Stony Coral Tissue Loss Disease Monitoring and Action Plan

Belize

Background

Stony coral tissue loss disease (SCTLD) was first seen in Florida in 2014 and since, other locations in the Caribbean have identified similar signs of the disease on their reefs. As of August 1, 2019, the disease has been confirmed in the Caribbean countries and territories of Jamaica, Mexico, Sint Maarten, the Dominican Republic, the U.S. Virgin Islands (St. Thomas), the Turks and Caicos Islands and Belize. The disease is characterized by its high mortality rate. Affected coral colonies present lesions that rapidly expand outward and can ultimately kill all live tissue.

The disease affects over 20 coral species of hard corals (Table 1) and is contagious between individual corals and among coral species. Highly susceptible species, such as the pillar coral (*Dendrogyra cylindrus*) are often the first to show signs of the disease, with the species of intermediate and low susceptibility showing signs thereafter. It is water-borne and can also spread through contact. Research to determine the pathogen(s) involved is ongoing and although one is yet to be determined, applications of the antibiotic amoxicillin have curbed disease progression in both laboratory and field experiments.

Identification of SCTLD is based on a multi-factor field diagnosis based on the characteristics such as species affected, the order in which species are affected, and prevalence of affected colonies within a given area.

Table 1. Degree of Susceptibility Found in Hard Coral Species (Adapted from Atlantic and Gulf Rapid Reef Assessment Program, 2019a).

High Susceptibility	Intermediate Susceptibility	Presumed Susceptibility	Low/No Susceptibility
Colpophyllia natans (Boulder brain coral)	*Orbicella annularis* (Lobed star coral)	*Agaricia agaricites* (Lettuce coral)	*Porites astreoides* (Mustard hill coral)
Dendrogrya cylindrus (Pillar Coral)	*Orbicella* faveolata (Mountainous star coral)	*Agaricia* spp. (Plate / saucer corals)	*Porites porites* (Finger coral)
Dichocoenia stokesii (Elliptical star coral)	*Orbicella franksi* (Boulder star coral)	*Madracis arenterna* (Pencil coral)	*Porites divaricata* (Thin finger coral)
Diploria labyrinthiformis (Grooved brain coral)	*Montastrea cavernosa* (Large-cup star coral)	*Favia fragum* (Golfball coral)	*Porites furcata* (Branched finger coral)
Eusmilia fastigiata (Smooth flower coral)	*Solenastrea bournoni* (Smooth star coral)	*Mussa angulosa* (Spiny flower coral)	*Acropora palmata* (Elkhorn coral)
Meandrina meandrites (Maze coral)	*Stephanocoenia intersepta* (Blushing star coral)	*Scolymia* spp. (Disc coral)	*Acropora cervicornis* (Staghorn coral)
Pseudodiploria strigosa (Symmetrical brain coral)	*Siderastrea siderea* (Starlet coral)	*Isophyllia* spp. (Sinuous cactus coral; rough star coral)	*Oculina* spp. (Bush corals)
Pseudodiploria clivosa (Knobby brain coral)			*Cladocoraarbuscula* (Tube coral)

Belize's SCTLD action plan will involve ongoing monitoring and treatment, where needed, by trained members of the National Coral Reef Monitoring Network, allowing more focused and timely response. An overview of monitoring and treatment activities can be seen below.

Monitoring

A multi-step SCTLD monitoring approach is recommended at the sub-regional level depending on the management needs and the stage of the disease (Image 1).

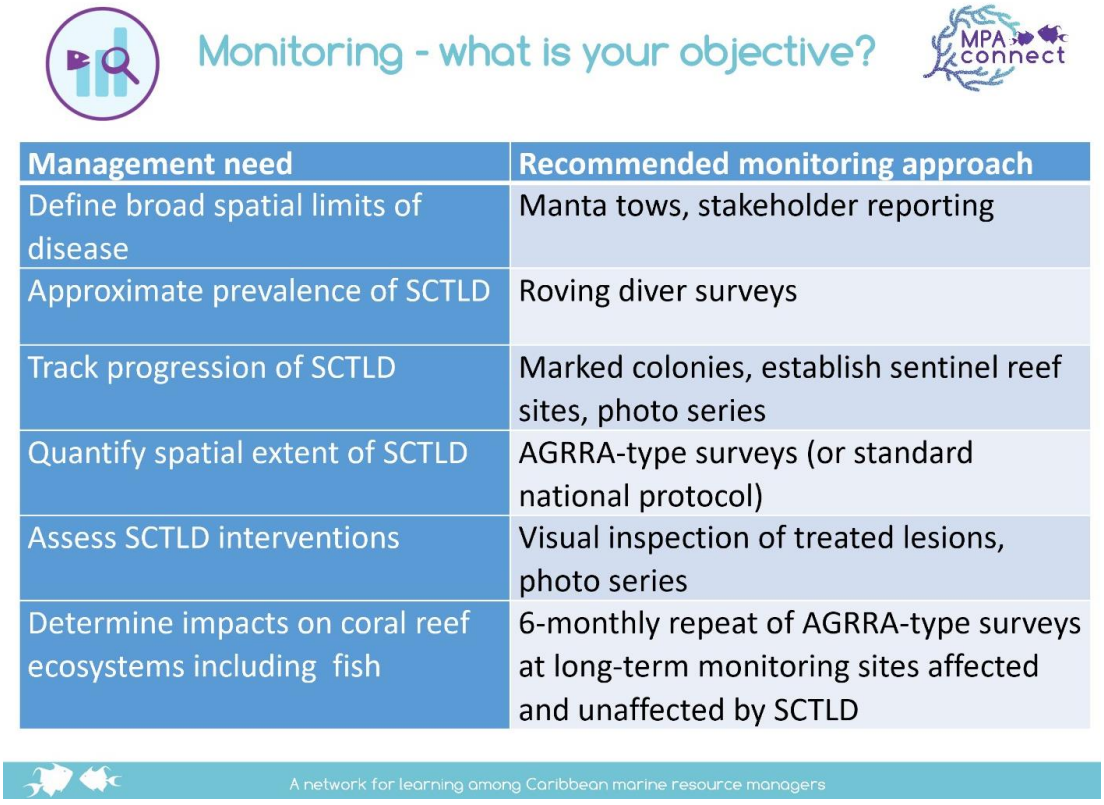

Image 1 Recommended approaches based on management needs

Belize's objectives are to:
(i) Identify early signs and affected species within the pre-invasion, invasion and epidemic conditions or periods in the various sub-regions.
(ii) Document progression of the disease in the invasion zone
(ii) Quantify spatial extent of SCTLD on the reef

Objective 1: Identify early signs and affected species within the pre-invasion, invasion and epidemic conditions or periods in the various sub-regions.

Pre-Invasion, invasion and epidemic conditions are defined by the duration of an area's exposure to SCTLD, disease prevalence and an evaluation of affected colonies known to be susceptible to the disease (Table 2). Each condition may require varied monitoring and treatment frequencies.

Table 2. Exposure Categories for Coral Reefs that are, or may be, Affected by Stony Coral Tissue Loss Disease. Adapted from Neely, 2018.

Condition	Duration of Exposure	Disease Prevalence	Coral Community
Pre-Invasion	None	None	Normal, pre-disease coral communities
Invasion	< 3 months	Low. Acute lesions visible only on early susceptible species	Still has full suite of species, though early susceptible ones will be experiencing mortality
Epidemic	3 months – 1 year	High. Lesions acute as well as chronic	Rapidly transitioning between pre-diseased community and one with lower abundances / absence of susceptible species
Endemic	1 – 4 years	May be low since susceptible species are rare. May be chronic on remaining susceptible species	Few to no remaining susceptible species. Diminished coral cover and higher proportion of non-susceptible species

In respective areas, each network member should conduct surveys using the following protocol:

Conduct a census swim of the site, focusing on species that are primarily impacted by this disease outbreak. Multiple divers can conduct the survey at one site, but should partition the site amongst themselves either vertically by depth and/or horizontally in opposite directions from a common starting point, or in parallel (as on different reef lobes). Their data should be entered separately.

1. Swim around the site (no greater than 50 m from the recorded coordinates) for at least 10 minutes and record minimum of 100 colonies. This can be done with a modified coral bleaching datasheet, or with a data sheet set to record the following metadata:

    a. Name
    b. Date
    c. Site Name
    d. Latitude and Longitude in Decimal Degrees
    e. Time start and Time end of roving diver swim (10 minutes minimum, but longer is fine)
    f. Depth interval of survey.

2. Record the species code of stony coral species seen on the swim. Exclude Milleporids, Acroporids, and Porites astreoides (PAST). Focus on colonies greater than 4 cm. For each species, tally the number of colonies exhibiting each of the following conditions:

    a. Recently dead colonies (white skeleton, polyp structure intact) presumed dead due to disease. Colonies with obvious other causes of mortality (breakage, toppling) should be excluded.

b. Actively diseased colonies. Colonies with any level of SCTLD disease should be included here.
c. Non-diseased colonies with symptoms of concern, colonies that do NOT have any active mortality due to SCTLD, but are showing unusual pale spots or focal bleaching. Colonies with dark spot disease should also be included. In meta-analyses, these colonies will be lumped in with “non-diseased” colonies.
d. Healthy colonies. No active disease or unusual signs.

3. Photos can be taken of unusual or interesting disease sightings, but are not required.

Objective 2: Documenting progression of the disease in the invasion zone

Once SCTLD has been identified from surveys, the recommended method to track progression of the disease is to identify priority coral reef sites and priority coral colonies for monitoring. Sentinel reef sites and sentinel coral colonies can be identified and marked to monitor disease progression with photo tracking. The following guiding principles should be used to select priority sentinel coral reef sites:

Methodology — During November and December 2017, Divers using SCUBA surveyed and marked coral colonies with ‘cow ear’ tags of the following species if present: *C. natans*, *D. labyrinthiformis*, *D. stokesii*, *M. cavernosa*, *M. meandrites*, *O. faveolata*, and *P. strigosa*. A central buoy was placed on the site, and a distance and bearing from this buoy to each marked coral was recorded to aid the diver’s navigation of the site during routine monitoring. When each colony was initially marked, the proportion of older exposed skeleton that was not the result of the white blotch disease was recorded. We also measured each colony’s length, width, and height to the nearest cm. At approximate two-week intervals, each marked coral head was examined for the presence of white blotch disease and if noted, the proportion of the colony affected was recorded. If disease was observed, a photo was taken of the colony.

Previously collected reef health monitoring data can also be used to evaluate species diversity at known sites to aid in site prioritization.

Objective 3: Quantify spatial extent of SCTLD on the reef

In areas where SCTLD is known to be present and any response/interventions are being implemented, especially if in MPAs, then AGRRA-type surveys should be used so that the spatial extent of the disease can be quantified in defined transects. These should be repeated at 6 monthly intervals to provide periodic assessment of the interventions. AGRRA type surveys at long term monitoring sites affected and unaffected by SCTLD can also be used to determine impacts of the disease on coral reef ecosystems including fish populations.
Identify affected sites to conduct assessment using photo mosaics as an option.

Site selection at set intervals/distance apart to ensure accurate representation to document the extent of the spread

AGRRA Protocol can be downloaded at https://www.agrra.org/training-tools/

Treatment

Research to determine the pathogen(s) involved is ongoing and although one is yet to be determined, applications of the antibiotic amoxicillin have curbed disease progression in both laboratory and field experiments. The recommendation from disease experts in Florida (NOAA, Nova Southeastern University, Florida Fish and Wildlife Commission, Florida Department of Environmental Protection, Florida Keys National Marine Sanctuary) is to treat the disease as quickly and as aggressively as possible once identified in new locations. Large-scale field trials indicate that the best practice is currently the application of amoxicillin powder with CoreRx Base2B (a silicone formulation) in 1:8 ratio, given high failure rates of alternatives (see image 2). This involves small scale, topical use of antibiotics for in situ disease mitigation on coral species that are highly susceptible to rapidly spreading SCTLD. In the opinion of Florida experts, the success of the amoxicillin on rescued coral in controlled laboratory settings, combined with the rapid and catastrophic loss of the species in the wild, justified the limited and targeted application of antibiotics.

Objective: Assess SCLD interventions

The recommended methodology is visual inspection of treated lesions 7 days after initial treatment and then at 1 month after treatment, capturing photos for photo series comparisons.

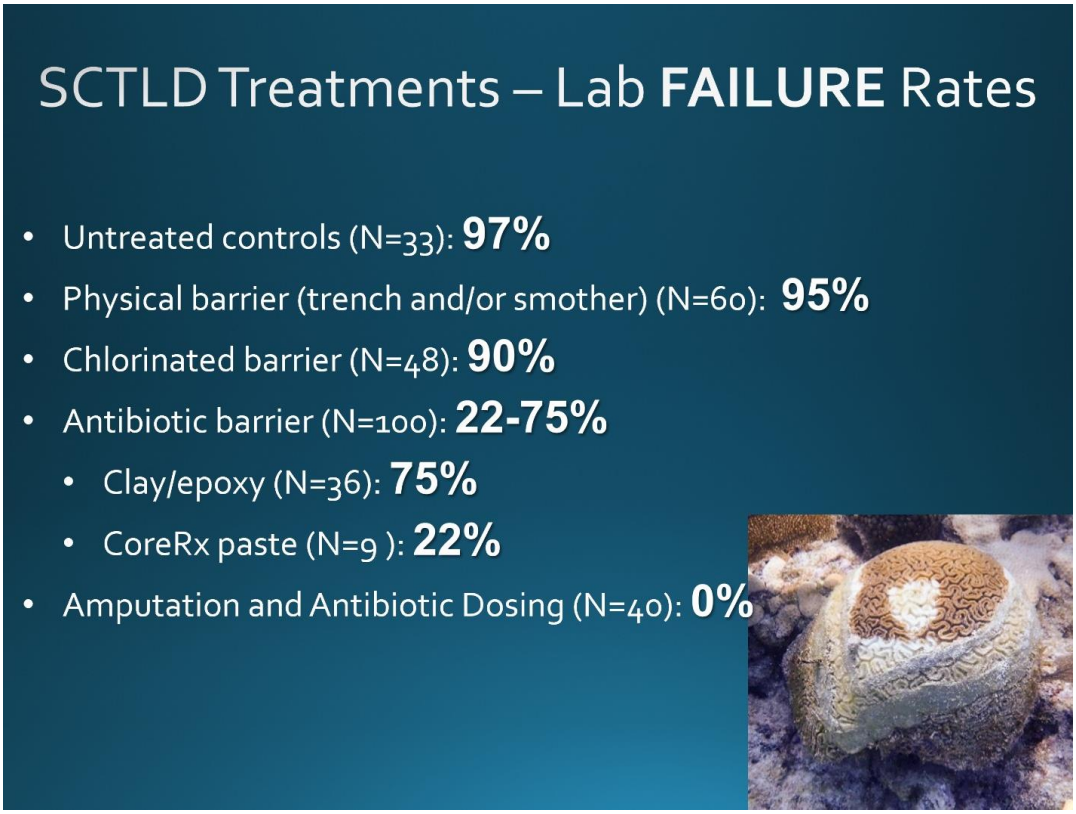

Image 2 showing failure rates of various treatment methods

Treatment Criteria

Selection criteria must guide the prioritization of SCTLD affected coral reef sites and coral colonies for monitoring and treatment. Large coral colonies close to others of the same species are priorities for monitoring and treatment, and colonies with a large amount of remaining tissue and a small number of active lesions are considered more treatable. Site selection criteria relate to the regulatory framework, for example, sites within an MPA may respond more positively to treatment since they may not be affected by additional stressors such as fishing pressure.

Recognizing limitations in capacity, corals should be prioritized for treatment according to the following guiding principles:

- Portion of colony unaffected: Treatment is likely to be more effective if the majority of the coral survives as a result. A recommended guideline is if greater than 75% of colony is still alive.
- Number of active SCTLD lesions: Each lesion requires initial treatment as well as follow-up. A greater number of lesions may also signify poorer overall health of a colony and thus a higher chance of new lesions developing. Colonies with fewer than 5 lesions are more treatable than those with more.

- Monitoring efficiency: Colonies in proximity to other treated corals, sites, or other ongoing projects will ease subsequent monitoring and re-treatment events.
- Suitability for treatment: Certain colonies may be disqualified for treatment for external reasons. For example, certain treatments (e.g. removal) may not be practicable if the coral is attached to a cultural resource. Individual sites and projects should consider these additional factors.

Permission from the Belize Fisheries Department must be obtained in writing, to treat any confirmed cases of SCTLD.

Methodology

The decision by the Belize Fisheries Department in regard to treatment is to approach with caution the use of CoreRx Base2B along with powdered amoxicillin, with proper documentation.

As per Neely, 2018, the protocol for applying antibiotics is as follows:

- Mix powdered amoxicillin into the CoreRx Base2B in a 1:8 by weight ratio. The current recommendation is **50g** of amoxicillin per 400g jar of CoreRx Base2B.
- Pack the mixture into a 30cc or 60cc syringe.
- Use the syringe to apply the CoreRx Base2B and amoxicillin mixture to cover the lesion and the immediate area surrounding the lesion. Use your fingers to apply the compound to ensure that it adheres to the lesion (Image 3) (Neely, 2018).
- For opportunistically treating Black Band Disease; Modelling clay can then be applied over the paste to increase adhesion to the coral (Doyle & O'Sullivan, 2019).

CoreRx Base2B should be mixed with amoxicillin powder just prior to application; otherwise the antibiotic will become ineffective after a few days. Reapply treatment if necessary, especially in highly susceptible species.

To prevent the spread of SCTLD, no-cost best practices such as diving healthy reefs before diving infected reefs are recommended. Local rental of dive and snorkel gear is highly recommended if traveling to or from a known contaminated site. Decontamination of gear involves soaking for 10 mins in 10% bleach solution, rinse in freshwater, air dry. The wash solution should be left out in the sun for 1 day to break down the bleach and it can then be disposed of without causing pollution.

Image 3 showing divers applying CoreRx Base2B with antibiotic to infect colony using syringes.

Reporting

Ongoing sightings for presence and absence of SCTLD should be reported to AGRRA website. Submission form can be access at https://www.agrra.org/experimental-interventions/.

On a monthly basis, reports on treatment success that include number of colonies, species affected, disease cessation etc, should be submitted via email to NCRMN. Data collected in line with objective three, where members will be assessing the spatial extent of SCTLD on reefs every six months, should also be included in the report when applicable. Following the Belize Fisheries Department template is recommended.
Each organization conducting treatment and monitoring should prepare a map reflecting the extent of disease within their area every 6 months.

Communication

Crisis communications measures are justified by managers in the face of the threat posed by SCTLD to coral reefs and associated economies. The lesson learned in Florida has been to ensure unified messaging by all partners involved in the disease, with careful use of appropriate language, minimum use of abbreviations, acronyms and technical jargon. Suggested language for use by managers in describing coral disease is summarized in Image 4.

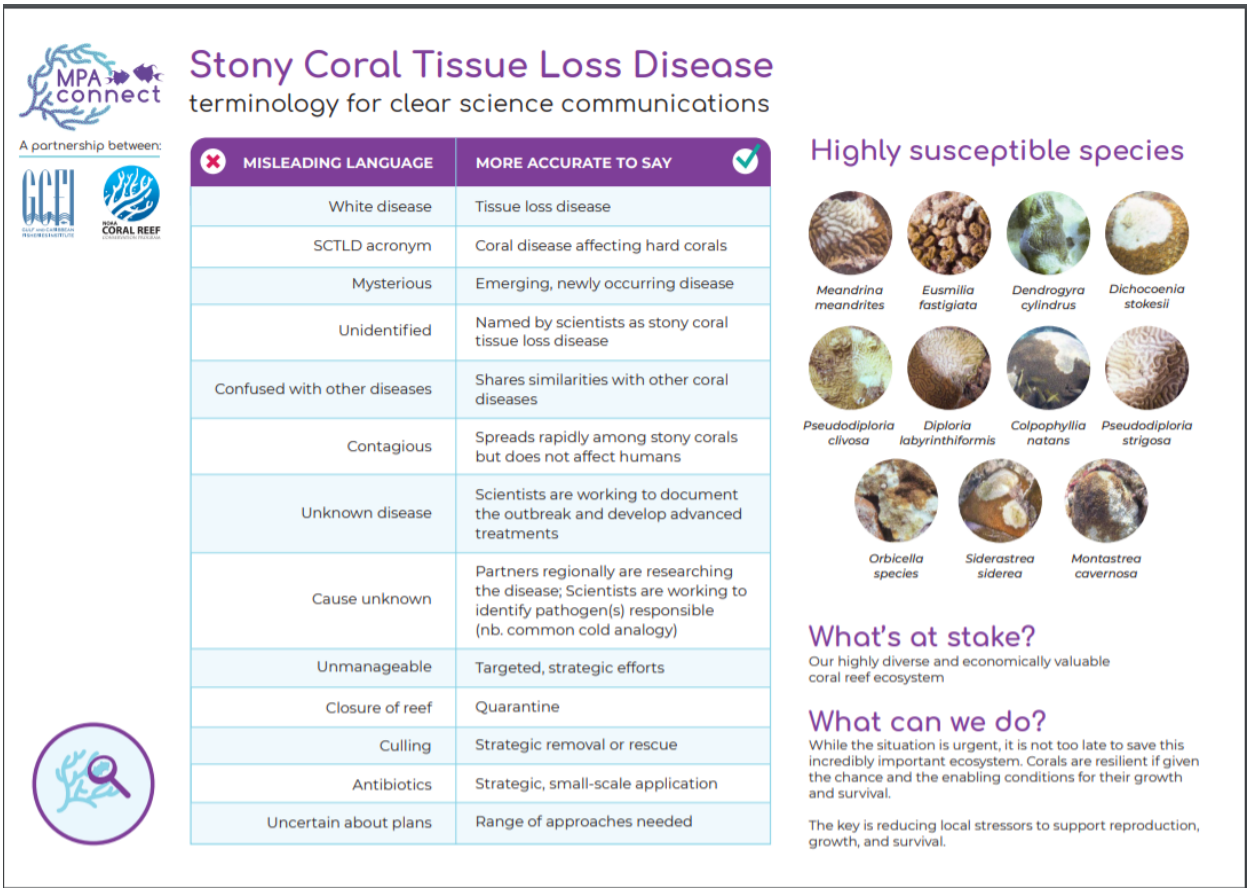

Image 4 Suggested language for use by managers in describing coral disease

Works Cited

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