






ANNUAL TECHNICAL REPORT 2018

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A large, vibrant photograph of a coral reef underwater, with various types of coral in shades of orange, brown, and white against a deep blue background.

1 LETTER FROM THE PRESIDENT

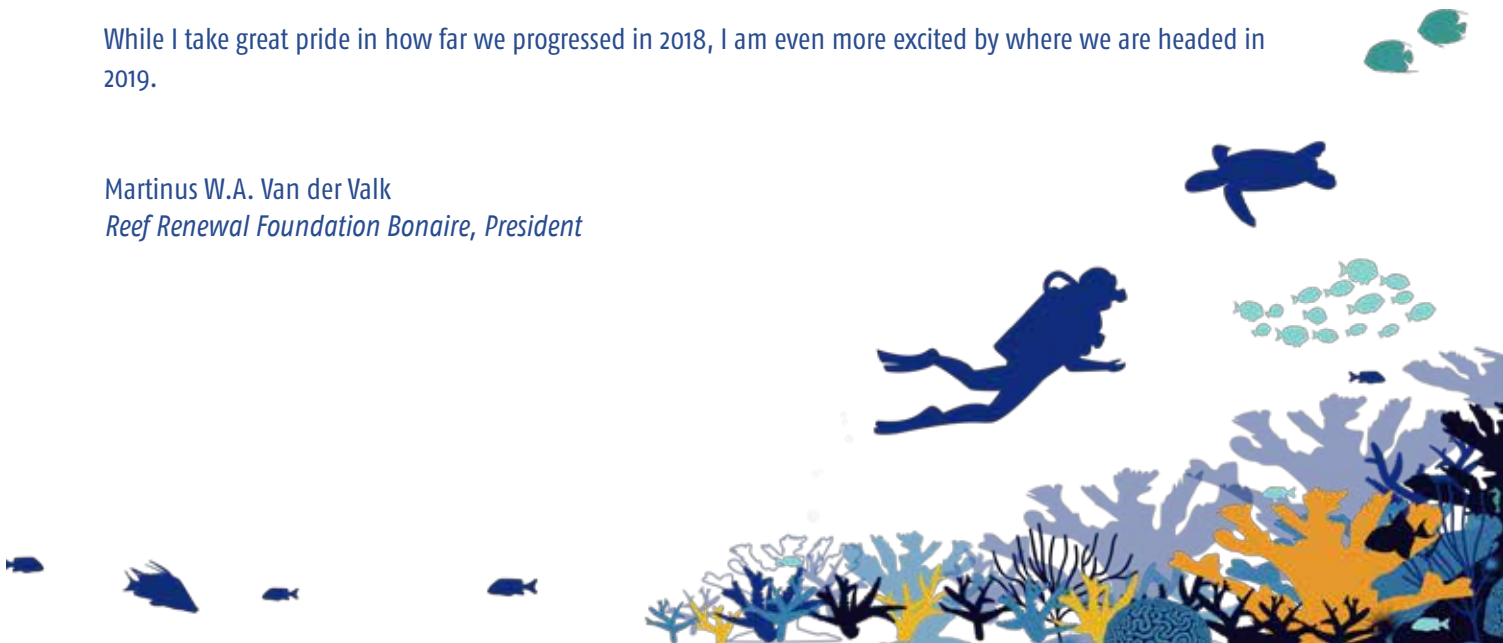
Since the beginning, I have watched our organization flourish and achieve a number of milestones with hard work and foresight. We have worked hard to grow from just a hope-fueled idea into an impactful organization making strides toward restoring the populations of staghorn and elkhorn corals on shallow water reefs surrounding Bonaire and Klein Bonaire.

In the past year, Reef Renewal Foundation Bonaire has grown in size and scope, building awareness with each passing day and laying the foundations for our future initiatives. By both growing our roots to solidify our efforts and branching out to reach new heights, this year has been transformational.

Through our restoration efforts, we reinforce our fundamental belief that a passionate and dedicated group of people can be the catalyst for change. Through our work, we will continue to stimulate cooperative, planned action within the entire island community to abate stressors and to protect and restore our coral reefs.

While I take great pride in how far we progressed in 2018, I am even more excited by where we are headed in 2019.

Martinus W.A. Van der Valk
Reef Renewal Foundation Bonaire, President





2 ABOUT US

We are dedicated to sharing effective and scalable reef restoration techniques around the world. We are driven by the urgency of the threats facing our reefs; there is no time to lose. We are inspired by communities around the world stepping up to restore their coral reefs.



Martinus W.A.
Van der Valk
President



Augusto A.
Montbrun Segnini
Secretary



Paulus P. Coolen
Treasurer



David J. Fishman
Director



Christine M. Wall
Director



MISSION AND VISION

The Mission of Reef Renewal Foundation Bonaire (RRFB) is to protect and restore coral reefs in Bonaire by:

- Developing new and innovative ways to restore reefs that are supported by research collaborations and shared worldwide
- Training, engaging, and inspiring the community locally and internationally through volunteering, educational events, and outreach
- Demonstrating that through community efforts there is still hope for coral reefs

The vision of Reef Renewal Foundation Bonaire is a world:

- Where knowledge and experience can be shared
- Where reefs are protected and restored
- Where reef degradation is halted
- Where ocean awareness is promoted

CORE VALUES STATEMENT

- Be committed and determined
- Be accountable
- Be transparent
- Be positive and motivational
- Have integrity
- Pursue growth and learning
- Embrace and drive change

3 WHAT A DIFFERENCE A YEAR MAKES

3.1 Expanding the vision, evolving the brand

Recognizing the urgency of the threats facing our reefs, we are evolving. Through a more comprehensive vision, we are diversifying both in the species we work with and the techniques we use to restore coral reefs.

Reef Renewal Foundation Bonaire will keep what works and add new, cutting-edge techniques to give Bonaire's reefs a helping hand on an ecological scale, focusing on not only genetic diversity, but species diversity as well. These new techniques and species will be part of a broader, more inclusive reef restoration approach.

As we grow, we will remain true to our purpose and our roots. Regardless of the species of coral or the technique, restoring Bonaire's coral reefs to the resilient, healthy ecosystems they used to be will continue to be a community effort.

We cannot possibly express enough gratitude to the Coral Restoration Foundation (CRF) Network. It is thanks to the knowledge and experience we've gained that we are eager to help the international restoration community and assist new restoration projects as well.

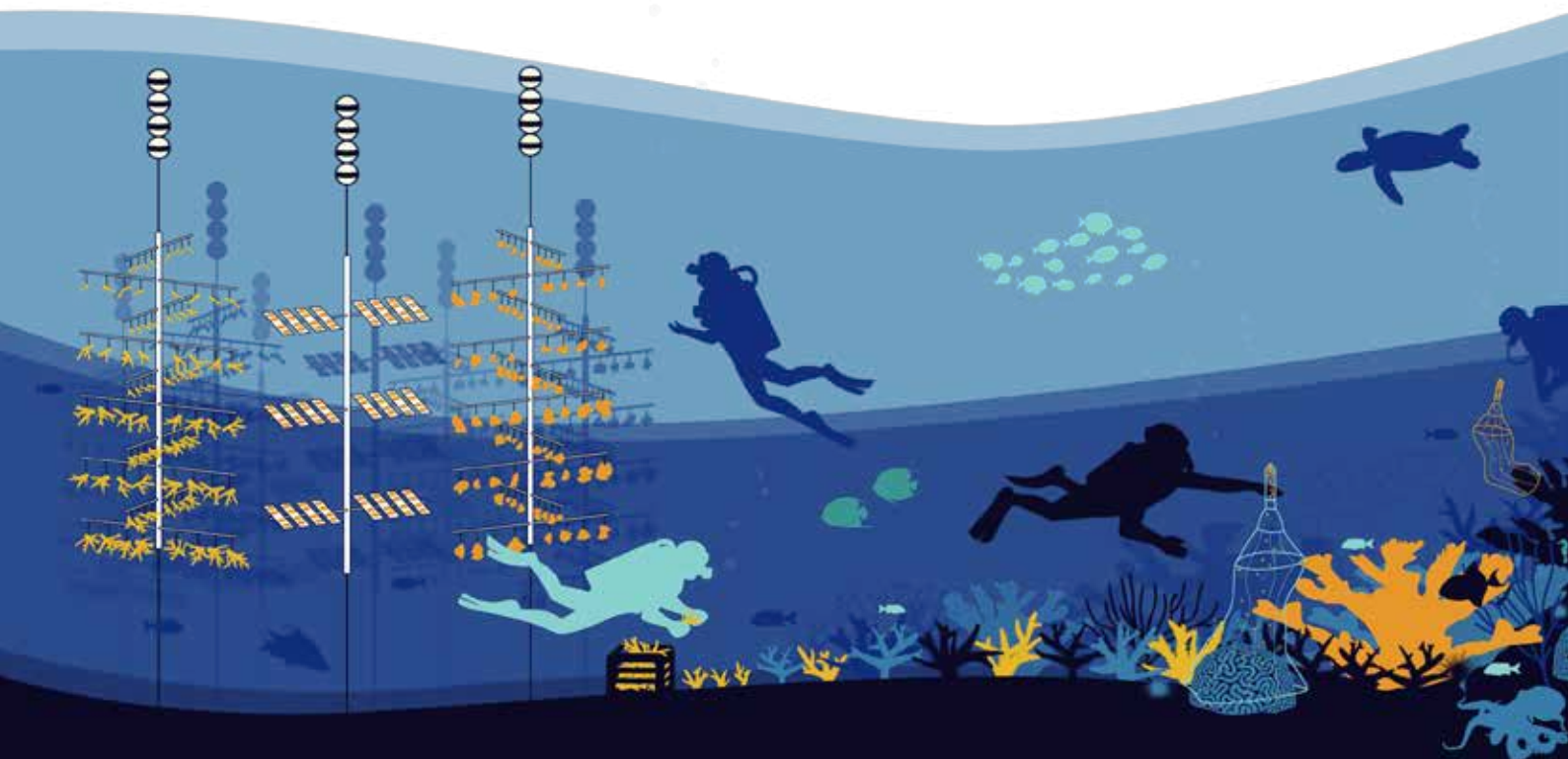
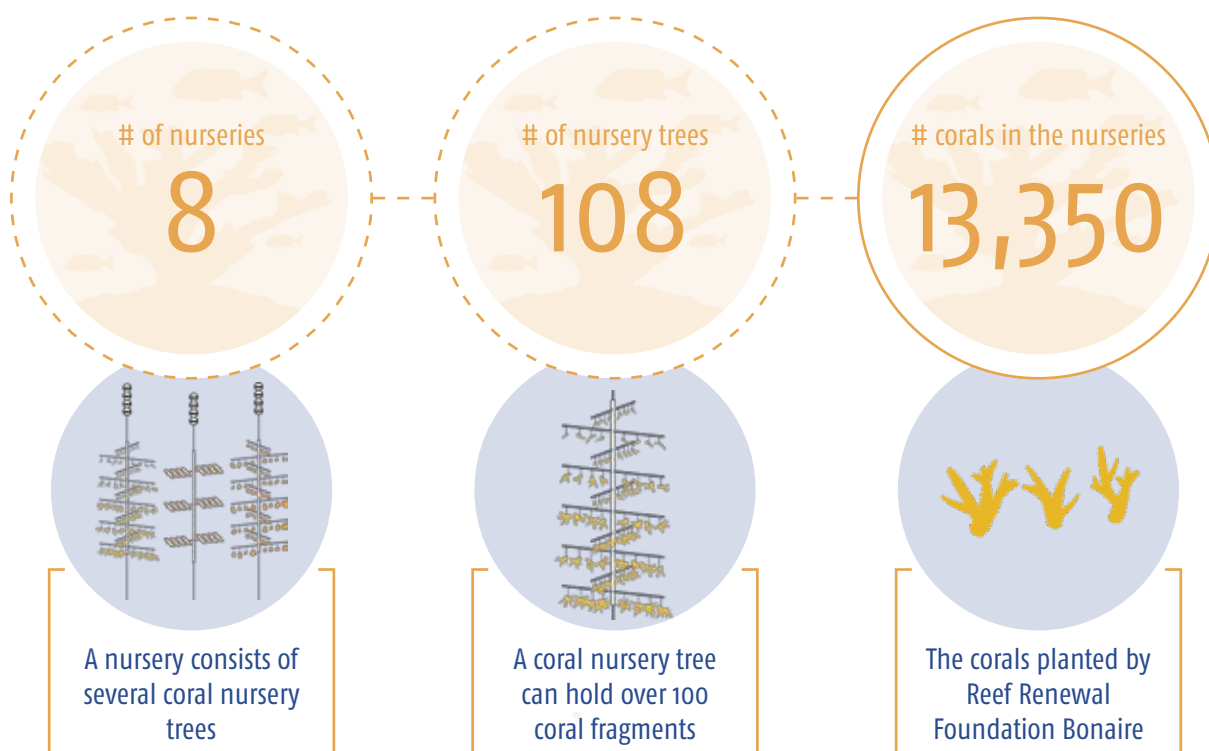
We will continue to work closely with CRF in the United States through our ongoing collaborations and as part of the international Coral Restoration Consortium.



3.2 2018 By the Numbers

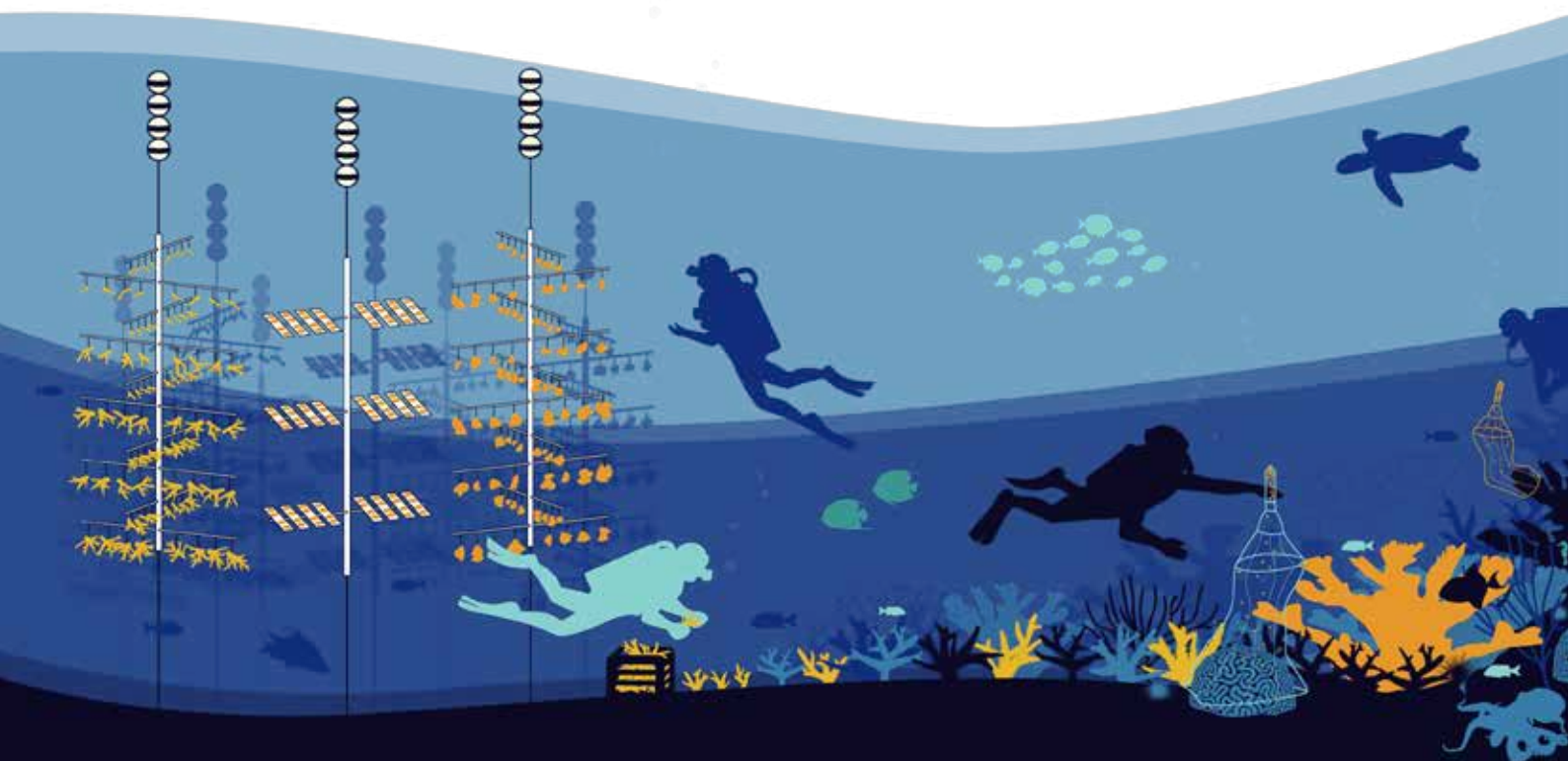
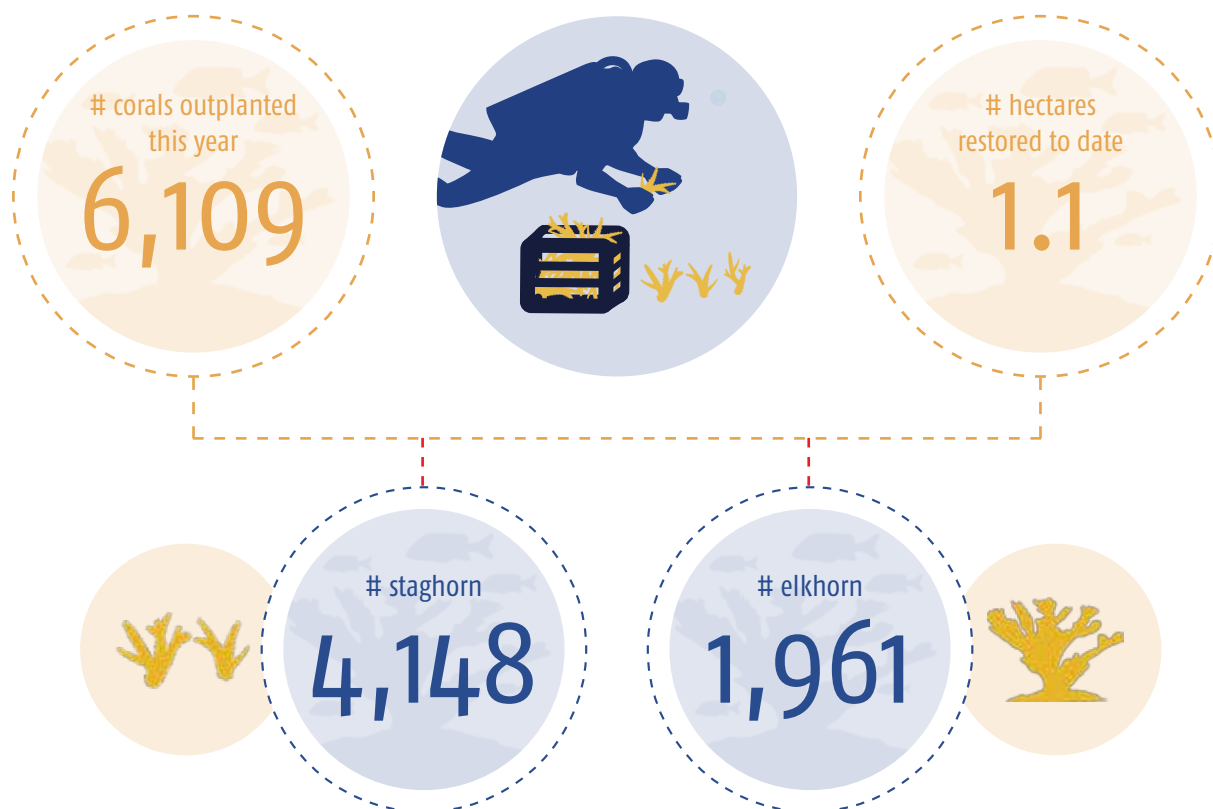
Nursery

Since 2012, Reef Renewal Foundation Bonaire has used a coral tree nursery design to grow large numbers of endangered *Acropora* corals. Trees are anchored to the seafloor just offshore and float up in the water column. Corals are propagated using fragmentation and hung from the branches of the tree, which can host upwards of 100 coral fragments. Suspended in the water column, the coral fragments typically grow into colonies large enough for outplanting in just six to nine months.



Outplanting

Corals are selected from the nursery and outplanted to the reef once they are “reef-ready”. This means their age, overall health, and size makes them better-suited for survival when exposed to predators and other stressors that exist in greater abundance outside of a nursery environment. Genetically diverse corals are then tagged, taken to a selected restoration site, and outplanted back to the reef.



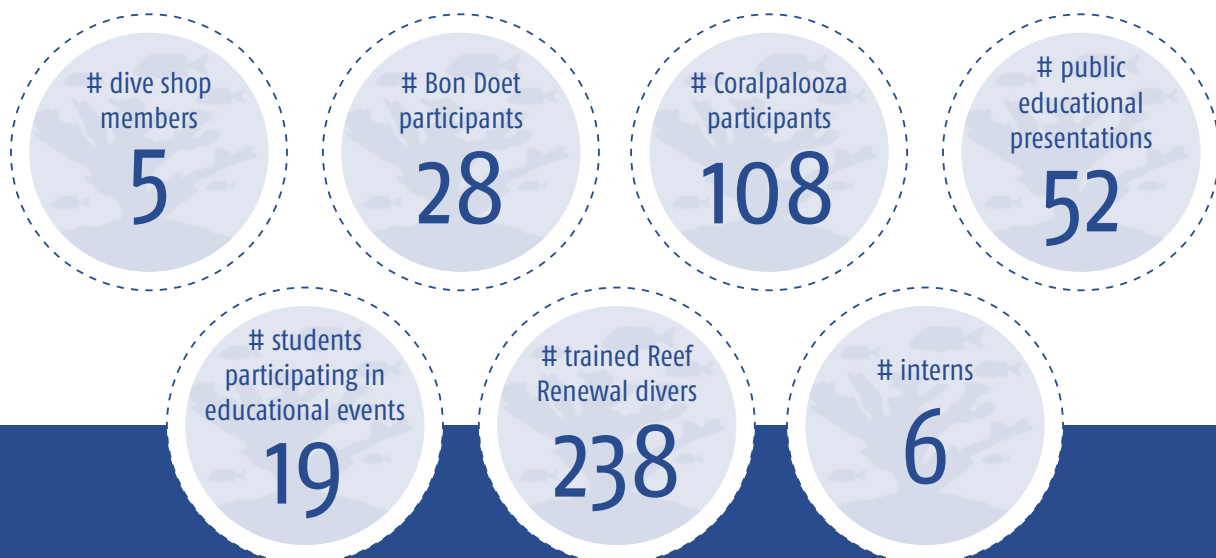
Community Involvement

Regardless of the species of coral or the outplanting technique, restoring Bonaire's coral reefs is a community effort. Local dive operators execute a practical restoration program that not only re-grows local reefs, but helps build their businesses with guests who return year after year to help maintain the nurseries and visit the reefs they helped replant.

Since 2013, **more than 1,000 people** (residents, tourists, researchers, interns, and local youth) have been trained by the Foundation and its five dive shop members.

After receiving their Reef Renewal diver certifications, divers are qualified to join RRFB staff as a volunteer. Volunteers not only help with day-to-day activities, but are also pivotal in sharing RRFB's vision with the wider community.

Interns work side-by-side with staff members in the field during restoration activities, and are provided with an educational experience, augmenting their conservation, biology, and business management backgrounds. Students from multiple programs around the island work closely with RRFB in a partnership to promote nature education amongst the local community, specifically Bonaire's youth. These students go snorkeling to learn about the basics of the program and receive firsthand experience working as divers in the nurseries and restoration sites.



3.3 Completed Projects

BEST 2.0

Thanks to a grant provided by the BEST 2.0 Programme supported by the European Commission, 750 elkhorn corals (*Acropora palmata*) have been planted at Oil Slick Leap. A “pop-up” coral nursery consisting of seven trees was installed at the site temporarily and was used to propagate 14 different genotypes of elkhorn corals. When ready, the elkhorn corals were strategically outplanted to maximize genetic diversity at the site. At the end of the year-long project, the trees were removed, leaving no visible trace of what was once there.

To assess the survival and health of the corals following outplanting, monitoring took place at specific intervals using 3D modelling and photomosaic techniques. This project helped RRFB to develop a new and more effective monitoring protocol, using 3D modelling and photomosaic techniques.

With all of the corals outplanted and the trees removed, the monitoring will continue throughout the long-term to evaluate the success of the restoration efforts. After 6 months, data collected on a randomized subset of corals shows that 97% of coral tissue is still alive.



More about the accomplishments, goals, and milestones of the project can be seen in the project video (https://www.youtube.com/watch?v=nkyq_xNj0HA&t=4s).

The Nature Fund

The Nature Fund from the Netherlands' Ministry of Agriculture, Nature and Food Quality (LNV) (previously Ministry of Economic Affairs) helped Reef Renewal Bonaire take the next step in restoring Bonaire's shallow reefs, strengthening its logistics and network to become a more independent organization. Finishing in the beginning of 2018, the project culminated in 5,000 staghorn corals (*Acropora cervicornis*) being outplanted at four restoration sites – Playa Lechi, Jeff Davis Memorial, Salt Pier, and Pink Beach. To accomplish this ambitious goal, the capacity of our coral tree nursery at Klein Bonaire was expanded to 6,522 corals (+54%) and a comprehensive monitoring program was established to assess outplanting success, gathering coral cover and mortality data of the different coral genotypes.

After finishing one year of monitoring for all sites, preliminary, unpublished data suggest that, at 3 out of 4 sites, mean coral cover increased from 15% to 40%. Cover increased linearly at a rate of 7% per 100 days or 25% per year. At the fourth site, Playa Lechi, trends were highly irregular and showed decreases on average by 7.7% (Meesters, et al. unpublished data). This site is located in a heavily populated and trafficked area, potentially providing good data to stimulate action and the development of a water quality monitoring program in the area.



3.4 Innovative Advances

Designing a pop-up nursery

A pop-up nursery is a temporary coral nursery that is used to grow corals in the same location they will be outplanted. When ready to be outplanted, the corals do not need to be transported to a new site by boat; rather, corals can be selected in the nursery and swum directly to the restoration site just a few meters away. The goal of this design is to acclimate the corals to their future home and reduce the stress that transportation might cause, which in turn would potentially increase the survivorship of these outplanted corals. The pop-up nursery design also simplifies dive logistics, allowing for more flexible planning and efficient outplanting.



Monitoring with new techniques

Reef Renewal Foundation Bonaire has begun incorporating new techniques into the monitoring program. Using photogrammetric processing of digital images to generate photomosaics and 3D models of our restoration sites and corals allows for the collection of additional data metrics. Photomosaics and 3D models can be revisited in the future for further data extraction, analysis, and direct comparisons between time points. Incorporating these techniques enables RRFB to have more adaptable and refined strategies, based on knowledge acquired from both quantitative and qualitative results of the monitoring program.

photomosaics
created

7

3D-models

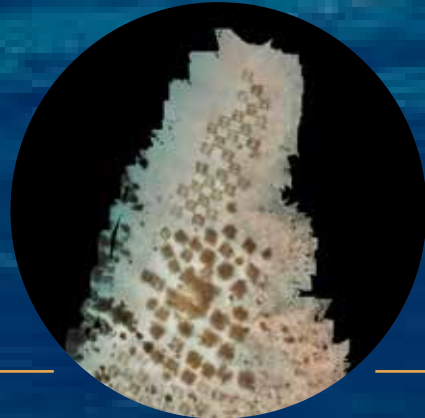
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Photomosaics

By stitching together hundreds to thousands of images, high-resolution photomosaics provide a useful tool for understanding coral reefs on an ecosystem-level scale and offers multiple advantages over the existing approaches of measuring benthic features in underwater habitats.

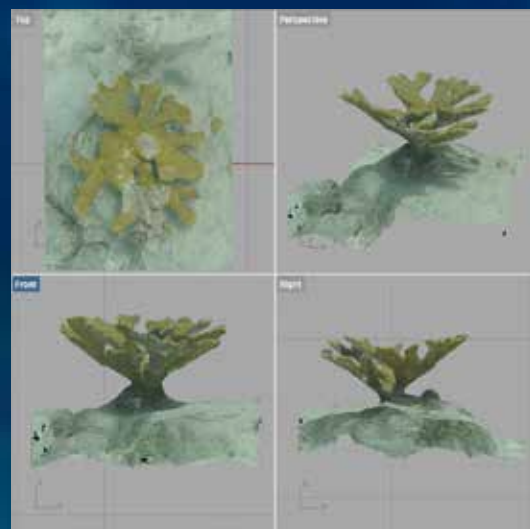
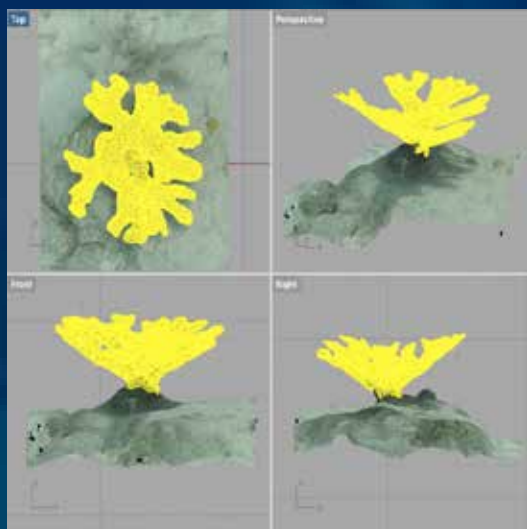
Measuring corals in situ is labor-intensive and time-consuming, especially if the goal is to measure thousands of individual coral colonies at an ecologically relevant scale. These digitalized reef images can capture an entire reefscape, including multiple colonies that might pass unobserved by divers doing field surveys, in a fraction of the in-water time.

Furthermore, on a coral reef, as in a forest, there are natural rules that govern the interactions between species and how they are distributed spatially on a reef, something that is difficult to capture on the same ecosystem-level scale with traditional monitoring methodologies. Understanding these spatial dynamics is key for successful restoration projects and can be used to inform restoration strategies.



3D-Modeling

Stepping beyond 2D rendering, is 3D photogrammetry. Using a similar computational process of stitching hundreds of pictures together, 3D modelling offers similar advantages to photomosaics. Integrating the 3D models in the monitoring method, although still in a development phase at RRFB, has proven to have wide applicability in the marine science field, being suitable for relatively small spatial extents (e.g. coral colonies), but with the potential to be stitched together for larger-extent reconstructions. 3D modelling is particularly advantageous as it has the capability to provide new metrics, such as coral surface area and volume, to better understand the growth patterns of outplanted corals. Like photomosaics, these models are archival and can be used in the future to pull out different metrics and compare them to the current situation.



3.5 Focus on Genetics

Genetic diversity is a crucial factor in any population, determining its capacity to adapt and survive when confronted with environmental changes and diseases. The higher the genotypic variance the more likely the population will be able to withstand stress. Coral reefs are no different and RRFB has made genetic diversity a priority in the restoration strategy.

In 2018, RRFB increased the genetic diversity within its nurseries, which now house 50 different genotypes. Additionally, a separate genetic bank was established within the nurseries to prevent genotype loss through a redundant system. RRFB has also planned, with the collaboration of CRF and Professor Steven Vollmer at Northeastern University (US), to complete an extensive genetic analysis of the corals by the end of 2019.



3.6 Spawning Success

Every year, staghorn and elkhorn corals synchronize and broadcast spawn. Across the entire Caribbean region, these corals simultaneously release bundles of gametes into the water column on nights following the August or September full moon. This process is vital for the health of wild coral populations as it can create new genetic strains and expand the distribution of these critically endangered species.

The 2018 September full moon saw another successful massive staghorn spawning event at the restoration site Jeff Davis Memorial. Once again, spawning was also recorded in outplanted elkhorn corals at Buddy's Reef. When



outplanted corals spawn, it is a sign that they are healthy and thriving and it is a major success for the population. These events represent flashes of hope for the natural recovery of these corals and the entire reef ecosystem.

3.7 Collaborating Internationally

SCORE Workshop

In June, RRFB staff traveled to Curaçao to a workshop hosted at CARMABI Marine Research Station to learn from scientists at SCORE International, a leader in providing technical innovations for restoring genetically diverse coral populations primarily via larval propagation. SCORE holds these workshops to serve as the basis to develop long-term partnerships to implement coral larval restoration in participants' own areas.



Thanks to the groundwork laid at the workshop, RRFB has signed a 5-year agreement with SCORE International. The partnership's goal is to establish a technical collaboration with the aim of sharing information, as well as testing, strengthening, and implementing the most effective and scalable coral reef restoration strategies in Bonaire, using innovative techniques based on coral sexual reproduction.

Reef Futures

Last December, over 500 coral scientists, practitioners, managers, and students from over 40 different countries gathered together in Key Largo, FL at Reef Futures 2018 – the first ever global coral restoration and intervention science symposium. It was a week-long conference full of inspirational talks, practical training workshops, collaborative discussions, and innovative ideas. After returning to Bonaire, Francesca Viridis, RRFB's Coordinator, had this to say about the motivational atmosphere of the conference: ***"The one thing I think everyone took away from the conference is that the need for collaboration is greater than ever before; only by working together can we make a difference around the world for our coral reefs."***

Reef Renewal Foundation Bonaire's participation at the symposium provided an excellent opportunity to raise the visibility and share the Foundation's successes to a large number of international colleagues, partners, and stakeholders. Francesca Viridis presented a talk entitled "Bonaire: a community-based coral restoration success story" (<https://www.youtube.com/watch?v=lqQ0denqeL8>) at the final plenary session as well as in the restoration vignette breakout session. Additionally, preliminary results of the RRFB Nature Fund project were also presented by a partner scientist, Dr. Erik Meesters, from Wageningen University & Research.





4 LOOKING FORWARD: The Future of Reef Renewal

4.1 Propagating Giants

In Bonaire, as well as throughout the greater Caribbean region, large framework-building species, such as Great star coral (*Montastraea cavernosa*), Mountainous star coral (*Orbicella faveolata*) and Lobed star coral (*Orbicella annularis*), have lost significant cover.

Recent developments in Florida have led to breakthrough methods of propagating boulder corals via fragmentation in both land-based and offshore nurseries. Reef Renewal Foundation Bonaire will be incorporating these techniques and using a modified coral tree nursery to propagate these critical species for outplanting back onto the reef.

Through the addition of these species to our restoration program, RRFB will be better-suited to initiate or accelerate the recovery of damaged reefs by increasing the diversity and complexity of coral communities and incorporating ecological processes into restoration planning.



THE GOALS FOR THE BOULDER CORAL PROJECT OVER THE NEXT THREE YEARS ARE:

- In the next year, develop a boulder coral nursery system and begin propagating corals;
- In the next two years, propagate corals within the nursery in preparation for outplanting;
- In the next three years, expand the boulder coral nursery system to increase outplanting capacity and begin outplanting more than 4,000 boulder corals to the reef each year.

4.2 Assisting recruitment

Recognizing the importance of collaboration to tackle complex problems such as reef degradation, Reef Renewal Foundation Bonaire will begin utilizing the innovative methods, tools, and processes developed by SECORE International, a world leader in the larval propagation of corals. The technique of larval propagation, or assisted recruitment, uses coral sexual reproduction as a restoration method. Incorporating this technique into the RRFB restoration program will potentially give the ability to scale-up the number of coral outplants, to work with numerous coral species and morphologies, and to increase the genetic diversity of corals on the reef.

In larval propagation, outplants are produced by taking advantage of sexual – instead of asexual – reproduction by collecting coral spawn and assisting with fertilization and larva settlement. Fertilized embryos are added directly to in-situ pools to complete their larva development and settlement phases. Once settled on the substrate, they are outplanted onto the reef.



THE GOALS FOR THE LARVA PROPAGATION PROJECT OVER THE NEXT THREE YEARS ARE:

- In the first year, conduct spawning observations of targeted coral species, collect spawn, fertilize eggs, and release larvae;
- In the second and third years, utilize settlement pools and outplanting substrates developed by SECORE to facilitate larva settlement on substrates that will be outplanted on Bonaire's reefs.

By participating in this work and conducting these field trials, RRFB will work with SECORE International to jointly improve coral larval propagation techniques through the exchange of data and feedback on the success of the methodology.



4.3 Scaling-up what works

Reef Renewal Foundation Bonaire will continue to grow and outplant genetically diverse, critically endangered *Acropora* corals. Utilizing the successful restoration methods, the focus will be on scaling-up the outplanting effort of these reef-building corals that once dominated the shallow reefs of Bonaire, providing habitat for marine life and helping to protect the leeward coastline of the island during storms.

Working to have an impact on a larger, ecosystem level, Reef Renewal Bonaire aims to outplant more than 20,000 staghorn and elkhorn corals in the next three years. These corals will bring the total restored area on Bonaire to more than 2 hectares.





5 FINANCIAL REPORT

Profits

Cost price profit

Expenses

Personnel

Sales expenses

Transportation expenses

Depreciation

Incidental (profits) and expenses

Financial (profits) and expenses

General

Balance profit and loss

2018	2017
USD	USD
159,499	296,540
30,577	56,455
128,922	240,085
56,633	55,419
8,048	3,451
1,736	1,453
2,339	992
5,510	(798)
965	1,010
19,594	16,182
94,825	77,709
34,097	162.376