Coral Reef Restoration Project – Octopus Diver

Background

Coral reefs are one of the most diverse and important ecosystems on Earth, providing food, jobs, medicine, money and leisurely activities for many people around the world. Furthermore, they: function as guardians of coastlines by dissipating wave energy and action from tropical storms; provide protection in the form of shelter for many marine organisms ranging from fish to invertebrates; are the source of nitrogen and other key nutrients in marine food webs; contribute to carbon and nitrogen fixation/uptake.

The aforementioned reasons are why the health and status of coral reefs are now recently of major concern and importance to marine biologists/ecologists. In 1998, the Seychelles experienced a cataclysmic bleaching event that resulted in a high percentage (70-90%) of corals that were bleached in many areas around the Seychelles. At this time, sea surface temperatures were recorded being 1-2°C more (30-31°C) than the average (29°C) for a period of more than 5 months, which was the hottest period ever recorded since 1982 (Goreau, 1998). Most recently, in 2016, the Seychelles was again ravaged by another warming event (El Niño coupled with the Indian Ocean Dipole) and was similarly devastating, reducing coral cover on reefs from 50% to 5%.

In response, numerous studies and projects have been implemented to combat the loss and degradation of coral cover on the reefs around the Seychelles in the form of 'Reef Restoration'. This refers to the rehabilitation and enhancement of damaged coral reefs by supplying them with newly grown transplanted corals from structures called 'nurseries'. These nurseries comprise of either 100s or 1000s of coral 'nubbins' that have been fragmented (broken apart into branchlets) to be tied to either roped or table nurseries.

With this in mind, Octopus Diver would like to restore degraded areas of reef around the small island of St Pierre, which lies just 1.3km off of the coast of Côte d'Or, Praslin. St Pierre is heavily used by tourists who snorkel and SCUBA dive, and of course the dive centres (Octopus Diver and White Tip Divers). The popularity of St Pierre is also its downfall, many boat operators take tourists to snorkel here and they drop anchor not knowing if there are corals beneath. With SCUBA diving, the problem arises with divers who have never dived before or whether they are experienced/inexperienced and have problems with buoyancy; they damage coral with fins when swimming (unintentionally) or panic when they feel too weighted and end up destroying fragile corals (J. McBride, personal observation as a training Divemaster).

Rationale

St Pierre Island is frequently visited by boat operators and dive centres almost every day. Everytime a vessel drops anchor and a SCUBA diver inadvertently damages some coral, the ecosystem as a whole is affected. Over time (since 1990), St Pierre has been degrading in terms of coral health (Veronique Vanacore, personal communication). Although a lot of marine life can be seen around St Pierre, its corals have been declining in health, and its overall condition is nowhere near it used to be.

As a dive centre, we recognize that it's our environmental obligation to ensure that dive sites (where corals exist) are healthy and to make note of any deterioration or arising problems over a given period of time. Given that coral reefs globally are already under stress due to rising sea temperatures and pollution, irresponsible diver actions and boat anchoring may be responsible for pushing the corals past their critical level of stress tolerance. However, these actions can be reversible by changing the mind-sets of the individuals who like to SCUBA dive and those that operate small boats for tourists.

These actions have made Octopus Diver realise that St Pierre is in a state of emergency, and reef restoration could be the key to revive parts of the reefs surrounding the small granitic island by transplanting nursery-grown corals to areas of degradation. Our idea is to show tourists (whether they are snorkelling or SCUBA diving) the work we are carrying out with the Seychelles National Park Authority (SNPA) to help recondition the coral reefs, to make sure they are healthy and not suffering further degradation from daily activities.

Our project has a mix of biological and socio-economic objectives: we want to restore areas of degraded reef around St Pierre Island and promote biodiversity in terms of both fish and coral, and we want to raise public awareness and environmental education to increase the appreciation of local coral reef ecosystems respectively.

Method and Design

Reef restoration programs are a common practice nowadays whose objectives and aims vary and thus require different approaches to management and set up. The type of restoration we will be following is the 'population enhancement' method, which refers to increasing the abundance of multiple species within a given area. This method can help degraded reefs to naturally recover over time from transplantation of nursery-grown corals. It employs the 'coral gardening' procedure that consists of growing corals in a 'nursery' for up to 6-12 months, depending on the species harvested. These nurseries will be anchored into the seabed to prevent them being destroyed by wave action, swells or storms.

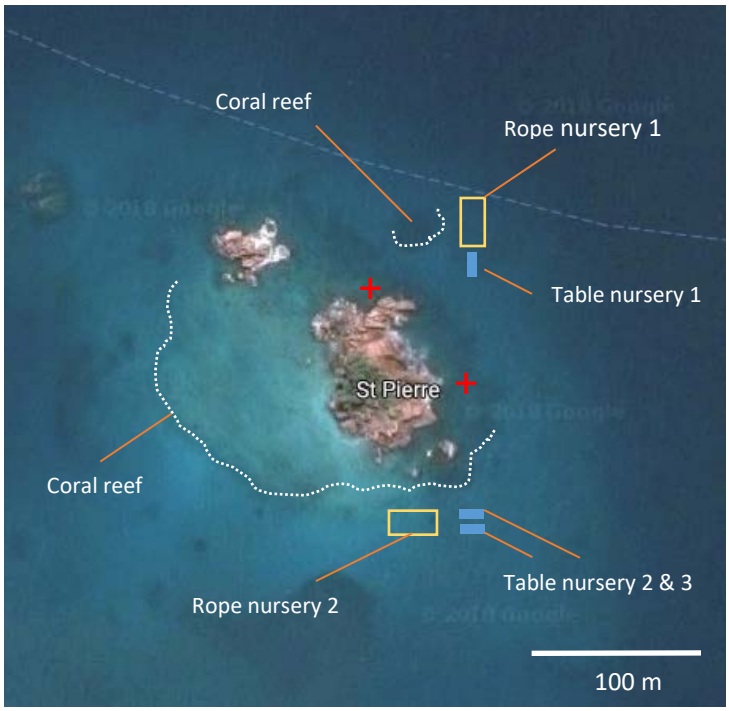

Fig. 1: Locations of the roped nurseries (yellow boxes), table nurseries (blue boxes) and transplant areas (red cross) around St Pierre Island.

The locations of the roped and table nurseries are described in Figure 1. Rope nursery 1 will be located in a sand flat just 10m east of a coral reef situated just 20m north of St Pierre. The water depth here is approx. 13-14m and the nursery will be suspended in the water column 3m off the seabed. There will be a smaller table nursery that will contain different species of coral immediately next to the rope nursery that will be raised approx. 1m off the the seabed. Rope nursery 2 will be located at the southern side of St Pierre Island on a sand flat just off of the gentle reef slope, where the water depth

reaches a max depth of 11m; the nursery will be suspended 2m off the seabed, lying at around 9m. Table nurseries 2 and 3 will also be located in this area, immediately next to the rope nursery; they will be raised 1m above the seabed to avoid sand smothering.

The transplantation sites were chosen by a team of five divers that visually surveyed the areas based on certain criterions being met such as: (1) is there suitable hard substrate available for transplantation; (2) have corals settled/grown here before; and (3) is it close to other coral colonies/patches. With the sites fulfilling the above criterions, it helped us narrow down the potential transplantation sites that could guarantee success with our project. The sites are areas with large granitic rocks that are generally flat and could house many coral colonies.

ROPE NURSERY DESIGN

The design of the rope nursery will consist of a simple structure, in which five nylon ropes (each 10m in length) will be attached in parallel between two PVC pipes/tubes using cable ties for added support (Fig. 2).

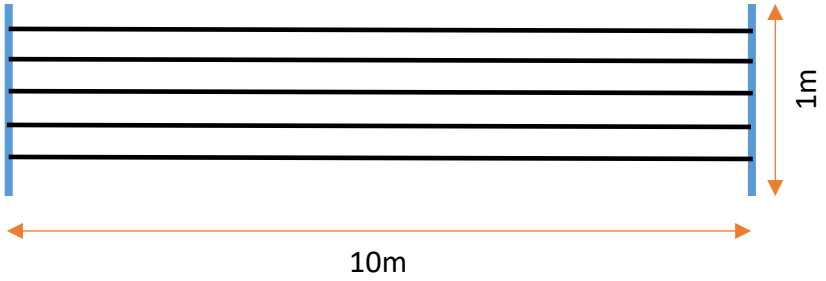

Fig. 2: Birds-eye view of the rope nursery design.

The nursery will be suspended in the water column approx. 3m off of the seabed as to try to avoid any sedimentation issues that may be encountered when there is adverse whether (tropical storms or strong wave action/swells). Sediment covering the corals in the nursery will severely inhibit their growth and undo any progress that has been made, therefore the nursery will be positioned above the sand. Weighted objects such as breeze blocks (x4) may be used to anchor the nursery into the seabed as ropes can easily be attached and tied around the holes with the blocks. In order to suspend the nursery in the water column, buoyancy aids will be attached to the PVC tubes at each of the four corners of the nursery and will be adjusted as necessary to fix the nursery into position. Naturally, the ropes will 'dangle' in an ovular position due to the force of gravity, and significantly more so when the coral fragments are attached to the ropes. Depending on the forces acting on the nursery, it may require extra weight blocks or angle bars to prevent the two ends moving towards each other due to the mass on the ropes (Fig. 3).

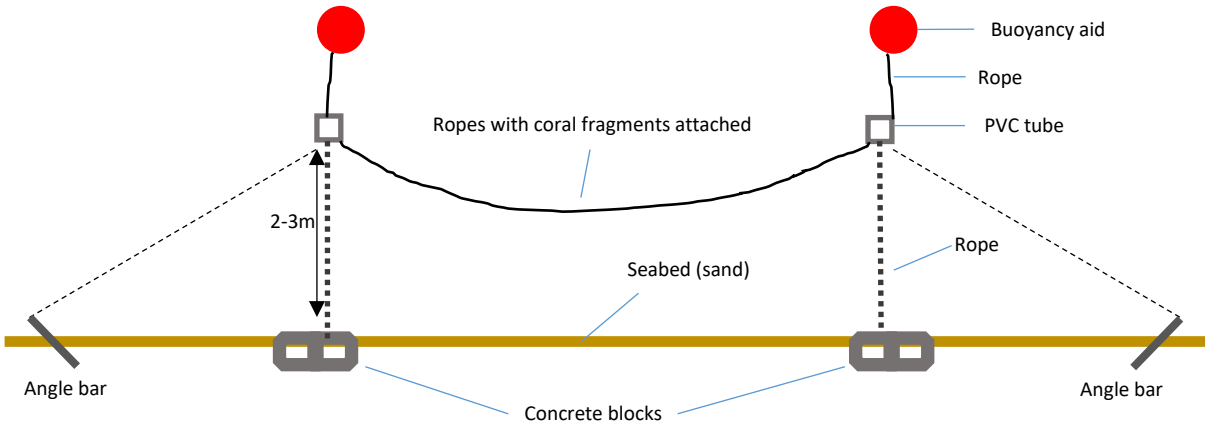

Fig. 3: Lateral view of the rope nursery design.

The nursery design is similar to that of the one employed by the Reef Rescuer program under Nature Seychelles (personal observation and having worked on this project as a volunteer), albeit on a smaller scale but the concept and purpose still remains the same.

A roped nursery can hold many more coral fragments than table and netted nurseries; for example, the nursery design in this project whereby the nursery's dimensions are 10m long and 1m wide could potentially hold **330** fragments of *Pocillopora* spp., assuming that there is a gap of 12-15cm between each fragment on the ropes, to allow for growth up to 10cm in diameter per fragment (more than adequate for at least 12 months of growth for this genus). Faster growing corals such as the Acroporids would need a larger distance between each coral fragment, meaning a reduction of individuals in that nursery (assuming the same dimensions in this project). Larger nurseries could be constructed for the Acroporids, so that there are more corals to harvest after the 12-month growth period; which will be decided in due course.

TABLE NURSERY DESIGN

To ensure that the species diversity of coral is high, we will be constructing 'table' nurseries that will hold an array of different species. These are simpler to construct as oppose to a roped nursery and can hold massive and sub-massive and complex structural, branching species of coral. However, they are limited to the number of individuals they can hold. The design of the table nurseries would consist of a piece of plastic mesh with the dimensions 2m length by 1m width that would be on placed on top of a simple rectangular structure with four legs, which will be anchored into the seabed using weighted objects. The plastic mesh would allow corals to be placed onto the surface and kept in place with plastic cable ties so the corals can grow radiate outwards and upwards. The table nurseries will stand at least 1m off of the seabed to avoid any suspended sedimentation smothering the growing corals, which will inhibit their growth (Fig. 4a and Fig. 4b).

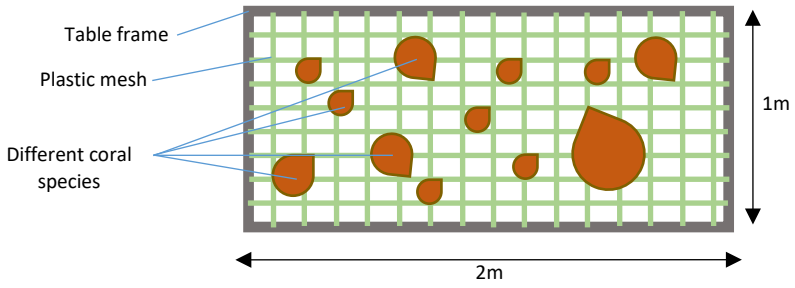

Fig. 4a: Birds-eye view of the table nursery design.

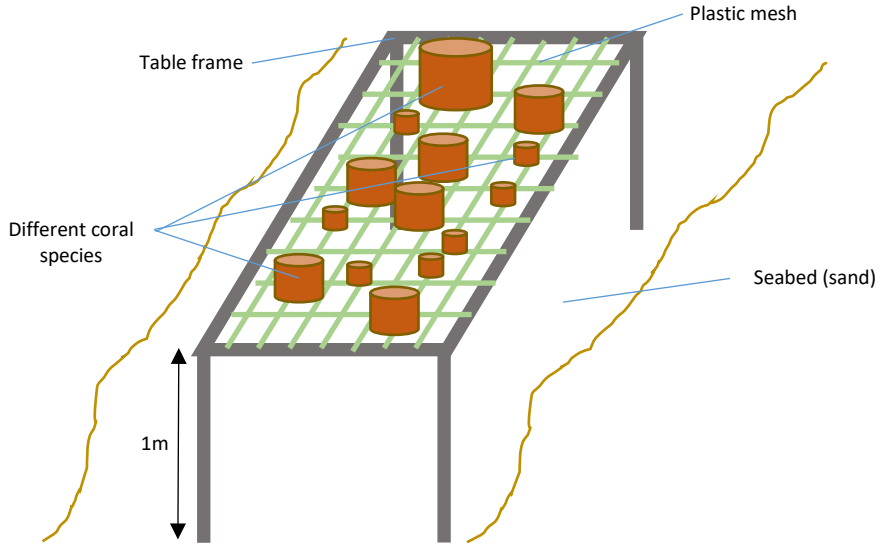

Fig. 4b: 3-Dimensional view of the table nursery design.

STOCK COLLECTION

When the nurseries are constructed, stock collection will commence. In teams of two, helpers will only collect corals that have either been detached from their original place or broken off segments that are lying on the seabed to be stocked onto the nurseries. If a coral colony has become detached due to storms or accidental breakage from a diver, we will try to place the colony in a crevice or sheltered area where it can still grow but remain on the reef in the same area. We will not be harvesting healthy corals that have already settled (i.e. using a hammer and chisel) as this will degrade the area even further and put additional stress on the reef. If an area is particularly damaged, with no other coral colonies in sight, then action may be taken to remove the colony and transplant it to a healthier area. This will be a topic of discussion if the issue arises, and the most appropriate course of action will be taken. Those coral colonies that have detached and look semi-healthy will more than likely be fragmented and stocked into the nursery in order to make them healthy again for transplantation.

INTERIM GROWTH PERIOD OF CORALS

Nursery maintenance: During the project, the corals in the nurseries will be closely monitored (every 1-2 weeks) to ensure that no problems arise such as accelerated algae growth, snail infestation (table nursery), disease etc. The build up of algae on the ropes and corals of the nursery is natural but too much algae can smother the coral polyps and stunt growth. This will be dealt with by routine maintenance of the nursery, which can be performed by any member of the dive centre; toothbrushes will be used on the corals themselves so that excess algae can be gently removed without causing any damage. The blunt edge of a table knife is more than enough to remove algae build-up from the surface of the ropes, by simply scraping the rope. It is expected that some herbivorous fish will naturally visit the nursery from time to time to graze on the algae (natural reef cleaners!). The nursery structure will be monitored for damage sustained when there is a period of stormy weather so that we can quickly identify and rectify any problems that may arise.

Crown of thorns starfish monitoring: It is in both Octopus Diver's and the SNPA's interest to set up a monitoring program for the crown of thorns starfish (COTS). COTS are a natural inhabitant of coral reefs and are corallivorous i.e. they feed upon the hard coral polyps of the outer skeleton of corals. They are not generally an issue on healthy reefs however outbreaks of COTS do happen, and when they do occur, thousands can be found on a single reef, which can be particularly devastating. It is considered an outbreak when the number of COTS per square hectare is greater than 30; levels of around 6/hectare are considered normal. When outbreaks of COTS occur, quick action is required as they can decimate large areas of reefs fairly rapidly if ignored. Generally, there are two methods of COTS control: (1) physical removal by impalement of a sharp object to be transferred to a bag or (2) injection using a large syringe filled with a hypersaline solution or highly concentrated dose of acetic acid (household vinegar).

Many dive sites around Praslin do not have a high abundance of COTS, approx. 3 or 4 seen at most (J. McBride, personal observation), however it would be still in our interest to monitor them.

***Drupella* removal:** These are corallivorous marine snails that also prey on corals and outbreaks of these are common on reefs. Again these are part of the reef ecosystem but outbreaks can have negative effects on reef health and for restoration programs. Were possible, these snails will be removed with forceps from healthy corals and put into a bag for disposal.

TRANSPLANTATION

After 8-12 months of growth in the nurseries, the 'farmed' corals will be ready for transplantation to the designated sites around the north side of St Pierre Island. The corals will be taken from the ropes and put into boxes to be transported to the transplant sites. However, every single coral wont be taken from the nurseries as we still need some to fragment some of the corals to form the basis for the next generation of transplants. This will most likely require a new nursery to be constructed for the propagation of the previous corals, or possibly an expansion of the current nursery.

After the propagation, the remaining bulk of corals will be taken from the nurseries and they will be fixed onto areas of hard substrate (preferably natural granite rocks) with the same species being planted close to each other to enhance their sexual reproduction for future generations. The rationale is that these healthy, transplanted individual coral colonies will become spawning members of the local population and help rebuild other degraded areas in a natural way after artificial transplantation.

POST TRANSPLANTATION

During the next couple of months after the initial transplantation of corals, the areas will be monitored for fish and invertebrate diversity and abundance to measure the project success, and to assess the overall health of corals around St Pierre.

MARINE SURVEYS: This will be achieved by carrying out fish and invertebrate surveys noting species diversity and abundance, which will allow us as researchers to gain an insight into the community assemblage of the given survey sites. These surveys will be performed by experienced staff who have considerable knowledge of marine fish species. Surveys will be conducted using either Line Intercept Transects (LITs) and Point Intercept Transects (PITs). Staff who are not familiar with these survey methods will be briefed in the form of a demonstration of the procedure and a description of how and why these procedures are used.

Studying the data received from these surveys will allow us to ascertain whether our work has had a positive or negative effect on the transplanted area. If it's a positive effect i.e. species diversity and relative abundances are greater than before the transplantation was carried out, then we could soundly assume that our work has had a helpful effect in terms of reef health. On the other hand, if our work has had a negative effect i.e. decreased species diversity and relative abundances are lower, then we can try and understand were we have gone wrong, what we can do better and more efficiently and thereby adjust our methods accordingly.

CORAL HEALTH CHECK: As well as monitoring fish and invertebrate diversity and abundances, we will be monitoring the health of the corals as a monthly ongoing task throughout the project duration. This is to ensure that the (1) the corals remain in a healthy condition and (2) to alert us of any environmental issues or pressures the corals may be facing. Early warning signs for bleaching for instance, will be apparent by the appearance of tips of the coral branchlets turning white. This is considered an early warning sign of things to come, and that the coral is currently under stress due to either sustained increased temperature, an overgrowth of algae or coral disease.