



Puerto Rico Coral Disease Action Plan - 2022



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INTRODUCTION

Since stony coral tissue loss disease (SCTLD) is the main disease threat to coral reefs in Puerto Rico as of April 2022, this coral disease action plan places heavy focus on the response to SCTLD, however, it can be adapted for the response to other coral diseases as well. The main goal of this plan is to list actions and provide guidelines to achieve the objectives and complete the tasks described in the Stony Coral Tissue Loss Disease (SCTLD) Puerto Rico Emergency Response Strategic Plan, developed in response to the declaration of a state of emergency in Puerto Rico due to SCTLD, as mandated in the Executive Order EO-2021-066. One million dollars was designated for this response by the Governor of Puerto Rico and will be used to implement this plan.

This document is organized following the SCTLD Puerto Rico Emergency Response Strategic Plan and includes actions by the categories and objectives following the order in which they appear in the Strategic Plan. The timeline for Phase I is a twelve-month period, which is the amount of time allotted to spending the \$1,000,000 designated to the SCTLD response through EO-2021-066. Month 1 refers to the first month that the DNER Coral Program has access to this funding.

It is important to note that as time passes, coral reef conditions are constantly changing. This document is a set of guidelines, rather than inflexible actions, which should be adapted as necessary to reflect new coral reef conditions. For example, a coral reef on the East coast, which has been affected by SCTLD for years, may have high mortality and may have a low prevalence of SCTLD. In these cases, rather than intervention, monitoring and evaluation may be a better option for groups of volunteers. However, reefs with a high prevalence of SCTLD should be considered for intervention.

For a detailed background of SCTLD in Puerto Rico, please refer to the Puerto Rico SCTLD Intervention Plan (2021).



ACTION PLAN FOR PHASE I: SHORT-TERM ACTIVITIES FOR CORAL REEF CONSERVATION



Phase I. Administrative Support Strategy

Objective 1: Convoke Coral Reef Interagency Advisory Committee

As designated in Law 147 of 1999, Law for the Protection, Conservation, and Management of Coral Reefs in Puerto Rico, the Interagency Advisory Committee will be constituted by the following qualified leaders (of different federal, state, and local agencies), who are designated to provide the necessary technical and professional advice to the DNER Secretary to implement the law:

- Director of the DNER Bureau of Fish and Wildlife
- President of the Planning Board
- President of the Environmental Quality Board
- Director of the Tourism Company
- Secretary of the Department of Agriculture
- Director of the U.S. Fish and Wildlife Service
- Director of the Caribbean Fishery Management Council
- Director of the NOAA National Marine Fisheries Service
- Two or more members from the scientific community and academia
- Other members as the DNER Secretary sees fit

Yolanda Díaz, the Deputy Chief of Staff to the Governor of Puerto Rico, will lead the first Coral Reef Interagency Advisory Committee (Advisory Committee, hereafter) meeting in 2022. Meeting reoccurrences will be confirmed during the first meeting. The objectives for the first, three-month, and six-month meetings are as follows:

- Objectives for the first meeting
 - Each committee member to designate a Point of Contact (POC) from their entity to serve as a liaison between the DNER and their entity in support of the Puerto Rico Emergency Response Strategic Plan
 - Develop a list of action items for each committee member about supporting the implementation of the Stony Coral Tissue Loss Disease Puerto Rico Emergency Response Strategic Plan (Strategic Plan, hereafter)



- Three-month objectives
 - POCs communicate opportunities for support and resource allocation for this effort to the DNER Coral Program
 - Resource gaps are identified and options for acquiring these resources are discussed
 - All divers able to participate in SCTLD intervention have completed all required training (see Objective 3.1)
- Six-month objectives
 - Available resources from each entity are allocated to the implementation of the Strategic Plan
 - POCs manage the day-to-day details of their entity’s support and resource allocation towards this effort, as well as the flow of communication within their organization
 - POCs communicate support and resource allocation to the DNER Coral Program

Advisory committee members will select a Point of Contact (POC) within their respective organizations to help identify the ability of the organization to support SCTLD response efforts. The POC will identify available resources from their organization for the SCTLD response and communicate this to the DNER Coral Program Manager. External liaisons who are coral reef stakeholders will discuss the availability of resources with the Program Manager. The Coral Reef Emergency Response Coordinator in the DNER Coral Program will organize divers and the use of these resources in the response efforts.

Action	Lead	Timeline
Plan and hold Advisory Committee meetings on a predetermined schedule	DNER Coral Program	Ongoing
Hold the first meeting	Yolanda Díaz	Month 1
Develop meeting goals and objectives	DNER Coral Program	Month 1
Clarify the roles and responsibilities of each Advisory Committee member	Yolanda Díaz / DNER Coral Program	Month 1
Select a POC for SCTLD response efforts for each organization	Interagency Advisory Committee members	Month 1
Allocate available resources from each organization to the SCTLD response	Interagency Advisory Committee members	Months 2-3



Action	Lead	Timeline
Identify and inventory available resources for SCTL D response	POCs from each organization	Month 2
Identify resource gaps and opportunities to fill those gaps	DNER Coral Program	Month 3
Hold education and outreach activities with personnel of the Permits Management Office and Puerto Rico Planning Board	DNER Coral Program/ SCTL D response experts	Months 3-4
Maintain communication flow within each organization and between POCs and the DNER Coral Program	Organization POCs	Ongoing

Objective 2: Marketing, Communications & Outreach

The DNER Coral Program will engage the Puerto Rico Tourism Company and the Department of Education in the implementation of the marketing and communications strategy for the public. The DNER Press Officer will be involved in implementing the communications strategy.

The DNER Coral Program will work with local organizations to develop coral conservation and coral disease educational materials to be shared widely, tailoring them to specific audiences such as scientists, citizen scientists, and the public. Educational materials may include posters, one-pagers, coral identification guides, videos, and posts on social media. A few of the strategies to increase public engagement about coral reefs include engaging with the press to announce SCTL D response efforts, sharing educational materials and videos, and promoting the DNER Coral Reef Week. The goal of the DNER Coral Reef Week is to increase awareness through educational activities about the importance of Puerto Rico’s coral reefs and ongoing efforts to protect them.

In addition, the DNER Coral Program will reorganize the monthly Puerto Rico SCTL D meetings (second Thursday of each month, from 2:30 pm –4:00 pm AST, as of April 2022) to reach SCTL D goals and objectives more effectively, as stated in this document. This reorganization will serve as better management of SCTL D efforts around the island, as well as sharing essential information to maintain stakeholders and collaborators up to date with SCTL D reports, coordination, intervention, investigation, and more.



Action	Lead	Timeline
Develop an island-wide marketing and communication strategy	DNER Coral Program	Ongoing
Develop educational materials adapted for specific audiences	DNER Coral Program	Months 2 - 12
Increase public reach and engagement using press releases, events, educational materials, and social media platforms	DNER Coral Program	Months 2 - 12
Reorganize Puerto Rico’s SCTLD monthly meeting based on SCTLD goals and objectives	DNER Coral Program	Month 1
Develop a general agenda for monthly meetings	DNER Coral Program	Month 1
Reevaluate objectives and pending tasks to address in monthly meetings	DNER Coral Program	Ongoing, Monthly

Objective 3: Administrative Process Optimization

The Coral Reef Internal Advisory Committee was developed by the DNER Coral Program for DNER stakeholders to meet once a month and brainstorm ideas for the NOAA Cooperative Agreement with the DNER Coral Program, and discuss coral-related projects, permitting, and updates. This committee will be reinitiated, and part of the committee meetings will be used to present and make decisions about the response to SCTLD. Through the Coral Reef Advisory Committee, the DNER Coral Program expects to increase the participation of DNER stakeholders in SCTLD response efforts and identify additional internal resources that can be allocated to the SCTLD response.

Action	Lead	Timeline
Reinitiate the Coral Reef Advisory Committee	DNER Coral Program Manager	Month 1
Identify committee members	DNER Coral Program Manager	Month 1
Plan and hold meetings at a predetermined frequency	DNER Coral Program Manager	Ongoing
Identify available DNER resources that can be used for the response to SCTLD	DNER Coral Program Manager	Month 2
Allocate available DNER resources to the response to SCTLD	DNER Coral Program Manager	Month 3



Phase I. SCTL D Intervention Strategies

The first intervention strategies used to respond to SCTL D involved colony culling, amputation, firebreaks, and applying the topical paste, or a combination. As of April 2022, the most successful single intervention practice documented has been CoreRX CoralCure Ointment mixed with amoxicillin applied topically. In 2019, Puerto Rico stakeholders decided to only use the topical antibiotic paste as an intervention strategy, as the other intervention strategies involve high effort, which leads to fewer colonies being treated due to the time it takes to create firebreaks, amputate lesions, and cull colonies. Throughout this document, the term intervention refers to the topical application of the CoralCure ointment mixed with amoxicillin.

Objective 1: Publish an updated inventory of SCTL D intervention sites in Puerto Rico

In 2021, the DNER and stakeholders selected the top sites to focus on SCTL D intervention, which was published in the Puerto Rico SCTL D Intervention Plan. Six sites were selected, one per general region of Puerto Rico (North, South, East, West, Culebra Island, and Vieques Island), along with three secondary sites per region. These sites were reviewed again by coral disease stakeholders and updated based on current conditions and knowledge of the sites.

Although groups of certified volunteers with a group leader will be permitted to intervene on coral reef sites across the island, funding designated to SCTL D response through Executive Order EO-2021-066 will show a preference for intervention at the primary sites, then intervention at the secondary sites. This will be flexible based on numerous factors, including but not limited to the ability of the volunteer group, the availability of resources to reach primary and secondary coral reef sites, and the conditions and safety at the site, among others.

Two meetings were held, in March 2022 and April 2022, to select the primary and secondary sites for each region of Puerto Rico. Stakeholders decided that instead of priority sites, the preference is to maintain intervention site flexibility and select one primary and three secondary sites per region. The primary sites include one coral reef site selected per



region to focus SCTLD intervention efforts in Puerto Rico. These are the sites that stakeholders determined were the most important to intervene (*Table 1*). These sites are included as part of the “Adopt a Reef” campaign, which is described in the section detailing Objective 3. Volunteers & Partnerships.

NOAA has contracted Sea Ventures to focus SCTLD intervention efforts in the south, specifically at the sites Pináculos, Turrumote I, and San Cristobal. These sites are completely funded by NOAA as of April 2022 and are expected to continue being funded into the near future. In addition, Sea Ventures collaborates with the DNER and treats sites Sand Slide, Palominos in the east, and Cayo Coral in the south. Although some of the primary and secondary sites are already funded, they were left as is, and are listed in the table below. In addition, three alternative sites were included as volunteer groups will not be treating at sites that are already fully funded, but these are also important sites for intervention.

Action	Lead	Timeline
Update the list of SCTLD intervention sites to select priority intervention sites for 2022	DNER Coral Program	Month 1 (Completed)
Hold a meeting to review SCTLD intervention sites with stakeholders and update the list based on current conditions		
Match volunteer groups with priority intervention sites through the “Adopt a Reef” program	DNER Coral Program	Month 2

Table 1. An updated list of primary and secondary intervention sites selected by coral disease stakeholders as the most important sites to treat coral colonies with SCTLD.

Site Category	Region	Site	Latitude	Longitude
Primary	West	Tres Palmas	18.34766	-67.2641
Primary	South	Pináculos (Funded by NOAA)	17.93263	-67.0117
Primary	East	Palominos	18.3373	-65.5654
Primary	Vieques	Mosquito	18.16185	-65.4991
Primary	Culebra	Carlos Rosario	18.3307	-65.3331



Site Category	Region	Site	Latitude	Longitude
Primary	North	La Ocho	18.46835	-66.0918
Secondary	South	Turrumote II	17.9289	-66.9751
Secondary	South	Cayo Coral	17.93626	-66.8884
Secondary	South	San Cristobal (Funded by NOAA)	17.94212	-67.0779
Secondary	West	El Ron	18.10297	-67.2854
Secondary	West	El Negro	18.15425	-67.2418
Secondary	West	Buye	18.04486	-67.2031
Secondary	North	Arrecife Isla Verde	18.44897	-66.0167
Secondary	North	El Eco	18.49159	-66.4098
Secondary	North	Seven Seas	18.373854	-65.6374
Secondary	East	Cayo Largo	18.31604	-65.5768
Secondary	East	La Blanquilla	18.37107	-65.5549
Secondary	East	Palominitos	18.33714	-65.5699
Secondary	Culebra	Luis Pena	18.29844	-65.3258
Secondary	Culebra	Carlos Rosario S	18.3271	-65.3314
Secondary	Culebra	Reef in Tamarindo	18.32265	-65.326
Secondary	Vieques	Punta Arenas	18.10098	-65.5766
Secondary	Vieques	Rompeolas (Mosquito Pier)	18.1483	-65.5139
Secondary	Vieques	Reef in Northern Vieques	18.15412	-65.4733
Additional	South	Media Luna Channel	17.93535	-67.0506
Additional	South	Turrumote I (Funded by NOAA)	17.93482	-67.0197
Additional	South	Enrique	17.9535	-67.0465

Objective 2: Evaluate the spatiotemporal effectiveness of coral treatments

The principal research question behind this objective is: **How does colony mortality change between treated and untreated corals across sites and depths over one year of monitoring?**

This will be assessed following a mixed multifactorial experimental design with the following sources of variation: site, depth, treatment condition, colony type, and visits.

Available data sources and/or local knowledge should be utilized during the site selection process for validating the selection criteria. The selection of sites for this research effort will be coordinated in consultation with DNER personnel and consulting staff considering site-specific characteristics such as:

- State of the disease
- Scleractinian community structure, composition, density, and colony sizes
- Reef topography
- Reef access (for frequent monitoring)

Objective 3 of this Plan aims to quantitatively characterize the natural demographic impacts of SCTLD in affected populations in the absence of interventions. This information is key to evaluate patterns of SCTLD impacts, prioritize future restoration efforts, and identify potentially resistant individuals, populations, and/or communities. Combining this impact assessment with antibiotic treatment monitoring could further clarify the adequacy of antibiotic treatments as an impact mitigation strategy by documenting and comparing demographic changes in scleractinian corals given the presence and absence of treatment efforts. Thus, it is imperative to select at least 2 sites where both treatment (Objective 2) and demographic (Objective 3) monitoring will be co-located. Selection of these sites will be achieved during the first month of implementation of this Plan in coordination between Sociedad Ambiente Marino (SAM) and the DNER.

Upon selection of sites, a detailed work plan will be developed. This work plan will include:

- Map of sites with individual coordinates
- Methodology for the treatment monitoring assessment
- Calendar of site visits
- Emergency permit application
- List of diving personnel to conduct the research
- Data management routines to keep a centralized database managed by the DNER with all colonies treated and corresponding metadata. This should include a routine to label and archive a photographic record of each tagged colony per visit. Also, diagrams (maps) of tagged colonies (each with an individual coordinate) in each site should be prepared and submitted to the DNER for reference.



Although this effort will focus on 4 sites where the research activity will be controlled, it provides a framework to relocate treated colonies and assess treatment effectiveness elsewhere. A significant portion of the PR SCTL D Strategic Plan will focus on increasing the capacity to treat corals in additional sites with the assistance of trained volunteers. This poses the opportunity to instruct volunteers on the experimental design to be implemented in Objective 2. and thus, quantitatively characterize the colony survivorship from additional sites. To achieve this, the DNER will ensure that volunteer trainings include training components on colony monitoring and data collection and management. This will likely focus on advanced volunteers who dominate scleractinian identification and survey techniques. The commitment encompassed in this effort (1-year of monitoring) and the output it will provide (fate-tracking information from “adopted” tagged corals) can serve as an incentive to gather long-term support from volunteer groups.

The research will be conducted for 12 months after the approval and transfer of funds to the DNER. Periodic updates on the progress of the project will be provided through existing monthly SCTL D calls organized by the DNER. During these calls, stakeholders engaged in the response to SCTL D in Puerto Rico report on-site observations, treatment initiatives, research updates, outreach and education initiatives, and coordination of response efforts in general. The DNER will be responsible for allocating time in the agenda of these calls to update on the research activities conducted as part of Objectives 2 and 3 of this Plan. A detailed progress report will be submitted to local stakeholders and the Caribbean Cooperation Team (led by NOAA and AGRRA) by month six of implementation and a final report will be presented by month 12. The final report should detail lessons learned from the treatment interventions as an impact mitigation strategy, including recommendations to maximize treatment effectiveness. Intelligence compiled in the final report should be disseminated during symposia and/or online platforms (webinars, infographics, social media, etc.).



Action	Lead	Timeline
Develop a work plan	DNER Coral Program	Month 1
Select four (4) sites to implement experimental the design to assess survivorship of treated corals and treatment effectiveness	DNER Coral Program	Month 1
Select two (2) research sites, one of which will also be used for Objective 3. <i>Document coral demographic changes impacted by SCTLD</i>	DNER Coral Program	Month 1
Finalize research methodology	DNER Coral Program	Month 1
Develop and implement data management plan	DNER Coral Program	Month 1
Coordinate with National Coral Reef Management Fellow and Volunteer Coordinator to involve volunteers	DNER Coral Program	Months 1 - 12
Conduct research	DNER Coral Program	Months 1 - 12
Provide monthly updates in the SCTLD monthly meeting	DNER Coral Program	Months 1- 12
Write a progress report on fieldwork completed and treatment effects	DNER Coral Program	Month 6
Final report presented and discussion on recommendations to maximize treatment effectiveness	DNER Coral Program	Month 12

Objective 3: Document coral demographic changes impacted by SCTLD

Sociedad Ambiente Marino (SAM) will be leading efforts to research changes in coral demographics due to SCTLD. This research will focus on the question **How does colony mortality change between SCTLD-impacted and control non-impacted corals across sites over one year of monitoring?** Similar to Objective 2.2, this will be assessed following a mixed multifactorial experimental design, but with the following sources of variation: site, time, species, colony condition, and colony size category. This will allow enhancing and supporting existing continued monitoring efforts of SCTLD demographic dynamics on affected coral populations in Puerto Rico.

Addressing the demographic dynamics of susceptible coral populations to SCTLD infections is critical to understanding which factors can lead to enhanced prevalence, virulence, and transmissibility of this condition. This effort can provide fundamental information to parameterize coral demographic models regarding the progression of the disease. It is proposed to expand current demographic monitoring efforts in Puerto Rico to at least four (4) locations, using *Pseudodiploria strigosa* as a model species to implement monthly monitoring of permanently identified colonies, every month, during a period of one year to understand spatiotemporal patterns of variation of SCTLD dynamics. This will target:

- One coral reef along the western shelf of Puerto Rico where SCTLD has not been documented yet
- One location where the disease is still actively affecting corals
- One location where the disease has become endemic, and prevalence has declined to very low levels and where there are abundant surviving colonies with remnant tissue physiological fragments
- One location with active amoxicillin treatments to compare treated and control colonies.

This will provide NOAA and DNER with timely information regarding the prevalence, virulence, and transmissibility of the condition. It will also provide essential quantitative data to parameterize population models to inform managers and decision-makers regarding affected population projections under variable environmental conditions.

Upon selection of sites, a detailed work plan will be developed. This work plan will include:

- Emergency permit application
- Map of monitoring sites with individual coordinates
- Methodology for monitoring assessment and demographic performance analysis
- Projected calendar of site visits

Data management routines to keep a centralized database managed by the DNER with all monitored colonies and corresponding metadata. This will include a routine to label and archive a photographic record of each tagged colony per visit. Also, diagrams (maps) of tagged colonies (each with an individual coordinate) in each site should be prepared and submitted to the DNER for reference.



Action	Lead	Timeline
Develop a work plan	Sociedad Ambiente Marino	Month 1
Select four (4) sites to investigate changes in coral demographics, one of which will also be used for Objective 2 <i>Evaluate the spatiotemporal effectiveness of coral treatments</i>	Sociedad Ambiente Marino	Month 1
Select two (2) research sites, one of which will also be used for Objective 2	Sociedad Ambiente Marino	Month 1
Finalize research methodology	Sociedad Ambiente Marino	Month 1
Develop and implement data management plan	Sociedad Ambiente Marino	Month 1
Coordinate with National Coral Reef Management Fellow and Volunteer Coordinator to involve volunteers	Sociedad Ambiente Marino	Months 1 - 12
Conduct research	Sociedad Ambiente Marino	Months 1 - 12
Provide monthly updates in the SCTLD monthly meeting	Sociedad Ambiente Marino	Months 1 - 12
Write a progress report on fieldwork completed and treatment effects	Sociedad Ambiente Marino	Month 6
Final report presented and discussion on recommendations to maximize treatment effectiveness	Sociedad Ambiente Marino	Month 12



Phase I. Volunteers & Partnerships

Objective 1: Provide continual support to PR DNER volunteer recruitment & training

A Volunteer Coordinator will be hired and will oversee recruiting, training, maintaining communication with, and supporting volunteers throughout the process of the response to SCTLD. The Volunteer Coordinator will promote awareness of this initiative through social media, the Coral PR email list, and by reaching out to stakeholders. The DNER Coral Program, in collaboration with the Volunteer Coordinator, will develop an *Adopt a Reef* program so that each volunteer group can concentrate on supporting SCTLD intervention efforts on one or more reefs that they have adopted. The sites available for the *Adopt a Reef* program will include sites that are selected as PRDNER primary and secondary sites for SCTLD Intervention. Once volunteers are trained to apply treatment to colonies with SCTLD, the Volunteer Coordinator will divide volunteers into volunteer groups based on their location and will work with the group to determine one or more sites for those groups to “adopt” and visit regularly. Volunteers can provide support to response efforts in a variety of ways, including:

- Preparing SCTLD treatment and materials
- Monitoring healthy coral reefs for SCTLD and report it to DNER
- Cleaning equipment used for treating
- Applying treatment to corals with signs of SCTLD

Treatment can be applied by snorkeling or by diving. To become a volunteer, participants should be experienced and comfortable at snorkeling and/or diving for extended periods. Divers should be able to maintain neutral buoyancy throughout their dive. In addition, volunteers must participate in the following:

- Three (3) virtual trainings:
 - General coral biology
 - Coral species identification, with a focus on SCTLD susceptible species
 - Coral disease
- One (1) out-of-water training session to practice applying treatment
- At least one (1) field trip to observe, treat, and monitor SCTLD treatment intervention



If the volunteer has a background in coral reef biology, species identification, and/or coral disease, they will not be required to take the respective training(s). Eventually, once there are enough volunteers, trainings will no longer be provided.

The DNER and HJR Reefscaping will aim to create at least 11 volunteer groups across Puerto Rico. The goal is to create two (2) groups in the South, two (2) in the East, and two (2) in the West; three (3) groups in the North; one (1) group in Culebra; and one (1) group in Vieques, however, this will depend on the number of volunteers who participate and their locations. These groups will strive to conduct biweekly visits, dependent on conditions and resources, for a total of 26 visits to pre-selected priority intervention sites per year. Each volunteer group will have a group leader, who will be communicating with the Volunteer Coordinator. The Volunteer Coordinator will be in charge of maintaining communication with the volunteer groups, providing them with instructions for applying site treatment, and providing materials, among other responsibilities about the groups.

The National Coral Reef Management Fellow will maintain close communication with the Volunteer Coordinator on all aspects of the volunteer program. All day-to-day operational logistics will be coordinated with the DNER Coral Program’s Coral Reef Emergency Response Coordinator, while higher-level logistics will be coordinated with the DNER Coral Program Manager. The volunteer group leader will provide the DNER Coral Program with photographs and data collected during each intervention dive. The idea is to follow the DNER Coral Program’s data standardization protocol found in the Puerto Rico SCTL D Intervention Plan (2021), however, this will be determined and adapted to what is feasible by the volunteer groups. The DNER Coral Program will provide the group leader with supplies for coral treatment and will track the dates and supplies going to each group. Group leaders will participate in monthly Puerto Rico SCTL D meetings to report progress.

Additional coral training resources include:

- Basic coral biology and anatomy and species identification: <https://vimeo.com/453482911>
- Identification of common coral species in Puerto Rico: <https://vimeo.com/455916825>
- Coral disease identification Part 1: <https://vimeo.com/455931003>
- Coral disease identification Part 2: <https://vimeo.com/477755501>
- SCTL D treatment: <https://vimeo.com/580959412>
- SCTL D susceptible coral species PowerPoint: https://docs.google.com/presentation/d/1IOW4ao6yIESb5N_3lzd5eKkXFPJ-5anq/edit#slide=id.p1

Action	Lead	Timeline
Develop an <i>Adopt a Reef</i> program	DNER Coral Program	Month 1



Action	Lead	Timeline
Create a contract to hire a Volunteer Coordinator	DNER Coral Program / HJR Reefscaping	Month 1
Develop a volunteer program	DNER Coral Program	Months 2-3
Recruit volunteers using the volunteer registration form	HJR Reefscaping	Month 1
Determine what data will be collected by volunteers	DNER Coral Program	Month 1
Maintain a database of volunteers and their contact information	HJR Reefscaping	Ongoing
Train volunteers	DNER Coral Program / HJR Reefscaping	As needed
Create at least 11 volunteer groups based on location and experience	DNER Coral Program / HJR Reefscaping	Ongoing
Designate a leader for each of the volunteer groups	DNER Coral Program	Month 2
Maintain communication and provide additional training to volunteer groups	DNER Coral Program / HJR Reefscaping	Ongoing
Maintain an organized evaluation and treatment database	DNER Coral Program	Ongoing
Train volunteers on data and photograph collection and organization	DNER Coral Program	Months 2 - 3
Input volunteer data into a database	DNER Coral Program	Ongoing

Objective 3.2: Develop communication strategies between the DNER & volunteers

Developing effective communication strategies upfront is essential to ensure the quality of the volunteer program over time. These strategies involve strengthening coordination efforts by keeping volunteers active through various platforms and activities.



Action	Lead	Timeline
Develop volunteer communication strategies	DNER Coral Program / HJR Reefscaping	Months 1 - 2
Develop an official online application for volunteer sign-up, training, and certification	DNER Coral Program / HJR Reefscaping	Month 1
Reinitiate the EREA Facebook page	HJR Reefscaping	Month 1
Develop a shared calendar between intervention leaders and volunteer group	DNER Coral Program / HJR Reefscaping	Months 1-2
Develop and collect information from a volunteer post-training evaluation survey to improve training and coordination	HJR Reefscaping	Month 2
Increase volunteer retention	HJR Reefscaping	Ongoing
Hold volunteer certification celebrations	HJR Reefscaping	Months 6 and 12
Hold a volunteer appreciation gathering	HJR Reefscaping	Month 12
Provide SCTLD response support with volunteers	DNER Coral Program / HJR Reefscaping	Ongoing
Conduct roving diver surveys in areas where SCTLD has not been reported	DNER Coral Program / HJR Reefscaping	Ongoing
Apply treatment to selected coral reef sites affected by SCTLD	DNER Coral Program / HJR Reefscaping	Biweekly per site

Objective 3: Implement a citizen science program

The Puerto Rico National Coral Reef Management Fellow is tasked with developing a citizen science program to help fill coral reef knowledge gaps and encourage local participation in ongoing data collection efforts on reef health, especially regarding stony coral tissue loss disease (SCTLD). This program is also meant to motivate individuals to become stewards of coral reefs. Through this program, citizens will help to collect data on coral reef health by providing observational support. In addition, this program will motivate citizen scientists that have no prior training to become trained volunteer scientists.



The DNER Coral Program and Fellow will develop a citizen science program with a clear goal and design that will promote reports from coral reef observers and that can be used to improve understanding and management of coral reefs in Puerto Rico. This program will prove essential in increasing observations on Puerto Rico’s coral reefs since there are numerous community members, dive shops, fisherfolk, and recreational users who visit coral reef sites regularly. Reports received shortly after SCTLD has arrived at a coral reef site allow a rapid response to the threat. In addition, citizen scientists will also be invited to receive the necessary training to become volunteers, as detailed in *Objective 1: Provide continual support to PR DNER volunteer recruitment & training.*

The citizen science program will involve identifying target audiences and creating education and outreach material that will effectively communicate key messages and encourage the submission of SCTLD and other disease reports. This can be done by creating posters that provide information about SCTLD and how citizens can make reports, designing and giving educational courses for groups of people (high school students, snorkelers, fisherfolk, etc.), and increasing social media outreach.

Action	Lead	Timeline
Design a citizen-based science program	DNER Coral Program / National Coral Reef Management Fellow	Months 1 - 3
Set goals and objectives	DNER Coral Program / National Coral Reef Management Fellow	Month 1
Set up a database to organize data	National Coral Reef Management Fellow	Month 1
Develop a citizen science data collection platform for Puerto Rico	National Coral Reef Management Fellow	Months 1-3
Promote citizen science reporting	National Coral Reef Management Fellow	Ongoing
Build a network of citizen science stakeholders and organizations	National Coral Reef Management Fellow	Months 4-6
Develop and promote SCTLD educational materials with reporting information	National Coral Reef Management Fellow	Months 3 -4



Develop education and training materials for a variety of audiences (e.g. high school students, university students, snorkelers, divers, fisherfolk)	DNER	Month 6
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Objective 4: Increase partnerships with local fisherfolk, dive shops & non-profit organizations

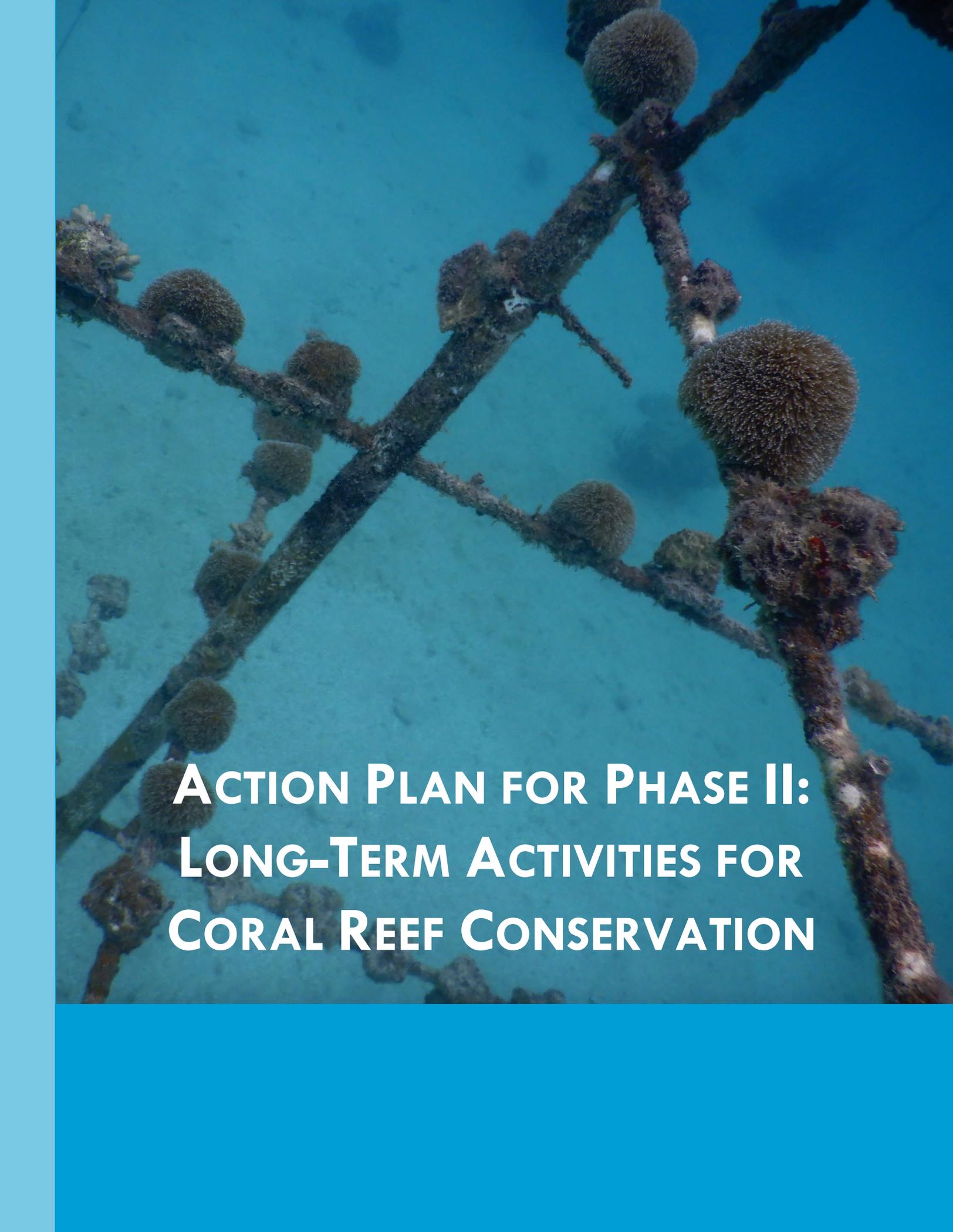
Coral reefs are important to people for a variety of reasons, ranging from food security and coastal protection to recreation and tourism. Through this shared interest, there is an opportunity to increase partnerships between stakeholders to create a diverse network supporting coral reef response efforts. The DNER Coral Program will engage diverse groups to participate in education and outreach efforts geared towards coral disease response and invite these groups to participate in SCTL D intervention efforts. The DNER Coral Program will reach out to key fisheries and dive shop stakeholders, including the Caribbean Fishery Management Council, Puerto Rico Sea Grant, NOAA Fisheries, local dive shop owners, and the Puerto Rico Tourism Company, to discuss opportunities for partnering in the response to SCTL D. NOAA Fisheries and the Caribbean Fishery Management Council partnerships would allow the opportunity to discuss ways in which the DNER can disseminate information and establish a citizen-science reporting network that is beneficial to both the DNER and the fisherfolk. This could involve providing resources for interested partners to help with data collection or intervention efforts.

The DNER Coral Program will approach the Puerto Rico Tourism Company with the idea to develop an eco-tour operator certification for snorkel and dive shops. The certification indicates that the shop follows guidelines for coral reef protection and trains their snorkelers/divers in appropriate conducts on the reef (e.g. do not touch corals or marine life, do not apply chemical-heavy products before diving, etc.), as well as hang up posters, show videos, or host educational talks discussing the importance of coral reef conservation and what citizens can do to help.

Action	Lead	Timeline
Engage diverse stakeholders to participate in the response to SCTL D	DNER Coral Program	Ongoing
Hold a meeting with fisheries stakeholders to discuss involving fisherfolk in SCTL D reporting and intervention	DNER Coral Program	Month 2
Provide training and resources to interested dive shops, fisherfolk, and non-profits	DNER Coral Program	Months 4-8



Action	Lead	Timeline
Develop a program for dive shops to educate about the importance of conserving coral reefs and appropriate conduct on a reef	DNER Coral Program	Months 3-12
Develop an eco-tour operator program and certify qualifying tourism companies	PR Tourism Company	Months 3-12

An underwater photograph showing several dark, branching coral structures. Attached to these branches are numerous spherical, brownish coral growths, likely a species of coral. The background is a clear, light blue water column. The overall scene is a close-up view of a coral reef structure.

**ACTION PLAN FOR PHASE II:
LONG-TERM ACTIVITIES FOR
CORAL REEF CONSERVATION**



Phase II. Stony Coral Rescue & Restoration Efforts

Rescue in this document refers to human intervention where coral colonies or coral fragments are removed from their location and transferred to another location in the hope of reducing or eliminating the threat of coral disease. Examples of rescue include moving colonies or fragments of colonies to land-based nurseries for a period of time or to *in situ* coral nurseries in areas that may present less risk of the disease.

Restoration in this document refers to human intervention where the result involves coral colonies or fragments stabilized in an area with the expectation of the colony to survive and sustain itself naturally afterwards. Steps towards restoration can include rescue efforts described above, microfragmentation, and fusion, among others.

Objective 1: Develop a coral species priority matrix for coral rescue efforts

The process of prioritizing stony coral species for rescue and restoration efforts will be led by Puerto Rico's NOAA Fisheries Liaison. This will allow stakeholders to focus efforts on species that are deemed essential for rescue efforts, depending on the available resources. The coral species priority matrix must not only include the level of endangerment, but also the susceptibility to SCTLD, growth rates, reef-building capacities, and outplanting success rates. The coral species prioritized will then be targeted for the establishment or expansion of land-based or *in-situ* nurseries.



Action	Lead	Estimated length of time
Prioritize coral species for rescue and restoration	NOAA Fisheries liaison	1 – 3 months
Develop a coral species priority matrix	NOAA Fisheries liaison	1 month (Completed)
Meet with Florida stakeholders to discuss their process for selecting priority species	NOAA Fisheries liaison	1 month (Completed)
Select criteria to use to select priority species	NOAA Fisheries liaison	1 month
Develop a draft list of species using ranking by criteria	NOAA Fisheries liaison	1 month
Hold a prioritization meeting with stakeholders	NOAA Fisheries liaison	1 month
Validate the priority matrix with stakeholders	NOAA Fisheries liaison	1 month

Objective 2: Support the establishment and/or expansion of land-based nurseries & in-situ nurseries

The University of Puerto Rico, Mayagüez Campus (UPRM) hosts the only coral and marine life land-based nursery currently in use, as of March 2022, which is located on Magueyes Island. Three land-based nurseries are in development. The Inter-American University in Arecibo, Puerto Rico, is currently building a land-based nursery with four tanks at the university. There is funding to build an oceanographic center in Roosevelt Roads, Ceiba, that will include an area for land-based nurseries for corals and *Diadema antillarum*. In addition, “[The Coral Nursery of Puerto Rico](#)” in Palmas del Mar, Humacao, is underway and expected to be completed and running during 2022. The DNER will complement the current land-based nurseries in Puerto Rico, as well as support research that targets questions that can provide more information to better inform management decisions. Options for additional land-based nurseries will be explored, including closed coral propagation systems.

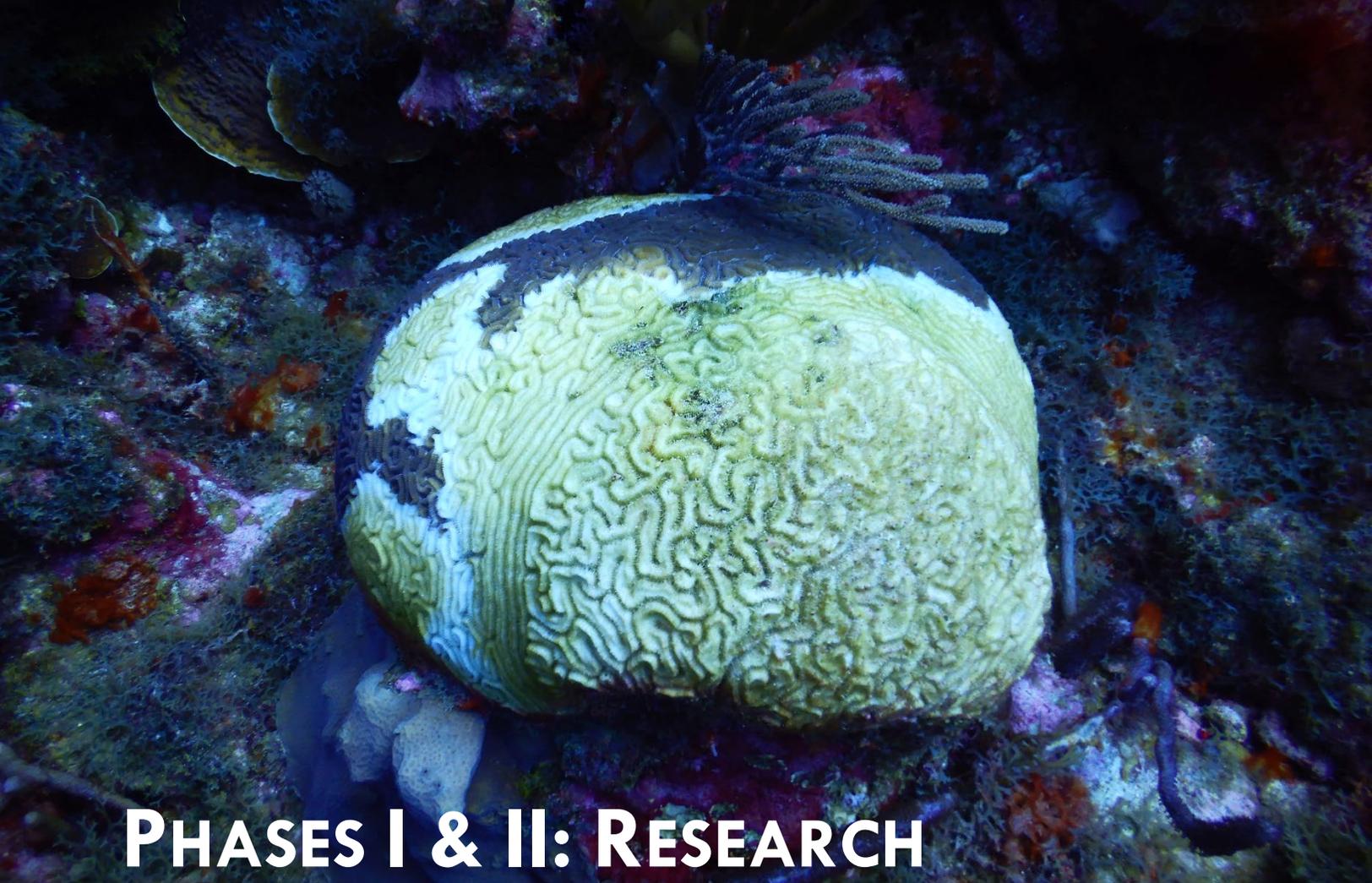


Action	Lead	Estimated length of time
Develop coral rescue and restoration goals and objectives	DNER Coral Program	1-3 months
Determine gaps and needs to reach goals and objectives	DNER Coral Program	1 month
Expand current or develop new coral nurseries in PR	DNER Coral Program	Ongoing
Research types of coral nurseries best suited for Puerto Rico and logistics	DNER Coral Program	1 month
Identify and apply to funding opportunities	DNER Coral Program	1 month

Objective 3: Support the development of NOAA's PR Coral Reef Restoration Plan

The NOAA Restoration Center is developing a comprehensive coral rescue and restoration plan for Puerto Rico, using NOAA's Manager's Guide to Coral Reef Restoration Planning and Design report (2020). Overall, it will provide recommendations for maintaining genetic diversity by rescuing a wide range of colonies, identifying resistant/surviving genotypes, propagation, and outplanting of resistant colonies, and the use of artificial reefs. This plan will take the threat of SCTLD into account when rescuing corals.

Action	Lead	Estimated length of time
Develop the NOAA PR Coral Reef Restoration Plan	NOAA Restoration Center	6 months
Participate in the review of the Coral Reef Restoration Plan	DNER Coral Program	1 to 3 months
Use final plan when making rescue and restoration decisions	DNER Coral Program	Ongoing



PHASES I & II: RESEARCH

Puerto Rico Department of Natural and Environmental Resources Priority Research Questions - Small Grants

In May 2021, the DNER Coral Program organized an interdisciplinary workshop to determine the top priority SCTLTD questions for research. In support of these priority questions, two calls for small grants, approximately \$30,000 each, will be developed and published among academic and research institutions and non-governmental organizations in Puerto Rico.

Action	Lead	Estimated length of time
Complete two small research projects that answer Puerto Rico’s priority SCTLTD questions	Entities selected for small grants	12-24 months
Develop and publish two Requests for Proposals for small grants (approximately \$30,000 each)	DNER Coral Program	6 months
Review and select proposals and grant money	DNER Coral Program	6 months



Collaborations in requesting external sources of funding

To continue with SCTL D response efforts over the long term, it is necessary to identify sustainable funding mechanisms. The DNER Coral Program will collaborate with stakeholders to identify and develop projects and apply for funding. Collaborations increase the capability of the project team to implement a project and provide a wider range of opportunities to apply for grants. For example, eligibility may prevent the DNER from taking the lead on a project, but the DNER could still act as a partner to another eligible organization.

Action	Lead	Estimated length of time
Develop a list of SCTL D-related priority projects for Puerto Rico	DNER Coral Program	1 month
Hold meetings with potential stakeholders to express interest in project collaborations	DNER Coral Program	Ongoing
Maintain an updated list of opportunities for external sources of funding	DNER Coral Program	Ongoing
Select and apply to funding opportunities	Project Lead	Ongoing
Identify project partners for projects of interest	Project Lead	Ongoing
Submit applications to requests for proposals	Project Lead	Ongoing