Malaysia Bleaching Response Plan 2026-2030

Prepared by:

Reef Check MALAYSIA

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1. Introduction: Coral Bleaching in Context

Coral reefs are an important ecological and economic resource in many countries around the world, providing a range of valuable ecosystem services to millions of people. Coral reefs provide jobs, food and coastal protection, among other benefits, to hundreds of millions of people. They are the most diverse marine ecosystems on earth. Despite being recognised for their economic and aesthetic value, coral reefs are being damaged by a variety of both local and global threats.

Between 2009 and 2018, there was a progressive loss of about 14% of world's coral reefs

The loss was mainly due to frequent large-scale coral bleaching events, combined with other local threats. The local threats are unsustainable fishing, coastal development, land-based and marine pollution and tropical storms.

In Malaysia, the Department of Fisheries Malaysia, Sabah Parks and Sarawak Forestry are tasked with managing these local threats to their protected reef areas. Meanwhile, Reef Check Malaysia (RCM) works with various stakeholders to conserve coral reefs.

The first significant mass coral reef bleaching event reported in Malaysia was in 1998 and an estimated 40% of corals in reefs around Peninsular Malaysia died. Reefs had barely recovered before the 2010 mass coral reef bleaching event occurred, which fortunately saw lower coral mortality. In 2024, reefs were heavily affected by the 4th Global Coral Bleaching Event, with bleaching observed at nearly 90% of surveyed locations. The event caused an average coral mortality of 34.1%, with the Terengganu archipelago experiencing the highest losses at 44.2%.

Scientists agree that mass coral reef bleaching is likely to occur with increasing frequency in the coming decades, and there is an urgent need to put in place plans to:

- Respond effectively to mass coral reef bleaching events with management interventions to protect reefs during bleaching events
- Build the "survivability" of coral reefs to better withstand future bleaching events.

This Bleaching Response Plan addresses the first problem: responding effectively to mass coral reef bleaching events. The Plan focuses on communication, to ensure all stakeholders are aware of what is happening during a bleaching event, and what is being done to mitigate the effects of bleaching. It also describes some limited management responses that are available to reef managers.

The Plan is adapted from Marshall & Schuttenberg (2006) and Oliver et al '*A Global Protocol for Assessment and Monitoring of Coral Bleaching*' (2004) and has been modified to reflect the current legal and institutional situation in Malaysia. It includes both routine and responsive tasks, to provide for flexibility in implementation. It is designed to ensure all stakeholders are well informed. Finally, it is a "live" document that will be revised based on experience.

In a wider context, the Plan should be seen as part of a long-term effort to build the resilience, or "survivability", of Malaysia's coral reefs, in line with the requirements of the Kunming-Montreal Global Biodiversity Framework (see section 5 for more details). The goal is to manage threats to ensure that reefs are better able to survive predicted bleaching events and other global threats. Prominently, it represents an urgent need for collaboration between all stakeholders, including managers, government, local communities, tourism operators and non-governmental agencies.

2. Coral Bleaching: Causes & Effects

Reef-building corals are fundamentally important to coral reefs and are responsible for creating the limestone (calcium carbonate) framework of the reef. They are unique in being a mutualistic symbiosis between a simple multicellular animal, the coral polyp, and a single-celled algae, or zooxanthellae.

2.1 What is Coral Bleaching?

The zooxanthellae living inside the cells of the coral host provide up to 95% of the coral's energy for growth, reproduction and feeding. They also provide much of the colour in a coral's tissue.

However, a variety of "stressors" can disturb this symbiotic relationship. The precise mechanism is unknown, but it appears that when corals become stressed, either the zooxanthellae degenerate within the coral or are expelled, or the zooxanthellae lose the chlorophyll that gives corals their vibrant colour. The resulting colourless coral tissue thus reveals the underlying white calcium carbonate skeleton, resulting in a "bleached" appearance, hence the term 'coral bleaching' (see figure 1 below).

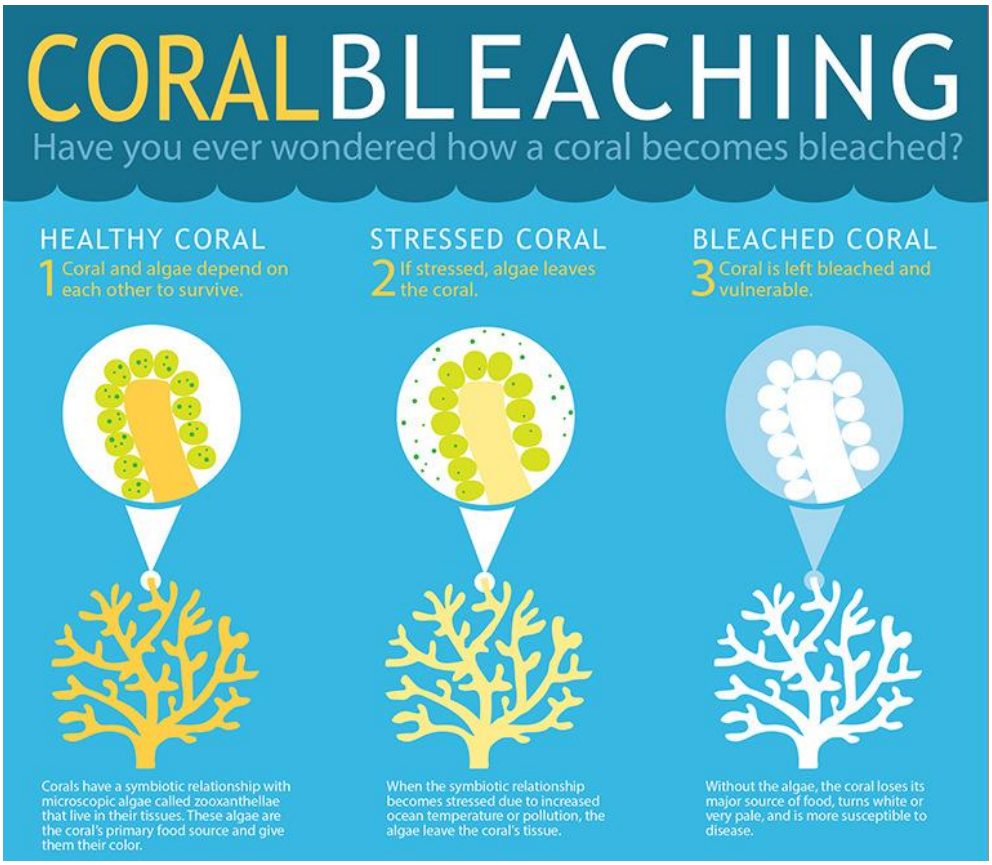

Figure 1: Stages in coral bleaching (source: https://oceanservice.noaa.gov/)

Bleached corals are still alive, and if stressful conditions subside soon enough, zooxanthellae can repopulate their tissues and the corals can survive the bleaching event. However, an intense and prolonged period of stress increases the chances of coral mortality.

2.2 Causes of Mass Coral Bleaching

A variety of factors can cause coral bleaching, including storms, sedimentation, disease, pollution, prolonged periods of exposure to air and temperature and salinity extremes. These stressors generally cause bleaching on a localised scale.

In contrast, mass coral bleaching is highly correlated with relatively short-lived increases of sea temperature (and increasingly, light levels) above summer norms. Over the past 20 years, there have been six major global cycles of coral bleaching ("mass coral bleaching events"). Thermal thresholds for bleaching generally begin at approximately 1°C above the sea temperature norm for a region. Coral reefs become stressed if exposed to slight increases (1 to 2°C) in water temperature and could experience coral bleaching. Such mass coral bleaching resulting from global climate change is a significant threat to the future of coral reefs.

Data available from the US National Oceanic and Atmospheric Administration (NOAA) include sea surface temperature and "Degree Heating Weeks (DHW)" that can be used to track temperature changes that might indicate the onset of bleaching (see figure 2).

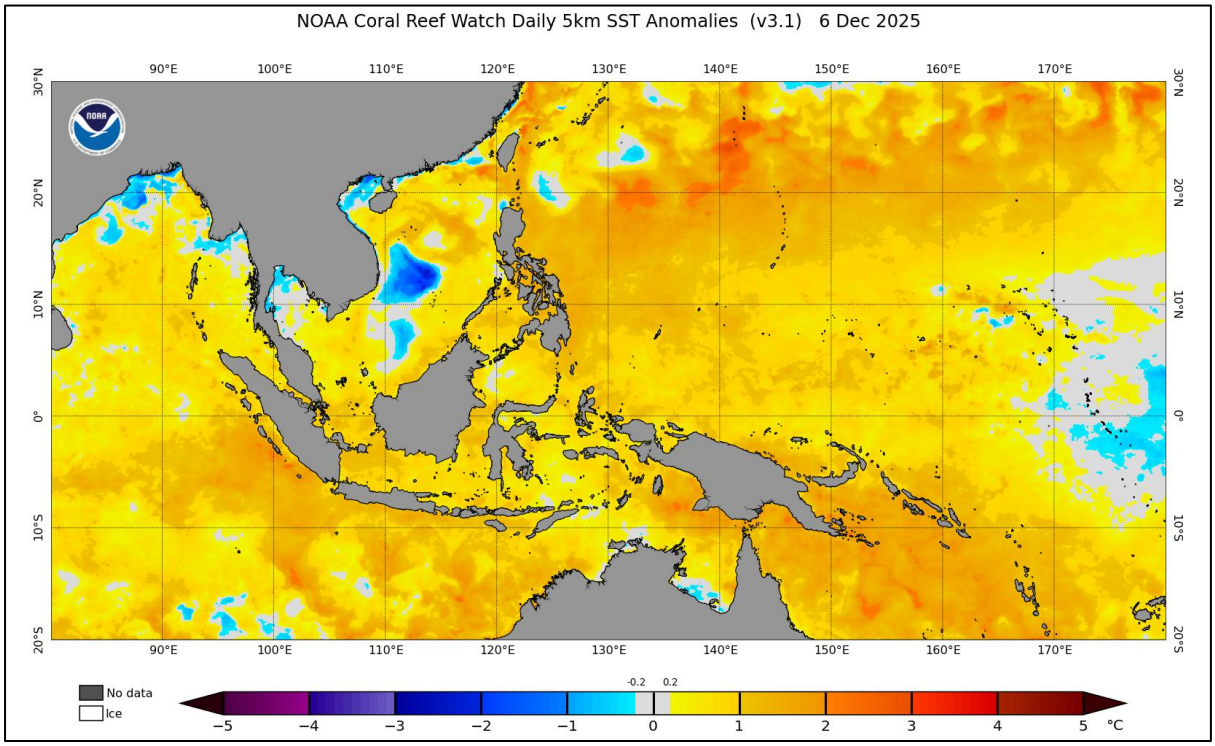

Figure 2: Sea surface temperature record used to track emerging bleaching events

In addition, a combination of the intensity and length of periods of elevated sea temperature can provide an accurate prediction of mass coral bleaching and mortality. Currently, NOAA's bleaching prediction is based on an ocean-land-atmosphere seasonal climate forecast model system known as Climate Forecast System (CFS) and can predict the likelihood of bleaching outlook up to 4 months in advance.

2.3 Past Mass Coral Bleaching Events in Malaysia

In the Indo Pacific, mass bleaching events have been widely reported since the 1980s'. In Malaysia, mass bleaching events have been recorded in 1998, 2004, 2010 and 2024, with many smaller scale bleaching events recorded from 2012 to 2023. During the 2024 4th Global Coral Bleaching Event, widespread bleaching was recorded at nearly 90% of the locations surveyed by Reef Check Malaysia, with an average coral mortality of 34.1%. Coral bleaching seems to reoccur with increasing frequency due to a rapidly changing environment and increasing anthropogenic threats.

2.4 Effects of Mass Coral Bleaching

While corals can recover from bleaching, extended periods of stress can cause high levels of mortality among corals. This in turn leads to wider reef degradation, causing a shift towards less diverse reef communities that have lower diversity and less coral cover. The condition of reefs and the ecosystem services they provide are likely to significantly deteriorate because of bleaching over the next few decades (Baker et al. 2008).

Coral reef degradation is likely to lead to socioeconomic losses due to impacts on fisheries, tourism and other ecosystem services. Communities that rely on coral reefs for their livelihoods may be forced to migrate, as tourism declines and fisheries resources dwindle. In addition to the direct economic consequences, there are wider implications to society from such migrations.

3. Bleaching Response Planning

3.1 Bleaching Response Plan Objectives

This Bleaching Response Plan defines a set of pre-determined actions to be implemented in response to bleaching-related events. The goal is to put in place a simple mechanism to respond to bleaching with timely and appropriate information and actions. More specifically, the objectives of the Plan are to:

- Raise awareness among key stakeholders of the possible impacts of mass coral bleaching
- Formulate guidelines for actions to respond to coral bleaching and establish a bleaching reporting/information system for public networking and information sharing
- Set up a coral bleaching response apparatus with members taken from government, non-governmental agencies and local stakeholders that will encourage immediate and long-term actions to reduce local stresses.

3.2 Bleaching Response Plan Primary Components

The Bleaching Response Plan flowchart is shown in figure 4. There are four primary components (refer to the relevant step in the Plan flowchart):

1) Early Warning System: increasingly, bleaching is being monitored on an international basis. Information is available from a variety of sources that provides an early warning of climate conditions that favour bleaching. This helps to predict bleaching events.

2) Response Triggers: bleaching is not uniform, nor is its progress predictable or consistent. The plan therefore includes triggers that result in programmed actions, providing flexibility in implementation, and adaptive management for different scenarios.

3) Management Actions: implement a variety of actions to reduce or eliminate local threats to coral reefs, enhancing the survivability of coral reefs to bleaching events.

4) Communications: a significant element of the plan involves communications with various stakeholder groups. The provision of timely, accurate information helps stakeholder groups understand what is happening, increasing the likelihood they will cooperate with management in its efforts to reduce the impacts of coral bleaching events.

3.3 Bleaching Response Plan Review

This Bleaching Response Plan is a “live” document and will be reviewed periodically to reflect experience and changing knowledge and understanding of mass bleaching events. The Plan will be reviewed annually to ensure that information contained within it is up to date (e.g. dive operator list). Every five years, a more comprehensive review will be conducted to revise technical information in the plan and reflect changes in bleaching response options and management.

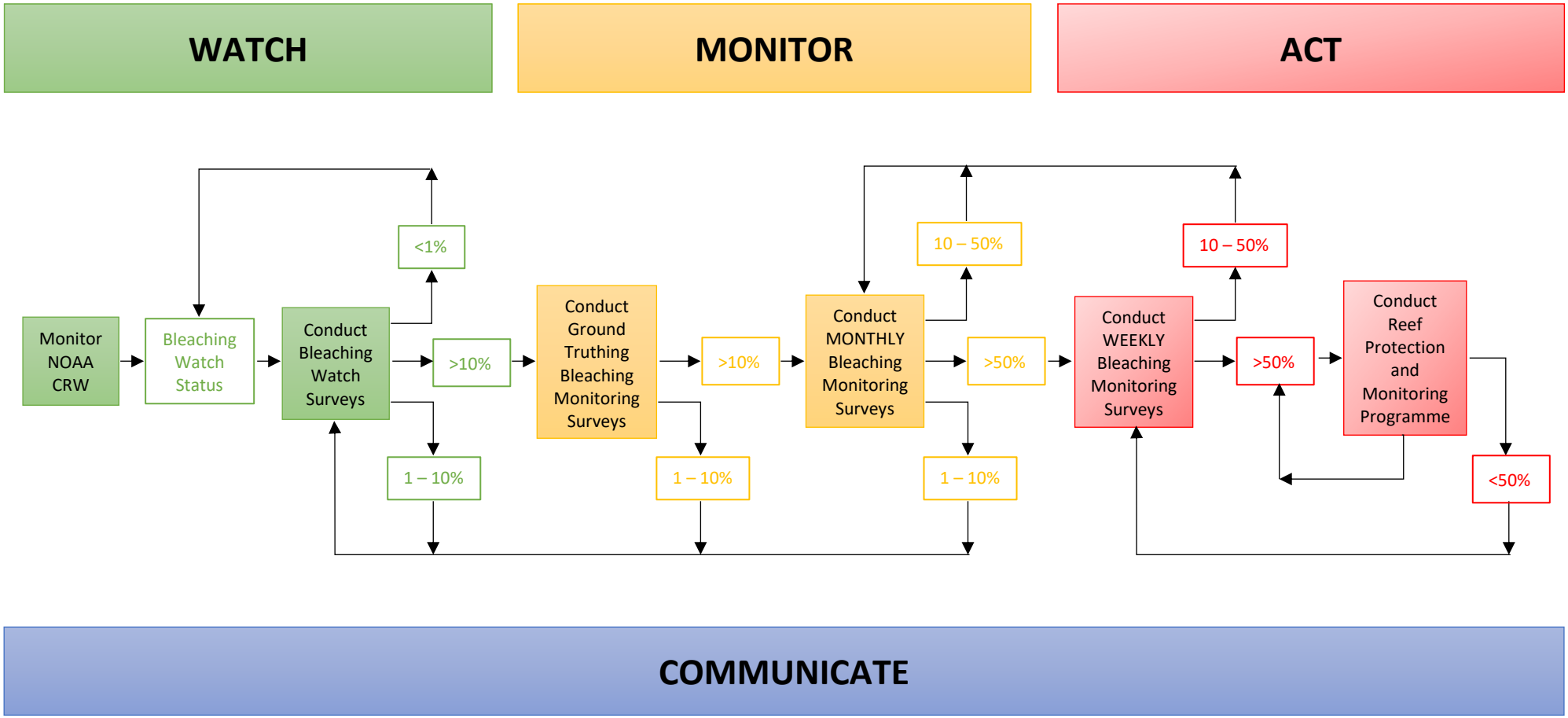

Figure 4: Bleaching Response Plan Flow Chart

4. Bleaching Response Plan

This Bleaching Response Plan defines a set of pre-determined actions that should be taken in response to mass coral reef bleaching related events, or triggers. The objective is to put in place simple steps to react to bleaching with timely and appropriate information and actions.

Event/scenario	Action
1. NOAA Status: Bleaching Watch	1.1 Notify Department of Fisheries, Sabah Parks and Sarawak Forestry Corporation of Bleaching Watch announcement.
	1.2 Notify dive operators of Bleaching Watch status and request them to report bleaching observations.
	1.3 Notify field experts of Bleaching Watch status and request them to submit Bleaching Watch reports
	1.4 Implement education and awareness programmes to raise awareness on coral bleaching and possible management actions; disseminate FAQ on bleaching.
	1.5 Implement management actions focused on reducing stressors.
	1.6 If bleaching observations and field expert Bleaching Watch reports show >10% bleaching, proceed to step 2.
2. NOAA Status: Bleaching Warning	2.1 Field experts conduct 'ground-truthing' at permanent monitoring sites if bleaching observations and Bleaching Watch reports show >10% bleaching.
	2.2 If ground -truthing shows >10% bleaching, implement MONTHLY Bleaching Monitoring Surveys (while continuing to collate bleaching observations).
	2.3 Implement education and awareness programmes to raise awareness on coral bleaching and possible management actions.
	2.4 Implement management actions focused on reducing stressors.
	2.5 If Bleaching Monitoring Surveys show >50% bleaching at permanent monitoring bleaching sites, proceed to step 3.
3. NOAA Status: Bleaching Alert Level 1/2	3.1 Initiate WEEKLY Bleaching Monitoring Surveys.
	3.2 Notify dive operators to discontinue bleaching observations.
	3.3 Implement education and awareness programmes to raise awareness on coral bleaching and possible management actions.
	3.4 Implement management actions focused on reducing stressors.
	3.5 Implement appropriate site restrictions.
	3.6 If WEEKLY Bleaching Monitoring Surveys show <50% of the coral at permanent bleaching monitoring sites are bleached, revert to MONTHLY Bleaching Monitoring Surveys, request dive operators to resume bleaching observations and lift site restrictions.
	3.7 If bleaching observations show <1% bleaching, at permanent bleaching monitoring sites, discontinue monitoring.
4. NOAA Status: No Stress	4.1 Continue periodic monitoring to assess mortality and recovery.
	4.2 Evaluate impact of management actions, at every step.

Note: the event triggers mirror NOAA alert status levels:

Stress level	Potential bleaching intensity
No stress	No bleaching
Bleaching watch	Incipient bleaching
Bleaching warning	Possible bleaching
Bleaching alert level 1	Significant bleaching/mortality likely

5. The Broader Picture: Building Resilience

This Bleaching Response Plan describes a series of steps to be taken in the event of future mass coral bleaching episodes in Malaysia. The primary, short-term objectives are to communicate to stakeholders what is happening, and to take steps to protect reefs during the bleaching event itself, for example through measures such as site closures. The Plan is largely responsive, not proactive.

The Plan does not incorporate long term objectives that attempt to address the cause of mass coral bleaching – increasing sea temperature. In reality, this is not possible at the local level. However, outside of the bleaching event itself, the focus of local management should be on making reefs healthier, or more "resilient", to ensure their survival in the long term.

5.1 Resilience Defined

"Resilience" describes the ability of an ecosystem to recover from an external impact - to recover to its former state after a disturbance has occurred. The three concepts of resilience are:

Resistance – ability to absorb or resist stressors (remain relatively unchanged in the face of major disturbance).

Recovery – ability to recover from stressors.

Transformation (key component of resilience) – changes that affect the function of the socio-ecological system; a complex process that involves changes at personal, cultural, organisational, institutional and systems levels.

A reef that returns to the same state even after major disturbances has high resilience, while one that shifts into another state has lower resilience. Certain factors can increase the resilience of a coral reef, categorised into ecological and spatial resilience factors. Ecological resilience factors are properties present within the spatial boundaries of the ecosystem; species and functional diversity are included in this context. Spatial resilience factors extend beyond ecosystem boundaries and include large-scale functions and processes, including reproduction and connectivity and shifting geographic ranges.

The natural resilience of reefs is being undermined by stresses related to human activities. These local pressures reduce the resilience of the system by undermining its ability to cope with additional stresses, such as those associated with climate change. Increasingly, policymakers, conservationists, scientists and the broader community are calling for management actions to restore and maintain the resilience of coral reefs to minimise the negative impacts of climate change.

5.2 Resilience Studies in Malaysia

The first attempt to provide information on the resilience of coral reefs in Malaysia was carried out in 2012, in a study which covered three Marine Parks off the East coast of Peninsular Malaysia (Redang, Tioman and Sibu & Tinggi). The latest resilience study was conducted in 2021, revisiting Redang, Tioman and Sibu & Tinggi and covering Perhentian and Aur & Pemanggil.

The latest study recommends that high-resilience sites experiencing low stress levels be designated as total no-access areas or conservation zones. Within these zones, limiting tourism, enhancing patrolling, and implementing long-term monitoring are essential to prevent additional stress and maintain healthy

coral reef conditions. For high-resilience sites experiencing medium-low to medium-high stress levels, mitigation measures should be intensified to reduce or remove stressors and prevent these reefs from declining into lower resilience categories. These sites should also be prioritized for temporary closures during major catastrophic events, such as mass bleaching, to reduce pressure and preserve their resilience.

Sites with medium-resilience rankings are suitable for controlled tourism activities. These areas require close monitoring through regular patrols and in-water monitoring programs to manage anthropogenic impacts. Increased education and awareness programs are recommended for all users of these areas.

For sites with low-resilience rankings, targeted interventions such as coral reef restoration programs may help improve overall resilience and increase live coral cover. These sites can serve as training areas for in-water activities such as SCUBA training, minimizing pressure on healthier reefs.

Resilience studies helped to define the role of improving management as the key to building resilience in conserving coral reefs in Malaysia.

5.3 Linking Biodiversity Targets, Resilience and Local Impacts

The Kunming-Montreal Global Biodiversity Framework agreed in December 2022 has four long-term goals for 2050 as part of the 2050 Vision for Biodiversity. Of these, Goal A references resilience:

- **Goal A:** The integrity, connectivity and **resilience** of all ecosystems are maintained, enhanced or restored, substantially increasing the area of natural ecosystems by 2050.

Two Targets reference resilience in greater detail. Under the targets relating to "reducing threats to biodiversity":

- Target 8: Minimise the impact of climate change and ocean acidification on biodiversity and increase its **resilience** through mitigation, adaptation and disaster risk reduction actions…
- Target 10: Ensure that areas under agriculture, aquaculture, fisheries and forestry are managed sustainably, in particular through the sustainable use of biodiversity…contributing to the **resilience** and long-term efficiency and productivity of these production systems…

Thus, resilience is identified as a key component of biodiversity conservation and building resilience should be viewed as a critical response to global warming and the likely impacts on marine ecosystems.

5.4 Local Impact Action Plans

Reef Check Malaysia has worked with Department of Fisheries to identify local impacts to coral reefs in Malaysia, and to develop Action Plans to eliminate or minimise those impacts, in compliance with Aichi Target 10. These Action Plans now form the focus for local management to conserve coral reefs in Malaysia.

The goal is to **manage and reduce local threats/impacts** to ensure that **reefs are better able to survive predicted future events** caused by global scale threats, including mass coral bleaching.

Success in this goal will require collaboration between managers, government, non-governmental agencies and stakeholders, to **implement the urgent immediate actions** necessary to improve reef ecosystem resilience.