

Fitzroy Island Coral Nursery Installation and Baseline Report

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ACRONYMS

AIMS	Australian Institute of Marine Science
AMPTO	Association of Marine Park Tourism Operators
DoEE	Department of the Environment and Energy
GBR	Great Barrier Reef
GBRMP	Great Barrier Reef Marine Park
GBRMPA	Great Barrier Reef Marine Park Authority
LTMP	Long Term Monitoring Program
NESP	National Environmental Science Program
RHIS	Reef Health and Impact Survey
RRF	Reef Restoration Foundation
TWQ	Tropical Water Quality

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EXECUTIVE SUMMARY

In December 2017, the Reef Restoration Foundation in collaboration with a team of volunteers, local businesses, organisations and researchers established the first coral nursery on the Great Barrier Reef. The project was implemented in the shallow fringing reef around Fitzroy Island, 25km east of Cairns. Six coral nursery trees were successfully deployed just offshore from Welcome Bay, at Bird Rock in a depth of 14m. The deployment was challenging as the project had a small budget and relied on volunteers for many tasks. The development and implementation resulted in many lessons learned and potentially represents a first step in a process to extensively utilising local-scale reef restoration projects to support the health and resilience of local reefs across the Great Barrier Reef.

1.0 INTRODUCTION

The Great Barrier Reef (GBR) is an important natural, cultural and economic asset. A growing number of threats place the ongoing health and resilience of the GBR at risk of suffering degradation beyond repair. Cyclones, sediment and nutrient run-off, crown of thorns starfish and coral bleaching, as well as unintentional damage from shipping, fishing and recreation, all threaten the continuing health of the GBR.

The reported declining health of the GBR has led many stakeholders to assess the potential socio-economic fallout of consecutive bleaching events and associated disturbances. This in turn has made many stakeholders consider what direct role they themselves may play in the recovery process. Internationally, local community groups, dive centres, and tourism operators have explored ways to engage in local stewardship activities to support the resilience and assist the recovery of reefs at local scales.

Reef restoration is the process of assisting recovery of ecosystems that have been degraded, damaged or destroyed. Restoration normally involves measures that remove impediments to natural recovery (passive restoration) or aim to accelerate recolonisation by transplanting of organisms or their propagules (active restoration). In the context of coral reefs, passive restoration includes activities such as controlling coral predators or removing nuisance algae. Active restoration includes activities such as transplanting corals, introducing urchins or enhancing recruitment of larvae. Restoration projects involving corals are often a combination of both active and passive restorations. While reef restoration projects can take many forms, key defining features of restoration include the species chosen as the focus for restoration actions, and the long-term goals.

Passive restorative activities introduced on the Great Barrier Reef include the crown-of-thorns starfish control program, measures to improve water quality through catchment management, and the implementation of mooring buoys to reduce damage to coral from mooring activities. Despite active reef restoration being implemented in numerous locations internationally, such activities have been conspicuous in their absence on the Great Barrier Reef. Recent bleaching caused widespread mortality in large sections of the Great Barrier Reef, much of it in the far northern sections previously believed to be resilient to disturbances due to its remoteness and limited direct impacts from coastal populations. This development has prompted many stakeholders to consider what some of the options are for reef restoration, and what role they might play in the Reef's recovery, and its future.

In 2017 the Reef Restoration Foundation (RRF), a local not-for-profit social enterprise sought permission to establish coral nurseries at multiple locations across the GBR. This was an innovative and challenging undertaking. The RRF worked with numerous stakeholders and sought the support of local, state and federal government to enable the establishment of locally based coral restoration and stewardship programs. After much consultation and collaboration, a permit was granted by the Great Barrier Reef Marine Park Authority (GBRMPA) to establish a pilot project at Fitzroy Island Reef in the Cairns section of the GBR (Figure 1).



Figure 1: Map of the Queensland indicating the location of Fitzroy Island (left); Fitzroy Island (right).

Fitzroy Island is one of 600 continental Islands within the Great Barrier Reef Marine Park (GBRMP) located 29 kilometres southeast from Cairns. Shallow fringing reefs between 0 – 12m deep encircle the 3.1km² island and these have suffered greatly over the last decade due to impacts from recreational activities and recent disturbances.

The aim of the project is to explore innovative methods and procedures to successfully grow coral using in-situ coral nurseries and subsequently assist in the recovery of damaged reefs. Working with local businesses, volunteer and community groups, the project aims to demonstrate that local coral reef restoration programs such as this can help support both the socio-economic and the ecological values of the local reefs.

The RRF team successfully established the first of their coral nursery ‘trees’ at Fitzroy Island between the 9th and 11th December, 2017.

2.0 METHODOLOGY

The establishment of the first coral nursery in Australia supporting coral reef restoration was undertaken at Fitzroy Island. This process includes:

1. Construction of the coral nursery trees,
2. Coral fragmentation and nursery propagation,
3. Monitoring, and
4. Coral transplantation.

This report focuses on the construction of the coral nursery trees, the coral collection, fragmentation and nursery propagation.

Prior to deployment into the field, a great deal of work had been done by team members to establish the coral nursery infrastructure. This included the sourcing of base materials for the coral nursery frames (PVC pipe, fibreglass rods, fishing wire, tags etc) and other essential items. Much of the cutting, drilling and construction work was conducted by representatives of the RRF. This allowed the RRF team to utilise field work time to focus on assembly and population of the coral nursery trees. Much of this infrastructure was delivered to Fitzroy Island in preparation for the team's arrival on 9 December. As part of the work program many of the volunteers assisted in the assembly process, helping to piece together the frames ready to receive coral fragments as part of the nursery set up.

2.1 Site selection

The project establishment focused on three sites (Figure 2):

- The two donor sites (Hidden Beach and Shark Fin Bay), where donor corals were collected, and
- The nursery site at Bird Rock.



Figure 2: Map of Fitzroy Island showing the location of the coral nursery (blue) and the two coral collection sites (yellow)

To support the aims of the research two donor sites had been pre-selected to collect corals due to the availability of the target coral species and coral cover being one of the highest around the island. Collection of corals from one site near the nursery site (Shark Fin Bay), and one site removed from the nursery site (Hidden Beach) will allow a comparison of coral response to fragmentation and transplantation from different locations.

The nursery location, offshore from the main beach on the northern coast of Fitzroy Island, provides easy access from the Fitzroy Island Resort and is sheltered from prevailing south-easterly winds of the GBR. In addition, our permit stipulates that coral propagation frames are not located within Locality 1 and Locality 4 Management Zones as defined in Fitzroy Island National Park and Marine Management Area Management Plan 2011 (Figure 3) and to avoid the long-term AIMS monitored sites.

Despite Hidden Beach's location on the opposite side of Fitzroy Island from the nursery, the transplantation of corals to Bird Rock does not constitute translocation as per GBRMPA permit requirements.



Figure 3: Fitzroy Island showing exclusion zones (locality 1 and 4).

Source: Fitzroy Island National Park and Marine Management Plan 2011

2.2 Nursery Assembly

Nursery assembly was conducted by volunteers led by Reef Restoration Foundation staff. The PVC and fiberglass construction process was made easy due to pre-work conducted by the Reef Restoration Foundation. Design specifications were based on designs established by the Coral Restoration Foundation, USA (Figure 4) and advice provided by Ken Nedimyer (Nedimyer, K., et al. 2011).

The coral nursery setup was conducted at the eastern end of the main beach in Welcome Bay. Volunteers assisted in the assembly of coral nursery trees and organising labels for the trees

and corals while the scientific team conducted baseline surveys and collected corals from donor sites.

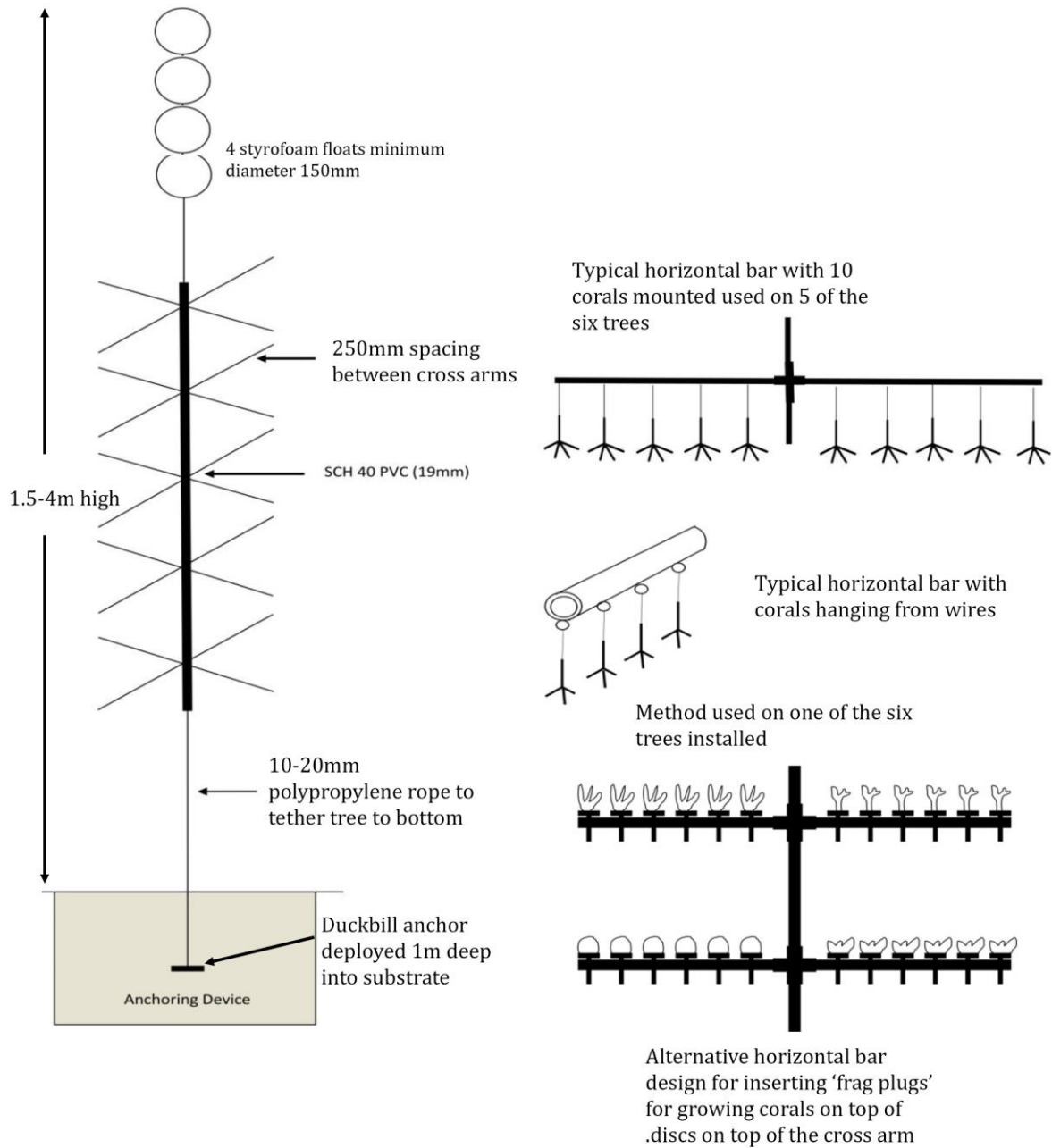


Figure 4: Coral nursery propagation frames design and setup.
(Source: Modified from the Coral Restoration Foundation)

2.3 Coral Collection

The collection of corals was achieved in two stages. First we collected a ‘mother colony’ from a larger donor colony on nearby reefs, we then separated part of this mother colony into smaller fragments for deployment into the nursery. At the two collection sites (Hidden Bay and Shark Fin Bay), partial coral colonies (‘mother colonies’) of target species were collected from healthy donor colonies using a hammer and chisel.

At the donor sites, Hidden Beach and Shark Fin Bay, all donor corals were marked with tags and georeferenced (Appendix C) so that we can monitor whether donor colonies are affected by the coral collection process. To this end, before and after images of donor colonies were collected (Figure 5).

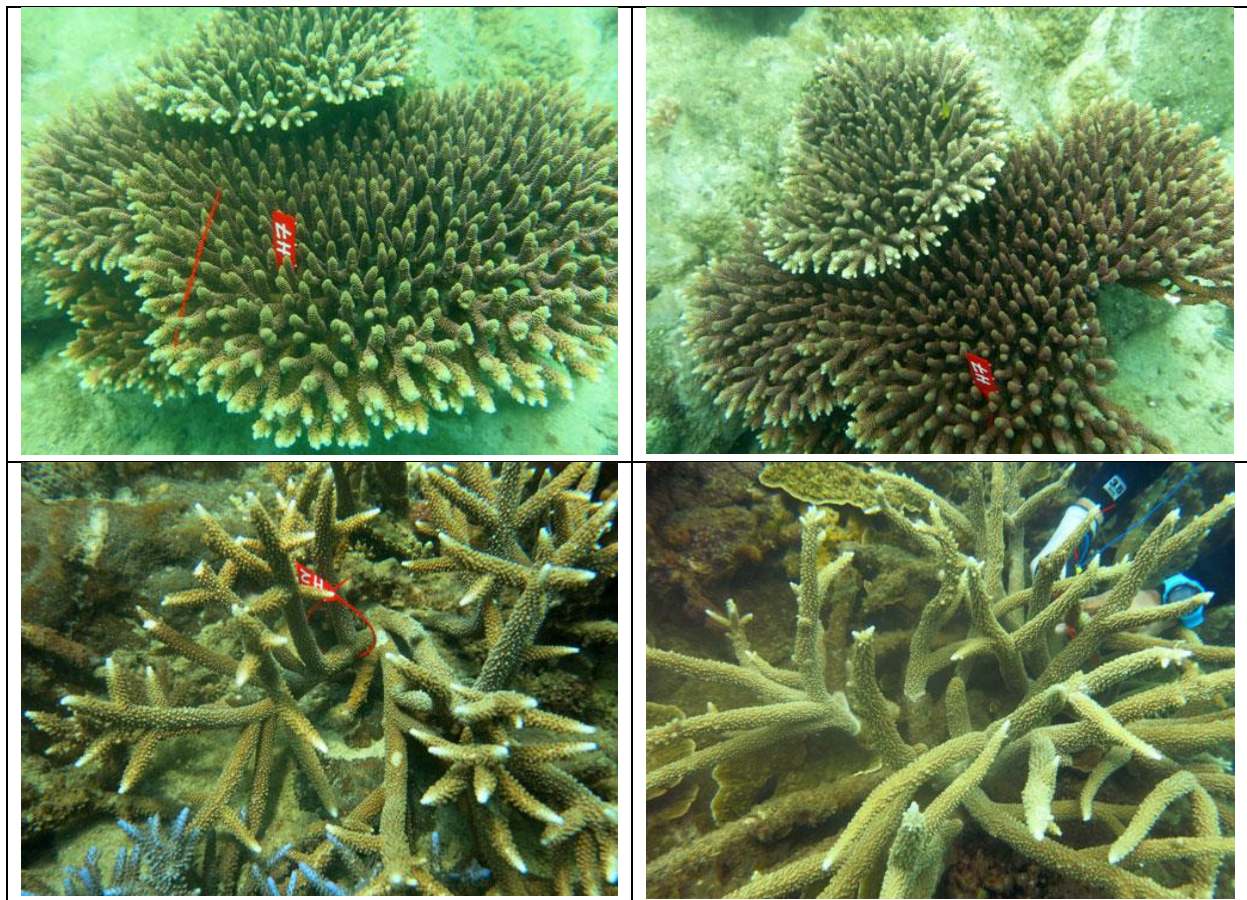


Figure 5: Donor coral colonies showing the bushy species (*Acropora digitifera*) before (top left) and after (top right) sampling and the branching species (*Acropora nobilis*) before (bottom left) and after (bottom right) sampling.

Over the three-day sampling period the team collected 24 partial coral colonies from the two sampling locations. Samples included 12 branching coral colonies (*Acropora nobilis* and *Acropora muricata* <30cm in length), and 12 bushy/corymbose coral colonies (*Acropora digitifera* and *Acropora nasuta* <15cm in length). The partial corals collected comprised <30% and <15% of the total donor colony volume (branching and bushy colonies respectively).

Eight partial coral colonies (four *Acropora muricata* and four *Acropora digitifera*) were collected from Hidden Beach on 9 December, 2017. An additional 16 partial coral colonies (eight

Acropora nobilis, four *Acropora digitifera* and four *Acropora nasuta* were collected on 10 and 11 December, 2017 from Shark Fin Bay. A list of samples can be found in the specimen collection list (Appendix D) and locations are outlined in Appendix B.

During collection, samples were carried in an open crate allowing exposure to ambient surrounding seawater. Upon return to the boat, samples were transferred into a seawater filled container on the boat for the short journey back to the coral nursery assembly location at Fitzroy Island Beach. Travel time from Hidden Beach was approximately 5-6 minutes and from Shark Fin Bay, three minutes.

2.3 Stocking the Nursery

Upon arrival at the beach, samples were returned to the sea in an open crate whilst awaiting fragmentation and propagation onto the coral nursery tree. Fragments were cut from the mother colonies using a hammer and chisel. Approximately 10% of each donor colony was collected. While 10 trees were planned for deployment during this initial development phase, we only managed to establish six coral nursery trees at Fitzroy Island. These were numbered according to research plans and consequently are not numbered sequentially (Table 1).

- On five of the six trees, 10 fragments from one mother colony were tied using monofilament line to a colour coded branch on the coral tree. Forty fragments from four mother colonies were added to each tree making a total of 200 fragments and 20 mother colonies.
- On one of the six trees, 40 coral fragments were individually super glued to fragment plugs custom fit into vinyl tubes attached to the fiberglass branches. The four mother colonies were hung from lower branches in the same way as all of the other nursery frames.

Eight donor colonies were collected and two coral nursery trees were stocked on each of the three days. Corals were fragmented using a hammer and chisel or pliers on the main beach at Fitzroy Island and attached to the tree using fishing line threaded through pre-drilled holes in the coral nursery tree branches.

The different species of corals showed a variety of stress responses common to corals when removed from the water for the purposes of fragmentation and coral nursery propagation. The most obvious stress response was the production of excess mucus to maintain moisture. Visual assessment noticed *Acropora nobilis* produced considerably more mucus than the other three species propagated. Corals were removed from water for the minimum duration possible while the tree was propagated. Once propagated the trees were immersed in shallow water by the beach before being transferred the short (~400m) distance to their deployment location at Bird Rock. For logistical ease, all coral fragments were measured before final deployment.

The coral nursery trees contained floats that ensured adequate buoyancy once deployed. Divers tied the coral nursery trees to pre-prepared anchors which were later adjusted to ensure the coral fragments were at an appropriate depth, similar to the depth where they had been sourced. Additionally, there is a legal requirement as per GBRMPA permit conditions (GBRMPA permit number G17-39917.1, Condition 25iii) to ensure coral propagation frames are no less than 2m below lowest astronomical tide.

We spent three days establishing the coral nursery trees. Following initial deployment, all coral fragments and mother colonies were alive however many of the corals exhibited partial bleaching common when corals are stressed. No signs of other disturbances such as predation or disease were identified upon the initial nursery stocking and deployment. One element of this investigation is comparing the different methods of attachment of the coral fragments to the frames.

The initial nursery stocking and deployment of two trees (number 1 and 2) was completed on Saturday, 9 December with both branching (*Acropora muricata*) and bushy (*Acropora digitifera*) coral colonies from Hidden Bay. The method of attachment for corals on tree number 1 using the coral fragment plugs was relatively ineffective.

Table 1: Number of corals deployed and still present following deployment.

# Tree	Source	Morphology	Total # fragments	Living	Dead	Missing	Species
2	HB	Branching	40	40	0	0	<i>A. muricata</i>
3	SFB	Branching	40	40	0	0	<i>A. nobilis</i>
9	SFB	Branching	40	40	0	0	<i>A. nobilis</i>
1	HB	Bushy	40	24	0	16	<i>A. digitifera</i>
5	SFB	Bushy	40	40	0	0	<i>A. nasuta</i>
10	SFB	Bushy	40	40	0	0	<i>A. digitifera</i>

Maintenance and monitoring dives are scheduled to be conducted weekly by divers and volunteers from Cairns Dive Centre, Fitzroy Island and the Cairns Turtle Rehabilitation Centre. Maintenance includes cleaning off overgrowing macroalgae and accumulating sediment and checking for any disturbances such as coral disease and predators. Additionally, the condition of the coral propagation frames will also be important to monitor to determine the durability of this method of coral nursery and its applicability on the Great Barrier Reef.

2.4 Monitoring

In order to assess the coral reef communities at the donor sites we conducted baseline surveys at the two donor sites, Hidden Beach and Shark Fin Bay. These surveys consisted of quantitative benthic surveys and fish community assessments.

To assess the growth, survival and condition of both fragments and mother coral colonies, we conducted baseline size assessments at the time of deployment. These measurements will be compared to measurements taken at three monthly intervals to assess coral growth. In addition, a count of live, deceased or missing colonies will be conducted as part of regular monitoring on a monthly basis.

2.4.1 Donor Sites

Surveys were conducted of benthic cover, coral condition and the fish community at the two coral collection sites, Hidden Bay and Shark Fin Bay (Figure 2). Two types of benthic assessments were conducted. Video transects along 50m line transects allowed for detailed analysis of the benthic community and provides a permanent record of the site. In addition,

Great Barrier Reef Marine Park Authority's (GBRMPA), Eye on the Reef - Reef Health and Impact Survey (RHIS) method allows a rapid evaluation of the composition and condition of the benthic community. We conducted three RHIS at each of the two coral collection locations, Hidden Beach and Shark Fin Bay. Finally, fish communities were surveyed using underwater visual census. We conducted three fish surveys (50 x 5m transects) at each of the two collection locations: Hidden Beach and Shark Fin Bay.

2.4.2 Nursery corals

To assess coral growth we measured height, maximum diameter, minimum diameter and, in the case of the branching morphology corals, the number of branches (Table 1). For bushy morphologies, the number of branches was not counted. Growth measurements on corals hanging from a wire is particularly tricky as there is no set base and coral colony swings freely on its axis from the connection point. Additionally, these coral morphologies will grow in multiple directions. Due to this anomaly it was decided, in the interests of efficiency and replicability, in-situ coral measurements would use the fixed point where the coral hangs as a reference for aligning photo records.

Table 2: Parameters and methods measured when quantifying coral fragments in the field (refer Figure 2).

Parameter	Method
Height	The total vertical height of a colony as it hangs freely on the wire. For those fragments attached to plugs, the height is measured from the top of the coral fragment plug to the top of the colony.
Maximum diameter	Width of the coral colony at its widest point.
Minimum diameter	Width of the coral colony at 90° from the measurement of the maximum diameter.
Number of branches	The number of obvious branches (i.e: more than 1-2 polyps) (branching morphologies only). Maximum of 15. Colonies with more than 15 branches are counted as >15.

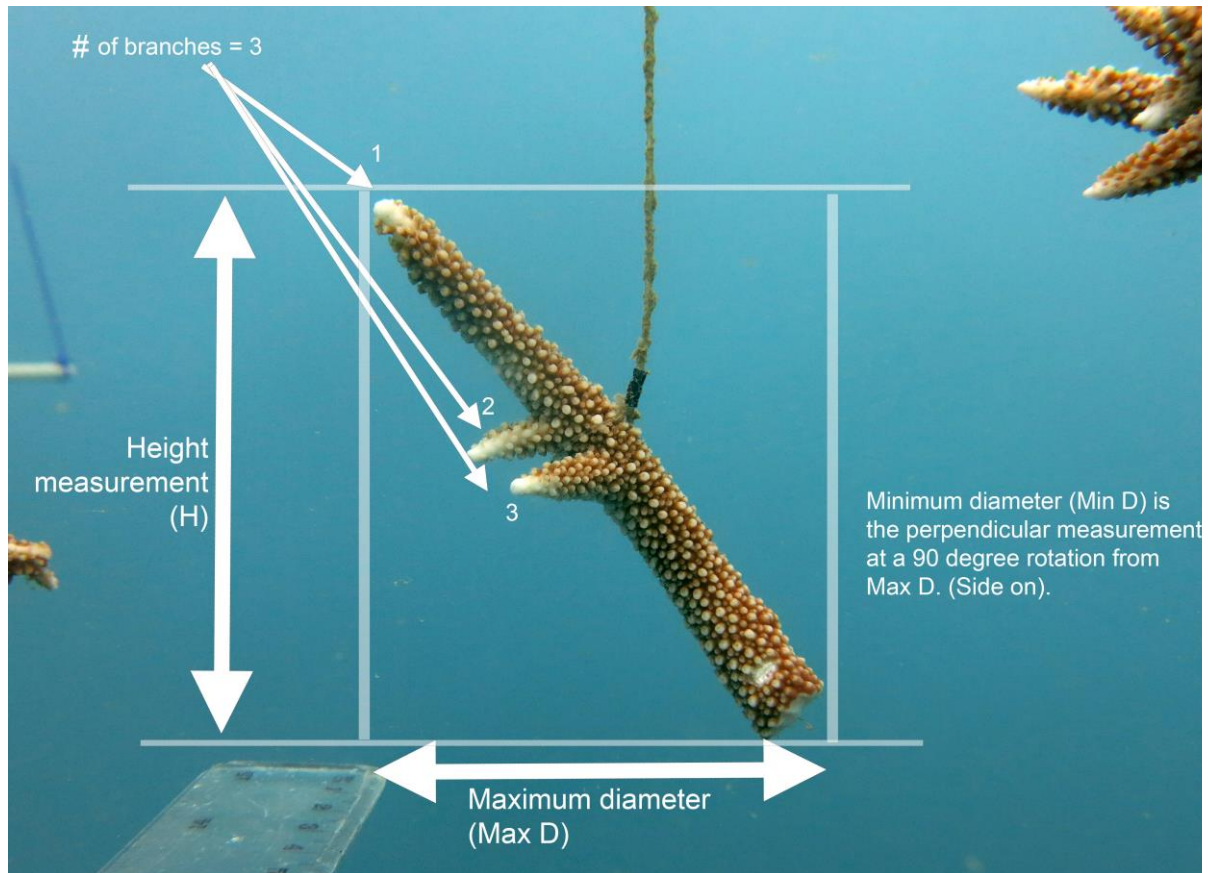


Figure 6: Guidelines for the measurement of coral fragments on the coral trees showing the height, maximum diameter, minimum diameter and the number of branches. Measurements are obvious in this image however will become more cryptic as the colony grows and develops.

Photo records of all coral fragments are to be collected as part of on-going monitoring. Coral fragments on four of the six trees were photographed in-situ using a Canon G15 in an underwater housing. All photographs were taken at a standardised horizontal distance of 30cm from the target coral fragment. Ideally coral fragments will be photographed with a standard measurement reference in the frame to assist coral measurement. A standardised photo-quadrat is to be developed and photographs taken as per design (Figure 7).

Figure 7: Photo records of coral fragments to be taken at a standardised distance of 30cm using a 30cm x 30cm photo-quadrat.

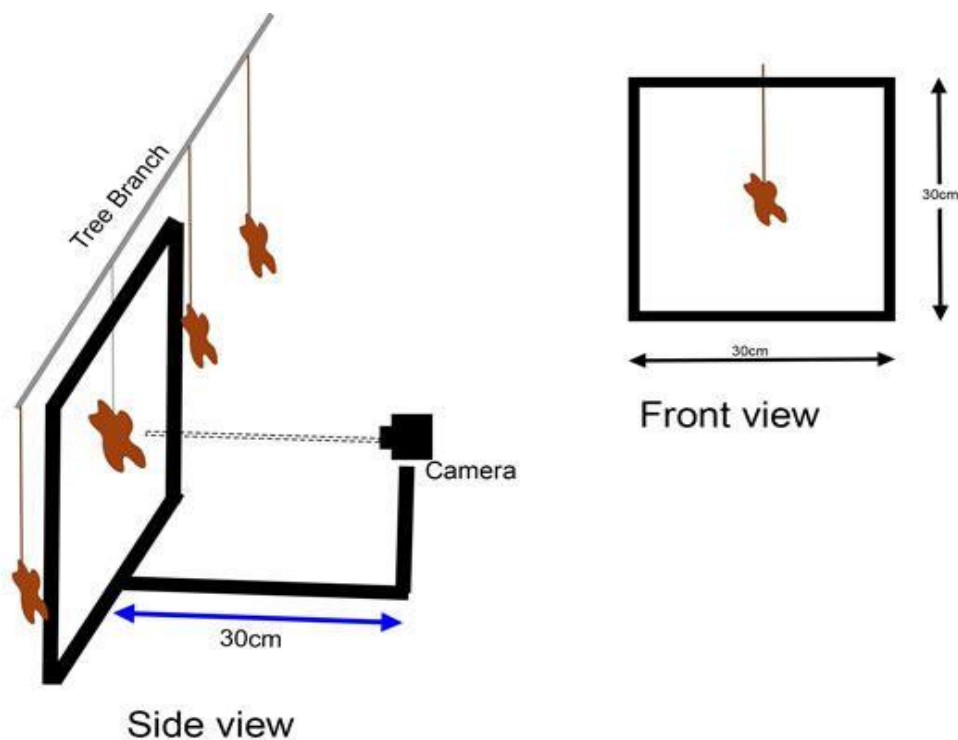


Figure 8: Photo records of coral fragments to be taken at a standardised distance of 30cm using a 30cm x 30cm photo-quadrat.

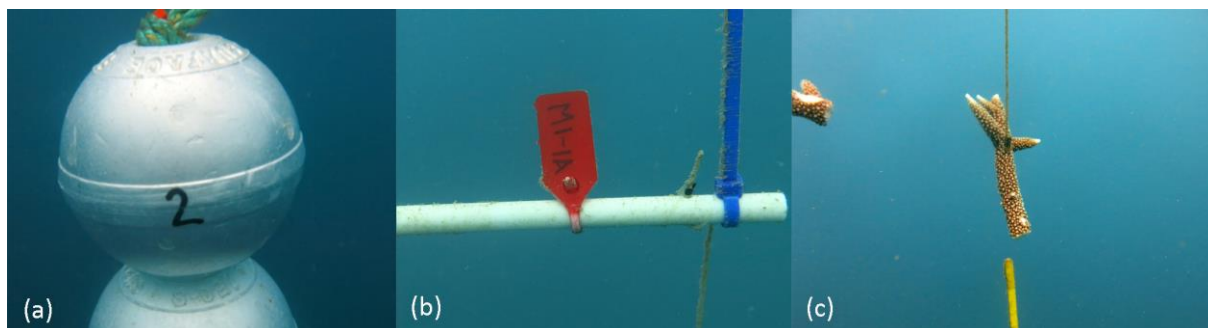


Figure 9: Photo records of coral fragments in the field to be taken by recording (a) the tree number, (b) first tag on each branch and finally (c) the 10 fragments of each branch.

2.4.3 Environmental Conditions



Figure 10: Hobo data logger attached to coral nursery tree

Remote environmental monitoring tools are excellent for providing environmental data about regions generally, however data loggers can provide accurate readings of environmental variables at local scales. One HOBO Pendant® temperature/light data logger (64K - UA-002-6) was attached to coral nursery tree #9 (Figure 9). The data logger has a 2 year battery life and storage capacity, logging data every 30 minutes. The data logger will be able to provide accurate temperature data of the Bird Rock nursery micro-habitat potentially allowing for more accurate interpretation of outcomes from the coral nursery research project.

3.0 PRELIMINARY RESULTS

3.1 Donor sites

Live coral cover (LCC) was similar at both locations with a mean of 42% (SE±8.28) LCC at Hidden Beach and 37% (SE±1.19) LCC at Shark Fin Bay. Hidden Beach was considered to be more aesthetically appealing to dive tourists, predominantly due to the absence of macroalgae and a higher proportion of hard scleractinian corals and live coral rock. Macroalgae cover was high (27.7%, ±1.19 SE) at Shark Fin Bay and low at Hidden Beach (1% ±0.47SE) macroalgal cover (Figure 10).

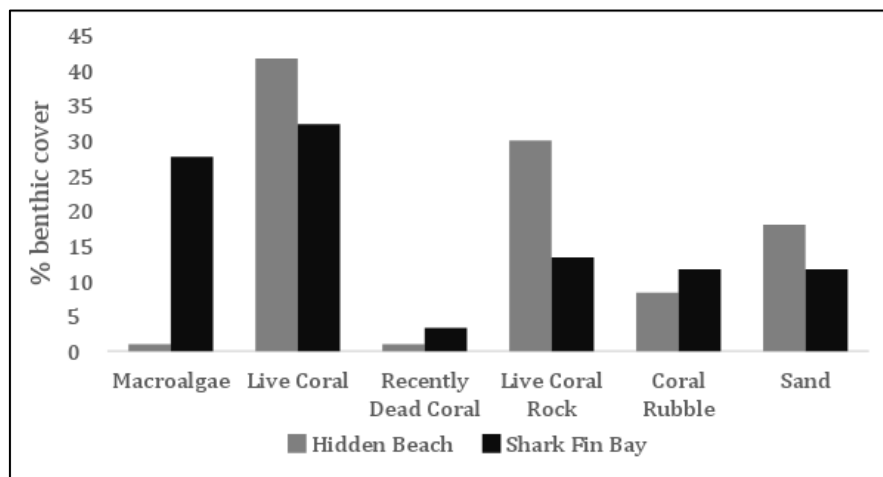


Figure 11: Proportion of benthic cover as assessed at Hidden Beach and Shark Fin Bay on 9-10 December 2017.

The coral community composition varied between locations. Hidden Beach was dominated by massive (42%) (SE±8.28) and bushy (32%) (SE±10.63) growth morphologies while Shark Fin Bay had a higher proportion of soft corals (42 ±4.9% of total live coral) (Figure 11). The RHIS survey data has been uploaded to GBRMPA's Eye on the Reef database (Survey ID numbers #37306 - 37311 (N=6).

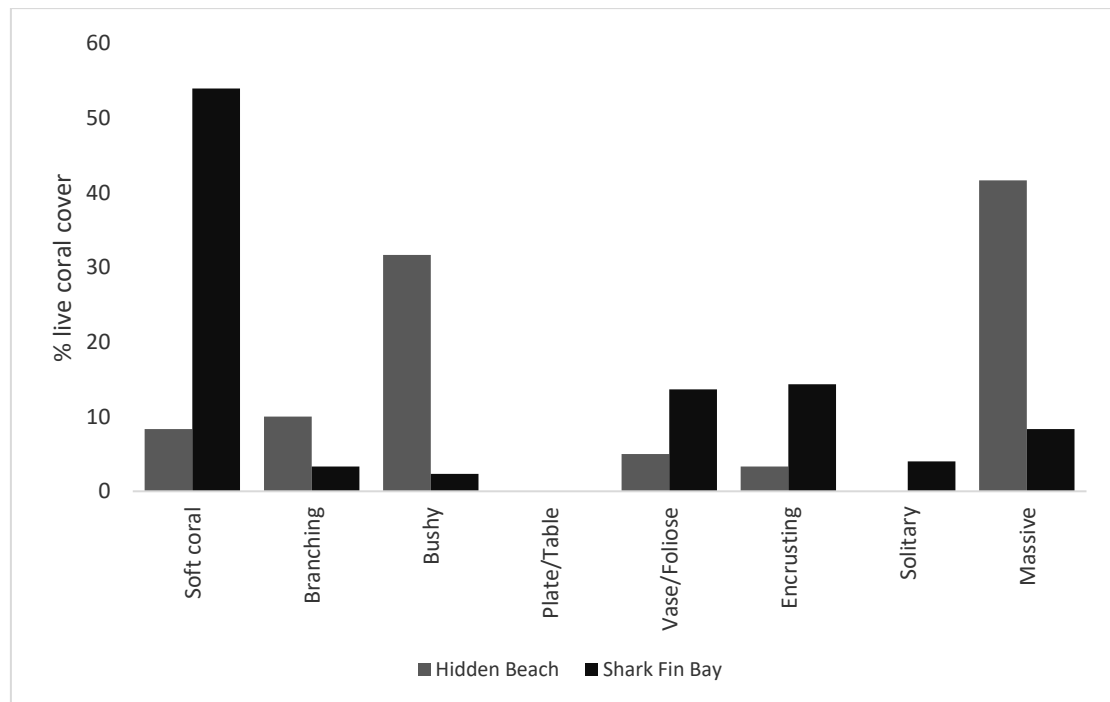


Figure 12: Community composition of the live coral highlighting the different morphologies contributing to benthic coral cover.

A total of 795 fish from 57 species were recorded in the six transects (Appendix A). The number of species recorded in this study was similar to that found during surveys undertaken by the Australian Institute of Marine Science (AIMS) Long-term Monitoring Program between the 1990s and 2017 (Figure 13). The fish assemblage was dominated by species from the wrasses, damselfish and butterflyfish families. Five species were numerically dominant in five of the six transects. These species were lemon damsel (*Pomacentrus moluccensis*), Australian gregory (*Stegastes apicalis*), cleaner wrasse (*Labroides dimidiatus*), greenback wrasse (*Halichoeres nigrescens*) and crescent wrasse (*Thalasoma lunare*). The most abundant species overall was the fragile cardinalfish (*Zoramia viridiveter*) which was recorded as a school of 200 individuals at one site. Herbivores were represented by parrotfish, surgeonfish and rabbitfish. Very few commercially and recreationally important species of fish were observed with the exception of two large coral trout (*Plectropomus leopardus*) at one site.

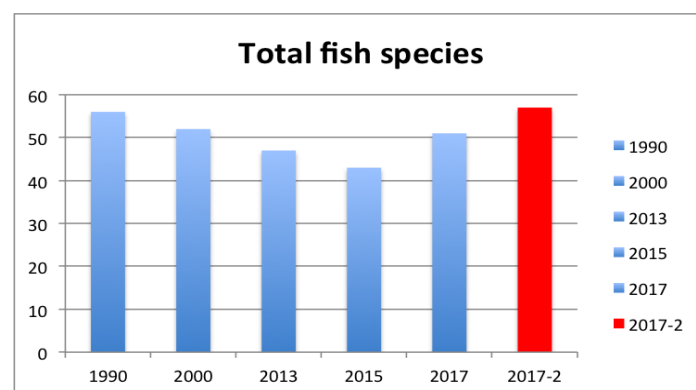


Figure 13: Comparison of total number of fish species recorded in baseline surveys (red) compared to AIMS Long-term Monitoring Program surveys at Fitzroy Island.

There was a higher average number of fish species at Hidden Beach than at Shark Fin Bay. This result was driven by the presence of a large school of 200 fragile cardinalfish (*Zoramia viridiveter*) in one transect at Shark Fin Bay. A full list of fish species identified is included at Appendix A.

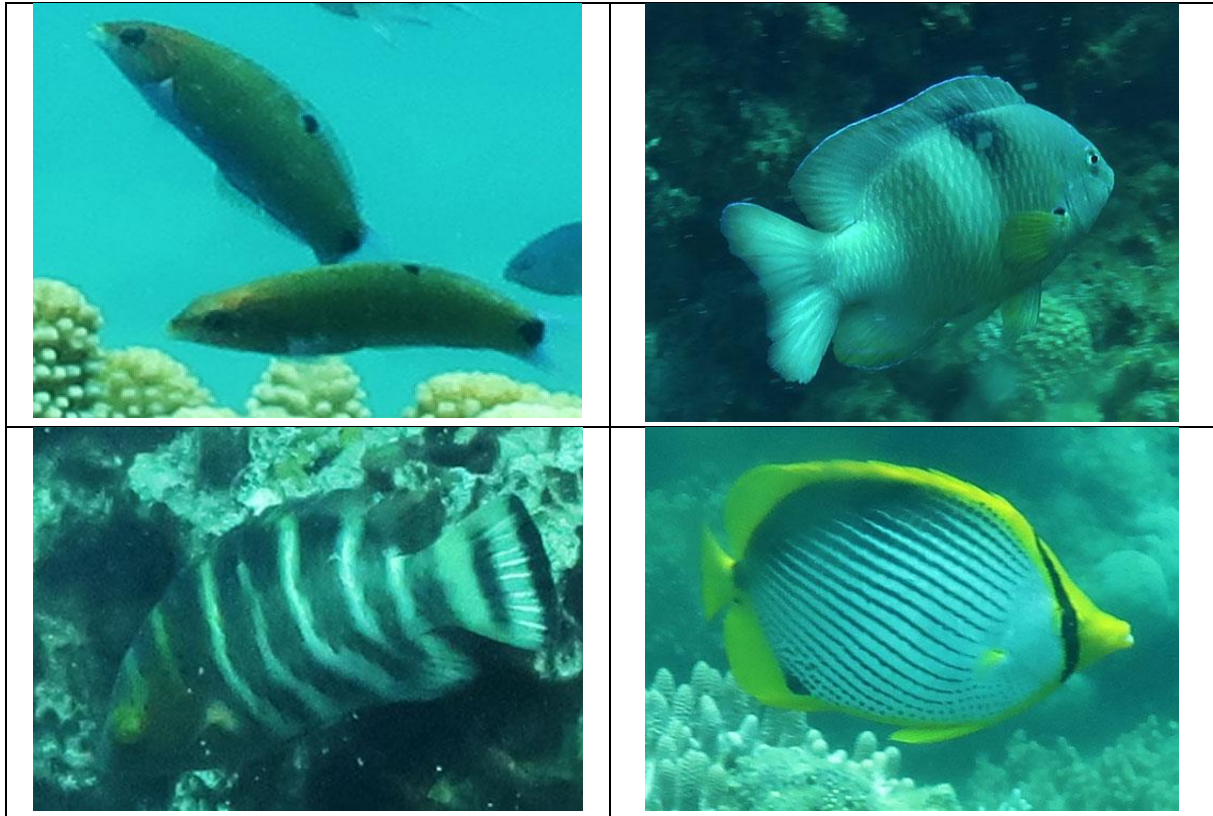


Figure 14: Selected species of fish recorded in baseline surveys at Fitzroy Island.

3.2 Nursery corals

Over the course of the project establishment the team managed to install and stock six coral nursery trees with 240 coral fragments from 24 mother colonies of the genus *Acropora*.

Methods used for attaching the corals to the trees were effective when using monofilament line attached to the coral nursery tree branches. The use of fragment plugs was a less effective method because the fragment plugs attached to vinyl tubes were difficult to slide onto the tree branches especially when coral fragments were attached. The coral fragments were attached with super glue to cement plugs, which provided time consuming and fragile to handle in the water. Consequently, a number of the corals became detached during installation (Figure 14). Due to the difficulty and apparent ineffectiveness of this method, all remaining coral fragments were attached by monofilament line to the remaining trees. We discussed alternatives such as attaching the vinyl tubes to the branches and on inspection two days later, on 11 December, 16 coral fragments were recorded missing.

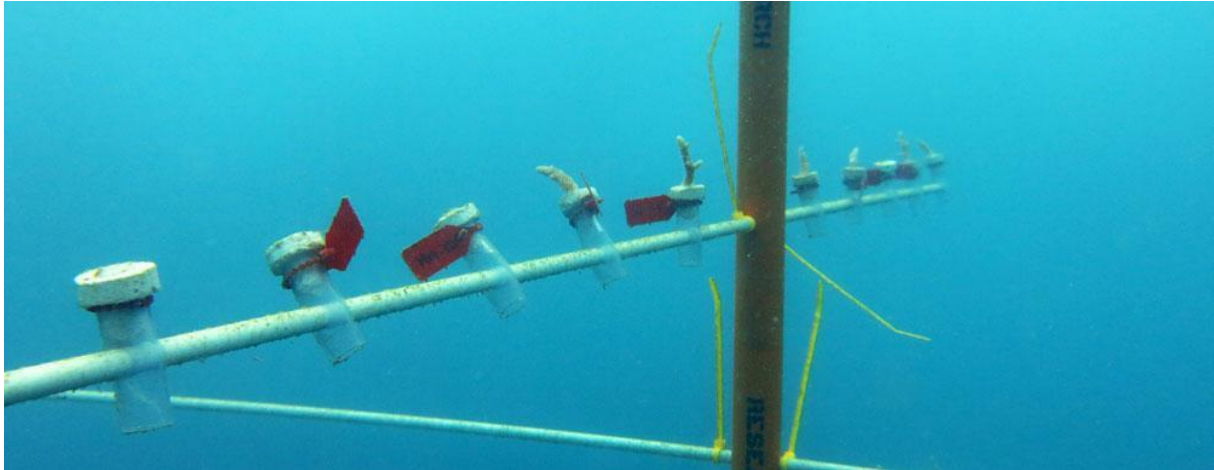


Figure 15: Coral nursery tree showing fragment plugs some with and some without their coral fragments after they became detached during installation.

Initial baseline measurements of the size of the coral fragments in the coral nurseries was collected (Table 3). All coral colonies were measured on four coral trees (tree numbers 3, 5, 9, and 10). This comprised 80 branching coral fragments and 8 mother colonies, and 80 bushy coral fragments and 8 mother colonies. On the two remaining trees, number 1 (bushy) and 2 (branching), a selection of 3 coral fragments were measured on each tree (n=12 per tree, total n=24). Those fragments measured were the first three fragments on each branch.

Table 3: Summary of average height, maximum and minimum diameters of all coral colonies measured.

Tree #	Height (mm)	Max D (mm)	Min D (mm)	# Branches	Comments
2	68	78	31	2.6	Source HB
3	42	69	19	1.6	Source SFB
9	53	53	23	2.2	Source SFB
Average all Branching	50	63	22	2.0	
2	28	13	12	n/a	Source HB
3	26	37	20	n/a	Source SFB
10	29	47	23	n/a	Source SFB
Average all Bushy	28	38	20	n/a	

Photo records were collected of all coral fragments on trees number 1, 2, 3 and 5 totalling 160 fragments and 16 mother colonies were collected on 11 December 2017. Photo records of the remaining two trees (number 9 and 10) were collected on 23 Dec 2017. Coral fragment growth on the nurseries will continue to be monitored on a quarterly basis.

4.0 DISCUSSION AND CONCLUSION

As an initial installation of a community-driven coral nursery project, the development and deployment the coral nursery trees at Fitzroy Island was successful. We collected corals from donor colonies at two sites and effectively propagated six coral nursery trees at the coral nursery site at Bird Rock.

The establishment of a new project is never easy, especially when involving volunteers and people with limited experience in the field. Corals were effectively and efficiently collected and transferred to the beach where they remained immersed. Our methods and processes became incrementally more efficient with each day. Relying on local businesses and volunteers to support such a project also adds challenging logistical elements. However, including local businesses and volunteers likely has other benefits such as increasing local knowledge and buy-in to GBR conservation and restoration activities. Except for the first day when we had access to a suitable support tender, the project was reliant on vessel support from tourism operators subject to the limitations of their daily work schedule, which coincided with a peak visitation at the commencement of summer school holidays. Having a dedicated vessel for future work will increase deployment efficiency and having access to suitable in-water working platforms for cutting and tagging coral would also increase productivity. However, this is reliant on having sufficient budget and resources.



Figure 16: Volunteers were a crucial support in the establishment of the coral nurseries at Fitzroy island. Dr Adam Smith giving a daily briefing (top left), Dr Adam Smith and volunteers attaching corals to the nursery trees (top right), volunteers displaying the assembled coral nursery trees (bottom left), and a volunteer underwater after successful deployment of the coral nursery trees (bottom right).

The active involvement of a suite of enthusiastic volunteers in the process of establishing and maintaining the coral nurseries has, thus far, been a real positive of this project (Figure 15). A total in-kind contribution for the set up and installation of the six coral nursery trees at Fitzroy Island has been valued at \$10,900. A total of 25 volunteer days comprising 200 hours represents an estimated direct in-kind contribution of \$6,000 in the initial set up of the coral nursery at Fitzroy Island. In all, \$3,400 was provided collectively by Fitzroy Island Resort and Cairns Dive Centre located on Fitzroy Island. Vessel use valued at \$1,500 was also provided by Fitzroy Island Resort and independent volunteers.

Ongoing monitoring and maintenance will be implemented for the coming few months looking at coral growth, survival and any signs of disturbances such as disease and predation. We are also monitoring the condition of the coral nursery frames to evaluate the effectiveness of this method for implementation on a broader scale across the Great Barrier Reef. Volunteers will be coordinated predominantly by staff from Fitzroy Island Resort gathering groups of between 4-6 people every 1-2 weeks to conduct maintenance and monitoring at the site. As corals can be vulnerable when first transplanted the team are keen to conduct maintenance more frequently in the early stages of this product.

A maintenance dive includes divers in buddy pairs using toothbrushes and gloved hands to clean overgrowing algae from the wires, tree branches and the primary frame of the coral tree nurseries. This helps reduce the abundance of competing organisms hopefully providing a competitive advantage to the growing corals.

REFERENCES

Nedimyer K., Gaines K., Roach S., 2011 Coral Tree Nursery©: An innovative approach to growing corals in an ocean-based field nursery. *AACL Bioflux* 4(4):442-446.

APPENDIX A: FISH SPECIES RECORDED DURING BASELINE SURVEYS

Fish species recorded at Hidden Beach (HB) and Shark Fin Bay (SF), Fitzroy Island.

<u>Common name</u>	<u>Species</u>	<u>HB</u> <u>1</u>	<u>HB</u> <u>2</u>	<u>HB</u> <u>3</u>	<u>SF</u> <u>1</u>	<u>SF</u> <u>2</u>	<u>SF</u> <u>3</u>
Sabre squirrelfish	<i>Sargocentron spiniferum</i>			1			
Bluespotted grouper	<i>Cephalopholis cyanostigma</i>	1					1
Leopard coral trout	<i>Plectropomus leopardus</i>		2				
Blue and yellow fusilier	<i>Caesio teres</i>			30			
Wolf cardinalfish	<i>Cheilodipterus artus</i>					1	
Fragile cardinalfish	<i>Zoramia viridiveter</i>					200	
Spanish flag	<i>Lutjanus carponotatus</i>						1
Two-spot snapper	<i>Lutjanus biguttatus</i>	1	1	2			
Monogram monocle bream	<i>Scolopsis monogramma</i>	1		1		2	
Manybar goatfish	<i>Parupeneus multifasciatus</i>	1					
Chevron butterflyfish	<i>Chaetodon trifasciatus</i>	2					
Black-backed butterflyfish	<i>Chaetodon melannotus</i>			2			
Golden-striped butterflyfish	<i>Chaetodon aureofasciatus</i>	1					
Redfin butterflyfish	<i>Chaetodon lunulatus</i>		8	2		1	
Triangular butterflyfish	<i>Chaetodon triangulum</i>			1			
Yellowtrimmed butterflyfish	<i>Chaetodon guentheri</i>		1				
Orange-banded coralfish	<i>Coradion chrysozonus</i>	2					
Scribbled angelfish	<i>Chaetodontoplus duboulayi</i>				1		
Six-banded angelfish	<i>Pomacanthus sexstriatus</i>		2		1		
Whitley's sergeant	<i>Abudefduf whitleyi</i>			2	2	2	6
Banded sergeant	<i>Abudefduf sexfasciatus</i>		23				
Humbug dascyllus	<i>Dascyllus aruanus</i>	2	15	10			
Honey-head damsel	<i>Dischistodus prosopotaenia</i>				2	3	
Bicolor chromis	<i>Chromis margaritifer</i>	1					
Spiny chromis	<i>Acanthochromis polycanthus</i>	2		50	6		7
White tail chromis	<i>Chromis leucura</i>						
Pacific half-and-half chromis	<i>Chromis iomelas</i>		15				
Lemon damsel	<i>Pomacentrus moluccensis</i>	38	28		16	49	65
Neon damsel	<i>Pomacentrus coelestis</i>		1				
Blue damsel	<i>Pomacentrus pavo</i>	12			2	7	20
Black damsel	<i>Neoglyphidodon melas</i>				6	3	7
Chinese demoiselle	<i>Neopomacentrus bankieri</i>						10
Australian gregory	<i>Stegastes apicalis</i>	2	6	10	2		1
Blackeye thicklip	<i>Hemigymnus melapterus</i>			1			
Bird wrasse	<i>Gomphosus varius</i>						1
Cleaner wrasse	<i>Labroides dimidiatus</i>	1	2	3		1	4
Shoulderspot wrasse	<i>Leptojulis cyanopleura</i>						
Slingjaw wrasse	<i>Epibulus insidiator</i>		1			1	1

Harlequin tuskfish	<i>Choerodon fasciatus</i>	1			1		1
Greenback wrasse	<i>Halichoeres nigrescens</i>	6	1	1	1		1
Pinstriped wrasse	<i>Halichoeres melanurus</i>			1			
Axilspot hogfish	<i>Bodianus axillaris</i>			1			
Slingjaw wrasse	<i>Epibulus insidator</i>			2			
Crescent wrasse	<i>Thalasoma lunare</i>	2	3	4	1		1
Redbreasted wrasse	<i>Chelinus fasciatus</i>				1		1
Tripletail wrasse	<i>Chelinus trilobatus</i>						1
Steephead parrotfish	<i>Chlorurus microrhinus</i>	2					
Surf parrotfish	<i>Scarus rivulatus</i>			1		2	
Blue-barred parrotfish	<i>Scarus ghobban</i>	1					2
Filament-fin parrotfish	<i>Scarus altipinnis</i>						
Unid parrot (juv)		1	5	10			1
Barred rabbitfish	<i>Siganus doliatus</i>		2	2	2	1	
Ringtail surgeonfish	<i>Acanthurus blochii</i>	1		2		2	
Blackspine surgeonfish	<i>Acanthurus fowleri</i>			2			
Pinktail triggerfish	<i>Melichthys vidua</i>		2				
Yellow boxfish	<i>Ostracion cubicus</i>					2	
Black-saddled toby	<i>Canthigaster valentini</i>					2	
Total diversity		21	18	23	14	16	19
Total abundance		81	118	141	44	279	132

APPENDIX B: LOCATION OF CORAL TREES AND MARKER BUOYS

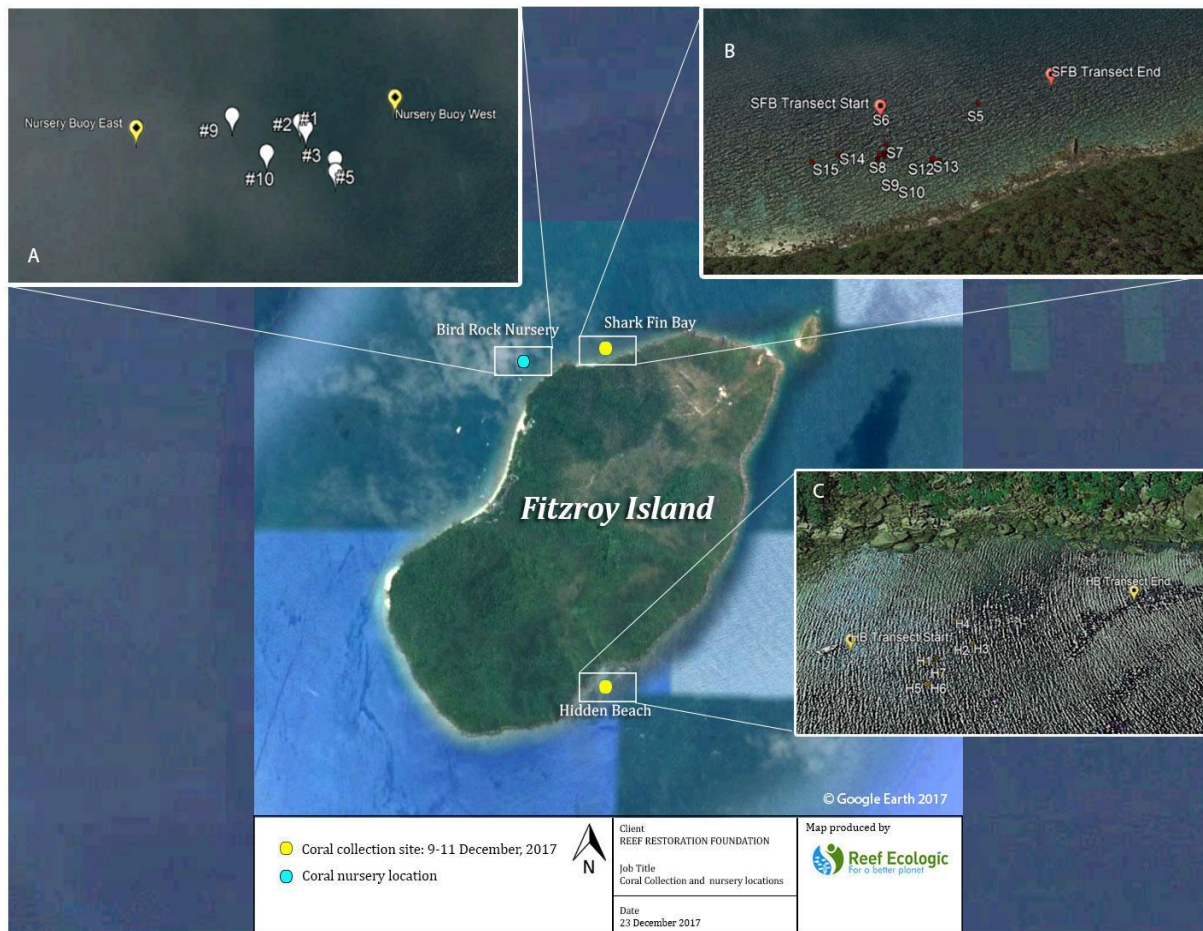


Figure 17: Map of Fitzroy Island showing location of coral nurseries including marker buoys (inset A) and coral collection sites including locations of transects for baselines surveys (Inset B, Shark Fin Bay and C, Hidden Beach). GPS coordinates for donor colonies, coral nursery locations and marker buoys can be found in Tables 4, 5, 6 below.

Table 4: Location of marker buoys of the coral nursery and the location of the trees.

Nursery Location:	Bird Rock	
Buoy 1 (West)	-16.92372	145.99097
Buoy 2 (East)	-16.92377	145.99051
1	-16.92376	145.99080
2	-16.92377	145.99086
3	-16.92382	145.99086
5	-16.92384	145.99086
9	-16.92375	145.99068
10	-16.92381	145.99074

APPENDIX C: LOCATION OF DONOR COLONIES

Table 5: Location of the donor colonies in Hidden Bay.

Location	Date	Donor Colony Tag #	Mother colony #	Type	Latitude	Longitude
Hidden Bay	9/12/17	H1	M1	Branching	-16.94044	145.99515
Hidden Bay	9/12/17	H2	M2	Branching	-16.94036	145.99529
Hidden Bay	9/12/17	H3	M3	Branching	-16.94036	145.99530
Hidden Bay	9/12/17	H4	M4	Branching	-16.94025	145.99524
Hidden Bay	9/12/17	H5	M5	Bushy	-16.94053	145.99515
Hidden Bay	9/12/17	H6	M6	Bushy	-16.94053	145.99516
Hidden Bay	9/12/17	H7	M7	Bushy	-16.94049	145.99518
Hidden Bay	9/12/17	H8	M8	Bushy	-16.94043	145.99518

Table 6: Location of the donor colonies in Shark Fin Bay.

Location	Date	Donor Colony Tag #	Mother colony #	Type	Latitude	Longitude
Shark Fin Bay	10/12/17	S1	M5	Branching	-16.92362	145.99483
Shark Fin Bay	10/12/17	S2	M6	Branching	-16.92360	145.99487
Shark Fin Bay	10/12/17	S3	M7	Branching	-16.92358	145.99487
Shark Fin Bay	10/12/17	S4	M8	Branching	-16.92358	145.99489
Shark Fin Bay	10/12/17	S5	M17	Bushy	-16.92318	145.99542
Shark Fin Bay	10/12/17	S6	M18	Bushy	-16.92332	145.99484
Shark Fin Bay	10/12/17	S7	M19	Bushy	-16.92351	145.99487
Shark Fin Bay	10/12/17	S8	M20	Bushy	-16.92358	145.99484
Shark Fin Bay	11/12/17	S9	M31	Branching	-16.92362	145.99483
Shark Fin Bay	11/12/17	S10	M32	Branching	-16.92360	145.99487
Shark Fin Bay	11/12/17	S16	M29	Branching	-16.92358	145.99487
Shark Fin Bay	11/12/17	S11	M30	Branching	-16.92358	145.99489
Shark Fin Bay	11/12/17	S12	M38	Bushy	-16.92318	145.99542
Shark Fin Bay	11/12/17	S13	M39	Bushy	-16.92332	145.99484
Shark Fin Bay	11/12/17	S14	M40	Bushy	-16.92351	145.99487
Shark Fin Bay	11/12/17	S15	M37	Bushy	-16.92358	145.99484

APPENDIX D: SPECIMEN COLLECTION FORM

Attachment A Specimen Collection Form

(To be completed for each visit and for all locations accessed)

Marine Parks Permit: G17/39917.1

Permittee: REEF RESTORATION FOUNDATION LIMITED (ACN 620 004748)

Address: 55/434 Kamerunga Road, REDLYNCH QLD 4870

Please Note:

- This specimen record form is to be completed after each visit on which collection takes place.
- This collection form must be kept with the permit at all times and be returned to the Great Barrier Reef Marine Park Authority annually and on expiry of the permit

Date	Location/ Reef	Site Name	Site ID	Frame ID	Specimen (Species)	Morphology	Sample Size	Survivorship	
9/12/2017	Fitzroy Island	Hidden Beach	16-054 f	2	Acropora muricata	Branching	28cm	- Number collected:	4
								- Number survived and outplanted	tbd
								- Number deceased	0
								- Number collected:	4
9/12/2017	Fitzroy Island	Hidden Beach	16-054 f	1	Acropora digitifera	Bushy/Corymbose	14cm	- Number survived and outplanted	tbd
								- Number deceased	0
								- Number collected:	4
10/12/2017	Fitzroy Island	Shark Fin Bay	16-054 a	3	Acropora nobilis	Branching	23cm	- Number survived and outplanted	tbd
								- Number deceased	0
								- Number collected:	4
10/12/2017	Fitzroy Island	Shark Fin Bay	16-054 a	5	Acropora nasuta	Bushy/Corymbose	10cm	- Number survived and outplanted	tbd
								- Number deceased	0
								- Number collected:	4
11/12/2017	Fitzroy Island	Shark Fin Bay	16-054 a	9	Acropora nobilis	Branching	27cm	- Number survived and outplanted	tbd
								- Number deceased	0
								- Number collected:	4
11/12/2017	Fitzroy Island	Shark Fin Bay	16-054 a	10	Acropora digitifera	Bushy/Corymbose	13cm	- Number survived and outplanted	tbd
								- Number deceased	0

