information provided in this map is correct at the time of publication. BMT does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

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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 second baseline survey was broken down into two field trips which sought to take advantage of a neap tide window and favourable weather conditions. Douglas and Haberfield Shoals experience 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 9-10 days in length.

The two trips were conducted between 9-14 April 2020 (Trip 1) and 16-21 April 2020 (Trip 2). Trip 1 focused on surface-based data collection which was not completed due to poor weather. Trip 2 initially was diver-based and the remainder of the surface-based work was finished once diving was complete.

1.3 Report Structure

This report presents a preliminary summary of the two field trips to Douglas and Haberfield Shoals as part of the second pre-remediation baseline survey. The report addresses each trip separately in chronological order. 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
- 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 2 April 2020

2.1.1 Daily Activity

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

Day	Date	Activities	Weather Conditions
1	Thursday 9/04/2020	0700-1600 Depart Brisbane, drive to Gladstone. 1600-1730 Pack boat and finalise equipment preparation. Night spent on Wild Blue at port to reduce risk of Covid-19 spread.	Not on water
2	Friday 10/4/2020	0700-1230 Toolbox meeting, continue prepare and mobilise gear on vessel, vessel inductions. 1230-1730 Steam to North West Island, arrive and pick up mooring. OHS and project inductions on steam out.	15 knot E wind, becoming light and variable in afternoon <1m swell
3	Saturday 11/4/2020	0600 Steam to Douglas Shoal, breakfast and toolbox while underway. Undertake towed video surveys at sites mB, mA, mD, mG, mE, mC. 1400 Undertake BRUV deployments at site mB. Undertake fish tissue sampling at sites mA and mB while BRUVs are in the water. 1630-1730 Return to Tryon Island, data backup.	Light variable winds, generally <10 knot, 0.8m NE swell
4	Sunday 12/04/2020	0600 Steam Tryon to Haberfield Shoal, breakfast and toolbox while underway. 0730 Undertake towed camera surveys at sites mH and mI. 0945 Deploy BRUVs at sites mH and mI and begin fishing at these locations. 1500 steam back to NW Island, data backup.	6-15 knot E to SE wind, 0.8 m E swell increasing to 1.2 m E in afternoon
5	Monday 13/04/2020	0600-0730 Steam to Douglas Shoal, breakfast and toolbox during transit. 0730-1000 Deploy BRUVs and site mA and fish tissue sampling while these are in the water. Additional deployments abandoned due to elevated wind and sea-state. Decision made to return to Gladstone as weather predicted to worsen throughout the day. 1000-1600 Return to Gladstone, data backup.	15-18 knot E wind increasing to 20-23knot during morning, 1.5-8m E swell with whitecaps developing
6	Tuesday 14/04/2020	Pack Car and drive Gladstone to Brisbane.	Not on water

2.1.2 Vessels and Personnel

The vessel 'Wild Blue' was used for the both sampling trips. Wild Blue is a twin engine 17m single hull fibreglass vessel, equipped with a 5m alloy dinghy. The vessel can support six 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 anchor at Douglas Shoal (rear A-frame winch in use)

Three BMT personnel 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.
Skipper	Rob Benn Holdings	Master the vessel and ensure that all vessel movements. moorings 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 and survey methodologies and was therefore primarily focused on towed camera, BRUV deployments, and fish tissue samples. The following samples/surveys were collected/completed during the first trip:

- Towed camera surveys at all sites
- BRUV surveys at site mB and mA
- Fish tissue sampling was completed at locations mB, mH and mI and 2/5 fish were collected at location mA.

2.1.3.1 BRUV

BRUVs were 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 “synchronisation 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 the BRUV, in order to avoid any contact with corals, however visibility conditions prevented use of this technique at all sites. Where the seafloor could not be seen, the BRUV was carefully and slowly lowered to the seafloor
- Once on the seafloor, A mark of the location was recorded using real-time kinematic (RTK) GPS, 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 2-4.

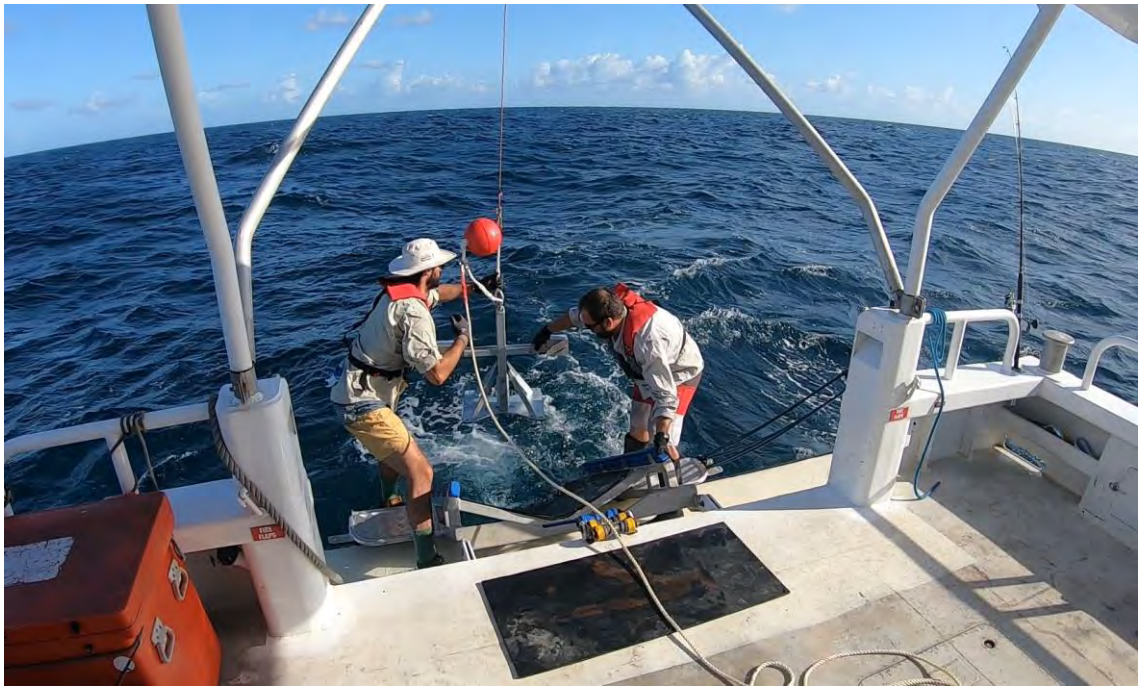

Figure 2-2 BRUV being deployed from back deck of Wild Blue

Figure 2-3 Scientist performing the synchronisation claps prior to deployment of the BRUV

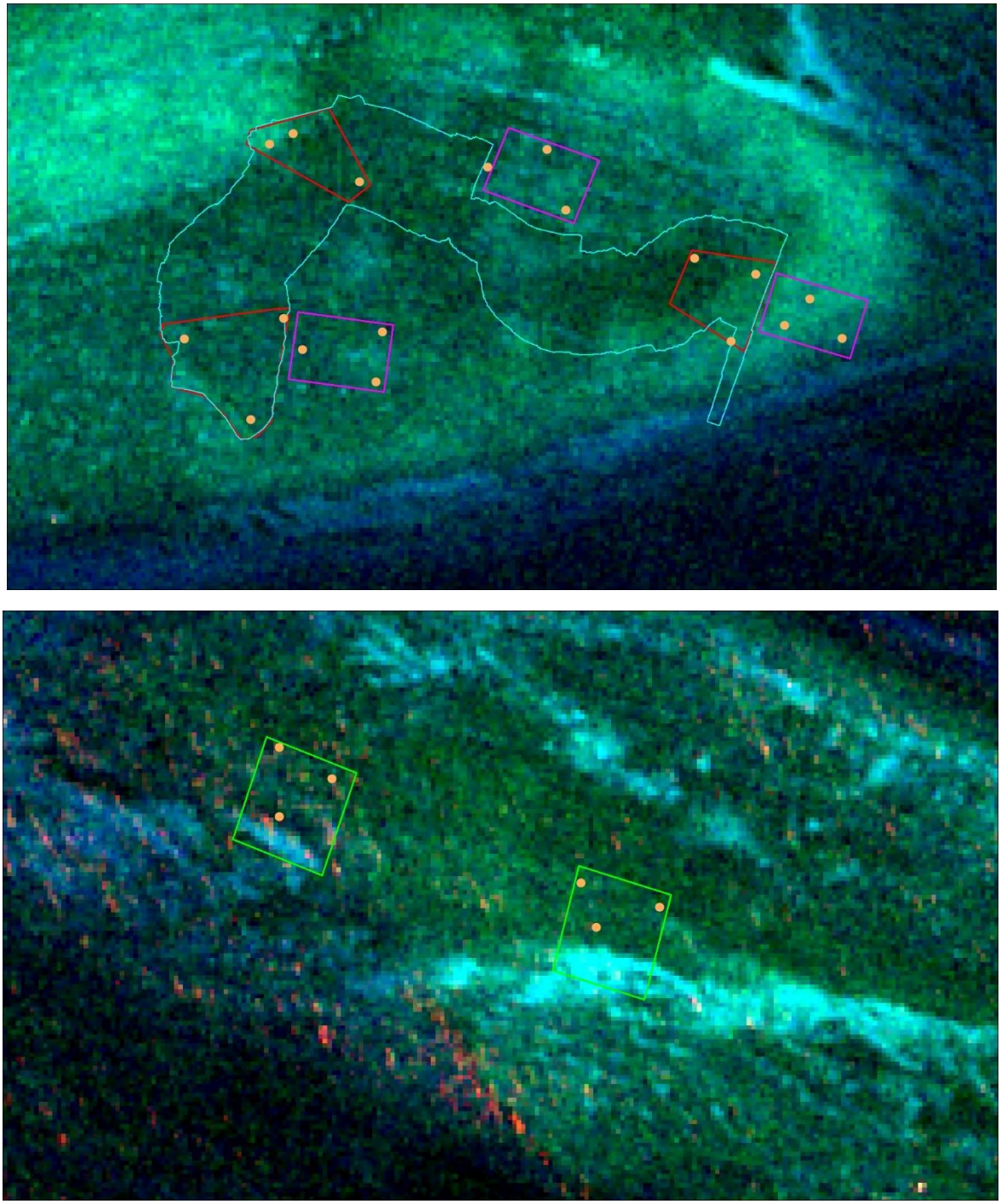

Figure 2-4 BRUV sites at Douglas (above) and Haberfield Shoals (below)

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. Simultaneous downfacing imagery was collected using red-filtered GoPro Hero 7 and Hero 4 cameras deployed on the winged stabilisation device. Imagery of the seafloor was taken 1 second intervals time-synchronised to the RTK GPS. The camera elevation was guided by a forward-facing live feed camera. Tows were conducted in an up and back "S" pattern with consecutive lines being approximately 50 metres apart. Towed camera linework is shown in Figure 2-7.

The procedure for towed camera sampling is described below:

- All devices were time synchronised to the RTK GPS
- GoPros 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
- RTK GPS 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 were backed up onto two external hard drives.

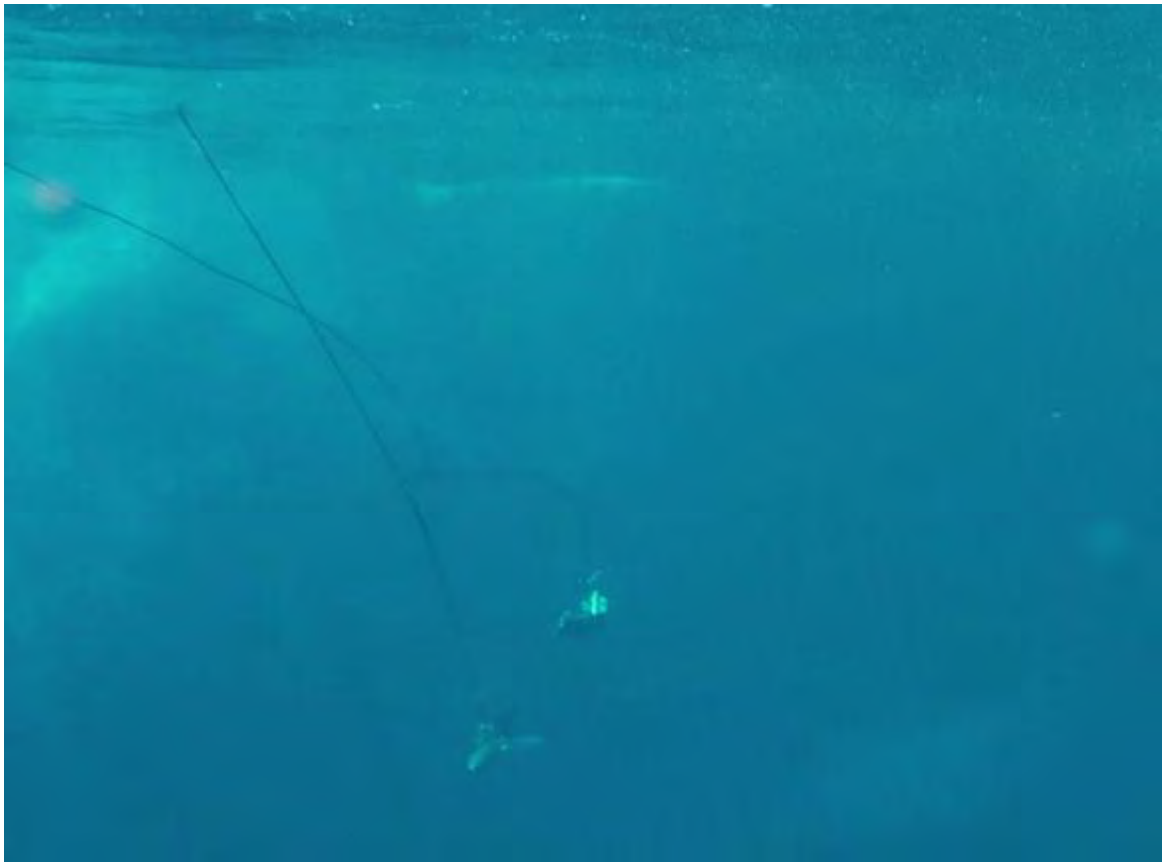

Figure 2-5 Towed camera array in operation

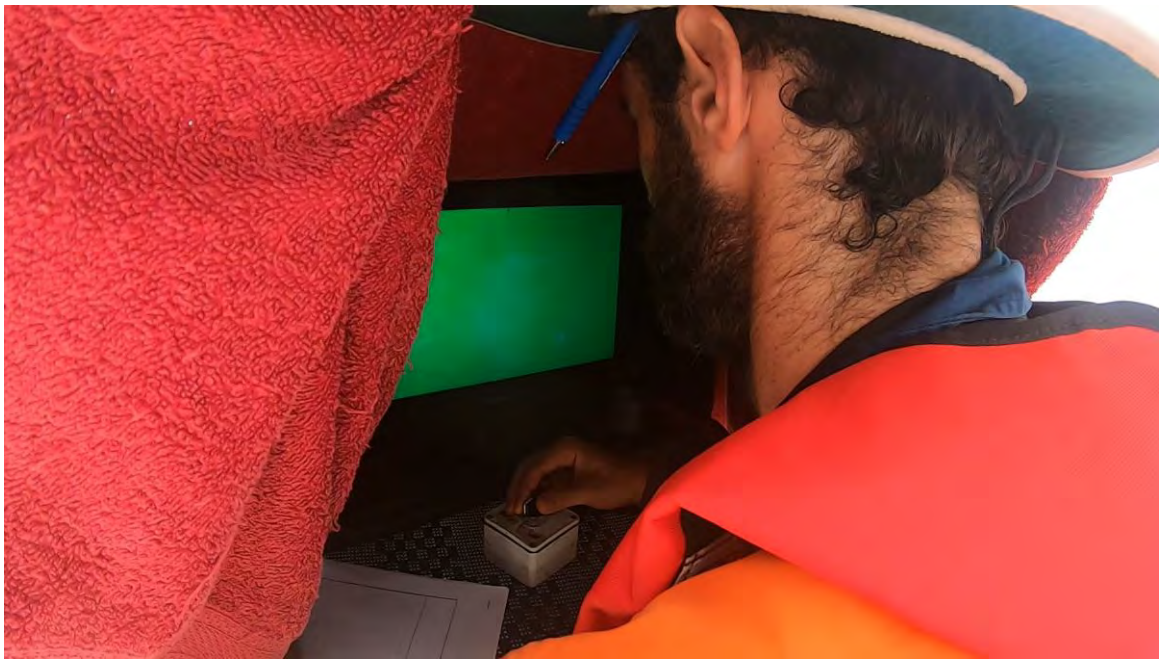

Figure 2-6 Scientist watching live camera feed and controlling height of glide above seafloor with the winch. Towel is used for shading to improve view of the screen.

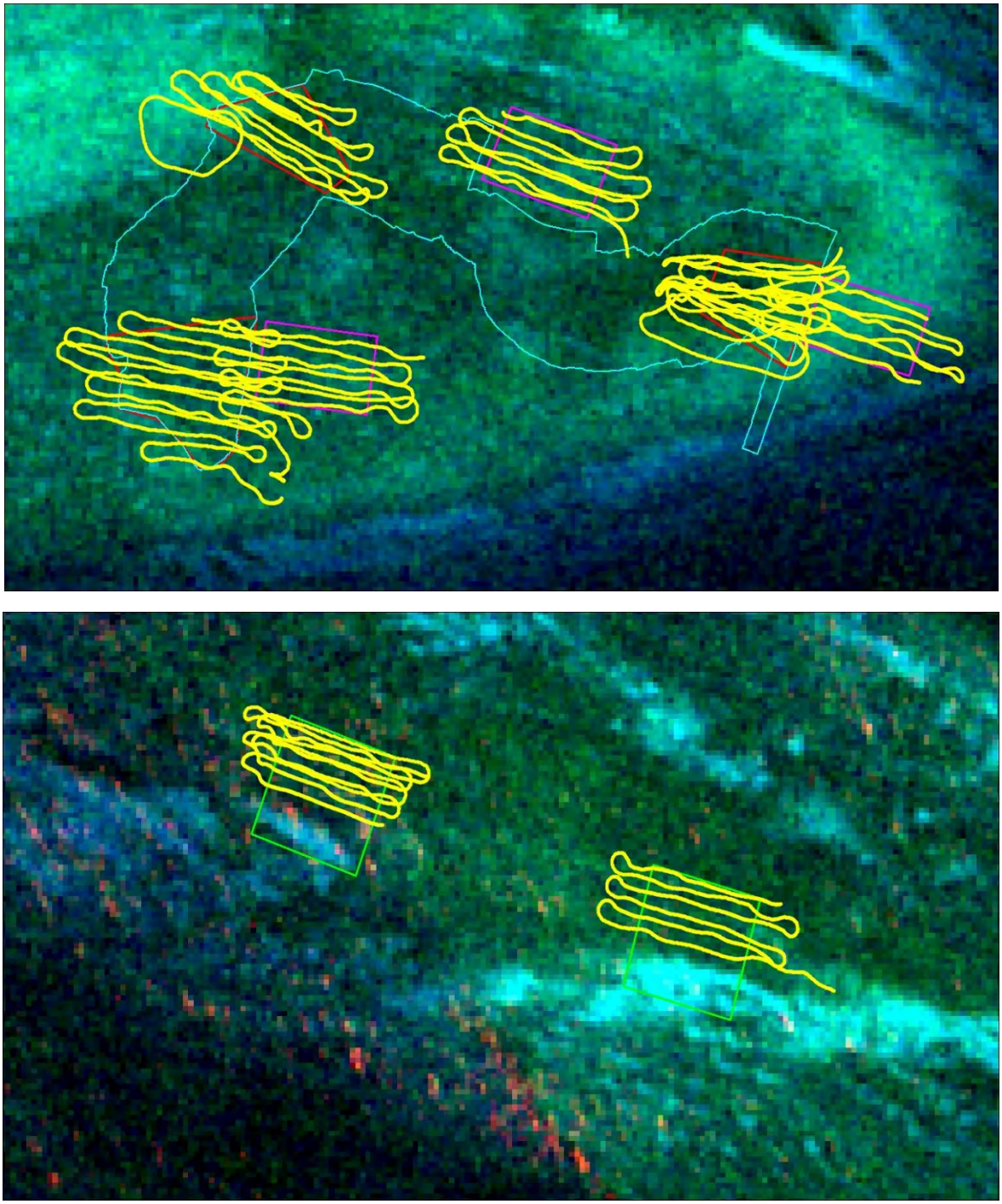

Figure 2-7 Towed camera transects at Douglas (above) and Haberfield Shoals (below)

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 required per location. A total of 17 of the 40 required fish were collected on the first trip. Samples were collected at Haberfield shoal sites mH and mI and Douglas Shoal sites mB and mA. 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 frozen in the vessel freezer for later analysis by the laboratory. The procedure for tissue sampling is detailed below.

- Fishing lines were prepared and baited. Four poles and onehand line were utilised in this sampling trip.
- Where the tidal movement was strong 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.
- Where the tidal current was weak (i.e. during slack tide periods) the skipper anchored the vessel in the middle of the box and shut off engines while fishing took place.
- 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 it 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. The scientist removing the side of the fish wore clean nitrile gloves at all times.
- 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 2-8 Scientists and deckhand pulling in a fish in preparation for tissue sampling

Figure 2-9 Red Throat Emperor caught at Douglas Shoal

2.1.4 Preliminary Observations

There were several notable observations regarding differences between the autumn 2020 and spring 2019 sampling trips, including the relative abundance of fish, sharks, coral bleaching, and visibility conditions. Line fishing during the first trip (9-14 April 2020) was more difficult compared to the October 2019 trip. This may have been due to the predominant north-westerly winds that were blowing for the majority of the most recent trip, which are regarded as unfavourable for fishing by some commercial and charter operators.

Compared to October 2019, visibility was notable poorer in April 2020. Whereas during the October 2019 trip the corals and sand patches were clearly visible from the surface, during April 2020, clear benthic features were rarely visible from the surface even at the lowest tides and under calm conditions. This was also noted on both the BRUV and towed camera footage when reviewed on board. Reduced visibility may have been due to a different current and tidal regime during this period, seasonal changes, or due to elevated sea states in the lead up to the trip.

Tidal currents were extremely strong even on the edge of the neap tides. One BRUV at location mB was seen to be pulled over onto its side by the currents when footage was reviewed. The surface marker buoys were also commonly pulled under the peaks of waves for short periods of time.

Large notable fauna included two tawny nurse sharks on BRUV footage at site mB. The sharks were investigating the bait bag at the end of the BRUV and were 1-2m in length. 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, and mutton birds which were numerous at both sites. A small marlin was seen breaching approximately five times jumping at location mA. Multiple sighting of olive sea snakes were noted across all sites, as were adult green sea turtles. Green sea turtle hatchlings were attracted to the back of the vessel when moored for the night at NW island. All exterior lighting was switched off to allow the hatchlings to disperse. Multiple spinner dolphins were also observed bow riding between North West Island and Douglas Shoal on two mornings.

The first 4 days of the trip coincided with Easter weekend. There were five recreational trailerboats fishing at Douglas Shoal each day. No vessels were noted at Haberfield Shoal.

2.2 Trip 2 April 2020

2.2.1 Daily Activity

Diver-based biota collections and remaining BRUV and fishing activities were conducted over a six day period between Thursday 16 April and Tuesday 21 April, 2020 (including mobilisation and demobilisation) Summary information for daily activities are provided in Table 2-3.

Table 2-3 Summary of Daily Activities for Trip Second Mobilisation

Day	Date	Activities	Weather
1	Thursday 16/04/2020	BMT mobilises from Brisbane to Gladstone, 0530-1300. Vessel inductions for divers, OHS inductions, equipment check, 1300-1400. Wild Blue steams Gladstone to North West Island, 1400-1900	SE winds 10-15 knots, Swell ~1m SE
2	Friday 17/04/2020	Depart NW Island 0600 breakfast and toolbox conducted underway. Arrive Haberfield Shoal 0730. 0830-1200, undertake diver based Algal and Invertebrate sampling at locations mH and mI. Current and wave conditions necessitate anchoring and tethered diving. 1415-1500, steam to Douglas Shoal. 1500-1600 diver-based sampling of algae and invertebrates at location mB and mA. 1645-1830 vessel returns to NW Island. Data backup and QA check.	NW winds 1-10 knots, Swell 1 m E with NW seas to 1m
3	Saturday 18/04/2020	Depart North West Island 0600 breakfast and toolbox conducted underway. Undertake diver-based sediment, invertebrate, and algal collections at Haberfield location mI, Douglas Shoal locations mD, mC, mE and mG. Depart Douglas Shoal at 15:00, arrive at Tryon Island at 17:00. Data backup and QA check. Multiple large tiger sharks seen in the water by spotters and during dives by divers on this day. Data backup and QA check.	NW winds 10-20 knots, Swell 1-1.5 m E with NW seas
4	Sunday 19/04/2020	Depart Tryon Island 0600 breakfast and toolbox conducted underway. Deploy BRUV's at locations mE, mG, mC, mD and Redeploy at site mB2. Fish tissue sampling at these sites while BRUVs are in water. Depart Douglas Shoal at 1630, arrive at North West Island at 1730. Data backup and QA check. No Shark sightings	NW-W winds <10 knots becoming, stronger in the afternoon. Seas 1-1.2 m NW
5	Monday 20/04/2020	Depart Northwest Island 0600 breakfast and toolbox conducted underway. Fish sampling at locations mG, mC, mD, mE. All samples required are taken. Samples are checked, data is QA checked. 0930-1500 vessel returns to Gladstone. Thorough data backup and QA check. Gear clean and pack.	E-SE winds <10. E, Swell 1-1.5 m
6	Tuesday 21/04/2020	0600 BMT staff and divers depart Gladstone. Arrive Brisbane 1400.	Not on water. Easterly winds and swell increasing.

2.2.2 Vessels and Personnel

The Wild Blue Was used again for this deployment. Personnel included two BMT staff, two commercial divers, the master and deckhand. The vessel can accommodate 6 passengers plus two crew (Master and deckhand) and has a 4 m aluminium tender (which was not used).

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 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.
Tech Lead	BMT	Assist with surface-based diving activities under the direction of the ADAS supervisors, assist with sample preparation, GPS work and QA checks.
Master	Rob Benn Holdings	Master the vessel and ensure that all vessel movement and anchoring 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 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 Biota Tissue Sampling

The methodology initially employed for diver-based sampling involved a diver on a two way through water communication system tethered to a floating buoy with a handheld GPS attached to the buoy. The vessel would remain out of gear drifting alongside the diver as the diver searched for samples on the seabed. The currents were found to be too strong for this methodology, and diver was out of the sampling areas before all sampling could be completed. So, in discussion with the ADAS supervisors and skipper of the vessel the decision was made to anchor the vessel at the upstream end of the sampling area and tether the diver to the vessel directly. The diver would also have a flag and GPS tethered directly to him. This allowed lifeline signals to communicate with the diver if the through water communications failed and the diver could be more easily be retrieved in case of an emergency. This technique was employed through the rest of the diver-based sampling.

The typical daily operation for diver-based biota 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 current through the site location. A Freedom 7 shark shield was attached to divers leg and switched on.
- The time of sampling was indicated to the dive deck through line signals. This was then recorded by the tech lead and later cross refenced with the GPS time to provide the divers position (giving an expected position within 10 m of true position) when sampling. Each specimen was placed into a labelled calico bag.
- 40 algal samples were collected (five sites in each of the eight locations). *Dictyota sp.* was sampled in every instance because this was present in the impact areas as well as non-impacted and reference areas. This differed to the spring 2019 campaign where *Dictyosperis sp* was sampled. However, this genus was not available at every location.
- 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.
- Upon surfacing, the sample was photographed and bagged. All sampling apparatus was sprayed with Decon-90 prior to being packaged into the catch bag.

The distribution of biota samples at Douglas and Haberfield Shoals are shown in Figure 2-10.

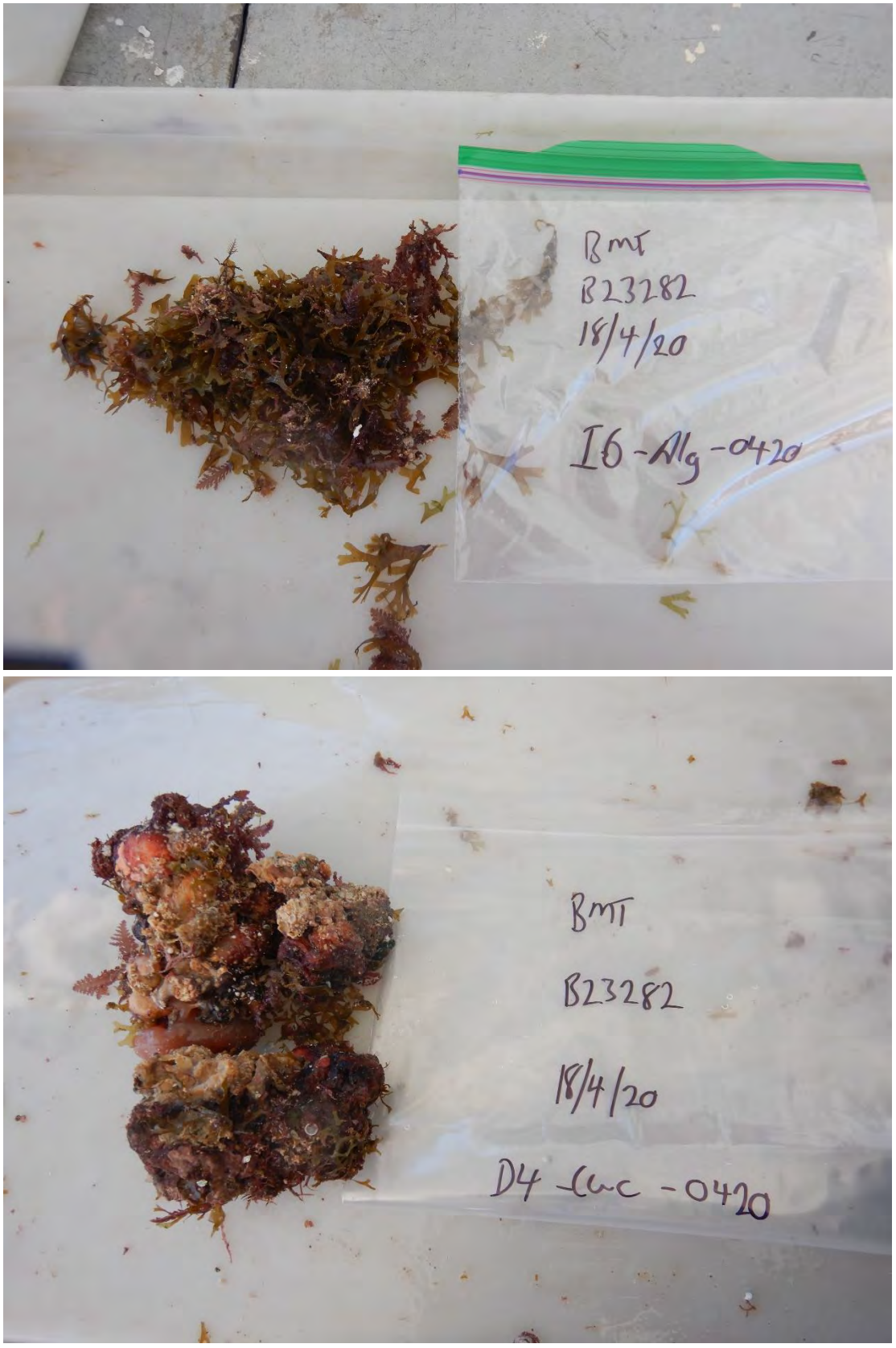

Figure 2-10 Ascidians *cf Polycarpa* (left) and algae (*Dictyota* sp.)

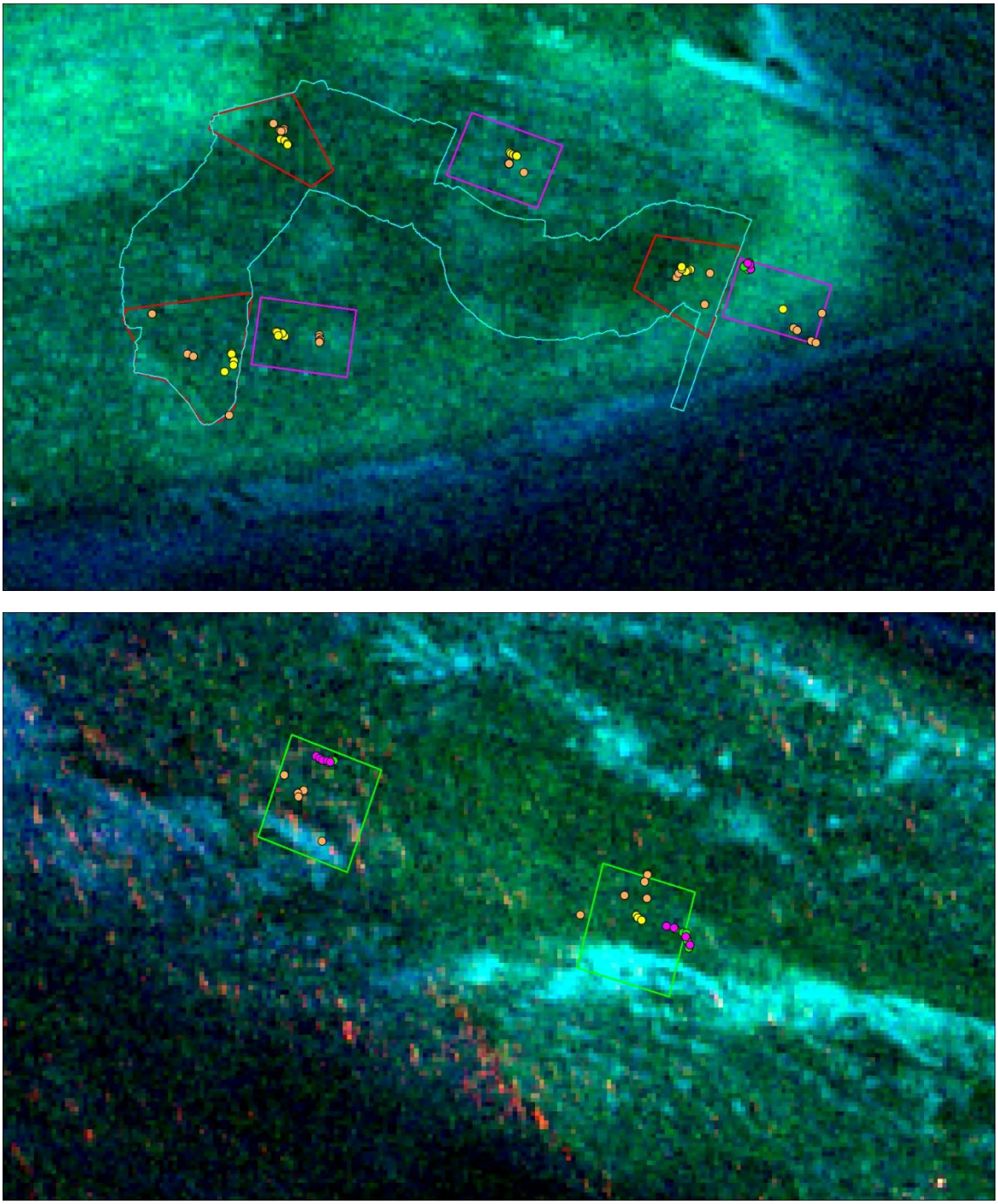

Figure 2-11 Biota sample sites at Douglas (above) and Haberfield Shoals (below). Ascidians are shown in purple, algae in green, algae and ascidians in yellow, fish in orange

2.2.4 Preliminary Observations

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

- 10+ sea snakes

- 6 x tiger sharks including 2 in water sightings
- 4 x green turtles
- 40 x Mutton birds (short-tailed shearwater)
- 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.

Long period east to south-east swell has the greatest influence on wave-driven seafloor conditions, including the movement of divers and stability of deployed instrumentation. While short period waves can create uncomfortable or unsafe surface conditions, their influence is not felt on the sea floor. Instrumentation such as BRUVs with surface connection is most likely to topple when long-period swells interact with tidal currents.

Some issues arising from short period swell and stronger winds usually occur when the vessel comes out of gear and is unable to maintain heading into the sea resulting in beam-on conditions. This can happen during BRUV/ instrument deployment or retrieval, or when passively drifting (e.g. fishing). During instrument retrieval, maintaining heading in strong winds with retrieval lines over the side can result in increased chances of interaction between propellers and instrument lines. When a return to Gladstone was performed during the first trip, wind speed had just exceeded 18knots from the south-east. Conditions such as these were considered outside the operational limits described above.

3.2 Tides, Currents and Turbidity

Increased turbidity during the most recent trips created more difficult conditions for BRUV positioning, towed camera (maintaining elevation and image clarity), and diving (seeing divers and sharks). Turbidity is highly variable through time and very hard to forecast. Tidal vectors during the recent trips (based on hydrodynamic model outputs) were different for the present Autumn 2020 period than during Spring 2019. The inclusion of some form of turbidity planning based on tidal vectors may assist field work in future; however, the timing of the autumn field campaigns is already heavily constrained by tidal amplitude and weather, therefore tidal vectors may not be helpful for future planning.

3.3 Shark Sightings

Tiger sharks were sighted on both diving days during the second trip. On the first day (Friday 17 April) a large (approximately 4m) tiger shark was seen while travelling between Haberfield Shoal and Douglas Shoal. The shark was 10 m from the boat in deep water between the shoals. It was not seen again while at Douglas Shoal. Shark Shields were worn on all dives.

On Saturday 18 April all dives were conducted at Douglas Shoal apart from the first. Dives were conducted at locations mA, mB, mC, mD, mE and mG. Prior to and during the first dive at Douglas

Shoal at site mD, no sharks were seen from the surface or from the water. Two minutes after the diver was recovered, a tiger shark was sighted approx. 10 m away from the vessel. After each sighting spotters were posted on the fly bridge of the vessel, a drone was launched to scout for shadows in the water, and at least half an hour was allowed to pass before divers re-entered the water.

The vessel was moved to location mC. A further two sightings were recorded from the surface and the above procedures were executed before the diver was allowed to enter the water. No sharks were sighted during the dive at location mC, although 7-8 remoras were swimming around the diver for the majority of the dive. The diver ascended and descended a shotline at the back of the vessel.

Multiple sightings from the surface were recorded at the other sites throughout the day and each time the procedures outlined in the HSEQ plan were put in place. The last dive of the day at 14:30 was conducted at location mG. No sharks were sighted on the surface prior to the diver entering the water. At approximately 10 minutes into the dive, the diver signalled a shark, although no sharks had been observed from the surface. While sampling he had interactions with two tiger sharks, (one 2 m and one 4m long) where approaches were made from the edge of visibility to within 1.5 m away from him and he was circled three times. The approaches were close but were not described as aggressive.

These interactions suggest that shark shields should always be worn and turned on. During this trip the same shield was used on consecutive dives. Although the shields have a reported battery life of 5-6hrs, the battery may not have been sufficient for effective protection by the last dive. The batteries of the shark shield should be charged and deployed at full strength or topped up after 3-4 hrs of use. Divers may also consider carrying a pushrod or other barrier if they feel it is required.

3.4 Equipment and Technique Improvements

Improvements to gear together with prior experience greatly increased the efficiency of this trip. BRUV design was changed to increase the strength and resilience of the frames and housings. All new housings were depth checked to ensure proper functioning prior to the campaign to minimise unnecessary re-deployments.

Apart from large swells toppling a single BRUV, and recovery of one BRUV frame that had jammed on the sea floor, no other issues were experienced in BRUV camera work. Deployed instrumentation with surface floats need to balance the length of the tether, size of the buoy, and weight of the instrument package, as adjustments to each of these variables can create unforeseen issues such as ballooning of the tether and excessive drag, over or under ballasting, instrument drag or toppling, or floats being pulled under. Completely vertical line retrieval is essential, but challenging once conditions exceed operational limits.

4 Preliminary Findings

Data has yet to be analysed, so very few preliminary findings exist. Significant preliminary findings will be reported in the pre-remediation monitoring report.

A large mass coral bleaching event commenced over the summer of 2019/2020. Sea temperatures were higher than average throughout the Great Barrier Reef and Coral Sea. Both Douglas and Haberfield Shoals showed clear evidence of this bleaching event. Initial visual estimates suggest that 10-50% of hard corals may have been affected on both shoals. This was noted by both the divers and is observable in towed camera imagery. Very few, if any, corals were bleached in the spring 2019 sampling round. Sample imagery of coral bleaching at Douglas and Haberfield Shoals is shown in Figure 4-1 and Figure 4-2.

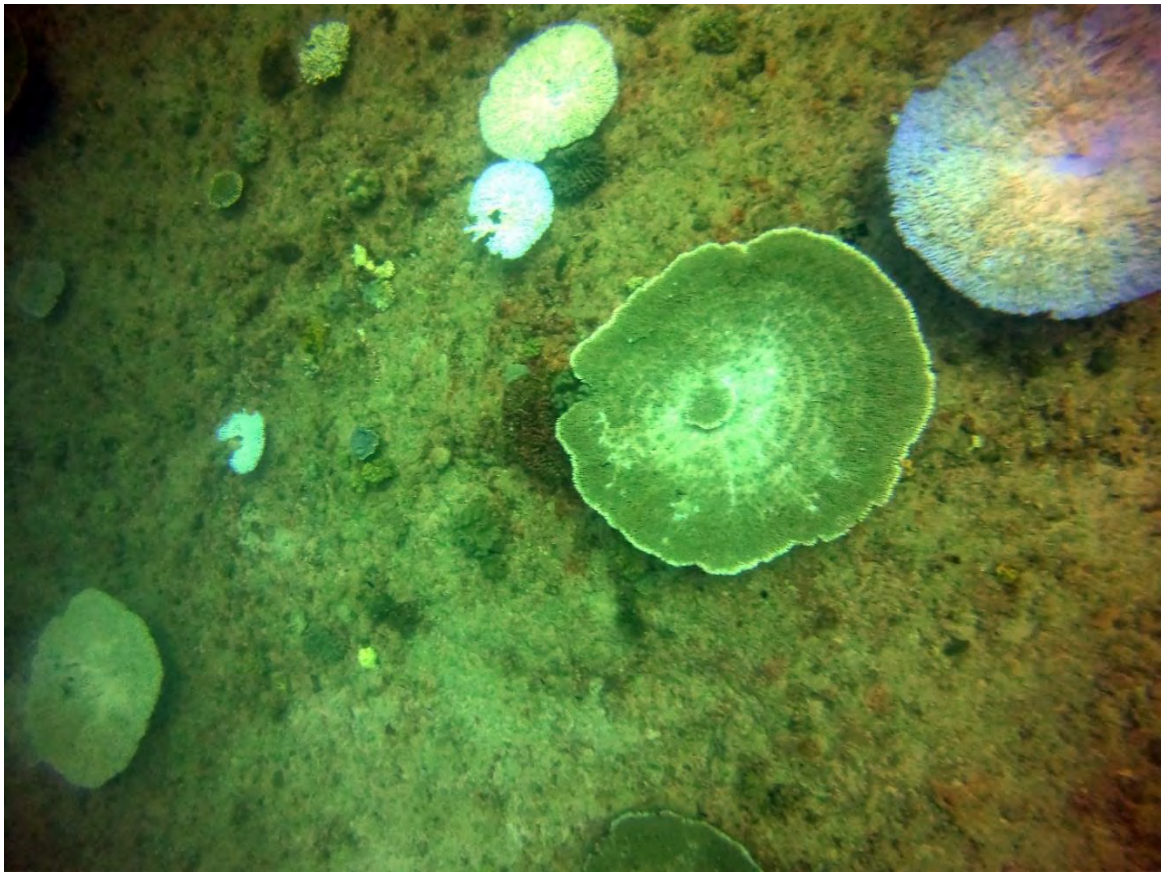

Figure 4-1 Coral bleaching at Site mB at Douglas Shoal

Figure 4-2 Bleaching at site mH at Haberfield Shoal

Appendix A Field Notes

Publication note: Appendix A has not been published

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