

REGIONAL REPORT V.0

Red List of Ecosystems assessment of Caribbean coral reefs

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ABSTRACT

Caribbean coral reefs extend across the Tropical Western Atlantic, with the western most coral reefs in the Gulf of Mexico, eastern most coral reefs in Barbados, northern most reefs in Bermuda, and most southern reefs from the coasts of Panama and Colombia, with reef area estimated to be 13,554km². These coral reefs span cross ten marine across the Wider Caribbean as defined by the Marine Ecoregions of the World framework. The region hosts two species of Critically Endangered *Acropora* that historically built shallow-water reef environments, and large bouldering *Orbicella* spp. that dominate typical fore-reef spur-and-groove coral reef habitat. These ecosystems face increasing pressure from climate change induced marine heatwaves that cause mass coral bleaching and extensive mortality, along with disease outbreaks, overharvesting of functional species,

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KEYWORDS

Red List of Ecosystems; coral reefs; ecosystem collapse; risk assessment; Caribbean

excessive sources of land-based pollution, and local development pressures such as dredging and anchoring. The IUCN Red List of Ecosystems assessment, based on four distinct lines of evidence (criteria A-D), found that coral reefs within all ten ecoregions are at high risk of collapse, with all ecoregions assessed as Critically Endangered. This was primarily driven by anthropogenic global warming, increasing the intensity and frequency of marine heatwaves that drive excessive episodes of mass coral bleaching. The RLE results highlight the urgent need for collective action to immediately reduce greenhouse gas emissions and promote effective conservation management to prevent local scale impacts compounding with climate change. Together, these efforts will provide Caribbean coral reefs the best chance of persistence through the 21st century.

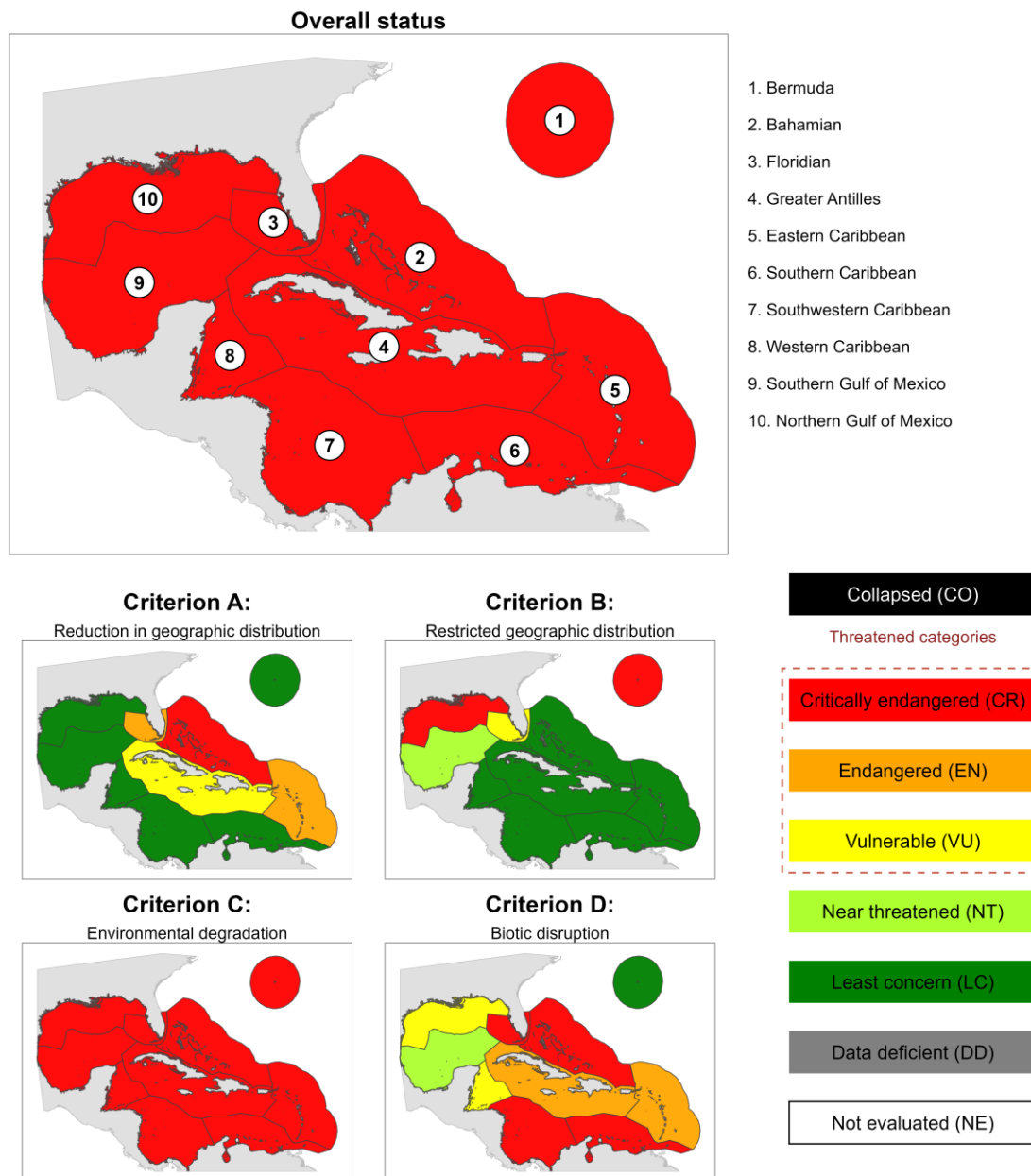


Figure 1. Distribution of the ten coral reef ecoregions in The Caribbean. The top panel (Overall Status) shows the overall Red List of Ecosystems risk status. The Criterion panels (Criteria A-D) display the risk status results for criteria A-D.

1. Study Area

This Red List of Ecosystems (RLE) assessment evaluates the risk of collapse for coral reefs across the Caribbean as of 2025. Caribbean coral reefs (IUCN Global Ecosystem Typology M1.3 - photic coral reefs) extend across the Tropical Western Atlantic, situated entirely within the Northern Hemisphere. The Americas separate Caribbean coral reefs from the

Pacific, with continental coral reefs occurring along the continental America, Major island reef systems in the Greater Antilles, while smaller island-based reef systems are scattered throughout the Caribbean. Overall, the region contains an estimated 13,554 km² of coral reefs based on measurements from the Millenium coral atlas layer (UNEP-WCMC and WRI, 2021).

Coral reefs of the Caribbean were grouped into ten ecoregions based on the Marine Ecoregions of the World (MEOW) framework developed by Spalding et al. (2007). These coral reef ecoregions capture ecological variation in community composition of shallow water benthic, invertebrate, and fish communities, with marked differences in the abiotic conditions based on climate, continental influence, and geology. These ecoregions are equivalent to level 4 of the IUCN Global Ecosystem Typology (regional sub-groups). Coral reefs in each ecoregion were independently assessed using the IUCN Red List of Ecosystems criteria (details on data collection/ monitoring in annex 1).

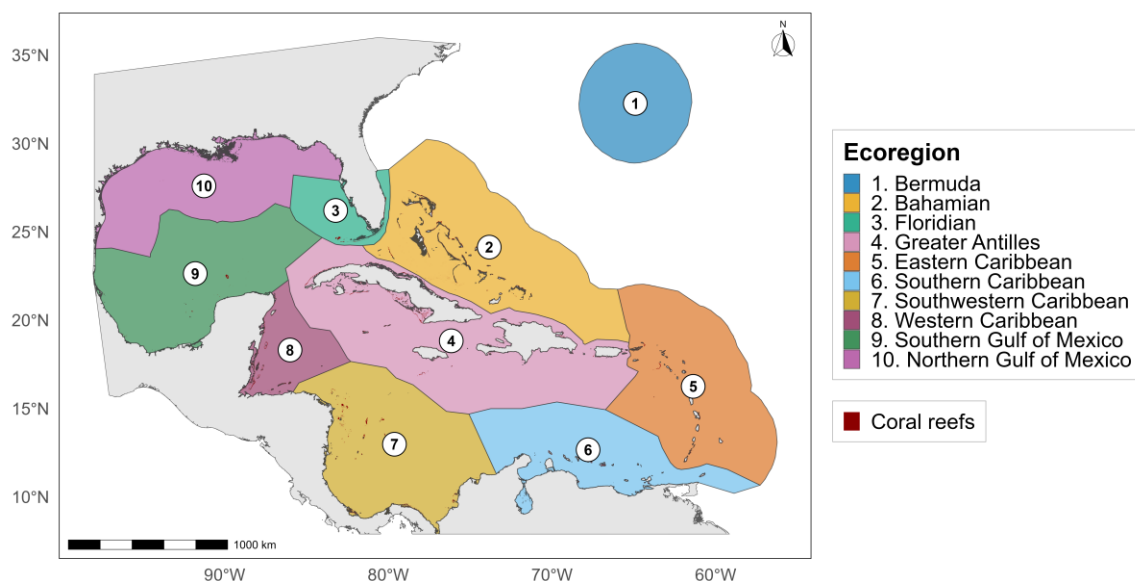


Figure 2. Coral reefs of the Caribbean derived from the Millenium coral reef layer, grouped within coral reef Marine Ecoregions of the World (Spalding *et al.* 2007) to be evaluated under the IUCN Red List of Ecosystems criteria and corresponding to Level 4 of the IUCN Global Ecosystem Typology.

2. Ecosystem Description

Caribbean coral reefs are evolutionarily and functionally distinct from their Indo-Pacific counterparts, having developed under markedly different environmental conditions following the closure of the Isthmus of Panama approximately 2.8 million years ago (O'Dea et al., 2016). Altered abiotic processes across The Caribbean after the closing of the Isthmus shaped the evolution of Caribbean reef taxa, such as coral reproductive strategies (Roff, 2021) and the trophic ecology of reef-associated organisms (Jackson and O'Dea, 2023). Despite spanning a broad geographic area, coral reefs throughout the Caribbean generally

exhibit high similarity in faunal composition and ecosystem function, with notable exceptions including the northern Gulf of Mexico, where reefs are largely restricted to submerged offshore banks below ~15 m depth, and Bermuda, a subtropical Atlantic system with distinct biogeographic influences. Caribbean reefs are typically characterised by shallow lagoonal habitats extending seaward to a reef crest in predominantly fringing reef formations, transitioning oceanward into fore-reef environments commonly defined by spur-and-groove morphology. In some areas, reef systems terminate in steep wall habitats associated with local tectonic and geomorphological processes.

2.1. Key Biotic Components

Hard coral species (order Scleractinia) that form symbiosis with photosynthetic microalgae (*Symbiodiniaceae*) are the foundation of Caribbean coral reefs. Approximately ~70 species of reef-building corals are found throughout the Caribbean region, far lower than species diversity of the Indo-Pacific (Veron et al., 2025). All native reef-building hard coral species are endemic to the Atlantic Ocean, with little endemism observed within Caribbean ecoregions due to the insularity and small size of the Caribbean basin (Veron et al., 2025). However, species diversity varies from the depauperate marginal ecoregions such as Bermuda – with 14 coral species – to the central ecoregions of the Caribbean such as the Western Caribbean and Greater Antilles with ~60 species (Veron et al., 2015). The keystone reef builders in the Caribbean vary by reef habitat, with *Acropora* spp. typically dominant in shallow water reef environments of the reef crest, while *Orbicella* spp. are the architectural reef builders of the fore-reef environment (Veron et al., 2015). Half of Caribbean coral species are threatened with extinction under the IUCN Red List of species framework, including 2 of the 3 *Orbicella* species listed as critically endangered, along with both *Acropora* species (Gutierrez et al., 2024). It is likely *Acropora* spp. are functionally extinct across many Caribbean ecoregions because of compounding impacts of White Band Disease in the 1980s, followed by the catastrophic 2023-2025 marine heatwaves (Birkart and Álvarez-Filip, 2025; Manzello et al., 2025). Other key benthic components that exist on Caribbean coral reefs include macroalgae, turf algae, crustose coralline algae, sponges (Porifera), soft corals (*Octocorallia*), and fire corals (*Milleporidae*).

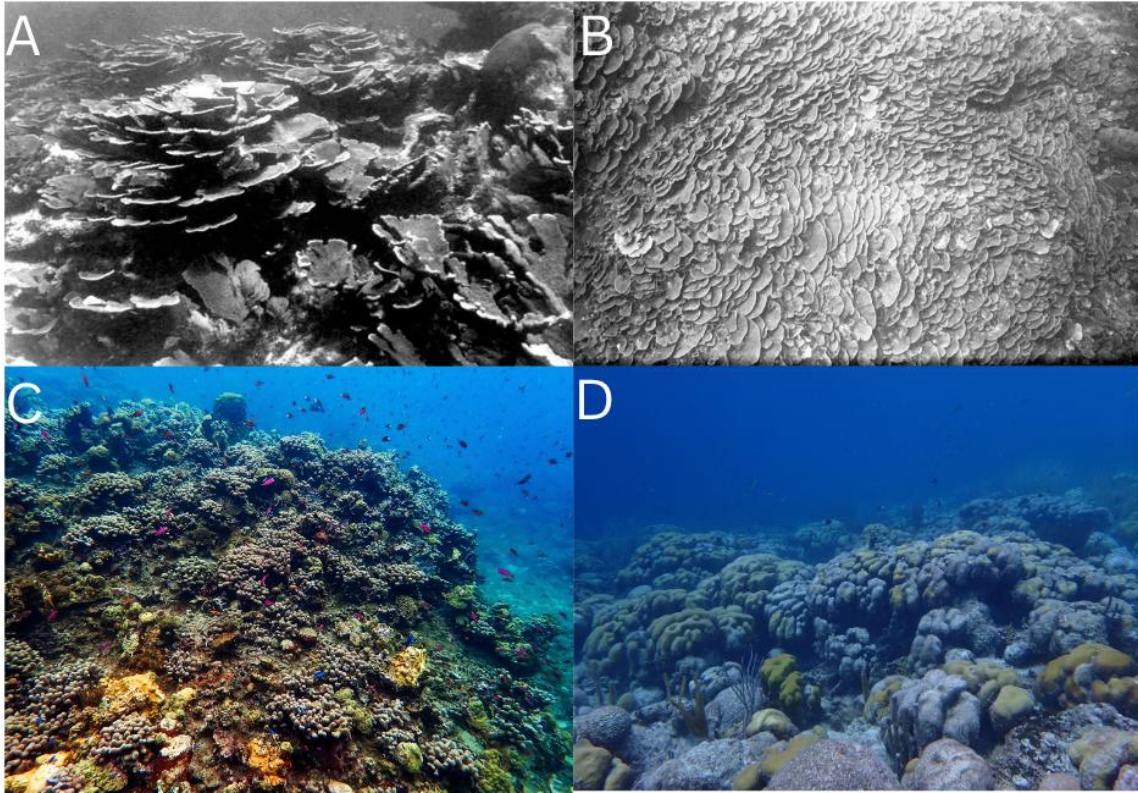


Photo composite 1. Examples of typical Caribbean coral reef structures from past (A & B), and the present (C & D). (A) is an *Acropora palmata* dominated reef from Puerto Morelos, Mexico in the 1980s. (B) is a field of *Agaricia* spp. from Discovery Bay, Jamaica between 1966 and 1968. (C) shows a typical Caribbean reef structure from the 2023 in Dominica, dominated by weedy *Porites* spp. and *Madracis* spp. (D) is a typical *Orbicella* spp. dominated reef structure, which has suffered extensive mortality, from Bonaire 2024. Photo credits: (A) Eric Jordán Dahlgren. (B) Kenneth Johnson (2016). *Coral reef imagery by Eileen Graham of Jamaica in the 1960s* [Data set]. Natural History Museum. <https://doi.org/10.5519/0008285>. (C) Anderson Mayfield. (D) Haley Davis.

Approximately 600 reef fish species are associated with coral reefs in the Caribbean, including corallivorous butterflyfish (*Chaetodontidae*), herbivorous parrotfish (*Scaridae*), surgeonfish (*Acanthuridae*), and carnivorous groupers (*Epinephelidae*) and snappers (*Lutjanidae*). Common invertebrates include various species of sea urchins, especially the genus *Diadema*, sea cucumbers (*Holothuroidea*), and numerous Mollusca. Megafauna such as Caribbean reef sharks are common in some locations where overexploitation of fisheries has not occurred (Valdivia et al., 2017), such as the Cayman Islands (Kohler et al., 2025). Loggerheads, Green, and Hawksbill turtles can also be found commonly on coral reefs where adequate protection of vulnerable life stages exist (Blumenthal et al., 2021), although carnivorous and herbivorous megafauna occur in far lower abundances than their historical number (Jackson et al., 2001).



Photo composite 2. Charismatic megafauna often associate with Caribbean coral reefs. (A) is a Spotted Eagle Ray (*Aetobatus narinari*) in Cayman Brac. (B) is a Caribbean Reef Shark (*Carcharhinus perezii*) from Little Cayman. (C) is a Nurse Shark (*Ginglymostoma cirratum*) from Little Cayman. (D) is a Hawksbill Turtle (*Eretmochelys imbricata*) entangled in Rope Sponge from Little Cayman. Photo credits: (A) and (C) Brian Cole. (B) and (D) Nathan Prince.

2.2. Key Abiotic components

Photic coral reefs in the Caribbean occur from 0-30m depth, in warm, clear, oligotrophic water, with some exceptions. Generally Caribbean coral reef substrates lie upon the seabed in spur and groove reef formations intersected by sand. Most coral reefs occur in water from 25°C to 30°C (Bove et al., 2022). However, Higher-latitude coral reefs of the Caribbean, such as the Bermuda ecoregion experience wintertime temperatures as low as 17°C. Salinity in the Caribbean ranges from 32-37 ppt, while pH ranges from 7.8 – 8.6 (McField and Kramer 2007). Many oceanic coral reef banks are surrounded by deep water (>1,000m depth) absent of input from land-based sources of pollution, and as such have exceptional water clarity down to mesophotic (>30m) depths, such as Banks in the Northern Gulf of Mexico, Southern Gulf of Mexico, the Greater Antilles, and the Western Caribbean. Tropical storms and hurricanes influence Caribbean coral reef composition in a multifaceted manner – causing both coral damage, but also cooling seawater during thermal stress events, thus alleviating bleaching (Manzello et al., 2007). Often, tropical storms break up *Acropora* on the reef crest, speeding up the process of asexual reproduction further contributing to *Acropora* dominance (Rogers et al., 1982). However, the loss of fast growing *Acropora* after a storm event can also allow

settlement and growth of slower growing, more stress tolerant corals in the shallow water environment (Rogers et al., 1982).

2.3. Key processes and interactions

The symbiotic relationship between endosymbionts of the family *Symbiodiniaceae* with Scleractinia reef corals is the foundation of coral reef ecosystems. Across the ~70 coral species in the Caribbean, more than 95% of their metabolic requirements are acquired from the photosynthetic endosymbiont (Wiedenmann et al., 2023). This obligate symbiosis underpins the survival, growth, and reproduction of coral holobionts, enabling energy resources to be utilised for calcification that builds the coral reef framework over millennia (Drake et al., 2020). Maintenance of this symbiosis is reliant on multiple abiotic factors within favourable ranges for the coral holobiont including temperature, pH, and turbidity (Suggett and Smith, 2020).



Photo composite 3. (A) Pillar Coral (*Dendrogyra cylindrus*) with polyp tentacles extended during daytime in Little Cayman. (B) is an *Acropora palmata* spawning from the Flower Garden Banks (FGB) in the Northern Gulf of Mexico. (C) shows other benthic taxa including fire coral (*Millepora*) along with Crustose Coralline Algae, Turf Algae, and Macroalgae on a coral head in Little Cayman. (D) is a spawning *Orbicella faveolata* from the FGB. (E) shows marine Tube and Barrel Sponges from Little Cayman. Photo credits: (A) Jack Johnson. (B) Brett Seymore, National Park Service; “Elkhorn coral spawning” by FWC Fish and Wildlife Research Institute, CC BY-NC-ND 2.0. (C) Brian Cole. (D) G.P. Schmahl/NOAA; “FGBNMS - Coral Spawning” by NOAA Office of National Marine Sanctuaries, Public Domain Mark. (E) Nathan Prince.

Macroalgae are the primary competitors with reef-building corals on Caribbean reefs, rapidly monopolising space following coral mortality and preventing coral recruitment, thereby creating a bottleneck for recovery (Mumby et al., 2006a). Macroalgal dominance is also associated with reduced crustose coralline algae (Guinotte and Fabry, 2008) - important for reef binding and coral settlement (Hill and Hoogenboom, 2022). Additionally, macroalgae can increase coral disease prevalence, chemical inhibition in corals, and cause physical smothering, forcing the coral holobiont to allocate resources to survival rather than growth and reproduction, reinforcing declines in coral cover over ecological timescales (Clements and Hay, 2019).

Herbivory by sea urchins (especially *Diadema*), parrotfishes (*Scaridae*), and surgeonfishes (*Acanthuridae*) counteract this process by either grazing macroalgae in specific scenarios (Dell et al., 2020), or more commonly, preventing turf algae succession to macroalgae. Thus, herbivory maintains space for coral recruits and reduces the likelihood of phase shifts to macroalgal dominance (Dell et al., 2020; Hughes et al., 2010; Mumby et al., 2006a). In turn, mesopredators such as snappers and groupers control herbivore populations through consumptive (Beets, 1997) and non-consumptive (Mitchell and Harborne, 2020) processes, thus influencing benthic cover via cascading trophic processes (Mumby et al., 2007). Additional processes include direct corallivory by fishes (*Chaetodontidae*) and gastropods, nutrient cycling by motile and sessile taxa such as sea cucumbers and sponges that may reduce coral disease (Clements et al., 2024), and parasite removal by cleaner fishes (*Labridae*), which enhances reef fish fitness (Ramírez-Ruiz et al., 2023) and supports trophic interactions influencing benthic composition and nutrient transfer across the reef.

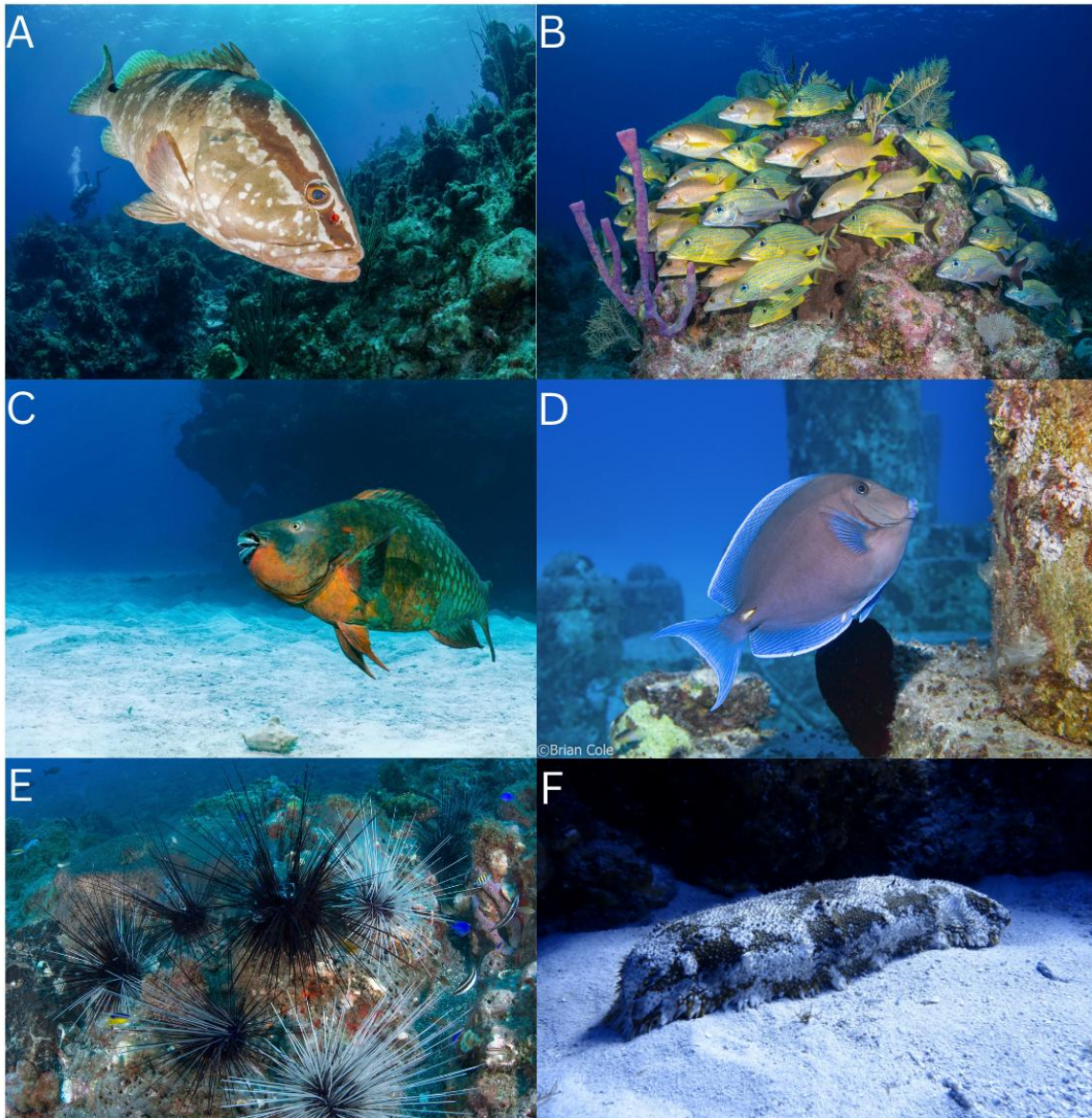


Photo composite 4. Functional reef taxa associated with Caribbean coral reefs. (A) is a carnivorous Nassau Grouper (*Epinephelus striatus*) from Little Cayman. (B) shows a mixed school of French Grunts (*Haemulon flavolineatum*) and Schoolmaster Snappers (*Lutjanus apodus*) around a coral head in Little Cayman. (C) is a Rainbow Parrotfish (*Scarus guacamaia*) in Little Cayman. (D) shows a Blue Tang (*Acanthurus coeruleus*) in Cayman Brac. (E) shows the herbivorous Long-Spined Sea Urchins (*Diadema antillarum*) from the Flower Banks Garden in the Northern Gulf of Mexico. (F) is a Furry Sea Cucumber (*Astichopus multifidus*) in Little Cayman. Photo credits: (A & B) Liv Barnett. (C) Nathan Prince. (D) Brian Cole. (E) Photo Credit: G.P. Schmahl/NOAA: "FGBNMS - Long Spined Sea Urchin" by NOAA Office of National Marine Sanctuaries, Public Domain Mark. (F) Leon Schlenger.

2.4. Main Threats

Anthropogenic global warming ranks among the most devastating threats to Caribbean coral persistence. Marine heatwaves are increasing in frequency and intensity (Hughes et al., 2018a; Oliver et al., 2018; Spady et al., 2026), causing widespread bleaching across the region (Reimer et al., 2024a). Bleaching, defined as the dysbiosis between photosynthetic endosymbionts and cnidarian hosts, now occurs for durations sufficient to cause extensive coral mortality (>50%) on many reefs (Bon et al., 2026; Doherty et al., 2025; C Mark Eakin et al., 2026; Spady et al., 2026). Between August 2018 and December 2025, 99.9% of Caribbean reef locations experienced heat stress indicative of coral bleaching (Spady et al., 2026). Corals that survive marine heatwaves often experience delayed impacts, including reduced growth, impaired reproduction, and increased disease prevalence (Levitan et al., 2014a). As marine heatwaves are becoming an annual occurrence (Bove et al., 2022; Spady et al., 2026), recovery windows for coral cover are increasingly short (Hughes et al., 2018a), with recruitment failing due to physiological damage to adults during heat stress or mortality of new recruits during subsequent events (Hughes et al., 2019; Levitan et al., 2014a).

Increased atmospheric CO₂ concentrations and chronic ocean warming pose additional direct threats. Sea surface temperatures in the Caribbean have increased by 1.07°C since 1985 (Bove et al., 2022), with increased ocean temperatures strongly linked to increased impacts from coral disease (Bruno et al., 2007). Combined impacts of warming and disease outbreaks are linked to reduced coral cover, increased macroalgae, declines in keystone *Orbicella* species, and proportional increases in weedy *Porites* spp. (Alvarez-Filip et al., 2022; Álvarez-Filip et al., 2026; Bruno et al., 2007; Wicquart et al., 2025). Subsequent marine heatwaves have eradicated many weedy corals throughout the Caribbean (Doherty et al., 2025; Spady et al., 2026). Warmer oceans also contribute to more frequent and powerful hurricanes (Balaguru et al., 2023), which caused substantial coral loss throughout the 20th century (Balaguru et al., 2023). However, the net impact of hurricanes has shifted in the last decade, providing relief to corals by lowering sea temperatures during time of bleaching (Manzello et al., 2007). Ocean acidification is an additional stressor, with pH declining by ~0.1 since pre-industrial times (Feely et al., 2009). Acidification reduces calcification rates of reef-building organisms, slows coral growth, and hinders survival (Erez et al., 2011), while reducing crustose coralline algae growth by ~40%, exacerbating coral recruitment loss by >70% (Guinotte and Fabry, 2008).

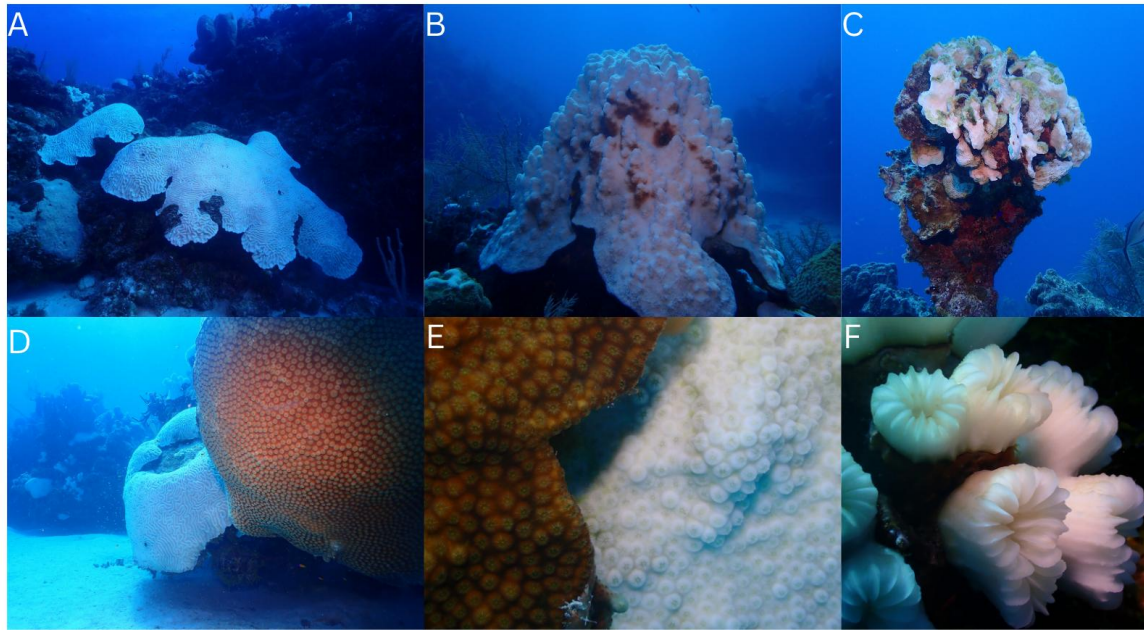


Photo composite 5. Climate change induced bleaching impacts on corals exemplified from the 2023 bleaching event in Little Cayman. (A) heavily bleached typically stress tolerant species *Colpophyllia natans*. (B) Bleached key reef builder *Orbicella faveolata*. (C) a coral head with bleached *Agaricia* spp. from Bonaire during the 2024 bleaching event. (D) shows interspecific differences in bleaching response with an unbleached/paling *Montastraea cavernosa* in the foreground, next to a heavily bleaching *C. natans*. (E) shows intraspecific variation in bleaching response, with two adjacent colonies of *O. faveolata* with the left colony unbleached, while the right colony is heavily bleached. (F) is a close-up image of a *Eusmilia fastigiata* – a typically stress tolerant coral – fully bleached. Photo credits: (A-F Haley Davis).

Coastal development and land use impacts are a major local disturbance intensifying through time on Caribbean coral reefs, with human populations living within 20 km of Caribbean reefs increasing from ~34 million in 2000 to 47 million in 2020 (Wicquart et al., 2025). Nutrient and sediment discharge from rivers and runoff associated with urbanisation and agriculture reduce coral fitness and promote macroalgal growth, shifting reefs toward algal dominance (Adam et al., 2021; Lesser, 2021; Zhao et al., 2021). Additional pollutants include pesticides and herbicides (Ajwang, 2024), marine litter (Pinheiro et al., 2023), sewage (Sutherland et al., 2010), and oil spills from the fossil fuel industry (Goodbody-Gringley et al., 2013). Maritime traffic also negatively impacts reefs, including noise effects on fish communities (Johnson et al., 2023), anchoring damage (Small and Oxenford, 2022), and cruise port expansion (Walker et al., 2012). These stressors are linked to increased prevalence of catastrophic diseases, including white band disease that decimated *Acropora* populations (Aronson and Precht, 2001), stony coral tissue loss disease causing declines up to 62% in some locations (Papke et al., 2024), yellow band disease, and black band disease. Waterborne pathogens caused mass mortality of *Diadema antillarum* (Mumby et al., 2006b), with major implications for coral recruitment via macroalgal proliferation (Mumby et al., 2006b). A second *Diadema* mortality event occurred in 2022 ranging from the Northern Caribbean

(Floridian and Bahamian coral reefs) through to the Southern Caribbean (Hewson et al., 2023).

Overharvesting and invasive species further reduce ecosystem resilience. Unsustainable fishing of carnivorous reef fishes (groupers and snappers) has caused trophic cascades via mesopredator release (Boaden and Kingsford, 2015; Valdivia et al., 2017). Overexploitation of invertebrates such as conch, lobster, and sea cucumbers impacts nutrient cycling likely affecting reef resilience (Clements et al., 2024). Finally, invasive species also alter reef communities, with *Pterois volitans* impacting food webs (Côté et al., 2013), and the soft coral *Unomia stolonifera* capable of overgrowing native reef corals (Ruiz Allais et al., 2014).

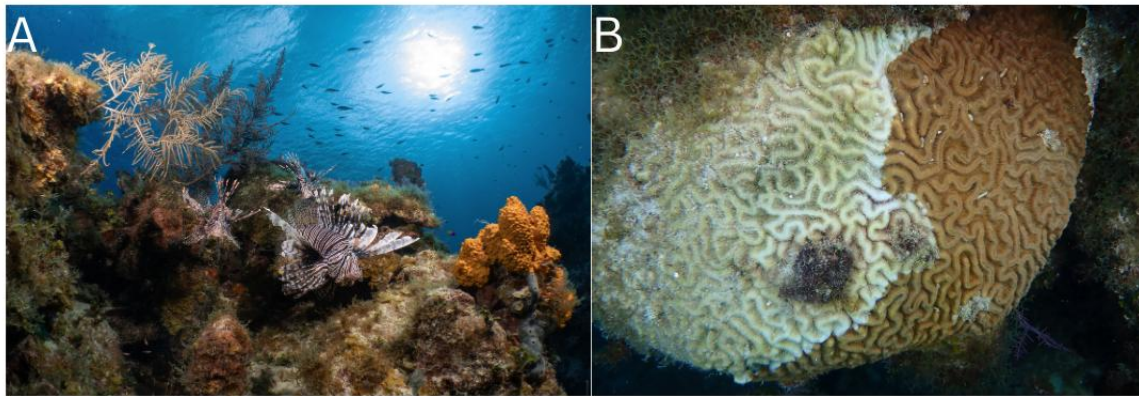


Photo composite 6. Other threats to Caribbean coral reef ecosystems. (A) are invasive Red Lionfish (*Pterois volitans*) native to the Indo-Pacific on coral reefs in Little Cayman. (B) shows a rapidly progressing coral disease margin, likely Stony Coral Tissue Loss Disease, causing extensive mortality on a *Colpophyllia natans* colony. Photo credits: (A) Nathan Prince. (B) Jack Johnson.

Table 1. Occurrence of major threats impacting coral reefs in each ecoregion categorised based on the IUCN Threat Classification Scheme. A ✓ (tick) represents threats currently having an impact within the ecoregion. A – (dash) indicates the threat is not an issue in that ecoregion, while a + (plus) indicates the threat is emerging and likely to become an issue in the near future. Ecoregions depicted in the following order: 1=Bahamian, 2=Bermuda, 3=Eastern Caribbean, 4=Floridian, 5=Greater Antilles, 6=Northern Gulf of Mexico, 7=Southern Caribbean, 8=Southern Gulf of Mexico, 9=Southwestern Caribbean, 10=Western Caribbean.

Threat type	Subcategory	1	2	3	4	5	6	7	8	9	10
1. Residential & commercial development	1.3 Tourism & recreation areas	✓	✓	✓	✓	✓	-	✓	+	✓	✓
3. Energy production & mining	3.1 Oil & gas drilling	-	-	+	+	✓	✓	✓	✓	✓	+
4. Transportation & service corridors	4.3 Shipping lanes	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
5. Biological resource use	5.4 Fishing & harvesting aquatic resources	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
6. Human intrusions & disturbance	6.1 Recreational activities	✓	✓	✓	✓	✓	-	✓	+	✓	✓
7. Natural system modifications	7.3 Other ecosystem modifications	✓	✓	✓	✓	✓	-	✓	✓	✓	✓
8. Invasive & problematic species	8.1 Invasive non-native species	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Threat type	Subcategory										
	8.6 Diseases of unknown cause	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
9. Pollution	9.1 Domestic & urban wastewater	✓	✓	✓	✓	✓	-	✓	✓	✓	✓
	9.3 Agricultural & forestry effluents	+	-	✓	✓	✓	-	✓	✓	✓	✓
11. Climate change & severe weather	11.3 Temperature extremes	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	11.4 Storms & flooding	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

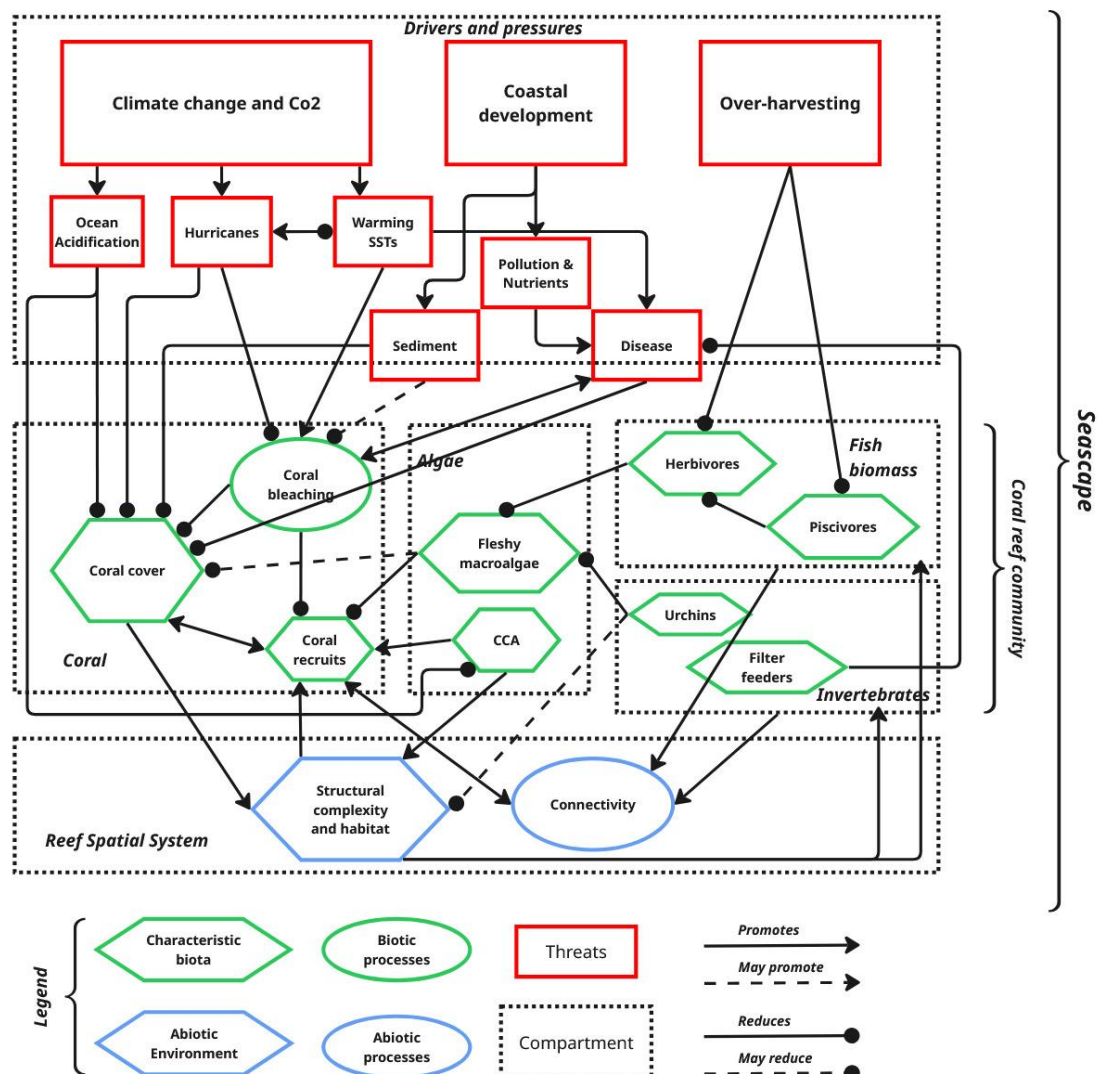


Figure 3. Conceptual model of Caribbean coral reef ecosystems. The model illustrates key biotic and abiotic components, as well as external drivers, threats, and the processes and interactions between them (Ferrer et al., 2024).

2.5. Definition of the collapsed state of the ecosystem

Ecosystem collapse represents the final stage of degradation. It occurs when an ecosystem's defining biodiversity and features decline to levels where the ecosystem transforms into a different type or is completely lost. This state can result from a number of pathways that reduce the capacity of an ecosystem to sustain its characteristic biota, such as disease, overharvesting, or a persistent change in environmental conditions. Collapse can occur locally, for example in a single reef. For an ecosystem type to be classified as 'Collapsed', it must have fully declined or degraded across its entire distribution, although recovery may still be possible under conducive conditions.

For coral reefs, collapse is signalled by the near or complete loss of hard corals to levels where defining processes such as carbonate accretion are absent (or negligible). A collapsed reef would have extremely low coral richness and diversity, with communities dominated by a few weedy or stress-tolerant species. Collapsed coral reefs are often characterised by a phase shift from coral dominance to high abundances of other benthic components, such as turf and fleshy algae, rubble, and sponges or other filter-feeding invertebrates. This state is also associated with low abundance and diversity of other key biodiversity including altered fish communities. In some cases, collapse corresponds to a simplified topographic structure or occurs where the geomorphological structure of coral reefs permanently disappears through land reclamation or coastal development. A collapsed reef may have an unsuitable abiotic environment due to declines in water quality, increases in temperature, as well as frequent and severe disturbance events.

Under the Red List of Ecosystems framework, collapse can be defined as when key biotic or abiotic indicators reach thresholds where the ecosystem's defining features are (or would be) lost.

For this assessment, coral reef ecosystem collapse is defined by any of the following:

- a) complete loss of coral reef area
- b) hard coral cover falling below **5%**;
- c) sea surface temperatures exceeding critical thresholds, resulting in frequent severe heatwaves and coral bleaching at an average return time between events of 10 bleaching events in a 30-year period, or 3 mortality events in a 5-year period.

In addition, the following biotic indicators reflect severe functional degradation but not complete ecosystem collapse, and can be used to elevate risk levels:

- a) a macroalgal-to-coral cover ratio exceeding 5:1;
- b) severe depletion of key fish groups (e.g., herbivores and piscivores) to levels well below historical baselines.

Table 2. Key abiotic and biotic features and characteristics of the coral reef's ecoregions in the Caribbean, derived from Spalding et al., (2007) – Marine Ecosystems of the World.

Ecoregion	Key Biotic	Key Abiotic	Key Threats
Bahamian	High diversity of reef-building corals and associated fishes and invertebrates. Seagrass and mangrove systems provide important nursery habitat and connectivity with reefs.	Extensive carbonate platforms and shallow banks; generally clear, oligotrophic waters with high reef development. Relatively low terrestrial sediment input. Strong influence of Atlantic currents and exposure to tropical storms and hurricanes.	Anthropogenic climate-driven warming causing coral bleaching; coral disease; fishing and harvesting; tourism and recreational activities; shipping; wastewater and coastal development.
Bermuda	High-latitude subtropical coral reef system with relatively low species richness compared with tropical Caribbean reefs. Distinctive coral assemblages adapted to cooler conditions. Reefs support diverse fish and invertebrate communities.	Isolated subtropical platform in the western North Atlantic, at the northern limit of extensive reef development. Seasonal temperature variability and periodic cold-water stress are greater than in tropical Caribbean ecoregions. Relatively deep surrounding ocean and limited terrestrial sediment input.	Marine heatwaves and temperature extremes; coral disease; recreational activities and boating; fishing; shipping; coastal development.
Eastern Caribbean	High coral and reef-fish diversity across the Lesser Antilles, with strong island-to-island variation in community composition. Fringing and patch reefs are common, with important herbivorous fish and coral assemblages.	Volcanic island arc with steep bathymetry, narrow shelves and generally oceanic conditions. High exposure to Atlantic trade winds, waves and hurricanes. Localised terrestrial runoff and sedimentation near developed islands.	Climate change induced coral bleaching; coral disease; fishing; coastal development; wastewater and agricultural runoff; tourism/recreation; storms.
Floridian	Diverse coral communities associated with the Florida Reef Tract, and Florida Keys, including extensive reef-building coral assemblages and high reef-fish diversity. Important populations of large reef fishes and herbivores.	Broad continental shelf with extensive shallow carbonate reef habitat. Strong influence of the Gulf Stream and Florida Current. Generally clear waters offshore but substantial coastal influence, freshwater discharge and nutrient inputs in some areas.	Coral disease, particularly SCTLD; warming and bleaching; coastal development and wastewater; fishing; recreational activities and vessel/anchor damage; shipping; storms.
Greater Antilles	Highly diverse coral reef communities associated with Cuba, Hispaniola, Jamaica and Puerto Rico. High regional coral and fish diversity, with substantial variation among islands. Extensive reef, mangrove and seagrass connectivity.	Large and geologically diverse islands with extensive continental/shelf and island-shelf reef habitats. Strong gradients in exposure, depth, currents and terrestrial influence. High exposure to tropical hurricanes.	Climate warming and bleaching; coral disease; overfishing; coastal development; wastewater and agricultural runoff; tourism; storms; shipping and pollution.
Northern Gulf of Mexico	High coral cover and relatively large, structurally complex reef-building coral colonies compared with many other Caribbean reefs. The banks support diverse reef-associated fishes, sponges, algae and invertebrates, and represent distinctive high-latitude coral	Isolated carbonate banks on the outer continental shelf, approximately 100–200 km off the Texas–Louisiana coast. Reefs occur in relatively deep water (>18m), with clear offshore waters and limited direct terrestrial influence. The region	Climate-driven warming and bleaching; coral disease; fishing; oil and gas activity and associated pollution; shipping.

Ecoregion	Key Biotic	Key Abiotic	Key Threats
	communities within the Gulf of Mexico.	experiences seasonal temperature variation and occasional exposure to cold-water events, marine heatwaves, and storms.	
Southern Caribbean	Diverse coral, fish, and invertebrate assemblages across fringing, patch, and platform reefs.	Generally warm tropical waters with relatively low seasonal temperature variation. Strong oceanographic influence from the Caribbean Current and South American freshwater discharge. Localised high productivity and sediment/nutrient inputs near continental coastlines.	Warming and bleaching; coral disease; fishing; coastal development; wastewater and agricultural runoff; oil and gas exploration/production.
Southern Gulf of Mexico	Diverse coral and reef-associated communities, including shallow coastal reefs and deeper mesophotic communities with large <i>Orbicella</i> colonies. Important reef-fish and invertebrate assemblages associated with carbonate and hard-bottom habitats. Free from SCTLD as of 2026.	Broad continental shelf with strong terrestrial influence from Mexican rivers and coastal development. High variability in turbidity, nutrients and sedimentation. Warm tropical to subtropical waters influenced by Loop Current dynamics and Gulf circulation.	Oil and gas exploration/production; oil spills; fishing; shipping; agricultural and urban runoff; warming and bleaching; coastal development; storms.
Southwestern Caribbean	High biodiversity associated with coral reefs along Colombia, Panama, Costa Rica and Nicaragua. Includes extensive fringing, barrier and platform reefs, with strong coral-mangrove-seagrass connectivity in places	Strong influence of continental runoff, seasonal rainfall and river discharge. Oceanographic conditions vary substantially along the coast, with localised upwelling and high productivity in some areas. Exposure to tropical storms is generally lower than in the northern Caribbean, although not absent.	Fishing; warming and bleaching; coral disease; sedimentation and agricultural runoff; coastal development; wastewater.
Western Caribbean	Exceptionally diverse coral reef ecosystems, including the Mesoamerican Barrier Reef and extensive reefs around Belize, Honduras, Guatemala and the Yucatán Peninsula. High coral and reef-fish diversity and strong connectivity with mangrove and seagrass habitats.	Extensive shallow carbonate platforms and shelf-edge reefs. Generally warm tropical conditions, with strong influence of Caribbean currents. Localised freshwater, nutrient and sediment inputs, particularly near major rivers and developed coastal areas.	Warming and bleaching; coral disease; fishing; coastal development; tourism; wastewater and agricultural runoff; shipping; storms.

3. Criterion Assessment

Coral reefs from the ten recognized MEOW ecoregions (Spalding et al., 2007) within the Caribbean were assessed using IUCN Red List of Ecosystems (RLE) Criteria A–D. The

following section briefly describes the approach used for each criterion with the detailed methods presented in the Annex.

Criterion A — Decline in Distribution

Decline in distribution of coral reefs over the past 50 years was assessed using hard coral cover data and was calculated as the proportion of reef sites currently with less than 5% hard coral cover, which is a conservative estimated minimum threshold (i.e. where credible intervals are no longer positive) for net accretion (Perry et al., 2013). Coral reefs in each ecoregion were classified as Vulnerable if they experienced a 30–50% decline, Endangered if the decline was 50–80%, and Critically Endangered if the decline exceeded 80%. Reefs with declines of 27–30% were classified as Near Threatened, and all others were considered Least Concern.

Criterion B — Restricted Geographic Distribution

Criterion B assess the extent of occurrence (EOO) and area of occupancy (AOO) of the current distribution of coral reefs. EOO is the total area within the outer limits of the ecosystem's distribution, while AOO is the area occupied by the ecosystem, measured as the number of 10 by 10 km grid cells. Both were derived using the Millennium Coral Reef Layer, validated by regional experts. For both metrics the thresholds from the RLE guidelines were applied to assess risk, and additional conditions on continuing decline were evaluated using threat and biotic data from Criteria C and D.

Criterion C — Environmental Degradation

Under Criterion C, we evaluated the most pertinent threat to the persistence and survival of coral reefs—thermal stress caused by ocean warming—assessing both historical changes over the past 40 years (sub-criteria C1) and projections (sub-criteria C2) for the next 50 years. For C1, we examined trends in Degree Heating Weeks (DHWs) over the past 40 years, while C2 considered projected increases in thermal stress over the next 50 years, based on annual maximum Degree Heating Weeks (DHW). For both C1 and C2, the relative severity of environmental degradation was calculated by comparing the magnitude of past and projected changes against established thresholds for coral reef collapse. Risk categories are triggered when the extent of reefs exposed to declines according to this matrix.

Criterion D — Disruption of Biotic Processes and Interactions

Criterion D assesses the disruption to four key biotic components over the past 50 years. This includes hard coral cover, macroalgae to hard coral ratio, herbivore biomass, and piscivore biomass, derived from in-situ monitoring data. For each reef site, the decline in each indicator is measured relative to both the state of the reef 50 years ago and a hypothetical collapse threshold, representing the point at which that biotic component is no longer functional. The proportion of sites experiencing varying degrees of decline is then evaluated, and a risk matrix is used to determine the risk status for each indicator. Finally, a heuristic, step-wise approach across all indicators is applied to derive the overall risk status under Criterion D for each ecoregion.

Table 3. Methodology, parameters and collapsed thresholds used to assess Coral Reef ecosystems in the Caribbean under the Red List of Ecosystem criteria.

Criterion	Sub-criterion	Indicator(s)	Data Sources	Collapse or risk Threshold(s)	Criterion Assessed? (Yes/No)	Comments
A Reduction in geographic distribution	A1 – (Past 50 years)	Reef habitat extent	Coral cover from benthic surveys	5% coral cover	Yes	Using proportion of coral reef sites below collapse threshold as proxy for reef extent
B Restricted geographic distribution	B1 – Extent of Occurrence (EOO)	Extent of Occurrence (EOO) + ongoing decline or number of threat defined locations	Regional reef maps, expert knowledge	EOO < 50,000 km ² + ongoing decline or threats	Yes	Calculated per eco-region using minimum convex polygons
	B2 – Area of Occupancy (AOO)	Area of Occupancy (AOO) + ongoing decline or number of threat defined locations	Grid-based reef presence (10×10 km), monitoring data	AOO < 50 + ongoing decline or threats	Yes	Fluctuation data limited; AOO estimates incomplete
C	C1 – Environmental degradation	Degree Heating Weeks (DHW)	NOAA Coral Reef Watch,	Return interval of ≤ 3 years between bleaching events or 3 severe marine heatwave events occurring within 5 years	Yes	Eco-region average
C	C2 – Projected future degradation	Degree Heating Weeks (DHW)	Global Climate Projections (SSPs) of DHWs	Return interval of ≤ 3 years between bleaching events or 3 severe marine heatwave events occurring within 5 years	Yes	Eco-region average
D	D1 – Disruption of biotic processes	Hard coral cover, macroalgae-coral ratio, herbivore biomass, piscivore biomass	Benthic cover and fish biomass estimates from UVC	Hard coral cover < 5%, ACR 0.833, herbivore biomass 5g/m ² , piscivore biomass 2g/m ²	yes	Large variance in data availability across and within ecoregions

4. Risk Status

Coral reefs across all ecoregions of the Caribbean were at a high risk of collapse (Vulnerable, Endangered or Critically Endangered) with all ten ecoregions classified as critically endangered. Threat assignment was primarily driven by disruption to the abiotic environment due to global climate warming (criterion C), highlighting the widespread and escalating pressure global warming inflicts onto Caribbean coral reefs. Previous disruption to biotic conditions, and historical degradation of the environment also results in every ecoregion to fall within a threatened category.

Table 4. Summary of RLE assessment results for Caribbean coral reef ecoregions. The overall *Red List of Ecosystems* status is the *highest* level of risk identified across all the assessed criteria.

Ecoregion	A	B	C	D	Overall
Bahamian	CR	LC	CR	CR	CR (A1, C2, D1a)
Bermuda	LC	CR	CR	LC	CR (B1, C1, C2)
Eastern Caribbean	EN	LC	CR	EN	CR (C2)
Floridian	EN	VU	CR	CR	CR (C2, D1a)
Greater Antilles	VU	LC	CR	EN	CR (C2)
Northern Gulf of Mexico	LC	CR	CR	VU	CR (B1, B2, C2)
Southern Caribbean	LC	LC	CR	CR	CR (C1, C2, D1a)
Southern Gulf of Mexico	LC	NT	CR	VU	CR (C2)
Southwestern Caribbean	LC	LC	CR	CR	CR (C2, D1a)
Western Caribbean	LC	LC	CR	VU	CR (C2)

Criterion A: Reduction in Geographic Distribution

Of the ten ecoregions assessed, four were classified within threatened categories (Vulnerable, Endangered or Critically Endangered), having lost a significant area of their coral reefs over the past 50 years based on our proxy of proportion of collapsed sites. Six of the ten ecoregions were assessed as Least Concern.

Table 5. Risk status of Caribbean coral reef ecoregions under Criterion A, determined from estimated declines in coral reef area over the last 50 years.

Coral Reef Ecoregion	Proportion of reef sites below critical hard coral cover threshold	Risk status Criterion A1
Bahamian	0.88	CR
Bermuda	0	LC
Eastern Caribbean	0.55	EN
Floridian	0.79	EN
Greater Antilles	0.43	VU
Northern Gulf of Mexico	0	LC
Southern Caribbean	0.19	LC
Southern Gulf of Mexico	0.22	LC
Southwestern Caribbean	0.12	LC
Western Caribbean	0.11	LC

Criterion B: Restricted Geographic Distribution

Under Criterion B, two of the ten ecoregions were assessed as Endangered or Critically Endangered, one Vulnerable, and one Near Threatened, while the remaining six were assessed as Least Concern. Smaller ecoregions with limited coral reef habitat, such as the Northern Gulf of Mexico and Bermuda, meet the thresholds for restricted EOO, combined with ongoing threats such as coral bleaching.

Table 6. Risk status of Caribbean coral reef ecoregions under Criterion B, determined from distribution of coral reefs measured as the Extent of Occurrence (EOO) and Area of Occupancy (AOO).

Coral Reef Ecoregion	Extent of Occurrence (EOO, km ²)	Area of Occupancy (AOO cells)	Sub-criterion B1 Status (EOO)	Sub-criterion B2 Status (AOO)	Overall Criterion B Risk
Bahamian	325,669	550	LC	LC	LC
Bermuda	1,041	13	CR	EN	CR
Eastern Caribbean	226,983	188	LC	LC	LC
Floridian	41,672	65	VU	LC	VU
Greater Antilles	754,568	788	LC	LC	LC
Northern Gulf of Mexico	39	2	CR	CR	CR
Southern Caribbean	206,861	112	LC	LC	LC
Southern Gulf of Mexico	333,142	53	LC	NT	NT
Southwestern Caribbean	537,722	274	LC	LC	LC
Western Caribbean	184,084	202	LC	LC	LC

Criterion C: Environmental Degradation

Based on historical Degree Heating Weeks (DHW) values, 9 out of 10 ecoregions are threatened through either chronic disturbance from coral bleaching events, or pulse disturbance from mass mortality events.

All Caribbean coral reef ecoregions are critically endangered based on projected DHWs values that will induce annual mass coral bleaching.

Table 7. Risk status of Caribbean coral reef ecoregions under Criterion C, determined from estimated declines in abiotic conditions, specifically changes extreme heat events.

Coral Reef Ecoregion	Risk Status Criterion C1	Risk Status Criterion C2
Bahamian	VU	CR
Bermuda	CR	CR
Eastern Caribbean	EN	CR
Floridian	VU	CR
Greater Antilles	VU	CR
Northern Gulf of Mexico	LC	CR
Southern Caribbean	CR	CR
Southern Gulf of Mexico	EN	CR
Southwestern Caribbean	EN	CR
Western Caribbean	EN	CR

Criterion D: Disruption of biotic processes or interactions

Out of the ten Caribbean ecoregions assessed under criterion D, nine met the threshold for threatened status, while only one was assessed as Least Concern. Current benthic conditions determined the final status of Criterion D for six of the ten ecoregions, with disruption to the fish community increasing overall risk status for the other four ecoregions.

Table 8. Risk status of Caribbean coral reef ecoregions under Criterion D, determined from estimated historical declines in critical biotic components. Risk status for each indicator and the overall status across all indicators. Ranges in risk e.g. EN-CR, represents uncertainty in the outcomes, and where relevant the most likely category is presented (outside of the parentheses) in addition to the range

Ecoregion	Hard coral cover	Macroalgae-coral ratio	Herbivore biomass	Piscivore biomass	Overall
Bahamian	CR	EN	VU	VU	CR
Bermuda	LC	LC	DD	DD	LC
Eastern Caribbean	EN	EN	EN	EN	EN
Floridian	CR	CR	EN	VU (VU-EN)	CR
Greater Antilles	EN	EN	EN	EN	EN
Northern Gulf of Mexico	LC	LC	CR	CR	VU
Southern Caribbean	EN	LC	EN	CR	CR
Southern Gulf of Mexico	NT (NT-VU)	LC	LC	LC	NT
Southwestern Caribbean	VU	VU	CR	CR	CR
Western Caribbean	VU	VU	LC	LC	VU

5. Conclusion and recommendations

Caribbean coral reefs face imminent risk of collapse because of anthropogenic climate change. Projected increases in mass coral bleaching episodes, which occur regardless of whether a reef experiences local-scale degradation or not, highlights that regional conservation measures alone cannot prevent continued decline if greenhouse-gas emissions remain high. However, ensuring Caribbean coral reefs are well protected from local stressors is essential for mitigating compounding impacts with climate change. Avoiding further loss of Caribbean coral reef ecosystems requires immediate and sustained reductions in global greenhouse-gas emissions, alongside adequate protection, conservation management, and adaptation measures that increase the capacity of reefs and dependent communities to cope with unavoidable climate impacts. World leaders should further advocate for ambitious climate mitigation through international treaties such as the Paris Agreement and strengthen the integration of climate considerations into national and regional biodiversity strategies.

This assessment is a call to action. Together with the IUCN Red List of Threatened Species assessment, which found that nearly half of Caribbean reef-building coral species are threatened with extinction (Obura et al., 2026), and the recent GCRMN report documenting a 48% decline in Caribbean coral cover since the 1970s (Wicquart et al., 2025), these

independent lines of evidence point to the same conclusion: Caribbean coral reefs face an escalating risk of collapse. Mitigating every fraction of a degree of warming matters. Rapid and sustained reductions in greenhouse gas emissions, alongside decisive action to reduce local stressors, are essential to give these ecosystems the best possible chance of survival. We highlight key policy recommendations below.

Policy recommendations

- **Urgently accelerate global greenhouse gas emissions reductions.** Assigned risk status of all Caribbean coral reef ecoregions as Critically Endangered under future climate-driven thermal stress highlights the urgent need for drastic emissions reductions consistent with the Paris Agreement, alongside strengthened national climate commitments and international advocacy for more rapid decarbonisation.
- **Strengthen local management to maximise reef resilience.** National governments should urgently reduce avoidable local stressors through improved coastal water quality, wastewater treatment, agricultural runoff management, sustainable fisheries management, and effective enforcement of marine protected areas. These interventions cannot prevent climate-driven collapse alone but may reduce cumulative pressures and improve the capacity of reefs to withstand and recover from thermal stress.
- **Prioritise the protection and recovery of remaining reef-building coral populations.** Conservation strategies should prioritise threatened framework-building corals, including *Acropora* and *Orbicella* species, alongside the protection of healthy reefs, coral recruitment habitats, and sites with demonstrated recovery potential. Restoration should complement, rather than substitute for, emissions reductions and effective management of local stressors.
- **Strengthen regional surveillance and response to coral disease and marine heatwaves.** Governments and regional organisations should improve coordinated monitoring, early warning systems, and rapid response protocols for marine heatwaves, mass bleaching, and coral disease outbreaks.
- **Institutionalise the IUCN Red List of Ecosystems assessment within conservation and development planning.** Governments should use the assessment results to inform national biodiversity strategies, marine spatial planning, environmental impact assessments, protected-area management, and climate adaptation plans. Ecosystem risk assessments should be undertaken at the national level, and periodically updated to track changes in reef condition, evaluate management effectiveness, and identify emerging priorities.
- **Invest in sustained, standardised regional monitoring and data sharing.** Governments, research institutions, NGOs, and regional monitoring programmes should strengthen long-term monitoring coverage, harmonise data collection

- protocols, and establish accessible data-sharing mechanisms to facilitate future regional assessments.
- **Mobilise coordinated regional and international financing.** Governments, multilateral environmental funds, development partners, and philanthropic organisations should increase sustained funding for reef monitoring, local threat reduction, coral conservation, and climate adaptation. Investment should be guided by assessed ecosystem risk, vulnerability, ecological importance, and the feasibility of effective intervention, with particular attention to under-resourced jurisdictions.

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8. Peer review

This report was reviewed by the IUCN Red List of Ecosystems global team and by members of other regional coral reef assessment teams under the Global Red List of Coral Reef Ecosystems initiative.

9. Disclaimer

The designation of geographical entities in this publication, and the presentation of the material, do not imply the expression of any opinion whatsoever on the part of IUCN concerning the legal status of any country, territory, or area, or of its authorities, or concerning the delimitation of its frontiers or boundaries.

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10. Contributors

In the modified version of the CRediT (<https://credit.niso.org/>) table below, all contributors are listed with their specific contribution(s) to the RLE assessment and publication.

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11. Annex

11.1. Boundary definitions

The unit of assessment for this regional Red List of Ecosystems assessment of Caribbean coral reefs occurred at the ecoregion level. The Caribbean was divided into 10 ecoregions based on the Marine Ecoregions of the World (MEOW) biogeographic classification (Spalding et al., 2007), which delineates ecologically distinct regions characterised by differences in species composition, ecological processes and ecosystem function.

Table 9. Overview of Ecoregion boundaries used for the Caribbean RLE assessment.

Ecoregion	Country/Territory	Coral Reef Area (km ²)	Boundary Description	Justification (Description as to why coral reefs in each ecoregion are different)
Bahamian	The Bahamas, Turks and Caicos Islands	2,408	Based on MEOW boundary.	See ecoregion factsheet
Bermuda	Bermuda	540	Based on MEOW boundary.	See ecoregion factsheet
Eastern Caribbean	Anguilla, Antigua and Barbuda, Barbados,	866	Based on MEOW boundary.	See ecoregion factsheet

Ecoregion	Country/ Territory	Coral Reef Area (km ²)	Boundary Description	Justification (Description as to why coral reefs in each ecoregion are different)
	British Virgin Islands, Collectivity of Saint Martin, Dominica, Grenada, Guadeloupe, Martinique, Montserrat, Saba, Saint-Barthelemy, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Sint- Eustatius, Sint- Maarten, United States Virgin Islands			
Floridian	United States	755	Based on MEOW boundary.	See ecoregion factsheet
Greater Antilles	Cayman Islands, Cuba, Dominican Republic, Haiti, Jamaica, Puerto Rico	4,044	Based on MEOW boundary.	See ecoregion factsheet
Northern Gulf of Mexico	United States	3.6	Based on MEOW boundary.	See ecoregion factsheet
Southern Caribbean	Aruba, Bonaire, Curacao, Colombia, Trinidad And Tobago, Venezuela	515	Based on MEOW boundary.	See ecoregion factsheet
Southern Gulf of Mexico	Mexico	422	Based on MEOW boundary.	See ecoregion factsheet
Southwestern Caribbean	Bajo Nuevo Bank, Colombia, Costa Rica, Panama	2,331	Based on MEOW boundary.	See ecoregion factsheet
Western Caribbean	Belize, Guatemala, Honduras, Mexico	1,669	Based on MEOW boundary.	See ecoregion factsheet

11.2. Methods description (detailed)

Data

Coastlines used for mapping and spatial analyses were derived from the Global Self-consistent, Hierarchical, High-resolution Geography (GSHHG; Version 2.3.7, June 2017) dataset (Wessel and Smith, 1996). The Millennium Coral Reef Mapping Project layer was used as the primary representation of coral reef extent and distribution across the Caribbean (UNEP-WCMC and WRI, 2021), as these were found to best represent coral reef extent by regional experts. The specific datasets and methods used to evaluate reef extent under Criterion B, together with the environmental datasets used to assess environmental degradation under Criterion C, are described in the relevant criterion sections below.

A total of 45 benthic monitoring datasets were compiled (Fig 4), standardised and used for the assessment, the majority of which were contributed through the data compilation undertaken for the 2024 GCRMN Caribbean report (Wicquart et al., 2022). These datasets

originated from a combination of long-term national monitoring programmes, regional monitoring initiatives and individual research and conservation projects. Regional datasets included the Atlantic and Gulf Rapid Reef Assessment (AGRRA), the National Coral Reef Monitoring Program (NCRMP) and Reef Check.

Benthic monitoring data were collected using a range of established survey methods, including point-intercept transects, benthic quadrats and photoquadrats. To ensure comparability across datasets, benthic observations were standardised following the workflow developed for the GCRMN 2024 Caribbean report (Wicquart et al., 2022). Although datasets varied in their taxonomic resolution, analyses focused on two common indicators available across monitoring programmes: hard coral cover and fleshy macroalgal cover.

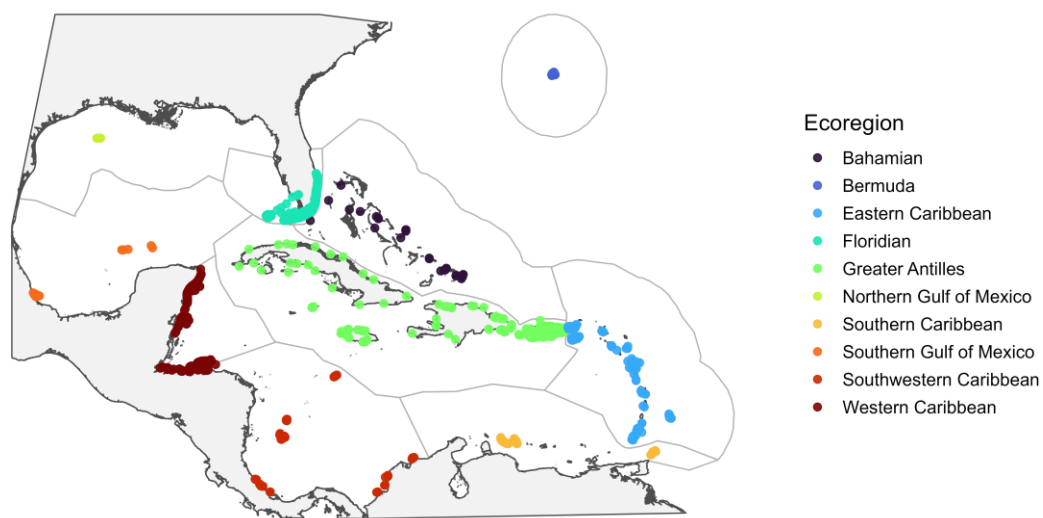


Figure 4. Overview of benthic monitoring data used for Criteria A and D in the RLE assessment. Points show the monitoring sites included from 2020-2025, and previously collapsed sites.

Fish community data were compiled from nine datasets. Owing to the challenges of standardising fish survey methodologies across independent studies, fish data were primarily sourced from established regional monitoring programmes, including AGRRA, NCRMP, Reef Check, Reef Life Survey, and MERMAID (Fig 4).

Fish surveys were predominantly conducted using underwater visual belt transects of varying dimensions, with biomass standardised to the surveyed area. NCRMP fish data were collected using stationary point count surveys. Fish biomass was calculated from species-level observations using published length–weight parameters from FishBase (Froese and Pauly, 2010), with genus-level coefficients applied where species-specific values were unavailable.

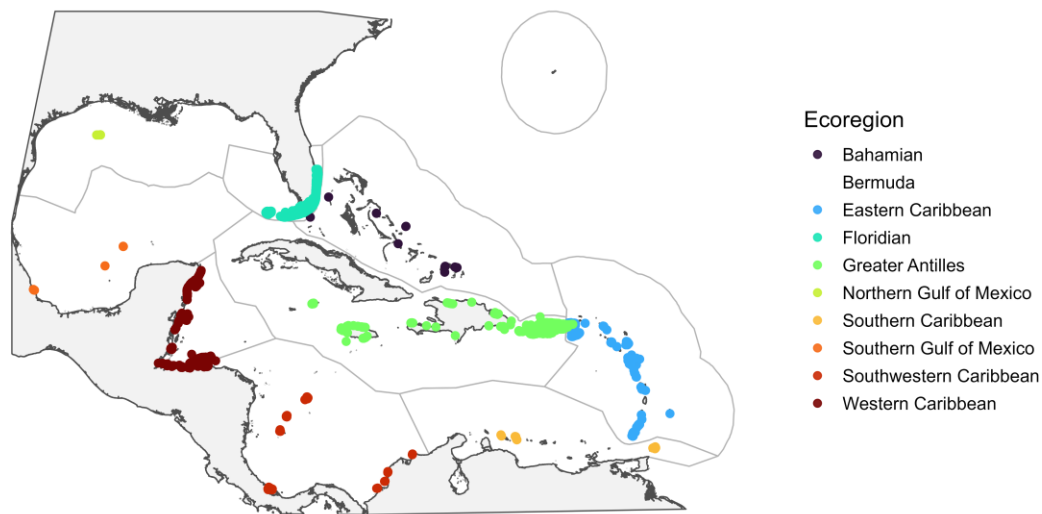


Figure 5. Overview of fish monitoring used to assess Criterion D in the RLE assessment. Points show the spread of monitoring sites from 2015-2025.

Reef typology

To determine which coral reef types to include in this assessment, we used the IUCN Global Ecosystem Typology (GET) to ensure a consistent and globally aligned definition of coral reef ecosystems (Keith et al., 2022).

Within the GET, true photic coral reefs are classified under the ecosystem functional group 'M1.3 Photic Coral Reefs' (<https://global-ecosystems.org/explore/groups/M1.3>). These ecosystems are characterised by active carbonate accretion and the development of a biogenic reef framework built by Scleractinia over millennial timescales (i.e. net biogenic accretion). However, coral communities also occur in marginal environments where environmental conditions or substrate constrain carbonate accretion and limit the development of reef structures. These systems were defined as 'marginal' coral reefs in this assessment.

To ensure the assessment captures the full diversity of coral reef ecosystems globally, an inclusive and standardised approach was adopted. Both true (Type A) and marginal (Type B) reefs were therefore included, recognising that marginal systems can represent dominant and ecologically important reef types in some regions. Potentially confounding ecosystem types that may host similar coral communities were excluded from the assessment. These include mesophotic coral reefs and rocky reefs (Type C), which are classified under their own ecosystem functional groups in the GET (e.g. M1.6 Subtidal rocky reefs <https://global-ecosystems.org/explore/groups/M1.6>). Care was taken not to exclude degraded coral reefs that may superficially resemble rocky or other reef systems, as these represent important expressions of coral reef degradation and are central to assessing collapse risk. For example, surveyed reefs around dredged ports (e.g. Miami) would still be included in the assessment,

as they represent contemporary collapsed coral reef systems due to anthropogenic stressors. (Enochs et al., 2023).

Criterion A: Reduction in geographic distribution

Criterion A assesses the reduction in the extent of an ecosystem over time, typically over a 50-year period. We focused on assessing sub-criterion A1, which measures the percentage of coral reef area lost across each ecoregion over the past 50 years (1975–2025). Criteria A2a, A2b or A3, requiring assessment into the future, were not evaluated. For coral reefs, historical mapped reef area data spanning ~50 years are rarely available. In addition, coral reefs can undergo functional decline, without any visible change in the structural extent mapped by satellites. For that reason, using mapped area reduction is not possible for coral reefs. Our method uses recent mean hard coral cover estimates at the site level from monitoring data between 2020 – 2025 as a proxy for declines in reef (Obura et al., 2022).

Each reef site was classified as either a functioning, net-accreting reef site or a degraded site, based on a collapse threshold of 5% hard coral cover. This threshold represents an established point where coral abundance is too low to maintain positive carbonate accretion on a reef (Perry et al., 2018), hence the reef losing its defining ecosystem process of reef growth. A sensitivity analysis was conducted across a range of thresholds (1–10%) and examined for validity. Each site was assumed to represent an equal portion of reef area, and the overall decline in coral reef area was estimated by calculating the percentage of monitoring sites below the coral cover threshold (i.e. sites no longer considered to be functioning coral reefs). We assumed that all monitored sites represented functioning coral reefs around 1975, therefore any losses occurred in the last 50 years. In total, 2,890 sites were used to assess Criterion A. To account for potential data gaps, 162 of these sites are known to have collapsed or been permanently lost due to anthropogenic or environmental pressures, such as cyclones, dredging, sedimentation, port development, or severe bleaching, before 2020 were also included, even if they are no longer part of ongoing monitoring programmes. Including these sites ensured that historical losses were adequately captured.

Where data were adequate, risk categories were assigned by comparing the percentage of sites with current coral cover below the collapse threshold (5%) (as an estimate for decline in extent) with the Red List of Ecosystems thresholds for Criterion A1, i.e. declines of ≥80%: Critically Endangered, 50–80%: Endangered, 30–50%: Vulnerable, 27–30%: Near Threatened, and <27%: Least Concern (Table 10).

Table 10. Criterion A relative extent of decline thresholds.

<i>Subcriterion</i>	<i>Time frame</i>	<i>CR</i>	<i>EN</i>	<i>VU</i>
A1	Past (over the past 50 years)	≥ 80%	≥ 50%	≥ 30%
A2a	Future (over the next 50 years)	≥ 80%	≥ 50%	≥ 30%
A2b	Any 50-year period (including past, present and future)	≥ 80%	≥ 50%	≥ 30%
A3	Historical (since approximately 1750)	≥ 90%	≥ 70%	≥ 50%

Criterion B: Restricted Geographic Distribution

Criterion B assesses ecosystems whose geographic distribution is so limited that they are at risk of collapse due to the chance occurrence of one or a few threatening events, such as a cyclone, bleaching event, or disease outbreak (Henriksen et al., n.d.).

To assess Criterion B, the RLE uses two standardised spatial metrics:

- (i) **Sub-criterion B1: Extent of Occurrence (EOO)** – the area within the outer boundary of the ecosystem’s known distribution;
- (ii) **Sub-criterion B2: Area of Occupancy (AOO)** – the area occupied by the ecosystem, measured using 10 by 10 km grid cells.

Selection and validation of coral reef extent layer:

The analysis requires a spatial layer representing the current distribution of coral reefs. Two satellite-derived global coral reef maps were considered: the Millennium Coral Reef Mapping Project layer curated by the UNEP World Conservation Monitoring Centre (UNEP-WCMC), and the Allen Coral Atlas (ACA) global reef map (Lyons et al., 2024; UNEP-WCMC and WRI, 2021). Both layers were interrogated by regional experts to determine the most suitable layer for each ecoregion, with both layers assessed for all ecoregions for comparison. After conducting a validation exercise of coral reef layers with regional experts, the Millennium UNEP coral reef layer better reflected reef extent within the Caribbean, especially in the context of assessing criterion B.

We projected the Millennium coral reef projected layer using the *EPSG:32618* coordinate reference system. The *makeEOO* function in the *redlistr* package (version 2.0) in R was used to generate the minimum convex polygon representing the EOO of each ecoregion. The *getAreaEOO* function was then used to calculate the EOO area in km². For Criterion B2, a 10 x 10 km grid was overlaid over the reef extent layer using the *makeAOOGrid* function, and the number of grid cells containing coral reefs was counted to estimate the AOO. All grid cells whose cumulative area of the reef ecosystem was <1% were excluded from the AOO count.

To determine the risk category under Criterion B, EOO and AOO values were compared against the thresholds defined in the Red List of Ecosystems (RLE) guidelines (Table 11).

and the main threat affecting their persistence into the future (Hughes et al., 2017b). This analysis is designed to capture broad-scale changes in the abiotic environment associated with increasing frequency of extreme marine heatwave events that cause coral bleaching (Emslie et al., 2024; Heron et al., 2016b; Hughes et al., 2018b), and determine how present and future environmental conditions threaten the survival and persistence of coral reef ecosystems.

Recurrent heat waves reduce the environmental suitability for reef-building corals through several pathways. A shift in disturbance regime increases the risk of large-scale coral mortality and affects the establishment and persistence of species (Elma et al., 2023; Mudge and Bruno, 2023b). These changes can be associated with substantial declines in coral abundance, reduced structural complexity, and lower carbonate accretion rates (Williams et al., 2019; Williams and Graham, 2019). Additionally, recurrent bleaching episodes weaken coral communities, reduce reproductive output, and increase susceptibility to other stressors such as disease (Briggs et al., 2024; Byrne et al., 2025; Croquer and Weil, 2009; Levitan et al., 2014b). As these events become more frequent, intervals between disturbances are shortened, preventing meaningful coral recovery and increasing the likelihood of progressive ecosystem degradation and eventual collapse (Emslie et al., 2024; Hughes et al., 2018b).

Indicator selection

To assess the likelihood of recurrent heat waves driving ecosystem collapse at regional scales, we assessed two plausible and distinct pathways, each requiring a different analytical approach.

The first is a chronic (press) pathway, driven by the cumulative effects of recurrent bleaching events that weaken coral communities, reduce growth and reproductive output, and increase susceptibility to secondary stressors such as disease. As bleaching events become more frequent, recovery intervals shorten, preventing meaningful recovery between disturbances and leading to progressive ecosystem degradation over time. The second is an acute (pulse) pathway, characterised by rapid decline following a small number of extreme heat stress events occurring over a short period. These events can cause widespread mortality across coral taxa, including stress-tolerant species, leading to near-complete coral loss and triggering collapse.

We assessed the relative change in disturbance conditions over:

- the past 50 years (1975–2025) as part of sub-criterion C1, and
- 50 years into the future (2026–2075) for sub-criterion C2

For the chronic pathway, the indicator is the expected number of severe bleaching events over a 30-year period, expressed as an average return interval (years between events).

For the pulse pathway, the indicator is the number of severe mortality events within a 5-year window.

Using DHW as a proxy for bleaching events

For both pathways, Degree Heating Weeks (DHW), a measure of the accumulation of heat stress over a rolling 12-week window, was used to approximate the occurrence of severe bleaching and mortality events (Liu et al., 2012).

Although data on historical bleaching observations exist (Donner et al., 2017; C. Mark Eakin et al., 2026; van Woesik and Kratochwill, 2022), they are not spatially or temporally extensive. DHW data are globally available since 1985, including for future climate projections (Mellin et al., 2024a; Skirving et al., 2019), and are underpinned by a well-documented, long-term relationship with coral bleaching across many regions globally (Heron et al., 2016a; Liu et al., 2005; Sully et al., 2019). Values of $DHW \geq 4$ are associated with bleaching onset, while values of $DHW \geq 8$ or more are historically linked to widespread coral mortality (Kayanne, 2017; Liu et al., 2005; Skirving et al., 2019). In addition, DHW has been widely used in recent studies assessing bleaching risk under climate change (Beyer et al., 2018; Bozec et al., 2025; Mellin et al., 2024a; Obura et al., 2021), and is supported by established thresholds linking DHW levels to bleaching severity developed by the NOAA Coral Reef Watch (https://coralreefwatch.noaa.gov/product/5km/index_5km_baa-max-7d.php). While DHW may not be the most precise predictor of bleaching severity at fine spatial or temporal scales, it provides a robust, scalable, and comparable indicator of bleaching risk suitable for capturing broad trends in disturbance regimes over time and supports a standardised approach across ecoregions.

Data

Sub-criterion C1 was assessed using satellite-measured DHW from NOAA Coral Reef Watch at a spatial resolution of 5 km (Liu et al., 2012). The standard RLE assessment timeframe is 50 years; however, satellite measurements of DHW began 40 years ago in 1985. For the period 1975–1984, thermal conditions were assumed to be broadly comparable to those observed during the earliest decade of the satellite record (1985–1995). This assumption is supported by the fact that the first global mass bleaching event occurred later, in 1997–1998 (Hoegh-Guldberg, 1999), and that global ocean heat content has been consistently above average since the mid-1990s, with ocean warming accelerating further since the late 90s and early 2000s (Cheng et al., 2023, 2017; Heron et al., 2016b; Merchant et al., 2025). The 1985–1995 period is therefore the closest available proxy for late-1970s thermal stress regimes. DHW values were spatially attributed to each reef pixel using a 50 km buffer, retaining only data from pixels within this distance of mapped reef extent, and assigning values through an interpolation process.

Sub-criterion C2 used modelled climate projections of daily Degree Heating Weeks from Mellin et al. (2024) for 1985–2100, available for three climate pathways: SSP2-4.5, SSP3-7.0, and SSP5-8.5. The dataset did not include projections corresponding to the Paris Agreement pathway (SSP1-1.9; approximately 1.5–2°C warming by 2100), which is considered increasingly unrealistic given current global emissions trajectories (Tagomori et al., 2026). All three scenarios with data were assessed to explicitly demonstrate how the degree of

climate mitigation affects risk outcomes for coral reefs. The highest emissions scenario (SSP5-8.5) represents an extreme case that is considered increasingly unlikely to eventuate (Sarofim et al., 2024), therefore, SSP2-4.5 and SSP3-7.0 were treated as the primary scenarios.

For both C1 and C2, daily DHW data were converted to an annual maximum value for each reef pixel by first calculating the monthly maximum, and then extracting the highest value recorded from each local summer season. In regions where the summer season straddles two calendar years (e.g. the thermal peak occurs during November–March), the seasonal maximum was attributed to the year the stress began. This produced an annual time series of maximum DHW for each reef pixel spanning the historical and future assessment periods.

Thresholds

To convert the annual maximum DHW data into a record of disturbance events, ecoregion-specific DHW thresholds were applied to classify each year as an event (value of 1) or not (value of 0). The DHW thresholds used for this classification differed between the two pathways, reflecting their distinct ecological mechanisms.

For the chronic pathway, a severe bleaching event is defined as one in which widespread bleaching occurs across approximately more than 50% of coral colonies. These events cause substantial loss of thermally sensitive species but may not typically reach the intensity required to cause widespread mortality of stress-tolerant taxa. For the pulse pathway, a severe mortality event is defined as an extreme, high-intensity thermal stress event that causes widespread mortality (more than 50% of colonies) across all coral taxa, including stress-tolerant species. Applying the thresholds produced two binary event time series for each reef pixel which forms the basis of the chronic and pulse analyses.

DHW thresholds corresponding to severe bleaching events (chronic pathway) and severe mortality events (pulse pathway) for each ecoregion were informed by historical observations of coral reef responses to marine heatwaves, specifically the levels of thermal stress associated with widespread bleaching and coral mortality. These thresholds were not treated as fixed, as the DHW level required to trigger a given bleaching response is expected to change over time. For example, in the 1980s and 90s, relatively lower DHW values may have resulted in severe bleaching and mortality (Hoegh-Guldberg 1999), whereas coral communities today (or in the future) may be altered or acclimated, potentially requiring higher DHW values to trigger comparable responses (Heron et al., 2016b; Pratchett et al., 2013; Sully et al., 2019). For C2, thresholds were informed by bleaching responses to thermal stress levels observed during the most recent years of the satellite record (2015–2025) and were adjusted upward into the future to account for anticipated species filtering, and potential thermal adaptation or acclimation. Thresholds were defined at the ecoregional level where locally relevant evidence supported this. To account for uncertainty in the exact level of heat stress that causes bleaching/mortality, two plausible DHW threshold values were applied for each pathway.

Bleaching and mortality DHW thresholds were determined (Table 12) primarily by relating DHW values associated with years when extreme marine heat waves caused mortality and bleaching within the Caribbean. The occurrence and differentiation of bleaching and mortality events for regions across years was derived from both the primary literature, and general knowledge/expert opinion of Caribbean Technical Working Group members. Future DHW thresholds for bleaching and mortality were based on the Coral Reef Watch alert levels, which also acted as the basis for selection of time-varying DHW thresholds for mortality and bleaching over the past 40 years (C1).

Table 12. C1 Degree Heating Week (DHW) thresholds used for both the pulse thermal stress and chronic thermal stress pathways.

Ecoregion	Years	Chronic thermal stress (50% of corals bleaching)	Pulse thermal stress (50% of corals dying)
		DHW threshold	
Bahamian	1985-2000	4	4
	2001-2017	6	8
	2018-2025	8	12
Bermuda	1985-2000	4	4
	2001-2017	6	10
	2018-2025	8	12
Easter Caribbean	1985-2000	4	4
	2001-2009	8	8
	2010-2025	10	12
Floridan	1985-2000	4	4
	2001-2009	4	5
	2010-2017	4	6
	2018-2025	4	8
Greater Antilles	1985-2000	4	4
	2001-2009	6	8
	2010-2025	8	12
Southern Caribbean	1985-2000	4	4
	2001-2009	8	10
	2010-2017	10	12
	2018-2025	12	14
Southern Gulf of Mexico	1985-2000	4	4
	2001-2017	6	8
	2018-2025	8	12
Southwestern Caribbean	1985-2000	4	4
	2001-2017	6	8
	2018-2025	8	12
Western Caribbean	1985-2000	4	4
	2001-2005	5	5
	2006-2017	6	8
	2018-2025	8	12

Table 13. C2 Degree Heating Week (DHW) thresholds used for both the pulse thermal stress and chronic thermal stress pathways.

Ecoregion	Years	Chronic thermal stress (50% of corals bleaching)	Pulse thermal stress (50% of corals dying)
DHW threshold			
All ecoregions	2025-2100	12	16

Calculation of decline and risk

Current values

To apply Criterion C, the RLE assesses the level of risk based on the severity of decline and the proportion of the ecosystem affected. Analyses were conducted independently for each pathway (chronic and pulse). The relative severity of decline for both sub-criteria C1 and C2 was calculated for each reef pixel using the formula:

$$\text{Relative severity of decline (\%)} = (\text{current conditions} - \text{initial conditions}) / (\text{collapse threshold} - \text{initial conditions}) \times 100$$

The chronic pathway is assessed in terms of the average return interval of severe bleaching events over a 30-year period (DeCarlo and Whitaker, 2025; Hughes et al., 2018b). Return interval is an ecologically meaningful indicator because recovery from disturbance is a slow process, typically requiring 10–15 years for fast-growing species and considerably longer for the full complement of coral life histories and morphologies (Gilmour et al., 2013; Robinson et al., 2019). As bleaching events become more prevalent and frequent, the combined effect of repeated mortality and shortened intervals between disturbances limiting recovery, drives cumulative coral loss and increases the likelihood of ecosystem-level collapse (C. Mark Eakin et al., 2026, p. 201; Hughes et al., 2018b; Pratchett et al., 2021).

Return intervals were estimated by fitting a binomial (logistic) regression model to the binary bleaching event time series for each reef pixel, where the probability of a severe bleaching event in any given year is modelled as a function of time (DeCarlo and Whitaker, 2025). This probabilistic approach provides a continuous, smoothed estimate of annual event probability. This reduces sensitivity to interannual variability and characterises the underlying trajectory of disturbance regimes, making it well suited to assessing chronic, long-term stress. The modelled annual probabilities were summed across all possible 30-year windows within the assessment periods of C1 (1985/6-2025) and C2 (2026-2075) to determine the expected number of severe bleaching events, which was then converted to an average return interval by dividing 30 years by the expected number of events. The current condition value was based on the shortest return interval (highest disturbance) over all 30-

year periods. For C1, the model was fitted using observed DHW data (1985–2025), and for C2, the models were fitted using projected DHW data (1985–2100).

For the pulse pathway, current conditions were assessed using a 5-year moving window, applied across the full assessment periods of C1 and C2 for each reef pixel. The number of severe mortality events within each window were counted, with the maximum count across any 5-year period, representing the highest observed or projected clustering of extreme events, used as the current condition value. This event-based approach preserves temporal variability and is specifically designed to capture the clustering of extreme events that characterises the acute collapse pathway.

Initial values

To calculate relative severity of decline, initial values reflecting the baseline disturbance regime of each assessment period (C1 and C2) must be established.

For the chronic pathway, under C1, historical baseline conditions (circa the 1970s) are characterised by bleaching events occurring at most once every 10–15 years, equivalent to approximately 2–3 events per 30-year period. This reflects a natural disturbance regime in which sufficient time elapsed between events for meaningful coral recovery (Baker et al., 2008; Gilmour et al., 2013; Graham et al., 2011; Hughes et al., 2018b; Robinson et al., 2019). For C2, the initial value is calculated from projected DHW data over the 30-year period immediately preceding 2026 (1996–2025), using the same probabilistic framework applied to the rest of the C2 analysis.

For the pulse pathway, under C1, the initial value is the maximum number of severe mortality events within any 5-year window at the start of the satellite time series (1985/86–1990/91). For C2, the initial value is the maximum number of severe mortality events within any 5-year window during the decade immediately preceding 2026 (2016–2025).

Collapse thresholds

To complete the calculation of relative severity of decline, it is necessary to define a collapse threshold, when the frequency of damaging heat waves creates a high likelihood of collapse. For coral reefs, collapse is defined by the near or complete loss of hard corals, corresponding to a hard coral cover below 5%. The same collapse thresholds are applied to both C1 and C2 because conceptually similar environmental conditions should lead to similar ecological outcomes regardless of when they occur.

For the chronic pathway, the collapse threshold is defined as severe bleaching events occurring, on average, every 3 years over a 30-year period (approximately 10 events per 30-year window) (DeCarlo and Whitaker, 2025). At this frequency, recovery intervals are considered insufficient to permit meaningful coral recovery between disturbances, and the cumulative, iterative mortality caused by several events drives progressive and significant ecosystem degradation (Emslie et al., 2024; Hughes et al., 2018b). As a sensitivity test, a threshold of one event every 5 years (~6 events per 30-year window) was also assessed as

even these narrow recovery windows do not allow for full recovery, and will lead to substantial decline after multiple decades (Hughes et al., 2018b). Annual severe bleaching is commonly cited when predicting future reef outlooks (De Clippele et al., 2023; van Hooidonk et al., 2016; Zeng et al., 2025), however it is considered overly conservative as collapse will likely occur before we reach conditions conducive to yearly bleaching (Lucie M. Bland et al., 2017a; Obura et al., 2021).

For the pulse pathway, the collapse threshold is defined as 3 severe mortality events occurring within any 5-year window, with 2 events in any 5-year window also performed as sensitivity analyses. This formulation was adopted in response to evidence that the collapse threshold used by Obura et al. (2021) for the Western Indian Ocean, and Bland et al. 2017 for the Meso-American Reef of two severe bleaching events per decade (equivalent to approximately one event every 5 years), may be insufficient to drive collapse under current conditions. Several reefs throughout the Caribbean have experienced two or more severe bleaching events within a decade between 2015 and 2025 without clear evidence of ecosystem collapse (C. Mark Eakin et al., 2026; Reimer et al., 2024b). Hence, a conservative threshold of 3 extreme mortality events within a 5-year window will reliably indicate conditions conducive to collapse.

Risk status assignment

For C2, analyses were conducted under three emissions scenarios (SSP2-4.5, SSP3-7.0, and SSP5-8.5), with SSP2-4.5 treated as the primary scenario.

To assign the risk status under Criteria C1 and C2 for each ecoregion, relative severity of decline was interpreted in conjunction with reef extent using the severity–extent matrix. The relative extent of decline for each ecoregion was approximated from the cumulative proportion of reef area experiencing different levels of decline ($\geq 20\%$, $\geq 30\%$, $\geq 50\%$, $\geq 70\%$, $\geq 80\%$, and 100%).

Where results differ between the chronic and pulse pathways, the risk category was reported based on the pathway with the greatest confidence, or a range of outcomes presented across both pathways. Uncertainty across DHW thresholds, collapse thresholds, and initial values was incorporated by repeating the analysis across all plausible combinations of these parameters, producing a range of possible risk outcomes. The final reported risk status for each ecoregion for C1 was based on the mean decline across all combinations, while for C2, the final status corresponded to the best-case scenario of an intermediate climate pathway (SSP2-4.5) with coral adaptation (higher future DHW thresholds).

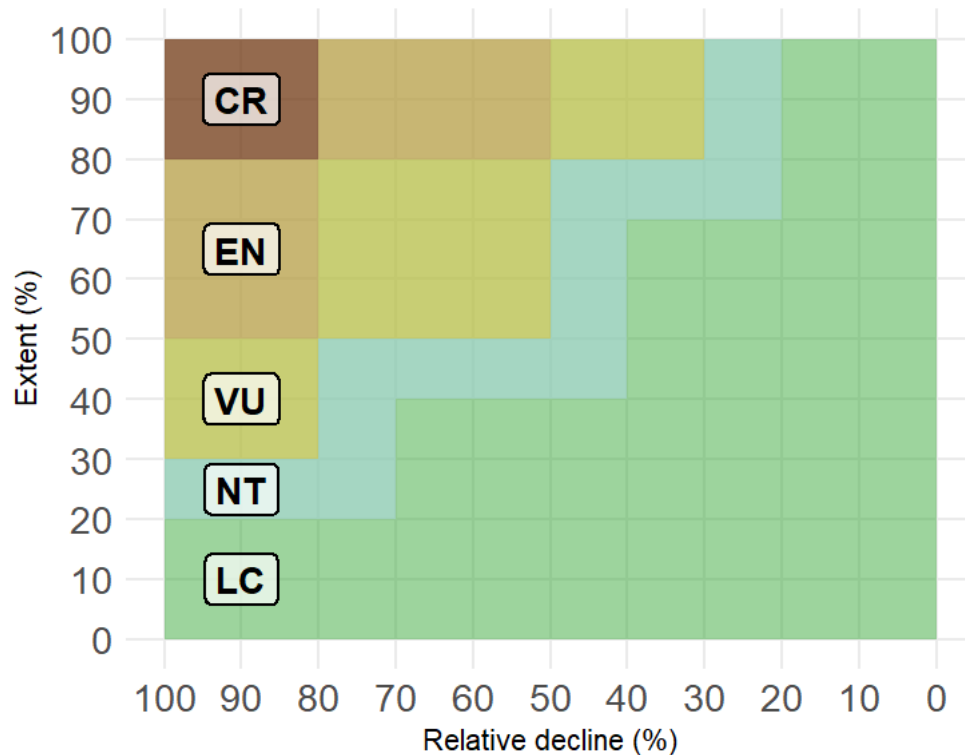


Figure 6. Risk assignment matrix for criterion C based on extent (%) and relative decline (%) of abiotic disruption.

Criterion D: Disruption of Biotic Processes and Interactions

Criterion D was evaluated to identify ecosystems experiencing severe disruption to biotic organisms, processes and interactions. This includes declines in characteristic species, shifts in community structure, and the loss of ecological functions necessary for maintaining ecosystem identity. The approach enables identification of the most degraded ecosystem components and how this degradation contributes to the overall risk of collapse. This assessment evaluated the degradation over the past 50 years (sub-criterion D1), estimating how close each ecosystem component was to collapse or severe functional disruption.

Indicator selection

In the Caribbean, four key biotic components were assessed using data derived from standard underwater survey methods (e.g. point intercept transects, belt transects, and photo-quadrats). These components include:

- Hard corals, as the keystone ecosystem taxa responsible for forming the habitat structure and accretion processes.
- Macroalgae, as the principal competitive taxa to hard corals;
- Herbivory, providing important top-down control of algae; and

- Piscivory, which helps regulate the food web and contribute to overall ecological balance.

For each component, indicators were selected based on ecological relevance, data availability, spatial coverage, sensitivity to ecosystem condition, and the ability to define both a reference state and a collapse threshold.

Hard coral cover (%) was selected as the indicator of coral state, as it has been consistently used as a key measure of reef health over several decades – and effectively used in previous RLE assessments (Lucie M. Bland et al., 2017a; Obura et al., 2021; Uribe et al., 2021).

Macroalgae-to-coral cover ratio was used to represent benthic competition, rather than macroalgae cover alone, as this directly captures the dynamic balance between coral and algal dominance. Macroalgae only included fleshy macroalgae when data were specified to the appropriate taxonomic level. However, the majority of monitoring datasets only stated functional algae groups (e.g. Turf algae, Calcareous algae, Macroalgae). In these situations, we selected macroalgae under the assumption that these data only represent fleshy macroalgae. The ratio was calculated as the total macroalgae cover divided by the sum of macroalgae and coral cover.

For herbivory, the combined biomass (g/m^2) of Parrotfishes and Surgeon fishes were used. We leveraged the Reef Health Indicators (RHI) by using the same species developed as indicators for reef health. Specifically, the Parrotfish species were from the genera *Scarus* and *Sparisoma*, along with the Acanthuridae family (McField and Kramer, 2007).

For piscivory, we again leveraged the RHI, using Grouper and Snapper fish biomass (g/m^2) as our indicators. Specifically, this includes the genera *Epinephelus*, *Cephalopholis*, and *Mycteroperca*, plus the Lutjanidae family.

Calculation of risk

Biotic degradation under Criterion D was assessed using the relative severity of decline. This metric compares the current state of each indicator to both a historical baseline (level approximately 50 years ago) and a hypothetical collapse threshold.

Current values

Current values for the benthic indicators (i.e. coral cover and macroalgae cover) were calculated at the site level using monitoring data available from 2020–2025. A “site” refers to a defined monitoring location where transects, quadrats, or other sampling units are situated, and at which data are aggregated. Where multiple records existed for a site within this period, the mean value across the years of available data from 2020–2025 was used. For fish biomass indicators, the same approach was used for the site level allocation, as well as calculation of mean values across years of present data, but we extended the current values to encompass ten years’ worth of data (2015–2025) given temporal variability of fish biomass data.

Table 14. Mean current values and variance of coral cover (%) per ecoregion (n – number of sites from 2020-2025).

Ecoregion	n	Mean	Std. dev	Min value	Max value
Bahamian	28	3.51	2.19	0.167	9.33
Bermuda	12	19.20	7.60	10.4	37.1
Eastern Caribbean	671	7.92	9.18	0	59.3
Floridan	852	4.12	6.52	0	70
Greater Antilles	439	8.89	7.45	0	48
Northern Gulf of Mexico	9	62.40	16.2	39	88
Southern Caribbean	250	14.20	9.72	0.05	53.8
Southern Gulf of Mexico	22	21.30	14.50	2.48	63
Southwestern Caribbean	122	18.30	12.50	0	65
Western Caribbean	314	19.00	13.50	0.33	84.3

Table 15. Mean current values and variance of the Macroalgae:coral ratio per ecoregion (n – number of sites from 2020-2025).

Ecoregion	n	Mean	Std. dev	Min value	Max value
Bahamian	28	0.7	0.25	0	0.99
Bermuda	12	0.39	0.15	0.17	0.73
Eastern Caribbean	666	0.73	0.28	0	1
Floridan	841	0.84	0.23	0	1
Greater Antilles	439	0.67	0.3	0	1
Northern Gulf of Mexico	9	0.19	0.15	0.02	0.51
Southern Caribbean	250	0.35	0.25	0	0.99
Southern Gulf of Mexico	22	0.27	0.32	0	0.83
Southwestern Caribbean	122	0.56	0.31	0	1
Western Caribbean	314	0.55	0.22	0.01	0.99

Table 16. Mean current values and variance of fish biomass (g/m²) for herbivore and piscivore indicators, per ecoregion (n – number of sites from 2015-2025). NA represents ecoregions without data.

Ecoregion	Indicator	n	Mean	Std. dev	Min value	Max value
Bahamian	Herbivore biomass	23	439	608	0	1780
Bermuda		NA	NA	NA	NA	NA
Eastern Caribbean		2008	46.9	192	0	2303
Floridan		3306	13	24	0	687
Greater Antilles		892	26.2	85.6	0	820
Northern Gulf of Mexico		149	5.83	7.77	0	56
Southern Caribbean		32	9.94	13.9	0	53.6
Southern Gulf of Mexico		17	226	223	2.67	875

Ecoregion	Indicator	n	Mean	Std. dev	Min value	Max value
Southwestern Caribbean		66	6.16	16.8	0	122
Western Caribbean		375	605	515	0	2732
Bahamian	Piscivore biomass	23	197	350	0	1597
Bermuda		NA	NA	NA	NA	NA
Eastern Caribbean		2008	20.1	101	0	2353
Floridan		3306	22.1	67.6	0	1936
Greater Antilles		892	6.69	19.3	0	258
Northern Gulf of Mexico		149	2.62	7.98	0	60.1
Southern Caribbean		32	5.96	20.2	0	109
Southern Gulf of Mexico		17	138	1222	13.7	516
Southwestern Caribbean		66	8	43.3	0	332
Western Caribbean		375	159	451	0	5643

Initial values

A reference state representing conditions of each indicator approximately 50 years ago (circa 1975) was established to quantify long-term change. Monitoring data from this period were generally limited/unavailable, or inconsistent, given standardised reef monitoring began in the late 1990s based on our collated dataset. Baseline conditions were therefore reconstructed using a combination of empirical data, literature, and expert knowledge. These estimates represent conditions across the whole ecosystem within each ecoregion and were derived as distributions (e.g. mean and standard deviation) rather than single values to account for natural variability and to incorporate uncertainty.

To determine the most suitable approach for deriving initial values, the first step was to consider the likely condition of reefs in each ecoregion in the mid-1970s for the selected indicators, specifically, whether reefs were in better condition, relatively pristine, or already degraded.

Coral cover – quantitative data combined with historical evidence

Regional experts assumed that reef condition in the 1970s was generally better than at present, and that 1997/8, the year of the first widespread global bleaching event, represented a major turning point in reef condition (Jackson et al., 2014). However, for the Caribbean there were several other catastrophic local/regional scale disturbances preceding this – including overfishing, herbivore die-off, rampant coastal development, and coral diseases (Hughes, 1994; Hughes et al., 2017a; Jackson et al., 2014).

For coral cover, we used a combination of literature estimates and very early monitoring data to estimate initial values. Ultimately, we managed to obtain quantitative estimates of mean coral cover and standard deviations for every ecoregion besides The Bahamas based on literature with historical values/estimates and early monitoring datasets (Table 17). For The

Bahamas, we simply used the estimated mean Caribbean 1970s coral cover ($33.5\% \pm 4.5$) from the GCRMN 2012 status of Caribbean coral reefs report (Jackson et al., 2014)– validated and agreed upon by regional coral reef experts in The Bahamas.

Table 17. Primary and secondary sources used for quantitative estimates of coral cover in the 1970s for Caribbean coral reefs.

year (s)	locality	MEOW Ecoregion	source
1975	Florida Keys	Floridian	https://www.int-res.com/journals/meps/articles/meps08438
1977	Florida Keys	Floridian	https://www.int-res.com/journals/meps/articles/meps08439
1970	Gulf of Mexico	Northern Gulf of Mexico	https://www.int-res.com/journals/meps/articles/meps08440
1971	Gulf of Mexico	Northern Gulf of Mexico	https://www.int-res.com/journals/meps/articles/meps08441
1973	Lesser Antilles		https://www.int-res.com/journals/meps/articles/meps08442
1974	Lesser Antilles		https://www.int-res.com/journals/meps/articles/meps08443
1978	Lesser Antilles		https://www.int-res.com/journals/meps/articles/meps08444
1970 - 1983	Barbados Leeward	Eastern Caribbean	Jackson, J., Donovan, M., Cramer, K. and Lam, V., 2014. <i>Status and trends of Caribbean coral reefs: 1970-2012</i> . Gland, Switzerland: Global Coral Reef Monitoring Network; International Union for the Conservation of Nature (IUCN).
1970 - 1983	Belize Central Barrier	Western Caribbean	Jackson, J., Donovan, M., Cramer, K. and Lam, V., 2014. <i>Status and trends of Caribbean coral reefs: 1970-2012</i> . Gland, Switzerland: Global Coral Reef Monitoring Network; International Union for the Conservation of Nature (IUCN).
1970 - 1983	Bermuda	Bermuda	Jackson, J., Donovan, M., Cramer, K. and Lam, V., 2014. <i>Status and trends of Caribbean coral reefs: 1970-2012</i> . Gland, Switzerland: Global Coral Reef Monitoring Network; International Union for the Conservation of Nature (IUCN).
1970 - 1983	Bonaire Leeward	Southern Caribbean	Jackson, J., Donovan, M., Cramer, K. and Lam, V., 2014. <i>Status and trends of Caribbean coral reefs: 1970-2012</i> . Gland, Switzerland: Global Coral Reef Monitoring Network; International Union for the Conservation of Nature (IUCN).
1970 - 1983	Colombia Santa Marta	Southwestern Caribbean	Jackson, J., Donovan, M., Cramer, K. and Lam, V., 2014. <i>Status and trends of Caribbean coral reefs: 1970-2012</i> . Gland, Switzerland: Global Coral Reef Monitoring Network; International Union for the Conservation of Nature (IUCN).
1970 - 1983	Costa Rica Cahuita	Southwestern Caribbean	Jackson, J., Donovan, M., Cramer, K. and Lam, V., 2014. <i>Status and trends of Caribbean coral reefs: 1970-2012</i> . Gland, Switzerland: Global Coral Reef Monitoring Network; International Union for the Conservation of Nature (IUCN).
1970 - 1983	Curacao Southwest	Southern Caribbean	Jackson, J., Donovan, M., Cramer, K. and Lam, V., 2014. <i>Status and trends of Caribbean coral reefs: 1970-2012</i> . Gland, Switzerland: Global Coral Reef Monitoring Network; International Union for the Conservation of Nature (IUCN).
1970 - 1983	Florida Upper Keys	Floridian	Jackson, J., Donovan, M., Cramer, K. and Lam, V., 2014. <i>Status and trends of Caribbean coral reefs: 1970-2012</i> . Gland, Switzerland: Global Coral Reef Monitoring Network; International Union for the Conservation of Nature (IUCN).
1970 - 1983	Florida Dry Tortugas	Floridian	Jackson, J., Donovan, M., Cramer, K. and Lam, V., 2014. <i>Status and trends of Caribbean coral reefs: 1970-2012</i> . Gland, Switzerland: Global Coral Reef Monitoring Network; International Union for the Conservation of Nature (IUCN).
1970 - 1983	Jamaica Montego Bay	Greater Antilles	Jackson, J., Donovan, M., Cramer, K. and Lam, V., 2014. <i>Status and trends of Caribbean coral reefs: 1970-2012</i> . Gland, Switzerland: Global Coral Reef Monitoring Network; International Union for the Conservation of Nature (IUCN).

year (s)	locality	MEOW Ecoregion	source
1970 - 1983	Jamaica North Central	Greater Antilles	Jackson, J., Donovan, M., Cramer, K. and Lam, V., 2014. <i>Status and trends of Caribbean coral reefs: 1970-2012</i> . Gland, Switzerland: Global Coral Reef Monitoring Network; International Union for the Conservation of Nature (IUCN).
1970 - 1983	Jamaica North East	Greater Antilles	Jackson, J., Donovan, M., Cramer, K. and Lam, V., 2014. <i>Status and trends of Caribbean coral reefs: 1970-2012</i> . Gland, Switzerland: Global Coral Reef Monitoring Network; International Union for the Conservation of Nature (IUCN).
1970 - 1983	Jamaica Port Royal Cays	Greater Antilles	Jackson, J., Donovan, M., Cramer, K. and Lam, V., 2014. <i>Status and trends of Caribbean coral reefs: 1970-2012</i> . Gland, Switzerland: Global Coral Reef Monitoring Network; International Union for the Conservation of Nature (IUCN).
1970 - 1983	Jamaica West	Greater Antilles	Jackson, J., Donovan, M., Cramer, K. and Lam, V., 2014. <i>Status and trends of Caribbean coral reefs: 1970-2012</i> . Gland, Switzerland: Global Coral Reef Monitoring Network; International Union for the Conservation of Nature (IUCN).
1970 - 1983	Mexico Veracruz	Western Caribbean	Jackson, J., Donovan, M., Cramer, K. and Lam, V., 2014. <i>Status and trends of Caribbean coral reefs: 1970-2012</i> . Gland, Switzerland: Global Coral Reef Monitoring Network; International Union for the Conservation of Nature (IUCN).
1970 - 1983	Panama San Blas	Southwestern Caribbean	Jackson, J., Donovan, M., Cramer, K. and Lam, V., 2014. <i>Status and trends of Caribbean coral reefs: 1970-2012</i> . Gland, Switzerland: Global Coral Reef Monitoring Network; International Union for the Conservation of Nature (IUCN).
1970 - 1983	Puerto Rico Vieques	Eastern Caribbean	Jackson, J., Donovan, M., Cramer, K. and Lam, V., 2014. <i>Status and trends of Caribbean coral reefs: 1970-2012</i> . Gland, Switzerland: Global Coral Reef Monitoring Network; International Union for the Conservation of Nature (IUCN).
1970 - 1983	USA East Flower Garden Banks	Northern Gulf of Mexico	Jackson, J., Donovan, M., Cramer, K. and Lam, V., 2014. <i>Status and trends of Caribbean coral reefs: 1970-2012</i> . Gland, Switzerland: Global Coral Reef Monitoring Network; International Union for the Conservation of Nature (IUCN).
1970 - 1983	USVI St Croix	Eastern Caribbean	Jackson, J., Donovan, M., Cramer, K. and Lam, V., 2014. <i>Status and trends of Caribbean coral reefs: 1970-2012</i> . Gland, Switzerland: Global Coral Reef Monitoring Network; International Union for the Conservation of Nature (IUCN).
1970 - 1983	USVI St John	Eastern Caribbean	Jackson, J., Donovan, M., Cramer, K. and Lam, V., 2014. <i>Status and trends of Caribbean coral reefs: 1970-2012</i> . Gland, Switzerland: Global Coral Reef Monitoring Network; International Union for the Conservation of Nature (IUCN).
1970 - 1983	USVI St Thomas	Eastern Caribbean	Jackson, J., Donovan, M., Cramer, K. and Lam, V., 2014. <i>Status and trends of Caribbean coral reefs: 1970-2012</i> . Gland, Switzerland: Global Coral Reef Monitoring Network; International Union for the Conservation of Nature (IUCN).
1965- 1966	La Blanquillas Pajaros, Anegada de Adentro	Southern Gulf of Mexico	Kühlmann, D. H. H. 1975. Charakterisierung der korallenriffe von Veracruz, Mexico. Museum für naturkunde on der Humboldt Universität zu Berlin. Internationale Revue der gesamten Hydrobiologie 60 (4): 495-521
1971	Isla de Ebmedio	Southern Gulf of Mexico	Rannefeld, J. W. 1972. The stony corals of Enmedio Reef off Veracruz, Mexico. M.S. thesis, Texas A&M University, College Station, Tex.
1980	Bermuda	Bermuda	Dodge RE, Logan A, Antonius A. Quantitative reef assessment studies in Bermuda: a comparison of methods and preliminary results. Bulletin of Marine Science. 1982 Jul 1;32(3):745-60.
1980	Bermuda	Bermuda	Dodge RE, Logan A, Antonius A. Quantitative reef assessment studies in Bermuda: a comparison of methods and preliminary results. Bulletin of Marine Science. 1982 Jul 1;32(3):745-60.
1980	Bermuda	Bermuda	Dodge RE, Logan A, Antonius A. Quantitative reef assessment studies in Bermuda: a comparison of methods and preliminary results. Bulletin of Marine Science. 1982 Jul 1;32(3):745-60.
1979	Bonanza	Western Caribbean	Historical data for Mexican Caribbean coral reefs, Data provided by Dr. Eric Jordán, Coral reefs systems lab, UNAM, Mexico Dahlgren,

year (s)	locality	MEOW Ecoregion	source
1979	Maroma	Western Caribbean	Historical data for Mexican Caribbean coral reefs, Data provided by Dr. Eric Jordán, Coral reefs systems lab, UNAM, Mexico Dahlgren,
1979	Nizuc	Western Caribbean	Historical data for Mexican Caribbean coral reefs, Data provided by Dr. Eric Jordán, Coral reefs systems lab, UNAM, Mexico Dahlgren,
1979	Puerto Morelos	Western Caribbean	Historical data for Mexican Caribbean coral reefs, Data provided by Dr. Eric Jordán, Coral reefs systems lab, UNAM, Mexico Dahlgren,

Table 18. Mean initial values with variance measures for Hard Coral Cover (%) for each ecoregion (n – number of sites). Data were obtained from literature and early monitoring data in the previous table.

Ecoregion	Mean	Std. dev	Min value	Max value	n
Bahamian	33.5	4.5	NA	NA	NA
Bermuda	18.8	5.45	13	26	4
Eastern Caribbean	32	7.28	23.7	42.6	5
Floridan	26.6	5.05	22	32.7	4
Greater Antilles	36.6	8.17	24	47	9
Northern Gulf of Mexico	42.5	13.6	31	57.5	3
Southern Caribbean	48.6	7.85	43	54.1	2
Southern Gulf of Mexico	40	7.07	35	45	2
Southwestern Caribbean	37.4	4.26	32.5	40.4	3
Western Caribbean	30.3	11	12.3	42.6	6

Macroalgae cover

Given the disparity in early monitoring data for macroalgae, and inconsistencies in the literature for how macroalgae has been recorded, we used the 1970s Caribbean wide estimate of macroalgae cover of 9.5% with a standard deviation of 4.5% derived directly from the GCRMN status of Caribbean Coral Reefs report (Jackson et al., 2014). These historical estimates were validated by regional coral reef experts.

Table 19. Mean initial values with standard deviation for Macroalgae Cover (%) regionally.

Ecoregion	Mean	Std. dev
All ecoregions	9.5	4.5

Fish baseline estimation

Baseline values for fish indicators were estimated using a space-for-time substitution approach. Fishing pressure was assumed to have been lower in the 1970s, and therefore fish populations were likely higher than present. A close approximation for these higher fish populations comes from well-managed, no-take marine protected areas (MPAs), along with marine expansive coral reef areas established to have low fishing pressure. The Reef Health Index (RHI) provides established Healthy Reefs Indicators (HRI) of fish biomass for both Herbivores, and Piscivores (McField and Kramer, 2007). The RHI ranges are based on extensive data collected from the Atlantic and Gulf Rapid Reef Assessment (AGRRA) database, covering 800 coral reef monitoring sites throughout the wider Caribbean (Kramer, 2003). Therefore, we decided to leverage the RHI, setting our initial values for piscivore and herbivore fish biomass as the median value between “Good” and “Very Good” based on the

RHI grade. Subsequently, this allowed us to set the standard deviation of fish biomass for both the herbivore and piscivore indicators as the difference between the median value of the category with the higher (i.e. Very Good) and lower (i.e. Good) RHI grades. Importantly, The RHI only considers herbivorous and piscivorous fish taxa recorded per the AGRRA protocol, which directly align with the herbivorous and piscivorous fish taxa used in this assessment.

Table 20. Initial values of fish biomass (g/m²) used for fish indicators based on the RHI for the entire Caribbean region.

Ecoregion	Indicator	Mean	Std. dev
All Ecoregions	Herbivore biomass	30	2
	Piscivore biomass	14	2

Collapse thresholds

Collapse thresholds were defined for each indicator to represent the degradation point at which ecosystem function or identity is completely lost, and the ecosystem is fundamentally changed.

For benthic indicators, thresholds reflect a transformation in state, for example away from a coral-dominated ecosystem to one which may be algae-dominated. For fish indicators, thresholds represented the loss of ecological function (e.g. insufficient herbivory or piscivory to influence ecosystem dynamics). Thresholds were based on published studies, empirical observations, expert judgment, and previous Red List of Ecosystem assessments for coral reefs (Lucie M. Bland et al., 2017a; Uribe et al., 2021). These collapse thresholds were applied consistently across all ecoregions.

For hard coral cover, a threshold of **5%** was applied, representing the minimum level required to sustain positive carbonate accretion on a reef (Perry et al., 2018).

For the algae-to-coral ratio, a threshold of 0.833 (i.e. algae cover five times greater than coral cover) was used, indicating a persistent shift to algal dominance where recovery becomes unlikely (Obura et al., 2021).

For fish indicators, thresholds were also derived from the RHI herbivore biomass and piscivore biomass HRIs. The RHI pertains a “Critical” herbivore biomass threshold of 10g/m², and 4g/m² for piscivore biomass. This “Critical” grade is analogous to Critically Endangered under the RLE framework, while a zero (0) value is representative of extinction rather than collapse under the RLE framework. ‘Collapse’ of these functions likely occurs prior to complete extirpation, therefore, in accordance with previous Caribbean coral reef RLE assessments using fish biomass indicators (Lucie M. Bland et al., 2017a; Uribe et al., 2021), we selected the midpoint value between the “Critical” grade in the RHI and zero (extinction). Thus, our final collapse thresholds were biomass values of 5g/m² for herbivores, and 2g/m²

for piscivores. These thresholds are only applicable to herbivorous and piscivorous fish taxa surveyed in the AGRRA protocol – aligning with the fish taxa used in this assessment.

Calculating relative severity of decline

Relative severity of decline was calculated for each site with current data using the formula:

$$\text{relative severity of decline (\%)} = 100 \times \frac{\text{initial value} - \text{current value}}{\text{initial value} - \text{collapse threshold}}$$

Uncertainty in initial conditions was incorporated by applying a bootstrapping approach. For coral cover, initial values were represented as a truncated normal distribution defined by the estimated mean, standard deviation, and hypothetical range of coral cover (i.e. 0-100%). The macroalgae:coral ratio was also defined with a truncated normal distribution defined by the estimated mean, standard deviation, and observed range (min and max acr values within the dataset). Meanwhile, initial values for fish biomass indicators were simply represented as a mean and standard deviation based on defined HRI values (above). Initial values were randomly sampled from this ecoregional distribution and assigned to each site.

The highest risk category was determined from the decline-extent matrix (Fig 6), with the ecosystem extent calculated as the proportion of sites exceeding decline thresholds ($\geq 20\%$, $\geq 30\%$, $\geq 50\%$, $\geq 70\%$, $\geq 80\%$, and 100% decline). This process was repeated 1,000 times, and each time the resulting highest risk category for the iteration was recorded. To determine the final risk category for each indicator, the distribution of outcomes across all iterations was considered. Where $\geq 80\%$ of iterations produced the same category, this was assigned as the final status. When a dominant result was not returned, an appropriate category or range of categories was applied, e.g. if 50% of iterations were LC, and 50% VU, then the overall risk was NT.

The analysis assumed that monitoring sites broadly reflect conditions across the entire ecoregion. Where spatial coverage was uneven or limited, we assessed whether observed patterns were representative of the unsampled areas based on the distribution of pressures and environmental conditions. If the available data were considered insufficient to reliably characterise ecosystem-wide patterns, the ecoregion was classified as *Data Deficient*.

Determining final risk class for Criterion D

The overall risk category for Criterion D for each ecoregion was determined by integrating results across all indicators using a stepwise approach, following previous coral reef RLE assessments (Lucie M Bland et al., 2017; Obura et al., 2022).

Indicators were evaluated in sequence according to their ecological role and interactions:

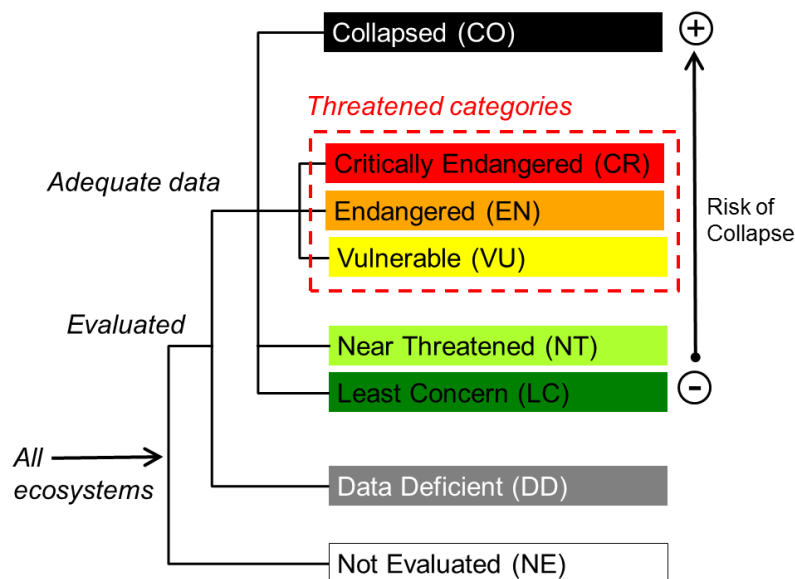
1. Hard corals (reef engineers);
2. Macroalgae (competitive dynamics);

3. Herbivorous fish (algal control);
4. Piscivorous fish (trophic regulation).

The assessment used the coral condition as the baseline classification. At each subsequent step, the overall risk category was increased by one level if the next indicator was classified at a higher risk level than the cumulative status to that point. This approach ensures that hard coral, as the foundational component of reef ecosystems, had the greatest influence on the final classification, while still accounting for the contribution of other biotic components. It also prevented the overall assessment from being disproportionately driven by secondary indicators (e.g. fish).

Overall risk status

Once all applicable RLE criteria and sub-criteria had been assessed, the overall risk status for coral reefs in each ecoregion was determined. A precautionary approach, consistent with the principles of the Red List of Ecosystems framework was applied whereby the final classification reflected the most severe risk category assigned across all evaluated criteria. This approach ensures that **any severe risk** which may drive collapse is not diluted or overlooked in the final assessment.



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11.3. Discussion

Regional risk is dominated by climate-driven thermal stress

Climate-driven thermal stress is the dominant driver of coral reefs collapse risk across the Caribbean, with future coral bleaching under Criterion C projected to push all ecoregions into the Critically Endangered category and ultimately towards collapse.

This future climate-driven risk is underpinned by substantial evidence of existing ecological degradation. Under Criterion D (biotic disruption), all but two ecoregions are in a threatened category, primarily due to declining coral cover and increasing macroalgal dominance. Declines in coral cover under Criterion D are closely linked to widespread coral mortality following previous thermal stress events assessed under Criterion C1 (Table 7). Consistent with this relationship, the Northern Gulf of Mexico, the only ecoregion assessed as Least Concern under C1, is also one of only two ecoregions not threatened by historical loss of coral cover (Criterion D1).

Risk Varies geographically among Criteria A, B, and D

Despite the consistency of the regional signal under criterion C, risk varied spatially among Criteria A, B, and D. The less typical Caribbean reef ecoregions of Bermuda and the Northern and Southern Gulf of Mexico showed comparatively lower levels of biotic degradation, while their restricted geographic distributions resulted in greater risk under Criterion B. Conversely, the more typical Caribbean ecoregions showed greater risk from biotic disruption but were not threatened based on their geographic distribution. This contrast highlights an unfortunate irony: although isolated and marginal reef systems may be less exposed to local-scale stressors such as agricultural runoff and coastal development, their restricted distributions may leave them particularly vulnerable to the increasingly pervasive effects of global climate change.

Long-standing and overwhelming evidence Caribbean coral reefs are cascading to collapse

Caribbean coral reefs assessed as Critically Endangered under the RLE framework is consistent with decades of evidence of widespread Caribbean reef degradation. Local-scale studies have demonstrated that chronic stressors can reduce coral cover from approximately 50% to 5% within 20 years by increasing mortality and limiting recovery through recruitment (Hughes, 1994). Superimposed on these local pressures, recurrent marine heatwaves and mass bleaching since the turn of the century have accelerated regional decline. Regional coral cover declined by approximately 50% between the 1970s and 2012 (Jackson et al., 2014), with the 2024 GCRMN assessment reporting a comparable 48% decline since the 1970s, alongside an 84.8% increase in macroalgal cover (Wicquart et al., 2025). Together, these changes have contributed to widespread shifts towards flatter, increasingly eroded reef structures across the Caribbean (Alvarez-Filip et al., 2009).

Evidence from previous IUCN assessments and species-level Red List assessments further supports this regional trajectory of catastrophic decline. Caribbean coral reefs were previously assessed as Endangered under the RLE framework (Keith et al., 2013), with Mesoamerican reefs and Colombian Caribbean reefs similarly assessed as Endangered (Lucie M. Bland et al., 2017b; Uribe et al., 2021). At the species level, approximately half of Caribbean reef-building coral species are threatened with extinction (Gutierrez et al., 2024), including both *Acropora* species, which are Critically Endangered, and the dominant fore-reef framework builders *Orbicella annularis* and *O. faveolata*. Collectively, these independent lines of evidence demonstrate that the high risk identified in this assessment represents the continuation of a long-term regional trajectory of coral reef degradation.

Variation among ecoregions reflect contrasting reef histories and environmental pressures

Despite the clear regional signal of collapse risk, Bermuda and the Northern and Southern Gulf of Mexico showed notably lower risk under Criterion D (biotic disruption), with benthic indicators classified as Least Concern. This may reflect differences in both reef history and exposure to local stressors. These predominantly offshore reefs experience less direct influence from land-based pollution (Wicquart et al., 2025), and lie largely outside the historical range of *Acropora*, a major Caribbean reef-building genus that has experienced severe declines since the 1970s (Wicquart et al., 2025). Consequently, the loss of *Acropora* that contributes substantially to declines in coral cover across much of the Caribbean is less pronounced in these ecoregions. Furthermore, these regions have not experienced the

emergence of Stony Coral Tissue Loss Disease (SCTLD), which has caused extensive mortality of susceptible reef-building corals elsewhere in the Caribbean (Alvarez-Filip et al., 2022; Precht et al., 2016).

The absence of these local and regional stressors may help explain why reefs in the Gulf of Mexico and Bermuda remain comparatively less degraded, with Gulf reefs continuing to exhibit net accretion while many Caribbean reefs have shifted towards net erosion (Álvarez-Filip et al., 2026; Perry et al., 2018). This contrast highlights the potential importance of local management interventions, particularly those that improve water quality and reduce disease impacts, in maintaining reef resilience alongside efforts to address global climate-driven stress.

Uncertainties and limitations affect magnitude but not direction of the regional signal

This assessment brings together benthic and fish data from dozens of monitoring programmes, but important gaps remain. The Bahamian ecoregion, for example, was represented by only 43 sites, which ideally would include an increased geographic extent for Criteria A and D. Improving national data-sharing mechanisms would therefore strengthen future assessments and support more evidence-based conservation particularly for The Bahamas (Sherman et al., 2025). Differences in taxonomic resolution among datasets also meant that benthic indicators were standardised to broad measures of coral and macroalgal cover. Future assessments using consistently collected datasets could provide greater resolution of changes in reef-building corals and algal communities, although robust thresholds would first need to be established.

Uncertainty also remains in historical baselines. While long-term coral-cover data are relatively well documented, quantitative estimates of macroalgal cover from the 1970s are scarce and difficult to standardise, necessitating the use of regional estimates derived from GCRMN syntheses. Where sufficiently documented historical data exist, these should be incorporated into future assessments. Similarly, fish indicator baselines were developed primarily from continental reef systems (Kramer, 2003) and may therefore be less representative of island and offshore reefs, particularly in the Gulf of Mexico. Fish indicators could not be assessed for Bermuda because of a lack of data.

Most importantly, the assessment may underestimate the magnitude of future climate impacts. Observed thermal stress during the 2023–2025 marine heatwaves exceeded levels not projected under SSP2-4.5 until at least the 2050s (Mellin et al., 2024b), while continued emissions could drive warming beyond the scenario used here. The Criterion C projections should therefore be considered conservative, with actual climate-driven deterioration potentially occurring sooner than indicated by the assessment.

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Criterion C – Environmental Degradation: supplementary figures

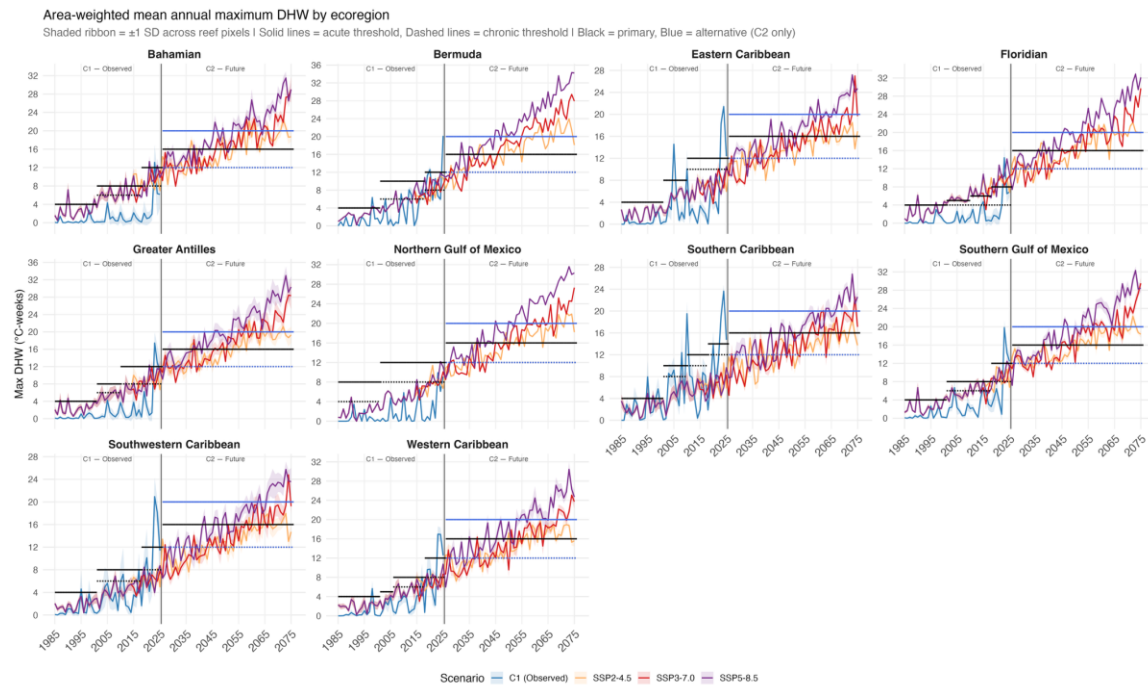


Figure S1. Annual maximum Degree Heating Weeks (DHW) averaged across coral reefs within each ecoregion from 1985-2075 for four trajectories: observed data used to assess sub-criterion C1 from 1985-2025 (blue line), and projections under three Shared Socioeconomic Pathways — SSP2-4.5 (orange), SSP3-7.0 (red), and SSP5-8.5 (purple). Shaded ribbons represent ± 1 SD in DHW across reef pixels within each ecoregion, reflecting spatial variability in thermal exposure. Horizontal lines show ecoregion-specific DHW thresholds at various points in time corresponding to severe bleaching events (chronic stress pathway; dashed lines) and severe mortality events (acute stress pathway; solid lines). Black lines indicate primary thresholds, and blue lines indicate alternative thresholds (C2 period only, 2026–2075). The vertical grey line marks the boundary between the observed (C1 - 1985-2025) and projected (C2 - 2026-2075) assessment periods.

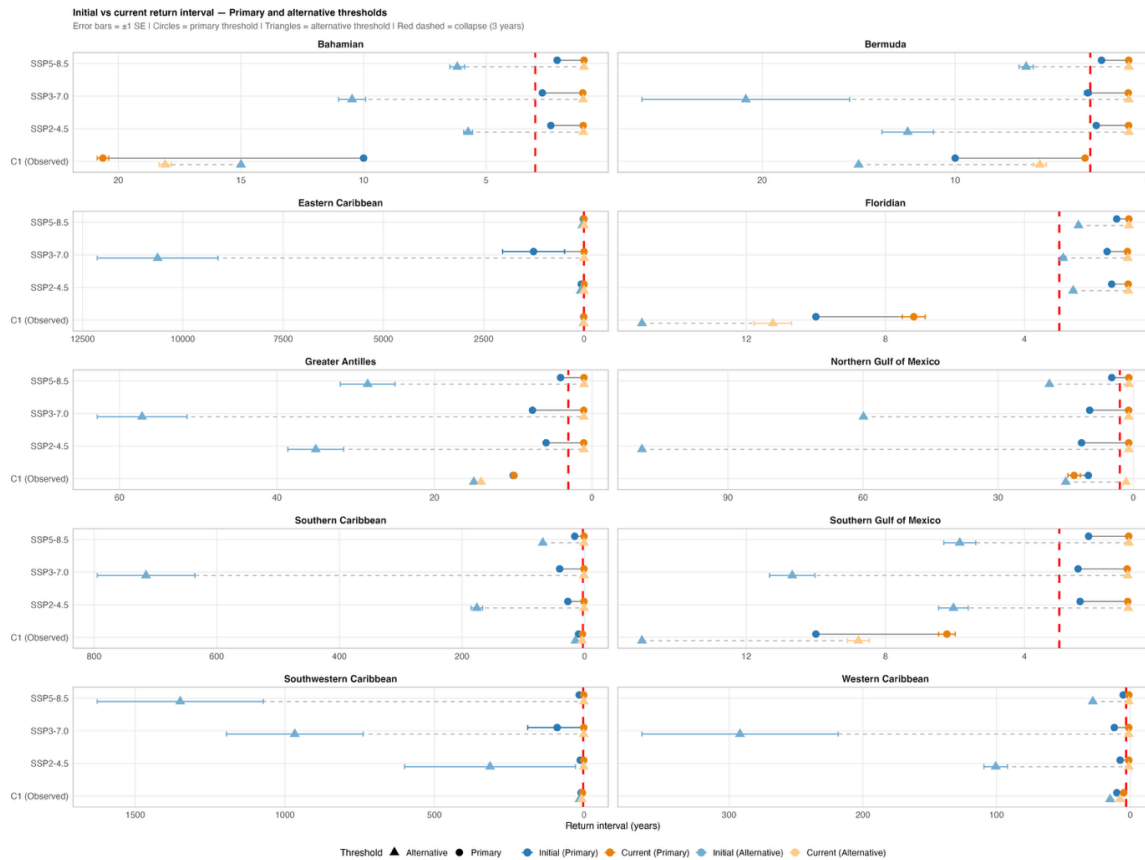


Figure S2. Change in the average return interval between severe bleaching events (years) for each ecoregion (x-axis), comparing initial conditions (blue) to current or projected future conditions (orange) across four trajectories (y-axis): observed data (C1) and projections under SSP2-4.5, SSP3-7.0, and SSP5-8.5. Connecting lines indicate the direction and magnitude of change between initial and current conditions. Return intervals were estimated for the chronic pathway by fitting a binomial regression model to the binary bleaching event time series for each reef pixel, with values representing the shortest return interval identified over each assessment period (C1: 1985–2025; C2: 2026–2075). Results are shown for both primary (filled circles) and alternative (filled triangles) DHW thresholds. For C1, initial conditions are assumed to reflect historical disturbance regimes prior to the satellite record, corresponding to a return interval of 10 years (primary threshold) and 15 years (alternative threshold). For C2, initial conditions are calculated from projected DHW data over 1996–2025 using the same probabilistic model. Error bars represent ± 1 SE across reef pixels within each ecoregion. The red dashed vertical line marks the collapse threshold of a 3-year return interval, below which disturbance frequency is considered sufficient to prevent meaningful coral recovery and drive progressive ecosystem degradation. Note that the x-axis is reversed such that movement from left to right represents a shortening return interval and worsening conditions.

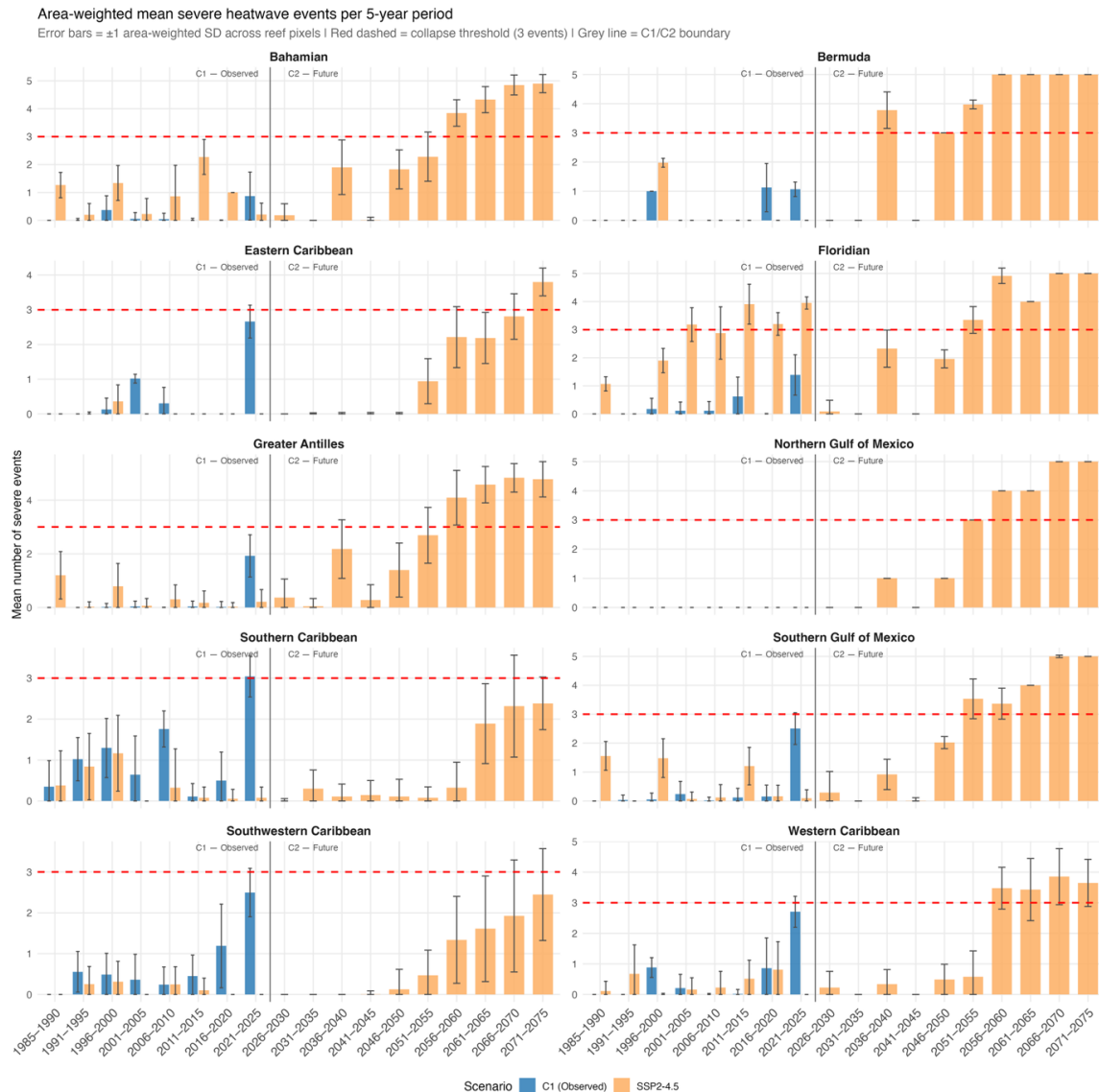


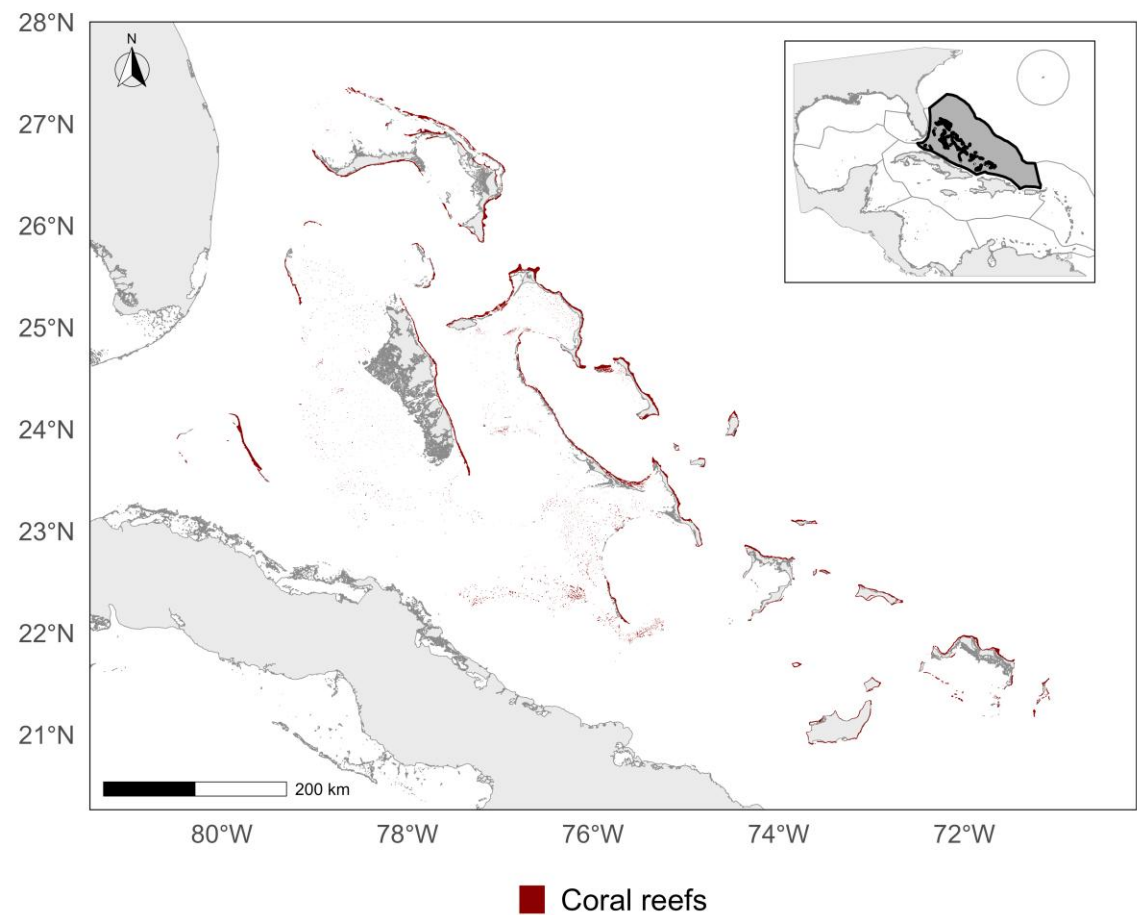
Figure S3. Mean number of severe mortality events per 5-year period, averaged across coral reef pixels within each ecoregion, under two trajectories: observed data used to assess sub-criterion C1 (blue bars, 1985–2025) and projections under SSP2-4.5 (orange bars, 1985–2075). Severe mortality events are defined as years in which annual maximum DHW exceeded ecoregion-specific acute stress thresholds associated with widespread coral mortality. Error bars represent ± 1 SD across reef pixels within each ecoregion, reflecting spatial variability in the frequency of severe thermal exposure. The red dashed horizontal line indicates the collapse threshold of 3 severe mortality events within a 5-year window. The vertical grey line marks the boundary between the observed (C1, 1985–2025) and projected (C2, 2026–2075) assessment periods.

Appendices: Ecoregional Factsheets – 2 pages per ecoregion

Bahamian – Critically Endangered

Spatial distribution

The Bahamian ecoregion coral reefs between 20 and 28 degrees north, bordering both the Caribbean Sea to the south and west, with the Atlantic Ocean to the north and east. The Bahamian ecoregion encompasses coral reefs from both the Bahamas and the Turks and Caicos Islands.



Coral reef area (km ²)	Reef area proportion in Tropical Western Atlantic (%)	Number of coral species	Number of threatened coral species
2408.46	17.7	59	24

Ecosystem description

Coral reefs of the Bahamian ecoregion form compositionally distinct coral reef systems associated with an extensive, shallow carbonate-platform archipelago comprising The Bahamas and Turks and Caicos Islands. Coral reefs in the Bahamian ecoregion are strongly associated with broad carbonate banks, where reef development interacts with extensive shallow platform habitats, tidal channels and carbonate sediment production. Major reef types include barrier and fringing reefs along platform margins, numerous patch reefs within shallow bank interiors, and reef complexes associated with isolated banks.

The shallow banks are characterised by clear, generally oligotrophic waters, strong tidal exchange, and substantial variation in temperature, salinity and suspended sediment over small spatial scales. The Florida and Antilles currents interact with the Bahamian platforms before joining to form the Gulf Stream, while trade winds and tidal flows strongly influence sediment transport and reef morphology. These conditions support distinctive assemblages adapted to shallow coral reef environments, including historically extensive *Acropora* and massive-coral communities.

Bahamian reefs have experienced historical impacts from hurricanes, coral disease, *Diadema antillarum* mortality events, fishing and coastal development, followed by increasingly frequent thermal stress that causes widespread coral bleaching.

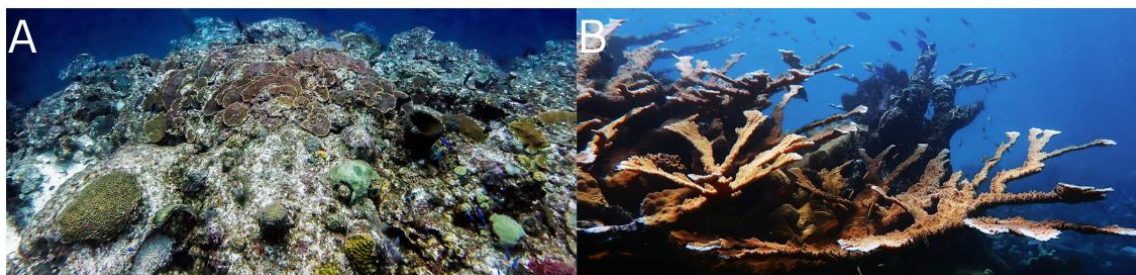


Photo credits: A & B. Anderson Mayfield, 2023.

Eco-region	Key Biotic	Key Abiotic	Key Threats
Bahamian	High diversity of reef-building corals and associated fishes and invertebrates. Seagrass and mangrove systems provide important nursery habitat and connectivity with reefs.	Extensive carbonate platforms and shallow banks; generally clear, oligotrophic waters with high reef development. Relatively low terrestrial sediment input. Strong influence of Atlantic currents and exposure to tropical storms and hurricanes.	Anthropogenic climate-driven warming causing coral bleaching; coral disease; fishing and harvesting; tourism and recreational activities; shipping; wastewater and coastal development.

Key values

Proportion of coral reef lost over the last 50 years (Criterion A)	Distribution (Criterion B)		Biotic Indicator Values (Criterion D)		
	EOO (km ²)	AOO		Baseline	Current
0.88	325,669	550	hard coral cover (%)	33.5	3.51
			algae-coral ratio	0.22	0.7
			herbivore biomass (g/m ²)	30	439
			piscivore biomass (g/m ²)	14	197

	Mean annual DHWs across selected decades (Criterion C)			
Scenario	1986-1995	2016-2025	2026-2035	2066-2075
Observed	0.24	3.33	-	-
SSP2-4.5	-	-	12	19.52
SSP3-7.0	-	-	11.67	22.92
SSP5-8.5	-	-	13.45	27.08

Criteria Assessment

Overall, the risk of collapse of the coral reefs in **the Bahamian** was assessed as **Critically Endangered (CR)**.

Summary of the assessment:

CRITERION			
A. Reduction in Geographic Distribution	A1	A2	A3
	Past 50 years	Future or any 50y period	Historical (1750)
	CR	NE	NE
B. Restricted Geo. Distribution	B1	B2	B3
	Extent of Occurrence	Area of Occupancy	# Threat-defined Locations < 5?
	LC	LC	No
C. Environmental Degradation	C1	C2	C3
	Past 50 years (1970)	Future or any 50y period	Historical (1750)

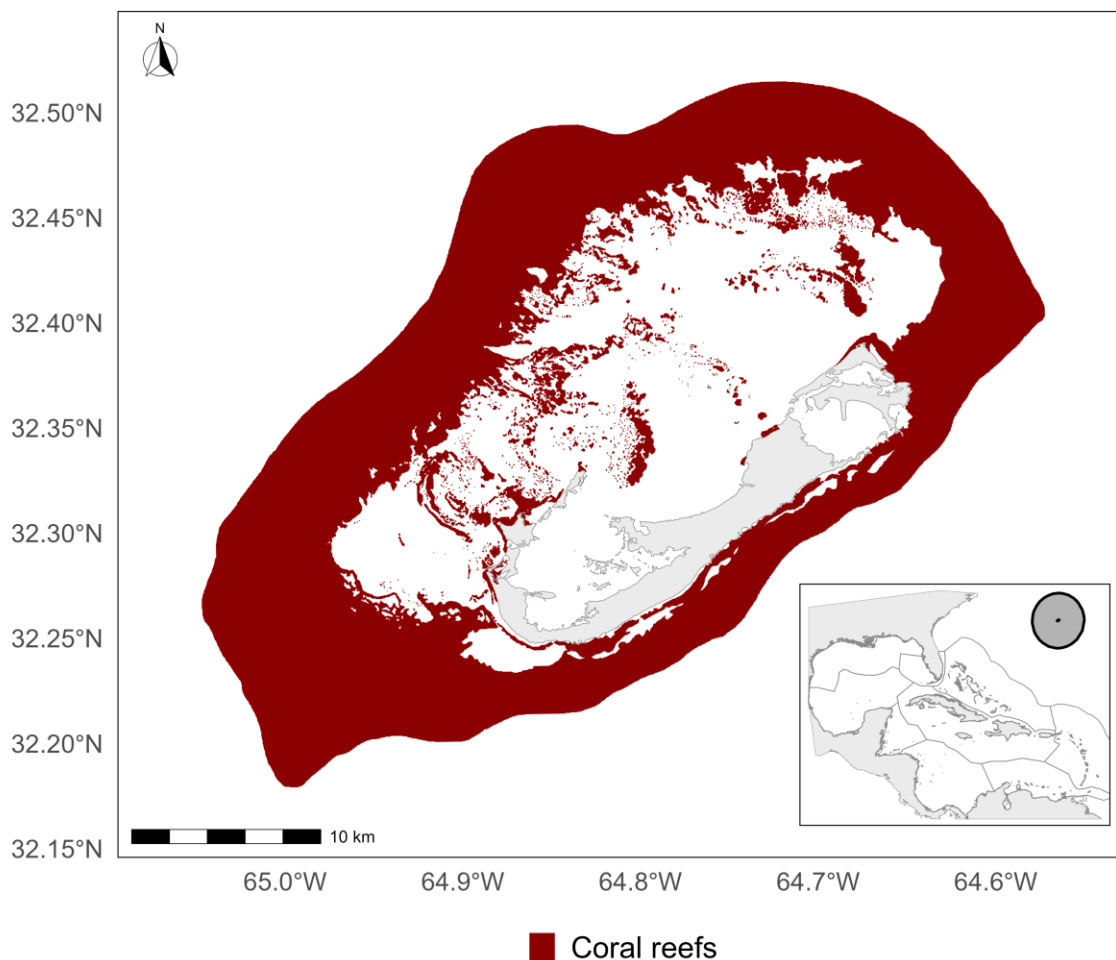
CRITERION			
A. Reduction in Geographic Distribution	A1	A2	A3
	Past 50 years	Future or any 50y period	Historical (1750)
	CR	NE	NE
	VU	CR	DD
D. Disruption of biotic processes	D1	D2	D3
	Past 50 years (1970)	Future or Any 50y period	Historical (1750)
	CR	NE	DD
E. Quantitative Risk analysis	NE		
OVERALL RISK CATEGORY	CR		

DD = Data Deficient; LC = Least Concern; NE = Not Evaluated

Bermuda – Critically Endangered

Spatial distribution

Coral reefs within the Bermuda Ecoregion are located in the Atlantic Ocean at sub-tropical latitudes between 32.1 degrees north and 32.6 degrees north.



Coral reef area (km ²)	Reef area proportion in Tropical Western Atlantic (%)	Number of coral species	Number of threatened coral species
540.12	4	28	9

Ecosystem description

The coral reefs of the **Bermuda ecoregion** form a compositionally distinct, isolated subtropical reef system at the northern limit of Atlantic coral-reef development. Bermuda lies approximately 1,000 km from the nearest continental landmass and supports a relatively depauperate Caribbean-derived coral fauna together with oceanic and subtropical species, producing a distinctive assemblage at the transition between tropical and temperate environments. The reef system is developed on a large volcanic seamount and has a distinct pseudo-atoll morphology, comprising a broad lagoon containing numerous patch reefs and a discontinuous shallow rim-reef tract, with extensive mesophotic reefs descending rapidly towards deep oceanic waters.

Bermuda's position within the Gulf Stream is central to its reef ecology. Warm-water transport permits reef development despite its relatively high latitude, with surrounding oligotrophic oceanic conditions. Sea surface temperatures vary seasonally, with summer temperatures of a 28–30°C during summer, and 18–20°C common during winter. There are 28 reef-building Scleractinian coral species in the Bermuda ecoregion, based on the IUCN RLTS. Hence, the Bermuda ecoregion is coral species depauperate compared to the tropical Caribbean, with *Acropora* spp. notably absent.

Bermuda reefs have experienced bleaching, disease, hurricane, and marine heatwaves driving multiple bleaching events. Their isolation, subtropical thermal regime, oceanic setting, distinctive pseudo-atoll geomorphology and relatively depauperate but characteristic coral assemblage create a highly unique coral reef ecoregion in context of a Caribbean wide assessment.



Photo credit: Haley Davis, 2023.

Eco-region	Key Biotic	Key Abiotic	Key Threats
Bermuda	High latitude subtropical coral reef system with relatively low species richness compared with tropical Caribbean reefs. Distinctive coral assemblages adapted to cooler conditions. Reefs support diverse fish and invertebrate communities.	Isolated subtropical platform in the western North Atlantic, at the northern limit of extensive reef development. Seasonal temperature variability and periodic cold-water stress are greater than in tropical Caribbean	Marine heatwaves and temperature extremes; coral disease; recreational activities and boating; fishing; shipping; coastal development.

Eco-region	Key Biotic	Key Abiotic	Key Threats
		ecoregions. Relatively deep surrounding ocean and limited terrestrial sediment input.	

Key values

Directly produceable and exportable from analysis

Proportion of coral reef lost over the last 50 years (Criterion A)	Distribution (Criterion B)		Biotic Indicator Values (Criterion D)		
	EOO (km ²)	AOO		Baseline	Current
0	1,040	13	hard coral cover (%)	18.8	19.2
			algae-coral ratio	0.34	0.39
			herbivore biomass (g/m ²)	NA	NA
			piscivore biomass (g/m ²)	NA	NA

	Mean annual DHWs across selected decades (Criterion C)			
Scenario	1986-1995	2016-2025	2026-2035	2066-2075
Observed	0.91	9.4	-	-
SSP2-4.5	-	-	11.26	21.38
SSP3-7.0	-	-	10.96	26.02
SSP5-8.5	-	-	13.38	31.17

Criteria Assessment

Overall, the risk of collapse of the coral reefs in **the Bermuda ecoregion** was assessed as Critically Endangered (CR).

Summary of the assessment:

CRITERION			
A. Reduction in Geographic Distribution	A1	A2	A3
	Past 50 years	Future or any 50y period	Historical (1750)
	LC	NE	NE
B. Restricted Geo. Distribution	B1	B2	B3
	Extent of Occurrence	Area of Occupancy	# Threat-defined Locations < 5?

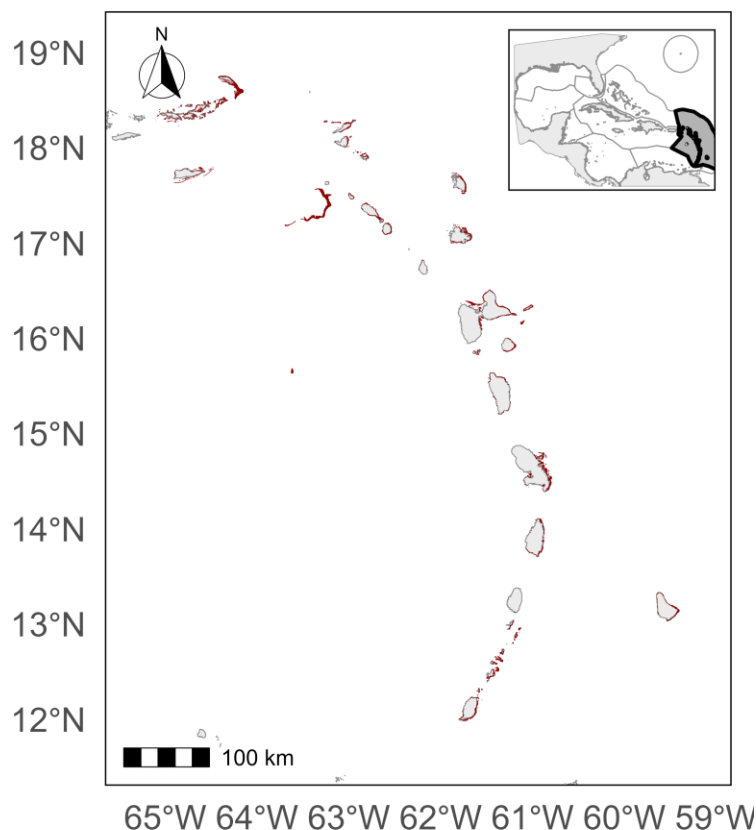
CRITERION			
A. Reduction in Geographic Distribution	A1	A2	A3
	Past 50 years	Future or any 50y period	Historical (1750)
	LC	NE	NE
	CR	EN	No
C. Environmental Degradation	C1	C2	C3
	Past 50 years (1970)	Future or any 50y period	Historical (1750)
	CR	CR	DD
D. Disruption of biotic processes	D1	D2	D3
	Past 50 years (1970)	Future or Any 50y period	Historical (1750)
	LC	NE	DD
E. Quantitative Risk analysis	NE		
OVERALL RISK CATEGORY	CR		

DD = Data Deficient; LC = Least Concern; NE = Not Evaluated

Eastern Caribbean – Critically Endangered

Spatial distribution

The Eastern Caribbean ecoregion extends in latitude from 12 degrees north to 19 degrees north, while also containing the eastern most coral reefs considered in this assessment. The Eastern Caribbean borders the Atlantic Ocean to the east and the Caribbean Sea to the west.



■ Coral reefs

Coral reef area (km ²)	Reef area proportion in Tropical Western Atlantic (%)	Number of coral species	Number of threatened coral species
866.34	6.4	56	23

Ecosystem description

The coral reefs of the **Eastern Caribbean ecoregion** form a compositionally distinct island reef system associated principally with the Lesser Antilles and the eastern Caribbean island arc. The region differs geologically and oceanographically from the larger continental shelves and carbonate platforms elsewhere in the Caribbean, with reefs developing around numerous volcanic and limestone islands separated by relatively deep passages. Reef morphology is consequently dominated by fringing and patch reefs associated with island coastlines, with local development of barrier-like structures. The complex island geography

creates strong gradients in exposure, depth, substrate and connectivity among individual reef systems.

The eastern Caribbean is strongly influenced by Atlantic water in the East entering through the Lesser Antilles, and the Caribbean Sea to the west. These conditions create pronounced environmental contrasts between exposed oceanic reefs and more sheltered island environments. The ecoregion also supports important populations of reef-building corals including *Acropora palmata* and *A. cervicornis*, although their abundance has declined substantially following disease, bleaching and other disturbances.

The region has experienced repeated hurricanes, coral disease, *Diadema* die-off, rampant coastal development, increased impacts from land-based sources of pollution, and overfishing. Severe marine heatwaves linked to mass bleaching events have been numerous throughout the 21st century, compounding impacts of local-scale stressors with mass mortality of coral colonies, and subsequent further mortality from coral diseases.

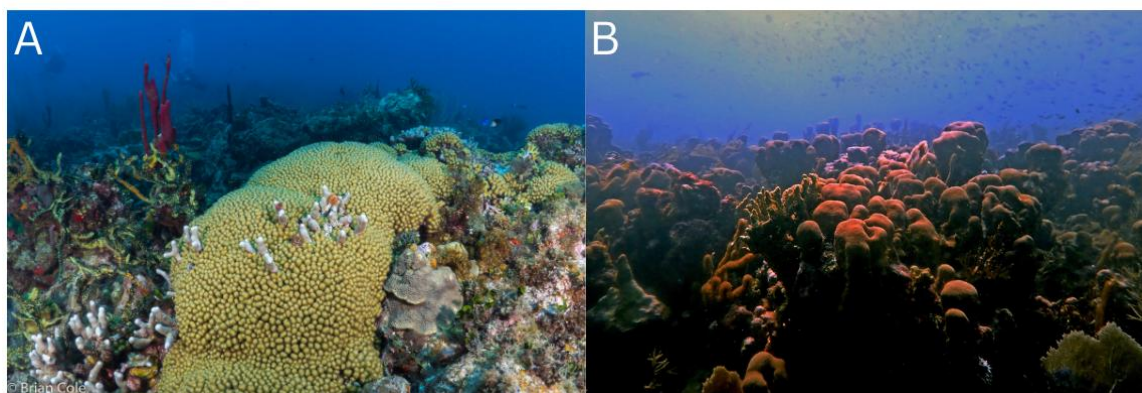


Photo credit: A. Brian Cole, 2016. B. Anderson Mayfield, 2023.

Eco-region	Key Biotic	Key Abiotic	Key Threats
Eastern Caribbean	High coral and reef-fish diversity across the Lesser Antilles, with strong island-to-island variation in community composition. Fringing and patch reefs are common, with important herbivorous fish and coral assemblages.	Volcanic island arc with steep bathymetry, narrow shelves and generally oceanic conditions. High exposure to Atlantic trade winds, waves and hurricanes. Localised terrestrial runoff and sedimentation near developed islands.	Climate change induced coral bleaching; coral disease; fishing; coastal development; wastewater and agricultural runoff; tourism/recreation; storms.

Key values

Directly produceable and exportable from analysis

Proportion of coral reef lost over the last 50 years (Criterion A)	Distribution (Criterion B)		Biotic Indicator Values (Criterion D)		
	EOO (km²)	AOO		Baseline	Current
0.55	226,983	188	hard coral cover (%)	32	7.92
			algae-coral ratio	0.23	0.73
			herbivore biomass (g/m²)	30	46.9
			piscivore biomass (g/m²)	14	20.1

	Mean annual DHWs across selected decades (Criterion C)			
Scenario	1986-1995	2016-2025	2026-2035	2066-2075
Observed	0.29	7.25	-	-
SSP2-4.5	-	-	11.43	16.5
SSP3-7.0	-	-	9.42	19.69
SSP5-8.5	-	-	12.09	23.43

Criteria Assessment

Overall, the risk of collapse of the coral reefs in The Eastern Caribbean was assessed as **Critically Endangered (CR)**.

Summary of the assessment:

CRITERION			
A. Reduction in Geographic Distribution	A1	A2	A3
	Past 50 years	Future or any 50y period	Historical (1750)
	EN	NE	NE
B. Restricted Geo. Distribution	B1	B2	B3
	Extent of Occurrence	Area of Occupancy	# Threat-defined Locations < 5?
	LC	LC	No
C. Environmental Degradation	C1	C2	C3
	Past 50 years (1970)	Future or any 50y period	Historical (1750)
	EN	CR	DD
D. Disruption of biotic processes	D1	D2	D3
	Past 50 years (1970)	Future or Any 50y period	Historical (1750)
	EN	NE	DD
E. Quantitative Risk analysis	NE		

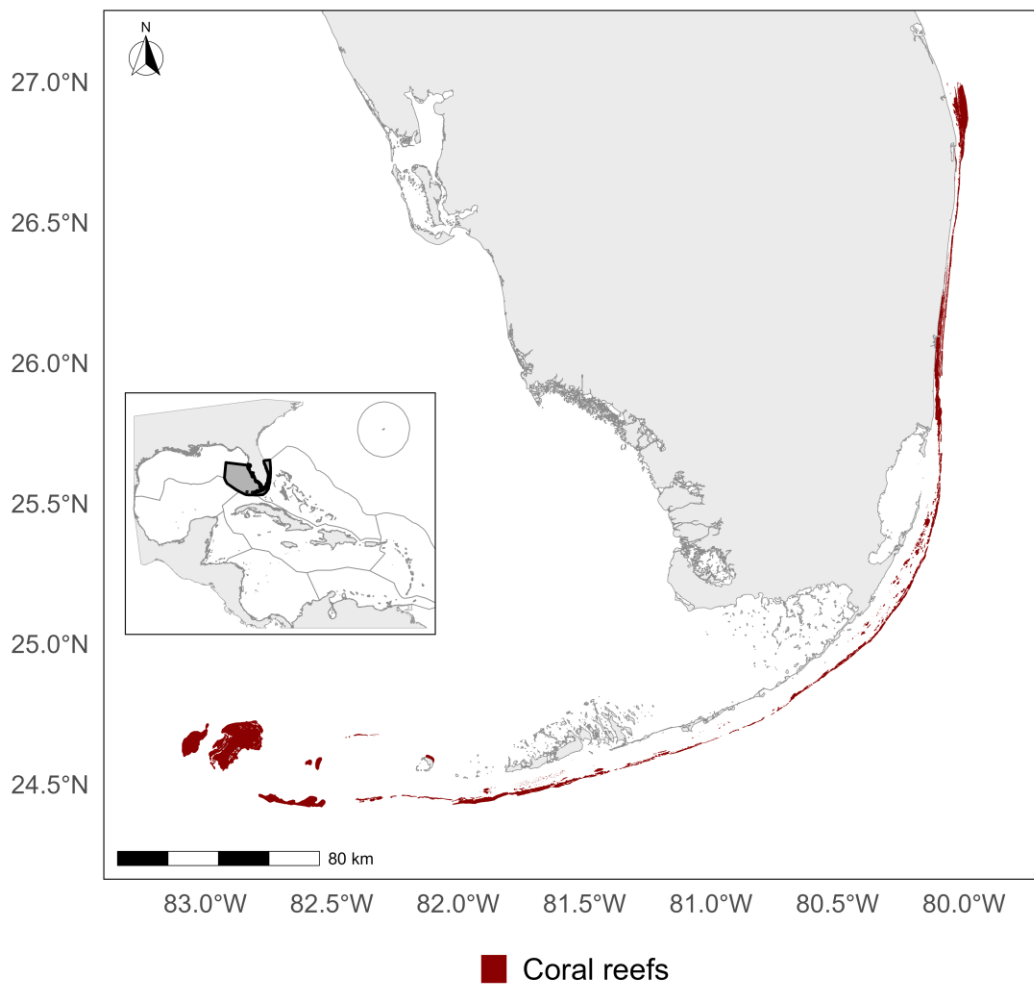
CRITERION			
A. Reduction in Geographic Distribution	A1	A2	A3
	Past 50 years	Future or any 50y period	Historical (1750)
	EN	NE	NE
OVERALL RISK CATEGORY	CR		

DD = Data Deficient; LC = Least Concern; NE = Not Evaluated

Floridian – Critically Endangered

Spatial distribution

Floridian coral reefs are located along the Florida Reef Tract from 27 degrees north down to 24.5 degrees of latitude, extending westward from 80 degrees west and terminating at 83 degrees west in Dry Tortugas.



Coral reef area (km ²)	Reef area proportion in Tropical Western Atlantic (%)	Number of coral species	Number of threatened coral species
754.87	5.6	59	23

Ecosystem description

The coral reefs of the Floridian ecoregion form a distinctive continental-margin reef system extending along southern Florida and the Florida Keys. The region represents the northern extension of Caribbean coral-reef development on the Florida Platform and differs from adjacent Bahamian and Caribbean Island systems through its extensive continental-shelf setting and strong influence from both tropical waters and subtropical coastal environments. Reef development includes nearshore patch reefs, bank reefs and an extensive offshore reef tract characterised by spur-and-groove morphology, with the Florida Reef Tract extending for more than 500 km along the Florida Keys and southeast Florida.

The region is strongly influenced by the Florida Current, which transports warm Caribbean water northwards through the Florida Straits and along the reef tract. Local environmental conditions vary considerably between offshore reefs and near shore reefs, influenced by mainland runoff, producing gradients in temperature, turbidity, nutrients and sedimentation. These gradients contribute to substantial variation in coral assemblages and reef condition. The reefs historically supported extensive stands of the framework-building *Acropora palmata* and *A. cervicornis* with diverse massive coral communities.

Floridian reefs have undergone major ecological change since the twentieth century. This includes cold-water events, *Diadema* mortality, white-band disease, and other coral diseases driving major losses of reef-building corals, while eutrophication, coastal development, fishing, and other local pressures contributed to widespread degradation. The 2005 bleaching event caused widespread thermal stress, while the exceptional 2023 marine heatwave produced the most severe bleaching yet documented in Florida, with extensive mortality of corals and the functional extinction of *Acropora spp.* along the Florida Reef Tract.



Photo credit: A. Anderson Mayfield, 2021. B. Brian Cole, 2013.

Eco-region	Key Biotic	Key Abiotic	Key Threats
Floridian	Diverse coral communities associated with the Florida Reef Tract, and Florida Keys, including extensive reef-building coral assemblages and high reef-fish diversity. Important populations of large reef fishes and herbivores.	Broad continental shelf with extensive shallow carbonate reef habitat. Strong influence of the Gulf Stream and Florida Current. Generally clear waters offshore but substantial coastal influence, freshwater discharge and nutrient inputs in some areas.	Coral disease, particularly SCTLD; warming and bleaching; coastal development and wastewater; fishing; recreational activities and vessel/anchor damage; shipping; storms.

Key values

Directly produceable and exportable from analysis

Proportion of coral reef lost over the last 50 years (Criterion A)	Distribution (Criterion B)		Biotic Indicator Values (Criterion D)		
	EOO (km ²)	AOO		Baseline	Current
0.79	41,672	65	hard coral cover (%)	26.6	4.12
			algae-coral ratio	0.26	0.84
			herbivore biomass (g/m ²)	30	13
			piscivore biomass (g/m ²)	14	22.1

Scenario	Mean annual DHWs across selected decades (Criterion C)			
	1986-1995	2016-2025	2026-2035	2066-2075
Observed	0.16	3.76	-	-
SSP2-4.5	-	-	11.78	20.17
SSP3-7.0	-	-	11.51	23.75
SSP5-8.5	-	-	12.82	29.14

Criteria Assessment

Overall, the risk of collapse of Floridian coral reefs was assessed as **Critically Endangered (CR)**.

Summary of the assessment:

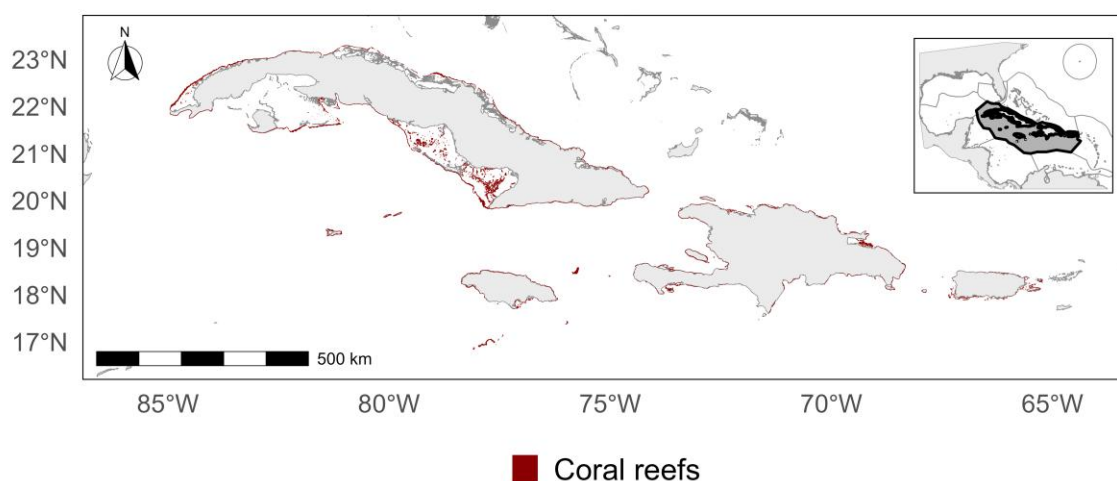
CRITERION			
A. Reduction in Geographic Distribution	A1	A2	A3
	Past 50 years	Future or any 50y period	Historical (1750)
	EN	NE	NE
B. Restricted Geo. Distribution	B1	B2	B3
	Extent of Occurrence	Area of Occupancy	# Threat-defined Locations < 5?
	VU	LC	No
C. Environmental Degradation	C1	C2	C3
	Past 50 years (1970)	Future or any 50y period	Historical (1750)
	VU	CR	DD
D. Disruption of biotic processes	D1	D2	D3
	Past 50 years (1970)	Future or Any 50y period	Historical (1750)
	CR	NE	DD
E. Quantitative Risk analysis	NE		
OVERALL RISK CATEGORY	CR		

DD = Data Deficient; LC = Least Concern; NE = Not Evaluated

Greater Antilles – Critically Endangered

Spatial distribution

The Greater Antilles are the largest coral reef ecoregion within the Wider Caribbean located centrally, and entirely within the Caribbean Sea. These coral reefs cover 20 degrees of longitude from 65 to 85 degrees west, while extending from 17 to 23 degrees of latitude.



Coral reef area (km ²)	Reef area proportion in Tropical Western Atlantic (%)	Number of coral species	Number of threatened coral species
4044.02	29.8	60	24

Ecosystem description

The coral reefs of the Greater Antilles ecoregion form a combination of large island reef system encompassing Cuba, Hispaniola, Jamaica, Puerto Rico, and seamount systems such as the coral reefs around the Cayman Islands. Reef development occurs across a wide range of settings, including fringing reefs, patch reefs, spur and groove reefs, and locally extensive barrier-like structures. The broad and varied continental and insular shelves of the Greater Antilles support substantial habitat heterogeneity, while deep channels and troughs, including the Cayman Trough and passages between the major islands, influence connectivity and oceanographic exchange.

The ecoregion spans strong environmental gradients. Large islands generate substantial local variation in runoff, turbidity and nutrient availability, while exposed northern and eastern margins receive strong oceanic influence. The region also lies across major pathways of Caribbean circulation, with currents and island passages influencing larval transport and connectivity. The Greater Antilles contain areas of high marine species richness and include important populations of reef-building corals such as *Orbicella* spp. and *Acropora* spp.

Historical disturbances include hurricanes, overfishing, coastal development, pollution, coral disease and *Diadema* die-off. Multiple severe marine heatwaves have occurred across the entire ecoregion since the turn of the 21st century, resulting in widespread catastrophic coral mortality.

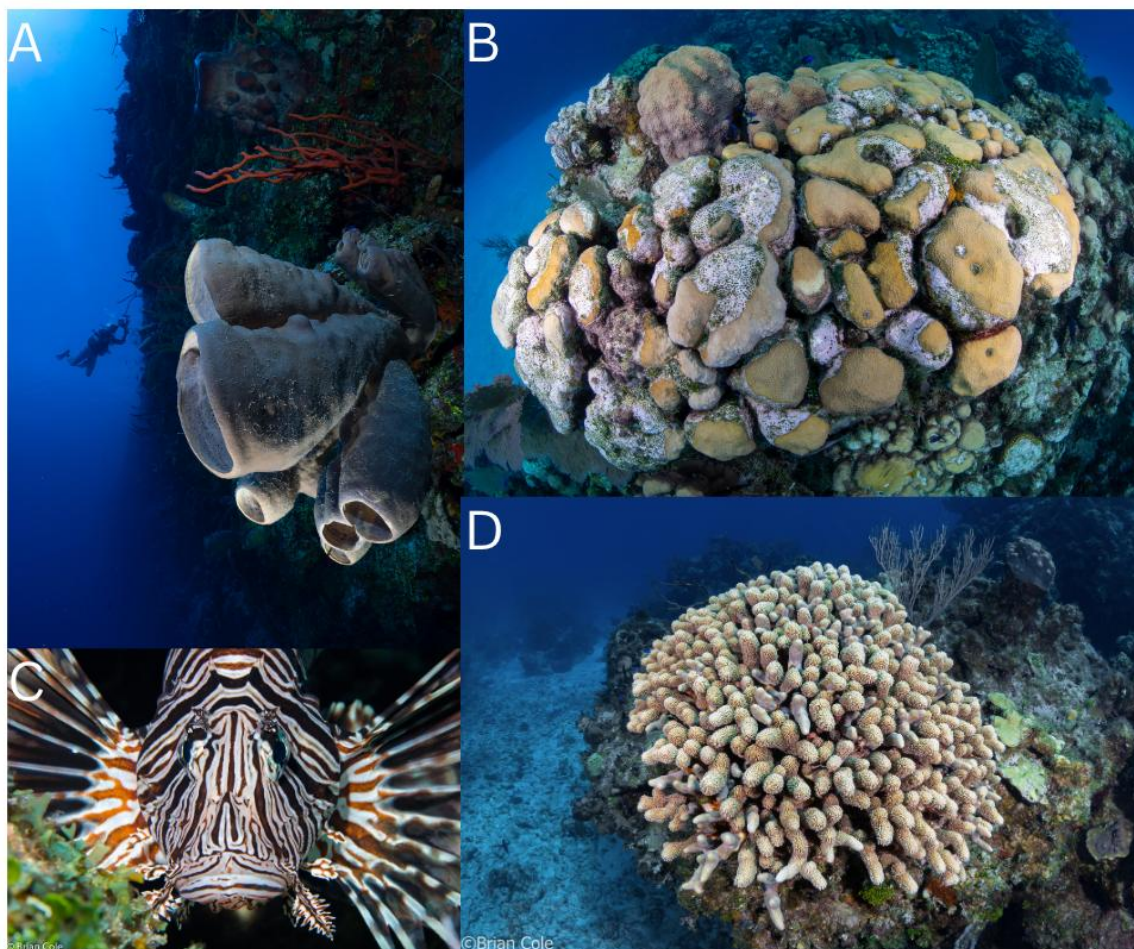


Photo credit: A & B. Nathan Prince, 2026. C & D. Brian Cole, 2017 & 2019.

Eco-region	Key Biotic	Key Abiotic	Key Threats
Greater Antilles	Highly diverse coral reef communities associated with Cuba, Hispaniola, Jamaica and Puerto Rico. High regional coral and fish diversity, with substantial variation among islands. Extensive reef, mangrove and seagrass connectivity.	Large and geologically diverse islands with extensive continental/shelf and island-shelf reef habitats. Strong gradients in exposure, depth, currents and terrestrial influence. High exposure to tropical hurricanes.	Climate warming and bleaching; coral disease; overfishing; coastal development; wastewater and agricultural runoff; tourism; storms; shipping and pollution.

Key values

Directly produceable and exportable from analysis

Proportion of coral reef lost over the last 50 years (Criterion A)	Distribution (Criterion B)		Biotic Indicator Values (Criterion D)		
	EOO (km²)	AOO		Baseline	Current
0.43	754,568	788	hard coral cover (%)	36.6	8.89
			algae-coral ratio	0.21	0.67
			herbivore biomass (g/m²)	30	26.2
			piscivore biomass (g/m²)	14	6.69

	Mean annual DHWs across selected decades (Criterion C)			
Scenario	1986-1995	2016-2025	2026-2035	2066-2075
Observed	0.21	5.56	-	-
SSP2-4.5	-	-	12.09	19.44
SSP3-7.0	-	-	11.65	24
SSP5-8.5	-	-	13.01	29.04

Criteria Assessment

Overall, the risk of collapse of the coral reefs in **the Greater Antilles** was assessed as **Critically Endangered**.

Summary of the assessment:

CRITERION			
A. Reduction in Geographic Distribution	A1	A2	A3
	Past 50 years	Future or any 50y period	Historical (1750)
	VU	NE	NE
B. Restricted Geo. Distribution	B1	B2	B3
	Extent of Occurrence	Area of Occupancy	# Threat-defined Locations < 5?
	LC	LC	No
C. Environmental Degradation	C1	C2	C3
	Past 50 years (1970)	Future or any 50y period	Historical (1750)
	VU	CR	DD
	D1	D2	D3

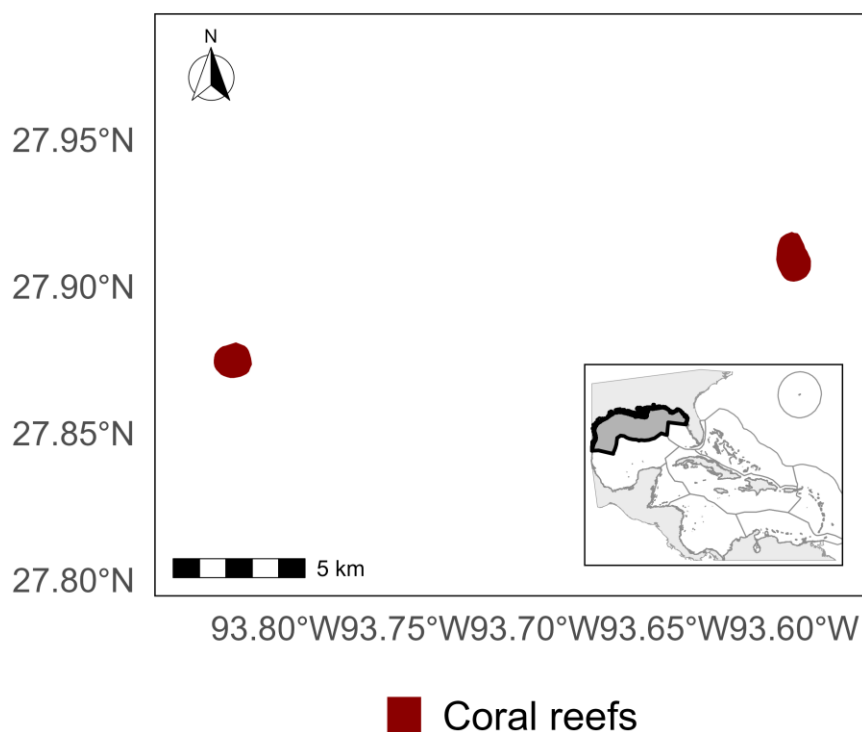
CRITERION			
A. Reduction in Geographic Distribution	A1	A2	A3
	Past 50 years	Future or any 50y period	Historical (1750)
D. Disruption of biotic processes	VU	NE	NE
	Past 50 years (1970)	Future or Any 50y period	Historical (1750)
E. Quantitative Risk analysis	EN	NE	DD
OVERALL RISK CATEGORY	CR		

DD = Data Deficient; LC = Least Concern; NE = Not Evaluated

Northern Gulf of Mexico – Critically Endangered

Spatial distribution

Coral reefs from the Northern Gulf of Mexico ecoregion are situated entirely within the Flower Garden Banks (FGB), approximately 80-120 miles from the coast of Texas (mainland United States of America). Deeper mesophotic reefs (>30m) are spatially more extensive than shallow water reefs in the FGB but are not considered in this assessment.



Coral reef area (km ²)	Reef area proportion in Tropical Western Atlantic (%)	Number of coral species	Number of threatened coral species
3.6	0.03	45	19

Ecosystem description

The **Northern Gulf of Mexico assessment area** is represented within this assessment by the isolated coral reef system of the Flower Garden Banks less than 30m depth. These reefs are compositionally distinct from most Caribbean reef systems because they occur at the northern geographical limit of tropical coral-reef development, approximately 200 km offshore on isolated continental-shelf banks. The reefs occupy elevated geological structures formed principally by salt-dome tectonics and include reef caps, deeper mesophotic habitats, and extensive non-reef hard-bottom communities.

The Flower Garden Banks experience relatively warm, stable waters despite their subtropical latitude, allowing high coral cover but supporting a substantially reduced coral species pool compared with the wider Caribbean. The reef environment is composed of massive species such as *Orbicella* spp., *Montastraea cavernosa*, *Colpophyllia natans* and *Pseudodiploria strigosa*. The banks are strongly influenced by the Gulf Loop Current, along with local eddies, which transport warm water, nutrients and larvae across the continental shelf.

Despite their relative isolation, the reefs have experienced coral disease outbreaks, tropical storms, and pressures associated with offshore oil and gas activity. The coral reef area from FGB within the photic zone have been impacted by bleaching since the turn of the century, albeit to a lesser extent than other regions in the Caribbean. Notably, these reefs experience minimal disruption from impactful stressors such as run off and land-based sources of pollution.

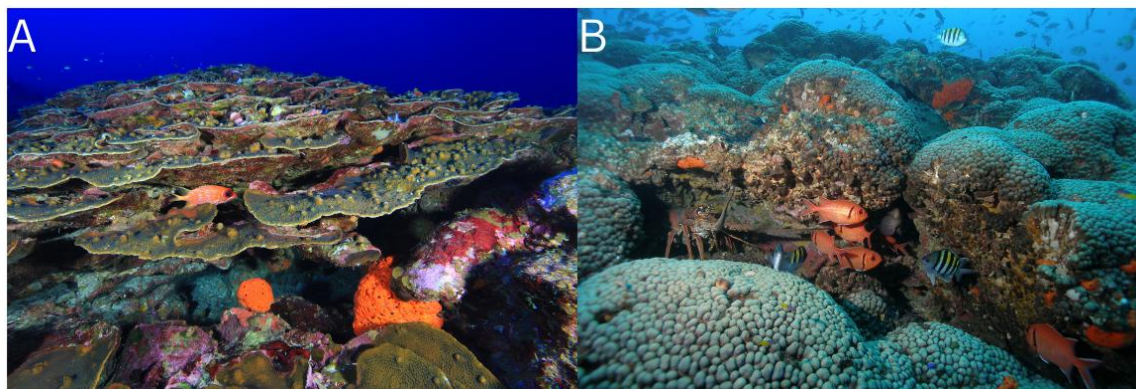


Photo credit: A. “FGBNMS Coral Crest” by NOAA Office of National Marine Sanctuaries, CC BY 2.0, Greg McFall/NOAA. B. “FGBNMS - Reef Scene” by NOAA Office of National Marine Sanctuaries, Public Domain Mark, Emma Hickerson/NOAA.

Eco-region	Key Biotic	Key Abiotic	Key Threats
Northern Gulf of Mexico	High coral cover and relatively large, structurally complex reef-building coral colonies compared with many other Caribbean reefs. The banks support diverse reef-associated fishes, sponges, algae and invertebrates, and represent distinctive high-latitude coral communities within the Gulf of Mexico.	Isolated carbonate banks on the outer continental shelf, approximately 100–200 km off the Texas–Louisiana coast. Reefs occur in relatively deep water (>18m), with clear offshore waters and limited direct terrestrial influence. The region experiences seasonal temperature variation and occasional exposure to cold-water events, marine heatwaves, and storms.	Climate-driven warming and bleaching; coral disease; fishing; oil and gas activity and associated pollution; shipping.

Key values

Directly produceable and exportable from analysis

Proportion of coral reef lost over the last 50 years (Criterion A)	Distribution (Criterion B)		Biotic Indicator Values (Criterion D)		
	EOO (km ²)	AOO		Baseline	Current
0	39	2	hard coral cover (%)	42.5	62.4
			algae-coral ratio	0.18	0.19
			herbivore biomass (g/m ²)	30	5.83
			piscivore biomass (g/m ²)	14	2.62

	Mean annual DHWs across selected decades (Criterion C)			
Scenario	1986-1995	2016-2025	2026-2035	2066-2075
Observed	0.85	3.82	-	-
SSP2-4.5	-	-	10.65	20
SSP3-7.0	-	-	10.67	23.08
SSP5-8.5	-	-	12.4	28.74

Criteria Assessment

Overall, the risk of collapse of the coral reefs in **the Northern Gulf of Mexico** was assessed as **Critically Endangered (CR)**.

Summary of the assessment:

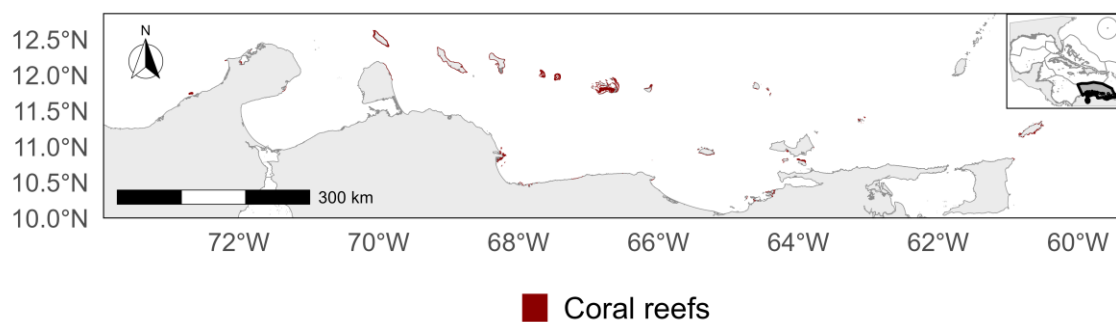
CRITERION			
A. Reduction in Geographic Distribution	A1	A2	A3
	Past 50 years	Future or any 50y period	Historical (1750)
	LC	NE	NE
B. Restricted Geo. Distribution	B1	B2	B3
	Extent of Occurrence	Area of Occupancy	# Threat-defined Locations < 5?
	CR	CR	No
C. Environmental Degradation	C1	C2	C3
	Past 50 years (1970)	Future or any 50y period	Historical (1750)
	LC	CR	DD
D. Disruption of biotic processes	D1	D2	D3
	Past 50 years (1970)	Future or Any 50y period	Historical (1750)
	VU	NE	DD
E. Quantitative Risk analysis	NE		
OVERALL RISK CATEGORY	CR		

DD = Data Deficient; LC = Least Concern; NE = Not Evaluated

Southern Caribbean – Critically Endangered

Spatial distribution

Southern Caribbean coral reefs extend from west Tobago at approximately 60 degrees west to the northeastern coast of Colombia at 73 degrees west. Coral reefs are scattered along the continental coast of South America starting at 10 degrees latitude up to 12.5 degrees latitude, with numerous offshore islands surrounded by coral reefs within this ecoregion.



Coral reef area (km ²)	Reef area proportion in Tropical Western Atlantic (%)	Number of coral species	Number of threatened coral species
515.42	3.8	58	24

Ecosystem description

The coral reefs of the **Southern Caribbean ecoregion** form a compositionally and environmentally distinct system along the southern margin of the Caribbean Sea, including

Venezuela, Aruba, Bonaire, Curaçao, Trinidad and Tobago and the offshore Venezuelan islands. The region differs from much of the central Caribbean through its proximity to continental South America and strong influence from seasonal upwelling, and the freshwater and nutrient inputs from South America.

Reef development is variable, ranging from well-developed fringing and patch reefs around offshore islands to more restricted coral communities along mainland coasts where sedimentation, freshwater discharge, and unstable substrates constrain reef formation. In contrast, the relatively clear, oligotrophic waters surrounding the ABC islands support extensive and comparatively well-developed reef communities.

Reefs have experienced fishing pressure, coastal development, sedimentation, eutrophication, coral disease and bleaching. Multiple substantial marine heatwaves have occurred since the turn of the century, resulting in recurrent widespread bleaching events.

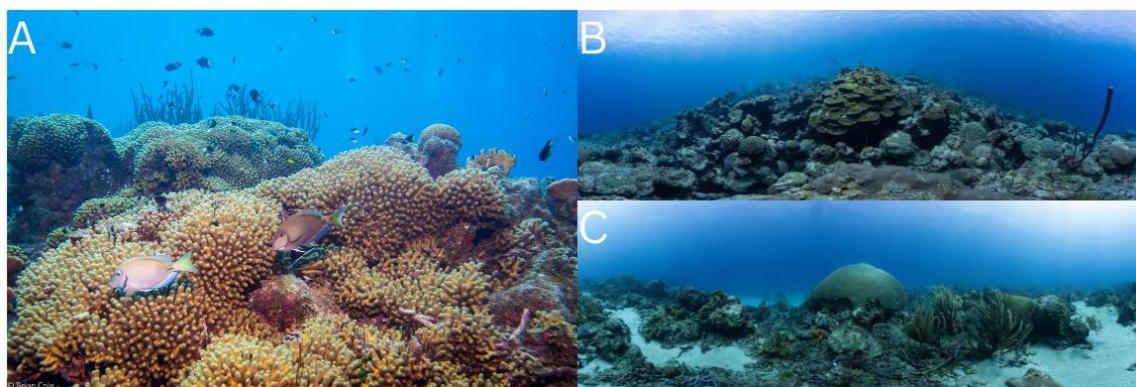


Photo credit: A. Brian Cole. B and C. Underwater Earth: The Maritime Ocean Collection.

Eco-region	Key Biotic	Key Abiotic	Key Threats
Southern Caribbean	Diverse coral, fish, and invertebrate assemblages across fringing, patch, and platform reefs.	Generally warm tropical waters with relatively low seasonal temperature variation. Strong oceanographic influence from the Caribbean Current and South American freshwater discharge. Localised high productivity and sediment/nutrient inputs near continental coastlines.	Warming and bleaching; coral disease; fishing; coastal development; wastewater and agricultural runoff; oil and gas exploration/production.

Key values

Directly produceable and exportable from analysis

Proportion of coral reef lost over the last 50 years (Criterion A)	Distribution (Criterion B)		Biotic Indicator Values (Criterion D)		
	EOO (km ²)	AOO		Baseline	Current
0.19	206,861	112	hard coral cover (%)	48.6	14.2
			algae-coral ratio	0.16	0.35
			herbivore biomass (g/m ²)	30	9.94
			piscivore biomass (g/m ²)	14	5.96

	Mean annual DHWs across selected decades (Criterion C)			
Scenario	1986-1995	2016-2025	2026-2035	2066-2075
Observed	2.07	11.43	-	-
SSP2-4.5	-	-	10.53	15.88
SSP3-7.0	-	-	8.64	18.28
SSP5-8.5	-	-	11.13	22.4

Criteria Assessment

Overall, the risk of collapse of the coral reefs in **the Southern Caribbean** was assessed as **Critically Endangered (CR)**.

Summary of the assessment:

CRITERION			
A. Reduction in Geographic Distribution	A1	A2	A3
	Past 50 years	Future or any 50y period	Historical (1750)
	LC	NE	NE
B. Restricted Geo. Distribution	B1	B2	B3
	Extent of Occurrence	Area of Occupancy	# Threat-defined Locations < 5?
	LC	LC	No
C. Environmental Degradation	C1	C2	C3
	Past 50 years (1970)	Future or any 50y period	Historical (1750)
	CR	CR	DD
D. Disruption of biotic processes	D1	D2	D3
	Past 50 years (1970)	Future or Any 50y period	Historical (1750)
	CR	NE	DD

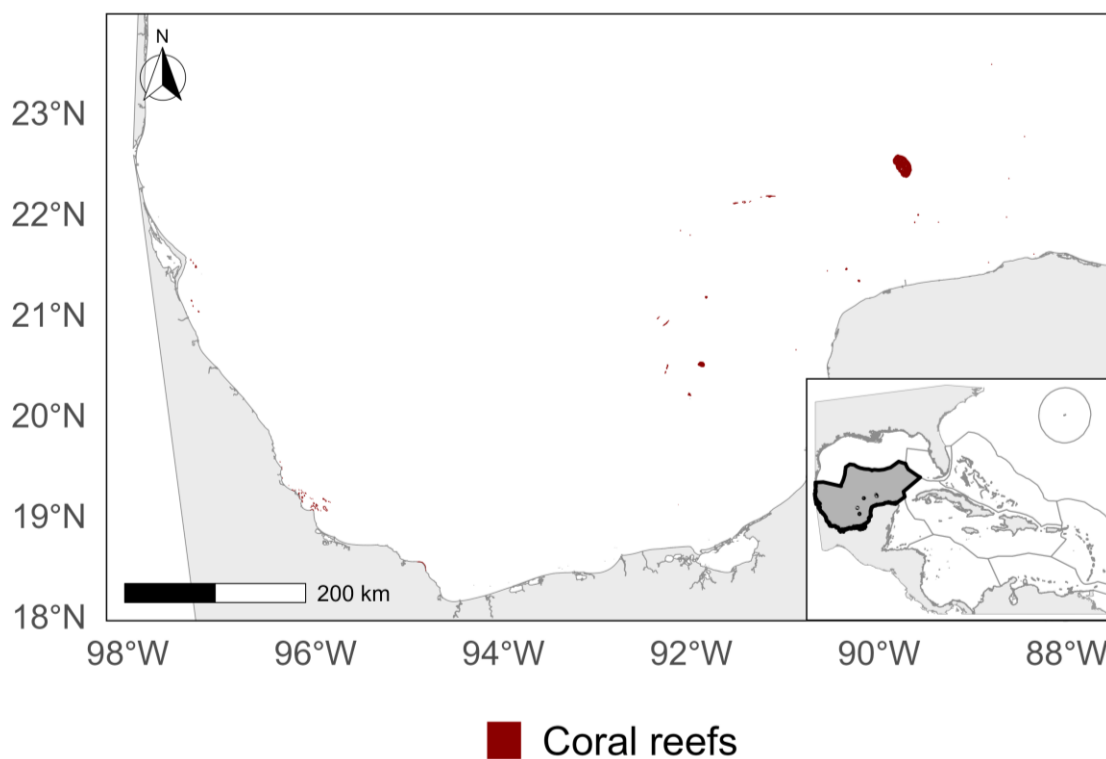
CRITERION			
A. Reduction in Geographic Distribution	A1	A2	A3
	Past 50 years	Future or any 50y period	Historical (1750)
	LC	NE	NE
E. Quantitative Risk analysis	NE		
OVERALL RISK CATEGORY	CR		

DD = Data Deficient; LC = Least Concern; NE = Not Evaluated

Southern Gulf of Mexico – Critically Endangered

Spatial distribution

The Southern Gulf of Mexico includes the most Western coral reefs in this assessment from - 97.28 degrees west, with the ecoregion stretching east to border the Caribbean Sea, and north the Northern Gulf of Mexico ecoregion.



Coral reef area (km ²)	Reef area proportion in Tropical Western Atlantic (%)	Number of coral species	Number of threatened coral species
422.02	3.1	57	23

Ecosystem description

Coral reefs of the **Southern Gulf of Mexico ecoregion** are composed of a combination of continental-shelf reef systems extending along the Gulf coast of Mexico and isolated offshore reefs scattered along Campeche Bank. Nearshore reefs here occur within a broad continental-margin environment influenced by river systems, coastal sediment transport, and extensive carbonate platforms. Offshore reefs are less influenced by terrestrial inputs, resulting in different environmental conditions and reef development. Reef types include fringing reefs, platform reefs and submerged banks.

Environmental conditions vary substantially across the ecoregion owing to different levels of input from the Mexican coast based on proximity to the continent. The nearshore reefs are influenced by coastal discharge generating seasonal changes in turbidity, salinity and sedimentation. In contrast, there is minimal impact of freshwater input for offshore reefs, resulting in low sedimentation and exceptional water clarity. However, these coral reefs maintain strong connectivity within the ecoregion due to oceanic currents and larval dispersal.

Major threats include sedimentation, eutrophication, coastal development, fisheries, tourism and climate-driven thermal stress. Coral reefs in the Southern Gulf of Mexico have experienced multiple severe marine heatwaves since 2010, while hurricanes and other extreme weather events periodically cause physical damage. Notably, the Southern Gulf of Mexico is void of Stony Coral Tissue Loss Disease (as of 2026).

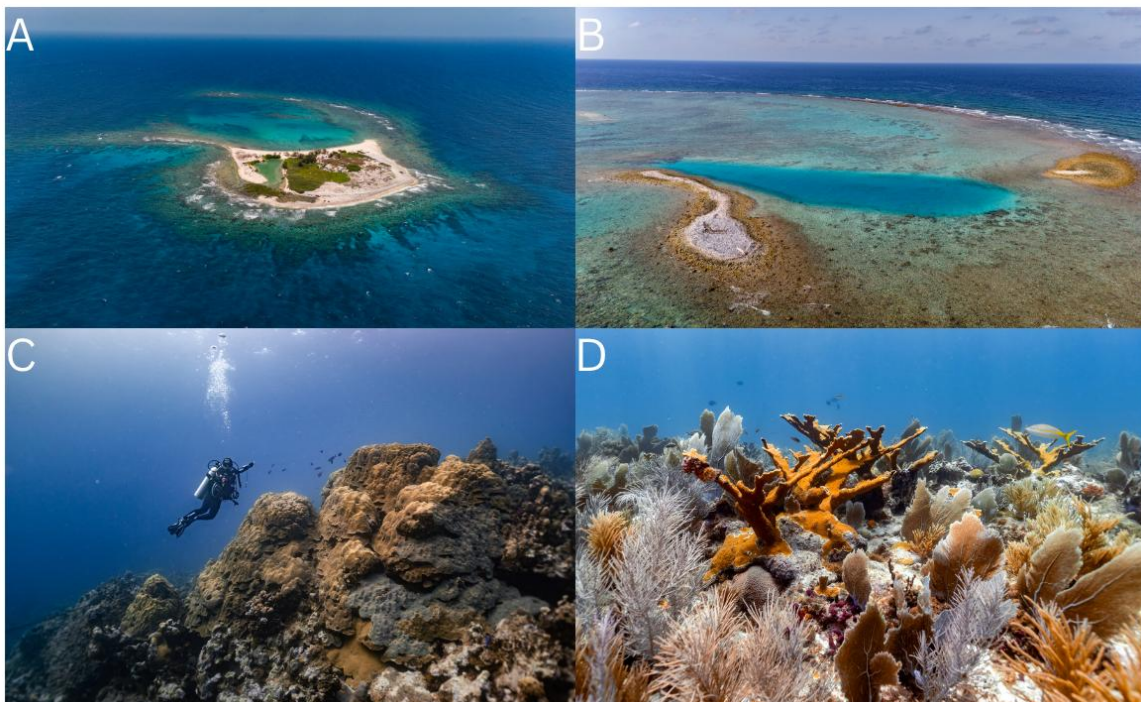


Photo credit: A & B. Cuauhtémoc Moreno. C & D. Nelly Quijano.

Eco-region	Key Biotic	Key Abiotic	Key Threats
Southern Gulf of Mexico	Diverse coral and reef-associated communities, including shallow coastal reefs and deeper mesophotic communities with large <i>Orbicella</i> colonies. Important reef-fish and invertebrate assemblages associated with carbonate and hard-bottom habitats. Free from SCTLD as of 2026.	Broad continental shelf with strong terrestrial influence from Mexican rivers and coastal development. High variability in turbidity, nutrients and sedimentation. Warm tropical to subtropical waters influenced by Loop Current dynamics and Gulf circulation.	Oil and gas exploration/production; oil spills; fishing; shipping; agricultural and urban runoff; warming and bleaching; coastal development; storms.

Key values

Directly produceable and exportable from analysis

Proportion of coral reef lost over the last 50 years (Criterion A)	Distribution (Criterion B)		Biotic Indicator Values (Criterion D)		
	E00 (km ²)	A00		Baseline	Current
0.22	333,142	53	hard coral cover (%)	40	21.3
			algae-coral ratio	0.19	0.27
			herbivore biomass (g/m ²)	30	226
			piscivore biomass (g/m ²)	14	138

Scenario	Mean annual DHWs across selected decades (Criterion C)			
	1986-1995	2016-2025	2026-2035	2066-2075
Observed	0.45	7.29	-	-
SSP2-4.5	-	-	12.51	19.46
SSP3-7.0	-	-	11.87	23.61
SSP5-8.5	-	-	12.76	28.28

Criteria Assessment

Overall, the risk of collapse of the coral reefs in **the Southern Gulf of Mexico** was assessed as **Critically Endangered (CR)**.

Summary of the assessment:

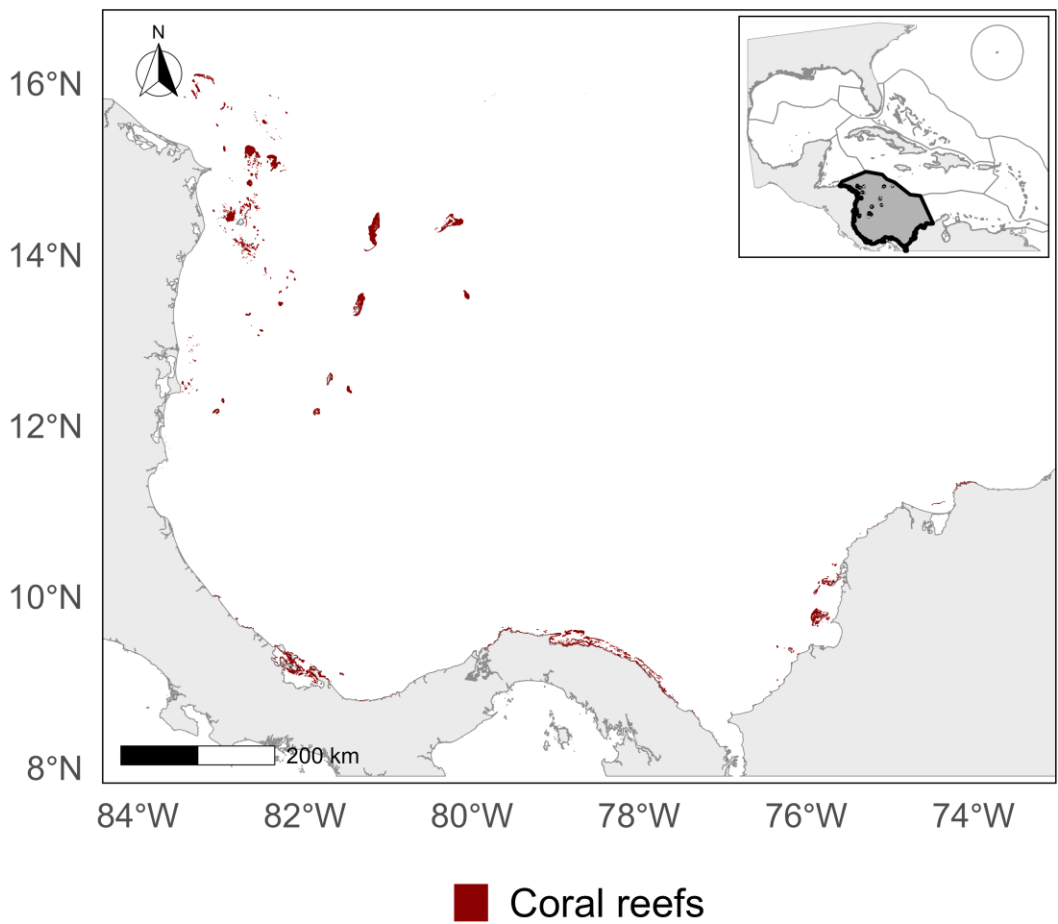
CRITERION			
A. Reduction in Geographic Distribution	A1	A2	A3
	Past 50 years	Future or any 50y period	Historical (1750)
	LC	NE	NE
B. Restricted Geo. Distribution	B1	B2	B3
	Extent of Occurrence	Area of Occupancy	# Threat-defined Locations < 5?
	LC	NT	No
C. Environmental Degradation	C1	C2	C3
	Past 50 years (1970)	Future or any 50y period	Historical (1750)
	EN	CR	DD
D. Disruption of biotic processes	D1	D2	D3
	Past 50 years (1970)	Future or Any 50y period	Historical (1750)
	NT	NE	DD
E. Quantitative Risk analysis	NE		
OVERALL RISK CATEGORY	CR		

DD = Data Deficient; LC = Least Concern; NE = Not Evaluated

Southwestern Caribbean – Critically Endangered

Spatial distribution

Coral reefs from the Southwestern Caribbean ecoregion are located both offshore and along the central American coast between 8-16 degrees north of latitude, while extending eastward from 74 to 84 degrees west.



Coral reef area (km ²)	Reef area proportion in Tropical Western Atlantic (%)	Number of coral species	Number of threatened coral species
2331.38	17.2	58	24

Ecosystem description

The coral reefs of the **Southwestern Caribbean ecoregion** form a compositionally distinct reef system associated with the Caribbean coasts of Nicaragua, Costa Rica and Panama, and

the Colombian Caribbean islands, along with offshore reefs. The region occupies the Colombian Basin and includes extensive shallow continental shelves, offshore islands, mangrove-fringed cays and reef complexes. Reef development varies considerably, including fringing reefs, patch reefs, reef crests, platform reefs and marginal reef formations.

The ecoregion is strongly influenced by the Caribbean Current and by interactions between oceanic circulation such as the Columbia-Panama Gyre. Coastal runoff produces substantial spatial variation in turbidity and sedimentation, particularly along Nicaragua and Panama. Upwelling and seasonal oceanographic variability are also important along parts of the Colombian coast, where changes in temperature, nutrients and water movement influence reef composition. These environmental gradients create a mixture of relatively turbid, marginal reef environments and clearer offshore reef systems.

Historical disturbances include hurricanes and storms, sedimentation, fishing pressure, coastal development, coral disease, and *Diadema* mortality. Bleaching events in the 21st century have impacted many coral reefs in this ecoregion. However, the nearshore reefs often experience less severe mortality from catastrophic heatwaves given the moderating effects of turbidity.

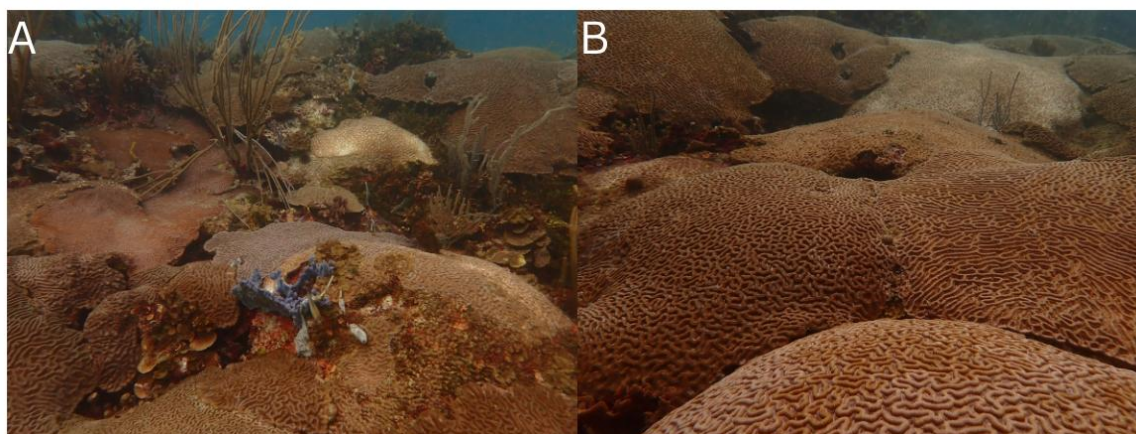


Photo credit: A & B. Matt Doherty.

Eco-region	Key Biotic	Key Abiotic	Key Threats
Southwestern Caribbean	High biodiversity associated with coral reefs along Colombia, Panama, Costa Rica and Nicaragua. Includes extensive fringing, barrier and platform reefs, with strong coral-mangrove-seagrass connectivity in places	Strong influence of continental runoff, seasonal rainfall and river discharge. Oceanographic conditions vary substantially along the coast, with localised upwelling and high productivity in some areas. Exposure to tropical storms is generally lower than in	Fishing; warming and bleaching; coral disease; sedimentation and agricultural runoff; coastal development; wastewater.

Eco-region	Key Biotic	Key Abiotic	Key Threats
		the northern Caribbean, although not absent.	

Key values

Directly produceable and exportable from analysis

Proportion of coral reef lost over the last 50 years (Criterion A)	Distribution (Criterion B)		Biotic Indicator Values (Criterion D)		
	EOO (km ²)	AOO		Baseline	Current
0.12	537,721	274	hard coral cover (%)	37.4	18.3
			algae-coral ratio	0.20	0.56
			herbivore biomass (g/m ²)	30	6.16
			piscivore biomass (g/m ²)	14	8

Scenario	Mean annual DHWs across selected decades (Criterion C)			
	1986-1995	2016-2025	2026-2035	2066-2075
Observed	0.85	9.21	-	-
SSP2-4.5	-	-	9.99	15.94
SSP3-7.0	-	-	8.31	18.86
SSP5-8.5	-	-	10.55	23.28

Criteria Assessment

Overall, the risk of collapse of the coral reefs in **the Southwestern Caribbean** was assessed as **Critically Endangered (CR)**.

Summary of the assessment:

CRITERION			
A. Reduction in Geographic Distribution	A1	A2	A3
	Past 50 years	Future or any 50y period	Historical (1750)
	LC	NE	NE
B. Restricted Geo. Distribution	B1	B2	B3
	Extent of Occurrence	Area of Occupancy	# Threat-defined Locations < 5?
	LC	LC	No
	C1	C2	C3

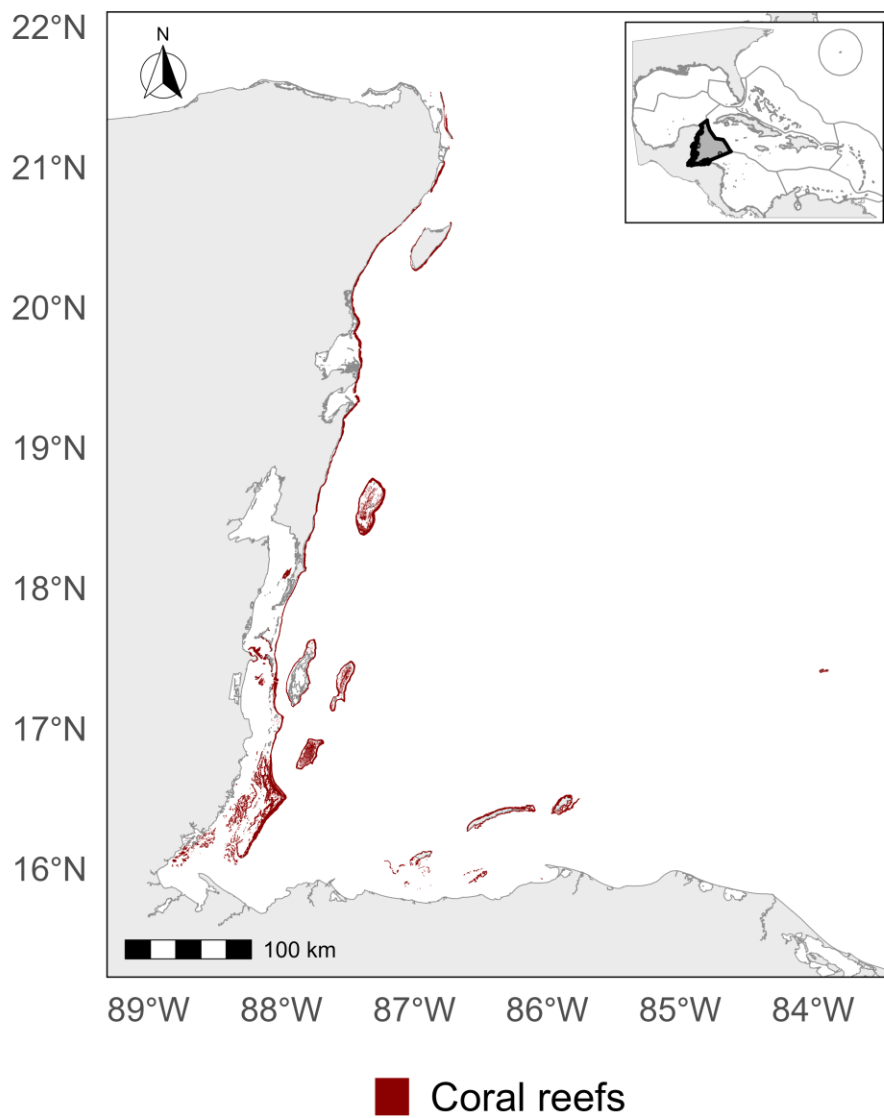
CRITERION			
A. Reduction in Geographic Distribution	A1	A2	A3
	Past 50 years	Future or any 50y period	Historical (1750)
C. Environmental Degradation	LC	NE	NE
	Past 50 years (1970)	Future or any 50y period	Historical (1750)
	EN	CR	DD
D. Disruption of biotic processes	D1	D2	D3
	Past 50 years (1970)	Future or Any 50y period	Historical (1750)
	CR	NE	DD
E. Quantitative Risk analysis	NE		
OVERALL RISK CATEGORY	CR		

DD = Data Deficient; LC = Least Concern; NE = Not Evaluated

Western Caribbean – Critically Endangered

Spatial distribution

Western Caribbean coral reefs are located between approximately 16 degrees north to 21.4 degrees north, bordering the Southern Gulf of Mexico to the northwest, Greater Antilles to the northeast, and Southwestern Caribbean to the southeast. Coral reefs are primarily located on the west side of the ecoregion along the continent, with scattered atolls, sea banks throughout the rest of the ecoregion. Longitude extends from 84 degrees west to 89 degrees west.



Coral reef area (km ²)	Reef area proportion in Tropical Western Atlantic (%)	Number of coral species	Number of threatened coral species
1668.53	12.3	56	23

Ecosystem description

The coral reefs of the **Western Caribbean ecoregion** form a compositionally distinct reef system centred on the Mesoamerican Caribbean coast from the Yucatán Peninsula through Belize and Guatemala to the Bay Islands of Honduras. The ecoregion contains the largest continuous barrier-reef complex in the Western Hemisphere, together with offshore atolls, patch reefs, fringing reefs and distinctive faro formations. The Belize Barrier Reef alone

extends for approximately 220 km and includes three offshore atolls, extensive shelf-lagoon habitats and numerous patch reefs.

The region is characterised by a continental shelf, with strong gradient from relatively clear oceanic waters on offshore reefs to more turbid, sediment-influenced environments near mainland coasts. River discharge and coastal wetlands influence sediment and nutrient availability, while the Caribbean Current drives predominantly westward and north-westward circulation along the shelf. The extensive reef-lagoon-mangrove-seagrass mosaic provides a high degree of habitat connectivity and supports diverse coral, fish and invertebrate assemblages.

Western Caribbean reefs have been affected by hurricanes, coral disease, overfishing, coastal development, sedimentation and pollution. *Diadema* die-off caused major ecological changes, while white-band disease contributed to the widespread decline of *Acropora*. Multiple widespread bleaching events have occurred in this ecoregion, compounding local scale stressors.

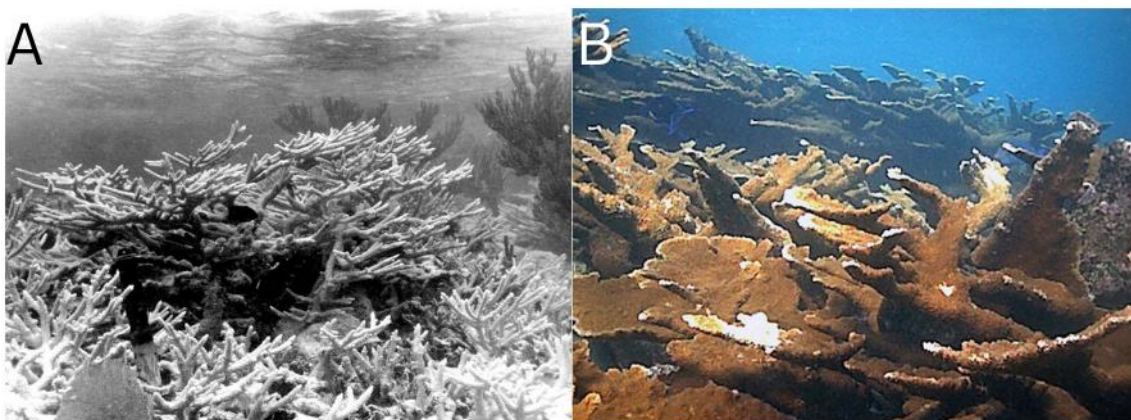


Photo credit: A. Eric Jordán Dahlgren, 1980s. B. Anderson Mayfield, 2003.

Eco-region	Key Biotic	Key Abiotic	Key Threats
Western Caribbean	Exceptionally diverse coral reef ecosystems, including the Mesoamerican Barrier Reef and extensive reefs around Belize, Honduras, Guatemala and the Yucatán Peninsula. High coral and reef-fish diversity and strong connectivity with mangrove and seagrass habitats.	Extensive shallow carbonate platforms and shelf-edge reefs. Generally warm tropical conditions, with strong influence of Caribbean currents. Localised freshwater, nutrient and sediment inputs, particularly near major rivers and developed coastal areas.	Warming and bleaching; coral disease; fishing; coastal development; tourism; wastewater and agricultural runoff; shipping; storms.

Key values

Directly produceable and exportable from analysis

Proportion of coral reef lost over the last 50 years (Criterion A)	Distribution (Criterion B)		SST-anomaly past 50 years (Criterion C)	Biotic Indicator Values (Criterion D)		
	EOO (km ²)	AOO			Baseline	Current
0.11	184,083	202		hard coral cover (%)	30.3	19
				algae-coral ratio	0.24	0.55
				herbivore biomass (g/m ²)	30	605
				piscivore biomass (g/m ²)	14	159

	Mean annual DHWs across selected decades (Criterion C)			
Scenario	1986-1995	2016-2025	2026-2035	2066-2075
Observed	0.29	8.59	-	-
SSP2-4.5	-	-	10.84	17.31
SSP3-7.0	-	-	9.51	21.19
SSP5-8.5	-	-	11.77	25.82

Criteria Assessment

Overall, the risk of collapse of the coral reefs in **the Western Caribbean** was assessed as **Critically Endangered (CR)**.

Summary of the assessment:

CRITERION			
A. Reduction in Geographic Distribution	A1	A2	A3
	Past 50 years	Future or any 50y period	Historical (1750)
	LC	NE	NE
B. Restricted Geo. Distribution	B1	B2	B3
	Extent of Occurrence	Area of Occupancy	# Threat-defined Locations < 5?
	LC	LC	No
C. Environmental Degradation	C1	C2	C3
	Past 50 years (1970)	Future or any 50y period	Historical (1750)
	EN	CR	DD
D. Disruption of biotic processes	D1	D2	D3
	Past 50 years (1970)	Future or Any 50y period	Historical (1750)

CRITERION			
A. Reduction in Geographic Distribution	A1	A2	A3
	Past 50 years	Future or any 50y period	Historical (1750)
	LC	NE	NE
	VU	NE	DD
E. Quantitative Risk analysis	NE		
OVERALL RISK CATEGORY	CR		

DD = Data Deficient; LC = Least Concern; NE = Not Evaluated