EVOLUTIONARILLY DISTINCT & GLOBALLY ENDANGERED

Survival Blueprint

Pillar Coral, *Dendrogyra cylindrus*

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Suggested citation: Cavada-Blanco, F; Croquer, A.; Villamizar, A.; Arocha, D.; Agudo, E.; Villamizar, E.; González, G.; Boadas, H.; Naveda, J.; Rodríguez, JP.; Pellegrini, N.; Sánchez, R. 2016. A Survival Blueprint for the Pillar coral, *Dendrogyra cylindrus*. Compilation from the Workshop "Strategic planning for the conservation and management of the Caribbean threatened species: *Dendrogyra cylindrus, Acropora palmata* and *A. cervicornis* and their habitat at Archipelago Los Roques National Park, South Caribbean". November 24th-28th 2015, Universidad Simon Bolivar, Caracas, Venezuela.

1. STATUS REVIEW

1.1 Taxonomy:

Cnidaria → Anthozoa → Hexacorallia → Scleractinia → Meandrinidae → Dendrogyra → cyclindrus

Common names (EN): pillar coral
Common names (ES): coral cathedral, caramujo

Dendrogyra cylindrus (Ehrenberg, 1834) is the only living species of the genus. The most noticeably diagnostic characteristics are: 1) the ample meanders of the skeleton made by connected valleys of the coralites; 2) a singular growth form with vertical pillars arising from an encrusting base and 3) the species is the only one in the Caribbean exhibiting its polyps extended during daylight (Veron, 2002; Brown & Bythell, 2005; Fig 1A). Growth initiates horizontally at the base, from which varying number of cylindrical pillars arise vertically. This growth pattern is continuous and the colony can resume vertical accretion from any pillar in case one – or even the entire colony- detach from the colony or substrate (Geister, 1972; Fig. 1B). This growth form results in wide colonies with low height (FFWCC, 2013). Average size reported varies from 0.57± 0.56m and 0.34±0.47m, to 3m depending on the reef (Szmant, 1986; Acevedo, 2003). The species is considered within the big coral colonies group (Darling *et al.,* 2012). The species was first describe by Ehrenberg in 1984, from samples collected in the West Indies.

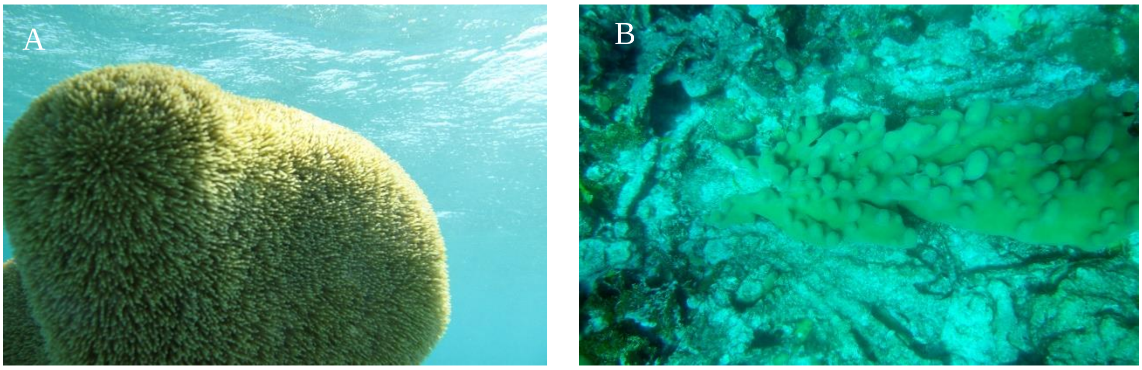

Figure 1. *Dendrogyra cylindrus* with extended polyps in the top of a pillar (A) and an over-turned colony of the species viewed from the top with resumed vertical accretion of pillars.

1.2 Distribution and population status:

Dendrogyra cylindrus is an endemic species of the Western Atlantic province. Its distribution range is restricted to Caribbean reefs with one colony reported for Bermuda (Aronson *et al.,* 2008). Colonies of this species have been reported between 2 and 20 meters depth (Goureau y Wells, 1967; Geister, 1972; Shelton y McFareland, 1984; Rogers *et al.,* 1984; Szmant, 1986; Reigl *et al.,* 2000; Geraldes, 2003; Quinn y Kojis, 2005; Kaczmarsky *et al.,* 2005; Bruckner y Bruckner, 2006; Hernández-Fernández *et al.,* 2008), reaching its highest abundance between 2-10 m in Providencia and San Andrés Island (Acosta, 2003) and between 2-6 m in Los Roques (Cavada-Blanco, unpublished).

1.2.1 Global distribution:

According to the 2008 IUCN assessment, *Dendrogyra cylindrus* distribution range extents throughout the Caribbean, encompassing more than 33 countries (Aronson *et al.,* 2008). From Florida in the north, to Venezuela, Bonaire and Curacao in the south and from Barbados in the west and the Mesoamerican Barrier System in the east. The only exception being coastal reefs of Colombia (Fig. 2). Guzman (2003) reported one colony observed in Panamá.

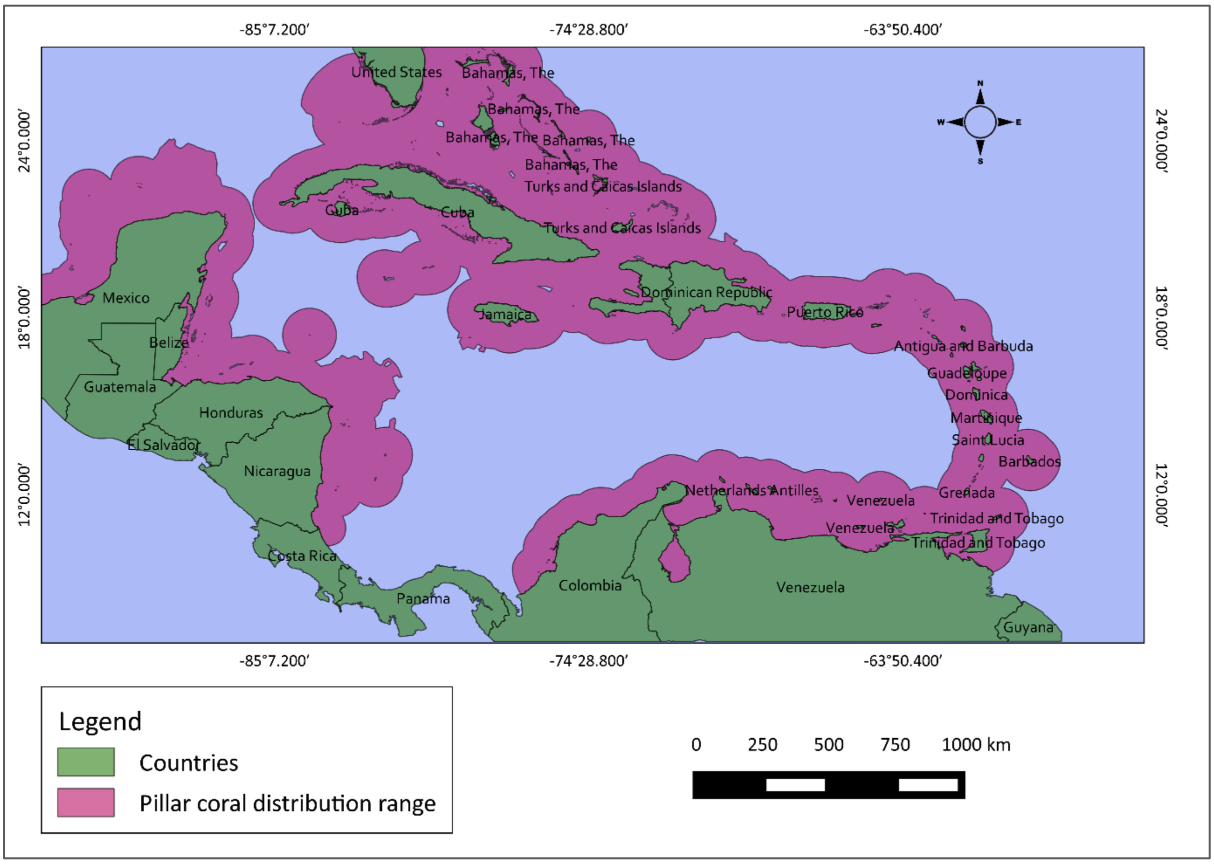

Figure 2. *Dendrogyra cylindrus* distribution range. Source: IUCN (International Union for Conservation of Nature) 2008. *Dendrogyra cylindrus*. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.1. http://www.iucnredlist.org . Downloaded on 30th June 2014.

Country	Population estimate (plus references)	Distribution	Population trend (plus references)	Reference
Puerto Rico	Unknown	El Mario reef; La India La Parguera; Mona and	Unknown	Szmant, 1986; Weil, 2000; García-Saís,

		Desecho Island		2008; Bruckner & Hill, 2009
Barbados	Unknown	Unknown	Unknown	Shelton & McFareland, 1986 Finney *et al.*, 2010 Wittenberg & Hunte, 1993
Bahamas	Unknown	Cat Island, Exuma and Moriah Harbour	Unknown	Shiel-Role (2015)
Belize	Unknown	Bacalar Chico Marine Reserve. Rocky point North-South and Hot point. Reef flats	Unknown	Chapmann, 2011
Bonaire	Unknown	Southwest of the island	Unknown	Bries *et al.*, 2004
Curacao	< 5% of scleractinian corals	West coast;	Cover decline	Bruckner & Bruckner, 2006; Nagelkerken, 2005
Colombia	0,17 colonies/m^2	Unkown	Unknown	Acosta, 2003; Karpouzli *et al.*, 2004
Cuba	Unknown	Boca de Canasí and Ciego de Ávila.	Unknown	Acosta & Illanso, 2004; Hernández-Fernández *et al.*, 2008
Cayman Islands	Unknown	Unknown	Unknown	Aronson *et al.*, 2008
United States	At least 7 stands (more than 130 colonies)	Florida keys; US Virgin Island	Stable. Only declining in Conch Reef	Jaap, 1985; Hudson & Goodwin, 1997; Somerfield *et al.*, 2008; Kemp *et al.*, 2011; Neely *et al.*, 2013; Miller *et al.*, 2013; Rogers

				et al., 1984, 2009; Edmunds, 2000; Miller *et al.*, 2004; Kacmarsky *et al.*,2005; Clark, 2009
Honduras	0.8 colonies/m2	Utila; Cayo Cochino and Roatan	Unknown	Scaps *et al.*, 2011; Riegl *et al.*, 2009
Jamaica	0.02 colonies/m2	Discovery Bay	Unknown	Goreu & wells, 1967; Wilkinson *et al.*, 1988; Quinn & Kojis, 2005
Mexico	Unknown	Yucatán peninsula	Unknown	Tunnel, 1985; LeJaneusse, 2002; Ward *et al.*, 2006; Rodríguez-Martínez *et al.*, 2012
Navassa	Unknown	Unknown	Unknown	Miller & Williams, 2007
Nicaragua	Unknown	Los Cayos	Unknown	Weijerman & Ubeda, 2002
Panamá	Unknown		Unknown	Guzmán 2003
Dominican Republic	Unknown	Parque Nacional del Este	Unknown	Geraldes, 2002
Saba	Unknown	Unknown	Unknown	McKenna & Etnoyer, 2010
Turks & Caicos	2% of scleractinian	Unknown	Unknown	Riegl *et al.*, 2000 Dykou *et al.*, 2009
Venezuela	0.5 colonies/100m	Archipelago Los Roques National Park; Isla de Aves	Unknown. Locally extinct at Morrocoy and San Esteban National Park	Cavada-Blanco, unpublished; Yranzo *et al.*, 2009

1.2.2 Local distribution:

Local distribution of *Dendrogyra cylindrus* appears to be highly variable, with a low frequency of occurrence and an apparent clumped distribution at reefs scales (Miller *et al.,* 2013). Out of the 71 reviewed published works where the species name is mentioned, only 49 reported abundance for the species, either quantitatively or qualitatively assessed. Population size estimates for the species distribution range from the published work might constitute a bias. Only a few of those works had the species included in the research objective, reporting a correlation between sampling effort and abundance (Acosta, 2003). Concomitantly, due to the apparently clumped distribution of the species, traditional coral reefs survey methods are inadequate for the species assessment (Miller *et al.,* 2013, Cavada-Blanco, unpublished).

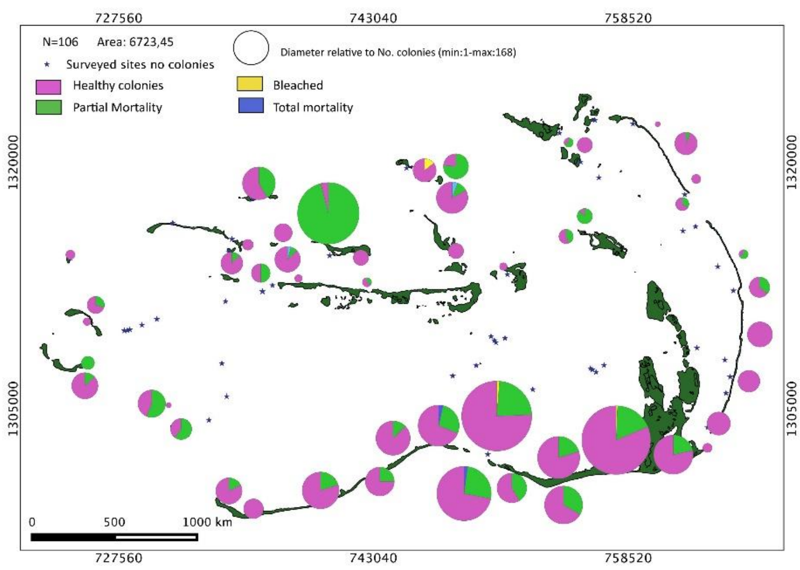

Figure 3. Distribution, abundance and health status of *Dendrogyra cylindrus* at Archipelago Los Roques National Park (ALRNP), South Caribbean, Venezuela. Source: Cavada-Blanco et al., unpublished.

Country	Region / province	Site	Level of Protection	Population size	Reference(s)
Puerto Rico	Greater Antilles	El Mario reef.	Unknown	30 colonies in 4,000m^2	Szmant, 1986
		La India reef. Reef crest		1 colony in 4,000m^2	
		La Parguera	Natural reserve	Mention a colony	Weil, 2000
				0.2% cover. Infrequent	García-Saís, 2008
		Mona and Desecho island	Natural reserve	Common	Brickner & Hill, 2009

Bahamas	The Bahamas	North Cat Island off Man o War point	None	20+ colonies	Shiel-Role, 2015
		South Cat Island off of Port Howe	None	20+ Colonies	
		Exuma Cays Land and Sea Park	No-take Zone (Sea Park)	6+ Colonies	
		Moriah Harbour	None	2 colonies	
		Egg Island	None	2 colonies	
Barbados	Lesser Antilles	Unknown	Unknown	Mentioned	Shelton & McFareland, 1986
				Unknown	Finney *et al.*, 2010
				1 colony no area reported	Wittenberg & Hunt, 1993
Belize	Mesoamerican Barrier System	Unknown	Unknown	1 colony no area reported	
		Bacalar Chico Marine Reserve. Rocky point North-South and Hot point. Reef flats	Marine reserve	3 colonies in 2,400 m^2	Chapmann, 2011
Bonaire	Southern Caribbean	Southwest of the island	Marine reserve	Mentioned	Bries *et al.*, 2004
Curacao		West coast	Unknown	Mentioned	
		All reefs	Unknown	Less than 5% of scleractinian population	Bruckner & Bruckner, 2006
		Reef terrace	Unknown	0.3-0.1 % cover	Nagelkerken, 2005
Colombia	Mesoamerica	Reef flat and terrace	Marine reserve	177 in 1,000m^2	Acosta, 2003
		Unknown	Marine reserve	2 colonies; area not reported	Karpouzli *et al.*, 2004

Cuba	Greater Antilles	Boca de Canasí. Shallow reefs	Managed Floristic reserve	4 colonies; area not reported	Acosta & Illanso, 2004
		Ciego de Ávila. Reef crest	National Park	1 colony in 30m	Hernández-Fernández *et al.*, 2008

1.3 Protection status:

Listed in the CITES appendix II since 1990. The species is also listed within the IUCN Red List of Threatened Species (criteria a4ce) and the EDGE of Existence list under the Vulnerable category. Within its distribution range, the species have been included within national Red Lists in México, Cuba, Dominican Republic, Nicaragua, United States of America (Endangered Species Act) including Puerto Rico and the US Virgin Islands, Netherlands Antilles and Venezuela, varying within the category. The habitat coincides with Marine Protected Areas in approximately 92% of its distribution range and it might ample under the CBD Aichi target number 11.

1.4 Ecology, behaviour and habitat requirements:

Dendrogyra cylindrus biology and ecology is poorly known. The species appears to have a clumped distribution with large stands of colonies (Miller *et al.,* 2013). This distribution could be a result of a close to adult recruitment or of high fragmentation rates; a feature of prime importance for population size estimation. Reproduction is achieved through fragmentation and gamete fertilisation (Szmant, 1986). The species is dioecious with an annual reproductive cycle (Szmant, 1986). It was thought to be a broadcast spawner, but recent research indicates that the species might be sperm-casting, with internal fertilisation of eggs inside the female colonies after sperm release by male colonies (Marhaver *et al.,* 2015). This highlights the importance of sex proportion and genetic diversity within close clumps or stands for the species persistence. Szmant (1986) reports a 1:1 sex proportion for one reef in Puerto Rico and only one male colony in 4 Km^2. Spawning occurs 3-5 days after the full moon of August (Neely *et al.,* 2013) and September (Marhaver *et al.,* 2015). Colony size at maturity is unknown and low recruitment and juvenile colonies have been reported (Rogers, 1984; Reigl *et al.,* 2000). Size structure have only been assessed in Colombia and Florida with more than 40% of the colonies surveyed within the 31-60 and 70-80 cm size classes, respectively (Acosta & Acevedo, 2006; Miller *et al.,* 2013). Growth rate varies between 0.88-2 cm/year (Hudson & Goodwin,1997; Edmunds, 2000; Acosta & Acevedo, 2006). Colony longevity is unknown, but according to reported growth rates, natural total mortality might occur between 44 and 150 years. It has been reported that Curacao populations might be facing a bottleneck, due to fertilisation failure plus larval or recruit mortality (Marhaver *et al.,* 2015). This situation might also be occurring in other populations within the species distribution range.

Specific habitat and resource requirement for the species have not been yet investigated. However, as other hermatipic corals with zooxanthellae endosymbionts, *Dendrogyra cylindrus* vertical distribution is restricted to the euphotic zone (Knowlton & Jackson, 2003). The zooxanthellae diversity found on the species, have been suggested as low-resistant to water temperature variations (LeJaneuosse, 2002; Finney *et al.,* 2010), however its susceptibility to bleaching varies considerably at local scales (Darling *et al.,* 2002; Bruckner & Hill, 2009). The species has been reported for shallow reefs with low slopes (Acosta & Acevedo, 2006; Chapman, 2011; Miller *et al.,* 2013; Cavada-Blanco, unpublished). At ALRNP it has been observed in diverse habitats, from sand flats to consolidated barrier reef terraces (Cavada-Blanco, unpublished). Although it has been suggested that the species is vulnerable to fragmentation due to wave exposure, its distribution among exposed-protected reefs is variable, but coincides with good water circulation conditions (Acosta & Acevedo, 2006; Marhaver *et al.,* 2015; Cavada-Blanco, unpublished). Its health status appears to be related to the habitat condition (Cavada-Blanco, unpublished) and thus, water quality, sedimentation, temperature, hydrodynamic and irradiance are important factors for the species (FFWCC, 2013).

1.5 Threat analysis:

Dendrogyra cylindrus is listed as Vulnerable in the IUCN Red List of threatened species, due to habitat loss, low juvenile survivorship and threat susceptibility (Aronson *et al.,* 2008).

The degree of threat to the species is prioritised as follows: low (□), medium (□□), high (□□□), critical (□□□□) and unknown (?)

Local Threats. These include those threats that operate at local scale. According to the mechanisms through which local threats affects the species and/or its habitat, these can be classified as:

1. Direct or proximate. These include those that imply direct contact that leads to mechanical damage, resulting in partial or total mortality:
   - Anchoring □□□ (Marshall & Schuttenberg, 2006)
   - Free and SCUBA diving □□ (Williams & Polunin, 2000)
   - Net and cage fishing gears □□□ (Chiappone *et al.,* 2005)
   - Free-diving spiny lobster fishing □□□□(Cavada-Blanco, unpublished)
   - Wave action due to hurricane, storms or vessel motors □□□(Antonious & Weiner, 1982; Bak *et al.,* 2005; Cavada-Blanco, unpublished).
2. Indirect or ultimate. These operate through interference, conferring competitive advantage to other taxonomic groups or diminishing the species competitive capacity, reproductive output through metabolic stress or the habitat resilience:

- Biological and/or chemical pollution [?] (Antonious, 2000)
- Watershed deforestation and coastal development [□□□] (Richmond *et al.,* 2007)
- Key functional species overfishing [□□□□] (Mumby *et al.,* 2012)
- Diseases and Syndromes [□□□](Cróquer & Weil, 2009)
- Tourism and recreational activities [□□□□] (Mumby *et al.,* 2014; Cavada-Blanco, unpublished)

Global Threats. These include those threats that operate at global scales, mainly the effects of climate change on the species and its habitat. All these are indirect threats

- Seawater temperature increase[□□□□]. This is the main cause of bleaching in reefs and it compromises the species metabolism, which might lead to the loss of annual reproductive cycles and partial or total mortality (Donner *et al.,* 2005; Bastidas *et al.,* 2012; Croquer *et al.,* 2016).
- Increase in frequency and intensity of hurricanes and storms[□□□]. This translates in higher colony mortality, sedimentation and reduced resilience due to chronic disturbance (Hough-Guldberg *et al.,* 2007).
- Changes in local currents patterns[?]. This is analogous to habitat modification, especially for the species that seems to require good circulation with moderate currents and could also constitute a change in larval dispersion, leading to loss or change of connectivity between populations (Walther *et al.,* 2002; Denman, 2008).
- Seawater acidification[?]. Lower pH due to an increase of the CO_2 partial pressure, which interferes with calcium carbonate accretion, compromising coral growth and skeleton density (Hoehg-Guldberg *et al.,* 2007).

Other ultimate threats that heighten both local and global threats include: 1) poverty levels within coastal zones and watersheds, 2) lack of governmental and technical infrastructure for the development of sustainable livelihoods, 3) lack of capacity, enforcement and control directed towards an effective and efficient management of coastal-marine areas, 4) weak governance and over-institutionalization and 5) deficiency in land-use planning within watersheds (Waite *et al.,* 2014).

1.6 Stakeholder analysis:

Country	**Stakeholder**	**Stakeholder's interest in the species' conservation**	**Current activities**	**Impact** *(positive, negative or both)*	**Intensity of impact** *(low, medium, high or critical)*
Venezuela	Fishermen	Livelihood improved through higher fish catches	Fishing of top and middle predators	Negatively impacting species habitat through	High

			and overfishing of key-functional groups as parrot fishes	grazing, biomass and abundance decrease	
	Spiny Lobster fishermen	Livelihood improved through higher catches and reduced effort	Cultural values associated to the species as a fishing ground	Negatively through mechanical damage when removing lobsters. Positive because of cultural value	High but occasional (time-bounded)
	Tourism operators	Indirect, species is part of natural features attractiveness of the site.	Complete inactivity and lack of knowledge on the species and its habitat	Indirectly negative due to carrying capacity overload and inaction to inform tourist about MPA regulations	High
Venezuela	Tourism boat transportation cooperatives	Indirect, species is part of natural features attractiveness of the site.	Complete inactivity and lack of knowledge on the species and its habitat	Indirectly negative due to carrying capacity overload and inaction to inform tourist about MPA regulations Directly negative due to anchoring and navigation behaviour.	High
	Dive operators	Touristic attractiveness	Dive sites in species occurrence area. Awareness campaign to divers	Negative because dive sites coincide with highest density sites	Medium (spatially-framed)
	National park authority (INPARQUES)	Conservation of species, its habitat and implementation of local and	Occasional vigilance rounds and spiny lobster catches	Neutral due to limited enforcement capacity	Low (spatially and temporally limited)

		national legislation	supervision		
	Local authority, TIFM (analogue to state government)	Implementation of local and national legislation. Management of public services and budget including taxes on ecosystem services	Occasional support to INPARQUES for vigilance rounds	Negative due to inefficiencies in public services management, internalization of externalities and projects that will increase land-based pollution	High
	National environmental authority	Conservation of species, its habitat and implementation of local and national legislation	Revision of MPA zoning and regulation plan	Neutral	Low
Venezuela	Francisco de Miranda Foundation	Conservation of species, its habitat. Monitoring and research	Non, due to lack of infrastructure	Positive	Could be high
	National Universities and Research Institutes	Research	Limited due to lack of founding	Neutral	Low

1.7 Context and background information that will affect the success of any conservation action for this species:

	Description	Barriers to conservation	Opportunities for conservation
Socio-cultural effects and cultural attitudes	The species has two direct socio-cultural effects, specific to stakeholders groups. To fishermen, the pillar coral colonies acts as spiny lobster fishing grounds and is considered an iconic species to some divers. As a shallow reef-building coral, this species aids in the provision of structural and biotic services of coral reefs	The fishing method for the spiny lobster can produce high rates of fragmentation, colony overturn and partial mortality, due to mechanical damage. If genetic diversity is low and since population(s) are dominated by adult colonies, this activity might be an important threat to the species persistence.	The characteristic and peculiar growth form, uniqueness and polyp display of the species have already proved to be advantageous in appealing divers and the curiosity and attention of non-diver stakeholders. This could be used in raising awareness about this species and coral reefs conservation. The value associated by fishermen also constitutes an opportunity, since the link between the persistence and protection of the species with spiny lobsters' catch maintenance or increase is more directly noticed.

Economic implications	The market value, calculated through gross rent, of the structural, biotic and goods services of coral reefs ecosystems services, surpassed the 7 million dollars in 2014 at ALRNP	The extremely high revenue of the economic activities which are derived from the ecosystem services simultaneously acts as pervasive incentives, these incentives is are difficult to meet through alternative livelihoods and other productive schemes	The direct dependence upon ecosystem services provided by coral reefs, may be used to depict the vulnerability of all stakeholders to the degradation of this habitat. Results from the benefit flow structure might be used to develop management and financial strategies for conservation
Existing conservation measures	Existing conservation measures only include a legal protection of 62% of species occurrence through higher protected zoning within the MPA.	There is uncertainty weather this protected occurrence represents enough female and male genetically different individuals as to ensure the viability of the population(s). The habitat complementarity and diversity within the highly protected zones is very low and thus, an episodic event that results in undermined colony numbers and habitat degradation (i.e. massive bleaching) could impede the recovery of the species populations within these protected zones.	The representativeness of the species is good within the MPA and the only action that would be needed to secure the protection in at least 50% of its occurrence, would be to enhance enforcement capacity of INPARQUES. Population genetics analyses are a prime to design conservation measures to ensure the species persistence and population(s) viability.

Administrative/political set-up	There are 8 governmental and community organisations, which have decision power to some degree in environmental related affairs. The ministry of Eco-socialism and Water (MPPEA) with no permanent local representative, The Insular territory Francisco de Miranda (TIFM) analogue to a state or province government with the same power but with the chief authority being appointed by the president, INPARQUES, The Community council (CC) and Commune (CO), both elected by local community, The fishermen association (FA), The boat transportation cooperatives (CL) and the lodge and tourism chamber (CTFM), all elected by the members. Although roles and responsibilities of each of these stakeholders are explicitly stated in various laws, in practice, TIFM holds the maximum power and the financial resources. CC and CO, representatives, like to be informed and aware of all the situations, but do not participate or engage in any activity beyond the mandatory meetings.	The main threat of this administrative and political set-up is that decision-making processes could be extremely lengthy and ultimately unproductive. The maximum authority does not have an environmental specialist within its staff, nor an environmental department. Extreme institutionalization and weak governance are an obstacle to conservation strategies. The main threat is that national state of affairs in politics and economics has percolated the lowest organisations.	Build a close relation with the TIFM as to advice in environmental issues could accelerate conservation actions; however aware that authorities and representatives are changed frequently and thus, the objectives might not be reached.

Local expertise and interest	The biologists from the new local government foundation are interested and capable of implementing a small scale-monitoring program. A local diving operator (ADC) is extremely interested in environmental education and awareness directed to divers. The brother of our boat captain who, has just graduated have also shown a lot of interest in the project.	Due to the highly changing scenarios within the local authorities, continuity of monitoring programs ran by the TIFM foundation could be hindered	All of these local people interested in keeping conservation-related activities in the pillar coral and coral reefs, might help in executing some of the activities needed to achieve the objectives
Cultural attitudes	Most of the stakeholders have a conservation-driven speech towards the species and corals in general. However, they do not take responsibility of actions that are, or increase the threats' impacts to the pillar coral and its habitat, if these actions provide an economic benefit	Economic incentives are extremely high which might lower the impact of conservation strategies, due to lack of compliance.	Working on awareness about the economic vulnerability that all stakeholders have to the degradation of coral reefs and reef-building coral species extinction might achieve a greater impact and advance towards behaviour change.
Appeal of species	The species has a great appeal to divers and fishermen. Among coral species, it is the most iconic for general public and it is used often in conservation focused adverts in the USA	Using the species as flagship, could ultimately increase local threats like diving and mechanical damage due to an increased interest to see the pillar coral	As non-mammal focused marine conservation is in its rise, these species could become the next panda of the corals, at least in the Caribbean.

Resources	Plenty human resources are available, however due to the political situation of the country, financial resources are extremely scarce and difficult to obtain. The economic situation, also makes the financial management of any in-country project, a highly risky investment.	No financial resources, political instability	Include the area a site within an international broader project could be a good strategy for implementing conservation actions. Having the financial management out of the country.

2. ACTION PROGRAMME

Vision (30-50 years)	
In the next 30 to 50 years, 90% of *Dendrogyra cylindrus* populations will be fully represented within marine protected areas, designed to ensure the species viability within its distribution range and with an adaptive management framework that eliminates local threats and reduce the effects of global threats to ensure the maintenance of coral reefs functions and the delivery of its ecosystem services.	
Goal(s) (5-10 years)	
• At least three ecologically functional populations in each of the nine species main habitat types in 70% of its regional and 100% of its national distribution range. • Represent 100% of these ecologically functional populations within Marine Protected Areas Networks with management plans that complement common goals and addresses site-specific needs for the species viability and the persistence of its habitat. • Increase habitat health status in at least 60% of the species national distribution range.	
Objectives	**Prioritisation** *(low, medium, high or critical)*
Scientific-based information about *Dendrogyra cylindrus* populations and its threats status in a timely manner and communication to key stakeholders for decision-making process aimed to design and implement management strategies and policies that ensures the species conservation within the next three years is generated.	Critical

For 2020, identify *D. cylindrus* conservation units and the degree of connectivity among them for prioritization purposes and MPA network design	High
The species extinction risk in the IUCN Red List of threatened species as well as in the national red lists and other legislations within its distribution range have been re-assessed by 2021	Medium
For 2022, adaptive management plans that include criteria for the conservation of *D. cylindrus* and its habitat according to the identified conservation units, threat distribution and intensity and socio-economic characteristics of local communities are drafted for the MPA network proposed.	High
For 2022, Develop and strengthen financial and human resources capacity for the conservation of *D. cylindrus* populations and its habitat within the proposed MPA Network	Critical
For 2022, monitoring plans implementing methods that ensure the detection of changes in population trends and health status of *D. cylindrus*, habitat health condition and threats intensity in a timely fashion are included within management plans.	Critical

<table>
<tr><th>Activities</th><th>Country / region</th><th>Priority (low, medium, high or critical)</th><th>Associated costs (GBP £)</th><th>Time scale</th><th>Responsible stakeholders</th><th>Indicators</th><th>Risks</th><th>Activity type</th></tr>
<tr><td colspan="9">Objective 1: Scientific-based information about Dendrogyra cylindrus populations and its threats status</td></tr>
<tr><td>Assess local distribution</td><td rowspan="6">All distribution range, except USA, Curacao and ALRNP. The last have to be included for epidemiology variables (prevalence and virulence)</td><td>Critical</td><td rowspan="6">An average of 12,000 GBP per country</td><td rowspan="6">If done at once, two years</td><td rowspan="6">Local park ranges and staff, NGOs, universities and governmental organizations</td><td rowspan="6">Distribution maps, peer-reviewed papers and reports</td><td rowspan="6">Opportunities:
(1) Currently funding opportunities for coral reefs conservation related projects is high
(2) Projects that involve various countries and institutions are prioritize for these grants
(3) Within the coral reefs research community, the species is “hot” as research object.

Threats: See next row</td><td rowspan="6">Improving Knowledge</td></tr>
<tr><td>Habitat characterisation</td><td>Critical</td></tr>
<tr><td>Assess partial mortality, bleaching and disease incidence, prevalence and virulence</td><td>Critical</td></tr>
<tr><td>Assess habitat health status</td><td>Critical</td></tr>
<tr><td>Identify and quantify local threats</td><td>Critical</td></tr>
<tr><td>Establishing population(s) size structure</td><td>Critical</td></tr>
</table>

Activities	**Country / region**	**Priority** *(low, medium, high or critical)*	**Associated costs (GBP £)**	**Time scale**	**Responsible stakeholders**	**Indicators**	**Risks**	**Activity type**
Determine species bleaching vulnerability through an experimental approach, replicated spatially within and between local habitats and regional occupancy as well as temporally. Also assessing endosymbiont variability	At least three sites nested within three localities (North, central and south Caribbean)	Medium	An average of 3,000 GBP/country	2 years	NGOs and researchers	Peer-reviewed papers and reports	Opportunities: Same as previous row Threats: (1) Multinational projects might not yield the expected results at all countries (2) Involving different laws related to research permits and different institutions might delay the actions as well as the budget	*Improving knowledge*
Conduct competition field experiments to establish interactions	At least one country in North and South Caribbean	Medium	Approximately 1,500 GBP/country	1 year		Peer-reviewed papers and reports		

Activities	**Country / region**	**Priority** *(low, medium, high or critical)*	**Associated costs (GBP £)**	**Time scale**	**Responsible stakeholders**	**Indicators**	**Risks**	**Activity type**
Determine genetic diversity and sex ratio in at least 60% of each local population. Identify sink and source populations and degree of connectivity among them	San Andres and Providencia Islands, Florida, Curacao, Bonaire and Venezuela Mesoamerican Barrier System, North Caribbean and Southern Caribbean	Critical	An average of 45,000 GBP	2 years	NGOs and researchers	Peer-reviewed papers and reports	Opportunities: same as previous row, except for number 1 Threats: aside from the ones stated in the previous table, funding needed to implement this action might be difficult to obtain	*Improving knowledge*
Determine natural larval mortality, recruitment rate and reproductive output variability		Critical	An average of 10,000 GBP/country	3 years	NGOs & Researchers	Peer-reviewed papers and reports	Same as previous table	Improving Knowledge
Determine larval dispersal		High				Peer-reviewed papers and reports		

Activities	Country / region	Priority *(low, medium, high or critical)*	Associated costs (GBP £)	Time scale	Responsible stakeholders	Indicators	Risks	Activity type
Communicate results to stakeholders and decision – makers.	Countries included in the aforementioned actions	Critical	An average of 1,500 GBP/country	6 months	NGOs, researchers, park staff	At least three workshops/country	Opportunities: Multinational effort is an attractive subject Threat: unwillingness to participate in workshops	Education and Awareness
Objective 2: Conservation units and connectivity for MPA Network design								
Based on Objective's 1 actions results, assess population(s) viability	Curacao, Bonaire and Venezuela Mesoamerican Southern Caribbean	Critical	3,000 GBP/country	6 months	NGOs and researchers	Population Viability Analysis compounded report and peer-reviewed papers	Opportunities: (1) Currently, funding opportunities for coral reefs conservation related projects is high, especially for	Improving knowledge

Activities	Country / region	Priority *(low, medium, high or critical)*	Associated costs (GBP £)	Time scale	Responsible stakeholders	Indicators	Risks	Activity type
Identify possible conservation units		Critical	3,000 GBP/country	1 year	NGOs and researchers, Environmental authorities' representatives and experts	Technical report	MPA networks (GEF-UNEP, TNC,CI,EU, etc.) (2) Projects that involve various countries and institutions are	

Activities	Country / region	Priority *(low, medium, high or critical)*	Associated costs (GBP £)	Time scale	Responsible stakeholders	Indicators	Risks	Activity type
Undertake workshops with local stakeholders, experts, decision makers and international organisations with leverage (i.e. UNEP, WCPA Caribbean and Latin America chapters CaMPAN, etc.) to prioritize and propose MPA networks		Critical	5,000 GBP/country	1 year	NGOs and researchers, National and regional authorities representatives and experts	Technical report/proposal with spatially explicit data and MPA network delimitation, including Conservation connectivity among MPAs of the network	prioritize for these grants Threats: (1) Political affairs and international politics might compromise the level of engagement and willingness to participate and/or endorse the creation of multinational MPAs	Land/Water protection Education & Awareness

Activities	**Country / region**	**Priority** *(low, medium, high or critical)*	**Associated costs (GBP £)**	**Time scale**	**Responsible stakeholders**	**Indicators**	**Risks**	**Activity type**
Assess socio-economic impacts of MPA network creation and trade-offs among local stakeholders and draw a plan to reduce them		Critical	4,000 GBP/country	1 year	NGOs and researchers, exiting MPAs staff	Technical report		Livelihood, Economic & Other Incentives

Activities	Country / region	Priority *(low, medium, high or critical)*	Associated costs (GBP £)	Time scale	Responsible stakeholders	Indicators	Risks	Activity type
Expand and or create new protected areas under IUCN categories I-VI to decree the MPA network and draft necessary policies/laws for implementation focused on building and maintaining resilient socio-ecological systems	Curacao, Bonaire and Venezuela Southern Caribbean	Critical	7,000 GBP/country	2 years	NGOs, National and regional authorities representatives and experts	Decrees, Laws/regulation, MPA network included in WCPA and WCMC-CCI databases	Same as previous rows	Land/Water protection Law & Policy
Objective 3: **Threatened status re-assessment**								

Activities	Country / region	Priority *(low, medium, high or critical)*	Associated costs (GBP £)	Time scale	Responsible stakeholders	Indicators	Risks	Activity type
Based on results from objective 1 reassess pillar coral extinction risk on IUCN and national Red Lists	All distribution range	High	1000 GBP/country	6 months	NGOs, experts and researchers	IUCN Red List of Threatened species and National red lists status revised	Opportunities: Information availability to assess extinction risk Threats: in most countries' status cannot be re-assessed for only one species	Improving knowledge
Objective 4: **Management plans design for MPA Network**								

Activities	Country / region	Priority *(low, medium, high or critical)*	Associated costs (GBP £)	Time scale	Responsible stakeholders	Indicators	Risks	Activity type
Establish financial and human resources needs for MPA implementation and adaptive management application	Curacao, Bonaire and Venezuela Southern Caribbean	Critical	25,000 GBP/country	3 months	NGOs, National and regional and MPA management authorities' representatives and experts	Technical report	1) Currently, funding opportunities for MPA networks is available Threats: (1) Political affairs, national laws and international politics might compromise consensus on management schemes	Land/Water Management Livelihood, Economic & Other Incentives
***Objective 5:* Strengthening of human and financial resources**								
Design curricula for and implement capacity building programme	Curacao, Bonaire and Venezuela Southern Caribbean	Critical	35,000 GBP	3 months	NGOs, National and regional and MPA management authorities' representatives and	Course Curricula. At least 50% of MPA management staff trained at each country	Opportunities: Incentive for MPA staff Threats: Availability of funding and loss of trained staff	*Capacity Building*

Activities	Country / region	Priority *(low, medium, high or critical)*	Associated costs (GBP £)	Time scale	Responsible stakeholders	Indicators	Risks	Activity type
Seek funds and design financial sustainability plan for MPA Network operation		Critical	20,000 GBP	1-year design (financial plan approx. 6 years)	experts	Financial plan Financial resources for operations for at least 3 years	Opportunities: highly touristic places with good economic benefits derived from these activities may be a good financial source through internalization of externalities Threats: National governance and institutionalization might not allow for financial sustainability	
Objective 6: **Monitoring plans designed and proved**								

Activities	Country / region	Priority *(low, medium, high or critical)*	Associated costs (GBP £)	Time scale	Responsible stakeholders	Indicators	Risks	Activity type
Test cost-benefit relation differences between monitoring methodology that is applicable to all MPAs within the network and select the lowest one.	Curacao, Bonaire and Venezuela Southern Caribbean	Critical	50,000 GBP	6 months	NGOs and researchers	Monitoring program methodology Databases Monitoring program Technical reports (yearly)	Opportunities: Use a collaborative approach with local research institutions, universities and organisations (citizen's science and thesis) allowing also for capacity building and cost reduction Threats: financial sustainability	Land/Water Management Education & Awareness
Data management, analysis and evaluation plan for monitoring programs in place		Critical		6 months	NGOs, researchers and MPA network staff			
Communication of evaluation and monitoring programs		Critical		management plan	NGOs MPAs Network staff	Web page, workshops		

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