Ninth Regional MPAConnect Peer-to-Peer Learning Exchange: Planning for Coral Rescue as a Response to SCTLD in the Caribbean

September 26, 2022
KEY LARGO, FLORIDA

Participants during the learning exchange (Photo: MPAConnect)

E. Doyle, J.C. Lang, C. McLaughlin, G.M. Ochoa, C. O'Sullivan and D. Wusinich-Mendez, Gulf and Caribbean Fisheries Institute, September 2022

TABLE OF CONTENTS

Please cite as: Doyle, E., J. Lang, C. McLaughlin, G.M. Ochoa, C. O'Sullivan and D. Wusinich-Mendez. 2022. Report on the Ninth Regional MPAConnect Peer-to-Peer Learning Exchange on Planning for Coral Rescue as a Response to SCTLD in the Caribbean. September, 2022, Key Largo, Florida.

This workshop report was prepared for the NOAA Coral Reef Conservation Program and United States Agency for International Development (USAID) project "Broadening MPAConnect Engagement with Priority Marine Protected Areas in the Caribbean Region", implemented by the Gulf and Caribbean Fisheries Institute (GCFI). The contents are the responsibility of GCFI and do not necessarily reflect the views of USAID or the United States Government.

The authors would like to thank all of the presenters and experts who helped to make the learning exchange a success. The learning exchange occurred during a particularly trying time, as Hurricane Ian moved through the Wider Caribbean Region. While some presenters were unable to attend in person, they either sent pre-recorded presentations or presented remotely via Zoom. Coral rescue experts attending the Reef Futures conference also graciously offered to step in and share their expertise when others could not attend. We are also grateful to the participants who attended the event and shared their experiences or expectations with us during the learning exchange.

Executive Summary

1. With stony coral tissue loss disease (SCTLD) now occurring in 25 countries and territories in the Caribbean region, coral reef managers need tools to save specimens representative of the unique (endemic) biodiversity of these slow-growing, reef-building corals. Where the disease has already decimated reefs, managers also need practical ways to keep rescued stony corals alive until oceanic ecosystem health has improved enough to realistically repopulate reefs. Coral rescue has developed to preserve the biodiversity of stony corals, and to help sustain ecosystem resilience during future coral disease outbreaks. MPAConnect's ninth regional peer-to-peer learning exchange focused on planning for coral rescue in the Caribbean in the face of SCTLD. It was held over one day in September 2022 in conjunction with the Reef Futures conference and attended by 43 coral reef managers and practitioners representing 15 Caribbean countries and territories.

2. There are various possible approaches to coral rescue. Collecting healthy or surviving corals (a form of gene banking) has been an early method adopted for coral rescue, whereby corals are held ex-situ in tanks with adequate husbandry eg. filtration of water to prevent disease spread and the provision of adequate nutrition to support their health. The ex-situ coral nursery approach has generally been used to prevent healthy corals from becoming infected with SCTLD and to provide opportunities for future coral propagation through micro-fragmentation or through captive spawning of ex-situ brood stock.

3. Coral rescue can also be approached through assisted fertilization of coral gametes and the subsequent rearing of coral larvae for distribution or out-planting on reefs. Gametes can either be collected from ex-situ brood stock or from wild spawning corals in the field. Good knowledge of coral reproduction types and the local coral spawning calendar is required for the collection of gametes by either approach. Laboratory equipment can be used to ensure assisted fertilization, with coral larvae reared in ex-situ or in-situ coral nurseries, the latter involving floating tanks or basins anchored at sea. Compared with ex-situ nurseries, in-situ nurseries can require significantly less investment in infrastructure, space and therefore funding. The lowest-tech and lowest-cost approach to assisted fertilization can involve the mixing of gametes in the field and then broadcasting the larvae.

4. The approach ultimately selected for coral rescue depends on the local conservation objectives and available resources, especially funding, space, equipment, and labor. In all cases, collaboration with a range of different stakeholders is necessary, including with government agencies, the private sector, researchers, and not-for-profit organizations.

5. The prioritization of coral species to be rescued is a key step in any coral rescue approach. This can be based on disease susceptibility, speed of the disease's progression, whole colony mortality, reef building contribution, conservation status, reproductive strategies and the amount of available space, staff, and funding.

6. Accessing funding for coral rescue involves tailoring sustainable financing solutions to the local context. This can require creativity and will involve engaging a wide range of stakeholders and possible partners. While not all partners might be able to provide cash funding, they could provide in-kind support such as donations of dive tanks, boat time, fuel, labor etc. Examples of sustainable financing mechanisms for coral rescue include sales of merchandise, symbolic reef adoption programs, sponsored events, paying volunteer programs, coral reef parametric insurance programs, and establishing alliances with conservation trust funds. Good communications about coral rescue are important in securing financing and building strong partnerships for implementation.

Introduction

First reported in Florida in 2014, as of September 2022 stony coral tissue loss disease (SCTLD) has since been confirmed in 25 countries and territories in the Caribbean region. At MPAConnect's last peer-to-peer learning exchange about SCTLD, held in Key West in 2019, coral reef managers learned how to identify, monitor, and treat corals affected by SCTLD. Countries in the region stepped up to the challenge to monitor and report on SCTLD regionally, to treat corals and to involve their local communities and stakeholders in responding to the disease. However, as the threat of SCTLD is still imminent managers are looking at different approaches to rescue corals on their reefs, depending on their objectives and needs.

A ninth peer-to-peer exchange was held on September 26, 2022 to assist coral reef managers and conservation practitioners in their efforts to plan for, and implement, the rescue of coral species that are being affected by SCTLD. This regional peer-to-peer learning exchange was an initiative of MPAConnect, a partnership of the Gulf and Caribbean Fisheries Institute and the US National Oceanic and Atmospheric Administration's Coral Reef Conservation Program (NOAA CRCP) with a network of Caribbean coral reef MPAs. The learning exchange was also supported and co-facilitated by the Atlantic and Gulf Rapid Reef Assessment Program (AGRRA) and Florida Sea Grant. It was funded by the US National Oceanic and Atmospheric Administration's Coral Reef Conservation Program as part of larger support to MPAConnect in 2023 together with USAID, and with additional sponsorship from the Dutch Caribbean Nature Alliance. It was held at the Ocean Reef Club in Key Largo in conjunction with the Reef Futures conference and was attended by 43 coral reef managers and practitioners representing 15 Caribbean countries and territories (see group photos in Figure 1).

Figure 1: Participants in the MPAConnect regional peer-to-peer learning exchange on planning for coral rescue as a response to SCTLD, Key Largo 2022 (Photo: MPAConnect)

The learning exchange shared advice and guidance from experts in different coral rescue approaches from the Florida Fish and Wildlife Conservation Commission (FWC), American Zoos and Aquariums (AZA), NOAA CRCP, Florida Keys National Marine Sanctuary (FKNMS), the Mexican National Institute of Fisheries and Aquaculture (INAPESCA), the Institute for Socio-Ecological Research (ISER), Reef Institute, Coral World Ocean and Reef Initiative, Turks and Caicos Reef Fund, Dominican Foundation for Marine Studies (FUNDEMAR), and Roatan Marine Park. A participant list can be found in Appendix I and a summary press note is provided in Appendix II. The press note was also distributed in Spanish.

Objective

The objective of the learning exchange was to assist coral reef managers and conservation practitioners in their efforts to plan for, and implement, the rescue of coral species that are being affected by SCTLD for the purpose of supporting the future restoration of these species on Caribbean coral reefs.

Peer-to-peer sharing

The learning exchange provided an opportunity for participants to gain new knowledge about coral rescue as a response to SCTLD, and to actively plan for possible approaches to coral rescue at their sites using new MPAConnect planning tools and with the guidance of experts and mentors. The agenda for the learning exchange is included as Appendix III. The presentations were divided into two sections, “Deep Dive into Coral Rescue” and “Getting Support”. Speakers in the section on coral rescue presented on implementing coral rescue initiatives including the need for coral rescue planning and identifying goals, relevant strategies and technology. Speakers in the section on support presented on financing mechanisms, and partnership-building. Participants had the opportunity to speak to coral experts directly through an interactive “Coral Rescue Cafe” and spent time mapping out an initial approach to coral rescue in their respective jurisdictions.

Figure 2: Dana Wusinich-Mendez (NOAA CRCP) introducing the MPAConnect Program (Photo: C. McLaughlin)

An overview of coral rescue in simple, infographic format (Figure 3) was used to help guide sharing about coral rescue throughout the learning exchange. As the first such infographic developed to conceptualize possible approaches to coral rescue, this supporting material helped to link the key steps and elements involved in the different approaches to coral rescue and provided the participants with a clear overview of the options available to them.

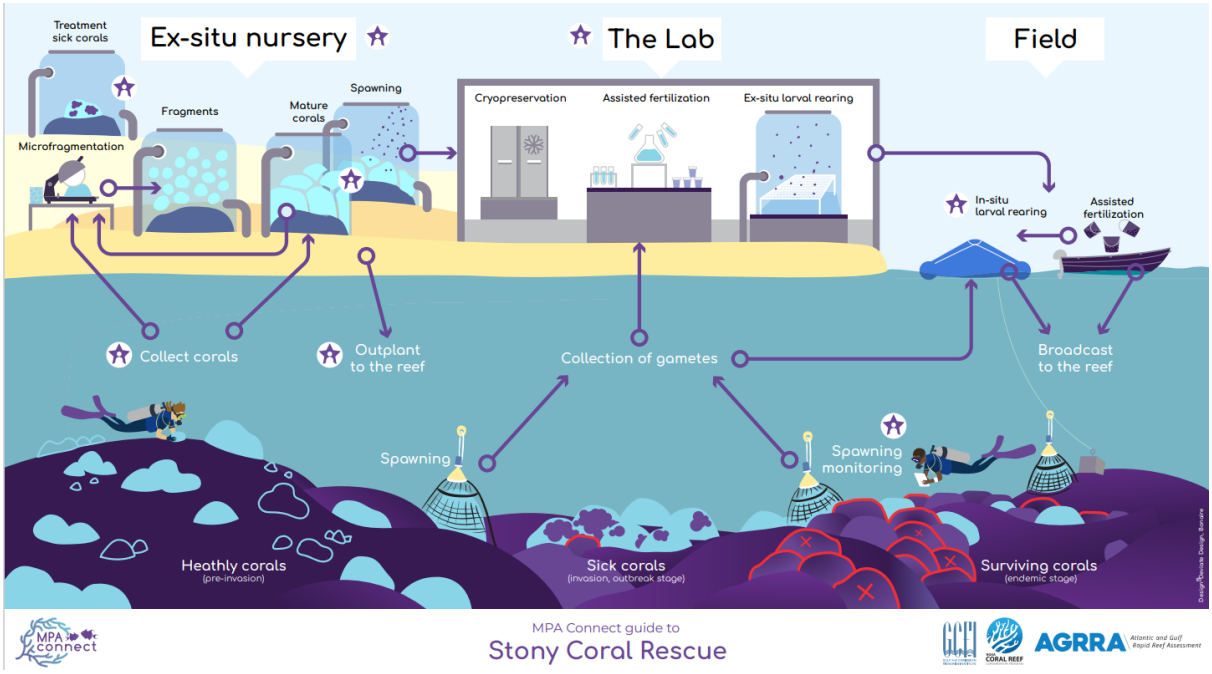


Figure 3. MPAConnect guide to stony coral rescue

The following approaches to coral rescue were considered:

Development of a Coral Collection Plan

1. A collection plan is required to establish a gene bank of corals, setting out species, genotypes and numbers of healthy corals to be collected from the wild.

2. Selection criteria should be developed and applied to identify and prioritize good candidate species for collection. These can be based on disease susceptibility, speed of the disease's progression, whole colony mortality, reef building contribution, conservation status, reproductive strategies, and the amount of available space, staff, and funding.

   In Florida, coral species were ranked according to four categories:

   - High priority-target: early susceptibility of the species to SCTLD, fast progression of SCTLD when the species is affected, high mortality of SCTLD-affected corals of important reef building species, ESA-listed or rare coral species;
   - High priority-opportunistic: Early susceptibility, fast progression, high or partial mortality, can survive multiple infection events, ESA-listed or rare species, species presence habitat specific;
   - Medium priority: later susceptibility, presence rare to low, species can survive multiple infections, species presence habitat specific;
   - Lower priority: late susceptibility, low mortality, rare to low abundance, low contribution to reef building.

3. Ensure genetic variability within the collection by planning to collect as much unique and potentially adaptive genomic diversity as practical. The genetic target for restoration is approximately 50 genets/species. This conservative estimate helps avoid inbreeding depression. In Florida, given the fact that there was no time or equipment to genotype corals, a target goal of collecting approximately 200 colonies/species was set. This became more difficult as the disease margin progressed. It is important also to collect colonies/species from reefs which are spatially and geographically different. Collections should create genet catalogues/databases to house all genetic information, and this should be available to the public.

4. Assess the health of the corals to be collected, as these will serve as the brood stock for future restoration efforts. Collected corals should:

    - Be between 10 - 30 cm in diameter. Collecting corals between these sizes will ensure that you are collecting adult corals which will produce offspring;
    - Have live tissue edges;
    - Not have any type of tissue loss, including abrasions or irritations;
    - Be as healthy as possible; and
    - Be easily removed from the substrate.

    If any part of a colony does not meet all health criteria, no part of the colony should be collected.

5. When transporting corals, conditions should remain as close as possible to the conditions present at the collection sites, in order to prevent stress. Use clean insulated containers and keep corals out of the sun. Bubble wrap can be used to prevent sloshing around and will help to keep corals in place. Water changes should be conducted every 2 hours.

6. Plan for biosecurity and maintain corals in artificial or natural sea water which is treated with managed ozone dosing and/or ultraviolet (UV) exposure. This is necessary to avoid infection by SCTLD. Additionally, cross contamination should be avoided by using only bio media, rocks or co-inhabitants that are from the same place from where the corals were sourced.

Gene Banking in Ex-situ Coral Nurseries

7. In the Dominican Republic, Mexico and Belize, small-scale, cost-effective ex-situ coral nurseries have been developed. These can be housed inside a building or outside and use closed systems. Figure 4 depicts an affordable closed system design.

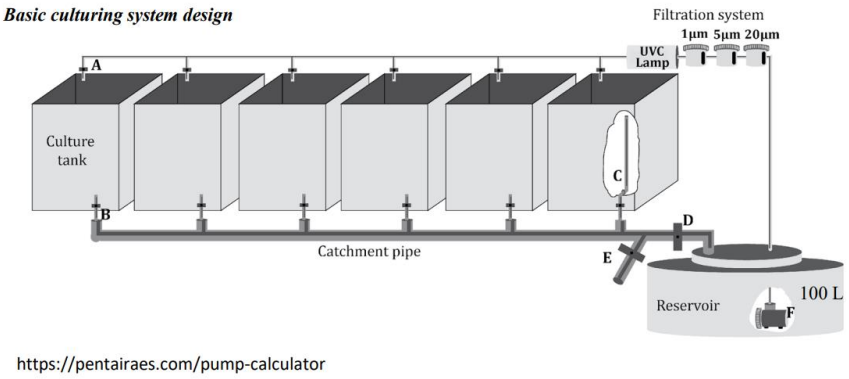


Figure 4: Basic culture design used in the Dominican Republic (Photo: Pentaires)

An outdoor, semi-protected system (housed partly outdoors with minimal cover), which is used by the University of Belize, is the most basic and least expensive in use. This type of system does not provide life support and is used mostly for larval propagation. In the Dominican Republic a shipping container was used by FUNDEMAR to house more advanced versions of the Belize system. Information on the development of these systems may be found here. The cost of these facilities varies between 5,000 USD to 30,000 USD (based on costs in the Dominican Republic), excluding operational, property and personnel costs.

8. In Mexico, INAPESCA has developed a coral rescue facility for the genetic banking of live corals. This facility has both outdoor raceways for resilient colonies called "mesocosms" and six indoor tanks used as quarantine modules where colonies affected by SCTLD can be treated. According to Claudia Padilla, the facility has been operating for three years and they have rescued 28 colonies of reproductive size. Approximately 10 colonies, belonging to 9 species, have spawned in the system. The team has cryopreserved sperm from *Pseudodiploria strigosa* and *Dendrogyra cylindrus*.

9. In the U.S. Virgin Islands (USVI), methods to collect and treat infected corals in ex-situ facilities have been developed. These use amoxicillin water dosing to treat in-coming corals. The goal of this approach to coral rescue is to mitigate population declines and preserve the biodiversity of SCTLD-affected species. This technique is most applicable for countries or sites in the invasion or epidemic phase. The resources needed for this type of coral rescue are personnel with experience in coral health or disease and aquarists. These ex-situ coral rescue facilities have life support systems with one system used for general holding of specimens while another is used to quarantine specimens. Containers are used to dose infected corals. These flow-through systems use a UV sterilizer to decontaminate incoming seawater. The use of critical care protocols is extremely important for treating coral ex-situ.

10. As with other approaches to coral rescue, prioritizing coral colonies for collection is key.

11. Ex-situ coral nurseries are very flexible and can be used for a variety of purposes and in different stages of the SCTLD epidemic. These systems can be either closed or flow through, depending on the water conditions in the area. Most commonly they are used to house coral colonies or coral fragments/microfragments. Simpler and cost-effective closed systems can be used for larval propagation.

12. Postlarval sea urchins *(Diadema antillarum, Tripneustes ventricosus)* can also be reared in ex-situ nurseries and out planted with nursery corals for their enhanced survival on reefs in which natural levels of herbivory are too low to prevent benthic algae from overgrowing corals.

Larval Propagation and In-situ Coral Nurseries

13. In-situ coral nurseries can be an alternative to ex-situ coral nurseries, especially for coral rescue via larval propagation. In-situ nurseries involve housing coral larvae inside floating tanks or basins that are anchored at sea. They require significantly less investment in infrastructure, land, and operating costs than ex-situ nurseries.

14. Coral rescue can be approached through assisted fertilization of conspecific gametes and the rearing of coral larvae for distribution or out-planting to the reef. Assisted fertilization of corals can draw on the collection of gametes from ex-situ brood stock or from wild spawning corals in the field. The collection of gametes in the field demands good knowledge of coral reproduction types and time and

labor-intensive spawning monitoring. Before setting up a spawning monitoring program it is important to determine your goals and priority species. Most coral species that are susceptible to SCTLD are hermaphrodites, meaning they spawn bundles of sperm and eggs. However, most highly susceptible species are gonochoric and have both male and female colonies. Once species are selected it is important to either use a spawning calendar from an area near you or take the time to create your own calendar and validate it. After validating your calendar, gamete collection and assisted fertilization can be conducted. Monitoring should start a day before, and end the day after, your predicted spawning date. For site selection, it is important to choose a site with approximately 10 colonies of your target species.

15. A laboratory setting and relevant equipment can be used to ensure assisted fertilization of corals. For the larvae to settle and grow, several partners have opted to use Coral Rearing In-situ Basins (CRIBs), developed by SECORE. The CRIBs can be set up on land and then transported into the water, where they can house 2000 substrates for larvae to settle on. However, CRIBs are proving inappropriate for some environmental settings, e.g., along coastlines with Sargassum influx or with rough seas. Additionally, certain species might not settle successfully in a CRIB.

16. The lowest tech/lowest cost, but likely lower efficacy approach to assisted fertilization, can involve the mixing of gametes in the field and then broadcasting the larvae.

Planning and Technical Mentorship

17. In the interactive Coral Rescue Cafe section of the program, participants had the opportunity to speak with experts and mentors for further technical advice about coral rescue. The participants rotated around six coral rescue tables with different technical topics: (1) Ex-situ nursery development, (2) Ex-situ treatment of SCTLD- affected corals, (3) In-situ larval rearing and coral spawning monitoring, (4) Ex-situ larval rearing, (5) Outplanting and survivorship and (6) Coral rescue supplies. The participants were provided with handouts for note-taking and planning, including the overview infographic (Fig. 3), selection criteria for collection (Appendix IV) and the coral rescue planning canvas (Fig. 5). The planning canvas served to highlight key elements in the planning process to help managers map the implementation needs for their selected coral rescue approaches. It also helped managers to think about the possible challenges they might encounter and how to overcome them. It was either completed electronically or filled in on broadsheet paper (Figs. 5&6). A copy of the canvas and other workshop materials can be found at Peer-to-Peer Workshop IX - Gulf and Caribbean Fisheries Institute (gcfi.org).

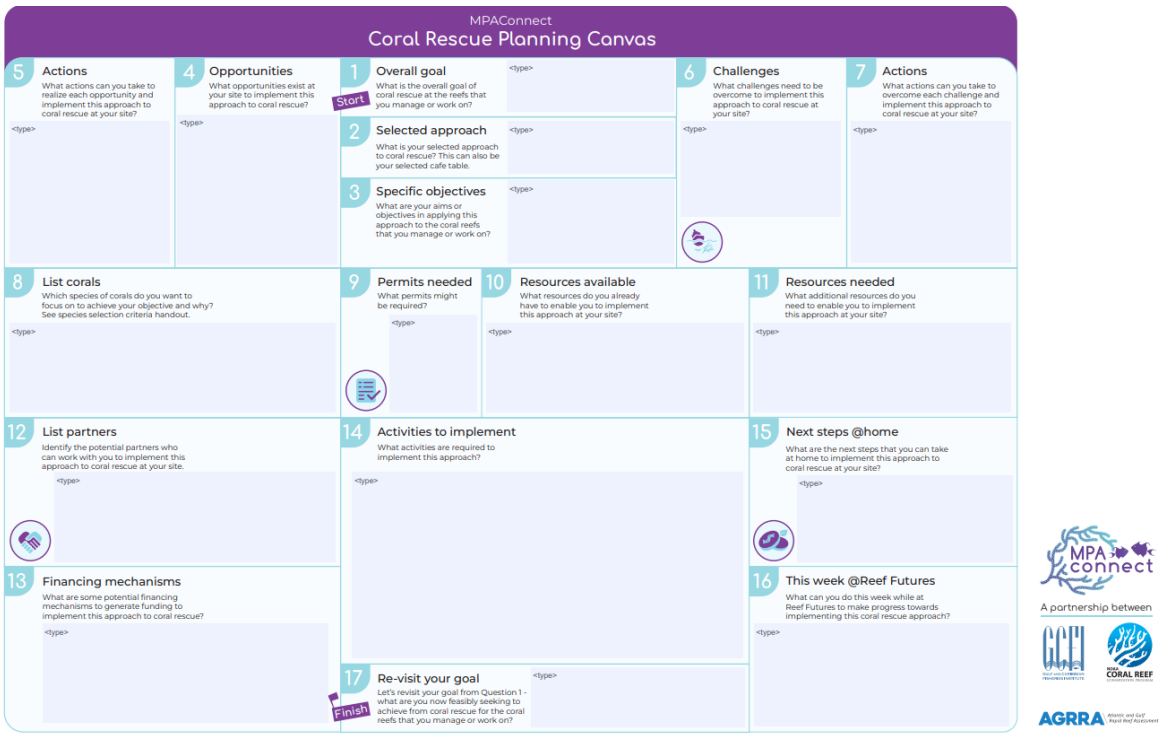


Figure 5. Coral Rescue Planning Canvas used by MPA Managers to plan their coral rescue approaches

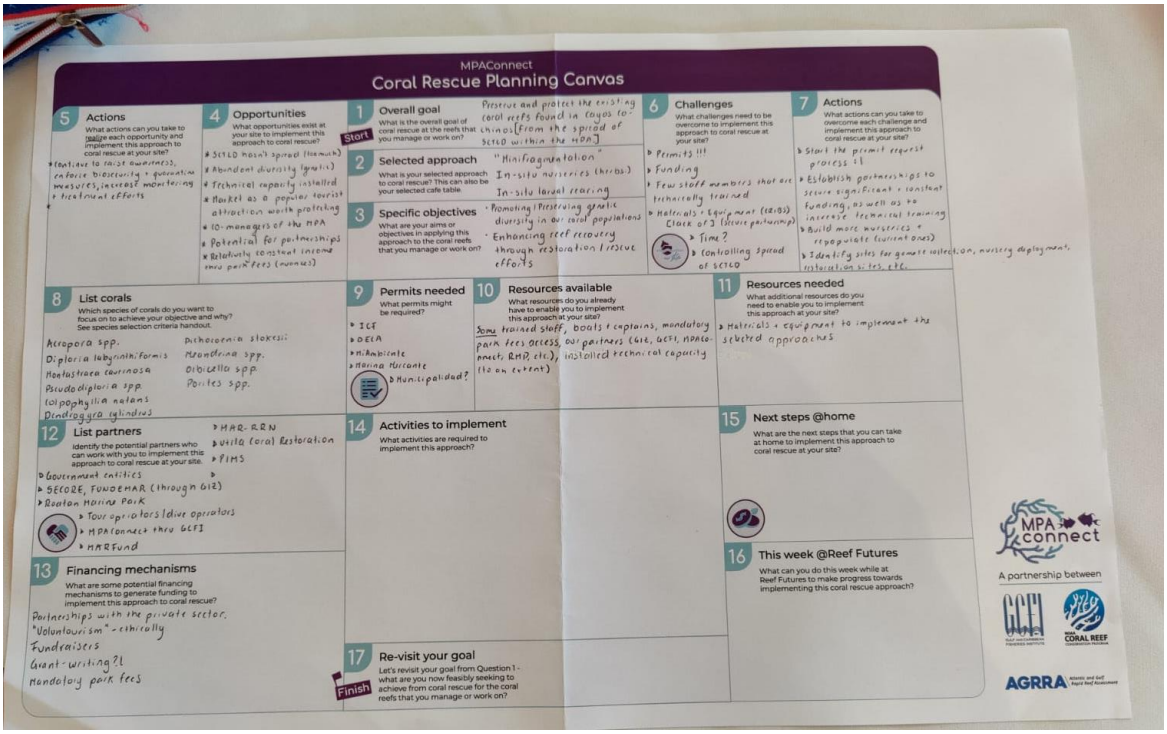


Figure 6. Sample coral rescue planning canvas in use by A. Godoy, Fundación Cayos Cochinos, Honduras

The experts/mentors for each coral rescue technical topic were:

- Ex-situ nursery development: Leneita Fix (The Reef Institute) and Alizee Zimmermann (Turks and Caicos Reef Fund);
- Ex-situ treatment of SCTLD affected corals: Logan Williams (St. Thomas);
- In-situ larval rearing and coral spawning monitoring: Maria Villalpando (FUNDEMAR) and Gabriela Ochoa (Roatan Marine Park/Gulf and Caribbean Fisheries Institute);
- Ex-situ larval rearing: Sergio Guendolain (FUNDEMAR) and Claudia Padilla (INAPESCA);
- Outplanting and survivorship: Andrew Bruckner (Florida Keys National Marine Sanctuary) and Sean Griffin (NOAA National Marine Fisheries Service), see Figure 7;
- Coral rescue supplies: Tanya Ramseyer (Florida Fish & Wildlife).

Figure 7. Participants in the Outplanting and Survivorship Coral Rescue Table led by Dr. Andrew Bruckner and Sean Griffin with NOAA (Photo: C. McLaughlin)

Financing for Coral Rescue

18. Financing coral rescue projects requires a collaborative and creative approach that engages a wide range of stakeholders. Engaging hotels and dive operators is a great way to get support to conduct your work. For example, dive operators can loan SCUBA tanks, boats, dive gear, etc. Being open to different partnerships and being flexible is very important. Corporate sponsorship with developments and resorts can support your work as well. There can be opportunities to collaborate with unlikely partners. For example, in the Turks and Caicos Islands (TCI) they have formed a collaboration with a rum company under the slogan "Rum Powered Research" which has raised over 28,000 USD for data collection and treatments in East Caicos.

19. MPAConnect shared lessons learned and tools/resources for sustainable financing for coral rescue which can be found in Figure 8. These derive from two peer-to-peer learning exchanges and 16 site-level projects on the implementation of sustainable financing initiatives.

Figure 8. Lessons learned on Financing Mechanisms and Sustainable Financing tools developed by MPAConnect.

Examples of key financing tools and resources include:

- The Eco2Fin Model guides you through a context analysis to assess ecosystem services, benefits, and decision makers involved to identify possible flows of funding. It uses SWOT analysis to identify obstacles and interventions to overcome those obstacles.
- Grants are the most common way to fund conservation action, but they are not very sustainable. A replacement for this type of funding can include the creation of alliances with conservation trust funds. Sustainable financing requires creative solutions to address financial gaps, and can include adoption mechanisms, sponsorship events, paying volunteers, entry fees, insurance, or the selling of merchandise.
- BIOFIN Catalogue and Panorama Solutions Database complement each other and are great places to find sustainable mechanism solutions in your region. Once you have determined some mechanisms, you can use a screening criterion to determine how successful and resilient they are.

- Good financial management is complemented by good budgets. MPAConnect has a budget template that MPA Managers can use. Forecasting can also be beneficial to understand, over the span of 3 to 5 years, the financial resources required to maintain your coral rescue initiatives.
- Some useful tools to support the development of sustainable financing mechanisms include the Business Model Canvas and the Value Proposition Canvas. The message box approach can help to target communications and develop strategic messaging. Social media can be very important in making effective calls to action for funding.

Developing Coral Rescue Partnerships

20. The Association of Zoos and Aquariums' Florida Reef Tract Rescue Project (AZA FRTRP) is the largest coral rescue operation in US history. This is a partnership between several organizations which to date has saved over 2,000 corals. The facilities are supported by holding facilities and friend facilities (facilities that are not able to hold corals but still help support the project's mission). Key lessons learned include:
    - The Seven Principles of Conservation Partnerships can support successful conservation projects. The principles are mutual interest and a shared vision, clear communication, trust and diversity, empowered leadership and effective decision making, evaluation and accountability, adaptability and creativity and sustainable resources.
    - For conservation partnerships to be successful it is important for the partners to have a shared vision and be able to work effectively together.
    - Clear consistent communication is essential for successful partnerships. Sharing successes, and failures, are integral to improving the management of coral rescue projects.
    - Conservation partnerships grow out of a recognition that the issues often take multiple interests, and the best solutions often involve multiple stakeholders. Partnerships built from varied experiences and expertise can be the most powerful, but these can also be mine-fields of competition for resources, recognition, and are sometimes characterized by disagreements to be resolved. Mediation and facilitation are a must!
    - Evaluation and accountability allow for changes in perspective and to acknowledge what is not wrong. Setting realistic roles and benchmarks is important for evaluation.

Collaborative Approaches

21. Since the first observations of SCTLD in Mexico, a strong collaborative approach has been used. Funds from the different participating groups were either allocated to specific tasks, reallocated from other projects, or SCTLD management was integrated into pre-existing projects. One of the main products of those early collaborations was the Mexican Action Plan, which was developed by representatives from 10 MPAs and more than 47 organizations. Lessons learned include:
    - Hiring a dedicated coordinator. If there is no sole coordinator to oversee communications and follow up with partners, it becomes difficult to maintain engagement and track progress.
    - Involving multiple stakeholders from the private sector, government, NGOs, and academia and sharing tasks according to organizational strengths. In Mexico, the teams at CRIAP-INAPESCA and Xcaret were involved in fragment and colony rescue at their facilities, while UNAM-Coralium focused on sexual reproduction and cryopreservation of gametes, which aligned with each of the participants' knowledge and individual objectives. Healthy Reefs Initiative played a

coordinating role, taking advantage of their many years of building collaborations and networks throughout the Mesoamerican Reef region. This involved the development of external communication materials, the collection of sighting reports, and the sharing of work done by partners through their extended networks. Amigos de la Isla Contoy assisted in administration and with the delivery of funding.

- Stakeholder engagement and keeping an open and transparent channel of communication is of utmost importance. Meeting regularly and creating exchange spaces to present and share the teams' strengths and challenges is also very important. Don't forget to celebrate even the "smallest" successes and have fun whenever you can.
- Adaptive management is key. Unforeseen events will happen, like hurricanes or pandemics. Having a simple plan with realistic objectives will enable organizations to adapt quickly.

Follow-up actions

After the learning exchange, GCFI and AGRRA worked with the participants in affected countries and territories, and with those seeking further support, to refine their coral rescue plans. This was done to support ongoing networking, secure funding for pilot coral rescue efforts, and assist with additional site-specific mentorship and additional capacity building. Specific follow-up initiatives include the:

1. Establishment, by MPAConnect, of a coral rescue WhatsApp group for continued networking among participants in the learning exchange, and the inclusion of other relevant colleagues and partners working on coral rescue in the Caribbean.
2. Efforts are being made to write proposals for funding to support our partner's rescue efforts in the Caribbean and further capacity building in coral reef monitoring and SCTLD response for all members of MPAConnect's network.
3. Provision of further one-on-one technical mentorship on stony coral rescue for specific MPAs. For example, mentorship for Soufriere/Scotts Head Marine Reserve and the Fisheries Division, Dominica in coral rescue planning by Roatan Marine Park and the Turks and Caicos Reef Fund.
4. Preparation of content for press and social media about Caribbean coral rescue, including co-authoring of a coral rescue article for Caribbean Compass (in press) by MPAConnect and Reef Renewal Bonaire.
5. Development of a summary table, by MPAConnect, which outlines different coral rescue approaches (Appendix V).

Participant evaluation of peer-to-peer learning exchange

At the end of the peer-to-peer workshop on Planning for Coral Rescue as a Response to SCTLD in the Caribbean, the workshop participants were asked to complete an evaluation form. This contained a mixture of open and closed-ended questions intended to evaluate the perceived usefulness, impact, and quality of the workshop. A total of seventeen questionnaires were completed by the participants.

Key findings from the evaluation were:

1. All participants (100%) would recommend the workshop to other colleagues.
2. A total of 94% reported that they now have more confidence in their ability to address coral rescue after participating in the workshop. They especially feel more confident speaking and communicating about the subject and developing stronger partnerships.
3. A total of 88% of participants reported that they learned something that they will apply in their work. The most important things they reported learning were about the different and scalable coral rescue techniques (8 mentions), partnerships (3 mentions) and financing (3 mentions).
4. Practically all participants (94%) reported that they desire further training. Topics suggested for further training and follow-up include larval rearing (5 mentions); in situ rescue (4 mentions); and financing (3 mentions).
5. The facilitators were rated highly, and Dana Wusinich-Mendez received a 94% rating as excellent/very good.
6. The handouts shared at the learning exchange were rated highly (82% rated the handouts as excellent/very good vs 79% average across all learning exchanges). The handouts included the MPAConnect Coral Rescue Poster and Coral Rescue Planning Canvas.
7. In addressing the disease, fewer participants than normal reported that they anticipate facing obstacles in applying what they learned (53% vs 63% average across all learning exchanges).

Appendix I

LIST OF PARTICIPANTS

	COUNTRY/TERRITORY	AFFILIATION
Facilitators/ Hosts		
Dana Wusinich-Mendez	USA	NOAA Coral Reef Conservation Program
Judy Lang	USA	AGRRA
Caroline McLaughlin	USA	Florida Sea Grant
Emma Doyle	USA	GCFI/MPAConnect
Gaby Ochoa	Honduras	GCFI/MPAConnect
Speakers/ Experts		
Claudia Padilla	Mexico	INAPESCA
Alizee Zimmermann	Turks & Caicos Islands	Turks & Caicos Reed Fund
Logan Williams	USVI	Coral World
Melanie McField	USA	Healthy Reef Initiative
Leneita Fix	USA	The Reef Institute
Maria Villalpando	Bayahibe, DR	FUNDEMAR
Sergio Guendulain	Bayahibe, DR	FUNDEMAR
Andy Bruckner	USA	NOAA Florida Keys National Marine Sanctuary
Sean Griffin	USA	NOAA National Marine Fisheries Service RC
Tanya Ramseyer	USA	Florida Fish and Wildlife Commission/Florida Wildlife Research Institute
Beth Firchau	USA	Association of Zoos and Aquariums
Participants		
Ayumi Kuramae	Saba	Saba Bank National Park
Marijn van der Laan	Saba	Saba Marine Park
Alicia Eck	Belize	Belize Fisheries Department
Nicole Craig	Belize	Healthy Reefs Initiative
Roddy McLeod	Turks & Caicos Islands	Department of Environment and Coastal Resources
Simon Walsh	Dominica	Soufriere/Scott's Head Marine Reserve
Zephra Baron	Dominica	Fisheries Division
Tammi Warrender	Cayman Islands	Department of Environment
Rachel Miller	The Bahamas	Perry Institute for Marine Science
Leslie Henderson	USVI	NOAA Coral Reef Conservation Program
Marilyn Brandt	USVI	University of the Virgin Islands
Matthew Warham	USVI	Department of Planning and Natural Resources
Courtney Tierney	USVI	Department of Planning and Natural Resources
Larry Dew	USVI	University of the Virgin Islands

Arelys Chaparro	USVI	University of the Virgin Islands
Erin Bowman	USVI	VI DPNR
Fabiola Riverra Irizarry	Puerto Rico	Sociedad Ambiente Marino
Samuel Suleiman	Puerto Rico	Sociedad Ambiente Marino
Caren Eckrich	Bonaire	STINAPA
Francesca Virdis	Bonaire	Reef Renewal Bonaire
Andrea Godoy Mendoza	Honduras	Cayos Cochinos Foundation
Gian Nunes	Aruba	Fundación Parke Nacional Aruba
Laurie Raymundo	Guam	University of Guam
Megan Murray	USA	Reef Renewal
Sam Cook	USA	FDEP/NSU
Victoria Baker	USA	Florida Sea Grant
Kathy Cummings	USA	Florida Fish and Wildlife Commission/Florida Wildlife Research Institute
Total attendees	**43 (female 33/males 10**	

Appendix II

Sharing strategies for coral rescue in the Caribbean

October 12, 2022 – The first Caribbean regional gathering on coral rescue recently brought together some 50 managers and experts from 15 countries to plan how to rescue and restore stony corals in the face of devastation caused by coral disease.

Since it first appeared in 2014 in Florida, stony coral tissue loss disease (SCTLD) has now spread to 25 countries and territories in the Caribbean region. Managers have responded by monitoring affected corals. In some cases, affected corals have been treated and some corals have successfully been saved. Other corals have proven resilient and survived despite the passage of the disease.

The Coordinator of the MPAConnect Network, Emma Doyle, commented: "Caribbean coral managers are looking for additional tools to save the biodiversity of these slow-growing, reef-building stony corals in the face of coral disease. Where the disease has already decimated reefs, they're looking for practical ways to restore those stony corals that have been lost."

Coral rescue refers to efforts to preserve and restore the biodiversity of stony corals in the face of this rapidly advancing and devastating coral disease.

Dana Wusinich-Mendez, Atlantic-Caribbean Team Lead for NOAA's Coral Reef Conservation Program explained: "Coral rescue has become an important tool in our efforts to address the destructive impacts of stony coral tissue loss disease. It can serve as an insurance policy that will help Caribbean coral reef resource managers in their efforts to restore their reefs in the future as well as to build ecosystem resilience to future coral disease outbreaks."

Participants and experts at the MPAConnect peer-to-peer learning exchange "Planning for Coral Rescue as a Response to Stony Coral Tissue Loss in the Caribbean"

With there being much already known about the restoration of other faster growing species of coral, the recent Reef Futures Symposium in Key Largo served as the venue for a dedicated workshop on planning for stony coral rescue. Regional coral experts shared about new approaches, latest science and evolving technologies to help save Caribbean stony corals that are otherwise succumbing to disease.

"As the field evolves, we're seeing a trend towards ex-situ coral rescue in the form of land-based nurseries housing whole healthy corals or microfragments of healthy corals. We're also seeing more monitoring of coral spawning and rearing of coral larvae in lab settings or in-situ," explained Ms. Wusinich-Mendez.

MPAConnect's sponsored workshop participants stayed on for the 3-day Reef Futures conference. "Notwithstanding the interruptions in the program caused by Hurricane Ian, they were able to deepen their knowledge of coral rescue and restoration by networking with the many experts who were present and by joining feature presentations", commented Dr. Judy Lang, Scientific Coordinator for the Atlantic and Gulf Rapid Reef Assessment Program (AGRRA).

"We can see how creative approaches and technical support from all over the world are producing innovative techniques for stony coral rescue," commented workshop participant Andrea Godoy from Fundación Cayos Cochinos in Honduras.

Coral rescue can represent tangible action to help stem the loss of reef building corals and maintain services that reefs provide for coastal communities and national economies. From a management perspective, questions surround the feasibility of coral rescue in the Caribbean and the workshop sought to help managers address the various dimensions of relevant management capacity.

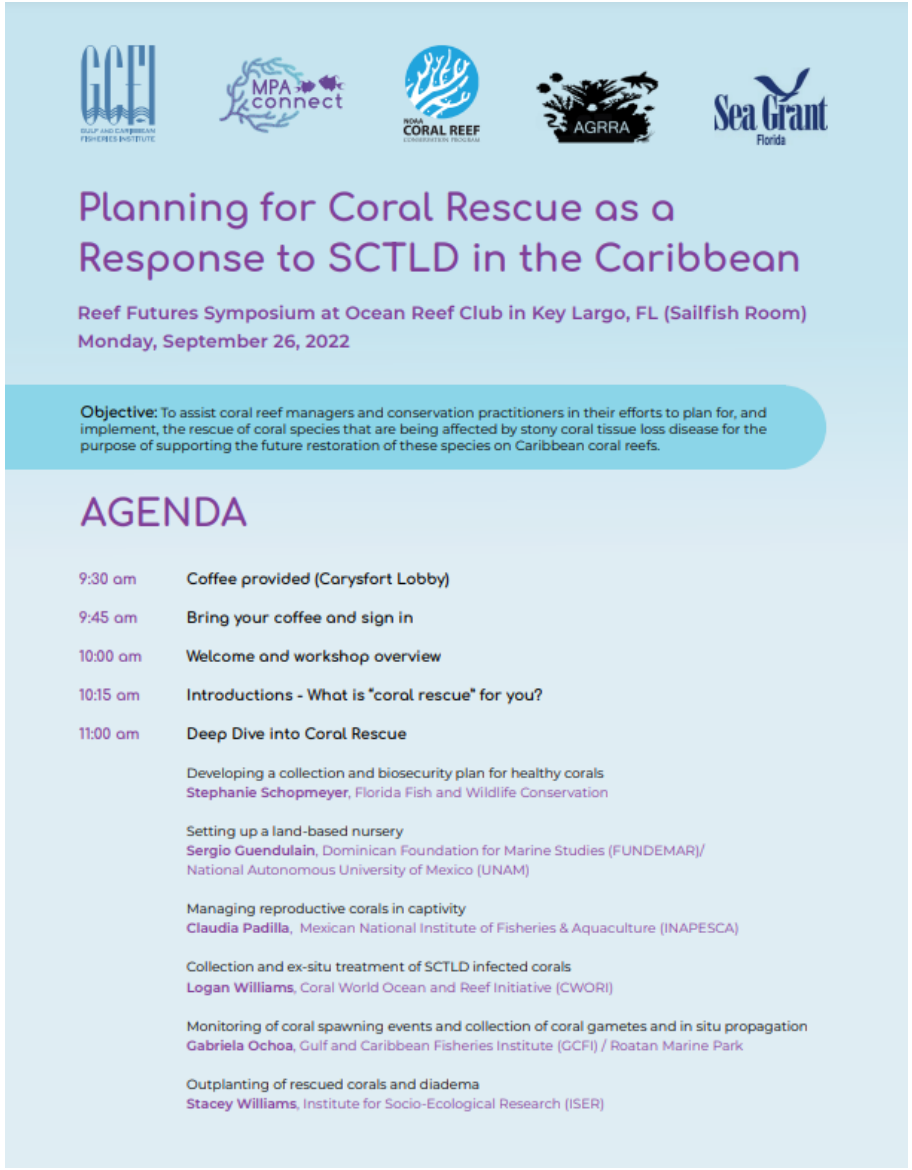
Caren Eckrich from STINAPA commented: "The workshop brought me in contact with others across the region battling SCTLD and I am now familiar with responses – those that worked and those that did not – as well as strategies for assisting our reefs and rescuing corals during the distinct phases of SCTLD."

Workshop co-host and co-organizer Caroline McLaughlin of Florida Sea Grant referred to the newly released Implementation Plan for NOAA's Stony Coral Tissue Loss Disease Response and Prevention Strategy: "We recognize that SCTLD will likely be present on Atlantic and Caribbean coral reefs for the foreseeable future. The plan emphasizes the importance of NOAA's continued collaboration with partners throughout the Caribbean, like GCFI and AGRRA, to build capacity for SCTLD response and enhance coral rescue programs throughout the region."

The presentations and materials used in the workshop will be available online at GCFI's website www.gcfi.org and at AGRRA's SCTLD resource hub https://www.agrra.org/coral-disease-outbreak/. The workshop was co-hosted by MPAConnect, the leaders of the Caribbean Cooperation Team from Florida's Stony Coral Tissue Loss Disease Response (NOAA's Coral Reef Conservation Program and AGRRA) and Florida Sea Grant. We thank NOAA's Coral Reef Conservation Program for supporting MPA capacity building in the Caribbean and for helping to share knowledge and best practices for coral rescue in the face of SCTLD. For more information please contact mpaconnect@gcfi.org.

Appendix III

AGENDA



Planning for Coral Rescue as a Response to SCTLD in the Caribbean

Reef Futures Symposium at Ocean Reef Club in Key Largo, FL (Sailfish Room)
Monday, September 26, 2022

Objective: To assist coral reef managers and conservation practitioners in their efforts to plan for, and implement, the rescue of coral species that are being affected by stony coral tissue loss disease for the purpose of supporting the future restoration of these species on Caribbean coral reefs.

AGENDA

9:30 am	**Coffee provided (Carysfort Lobby)**
9:45 am	**Bring your coffee and sign in**
10:00 am	**Welcome and workshop overview**
10:15 am	**Introductions - What is "coral rescue" for you?**
11:00 am	**Deep Dive into Coral Rescue**

Developing a collection and biosecurity plan for healthy corals
Stephanie Schopmeyer, Florida Fish and Wildlife Conservation

Setting up a land-based nursery
Sergio Guendulain, Dominican Foundation for Marine Studies (FUNDEMAR)/ National Autonomous University of Mexico (UNAM)

Managing reproductive corals in captivity
Claudia Padilla, Mexican National Institute of Fisheries & Aquaculture (INAPESCA)

Collection and ex-situ treatment of SCTLD infected corals
Logan Williams, Coral World Ocean and Reef Initiative (CWORI)

Monitoring of coral spawning events and collection of coral gametes and in situ propagation
Gabriela Ochoa, Gulf and Caribbean Fisheries Institute (GCFI) / Roatan Marine Park

Outplanting of rescued corals and diadema
Stacey Williams, Institute for Socio-Ecological Research (ISER)

Agenda: Continued

12:45 pm	**Lunch break** (boxed lunch provided)
1:30 pm	**Coral Rescue Café**
3:00 pm	**Coffee break (Carysfort Lobby)**
3:30 pm	**Getting support**

Financing your rescue effort
Alizee Zimmerman, Turks & Caicos Reef Fund
Emma Doyle, MPA Connect/Gulf and Caribbean Fisheries Institute

Partnership development and available resources
Lisa Gregg, Florida Fish and Wildlife Conservation,
Beth Firchau, Association of Zoos & Aquariums,
Claudia Padilla, Mexican National Institute of Fisheries & Aquaculture (INAPESCA)

4:30 pm	**Rescue planning - financing and partnerships**
5:00 pm	**Group share**
5:30 pm	**Revisit your goals and plan next steps**
5:45 pm	**Wrap up** Highlight relevant upcoming sessions and presentations at Reef Futures Symposium
6:00 pm	**Adjourn**

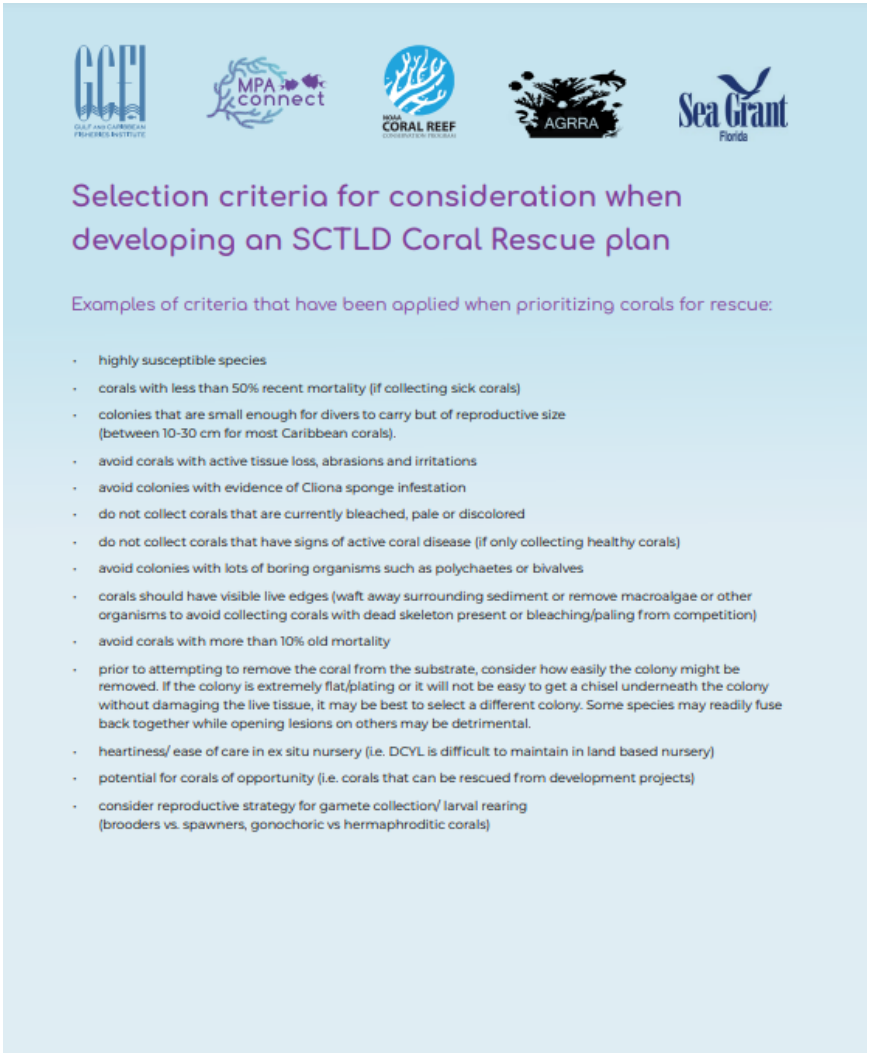
Appendix IV

Coral Collection Selection Criteria

Species specific considerations when prioritizing corals for rescue:

Excerpt from "Florida Coral Rescue Plan", Florida Fish and Wildlife Conservation, 2020

Species	Applied Criteria
Colpophyllia natans (CNAT)	Early susceptible species, rapid mortality, important framebuilder, disease mortality removes small colonies from affected reef while only remnants remain of large colonies
Dendrogyra cylindrus (DCYL)	Early susceptible species, extremely rapid mortality, extremely rare species following past bleaching and disease events, disease mortality removes species from affected reef
Dichocoenia stokesii (DSTO)	Early susceptible species, extremely rapid mortality, disease mortality removes species from affected reef
Diploria labyrinthiformis (DLAB)	Becoming an uncommon species, early susceptible species, rapid mortality, species becomes rare on affected reef after disease mortality
Eusmilia fastigiata (EFAS)	Uncommon coral, early susceptible species, extremely rapid mortality, disease mortality removes species from affected reef
Meandrina meandrites (MMEA)	Early susceptible species, rapid mortality, disease mortality removes species from affected reef, reproduces by brooding larvae which may delay recovery
Montastraea cavernosa (MCAV)	Important framebuilder, late susceptibility, slow mortality, can survive multiple infection events
Orbicella annularis (OANN)	Important framebuilder, uncommon species, late susceptibility, can survive multiple infection events
Orbicella faveolata (OFAV)	Important framebuilder, late susceptibility, can survive multiple infection events, slow mortality, large colonies or remnants remain after disease mortality
Pseudodiploria strigosa (PSTR)	Early susceptible species, rapid mortality, species becomes rare on affected reef after disease mortality
Madracis auretenra (MAUR)	Rare species, potentially affected by disease, drastic reductions in prevalence within CREMP sites, small and not a framebuilder
Mussa angulosa (MANG)	Uncommon coral, affected by disease (potentially rapid mortality), disease mortality would remove species from affected reef
Mycetophyllia aliciae (MALI)	Uncommon coral, rapid mortality, disease mortality removes species from affected reef
Mycetophyllia ferox (MFER)	ESA listed, uncommon coral, rapid mortality, disease mortality removes species from affected reef
Mycetophyllia lamarckiana (MLAM)	Uncommon coral, rapid mortality, disease mortality removes species from affected reef
Pseudodiploria clivosa (PCLI)	Rare species (up to 70% spatial reduction within CREMP sites), early susceptible species, rapid mortality, species becomes rare on affected reef after disease mortality
Agaricia lamarcki (ALAM)	Uncommon species, reproduces by brooding larvae which may delay recovery
Favia fragum (FFRA)	Extremely rare species (considered functionally extinct following 98/99 summer bleaching event), unknown response to STLD
Orbicella franksi (OFRA)	Important framebuilder, also present in deep water, can survive multiple infection events, late susceptibility, limited info on STLD
Solenastrea bournonii (SBOU)	Potential late susceptibility, limited info on STLD, common to inshore patch reefs and other habitats (e.g. grassbeds)



Selection criteria for consideration when developing an SCTLD Coral Rescue plan

Examples of criteria that have been applied when prioritizing corals for rescue:

- highly susceptible species
- corals with less than 50% recent mortality (if collecting sick corals)
- colonies that are small enough for divers to carry but of reproductive size (between 10-30 cm for most Caribbean corals).
- avoid corals with active tissue loss, abrasions and irritations
- avoid colonies with evidence of Cliona sponge infestation
- do not collect corals that are currently bleached, pale or discolored
- do not collect corals that have signs of active coral disease (if only collecting healthy corals)
- avoid colonies with lots of boring organisms such as polychaetes or bivalves
- corals should have visible live edges (waft away surrounding sediment or remove macroalgae or other organisms to avoid collecting corals with dead skeleton present or bleaching/paling from competition)
- avoid corals with more than 10% old mortality
- prior to attempting to remove the coral from the substrate, consider how easily the colony might be removed. If the colony is extremely flat/plating or it will not be easy to get a chisel underneath the colony without damaging the live tissue, it may be best to select a different colony. Some species may readily fuse back together while opening lesions on others may be detrimental.
- heartiness/ ease of care in ex situ nursery (i.e. DCYL is difficult to maintain in land based nursery)
- potential for corals of opportunity (i.e. corals that can be rescued from development projects)
- consider reproductive strategy for gamete collection/ larval rearing (brooders vs. spawners, gonochoric vs hermaphroditic corals)

Appendix V

Summary of Coral Rescue Approaches

Approach	Physical Location	Apply During Stage of SCTLD	Funding (High-Medium-Low)	Technical Capacity (High-Medium-Low)	Infrastructure and Equipment	Permits	Potential Partners
Ex-situ nursery with reproductively mature or sized healthy living corals Presenter/Expert: Alizee Zimmerman and Lenetia Fix	Land-based	Healthy corals pre-invasion. Endemic-stage survivor corals	**High-medium** • Sea water intake (closed or open system) • In some cases, artificial sea water • Equipment and infrastructure installation • Maintenance and supplies • Shipping and transporting • Electricity costs/generator • Staff	**High** Team includes: • Staff for in-water activities • Coral biologist • Aquarist…. • Ex-situ coral husbandry • Veterinarian	• Land • Aquaria • Aquarium life support equipment • Fuel • Lab • Boat	Yes	• Academic institutions • Dive shops • Public aquaria • Government agencies
Ex-situ nursery with micro fragmented healthy corals (and enhancing herbivory with nurseryedpost larval *Diadema)* Presenter: Stacey Williams	Land-based	Healthy corals pre-invasion; Endemic-stage survivor corals	**High-medium** • Sea water intake (closed or open system) • In some cases, artificial sea water • Equipment and infrastructure installation • Maintenance and supplies • Shipping and transporting • Electricity costs/generator • Staff	**High** Team includes: • Staff for in-water activitiesCoral biologist Aquarist…. • Ex-situ coral husbandry • Veterinarian	• Land • Aquaria • Aquarium life support equipment • Fuel • Lab • Boat	Yes	• Academic institutions • Dive shops • Public aquaria Government agencies

Approach	Physical Location	Apply During Stage of SCTLD	Funding (High-Medium-Low)	Technical Capacity (High-Medium-Low)	Infrastructure and Equipment	Permits	Potential Partners
Ex-situ nursery with sick corals receiving treatment (Presenter/Expert: :Logan Williams)	Land-based	Sick corals collected during the invasion /outbreak stage	**Medium-low** • Sea water intake (closed or open system) • In some cases, artificial sea water • Equipment and infrastructure installation (low tech) • Shipping and transporting • Electricity costs/generator • Staff	**High** Team includes: • Staff for in-water activities • Coral biologist • Aquarist • Ex-situ coral husbandry • Veterinarian	• Land • Aquaria • Aquarium life support equipment • Fuel • Lab • Antibiotics or other disinfectants • Boat	Yes	• Academic institutions • Dive shops • Public aquaria • Government agencies
Collection of gametes from spawning corals and assisted fertilization in a lab (Presenter/Expert Sergio Guendolain)	Lab	Healthy corals pre-invasion; Endemic-stage survivor corals	**Medium** • Equipment and infrastructure installation sourced locally • Electricity costs/generator • Field costs • Staff	**High** Team includes: • Staff for in-water activities • Coral biologist • Aquarist • Lab technician • Geneticist	• Land • Red lights • Nets • Tanks • Filter • Pump equipment • Generator • Fuel • Lab • Boat	Yes	• Academic institutions • Dive shops • MPAs • Public aquaria • Government agencies
Cryopreservation of coral gametes / sperm (Presenter Claudia Padilla)	Lab	Healthy corals pre-invasion; Endemic-stage survivor corals	**Medium** • Equipment and infrastructure installation • Electricity costs/generator • Field costs • Staff **But very high if storage costs are considered**	**High** Team includes: • Lab technician • Geneticist	• Lab • Liquid nitrogen • Refrigeration • Generator	Yes	• Academic institutions • Public aquaria • Government agencies

Approach	Physical Location	Apply During Stage of SCTLD	Funding (High-Medium-Low)	Technical Capacity (High-Medium-Low)	Infrastructure and Equipment	Permits	Potential Partners
Ex-situ rearing of coral larvae Presenter/Expert: Sergio Guendolain and Claudia Padilla	Lab/Land-based	Healthy corals pre-invasion; Endemic-stage survivor corals	**Medium-Low** • Sea water intake (closed system) • Equipment and infrastructure installation • Shipping and transporting • Electricity costs/generato • Staff	**High** Team includes: ● Coral biologist ● Aquarist ● Ex-situ coral husbandry ● Veterinarian	● Lab ● Land ● Aquaria ● Aquarium life support equipment	Yes	● Academic institutions ● Public aquaria ● Government agencies
Collection of gametes from spawning corals and assisted fertilization in field Presenter/Expert: Maria Villapando and Gabriela Ochoa	Field	Corals during the pre-invasion, invasion/ outbreak or endemic stages	**Low** • Field costs • Lab equipment • Staff	**Low** Team includes: ● Staff for in-water activities ● Volunteer divers ● Marine biologist	● Nets ● Red lights	Yes	● Academic institutions ● Dive shops ● MPAs ● Government agencies
In-water rearing of coral larvae / CRIBs Presenter/Expert: Maria Villapando and Gabriela Ochoa	Field	Pre-invasion / Endemic stages	**Low** • Field costs • CRIB and substrates • Lab equipment • Staff	**Medium** Team includes: ● Staff for in-water activities ● Volunteer divers ● Marine biologist	● CRIB ● Coral trees ● Boat ● Fuel ● Dive gear ● Dive tanks	Yes	● Academic institutions ● MPAs ● Government agencies
Micro Fragmentation of biobank corals and outplanting	Land-based	Endemic stage	**Medium-Low** • Field costs • Lab equipment/tools • Staff	**Medium** Team includes: ● Staff for in-water activities ● Volunteer divers ● Marine biologist	● Power tools ● Coral settlement tiles ● Boat ● Fuel ● Dive gear	Yes	● Academic institutions ● Dive shops ● MPAs ● Government agencies