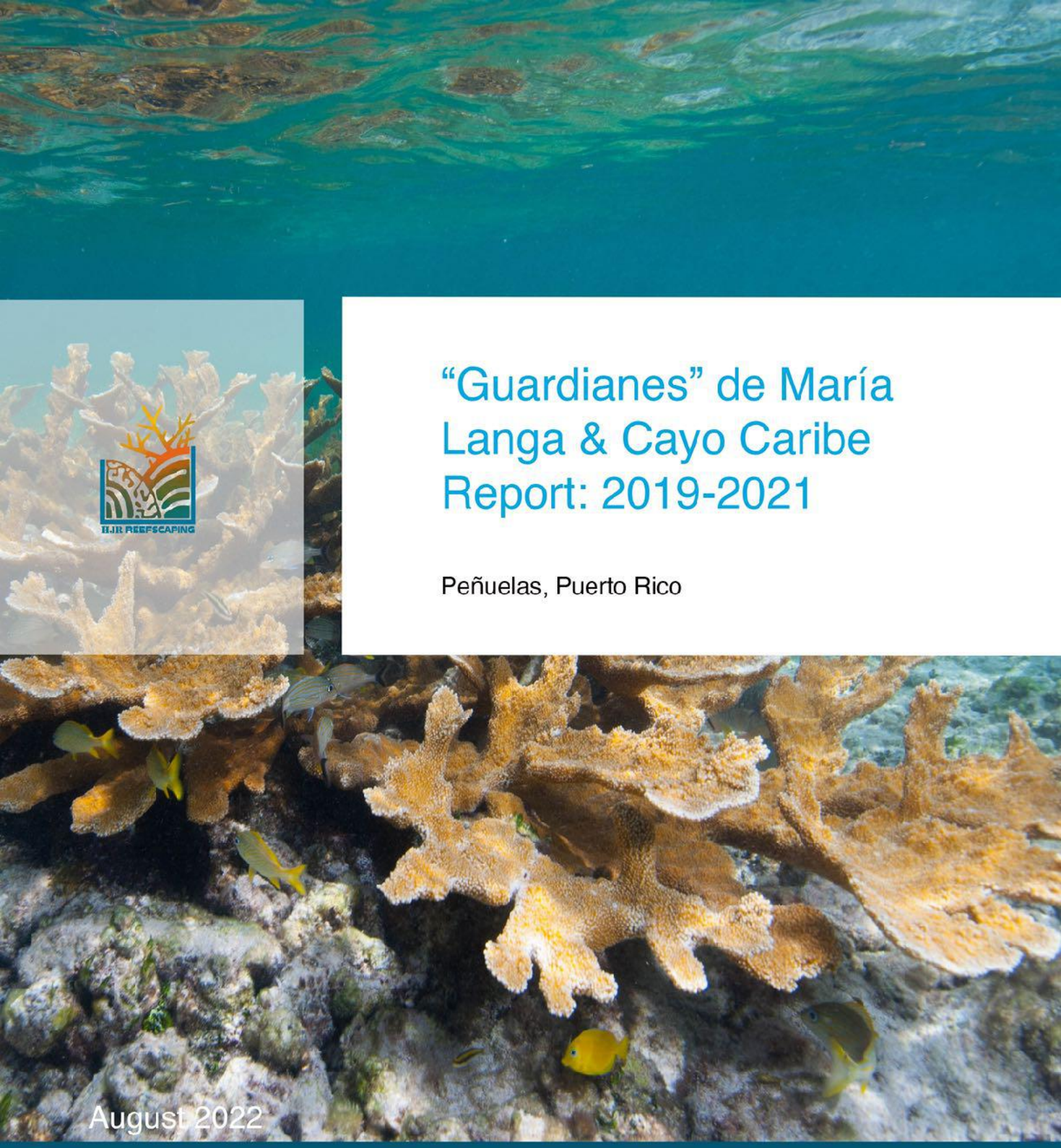

# “Guardianes” de María Langa & Cayo Caribe Report: 2019-2021

Peñuelas, Puerto Rico

August 2022


Submitted to:
Yamaris Alancastro Miranda
Corporate Social Responsability Manager
Road 337 Km. 3.7
Tallaboa Poniente Ward
Peñuelas, PR 00624

Prepared by:
Jose Vargas
HJR Reefscaping
P.O. Box 1126
Hormigueros, PR 00660

# 2019-2021 Guardianes of María Langa Report

## 2019

With a cooperative agreement with DRNA, HJR Reefscaping constructed and maintained an Acropora palmata (A. palmata) nursery for the restoration efforts of coral reefs around Puerto Rico. As part of Guardianes of María Langa project (GML), in 2016 we outplanted 12 colonies of A. palmata  south on the key as part of a pilot project. The picture below (Figure 1) shows the excellent results and growth after two and a half years. The small islands in Guayanilla area provide a great opportunity and the conditions to restore coral populations designated as threatened by the Endangered Species Act. Also, serves as natural barrier for the coast and structures protection, and raw material input for the keys sustainability.

Figure 1. A*cropora palmata* colony outplanted  at Maria Langa as part of the restoration efforts.

After assessing areas, we started to build a permanent A.palmata nursery at the north side of María Langa (ML). In June (2019), two Benthic Underwater Coral Arrays (BUCA's) that fit around 156 colonies were installed. Picture below shows the process (Figure 2 & 3).

Figure 2. Small plastic cup (10 oz.) used as moulds.

Figure 3. Cement cups used for stabilizing coral fragments in the BUCA's.

Fragments of opportunities were collected from the reefs close to the nursery to fill the BUCA's (Figure 4 & 5). Once the colony will have the desire size, a two year outplanting activities will be conducted in the near reef of ML, Cayo Caribe key and the other keys as well as need. A few colonies will remain in the BUCA's to use another technique, cutting, to fill the empty holes with new fragments to be planted in the future. The "cutting" or outcroping technique consists in take a fragment from the donor colony (by cutting the "ears") and bonded to the substrate with cement. This actions will intent to increase the number of A. palmata (in situ) in a short term and increase the probabilities of survival. To minimize the predation by snail (Coralliophila caribbaea), the mollusk will be sought and remove from the reef (picture below).

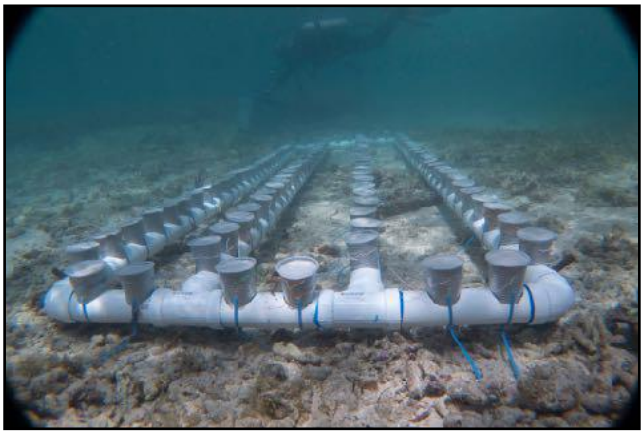

Figure 4. BUCA installed in the nursery ready for coral fragments.

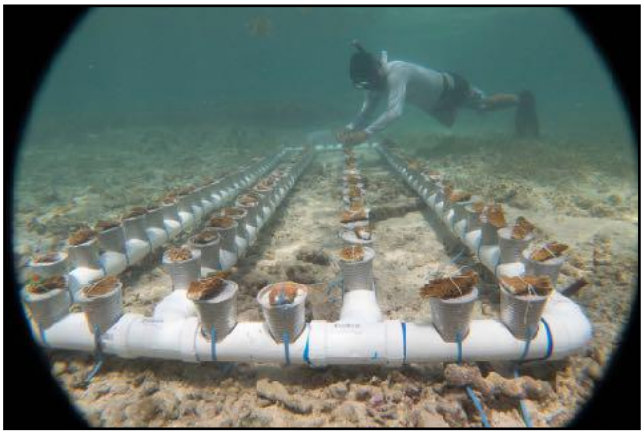

Figure 5. BUCA with the fragments already in place.

Figure 6. Coral eating snails removed from the out-planting sites.

**Rat population control**

After hurricane María and the earthquakes we deployed 6 Automatic traps around María Langa key for a safety perimeter rat population control. Unfortunately four of them were stolen and we decided to stop the activity for safety reasons.

**Bird counts**

We began in 2016 a bimontly bird counts in Caribe. A total of 46 bird species were recorded; 17% were nesting birds, 46% were migratory birds and 54% were resident (Table 1). In summary, some species like Gray kingbird and White-winged dove was recorded just during nesting season and then disappear. Some common species are: Clapper rail, Yellow-crowned night-heron, Yellow warbler, Brown pelican. One predator bird and one parasite bird just appear during the nesting season: Pearly-eyed thrasher and the Shiny cowbird. One migratory bird from south and central America: Antillean nighthawk, and a bird that nest on the sandy areas: American oystercatcher. The table below shows all the specie recorded during all the years of bird counts and it classification as resident, migratory and bird that nest on the keys.

Table 1. Bird species recorded at Cayo Caribe and their classification.

| Specie name | Scientific name | Alpha code | Resident | Migratory | Key Nester bird |
|---|---|---|---|---|---|
| American oystercatcher | *Haematopus palliatus* | AMOY | | √ | √ |
| Antillean nighthawk | *Chordeiles gundlachii* | ANNI | | √ | |
| Black-bellied plover | *Pluvialis squatarola* | BBPL | | √ | |
| Belted kingfisher | *Megaceryle alcyon* | BEKI | | √ | |
| Blackpoll warbler | *Setophagia striata* | BLPW | | √ | |
| Black-necked stilt | *Himantopus mexicanus* | BNST | √ | | |
| Brown pelican | *Pelecanus occidentalis* | BRPE | √ | | |
| Cave swallow | *Petrochelidon fulva* | CASW | √ | | |
| Clapper rail | *Rallus longirostris* | CLRA | √ | | √ |
| Common ground-dove | *Columbina passerina* | COGD | √ | | |

| | | | | | |
|---|---|---|---|---|---|
| Great blue heron | *Ardea herodias* | GBHE | √ | | |
| Greater yellowlegs | *Tringa melanoleuca* | GRYE | | √ | |
| Glossy ibis | *Plegadis falcinellus* | GLIB | | √ | |
| Gray kingbird | *Tryranus dominicensis* | GRAK | √ | | √ |
| Great egret | *Ardea alba* | GREG | √ | | |
| Green heron | *Butorides virescens* | GRHE | √ | | |
| Hooded warbler | *Setophaga citrina* | HOWA | | √ | |
| Killdeer | *Charadrius vociferus* | KILL | √ | | |
| Little blue heron | *Egretta caerulea* | LBHE | √ | | |
| Least sandpiper | *Calidris minutilla* | LESA | | √ | |
| Lesser yellowlegs | *Tringa flavipes* | LEYE | | √ | |
| Mangroove cuckoo | *Coccyzus minor* | MACU | √ | | |
| Magnificent frigatebird | *Fregata magnificens* | MAFR | √ | | |
| Northern waterthrush | *Parkesia noveboracensis* | NOWA | | √ | |
| Osprey | *Oandion hallaetus* | OSPR | | √ | |
| Palm warbler | *Setophaga palmarum* | PAWA | | √ | |
| Pearly-eyed thrasher | *Margarops fuscatus* | PETH | √ | | √ |
| Unidentified plovers | *Unidentified plovers* | pips | | √ | |
| Roseate tern | *Sterna dougallii* | ROST | √ | | |
| Ruddy turnstone | *Arenaria interpres* | RUTU | | √ | |
| Sandwich tern | *Thalasseus sandvicensis* | SATE | √ | | |
| Semipalmated plover | *Charadrius semipalmatus* | SEPL | | √ | |
| Shiny cowbird | *Molothrus bonariensis* | SHCO | √ | | |
| Snowy egret | *Egretta thula* | SNEG | √ | | |
| Scaly-naped pigeon | *Patagioenas squamosa* | SNPI | √ | | |
| Solitary sandpiper | *Tringa solitaria* | SOSA | | √ | |
| Spotted sandpiper | *Actitis macularius* | SPSA | | √ | |
| Stilt sandpiper | *Calidris himantopus* | STSA | | √ | |
| Tricolored heron | *Egretta tricolor* | TRHE | √ | | |

| | | | | | |
|---|---|---|---|---|---|
| White-cheeked pintail | *Anas bahamensis* | WCHP | √ | | √ |
| Western sandpiper | *Calidris mauri* | WESA | | √ | |
| Willet | *Tringa semipalmata* | WILL | | √ | |
| Wilson's plover | *Charadrius wilsonia* | WIPL | √ | | |
| White-winged dove | *Zenaida asiatica* | WWDO | √ | | √ |
| Yellow-crowned night-heron | *Nyctanassa violacea* | YCNH | √ | | √ |
| Yellow warbler | *Setophaga petechia* | YEWA | √ | | √ |

We used the data collected by year and species and analyzed it using PERMANOVA. Below is an example of a graph (Figure 7) showing three consecutive years and during the four seasons. In general, it shows the movement of birds during a year through the Cayo Caribe and María Langa keys. We can notice how during the spring they were more birds than other seasons. That means that some birds use the keys to nest and the disappear during fall and winter. Also shows how after hurricane María (2017) and the lost of vegetation the numbers decreased during 2018. It is important to know that the keys play an important roll as a feeding area and resting area year around.

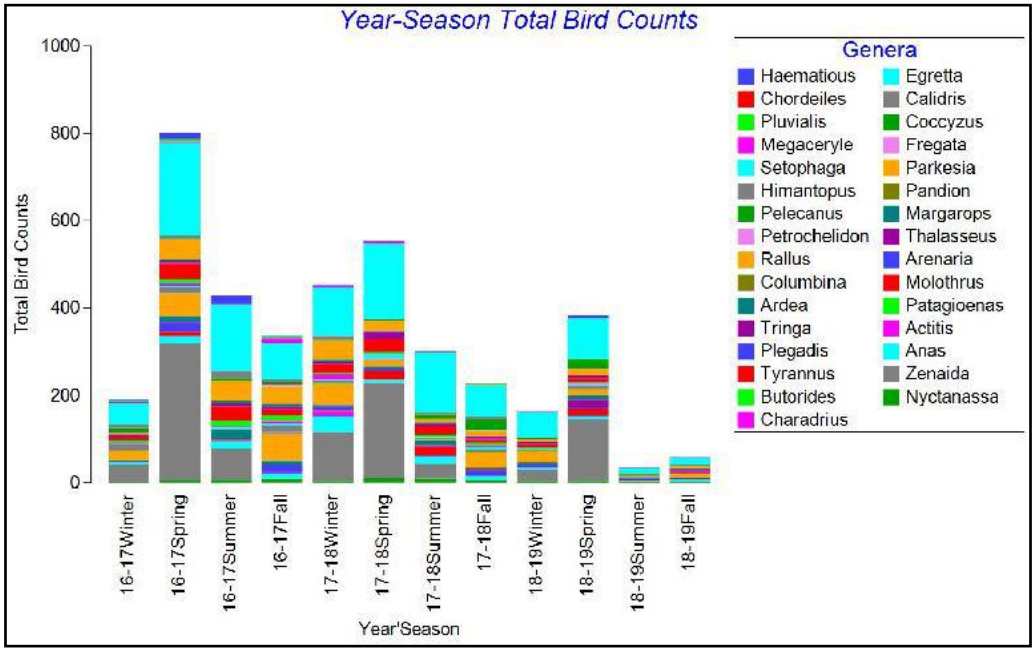


Figure 7. Total bird count from 2016-2019 by genera

## Drone and mapping

Drone flights continue over ML and Caribe. That help us to monitored both island and see changes through time. Also allowed us to create maps like benthic habitat maps for ML and emerged habitat map for Caribe (see maps below). This tool can help managers and restoration projects to be more effective.

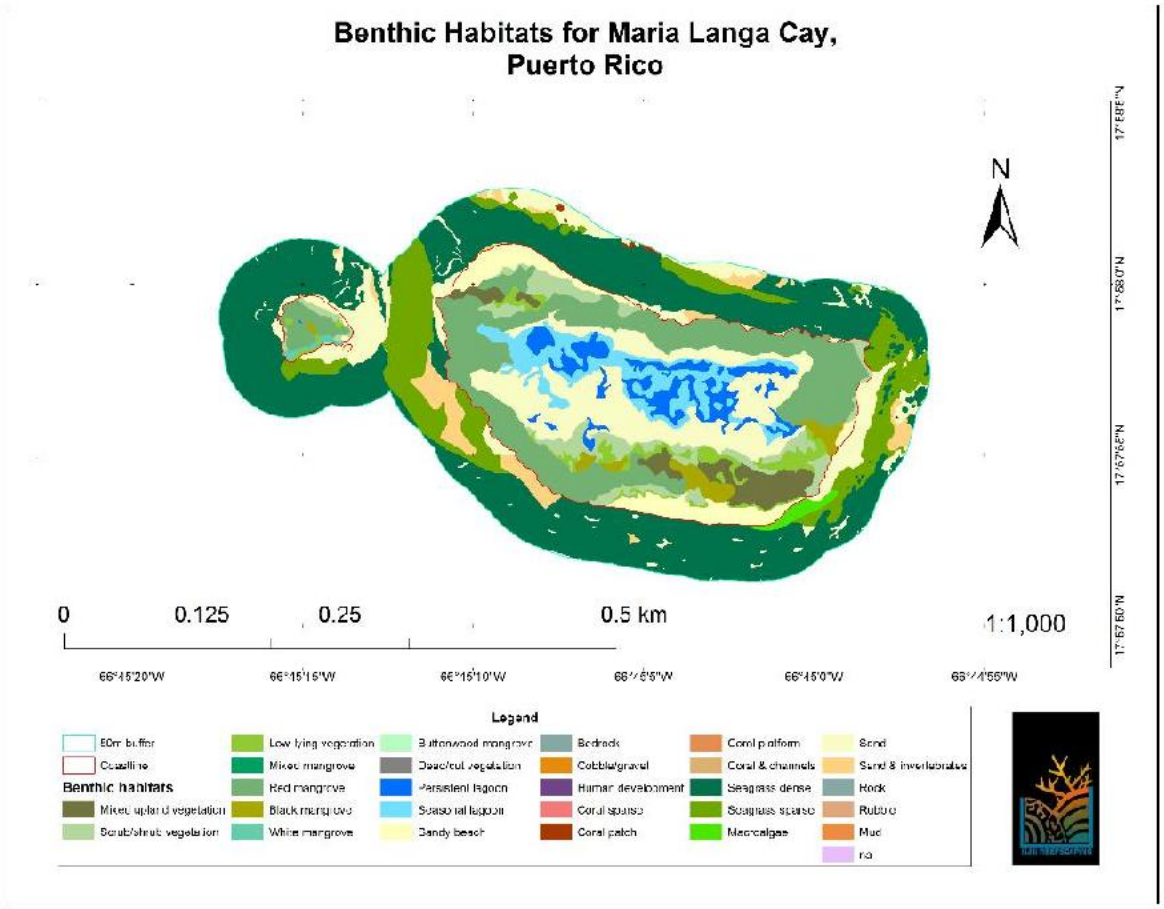


Figure 8. Habitats map at Maria Langa, Puerto Rico

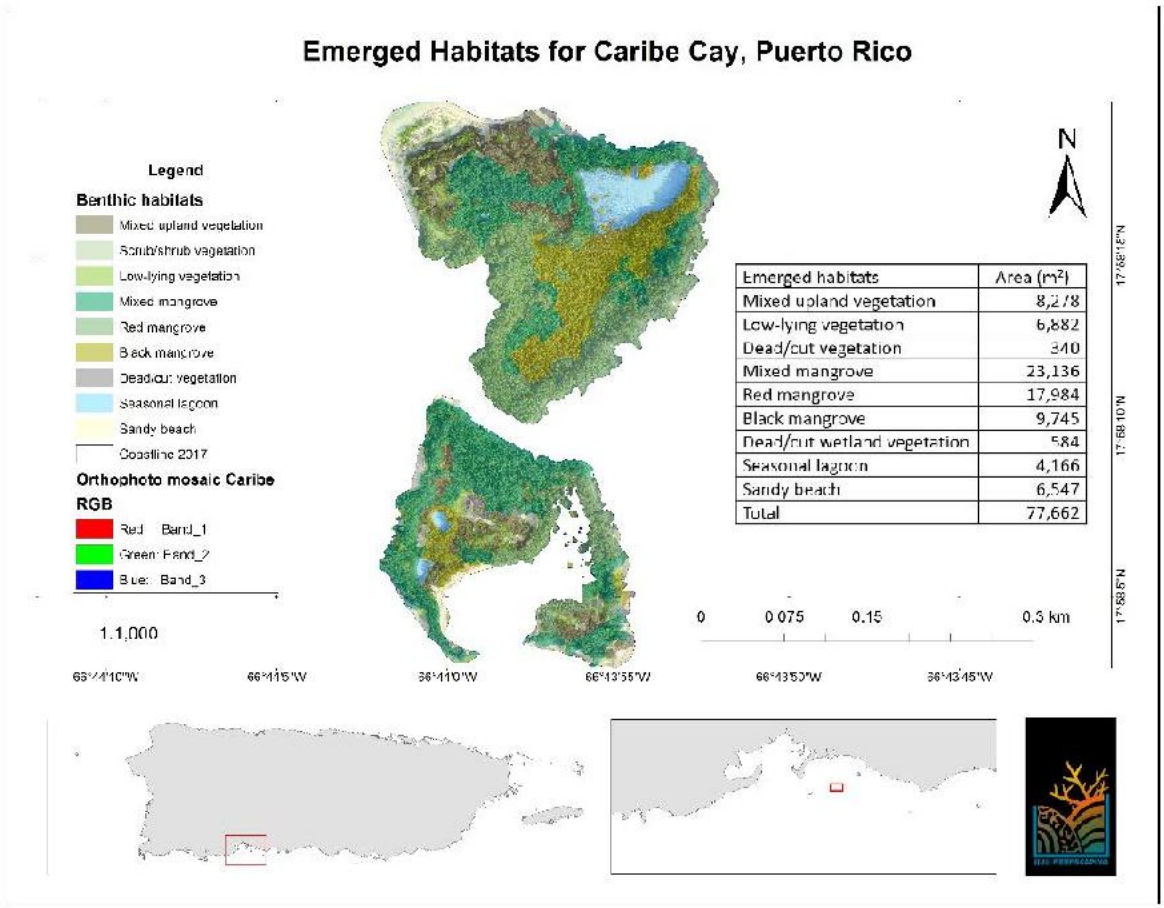


Figure 9. Habitat map at Cayo Caribe.

## 2020

The 2020 was an abnormal year of natural events that affect all of the island activities. First, since January, the earthquakes that damage mostly the south-southwest part of the island. The telluric movements affect the boat ramp area at “El Triángulo” due  the land settlement and sand deposition and later the the COVID-19 pandemic.  However, we continue working after three months of lock-down, always taking the security measures. We continued to fly the drone to have and idea of the damages caused by the earthquakes to the key. With the Digital Elevation Model (DEM) provided by the program, we identified a slight sinking on Cayo Caribe key (Figure 10), and a reduction in altitude and vegetation coverage.

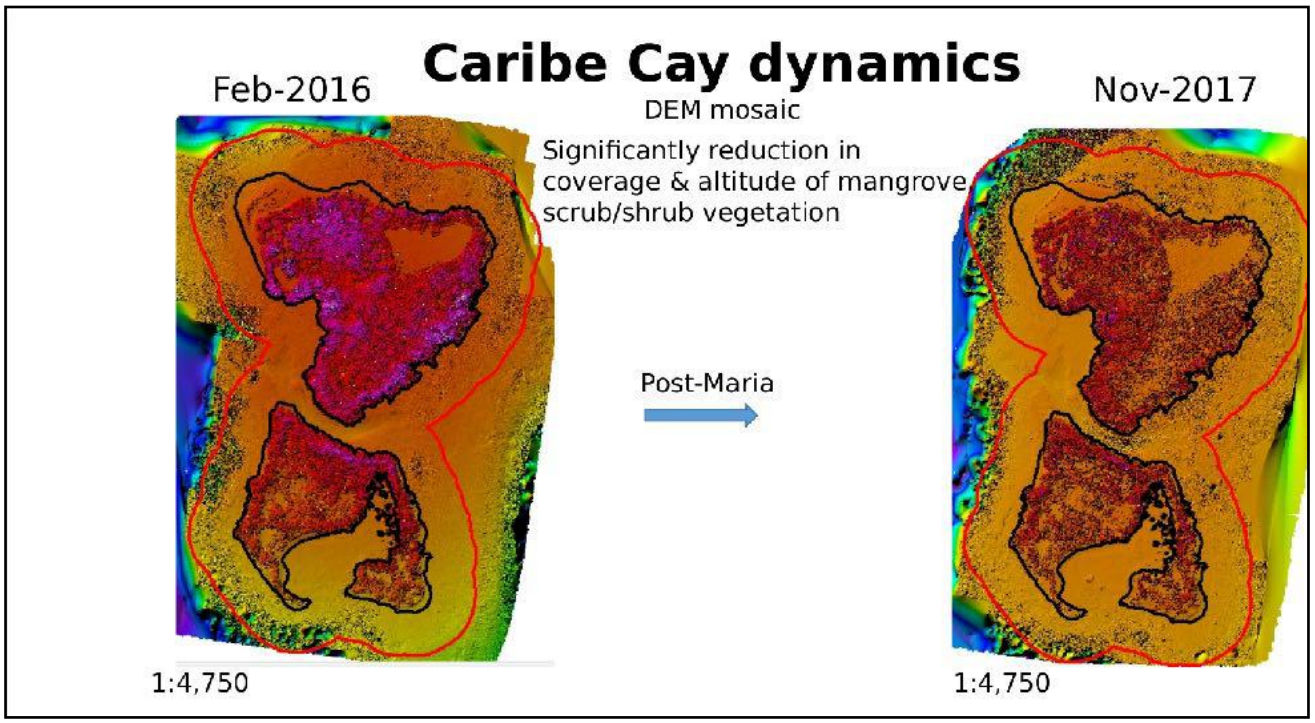


Figure 10. Digital elevation model map showing the significant reduction in coverage & altitude in Cayo Caribe

Using the orthomosaics we calculated the habitat lost per area in square meters after the hurricane. Also we observed how the inner lagoon still full of water due the erosion of the east part of the key caused by the previous damage by the hurricane and the slight subsidence of María Langa (Figure 11)

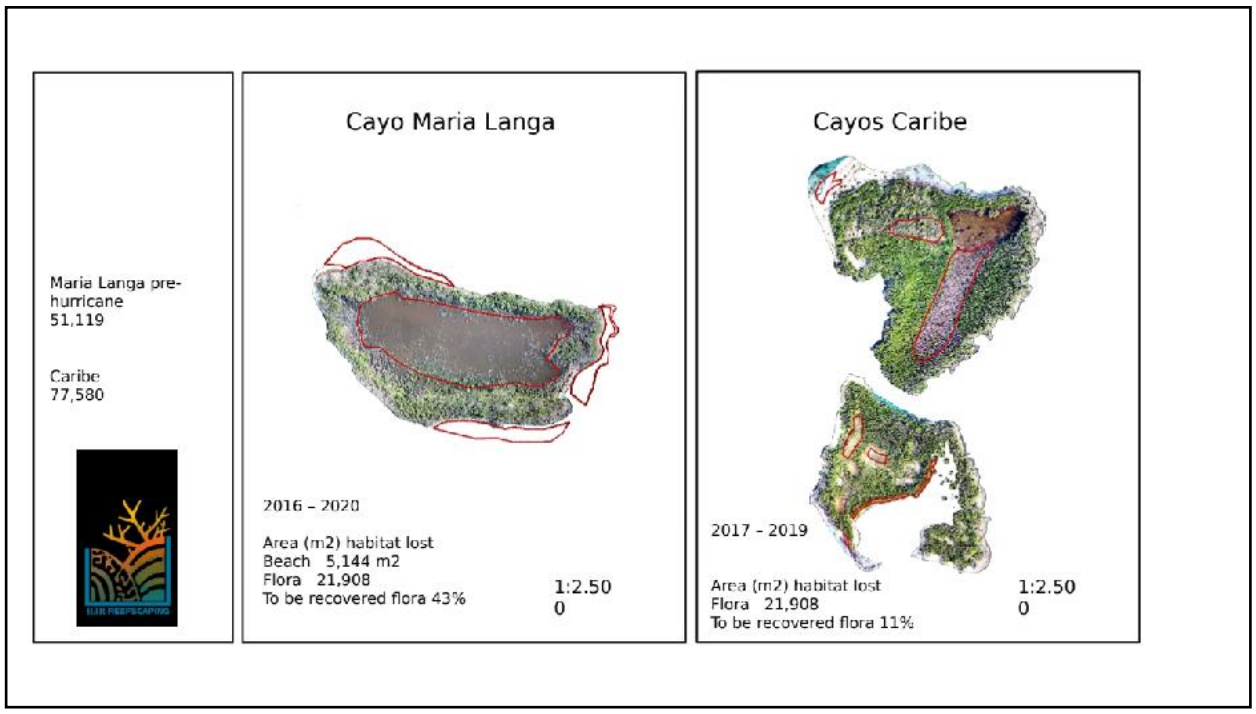


Figure 11. Maps of Maria Langa and Cayo Caribe showing the effects of the hurricanes and earthquakes

We continue the *A.palmata* nursery maintenance and monitoring in 2020 (Figure 12).

Figure 12. *Acropora palmata* colonies ready to be cut for restoration efforts

Maintenance to the manatee buoy's continued during this year (2020). One of the 5 mph buoy was reinstalled after losing it. Occasionally, garbage was collected and deposited in the trash bins of “El Triángulo” (Figure 13).

Figure 13. Garbage collected at Cayo Caribe to be disposed at El Triangulo.

A HOBO (temperature sensor) network was deployed thought the Guayanilla bay to track drastic shifts in seawater temperatures that can affect corals in the nursery and restoration areas (Figure 14).

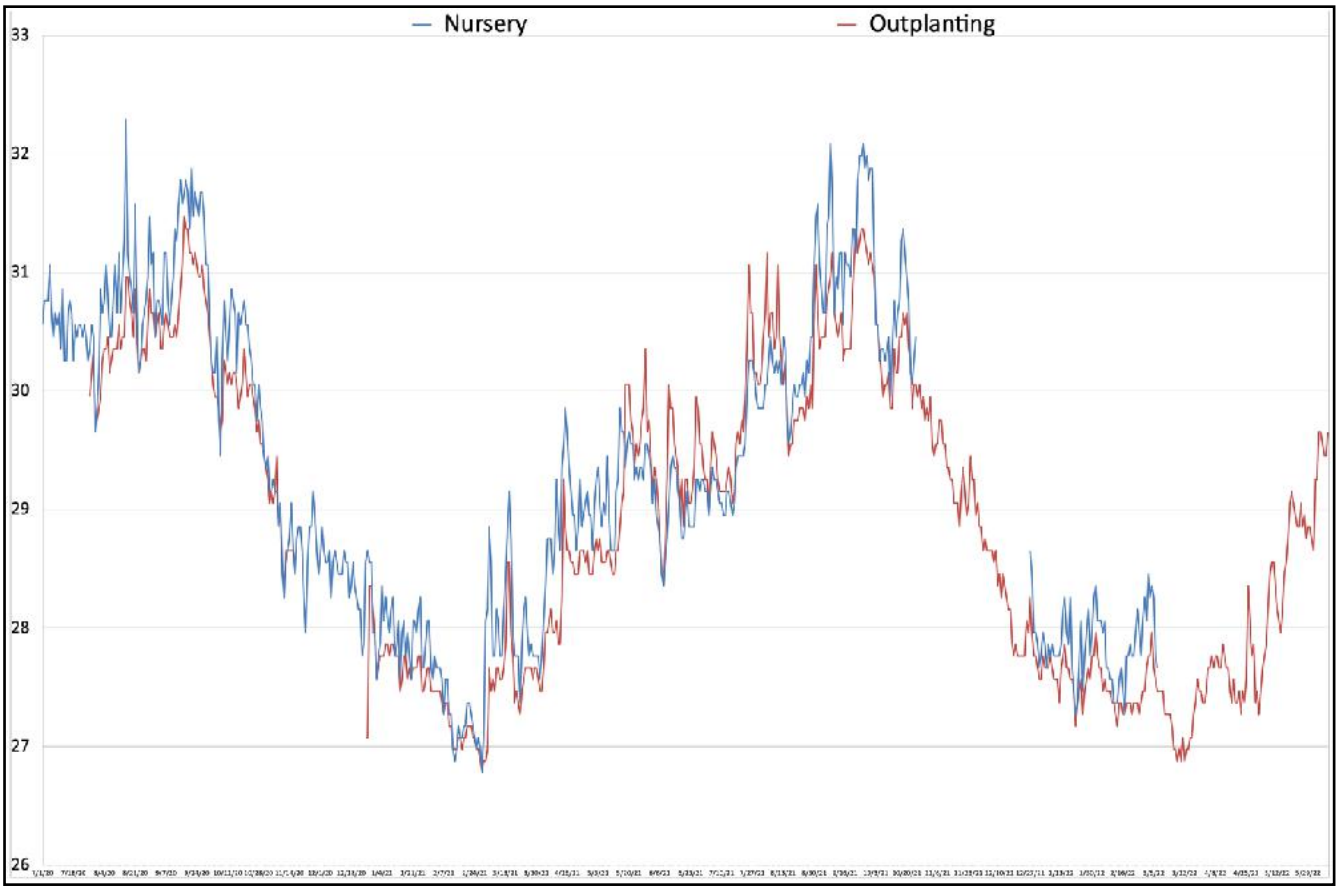


Figure 14. Maximum daily seawater temperatures at the coral nursery and the out planting site at Maria Langa from September 2020 to May 2022.

## 2021

During this year we started the project of *A. palmata* restoration in María Langa key in collaboration with Cervecera de Puerto Rico (Medalla). For the first stage of this project we start to assess different mix and different ratios at the office. We end up with four mixes: the first mix is our control mix and contains only cement and marmoline at a 2:1 ratio respectively. This is the mixture we traditionally use to cement coral fragments to the reef. The other three groups are our experimental, or treatment, mixes. The first mix is 2:1:1 of cement, marmoline and recycled glass sand (RGS), the second is 1:1:1 and the third is 2:0:1 of the same components. At this point Eco Eléctrica and it employees with their recycle p[program were able to provided a total of 1,748 bottles that became 874 pounds RGS. The purpose is to see how much RGS we can incorporate before the integrity of the mix is compromised. This is an pilot project, at the end of the experiment on 2023 we will know which recipe is best and can be pass to group of scientist doing the same restoration projects around the island or share it to other islands in the Caribbean.

After clipping 100 fragments from the adjacent coral nursery, maintained by HJR Reefscaping, the team located a suitable area to evenly distribute our coral fragments in experimental plots. The photomosaics below show the area before and after the planting (Figure 15).

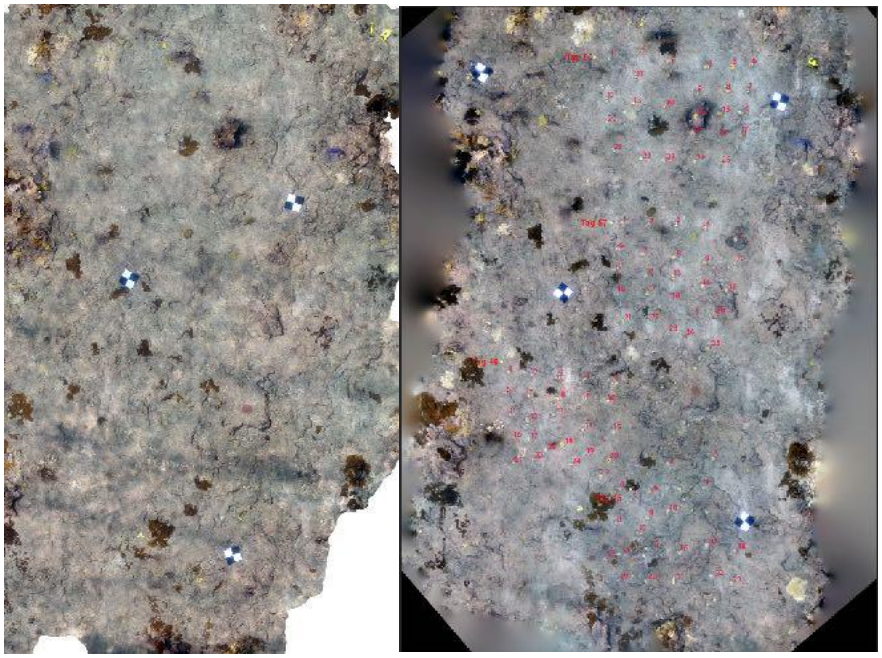

Figure 15. Image on the left showing the area before planting coral colonies. Image to the right is showing the same area after out planting 100 fragments using the RSG mixes at Maria Langa.

After all the corals were planted, we returned to the location to monitor their growth every three months.  We have 400 corals planted as part of the experiment and other 200 as non experimental plots. Each plot had over 76% survivorship, in general most coral reef restoration initiatives are considered a success when at least 50% of the fragments survive. Some plots had 100% of survivorship. The average size was 11 - 12 cm (4 inches) in length and 2-3 cm (1 inch) in height. The picture below show one of the planted fragment and we can see the RGS in the mix (Figure 16).

Figure 16. Planted fragment at Maria Langa showing the glass pieces in the cement mixture.

In 2019 was reported for the first time in Culebra island a disease called Stony Coral Tissue Lost Disease (SCTLD) and there was an alert about the disease that was affecting most of the coral species around the island. With help of the Department of Natural and Environmental Resources (DNER) we start looking for it around the keys of Guayanilla. After seen it in the south of Puerto Rico we start applying treatment at the reef south of María Langa near the outplanting sites. The pictures below show a colony with the SCTLD (left) and with treatment (right) (Figure 17).

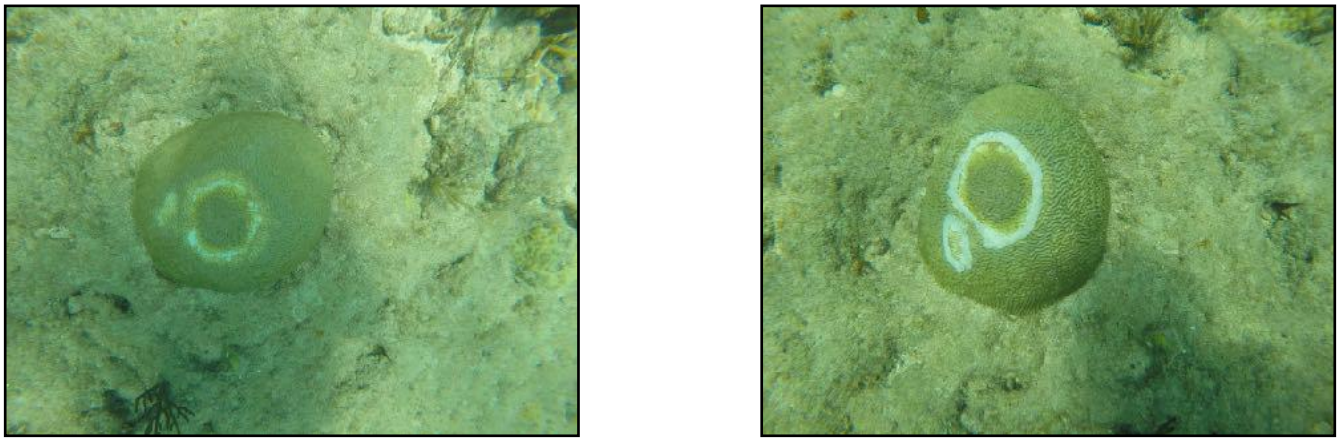

Figure 17. *Pseudodiploria strigosa* coral colony with the SCTLD (left) and with antibiotic treatment (right).

Also, we start a restoration assessment with DNER to make a proposal for a coral and mangrove restoration around the keys at Guayanilla coast.