

Coral community changes after three years of Stony Coral Tissue Loss Disease (New Providence, The Bahamas)

Cambios en la comunidad coralina después de tres años de la llegada de la enfermedad de pérdida de tejido (New Providence, Las Bahamas)

Changements dans la communauté corallienne après trois ans de maladie de perte de tissu corallien sur coraux durs (New Providence, Bahamas)

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EXTENDED ABSTRACT

Coral reefs are invaluable ecosystems that provide critical services, supporting biodiversity and offering a habitat for numerous marine species (Moberg and Folke, 1999). These vibrant underwater ecosystems also contribute to coastal protection by acting as natural barriers against storm surges and waves, safeguarding adjacent shorelines. Furthermore, coral reefs play a pivotal role in sustaining fisheries, ensuring the livelihoods of millions of people who depend on them for food and income. The effectiveness of these ecosystem services is decreasing due to various threats, including severe storms, hurricanes, sea level rise, ocean acidification, increased pollution, and, of course, rising seawater temperatures. The potential consequences of higher seawater temperatures include coral disease outbreaks and bleaching events. Caribbean reefs are known as hot spots for reef diseases, and the latest deadly coral disease is Stony Coral Tissue Loss Disease (SCTLD). Since its first observation in 2014 in Florida, it has spread to at least 30 countries. In The Bahamas, SCTLD was first reported in 2019 off Grand Bahama and in 2020 around New Providence (Dahlgren et al. 2021). In this study we wanted to understand how many coral colonies have been lost as a result of SCTLD and how this was changing the coral community around New Providence (The Bahamas).

To understand how coral communities have changed in New Providence since SCTLD started, we collected data using two different methods: (1) AGRRA coral transects from 2019 and 2023, specifically data related to coral species density and health; and (2) rapid assessments, consisting of swimming around a reef area for 15 minutes, counting all coral colonies with a diameter larger than 4 cm. These rapid assessments were conducted in 2020, 2021, and 2023. We collected data on the number of coral colonies and their status: healthy, diseased with SCTLD, dead, and other diseases, including bleaching. There are some caveats to the rapid assessment data: in 2020, we only included 17 coral species, all highly susceptible to SCTLD, and in 2021, *Porites astreoides* and *Agaricia* spp. were not included because they were considered then non-susceptible to SCTLD. For 2023 data all species were collected.

Table 1. Changes on coral colony abundance for 14 species before Stony Coral Tissue Loss Disease (SCTLD) outbreak and during the SCTLD outbreak using two coral survey methods: AGRRA and Rapid assessments. Coral colony density increased in all species between 2019 and 2023, except for *Solenastrea intercepta*, which is classified as an SCTLD

Species	AGRRA			Rapid assessment		
	Before SCTLD	SCTLD	Change	Before SCTLD	SCTLD	Change
AAGA	2.42	1.38	-42.98			
CNAT				2.39	0.06	-97.67
DLAB	0.12	0.08	-33.33	11.78	3.17	-73.11
DSTO				1.06	0.50	-52.63
EFAS				1.89	0.50	-73.53
MCAV	0.22	0.14	-36.36	11.72	4.00	-65.88
MMEA				2.61	0.83	-68.09
OANN	0.56	0.24	-57.14	21.89	6.50	-70.30
OFAV	1.18	0.22	-81.36	26.44	10.83	-59.03
OFRA	0.78	0.60	-23.08	13.33	4.17	-68.75
PAST	2.22	2.08	-6.31			
PSTR	0.08	0.02	-75.00	6.06	2.00	-66.97
SSID	0.92	0.7	-23.91	36.61	12.39	-66.16
SINT	0.10	0.12	20.00	3.17	2.84	10.32
Average: 42.16%			Average: 69.28%			

Table 2. Estimated number of colonies lost due to Stony Coral Tissue Loss Disease (SCTLD) for 11 coral species, calculated using number of corals before SCTLD and during the SCTLD outbreak in 63 km² around New Providence and Rose Island (The Bahamas). Coral species using AGRRA codes.

Species	Before SCTLD	SCTLD	Lost colonies
AAGA	152,460,000	86,940,000	65,520,000
DLAB	7,560,000	5,040,000	2,520,000
MCAV	13,860,000	8,820,000	5,040,000
OANN	35,280,000	15,120,000	20,160,000
OFAV	74,340,000	13,860,000	60,480,000
OFRA	49,140,000	37,800,000	11,340,000
PAST	139,860,000	131,040,000	8,820,000
PSTR	5,040,000	1,260,000	3,780,000
SSID	57,960,000	44,100,000	13,860,000
Total	535,500,000	343,980,000	191,520,000

-susceptible species regionally but is not affected in The Bahamas. This species' density increased slightly between 2019 and 2023. Similar trends were observed from rapid assessments data: all species' abundance decreased except for *Solenastrea intercepta*. This decrease varies between methods: using AGRRA is, on average, around 42.16%, and using rapid assessments, 69.28% (Table 1). This information, combined with the coral reef data from the Caribbean marine maps from The Nature Conservancy (<https://caribbeanscienceatlas.tnc.org/>), allowed us to estimate how many coral colonies have died because of SCTLD since it started in 2020 around New Providence. For this, coral colony density was calculated using the data collected from AGRRA and extrapolating it to a total reef area (approx. 63 sq. km, Source: TNC). We estimated that we have lost about 191 million coral colonies from 11 species around New Providence (including Rose Island) (Table 2).

Our results suggest that The Bahamas is facing similar changes and losses as seen in other Caribbean areas affected by SCTLD (Estrada-Saldívar et al. 2020; Alvarez-Filip et al. 2022; Hayes et al. 2022), including the high risk of regional extinction, as is the case of the pillar coral (*Dendrogyra cylindrus*). Specifically for The Bahamas, other species are facing a high risk of local extinction, including the elliptical star coral, (*Dichocenia stokesii*), the flower coral (*Eusmilia fastigiata*), and both maze brain coral (*Meandrina meandrites* and *M. jacksoni*). For other species, the decline might not mean regional or local extinction but implies a higher risk of colony isolation, bottleneck events, and a decreased ability to cope with environmental changes. In addition, this massive die-off affects reef structure and functionality, increasing macroalgae dominance, higher abundance of opportunistic species, and the decline in reef accretion as a result of the mortality

of major reef-building species (Estrada-Saldívar et al. 2020; Alvarez-Filip et al. 2022; Toth et al. 2023). Long-term consequences in the decades to come include a decrease in reef framework production and habitat complexity (Alvarez-Filip et al. 2022). Consequently, we will be losing coral reef ecosystem services, directly affecting economies in countries like The Bahamas and their inhabitants. The loss of coral colonies and its potential effects on reef functionality call for governmental and non-governmental organizations to work on conservation and management strategies for conserving the remaining corals and for effective coral restoration programs.

KEYWORDS: Coral mortality, coral reef degradation, reef functionality loss, local coral extinction

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