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CHAPTER 7

Sea turtle conservation in Borneo: Malaysia's oldest and strongest conservation legacy

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Abstract: Long-term conservation efforts in Sabah and Sarawak have contributed significantly to the protection of sea turtles in Malaysia. Protection of nesting beaches, hatchery management, enforcement, community participation, and research have supported positive conservation outcomes across the region. Recent advances in genetic studies, satellite tracking, and long-term monitoring have improved the understanding of turtle connectivity and strengthened conservation management. Despite these achievements, threats such as fisheries bycatch, habitat degradation, marine pollution, and climate change continue to challenge conservation efforts. Future conservation success will depend on sustained protection, science-based management, and strong collaboration among stakeholders.

INTRODUCTION

Sea turtle conservation represents one of the longest-standing and most well-established conservation successes in Malaysia, with Sabah and Sarawak forming the foundation of this national legacy (Joseph *et al*. 2021). Conservation initiatives in Borneo can be traced back to the early 20th century and have continued uninterrupted for decades through a combination of legal protection, hatchery management, sustained enforcement, scientific research, and increasing community involvement. Together, these long-term and coordinated efforts have positioned East Malaysia as a regional leader in sea turtle conservation in Southeast Asia (Joseph *et al*. 2021; Bali *et al*. 2023; Sabah Wildlife Department 2025).

This conservation legacy is supported by strong state-level legislative frameworks in Sabah and Sarawak (Bali *et al*. 2023; Sabah Wildlife Department 2025). In Sabah, sea turtles and their eggs are protected under the Sabah Wildlife Conservation Enactment 1997, while key nesting and foraging habitats are further safeguarded through the Parks Enactment 1984 (Amendment 2024). In Sarawak, protection is provided under the Sarawak Wild Life Protection Ordinance 1998. Together, these legislative frameworks prohibit the taking, possession, and trade of protected species while supporting the conservation and management of important habitats.

In Sabah and Sarawak, two species of sea turtle nest regularly (Bali *et al*. 2023; Jolis *et al.* 2023; Sabah Wildlife Department 2025), namely the green turtle (*Chelonia mydas*; local name: *penyu agar* or *penyu hijau*) and the hawksbill turtle (*Eretmochelys imbricata*; local name: *penyu karah* or *penyu sisik*). Olive ridley turtle (*Lepidochelys olivacea*;

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local name: *penyu lipas*) continue to nest in the region, although nesting occurs at very low frequency and remains sporadic. The leatherback turtle (*Dermochelys coriacea*; local name: *penyu belimbing*) and loggerhead turtle (*Caretta caretta*; local name: *penyu tempayan*) were historically recorded nesting in Sarawak (Bali *et al*. 2023), but these records were limited to single, isolated nesting incidents and no longer occur today.

In contrast to the restricted nesting assemblage, the coastal and offshore waters of Sabah and Sarawak support foraging habitats for four sea turtle species: green turtles, hawksbill turtles, olive ridley turtles, and leatherback turtles (Nishizawa *et al.* 2016, 2018; Joseph *et al*. 2021). These waters function as important migratory corridors, temporary stopover sites, and in some cases, resident feeding grounds for turtles originating from multiple regional rookeries (Nishizawa *et al.* 2016, 2018; Joseph *et al*. 2021; Bali *et al*. 2023). Loggerhead turtles, while documented at foraging grounds in Peninsular Malaysia (Abdul Rahman *et al.* 2021), have not been recorded utilising foraging habitats in Sabah and Sarawak. Collectively, these patterns show the significance of Borneo not only as a regional nesting area for selected species, but more importantly as a critical feeding and transit zone within the broader Indo-Pacific seascape.

Recent global and regional assessments reflect the positive outcomes of sustained conservation efforts in the region. The green turtle has been downlisted to Least Concern on the IUCN Red List (IUCN 2026), with one of the key contributing factors being the recovery of major populations in the Sulu Sea. Nesting populations in this region have increased by approximately threefold over recent decades, with Turtle Islands Park alone now recording more than 20,000 nests annually (Joseph *et al*. 2021). This site represents one of the largest green turtle rookeries in the Indo-Pacific and provides strong evidence that long-term protection, effective hatchery management, and consistent enforcement can lead to population recovery on a scale.

Beyond formal protection and enforcement, sea turtle conservation in Sabah and Sarawak has been strengthened by active participation from local communities, non-governmental organisations (NGOs), and research institutions, many of which have worked in close partnership with state agencies over extended periods (Joseph *et al*. 2021; Sabah Wildlife Department 2025; NRES 2026). Community-led nesting monitoring, hatchery management, outreach programmes, and collaborative research initiatives have played an important role in sustaining conservation outcomes (Jolis *et al*. 2023). Importantly, conservation efforts in East Malaysia are supported by strong scientific capacity, with long-term monitoring, tagging (Joseph *et al*. 2021; Bali *et al*. 2023; Sabah Wildlife Department 2025) satellite tracking (Pilcher *et al*. 2019), and genetic studies (Nishizawa *et al*. 2016, 2018, 2024) providing the evidence needed to guide adaptive management and policy decisions.

Despite these achievements, recovery trends are not uniform across all species. Hawksbill turtle nesting remains low and vulnerable, while olive ridley nesting continues to be extremely rare (Joseph *et al.* 2021; Joseph 2017). Persistent threats, including egg poaching, fisheries bycatch, coastal development, marine pollution, and climate change continue to challenge conservation efforts (Joseph *et al.* 2021). Emerging pressures, such as increasing tourism pressure at key foraging sites, further complicate management across multiple habitats. Overall, the conservation outcomes observed in Sabah and Sarawak reflect the strengths of long-term protection, governance, and institutional commitment, while ongoing threats and uneven recovery among species highlight the need for adaptive, forward-looking conservation strategies.

CURRENT STATUS AND DISTRIBUTION

The current status and distribution of sea turtles in Sabah and Sarawak vary markedly across sites and species, reflecting differences in historical exploitation, protection intensity, and monitoring effort (Joseph *et al*. 2021; Bali *et al*. 2023; Sabah Wildlife Department 2025). Nesting activity is concentrated at a limited number of key locations, while foraging grounds are more extensive and widely distributed (Figure1).

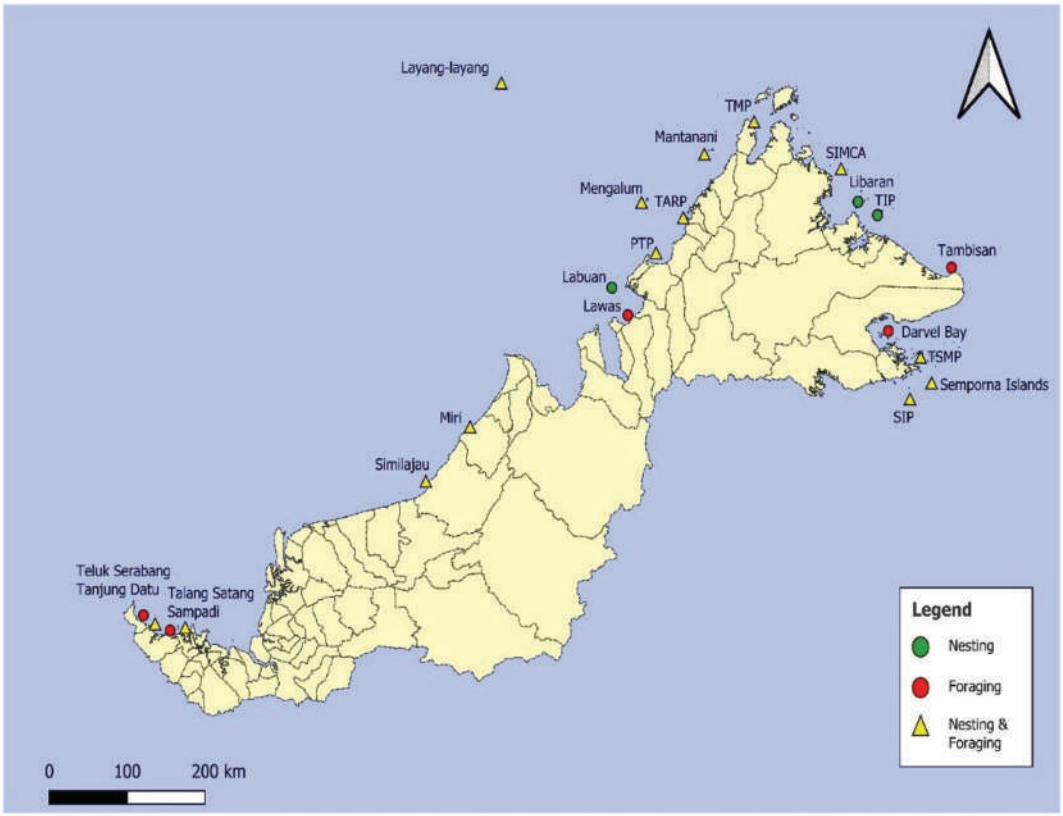

Figure 1. Distribution of sea turtle nesting and foraging areas across Sabah and Sarawak. (TIP – Turtle Islands Park; TMP – Tun Mustapha Park; SIMCA – Sugud Islands Marine Conservation Area, TSMP – Tun Sakaran Marine Park; TARP-Tunku Abdul Rahman Park; PTP – Pulau Tiga Park; SIP- Sipadan Island Park).

Sarawak: From historical decline to sustained protection and conservation gains

Long-term nesting records from Sarawak indicate a marked decline in sea turtle nesting since the early 1950s (Bali *et al*. 2023). Current nesting levels are estimated to be approximately 90% lower than those recorded in 1951 (Figure 2), reflecting the legacy of historical egg harvesting, coastal habitat loss, and prolonged exploitation prior to the implementation of comprehensive conservation measures.

Since the mid-1960s, nesting numbers have remained consistently low, fluctuating within a relatively narrow range. While this pattern reflects stabilisation at a depleted population level rather than population recovery, it also indicates that further declines have largely been prevented through sustained protection efforts. Nesting in Sarawak is dominated by green turtles, which account for approximately 95% of recorded nests (Bali *et al*. 2023). Hawksbill turtles contribute a smaller proportion (4%), while olive ridley nesting remains rare and irregular (Bali *et al*. 2023).

Despite the long-term reduction and stabilisation of nesting numbers, hatchling production in Sarawak has shown a clear and encouraging upward trend since the late 1970s. This increase coincides with gradual improvements in egg protection and hatchery management practices. Between 1980 and 1990, egg conservation efforts expanded substantially, resulting in a steady rise in hatchling output over this period. A major milestone in strengthening marine turtle protection occurred with the gazettement of the Wild Life Protection Ordinance in 1998. From 1999 onwards, the sale of turtle eggs from the Sarawak Turtle Islands to the public was fully discontinued. Instead, all eggs were systematically purchased and incubated under the coordinated management of the Sarawak Forestry Department, Sarawak Museum Department, and subsequently the Sarawak Forestry Corporation. These institutional arrangements marked a significant shift from exploitation to full conservation-oriented management.

As a result, hatchlings production continued to increase consistently through time, even in the absence of corresponding increases in nesting abundance (Figure 2). This pattern demonstrates that strengthened legal protection, improved hatchery infrastructure, and standardised egg management practices have substantially enhanced reproductive output and contributed meaningfully to the long-term conservation of sea turtles in Sarawak.

Beyond nesting beach protection, sea turtle conservation in Sarawak has progressively expanded to include habitat enhancement within coastal waters. Through the BEACON Project (Bali *et al*. 2023), reef ball (artificial reef) structures have been deployed at multiple locations along the Sarawak coastline to restore degraded marine habitats, discourage destructive fishing practices, and enhance overall marine biodiversity. Although these reef ball installations are not located directly on nesting beaches, they play an important role in improving nearshore habitats utilised by sea turtles during critical at-sea life stages. During inter-nesting periods and along coastal migration routes, turtles spend considerable time resting and foraging in coastal waters. By increasing habitat complexity and food availability, reef ball structures contribute to improved foraging conditions and help reduce exposure to anthropogenic threats such as fishing activities and accidental entanglement. Collectively, these long-term trends and integrated management approaches highlight Sarawak's transition from historical overexploitation to sustained protection, demonstrating the tangible conservation gains achieved through decades of commitment by the Sarawak Forestry Corporation and its partner agencies (Figure 3).

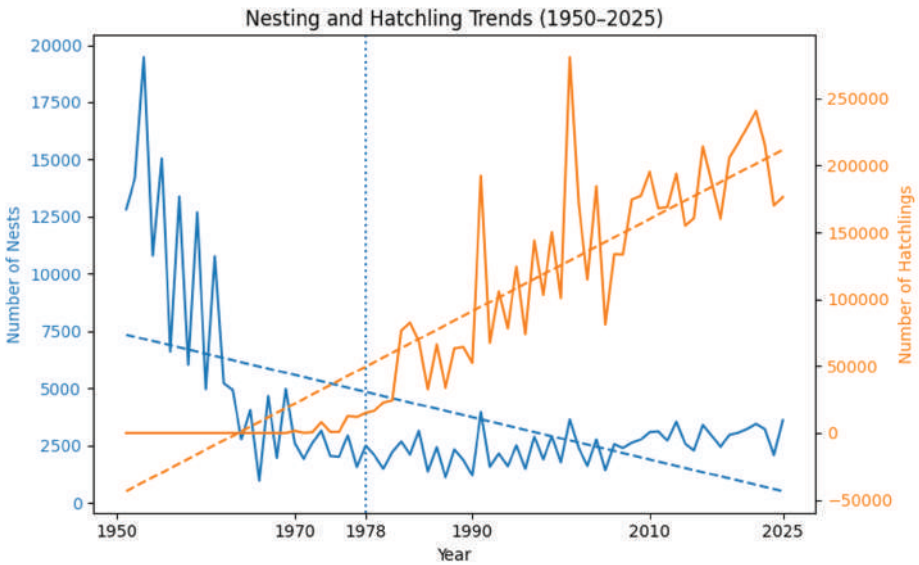

Figure 2. Long-term sea turtle nesting and hatching in Sarawak (1950 – 2025).



Figure 3. Sea turtle hatcheries in Sarawak under the management of the Sarawak Forestry Corporation.

Sabah: Conservation successes, adaptive management and community-led stewardship
One of the most successful sea turtle conservation programmes in Southeast Asia is found at the Turtle Islands Park (TIP), Sabah (Joseph *et al*. 2021; Sabah Wildlife Department 2025). TIP forms part of the Turtle Islands Heritage Protected Area (TIHPA), established in 1996 as the world's first transboundary protected area dedicated specifically to sea turtle conservation between Malaysia and the Philippines. The TIHPA comprises three islands under Sabah's jurisdiction and six islands under the Philippines, all designated primarily for conservation.

At TIP, continuous nest relocation, hatchery management, and strict enforcement have been implemented for over five decades (Joseph *et al*. 2021; Sabah Wildlife Department 2025). The islands are managed exclusively for conservation purposes, with no permanent local communities present. Eco-tourism is permitted only on Selingaan Island, where visitor numbers and activities are strictly controlled to minimise disturbance to nesting turtles. Revenue generated from this regulated eco-tourism is reinvested directly into conservation and park management.

Consistent with these management interventions, long-term monitoring data from TIP (Figure 4) demonstrates a clear and sustained increase in green turtle nesting from 1979 to 2023 (Joseph *et al*. 2021; Jolis *et al*. 2023). This trend reflects a strong positive population response under strict protection, systematic hatchery management, and consistent enforcement. In contrast, hawksbill turtle nesting at the same site shows a long-term declining trend over the same period (Joseph *et al*. 2021; Jolis *et al*. 2023). This divergence highlights species-specific differences in vulnerability and suggests that pressures operating outside nesting beaches, particularly at foraging grounds and along migratory routes, continue to disproportionately affect hawksbill populations.

Nesting trends at Sipadan Island Park (Joseph *et al*. 2021; Jolis *et al*. 2023) show high inter-annual variability (Figure 5), with no consistent long-term increase or declining pattern. Sipadan has a long history of protection, having been declared a bird sanctuary as early as 1933, reflecting early recognition of its ecological importance. In 2004, Sipadan was formally gazetted as a marine park, and all accommodation facilities on the island were subsequently closed to further safeguard its pristine natural environment.

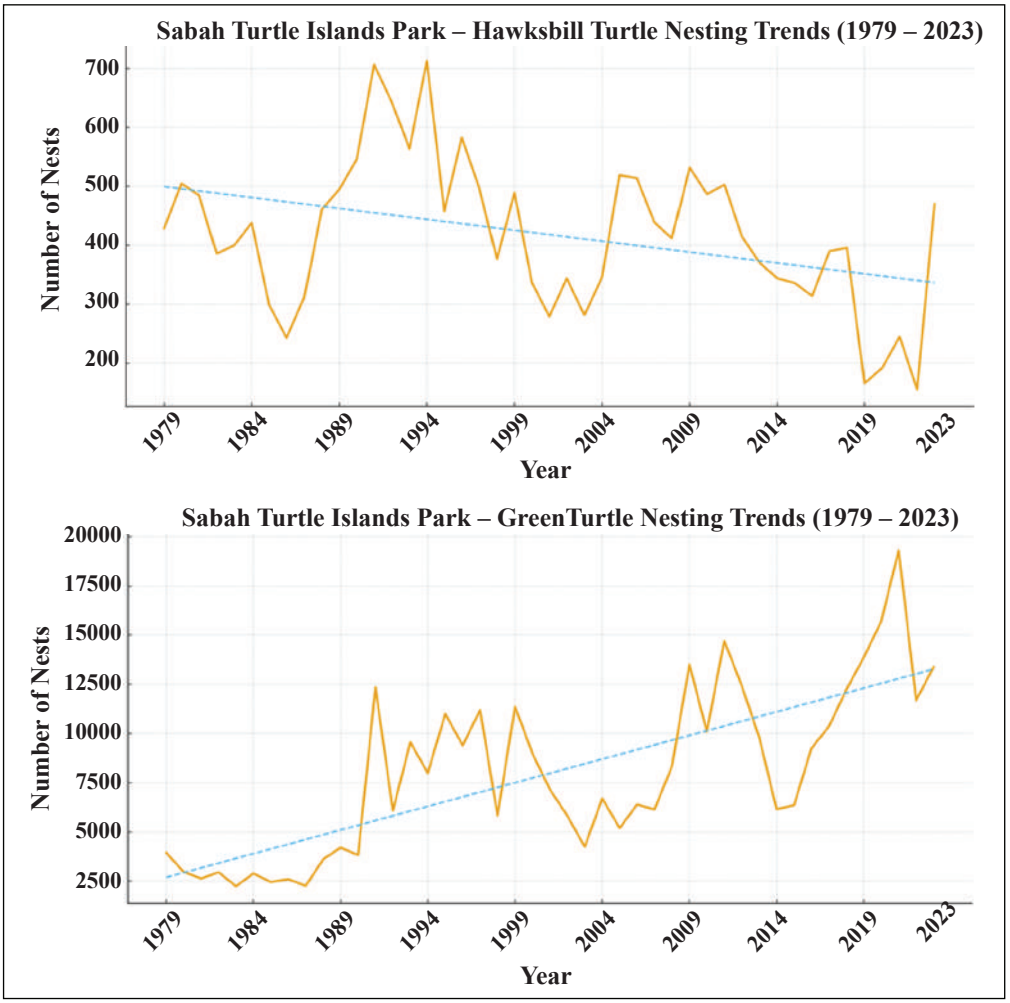

Figure 4. Long-term nesting trend for green and hawksbill turtles at Turtle Islands Park (1979 – 2023).

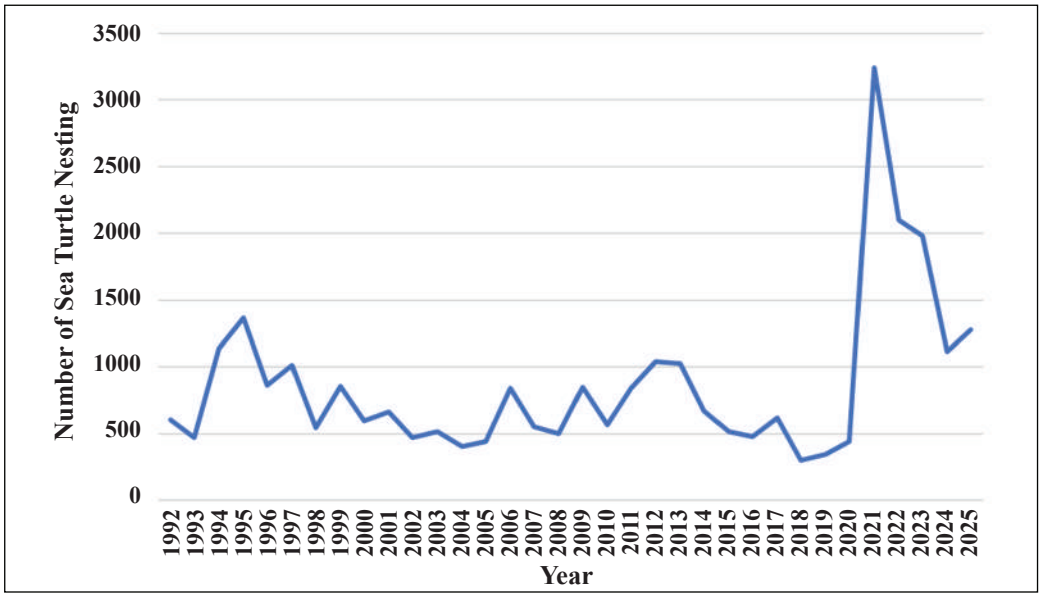

Figure 5. Long-term trends in sea turtle nesting at Sipadan Island Park.

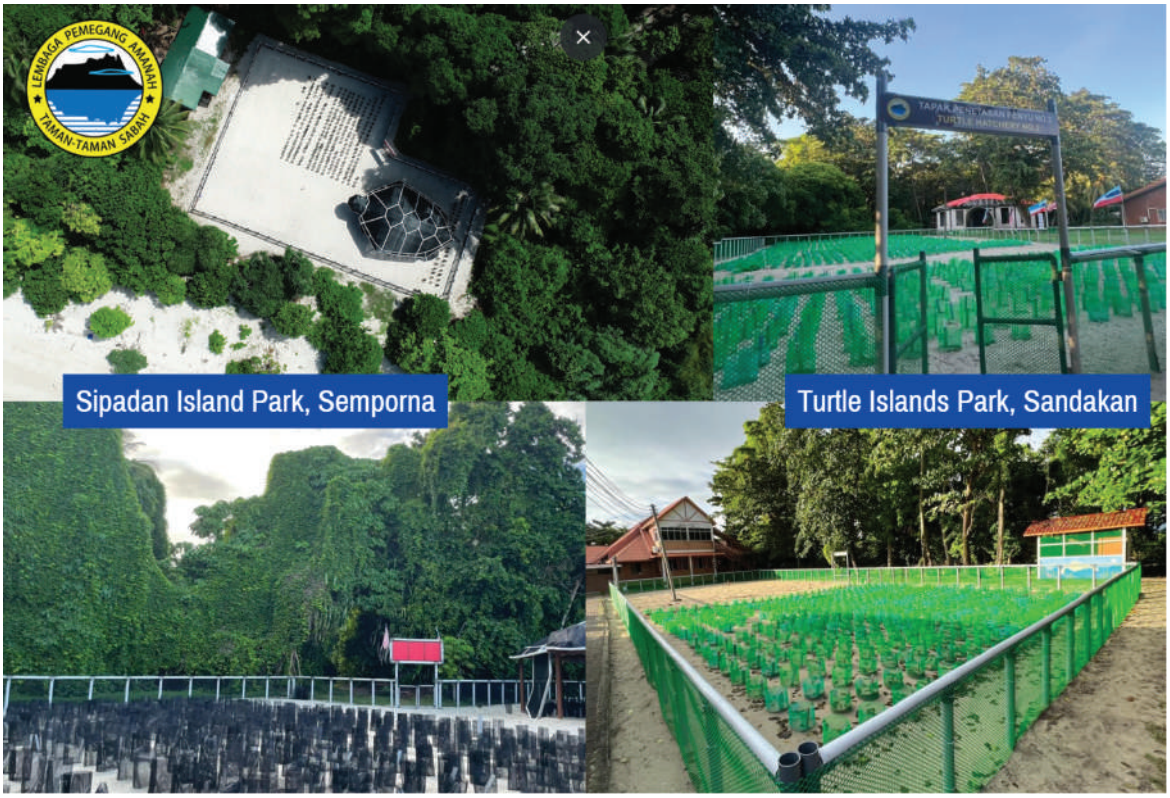

Figure 6. Sea turtle hatcheries in Sabah under Sabah Parks management.

The sharp increase in nesting records observed from 2021 onwards is therefore most likely associated with improvements in monitoring effort and nest detection, rather than a sudden biological increase in nesting activity. This distinction highlights the importance of accounting for changes in monitoring intensity when interpreting nesting trends at highly protected sites such as Sipadan, where management effectiveness has remained consistently high.

Beyond the main nesting strongholds, sea turtle nesting in Sabah also occurs at several additional sites with varying nesting intensity. Low-density nesting, typically involving fewer than 50 nests annually, is recorded at Tun Mustapha Park (Kudat), Pulau Mengalum, Pulau Mantanani, Pulau Tiga Park, and Tunku Abdul Rahman Park. Nesting sites located within gazetted marine parks, including Pulau Tiga Park, Tunku Abdul Rahman Park, and Tun Sakaran Marine Park are managed by Sabah Parks, where nest monitoring, protection, and egg management are carried out exclusively by parks rangers as part of the parks' conservation and enforcement mandate, except for Tun Mustapha Park which is led by local communities.

In eastern Sabah, the Semporna Islands and the Sugud Islands Marine Conservation Area (SIMCA) support moderate nesting activity, with approximately 200 – 1,000 nests recorded annually. These sites function as important secondary nesting areas. Here, nest monitoring and protection are largely conducted by local communities, NGOs, and resort operators who have undergone formal training and are appointed as Honorary Wildlife Wardens, working in close collaboration with Sabah Wildlife Department. The establishment of Priority Conservation Areas (PCAs) within Semporna has further strengthened the protection of important nesting and foraging habitats, while promoting sustainable ecotourism and community participation as complementary conservation strategies.

Community-based programmes in Kudat and Semporna represent some of the strongest success stories, demonstrating how local stewardship can be a replicative mode (Joseph *et al*. 2021) and can effectively complement state-led management, particularly areas with low or medium-density nestings, especially when enforcement and monitoring resources of government agencies are limited. Community involvement in night patrols, hatchery operations, volunteer programmes, and hatchling release activities has significantly strengthened nest protection and reduced poaching risk. At the same time, these initiatives have created opportunities for supplementary income through conservation-linked volunteering and nature-based tourism. This model highlights the dual benefits of community engagement and enhancing conservation outcomes while supporting sustainable livelihoods within Sabah's broader sea turtle conservation framework.

Foraging grounds and spatial patterns

Major foraging grounds for sea turtles have been identified along the coasts of Sabah and Sarawak (Figure 1), supporting large mixed-stock aggregations composed of individuals originating from multiple nesting rookeries across the region. These foraging habitats play a critical role in sustaining regional sea turtle populations, as turtles spend a substantial proportion of their life cycle feeding, growing and maturing in these areas.

The most extensive and well-studied foraging aggregation in Malaysia occurs in Lawas, Sarawak (Joseph *et al.* 2016, 2023), where large numbers of green turtles forage in seagrass-dominated habitats. Genetic mixed-stock analyses and satellite telemetry studies have demonstrated that turtles utilising this area originate from multiple rookeries (Nishizawa *et al.* 2018; Joseph *et al.* 2016), with major contributions from the Sulu Sea, Peninsular Malaysia, and Sarawak. Lawas (Brunei Bay) is therefore recognised as a key regional foraging and developmental habitat in South China Sea rather than a nesting area, highlighting its importance within the broader life cycle of sea turtles.

In Sabah, important foraging grounds have been identified in both eastern and northern waters, particularly around the Semporna Islands (Kirishnamoorthie 2023; Samsol *et al*. 2025) and Tun Mustapha Park, Kudat (Nishizawa *et al.* 2024). These areas support substantial foraging aggregations of green and hawksbill turtles and are considered among the largest and most significant foraging grounds in Southeast Asia. Foraging habitats in these areas are closely associated with coral reefs and seagrass beds, providing essential food resources and shelter. Ongoing research has highlighted their importance as residents and long-term feeding grounds for both juvenile and adult turtles (Jolis 2023).

Similar to Brunei Bay, turtles foraging in the Semporna Islands and Tun Mustapha Park originate from multiple rookeries, with strong genetic contributions from the Sulu Sea and Sarawak (Nishizawa *et al.* 2024). Notably, genetic evidence indicates that a proportion of green turtles foraging in Semporna originate from Micronesian rookeries (Nishizawa 2018), highlighting the international connectivity of these foraging grounds and their relevance to regional and transboundary conservation efforts. Foraging activity has also been recorded at Tambisan, although existing data remain limited due to small sample sizes. Further surveys and expanded genetic sampling are required to better characterise the population structure and conservation significance of this site.

The presence of large, mixed-stock foraging aggregations in Sabah and Sarawak highlights the importance of protecting foraging habitats alongside nesting beaches. As turtles from multiple rookeries converge at shared feeding grounds, localised exploitation or habitat degradation in these areas can have far-reaching impacts across regional populations. These findings reinforce the need for targeted management, spatial protection, and continued research to safeguard foraging habitats as integral components of effective, life-cycle-based sea turtle conservation.

CHALLENGES AND THREATS

Despite decades of conservation progress, sea turtles in Sabah and Sarawak continue to face mounting pressures driven by human activities and environmental change. While early conservation efforts understandably focused on nesting beaches, effective long-term conservation requires safeguarding sea turtles across all life stages, from eggs and hatchlings to juveniles, subadults, and breeding adults. The long lifespan and highly migratory nature of sea turtles expose them to multiple threats across diverse habitats, making life-cycle-based conservation both essential and challenging.

Egg poaching, illegal harvesting and direct take
Despite comprehensive legal protection, illegal egg collection, direct harvesting of turtles, and associated black-market trade continue to occur in some areas. Demand for turtle eggs for human consumption remains a key driver of illegal egg collection in certain localities, despite growing public awareness and strengthened enforcement efforts. These activities are now largely localised and sporadic, but remain of concern, particularly along transboundary routes within the Sulu–Sulawesi region, where enforcement is complex and cross-border coordination is required.

Bycatch in fishing gear
Incidental capture in fishing gear, particularly trawl nets and drift nets, remains a significant source of mortality for sea turtles. Trials of Turtle Excluder Devices (TEDs) in Sabah and Sarawak have demonstrated encouraging results, although wider adoption and consistent implementation remain key challenges.

Habitat degradation
Coastal development, artificial lighting, and shoreline erosion continue to reduce the quality and availability of suitable nesting habitats and disrupt natural nesting behaviour, particularly at low-density or fragmented nesting sites.

Marine debris and plastic pollution
Ingestion of plastics and entanglement in marine debris are increasingly reported, especially among juvenile and subadult turtles.

Climate change
Rising sand temperatures influence hatchling sex ratios, while sea-level rise and increasing storms intensity threaten the stability and persistence of nesting beaches, adding long-term uncertainty to conservation planning.

FUTURE DIRECTIONS AND RECOMMENDATIONS

To ensure the long-term conservation of sea turtles in Malaysia especially in Sabah and Sarawak, conservation efforts must continue to extend beyond nesting beaches to encompass all stages of the sea turtle life cycle. While protection of nesting sites remains essential, sea turtles spend most of their lives in offshore and coastal waters, and migrate across national boundaries, where they are exposed to a wide range of threats. As long-lived and highly migratory species, their effective conservation therefore requires coordinated action across habitats and jurisdictions.

Strengthening enforcement at high-risk nesting areas and along known illegal trade routes remain a priority. At the same time, reducing incidental capture in fisheries, through wider adoption of turtle-friendly fishing practices, including TEDs is important. Continued awareness and outreach programmes, coupled with incentives that encourage sustainable

fishing practices, could further strengthen industry participation and reduce turtle bycatch. Protection of key foraging grounds and migratory corridors should be further enhanced through integrated marine management approaches.

Continued research, long-term monitoring, and data sharing will be critical to improving understanding of sea turtle movements, population structure, and emerging threats. In this context, the ShellBank Malaysia represents an important advancement in conservation and enforcement. By integrating genetic data, satellite tracking, and traceability tools, ShellBank strengthens the ability to identify the origin of turtles and turtle products, supports investigations into illegal trade, and provides a scientific foundation for evidence -based management and regional collaboration.These efforts are further supported by the Sabah Wildlife Department Wildlife Health, Genetics and Forensics Laboratory, which is listed in the CITES Directory of Laboratories Conducting Wildlife Forensic Testing.

International and regional collaboration remains equally important, as many sea turtles that nest or forage in Malaysian waters originate from, or migrate through, neighbouring countries within the Coral Triangle and wider Indo-Pacific region. Effective conservation therefore depends on sustained cross-border cooperation, information exchange, and shared management responsibilities, particularly for species that utilise transboundary foraging grounds and migratory corridors.

Finally, the continued engagement of local communities, government agencies, research institutions, and non-governmental organisations will remain central to the success of sea turtle conservation in Malaysia. Community stewardship, capacity building, and partnerships with the private sector have already demonstrated tangible conservation gains in Sabah and Sarawak. By strengthening these collaborations and adopting an integrated, life-cycle-based approach supported by science and innovation, Malaysia is well positioned to further consolidate its role as a regional leader in sea turtle conservation.

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