

SPECIAL FEATURE

SEA TURTLES OF
Southeast Asia



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A REGION OF REMARKABLE DIVERSITY

Southeast Asia is a cradle of evolution, home to globally outstanding levels of biodiversity. Terrestrially, there are three biodiversity hotspots within Southeast Asia—the Philippines, Indo-Burma, and Sundaland—as well as a portion of the major wilderness area of New Guinea and three megadiversity countries (Indonesia, Malaysia, and the Philippines). From a marine perspective, Southeast Asia’s underwater realm is the undisputed global epicenter of biological diversity. The Coral Triangle—a zone roughly demarcated by the triangle formed between Indonesia, Melanesia, and the Philippines—encompasses a large swath of Southeast Asian waters that are home to unfathomable numbers of species, including 75 percent of the world’s coral species.

From a human standpoint, Southeast Asia’s cultural diversity is equally rich, represented by a kaleidoscope of ethnicities, languages, and traditions that have flourished since the arrival of humans more than 70,000 years ago. Today the region is home to more than 675 million people from 10 nations. And though the region grapples with challenges like high population densities, wealth disparities, and climate change impacts, the countries of Southeast Asia strive to maintain a delicate balance between tradition, culture, human activities, and the natural environment both on land and at sea.

A TENUOUS STRONGHOLD FOR SEA TURTLES

Six of the planet’s seven sea turtle species are found along the coasts and in the adjacent waters of the countries of Brunei, Cambodia, Indonesia, Malaysia, Myanmar, the Philippines, Singapore, Thailand, Timor-Leste, and Vietnam (see maps, pp. 30–31). Five sea turtle regional management units (RMUs, or subpopulations) lie almost fully within the region, including one RMU each for the green turtle, hawksbill, and olive ridley, and two RMUs for the leatherback. In addition, parts of the ranges of four more RMUs (two for the green turtle, two for the hawksbill) occur in the region.

Green turtles are the most prevalent Southeast Asian species, followed by hawksbills, olive ridleys, and leatherbacks (see maps, pp. 30–31). Loggerheads also are reported sporadically in Malaysia, Myanmar, Thailand, Timor-Leste, and Vietnam, though the species no longer nests in the region. Even the flatback, an Australian endemic, occasionally wanders into Southeast Asian waters.

The region’s sea turtles have confronted an array of threats over the years, which have left many rookeries in a depleted state and others extinct, or nearly so. In contrast, some populations are stable or rising thanks to effective conservation measures. Conservationists must continue to work hard to slow and reverse the impacts of egg harvest, direct take, pollution, habitat alteration, and climate change, and to confront the severe and immediate dangers posed by fishery bycatch.



A hawksbill swims over Tubbataha Reef in the Philippines. Hawksbills are still prevalent in Southeast Asia, though many populations have declined significantly. © David Fleetham/Alamy Stock Photo; PREVIOUS SPREAD: Green turtles at a cleaning station near Sipadan Island, Sabah, Malaysia. Southeast Asia is home to the world’s most diverse coral reef ecosystems and six of the planet’s seven sea turtle species. © Jason Isley/Scubazoo

Countries of the Region

From a sea turtle's perspective, Southeast Asia is a maze of tens of thousands of islands, large and small, spread across millions of square miles of sea and bounded by the immense Indian Ocean to the south and west and the vast Pacific to the east. What these reptiles cannot see are the human-made borders of more than a dozen countries and the delineations of numerous seas wherein cultural, economic, and legal differences shape their fate. Instead, they are guided by their senses and a deeply embedded cellular awareness of which beaches possess the proper conditions for nesting, and where to find food and shelter among the region's innumerable coral reefs, seagrass pastures, and mangrove forests and the open ocean expanses between them.

BRUNEI DARUSSALAM



Brunei has a short 161-kilometer (100-mile) coastline in north Borneo that is the site of the only substantial rookery of olive ridley turtles on the island, with a nesting season that coincides with the northeast monsoon (November–June). Although the adjacent Malaysian states of Sarawak and Sabah are dominated by greens and hawksbills and receive only infrequent olive ridleys, Brunei exhibits the reverse, with mostly olive ridleys and only a small number of nesting greens and hawksbills. There was little in the way of sea turtle conservation and management in Brunei until the early 1990s, when the Departments of Fisheries and Museums began artificially incubating eggs to improve hatchling production and reverse dwindling turtle numbers. The first two years of the program yielded just 107 eggs and 67 hatchlings, but by 2002–2003 those numbers had increased to 4,215 eggs incubated (3,986 olive ridley, 229 hawksbill) yielding 3,562 hatchlings released into the wild and others held for head-starting prior to liberation. The current government strategy, led by a National Sea Turtle Management and Conservation Committee, aims to increase the numbers of hatchlings and pursue public outreach, especially to schoolchildren.

CAMBODIA



Cambodia's relatively short 443-kilometer (275-mile) coast and adjacent seas support a rich abundance of marine life that once included olive ridley, hawksbill, loggerhead, green, and leatherback turtles, though only green and hawksbill turtles have been seen in the past decade. Juveniles are reported foraging in nearshore seagrass pastures and are frequently caught by fishers both incidentally and as direct take. These young animals show high site fidelity in these habitats, then move to other locations as adults, making Cambodian waters an important developmental habitat for Gulf of Thailand turtles. Some nesting is also known to occur on the country's islands.

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Evidence suggests that sea turtles are in decline in Cambodia due to bycatch, direct take, habitat degradation, and coastal development. The widespread use of trawling and push nets is of particular concern, because such nets are deployed in seagrass foraging habitats. Recent surveys conducted by Fauna & Flora International (FFI) estimated that in more than 800 bycatch incidents, some 491 animals were released, 199 were sold, and 92 were consumed by fishers. Meanwhile, egg harvesting now appears to be minimal in Cambodia.

Numerous government agencies, nongovernmental organizations (NGOs), and communities manage Cambodia's sea turtle conservation efforts, focusing on different themes and locations. At the national level, a key milestone was the development of the Action Plan for the Protection of Sea Turtles in Cambodia (2016–2026) by the Fisheries Administration with the support of FFI. A national database for sea turtle sightings and information on nesting and bycatch has also been developed and is being used to inform national policies.

At the remote islands of Koh Tang, Poulo Wai, and Koh Pring, southwest of Preah Sihanouk Province, nesting is monitored by FFI and the Royal Cambodian Navy, and every four years bycatch assessments are conducted at key landing sites to measure the size and nature of the turtle trade. Those surveys found that fishers were not aware of national regulations, so a broad outreach and information campaign was launched.

Historical records suggest that nesting once spanned Cambodia's coasts and islands, yet records in recent decades are few. The rediscovery of turtle nesting on Cambodian beaches in 2021 after a decade-long search resulted from a lucky find by FFI staff members who spotted hatchlings on the remote island of Poulo Wai. That sighting led to surveys that found additional signs of turtle nesting in 2022 and 2023, when volunteers on Koh Pring witnessed five possible and four confirmed clutches. Subsequent excavations showed a high hatch rate.

The coastal provinces of Kampot and Kep harbor coral reefs and the largest seagrass meadows in the Gulf of Thailand. Those systems provide foraging and resting habitat for green and hawksbill turtles, especially juveniles. In that region, rates of bycatch, intentional capture, and meat consumption are among the highest in Cambodia. The Kampot–Kep region also faces acute pressures from coastal development and illegal fishing practices, including bottom trawling.

On Cambodia's southwest coast, the Fisheries Administration collaborates with Wild Earth Allies, Marine Conservation

Cambodia, and others to use a spatial management approach that assigns territorial rights to communities, and establishes and manages marine protected areas. A network of 10 communities now protects sea turtles and their habitats, monitors fisheries, and implements bycatch responses. This work has improved reporting and increased the safe release of incidentally captured sea turtles.

INDONESIA



A vast country of some 18,000 islands, Indonesia has a coastline of 99,083 kilometers (61,567 miles), among the largest on Earth; Indonesia faces both the Pacific and Indian Oceans, as well as numerous local and regional seas. Its waters are home to six species of sea turtles, and its beaches host nesting grounds for four of them (leatherback, hawksbill, green turtle, and olive ridley). Turtle nesting is widespread, though many islands are uninhabited and unmonitored, so it is difficult to obtain a full picture of sea turtle abundance in the country. Many rookeries were assessed in the 1970s and 1980s but have not been monitored since, or updates are not available. Plus, new rookeries are still being found thanks to the rapid growth of local nonprofits, community groups, dive shops, and other institutions that generate citizen science.

All sea turtle species are legally protected in Indonesia, though illegal consumption of eggs, meat, and turtle shell still occurs in many areas. Bali was once famous for its massive turtle market, but harvest is now banned there and the open market shut down in the early 2000s (see sidebar). Historically, Indonesia was also the largest commercial exporter of tortoiseshell, with an estimated 2.5 million hawksbills exported between the mid-1800s and 1990s. Though illegal since 1978, trade in sea turtles remains prevalent in the country and even online (see pp. 18–19). Traditional hunting of leatherbacks for food still occurs in the Kei Islands as well (discussed later). Fishery bycatch and bomb fishing also cause widespread impacts on Indonesia's turtles, and researchers even report the use of sea turtle viscera as bait in shark fisheries.

The Bird's Head Peninsula of the Indonesian province of West Papua is where approximately 75 percent of all western Pacific leatherback nesting occurs, at two main beaches: Jeen Yessa (formerly Jamursba Medi; 18 kilometers, or 11 miles) and Jeen Syuab (formerly Wermon; 6 kilometers, about 4 miles). These beaches also host nesting olive ridleys, greens, and hawksbills. The Indonesian Ministry of Marine Affairs and Fisheries created the Jeen Womom Coastal Park to protect these two nesting sites. The area once hosted 3,000–13,000 leatherback, 5,000–6,500 hawksbill, and 4,000–5,000 green turtle nests annually, but large-scale egg collection from the 1970s to 1990s, as well as fisheries bycatch, caused the populations to decline. Leatherback nesting has dropped by nearly 6 percent per year since the 1980s, and the statuses of other turtle species are still being

Bedawang Nala and the Bali Turtle Market

By Ketut Sarjana Putra

The Indonesian island of Bali has been a thriving tourist destination for half a century or more, attracting international visitors to enjoy its beautiful beaches and forests and to appreciate its rich cultural diversity. Over time Bali has increasingly become a hopping-off point for scuba divers, surfers, and ecotourists who are interested in experiencing Indonesia's vast wealth of species and ecosystems. The fact that the island was also the epicenter of green turtle harvest—and the site of what was arguably the world's largest unconcealed green turtle market from the 1960s to the early 2000s—was a sad and stark juxtaposition. The Bali green turtle market had long been justified as both a key part of Bali's cultural and religious traditions and an important economic driver among the region's fishers.

Records show that at least 35,000 green turtles were landed and sold there annually, originating from many of Southeast Asia's largest green turtle rookeries and key feeding areas in the Arafura Sea; the Raja Ampat Archipelago of West Papua; and the islands of Borneo, Java, Nusa Tenggara, and Sulawesi. In addition to green turtles, mostly consumed for their meat and oil, a large number of hawksbills also entered the Bali market and from there became part of the larger international tortoiseshell trade. The massive harvest of green turtles destined for the Bali market drove measurable downturns in nesting turtle populations throughout Indonesia.

Bold efforts spearheaded by the Indonesian and Bali governments over a period of seven years (1995–2001) introduced new policies and regulations that effectively closed the Bali turtle market in the early 2000s. Those changes were accompanied by intensive and strategic education and awareness efforts led by conservation nongovernmental organizations and supported by public media, which emphasized the high volume of trade and the significant decline of green turtle nesting populations.

One of the keys to the success of the legal shutdown of the market, and of the black-market trade in turtles, came from the effective inclusion of Balinese Hindu communities and religious leaders, who came to embrace sea turtle conservation as important to the health of the environment and, ultimately, to the sociocultural and economic well-being of the Bali community. Once aware, the Hindu community fully stopped the trade in turtles and to this day continues to conduct community-based turtle conservation on nesting beaches that aims to reverse decades of turtle losses and “pay back the karma.” One of the legendary turtle traders from the turtle market's heyday confessed, “I should have learned more and believed in the *bedawang nala*.” The *bedawang nala* is the sea turtle statue that sits at the base of every Hindu temple to support its tie to Earth. It is a holy creature that must be fully preserved and respected, not just as a mythical deity, but as a living creature.



Researchers from the Anambas Foundation monitor a nesting green turtle in Indonesia's Anambas Islands. With more than 18,000 islands, Indonesia is home to innumerable sea turtle nesting sites, many of which are unmonitored. © Anambas Foundation

quantified. Egg collection is no longer a threat, but poor hatching success is thought to still impede the recovery of the population. Collaborative research between the State University of Papua and the U.S. National Oceanic and Atmospheric Administration's Southwest Fisheries Science Center identified the threats as nest predation by pigs, dogs, and monitor lizards; extreme sand temperatures; erosion; tidal inundation; and invasion of beach creeper (*Ipomoea spp.*).

Management measures have been implemented and continually refined since 2006 to maximize hatchling production at Jeen Womom. Since 2017, the State University of Papua's Abun Leatherback Project (ALP) has protected nests by targeting a combination of threats for each beach section by season. ALP then evaluates success to increase conservation activities' effectiveness in subsequent years. The Abun people own the two main nesting beaches, and ALP has worked with them to prohibit illegal take, ensure stable access to beach work, and maximize nest protection and hatchling production. ALP's workers live in the villages and support efforts to develop local livelihoods and build trust with the community.

Nearby, in the Raja Ampat Archipelago of West Papua, conservation efforts aimed at reducing take of green turtles have delivered mixed results. In an exchange facilitated by Conservation International Indonesia, Papuan leaders from the Ayau and Asia Islands met with Balinese turtle conservation groups and learned how the Balinese had stopped hunting turtles. The leaders developed a strategy that initially stopped hunting in the Ayau Islands, where 1,000 or more green turtles were harvested annually, and built an organic piggery to substitute farm-raised pork for turtle protein. One Papuan

leader commented, "To continue killing sea turtles is like stealing our children's future." Sadly, when resources to support the effort disappeared and problems arose with the piggery, locals quickly reverted to turtle hunting. The Piai Island rookery, with 1,500–3,200 green turtle nests annually, was one of the target areas of the Ayau turtle hunters. It has been protected, but Ayau islanders are still known as the most adept turtle hunters in West Papua.

To the south, in the Kei Islands of Maluku Province, villagers continue the legal, traditional hunt of leatherback turtles. Since 2016, WWF-Indonesia has worked with hunters from several villages there, and with support from church leaders and fisheries agencies, it has carefully monitored take, which in 2017 reached 104 animals. In response, a multifaceted strategy was undertaken to set limits for the hunt, a program that has reduced the harvest significantly in its initial years.

Also in Maluku Province, WWF-Indonesia has led efforts to monitor and protect recently discovered leatherback nesting beaches on Buru Island since 2017. Of the average of 160 nests laid per year, more than 60 percent were being taken by people or other predators, and up to five nesting females per year were taken as food. New laws have now been enacted in Buru to prevent egg and turtle harvest, and a community-based conservation group (Pokmaswas), is working to create a marine protected area.

Further to the south, in the Alor Archipelago of East Nusa Tenggara Province, turtles are still relentlessly exploited and eggs are openly sold in markets. On the beach of the SAVU South Alor resort on Alor Island, hawksbill and green turtle nests are protected from September to December. The resort is

spearheading awareness campaigns, as well as advocating for enhanced enforcement with local authorities.

In East Kalimantan, off the eastern coast of Borneo, the Berau or Derawan Archipelago hosts one of the largest green turtle nesting populations in all of Southeast Asia. Yayasan Penyu Indonesia and the Turtle Foundation estimate that an average of 15,000 clutches are laid annually in the archipelago, with most nesting occurring on the coral islands of Belambangan, Bilang-Bilangan, Mataha, Sambit, and Sangalaki. Historical data suggests that, due to massive and organized exploitation of eggs, this is only a remnant of a nesting population that was up to 10 times larger more than 70 years ago. In 2002, one of the islands, Sangalaki, was given year-round protection against egg collection, and in the following years, protection efforts were extended to the other islands. Today, several government agencies and nongovernmental organizations help to protect the nesting beaches, and the Derawan Archipelago has been declared a marine protected area.

The western Indonesian islands of Sumatra and Java and their offshore islands are home to numerous nesting sites and many local and international sea turtle research and conservation projects. The region primarily receives nesting green and hawksbill turtles, with at least one significant olive ridley nesting site, plus a small number of leatherbacks on the Indian Ocean coast. The Segama and Momperang Islands, north of Jakarta in the Java Sea, are another important stronghold for hawksbill turtles in Indonesia. Monitoring efforts in the Segama Islands led by Everlasting Nature of Asia (ELNA) and Yayasan Penyu Laut Indonesia (YPLI) have shown growth in nesting, from 100–150 clutches per year in 1996–1998 to more than 1,000 per year in 2016–2018. To the north, the islands of Pesemut and Momperang also host an estimated 915 hawksbill clutches per year (2016–2018) according to ELNA and YPLI.

On the Indian Ocean coast of Java, Alas Purwo National Park (East Java) hosts a robust population of olive ridleys, with 1,100 clutches reported in 2018, as well as consistent low-level leatherback nesting (5 clutches in 2016). The expansive beach is monitored and protected by park authorities. There, and in the offshore islands of Sumatra, green turtles and small numbers of leatherbacks also nest. Significant green turtle populations are found at Pangumbahan Beach in West Java and on Bangkaru Island in the Banyak Islands of Sumatra (Aceh), where approximately 2,000 clutches were recorded annually in 2022 and 2023. In 2017, leatherback nesting was also discovered off the west coast of Sumatra by Yayasan Penyu Indonesia and the Turtle Foundation, first on Sipora (Mentawai), and later on Selaut Besar and at Along Beach on Simeulue (Aceh), and high levels of poaching were observed. Protective efforts by local rangers and hatcheries are helping to reduce those pressures. Leatherback clutches on Selaut Besar Island (19) and Sipora Island (29) were reported in 2021–2022, along with green turtle and olive ridley nests.

MALAYSIA



Malaysia's 4,675 kilometers (2,905 miles) of coastline are spread across both sides of the peninsula, which shares a land border with Thailand and maritime borders with Indonesia, Singapore, Thailand, and Vietnam, and continue in the east across the South China Sea on the island of Borneo. There, the Malaysian states of Sabah and Sarawak share a land border with Indonesia to their south (Kalimantan) and with the

Sea Turtle Biogeography of Southeast Asia

The maps on pp. 30–31 display available nesting and satellite telemetry data for sea turtles in Southeast Asia. Because the Andaman and Nicobar Islands are biogeographically part of the Southeast Asian region (see sidebar, p. 37), they were also included in these maps. The data include 642 nesting sites and 234 satellite tags representing greens, hawksbills, leatherbacks, and olive ridleys (note that historical records of loggerhead nesting in the region exist, but recent nesting could not be confirmed, so they were excluded from the maps). Data were compiled through a literature review or were provided directly to SWOT by hundreds of data contributors. For metadata and information about data sources, see the data citations on pp. 54–57 or visit <https://www.seaturtlestatus.org/maps/southeast-asia-sea-turtles>.

NESTING BIOGEOGRAPHY

On the map of sea turtle nesting in Southeast Asia on p. 30, nesting sites are represented by dots colored by species and scaled according to their relative nesting abundance in the most recent year for which data are available. At sites where multiple species nest, data from all species were combined to form an abundance-scaled pie chart that indicates the proportion of each species nesting at that site. For uniformity, all types of nesting counts (e.g., number of nesting females, number of crawls) were converted to number of clutches as needed. Conversion factors ranged from 2.2 to 5.0 clutches per female and 0.55 to 0.81 crawls per clutch.

SATELLITE TELEMETRY

The satellite telemetry map on p. 31 presents data from green, leatherback, hawksbill, and olive ridley turtles and represents more than 47,000 animal locations. Only tracks from tags deployed in Southeast Asia and the Andaman and Nicobar Islands were included, thereby excluding some turtles that were tracked from outside of Southeast Asia into the region's waters. For more information on the mapping methodology, see the map's legend.

We are grateful to all of the data contributors and projects that participated in this effort. For details, please see the complete data citations on pp. 54–57.

tiny Sultanate of Brunei, nested within Sarawak on the island's northern coast. Malaysian Borneo also shares maritime borders with Indonesia and the Philippines.

Four sea turtle species (green, hawksbill, olive ridley, and leatherback) have active nesting beaches in 10 Malaysian states, though ongoing threats have led to diminished numbers of most species. The once-robust Malaysian leatherback population is considered extinct (see sidebar, p. 33), hawksbills have declined to fewer than 200 clutches per year in Sabah (though nesting has increased significantly in Malacca to about 1,000 clutches in 2022), and olive ridley nesting is now exceptionally rare (fewer than 5 clutches per year). Only the green turtle population is considered stable, or potentially increasing, with 15,000–20,000 clutches per year in Sabah and 5,000–10,000 clutches per year in Terengganu.

Adjacent seas are foraging and migration grounds for green turtles and hawksbills, which are the most common species, and for rare olive ridleys and leatherbacks. The largest foraging grounds for green turtles and hawksbills are in the southeast of Sabah (Celebes Sea), and other foraging grounds are found in the Sulu and South China Seas and in the Strait of Malacca. A single living loggerhead was seen in Malaysia in 2021, though loggerheads are known to occur in the South China Sea, may once have nested in Sarawak, and are occasionally found stranded on the west coast of Peninsular Malaysia.

Green turtle eggs from Sarawak's Turtle Islands (Talang-Satang Islands) were traded with the Chinese going back to the 1600s, and there was a commercial hatchery on Pulau Talang-Talang Besar beginning in 1951. In 1999, those islands were transformed into Talang-Satang National Park, Sarawak's first marine protected area, providing full protection for turtles on land and sea. Sarawak today hosts 3,000–5,000 clutches annually. Meanwhile, in Sabah, the British North Borneo Company issued decrees to protect the egg trade in 1927. There too, in 1977, a former turtle farm became part of Turtle Islands Park, which includes Seligaan, Gulisaan, and Bakkungaan Kecil Islands. The Turtle Islands Heritage Protected Area was later established to include both the Turtle Islands of Sabah and the Philippines (see "Philippines" section), making it the world's first transboundary marine protected area for sea turtles.

In addition to government authorities, numerous nongovernmental organizations contribute to sea turtle research and conservation in Malaysia, including WWF-Malaysia, the Marine Research Foundation, the Perhentian Turtle Project, Lang Tengah Turtle Watch, Juara Turtle Project, Bubbles Turtle Conservation, Kapas Turtles, Tengah Island Conservation, Kampung Penyu Pulau Pangkor, Kudat Turtle Conservation Society, TRACC (Tropical Research and Conservation Centre), Scuba Junkie Sipadan, and the Gaya Island Resort Marine Center. Educational institutions—including the Sea Turtle Research Unit (SEATRU) of the Universiti Malaysia Terengganu, the Universiti Sains Malaysia, and the Universiti Malaysia Sarawak—are also engaged in sea turtle research and conservation. One of those institutions, the Sea Turtle Research Group of the Borneo Marine Research Institute (Universiti Malaysia Sabah), contributes to the understanding and conservation of sea turtles through research on genetics, foraging grounds, and migratory routes as well as improvements to hatchery management, tagging, and the establishment of regional networks.

Sea turtles are protected under various federal and state laws in Malaysia. But not all states provide legal protection for

sea turtles. Although trade and consumption of turtle eggs is illegal in most states, including Sabah, Sarawak, and Terengganu, it is still allowed in some states in Peninsular Malaysia. Turtle eggs are often seen in markets in some parts of Malaysia, and illegal egg harvest remains an ongoing threat. There is strong evidence of continued exploitation of green turtles at some sites, and hawksbills are still illegally harvested for their shells around Semporna (Sabah) and elsewhere.

Fishers using gillnets, trawls, and longlines also kill many turtles incidentally in Malaysian waters. Additional challenges to Malaysia's turtles include plastic ingestion and entanglement, habitat destruction (including nesting habitat), and boat strikes.

Efforts to reverse the decline of sea turtles in Malaysia have begun to succeed in some cases, and populations of green turtles in Sabah and Terengganu are considered stable or increasing, as are populations of hawksbills in Malacca.

MYANMAR



Myanmar is the westernmost nation in Southeast Asia, and its 2,227 kilometers (1,384 miles) of coastline along the Andaman Sea are contiguous with Bangladesh to the north and Thailand to the south. Five of Southeast Asia's sea turtle species ply the waters of Myanmar while feeding and migrating, and all of them except the loggerhead nest there. The most common are green, olive ridley, and hawksbill turtles, with only rare occurrences of leatherbacks and loggerheads. Studies done on Thameehla Island (Ayeyarwady Region) by FFI and local partners show a near doubling in nesting as well as an increase in hatching rates at sites on the island since 2017. Nesting has also been documented on Wa Ale Island (Tanintharyi Region) and on the Mawtin Coast (Ayeyarwady Region). The main threats to sea turtles nationally are trawl and artisanal fisheries, with secondary impacts coming from egg harvest, especially in Rakhine State, though the harvesting is not on a commercial scale. Turtles are protected by national law, and enforcement falls to the Myanmar Department of Fisheries. Nongovernment institutions also aid in conservation efforts, including the FFI Myanmar sea turtle project, which works to build local and national capacity and fill gaps in knowledge for priority turtle populations in Rakhine State, the Ayeyarwady Delta, and the Tanintharyi Region. The project addresses threats to turtles on beaches and at sea, implements public education programs, supports the Department of Fisheries' efforts to spread the use of TEDs (turtle excluder devices), and more. Rescue operations have also proven effective, with some 43 green turtles, hawksbills, and leatherbacks recovered from fishery bycatch and later released alive in just the past three years in Ayeyarwady Region alone.

PHILIPPINES



A country of more than 7,600 islands lying on the eastern extreme of Southeast Asia, the Philippines has one of the longest coastlines of any country, extending some 36,289 kilometers (22,549 miles). Two long tendrils of land reach across the sea toward the west: the island of Palawan and the chain of Turtle Islands that

stretch across the border between the Sulu and Sulawesi (Celebes) Seas. The story of sea turtle conservation in the Turtle Islands is one of the most striking examples of success and binational partnership in Southeast Asia.

An in-depth analysis of 37 years (1984–2021) of nesting data from the Turtle Islands reveals a 388 percent increase in nesting across the five islands of Taganak, Baguan, Lihiman, Great Bakkungaan, and Langaan. Baguan Island alone—only 34 hectares (84 acres) of land, with some 1,200 meters (0.75 miles) of beach—showed an extraordinary increase of 1,002 percent in nesting, escalating that tiny island's contribution to the aggregate from 36 percent in 1984 to 80 percent in 2021! That remarkable success stems from stringent monitoring, protection, hatchery management, and research by the Pawikan Conservation Project in the 1980s, with support from WWF-Philippines (1993–2003) and Conservation International Philippines (2003–2012) under the leadership of Romeo Trono (1982–1993).

When the effort began, turtle nesting in the islands had shown a distressing 88 percent decline since the 1950s. The designation of Baguan Island as a marine turtle sanctuary gave the Pawikan Conservation Project team a legal mandate to enforce regulations. Every night the team patrolled the beach taking measurements, saturation tagging, transferring eggs to hatcheries, and releasing thousands of hatchlings. What began as the Baguan Island sanctuary ultimately became the Turtle Islands Wildlife Sanctuary (TIWS), comprising six islands and an impressive expanse of 242,958 hectares (600,362 acres). Through a diplomatic accord between the governments of Malaysia and the Philippines, the Turtle Islands Heritage Protected Area emerged as the world's first transboundary protected area for green turtles, earning the prestigious J. Paul Getty Wildlife Conservation Prize in 1996.

The successes of TIWS formed the foundations of several sea turtle conservation efforts across the country in partnership with the Philippines' Department of Environment and Natural Resources. Of note are the El Nido Marine Turtle Conservation Network (ENMTCN), in Palawan; Large Marine Vertebrates Research Institute Philippines (LAMAVE), working across the Philippines; and Coastal Underwater Resource Management Actions (CURMA), in La Union, where poachers have been turned into patrollers, leading to the protection and release of more than 200,000 hatchlings. Areas such as La Union and Palawan—as well as others where civil

The Once-Thriving Leatherback Population at Terengganu, Malaysia

By Jeanne A. Mortimer

Each year in the late 1960s, between June and September, an estimated 2,000 female leatherbacks laid approximately 10,000 egg clutches along a 15-kilometer (9-mile) stretch of coastline at Rantau Abang, Terengganu, on the east coast of Peninsular Malaysia. At that time, it was the nesting area of one of the largest and most famous leatherback populations in the world. The eggs had been collected by the coastal inhabitants since at least 1920, and in 1960 an estimated 1.66 million leatherback eggs were consumed annually. The eggs appeared to be an inexhaustible resource. Unfortunately, from the 1960s onward, the leatherback population declined precipitously. By the late 1980s, only 40 females were nesting annually; that dropped to a mere 5 animals by the early 2000s, and by 2010, the population was considered functionally extinct.

What went wrong? In short, almost everything. By the late 1950s nearly 100 percent of all leatherback eggs laid were consumed by people. So a hatchery management program was implemented during the 1960s. Sadly, resource managers at the time believed that protecting 1 percent of all the eggs laid and consuming the other 99 percent would be sufficient to maintain the population. Apparently, it was not. To make matters worse, high incubation temperatures in the hatcheries produced primarily females. By the late 1980s, a high proportion of the hatchery eggs were infertile, possibly because too few males had been produced and adult females were unable to find mates.

But those were not the only problems faced by the leatherbacks of Terengganu. Reportedly, the greatest population decline coincided with the rapid expansion of fisheries in Malaysia. Studies showed that trawl nets, drift nets and gillnets, and bottom longlines were capturing at least several hundred turtles each year within Malaysian territorial waters during the 1970s and 1980s. In the late 1980s, at least 8 percent of the estimated 40 females nesting annually were found washed ashore dead at Rantau Abang, tangled in fishing gear. Meanwhile, outside of Malaysian waters where the pelagic leatherbacks spent most of their lives, they were often caught incidentally by fishers in the high seas.

In 1988, the Terengganu state government enacted several remarkable measures based on recommendations spearheaded by Dr. Chan Eng Heng (see "Living Legends," p. 52). The measures stopped the commercial sale and consumption of leatherback eggs, mandating that 100 percent of eggs be incubated in hatcheries; and the government established the Rantau Abang beach sanctuary to prevent disturbance to turtles and further development of the critical nesting beaches. In 1989, the government banned large-meshed gillnets throughout Malaysian coastal waters. And in 1990 and 1991, it established the Rantau Abang Offshore Turtle Sanctuary—extending to 18.5 kilometers (11.5 miles) offshore along some 30 kilometers (18 miles) of coastline—and it banned destructive fisheries practices within the sanctuary's boundaries. Unfortunately, those actions, which probably would have met with success had they been implemented two decades earlier, came too late to save the leatherback turtles of Malaysia. Nevertheless, the lessons learned are being applied toward saving the hard-shelled turtles of Malaysia, especially the green turtles and the hawksbills.

society organization-led conservation is in place, such as Zambales, Bataan, and Cavite—see a predominance of olive ridley turtle nesting.

Despite all those successes, several challenges remain. Governance authorities often grapple with flagging technical and financial resources, and the ever-rising tides brought by climate change diminish nesting areas. Egg poachers may exploit that vulnerability, so the situation requires immediate attention to avoid backsliding on nearly four decades of success for TIWS and more recent efforts.

SINGAPORE



Singapore lies off the southern tip of Peninsular Malaysia and shares a southern maritime border with Indonesia. Land reclamation efforts that have been underway since 1819 have increased its coastline significantly from 480 kilometers (300 miles) in 1993 to 505 kilometers (315 miles) in 2011, with plans to expand to more than 600 kilometers (370 miles) by

2030, including through the Long Island reclamation plan, covering the entire coastal front of East Coast Park. As a result, many natural coastlines and turtle nesting beaches have been and will be disrupted to protect human infrastructure against sea-level rise. Nonetheless, hawksbills (nesting) and green turtles (foraging) persist, though both species are listed as critically endangered on the national Red List of Threatened Species. A turtle hatchery was established in the Sisters' Islands Marine Park in 2018 to incubate hawksbill clutches found on both public and private beaches, including Sentosa Island. Hawksbill nesting has seen an increase in recent decades because of improved reporting from citizen scientists, and genetic work has revealed that Singapore nesters exhibit five distinct haplotypes: three that are new to science, and two that also occur in Malaysia. Population genomic analysis has also revealed inbreeding within the hawksbill population and even identified related parents within a multiple-paternity clutch. Green turtles do not nest in Singaporean waters but are found foraging around the islands south of Singapore, where seagrass habitats are still intact. Stranded green turtles are often found with wounds indicating boat strikes as the cause of death. A single leatherback was captured in Singaporean waters and is currently kept on display at the Lee

Kong Chian Natural History Museum. It is possible that loggerheads are also present in Singaporean waters, since they have been reported nearby in Malaysia (Penang and Malacca). Although a single dead olive ridley carcass was also found in 2018, olive ridleys are not known to forage or nest in Singapore.

THAILAND



Thailand shares land borders with Cambodia, Malaysia, and Myanmar and has 3,148 kilometers (1,956 miles) of coast on both the Gulf of Thailand to the east and the Andaman Sea to the west. It also has approximately 250 small islands. A large number of coastal zones host beach habitats that are appropriate for sea turtle nesting, though many are crowded with human development (e.g., hotels, restaurants, urban areas) that can hinder or prevent nesting. Historically, Thailand hosted five species of sea turtles, with hawksbills, green turtles, and (infrequently) leatherbacks found in the Gulf of Thailand and leatherbacks, green turtles, olive ridleys, and loggerheads in Andaman Sea waters. Generally, in-water sightings of leatherbacks, olive ridleys, and loggerheads have been very low, and most data on Thailand's turtles are collected from stranding events, with hundreds of animals of all four species washed ashore dead, alive, or injured every year since the early 1990s.

Sea turtles nest in relatively small numbers on Thai beaches today. On the Andaman coast, mainly leatherbacks (October–February), green turtles (March–July), and ever-declining numbers of olive ridleys (October–February) are found. Hawksbills and green turtles also nest sporadically in the Gulf of Thailand (May–September) in several provinces, including in Koh Khrum, according to data from the Royal Thai Navy, as well as in Koh Samet, Koh Kudi, Koh Talu, Koh Kula, Koh Kra, Koh Tau, Thap Sakae, and Chumphon. Koh Khrum, which has been protected by the Royal Thai Navy since 1950, has shown promising increases in hawksbill nesting in recent years.

Although sea turtles have been protected under national law since 1947, populations have declined significantly. Intensive egg harvesting from the mid-1940s to the late 1970s was the likely culprit, though today that threat has dramatically declined. Instead, the main threats are now from fisheries bycatch, beachfront development, habitat degradation, and some black-market trade in turtle products.

Head-starting (captive rearing of hatchling turtles before release) has been the country's main sea turtle conservation strategy since the 1970s, though little information is available on releases, survival rates, and returns of head-started animals, and there is uncertainty about the effectiveness of those efforts. Genetic, distribution, and nesting studies are now adding new information to the state of knowledge of sea turtles in Thailand.

TIMOR-LESTE



Although the government has imposed laws to protect the country's five sea turtle species since 2015, commercial and artisanal hunting remains a severe threat in the tiny island nation of Timor-Leste, and turtle meat, eggs, and tortoiseshell are regularly seen in local markets. Predation of

eggs and hatchlings by feral dogs, rats, and pigs is also a threat on nesting beaches.

The main international organizations that focus on sea turtle conservation with the Timor-Leste government are Conservation International Timor-Leste, Arafura and Timor Seas Ecosystem Action, and the Coral Triangle Center. Lenuk Tasi is a sea turtle rescue center led by students from the National University of East Timor and located near the capital of Dili. The group conducts research and educates the public and decision-makers about sea turtles. To date, Lenuk Tasi has rescued 24 olive ridley, green turtle, loggerhead, and hawksbill nests. It also partners with Sustainable Ocean Alliance Timor-Leste, Ocean Heroes Bootcamp, and government authorities to address the threat of sea turtle consumption and to host hatchling releases and other activities to advance public engagement in sea turtle conservation.

At a recent historic meeting in Bali—the Archipelagic and Island States Forum—Prime Minister Xanana Gusmão announced Timor-Leste's intent to establish a transboundary park between Timor-Leste and Indonesia that will encompass a network of marine protected areas and extend around the border of those two nations. Positioned just east of Komodo Island, Timor-Leste is a remarkable area for marine biodiversity, and the park is just one step in the country's broader efforts to transition to a blue economy as a pathway for development.

VIETNAM



Green turtles, hawksbills, olive ridleys, and leatherbacks have all nested along Vietnam's lengthy 3,260-kilometer (2,030-mile) coastline in the past, and all have severely declined in recent decades. Green turtles represent 99 percent of the total nesting population in Vietnam today, with occasional nesting leatherbacks also reported.

Nesting hawksbills and olive ridleys have been absent for more than a decade. Consequently, all sea turtle species appear on the Vietnamese Red List of Threatened Species and are prioritized for legal protection.

A nesting population of leatherbacks that was estimated to include 500 females laying 10–20 nests per night prior to the 1960s declined to a small remnant population with 10–20 nests per year by 2002. Leatherbacks still nest occasionally, last seen at Cat Dai beach in Cam Lam District (Khanh Hoa Province) in 2013, and at Trieu Lang (Quang Tri) in 2010.

Currently, only around 700 green turtles nest regularly throughout Vietnam, and Con Dao National Park (Ba Ria–Vung Tau Province) is home to the largest rookery by far, with an average of 624 nesting turtles per season on 14 beaches. The nesting population at Con Dao is considered stable and has experienced a noticeable increase in nesting activity in recent years. Other nesting areas include Nui Chua National Park (Ninh Thuan Province), with an average of six nesting females per season on three main beaches (Thit, Dai, and Mong Tay) and Hon Cau Island (Binh Thuan Province), with three to five nesting females per season.

About 20 green turtles per year nest across other regions of Vietnam, including on a 70-kilometer-long beach (43 miles) in Quang Tri Province, at Hai Giang and Hon Kho Island in Binh Dinh Province, and in Cam Lam District and on the islands in Nha



A leatherback turtle returns to the Indian Ocean after nesting on Selaut Besar in Aceh, Indonesia. Southeast Asia is home to two subpopulations (regional management units) of leatherbacks (Northeast Indian Ocean and West Pacific). © Hiltrud Cordes

Trang Bay in Khanh Hoa Province. Several other former nesting sites—such as the islands in Bai Tu Long Bay (Quang Ninh Province), the Cat Ba Archipelago (Hai Phong City), the Son Tra Peninsula (Da Nang) and the Phu Quoc Archipelago (Kien Giang Province)—have lacked sea turtle nesting for a considerable period. The nesting season in Vietnam spans from March to November, with some 83 percent of nesting taking place from June to September.

Interviews with fishers suggest that the aforementioned four species, along with a fifth, the loggerhead, still occur in Vietnamese waters. Green turtles inhabit shallow waters with

seagrass beds around offshore islands such as Phu Quy Island (Binh Thuan Province), Phu Quoc (Kien Giang Province), Con Dao (Ba Ria–Vung Tau Province), the Hoang Sa Archipelago (Da Nang), the Truong Sa Archipelago (Khanh Hoa Province), and Bach Long Vi (Hai Phong City). Green turtles also feed in coastal areas, specifically coastal lagoons such as Tam Giang–Cau Hai or Thuy Trieu (Thua Thien Hue Province). Loggerheads have been found in the central provinces (Nghe An and Binh Thuan), and leatherbacks are rarely sighted in shallow waters, predominantly residing in deep offshore waters, where they are seen only a few times per year.



An olive ridley dines on a sea tomato jellyfish (*Crambione mastigophora*) in the Kei Islands of Indonesia. © Tui de Roy/Princeton University Press

The postnesting migrations of Vietnamese green turtles from Con Dao take them to foraging sites in Malaysia (Pahang State), the Philippines (Palawan), and Indonesia (Natuna Islands), and to Phu Quy Island and the Truong Sa Archipelago. Additionally, green turtles that nest in Lamma Island (Hong Kong) and Koh Kham Island (Thailand) return to their feeding grounds in Bach Long Vi Island (Hai Phong City), Son Tra (Da Nang), and the Con Dao Archipelago (Ba Ria–Vung Tau Province).

Threats to sea turtles in Vietnam include bycatch, habitat degradation, tourism development, harvest of eggs and adults, and climate change. Sea turtle research and conservation efforts in Vietnam have been led by IUCN Vietnam and WWF-Vietnam for more than two decades. Recently, the concerted efforts of additional organizations, such as FFI, Humane Society International, Education for Nature of Vietnam, the Center for Biodiversity Conservation and Endangered Species, TRAFFIC, and Wildlife At Risk have contributed significantly to those initiatives. The comprehensive approach to conservation involves a variety of strategies, including volunteer programs, outreach and education, establishment and maintenance of a population database, development of species distribution models for foraging populations, mitigation strategies to minimize the impact of climate change, GPS tracking of nesting turtles for more accurate monitoring, plastic litter monitoring, and improvements to sea turtle nesting and foraging habitats.

Hopeful Signs

In Southeast Asia, like so many places in the world, sea turtles have survived with varying degrees of success. Some populations have sadly become extinct, and many have declined significantly, yet others are steadily growing and even thriving in areas where conservation has taken hold. Sea turtle protection efforts at all scales are growing, and the overall attention paid to conserving marine biodiversity is on the rise both here and worldwide, evidenced by a proliferation of locally based programs, increasing engagement by governments, and the emergence of a robust and concerned new generation of conservationists.

The most significant historical threat to turtles in this region—rampant take and trade—has diminished dramatically in recent decades, and nine Southeast Asian countries are now parties to CITES. Moreover, ongoing multinational efforts like the Indian Ocean–South-East Asian Marine Turtle Memorandum of Understanding and the Coral Triangle Initiative point to the region’s strong commitment to effective conservation programs that transcend national boundaries.

Significant obstacles remain for sea turtles in Southeast Asia—namely, climate change, coastal development, habitat loss, pollution, overexploitation, illegal trade, and fisheries impacts. But it is clear that there is reason for hope, thanks to an active conservation movement that is working to overcome those obstacles and ensure a brighter future for sea turtles and their ocean homes in Southeast Asia. ●

Sea Turtles of the Andaman and Nicobar Islands

By Adhith Swaminathan and Kartik Shanker

India’s Andaman and Nicobar Islands (ANI), located east of mainland India in the Andaman Sea, are biogeographically (though not politically) part of the Southeast Asian region, connected to both the Indo-Burma and Sundaland hotspots. The islands are home to four of the five species of sea turtles found in Indian waters and are the only location in India where green, hawksbill, leatherback, and olive ridley turtles all nest. The archipelago, in addition to having significant nesting beaches, also hosts foraging grounds in the surrounding coral reefs and seagrass meadows, which are critical habitats for hawksbill and green turtles.

Satish Bhaskar (see “In Memoriam,” p. 58), a pioneer of sea turtle biology and conservation in India, first visited ANI in 1978 and over a span of nearly two decades carried out extensive surveys in the islands, which have since been followed by numerous research and conservation initiatives throughout the islands. The ANI Department of Environment and Forest actively monitors important olive ridley nesting beaches in the North and Middle Andaman Islands, where hatchery programs have been running for several decades. In 2014, a small mass nesting site was discovered at Cuthbert Bay on Middle Andaman Island, leading to the establishment of a permanent monitoring camp there.

ANI also hosts India’s best nesting beaches for leatherback, hawksbill, and green turtles. Leatherback nesting has been monitored for the past four decades through periodic surveys of remote nesting sites and, more recently, through long-term annual monitoring. Of the more than 500 islands in the archipelago, leatherbacks nest in consistently high numbers on just three islands: Little Andaman, Little Nicobar, and Great Nicobar Islands. With annual numbers of about 1,000 nests in the Nicobar group and 100–200 nests on Little Andaman Island, these are the most significant nesting grounds for leatherback turtles in the northeastern Indian Ocean.

Following the 2004 Indian Ocean tsunami and earthquake, nesting on Little Andaman Island has remained stable. Beaches in the Nicobar Islands now witness nesting comparable to the pre-tsunami period, including on some beaches that were completely destroyed and have since formed again. Leatherbacks that originate in ANI migrate to foraging grounds in the Indian Ocean, as far east as Western Australia and as far west as Mozambique and Madagascar (see map p. 31). Demonstrating their resilience to natural calamities like the tsunami of 2004, those leatherbacks have continued to return to their ANI nesting and foraging grounds year after year.