

Response to Physical Impacts on Coral Reefs in Puerto Rico and the USVI

2020 Report

Prepared by

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Figure 1: Coral reef damaged caused by 2019/2020 earthquakes in Puerto Rico. Photos by Sea Ventures Marine Response Unit

Since 2009, NOAA’s Restoration Center (RC) performed restoration at 137 sites in PR and the USVI and reattached over 48,000 corals (Table 1). In 2020, the RC received reports of 23 groundings in PR and the USVI. Due to government implemented mandatory closures as a result of the COVID-19 pandemic in 2020, emergency restoration was only conducted at 1 site saving approximately 1,336 corals. The number of vessel groundings during 2020 was half the annual average due to COVID-19 restrictions on vessel operations. Closures due to COVID-19 also prevented response and restoration to the extensive coral reef damaged caused by the earthquakes in Puerto Rico (Figure 1, Appendix A).

Response to physical impacts is a Jurisdictional Priority in both PR/USVI, an identified capacity gap in both jurisdictions, and a priority element of the draft Acropora recovery plan. Puerto Rico and the USVI have acknowledged that because of internal limitations and the need for quick and flexible response that more robust action on the part of NOAA was necessary to help stem the unchecked and unnecessary coral losses that were occurring after physical impacts.

In 2009, an emergency response support contract with a local firm was set up. This in combination with the RC’s on-the-ground presence in the region has enabled NOAA to address the numerous impacts that

were occurring annually. The support contract provides NOAA, PR DNER, and USVI DPNR support to have a functional emergency restoration. A notification network along with a form to report grounding incidents has been set up with the US Coast Guard, salvors, and the local communities so that we are notified immediately of impacts. This notification system has allowed us to often get personnel onsite while the vessel is still aground on the reef. In many of these cases, our team has been able to provide feedback to the salvors to minimize further impacts during vessel extractions, saving countless corals. On multiple occasions we have found that the salvors preferred extraction path would have resulted in significant additional damage and on more than one occasion prevented entire thickets of *Acropora spp.* from being destroyed.

Funding for this work provided by NOAA’s Restoration Center, the Coral Reef Conservation Program, Protected Resources Division, Assessment and Restoration Division and the South East Regional Office. In addition to physical impact response, the support contract that has been set up has also served as a vehicle for funding additional restoration, research and monitoring activities in the region. Funds have been further leveraged by getting private parties and insurance companies to directly cover the cost of emergency restoration at multiple sites. This was only possible because we had the capability to do immediate post-grounding site assessment and an approved/permitted contractor. With all of the restoration work that has been done, there still is not enough funding to address all of the reported impacts.

Table 1: Summary of NOAA RC grounding response activities since 2009. * In 2014, an additional 8 Caribbean coral species were included as Threatened on the ESA list.

Year	Total # of Incidents Reported	On-Site Confirmation	Restoration Implemented	# Corals Reattached	% of Restored Sites with Acropora/ ESA Impacts *
2009	51	25%	7	9,074	43%
2010	32	47%	3	1,045	33%
2011	55	75%	7	915	57%
2012	36	50%	4	2,835	50%
2013	32	31%	3	214	100%
2014	42	48%	12	2,132	67%
2015	51	33%	3	1,919	100%
2016	57	46%	5	8,122	80%
2017	1,080	98%	44	10,552	100%
2018	35	37%	36	9,753	100%
2019	56	27%	2	140	100%
2020	23	13%	1	1,336	100%
Total or Average Percent	1,550	44%	137	48,625	78%

Appendix A

Pre-Assessment for Earthquake Damage to Coral Reefs in La Parguera, Guanica and Guayanilla Puerto Rico

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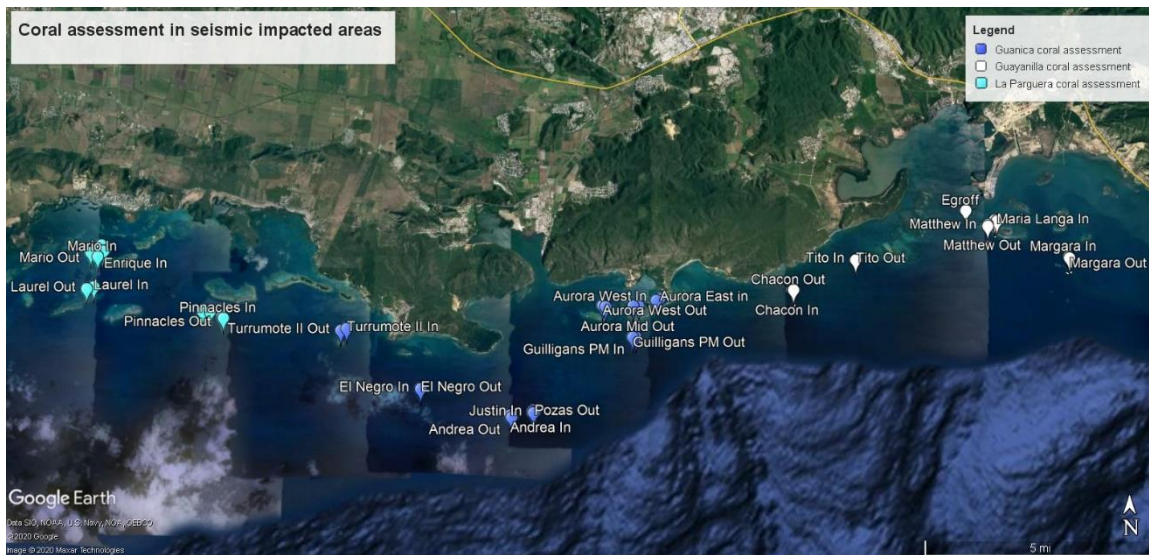


Figure 1: Earthquake damage pre-assessment survey sites in La Parguera, Guanica and Guayanilla, Puerto Rico.

Pre-assessment surveys were performed at seventeen reef sites to search for damage related to the seismic activity off the south coast of Puerto Rico that has been ongoing since the last days of 2019. Six sites were surveyed in La Parguera, six in Guanica and five in Guayanilla (Figure 1, Table 1). The area covered by roving diver surveys averaged approximately 1,000-1,500 m² (200-300 m track x 5 m width).

Severe damage was observed at Enrique and Mario in La Parguera, at Cayo Aurora, Guilligans PM and Andrea in Guanica, and at Tito in Guayanilla. Minor damage was observed at Pinnacles in La Parguera, El Negro in Guanica and Marialanga and Matthew in Guayanilla. No damage was observed within the surveyed area at the remaining sites, but damage could be present on adjacent reef areas that were not surveyed in this pre-assessment. Observations of damage at a site due to seismic activity does not always mean there is the potential for coral triage at the site. For site and survey details, see Tables 2 and 3.

Damaged sites with high triage potential

Cayo Aurora, Guanica

At Cayo Aurora, surveys were done at three points. In total, approximately 250 loose *Acropora palmata* fragments were counted in roving dive surveys (Figure 2). 55% of fragments were 20-50 cm, 35% were 50-100 cm and 10% were over 1 m. In some cases, large branches had detached from and dropped next to the colony base. Damage was observed throughout surveys and it is estimated that there at least 1,000 loose fragments that could be triaged along Cayo Aurora. At the time of the survey, fragments were loose and mostly resting on hard substrate but were not observed beginning to attach to the substrate. The large majority of fragments were in good condition with healthy looking tissue. Triage should be done as soon as possible to avoid tissue loss.



Figure 2: *Acropora palmata* fragments observed at Cayo Aurora during earthquake damage pre-assessment surveys.

Guilligans PM, Guanica

At Guilligans PM, there are hundreds of corals that appear to have been shaken loose by seismic activity (Figure 3). Hundreds of loose corals were observed in the survey, mostly *Montastraea cavernosa*,

Dendrogyra cylindrus and *Orbicella* spp and it is likely that there is similar damage in the area outside of the survey track. Most loose corals are face up and temporarily stable, and 10 were turned face up and temporarily stabilized.



Figure 3: Loose and broken corals observed at Guilligans PM during earthquake damage pre-assessment surveys.

Enrique, La Parguera

At Enrique, a collapsed ledge (Figure 4) and hundreds of loose corals were observed. While approximately 100 loose corals were surveyed, mainly *Orbicella* spp, *Colpophyllia natans*, *Dendrogyra cylindrus*, *Diploria labyrinthiformis* and *Pseudodiploria* spp., approximately 140 additional corals were turned upright and temporarily stabilized. Most loose corals were less than 50 cm, but about 20 of the surveyed *C. natans* were between 50 and 100 cm. Damage was observed throughout the 1,750 m² (350 m x 5 m) of reef surveyed. There are likely hundreds more loose corals spread out over a large area at this site. While corals buried in the ledge collapse are not likely to be salvageable, many corals at this site appear to have collapsed a short distance into an upright position and are loose but in good condition.



Figure 4: Photographs of damage observed at Enrique.

Damaged sites with medium triage potential

Andrea, Guanica

At Andrea, cracks were observed on the spurs near the sand channel. Some slabs have collapsed and are resting in the sand (Figure 5). Approximately 65 corals between 20 and 50 cm, mainly *Orbicella* spp, *Montastraea cavernosa* and *Dendrogyra cylindrus*, were surveyed on these collapsed slabs. The slabs are relatively stable but could be moved by a major storm surge, threatening the corals.



Figure 5: Damage observed at Andrea during earthquake damage pre-assessment surveys.

Damaged sites with low triage potential

Tito, Guayanilla

A large crack approximately 100 meters long and an average of 1 meter wide was observed. Approximately 40 loose corals were observed. Most were attached to larger slabs and face up. 5 loose colonies were turned face up and stabilized. Triage potential is low at this site because it is too deep to work safely, and most corals are stable.



Figure 6: Damage observed at Tito's during earthquake damage pre-assessment survey.

Mario, La Parguera

At Mario, there are large cracks on the back edge of the reef and some ledges have collapsed. The collapsed areas appear to have been colonized by mostly gorgonians with few corals. In other areas throughout the survey 17 loose corals were observed, mostly *C. natans* and *Orbicella* spp. Most loose corals were less than 50 cm, but 6 were between 50 and 100 cm. All were turned face up and temporarily stabilized.

Maria Langa, Guayanilla

At Maria Langa, 13 loose *Acropora palmata* fragments were observed. At the time of the survey, fragments were loose and mostly resting on hard substrate but were not observed beginning to attach to the substrate. Most fragments were in good condition with healthy looking tissue. There were not many live corals inside the survey track so if there are areas of Marialanga with more corals, it is possible that there are more loose fragments.

Pinnacles, La Parguera

At Pinnacles, 7 *Acropora palmata* fragments and one *A. cervicornis* fragment were observed. All fragments were between 30 and 50 cm and were turned face up and temporarily stabilized.

Sites with no triage potential

El Negro, Guanica

At El Negro, cracks were observed near the edges of the reef, but no collapsed areas were observed. Only one loose *Colpophyllia natans* colony was observed.

Matthew, Guayanilla

At Matthew, a few loose corals were observed, but there is potential for more damage at this reef since it has areas with high coral cover.

At the remaining sites, Turrumote, Laurel and Turrumote II in La Parguera, Pozas and Justin's Fault in Guanica, and Chacon and Margara in Guayanilla there was no damage observed and there is no triage potential within the area covered by roving dive surveys.

Other triage potential

It is likely that there are additional reefs that have been damaged by seismic activity in La Parguera, Guanica and Guayanilla and also in Ponce, Puerto Rico which has not yet been surveyed. More information about sites with earthquake damage and coral triage potential may be collected by continuing to talk to local fishermen and dive professionals about their observations. Another way to find sites

would be to map the epicenters of the largest earthquakes over existing benthic habitat maps to find sites with high coral cover that are likely to have suffered earthquake damage.

Table 1: Coordinates of beginning and end of each site survey.

Area	Survey start			Survey end		
	Waypoint name	Latitude	Longitude	Waypoint name	Latitude	Longitude
La Parguera	Pinnacles In	17.932669	-67.011936	Pinnacles Out	17.933175	-67.012298
	Turumote In	17.934609	-67.016424	Turumote Out	17.93466	-67.018852
	Enrique In	17.953675	-67.052461	Enrique Out	17.955604	-67.053231
	Mario In	17.951941	-67.054358	Mario Out	17.95324	-67.056757
	Laurel In	17.94237	-67.055267	Laurel Out	17.941748	-67.057594
	Turumote II In	17.929167	-66.970853	Turumote II Out	17.928859	-66.972936
Guanica	El Negro In	17.9107	-66.946255	El Negro Out	17.91075	-66.946217
	Andrea In	17.902577	-66.916755	Andrea Out	17.901951	-66.9162
	Pozas In	17.904147	-66.908755	Pozas Out	17.903522	-66.908769
	Justin In	17.903373	-66.909045	Justin Out	17.903645	-66.909229
	Guilligans PM In	17.92699	-66.87528	Guilligans PM Out	17.926976	-66.876343
	Aurora East In	17.939179	-66.867358	Aurora East Out	17.938548	-66.868508
	Aurora Mid In	17.936798	-66.87439	Aurora Mid Out	17.936786	-66.876219
	Aurora West End	17.936508	-66.885319	Aurora West End Out	17.936941	-66.886347
Guayanilla	Chacon In	17.942013	-66.823251	Chacon Out	17.941921	-66.822913
	Tito In	17.951488	-66.80203	Tito Out	17.951447	-66.802084
	Margara In	17.95262	-66.731019	Margara Out	17.952186	-66.730779
	Matthew In	17.962284	-66.75773	Matthew Out	17.962709	-66.757787
	Marialanga In	17.963922	-66.754641	Marialanga out	17.964212	-66.755392

Table 2: Depth, damage level, loose corals observed, corals stabilized during survey and triage potential at each site surveyed during the earthquake damage assessment.

Survey date	Area	Site Name	Depth (feet)	Damage to site	Loose corals	Stabilized corals	Triage potential
2/26/2020	La Parguera	Pinnacles	10-49	minor	8	1	low
		Turrumote	25-37	none	1	0	no
		Enrique	10-49	severe	98	161	high
		Mario	15-26	severe	17	5	low
		Laurel	15-22	none	0	0	no
		Turrumote II	15-42	none	0	0	no
2/27/2020	Guanica	Negro	35-40	minor	1	0	no
		Andrea	52	moderate	65	0	medium
		Pozas	35-42	none	0	0	no
		Justin's Fault	35-42	none	0	0	no
		Guilligans	43	severe	380	10	high
		Cayo Aurora	5-10	severe	149	0	high
2/28/2020	Guayanilla	Chacon	22	none	0	0	no
		Tito	48-60	severe	39	5	low
		Margara	35-45	none	0	0	no
		Matthew	33-42	minor	3	1	no
		Maria Langa	5-8	minor	13	0	low

Table 3: Loose corals by species and size observed during each damage assessment survey.

Area	Site	Loose corals			
		Species	Medium (20- 50cm)	Large (51- 100cm)	Extra Large (101cm+)
La Parguera	Pinnacles	<i>Acropora palmata</i>	7		
		<i>Acropora cervicornis</i>	1		
	Enrique	<i>Colpophyllia natans</i>	24	21	1
		<i>Pseudodiploria</i> spp.	6		
		<i>Orbicella</i> spp.	20	2	
		<i>Dendrogyra cylindrus</i>	10		
		<i>Montastraea cavernosa</i>	6		
		<i>Diporia labyrinthiformis</i>	7		
		<i>Siderastrea siderea</i>		1	
	Mario	<i>Colpophyllia natans</i>	6	2	
<i>Agaricia</i> spp.			1		
<i>Orbicella</i> spp.		5	3		
Guanica	Negro	<i>Colpophyllia natans</i>		1	
	Andrea	<i>Dendrogyra cylindrus</i>	10		
		<i>Orbicella</i> spp.	30		
		<i>Montastraea cavernosa</i>	25		
	Guilligans PM	<i>Orbicella</i> spp.	80		
		<i>Diporia labyrinthiformis</i>	100		
		<i>Montastraea cavernosa</i>	200		
	Cayo Aurora	<i>Acropora palmata</i>	67	46	9
Cayo Aurora	<i>Acropora palmata</i>	55	49	16	
Cayo Aurora	<i>Acropora palmata</i>	5	2		
Guayanilla	Tito	<i>Montastraea cavernosa</i>	8		
		<i>Meandrina</i> spp.	10		
		<i>Diporia labyrinthiformis</i>	1		
		<i>Mycetophyllia</i> spp.	5		
		<i>Xestospongia</i> spp.	3		
		<i>Colpophyllia natans</i>	5		
		<i>Orbicella</i> spp.	10		
	Matthew	<i>Pseudodiploria</i> spp.	2		
		<i>Orbicella</i> spp.	1		
	Maria Langa	<i>Acropora palmata</i>	8	3	2