

# GLOBAL CORAL REEF ALLIANCE

A non-profit organization for protection and sustainable management of coral reefs

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## **BIOROCK CORAL REEF RESTORATION AND SHORE PROTECTION PROJECTS IN MAJURO, REPUBLIC OF THE MARSHALL ISLANDS: PRELIMINARY REPORT**

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### **INTRODUCTION**

The Marshall Islands are critically dependent on the health of their coral reefs: every rock and sand grain on the islands are the remains of coral reef organisms. Only actively growing coral reefs can protect the islands against ocean waves and global sea level rise, and provide fish to feed the people. These crucial services are rapidly deteriorating because global warming is bleaching and killing corals, while also accelerating the spread and virulence of coral-killing diseases. As a result every atoll island has a serious erosion problem, which will get much worse as global sea level rise and storm intensity accelerate, unless the reefs that protect the islands can be grown back. The solutions now being used to protect the shoreline are both costly and ineffective. In order to demonstrate practical solutions to these problems we started three pilot coral reef restoration projects and one pilot shore protection project in Majuro using Biorock® Technology in early 2007.

Biorock technology uses safe low voltage direct electrical current, provided by solar panels, windmills, ocean current turbines, or chargers, to grow solid limestone structures of any size or shape on top of steel construction elements. The limestone rock is typically grown at up to an inch a year, and can be up to three times harder as ordinary concrete. Biorock structures grow constantly in strength, and are self repairing: any damage grows back preferentially. This makes them uniquely suited as frameworks to restore coral reefs and fisheries, and to grow breakwaters for shore protection from erosion. Coral fragments transplanted onto them grow typically 3-5 times faster than normal, and survive extreme stress, such as from abnormally high temperatures,

16-50 times more than surrounding coral reefs. They have very high rates of baby coral settlement and quickly build up dense populations of reef fish. Because they can be built with many layers of holes of any size or shape, and because corals can be elevated above the bottom and get more light and food, they can support much denser fish populations than even natural reefs. In the Maldives, one of the lowest lying atoll countries in the world, Biorock reefs grown in front of severely eroding beaches turned them into 50 feet of beach growth in a few years.

Because these breakwaters slow waves passing through them they do not cause scouring of sand like conventional walls that reflect waves. Biorock breakwaters cost a fraction of rock or cement or gabion seawalls, and create ecotourism resources and fish habitat, making them far superior to conventional methods. Due to the huge untapped tidal current resources of the Marshall Islands, many islands could be protected using local energy resources, but solar and wind energy can also be used. Due to the severe erosion of all Marshallese islands, and the deterioration of the coral reefs, especially in Majuro, these methods are critically needed to protect the islands from rising global temperatures and sea levels.

Our projects are small demonstration projects meant to show the potential of the technology to protect the Marshall Island's marine and land resources from global climate change if used on a large scale. These projects were carried out in collaboration between the Global Coral Reef Alliance (an international non-governmental non-profit organization for research, protection, and sustainable management of coral reefs), Pacific Aquaculture Cooperatives – RMI (a locally registered company developing the Marshall Islands' sustainable mariculture resources), and RRE Enterprises (a Marshallese company), with the support of local landowners of Enemanit Island. This report describes the pilot projects that were built in May 2007, and shown in photographs taken in June and August. That is to say after only a few months. If power is maintained the corals will grow very rapidly and attract many more fish in the future.

## THE PROJECTS

### A) ENEMANIT REEF RESTORATION PROJECTS

Three pilot coral reef restoration projects were built and installed at the southwestern side of Enemanit Island. These projects are powered by solar panels installed on a rack over a small stone dock, and wired to produce 6 volts of power. These structures, varying in size and shape, are growing very slowly, much slower than is typical for such projects, because they are only getting a small trickle of power relative to their size. Broken corals lying on the bottom, which would most likely die from rolling around and being abraded or buried in the sand, were rescued and attached to the structures by either wedging them between steel bars or tying them on with steel tie wire. Power was supplied

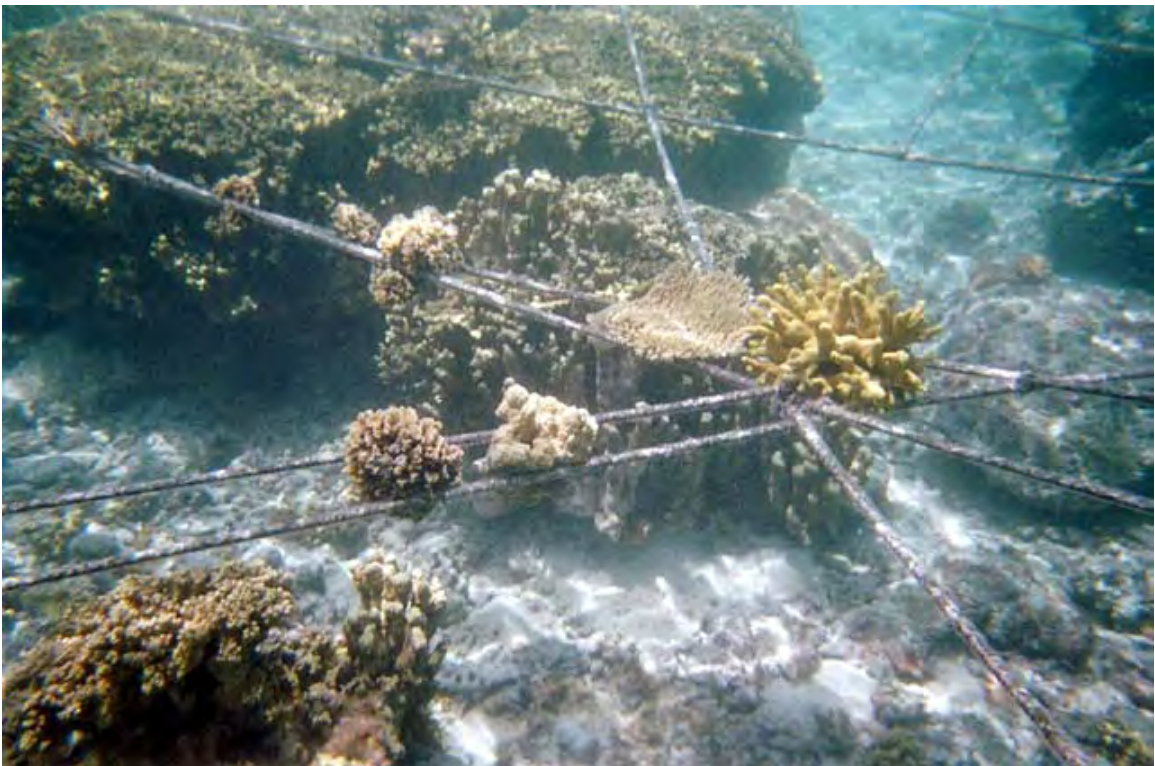
directly to the dome, with secondary wires leading to the other two structures, which are consequently getting less power than the other two. One structure has no anode, and so gets the least current of all. The conditions thus cover a range of power levels, as well as heights above the bottom. The three structures put together are getting about as much current as a moderately bright light bulb. Although each is differently shaped, these pilot projects represent only a very small part of the range of structures that could be built to restore coral and fish habitats.

## 1. STICK CHART REEF RESTORATION PROJECT

The first structure built was made in the form of a classic Marshall Islands Stick Chart, a traditional map designed to teach sailors how to navigate between the atolls using the ocean swell to orient themselves. The Biorock stick chart is 10 meters on a side, and made of ordinary steel construction reinforcing bar cut and wired together to replicate a Stick Chart. It was laid on top of large shallow coral heads that rise about 3 feet above the sand. No rusting has taken place on the stick chart, and the corals attached to it are growing very well. The corals it is resting on began growing around and over it within days. Fish were immediately attracted.

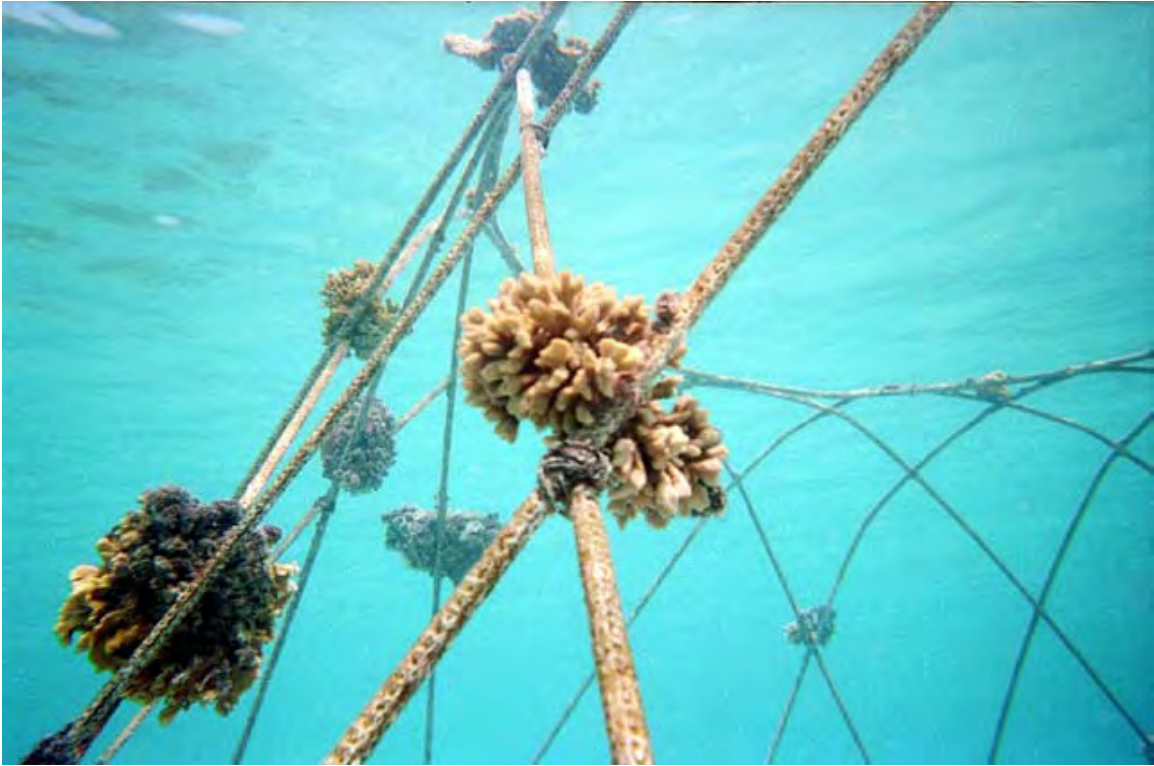




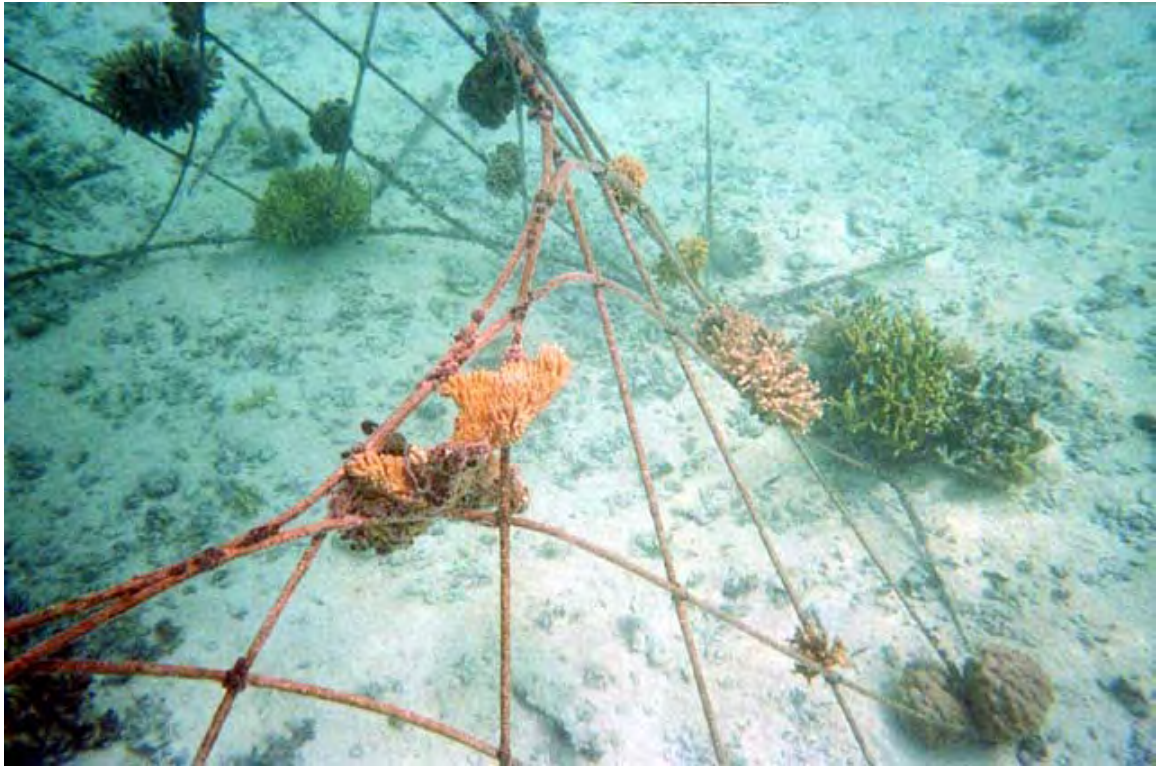


## 2. DOME REEF RESTORATION PROJECT

The dome is about 7 feet tall and about 15 feet wide, located in deeper water and is getting the most current. It is located over sand that had no corals and very few fish. The steel framework began to turn white with limestone growth in a day. Coral fragments attached to it quickly cemented themselves on and began to branch. They range in height from sitting on the sand to about 7 feet above it. The corals have proceeded to grow rapidly and attract fish.









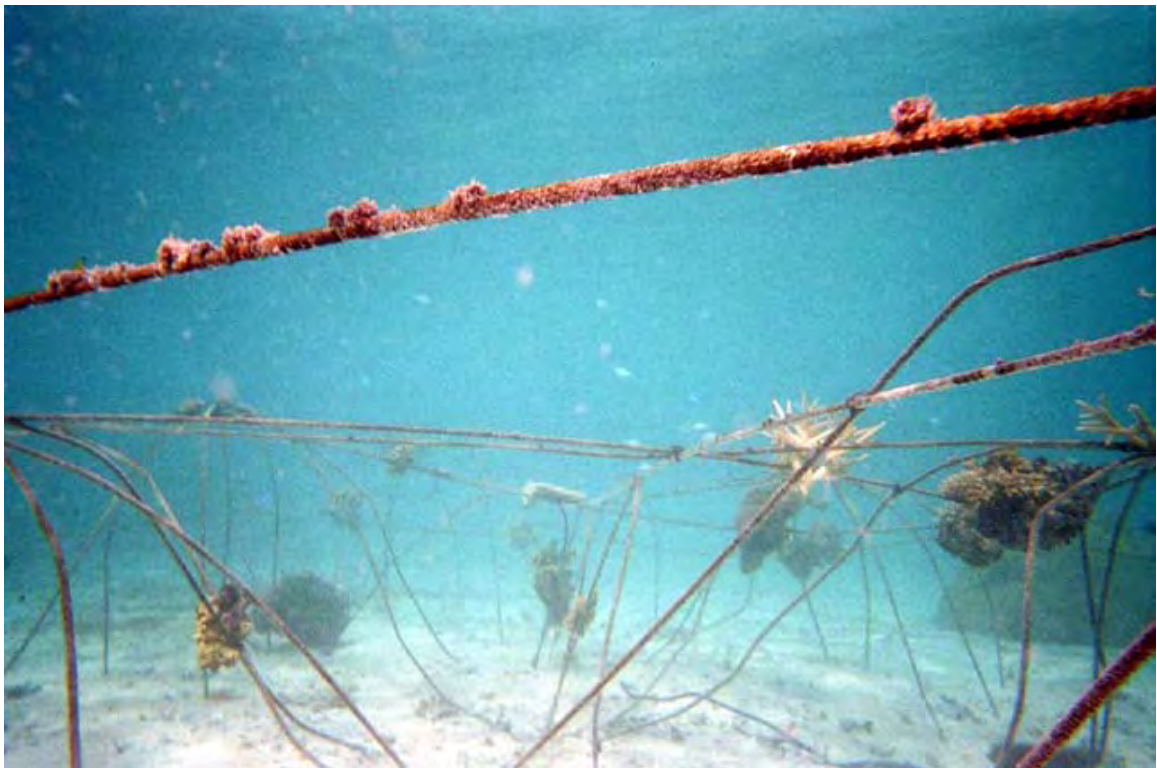




### 3. BOAT REEF RESTORATION PROJECT

The boat is the longest and lowest structure, and is receiving the least current because it is furthest from the power source and has no anode of its own, relying on current from the anode in the dome. Corals attached to it are less than three feet above the sand. The structure shows no rusting, the corals have attached themselves and are starting to branch, and fish have been attracted.











## B) SHORE PROTECTION PROJECT

### 4. REIMER'S DOCK SHORE PROTECTION PILOT PROJECT

The shoreline here is composed of gabion wire baskets filled with rocks. The original gabion wire was uncoated, and quickly rusted and fell apart. It was then replaced with more costly plastic coated wire. However the plastic coating has now cracked or been abraded in many places, so the interior wire is rusting, and many of the wire baskets have broken open, spilling the rocks, and causing the structure to sag. In several places the sand beneath the baskets has been washed away by waves, undermining them and causing all the structures above them to sag and settle. This is widely seen all along the Majuro shoreline.

The shore protection project is located along the northern intertidal portion of the Reimer's dock. It consists of old scrap square mesh fencing material that was being thrown out. This has been attached to the outer vertical surface of the dock wall using rebar pins. The mesh is charged by a small battery charger running at 6 volts and several amps, drawing as much power as a dim light bulb. The white mineral growth on this was very rapid, so an additional piece of fencing was added to extend the project. This has grown less because it has had less time and is further from the power source. While the material used in this project was fairly flimsy and only intended as a demonstration, it indicates that with stronger material and more power the entire dock wall could be encased in a solid limestone surface that would end the crumbling and collapse of the dock, and that similar steps could be taken to protect all of the shoreline that is now subject to erosion. Not only would this be far more effective than the current methods now being used to armor the shoreline, it would be far cheaper and permanent.

