MAR FUND

RESPONSE PROTOCOL FOR THE

RESCUE OF CORAL REEFS AFFECTED BY HURRICANES

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A. INTRODUCTION

A.1 IMPORTANCE OF REEFS

Coral reefs are highly biodiverse and productive ecosystems, which are fundamental for providing goods and services that support both human communities and marine biodiversity (Hughes et al. 2003). They act as natural barriers that dissipate up to 90% of wave energy, reducing coastal erosion and storm damage (Franklin et al. 2018; Ferrario et al. 2014; NOAA 2024). Additionally, they sustain and provide fishery resources, enable recreational activities, generate income through tourism (Moberg and Rönnbäk 2003), and produce bioactive compounds with pharmacological potential (Karthikeyan et al. 2022).

A healthy reef hosts a variety of reef-building coral species, whose diversity helps maintain key functions such as coastal protection, habitat provision for numerous species, and calcium carbonate production (Álvarez-Filip et al. 2011). In the reefs of the Mesoamerican Reef System (MAR), branching coral species like *Acropora palmata*, one of the primary reef builders in shallow areas that dissipate wave energy are found (De Hoyos-Jiménez et al. 2025; Alcolado et al. 2009; Busutil et al. 2011; Gardner et al. 2005; Lightly *et al.* 1982), along with large massive corals of the genus *Orbicella* and brain corals of the genera *Diploria* and *Pseudodiploria*, amongst others, contribute to the consolidation and growth of the reef structure (Weil and Knowlton 1994; Aronson et al. 2002; Edmunds et al. 2010).

In recent years, there has been an increasing dominance of coral species considered pioneer species, which contribute little to the formation of reef structure. This has resulted in reefs with low carbonate production and reduced structural complexity, negatively affecting their functionality and productivity (Estrada-Saldivar et al. 2019; González-Barrios & Alvarez-Filip 2018). As a result, the collection and stabilization of reef-building species such as *A. palmata*, *Orbicella* spp., and brain corals are key to conserving healthy, complex, and diverse reefs that maintain ecosystem functions and enhance coastal protection (Alcolado et al. 2009).

Healthy colony providing habitat protection for typical coral reef fish species. Author: Sara Gutiérrez Plata.

A.2 IMPACT OF HURRICANES ON CORAL REEFS

Storms and hurricanes represent a significant vulnerability factor for coral reefs, especially in shallow areas, due to the generation of intense waves, strong currents, and storm surges that cause mechanical and structural damage (Harmelin-Vivien 1994; Massel and Gourlay 2000). The damage that hurricanes can inflict on reefs includes the destruction of the carbonate structure and generation of debris, fragmentation and dislodgement of colonies, abrasion of coral tissue by sediments, and burial of corals by displaced sediments and debris (Gulko et al. 2008; Hernández-Delgado et al. 2024). The magnitude of this damage depends on the frequency, intensity, and duration of the cyclones, which due to climate change are becoming increasingly common (Mann and Emanuel 2011). Biological and morphological characteristics of dominant species, site depth, specific reef features, as well as anthropogenic factors and the ecological history of the area, also contribute to the vulnerability of the site to these events (Hughes et al. 2003).

The most affected coral species in Atlantic reefs are *Acropora palmata* (elkhorn) and *Acropora cervicornis* (staghorn) due to their branching morphology and distribution in shallow areas, which make them particularly fragile and prone to fragmentation during hurricanes (Bak and Criens 1982).

Detached and overturned *Acropora palmata* colony after the impact of a hurricane. Author: Claudia Padilla Souza.

However, these fragments can be stabilized to generate new colonies through clonal propagation (Hughes 1989), a natural strategy that helps maintain and increase populations of these corals (Lirman 2000).

It has been documented that, under conditions of low frequency and intensity, hurricanes act as disturbances that can enhance marine biodiversity by reducing the dominance of competitive species and allowing the proliferation of others (Connell 1978). Nevertheless, the increasing intensity and frequency of hurricanes, attributed to climate change, hinders reef recovery and threatens their health and functioning (Mann and Emanuel 2011).

In response to these challenges, the conservation and restoration of reefs require mitigation and management actions. The removal of debris and waste after catastrophic events is crucial to prevent further damage. Additionally, techniques such as fragment stabilization, coral nursery establishment, and coral transplantation are effective strategies to accelerate the recovery of damaged areas (Rinkevich 2005; Johnson et al. 2011; Shaver et al. 2020; Padilla et al. 2021 and 2023).

Strengthening response capabilities contributes to the resilience of coral reef ecosystems.

A timely and coordinated response to the effects of hurricanes, accompanied by proper management, can make the difference between permanent loss and the recovery of these ecosystems. These actions strengthen reef resilience against climate change impacts, and safeguard biodiversity, and ensure the continued provision of essential ecosystem services.

A.3 OBJECTIVE OF THE PROTOCOL

The objective of this Protocol is to provide tools and guidance for reef response brigades throughout the Mesoamerican Reef System, with the potential for replication in other regions with existing response capacity. Its purpose is to enable timely, effective, and coordinated action when facing reef damage caused by hurricanes and storms. The Protocol ensures that response prioritizes the safety of both, brigades and the ecosystem, while optimizing efficiency of actions through clear coordination, effective communication, and proper decision-making. The ultimate goal is to provide immediate attention to rescue as many affected corals as possible and reduce the risk of further damage.

This document is an updated version of the **Early Warning and Early Response Protocol: Actions to mitigate the impact of Tropical Cyclones on Coral Reefs**, published in 2019 (Zepeda- Centeno et al., 2019). The update process aimed to improve the original content, by incorporating new techniques response strategies, and lessons learned, in order to provide a more practical and effective tool for addressing hurricane impact on coral reefs under changing conditions.

A.4 POST-STORM RESPONSE CAPACITY

Post-storm response capacity refers to the organized group that enables the efficient implementation of actions aimed at mitigating the damage caused by hurricanes to coral reefs, ensuring a safe and effective intervention. This involves establishing institutional agreements, providing support, offering tools that guide the process, developing human and financial resources, and acquiring the necessary equipment, in order to facilitate an effective implementation of the response.

In 2018, The Nature Conservancy (TNC) and government agencies in Mexico developed a protocol for storm response and reef rescue. This document, published in 2019 (Zepeda-Centeno et al., 2019), establishes the **Early Warning and Rapid Response Protocol**, which guides managers, brigade members, and other key actors on the actions to take before, during, and after a cyclone to reduce its impact on the reefs.

The pilot training was conducted in Puerto Morelos, where 39 brigade members were trained. In 2019, an additional 17 brigade members were trained for Isla Mujeres. Several of these participants later applied their knowledge and skills in coral rescue actions following Hurricanes Delta and Zeta in October 2020 in Quintana Roo, as well as during responses to Hurricane Grace in 2022 and Hurricane Beryl in 2024. All these responses took place in the Puerto Morelos Reef area. In November 2022, brigade members from Belize activated a response to Hurricane Lisa in the Turneffe Atoll Marine Reserve.

Between 2018 and November 2025, more than **300 brigade members** have been trained in the MAR. Likewise, **7 Post-Storm Response Coordinating Committees** have been formed, and **33 instructors** have been certified. Between 2021 and 2022, MAR Fund and TNC jointly developed **7 courses for brigade members** and **3 courses for instructors**, training 96 brigade members and 17 instructors across the four countries of the MAR. It is worth noting that brigade members from Belize activated a response to Hurricane Lisa in the Turneffe Atoll Marine Reserve in November 2022.

By November 2025, MAR Fund has contributed **22 training courses** for brigade members and instructors. Additionally, capacities were strengthened in other regions through **4 extra courses**, certifying 69 brigade members and 4 instructors.[1]

Post Storm Reef response brigade training. Author: Comisión Nacional de Áreas Naturales Protegidas (CONANP).

1 In the Archipelago of San Andrés, Providencia, and Santa Catalina, Colombia, Fondo Acción, with support from MAR Fund and in partnership with the Ocean Risk Resilience Action Alliance, delivered three brigade training courses in Colombia and one training-of-trainers course in the MAR. In Guam, the Reef Resilience Network, the Guam Coral Reef Initiative, and TNC conducted a brigade training course.

B. RESPONSE COORDINATION

Implementing the Protocol requires establishing a structure that comprehensively guides the coordination of the response to hurricane impacts. This structure should include two key components: **planning and organization**, and **preparation**. Both components must be aligned and adapted to the specific conditions of each locality to ensure a timely, efficient, and safe response.

It is essential to designate a dedicated group responsible for each component. This group can be organized as a **Committee**, a **Commission**, or a **Working Group**, and will be responsible to oversee the development and implementation of mechanisms needed to develop and carry out preparation and response activities.

PLANNING AND ORGANIZATION

This component is responsible for developing the strategic framework for implementing the Protocol. Its functions include designing, coordinating, facilitating, and supervising the necessary procedures to achieve the established objectives. It must also define the operational structure, clearly outlining the roles, functions and responsibilities of the different actors involved.

PREPARATION

This component focuses on defining the processes, intervention methods, and logistical mechanisms required for implementing the response. It also includes planning human and material resources, identifying operational needs, and organizing technical procedures to ensure effective execution.

FIGURE 1. **Diagram of responsibilities in the stages: a) planning and organization, and b) preparation for the response.**

B.1 PLANNING AND ORGANIZATION

The specific tasks to be carried out during the planning and organization phase prior to hurricane season are:

a) Definition of roles, functions, and responsibilities

Assigning roles, functions, and responsibilities during the implementation of the Protocol, is essential for establishing a clear and effective strategy for the working group. The organizational and coordinating structure, both in the planning stage and during execution, must remain flexible and capable of adapting to the different situations the brigade may face.

For this reason, this Protocol focuses on describing the necessary processes rather than prescribing rigid roles, allowing existing brigades to validate their current organization or make adjustments if needed, while providing new brigades with a flexible guide to structure themselves according to their specific needs. It is crucial to consider all individuals involved, ensuring their roles and responsibilities are clearly defined and assigned based to their skills, to guarantee effective coordination.

The structure should be adaptable to available resources, enabling flexible assignment of roles and responsibilities, through organizational charts, hierarchies, or the creation of committees or specialized teams to address specific processes.

Additionally, it is important to establish simple decision-making and accountability mechanisms that foster participation, transparency, and trust within the group. Ensuring that all roles are properly assigned and covered helps maintain consistency and efficiency throughout to the system.

Figure 2 illustrates the key processes required to build an organizational structure responsible for planning, in coordination with an operational structure in charge of execution. It also specifies the purpose of each process.

Furthermore, it is essential to **implement decision-making and accountability mechanisms** that are clear, accessible, and easy to understand for all involved. These mechanisms should encourage active member participation, fostering transparency and mutual trust. By establishing simple and well-defined processes, roles and responsibilities become easier to understand and fulfill, strengthening commitment and collaboration among all actors. Moreover, ensuring that all necessary functions and roles are clearly assigned and covered allows operations to remain consistent, efficient, and aligned with shared objectives. This creates an environment where participation is genuine and trust is consolidated, contributing to more effective and sustainable management.

b) Response plan

The response plan must be prepared annually, prior to the start of the hurricane season, to establish a clear and efficient strategy for addressing hurricane impacts. This plan outlines specific actions and steps-by-step procedures to guide all members of the working group. It includes defined tasks, assigned responsibilities, key contacts, and required suppliers. Additionally, it provides a timeline that facilitates coordination, communication, and timely execution of actions.

The response plan also incorporates safety plans and complies with legal requirements of each country to ensure an effective and safe response.

ORGANIZATIONAL AND COORDINATING STRUCTURE	INSTITUTIONAL LINKAGE AND REGULATORY COMPLIANCE	Ensure coordination, compliance, and the strengthening of institutional actions necessary for implementing the Protocol, as well as adhere to regulations related to species management and the application of safeguards.
	INTERNAL MANAGEMENT	Ensure an efficient and coordinated response through resource management, effective communication, and continuous evaluation of the response plan, including the goals and actions to achieve it. It defines the hierarchy, roles, responsibilities, and relationships among members, establishing an internal coordination structure to achieve the stated objectives.
	FINANCIAL MANAGEMENT	Identify funding opportunities, manage resources efficiently, and ensure proper accountability.
	TECHNICAL AND SCIENTIFIC SUPPORT	Guide the implementation of response actions based on the best available technical and scientific knowledge.
	SECURITY AND RISK MANAGEMENT	Ensure the safety of the entire team before, during, and after activities. Design, promote, and update safety and emergency protocols to reduce potential risks in operations.
	COMMUNICATION AND DISSEMINATION	Promote the dissemination and recognition of the working group's activities.
OPERATIONAL STRUCTURE	COORDINATION OF THE OPERATION	Plan, coordinate, and supervise field activities. Manage logistical and material resources and maintain internal communication for efficient operations.
	STRENGTHENING AND TRAINING	Build skills and capacities within the brigade team. Maintain an updated record of brigade members and be aware of their skills.
	SECURITY PROTOCOL OPERATION	Implement safety and emergency protocols, and foster preventive culture to minimize potential threats in operations.
RESPONSE STRUCTURE	IMPLEMENTATION OF ACTIONS	Execute field activities according with the response plan and the established operational procedures for response management.

FIGURE 2. Key processes to consider for the organizational and coordinating, operational, and response structures.

This tool clearly defines the functions and responsibilities of the entities, institutions, and individuals involved within the organizational and coordinating, operational, and response structures, guaranteeing a coordinated and effective response to emergencies that may affect the reef. A template is provided as a guide to develop a response plan (ANNEX 1).

c) Network of allies

It is essential to establish agreements or partnerships with allies that support the implementation of the Protocol, including government institutions, private companies, and civil organizations. These agreements must be formalized prior to the hurricane season. Key topics include:

- Establish communication channels with local authorities or relevant agencies to receive alerts during the warning phase and manage collected waste, among other tasks
- Secure space for the Operations Center
- Establish agreements with suppliers for essential items such as food, vessels, fuel, materials, and tools for the brigades
- Setting a calendar for inter-institutional coordination meetings
- Establish agreements with NGOs, academic institutions, and other partners to provide volunteers during the response

d) Financing

The implementation of the Protocol requires funding to carry out the planned actions. It is crucial to secure resources and supplies in advance for logistics and operations (rental of vessels, vehicles, dive tanks, diving equipment), materials and supplies (tools, safety equipment, fuels, cement, food), as well as training and drill activities. For this purpose, a detailed annual budget must be prepared, using the guide template included in ANNEX 2.

It is also necessary to identify and select potential funding sources to secure resources. Some options may include government contributions, international cooperation, and. There are also some innovative alternatives:

- Parametric insurance for marine ecosystems, which provides immediate payouts to address emergency response in coral reefs
- National or international emergency funds, or those applicable to the region and work site
- Contributions from the private sector (e.g., tourism providers, ports, non-governmental organizations, dive shops, others)
- Environmental compensation funds
- Payments for ecosystem services
- Taxes and pricing mechanisms

To access these funding sources, it is essential to understand their guidelines, prepare proposals and budgets, negotiate agreements managed, and comply with the terms and conditions established for receiving, managing, and using the funds.

e) Identification, mapping, and prioritization of Specific Areas of Interest (SAI)

For a more efficient response, it is useful to have prior information on reef areas within the brigade's scope that hold significant ecological, social, or economic value and are highly vulnerable to extreme weather events. These are referred as Specific Areas of Interest (SAIs).

Data collection can be carried out with the support of local partners, community members, research institutes, as well as tourism and diving services providers, to build a broad and robust understanding of the sites to be addressed. If the site is located within a Marine Protected Area (MPA), it is important to involve managers and co-managers to consider criteria established in management plans and regulations to support prioritization.

The information gathered allows for creating a map of SAIs and classifying them according to their characteristics. It is recommended to use a data collection matrix to facilitate a comprehensive evaluation of each area, helping to prioritize sites for review and intervention. Table 1 provides criteria that can assist in identifying and assessing the sites.

Once the SAIs are defined, it is recommended to create a map associated to the table, including the location of all sites. Subsequently, these should be prioritized. This ensures that the necessary information for operations planning is readily available. Data such as site depth, distance from the base, proximity to docks, and the presence of species or reefs can be filled directly into the table. Having this information in advance will facilitate planning for potential hurricane impacts.

Criteria		Site 1	Site 2	Site 3
Ecological value	Presence of colonies from priority species and reproductive size			
	Reproductive aggregation zones for any priority species			
	Ongoing conservation, research, and/or management actions at the site			
Social, cultural and economic value	Site visited by local communities and/or tourists			
	Fishing importance for local communities			
	Cultural or spiritual value associated with the reefs			
Accesibility and logistics	Proximity to the operational base, dock, or support infrastructure			
	Ease of access for transporting equipment and technical personnel			
Risk	Site depth (greater depth = higher risk)			
	Current and wave dynamics			
	Presence of pollution or external environmental degradation			
	Unregulated human activities or illegal extractive activities			
	Presence of social conflicts, presence of criminal groups, or security issues			

TABLE 1. **Supporting criteria for the identification of Specific Areas of Interest.**

B.2 PREPARATION

a) Development of operational procedures

The preparation phase should begin with the development of standardized operational procedures for all response actions. These procedures serve as a clear, detailed guidelines to ensure an effective, safe, and coordinated response. They must address all necessary elements within the organizational structure, including facilities, equipment, brigade members, procedures, and communication channels. These documents should be concise and practical, outlining actions, considering the following main tasks:

1. Define objective of the action.
2. Identify key steps and their logical sequence.
3. Assign responsibilities.
4. Establish monitoring mechanisms.

All protocols and operational procedures must be validated by all members of the response capacity to ensure their clarity and understanding, and be reviewed and updated periodically to maintain efficiency.

b) Organization and training of brigades

To ensure a successful and efficient response, sufficient personnel must be available to carry out the activities outlined in the Protocol. The following actions should be implemented:

1. **Update the list of active brigade members** through the annual recruiting form (ANNEX 3). This information will help determine whether the current is complete or if or if additional members need to be recruited and trained.
2. **Provide training courses for new brigade members**, as needed, depending on available budget and time.
3. **Organize refresher sessions for certified brigade members** to keep information up to date and ensure alignment in team actions.
4. **Conduct aquatic skills assessments** to evaluate performance in the water, reinforce capabilities, and strengthen teamwork.
5. **Design and conduct rescue drills** to prepare the team to respond to emergencies by practicing essential skills for immediate response.
6. **Coordinate with allies or specialized entities** to deliver first aid training.

Training should incorporate updated information on coral management and rescue techniques in an accessible format, ensuring a well prepared and informed team. Physical conditioning should also be promoted to minimize risks during activities in potentially hazardous environments.

The brigade should be structured according to the planned activities, with clearly assigned roles for each member to ensure an organized and effective response. Key roles include:

- **Brigade Leader:** Responsible for coordinating the team.
- **Divers for response actions:** Responsible for site cleaning and coral rescue.
- **Snorkeling support:** Provides assistance and handle materials for the divers' work.

- **Surface support:** Manage materials on the boat (preparing cement, supervising work groups, maintains communication with the onshore person in charge).

c) Handling of equipment and materials for the response

Ensuring an efficient response requires having the necessary equipment, materials, and tools. A protocol should be established for their handling, inventory, and maintenance, considering the following activities:

- **Materials and tools:** Maintain an inventory of materials, implement a maintenance and replacement program for materials, and establish a storage regulation.
- **Safety and first aid equipment:** Ensure the availability of a first aid kit with an oxygen tank.
- **Personal equipment per brigade member:** Perform annual preventive maintenance on diving gear, keep basic equipment (fins and snorkel) in excellent condition, and provide a surface signaling buoy.

ANNEX 4 contains a general list of materials commonly used in response actions, and ANNEX 5 is an inventory and tracking form for the brigade materials.

d) Hurricane Season Kick-off meeting

The last activity to be carried out during preparation is the start-of-hurricane-season meeting. During this meeting, a review of the previous year's actions is conducted, focusing on identifying positive aspects to maintain and areas for improvement in the current year. The hurricane season forecasts and the annual response plan are presented. Brigade members are encouraged to participate actively and get involved, and team-building activities are conducted to strengthen teamwork.

Brigade team conducting an inventory of materials and tools. Author: Sara Gutiérrez Plata.

C. RESPONSE EXECUTION

The response for rescuing corals damaged by hurricanes is divided into 3 stages (Figure 3):

STAGE 1 EARLY WARNING

Start with the formation of a storm or hurricane in the area

Finish when the "Out of Danger" notice is received from the authorities

1.1 Activation of the alert

STAGE 2 IMMEDIATE RESPONSE

Start when the "Out of Danger" notice is received from the authorities

Finish when having collected and stabilized the corals

2.1 Damage classification

2.2 Site cleaning and debris removal

2.3 Coral collection and stabilización

2.4 Tagging and mapping of intervened zones

STAGE 3 POST-RESPONSE

Start if there are non-priority organisms available after the Immediate Response

Finish depending on agreements with restoration programs and networks

3.1 Monitoring and follow-up of rescue actions

3.2 Establishment of coral nurseries

3.3 Linking with restoration networks

3.4 Evaluation and closure

FIGURE 3. General structure for the execution of the response.

Damage classification using the Manta Tow method. Author: Juan Carlos Huitrón.

The following diagram (Figure 4) provides a concise overview of the critical response execution path, highlighting the key stages along the decision-making processes and steps required within each one.

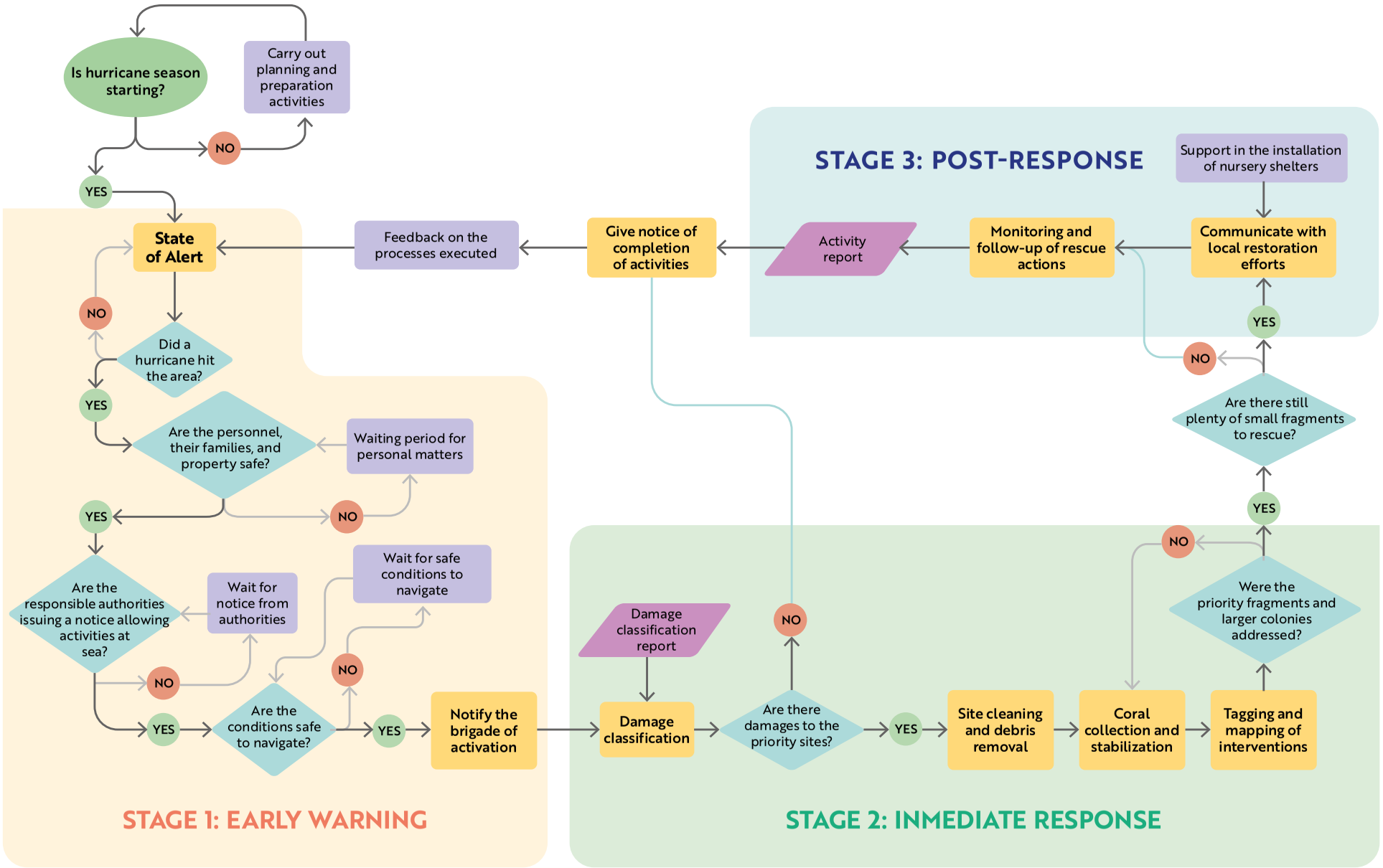


FIGURE 4. Critical path for response execution.

STAGE 1

EARLY WARNING

Start: When the formation of a meteorological phenomenon is detected

Finish: When the 'Out of Danger' signal is received from local authorities

1.1 ACTIVATION OF THE ALERT

Since the start of hurricane season, the brigade remains alert to the possible formation of a meteorological event. Thanks to the planning, organization, and preparation actions carried out prior to the season began, the brigade is ready to respond in case a natural phenomenon impacts the area.

Stage 1 begins when official authorities or monitoring systems detect the formation of a hurricane. From that moment, the brigade enters a state of alert and monitors its development and trajectory during the approach phase, landfall, and departure phase. The early warning ends when the official 'Out of Danger' signal is issued. There are different alert moments defined by the estimated time or distance from the hurricane zone during the approach and departure.

If a hurricane or storm impacts the area, it will be necessary to verify that certain safety criteria are met before mobilizing the brigade and starting Stage 2, following the diagram in Figure 6.

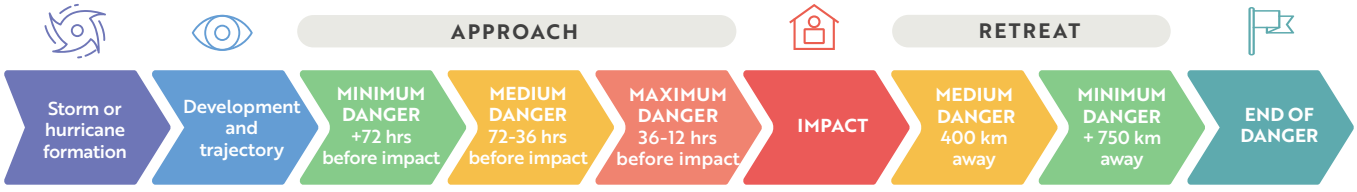


FIGURE 5. Phases of approach, impact, and withdrawal of a hurricane.

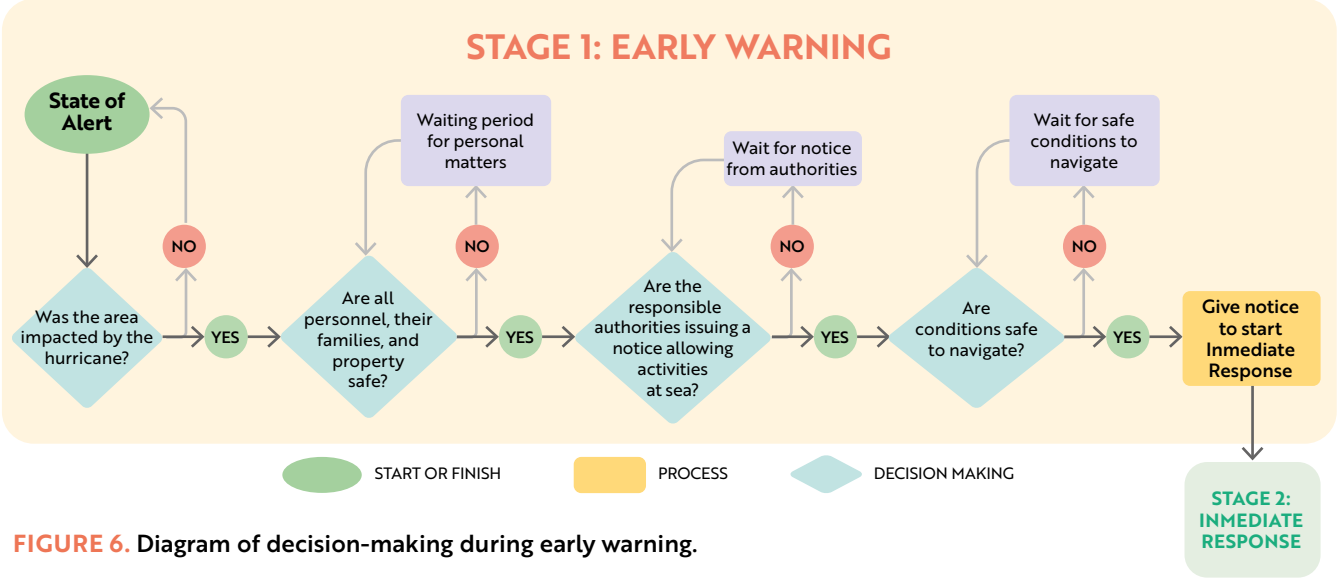


FIGURE 6. Diagram of decision-making during early warning.

1.2 SPECIFIC RESPONSIBILITIES DURING EARLY WARNING

During the early warning stage, each team member assumes specific roles and responsibilities, which are described in Figure 7 below.

	ALERT					
	APPROACH PHASE			IMPACT	WITHDRAWAL PHASE	
	MINIMAL DANGER +72 hrs to impact	MEDIUM DANGER 72-36 hrs to impact	MAXIMUM DANGER 36-12 hrs to impact		MEDIUM DANGER Cyclone more than 400 km away	MINIMAL DANGER Cyclone more than 750 km away
ORGANIZATIONAL AND COORDINATING STRUCTURE	**FIRST ALERT NOTICE** Coordinate with authorities the removal of marine infrastructure	**SECOND ALERT NOTICE** 1. Monitor weather conditions 2. Charge batteries and communication devices	**THIRD ALERT MESSAGE** 1. Monitor weather conditions 2. Charge batteries and communication devices	**REMAIN SHELTERED IN A PROTECTED PLACE.** **REMAIN ALERT TO MESSAGES AND ANNOUNCEMENTS**	**FOURTH ALERT MESSAGE** 1. Monitor weather conditions 2. Assess the condition of those involved 3. Communicate with authorities	**FIFTH ALERT MESSAGE** 1. Confirm authorization from authorities before starting any activities 2. Manage emergency funding
OPERATIONAL STRUCTURE	1. Safeguard materials and equipment 2. Check weather alerts	1. Safeguard materials and equipment 2. Charge batteries and communication devices	1. Remain alert to official communications 2. Remain in a safe place 3. Charge batteries and communication devices		1. Disseminate information on the severity of the impact in the locality	1. Check the condition of materials 2. **Send the activation message to the Brigade**
RESPONSE STRUCTURE	1. Remain alert to official communications 2. Personal preparations for the hurricane	1. Remain alert to official communications 2. Personal preparations for the hurricane	1. Remain alert to official communications 2. Remain in a safe place 3. Charge batteries and communication devices		1. Remain to official announcements 2. Respond to welfare messages 3. Everyone must remain in a safe place	1. **Answer activation call**

FIGURE 7. **Specific responsibilities during the early warning stage.**

1.3 HURRICANE AND STORM TRACKING TOOLS

During this stage, it is crucial to have the most accurate and up-to-date information on storm or hurricane, including their trajectory, and estimated time of arrival. It is recommended to use the following international digital platforms, while also considering national tools for country-specific alerts.

NOAA

https://www.nhc.noaa.gov

Windy.com

https://www.windy.com/-Waves-waves

ZOOM EARTH

https://zoom.earth

Post Storm Reef response brigade training. Author: Martin Leglize.

STAGE 2

IMMEDIATE RESPONSE

Start: When the 'Out of Danger' notice is received and it is verified that the necessary safety conditions are met to begin the immediate response

Finish: When priority corals have been collected and stabilized, and only small fragments or corals remain to be rescued, leading to Stage 3: Post-response

The immediate response focuses on urgently attending the reef after the impact of a meteorological event. The main objective of this phase is to classify the damage caused, prevent further damage, and avoid the loss of key corals that perform ecological functions in the ecosystem.

This stage involves direct in-water intervention and is carried out in four main phases:

1. Damage classification following the impact of a hurricane or storm
2. Site cleaning and debris removal to eliminate hazards to corals and facilitate brigade activities
3. Coral collection and stabilization
4. Tagging and mapping of intervention zones

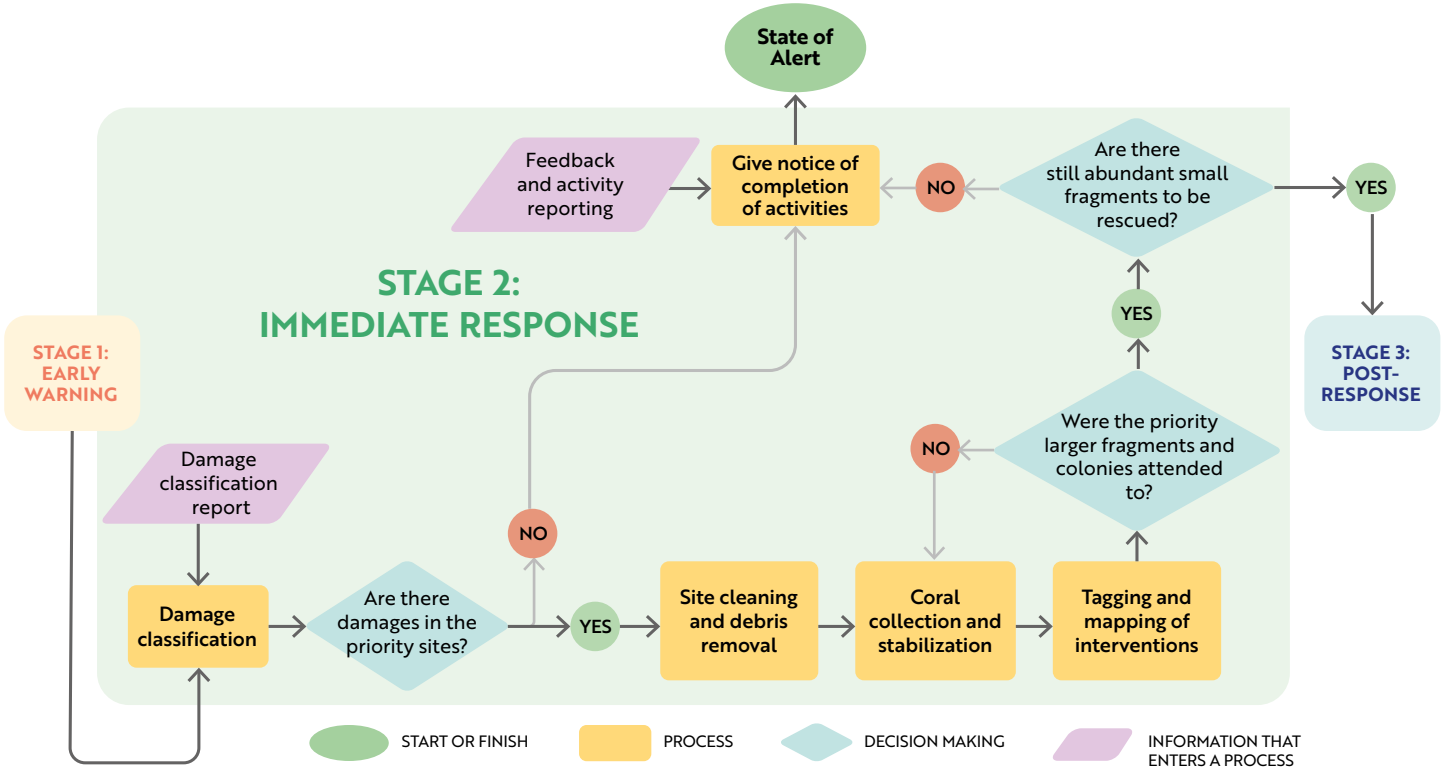


FIGURE 8. Decision-making diagram for addressing the immediate response.

2.1 PREPARATORY PROCEDURES FOR DEPARTURES

Prior preparation before any field operation is essential to ensure team safety, efficient use of resources, and achievement of the activity's objectives. Proper planning allows anticipating needs, assigning responsibilities, identifying risks, and ensuring that all required information and materials are available at the time of the operation. To achieve this, the following resources are recommended:

a) Activity Planner

For immediate response activities, prior planning that specify tasks and responsible parties is essential. To ensure a successful primary response, complete the activities presented in Stage 2's Activity Planner (Figure 9).

b) Proposed Action Plan

For each action carried out in the field, it is essential to prepare an Action Plan beforehand. This document must detail all the necessary information for its proper execution, including:

- The name and coordinates of the intervention site, and the type of vessel and crew required
- A review of weather conditions and aspects to consider
- The specific resources and materials that must be prepared before the operation
- The number and profile of brigade members required
- A description of the operation, with assigned responsibilities and roles
- Field formats to be used
- Details of the information to be collected during the activity
- Special considerations for the operation

c) Tools and resources for the primary response

For all field operations, a list of materials is required that applies to all outings, along with some unique resources for each maneuver. Figure 10 specifies the resources and tools to generally consider in all actions, as well as the specific resources for each of the primary response activities.

d) Safety procedures and task checklists

For all field actions, it is essential to follow safety protocols and complete a checklist before each outing to ensure compliance. This checklist allows confirming that all necessary equipment is available and that safety requirements have been met prior to boarding. The list can be complemented with the safety verification checklist found in ANNEX 6.

A crucial part of the success of the operation is ensuring that all members, including brigade members, crew, and external support staff, clearly understand the activity to be carried out. To this end, a briefing meeting is held prior to departure, following the proposed outline in ANNEX 7, and the **Proposed Action Plan** as a guide.

When concluding each field operation, the relevant checklist should be completed, followed by a debrief meeting to review the day's activities. This meeting provides an opportunity to share important information regarding the operation. The debrief follows the format outlined in ANNEX 8.

ACTIVITY PLANNER » STAGE 2: IMMEDIATE RESPONSE

ORGANIZATIONAL AND COORDINATING STRUCTURE	INSTITUTIONAL LINKAGE AND REGULATORY COMPLIANCE	❑ Communicate the brigade's actions to local authorities ❑ Coordinate with authorities for garbage and debris collection ❑ Ensure access to permits for species management
	INTERNAL MANGEMENT	❑ Identify necessary information to be collected during operations ❑ Gather information of the results of activities
	FINANCIAL MANGEMENT	❑ Manage emergency funding ❑ Communicate resource availability ❑ Monitor and verify expenses
	TECHNICAL AND SCIENTIFIC SUPPORT	❑ Share resources and guide materials for various activities to be carried out ❑ Update databases
	SECURITY AND RISK MANAGEMENT	❑ Designate a person on land as the point of contact for each outing
	COMMUNICATION AND DISSEMINATION	❑ Issue calls for participation in the operations ❑ Create outreach materials
OPERATIONAL STRUCTURE	COORDINATION OF THE OPERATION	❑ Prepare the Action Plan proposal for the operation, specifying requirements for materials, personnel, vessels, and tanks ❑ Update inventory after each outing and replenish as needed (ANNEX 5) ❑ Specify the information to be collected from each action (damage classification, debris removed, number of corals stabilized, etc.)
	STRENGTHENING AND TRAINING	❑ Collect information on positive aspects and areas for improvement during operations (techniques, efficiency, safety) ❑ Refresh knowledge on handling tools, debris, and corals ❑ Conduct a post-outing feedback meeting (ANNEX 8) ❑ Guide brigade members in documenting the operation results
	IMPLEMENTATION OF SECURITY PROTOCOLS	❑ Assign a person responsible for safety in each operation ❑ Hold an informational meeting for the operation, establishing specific responsibilities and roles (ANNEX 7) ❑ Prepare a safety checklist before each outing (ANNEX 6) ❑ Notify the person in charge on land at the start of activities ❑ Report any risks identified during the actions
RESPONSE STRUCTURE	IMPLEMENTATION OF ACTIONS	❑ Respond to participation requests ❑ Review the Action Plan proposal and clarify any doubts before outings ❑ Assist in preparing materials prior to the outing ❑ Carry out immediate response actions (damage classification, debris cleaning and removal, fragment stabilization, and mapping and tagging intervention sites) ❑ Collect and share the required information for each operation (ANNEXES 10, 11, 12 y 13) ❑ Actively participate in the post-outing feedback meeting ❑ Assist with cleaning and restocking materials after the outing ❑ Help prepare reports for each outing (ANNEX 9)

FIGURE 9. Activity Planner for Stage 2- Immediate Response.

It is also recommended to prepare a brief report summarizing the activity, including the actions carried out, the data collected during the outing, and areas for improvement identified in the feedback meeting. For preparing this report, it is suggested to use the template provided in ANNEX 9.

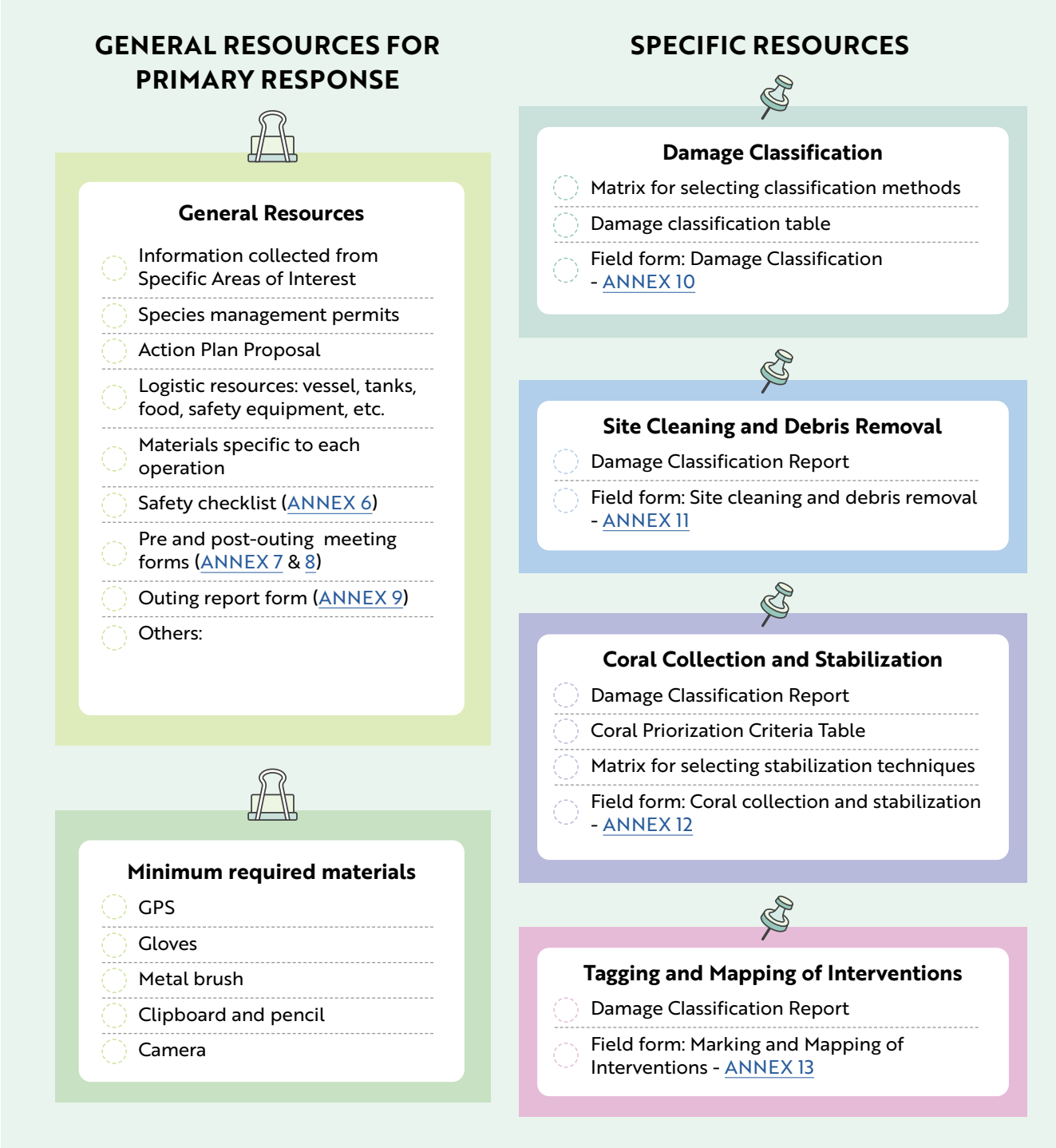


FIGURE 10. Resources needed for field activities in Stage 2: Immediate Response.

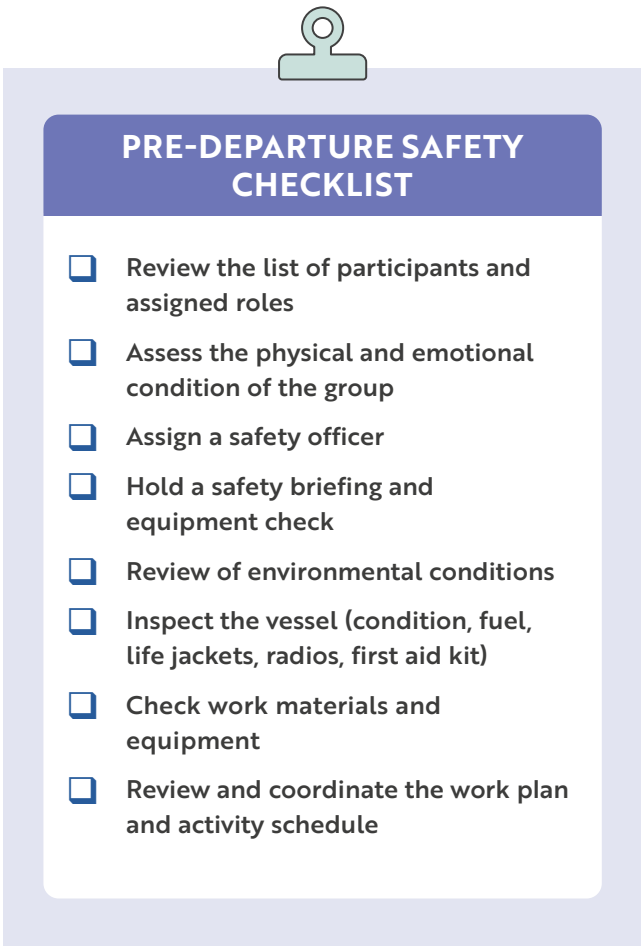


FIGURE 11. Pre-Departure Safety Checklist.

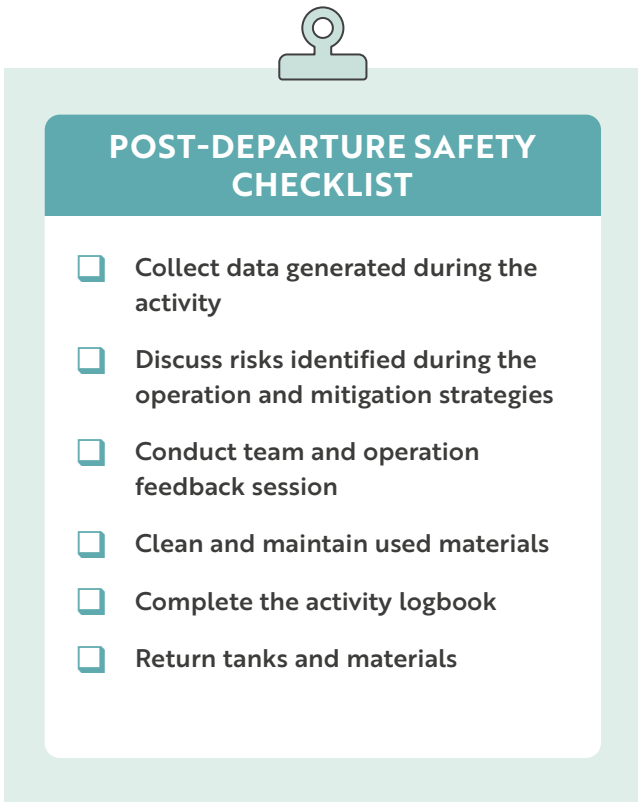


FIGURE 12. Post-Departure Safety Checklist.

2.2 DAMAGE CLASSIFICATION

During damage classification, the main objective is to identify the condition of the reef after a storm or hurricane and classify it using the damage classification table (Table 3). This step facilitates the planning and execution of subsequent actions such as site cleaning and debris removal, as well as coral collection and stabilization. The information gathered should focus on three main aspects, as indicated in the damage classification form from ANNEX 10, for which a simplified version and a detailed version are presented:

1. Presence of debris and/or external objects
2. Accumulation of sediment and rubble, and evidence of coral tissue erosion
3. Condition of corals, considering:
   a. Level of fragmentation
   b. Dislodgement of colonies

During this phase, it is recommended to gather as much information as possible about the condition of the affected sites after the impact of a hurricane or storm. This information will be essential for properly planning subsequent operations.

During the damage classification phase, each team member will have clearly defined roles and responsibilities, which are described in Stage 2's planner. This assignment ensures an orderly and efficient execution of the process, facilitating the collection of accurate information about the condition of the reef. Each role must be performed as established, ensuring coordination among brigade members, proper use of standardized methodologies, and correct application of classification criteria.

a) Tools for Damage Classification

Damage Classification

- Matrix for selecting classification methods
- Damage classification table
- Field form: Damage Classification - ANNEX 10

*It is assumed that all methods require basic navigation conditions and visibility greater than 2 meters.

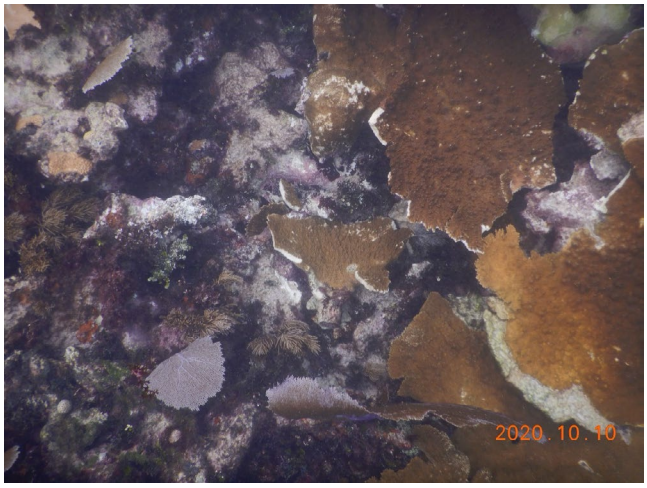
Technique	Depth	Area coverage	Benefits	Limitations	Specific Equipment	Personnel required per area
Survey with scuba diving	Greater than 2 meters	Low (0 to 100 meters)	- Detailed observation of damages	- Limited area coverage for evaluation - Between 50 and 80 minutes available (per dive) - No-decompression limits	- SCUBA Equipment - Diving tanks - Vessel of appropriate type and size	3 to 5 divers
Snorkel Survey	0 to 10 meters	Medium (100 to 500 meters)	- Detailed observation of damages	- The area coverage is limited by the endurance/ stamina of the team members - Visibility may limit the evaluation	- Basic equipment (mask, snorkel fins)	3 to 5 snorkelers
Snorkel tow / Manta Tow	5 to 10 meters	High (+ than 500 meters)	- Covers large distances - General observation	- Not suitable for shallow reefs - Limited detail in observations	- Basic equipment - GPS - Rope - Manta Tow (optional)	Minimum team of 3 people Captain experienced and informed about the activity
Drone	0 to 7 meters	High (+ than 500 meters)	- Provides information for photogrametry and map generation - Creates a historical record	- Calm sea conditions (no waves) - Work hours limited by light reflection - Post-processing time, equipment cost, battery lifey	- Dron Drone and related equipment (batteries, SD cards, etc.) - Image analysis equipment and software	Personnel trained in drone operation

TABLE 2. **Matrix for selecting methods for damage classification.**

DAMAGE CLASSIFICATION TABLE

Level	Category	What you see				% of affected coral colonies	Required response action
		External objects or debris	Sediment & fragments / Coral tissue erosion	Condition of the corals			
0	No Damage	No external objects or debris found	No sediment or fragments on live coral tissue	The corals are intact. There are no visible recent damages or broken corals caused by the storm		0%	NO
1	Minor Damage	Some small external objects or debris found, easily removable	Some sediment and a few fragments on live corals	**Low level of fragmentation:** Some coral colonies with broken parts or branches	**Colony detachment:** No colonies detached or overturned	1%–25%	Actions are optional if time and budget allow
2	Major Damage	Large amounts of external objects and/or debris observed Garbage removal activities are necessary	A lot of sediment and fragments on live coral colonies Debris and sediment removal activities are necessary	**High level of fragmentation:** Many coral colonies with broken branches or parts Fragments visible on the seafloor	**Colony detachment:** Presence of detached or overturned colonies	26–75%	First Priority
				Actions for collecting and stabilizing corals are necessary			
3	Extreme Damage	Large amounts of external objects and/or debris observed Specific garbage removal activities are necessary	Large areas devastated or covered by fragments	Most coral colonies have been destroyed		More than 76%	Contact local restoration programs

TABLE 3. Damage classification.



Example of minor damage: Presence of broken tips. Author: Andrea Marina Sánchez López.

Example of major damage: Presence of colonies detached and overturned. Author: Arcelia Romero Nava.

2.3 SITE CLEANING AND REMOVAL OF DEBRIS

Although prior planning of actions facilitates a safe operation, brigade members must always keep their safety as the top priority. Before approaching, divers and snorkelers should inspect the area for possible hazards and approach debris carefully, especially when handling large or dangerous objects such as metal, glass, or sharp items.

If foreign objects to the reef are identified during the damage classification, one of the priority actions is their cleaning and removal. This measure helps create a safe working environment for the brigade members and at the same time prevents additional damage that may be caused by the movement or impact of these objects on the corals. The planning of the cleaning operation should be based on the findings from the damage classification, anticipating the need to use larger vessels or lift bags to remove heavy or large objects.

During the cleaning, brigade members are responsible for removing any objects foreign to the reef, whether natural elements (branches, logs, or trees) or anthropogenic (solid waste, beach chairs and umbrellas, debris). These actions should be repeated as many times as necessary to ensure that the area is completely free of debris resulting from the disaster, thereby guaranteeing safe conditions for the brigade members during the rescue phase. All the information collected must be documented in the corresponding form (ANNEX 11) with the aim of maintaining a detailed record of the interventions carried out by the brigade.

Finally, once the operation is completed, it is necessary to notify the person responsible onshore to coordinate the proper collection and disposal of the removed objects.

a) Tools for debris cleaning and removal

Site Cleaning and Debris Removal

- Damage Classification Report
- Field form: Site cleaning and debris removal - ANNEX 11

2.4 COLLECTION AND STABILIZATION OF CORALS

Once the debris-cleaning and removal stage has been completed, the results obtained during the damage assessment must be reviewed to properly plan the coral collection and stabilization phase. Based on this evaluation, the logistical strategy for the operation will be determined, which should take into account:

- The number of days required to carry out the operations
- The number of vessels needed
- The number of brigade members required
- The necessary materials and tools
- An efficient rescue plan adapted to the conditions identified

The main objective of this phase is to recover as much live, healthy coral tissue from hard corals as possible and to stabilize it appropriately to ensure its survival and potential growth.

a) Tools for coral collection and stabilization

Coral Collection and Stabilization

- Damage Classification Report
- Coral Priorization Criteria Table
- Matrix for selecting stabilization techniques
- Field form: Coral collection and stabilization - ANNEX 12

b) Coral priorization

The coral collection process begins with the identification and selection of viable fragments or colonies, with priority given to those presenting the greatest amount of healthy, living coral tissue. The following prioritization criteria are applied:

Criteria	High priority	Low priority	Not a priority	Not recoverable
Size	Large (greater than 100 cm)	Medium (100 a 30 cm)	Small (less than 30 cm)	n/a
Percentage of living tissue	More than 50%		Less than 50%	n/a
Health status	No signs of disease			Presence of disease*
Coloration	Vibrant color	Pale	Bleached	n/a

* Corals found to be diseased should not be handled to prevent the spread of disease to other corals. These corals are considered "not recoverable".

TABLE 4. Prioritization criteria for coral rescue.

Examples of coral collection

a) Brigade member inspects the coral fragments to carry out proper collection. Author: María del Carmen García Rivas.

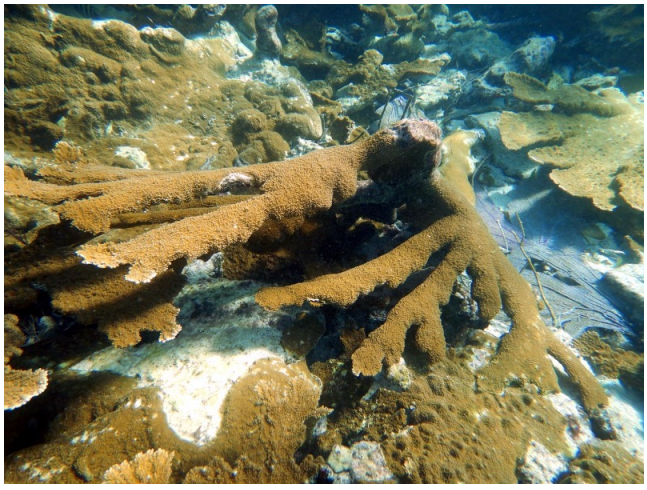
b) Transport of fragments to suitable sites for stabilization. Author: Arcelia Romero Nava.

c) Two brigade members coordinating during the transfer of corals from unstable areas to suitable sites for stabilization. Author: Arcelia Romero Nava.

d) Collection of medium-sized fragments in a crate. Autor: David González Vázquez.

Based on the previously established prioritization criteria, the response planning must be adjusted according to existing capacities, available budget, and the availability of brigade members, always prioritizing the rescue of the greatest amount of healthy tissue.

Examples of high priority corals for rescue



a) Large overturned *Acropora palmata* colony. Author: Claudia Padilla Souza.

b) Large detached *Agaricia tenuifolia* colony. Author: Sara Gutiérrez Plata.

c) Large *Orbicella annularis* fragment detached. Author: Sara Gutiérrez Plata.

d) Several fragments of *Acropora cervicornis.* Author: Turneffe Atoll Sustainability Association (TASA).

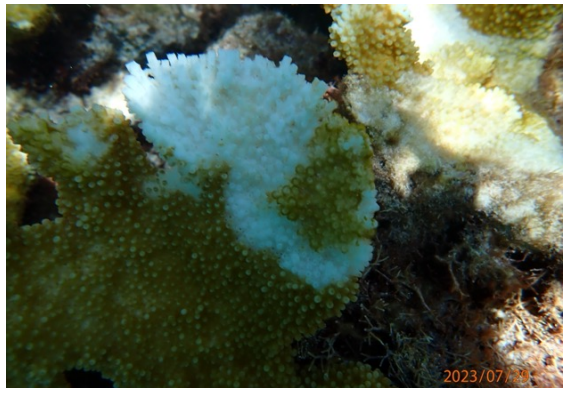
Corals of lower priority for rescue

a) Small *Acropora palmata* fragments. Author: Erika Y. Hernández Ortiz.

b) Bleached medium sized *Acropora palmata* colony. Author: Andrea Marina Sánchez López.

c) Small and eroded *Acropora palmata* fragments. Author: Andrea Marina Sánchez López.

Unsalvageable corals



a) Diseased *Acropora palmata*, unsalvageable. Author: Sara Gutiérrez Plata.

b) Diseased brain coral, unsalvageable. Author: Sara Gutiérrez Plata.

c) Diseased labyrinth coral, unsalvageable. Author: Sara Gutiérrez Plata.

c) Substrate selection

Once the corals to be rescued have been identified and the intervention sites defined, the next step is to carefully select the substrate for stabilization. This selection is critical, as choosing the appropriate substrate directly influences the success of the rescue efforts and the survival of the coral fragments. The selection should consider factors such as substrate firmness, stability against wave action, ecological compatibility, and ease of coral attachment.

Once the appropriate substrate is selected, preparation begins, which may include localized cleaning, surface adjustments, application of adhesives, or installation of support structures as needed to achieve successful stabilization.

Figure 16 outlines the steps for substrate selection and preparation, as well as the key aspects to consider.

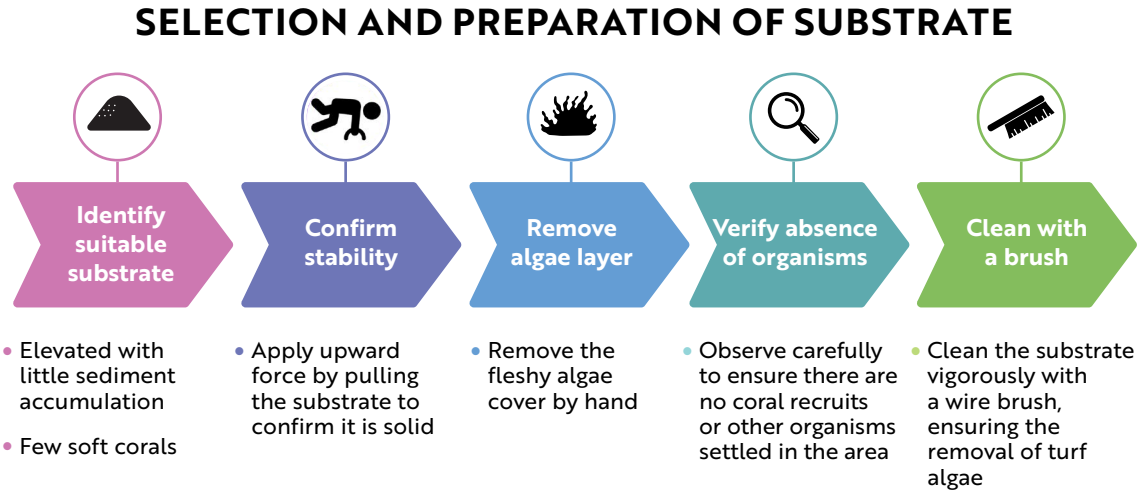


FIGURE 16. Steps for substrate selection and preparation.

a) Mountain coral skeleton, suitable for coral stabilization. Author: Andrea Izaguirre.

b) Unstable substrate, not suitable for coral stabilization. Author: Sara Gutiérrez Plata.

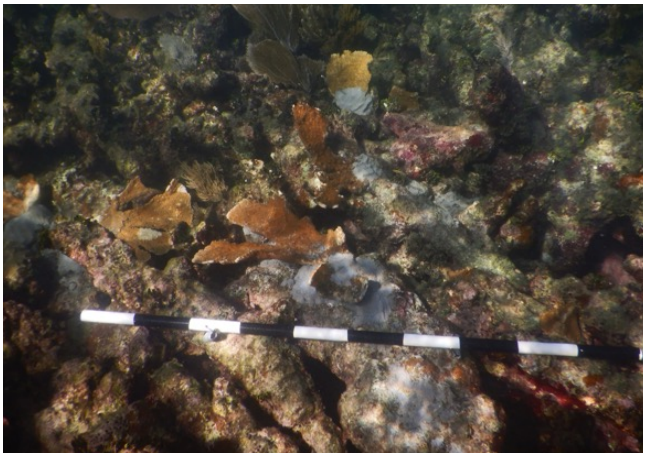
d) Coral stabilization

Coral stabilization is a crucial action in the response process. The choice of technique will depend on several key factors such as the number of fragments to be rescued, the type and characteristics of the substrate at the site, the type and size of the coral, as well as the availability of materials, tools, and resources.

To guide this process, a stabilization technique selection matrix (Table 5) is provided, designed to facilitate a choice adapted to the different needs, considering the scope and specific limitations of each situation.

Each brigade member is responsible for recording, in the template provided in ANNEX 12, the number of fragments rescued and the stabilization technique used. This record is essential for the proper planning of subsequent follow-up and monitoring actions.

The form can be adapted to the group's capabilities and knowledge. However, the more detailed the information collected during the rescue, the higher the quality and accuracy of the follow-up that can be conducted later.



a) Stabilization with cement. Author: David González Vázquez.

b) Stabilization with zip ties highlighting the importance of cutting off excess material. Author: TASA.

c) Stabilization with pneumatic drill. Author: John Bodden.

Technique	Size of fragments and colonies that can be attended to			Number of corals that can be attended to	Type of substrate needed	Benefits	Limitations	Required Equipment	Cost
	Small	Medium	Large						
Wedging	✓	✗	✗	Large amount	Complex reef relief with holes and crevices of various sizes	- Fast - Suitable for working with many fragments	- Does not ensure stabilization - Requires hard substrate with enough holes of various sizes	None	$- Very Low
Cement	✓	✓	✗	Large amount	Any fixed substrate	- Ensures stabilization - Suitable for working with many fragments - Stabilizes on any fixed substrate	- Strong swell or current can affect curing and stabilization - Volatile in the environment - Difficult to transport: adds weight on the vessel and during material transfer - Makes the vessel and materials dirty (requires cleaning time)	Cement kit • Tarp • Container • Shovels • Gloves • Bags • Rubber Bands • Additive	$$- Low
Wedging & Cement	✓	✓	✓	Large amount	Complex reef relief with holes and crevices of various sizes	- Ensures maximum stabilization - Suitable for working with many fragmentss	- Requires hard substrate with enough holes of various sizes - Strong swell or current can affect curing and stabilization - Volatile in the environment - Cement is difficult to transport: adds weight on the vessel and during material transfer - Makes the vessel and materials dirty (requires cleaning time)	Cement kit • Tarp • Container • Shovels • Gloves • Bags • Rubber Bands • Additive	$$- Low
Zip Ties	✓	✓	✗	Equal to the number of zip ties available	Complex reef relief with holes and crevices of various sizes	- Secures firmly and quickly - Multiple zip ties can be joined - Can be combined with cement while it cures and then removed - Reusable (with caution)	- Zip tie size may limit the size of corals that can be secured - Use of plastic - Requires hard substrate with protrusions for attachment	- Zip ties - Scissors - Waste bag	$$- Low
Tarred yarn	✓	✓	✓	Moderate amount	Complex reef relief with holes and crevices of various sizes	- Low cost - Versatile	- Knotting experience is required to ensure secure attachment - Requires hard substrate with protrusions for tying - Thread is quickly colonized by algae that can affect coral health	- Tarred yarn - Scissors	$$- Low
Epoxy Clay	✓	✗	✗	Moderate amount	Any fixed substrate	- Ensures stabilization - Stabilizes on any fixed substrate	- After extended time in seawater, it may lose its adhesion - High costs, limited reach	- Epoxy clay	$$$- High
Pneumatic Drill	✗	✓	✓	Low amount	Any fixed substrate	- Maximum fixation for large colonies - Stabilizes on any fixed substrate	- Technique with the highest risk of accidents - Limited reach - Requires more time per coral	Pneumatic drill kit: • Drill • Regulator • Drill bit • Epoxy putty or cement • WD40 • Extra Tanks	$$$- High

TABLE 5. Matrix for selecting stabilization techniques.

2.5 TAGGING AND MAPPING OF INTERVENTIONS

Monitoring rescue actions is a critical component for assessing the effectiveness and success of the interventions carried out. To ensure effective monitoring, it is essential to precisely identify the intervened area and the total number of corals rescued, enabling the selection of a representative sample for follow-up. The larger the proportion of monitored area and corals, the more robust the resulting data will be. However, considering potential limitations in resources, time, and personnel availability, it is recommended to monitor approximately **30% of the rescued corals** whenever feasible. Proper tagging and mapping of colonies and intervention sites are indispensable, allowing for accurate site revisits and ongoing monitoring

If site conditions allow, it is recommended to establish rescue quadrants where a predetermined number of corals can be stabilized and marked for subsequent monitoring. If there is insufficient space to set fixed quadrants, **Specific Intervention Sites (SIS)** can be delineated using GPS records (routes), which facilitates georeferencing and future access to the intervened points. The tagging information obtained should be compiled into a table that consolidates this data using the suggested template in ANNEX 13.

a) Inputs for mapping and tagging interventions

Tagging and Mapping of Interventions

- Damage Classification Report
- Field form: Marking and Mapping of Interventions - ANNEX 13

b) Mapping

It is recommended to delineate the perimeter of the areas where coral collection and stabilization interventions were carried out, known as Specific Intervention Sites (SIS), using a GPS. This will allow for the precise calculation of the intervened area, a key piece of information to determine the scope of the actions performed. Additional information can be added to each SIS, such as the names of participating brigade members, the total number of corals rescued, the date of intervention, and the stabilization technique used.

c) Coral tagging

It is recommended to monitor approximately 30% of the rescued corals. To do this, it is necessary to tag the selected fragments or colonies with visible signs that allow their identification as individuals to be monitored.

KEY POINTS: TAGGING AND MAPPING OF INTERVENTIONS

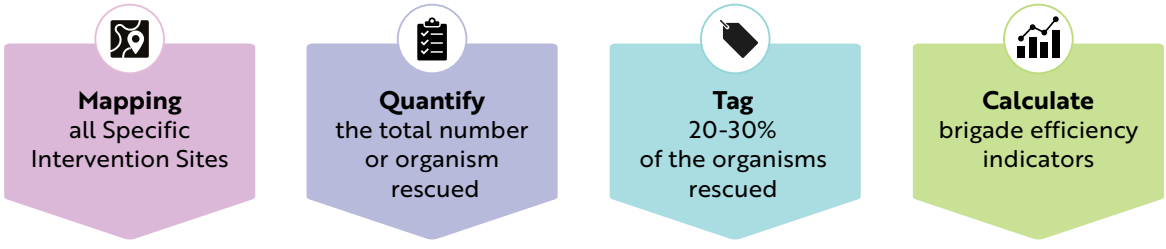


FIGURE 17. **Key points to remember during the mapping and tagging of interventions.**

Examples of different plastic tags that can be used for tagging of rescued corals. Author: Sara Gutiérrez Plata.

Although it is not essential to use numbered tags, having individual identifiers can be very useful if more detailed monitoring is desired in the future, such as tracking growth rates over time.

d) Efficiency indicators

In addition to tagging and field monitoring, it is essential to collect information that allows for calculating the operational efficiency of the brigade during rescue. This indicator is based on the time invested and the number of people involved in rescuing a given number of corals. This metric is key to projecting the operational capacities and needs of brigade members for future rescue efforts. It will serve as an indicator to optimize the allocation of human and material resources, inform management and decision-making processes, and support funding requests by demonstrating the team's response capacity and efficiency.

Hourly rescue rate: It measures how many corals can be rescued per person per hour, assessing team productivity.

$$\textit{Hourly rescue rate} = \frac{\textit{Number or rescued corals}}{\textit{(\# of brigade members x hours invested)}}$$

Area coverage: It measures how much area the brigade can cover based on the time and personnel available, helping to estimate the response capacity in events of different magnitudes.

$$\textit{Area coverage per day} = \frac{\textit{Intervened Area}}{\textit{(\# of brigade members x hours invested)}}$$

These indicators help evaluate the efficiency of the brigade; however, additonal relevant indicators can be adapted based on the characteristics of specific areas or projects. Systematic data recording contributes to stronger planning, justifies investments, and promotes continuous improvement in the brigades' performance.

STAGE 3

POST-RESPONSE

Start: When the immediate response actions have been completed

Can continue: Depending on the agreements with restoration programs and networks

3.1 MONITORING AND FOLLOW-UP OF RESCUE ACTIONS

Monitoring and follow-up actions are essential to evaluate the brigade's effectiveness, verify correct application of, and determine whether the rescue objectives were achieved. Monitoring should focus primarily on two main indicators: the stability and survival of rescued corals. If resources allow, more detailed measurements, such as growth monitoring can be incorporated.

Stability is assessed through direct observation and light physical contact with fragments to confirm they are firmly attached to the substrate. Additional signs, such as healing at the coral base and tissue growth on the substrate, can also be recorded as indicators of successful attachment.

Survival is determined through direct observation, verifying whether the coral is alive or dead. More detailed data may include the percentage of live or dead tissue, the presence of visible diseases, and signs of paleness and bleaching.

Coral reef monitoring. Author: Roatán Marine Park.

The more information gathered during monitoring, the more robust the follow-up process will be. This may improve technical assessment, strengthen the team's ability to adjust strategies, justify results, and communicate impacts.

The suggested monitoring schedule is shown in Table 6.

In addition to data collection, it is essential to create a structured database that facilitates the storage, organization, and efficient management of the collected information. This database should ensure security, accessibility, and ease of use, enabling subsequent analysis, optimizing data management, and evidence-based decisions making. The database must contain the same fields and information types as the forms used in the field to ensure that all information is collected, preventing data loss or errors during transfer.

Monitoring ID	Days Post-Intervention	Objective
0 – Baseline	Before the intervention	The baseline allows us to understand the conditions of the area before the brigade's interventions and provides a point of comparison after the interventions, adding greater value to the rescue efforts.
1 – Initial Survival	15–30 days	Quantify the immediate survival of the fragments and determine if the stabilization process was successful. Note: If unstable fragments are found, repair actions can be planned.
2 – Persistence	Every 3–6 months	Quantify the population's persistence once the stress caused by fragmentation and rescue has ended.

TABLA 6. **Frequency for monitoring activities.**

3.2 ESTABLISHMENT OF CORAL NURSERIES

In cases where numerous numbers of small corals classified as "non-priority" remain unattended, it is advisable to establish nursery refuges. This strategy optimizes coral rescue efforts and maximizes the use of available coral tissue, minimizing loss. It is essential to estimate an approximate number of fragments requiring rescue, develop an action plan, and assess the human, logistical, and material resources necessary for this activity.

Coordination with local restoration initiatives is recommended, as these groups often have identified the most suitable type of nursery for the area, established management and monitoring protocols, and possess available technical expertise. While the brigade primarily focuses on coral rescue after hurricanes, it can also support existing restoration projects, provided the

There is a wide variety of nurseries that can be established for the rescue of coral fragments damaged by hurricanes. The main objective of these nurseries is to provide stability and optimal conditions for the rescued corals, allowing their recovery before being relocated or integrated into restoration projects. The choice of nursery type will depend on several factors to consider:

- Coral species involved.
- Number of fragments rescued
- Availability of human and material resources
- Environmental conditions of the site where the nursery is planned to be established

Examples of coral collection

a) Type of hanging nursery in Turneffe Atoll Marine Reserve. Author: TASA.

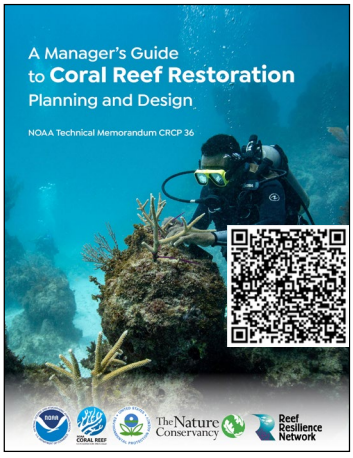
b) Type of hanging nursery from the Akumal Ecological Center Restoration Project. Author: Sara Gutiérrez Plata.

c) Type of modular nursery installed in collaboration with the IMIPAS restoration project in Puerto Morelos. . Author: Sara Gutiérrez Plata.

d) Type of fixed-structure hexadome nursery inspired by the Reef Stars of the Mars Assisted Reef Restoration System. Author: Jacob Rubio Molina.

To make informed decisions about which type of nursery to choose, it is recommended to consult specialized sources that offer up-to-date guides on coral restoration. Among these are the International Coral Reef Initiative (ICRI), the National Oceanic and Atmospheric Administration (NOAA), and The Nature Conservancy, which provide a variety of tools, including manuals and practical guides on reef restoration, from in situ nurseries to debris stabilization. These sources are regularly updated and have available materials; some examples are shown next .

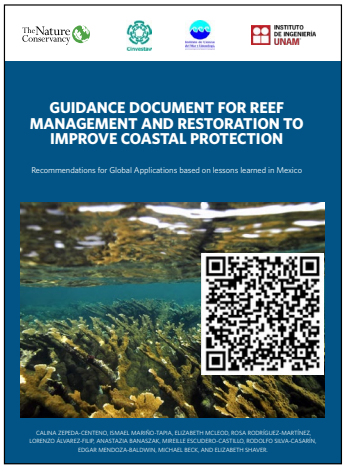
1. *A Manager's Guide to Coral Reef Restoration Planning and Design* NOAA- Technical Memorandum CRCP 36_ 2020



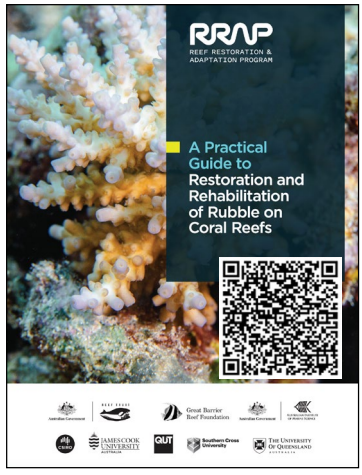
2. *Guide to Coral Reef Restoration- Optimizing Efficiency and Scale for in Situ Nurseries and Outplanting.* CRC 2025

3. *Coral Reef Restoration Monitoring Guide: Methods to Evaluate Restoration Success from Local to Ecosystem Scales.* NOAA Technical Memorandum NOS NCCOS 279

4. *Guidance Document for Reef Management and Restoration to Improve Coastal Protection-* The Nature Conservancy 2019



5. *A Practical Guide to Restoration and Rehabilitation of Rubble on Coral Reefs*



3.3 ENGAGING WITH REEF RESTORATION EFFORTS AT LOCAL AND REGIONAL LEVELS

Response brigades should be part of the local and regional reef restoration network because they members capable of providing support and acting quickly after storms or hurricanes. Additionally, coordination can be established so that brigade members assist in existing restoration efforts by contributing committed volunteers with reef work experience. By being connected to this network, the brigades can also ensure that their actions follow guidelines of responsible organizations, making work safer, more coordinated, and more effective.

3.4 EVALUATION AND CLOSURE

At the end of the hurricane season, it is essential to carry out a series of closing actions, including evaluating the response and preparing for the next season. It is necessary to issue a notification to the brigade and relevant government authorities regarding the conclusion of the brigade's activities. Internally, the following actions are recommended:

ACTIVITY PLANNER » CLOSURE AND EVALUATION OF THE SEASON

ORGANIZATIONAL AND COORDINATING STRUCTURE	INSTITUTIONAL LINKAGE AND REGULATORY COMPLIANCE	❑ Issue an official notification of the brigade's activity completion ❑ Provide support for the reinstallation and maintenance of signage ❑ Strengthen relationships with partners, institutions, and suppliers
	INTERNAL MANAGEMENT	❑ Plan and conduct the end-of-season meeting
	FINANCIAL MANAGEMENT	❑ Prepare and deliver required reports and deliverables ❑ Close ongoing projects ❑ Communicate administrative status and closure
	TECHNICAL AND SCIENTIFIC SUPPORT	❑ Review and update databases ❑ Analyze data and contribute to reporting activity results
	SAFETY AND RISK MANAGEMENT	❑ Prepare safety report identifying any incidents that occurred ❑ Propose adjustments to safety protocols
	COMMUNICATION AND OUTREACH	❑ Communicate the end of the season ❑ Share results of the actions taken
OPERATIVE STRUCTURE	COORDINATION OF THE OPERATION	❑ Perform end of the season cleanup and restock materials ❑ Complete final inventory of materials ❑ Secure equipment storage ❑ Updating equipment maintenance logs
	CAPACITY BUILDING AND TRAINING	❑ Identify areas for improvement and document lessons learned ❑ Share evaluation results and feedback during the closing meeting ❑ Identify training needs and knowledge updates
	IMPLEMENTATION OF SECURITY PROTOCOLS	❑ Compile risks identified during the activities
RESPONSE STRUCTURE	IMPLEMENTATION OF ACTIONS	N/A
	ACTIVATION	❑ Attend the closing meeting ❑ Assist with inventory, cleaning, and safekeeping of materials ❑ Provide information gathered during the field outings

FIGURE 19. Activity Planner for the Season Closure and Evaluation.

D. GLOSSARY

Brigade: An organized group of trained and coordinated individuals tasked with carrying out specific rescue, conservation, or rehabilitation actions for affected reefs and marine ecosystems.

Brigade Member: An individual member of a brigade, responsible for carrying out specific tasks during rescue and recovery operations of reefs affected by hurricanes.

Collection: Identifying and gathering or manually picking up coral fragments and grouping them into containers or designated sites.

Coral Colony: A group of coral polyps living together in the same structure, forming a reef or a section of a reef.

Coral Fragment: A portion of coral that has broken off from a colony or reef, which can be used for rehabilitation or replanting in restoration programs.

Coral Nursery: An area or structure designed for the cultivation and rearing of coral fragments, aimed at reforesting and restoring reefs damaged or affected by climatic events.

Debris: Residual material and fragments resulting from damage caused by hurricanes, such as rocks, wood, dead coral, solid waste, and other residues in reefs and coastal areas.

Diver: A person trained and certified in SCUBA diving techniques, responsible for carrying out exploration, classification, monitoring, and rescue activities on reefs affected by hurricanes, following established safety protocols.

Drill: A practical and organized exercise that simulates an emergency to train participants in rapid and effective response to natural disasters such as hurricanes.

Emergency Fund (EF): A financial instrument established by a government or private institution to provide immediate and timely funding for reefs affected by natural disasters or human activities.

Forecast: Prediction or estimation of weather behavior and meteorological events, including hurricanes, based on scientific data and weather models.

Hurricanes: Large-scale meteorological phenomena characterized by intense and cyclonic storm systems that form over tropical or subtropical oceans. They feature very strong winds, heavy rainfall, and low atmospheric pressure, and can cause significant damage to ecosystems, infrastructure, and coastal communities, including coral reefs.

Hurricane Season: The time of year when the probability of hurricane formation and activity is highest in a specific region, typically from June to November in the Northern Hemisphere.

Lifting bag: A robust, inflatable, airtight bag, used in diving to lift and move heavy or hazardous objects, such as loads of coral fragments or debris, during rescue and recovery operations.

Live Coral Tissue: The part of the coral that is in good condition, recognized by the characteristic color of the colony and the presence of living polyps.

Mallet: Tool or device used to hold, lift, or manipulate heavy objects, including coral fragments or debris in rescue operations.

Operations Center: A centralized location where all planning, monitoring, and execution of actions related to the rescue and protection of affected reefs are coordinated.

Operational Structure: A set of procedures, tasks, and specific activities carried out in the field during the rescue and assessment operation of affected reefs, ensuring the effective implementation of the action plan on-site.

Organizational and Coordinating Structure: A set of defined roles, responsibilities, and hierarchies that coordinate actions during the rescue and recovery of affected reefs. It includes leadership teams, technical coordination, logistics, and support, ensuring an efficient and orderly response.

Parametric Insurance: An instrument that provides a payment when extreme weather events exceed certain predefined thresholds, such as droughts, heavy rainfall, or hurricanes. Unlike traditional insurance, it does not require damage assessment to trigger the payment; if the climatic parameter is met, the beneficiary receives the pre-agreed payment.

Processes: Sequences of actions, from initial planning, classification, intervention, monitoring, to reporting, carried out to rescue and recover reefs affected by hurricanes, following established protocols and ensuring the efficiency and safety of operations.

Reef crest: The shallow or highest part of a reef, which may be exposed at low tide and acts as a natural barrier against waves and swells.

Reef Lagoon: A shallow body of water located between a reef and the coast, which serves as a refuge for various marine species and protects the inland areas from wave impact.

SCUBA Diving: A diving technique in which the diver uses a self-contained breathing apparatus (compressed air tank) that allows deep-water dives without the need for a cable or surface line. It is essential for conducting inspections, monitoring, and rescue operations on affected reefs.

Specific Area of Interest (SAI): A defined area within the reef or marine environment that requires priority attention due to its ecological attributes, such as the presence of priority species, reproductive aggregation zones, or tourism importance.

Specific Intervention Sites (SIS): Areas where coral collection and stabilization interventions were carried out.

Snorkeler: A person who practices snorkeling, supporting brigade activities such as monitoring, cleaning, recovery, and stabilization.

Snorkeling: A recreational and observational activity in which a person swims on the water's surface using a snorkel tube and fins to explore marine ecosystems.

Stipend: Payment or monetary compensation given to brigade members or personnel involved in rescue and conservation activities, as a form of support or incentive for their work.

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F. ANNEXES

ANNEX 1 - RESPONSE PLAN

It is recommended to develop an annual response plan before the hurricane season to establish a clear and coordinated strategy that guides activities to address climatic events that could damage the reef.

This plan should include specific actions, responsible parties, key contacts, suppliers, a timeline, and safety considerations, as well as comply with the legal requirements of each country.

It should also define the roles and responsibilities of the entities involved within an organizational and coordinating structure that ensures an effective emergency response, using a guideline format for its development.

It is suggested that the response plan addresses the following elements:

I. Functions and responsibilities

The Response Plan defines the organizational and operational structure of the group, establishing the roles and responsibilities of each entity, committee, or member. This ensures clear organization, operations, and communication for everyone. A graphic representation of the organizational structure should be developed to show the hierarchical relationships, responsibilities, and functions of the different positions or areas within the organization, making it easier to understand how it is structured and who reports to whom.

II. Logistical capacity

It is essential to understand the available logistical capacity for the response and clearly define the specific needs required at each stage of the response. To do this, the following aspects must be considered:

- Number of diver brigade members
- Number of snorkeler brigade members
- Number of brigade kits/boxes
- Number of vessels
- Number of vehicles
- Number of diving equipment sets
- Number of diving tanks

III. Strategic logistics plan

It is the logistical strategy that details the actions, methods, and resources to implement the stages of the Protocol in order to achieve the objectives through a schedule and performance indicators. The procedures, processes, and necessary activities must be defined to carry out the following actions:

III.1. Damage Classification

III.2. Immediate Response

- Site cleaning and debris removal
- Coral rescue and stabilization
- Tagging and mapping of intervened areas

III.3. Post-Response

- Monitoring and follow-up of rescue actions
- Establishment of nurseries
- Connection with the local and regional Restoration network
- Evaluation and closure

III.4. Alert activation and deactivation

- A protocol must be established to activate the alert. The response begins when a potential hurricane is detected at this stages
- The brigade is deactivated at the end of the hurricane season, following a closing meeting to evaluate results and identify areas for improvements

IV. Communication protocol

A set of internal and external communication protocols must be established to ensure a safe, efficient, and coordinated operation through clear, secure, and timely communication among all actors involved in the response.

IV.1. Communication structure

- Communication flowchart (who reports to whom)
- Roles and responsibilities within the communication chain

IV.2. Communication channels and methods

Define the mechanisms through which communication, both external and internal, specifying the type of communication and the kind of messages that should be issued at each stage of the response.

External communication methods may include:

- Radio
- Press
- Television
- Social media

Internal communication methods can be:

- Instant messaging (WhatsApp, Telegram, Signal, etc.)
- Mobile phone calls
- Satellite phone calls
- VHF/UHF radio messages
- Email

IV.3. Contact List

- External Contacts
- Internal Contacts

V. Budget

The response plan must include a budget that specifies the resources required for each phase of the response. A resource management strategy should be considered, including support from volunteers, donations, and loans, as well as the management of emergency funds, insurance, and other mechanisms. The budget should account for the following expenses (an Excel template is provided in Annex 2):

- Use of boats for maritime transport
- Fuel for boats
- Fuel for land transport vehicles
- Stipend payments
- Rental of diving equipment
- Rental of diving tanks
- Food and water for fieldwork
- Materials for fieldwork

VI. Security Plan

It is very important to include a plan to ensure the safety of all personnel during field activities, the protection of the ecosystem, and the effectiveness of the operation. It is recommended to consider the following key aspects:

VI.1. Prevention and Safety Protocols:

- Navigation plan and coordination between the operational team and the crew.

- Procedures for entering and exiting the water.
- Diving plan with dive profiles.
- Directory of services and brigade members (including medical information, emergency contacts, and diving insurance details) and emergency response routes.
- Establishment of a constant communication system between the operational team members and a support base on land.

VI.2. Emergency and Response Plan:

- Rescue protocols in case of incidents such as injuries, exhaustion, or equipment problems.
- Protocol for oxygen supply (carry an oxygen kit on the boat).
- Identification of evacuation routes and assembly points on land.
- Availability of first aid and quick access to medical care.
- Coordination with local emergency services if necessary.

VII. Communication Procedures

The response plan must define communication procedures, including channels, notification routes, protocols, and those responsible for reporting and coordinating. Agreed-upon methods such as calls, messages, radios, and social media should be used. It is essential to have an updated directory of the brigade, including contacts and medical information. The communication process begins with the activation of the alert and ends with its deactivation.

VIII. Training Plan

A training plan should be developed that outlines the frequency and content of training for the brigades. Training can be conducted in the following categories:

- Training of new brigade members with the aim of increasing the number of brigades or ensuring sufficient brigade member availability during the response.
- Ongoing training for brigade members: A series of trainings conducted throughout the year to update the knowledge and skills of brigade members and Committee members.
- Drills: To practice procedures and evaluate the effectiveness of the response plan.

IX. Threat analysis and risk reduction

It is important to develop a strategy for identifying and mapping coastal threats that may occur due to a hurricane and could damage the reef. A threat mitigation plan should be included.

X. Evaluation and Improvement

The response plan must be flexible to address emergencies of varying types and severity. It should be reviewed periodically to maintain its effectiveness and adapt to new risks. It is recommended to prepare an activity report at the end of each hurricane season, including an evaluation that allows for adjustments to the plan for subsequent years.

ANNEX 2 - BUDGET TEMPLATE

Response Budget

TEMPLATE FOR PREPARING A BUDGET THAT INCLUDES THE IMPLEMENTATION OF ACTIVITIES RESPONSE PROTOCOL FOR THE RESCUE OF REEFS AFFECTED BY HURRICANES IMPLEMENTATION

The budget is based on estimating the brigade intervention in each stage of the protocol.

Instructions
Green cells: Requires user input
Grey cells: Blocked (Spread sheet formulas)

FILL OUT THE GREEN CELLS WITH THE REQUIRED INFORMATION
BLOCK 1: Define the unitary costs for the fixed concepts on the list
BLOCK 2: For each activity define the necessary effort for each of the concepts in columns C-H.
BLOCK 3: Add the costs of other costs for each stage in the green cells and point 8.
Note: The budget can be elaborated in your local currency or US dollars

BLOCK 1:

FIXED CONCEPTS	UNITARY COST
Boat Rental (1 day)	$ 5,000.00
Vessel fuel (1 day of work)	$ 1,500.00
Land transportation fuel (1 day of work)	$ 500.00
Stipend for 1 day of work per person	$ 800.00
Tank rental per day	$ 100.00
Food and Water for 1 days work	$ 150.00
Materials and tools	$ 150.00

BLOCK 2:

	EFFORT CONCEPTS					
ACTIVITY	# of field days	# of active	# of reef	# tanks needed	# Necessary crew	Cost of materials
1. Damage classification	1	1	6	1	2	$ 100.00
2. Debris removal and clean up	2	2	6	2	2	$ 200.00
3. Coral collection and stabilization	3	3	6	3	2	$ 300.00
4. Intervention tagging and mapping	4	4	6	4	2	$ 400.00
5. Monitoring and follow up	5	5	6	5	2	$ 500.00
6. Establishing coral nursery	6	5	6	5	2	$ 600.00
7. Restoration or other actions	7	5	6	5	2	$ 700.00

BLOCK 3:

STAGE	CONCEPT	QUANTITY	UNITARY COST	# DAYS	SUBTOTAL	STAGE SUBTOTAL
1. Damage classification						$ 13,200.00
	Boat Rental (1 day)	1	$ 5,000.00	1	$ 5,000.00	
	Vessel fuel (1 day of work)	1	$ 1,500.00	1	$ 1,500.00	
	Land transportation fuel (1 day of work)	1	$ 500.00	1	$ 500.00	
	Stipend for 1 day of work per person	6	$ 800.00	1	$ 4,800.00	
	Tank rental per day	1	$ 100.00	1	$ 100.00	
	Food and Water for 1 days work	8	$ 150.00	1	$ 1,200.00	
	Materials and tools	1	$ 100.00	1	$ 100.00	
	Other expenses					
2. Debris removal and clean up						$ 53,200.00
	Boat Rental (1 day)	2	$ 5,000.00	2	$ 20,000.00	
	Vessel fuel (1 day of work)	2	$ 1,500.00	2	$ 6,000.00	
	Land transportation fuel (1 day of work)	2	$ 500.00	2	$ 2,000.00	
	Stipend for 1 day of work per person	12	$ 800.00	2	$ 19,200.00	
	Tank rental per day	4	$ 100.00	2	$ 800.00	
	Food and Water for 1 days work	16	$ 150.00	2	$ 4,800.00	
	Materials and tools	2	$ 200.00	2	$ 400.00	
	Other expenses					
3. Coral collection and stabilization						$ 120,600.00
	Boat Rental (1 day)	3	$ 5,000.00	3	$ 45,000.00	
	Vessel fuel (1 day of work)	3	$ 1,500.00	3	$ 13,500.00	
	Land transportation fuel (1 day of work)	3	$ 500.00	3	$ 4,500.00	
	Stipend for 1 day of work per person	18	$ 800.00	3	$ 43,200.00	
	Tank rental per day	9	$ 100.00	3	$ 2,700.00	
	Food and Water for 1 days work	24	$ 150.00	3	$ 10,800.00	
	Materials and tools	3	$ 300.00	3	$ 900.00	
	Other expenses					
4. Intervention tagging and mapping						$ 216,000.00
	Boat Rental (1 day)	4	$ 5,000.00	4	$ 80,000.00	
	Vessel Gasoline (1 day of work)	4	$ 1,500.00	4	$ 24,000.00	
	Land transportation gasoline (1 day of work)	4	$ 500.00	4	$ 8,000.00	
	Stipend for 1 day of work per person	24	$ 800.00	4	$ 76,800.00	
	Tank rental per day	16	$ 100.00	4	$ 6,400.00	
	Food and Water for 1 days work	32	$ 150.00	4	$ 19,200.00	
	Materials and tools	4	$ 400.00	4	$ 1,600.00	
	Other expenses					
5. Monitoring and follow up						$ 340,000.00
	Boat Rental (1 day)	5	$ 5,000.00	5	$ 125,000.00	
	Vessel fuel (1 day of work)	5	$ 1,500.00	5	$ 37,500.00	
	Land transportation fuel (1 day of work)	5	$ 500.00	5	$ 12,500.00	
	Stipend for 1 day of work per person	30	$ 800.00	5	$ 120,000.00	
	Tank rental per day	25	$ 100.00	5	$ 12,500.00	
	Food and Water for 1 days work	40	$ 150.00	5	$ 30,000.00	
	Materials and tools	5	$ 500.00	5	$ 2,500.00	
	Other expenses					
6. Establishing coral nursery						$ 408,600.00
	Boat Rental (1 day)	5	$ 5,000.00	6	$ 150,000.00	
	Vessel Gasoline (1 day of work)	5	$ 1,500.00	6	$ 45,000.00	
	Land transportation gasoline (1 day of work)	5	$ 500.00	6	$ 15,000.00	
	Stipend for 1 day of work per person	30	$ 800.00	6	$ 144,000.00	
	Tank rental per day	25	$ 100.00	6	$ 15,000.00	
	Food and Water for 1 days work	40	$ 150.00	6	$ 36,000.00	
	Materials and tools	5	$ 600.00	6	$ 3,600.00	
	Nursery construction and installation					
	Other expenses					
7. Restoration or other actions						$ 477,400.00
	Boat Rental (1 day)	5	$ 5,000.00	7	$ 175,000.00	
	Vessel fuel (1 day of work)	5	$ 1,500.00	7	$ 52,500.00	
	Land transportation fuel (1 day of work)	5	$ 500.00	7	$ 17,500.00	
	Stipend for 1 day of work per person	30	$ 800.00	7	$ 168,000.00	
	Tank rental per day	25	$ 100.00	7	$ 17,500.00	
	Food and Water for 1 days work	40	$ 150.00	7	$ 42,000.00	
	Materials and tools	5	$ 700.00	7	$ 4,900.00	
	Other tools and equipment					
	Other expenses					
8. Other required expenses						0
TOTAL PROJECT COST						$ 1,629,000.00

ANNEX 3 - ANNUAL RECRUITING FORM FOR BRIGADE MEMBERS

1. **Email Address**
2. **First Name**
3. **Paternal Last name**
4. **Maternal Last name**
5. **Date of birth (DD/MM/YYYY)**
6. **Phone number (including area code)**
7. **Participation type: full-time, occasional, or other (specify)**
8. **Profession**
9. **Role within the brigade (Snorkeler, Diver, Cementing, Captain, Technical-Scientific Support, Academic Support, Operations-Communication Support)**
10. **Diving insurance, major medical insurance, or insurance that guarantees your safety at sea**
11. **Diving certification number and agency (PADI, FMAS, SSI, or other) *Answer n/a if not a diver**
12. **Diving certification (upload the PDF file proving your certification)**
13. **Do you have a first aid or EFR certificate? (Yes / No)**
14. **Write the name of the first aid or EFR certificate and the certification number obtained**
15. **Blood type**
16. **Have you undergone surgery or are you in the process of undergoing surgery? (If yes, please describe below)**
17. **Do you have any allergies? (If yes, please describe below)**
18. **Do you have any of the following cardiovascular conditions?**
    - Heart attack or heart surgery
    - Angina or chest pain
    - High blood pressure (with or without treatment)
    - Stroke or vascular disease
19. **Do you have any medical conditions we should know about?**
20. **Do you have any of the following respiratory conditions?**
    - Asthma or difficulty breathing
    - Chronic bronchitis or emphysema
    - pneumothorax (collapsed lung)
    - Previous lung surgery
21. **Do you have any of the following neurological conditions?**
    - Seizures, epilepsy, or fainting
    - Significant head injury
    - Unexplained loss of consciousness

22. **Do you have any of the following psychological or behavioral problems?**
- Panic attacks or severe anxiety
- Mental health conditions that may affect judgment or physical performance
- Use of psychiatric medications

23. **Do you have any of the following metabolic or endocrine conditions?**
- Diabetes (especially if using insulin)
- Thyroid diseases

24. **Other relevant conditions:**
- Pregnancy
- Recent surgeries (especially abdominal, thoracic, or ear)
- Hernias
- Chronic back or joint problems
- Vertigo, dizziness, or balance problems

25. **Full name of emergency contact**

26. **Phone number of emergency contact**

27. **Relationship to emergency contact**

28. **Is your emergency contact aware of your medical conditions and knows the necessary information in case of emergency? (Medical insurance number, location of identification documents, etc.)**

ANNEX 4 - LIST OF MATERIALS, EQUIPMENT AND TOOLS FOR THE RESPONSE

No.	Items	Unit	Quantity	Image
1	Waterproof toolbox with handle and wheels	unit	2	
2	Submersible pneumatic drill	unit	2	
3	Concrete drill bit for the drill (24 in x 5/8)	unit	4	
4	First stage regulator and low pressure hose with adapter for the pneumatic drill	unit	2	
5	Diving or garden gloves (thin)	pair	20	
6	Dishwashing gloves to prepare cement	pair	20	
7	Lifting bag 80 pounds	unit	2	
8	Lifting bag 140 pounds	unit	2	

No.	Items	Unit	Quantity	Image
9	Zip ties (size 35 - 40 cm)	unit	400	
10	Stainless steel wire brushes	unit	10	
11	GPS	unit	2	
12	Underwater diving camera	unit	2	
13	Submerged buoy	unit	20	
14	Diver Surface marker buoys	unit	5	
15	Diver Surface Marker Buoy with reel	unit	5	
16	70 ft of Marine rope (¾ inch thick)	meter	20 m	
17	Tarred twine / bank line	unit	2	

No.	Items	Unit	Quantity	Image
18	Titanium scissors	unit	2	
19	Stainless Steel carabiner	unit	8	
20	Epoxy clay (3 sets)	unit	4	
21	Medium Spatula	unit	4	
22	Sack of Cement	unit	4	
23	Large container to mix cement	unit	2	
24	Plastic tarp	unit	1	
25	Mallet	unit	4	
26	Chisel	unit	4	
27	Adjustable wrench	unit	2	

No.	Items	Unit	Quantity	Image
28	5 gallon bucket	unit	6	
29	WD-40	gallon	2	
30	Thick plastic bags	unit	20	
31	Thick led pencils	unit	20	
32	Container for cement	unit	2	
33	Diving acrylic slate	unit	4	
34	First aid kit	unit	2	
35	Diving knife for emergencies	unit	2	
36	Oxygen kit with mask	unit	1	

ANNEX 5- EQUIPMENT INVENTORY FORM

Code /ID	**Item name**	**Material Type** (Consumable / Non-Consumable)	**Amount available**	**Unit of Measure** (Piece, Volume, Pair)	**Location / Storage**	**Condition** (New, Used, Repair Needed)	**Notes/ Comments**

ANNEX 6 - SAFETY CHECKLIST FOR DEPARTURES

Personnel

- ☐ Check the list of participants with assigned roles
- ☐ Conduct assessment of the team's physical and psychological condition
- ☐ Conduct safety briefing and review the day's operational plan
- ☐ Designate safety officer
- ☐ Verify updated emergency contact list

Environmental Conditions

- ☐ Review weather forecast, wind, and wave conditions
- ☐ Validate safe navigation and diving conditions
- ☐ Establish alternative plan in case of changing conditions

Vessel

- ☐ Vessel is in good condition and up-to-date with maintenance
- ☐ Ensure sufficient fuel for the operation
- ☐ Check availability and condition of life jackets
- ☐ Ensure VHF radio or communication device is functional
- ☐ Fire extinguisher, first aid kit, and lifebuoys on board
- ☐ Verify condition of accessories: GPS, ladder, anchor, and compass
- ☐ Verify passenger list on board

Diving and Work Equipment

- ☐ Inspect personal gear: mask, fins, regulator, BCD, weights
- ☐ Ensure tanks are full and valves checked
- ☐ Prepare additional equipment as required (buoys, hammers, tools, etc.)
- ☐ Check signaling devices (SMB, whistle, mirror)
- ☐ Review assigned equipment

Planning and Coordination

- ☐ Coordinate with authorities (Harbormaster, Navy, Marine Park)
- ☐ Obtain necessary permits or notifications
- ☐ Estimate activity duration communicated to all team members
- ☐ Designate a meeting point on land

Safety and Emergency

- ☐ Complete and checked first aid kit
- ☐ Develop Emergency Evacuation Plan
- ☐ Gather emergency services and hyperbaric chamber contact numbers
- ☐ Communicate Medical Evacuation Plan to all team members
- ☐ Carry-out risk assessment for the specific activity (e.g., currents, wildlife, depth)
- ☐ Compile emergency contact list for all personnel on board

ANNEX 7- BASIC PRE-DEPARTURE MEETING TEMPLATE

1. **Introduction of Team Members and Crew**
2. **Objective of the Operation/Departure**
3. **Review of Activity Plan (prepared in advance)**
   a) Intervention sites
   b) Schedule and estimated duration
   c) Tasks to be performed
4. **Role Assignment**
   a) Responsible personnel for activities, logistics, safety, documentation, etc.
5. **Environmental Conditions and Risks**
   a) Weather forecast, sea state, tides, potential risks, and mitigation measures
6. **Review of Safety Protocols**
   a) Emergency procedures, communication plan, use of safety equipment
7. **Required Equipment**
   a) List of materials, tools, and equipment to be taken (per prior planning)

ANNEX 8 - POST-DEPARTURE MEETING TEMPLATE

1. **Brief summary of the activity carried out**

2. **Results and Findings**
   a) Collected data (observed damage, identified debris, corals collected and stabilized, intervention areas marked and mapped)
   b) Relevant observations

3. **Difficulties or incidents**
   a) Technical, logistical, or environmental issues
   b) Lessons learned

4. **Compliance with Protocols**
   a) Assessment of adherence to established procedures

5. **Team feedback and recommendations**
   a) Opinions on coordination, logistics, and individual and group performance
   b) Necessary Adjustments

6. **Next Steps**
   a) Report preparation
   b) Assigned tasks and responsible parties

ANNEX 9- FIELD OPERATION REPORT FORM

Date		Intervention Site		Funding	
Participants					
Number of tanks	Vessel name		Name of Captain		
Boarding site (place)		Departure Time		Arrival Time	
Operation Coordinator			Safety Coordinator		
General Objective of the Operation					
Specific Objectives of the Operation and Responsible Personnel					
Weather Conditions					
Water Temperature	Visibility	Surge	Current	Waves	Others
Coordinates Obtained					
Site Name	Name in GPS	N Coordinate	W Coordinate	Observations	
Incident or Near-Miss Report					
Feedback Remarks (strengths and improvement opportunities)					

ANNEX 10 - DAMAGE CLASSIFICATION FORM

Date	Data Collector		Site Name		Evaluated Area	
Time	Temperature		Deptrh		Classification Method	
Type of damage	Observations					
	External Objects/ Debris	Sediment & Fragmentation / Tissue Erosion	Level of Fragmentation	Colony Detatchment	% of Colonies Affected	Required Response Actions
0. No Damage	No external objects or debris were found	There is no sediment or fragmentation on top of live corals	There is no coral fragmentation	There are no detached or overturned colonies	0%	NO
1. Minor Damage	Some small external objects or debris found. Easily removable	Some sediment and little fragmentation on live corals	Some coral colonies with broken parts or branches	There are no detached or flipped colonies	1%- 25%	Optional actions if time or budget allow
2. Major Damage	Large amounts of external objects and/or debris found	A lot of sediment and fragmentation on live coral colonies	Many coral colonies with broken branches or parts. Fragments visible on the seabed	Presence of detached or overturned colonies	26%- 75%	First Priority for Attention
3. Extreme Damage	Large amounts of external objects and/or debris observed	Large areas devastated or covered with fragmentation	Most corals have been fragmented	Most colonies have been detached or overturned	More than 76%	Contact locarl restoration programs

ANNEX 11 - SITE CLEANING AND DEBRIS REMOVAL FORM

Date		Name of brigade member	Site name	Intervened Area (m^2)
Time		Temperature	Depth	
Object found	Dimensions	Quantity	Observations	

ANNEX 12 - CORAL COLLECTION AND STABILIZATION FORM

Date		Name of brigade member			Site Name			Intervened Area (m^2)
Time	Temperature	ID of Specific Intervened Site (SIS) (YYYY-MM-DD-Brigade Member Initials						Depth
Type	Size	Stabilization Technique						Observations
		Cement	Wedging	Cement & Wedging	Zip ties and thread	Epoxy Clay	Pneumatic Drill	
Fragment: A piece broken off a coral colony	Small (10-30 cm)							
	Medium (30- 80cm)							
	Large (+80 cm)							
Colony: A whole coral organism detached from the substrate	Small (10-30 cm)							
	Medium (30- 80cm)							
	Large (+80 cm)							

ANNEX 13 - MAPPING AND MONITORING INTERVENTIONS FORM

Date	Site Name		Intervened Area (m^2)	
Number of brigade members in the operation		Total # of corals rescued during the day		
SIS ID (YYYY-MM-DD-Brigade Member Initials)	Number of Corals Rescued in SIS	Coordinates of SIS	GPS Track ID	Markers established within SIS

ANNEX 14 - ANNUAL EVALUATION REPORT FORM

Date		Intervention Site		Funds	
Participants					
Number of tanks		Name of vessel		Name of captain	
Boarding Site		Departure Time		Arrival Time	
Operations Coordinator:			Safety Coordinator		
General objective of the operation					
Specific objectives of the operation and responsible parties					
Description of conditions					
Water Temperature	Visibility	Surge	Current	Wave	Others
Coordinates obtained					
Site Name	Name in GPS	N Coordinate	W Coordinate	Observations	
Incident or Near-Miss Report					
Feedback comments (improvements needed and positive highlights)					

MAR FUND

Photo: Sara Gutiérrez Plata

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