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# A Global Coral Reef Review

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## Conservation and Management Challenges

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# SUMMARY

This volume reviews the major coral reef regions of the world, examining their present condition and the principal conservation and management challenges affecting each area. It places particular emphasis on regional variation, recognising that coral reef decline is not uniform but shaped by the interaction of global climate stressors and local human pressures. Across the Caribbean, the Pacific Islands, Australia, Southeast Asia, the Indian Ocean, the Red Sea, the Persian/Arabian Gulf, the Eastern Tropical Pacific and Brazil, reefs are shown to be increasingly vulnerable to marine heatwaves, coral bleaching, disease, ocean acidification, overfishing, pollution, sedimentation and coastal development.

The review highlights that the Caribbean remains one of the clearest examples of long-term reef degradation, with many jurisdictions experiencing substantial coral loss, reduced structural complexity and widespread macroalgal dominance. In contrast, parts of the Pacific and some more remote reef systems retain greater ecological function, although these areas are also increasingly affected by climate-driven disturbance. Case studies from individual islands and territories demonstrate that local management can improve reef resilience through marine protected areas, fisheries regulation, watershed management, restoration and community-based conservation. However, the volume also shows that even relatively well-managed reefs are now struggling to recover fully between repeated thermal stress events.

A central argument of this work is that coral reef conservation can no longer rely on local management alone. While local and regional action remains essential for reducing direct pressures and preserving ecosystem function, long-term reef survival depends equally on rapid global action to address climate change. The volume concludes that coral reef futures will be determined by the extent to which local resilience-building measures are combined with broader efforts to limit ocean warming and associated environmental change.

# INTRODUCTION

Coral reefs are among the most ecologically valuable and socially important marine ecosystems on Earth. They support immense biodiversity, provide food, fisheries income, coastal protection, cultural value and tourism revenue, and in many tropical countries they underpin local and national economies. Yet reefs are now increasingly defined by disturbance. The Global Coral Reef Monitoring Network's global assessment found that reefs worldwide have undergone marked declines in live hard coral cover over recent decades, with marine heatwaves, bleaching, disease, ocean acidification, overfishing, pollution and coastal development interacting to undermine reef resilience. The key point is that coral reef decline is not produced by one driver alone. Rather, climate stress now acts on top of long-standing local and regional pressures, and the combined effect is often more damaging than either pressure in isolation (GCRMN and ICRI, 2021h).

There is, however, no single global coral reef story. Reef condition varies strongly among ocean basins, countries and even neighbouring islands. Some systems still retain comparatively high coral cover or stronger fish communities; others have shifted towards algae-dominated states, reduced structural complexity, high disease prevalence or chronically low recruitment. Some regions, such as parts of the Red Sea and the Persian/Arabian Gulf, have drawn scientific attention because of apparent thermal tolerance, while others, such as much of the Caribbean, are often discussed as warning systems for how quickly reef function can unravel when chronic human pressures and repeated climate shocks coincide. Effective analysis therefore requires a regional and subregional approach rather than general statements about “coral reefs” as a single unit (GCRMN and ICRI, 2021h; GCRMN and ICRI, 2025).

This chapter-style review surveys the world's major coral reef regions, but with particular expansion of the Caribbean and Pacific on an island-by-island or archipelago basis. For each area, the discussion considers the condition of reefs, the main ecological and management pressures, and the particular conservation difficulties that shape outcomes on the ground. In some places, especially among smaller islands, recent island-specific peer-reviewed summaries are limited in the public domain, so regional monitoring syntheses and official jurisdictional reports provide the most defensible basis for comparison. Where that is the case, it is stated clearly rather than disguised.

Degraded reefs can be found all over the world



The wider Caribbean holds roughly a tenth of the world's coral reefs despite occupying a far smaller share of the global ocean, and it has long been one of the most intensively studied reef provinces. It is also one of the clearest examples of long-term coral reef decline. The newer Caribbean assessment published by the GCRMN in 2025 presents the region as one in which climate change, local stressors and disease have combined over decades to drive sustained loss, punctuated by limited and uneven recovery. The Caribbean is therefore no longer usefully understood as a region suffering isolated reef crises; it is a region living through a long ecological transition in which many reefs have become less structurally complex, less coral-dominated and less resistant to disturbance (GCRMN and ICRI, 2025).

The key Caribbean pattern is that reef condition often reflects the interaction between marine heat stress and earlier ecological simplification. Many Caribbean reefs had already been weakened by overfishing, herbivore loss, nutrient enrichment, sewage inputs, coastal construction and sediment runoff before the more recent era of repeated marine heatwaves. The result is that bleaching and disease now hit systems whose recovery mechanisms are often already impaired. This is why Caribbean management cannot focus only on coral transplantation or reef restoration. Restoration may be useful in selected contexts, but reef futures are determined equally by sewage treatment, watershed governance, fisheries enforcement, tourism policy and, ultimately, global emissions trajectories (GCRMN and ICRI, 2021h, GCRMN and ICRI, 2025).

Elkhorn coral (*Acropora palmata*)  
are increasingly rare in the  
Caribbean as a whole



## Bermuda

Bermuda is biogeographically distinctive because it lies at the northern limit of Atlantic reef development, and its reefs are often treated separately from more typically tropical Caribbean systems. That marginal position has sometimes given Bermuda a special place in coral reef science, yet it does not mean insulation from modern stress. Bermuda's reefs face warming seas, storm impacts, ocean acidification and disease risk, even if their species composition and oceanographic setting differ from lower-latitude Caribbean reefs. Within regional analyses, Bermuda contributes to the picture of a subregion that suffered early declines and has not simply returned to former coral baselines (GCRMN and ICRI, 2021h).

The conservation problem in Bermuda is less about uncontrolled coastal sprawl than in some Caribbean islands, and more about maintaining reef function under shifting climatic conditions. Because Bermuda is scientifically well known and institutionally relatively capable, it highlights an important point: even well-governed reef systems are now vulnerable to thermal stress and chronic environmental change. Management can still improve local resilience, but it cannot guarantee ecological stability in a warming ocean (GCRMN and ICRI, 2021h).

## The Bahamas

The Bahamas still contain extensive reef habitat and, compared with some heavily urbanised Caribbean jurisdictions, parts of the country retain relatively better reef condition. Their archipelagic geography creates ecological variation, with some reefs more exposed to fishing, tourism and shipping than others. That spatial spread can be an advantage because it prevents the entire national reef system from being subject to exactly the same local pressure. However, it can also make governance more difficult, because enforcement must be spread across a very large and fragmented marine area (Pivard et al., 2021).

The major challenge in the Bahamas is to maintain reef condition before decline becomes as severe as in more degraded parts of the Caribbean. Tourism development, anchoring, fishing pressure and climate stress all place pressure on reef systems that are essential both for biodiversity and national income. In practical terms, this means that fisheries management, marine protected area effectiveness and control of coastal development remain crucial, but the Bahamas also illustrate the regional reality that relatively better present condition does not equal long-term security (GCRMN and ICRI, 2021h; GCRMN and ICRI, 2025).

Lionfish (*Pterois* spp.) are invasive in the Caribbean



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## Cuba

Cuba is often discussed as a comparative bright spot within the Caribbean because it still retains extensive reef areas that were historically less transformed by intensive coastal development than many neighbouring states. That relative advantage is important, but it should not be overstated. Cuban reefs remain subject to bleaching, disease, invasive species risks and broader Caribbean warming trends. Their significance lies partly in the fact that they may preserve larger tracts of reef with more intact ecological processes and potentially stronger larval supply than many parts of the northern Caribbean basin (GCRMN and ICRI, 2025).

Cuba therefore presents a preventive conservation case. In a region where many countries are struggling to restore heavily degraded reefs, Cuba still has the opportunity to retain and strengthen relatively functional systems. That means careful tourism planning, continued fisheries management, early response to invasive organisms, disease surveillance and the maintenance of large-scale protected areas. The Caribbean-wide warning is clear: once reefs cross certain ecological thresholds, recovery becomes much harder and much slower (GCRMN and ICRI, 2021h, GCRMN and ICRI, 2025).

## Jamaica

Jamaica remains one of the most frequently cited examples of reef degradation in the Caribbean. Its reefs became emblematic of the shift from coral to macroalgal dominance following the interaction of overfishing, declining herbivory, hurricane damage and the collapse of the long-spined sea urchin *Diadema antillarum*. In reef science, Jamaica is important because it demonstrated early and clearly that coral reef decline is not only about coral death; it is about what replaces coral, and whether the processes needed for recovery still exist once disturbance has passed (GCRMN and ICRI, 2021h).

The management implications remain highly relevant. Jamaica's reefs require not just protection from direct extraction, but a rebuilding of ecosystem processes. Herbivore conservation, wastewater treatment, sediment control and coastal planning all matter because they shape whether coral recruits can survive and whether algae remain in check. Jamaican reefs therefore illustrate one of the central lessons of Caribbean conservation: where ecological degradation has become systemic, reef management has to extend well beyond the sea into watershed and urban governance (GCRMN and ICRI, 2021h).

Crystal clear Caribbean waters

## Cayman Islands

The Cayman Islands, especially Little Cayman, have often been viewed as places where comparatively strong management and lower human population pressure supported healthier reef trajectories than in many neighbouring territories. That perception was strongly challenged by the 2023–2024 bleaching aftermath. The Central Caribbean Marine Institute reported that coral cover in Little Cayman fell from 26% in 2023 to 9.8% in 2024, the lowest recorded in CCMI surveys since monitoring began in 1999, while the share of reefs ranked at least “good” collapsed from 90% to 18% in a single year (CCMI, 2025).

This matters far beyond the Cayman Islands themselves. Little Cayman had often been treated as evidence that strong local management could preserve reef condition. The sharp decline after the 2023 marine heatwave showed instead that even comparatively well-managed reefs can undergo severe losses when thermal stress crosses ecological thresholds. The hopeful element in CCMI’s report is that herbivorous fish populations, especially parrotfish, remained strong enough to help suppress macroalgal takeover. That does not remove the seriousness of the collapse, but it does suggest that local management can still influence post-disturbance recovery even when it cannot prevent the disturbance itself (CCMI, 2025).

## Hispaniola: Haiti and the Dominican Republic

The island of Hispaniola contains two very different governance contexts, but both demonstrate the importance of land-sea coupling in coral reef decline. In the Dominican Republic, major tourism development, shoreline transformation and coastal pollution place pressure on reef systems, while fishing and sediment runoff remain important local drivers. In Haiti, these problems are intensified by watershed degradation, severe deforestation, sediment delivery and more limited institutional capacity for marine and terrestrial environmental regulation (GCRMN and ICRI, 2021h).

These reef systems show why conservation failure is often not mainly a marine technical problem. On coasts affected by catchment erosion, weak wastewater systems and poorly regulated development, even well-designed marine reserves struggle to maintain coral condition. Hispaniola’s reefs therefore reveal the limits of marine-only policy and the importance of integrated coastal zone and watershed management. In effect, the reef condition off these coasts is partly a reflection of governance on land (GCRMN and ICRI, 2021h).

Macroalgae can dominate degraded reefs



## Puerto Rico

Puerto Rico's reefs are among the most thoroughly monitored in the insular Caribbean, and the territory offers one of the clearest examples of both intense modern reef stress and relatively sophisticated management response. NOAA's jurisdictional summary notes ongoing disease and herbivore problems, including *Diadema* die-offs, especially near harbours and marinas, as well as the spread of SCTLD. At the same time, Puerto Rico has maintained long-term reef monitoring since 1999, expanded water-quality sampling in 2023, built multiple land-based and in situ coral nurseries, and created the Jardines Submarinos de Vega Baja y Manatí MPA in 2024, protecting 203 km<sup>2</sup> of coral reefs, mangroves and seagrass habitats (NOAA, 2025a).

Puerto Rico's situation is therefore one of high pressure but also high management activity. The challenge is scale and recurrence. The territory is dealing simultaneously with bleaching, disease, invasive soft corals, watershed-driven pollution and storm legacies. The existence of monitoring programmes, restoration facilities and pollution-reduction efforts is significant, but it also underlines how reef management in places like Puerto Rico has become a permanent emergency response structure. The reefs are not being managed from a stable baseline; they are being managed through overlapping crises (NOAA, 2025a; U.S. Coral Reef Task Force, 2026).

## U.S. Virgin Islands

The reefs of St Thomas, St John and St Croix have experienced particularly severe recent stress. NOAA reports that the U.S. Virgin Islands suffered an exceptionally severe bleaching event in 2023 and further severe bleaching in 2024, with some nursery outplant sites losing all corals. The territory has also faced SCTLD since 2019, while sediment and silt from land-based pollution continue to harm stressed reefs. Yet the USVI also maintain a long-running territorial monitoring programme, a ten-year coral restoration plan published in 2023, watershed initiatives and substantial community engagement through Coral Reef Week and related activities (NOAA, 2025b).

The U.S. Virgin Islands exemplify the “value and limit” problem in modern coral reef conservation. Long-term data, coordinated restoration and institutional support clearly matter. They improve diagnosis, local resilience and public awareness. But they do not prevent bleaching when extreme heat persists. In the USVI, as in Puerto Rico, conservation is now less about preserving a stable reef status quo and more about slowing decline, identifying refugia, prioritising the most resilient species and protecting post-disturbance recovery processes (NOAA, 2025b).

Coral bleaching is a global problem



## British Virgin Islands

The British Virgin Islands are ecologically connected to the northern Lesser Antilles and the Virgin Islands platform, and their reefs face many of the same problems seen in neighbouring U.S. waters: hurricane damage, tourism pressure, boating impacts, disease and bleaching. Like several smaller Caribbean jurisdictions, the BVI often appear less prominently in the international monitoring literature than larger reef provinces, but their conservation challenges are structurally familiar. Heavy dependence on marine tourism means reefs are economically critical, yet that same tourism economy can intensify anchoring, coastal construction and wastewater pressures unless tightly managed (GCRMN and ICRI, 2025).

The management challenge in the British Virgin Islands is not simply to designate marine protected areas, but to make them effective within a multi-use seascape. Stronger mooring systems, boating regulation, coastal water-quality control and recovery planning after storms are all central. Smaller island territories often know what they need to do, but face resource and staffing constraints that make long-term implementation difficult (GCRMN and ICRI, 2025).

## Anguilla

Anguilla is frequently omitted from broad Caribbean reef summaries, yet it has significant reef and seagrass resources. Conservation organisations working there note that monitoring examines both coastal ecosystem condition and the severity of pressures affecting reefs and seagrasses, while earlier Anguilla research also emphasised the management problems common to small-island MPAs, including limited baseline data, uneven monitoring and resource constraints that can produce “paper park” outcomes if institutions are not adequately supported (AXA National Trust, n.d.; Government of Anguilla, 2017).

What makes Anguilla important analytically is that it represents a familiar Caribbean governance challenge in miniature. The island may not feature in global headlines, but its reefs face the same creeping pressures from tourism, fishing, anchoring and development that, over time, have eroded reef condition elsewhere. Small size is not automatically an ecological advantage. In management terms, small islands may have closer social ties and clearer jurisdiction, but they also tend to have thinner budgets, fewer technical staff and less redundancy in environmental governance (AXA National Trust, n.d.; GCRMN and ICRI, 2025).

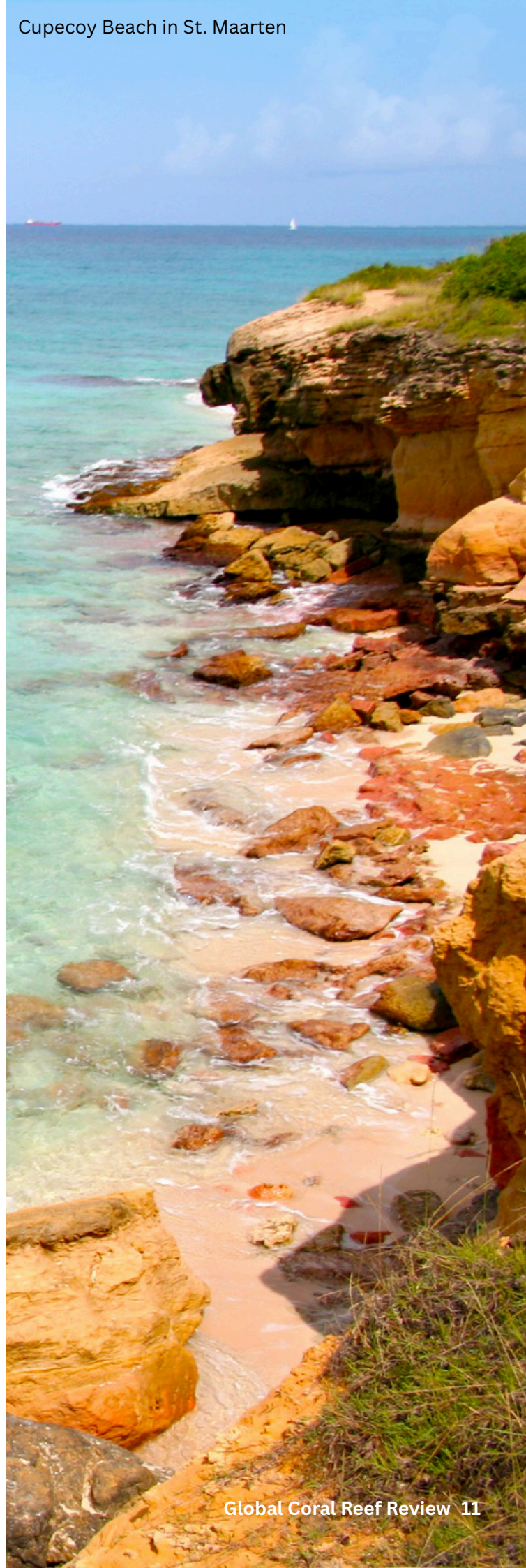


Shoal Bay in Anguilla, one of dozens of pristine beaches on the island

## Saint Martin / Sint Maarten

Sint Maarten now has one of the clearest publicly available island-specific reef assessments in the northeastern Caribbean. The Nature Foundation's 2024 analysis concluded that the island's reefs are in poor condition, although they had not worsened significantly over the preceding seven years. The same report found substantial bleaching during the hot months of 2023, with bleaching frequency increasing by 230% compared with previous years. Over 85% of surveyed reefs were classed as having critically low live coral cover, herbivorous fish populations were critically low, and macroalgae cover was much higher outside the protected area than within it. The Man of War Shoal Marine Park performed measurably better than unprotected sites, with higher coral, gorgonian and sponge abundance and healthier reproductive patterns (Nature Foundation Sint Maarten, 2024).

Sint Maarten is therefore an important contemporary case study. Its reefs are already degraded, but local protection still appears to matter. The lesson is not that marine parks solve everything, but that they can preserve relative ecological advantage within an otherwise stressed seascape. The challenge is that a protected reef with low herbivore levels and recurrent bleaching is still a vulnerable reef. Protection must therefore be linked to broader fisheries rebuilding, coastal water-quality management and adaptation planning for future thermal stress (Nature Foundation Sint Maarten, 2024).



# Saint Barthélemy, Saba, St Eustatius, St Kitts and Nevis, Antigua and Barbuda, Montserrat, Guadeloupe, Dominica, Martinique, Saint Lucia, St Vincent and the Grenadines, Grenada, Barbados, Trinidad and Tobago

Across the eastern Caribbean chain, the main pattern is one of ecological connectivity but uneven monitoring and management capacity. These islands do not all have equally detailed recent public reef summaries, but regional reporting shows that they share the same broad pressure complex: bleaching, disease risk, declining herbivory, tourism and fisheries dependence, coastal development and limited enforcement capacity. The Nature Conservancy's eastern Caribbean reef report-card work was designed in part to help small states build comparable baselines and identify management gaps, which itself reveals a major regional problem: in several islands, one of the first conservation deficits is not lack of concern but lack of sustained and comparable long-term data (The Nature Conservancy, 2016; GCRMN and ICRI, 2025).

In ecological terms, these islands contain a mosaic of fringing reefs, patch reefs and banks, often closely tied to seagrass and mangrove systems. In governance terms, they illustrate the difficulty of running effective, science-based reef management on small budgets while also depending heavily on the same coastal and marine spaces for tourism, fisheries and infrastructure. Barbados and Trinidad and Tobago add the complications of denser coastal use and, in Trinidad and Tobago's case, turbidity and riverine influence. The central lesson is that small-island reef conservation depends on durability: monitoring must persist, local rules must be enforced consistently, and land-sea planning must not be treated as optional (The Nature Conservancy, 2016; GCRMN and ICRI, 2025).

Typical Eastern Caribbean Coastal View



## Aruba, Bonaire and Curaçao

The ABC islands are especially important because Bonaire has often been celebrated as a Caribbean reef management success story. Long-term protection, diver management and herbivore safeguards helped build that reputation. Yet recent bleaching has demonstrated that even a comparatively well-managed reef island remains highly exposed to climate stress. A recent Bonaire bleaching summary, drawing on STINAPA monitoring, reported that the proportion of corals affected by thermal stress rose from 25% in 2016 to over 80% in 2023, with widespread bleaching continuing into 2024 alongside disease and regional heat stress (Reef Renewal Bonaire Foundation, 2024).

The Dutch Caribbean therefore underline one of the most important themes in this chapter. Local management can produce real benefits, including stronger fish populations, better diver regulation and a more resilient reef framework than would otherwise exist. But it cannot fully shield reefs from unprecedented ocean temperatures. Aruba and Curaçao face somewhat stronger development and tourism intensity than Bonaire, while all three islands sit within a wider southern Caribbean system that is warming rapidly. The policy challenge now is how to maintain the gains of local management while redesigning conservation around chronic climate instability rather than historical reef stability (GCRMN and ICRI ,2021h; Reef Renewal Bonaire Foundation, 2024).

## The Mesoamerican Reef: Mexico, Belize, Guatemala and Honduras

The Mesoamerican Reef is the largest reef system in the Atlantic and one of the most socially important reef corridors in the Caribbean basin. The 2024 Mesoamerican Reef Report Card found that most monitored sites were still in poor or critical condition, although there had been some improvement in the share of reefs classed as fair or good. This mixed pattern is significant. It indicates that management interventions and local resilience still matter, but the overall system remains fragile and vulnerable to basin-scale stressors (MAR Fund, 2024).

Belize contains the most famous stretches of this reef complex, including barrier reefs and offshore atolls, but the system is fundamentally transboundary. Mexican Caribbean reefs face tourism-driven coastal transformation and disease pressures; Honduras and Guatemala deal with runoff, port and urban pressures in the Gulf of Honduras; Belize must balance international reef prestige with rapid development and marine use. Because it spans four countries, the Mesoamerican Reef demonstrates that reef management is also a diplomatic and institutional challenge. The health of the reef depends not only on site protection, but on regional cooperation in fisheries, watershed management, tourism standards and emergency response (MAR Fund, 2024).

# The Pacific Islands

## Regional Overview

The Pacific is by far the largest reef-bearing island region in the world. The GCRMN's Pacific assessment notes that the region supports almost 27% of global coral reef area across more than 25,000 islands. Unlike the Caribbean, where many reefs are closely linked to continental margins and heavily populated coasts, the Pacific includes vast numbers of oceanic islands and atolls with very different histories of human pressure, exposure, disturbance and customary governance. Average hard coral cover at the regional scale declined over the long term, but the Pacific remains highly heterogeneous: some areas have retained substantial reef function, some have shown partial recovery after disturbance, and some remote reef systems remain less affected by chronic local pressures than most reefs elsewhere in the tropics (GCRMN and ICRI, 2018).

The Pacific's relative strength lies in scale, diversity and, in many places, still-functioning customary or community-based governance. Its weakness lies in remoteness, management fragmentation, limited technical capacity in small states and the growing reach of climate extremes. A remote reef may have low pollution and lower fishing intensity, but it can still bleach catastrophically. A customary-managed reef may retain strong local legitimacy, but it may still be vulnerable to changing markets, population shifts and increasingly frequent marine heatwaves. Pacific conservation therefore requires a nuanced approach that takes social and geographic diversity seriously rather than treating "the Pacific islands" as a single ecological category (GCRMN and ICRI, 2018; NOAA Fisheries, 2025).

Palau Islands, Pacific



## Palau

Palau remains one of the most significant reef nations in the Pacific, both ecologically and politically. A major reef assessment by the Khaled bin Sultan Living Oceans Foundation described Palau's benthic communities as among the best-managed and most pristine reefs surveyed in the western Pacific, with high coral diversity and strong customary and state-level conservation structures. The report also notes that Palau has protected a very large share of its EEZ and retains customary conservation practices such as *bul*, while reef management is reinforced through the Protected Areas Network. At the same time, the report emphasises that fishing pressure near more populated areas and on lagoonal reefs remains an important management concern (Khaled bin Sultan Living Oceans Foundation, 2020).

Palau is therefore often treated as a Pacific success case, and rightly so, but it is not outside the global reef crisis. Its value lies in showing how customary authority, national legislation and large-scale marine protection can still preserve relatively strong reef condition. Yet even Palau faces typhoon impacts, climate-related bleaching risk and pressures near access points and population centres. Its long-term challenge is not simply to maintain reef area, but to preserve ecological quality while balancing tourism, fisheries and climate uncertainty (Khaled bin Sultan Living Oceans Foundation, 2020).

## Micronesia

The Federated States of Micronesia include Yap, Chuuk, Pohnpei and Kosrae, each with substantial reef and lagoon systems, but with very different demographic and governance settings. Across Micronesia, the defining tension is between large reef dependence and limited institutional capacity. Many islands still benefit from lower industrialisation and strong local stewardship traditions, yet their remoteness increases the cost of monitoring, enforcement and rapid response to disturbance. In practice, this means that reefs may remain ecologically valuable but administratively vulnerable (GCRMN and ICRI, 2018).

The conservation challenge in FSM is therefore one of sustained capacity. Fisheries management, climate adaptation and local reef stewardship all matter, but so does the ability to maintain long-term data series, patrol marine closures and integrate customary systems with modern law. For many Micronesian nations, the biggest threat is not simply ecological decline, but the slow erosion of management continuity under the strain of small-island governance (GCRMN and ICRI, 2018).



Coral reef in Palau

## Marshall Islands

The Marshall Islands contain extensive atoll reef systems that remain globally important, yet they are also among the places where reef conservation is inseparable from broader climate vulnerability. Reef health matters not only for biodiversity and fisheries, but for shoreline protection in a nation already heavily exposed to sea-level rise. Local pollution and fisheries pressures exist, but the most existential threat is the changing ocean climate and the physical insecurity of low-lying atolls themselves (GCRMN and ICRI, 2018).

For the Marshall Islands, coral reef management cannot be separated from national adaptation policy. Protecting herbivores, controlling local damage and maintaining customary closures remain useful, but the deeper problem is that reef decline would directly undermine island habitability. In the Marshalls, reef conservation is therefore also coastal survival policy (GCRMN and ICRI, 2018).

## Guam

Guam's reefs are among the best documented in the western Pacific because of long-standing U.S. involvement in monitoring and coral reef management. The 2024 jurisdictional report to Congress states that Guam's reefs support more than 3,500 species, including over 1,000 fish and over 400 coral species, but face strong local pressures such as overfishing, land-based pollution, vessel groundings and coral predators, alongside global threats from warming, acidification, disease and potentially stronger typhoons. This makes Guam a classic case of a densely used island reef system under both local and global pressure (U.S. Coral Reef Task Force, 2026).

Guam's challenge is therefore not lack of knowledge, but cumulative pressure. Its reefs are economically and culturally important, yet military infrastructure, urbanisation and coastal use raise the stakes for environmental governance. In places like Guam, coral reef conservation requires close integration between watershed management, coastal infrastructure policy, fisheries regulation and climate adaptation, because none of these pressures acts in isolation (U.S. Coral Reef Task Force, 2026).

Sunset over beach in Guam



## Northern Mariana Islands

The Commonwealth of the Northern Mariana Islands (CNMI), including Saipan, Tinian and Rota, share many ecological and management characteristics with Guam but have their own local dynamics. Their reefs are important for fisheries, tourism and shoreline protection, yet are exposed to typhoons, bleaching, fishing and land-based runoff. The CNMI also illustrate how island-to-island variation matters within a single political jurisdiction: some reef areas are more urban and accessible, others less so, and this affects both pressure and recovery (NOAA Fisheries, 2025).

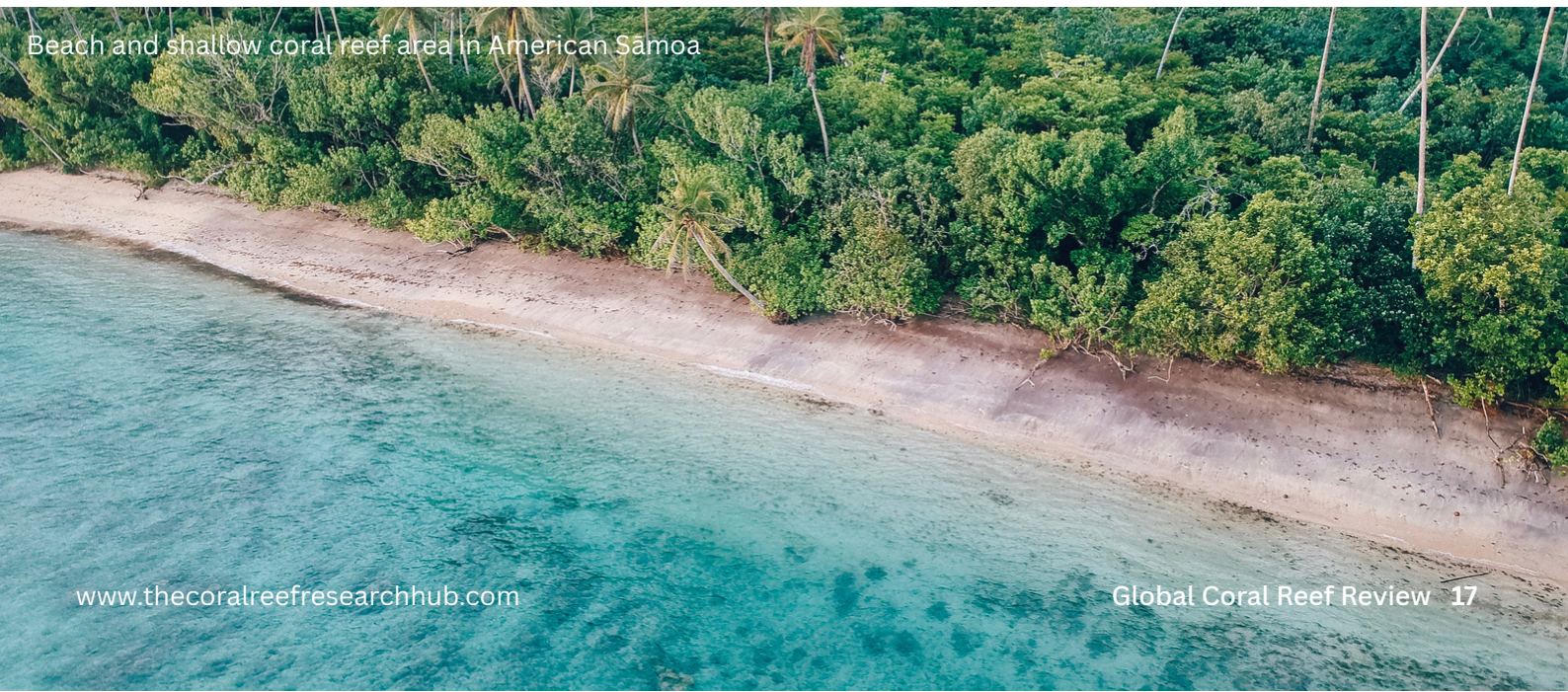
The conservation difficulty in the CNMI lies in maintaining capacity across dispersed islands with different development intensities. Monitoring, restoration and fisheries enforcement all require resources, and those resources are often stretched. As elsewhere in the Pacific, small island populations may foster strong place-based stewardship, but they do not eliminate the need for technically supported long-term management (NOAA Fisheries, 2025).

## American Sāmoa

American Sāmoa's reefs have repeatedly been discussed in relation to cyclone disturbance, bleaching and local fishing pressure, but they also remain central to food systems, cultural identity and lagoon protection. NOAA's Pacific monitoring framework includes American Sāmoa precisely because long-term, standardised monitoring is essential in dispersed island reef provinces where disturbance can be patchy but severe. American Sāmoa thus represents the Pacific lesson that coral reef conservation is as much about social continuity and local livelihoods as about benthic cover alone (NOAA Fisheries, 2025).

Management challenges include balancing subsistence and cultural use with ecological recovery, especially after major thermal events or storms. As with many Pacific territories, the biggest issue is not the absence of conservation values, but the practical difficulty of sustaining monitoring, enforcement and adaptation planning over long time periods under recurrent disturbance (NOAA Fisheries, 2025; GCRMN and ICRI, 2018).

Beach and shallow coral reef area in American Sāmoa



## Hawai'i

Hawai'i is one of the most intensively studied coral reef jurisdictions in the world, but its reefs are ecologically and socially distinctive. In the Pacific regional synthesis, Hawai'i did not show the same broad regional collapse in hard coral cover seen in some other places, but algal cover increased, indicating that apparent stability in coral cover does not necessarily mean broader ecosystem health. Hawai'i therefore provides an important warning against using coral cover alone as a sufficient measure of reef condition (GCRMN and ICRI, 2018).

Hawai'i also faces invasive species issues, including invasive soft corals such as *Unomia stolonifera* in Pearl Harbor, alongside the familiar problems of development, runoff, fisheries pressure and warming. In highly studied systems like Hawai'i, the management challenge is not identifying threats but integrating them into a coherent and durable strategy that can work at the scale of an entire archipelago. The state's reefs show how even well-researched reef systems can be gradually altered by the cumulative effects of multiple stressors (U.S. Coral Reef Task Force, 2026; GCRMN and ICRI, 2018).

## Fiji

Fiji's reefs are ecologically rich and socially central, and the country is often cited for its development of locally managed marine areas. This has made Fiji important in global reef governance discussions because it demonstrates that community-based and customary approaches can be highly effective when local institutions remain strong. At the same time, Fiji is not exempt from bleaching, storm damage, overfishing near population centres and growing development pressure (GCRMN and ICRI, 2018).

Fiji's core management challenge is scaling local success without diluting it. Community-managed areas can work very well, but they depend on social legitimacy, compliance and continuity. Where cash economies expand, coastal populations grow or fish markets intensify, those systems can become harder to maintain. Fiji therefore stands as an example both of Pacific governance innovation and of its fragility under changing social and climatic conditions (GCRMN and ICRI, 2018).

Small Fijian island surrounded by coral reefs



## Papua New Guinea

Papua New Guinea contains one of the largest and most diverse reefscape in the tropical Pacific, and parts of its reef estate remain among the most ecologically significant in the world. The sheer scale of PNG's coastline and reef systems, however, makes governance exceptionally difficult. Much of the country still relies on customary marine tenure, and this remains a major strength. Yet remoteness, population growth, extractive development and uneven public service capacity all complicate long-term management (GCRMN and ICRI, 2018).

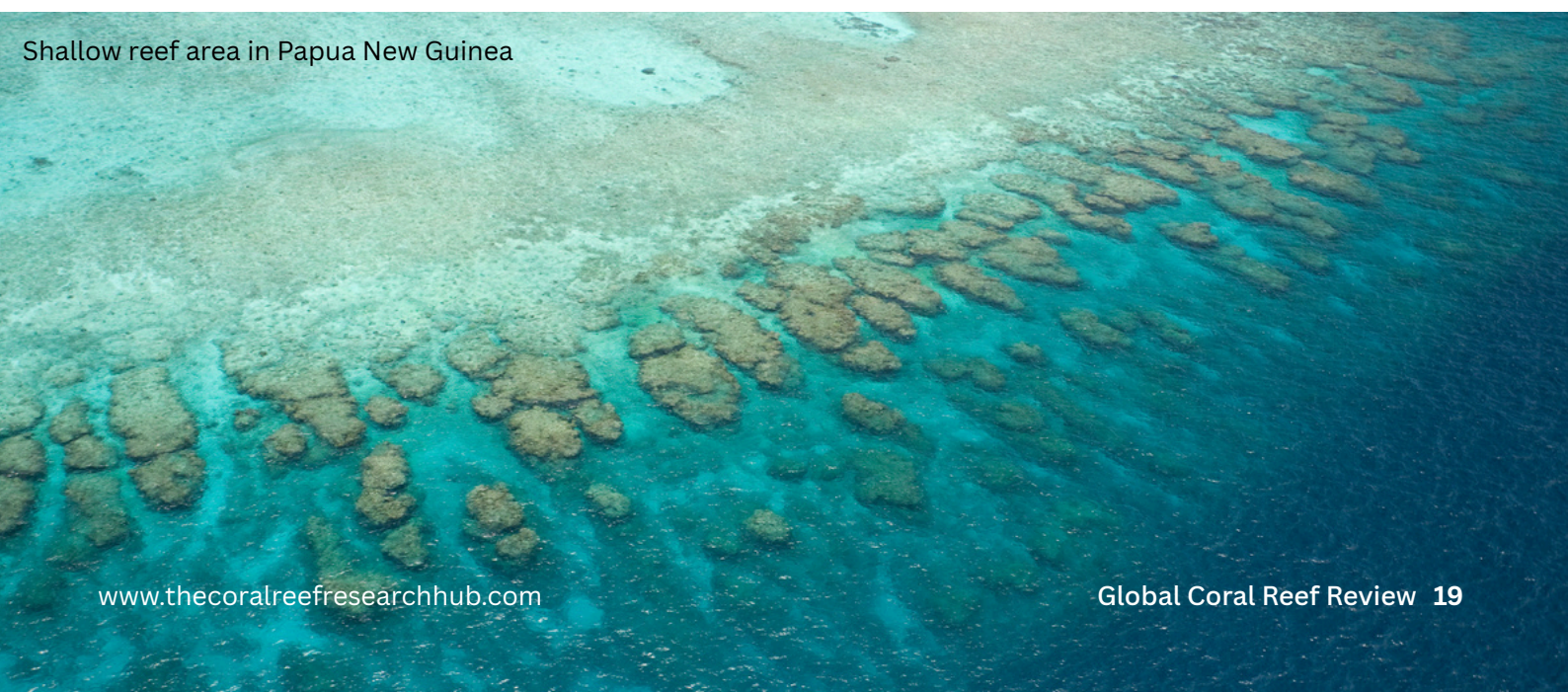
PNG's reefs therefore illustrate a recurring Pacific pattern: very high ecological value paired with incomplete management coverage. The danger is not simply overfishing or bleaching in one site, but the possibility that large and globally important reef systems will experience piecemeal degradation because institutions cannot keep pace with the scale of the resource. Conservation in PNG must therefore work through both customary and national frameworks (GCRMN and ICRI, 2018).

## Soloman Islands

The Solomon Islands hold extensive coral reef habitats and remain a critical part of the southwest Pacific reef mosaic. As in PNG, many reefs are still buffered from some of the chronic pollution and development pressures common in densely populated continental settings. However, local overfishing, logging-related sedimentation, urban growth around Honiara and climate stress increasingly affect reef condition. Like several Melanesian countries, the Solomons face the challenge of governing a vast, dispersed reef estate across many islands and communities (GCRMN and ICRI, 2018).

The Solomon Islands matter because they still contain significant reef systems with recovery potential. The policy priority is therefore not only restoration but protection of remaining function. Once sedimentation, destructive extraction or repeated bleaching drive major structural decline, the archipelago's comparative advantage as a large reef nation could diminish rapidly (GCRMN and ICRI, 2018).

Shallow reef area in Papua New Guinea



## Vanuatu and New Caledonia

Vanuatu and New Caledonia occupy an important middle ground in Pacific reef analysis. Both contain substantial reefs and significant traditional links to marine management, but they face different mixes of pressure. New Caledonia's barrier and lagoon systems are globally important and scientifically prominent, while Vanuatu's reefs are central to island livelihoods and vulnerable to storm damage and changing coastal use. In the Pacific synthesis, reefs in this part of Melanesia did not show the worst regional-scale declines, but that should be interpreted as relative resilience, not safety (GCRMN and ICRI, 2018).

The challenge in both territories is to maintain ecosystem integrity while climate disturbance becomes more frequent. In New Caledonia, industrial and mining-linked land pressures also matter; in Vanuatu, storm exposure and capacity limits are particularly important. Both show that reef conservation must be tailored to local political economy, not only ecological diagnosis (GCRMN and ICRI, 2018).

## French Polynesia

French Polynesia has often been portrayed as a relatively low-pressure reef region because of its remoteness and comparatively lower industrial intensity. The Pacific regional assessment complicates that image. It reports that French Polynesia experienced gains in average hard coral cover up to around 2010, followed by a substantial decline in the last decade. This shows that remoteness can reduce local stress but does not protect reefs from marine heatwaves or other basin-scale disturbances (GCRMN and ICRI, 2018).

French Polynesia therefore exemplifies the new climate geography of coral reefs. Historically low local pressure is valuable, but it is no longer enough to guarantee favourable outcomes. The management priority is to keep local impacts low while identifying and protecting the most resilient reef areas, because climate-driven losses can now occur even in places long imagined as quasi-pristine (GCRMN and ICRI, 2018).

Aerial view of Tikehau Atoll, French Polynesia

## Samoa, Tonga, Cook Islands, Kiribati, Tuvalu and other small Polynesian and central Pacific states

Many smaller Pacific island states have reef systems that are locally essential but globally under-documented. Their reefs support food security, coastal protection and cultural continuity, yet the countries themselves often have limited capacity for sustained scientific monitoring and enforcement. In these places, the problem is not usually absence of dependence on reefs, but the opposite: coral reefs are so central that any decline has immediate social consequences (GCRMN and ICRI, 2018).

For low-lying countries such as Kiribati and Tuvalu, reef condition is also tightly linked to national climate vulnerability. Reefs act as living coastal infrastructure. If bleaching, erosion of reef framework or declining carbonate production accelerate, shoreline stability and island habitability are affected. Thus, in many central Pacific states, coral reef conservation should be understood not merely as biodiversity policy but as climate adaptation and national security policy (GCRMN and ICRI, 2018).



# Other Regions

## Australia

Australia's reef systems, above all the Great Barrier Reef, remain the most globally visible coral reef province. The GCRMN Australia chapter showed repeated declines associated with bleaching, cyclones and crown-of-thorns starfish outbreaks, especially after the 2016 and 2017 bleaching events. The Great Barrier Reef therefore stands as both a conservation achievement and a warning. It is one of the best-managed reef systems in the world in terms of zoning, scientific monitoring and water-quality policy, yet repeated heat stress has still caused major ecological loss (GCRMN and ICRI, 2021a).

Western Australia presents a somewhat different picture, with reefs affected by recurrent bleaching and strong climate variability across very different latitudes and oceanographic settings. Together, eastern and western Australia show that sophisticated management remains vital but cannot substitute for climate mitigation. Australia therefore provides perhaps the clearest evidence that local excellence in reef management is necessary but insufficient in the age of repeated marine heatwaves (GCRMN and ICRI, 2021a; Souter et al., 2021).

## The Coral Triangle and Southeast Asia

The Coral Triangle, encompassing Indonesia, the Philippines, Malaysia, Timor-Leste, Papua New Guinea and Solomon Islands, remains the global centre of coral reef biodiversity. It supports the highest known coral diversity on Earth and enormous human dependence on reef fisheries. Yet it is also one of the regions where local pressures are most intense, especially in Indonesia and the Philippines, where large coastal populations, fishing pressure, pollution and coastal development combine with climate stress (Souter et al., 2021).

Management in the Coral Triangle is complicated by scale, governance diversity and poverty-linked dependence on marine resources. Marine protected areas are important, but they are only part of the answer. Effective reef conservation there must include fisheries reform, livelihood support, pollution control, local enforcement and strong regional coordination. The region matters globally because the future of coral reef biodiversity as a whole is inseparable from the future of reefs in Southeast Asia (Souter et al., 2021).

Checkerboard Wrasse (*Halichoeres hortulanus*) on a degraded reef area in Thailand



## South Asia

The South Asia reef region includes the Maldives, Chagos, Sri Lanka and India's reef provinces such as Lakshadweep, the Gulf of Mannar and the Andaman and Nicobar Islands. GCRMN's regional synthesis found that gains made after recovery from the 1998 bleaching event were later erased by renewed decline, leaving the region with significantly lower average hard coral cover by the late 2010s. That trajectory is especially important because it shows that even reefs capable of substantial recovery can lose that advantage when heat stress becomes more frequent (GCRMN and ICRI, 2021g).

The Maldives highlight the dependence of a low-lying tourism economy on reef function, while Indian reef provinces face diverse combinations of bleaching, fisheries, shipping, dredging and coastal development. Chagos is often discussed as relatively remote and better protected, but remoteness does not prevent bleaching. South Asia's central conservation problem is therefore how to maintain reef recovery capacity while rapid development and recurrent thermal stress converge (GCRMN and ICRI, 2021g).

## Western Indian Ocean

The Western Indian Ocean includes East Africa, Madagascar, Comoros, Seychelles, Mauritius, Réunion and related island systems. The region has shown both significant damage and notable recovery over time. GCRMN's regional chapter found that reefs recovered substantially after the 1998 bleaching event before later disturbances drove renewed decline. This means the WIO still contains many reefs with meaningful recovery potential, but that potential is increasingly being tested by repeated climate events (GCRMN and ICRI, 2021b).

The mainland East African states face particularly strong pressures from artisanal fishing, sedimentation, population growth and urbanisation, while island states must manage tourism and coastal infrastructure alongside bleaching risk. The WIO is therefore a region where management still has real room to make a difference, but only if local stressors are reduced enough for recovery windows to remain open (GCRMN and ICRI, 2021b).

Canoeing over shallow reef area in Southern Asia



## Red Sea and Gulf of Aden

The Red Sea and Gulf of Aden are globally significant because parts of the Red Sea appear more heat-tolerant than many other coral reef regions. Yet the GCRMN regional synthesis also shows clear cycles of decline and partial recovery rather than uninterrupted resilience. This is a comparatively robust region in some sectors, not an invulnerable one (GCRMN and ICRI, 2021c).

Its conservation importance is rising because potential climate refugia are strategically valuable. But the region also faces rapid coastal development, tourism expansion, desalination, port activity and, in some areas, political instability and conflict. The management challenge is therefore unusually high-stakes: if these reefs do retain relative thermal resilience, protecting them becomes important not just regionally but globally (GCRMN and ICRI, 2021c).

## Persian/Arabian Gulf and Gulf of Oman

The reefs of the Persian/Arabian Gulf and Gulf of Oman live in some of the hottest reef environments on Earth and have long attracted attention for their tolerance of extreme conditions. Yet the region has also suffered severe bleaching-related collapses and subsequent recoveries. It shows both remarkable resilience and exceptional vulnerability. Recovery may occur, but it happens within one of the most industrialised and physically altered reef seascapes in the world (GCRMN and ICRI, 2021d).

Coastal reclamation, dredging, shipping, desalination and oil and gas infrastructure make this a uniquely difficult reef management environment. The region's reefs are scientifically fascinating, but they are also politically and industrially exposed. Conservation here must therefore operate under conditions that are more complex than in most other reef provinces (GCRMN and ICRI, 2021d).

Coral reef scene in Sharm El Sheikh, Red Sea, Egypt



## Eastern Tropical Pacific

The Eastern Tropical Pacific, including Pacific Mexico, Costa Rica, Panama, Colombia, Ecuador and the Galápagos, is naturally more disturbance-prone than many central Indo-Pacific reef regions. GCRMN reported a substantial long-term decline in hard coral cover and rising algae in the region, reflecting strong sensitivity to El Niño-driven heat stress and other oceanographic variability. These are reefs already living near ecological limits (GCRMN and ICRI, 2021e).

The Galápagos and other protected islands demonstrate that strict protection does not prevent climate-driven bleaching. Mainland coasts add runoff, coastal development and fishing pressures. The conservation task is therefore to reduce whatever local stressors can be controlled, while recognising that these reefs are among the most climatically exposed in the world (GCRMN and ICRI, 2021e).

## Brazil

Brazilian reefs are distinct from Caribbean and Indo-Pacific systems but remain highly important. GCRMN's Brazil chapter described a fluctuating trajectory in coral cover, with significant recent bleaching and high mortality during the 2019–2020 marine heatwave. It also found a major rise in algal cover over the longer term, indicating changing benthic composition and mounting ecological pressure (GCRMN and ICRI, 2021f).

Brazil matters because its reefs were sometimes imagined as potentially buffered by turbidity or local conditions, yet recent events have shown that they too can experience severe climate-driven mortality. The management challenge lies in preserving reef function while dealing with warming, development and altered benthic competition. Brazil therefore reinforces the global conclusion that no reef province should be treated as safely outside the climate crisis (GCRMN and ICRI, 2021f).



Porto de Galinhas, Pernambuco, Brazil features vibrant, shallow coral reefs

# Final Insights



The world's coral reefs are now defined by uneven but unmistakable decline. The Caribbean provides the clearest long-term example of cumulative degradation driven by overfishing, disease, declining herbivory, pollution and repeated bleaching. The Pacific still contains some of the world's most ecologically intact and socially embedded reef systems, but remoteness and customary stewardship are no longer enough to prevent climate-driven damage. Australia shows that even world-class reef governance cannot fully shield reefs from marine heatwaves. The Red Sea and Gulf regions may hold important lessons about resilience, but they too are exposed to disturbance and rapid development. In every ocean basin, the same conclusion emerges: local management still matters profoundly, but global climate forcing increasingly sets the outer limits of what local management can achieve (GCRMN and ICRI, 2018; GCRMN and ICRI, 2021h; GCRMN and ICRI, 2025).

That leads to a final and unavoidable point. Coral reef conservation now has two inseparable fronts. The first is local and regional: fisheries rebuilding, watershed management, pollution control, disease monitoring, enforcement, restoration where appropriate and protection of ecologically resilient sites. The second is global: rapid emissions reductions to limit further warming and acidification. Without both, the most likely future for many reef regions is continued simplification rather than recovery. Reef conservation in the twenty-first century is therefore no longer only an environmental issue. It is a question of food security, coastal protection, biodiversity persistence and, in many island states, long-term social viability (GCRMN and ICRI, 2021h); NOAA, 2025a; NOAA, 2025b).

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