



CAN-043-Coral Rehab-Caribbean

Join us to save coral reefs

Vic Ferguson

The World Federation for Coral Reef Conservation 281.971.7703 P.O. Box 311117 Houston Texas 77231
7/8/16

FORWARD: "Results show clearly that current restoration practices by CRFB of transplanting Staghorn colonies to different locations is likely to be an excellent way to restore the Staghorn fields of Bonaire".

"We all should realize that there is a problem with our oceans and should be addressed globally, it's our ocean to save.....Executive Director WFCRC"

Coral Reef Rehabilitation in the Dutch Caribbean

13th May 2016 | By: [Dutch Caribbean Nature Alliance](#) | Posted in: [News](#).

The Dutch Caribbean islands are recognized worldwide for their healthy reefs and outstanding dive sites. Nevertheless, while these reefs are showing signs of resilience and recovery from recent bleaching events (6), they still face a large number of local, regional and global threats such as eutrophication and development, bleaching, diseases and hurricanes as well as ocean acidification and climate change. In light of the accelerated decline of many coral species and a rise in hard-to-control threats, coral reef conservation efforts have begun to focus on active





CAN-043-Coral Rehab-Caribbean

[Join us to save coral reefs](#)

Vic Ferguson

The World Federation for Coral Reef Conservation 281.971.7703 P.O. Box 311117 Houston Texas 77231
rehabilitation of populations of threatened coral species.

The Caribbean population of two important reef-building species, staghorn coral (*Acropora cervicornis*) and elkhorn coral (*Acropora palmata*) especially suffered from white band disease in the late 1970s and early 1980s with close to 95% of the population whipped out. Having collapsed throughout the entire Caribbean Region, both coral species are now listed as Critically Endangered under IUCN's Red List of Threatened Species. *A. cervicornis* and *A. palmata* used to dominate shallow reefs in the region and create a 3D framework that served as habitat for a myriad of other organisms including important commercial fish and their juveniles. In light of the important ecological role that both corals play, they have been especially targeted for rehabilitation.

On Bonaire, early rehabilitation attempts focused on the use of Reef Balls, but these were rapidly abandoned due to resulting low coral recruitment. Hurricane Lenny (1999) and Hurricane Omar (2008) caused significant damage to the remaining shallow water populations of staghorn and elkhorn coral on the island's west coast. Nowadays, the Coral Restoration Foundation Bonaire (CRF Bonaire) leads coral restoration efforts on the island. The foundation was established in 2012 in partnership with Dive Buddy Dive Resort; today it is sponsored by two more dive operators, Eden Beach Resort and Harbour Village Beach Club, and is supported by both the local government and the Bonaire National Marine Park. In just four years, CRF Bonaire has made incredible strides in its mission to "develop affordable, effective strategies for protecting and restoring the shallow water population of staghorn and elkhorn corals along the coastlines of Bonaire and Klein Bonaire" (CRF Bonaire, 2015).

The coral propagation and reef restoration technique used by CRF Bonaire is known as coral gardening and is the most commonly used within the Caribbean. This method uses the natural process of asexual reproduction of staghorn and elkhorn coral through fragmentation to provide new coral clones for population growth (5). Small fragments are taken once from healthy wild populations, fragmented and grown in underwater nurseries and then transplanted to degraded reef areas. While this coral rehabilitation method was until recently believed to be restricted to branching species, Coral Restoration Foundation in the Florida Keys is currently growing blade fire coral, pillar coral and boulder star coral in their offshore nursery using the same method.

CRF Bonaire currently has four mid-water nurseries around the island with a total coral production of 8500 corals every 6 to 8 months. Within each nursery are rows of what most described as "Christmas tree-like trees", structures with a PVC trunk and coral fragments suspended on branches made of fiberglass (see image). A "full" tree can hold anywhere from 100 to 160 corals. Presently, there are 12 *A. cervicornis* and 11 *A. palmata* genotypes (i.e. coming from different parental colonies) within the nurseries. A recent series of field experiments conducted by Meesters et al. (4) in the CRF Bonaire nurseries found a very fast and high regeneration of cut surfaces on fragments and mother colonies (99.6%), with cut surfaces completely healed within 2 to 3 weeks. Growth rates were also found to be excellent, at about 2.5 cm per month.

Once the healthy fragments have reached sufficient maturity (this takes on average 8 months), they are transplanted to degraded reef areas. Two corals transplanting methods are used to stabilize fragments on the restoration sites: "gluing" fragments to rocky substrate using marine epoxy or tying fragments to horizontal structures, elevated 20 cm from the bottom. Tying corals on the structure allows transplantation on unstable substrate and keep the corals, initially small, relatively far from the bottom and less affected by predators.



CAN-043-Coral Rehab-Caribbean

Join us to save coral reefs

Vic Ferguson

The World Federation for Coral Reef Conservation 281.971.7703 P.O. Box 311117 Houston Texas 77231

Meesters et al. (4) found transplant growth of staghorn in CRF Bonaire nurseries to be very high, almost 14 cm per year per branch tip. They also found that the rate of survival was 100% after 7 weeks and was not affected by the differing environmental conditions of transplant sites. **"Results show clearly that current restoration practices by CRFB of transplanting Staghorn colonies to different locations is likely to be an excellent way to restore the Staghorn fields of Bonaire.** The measured survival, regeneration, and growth rates indicate that current restoration practices of CRFB are highly sustainable and may create viable clusters of staghorn colonies which may initiate the regrow of staghorn corals into thick fields." (Meesters et al. (4). To date, CRF Bonaire has transplanted close to 6000 coral colonies in 7 restoration sites around Bonaire.



In May 2015, Ocean Encounter Curaçao launched the Coral Restoration Foundation Curaçao Program with the support of Coral Restoration Foundation International and the Coral Restoration Foundation Bonaire. As with CRF Bonaire, the main objective is to restore the Curaçao's shallow water reef system. The first coral nursery was immediately set up with ten "trees" holding elkhorn and staghorn coral fragments. A similar coral reef nursery project, but on a much smaller-scale, was recently launched on Saba. Sea and Learn started this project last October in partnership with the Coral Restoration Foundation, Samford University, Saba Conservation Foundation, Youth Environmental Leadership Program (YELP) and Sea Saba Dive Center (BioNews 22, page 8).

On Curaçao, researchers of SECORE International, the CARMABI Foundation and the University of Amsterdam have been investigating since 2010 the effectiveness of another coral propagation method that employs larval seeding rather than coral fragmentation. Unlike coral gardening, larval seeding is based on the sexual reproduction of corals. This method allows for genetic recombination, which is essential for corals to adapt to the environmental conditions experienced by coral reefs at present. Male and female gametes are typically collected on the reef during coral spawning events, fertilized and grown in a laboratory setting and then transplanted to degraded reef areas. SECORE has developed a technique whereby male and female gametes are caught in the wild using non-invasive techniques and those gametes are fertilized in vitro to raise large numbers of genetically unique corals that could harbor the genetic make-up to survive on present day Caribbean reefs.

Several studies by Chamberland et al (1;2) have looked into the potential of this method to rehabilitate threatened elkhorn coral populations on Curaçao. In 2011, collected gametes were reared in a land-based nursery for one year and then transplanted to shallow waters (1). Survival was quite high: seven of the nine colonies survived and kept growing four years later. Even more exciting: two colonies were observed spawning, which is "the first time that an endangered Caribbean coral species was raised from larvae and grown to sexual maturity in the field" (Chamberland et al (1)). Since then, many more elkhorn corals have been outplanted but "coral offspring are no longer kept in aquaria very long; they are outplanted two to three weeks after they settle to reduce associated costs and labor and has proven to be more successful than long-term periods in nurseries" (Valérie F. Chamberland, personal comment). A study published in July 2015 by Chamberland et al (2) reported that the survival rate of A.



CAN-043-Coral Rehab-Caribbean

Join us to save coral reefs

Vic Ferguson

The World Federation for Coral Reef Conservation 281.971.7703 P.O. Box 311117 Houston Texas 77231
palmata settlers outplanted two weeks after settlement was 6.8 times higher than that of settlers kept in a land-based nursery, and was much more cost-effective.

Larval seeding has also successfully been used for other coral species. SECORE International, in partnership with the CARMABI Foundation and the University of Amsterdam, has successfully reared and outplanted thousands of brain coral off springs in reefs under a variety of conditions. Only time will tell now whether these brain corals can help strengthen degraded reef areas in the long-run.

Researchers from CARMABI as well as from the University of California, the University of Amsterdam and Pennsylvania State University have begun to investigate the potential of larval seeding for pillar coral (*Dendrogyra cylindrus*); this coral has a very low recruitment rate that compromises its recovery (3). Rapid embryonic development was documented and two of the larvae fertilized in the lab and successfully reared to primary polyp settler stage survived for over 7 months. While these results show some success, further research on a much larger scale is now needed.



The use of either coral gardening or larval seeding to rehabilitate local damaged reef areas is dependent on many factors, as both methods have shown great potential as well as certain limitations. One very positive impact of coral gardening is its effect on the education of locals and visitors by involving volunteers in the restoration program. Volunteers for CRF Bonaire help with many crucial tasks such as maintaining nurseries and transplant sites as well as monitoring fragment growth and survival. However, coral gardening carries the risk of creating coral populations with little genetic variability due to its

reliance on fragmentation. In their study of the CRF Bonaire nurseries, Meesters et al. (4) found that parental origin of the transplanted fragments significantly affected damage regeneration and growth rates. Larval seeding, on the other hand, is more likely to lead to genetic diversity, which implies more long-term success of restoration efforts. Both methods, however, are "limited by costs and labor that are mostly related to the outplanting phase as each coral fragment/offspring needs to be carried to the reef and attached to the substrate manually which is extremely time consuming and costly" (Valérie F. Chamberland, personal comment). Meesters et al. (5) suggest combining characteristics of both to create a hybrid approach that would increase growth, survival and genetic diversity.

Several knowledge gaps within the Dutch Caribbean must be filled to help increase the genetic variation within coral restoration efforts, such as the identification of genotypes used in reef restoration efforts, the genetic variation of natural populations of corals and the long-term success of restoration methods. Most importantly, coral rehabilitation alone cannot be successful in safeguarding our reefs. To ensure long-term success, restoration must come hand in hand with the active and effective management of local, regional and worldwide threats.



CAN-043-Coral Rehab-Caribbean

Join us to save coral reefs

Vic Ferguson

The World Federation for Coral Reef Conservation 281.971.7703 P.O. Box 311117 Houston Texas 77231

References

1. Chamberland, V.F.; Petersen, D; Latijnhouwers, K.R.W.; Snowden, S.; Mueller, B.; Vermeij, M.J.A. (2016). Four-year-old Caribbean *Acropora* colonies reared from field-collected gametes are sexually mature. *Bulletin of Marine Science*, 92(2).
2. Chamberland VF, Vermeij MJA, Brittsan M, Carl M, Schick M, Snowden S, Schrier A, Petersen D (2015). Restoration of critically endangered elkhorn coral (*Acropora palmata*) populations using larvae reared from wild-caught gametes. *Glob. Ecol. Conserv.* 4:526–537.
3. Marhaver, K.L; Vermeij, M.J.A.; Medina, M.M. (2015). Reproductive natural history and successful juvenile propagation of the threatened Caribbean Pillar Coral *Dendrogyra cylindrus*. *BMC Ecology* 15(9).
4. Meesters, E.H.; Boomstra, B.; Hurtado-Lopez, N; Montbrun, A.; Viridis, F. (2015). Coral restoration Bonaire. An evaluation of growth, regeneration and survival. *IMARES report C152/15*.
5. Meesters, E.H.W.G; Smith, S.R.; Becking, L.E. (2015). A review of coral reef restoration techniques. *IMARES report C026/14*.
6. Steneck, R.S.; Arnold, S.N.; León, R. de; Douglas, B.R. (2015) *Status and Trends of Bonaire's Coral Reefs in 2015: Slow but steady signs of resilience. Online report.*

Vic Ferguson
The World Federation for Coral Reef Conservation
Executive Director
P.O. Box 311117
Houston, Texas 77231
vic.ferguson@wfcrc.org
www.wfcrc.org
281.886.7428 (office)
512.986.1902 (cell)

The only thing necessary for the triumph of evil is that good men do nothing"....Edmund Burke