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CHAPTER 4

Connectivity Science: Coral Triangle Initiative

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Abstract: Malaysia lies within the Coral Triangle—the global center of marine life. Its waters are rich in coral reefs, fish, and other resources that provide food and jobs for many Malaysians. However, marine life and threats cross national borders and no single country can protect these assets alone. This is why Malaysia co-founded the Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security (CTI-CFF) with five other nations. Through this partnership, the nations plan and share responsibility for their shared ocean. As a founding member, Malaysia gains support, funding opportunities, and a stronger voice in regional ocean management. Malaysia also leads by example at home. Tun Mustapha Park in Sabah is the country's largest marine park, co-managed with local communities to restore fisheries and reefs. Sugud Islands Marine Conservation Area (SIMCA) is the first privately run marine reserve in Malaysia and has successfully protected turtle nesting beaches. On Omadal Island in Semporna, a local women's group patrols beaches to guard turtle nests and fund conservation by selling handicrafts. These efforts show how teamwork from the ground up delivers results. The best proof of collaboration is the green turtle's comeback. In 2024, this species moved from Endangered to Least Concern on the global list after years of joint protection across the region. Green turtles nest in Malaysia but feed in other countries, so only teamwork could save them. This success shows that when nations work together, nature recovers.

INTRODUCTION

Many Malaysians who grow up inland often view the ocean as distant, or as a place for family vacations. The truth is the ocean is much closer to us than we realise: it dictates our climate, regulates our weather and is responsible for over half of the oxygen we breathe (Hoegh-Guldberg *et al*. 2023). As Sylvia Earle, the celebrated marine biologist once said, "*Every drop of water you drink, every breath you take—that's how you are joined to the sea*" (DeLoughrey 2019). This connection is not merely symbolic; it is fundamental to our everyday lives and wellbeing.

The waters of Malaysia are a part of the Coral Triangle, a unique underwater world that spans six countries: Malaysia, Indonesia, the Philippines, Timor-Leste, Papua New Guinea and the Solomon Islands (Hoegh-Guldberg *et al.* 2009). Renowned as the "Amazon of the Sea," this area boasts 76% of all known coral species and supports the highest diversity of reef fishes worldwide (Hoegh-Guldberg *et al.* 2009). Coral reefs are more than just majestic landscapes, they are living systems that absorb carbon, protect coastlines, shelter marine life, and sustain fisheries that feed millions.

The ocean is not confined by political boundaries and jurisdictions; rather, it extends across national borders and forms part of a wider marine network (Treml and Halpin 2012). Fish, turtles, sharks—even marine debris—travel freely across national waters. The coral reefs, mangroves, and seagrass beds function as complementary habitats that nurture the diverse marine species throughout their different life stages, and enable crucial ecological processes such as larval dispersal, species migrations, and ocean currents (Mao *et al.* 2026).

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The Coral Triangle represents a shared ecological, economic, and social landscape that links the countries within the region through common marine resources and ecosystems (Beger *et al*. 2015). This calls for a transition from isolated national conservation efforts towards integrated, multilateral initiatives that recognise the region's significance as an essential climate refuge (Fidelman *et al*. 2011). This requires governance approaches that extend beyond conventional maritime jurisdictions and account for ecological processes, including species movements across national boundaries (Telesetsky 2018).

Existing transboundary governance frameworks such as the Sulu-Sulawesi Marine Ecoregion Project allow ecological connectivity to be embraced through harmonising management strategies for migratory marine species across Indonesian, Malaysian, and Philippine borders (WWF-SSME 2004; Araújo *et al*. 2019). The Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security (CTI-CFF), established in 2009 with Malaysia as one of its founding members, was a landmark multilateral partnership aimed towards addressing systemic threats and sustainable resource management at this biodiversity hotspot (Foale *et al.* 2012).

WHY THE CORAL TRIANGLE IS IMPORTANT: CONNECTIVITY SCIENCE

Stretching across Malaysia, Indonesia, the Philippines, Timor-Leste, Papua New Guinea, and the Solomon Islands, Coral Triangle is recognised as the epicenter of marine biodiversity (Foale *et al*. 2012). Its ecological richness extends beyond its remarkable species diversity; it functions as an interconnected web, where the movement of larvae and adults sustain the ecological life along the vast transboundary marine corridors (Treml and Halpin 2012).

The green turtle (*Chelonia mydas*) is a classic example. Satellite tracking showed that these ancient mariners forage at transboundary feeding grounds, shared between Indonesia and the Philippines (Merwe *et al.* 2009; Chomchat *et al.* 2024). Genetic evidence has linked these turtles to nesting sites in Sabah (Joseph *et al.* 2023), thus emphasising the need for cross-border conservation efforts. Although individual countries may implement measures to protect nesting beaches and feeding grounds within their jurisdiction, the turtle populations remains at risk if critical habitats elsewhere along the turtles' migratory routes remain unprotected. Transboundary movements of this nature highlight the importance of a regional management approach that extends beyond individual national responsibility in maintaining the ecological integrity of the Coral Triangle marine corridors (Beger *et al.* 2015).

Green turtles are not the only species whose movements transcend national boundaries. Sharks, rays, and other endangered, threatened and protected species also travel the Borneo-Sulu-Celebes seascape, using habitats from ocean trenches to shallow coral reefs, across multiple national jurisdictions (Araújo *et al.* 2019). However, critical habitats for sharks and rays in Asia remain largely unprotected (González-Pestana *et al.* 2026).

Even microscopic and drifting coral larvae can travel far. Currents carry these coral larvae across the Indo-West Pacific, allowing them to settle and repopulate reefs miles away from their origin (Pata and Yñiguez 2019). Consequently, spawning events in one area may contribute to the reef recovery in another area (Treml and Halpin 2012). Consequently, the recovery of degraded coral reefs in Malaysian waters may depend, in part, on larval supply from reefs located hundreds of kilometres away, including those beyond our national jurisdictions (Schill *et al.* 2015).

Reefs in the Coral Triangle also act as important carbon sinks and storm buffers (Beck *et al.* 2018). They support the livelihood of more than 120 million people through fisheries, tourism, and other coastal activities (Green *et al.* 2011). Coral reefs closely interact with neighbouring habitats such as seagrass meadows and mangrove forests. These habitats function complementarily as nurseries and feeding grounds to various marine species. Disruptions to one ecosystem can caues ecological consequences to another ecosystem and triggers a ripple effect through national borders.

The movement of marine debris presents another dimension of this regional challenge. It is estimated that 80% of marine debris originated in land-based human activity (Cordova and Nurhati 2019), with plastic bottles, discarded fishing gears, and microplastics accumulating across the shared marine environments (Puspita *et al.* 2026). As marine debris can drift across national waters, pollution originating from one location may threaten marine species and their ecosystems elsewhere. In Malaysia, marine entanglement and ingestion of plastics have been observed in sea turtles and other marine fauna (Tan *et al.* 2022). This is a transboundary issue for international matters, not only in the local context (Puspita et al. 2026). Hence, maintaining the regional integrity of such seascapes requires coordinated management that extends beyond political boundaries, such as the establishment of marine protected area networks (Weeks *et al*. 2014), to protect the migratory pathways and larval exchange, both of which are critical for ecological resilience (Fidelman *et al.* 2011).

CTI-CFF IN THE PAST AND PRESENT

Malaysia's involvement in regional efforts to protect the Coral Triangle began well before the formal establishment of the Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security (CTS-CFF). In 2001, Malaysia joined the planning process of the Sulu-Sulawesi Marine Ecoregion (SSME; WWF 2004), working alongside Indonesia and the Philippines on a shared vision to conserve marine ecosystems across the region (WWF-SSME 2004; Fidelman *et al*. 2011). This early collaboration laid the foundation for subsequent multilateral conservation efforts.

In May 2009, the CTI-CFF was formally launched at the Leaders' Summit held at the Manado, Indonesia (Asaad *et al.* 2019). At this historic moment, representatives from Indonesia, Malaysia, Papua New Guinea, the Philippines, Solomon Islands, and Timor-Leste, signed the CTI Leaders' Declaration, founding the Coral Triangle Initiative. The declaration rightfully recognises that the transboundary nature of seascape conservation requires the cooperation and stewardship of the CTI countries.

The CTI-CFF's initial Regional Plan of Action (RPOA) had focused on ecosystem -based fisheries, community resilience, and recovery in threatened species. Since then, the six member nations have expanded this scope to include the systematic designation of priority seascapes and the establishment of robust, region-wide marine protected area networks (Asaad *et al.* 2019).

Today, the adoption of the RPOA 2 (2021–2030) marks a new era. It is shifting the paradigm from just biodiversity to climate resilience and sustainable finance, food security and recovery of threatened species. These priorities aligned with the broader international conservation commitments, including the global ambition to protect 30% of land and sea by 2030 (30×30) and commitments related to blue carbon. It emphasises resilient MPA networks, food security and threatened species recovery, under a connectivity framework.

MALAYSIA IN THE CORAL TRIANGLE INITIATIVE

Since the establishment of CTI-CFF, Malaysia has translated and implemented the Regional and National Plan of Actions domestically, whilst adhering to the principles of science-based participatory conservation, decisions made in consensus, alignment with international conventions and practices. The following examples illustrate how the regional objectives of CTI-CFF is being implemented locally in Sabah.

Tun Mustapha Park (TMP), Sabah

As Malaysia's largest multi-use marine protected area (MPA), TMP demonstrates how connecting ecosystems and managing them with local communities reduces destructive fishing, turtle poaching and helps reefs recover (Justine 2025). Its establishment was a 15-year journey of negotiation, community dialogue, and trust-building, beginning in 2003 and culminating in full gazettement in 2016 (Jumin *et al*. 2017). Through a zoning and co-management system, TMP is where fishing, tourism, and conservation all complement each other, allowing local communities to maintain their livelihoods while safeguarding the area's ecological functions (Teh *et al.* 2013). Today, TMP serves as a model where its various stakeholders collaborate equitably towards a shared vision—a large-scale MPA in Malaysia.

Sugud Islands Marine Conservation Area (SIMCA), Sabah

Established as the first private marine conservation area in Malaysia (Teh *et al.* 2007), SIMCA is also the first marine IUCN Green List site in Asia. This awards the country's first degree of legally protected, environmentally and operationally sustainable nature conservation in Malaysia. This certification recognises that SIMCA meets the world's highest standards of conservation effectiveness and governance. Through strict control of fishing activities, continuous protection of turtle nesting beaches, and sustained patrolling against illegal extraction, SIMCA demonstrates how sustained management and enforcement can contribute to actual biodiversity recovery (Chung 2026).

A recent study by Chung *et al*. (2026) reported a Coral Reef Fish Diversity Index (CFDI) of 647 species, including 36 species listed on the IUCN Red List. Of these. four are Critically Endangered elasmobranch species. The study also reported the first record of *Rhina ancylostoma* (Bowmouth Guitarfish) in SIMCA.

Community empowerment in Omadal Island, Semporna, Sabah

Wanita Pulau Omadal (WAPO)-Omadal Women in Conservation (Figure 1) conducted daily beach patrols that protect nesting sea turtles and document landings. Alongside conservation activities, they also produce weaved handmade items like bags and accessories using *Pandanus* and other locally-available natural materials (Figure 2), which attracted recognition beyond their local community. The income from these products helps sustain their conservation initiatives such as purchasing fuel for patrol vessels, allowance for patrollers and support community awareness (Musa 2026).

The importance of alternative and sustainable livelihoods in conservation initiatives cannot be understated, where local participants must be able to sustain themselves while being stewards of the environment, ensuring the long-term sustainability and success of conservation initiatives. The WAPO's story shows how community-led marine management can support community livelihoods while actively contributing to environmental stewardship.



Figure 1. A cultural *igal-igal* dance performance by Wanita Pulau Omadal (WAPO). Photo by WWF-Malaysia.



Figure 2. Weaved handicrafts made by WAPO. Photo by WWF-Malaysia.

CHALLENGES AND OPPORTUNITIES

Despite significant achievements, Malaysia still faces persistent challenges in conserving its marine ecosystems (Praveena *et al.* 2012). Fragmented marine governance, shortage of long-term financing, and enforcement gaps can undermine implementation (Ong 2020; Suherman *et al.* 2020). Many conservation efforts last only a year or two. While these short-term projects please donors, they often fail to deliver sustainable results for the local communities (Booth *et al*. 2022). Without long-term investment, efforts such as turtle monitoring, reef rehabilitation and community patrols remain difficult to scale or sustain.

This is where regional planning under the CTI-CFF becomes vital. It helps shift Malaysia from isolated, short-term projects toward long-term strategies, steady funding, and closer cooperation with neighbors (Foale *et al*. 2012). This is especially true for threats like illegal fishing, wildlife trafficking, and destructive practices as these issues span borders and require coordinated regional action (Widjaja *et al.* 2023).

Marine debris is another clear example of a shared environmental problem (Zambrano 2026). Plastic waste, ghost nets and other debris move across borders and continue to threaten biodiversity, fisheries and marine wildlife, including turtles, sharks, rays and marine mammals (Kühn *et al.* 2015). Transboundary environmental issues cannot be addressed in isolation by individual nations alone (Kamaruddin *et al.* 2022; Omeyer *et al.* 2022). Instead, through CTI-CFF, Malaysia can work with neighbours to align waste policies, track plastic sources, and move toward a circular economy.

Sustainable financing is another critical gap, but also an important opportunity to strengthen regional cooperation. Through the CTI-CFF and its regional partnerships, Malaysia has a unique opportunity to explore joint financial arrangements that bring together multilateral donors and regional counterparts. These multilateral funding sources such as the Green Climate Fund, the Global Environment Facility (GEF), SOMACORE and SEACONNECT may be utilised to support and expand future CTI-CFF initiatives. These mechanisms could help mobilise resources for cross-border initiatives, such as restoring ecosystems, managing coral reefs, and helping coastal communities adapt to climate change. Such collaborative financing arrangement would not only benefit Malaysia but also support shared solutions across borders. Such proposals can encourage blue carbon, coral restoration, coastal resilience, sustainable fisheries, and community-based adaptation, and allow for transitioning from short project cycles to long-term investments (Victurine *et al.* 2022).

Climate change challenges extend beyond mere lack of data. Even where data are available, they are often scattered across institutions, not fully accessible to the public, and not always translated into policy planning (Ooi *et al*. 2025). When ocean monitoring, biodiversity data, and climate vulnerability assessments are not available in a shared database, decision-makers are unable to use them to proactively address climate change issues. In this regard, the CTI-CFF provides an opportunity to improve regional knowledge sharing through tools such as the Coral Triangle Atlas (CT Atlas), while supporting marine spatial planning and better use of data for conservation, fisheries and climate adaptation (Cros *et al.* 2014). Data on MPAs, OECMs, coral reefs, seagrass, mangroves, threatened species, marine debris and climate vulnerability can be better integrated and made easier to use for planning. This would also contribute to a more robust evidence base for marine spatial planning, helping Malaysia decide exactly where to prioritise protection, restoration, and fisheries management (Wan Talaat *et al.* 2020).

Marine spatial planning enables the authorities to manage, conserve, and sustainably utilise the marine environment and the resources contained therein, *inter alia* fishery zones, protected areas, oil and gas development blocks, and community conserved areas (Wan Talaat *et al.* 2020; Lua and Aziz 2025). Through better spatial planning, Malaysia can then identify where protection, restoration, fisheries management and community use should take place (Jumin *et al*. 2017). This approach also provides an opportunity to establish an integrated network connecting marine protected areas (MPAs), other effective area-based conservation measures (OECMs), and locally managed marine areas, especially in Sabah. Peer learning can help MPAs move from designated but ineffective 'paper park' to an effectively-managed protected area. Under CTI-CFF, a regional MPA managers' network was established in May 2026, during the MPA Technical working group meeting in Kota Kinabalu (*pers. obs*.). This network enables practitioners to share insights with counterparts across the Coral Triangle on key management aspects from zoning and reef monitoring to financing and community engagement.

The various successful CTI-CFF initiatives in Malaysia should be highlighted in regional peer-to-peer sharing conferences and workshops, where CTI-CFF members can learn from and build on each other's successes. Examples such as the women-led turtle patrols in Omadal and the co-managed governance of Tun Mustapha Park show that conservation can be made more effective and sustainable when communities are part of the solution and long-term conservation achievement. Malaysia is also the first country to use climate adaptation tools such as the Local Early Action Planning (Christensen 2013) to bolster the resilience of vulnerable island communities in Mabul, Semporna (Semporna District Office 2024). By amplifying such experiences though regional platforms, combined with the strategic integration of such inclusive approaches into the current strategies, Malaysia has an opportunity to help chart the way forward for CTI-CFF, working collectively with our regional neighbours.

POLICY RECOMMENDATIONS

To build on the opportunities under the CTI-CFF, Malaysia can strengthen regional conservation planning and ensure closer alignment to national marine priorities. Conservation efforts should not depend only on short-term projects. Malaysia would benefit from the CTI-CFF's support for long-term seascape strategies, especially in Sabah (where marine protected areas, prospective OECMs, locally managed marine areas and community conservation sites are ecologically connected) (Lubchenco *et al*. 2023). Scaling these efforts would not only contribute to regional targets, but also accelerate Malaysia's progress towards the global 30×30 goal (Henneker *et al.* 2026). The CTI-CFF's framework provides guidance on scaling existing MPAs into more ecologically-linked networks to enhance resilience and meet international benchmarks (Walton *et al.* 2014).

To achieve this, Malaysia requires a stronger National Ocean Policy to provide strategic direction and improve coordination between federal and state authorities. Such policy would establish a more coherent framework, integrating sectoral priorities from fisheries and tourism to climate adaptation, under one clear plan (Hills *et al.* 2021). Harmonising cross-sectoral mandates can help countries better integrate national strategies with broader regional objectives established under the initiative (Putri *et al*. 2025).

Regional cooperation must also be strengthened to stop illegal fishing, destructive practices, and wildlife trafficking (Jiao *et al*. 2021) across the national borders (Witbooi *et al.* 2020). Through CTI-CFF, Malaysia can collaborate with neighbouring nations to improve information sharing, joint surveillance, enforcement coordination and response mechanisms for shared seascapes such as the Sulu-Sulawesi Seascape (Ellett 2021).

CONCLUSION

The Coral Triangle Initiative offers significant benefits for Malaysia. It gives credence to the marine parks and OECM sites, reinforces Malaysia's responsibility as a maritime nation to contribute to the conservation of shared marine species like turtles and sharks, provides access to international financing opportunities, and gives Malaysia a stronger voice in global ocean governance. The green turtle reminds us why this regional cooperation matters. Although green turtles nest in Malaysia, they also forage and migrate across waters shared with neighbouring countries. While Malaysia can protect our nesting beaches, the long-term recovery of the turtle population depends on effective management of their feeding grounds, migration routes, and fisheries interactions across their wider range. In 2024, some green turtle subpopulations were downlisted to Least Concern on the IUCN Red List, where interventions such as international cooperation, establishment of marine protected areas, and participatory conservation collectively contributed to the rebound of the green turtle. This case study exemplifies the multifaceted conservation initiatives combined with regional efforts, which alleviate existing anthropogenic pressures and allow marine ecosystems to recover. As Malaysia moves toward its 2030 aims, the path forward is clear: the ocean's future extends far beyond Malaysia's shores. Our prosperity depends on healthy reefs, safe migration corridors, sustainable fisheries, strong communities, and regional trust. Recognising these ecological and socio-economic interconnections, CTI-CFF gives us the platform to act on that science. Malaysia's success will depend on continued leadership, long-term collaboration, and our shared commitment to protect the sea that connects us all.

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