



CORAL
RESTORATION
FOUNDATION™

2019

NEXT GENERATION



THIS IMAGE: A familiar scene around the world – a once thriving coral reef reduced to a rubble field as a result of human activity (AN)

FOR THE FIRST TIME IN HUMAN HISTORY, WE ARE FACING THE EXTINCTION OF AN ENTIRE ECOSYSTEM.

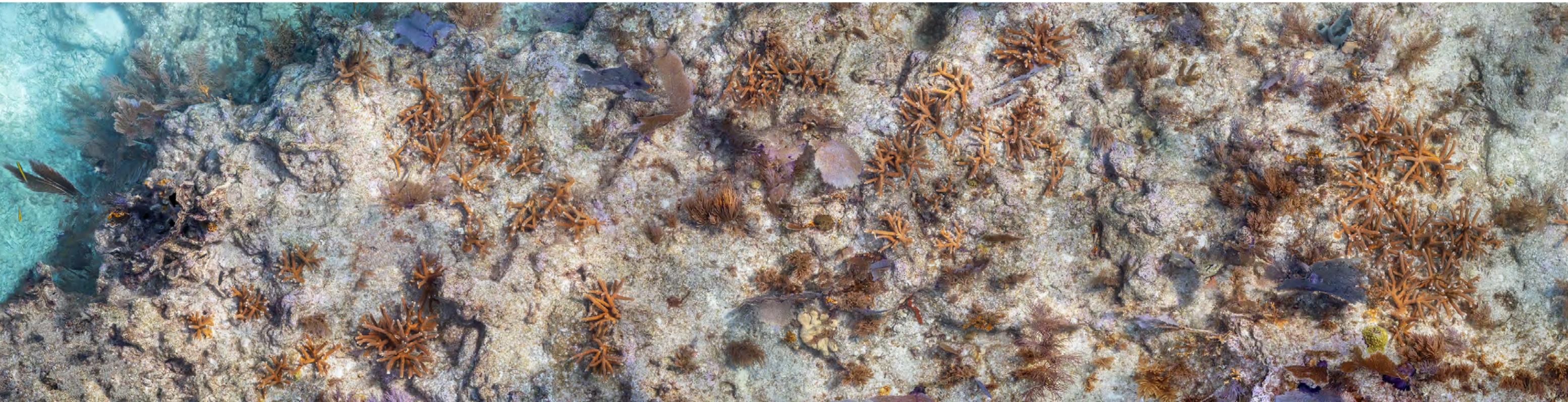
- Without action, we could lose all shallow-water coral reefs by 2100.
- We have lost 50% of the world's coral reefs in the last 30 years.
- In the Florida Keys, coral cover is down to just two percent at many sites.



THIS IMAGE: Nursery-raised staghorn coral provides a new home for marine life (JL)

AT CORAL RESTORATION FOUNDATION™ WE ARE SUCCESSFULLY BRINGING CORAL REEFS BACK.

- We manage the largest coral reef restoration program on the planet, returning tens of thousands of corals to the wild every year.
- We invented the Coral Tree™, now used by organizations around the world.
- We support efforts to scale up international restoration work.
- We see our outplanted corals spawning, kick-starting the reefs' natural processes of recovery.



NEXT GENERATION

Evolution occurs as successful genetic adaptations are carried from one generation to the next. Those of us working to save species and restore ecosystems must continually evolve as well. We have to evaluate our methods, learn from our experiences, and continue to develop techniques that build on best practices.

For reefs to survive and thrive, they need to be capable of adaptation, especially in a world characterized by the uncertainties of climate change.

At Coral Restoration Foundation™, our focus is on returning both species and genetic diversity to degraded reefs; this is how we are actively supporting the reefs' natural processes of recovery.

But to do this effectively, we have to apply evolutionary principles to our own work. Through ongoing research and development, we are pioneering the next generation of reef restoration techniques.

We are now taking the world of coral restoration to the next level, embarking on the most ambitious coral recovery program the world has ever seen.

All images thanks to: Alexander Neufeld (AN), Jessica Levy (JL), Dan Burdeno (DB), & Garrett Fundakowski (GF) / Coral Restoration Foundation™ & Jack Fishman/Project Aware (JF)

RESTORATION

We are actively restoring coral reefs on a large scale. Our innovative methods are cost-effective and scalable.

page **8**

SCIENCE

Our approach is guided by rigorous scientific research into coral reproduction, growth, and survivorship.

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EDUCATION

We work with schools, the public, and other NGOs to generate engagement around marine conservation issues.

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ABOVE: Section of a photomosaic of Carysfort Reef showing staghorn corals thriving around 18 months after being introduced to the reef (AN)



FROM OUR CEO

“ The scale of the crisis facing coral reefs cannot be underestimated. For us to keep pace with the decline, we must continue to evolve and work together. In 2019, Coral Restoration Foundation™ leveraged developments from the last few years to embark on pioneering strategies for securing a future for our world’s coral reefs.

In the Florida Keys, our reefs are among the most degraded in the world; without our interventions they would be functionally extinct. Thankfully, Coral Restoration Foundation™ is now capable of responding to this emergency at an unprecedented scale.

We have become so proficient at growing corals that, historically, we have produced more corals than we could efficiently return to the reefs. In 2019, we implemented trials of novel outplanting techniques to enable us to get corals out into the wild more quickly. These trials are now starting to show promise for a more rapid restoration of full ecosystem functionality.

Thanks to years of successful collaborations around the annual Acroporid spawning event, in 2019 we also became one of the first organizations in the world to outplant staghorn genotypes created by sexual reproduction. Around 100 of these new genotypes were also banked in our nursery, contributing a huge boost to the preservation of genetic diversity for these critically endangered species.

These developments, combined with the success of our focused restoration effort at Carysfort Reef and our robust relationships with partners including NOAA, the Florida Keys National Marine Sanctuary, and others, have resulted in the launch of a collaborative effort that will change the game for large-scale reef restoration around the world – “Mission: Iconic Reefs”.

This is the next generation of reef restoration: we are demonstrating that hope exists, and that we have the capacity to tackle one of the biggest challenges that humanity has ever faced.

R. Scott Winters
Coral Restoration Foundation™, Chief Executive Officer

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Alert Diver
- Steven Miller**
Senior Research Scientist, NOVA Southeastern
University Oceanographic Center
- Sascha Simon**
Founder, President, and Chief Science Officer
of Sfara

*LEFT: Schooling jacks in the
Tavernier Coral Tree™ Nursery,
which has become a hotspot
of biodiversity (AN)*

April 3
NEW GENETS ARRIVE
1,500 new genotypes
installed in the CRF™ nursery

April 6
RAISE THE REEF 2019
CRF™ 7th Annual Gala is the
most successful to date

June 4
NEEMO23
We collaborate with NASA
& ESA on a training mission

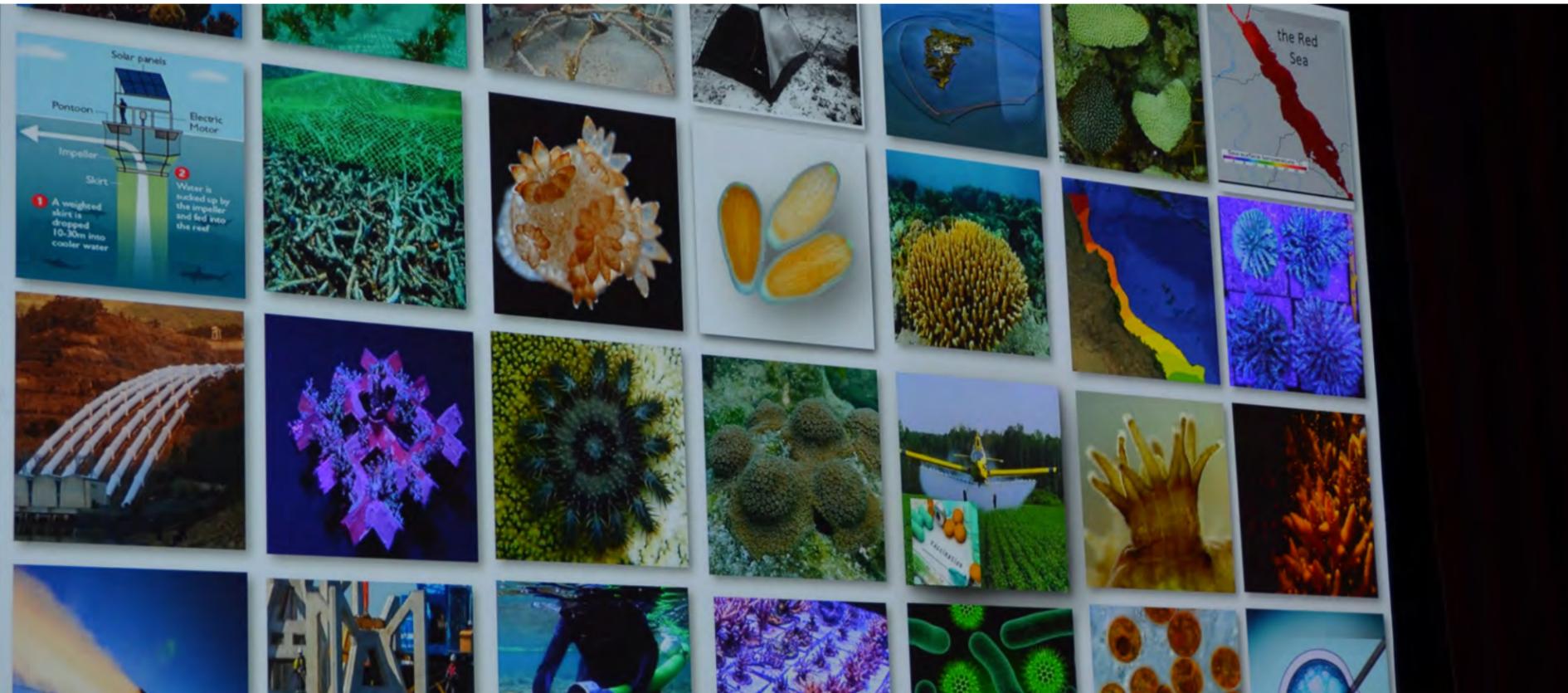
June 6
CORALPALOOZA™ 2019
The 5th Annual World
Oceans Day celebration

August 9
CORAL SPAWNING
Scientists visit CRF™ to
conduct vital research

August 16
100,000 CORALS
We plant our 100,000th coral;
a record for restoration

October 28
NEW GENETS ON THE REEF
Brand new genotypes
introduced to the wild

December 9
“MISSION: ICONIC REEFS”
Announcing the world’s most
ambitious restoration plan



ABOVE: Saving and restoring coral reefs requires diverse strategies and international collaboration

INTERNATIONAL IMPACT THROUGH COLLABORATION

CRF™ co-founded the Coral Restoration Consortium (CRC), an international community of practice comprised of scientists, managers, coral restoration practitioners, and educators dedicated to enabling coral reef ecosystems to survive the 21st century and beyond.

The Coral Restoration Consortium was created in response to rapidly deteriorating climate, land, and ocean conditions and the concomitant expansion of active coral restoration programs.

The CRC was designed primarily to facilitate knowledge transfer and collaboration.

The CRC serves as a coordinating body that seeks to disseminate best practices, foster technological innovation, and identify and address key research gaps.

All actions we undertake are intended to improve the efficiency with which coral reefs are restored so that reef ecosystems can protect coastlines, foster fisheries, serve as the basis for local, regional, national, and international economies, and be enjoyed for their beauty by future generations.

WORKING GROUPS

Dedicated CRC Working Groups are developing solution-oriented action plans and establishing best management practices for the following priorities:

- Defining common terms and standard metrics for coral restoration.
- Increasing restoration efficiency by at least an order of magnitude.
- Scaling-up larval propagation to optimize recruit health, growth, and survivorship.
- Providing guidance on how to restore not just corals, but ecological functionality for today's and tomorrow's coral reefs.
- For threatened and endangered coral species, conducting coral reef restoration within well-informed population management plans.
- Sharing knowledge and offering training support.

REGIONAL GROUPS

In addition to Working Groups, the CRC also has several regional and ad-hoc groups.

Regional groups form to share information across geographic regions, similar time zones, and/or a shared language. Ad-hoc groups are informal groups that form to tackle sub-topics as needed.

CRC: A BODY OF ACTION

The Coral Restoration Consortium is driven by action and results. We believe that through innovation, open access to data and education, and a collaborative, coordinated approach, we can provide goal setting and supporting resources to restore coral reefs in an ecologically meaningful manner to help ensure their sustainability for future generations.

The CRC currently has over 1,800 members around the world, all working towards the goal of ensuring that coral reefs will continue to be a feature of life on Earth.

THE CRC LEADERSHIP TEAM 2019-2023

STEERING COMMITTEE

R. Scott Winters (Co-Chair)
Coral Restoration Foundation™

Tom Moore (Co-Chair)
NOAA Restoration Center

Tali Vardi (Executive Coordinator)
ECS for NOAA Fisheries Office of Science and Technology

Jessica Levy (Coordinator)
Coral Restoration Foundation™

Michelle Loewe (Coordinator)
ERT for NOAA Restoration Center

Petra MacGowan
Reef Resilience Network

Petra Lundgren
Great Barrier Reef Foundation

MEMBERS AT LARGE

David Gulko
Hawaii Department of Aquatic Resources

Ilsa Kuffner
U.S. Geological Survey

Les Kaufman
Boston University

Phanor Montoya-Maya
Corales de Paz

Joe Pollock
The Nature Conservancy

Sandrine Pivard
UN Environment – Caribbean Environment Programme

Buki Rinkevich
National Institute of Oceanography

Anastazia Banaszak
The National Autonomous University of Mexico

WORKING GROUP CHAIRS

Restoration Genetics
Iliana Baums
Penn State University

Larval Propagation
Valerie Chamberland
SECORE International

Field-based Propagation
David Suggett
University of Technology-Sydney

Management
Liz Shaver
Reef Resilience Network

Restoration Monitoring
Shay Viehman
NOAA NCCOS

Land-based Propagation
Chelsea Wolke
Hawaii Division of Aquatic Resources

REGIONAL GROUP CHAIRS

Australia
Nathan Cook
Reef Ecologic

Latin America
Samuel Suleiman
Sociedad Ambiente Marina

Eastern Tropical Pacific
Tatiana Villalobos
Raising Coral Costa Rica

REEF FUTURES 2021

In 2018, through the CRC, CRF™ co-hosted the world's first symposium dedicated to reef restoration, **Reef Futures 2018**. The event, held at and co-hosted by Ocean Reef Club®, brought together more than **450 participants** from over **40 countries**. The second **Reef Futures** will take place in **2021**, and will be held once again at the illustrious Ocean Reef Club®.

“To help increase the scale and efficiency of coral restoration, we work to promote a positive, collaborative environment that fosters teamwork and information sharing”



“MISSION: ICONIC REEFS”: A BOLD NEW PLAN

In 2019, NOAA, Coral Restoration Foundation™, and other partners announced a groundbreaking reef restoration effort - “Mission: Iconic Reefs”, a collaborative plan that fast-tracks bold action to fully restore seven iconic reefs of the Florida Keys.

“Mission: Iconic Reefs” is a bold, collaborative, and holistic strategy to restore and preserve seven coral reef sites in the Florida Keys. It is part of an unprecedented, decades-long effort to revitalize the region’s highly diverse and economically valuable marine ecosystems.

A WORLD-LEADING EFFORT

The project calls for restoring 93,000 square meters of the Florida Reef Tract, about the size of 52 football fields – one of the largest strategies ever proposed in the field of coral restoration.

In the coming years, NOAA will support this effort and work with outside partners to secure additional public and private funds.

“NOAA is fundamentally changing its approach to coral reef restoration by proactively intervening to restore reef health and improve ecological function,” said Neil Jacobs, Ph.D., acting NOAA administrator. “Bold and decisive action has the very real potential to save one of the largest and most economically important reef ecosystems in the world before it’s too late.”

ADDRESSING DECADES OF DECLINE

Since the 1970s, hurricanes, heat-induced coral bleaching, cold snaps, and disease events, as well as acute impacts such as pollution, ship groundings, prop scarring, and misused boat anchors, have reduced coral coverage in the Florida Keys from 25 percent to just two percent, based on observations at the Iconic Reef sites.

BUILDING ON RESTORATION SUCCESS

“Mission: Iconic Reefs” also complements the Florida Keys Restoration Blueprint and management plan released by NOAA in the summer of 2019 to support restoration of all habitats within the Florida Keys National Marine Sanctuary.

Over the past 15 years, pioneering restoration efforts involving growing and transplanting corals have proven successful in the Florida Keys, setting the stage for this new, large-scale restoration effort.

The mission will focus on seven reefs within the Florida Keys National Marine Sanctuary:

Carysfort Reef, Horseshoe Reef, Cheeca Rocks, Sombrero Reef, Newfound Harbor, Looe Key Reef, and Eastern Dry Rocks.

These sites represent a diversity of habitats, support a variety of human uses, span the full geographic range of the Florida Keys, and show a high probability of success.

A PHASED APPROACH

This project aims to restore diversity and ecological function to the reefs by returning coral cover at target reef sites to a self-sustaining level.

The restoration effort will incorporate a phased implementation approach spanning the next 20 years. The first phase, designed to increase coral cover from two percent to 15 percent over 10 years, will focus on the fast-growing elkhorn and staghorn corals (species that have not been affected by the current outbreak of stony coral tissue loss disease) as well as resilient corals of other, slower-growing, species.

At these sites, scientists will remove nuisance and invasive species like algae and snails, and reintroduce depleted species including sea urchins and crabs to help keep the reefs healthy. The second phase, which is designed to return the reef to its historical coral cover of 25 percent,

will focus on adding additional slower-growing, foundational coral species propagated from colonies that have survived or been rescued from bleaching and disease events.

WORKING TOGETHER

Collaboration among federal and state agencies, leading coral reef experts, local restoration practitioners, and the Florida Keys community will be key to the success of this ambitious effort. Partners include the State of Florida, Coral Restoration Foundation™, Mote Marine Laboratory and Aquarium, The Florida Aquarium, The Nature Conservancy, Reef Renewal, and the National Marine Sanctuary Foundation.

“At Coral Restoration Foundation™ we have been working on radically scaling up our restoration efforts over the last couple of years. But, if we want to save the Florida Reef Tract, we can be more effective if we work together,” said R. Scott Winters, CEO of Coral Restoration Foundation™.

“In much the same way that a healthy ecosystem is the result of diverse species each occupying an important niche, through ‘Mission: Iconic Reefs’ we have an opportunity to combine our expertise to have a hugely significant impact on the future of our coral reefs.”

ABOVE: Carysfort Reef, one of the most iconic sites in the Florida Keys, will form the heart of the “Mission: Iconic Reefs” effort (JF)

“The project calls for restoring 93,000m² of the Florida Reef Tract, about the size of 52 football fields – one of the largest strategies ever proposed in the field of coral restoration

“The goal is to restore diversity and ecological function to the reefs by returning coral cover at target reef sites to a self-sustaining level

REGENERATING ECOSYSTEMS

We are taking an active, ecosystem-wide approach to reef restoration, restoring both abundance and genetic diversity to the reefs of the Florida Keys.

- We grow and outplant **genetically diverse, critically endangered** corals to restore reef sites to a healthy state.
- Our outplanted corals are **spawning**, kick-starting the reefs' natural processes of recovery.
- Our **program partners** include government agencies, non-profits, academic institutions, and private enterprises.
- As a result of our program's success, Coral Restoration Foundation™ has become a **resource for other organizations** seeking to implement reef restoration programs in their local waters.
- In 2019, we provided **restoration infrastructure and training** to organizations from **10 countries**.

RESTORATION SITES

In 2019, we worked on **10 restoration sites** along the Florida Reef Tract.

In 2020, we will be focusing our large-scale efforts at two of the "Mission: Iconic Reef" sites, and conducting pilot restoration programs at four of the other sites.



THIS SPREAD: Staghorn corals fusing together roughly three months after being introduced to the wild. (AN)

THE WORLD'S LARGEST CORAL NURSERIES

We invented the Coral Tree™ – now considered one of the best methods in the world for growing large numbers of corals.

We are continuing to develop this technology to accommodate even more coral species.

Our Coral Tree™ Nurseries are the largest in the world, capable of raising **44,000 corals** to a "reef ready" size every year.



MEASURABLE, ECOSYSTEM-LEVEL IMPACT

Over the last 11 years, we have returned more than **120,000** corals to the reef, restoring more than **8,000 square meters** of the Florida Reef Tract.

In the next three years, and as part of the "Mission: Iconic Reefs" project, we are contributing to the restoration of **93,000 square meters** of coral reef.

In 2019 we returned **32,373 corals** to the reefs of the Florida Keys:

- Staghorn (*Acropora cervicornis*): **17,144**
- Elkhorn (*A. palmata*): **13,792**
- Boulder star coral (*Orbicella annularis*): **389**
- Mountainous star coral (*O. faveolata*): **1,048**





OUR METHODOLOGY

PROPAGATION

To grow large numbers of corals for outplanting, we take advantage of the way in which corals naturally reproduce asexually through fragmentation. When a coral breaks, the separate pieces will grow into new, genetically identical colonies. This is known as propagation.

More than a decade ago, we took clippings from wild coral colonies to begin propagating them. Now, our stock is self-sustaining.

CORAL TREES™

The Coral Trees™ we invented are tethered to the ocean floor and buoyed with a subsurface float.

They float in the water column and are able to move with wave surges and currents. This helps prevent damage to the tree structures and corals by absorbing the wave energy.

Coral fragments are hung from the branches of the trees using monofilament line.

We clean the trees regularly so that the corals do not have to compete with any other organisms for space or food.

Suspended in the nutrient- and sunlight-rich water column, the fragments of *Acropora* corals on our Coral Trees™ grow into colonies that are large enough to be planted onto the reef in just six to nine months.

REEF READY

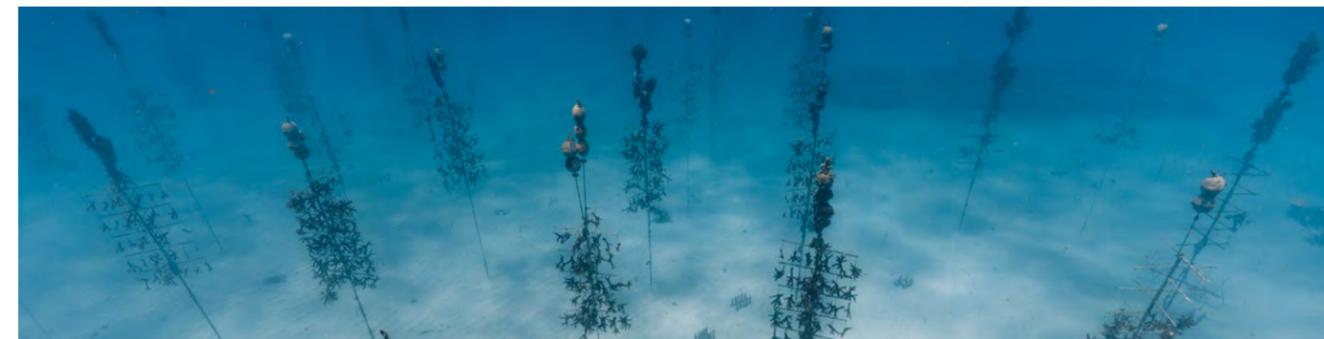
After the coral colonies have reached “reef ready” size, they are removed from the Coral Tree™, tagged, and taken to a carefully selected site.

At the site, they are grouped into clusters of around 10 corals of the same genotype. Each cluster occupies the size of a hula hoop.

They are attached directly to the substrate using a two-part marine epoxy.

MONITORING

Our Science Program then monitors the corals one to three months and one year after they have been introduced to the wild.



ABOVE LEFT & ABOVE: The Tavernier Coral Tree™ Nursery is the largest in the world, covering 1.5-acres of sea floor (AN)

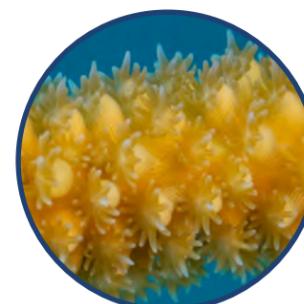
BELOW LEFT: Restoration Program Manager, Jessica Levy, returning staghorn corals to the wild (AN)

DIVERSITY IN OUR NURSERIES

In order for restoration efforts to be successful in the long term, it is essential that the corals we outplant are genetically diverse. We are currently working with 415 putative coral genotypes across 11 species.

Healthy reefs rely not only on a diversity of species but also on genetic diversity within each species. Genetic diversity results in resilience; restoring diversity is vital in mitigating risks associated with inbreeding, including genetic mutations, and the inability of coral populations to adapt to dynamic environmental conditions.

Our nurseries have now become a vital repository of genetic diversity for corals whose populations are in a spiral of decline – our genetic ark comprises the world’s largest genetic “bank” of corals. Some of these genotypes can now only be found within our nurseries, as they have unfortunately been lost in the wild.



ACROPORIDS

The majority of our nursery stock consists of the reef-building, branching corals *Acropora cervicornis* and *Acropora palmata*.

These were once the Caribbean’s dominant reef-building corals. Populations of both have **declined by as much as 95%** in the Caribbean in the last **40 years**, and both species are now listed as “Threatened” under the U.S. Endangered Species Act (ESA), and as “Critically Endangered” on the IUCN Red List of Endangered Species, one step away from “Extinct in the Wild”.



STAR CORALS

We have scaled up our propagation of two species of star corals: *Orbicella annularis* and *Orbicella faveolata*. Boulderizing species like star corals are important reef stabilizers.

Within the past **20 years**, *Orbicella annularis* has seen a greater than **50% decrease** in population and is now listed as “Endangered” on the IUCN Red List.

In 2018, we developed and implemented outplanting methods for boulderizing corals and began reintroducing them to Carysfort Reef.



PILLAR CORAL

We are one of a handful of organizations that house living colonies of pillar coral, *Dendrogyra cylindrus*.

This species, like the elkhorn coral, is now functionally extinct in the wild in Florida.

In April 2019, we increased our stock of *D. cylindrus* colonies with the transfer of fragments from Mote Marine Laboratory’s ex-situ nursery.

These corals represent 13 genotypes previously not housed in the Tavernier Nursery stock, bringing our total count of pillar corals to 20 genotypes.

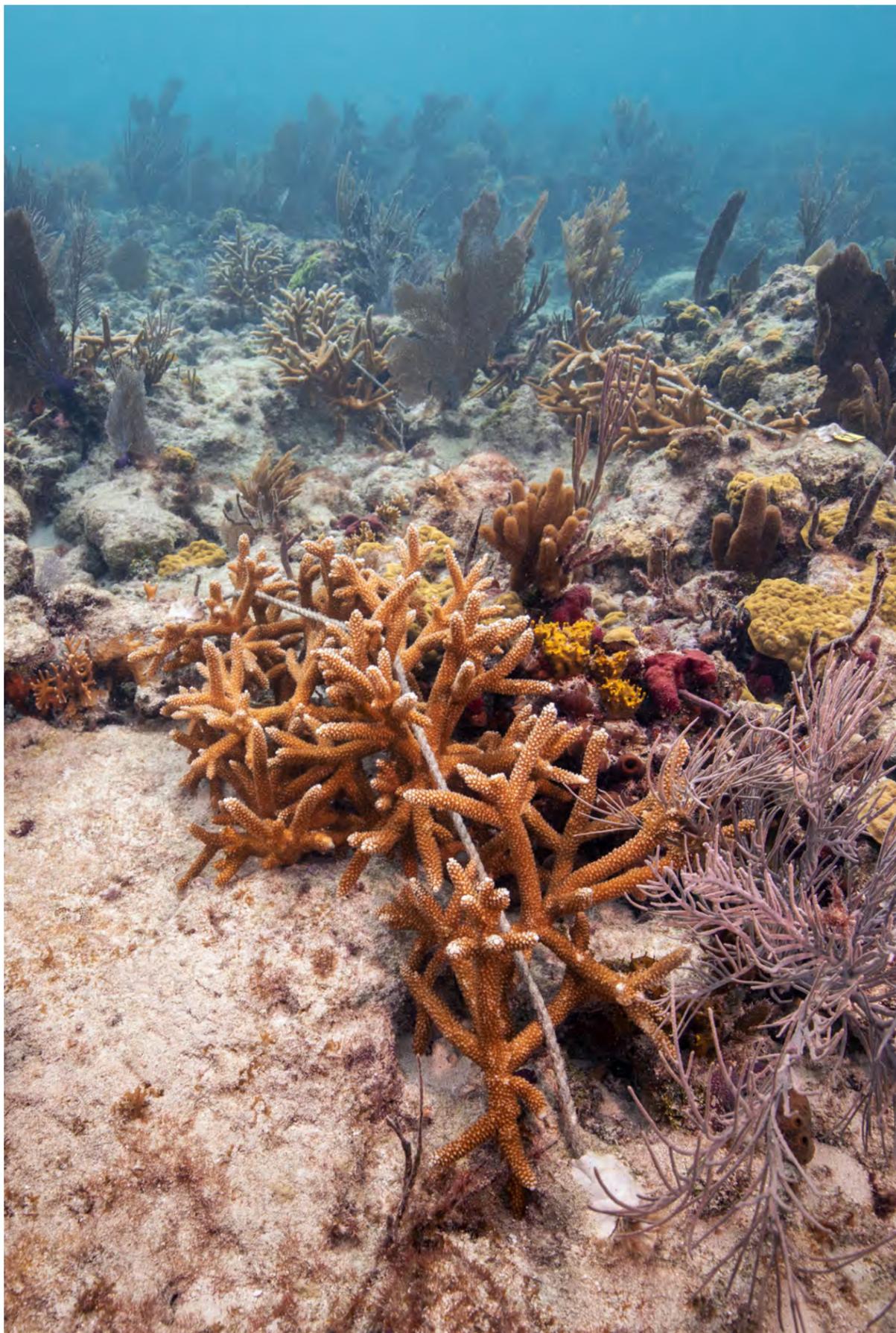


OTHER SPECIES

Our nurseries also contain populations of *Porites porites* and *Porites astreoides* (finger corals), *Occulina diffusa* (a branching coral), and *Siderastrea siderea* (a massive coral).

These species found a home in our nurseries after we undertook mitigation work in collaboration with the Florida Keys Electric Cooperative in 2017.

Populations of all these species are in decline around the world.



NEXT LEVEL METHODS TO RAMP UP OUR IMPACT

At CRF™ we grow more than 44,000 “reef ready” corals every year. Now, we are developing techniques to get these corals out onto the reef more quickly, to enable us to accomplish the unprecedented goals of the next generation of large-scale reef restoration.

ABOVE: Corals attached to bamboo frames are installed on the reef (AN)

LEFT: Corals held against the reef using hemp rope are successfully fusing to the substrate (AN)

“

By outplanting large, sexually mature colonies, we are introducing structural and biological complexity to the reefs very quickly

As we launch “Mission: Iconic Reefs”, an initiative which hugely expands the extent of our work, we are also conducting trials that will eventually enable us to implement new outplanting methods. These will be a critical component of this next phase of reef restoration.

After spending a year developing two novel outplanting techniques, in 2019 we launched a pilot study to evaluate the effectiveness of each. This study was conducted under permit from the Florida Keys National Marine Sanctuary.

Alexander Neufeld, Coral Restoration Foundation™ Special Projects Coordinator, explains, “These novel techniques represent the next evolution in the Coral Restoration Foundation™ model – one that will allow us to begin returning critically endangered corals to the reef at a scale that is immediately relevant from an ecological perspective.

“By outplanting large, sexually mature colonies, we are not only introducing structural and biological complexity to the reefs very quickly, but we are also accelerating the reefs’ natural process of recovery via spawning.”

SUSTAINABLE MATERIALS

These new methods use sustainable materials that degrade over time. The first new method involves attaching multiple corals to bamboo frames and then attaching the frames to the reef. The second uses hemp rope to secure eight to 10 large corals against the substrate.

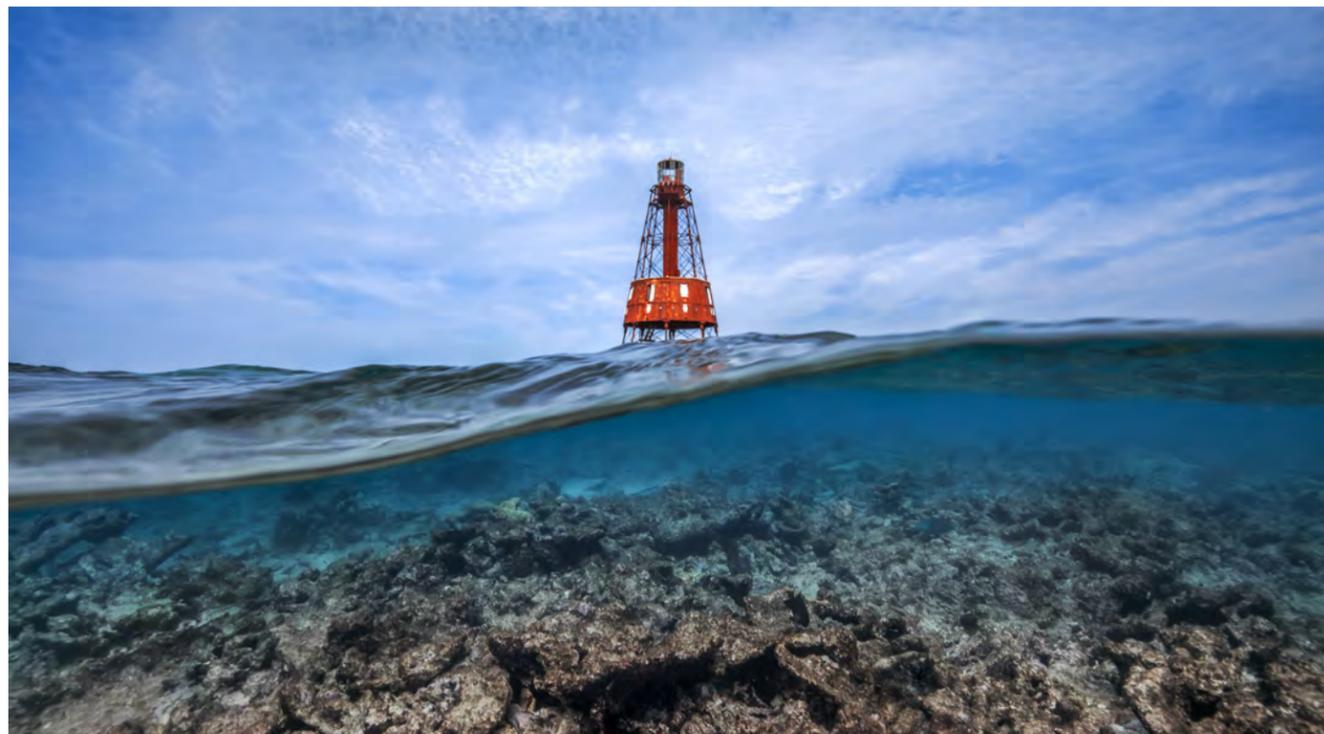
RESULTS

With a few modifications, the hemp rope technique was quickly revealed to be the more efficient and successful of these two methods.

The bamboo frames did not result in any overall increase in efficiency, and regular monitoring of the pilot sites soon showed that corals secured with hemp rope were fusing to the substrate more successfully than those attached to the bamboo frames.

SCALING UP

Ongoing innovation is critical if we want to successfully take our operations to scale. In 2020, we hope to evolve our protocols to include new outplanting methods as standard practice – a development that heralds new hope for large-scale reef restoration around the world.



ABOVE: Carysfort Reef is one of the world's first iconic reefs. Today the lighthouse stands over a reef in crisis (AN)

CARYSFORT REEF: LEVERAGING SUCCESS

In 2019, the success of our work at the iconic Carysfort Reef helped to provide a launch pad for the world's most ambitious restoration initiative. By the end of 2020, we will have re-populated this iconic site with more than 35,000 new corals, 6,162 of these in 2019 alone. Now, in a world first, this entire reef system could be fully restored in just one generation.

Carysfort Reef has received more new corals than any other restoration site in the Florida Keys. As a result, it is slowly becoming one of the healthiest reef sites along the Florida Reef Tract. This focused restoration effort is so successful that it has become a cornerstone of the "Mission: Iconic Reefs" program – an unprecedented collaborative effort that will provide the world with a shining example of large-scale reef restoration.

A COLLABORATIVE EFFORT

The ecological impact we are able to make at this famous location is only possible thanks to Ocean Reef Club®. Through a five-year partnership that directly supports the restoration of Carysfort Reef, Ocean Reef Club® has demonstrated a genuine investment in the future of this precious ecosystem. This collaboration means that Carysfort Reef will receive more than 35,000 corals by the end of 2020.

BOULDERING CORALS RETURNING

In a first for Coral Restoration Foundation™, star corals were successfully reintroduced to Carysfort Reef in October 2018. Carysfort now has a total of 1,751 new bouldering star corals, which will grow to stabilize this important reef site.

DEMONSTRATING SUCCESS

In 2019 alone, Carysfort Reef was repopulated with 3,354 staghorn, 1,537 elkhorn, and 1,271 star corals – corals which are healthy and thriving! Star corals showed an 80% survivorship one year after being introduced to the reef.

In 2019, the one-month survivorship of Acroporid corals (staghorn and elkhorn) planted at Carysfort Reef was 93%. Our photomosaic monitoring project is also revealing an increase in coral coverage on the reef. We have now returned more than 25,000 corals to Carysfort Reef since 2015, which means we are on target to hit a total of 35,000 by the end of 2020.

INSPIRING THE WORLD

High survivorship, healthy corals, and fast growth rates mean this site is an excellent example of what restoration goals for the rest of the Keys should look like.

This success has placed restoration at Carysfort Reef at the heart of the newly-announced "Mission: Iconic Reefs" effort, a project that will show the world that large-scale restoration is possible, and that we really can secure a future for our planet's disappearing coral reefs.

BOTTOM RIGHT PAGE: Elkhorn coral growth at Carysfort Reef from 2017 to 2019 (AN)



THIS IMAGE: Divers introduce new elkhorn corals to Carysfort Reef (AN)



“This focused restoration effort is so successful that it has become a cornerstone of the “Mission: Iconic Reefs” program



RESTORATION PARTNERS

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Our 3-year restoration plan is funded by NOAA. The plan coincides with the needs of the NOAA-published Acropora Recovery Plan.

NOAA RESTORATION CENTER

NOAA RC has been pivotal in providing guidance, advice, and input on decision-making. Through the CRC, their team helped manage Reef Futures 2018 at ORC.

THE FLORIDA FISH AND WILDLIFE CONSERVATION COMMISSION & THE FLORIDA KEYS NATIONAL MARINE SANCTUARY

FWC and FKNMS provide the permits that make our work possible.

OCEAN REEF CLUB®

ORC has been a key partner in the ongoing restoration of Carysfort Reef, one of the healthiest reefs along the Florida Reef Tract. Ocean Reef Club® also co-hosted Reef Futures 2018, and continues to welcome us for our annual gala.

GEORGIA AQUARIUM

Our long-term partnership with the Georgia Aquarium continues, highlighted by quarterly restoration trips, where Georgia Aquarium volunteers help us focus on nursery maintenance, expansion, and outplant efforts.

THE COLLEGE OF THE FLORIDA KEYS

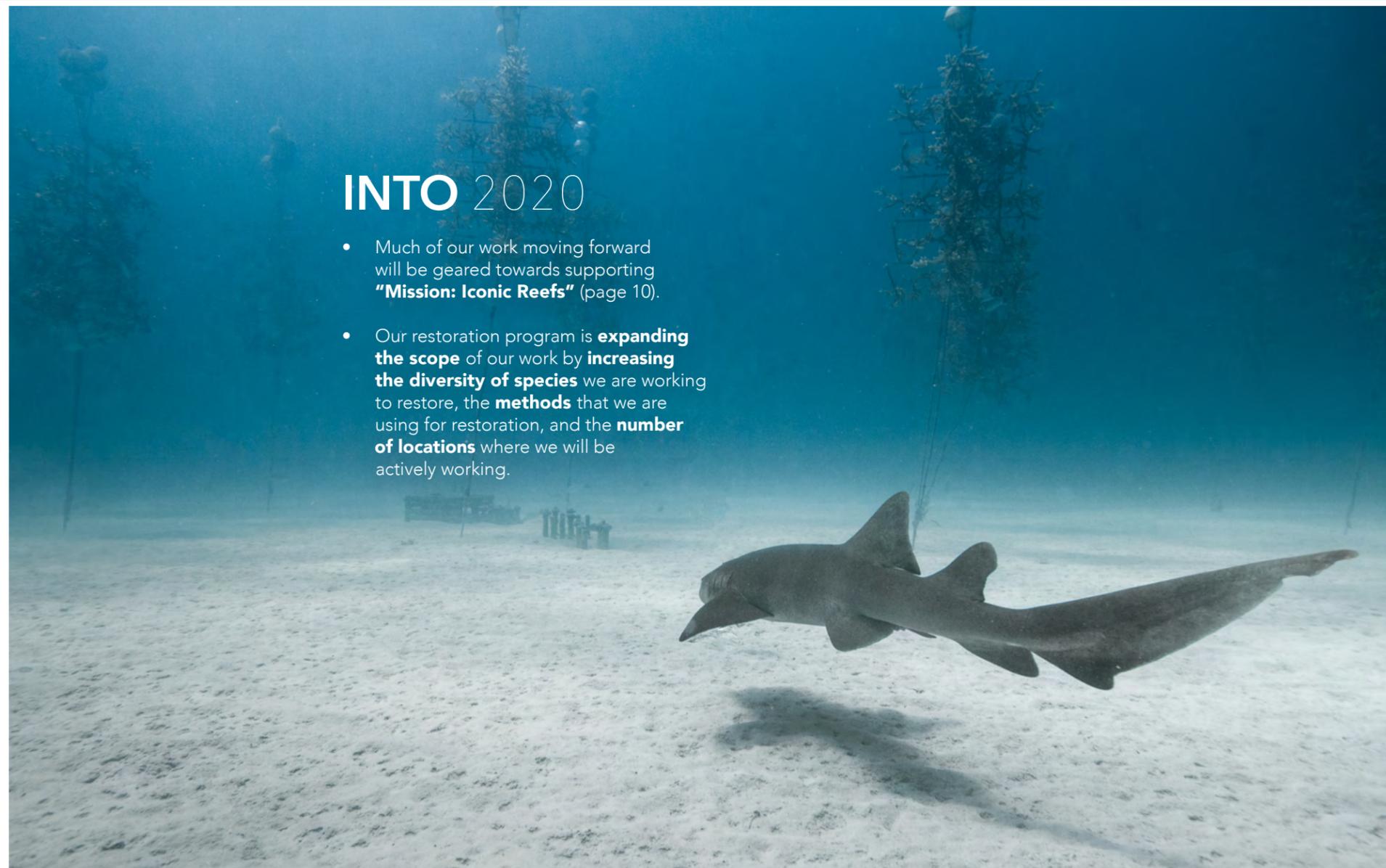
Our internship program with CFK enables three interns to assist in our Key West nursery and restoration operations, which include guiding divers, outreach events, and monitoring efforts.

CORAL RESTORATION CONSORTIUM

Through our leadership role in the CRC, we have been helping to facilitate information exchanges and build on the opportunities presented by this community of collaboration.

LEFT: Divers leave behind staghorn corals newly-introduced to Carysfort Reef (AN)

RIGHT: A nurse shark swims through the Tavernier Coral Tree™ Nursery, the largest in the world and a habitat for diverse marine life in its own right (GF)



INTO 2020

- Much of our work moving forward will be geared towards supporting **“Mission: Iconic Reefs”** (page 10).
- Our restoration program is **expanding the scope** of our work by **increasing the diversity of species** we are working to restore, the **methods** that we are using for restoration, and the **number of locations** where we will be actively working.

2019 HIGHLIGHTS

OUTPLANT NUMBERS

We conducted restoration work at 10 reef sites along the Florida Keys, with focused, large-scale restoration at eight sites:

- We returned 32,373 corals to the reefs of the Florida Keys, more than we have done in any other year.
- CRF™ has now outplanted nearly as many corals in the two years since Hurricane Irma as we had in the decade before the storm.
- We achieved all of our goals in terms of species and abundance, thanks in part to a shift in our outplanting planning methods. This year, we hired dozens of large charters to allow large numbers of dive staff, interns, and volunteers to outplant huge numbers of corals at once. This also led to an overall decrease in water days for our workforce.

NOVEL OUTPLANTING METHODS

We initiated ongoing trials of novel outplant methods at Pickles Reef and Carysfort Reef. These trials are providing ways for us to scale up in 2020.

“MISSION: ICONIC REEFS”

In collaboration with NOAA and other partners, we announced the world’s most ambitious plan for coral reef restoration. Together, we are aiming to restore 93,000 square meters of reef over the next three years, as part of a 20-year effort.

GUIDING THE FUTURE OF REEF RESTORATION

Our Science Program is a nexus of expertise and resources for restoration practitioners around the world. It also ensures that we are using the best practices possible for reef restoration. And it is proving that coral restoration – on a massive scale – works.

- We currently work with **415 unique coral genotypes across 11 species** to ensure that we are restoring the reefs' genetic diversity and resilience.
- We rigorously monitor our outplanted corals and reef sites, and are involved in **research into the wider ecological impact of our work.**
- This data informs our strategic development, and the **research provides a focal point for collaborations** with government agencies including NOAA, universities, NGOs, and others.
- We supply scientists from around the world with **unique resources for research** into coral reefs.

RECORDING SUCCESS

In 2019, we monitored the survivorship of our corals one year after their introduction to the wild. The data shows that our corals are thriving:

- *Acropora cervicornis* **70% survivorship**
- *Acropora palmata* **63% survivorship**
- *Orbicella annularis* **82% survivorship**
- *Orbicella faveolata* **79% survivorship**

We are now moving toward using photomosaics for monitoring the ecosystem-level impact of our work and the area of reef that we are restoring.

As of December 31st, 2019, we have restored **8,000 m²** of reef in the Florida Keys.

THIS SPREAD: Science Program Manager, Amelia Moura, uses a DPV to collect images for a photomosaic that will allow us to measure the area of reef that we are restoring (AN)



ABOVE: Science Program Manager, Amelia Moura, installing new staghorn genotypes in the nursery (GF)

DIVERSITY: A NEW GENERATION OF RESILIENCE

Restoring genetic diversity is a critical component of rebuilding resilient ecosystems. At Coral Restoration Foundation™ we are doing just that by applying the latest science, working with other experts, and making our techniques and data available to the world.

“Our Coral Tree™ Nursery contains two sections dedicated to “banking” genetic material – increasingly critical as we continue to lose wild coral populations

Restoring coral reef ecosystems means rebuilding ecosystem functionality, self-sufficiency, and resilience. This requires both saturating these degraded reefs with huge abundances of corals and ensuring that these corals comprise multiple species with as much genetic diversity as possible.

BANKING ON DIVERSITY

We have exhaustive genetic information on every coral that comes through our nurseries. Our Tavernier Coral Tree™ Nursery contains two sections dedicated to “banking” genetic material, containing representatives of multiple species and multiple genotypes. This genetic ark is increasingly critical as we continue to lose wild coral populations – it is a vital repository of genetic diversity.

RESILIENT STOCK

For many years, we have been focused on the restoration of populations of staghorn and elkhorn corals. These Acroporid species were the dominant, reef-building species of the Florida Keys. We originally collected corals from wild colonies that had survived more than 40 years of stressors – pollution, disease, warming water, and other human impacts. As a result, we know that these corals are likely to be hardy and are already capable of surviving under difficult conditions.

Every site that we work on currently receives at least 50 different genotypes of staghorn and 50 different genotypes of elkhorn. As these corals spawn and create new genetically distinct individuals they are contributing to evolutionary processes that will hopefully result in increasingly



ABOVE: Recently re-homed star corals begin to fuse next to established staghorn outplants (AN)

resilient coral genotypes in the future - capable of surviving and thriving in a changing world.

DIVERSIFYING SPECIES

We have now become world-leading experts at growing huge quantities of these species – we currently raise around 44,000 staghorn and elkhorn colonies to a “reef-ready” size every year. In 2019, we began scaling up our production of other coral species, specifically two “bouldering” or “massive” species – *Orbicella annularis* and *Orbicella faveolata*. These star corals are important reef stabilizers and by returning them to the reefs they will contribute to future ecosystem resilience and functionality.

GENOTYPES NEW TO SCIENCE

In April 2019, CRF™ received over 1,500 brand new sexually propagated coral recruits from the Florida Aquarium’s land-based nursery. The majority of these corals were *Acropora cervicornis* recruits, a direct result of our hugely successful 2018 coral spawning collaboration.

The eight-month old recruits were first installed in the Tavernier Nursery to grow out and acclimate to an open ocean environment. In November 2019, most of these new colonies

were introduced to the wild at Carysfort Reef. The remainder were kept in the nursery where they will continue to grow and be monitored as a critical part of our growing genetic ark.

GENET REGISTRY

In 2019, we made great strides with the production of the world’s first genotype registry for corals used in restoration efforts. Currently, restoration practitioners from different organizations may use genetically-identical corals from the same wild parent colonies but manage them using different naming conventions.

The CRF™ Genet Registry will be a freely available resource that will provide practitioners, academics, and managers with a single source of truth to reference when seeking to understand which genotypes are being propagated, banked, or duplicated across restoration efforts and research projects.

Once the Genet Registry is released in 2020, it will give all restoration practitioners a common “language” for talking about particular coral genotypes, facilitating information transfer and collaboration.



The Genet Registry will give all restoration practitioners a common “language” for talking about coral genotypes, facilitating information transfer and collaboration



ABOVE: Restoration Program Coordinator, Dan Burdeno, flying the DPV photomosaic rig (AN)

PHOTOMOSAICS: PUSHING THE FRONTIER

As we continue to break new boundaries with the enormous scale of our outplanting efforts, our monitoring efforts must keep pace. Photomosaics allow us to scale our monitoring efforts to an ecosystem level. This approach will be critical as we begin the next phase of this historic restoration effort.

“*This switch in methodologies will save valuable time in the field and will give us the ability to accurately measure the overall impact of our outplants*”

The scale of our restoration work is massive – we are now returning tens of thousands of corals to the reefs every year. As a result, old monitoring methods of swimming around a reef and tracking individual corals no longer provide metrics that capture the full story of restoration successes and failures on an ecosystem level. To get an accurate, holistic picture of our impact, we are now using photomosaics to monitor our restoration sites.

ALIGNING WITH OUR MISSION

Photomosaics are huge, high resolution images of reef sites created by stitching together thousands of smaller images. The high-resolution image that is produced allows us to accurately measure increases in coral coverage.

Assessing our work in terms of populations and communities instead of simply by fate-tracking individuals aligns more closely with our mission to restore not just corals, but entire reef systems.

ASSESSING THE METHOD

We began to “monitor by mosaic” as part of our standard operating procedures in 2019. CRF’s monitoring trips continued to utilize paper-and-pencil diver surveys as normal, but now also included a simultaneous mosaic component.

In 2019, we stitched and analyzed 59 mosaics across nine reef sites. The mosaics range in real-world size from 35 to 2,470 square meters.

To evaluate the method, we analyzed our photomosaics and monitoring datasets separately. The results showed that our photomosaic technique was able to capture the survivorship of our corals to within 5% of the value achieved by our traditional method while only using half the number of dive hours. The success of these comparisons allowed CRF to propose moving to a strictly mosaic-based approach to monitoring in 2020.



ABOVE: A photomosaic of healthy elkhorn outplants at Carysfort Reef showing an area of 10m² (AN)

HARNESSING NEW TECHNOLOGY

In 2019, we also began experimenting with DPVs (Diver Propulsion Vehicles), aka “scooters”. We developed a way to mount our photomosaic camera rig on the scooters to allow us to create photomosaics of very large reef areas in a short amount of time.

While this method has yet to be fully implemented into our mosaic and monitoring program, the potential does exist for DPVs to become more regularly used in the future, as we increase the scale of our work and the sizes of reef areas we mosaic.

INTO 2020

To realize the potential offered by photomosaics, CRF™ will be diligently completing mosaics before, during, and after the completion of outplanting at each of our 2020 restoration sites.

This effort will require completing mosaics of much larger areas than in past years, as well as mosaics at reefs where we have previously never worked. In doing so, we will be able to measure survivorship, mortality, and growth rates of our corals.

By creating a visual catalog of these sites now and into the future, we will be able to observe the ways in which the benthic reef environment reacts to the reintroduction of previously absent coral species.

In 2020, it is our hope that photomosaics will account for nearly all of our monitoring work, replacing the in-water, paper-and-pencil diver surveys that no longer give us an accurate picture of our restoration success.

This switch in methodologies will not only save valuable time in the field, it will also give us the ability to accurately measure the growth, distribution, and overall impact of our outplants in the context of the reef environment.

SUPPORTING THE COMMUNITY

At Coral Restoration Foundation™ we are committed to sharing our lessons learned with the world’s restoration community. In 2019 we released our photomosaic procedures on our website as an open-source white paper, and, on July 25th, 2019, we co-hosted a webinar through the Coral Restoration Consortium to share our experiences and techniques.



Assessing our work in terms of populations and communities instead of simply by fate-tracking individuals aligns more closely with CRF’s mission to restore entire reef systems



ABOVE: Staghorn corals spawning in the CRF™ Tavernier Coral Tree™ Nursery (AN)

SPAWNING: THE CORALS OF THE FUTURE

Spawning is how corals create successive generations and new, genetically unique, individuals. Through our collaborations around the annual Acroporid spawning event, we are giving these natural evolutionary processes a helping hand.

Every year across Florida and the Caribbean, around the late-summer full moon, Acroporid corals simultaneously release “gametes” – bundles of eggs and sperm – into the water. This process is called “spawning” and it is vital for the health of wild coral populations.

Upscaling restoration means ensuring that spawning corals are able to seed the reefs with new genetic strains, expanding the geographic distributions of these critically endangered species.

SUPPORTING REEF REGENERATION

Ten years ago, in a historic first, corals we had returned to the “Wellwood Site” on Molasses Reef became the world’s first outplanted corals documented to spawn.

Since then, we have recorded spawning at multiple restoration sites – strong evidence that our methods are working.

A SOURCE OF GENETIC MATERIAL

Our broodstock corals in the nursery also spawn every year, and provide a unique opportunity for studying this extraordinary event. We have comprehensive genetic information about the corals in our nursery, which is invaluable to spawning researchers interested in creating new genetic strains.

By carefully monitoring our corals, we determine gamete maturity, which allows us to predict when spawning will occur.

Gametes collected from our corals are helping researchers better understand coral sexual reproduction to improve monitoring, to enhance the impact of spawning events, and to create new coral genotypes.

Corals raised from gametes collected at our facilities are thriving with organizations around the world. Coral sperm and eggs from our nurseries



ABOVE LEFT: Coral Restoration Foundation™ Science Program Manager, Amelia Moura, prepares a large broodstock coral for transfer to the lab (DB)

ABOVE RIGHT: Staghorn gamete bundles can be seen in an early stage of development in the skeleton about one month before spawning occurs (JL)

BELOW RIGHT: Gamete bundles of eggs and sperm being released from staghorn polyps (DB)

have also been cryopreserved by SEZARC, which has secured a future for unique genetic strains of these disappearing corals.

SPAWNING IN THE LAB

In 2019 we switched our spawning operations from in-water collections to in-lab collections, to allow for a more controlled and reliable collection of gametes.

We worked with a team of scientists that included representatives from Keys Marine Lab, University of South Florida/Florida Institute of Oceanography, Georgia Aquarium, College of Charleston, Nova Southeastern University, NOAA, SeaWorld, Southeast Zoo Alliance for Reproduction and Conservation (SEZARC), the University of Florida, and was led by The Florida Aquarium.

We took large broodstock corals of 12 genotypes of staghorn and seven genotypes of elkhorn from the Tavernier Coral Tree™ Nursery, and moved them to holding tanks at Keys Marine Lab.

Spawning started slowly on August 18th, 2019 but by the 21st, 18 genotypes had spawned. Researchers collected their sperm and eggs and

mixed them together to assist in fertilization. The resulting larvae were transferred to The Florida Aquarium’s Center for Conservation in Apollo Beach where the new corals will be raised.

RESTORING RESILIENCE

In 2018, The Florida Aquarium (FLAQ) mixed coral gametes collected from our broodstock corals and created over 3,000 new genotypes by cross-breeding different genets. In 2019, the FLAQ team brought 1,500 of these genotypes to be installed in our Tavernier nursery, where we raised them before introducing most of them to the wild.

These new genotypes represent the newest generation of staghorn corals. After a short period in the nursery to acclimate to a natural ocean environment, they were transferred to the reef where they are doing extremely well. These new genotypes represent a huge leap forward for the restoration community in promoting genetically diverse and resilient populations in the Florida Keys.

We are now gearing up for the 2020 spawning season, which promises to offer even more opportunities to learn about this extraordinary phenomenon.

“We have recorded spawning at multiple restoration sites – strong evidence that our methods are working”

“These new genets represent a huge leap forward for the restoration of increasingly resilient coral populations”

Nicole Johnston
Georgia Institute of Technology

Nicole Johnston is evaluating the relative growth, health, and survival of tropical coral species in comparison to temperate corals. In the face of climate change, the migration of tropical coral species towards the poles is possible, and this research aims to observe the relative effects of disease and heat stress on tropical and temperate corals.

Emily Parsons
College of Charleston

Emily Parsons is testing whether genetic relatedness contributes to reproductive success. She is performing cross-fertilizations on coral genotypes that regularly spawn and measuring their success in producing viable offspring. This information could be used to assist restoration practitioners in the selection of genotypes for outplanting to enhance restoration success.

COMMUNITY STRUCTURE & RESTORATION SUCCESS

Dr. Andrew Altieri
University of Florida

Dr. Altieri is exploring the impacts that hypoxia can have on coral health and reef diversity. Sensors have been deployed at a CRF™ nursery to measure water temperature and dissolved oxygen concentrations. Increasing our understanding of how dissolved oxygen and other water quality parameters impact coral populations will better equip practitioners in making restoration decisions.

Matz Indergard
University of North Florida

Matz Indergard is building upon previous research to determine if outplanting success can be increased by the administration of short-term heat stress prior to outplanting. This study focuses on two species at two reef sites, and will identify trends in survival based on depth of outplant and treatment.

IMPACTS OF DISEASE & BLEACHING



RESEARCH COLLABORATIONS

We work with leading researchers, universities, scientists, and other organizations to help answer the questions that will advance our coral restoration goals.

We are in the unique position of being able to provide scientists with corals from our nurseries, as well as limited field support, for experimental work that is aligned with our research priorities.

In the past year, we have worked to facilitate collaborations with 14 research partners.

COMMUNITY STRUCTURE & RESTORATION SUCCESS

Les Kaufman
Boston University

Les Kaufman is monitoring ecological processes on restored versus unrestored reef habitats. The primary goal of this study is to understand the value added by restoring branching and massive corals together. Secondary goals include assessing community structure, ecological function, and ecosystem service flow of restoration efforts.

Aneri Garg
University of Alberta

Aneri Garg is studying fish habitat preferences, recruitment patterns, and community dynamics for coral reefs restored with natural and artificial substrates. The outplant design, which studies mixing real and artificial corals together, will help to tease out the effect of both coral chemical cues and structural complexity on fish recruitment.

Noelle Helder
University of Alberta

Noelle Helder is using 3D habitat reconstructions to investigate how changes in habitat complexity influence the spatial dynamics of fish recruitment and habitat usage. These changes in habitat use by important functional groups of fish impact the distribution of herbivorous fishes, nutrient availability, and algal community composition.

IMPACTS OF DISEASE & BLEACHING

Ben Young
University of Miami

Ben Young is focusing on the role of genetics in corals affected by white band disease, analyzing various genotypes to determine which individual genes are most closely associated with disease resistance to this particular stressor. The aim of this research is to build a tool that researchers can use to quickly determine whether a coral is vulnerable to disease, based on its gene expression.

Dr. Harmony Hancock
Old Dominion University

Dr. Hancock studies the role that recent thermal history plays in coral susceptibility to bleaching. Her research aims to reconcile regional predictions of bleaching events with local patterns of temporal variability by performing a high-resolution examination of the influence of recent thermal history on two species. This data will help better understand and predict localized bleaching events.

Dr. Valerie Paul
Smithsonian Marine Station

Dr. Paul is working to better understand the Stony Coral Tissue Loss Disease which has impacted dozens of coral species along the Florida Reef Tract. Her goal is to isolate and potentially identify any viral or bacterial agents responsible for the outbreak of the disease.



Rachel Serafin

Florida Aquarium

Rachel Serafin led a hugely successful spawning season in August. In 2019, our partners harvested from a new slate of coral genotypes, resulting in genetically-novel recruits. These corals will continue to increase the genetic diversity of the Florida Reef Tract.

Dr. Barry Hicks

U.S. Air Force Academy

Dr. Barry Hicks's research is focused on analyzing the fluorescing proteins in corals. Dr. Hicks visited the CRF™ Tavernier Nursery to trial low-cost equipment that captures fluorescing chlorophyll in the coral's symbiotic zooxanthellae on the visual and infrared spectra. This dual imaging could be used to set up inexpensive and remote time-lapse monitoring systems to monitor coral health, resulting in early alert systems for managers.

INNOVATION



RESEARCH COLLABORATIONS

CORAL NURSERIES

NEEMO 23

NASA/FIU

Astronauts and other crew members from NASA and the European Space Agency spent ten days underwater at the FIU Aquarius Habitat to train for deep space missions. As part of their training, the teams installed six boulder coral trees at a depth of 60ft, at several distances from the habitat. FIU researchers will be visiting the corals over the course of four years, studying predation and growth rates at this depth.

Joseph Henry

University of Florida

Joseph Henry is determining the optimal time for outplanting staghorn corals settled and raised in ex-situ aquaria, and comparing the survivorship of corals moved to an in-situ nursery to those outplanted on a reef. This research will help to inform how to reduce the costs and increase the scale of ex-situ sexual reproduction efforts.



OUR RESEARCH FOCUS

1) CORAL NURSERIES

The coral propagation data we collect in our nurseries helps us increase the number of nursery-raised corals that can be successfully outplanted.

2) OUTPLANTING METHODS

We are currently experimenting with new outplanting techniques that will help move the overabundance of corals we are cultivating into the wild.

3) MONITORING TECHNIQUES

We are constantly looking to improve the ways we analyze outplanted corals and their impact on the ecosystem. By capitalizing on new technologies, we can show how restoration success is not only possible, but also quantifiable.

4) SUITABLE RESTORATION SITES

Identifying suitable restoration sites is a priority that was highlighted by the Coral Reef Ecosystem Restoration Working Group, during a review of the Florida Keys National Marine Sanctuary management plan. Ongoing research at CRF™ seeks to better understand why some sites exhibit a higher survival rate for outplanted corals than others.

5) GENETIC RESILIENCE

Our research tracks how different coral genotypes (and their associated microbes and symbionts) survive and grow, and the how different outplanting techniques correlate with restoration success.

6) COMMUNITY STRUCTURE & RESTORATION SUCCESS

By monitoring our outplanting sites, CRF™ is demonstrating how ecology impacts coral restoration. Specifically, we show how other organisms and reef conditions can affect the condition of corals returned to the wild.



OPPOSITE: Staghorn corals from FLAQ spawning collaboration (AN)

ABOVE: Staghorn polyps with tentacles extended (AN)

BELOW LEFT: A lobster makes its home in the reef (AN)

PUBLICATIONS

Our expertise and infrastructure facilitated three studies published in peer-reviewed journals in 2019.

Biological Conservation Vol 229

January, 2019

Coral restoration: Socio-ecological perspectives of benefits and limitations

Authors: Margaux Y.Hein, Alastair Birtles, Bette L.Willis, Naomi Gardiner, Roger Beeden, Nadine A.Marshall

PeerJ

April 8, 2019

Genotypic variation in disease susceptibility among cultured stocks of elkhorn and staghorn corals

Authors: Margaret W. Miller, Philip J. Colburn, Emma Pontes, Dana E. Williams, Allan J. Bright, Xaymara M. Serrano, Esther C. Peters

Frontiers in Marine Science

November 21, 2019

*Native herbivores improve sexual propagation of threatened staghorn coral *Acropora cervicornis**

Author: Joseph A. Henry, Keri L. O'Neil, Joshua T. Patterson



A NEW GENERATION OF CHANGEMAKERS

Our work inspires and empowers people of all ages to make a difference.

At CRF™ we provide practical, meaningful ways for everyone to learn from, and physically get involved in, our mission.

We are giving the next generation of changemakers the tools they need to thrive in a changing world.

- **Recreational Dive Programs** let all ocean lovers make a difference, while enjoying fun days out on the water working alongside our team.
- **Internships** provide university-level students with **vocational training and experience**. Our interns go on to launch exciting careers in marine science and related fields.
- Our **educational materials complement state standards**, and can be easily incorporated into teachers' lesson plans.
- **Presentations** at our Exploration Center, or by Skype, can be tailored for any group.
- **Volunteers** from the local community contribute to our daily work, both on and off the water.



WORLD-CLASS INTERNSHIPS

We offer vocational training to university-level interns. In 2019, we welcomed **39 interns** to the internship program.



COMMUNITY ENGAGEMENT

We have opportunities for everyone to join us in the water and on land, either as a regular **volunteer**, or for a single "restoration adventure day" on one of our **dive programs**.



RESOURCES, WORKSHOPS, & AFTER SCHOOL CLUBS

Free **Skype presentations**, free **CPALM-Activity packs**, **in-school Workshops**, and **After School Programs** are helping to ensure that the next generation is well prepared to combat the environmental challenges of the future.



EDUTAINMENT IN ACTION

A swashbuckling adventure into marine science, the CRF™ **Captain Coral Show**, takes learners of all ages on an explosive journey into coral conservation.



ABOVE: Thanks in part to a grant from the Disney Conservation Fund, we run regular, immersive programs with students in Broward County (AN)

EMPOWERING THE NEXT GENERATION

In the face of massive ecosystem degradation, the coming generations have unique and complex challenges ahead. At Coral Restoration Foundation™, we are giving them the tools and opportunities they need to learn how to thrive in the world we are handing them.

The biggest challenges of this century will be the result of the widespread loss of our planet's life support systems.

Effective responses to environmental challenges will come from people with transferable skills and with the abilities to experiment, to problem solve, and to think creatively.

Research published in the *Journal of Microbiology & Biology Education* shows that the key to giving students these tools lies in STEAM-based learning, which unites the fields of science, technology, engineering, and mathematics, with the arts.

Our work provides a case study of a successful, science-based solution to a global problem. The solution is holistic, inspiring, and it is the perfect starting point for introducing learners of all levels to complex problem solving, science, and interdisciplinary studies.

With this approach, CRF™ has built a practical, future-focused path of engagement with science and ecosystem restoration.

EDUTAINMENT: HOLISTIC EDUCATION
Our 66 STEAM-based "Learning Labs" follow state standards and can be integrated into any classroom from grades K through 12. In 2019,

“*It is essential that we equip learners with the ability to think critically and creatively*”



more than 5,800 students were exposed to these "edutainment workshops".

CORAL CLUB

In 2019, we continued to bring these holistic approaches to students in Broward County.

With a grant from the Disney Conservation Fund, we have helped CORAL Club become a self-sustaining after school program, filled with passionate, focused students from South Broward High School.

CAPTAIN CORAL

Taking edutainment to the next level, the Captain Coral Show debuted in 2018. This swashbuckling performance takes the audience on an explosive journey into marine science. It has become a hit with audiences of all ages.

REACHING OUT

Through social media, we now reach more than 600,000 people every month, giving them access to our mission.

INTERNSHIPS

We are helping to nurture tomorrow's marine scientists.

We offer vocational training to university-level interns, providing them with a structured learning environment and the opportunity to contribute on a professional level to a world-class non-profit. Interns can expect to be challenged, mentored, and inspired, working with a dynamic team that is dedicated to helping them find their focus.

Our intern training program includes training in benthic monitoring protocols (RECON) and a NAUI Coral Restoration Scientific Diver certification.

We welcomed 39 new interns in 2019, all of whom became inspirational role models for hundreds of younger students. Our interns are now well on their way to launching exciting careers in marine science.



ABOVE LEFT: CRF™ Interns assist with the relocation of coral recruits to our Tavernier Coral Tree™ Nursery (GF)

ABOVE LEFT & RIGHT: CRF™ Interns inspire and impact the lives of learners of all ages (AN)

In 2019, Coral Restoration Foundation™ impacted 10,900 learners of all ages with our tailored education programs, outreach events, and presentations.

These developments also mean that our vibrant and informative Exploration Center in Key Largo has seen its highest level of foot traffic to date.

CORAL ACADEMY

2019 also saw the beginning of the build out of our new Coral Academy. This is a cross-departmental endeavor that will launch in 2020. Through the Coral Academy, we will invite other coral practitioners to come and learn from our best practices, using both online learning modules and in-person developmental workshops, with the goal of strengthening coral restoration across the world.

BUILDING RESILIENCE

As we move into an increasingly unpredictable future, we are supporting the resilience of the next generation. Our oceans are in good hands.



We now reach more than 600,000 people every month, giving them access to our educational initiatives



ABOVE: Dive & Volunteer Program Coordinator, Roxane Boonstra, prepares a reef during Coralpalooza™ 2019 (AN)

BELOW RIGHT: The Coralpalooza™ afterparty is a chance for all participants to celebrate (AN)

RESTORATION ADVENTURES FOR EVERY DIVER

These days, divers want to give back to the reefs they love. Thanks to our local dive community, it has never been so easy for people to come and experience the magic of holding the future of our coral reefs in their hands.

Our dive and snorkel programs give everyone the chance to immerse themselves in a world of hope for coral reefs.

Year-round public programs, set by local dive operators, have made it incredibly easy for anyone to experience a restoration adventure.

THIS IS COMMUNITY SUPPORT

Signing up with the click of a button, 1,379 people joined our Dive Programs in 2019. Together, they reintroduced 4,700 corals back into the wild – 15% of all the corals we re-homed on the reefs!

More than 400 of these people had come back for a second or third time to help prevent a species from becoming extinct. And of course, this would not have been possible without the dive operators.

PERFECTING THE EXPERIENCE

We have listened to what our participants have

to say, and throughout 2019 we continued evolving the experience based on diver feedback, to make future programs as rewarding as possible.

PRIVATE PROGRAMS

We tailored private programs for groups from all over the country. Teachers, students, and families forged memories while helping to restore reefs. We also crafted specialized programs for organizations and clubs like Diveheart, a scuba club for children, adults, and veterans with disabilities.

THE CORE OF OUR CORAL CREW

Thanks to the expansion of our internship and volunteer programs, more of our interns and volunteers are now trained to guide Coral Restoration Adventures, as “Coral Crew”. Their leadership enriches our Dive Programs immensely, giving the public a chance to engage with some of the world’s most promising young marine scientists.

“

Our dive and snorkel programs give everyone the chance to become immersed in a world of hope for coral reefs



THIS IMAGE: Volunteers clean trees in the Tavernier Coral Tree™ Nursery (AN)



CORALPALOOZA™

Every World Oceans Day, we take an army of ocean lovers out for the biggest “Restoration Adventure” in the world.

In 2019, around **300 people** from **11 countries** took part in Coralpalooza™, and in the Florida Keys alone more than **250 divers** helped to return over **1,700 critically endangered corals** to the Florida Reef Tract.

KEY WEST

In 2019, we have been running regular **dive programs in Key West**.

Captain’s Corner dive shop has joined the mission, providing **more opportunities for divers** in Key West to become involved in our work.

EDUCATION COLLABORATORS

GIRL SCOUTS OF SOUTHEAST FLORIDA
CRF™ and the Girl Scouts are offering Florida's girls a future in marine science and conservation.

CORAL CLUB
Collaborating with this after-school club from South Broward High School has helped us to engage a new community in our mission.

PROJECT GREEN SCHOOLS
Worked with us to offer our annual Coral Restoration Summer Camp.

THE LOCAL NGOs COMMUNITY
REEF, The History of Diving Museum, MarineLab, and the Florida Keys Wild Bird Center collaborated with us during Coralpalooza™ 2019.

AMORAY, RAINBOW REEF, CAPTAIN'S CORNER, SILENT WORLD
These dive operators offered regularly-scheduled public coral restoration dive programs in the Keys in 2019.

DIVEHEART, DIVING WITH A PURPOSE, & ROAD LESS TRAVELED
Private programs were bolstered by relationships with these inspiring groups.

ANGARI, FURY WATER ADVENTURES, RAINBOW REEF, KEY DIVES, KEYS DIVER, HORIZON DIVERS, ISLAND VENTURES, SILENT WORLD, JOHN PENNEKAMP STATE PARK, FILTER KING, & REEFBOX
These companies sponsored Coralpalooza™ 2019 and helped make it our most successful World Oceans Day event to date.

STEMCONNECT
Allowed us to reach classrooms around the world with our Skype presentations.

THE EXPLORERS CLUB
Our interns now have the opportunity to become members of this prestigious institution.



ABOVE: CORAL Club students at South Broward High School

BELOW: Volunteers become restoration experts (AN)

VOLUNTEERING

Coral Restoration Foundation™ volunteers regularly work alongside our staff and interns, all year round, on land and on the water, to further the overall mission of restoring coral reefs.

The local dive community has been increasingly supportive of our volunteer training, helping our volunteers gain the certifications they need to work alongside us.

Visiting volunteers also made a significant splash in 2019. Visiting volunteers are here for a minimum of three weeks at a time. Three visiting volunteers joined us in 2019, from Switzerland, Singapore, and the USA. During their stay they spent almost every single day with us, actively helping to save an ecosystem.

In 2019, our 265 active volunteers accomplished a total of 15,372 hours of work, and ran 43% of our dive programs as "Coral Crew".

2019 HIGHLIGHTS

THE "PLASTIC FREE TREE" DESIGN CHALLENGE

We announced the winners of our first state-wide student challenge, in association with Healthy Aquatics Marine Institute, 5 Gyres, and sponsored by Titan Aquatics, Neptune Systems, EShopp's, Reef Brite, and Titan Composites.

THE NATIONAL "CORAL TO ACTION" STUDENT CHALLENGE

We launched our first nation-wide student challenge (in association with NBC6, The Ocean Agency, Titan Aquatics, and others) and more than 100 schools downloaded the Learning Labs.

THE 5th ANNUAL CORALPALOOZA™

More than 300 people from 11 countries took part in the biggest restoration adventure on the planet. Coralpalooza™ 2019 attracted more sponsors than in any other year, and enabled participants to return 1,760 critically endangered corals to the reefs of the Keys in just six hours.

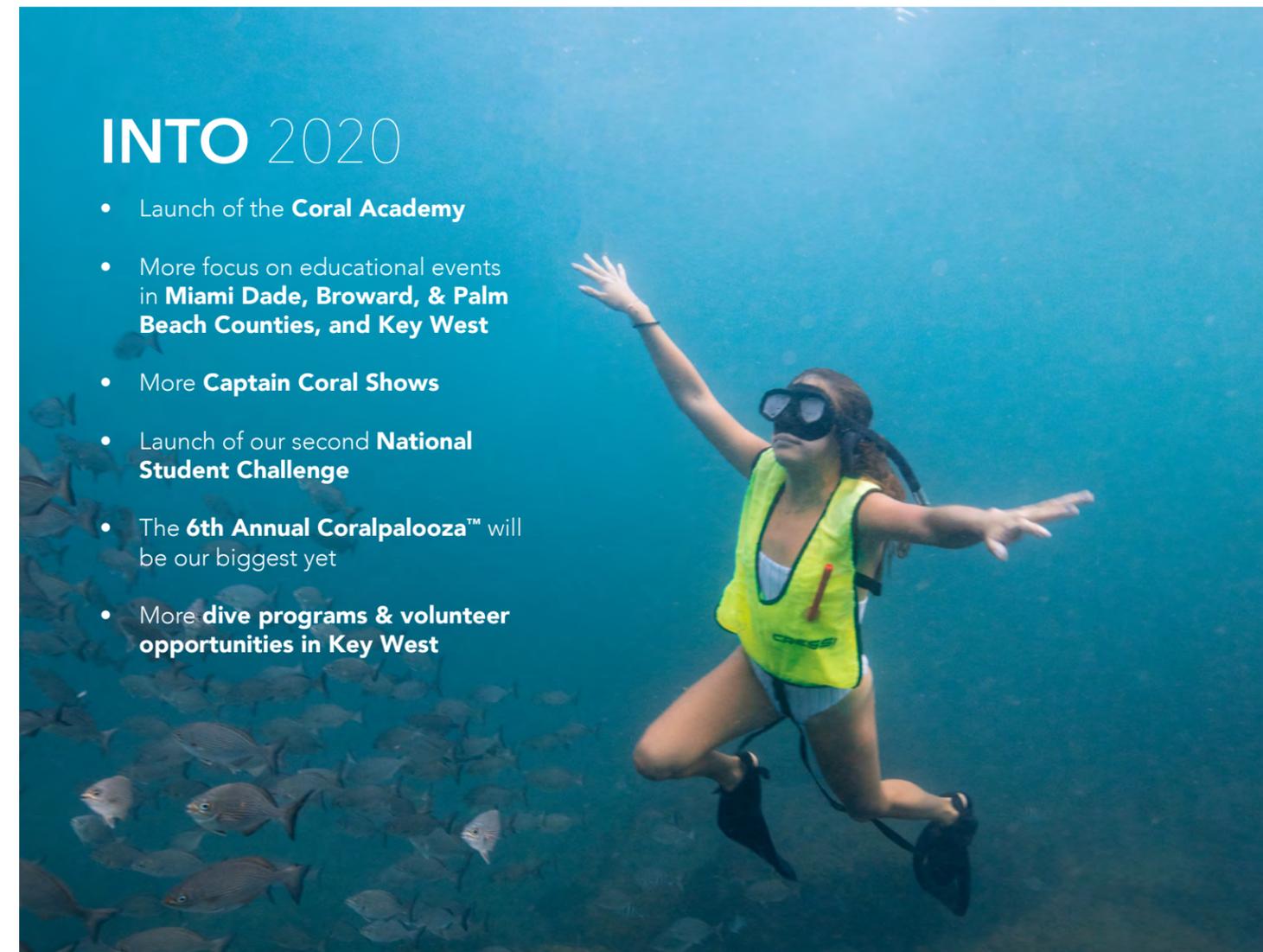
AFTER SCHOOL CLUBS

In 2019, we developed a five-week After School Club program. Every After School Club is launched by Captain Coral himself, and gives students in South Florida access to five of our inspiring STEAM-based workshops.

BELOW: A CORAL Club student immerses herself in our ocean world (AN)

INTO 2020

- Launch of the **Coral Academy**
- More focus on educational events in **Miami Dade, Broward, & Palm Beach Counties, and Key West**
- More **Captain Coral Shows**
- Launch of our second **National Student Challenge**
- The **6th Annual Coralpalooza™** will be our biggest yet
- More **dive programs & volunteer opportunities in Key West**





DIVE WITH US!

AN UNFORGETTABLE EXPERIENCE

Join the CRF™ team out on the water for a day of diving unlike any other.

We run regular public dive programs all year round - you can sign up at the click of a button!

We also tailor private programs for groups.

We even offer PADI Coral Restoration Certifications!

For more information, visit www.coralrestoration.org/dive-programs

EDUTAINMENT WORKSHOPS & AFTER SCHOOL CLUBS

TAKE YOUR STUDENTS ON A FIELD TRIP WITHOUT LEAVING THE SCHOOL!



Our young marine biologists will come to any school in south Florida for programs that follow CPalm and state standards.*

To book, email us at: education@coralrestoration.org

*Prices for CRF™ In-School Edutainment Workshops and After School Clubs vary. Contact us for more information.



FREE LEARNING RESOURCES



DIGITAL CLASSROOM PRESENTATIONS

Free digital presentations bring us to your classroom, wherever you are.

To book, email us at: education@coralrestoration.org



ACTIVITY PACKS: GO-TO LESSON PLANS

Anyone can download our STEAM-focused Activity Packs that follow CPalm and Florida state standards for grades K-12.

Go to: www.coralrestoration.org/activity-packs



Millions of people around the world are now being motivated to generate positive change, with our story of hope for coral reefs as inspiration.

In 2019, the CRF™ mission was picked up by national and international media including **PBS, BBC, The Washington Post, National Geographic, Now This, Yahoo Finance, ARTE, Forbes, NBC 6, Grist, CBS,** and the **Miami Herald.**

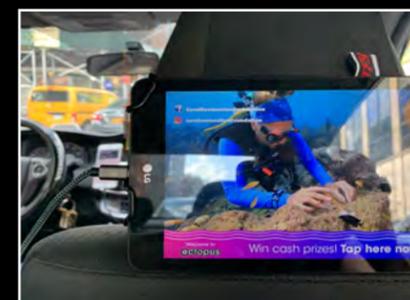
We reached people with attention-grabbing campaigns including a digital billboard in Times Square and a campaign in the back of Uber cars nationwide.

We can't do this alone. We need to empower everyone to choose to make a change, and by reaching the masses with our message, we are doing just that.



TIMES SQUARE

From June to December 2019 more than 2.6 million people visited Times Square, New York, where three different inspirational, empowering, and seasonal messages from Coral Restoration Foundation™ played in lights three times every hour.



NATIONAL UBER CAMPAIGN

We reached more than 2.9 million people around the USA through a spot on PlayOctopus – the Uber riders' entertainment companion.

CORAL RESTORATION FOUNDATION™ SOCIAL MEDIA

We reach more than **600,000 people** every month with our messaging on social media alone!

Inspiring content, world class images, and creative collaborations with corporate sponsors have propelled our social media audience into the stratosphere.

78,700+

28,500+

3,700+

10,000+

RELATIONSHIP BUILDING

Our work is made possible by committed, mutually-beneficial relationships with visionary, practical, and passionate people.

Would you like to help us preserve the legacy of our coral reefs?

MEANINGFUL GIVING

CAPACITY TO SCALE

We have the ability to absorb significant funding and put it to work, producing tangible results backed by scientific research.

CAUSE-RELATED COLLABORATIONS

CREDIBLE PARTNERS

Sponsors and donors can be sure of visible credibility as genuine ocean advocates.

THIS SPREAD: Science Program Manager, Amelia Moura, at work wearing a rashguard from one of our 2019 corporate sponsors, Petco. (AN)



INCOME & EXPENSES

Coral Restoration Foundation™ is supported by individuals, corporations, private foundations, and government agencies.

The sources and allocation of our funding in 2019 are broken down as follows:

SOURCES OF INCOME

Total Income: \$3,159,895

- Government \$1,326,095
- Foundations \$583,859
- Corporations \$438,771
- Individuals \$655,699
- Other \$155,471



EXPENSES

Total Expenses: \$2,068,868

- Program Expenses \$1,459,068
- General & Admin \$360,790
- Fundraising \$249,010



PERCENTAGE EXPENSES BY PROGRAM

- Restoration 51%
- Science 11%
- Education 38%

JOIN US!

To make a gift, including those of stock or a bequest, please contact our Development Department by phone at (305) 453-7030, or send an email to donors@coralrestoration.org.



ABOVE: Our nurseries are thriving ecosystems in their own right - the healthy coral and tree structures attract all manner of marine species (AN)

THANKS TO OUR CONTRIBUTORS IN 2019

Our goals are ambitious, but thanks to the generous support of individuals, corporations, and foundations we are achieving our vision - to inspire hope and restore our reefs to healthy, thriving ecosystems.

Although space does not permit the listing of every donation, each contribution makes a crucial difference for our reefs. Thank you to the following supporters, who made gifts of \$500 or more between January 1, 2019 and December 31, 2019.

- 4Ocean
- Diedre and Andrew Agustin
- Kurt Allebach
- Amazon Smile
- American Airlines
- American Spirits Exchange
- Paul M. Angell Family Foundation
- Anonymous (61)
- Aquashella
- ArcaMax Publishing
- Aspiration
- Atlanta Reef Club
- Kelly Baker and Whitney Ellerman
- Baker's Cay Resort, Key Largo
- Barrette Family Fund of the New Hampshire Charitable Foundation
- Christian Bartholomew
- The Batchelor Foundation
- Dr. Sally E. Bauer
- Don & Marta Baum
- Bill Beal
- Wendy Benchley
- Benevity
- Benevolent Auctions, LLC
- James J. and Mary L. Boilini
- Annie and Shane Briening
- Michael and Karen Brisch
- BRÖÖ Haircare
- The Buchanan Family Foundation
- Caribbean Club
- Humberto Casariego and Teresa Carreño
- Chad and JT
- Michele Chan
- The Charles Hazlehurst Moura Family Foundation
- Liz Rose Choi at GiveMeFive
- Cindi Clapp
- Clarendon Partners
- Clif Bar Family Foundation
- Laurie MacDonald Coe
- Jill Cohen, MD and Justina Cotter
- The Colina Foundation
- Michael Collins Family, Neil Armstrong Family, James C Hays
- Connemara Fund

- The Christopher H. Covington and Bonnie G. Covington Fund at The Boston Foundation
- Scott Cyders
- Cypress Bay High School Marine Science Society
- Tom Davidson Family
- Patty and Tom Davidson
- Holly Dayton
- Craig and Cristina Decker and Family
- Nathaniel Deknatel
- Debbie and Ken Dewey
- The Craig Dietrich Collection
- Clarence and Anne Dillon Dunwalke Trust
- Disney Conservation Fund
- Jack and Barb Draves
- EcoBee, Inc.
- EET21
- Wendy and Michael Esposito
- Facebook
- Sarah Fangman
- Fidelity Charitable Gift Fund

- The Fikes Family
- First Horizon Foundation
- Firth-Link Family Foundation
- Chris and Russ Fisher
- Sidney Fleck Charitable Foundation
- The Florida Aquarium
- Robert and Lisa Forsyth
- The Fullgraf Foundation
- The Fund for Charitable Giving
- Fury Water Adventures
- Galgano Family Fund
- The Garden Group at Ocean Reef
- The Fred Gellert Family Foundation
- Georgia Aquarium
- Kristin and Cory Gilchrist
- Glunz Ocean Beach Club Resort
- Goldman Sachs Philanthropy Fund
- Stephanie Graeler
- Greensboro Science Center, Wiseman Ocean Conservation Fund
- Steve Greenwell
- Fritz Grimm
- David and Patti Gross
- Emily and John Grunow
- Halcyon Seas
- David & Teri Hammer in honor of Scott Hammer
- Laura & Fred Hartner
- Harvard Business School OPM 16 class in honor of Kathy and Bud Orr
- Michelle Holiman
- Dean Howard
- The Hyatt Family Charitable Fund
- Illinois Valley Reef Club
- Patricia and David Jacobson
- JBL
- Karen Kamfjord
- Kansas City Zoo AAZK Chapter
- Karlson Family Foundation
- Kelly Foundation, Inc.
- Key Dives
- The Key West Attractions Association
- Alison and Andrew Knoll, Station 6 – New Orleans
- Andy and Cathy Knudsen
- Linda and Lester Knutsen
- Mike and Mackenzie Koupal
- Gabriel and Angela Kwentus
- Joe La Magna
- La Storia Productions
- Jon and Julie Landau
- Dorothy L. Lappin Foundation in memory of Joshua Gross
- Lary Foundation
- Kyle Lauderdale
- Forrest Lee
- The Lenton PARKS Fund
- Steven and Carole Levin and Levin Riback Adelman & Flangel, PC
- Marianne and Tri MacDonald
- Paul D. MacDougal
- MANG, LLC
- Samar Manjeshwar
- David and Marie Manthey & Family
- Marine Aquarium and Reef Society of Houston
- Frank & Susan Mars
- Elizabeth Mazzie
- The Edward and Gale McBride Foundation Inc.
- McCombs School of Business Spring 2019 Philanthropy Class at The University of Texas at Austin
- Cheryl Meads
- The Meeker Rom Family Foundation
- Jose Melendez
- Mary and Barry Menne
- Dr. Steven Miller
- Erin and Timothy Moeller
- John J. Moller Family Foundation
- Monroe County Tourist Development Council
- The J.P. Morgan Charitable Giving Fund
- Douglas Morrison
- The Mortenson Family
- Timothy J. Mullican, DVM
- Hector and Angie Muñoz
- Bob Murray and Barbara Overton
- MyCHELLE Dermaceuticals
- The Negley Flinn Charitable Foundation
- Neptune Systems
- Network for Good
- NOAA's Office of Habitat Conservation
- Kevin M. Nuccitelli
- The Ocean Foundation
- Ocean Reef Club
- Ocean Reef Conservation Association
- Oris Watches
- The Richard Laurence Parish Foundation
- PayPal Giving Fund
- Marc and Diana Pelath
- Petco Animal Supplies
- Pledgeling Foundation
- Laura Pollak and Jeff Petrinitz
- Russ Post – Ocean Sotheby's International Realty
- Providence College Field Hockey
- David Puyanik
- Max Puyanik
- Qatalyst, Inc.
- Rainbow Fund at the Rochester Area Community Foundation
- Reborn Rubber Inc.
- Reef Gallery Inc.
- ReefBox
- David Rivera
- Rock the Ocean Foundation
- Royce Family Fund
- Crista Ryan
- Stephanie Saba
- Jack and Linda Salisbury
- Jason Schug
- Schwab Charitable Foundation
- SeaWorld & Busch Gardens Conservation Fund
- Segrest Inc.
- Sho Tank Aquariums LLC
- The Shumway Fund of the Ocean Reef Community Foundation
- The Silver Foundation
- Sascha and Anka Simon
- Dr. Susanne Skyrn
- Richard and Sharon Slosar
- Mr. & Mrs. Allerton G. Smith
- Dave Smith
- South Lakes High School Chorus, Reston, VA
- David Splitt and Laurene McKillop
- Stephen Frink Photographic, Inc.
- Kathryn and Robert Stewart

- MaryBeth and Kevin Sullivan
- Swamp Head Brewery
- Michael and Janice Talbert
- Stephen Tillinghast
- Tom Thumb Food Stores, Inc.
- Triad Foundation
- Tropic Labs
- United Jewish Foundation
- USBG of Miami Inc.
- Van Swaay Charitable Foundation
- Vandana and Vishal
- Vanguard Charitable
- Virginia Wellington Cabot Foundation
- Karen and Don Waite
- Philip and Betsey Walker
- Wallace Research Foundation
- The Rev. Jeanne L. Warner
- Michele White
- Wildhorn Outfitters
- William Grant & Sons
- The Wilson Family
- The Wing Arts and Humanities Fund
- David and Donna Wing
- Dr. R. Scott and Janice Winters
- What If Media Group
- The Wong Family
- Sim and Currie Wooten
- The Woroch/Vobach Family
- Xtinctio
- Yardi Systems Inc.
- Antony Young and Allysa Lund
- YourCause

In Kind/Service Donations

We are grateful to those who have donated goods and/or services to support our mission between January 1, 2019 and December 31, 2019.

- 4Ocean
- Caribee Boat Sales and Marina
- Dive Rite
- ESHOPPS
- Florida Keys Brewing Company
- Forever Young Charters
- GSW New York
- Jacob's Aquatic Center
- John Pennekamp State Park
- Marine Aquarium Societies of North America
- Neptune Systems
- The Perry Hotel – Key West
- Pilot House Marina & Restaurant
- PlayOctopus
- Quiescence Diving Services, Inc.
- Rainbow Reef Dive Center
- Reef Brite
- The Riviera Towel Company
- Stephen Frink Photographic, Inc.
- Tinsley Advertising
- Titan Aquatics
- Titan Composites

We strive for accuracy and are appreciative of the generosity of our many supporters. Please accept our sincere apology for any omissions or errors and feel free to bring corrections to the attention of our Development Department at (305) 453-7030.

PLANT A CORAL, RESTORE A REEF

CORALPALOOZA™ 2021



Join an army of ocean lovers for the world's biggest celebration of reef restoration!

WORLD OCEANS DAY

JUNE 5, 2021

Sponsorship opportunities are now available!
Contact Roxane Boonstra at roxane@coralrestoration.org

RAISE THE REEF 2021



CORAL RESTORATION FOUNDATION™
9TH ANNUAL GALA

Sponsorship opportunities are now available!
Contact Bridget Hickey at bridget@coralrestoration.org



WELCOME TO THE BIGGEST REEF RESTORATION EFFORT IN THE WORLD.

www.coralrestoration.org



2019
IN NUMBERS

8,000+

Square meters of reef restored in the Florida Keys National Marine Sanctuary since 2012

113,000+

Number of critically endangered corals returned to the Florida Reef Tract since 2007

32,300+

Number of critically endangered corals returned to the Florida Reef Tract in 2019 alone

As seen on FOX, CBS, ABC, BBC, NBC, PBS, Animal Planet, Forbes, The Guardian, NBC Nightly News, The History Channel, CNN, National Geographic, Miami Herald, NowThis, Yahoo Finance, The LA Times, The New York Times, and The Washington Post.

CORAL
RESTORATION
FOUNDATION™