

# The Caribbean Coastal Co-management and Coral Regeneration Programme

## 4Cs BARBADOS PROJECT

### CARIBBEAN CORAL RESTORATION TRAINING MODULE

*Implemented by*



Foundation for the  
Peoples of the South  
Pacific International



*In collaboration with*



Centre for Resource Management and Environmental Studies

*Funded by*



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# CARIBBEAN CORAL RESTORATION TRAINING MODULE



*Photo Courtesy of David Gill*

This Training Module has been prepared for those who wish to learn about rescuing damaged corals and rehabilitating Caribbean reefs. It should be used as a guideline, in collaboration with others who are trained to rescue corals – and with reference to the laws of the Caribbean.

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## SOME WORDS OF WISDOM .....BEFORE WE BEGIN

**Before learning how to replant corals to restore damaged reefs, it is important to be cautious. Consider these factors:**

1. Planting corals is not a “quick-fix” solution to coral and reef decline because it does not solve the root causes of coral reef decline.
2. Coral planting is only effective as a management tool when combined with other conservation strategies, such as marine protected areas and measures to decrease reef damage.
3. Coral planting is only effective in some areas and under certain conditions.
4. If the cause of corals dying at a particular site continues to be a problem, it is useless to replant corals, only to watch them die later.
5. Most importantly, in our work we must not give others the impression that we have found a quick-fix solution to coral reef decline. It is not okay to destroy reefs because they can be easily replanted!

**Bearing all these aspects in mind .....**

**THANKS FOR YOUR INTEREST IN RESCUING CORALS!!!**

# Introduction

## ***What are Corals?***

There is more to corals than just being pretty stones. Unlike land stones, corals are alive and grow bigger over time. Corals also need sunlight in order to live and grow, just like plants. So are corals plants? Well sort of... corals have tiny plants inside their flesh, (*single-celled algae called zooxanthellae, but don't use this word with most audiences*). The very thin layer of flesh covering the otherwise white skeleton of living corals is normally golden brown in colour because of the presence of thousands of these tiny plants in each centimeter of coral tissue.

But there is more still...corals need to eat food in order to live, just like animals. Corals have tiny (nearly-invisible) mouths for eating, surrounded by tiny arms "tentacles" for catching their food. Each mouth is located over a small hole on the surface of the coral skeleton, and these small holes can easily be seen on close inspection of the coral. Each mouth and ring of arms forms a tiny flower-shaped unit called a "coral polyp". An individual coral usually has many hundreds of polyps covering its surface. Each coral is composed of a group or "colony" of coral polyps, so it is called a "coral colony".

## ***Why are Corals Important?***

Corals are important to fishing communities because they provide homes for fish, lobsters, and other valuable resources on the reef, and these animals can be caught for food or sold for cash. If a reef is covered with beautiful corals, it is also attractive to visitors, and tourism can help bring jobs and money to communities. When corals die, they don't make such good homes for fish, and they look less beautiful. Healthy corals and abundant fisheries resources help lead to healthy and prosperous communities.

## ***Where have all the Corals Gone?***

Corals need clean water in which to live and grow, and they are easily damaged and killed. Careless people often break and kill corals when they walk on corals in shallow reef areas, collect them as mementoes, throw anchors onto them, or pollute the water in which they live.... Many reefs have been damaged by these sorts of impacts over the years. Natural events like hurricanes can also cause serious damage to reefs. Smashed corals often become rubble beds that do not recover coral populations for many generations.

Fish and other reef animals help to keep corals healthy. Predatory fish like groupers help keep the dusky damselfish (*Stegastes* spp) under control, that otherwise kill corals by cultivating hairy seaweeds on the corals, often spreading coral disease as they bite and wound the corals. Lobsters and crabs keep the coral-eating snails (*Drupela* and *Coralliophila* spp.) under control, and other species keep the coral eating fire worms under control. Sea cucumbers clean the sand, while sea urchins and parrotfish clean the reef of excessive seaweeds which can smother living corals and may also provide an environment for coral diseases to thrive.

Over-fishing of fish and sea urchins on some reefs has resulted in the death of corals through overgrowth by seaweeds, while on other reefs seaweed overgrowth has prevented coral recovery after storms. The most abundant and important sea urchin species in the Caribbean, the black spined *Diadema*, suddenly died out on most reefs from 1982-84 due to a disease, and this has resulted in coral reef decline in many areas.

Land-based threats to reefs are serious factors as well, especially near larger land masses. Sewage from communities and fertilizers from agriculture empty into the sea, and these land pollutants compound the problem of seaweed overgrowth on reefs, increasing coral disease and causing coral death. Where land has been cleared for development, logging, or agriculture, rivers become muddy and this mud empties into the sea. This muddy water smothers and kills the corals, sometimes travelling with the currents to affect reefs many kilometers away. These land-based problems may take many years to solve, and preventing them from worsening is a global priority, and beyond the scope of most reef managers.

Unusually high sea water temperatures are also a problem for corals, resulting in 'bleaching' of their tissues through the loss of their tiny plants. These plants (zooxanthellae) provide most of the corals' nutritional needs, so when the plants are lost, the corals begin to starve, become very weak and eventually die if the bleaching goes on for more than a few weeks. The Caribbean has suffered several mass coral bleaching events since the 1990s, as a result of high water temperatures, probably associated with global warming, and a lot of coral has died as a result.

Coral reef restoration will require dealing with each of the root causes of coral reef decline for each reef. On many reefs, increasing fish populations alone through proper fisheries management will do much to increase coral and reef health. For other reefs, coral planting may help accelerate the process of reef recovery. For yet other reefs, those with serious chronic land-based threats, the root cause of the problem may take many decades to solve, and these reefs should be regarded as non-restorable over the short-term.

### **A Major Problem: Caribbean-wide *Acropora* Decline**

The staghorn coral *Acropora cervicornis* was until recent years one of the three most important reef-building coral species of the Caribbean. This species has declined drastically throughout the Caribbean over the past two decades, dying out on most of the reefs where it was formerly abundant. As the only large open-branched coral of the Caribbean, *A. cervicornis* provides a unique type of fisheries habitat in both shallow and deeper waters in both calm back reef and higher-energy fore reef environments. As a primary component of Caribbean reefs, a decline in *A. cervicornis* has serious ramifications: basic geological processes and biodiversity on Caribbean coral reefs are threatened, and the regional economy in the areas of fisheries and tourism will suffer.

Several factors have been responsible for the demise of *A. cervicornis* -- ecological imbalances leading to algal overgrowth and disease, high-temperature related coral bleaching, and hurricane damage. While greatly decimated, in some areas *Acropora* decline has now stabilized, and surviving corals are conceivably of the more resistant genotypes.

### **How do Corals Reproduce?**

Plants in our gardens reproduce in two ways: sexually by seeds and asexually by cuttings. Corals also reproduce in two ways: sexually by producing very small babies (planula larvae) and asexually by budding new polyps and, in the case of branching corals, from broken pieces called *fragments*. It is very hard to see coral larvae because they are so small and are made only at certain times of the year, always at night.

The tiny coral larvae swim in the water and look for good places to settle down and grow, especially clean dead coral skeletons (rocks). If you look closely at dead coral rocks on the reef, you will sometimes see the tiny corals (coral spats or coral recruits) that have settled down and planted themselves. They are about the size of a pencil rubber, or smaller. If a tiny coral

survives, it will be the size of an orange in about 2-3 years. Many newly settled corals do not survive for even a year, as they are easily eaten, covered by sand, stepped on, or overgrown by sea plants and bigger corals. Good places for coral recruits to survive are clean seaweed-free rocky areas with clean sea water.

When coral larvae settle onto dead broken up corals, the dead coral pieces may later be turned over by currents, stingrays, or other disturbances. If this happens, the tiny corals are buried underneath and die. This is why broken reefs (from storms, dredging, trampling, or blasting) may not recover coral populations. Likewise, if dead coral rocks are covered with seaweeds, coral larvae cannot settle, and the coral population will not recover.

## **Coral Restoration: Getting Started**

### ***Helping Coral Recruits Survive***

While coral recruits may be too small and too hard to catch and be planted easily by people, there are some things that we can do to increase the settlement and survival of the young corals, such as keeping the seawater clean and free of rubbish. Some types of fish also help young corals survive by cleaning small sea plants from the dead coral rocks, helping the coral larvae settle down and survive. This is why making a no-fishing area can help corals return to a damaged reef on their own, as the fish begin cleaning the reef when they return.

### ***Where Should Corals be Planted?***

**Survey the restoration site well before the day of rescuing, so that the best sites are located within the general area and the best method is chosen, allowing the corals to be immediately planted, rather than delaying while the specific sites are chosen and cleaned or otherwise prepared.**

Dynamite fishing, reef dredging, and severe storms can leave behind broken and dead coral gravel mixed with sand that cannot easily recover coral populations. Once reefs become poor in corals, they usually become poor in fisheries resources. There is still hope if corals can be replanted to shorten the natural recovery period from hundreds of years to only a few years. However, if the cause of the problem is not solved before the coral planting begins, it might be useless to replant corals, as they will only be killed again. Coral replanting should therefore only be used in conjunction with proper coral reef management and the implementation of effective conservation plans.

Perhaps the most effective use of coral replanting is within well-established no-fishing Marine Protected Areas (MPAs). Such areas are protected from coral harvesting, fishing net damage, and other things that work against coral replanting. Restoring damaged reef areas can help speed up the natural reef recovery process and help the reef regain lost fisheries resources, providing increasing numbers of homes for fish. In this way coral replanting can help make no-fishing MPAs more effective.

### ***Weather and the Season of Planting can Sometimes Make a Difference***

**Take advantage of calm weather if possible, and be prepared if rough seas develop during the day**

You may be unfortunate in timing your rescue activities if the sea conditions pick up during the course of the day. This makes doing any kind of dive work, let alone the careful handling and cementing of corals, very difficult. The surge from the waves may have both divers and snorkellers working just to stay in position, without an extra hand for the cementing. Try attaching lines to the substrate, which allows the divers and/or snorkellers to hang on during the roughest sets of swells.

Sometimes the season that corals are planted can make a big difference in success. If storms or strong wind-driven currents are a seasonal problem, it may be best to try planting corals during the calm season. Coral fragments cement themselves to the rocks that they touch as they grow, and they begin cementing the dead coral stones together. Coral fragments in this way become more attached and more stable over time.

Corals often grow best after handling during the coolest part of the year, having a lower death rate and growing faster. However, the coolest part of the year may not be during the calm season, so the best time for coral planting at a site may not always be easy to decide.

Some corals may die after rescuing. The problem could be related to season: if corals are planted during the warmest time of year, or during the time for coral reproduction and larvae formation, when the corals are weakest. Also if the corals are already fighting a disease, the extra stress of reattaching may be too much for an infected coral to endure.

If there are strong seasons, it is important to allow the coral restoration trials one full year before proclaiming success and doing more coral rescue work. Corals may grow very well during one season, only to be killed in a later season by fresh water draining off the land, by high temperatures, storms, or other factors.

### ***Starting the Work with a Coral Planting Test***

**Before planting a lot of corals at any site, it is very important to do a test planting first. This means taking a few branches of each type of coral that will be used from the source corals, and planting them into the restoration site, to observe for six months to a year.**

One experiment for restoring a broken coral rubble bed might use three small plots of each coral to be used: five small branches <10cm, five branches between 10-20cm, and one or two branches >20cm. If the results turn out very well, more work can be done with the coral types and sizes that survived and grew the best. If the overall results don't turn out very well, the reason(s) should be considered. More tests might then be done using different types of corals or different planting methods, depending on the seriousness of the problem, only expanding the work when the result is very good. Corals attached to wire mesh A-frames might survive where corals placed on the bottom die.

**Take special care during the cement mixture process: not too much water and good timing. Run sufficient trials on land to be sure of the proportions of cement, Plaster of Paris, and water, needed for the correct mixture.**

Consistency and timing of mixing the cement batches is very important. If the cement is mixed too soon (before the cementing team is ready for it), then it will solidify in the bag before being applied to the substrate. If the cement is squeezed out of the bag before it set, or if it is mixed with too much water, it will probably just disintegrate into cement dust in the water.



**Allocate jobs specifically to each participant, and be sure that everyone is aware that they cannot crowd around the worksite. It is advisable to have one person (snorkelling) in the water who is supervising all the bodies in the water.**

Avoid having too many people close together when the cementing process is being attempted. This causes crowding problems and creates difficulty in manoeuvring around the corals. Limit the total number of participants in the water if the sea becomes rough, and you are working in a small area.

## ***Guidelines for Handling and Restoring Corals***

**Government permission should be secured before beginning coral restoration work, and the work should be undertaken under the guidance of scientists trained in “Coral Rescue” methods.** Other types of restoration interventions can be done without such advice and permissions, such as removing seaweeds overgrowing corals, removing disease-spreading *Stegastes* damselfish, and removing coral-killing snails and fire worms. These actions help coral populations regain a more healthy state without handling and moving corals.

### **1. Handling Guidelines:**

- a. Wash your hands with baby shampoo and seawater directly beforehand. Coral handlers must have very clean hands: no sunscreen, gasoline, or oils.
- b. Gloves are not recommended unless they are non-absorbent otherwise they can trap foreign proteins that can cause corals to react negatively.
- c. **The part of the human body most similar to coral tissue is the surface of our eyes, so show the corals some sympathy as you touch and handle them.**

### **2. Transport Guidelines:**

- a. Shade the fragments during transport (if being transported by boat)
- b. Transport the corals in mesh bags, one clone (genetic type) per mesh bag.
- c. Corals should best be moved during the winter months when the burning rays of the sun (ultraviolet radiation) are less strong (from November to March in the Northern hemisphere). The closer the site is to the equator the less important the season of restoration. If corals are rescued during the summer months, special care should be taken.

### **3. Restoration Guidelines:**

- a. Coral branches should be planted with the up-side up. Close inspection shows a lighter colour and distinctive “reaching towards the light” polyp pattern on the bottom side of horizontal *Acropora* branches.
- b. The bigger polyps at the end of each staghorn coral branch (called axial or apical polyps) should face upward as much as possible when planted.

***The introductory text and Guidelines for Handling and Restoring corals (above) are based on training materials prepared by Dr. Austin Bowden-Kerby of the Foundation for the Peoples of the South Pacific (FSPI). These training materials have been customised to the Caribbean situation, based on the field experience of Renata Goodridge and David Gill while undertaking the 4Cs -- Caribbean Coastal Co-management and Coral Regeneration Programme, in Barbados and Jamaica.***

## **APPENDIX I: Sample of a Proposal to Conduct Coral Restoration Exercises**

### **Centre for Resource Management and Environmental Studies**



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#### ***Proposal for a One Day Coral Rescue Exercise***

##### **Background**

The acroporid corals (*Acropora palmata*, *A. cervicornis* and *A. prolifera*) are in decline throughout the Caribbean, and as such are presently under review by CITES for consideration as 'Endangered species'. These corals were the primary reef building corals in the Caribbean and are still important members of the reef community. Acroporid corals provide superior quality habitat for reef fishes. These branched corals form intricate three-dimensional living spaces and shelter for reef fishes. Their skeletons act as sturdy protective barriers in shallow water, protecting shorelines and also provide suitable foundation for settlement and growth of new coral settlers. Acroporids also have high aesthetic value, particularly *A. palmata* (the elkhorn coral) which is one of the most attractive shallow-water coral species found in the Caribbean.

In Barbados, like other Caribbean countries, coral disease, poor water quality and physical damage have all contributed to the decline of local populations of these ecologically important species. As such, there are few reefs in Barbados where *Acropora* spp can be found in any abundance, and work is currently ongoing through the Counterpart Caribbean project (jointly implemented by CERMES and the Barbados Marine Trust) to map these sites.

The recent passage of Hurricane Ivan (September 7, 2004) to the south of Barbados resulted in significant storm waves affecting the southeast and southwest coasts of the island. These waves caused severe damage to nearshore reefs along these coastlines, down to a depth of about 15 m. Not only were huge numbers of soft corals ripped up and washed ashore, but dive operators are reporting significant physical damage to hard coral colonies along the southwest coast. In particular, a shallow reef area (2 – 4 m deep) located off the Bougainvillea Hotel, Maxwell, has sustained significant physical damage. Furthermore this site has the largest patch of living *Acropora palmata* and the only *A. prolifera* known on the island as well as some *A. cervicornis*. These acroporid colonies have all been damaged by Hurricane Ivan, with considerable breakage and scattering of up-turned branches over the surrounding sandy areas.

##### **Proposed Coral Rescue**

Coral rescue (restoration) can be instrumental in helping coral reefs to recover from storm, anchor and boat grounding damage. Coral fragments that have been broken off colonies, or whole coral colonies which have been overturned can be recovered, righted and stabilised, thereby giving them a chance to recover and continue growing. Fragments can be secured to nearby stable hard substrate (by cementing or attaching with cable ties) and upturned colonies

can be turned upright and re-fixed in place with cement, or at least stabilised in place to re-grow and prevent rolling and further damage.

CERMES, UWI and the Barbados Marine Trust are proposing a one-day pilot activity in which we train keen, responsible marine naturalists, under the supervision of Renata Goodridge (CERMES, UWI) and David Gill (BMT), on how to secure coral fragments to hard substrate *in situ* to promote recovery of a damaged reef. Both scientists have extensive underwater experience and have recently undergone specific training in handling and promoting the growth of broken fragments of acroporid colonies. We wish to use this opportunity to effect restoration of the acroporid colonies at the Bougainvillea Hotel reef site. It is proposed that the one-day training activity, slated for February 19, 2005, will consist of a morning classroom training session and an afternoon field session at the Bougainvillea Acropora site to secure and stabilise broken coral fragments, thereby promoting regrowth and recovery of these vital colonies. No corals will be taken from the site and moved to another, nor will any coral colonies or fragments be taken out of the sea. All restoration work will be done *in situ*.

For more information please feel free to contact us at the following numbers or email.

Renata Goodridge: phone: 417-4726 email: [rgoodridge@uwichill.edu.bb](mailto:rgoodridge@uwichill.edu.bb)

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Sincerely,

Renata Goodridge  
CERMES, UWI

David Gill  
Barbados Marine Trust

## **APPENDIX 2: Sample Restoration Workshop Outline**

**This is a one-day workshop**

### **8:00 am**

1. Logistics
2. Checking that all materials are on-site and ready for action
3. Review of workshop plans and specifics for transportation

### **8:30 Orientation and Presentations**

1. Workshop participant introductions on the work and interests of each participant
2. Biology and ecology of coral, particularly the importance of *Acropora palmata*\*
3. How to select and handle (and not to handle) coral fragments for transplanting\*
4. Example transplant
5. Leave for restoration site by vehicles and by boat

### **10:30 am Restoration Activity at Bougainvillea**

1. Team 1: Locate fragments
2. Team 2: Locate suitable bedrock (look out for fire worms and snails)
3. Team 3: Prepare cement (mixture of cement and Plaster of Paris)
4. Transport cement, heavy dive gear and participants as close to site by car
5. Team 2: Clean chosen bedrock sites of any existing turf or macroalgae, using a wire brush
6. Team 1: Carefully carry fragments to cleared bedrock
7. Team 3: Transfer mixed cement from boat to cementing site, while Teams 1 & 2 cement coral into place
8. Secure or transfer loose rubble from the immediate vicinity in order to prevent future damage to corals

### **Future Work**

1. Project evaluation by participants
2. Monitoring health of any rescued corals

**S – Snorkel**

**D – Diving**

**L – Land**

**\* For more information please refer to the Supplementary Training Aids listed in Appendix 3**

### ***APPENDIX 3: List of Supplementary Training Aids for this Module***

1. *The PowerPoint presentation "Rescuing Damaged Coral" which is available on CD*
2. *Two videos showing a coral transplantation experience in Jamaica available on CD*
3. *One video showing an interview with Dr. Austin Bowden-Kerby in which he describes the importance of coral reefs and restoration, with footage from Jamaica and Barbados; and*
4. *Numerous presentations, posters and brochures relating to "Caring for Our Coasts and Our Future" on CD.*

### ***APPENDIX 4: Coral Rescue Exercise- Sample List of Materials required***

<ul style="list-style-type: none"><li>• 3 Mesh bags</li><li>• Flagging tape</li><li>• Dive Flag</li><li>• 25 Plastic sealable bags</li><li>• 100 Plastic ties</li><li>• Baby shampoo</li><li>• Stakes</li><li>• 3 Rulers</li><li>• Mixing bowls</li><li>• Latex gloves</li><li>• Cup measure</li><li>• 3 Slates</li><li>• Pencils</li><li>• Video camera and housing</li><li>• Dive boat (uwi-chill)</li></ul>	<ul style="list-style-type: none"><li>• 12 Plastic bottle "buoys"</li><li>• 2 Knives</li><li>• String/rope</li><li>• Hatchet</li><li>• 2 Scrubbing brushes</li><li>• Hammer</li><li>• 4 Buckets</li><li>• buckets</li><li>• Fishing line</li><li>• 1 Bag of Cement</li><li>• Plaster of Paris</li></ul>	<ul style="list-style-type: none"><li>• 8 Tanks</li><li>• Scuba gear</li><li>• Air Fills for tanks</li><li>• 2 vehicles</li><li>• Boat fuel</li></ul>
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