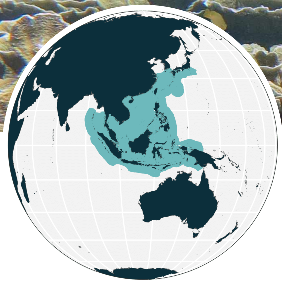
Coral reef in Pulau Pemanggil, Malaysia
Credit: Affendi Yang Amri



EAST ASIAN SEAS

Authors

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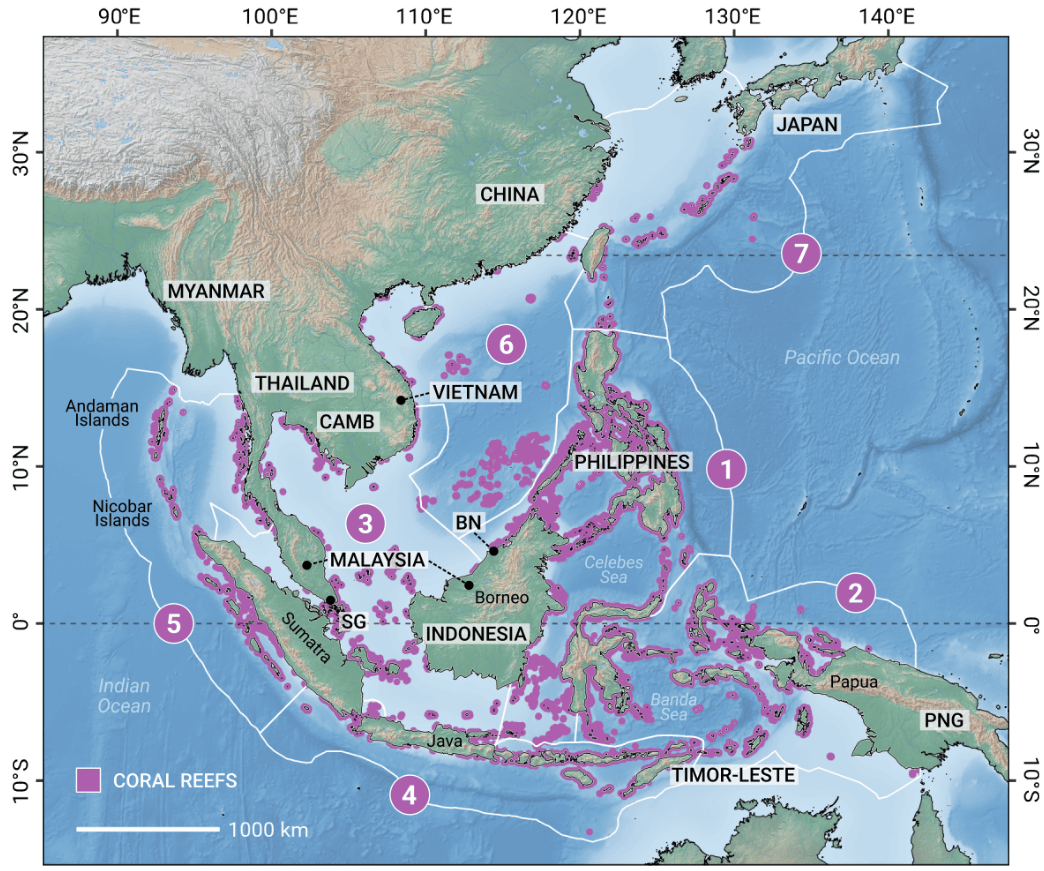
INTRODUCTION

The GCRMN East Asian Seas region extends over a maritime area of around 13.5 million km^2, ranging across 50° of latitude and 55° of longitude. The region hosts 75,765 km^2 of coral reefs, which represent 30.3% of the world's coral reef extent, and is the largest GCRMN region in terms of reef extent. Coral reefs reside within the exclusive economic zones of 18 countries and territories within the region, ranging from Japan in the north to Indonesia in the south, and from the Andaman and Nicobar Islands in the west to the Indonesian province of Papua in the east (Figure 2.4.1).

For the purpose of this report, the GCRMN East Asian Seas region was divided into seven subregions (Figure 2.4.1). Subregion 1 (Northern Coral Triangle) hosts 42.3% of coral reef extent in the region (32,019 km^2) whereas subregion 7 (Kuroshio) hosts 3% of coral reef extent (2,286 km^2) (Table A.1).



▲ **Figure 2.4.1.** The distribution of coral reefs within the East Asian Seas region and respective subregions. White polygons and numbers represent subregions. Subregion 1 = Northern Coral Triangle, Subregion 2 = Central Coral Triangle, Subregion 3 = Sunda Shelf, Subregion 4 = Southern Java and Sunda, Subregion 5 = Andaman, Subregion 6 = South China Sea, Subregion 7 = Kuroshio. Coral reefs are delineated with a 20 km buffer to enhance interpretation, and only coral reefs within the region are represented. The scale bar provides distance at the equator and may not accurately represent distance over the entire latitudinal range of the region. BN = Brunei Darussalam, CAMB = Cambodia, SG = Singapore.

As of 2020, a total of 54.7 million inhabitants were living within 5 km of coral reefs of the East Asian Seas. From 2000 to 2020, the region recorded a 41.2% increase in populations residing within 5 km of coral reefs, representing an average annual increase of approximately 800,000 inhabitants. The greatest increase in populations over this period was recorded in subregion 1 (Northern Coral Triangle), which also recorded the highest number of inhabitants in 2020 (Table A.2).

THREATS AND DISTURBANCES

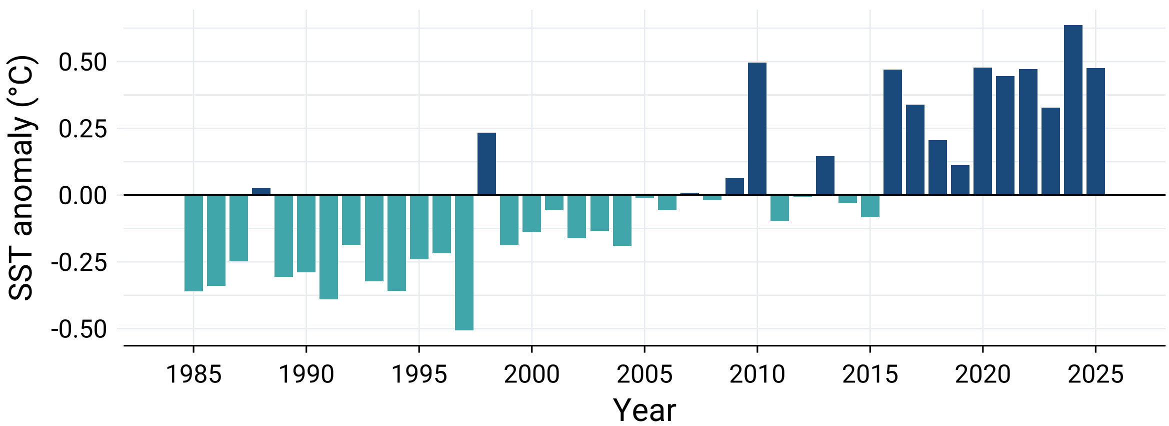
Heat stress

From 1985 to 2025, the long-term average sea surface temperature (SST) recorded over coral reefs within the East Asian Seas region was 28.64 °C. During this period, the SST over coral reefs in the region increased by 0.83 °C, corresponding to an average warming rate of 0.21 °C per decade (Table A.3).

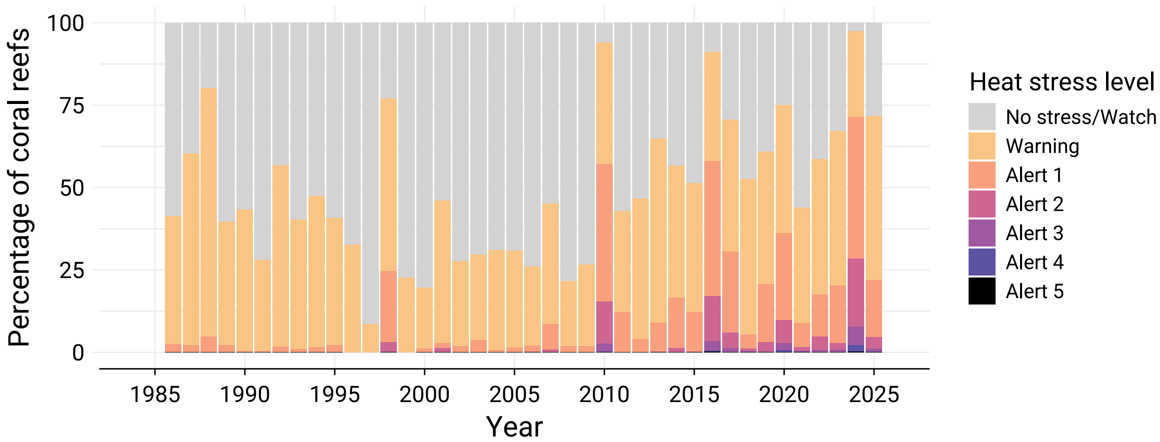
From 1986 to 2024, periods of major heat stress occurred in and around the years of 1998, 2010, 2016, and 2024, corresponding to the four global bleaching events. In addition, there was also significant coral bleaching observed in 2020 at various localities in the region [256, 257]. Each of the last three major heat stress events since 2010 placed over 15% of coral reefs in the region at minimum Alert 2 stress level (reef-wide bleaching and mortality of heat-sensitive corals, 8–12 DHW, Figure 2.4.3).

Typhoons

In the East Asian Seas region, cyclones are known as typhoons. From 1980 to 2025, a total of 558 typhoons passed within 100 km of coral reefs within the East Asian Seas region, representing an average of 12.1 $\pm$ 2.6 SD typhoons per year (Figure 2.4.4). The typhoon with the highest sustained wind speed over the studied period was the typhoon Meranti, in September 2016, which passed 25 km from a coral reef with sustained wind speed of 306 km.h^{-1} (Figure 2.4.5). Although the 100 km threshold was selected, typhoons passing at a greater distance from a coral reef, not represented within this figure, may also have had an impact on coral reefs [108].



▲ **Figure 2.4.2.** Annual mean sea surface temperature (SST) anomalies (°C) over the coral reefs of the East Asian Seas region from 1985 to 2025. SST anomalies were calculated based on the long-term average over the period 1985–2025. Positive values (red bars) indicate SST warmer than the long-term average, whereas negative values (blue bars) indicate SST cooler than the long-term average. Derived from NOAA Coral Reef Watch data (Skirving *et al.* [107]; see Materials and Methods).



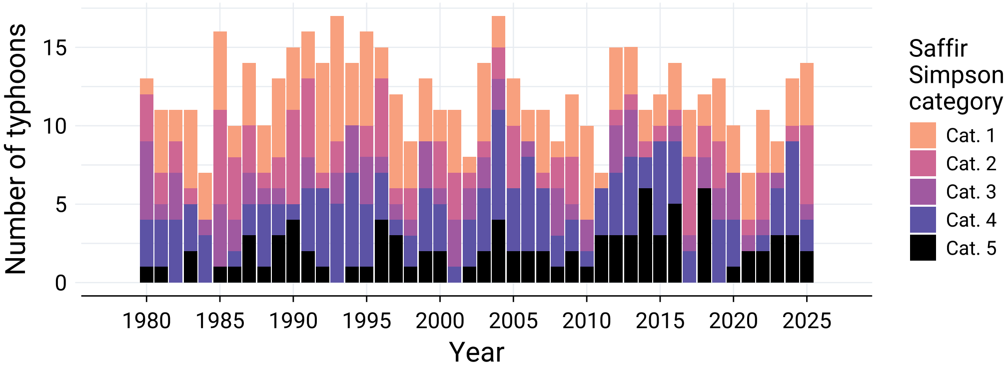
▲ **Figure 2.4.3.** Percentage of the coral reefs within the East Asian Seas region experiencing heat stress levels per year, from 1986 to 2025. No stress/Watch (DHW = 0); Warning (possible bleaching, $0 < \text{DHW} < 4$); Alert 1 (reef-wide bleaching, $4 \leq \text{DHW} < 8$); Alert 2 (reef-wide bleaching and mortality of heat-sensitive corals, $8 \leq \text{DHW} < 12$); Alert 3 (multi-species mortality, $12 \leq \text{DHW} < 16$); Alert 4 (severe multi-species mortality, $16 \leq \text{DHW} < 20$); and Alert 5 (near-complete mortality, $\text{DHW} \geq 20$). Derived from NOAA Coral Reef Watch data (Skirving *et al.* [107]; see Materials and Methods).

Regional disturbances

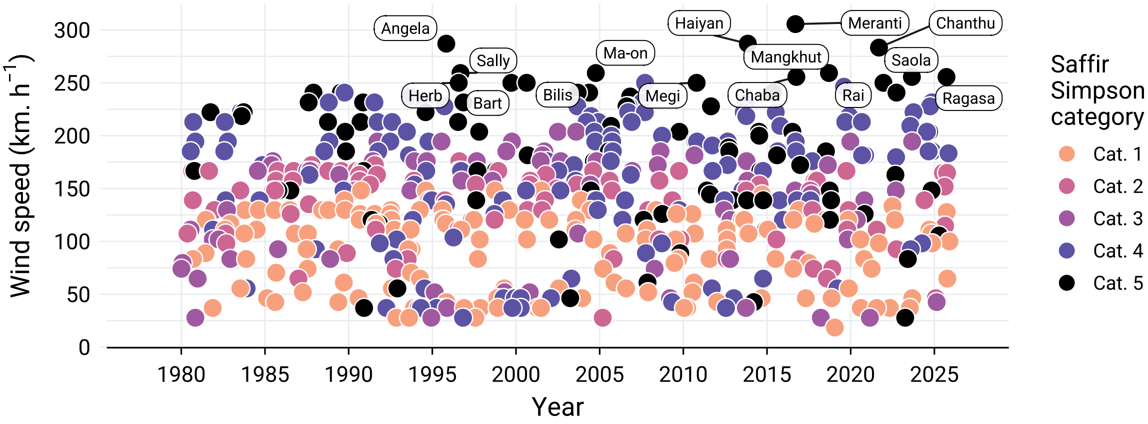
Region-wide analyses of benthic cover over nearly four decades have shown that large variations in nutrient influx from land-based activities adjacent to coastal coral reefs have a negative influence on coral cover, while high levels of nutrients have a positive effect on macroalgal cover [178, 258]. Elevated nutrient levels have been reported on the reefs of various reef environments in the East Asian Seas region [259, 260], where they can drive macroalgae to proliferate and outcompete corals [261], and also increase the severity of coral bleaching and disease [262, 263]. Marine litter in the form of marine plastics and microplastics is an emerging threat, with countries in the East Asian Seas region accounting for the majority of marine plastic pollution in the world [264, 265].

Increased sedimentation due to coastal development and land reclamation occurring throughout the region may also account for long-term changes in coral reef communities [266–268]. Sediment can physically abrade and smother corals by generating an anoxic microenvironment under layers of deposited material [269–271]. Suspended sediment can also lead to increased water turbidity, thereby curbing the growth and survival of corals [272–274].

Unabated fishing pressure continues to threaten key reef areas in the region. Overfished reef sites may exhibit uncontrolled macroalgal growth, curtailing coral recruitment and recovery [275]. A previous estimate showed that there are over 3 million coral reef fishers in Southeast Asia, accounting for half of the total number worldwide [14]. However, with a higher proportion of underfished stocks compared to the rest of the world, and as the human population in the region is expected to stabilise over the next few decades, fisheries demand could level off [276], providing opportunities for more effective reef management and restoration.



▲ **Figure 2.4.4.** Number of typhoons that passed within 100 km of the coral reefs of the East Asian Seas region from 1980 to 2025. Colors correspond to the Saffir–Simpson category of the typhoon along its entire track. Derived from IBTrACS data (Knapp *et al.* [118]; see Materials and Methods).



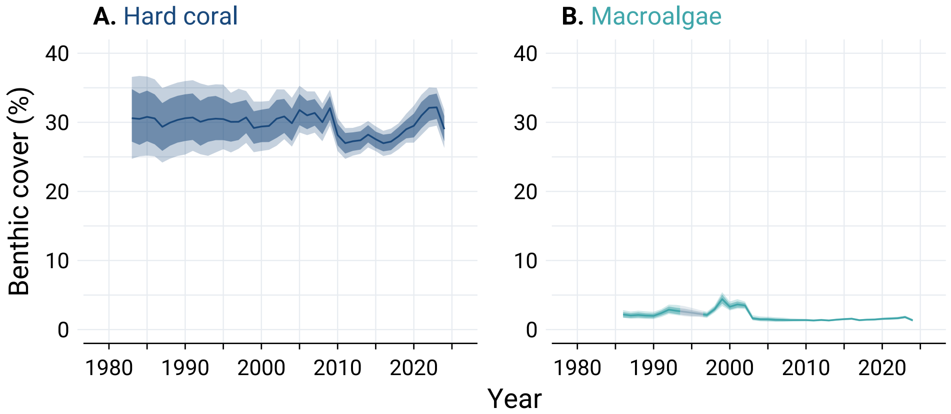
▲ **Figure 2.4.5.** Maximum sustained wind speed of typhoons that passed within 100 km of a coral reef in the East Asian Seas region between 1980 and 2025. Colors correspond to the Saffir–Simpson category of the typhoon along its entire track. However, the values of sustained wind speed are extracted from the nearest typhoon position from a coral reef. For this reason, some sustained wind speed values are below the lower threshold of category 1 Saffir–Simpson scale (*i.e.* 119 km.h^{-1}). Derived from IBTrACS data (Knapp *et al.* [118]; see Materials and Methods).

STATUS OF CORAL REEFS IN THE REGION

Based on the modelled results, regional hard coral and macroalgal cover trends (Figure 2.4.6) are described in periods from 1983–1997, 1998–2019 and 2020–2024. Turf algal cover trends were excluded from the East Asian Seas region due to limited and unevenly distributed data across subregions to support a meaningful analysis.

1983–1997: Relatively stable hard coral cover, variable macroalgal cover

Although data are available from 1983 to 1997, this period was generally characterised by limited availability and uneven spatial coverage of data across the East Asian Seas region.



▲ **Figure 2.4.6.** Modeled temporal trends of benthic cover in the East Asian Seas region from 1980 to 2024 for hard coral (A) and macroalgae (B). The solid line represents the estimated median benthic cover while darker and lighter ribbons represent 80% and 95% credible intervals, respectively. Grey areas represent periods during which no field data were available.

Over the period, hard coral cover remained relatively stable at a median of 30.3% (credible interval at 95% [$CrI_{95\%}$]: 25.3 – 35.7%), with limited interannual variability.

From 1986 to 1997, median macroalgal cover averaged around 2.3% ($CrI_{95\%}$: 1.8 – 3.0%).

1998–2019: Persistence through repeated thermal disturbances

Ranging over two decades, this period covered the longest time period, during which the first three global bleaching events occurred, in 1998, 2010, and 2016 (Figure 2.4.3), representing distinct disturbance intervals and pronounced shifts in both hard coral and macroalgal cover in the regional time series.

Following the first global bleaching event in 1998, hard coral cover showed a slight decline of 1.5 percentage points, decreasing to 29.2% ($CrI_{95\%}$: 25.7 – 33.0%) in 1999. This was followed by a prolonged period of variable but gradually increasing hard coral cover through the 2000s, with median values generally increasing to a high of 32.0% ($CrI_{95\%}$: 29.5 – 34.7%) in 2009. After the second global bleaching event in 2010, the regional median hard coral cover experienced its steepest decline, falling to 27.0% ($CrI_{95\%}$: 24.7 – 29.2%) in 2011. It then remained broadly stable at that level through the third global bleaching event in 2016. Interestingly though, despite the repeated thermal anomalies that occurred after 2016 (Figure 2.4.3), regional hard coral cover registered a distinct upward trend to 29.0% ($CrI_{95\%}$: 27.1 – 31.2%) in 2019.

In contrast to hard coral cover, macroalgal cover increased abruptly at the beginning of the period, reaching a short-term regional peak of 4.4% ($CrI_{95\%}$: 3.4 – 5.4%) in 1999, before declining rapidly until 2003. From 2003 onward, macroalgal cover remained persistently low, at around 1.4% ($CrI_{95\%}$: 1.2 – 1.7%), with limited interannual variability and no sustained upward trend over the remainder of the period.

2020–2024: Increased variability signals

There is strong evidence that hard coral cover increased between the 2010s and 2020–2024, with a gain of 3.1 percentage points, corresponding to a 11.1% relative increase. This is reflected further by the continued rise until 2023, slightly surpassing its

2009 peak at 32.2% (CrI $_{95\%}$: 29.5 – 35.0%). However, the fourth global bleaching event, declared in 2023 resulted in a 3.2 percentage point drop in regional hard coral cover, reducing median hard coral cover to 29.0% in 2024 (CrI $_{95\%}$: 26.3 – 31.8%). As this report and analysis does not capture the impacts of the fourth global bleaching event on reef status, it is unclear if regional hard coral cover will rebound like it did over the last two decades. Additional monitoring is therefore required to determine whether recent declines represent short-term disturbance responses or a more persistent shift in regional hard coral cover [277].

Macroalgal cover remained persistently low from 2020 to 2024, with a modest uptick in 2023 (median cover of 1.8%), followed by a drop in 2024, to 1.3% (CrI $_{95\%}$: 1.2 – 1.5%). However, there is strong evidence that macroalgal cover increased between the 2010s and 2020–2024, although the relative change was modest (+11.9%).

STATUS OF CORAL REEFS IN THE SUBREGIONS

Temporal trends in hard coral cover varied considerably across the seven East Asian Seas subregions. Availability of data, including of long-term datasets, was also variable across subregions.

East Asian Seas 1 - Northern Coral Triangle

The Northern Coral Triangle subregion carries the largest relative coral reef extent (42.3%), making its trends disproportionately influential to the East Asian Seas region. Median hard coral cover in the Northern Coral Triangle remained relatively stable at 31.2% (CrI $_{95\%}$: 23.8 – 39.0%) between 1986 and 1998, followed by a modest decline and increased variability around the late-1990s, coinciding with the first global bleaching event in 1998. There is no evidence of a change in hard coral cover between 1986–2009 and 2020–2024.

Macroalgal cover exhibited a pronounced but short-lived increase centred around the late-1990s to early-2000s, peaking briefly at 8.0% in 1999 before declining rapidly and remaining persistently low at below 2% thereafter.

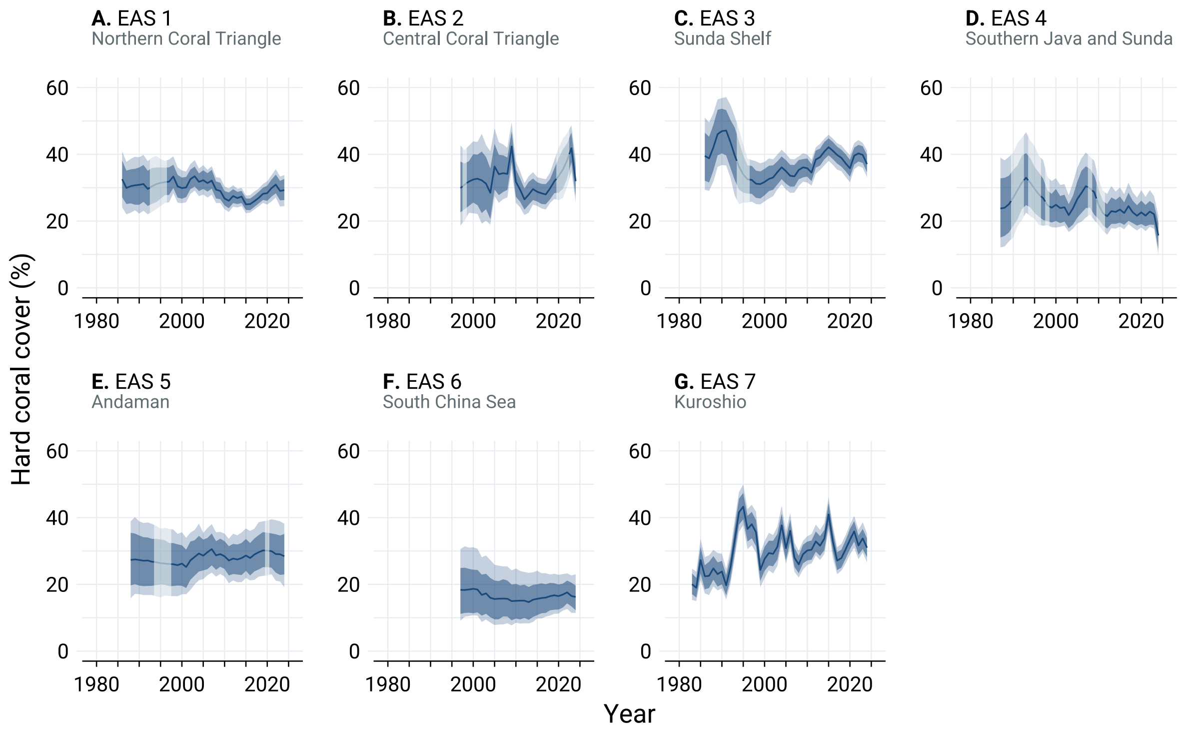
East Asian Seas 2 - Central Coral Triangle

In the Central Coral Triangle subregion, the results showed no evidence of a change in hard coral cover between 1997–2009 and 2020–2024. However, marked post-disturbance variability was observed, particularly following the second global bleaching event in 2010. Hard coral cover declined from 36.2% (CrI $_{95\%}$: 28.4 – 45.2%) in 2005–2009 to 29.0% (CrI $_{95\%}$: 23.8 – 34.4%) in 2010–2014, corresponding to an absolute loss of 7.2 percentage points. This decline was followed by an increase in hard coral cover into the early 2020s.

Macroalgal cover remained relatively low at a median of 1.1% (CrI $_{95\%}$: 0.8 – 1.9%) from 1997 to 2024, with no discernible increase following disturbance events, and no evidence of change in cover, despite a slight increase to 2.3% in 2023.

East Asian Seas 3 - Sunda Shelf

Hard coral cover within the Sunda Shelf subregion was high from 1986 to 1991, with cover peaking at 47.1% (CrI $_{95\%}$: 36.7 – 57.2%) in 1991, but declining thereafter to 31.1% (CrI $_{95\%}$: 25.0 – 37.3%) in 1999, and subsequently recovering to stable levels through the 2000s and early 2010s. There is strong evidence that hard coral cover increased between the 2000s and 2010s, with a gain of 4.6 percentage points over the period. While interannual



▲ **Figure 2.4.7.** Modeled temporal trends of hard coral cover in East Asian Seas (EAS) subregions from 1980 to 2024. The solid line represents the estimated median hard coral cover while darker and lighter ribbons represent 80% and 95% credible intervals, respectively. Grey areas represent periods during which no field data were available.

variability was evident, hard coral cover remained consistently moderate to high, with a median of 37.5% (CrI $_{95\%}$: 31.3 – 43.7%) from 1986 to 2024. The Sunda Shelf subregion showed no evidence of a change in hard coral cover between 1986–2009 and 2020–2024.

Macroalgal cover remained generally low in the Sunda Shelf subregion, at 2.3% (CrI $_{95\%}$: 1.7 – 2.9%) from 1986 to 2024, showing only minor fluctuations and no evidence of a change over the period.

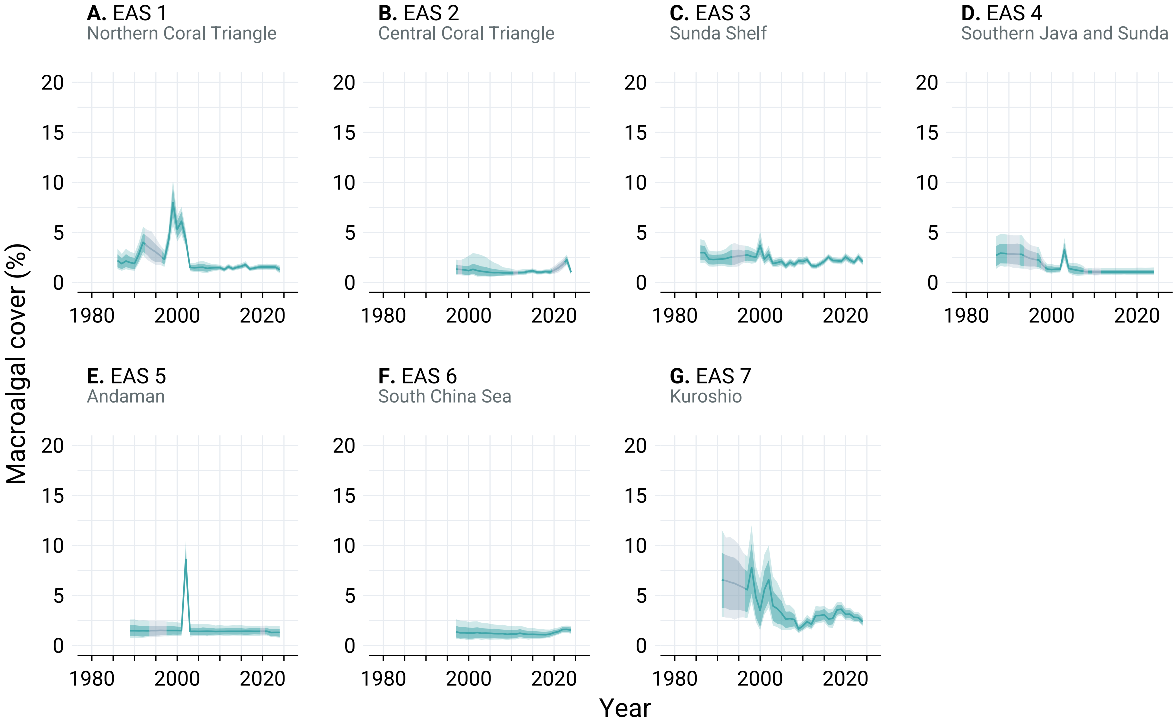
East Asian Seas 4 - Southern Java and Sunda

Despite having the largest data gaps among the subregions, there is strong evidence of a decline in hard coral cover in the Southern Java and Sunda subregion between 1987–2009 and 2020–2024, with a relative decrease in hard coral cover of 22.4%, corresponding to an absolute loss of 6.0 percentage points. This subregion experienced the greatest decline in hard coral cover over the study period across the East Asian Seas region.

Macroalgal cover, although generally low at 1.6% (CrI $_{95\%}$: 1.0 – 2.5%) from 1987 to 2024, decreased sharply around the late-1990s and remained low at around 1.2% thereafter. There is strong evidence that macroalgal cover declined between 1987–2009 and 2020–2024.

East Asian Seas 5 - Andaman

Hard coral cover in the Andaman subregion showed no evidence of a change between 1988–2009 and 2020–2024. Median hard coral cover from 1988 to 2024 was 27.9% (CrI $_{95\%}$: 19.7 – 37.0%) and rem-



▲ **Figure 2.4.8.** Modeled temporal trends of macroalgal cover in East Asian Seas (EAS) subregions from 1980 to 2024. The solid line represents the estimated median macroalgal cover while darker and lighter ribbons represent 80% and 95% credible intervals, respectively. Grey areas represent periods during which no field data were available.

ained relatively stable throughout the entire study period, with moderate interannual variability.

Except for a peak in 2002 at 8.6% ($CrI_{95\%}$: 6.8 – 10.5%), macroalgal cover remained consistently low between 1988 and 2024. There is also weak evidence of a decline between 1988–2009 and 2020–2024, corresponding to a relative decrease of 25.4%.

East Asian Seas 6 - South China Sea

The South China Sea subregion is characterised by consistently low hard coral cover, compared to other subregions, with a median of 16.4% ($CrI_{95\%}$: 9.7 – 25.6%) from 1997 to 2024. There is no evidence of a change in hard coral cover between 1997–2009 and 2020–2024 (but see Xu *et al.* [278]). The reefs within the South China Sea subregion stand out for their low absolute hard coral cover and relative stability over time, compared to the other subregions.

Macroalgal cover remained low at 1.2% ($CrI_{95\%}$: 0.7 – 2.0%) from 1997 to 2024 and was largely stable throughout the entire period, with no evidence of a change between 1997–2009 and 2020–2024.

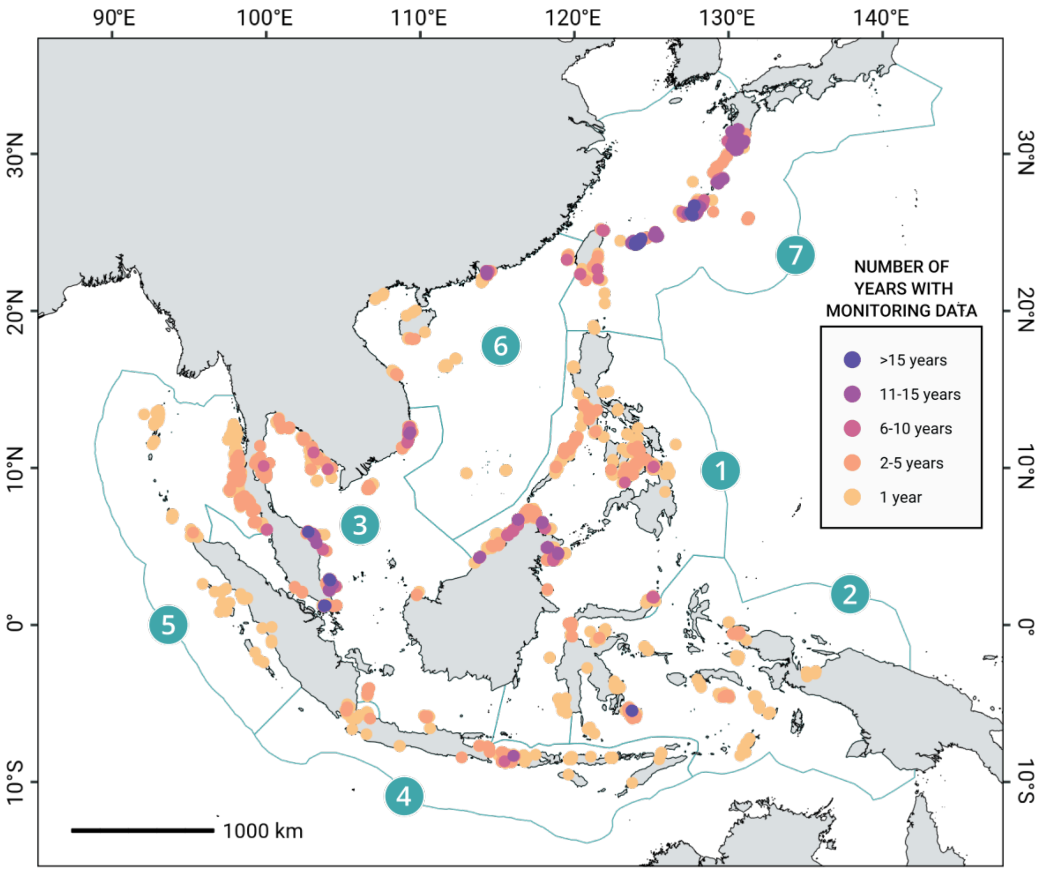
East Asian Seas 7 - Kuroshio

The Kuroshio subregion exhibited substantial interannual variability in hard coral cover, but also recorded one of the largest increases among the East Asian Seas subregions between 1983 and 2024. Indeed, there is strong evidence that hard coral cover increased between 1983–2009 and 2020–2024, by 4.0 percentage points, corresponding to a relative gain of 13.7%. However, substantial declines in hard coral cover were observed in 1998–1999 (-11.2 percentage points) and 2015–2017 (-13.8 percentage points), potentially associated with the first and third global bleaching events.

Macroalgal cover was relatively high and variable from 1991 to 2004, with a median of 5.6% ($CrI_{95\%}$: 2.7 – 9.3%), but declined over the 2010s. There is strong evidence of a decline between 1991–2009 and 2020–2024, with a 42.1% relative decrease. Among the seven East Asian Seas subregions, the Kuroshio subregion showed the clearest inverse temporal relationship between hard coral cover and macroalgal cover.

DESCRIPTION OF MONITORING DATA

Temporal trends in the percentage cover of benthic categories were estimated using data from 29 datasets encompassing 5,360 monitoring sites. These data were collected through 19,994 surveys conducted between 1983 and 2025, with 90% of surveys taking place after 2001 (Figure A.1). Of all surveys carried out in the region between 1983 and 2025, 43.1% (representing 33.2% of surveyed sites) were conducted in subregion 7, whereas only 2.2% (4.3% of sites) were conducted in subregion 5.



▲ **Figure 2.4.9.** Spatio-temporal distribution of benthic cover monitoring sites across the East Asian Seas region and respective subregions. Light blue polygons and numbers represent subregions. Subregion 1 = Northern Coral Triangle, Subregion 2 = Central Coral Triangle, Subregion 3 = Sunda Shelf, Subregion 4 = Southern Java and Sunda, Subregion 5 = Andaman, Subregion 6 = South China Sea, Subregion 7 = Kuroshio. The scale bar provides distance at the equator and may not accurately represent distance over the entire latitudinal range of the region.

In addition, just over 50% of the surveys were surveyed only once, and another 27.4% surveyed between 2 to 5 years (Table A.4).

CONCLUSIONS

The results indicate that although hard coral cover trends were highly variable across subregions, they were generally moderated at the regional scale due to spatial averaging of aggregated data. For example, declines in Southern Java and Sunda and parts of the Northern Coral Triangle were offset by gains in the Central Coral Triangle and Kuroshio, resulting in relatively stable regional averages despite substantial subregional changes. This suggests that apparent regional stability may mask important local variability and vulnerability. However, resolving such patterns will require consistent, fine-resolution data, which are currently lacking at the regional scale.

Across all subregions, bleaching-associated change in 1998 appears as a pulse rather than a phase shift. Disturbance signals were evident around 1998–2000, but reefs across subregions largely re-equilibrated thereafter. Notably, the reefs of the East Asian Seas appear to have transitioned from poorly resolved baseline conditions (pre-1998) to a period of increased hard coral cover with relative persistence through repeated thermal disturbances (1998–2020). Since 2020, however, there are indications of declining hard coral cover, coinciding with chronic heat stress associated with sustained sea surface temperature elevation following the third global bleaching event in 2016, most notably in the Southern Java and Sunda subregion. Whether the post-2020 period reflects a transient disturbance response or the onset of a longer-term regional shift remains uncertain, and will depend on future climate trajectories and the availability of comprehensive monitoring data.

Despite considerable subregional differences, macroalgal cover remained consistently low (generally below 5%), particularly after 2000. There is no clear evidence of macroalgal regime shifts; instead, macroalgal increases were short-lived, region-specific, and largely confined to the late 1990s. Importantly, there was no evidence of a macroalgal increase corresponding to declines in hard coral cover. This pattern is especially evident in the Southern Java and Sunda subregion, where hard coral cover declined without a concomitant rise in macroalgal cover.

DATA CONTRIBUTORS

Muhammad Abrar, Yang Amri Affendi, Abigail Alling, Put Jr. Ang, Maria Vanessa Baria-Rodriguez, Victor Brun, Anna Celis, Chaolun Allen Chen, Loke Ming Chou, Apple Pui Yi Chui, Luigi Colin, Alistair Cole, Frederick Chong, Kitty Currier, Laure de Ville d'Avray, Orla Doherty, Graham J. Edgar, Jan Freiwald, Giyanto, Rickdane Gomez, Danwei Huang, Hui Huang, Lintao Huang, Ya-Yi Huang, Lei Jiang, Yuko Kitano, Taihun Kim, Tadashi Kimura, Lucas Yutaka Kimura, Lena Kraft, Chao-Yang Kuo, Jiansheng Lian, Zau Lunn, Tom Martin, Jenny Mihaly, Carol Milner, Tamal Mondal, Takashi Nakamura, Cleto L. Nañola, C.S. Lionel Ng, Van Long Nguyen, Alex H. O'Brien, Elizabeth Oh, Heung-sik Park, Chelladurai Raghunathan, Marlen Schlotheuber, Rikoh Manogar Siringoringo, Rick D. Stuart-Smith, Makamas Sutthacheep, Frédéric Tardieu, Minh Quang Thai, Ray Jing Tong, Tai Chong Toh, Karenne Tun, Ouk Vibol, Si Tuan Vo, Christian R. Voolstra, Zarinah Waheed, Thamasak Yeemin, Leonora Yeo.

Access to online supplementary materials

The modelled benthic cover data, detailed outputs from the data analyses, and the CRediT author contribution statement are available on Zenodo.

CASE STUDY 5

Indigenous stewardship of coral reefs: the Tagbanwa of Calawit Island, Palawan

Authors*

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Across the tropics, coral reefs have long been stewarded by Indigenous peoples and local communities, whose knowledge systems, cultural values, and customary governance have shaped the sustainable use and protection of marine ecosystems for generations. In many places, these systems predate modern conservation frameworks by centuries, embedding ecological understanding within spiritual beliefs, social norms, and daily livelihoods. Yet, despite growing recognition of their effectiveness, Indigenous stewardship has often been overlooked or undervalued in formal reef monitoring and management. As global efforts intensify to halt reef degradation and biodiversity loss, there is an urgent need to recognise, support, and integrate these knowledge systems alongside scientific approaches. Integration of knowledge systems not only strengthens conservation outcomes, but also upholds the rights, identities, and resilience of the communities who have long served as guardians of coral reef ecosystems.

The Municipality of Busuanga is part of the Calamianes Islands, in the province of Palawan, Philippines. It lies within the Coral Triangle, a region of globally significant marine biodiversity. Busuanga's coral reefs have an average hard coral cover of around 35% and high reef fish diversity, estimated at 53 species per 500 m^2 [279]. Calawit Island, situated northwest of Busuanga, supports extensive mangroves, seagrass beds, and coral reefs, and is a key habitat for the dugong (*Dugong dugon*) (Figure C5.1; [280]). The island is part of the ancestral homelands of the Tagbanwa people, whose history has been profoundly shaped by displacement and resilience.

In 1976, the Tagbanwa were forcibly relocated from the island by the Marcos government to create an African game reserve with the island becoming home to imported animals including giraffes, impala, gazelles and zebras. The Calawit Tagbanwa were resettled in nearby Culion. However, the land provided was unsuitable for habitation and agriculture, leading to many years of struggle to legally return to Calawit Island. They were eventually successful in reclaiming their settlement rights in 2008, when they were awarded a Certificate of Ancestral Domain Title from the Philippines National Council of Indigenous Peoples, which also included over 50,000 ha of ancestral waters (Figure C5.1). However, it was not until 2015 that all outstanding challenges to their claim were dismissed by the Supreme Court.

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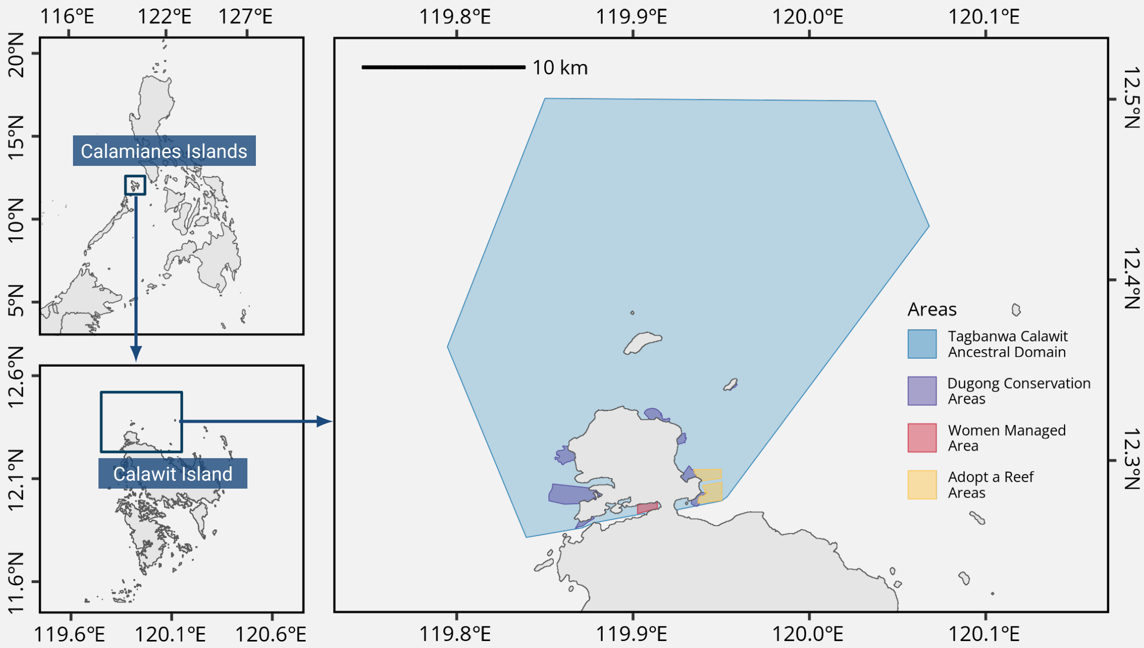

▲ **Figure C5.1.** Location of the different management areas within the Tagbanwa Calawit Ancestral Domain, Calamianes Islands, Philippines.

The Tagbanwa have long viewed care for their environment as an inherited responsibility. Today, they manage their coastal habitats through a formal Indigenous Peoples Organization and an Ancestral Domain Sustainable Development and Protection Plan (ADSDPP), guided by traditional systems of governance and led by the Indigenous Political Structure and general assembly. Key initiatives of the SDPP include the implementation of community-based dugong-watching guidelines in demarcated Dugong Conservation Areas with local supervision and a fee system; establishment of a 130-hectare women-managed area for farming window-pane oysters (*cachipay*, *Placuna* spp.); and designation of no-take zones where only snorkeling and diving are permitted (Figure C5.1). Through partnerships with local non-government organizations (NGOs) and government agencies, the Tagbanwa are integrating traditional ecological knowledge with formal monitoring protocols, ensuring data from their ancestral domain contributes to regional biodiversity and habitat assessments. For example, an "adopt a coral reef" scheme allocates approximately one hectare of reef within no-take zones to individual clans or families who take responsibility for its protection and regular observation, reinforcing accountability and intergenerational knowledge transfer (Figure C5.1). Endangered species such as dugongs, and critical habitat such as seagrass beds, are monitored by teams of Tagbanwa and supported through partnerships with NGOs and academic institutions.

Across the ancestral waters, harvesting or selling marine resources such as sand (*buhangin*), rock (*bato*), mangrove (*bakawan*), shells (*samong*), coral (*bahura*), sea urchin (*tirik*), and lobster (*banagan*) is prohibited, as are destructive practices such as dynamite, cyanide, or muro-ami fishing. Zoning of the ancestral waters is guided by traditional beliefs, such as certain reefs and rock outcrops that are recognized as *yungto* — sacred places guarded by powerful sea spirits like the *mamalyaw*, a vast creature said to reveal itself when its domain is disturbed. Elders recount that boats may sink or fishers lose their way if they enter without ritual consent, affirming deep spiritual reverence for coral reefs as living guardians of the sea. Corals themselves hold cultural significance; for instance, octocorals are traditionally used to ward off malevolent spirits, hung on the doorways of Tagbanwa homes, or burnt before important fishing trips to ensure safe passage and good fortune.

The Calamian Tagbanwa case demonstrates how Indigenous stewardship of coastal ecosystems can simultaneously sustain biodiversity and cultural survival. It underscores the value of legal recognition of ancestral rights, participatory management rooted in customary law, and the complementarity between Indigenous and scientific knowledge in achieving long-term conservation objectives.

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