

Forum: Environmental Committee

Issue: Preserving biodiversity in the Mesoamerican Barrier Reef System

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TOPIC INTRODUCTION

The Mesoamerican Barrier Reef System (MBRS) also known as Mesoamerican Reef (MAR) is the second largest (or largest in the western hemisphere) barrier reef in the world. It extends through four different countries, Mexico, Belize, Honduras and Guatemala. It contains 67 different species of reef-building corals, however throughout the last 20 years those are being gradually replaced by structurally simpler species. This results in less cover from predators and less breeding grounds for many species.¹ The MBRS also supports many livelihoods, with an estimated 2 million people relying on it for food, water and jobs.²

Corals play a very important role in maintaining the biodiversity of ocean ecosystems, despite accounting for less than 1% of the ocean floor, they facilitate 25% of all ocean life!³ Biodiversity simply put, is having a wide variety of different organisms. Without it, people would not have access to food or even oxygen.⁴ Biodiversity also supplies us with medicine, many of the compounds that are used to save lives globally, would not exist if not for the sheer amount of organisms around us. Biodiversity also plays a vital role in allowing ecosystems to resist natural disasters, disease, extinctions, and recover from them.⁵

The MBRs is a transboundary ecosystem, meaning it spans the borders of multiple countries; Mexico, Belize, Honduras, Guatemala. This comes with unique challenges,

¹ Red List of Ecosystems. "IUCN Ecosystems." *Assessments.iucnrl.org*, assessments.iucnrl.org/assessments/20.

² The Nature Conservancy. "Mesoamerican Reef | the Nature Conservancy." *Nature.org*, 2020, www.nature.org/en-us/get-involved/how-to-help/places-we-protect/mesoamerican-reef/.

³ MacPherson, Rick. "Coral Reefs Need You | Smithsonian Ocean." *Ocean.Si.Edu*, Oct. 2010, <https://ocean.si.edu/ecosystems/coral-reefs/coral-reefs-need-you>. Accessed 11 July 2026.

⁴ The Royal Society. "Why Is Biodiversity Important?" *Royalsociety.Org*, The Royal Society, 2024, <https://royalsociety.org/news-resources/projects/biodiversity/why-is-biodiversity-important/>. Accessed 11 July 2026.

⁵ "Services Provided by Biodiversity - Biodiversity (U.S. National Park Service)." *Www.Nps.Gov*, 15 Mar. 2016, <https://www.nps.gov/subjects/biodiversity/services-provided-by-biodiversity.htm>. Accessed 11 July 2026.

international collaboration is key to ensuring the survival of the reef, while ensuring that local populations are not adversely impacted. This links with the DSAMUN theme “rediscovering diplomacy in an era of political instability”.

DEFINITION OF KEY-TERMS

Marine Protected Area (MPA)⁶

A Marine Protected Area or (MPA) defined by the National Oceanic and Atmospheric Administration is a “defined region designated and managed for the long-term conservation of marine resources, ecosystems services, or cultural heritage”.

Coral Reef (System)⁷

According to the National History museum, coral reefs are “made up of colonies of hundreds to thousands of tiny individual corals, called polyps.”

Biodiversity⁸

According to the Merriam Webster Dictionary, Biodiversity is defined as a “biological diversity in an environment as indicated by numbers of different species of plants and animals”.

Coral Bleaching⁹

Bleaching is a coral's response to stressful conditions, for example change in temperature, pH (acidity), salinity, and light. Algae are ejected from the coral's tissue, this does not mean it is dead, however prolonged or extreme bleaching can cause death. Increasing sea temperatures due to climate change cause more frequent bleaching.

Overfishing

According to the Marine Stewardship Council, “Overfishing occurs when too many fish in a particular stock are caught and there are not enough adults to breed and sustain a healthy

⁶ “What Is a Marine Protected Area (MPA)? - NOAA Ocean Exploration.” *NOAA Ocean Exploration*, 26 Jan. 2021, oceanexplorer.noaa.gov/ocean-fact/mpas/. Accessed 18 June 2026.

⁷ Natural History Museum. “What Is a Coral Reef? | Natural History Museum.” *Www.nhm.ac.uk*, 2022, www.nhm.ac.uk/discover/quick-questions/what-is-a-coral-reef.html. Accessed 18 June 2026.

⁸ Merriam-Webster. “Definition of BIODIVERSITY.” *Merriam-Webster.com*, 2019, www.merriam-webster.com/dictionary/biodiversity. Accessed 18 June 2026.

⁹ Australian Institute of Marine Science. “What Is Coral Bleaching?” *AIMS*, 2016, www.aims.gov.au/research-topics/environmental-issues/coral-bleaching/what-coral-bleaching.

population.” It lowers biodiversity and propagates the degradation of an ecosystem’s health, both of which in turn can lead to ecosystem death.¹⁰

Sustainable fishing

Fishing at a rate that the environment can naturally replenish and continue to exist in the future.¹¹

Ocean Acidification¹²

Increase in CO₂ causes the sea to absorb more of it. Carbon Dioxide then decomposes into, among others, hydrogen ions. Hydrogen ions decrease the average pH of the ocean. This is important as all organisms operate at a specific optimal pH, operating too much outside that pH causes organisms to not function properly, or die.

Blue Economy

The blue economy is a group of business or industry sectors related to oceans.¹³ The concept was put forward by island and ocean nations in 2012, drawing attention to the lack of regulation on ocean based growth, and the negative impact it was having on marine ecosystems.¹⁴Will expand further on what it is and how approximately it could be implemented.

Sedimentation¹⁵

According to the University of California Berkeley, Sedimentation is “the deposition of rock fragments, soil, organic matter, or dissolved material that has been eroded, that is, has been transported by water, wind, ice, or gravity. “

¹⁰ Marine Stewardship Council. “What Is Overfishing.” *MSC International - English*, Marine Stewardship Council, 2025, <https://www.msc.org/what-we-are-doing/oceans-at-risk/overfishing>. Accessed 11 July 2026.

¹¹ National Geographic. “Sustainable Fishing.” *Education.Nationalgeographic.Org*, National Geographic, 2023, <https://education.nationalgeographic.org/resource/sustainable-fishing/>. Accessed 11 July 2026.

¹² National Oceanic and Atmospheric Administration. “What Is Ocean Acidification?” *National Ocean Service*, NOAA, 16 June 2024, oceanservice.noaa.gov/facts/acidification.html.

¹³ McBain, Darian. “What Is the Blue Economy?” *Grantham Research Institute on Climate Change and the Environment*, 16 May 2023, www.lse.ac.uk/granthaminstitute/explainers/what-is-the-blue-economy/.

¹⁴ “Overview.” *Worldbankgroup.Org*, 2021, <https://ieg.worldbankgroup.org/evaluations/making-waves/overview>. Accessed 11 July 2026.

¹⁵ University of California Museum of Paleontology. “Sedimentation.” <https://ugc.berkeley.edu/background-content/sedimentation/>. Accessed 29 July 2026.

BACKGROUND INFORMATION

Geography of the Mesoamerican Barrier Reef

What is a coral

Barrier reefs, contrary to popular misconception, are neither rocks, nor plants, they are small colonial carnivores, individually called “polyps”. The fundamental biology of corals is very similar in all species. They consist of a mouth, a stomach and tentacles bearing nematocysts, which are small stinging cells, similar to ones found on jellyfish. The “mouth” is used both for egestion and ingestion. Below can be seen a diagram of a polyp.¹⁶

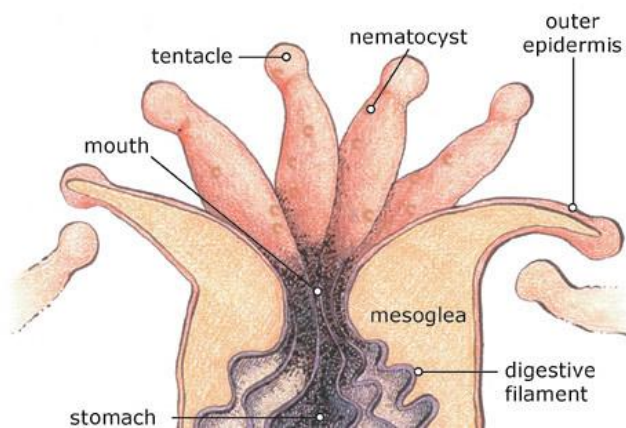


Figure 1

It is important to note that there are two main types of coral, stony (or hard) and soft corals. Stony corals are the ones usually thought of when talking of corals, they use the process of calcification to build a hard, hence the name, skeleton which they latch on to. Calcification involves taking carbonate ions ($[\text{CO}_3^{2-}]$) from the sea and turning them into the calcium carbonate that makes up coral skeletons.¹⁷ Soft corals on the other hand make their skeleton out of a protein,

¹⁶ National Ocean Service. “What Are Corals? - Corals: NOAA’s National Ocean Service Education.” *Noaa.gov*, 2019, oceanservice.noaa.gov/education/tutorial_corals/coral01_intro.html.

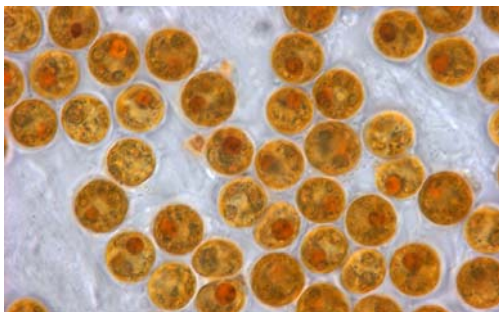
Figure 1: National Ocean Service. “What Are Corals? - Corals: NOAA’s National Ocean Service Education.” *Noaa.gov*, 2019, oceanservice.noaa.gov/education/tutorial_corals/coral01_intro.html.

¹⁷ Mollica, Nathaniel R., et al. “Ocean Acidification Affects Coral Growth by Reducing Skeletal Density.” *Proceedings of the National Academy of Sciences*, vol. 115, no. 8, 29 Jan. 2018, pp. 1754–1759, <https://www.pnas.org/content/115/8/1754>. Accessed 28 July 2026.

gorgonin, resulting in much more flexible structures. Unlike stony corals, soft corals do not build reefs, however they do appear in reef ecosystems.¹⁸

Threats to Corals

Most coral polyps contain small algae called zooxanthellae. These are separate organisms that live in symbiosis with the coral. Corals provide them with protection, while the algae provide the coral with the necessary building blocks for proteins and sugars. 90% of the biological material produced by photosynthesis by the zooxanthellae is given to the coral¹⁹. They are also responsible for the coral's colour. If a coral becomes physically stressed, it will expel the algae from its tissue, losing a vital food source.²⁰ This can happen due to, but not limited to: too high or low temperature, pH, pollutants, too much sunlight, exposure to air.²¹ When conditions improve, the coral will take in zooxanthellae, however they do not necessarily have to be of the same species. Different zooxanthellae can be more resistant to high temperatures and bleaching.²²



¹⁸ “What Are Corals.” *Florida Fish and Wildlife Conservation Commission*, 2026, <https://myfwc.com/research/habitat/coral/news/what-are-corals/>. Accessed 7 July 2026.

¹⁹ Hobson, Melissa. “What Causes Coral Bleaching? Here’s How It Threatens Ocean and Human Life.” 8 July 2025. <https://www.nationalgeographic.com/environment/article/coral-bleaching-causes-impacts>. Accessed 28 July 2026.

²⁰ National Oceanic and Atmospheric Administration (NOAA). “Zooxanthellae...What’s That - Corals: NOAA’s National Ocean Service Education.” *Noaa.Gov*, 12 Dec. 2024, https://oceanservice.noaa.gov/education/tutorial_corals/coral02_zooxanthellae.html. Accessed 7 July 2026.

²¹ National Oceanic and Atmospheric Administration. “What Is Coral Bleaching?” *Noaa.Gov*, NOAA, 16 June 2024, https://oceanservice.noaa.gov/facts/coral_bleach.html. Accessed 7 July 2026.

²² National Oceanic and Atmospheric Administration (NOAA). “Zooxanthellae...What’s That - Corals: NOAA’s National Ocean Service Education.” *Noaa.Gov*, 12 Dec. 2024, https://oceanservice.noaa.gov/education/tutorial_corals/coral02_zooxanthellae.html. Accessed 7 July 2026.

Figure 2: “Coral Figure 5.” *Flickr*, Coral figure 5 | Corals contain dense populations of round m... | Flickr, 31 Mar. 2025, <https://www.flickr.com/photos/oregonstateuniversity/30024509728>. Accessed 7 July 2026.

Figure 2. ²³

What are Marine Protected Areas (MPA)

Firstly, it is important to establish what a Marine Protected Area is. An MPA is a general ‘umbrella term’ for any area of ocean or coast under legal protection. MPAs can have various objectives and be managed very differently depending on the country.²⁴ The International Union for the Conservation of Nature (IUCN), established in 1948, is considered the “world’s largest and most diverse environmental network”.²⁵ In 1994 it created a method for the categorisation of MPAs by their management objectives, widely used thanks to their endorsement and integration by the United Nations Convention on Biological Diversity²⁶. The framework can be seen below.

IUCN categories (I-VI) with WIO examples (where they exist).	
Ia.	Area managed mainly for science, or as a Strict Nature Reserve (Cousin I. Special Reserve, Seychelles).
Ib.	Area managed mainly for wilderness protection.
II.	Area managed mainly for ecosystem protection/recreation (all Marine National Parks in Kenya).
III.	Area managed mainly for conservation of specific natural features; often called a National Monument.
IV.	Area managed mainly for conservation through management intervention e.g. habitat management areas (Mauritius Fishing Reserves).
V.	Area managed mainly for land/seascape conservation and recreation.
VI.	Area managed mainly for sustainable use of natural ecosystems e.g. multiple-use protected area (Mafia Island Marine Park, Tanzania).

Figure 3

However, it can be difficult to properly sort MPAs, they do not always fit neatly into each category. Additionally, not all organisations and countries adhere to or know of the IUCN's

²³ van Woesik, Robert et al. “Effects of ocean acidification on the dissolution rates of reef-coral skeletons.” *PeerJ* vol. 1 e208. 21 Nov. 2013, doi:10.7717/peerj.208 <https://pmc.ncbi.nlm.nih.gov/articles/PMC3840418/>. Accessed 10 July 2026.

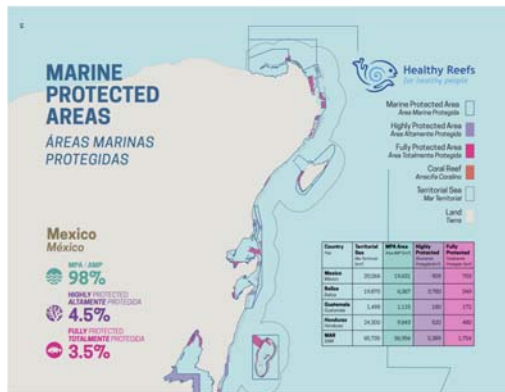
²⁴ WIOMSA. “MPA Definitions.” https://www.wiomsa.org/mpatoolkit/Themesheets/A1_Types_and_categories_of_MPAs.pdf. Accessed 8 July 2026.

²⁵ IUCN. “About IUCN | IUCN.” *Iucn.Org*, 2024, <https://iucn.org/about-iucn>. Accessed 9 July 2026.

Figure 3: WIOMSA. “MPA Definitions.” https://www.wiomsa.org/mpatoolkit/Themesheets/A1_Types_and_categories_of_MPAs.pdf. Accessed 8 July 2026.

²⁶ 30x30 Solutions. “Protected Areas.” *30X30 Solutions*, <https://www.30x30.solutions/protected-areas/>. Accessed 31 July 2026.

guidelines.²⁷ This is especially important considering the MBRs is a transboundary ecosystem, not having a 'common language' makes intergovernmental cooperation much harder.



Marine Protected Areas in the Mesoamerican Barrier Reef

Currently the MBRS has over sixty MPAs.²⁸ The first MPA established in the MBRS is the Sian Ka'an Biosphere Reserve in Mexico, established in 1986. The entire plot measures 528,000 hectares (one hectare is 10,000m²).²⁹ This was followed by the Hol Chan Marine Reserve situated in Belize in 1987³⁰ and the Honduran "Cayos Cochinos Marine Park" in 1993³¹. Many more MPAs were established afterwards. It is important to note that MPAs do not encompass entire regions, for example, although Belize has 25.3% of its MBRS territory under protection.³² This is divided into 27 total MPAs.³³ On the Left is visible a

²⁷ WIOMSA. "MPA Definitions."

https://www.wiomsa.org/mpatoolkit/Themesheets/A1_Types_and_categories_of_MPAs.pdf. Accessed 8 July 2026.

²⁸ Network, Global Transboundary Protected Areas. "Global Transboundary Protected Areas Network." *Global Transboundary Protected Areas Network*, <https://www.tbpa.net/page.php?ndx=66>. Accessed 10 July 2026.

²⁹ Centre, UNESCO World Heritage. "Sian Ka'an." *UNESCO World Heritage Centre*, <https://whc.unesco.org/en/list/410/>. Accessed 7 July 2026.

³⁰ "HCMR." *Fisheries Department*, 2026, <https://fisheries.gov.bz/hcmr/>. Accessed 7 July 2026.

³¹ Reserve, Cayos Cochinos Biological. "Cayos Cochinos Biological Reserve." *Si.Edu*, 2026, <https://global.si.edu/projects/cayos-cochinos-biological-reserve>. Accessed 7 July 2026.

³² Dallison, Thomas. "Don't Miss: Mesoamerican Reef 2022 Health Report - Poor Reef Health and Fish Decline." *ICRI*, 14 Feb. 2023, icriforum.org/mesoamerican-reef-health-report-2022/.

³³ "Case Study: Belize – Towards Expansion of No-Take Areas in the MPA System." *Commonwealth*, <https://thecommonwealth.org/case-study/case-study-belize-towards-expansion-no-take-areas-mpa-system>. Accessed 9 July 2026.

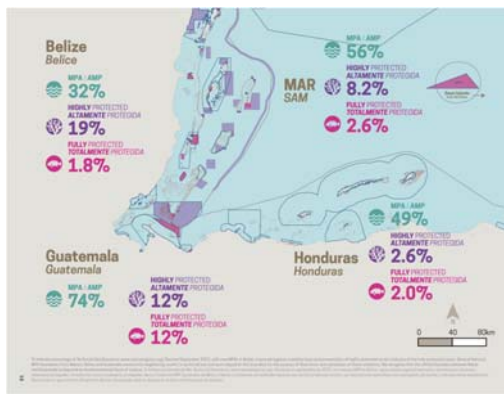
Figure 4: Reporte, Del, and Mesoamericano. *LESS Words, MORE Actions 022 Mesoamerican REEF Report CARD*. https://cdn.prod.website-files.com/66b16833c7877e9078babf9d/MAR_Report.pdf Accessed 8 July 2026

map of all the MPAs in the MBRS. Fully protected areas and highly protected areas are shown separately, however they are still considered MPAs.

In order to create an MPA it is important to consider the economic effects of establishing it, arbitrarily

Figure 4

deciding a territory should become an MPA can jeopardize locals' livelihoods. Not only will this negatively affect the ability of a nation to continue conservation efforts in the future, but it will also cause opposition against conservation efforts and make management of the MPA much harder.



It may be tempting to establish many ideal MPA's, however this may not be the most effective route; it is important to take into account whether this MPA can be managed effectively and secure the public's support. However, the social, political and economic conditions that prevent the establishment of an MPA can, given time, be changed allowing for larger MPA coverage.³⁴

Industries Reliant on or Affecting the Mesoamerican Barrier Reef

Fishing

Fishing reliant on the MBRS generates over 180 million USD per year. Commercial fishing accounts for over 100 million, while local fisheries account for approximately 50 million, the rest is taken up by processing and cleaning of the fish. Interestingly, this divide is not uniform throughout the four countries. In Mexico, Honduras and Belize, local fisheries are economically insignificant, while in Guatemala, practically the entire industry is made up of local fishermen. Additionally, not all countries generate the same amount from fishing, Honduras accounts for 54% of total fishing, Guatemala 23%, Mexico 12% and Belize the remaining 11%.³⁵

³⁴ Guidelines for Establishing Marine Protected Areas.

<https://portals.iucn.org/library/sites/library/files/documents/MRN-001.pdf>. Accessed 9 July

³⁵ Albatros, Fundación. *Economic Valuation of the Ecosystem Services of the Mesoamerican Reef*.

https://marfund.org/en/wp-content/uploads/2024/06/MARValuation_English_fv.pdf. Accessed 10 July 2026.

Overfishing can lead to a loss of species diversity, and can lead to extinctions of not only the target catch, but also other species - species in an ecosystem are interlinked, extinction of one species can lead to knock on effects and further extinctions. Overfishing can also interact with other sources of stress for reefs, making it much harder for reefs to recover from changes in their habitat e.g. hurricanes.³⁶ Additionally, fish can provide corals with protection from pests, nutrients (when they die), and keep harmful algae away.³⁷

Overall loss of biodiversity also makes it much harder for ecosystems to both resist and recover from any changes, including extinctions, which can eventually lead to ecosystem collapse.³⁸ A loss of biodiversity is also directly harmful to human health, as communities are dependent on the health of an ecosystem and its ability to produce for them.³⁹ Interestingly, the strongest predictor of coral fish biomass was very consistently temperature, acting both directly and indirectly in order to increase fish biomass. This was followed by species richness, which means the amount of species present in an ecosystem, and functional diversity, which is the total amount of different functions carried out by different species in an ecosystem.⁴⁰ In simpler terms, a loss of biodiversity will decrease the 'amount' of fish, thereby harming fishing industries and local populations.

Tourism

Millions of tourists are drawn towards the MBRS,⁴¹ generating a massive 3.9 billion USD per year. Of the 3.9 billion, approximately 75% is generated by accommodation industries, the other 25% with activities related to reefs. Although the tourism industry throughout the entire

³⁶ ROBERTS, CALLUM M. "Effects of Fishing on the Ecosystem Structure of Coral Reefs." *Conservation Biology*, vol. 9, no. 5, Oct. 1995, pp. 988–995, 10.1046/j.1523-1739.1995.9051332.x-i1.

³⁷ NOAA Fisheries. "How Are Fisheries and Coral Reefs Connected?" NOAA, 5 Jan. 2023, <https://www.fisheries.noaa.gov/feature-story/how-are-fisheries-and-coral-reefs-connected>. Accessed 11 July 2026.

³⁸ Li, Jolin. "What Are the Consequence of Biodiversity Loss?" *Earth.Org*, Earth.Org, 29 Aug. 2024, <https://earth.org/what-are-the-consequence-of-biodiversity-loss/>. Accessed 11 July 2026.

³⁹ Li, Jolin. "What Are the Consequence of Biodiversity Loss?" *Earth.Org*, Earth.Org, 29 Aug. 2024, <https://earth.org/what-are-the-consequence-of-biodiversity-loss/>. Accessed 11 July 2026.

⁴⁰ Duffy, J. Emmett, et al. "Biodiversity Enhances Reef Fish Biomass and Resistance to Climate Change." *Proceedings of the National Academy of Sciences*, vol. 113, no. 22, 16 May 2016, pp. 6230–6235, <https://www.pnas.org/doi/10.1073/pnas.1524465113>. Accessed 11 July 2026.

⁴¹ Albatros, Fundación. *Economic Valuation of the Ecosystem Services of the Mesoamerican Reef*. https://marfund.org/en/wp-content/uploads/2024/06/MARValuation_English_fv.pdf. Accessed 10 July 2026.

MBRS is much larger than fishing, in Guatemala specifically, it accounts for less than a sixth of total value.⁴²

Tourism, despite its positive effects on local populations, can have differing effects on coral reefs. Simply tourists touching, scraping or accidentally breaking off parts of the coral can stress it, eventually causing or exacerbating bleaching. Sedimentation - soil and debris being deposited into the sea and making their way to the sea floor, blocking sunlight and polluting ecosystems - is also a major threat to coral health, and is largely caused by coastal development motivated by the tourism industry.⁴³ The ever-present side-effect of human presence, pollution, ranging from plastic to non reef-safe sunscreen places additional stress on corals.⁴⁴

The tourism industry's effects need careful balancing, strict regulation can alleviate pressure on ecosystems, however it can cause backlash from local businesses and locals reliant on tourism for their livelihood. On the other hand, allowing the tourism industry to go about its business unchecked, although it can be very beneficial for local economies, it can also lead to irreversible damage to ecosystems. Additionally, revenue from tourism can and is used to help reef conservation.⁴⁵

Other Industries

Other industries that affect reef ecosystems include agriculture, aquaculture, general urban development, and mining. These may not cause as much damage or generate as much revenue as tourism and fishing, however they also play a significant role in coral reef health and the economics of the Mesoamerican Barrier Reef System. Agriculture along with aquaculture, mainly in the form of shrimp farming, can disturb soil and further cause sedimentation. They also release large amounts of pesticides and other pollutants, which eventually make their way into the ocean and reef ecosystems.⁴⁶ Fertilizer runoff specifically can have very negative

⁴² Albatros, Fundación. *Economic Valuation of the Ecosystem Services of the Mesoamerican Reef*. https://marfund.org/en/wp-content/uploads/2024/06/MARValuation_English_fv.pdf. Accessed 10 July 2026.

⁴³ Cossio, Camila. "Coral Reefs and the Unintended Impact of Tourism." *Earthjustice*, 18 Apr. 2016, <https://earthjustice.org/article/coral-reefs-and-the-unintended-impact-of-tourism>. Accessed 11 July 2026.

⁴⁴ The Sea People. "Impact of Tourism | the SEA People." *The SEA People*, 9 Dec. 2024, <https://theseapeople.org/impact-of-tourism-2/>. Accessed 11 July 2026.

⁴⁵ Reefs, Coral. "Sea Going Green." *Sea Going Green*, 25 Sept. 2025, <https://www.seagoinggreen.org/blog/the-impact-of-overtourism-on-coral-reefs-and-what-travelers-can-do>. Accessed 11 July 2026.

⁴⁶ "The Mesoamerican Coral Reef." *World Wildlife Fund*, 2019, <https://www.worldwildlife.org/places/mesoamerican-reef/>. Accessed 11 July 2026.

consequences for an ecosystem, where the fertilizer stimulates algal growth, which blocks out sunlight and uses up nutrients, eventually creating “dead zones.”⁴⁷

Although it is not an industry, it is extremely important, and in a way ‘generates’ revenue. The MBRS protects from coastal damage, potential flooding, and sea level rise, saving an estimated 438,000 USD per year, more than twice the amount generated by fishing.⁴⁸

MAJOR COUNTRIES AND ORGANIZATIONS INVOLVED

Belize

Belize has only 32% of its MAR area in MPAs, however 19.6% of that area is highly protected and 1.8% of its area fully protected.⁴⁹ Belize is the most ambitious in establishing fully protected areas.⁵⁰ Since 2011, Belize’s Government along with its Department of Fisheries established a system where access to fishery areas is only permitted through a Managed Access license. Additionally, it has created no take zones, on breeding grounds to allow marine populations to replenish and collects fishing data to monitor marine health.⁵¹ Belize is one of the first countries to issue a complete ban on oil drilling on its territorial waters.⁵²

⁴⁷ “The Maya Reef: Protecting the Mesoamerican Barrier Reef.” *Maya Bioregion*, 22 Oct. 2024, <https://mayabioregion.org/the-maya-reef-protecting-the-mesoamerican-barrier-reef/>. Accessed 11 July 2026.

⁴⁸ Albatros, Fundación. *Economic Valuation of the Ecosystem Services of the Mesoamerican Reef*. https://marfund.org/en/wp-content/uploads/2024/06/MARValuation_English_fv.pdf. Accessed 10 July 2026.

⁴⁹ Dallison, Thomas. “Don’t Miss: Mesoamerican Reef 2022 Health Report - Poor Reef Health and Fish Decline.” *ICRI*, 14 Feb. 2023, icriforum.org/mesoamerican-reef-health-report-2022/. Accessed 18 June 2026.

⁵⁰ Butler, Rhett. “Belize’s Blue Reputation Vs. Reef Reality: Marine Conservation Wins, and What’s Missing (Commentary).” *Conservation News*, 31 Oct. 2025, <https://news.mongabay.com/2025/10/belizes-blue-reputation-vs-reef-reality-marine-conservation-wins-and-whats-missing/>. Accessed 11 July 2026.

⁵¹ Reef Resilience Network. “Belize Lobster and Conch Fisheries: Collective Impact of Managed Access Programs Puts Fisheries on Path to Recovery.” *Reef Resilience*, <https://reefresilience.org/case-studies/belize-fisheries-management/>. Accessed 31 July 2026.

⁵² National Geographic . “Belize Restores Coral Reefs After Oil Drilling Ban.” *National Geographic*, <https://www.nationalgeographic.com/science/article/belize-restores-coral-reefs-oil-drilling-ban-environment>. Accessed 31 July 2026.

Honduras

Honduras protects 40.6% of its MBRs territory, 0.2% is partially protected and 2.0% is fully.⁵³ On the complete contrary to Belize, Honduras' government is not active in MBRs protection, offering little to no funding to conservation efforts, leaving much work to NGOs.⁵⁴ As mentioned previously, the Honduran economy is dominated by fishing, especially artisanal fishing, with 17 in 20 people employed in fishing being small-scale and local.⁵⁵

Guatemala

Guatemala has covered 74% of its MBRs territory in MPAs, it has 12% partially protected, and another 12% fully protected.⁵⁶ Guatemala has the least of the MBRS, having only 150km of coastline to it.⁵⁷ For Guatemalan Reefs, sedimentation acts as the biggest threat, as the majority of reefs are placed downstream from a large deforested watershed.⁵⁸ Guatemala has partnered with NGOs to install initiatives to clean up rivers, preventing pollution from even reaching the sea tying to Ridge to Reef Methodology. This is of particular importance as there are many indigenous and rural populations settled nearby the river, which depend on it for clean water.⁵⁹

⁵³ Dallison, Thomas. "Don't Miss: Mesoamerican Reef 2022 Health Report - Poor Reef Health and Fish Decline." *ICRI*, 14 Feb. 2023, icriforum.org/mesoamerican-reef-health-report-2022/. Accessed 18 June 2026

⁵⁴ "Honduras – Invasive Species | Reef Resilience Network." *Reefresilience.Org*, 2022, <https://reefresilience.org/case-studies/honduras-invasive-species/>. Accessed 12 July 2026.

⁵⁵ Environmental Law Institute. *Eli Legal Reports: Honduras*. Environmental Law Institute (ELI), <https://www.eli.org/sites/default/files/eli-pubs/eli-mar-legal-reports-honduras.pdf>. Accessed 31 July 2026.

⁵⁶ Dallison, Thomas. "Don't Miss: Mesoamerican Reef 2022 Health Report - Poor Reef Health and Fish Decline." *ICRI*, 14 Feb. 2023, icriforum.org/mesoamerican-reef-health-report-2022/. Accessed 18 June 2026

⁵⁷ Gonzalez-Bernat, Maria J., and Julian Clifton. "'Living with Our Backs to the Sea': A Critical Analysis of Marine and Coastal Governance in Guatemala." *Marine Policy*, vol. 81, July 2017, pp. 9–20, https://www.academia.edu/31914949/living_with_our_backs_to_the_sea_a_critical_analysis_of_marine_and_coastal_governance_in_guatemala 10.1016/j.marpol.2017.03.003. Accessed 11 July 2026.

⁵⁸ Yáñez-Arancibia, Alejandro, et al. "The Ecosystem Framework for Planning and Management the Atlantic Coast of Guatemala." *ScienceDirect*, 30 Apr. 1999, <https://www.sciencedirect.com/science/article/abs/pii/S0964569198000581>. Accessed 11 July 2026.

⁵⁹ the Borgen Project. "Guatemala's Motagua River." *Borgen Project*, <https://borgenproject.org/guatemalas-motagua-river/>. Accessed 31 July 2026.

Mexico

Mexico is the nation with the most territory in MPAs. It is on track to have protected 30% of all of its marine territory by 2030.⁶⁰ Additionally, it has 97.8% of all of its Mesoamerican barrier reef protected, however only 4.6% is highly protected, while 3.5% fully protected.⁶¹ In addition to its protection of Reef areas, Mexico has launched many capacity building programs. In 2018, Mexico began a program in which it insures coral reefs, it is funded by taxes on the tourism industry, and donations. After hurricane Delta it paid out 800,000 USD.⁶²

Mesoamerican Reef Fund (MAR Fund)

The Mesoamerican Reef Fund is a very large organisation that funds a variety of different conservation efforts directly targeted at the MAR, this can range from waste management, to spawning site conservation.⁶³ Organisations applying for grants must be stationed in one of the four MBRS countries, individuals can apply, however they must be supported by an NGO, this could be for example, the Central American Integration System (SICA).⁶⁴

⁶⁰ Perera-Valderrama, Susana, et al. "Mexico on Track to Protect 30% of Its Marine Area by 2030." *Sustainability*, vol. 15, no. 19, 1 Jan. 2023, p. 14101, www.mdpi.com/2071-1050/15/19/14101, <https://doi.org/10.3390/su151914101> Accessed 18 June 2026

⁶¹ Dallison, Thomas. "Don't Miss: Mesoamerican Reef 2022 Health Report - Poor Reef Health and Fish Decline." *ICRI*, 14 Feb. 2023, icriforum.org/mesoamerican-reef-health-report-2022/. Accessed 11 July 2026

⁶² Martin, Ben. "Insuring Coral Reefs in Mexico." *Green Economy Coalition*, 8 Nov. 2018, <https://www.greeneconomycoalition.org/news-and-resources/insuring-coral-reefs-in-mexico>. Accessed 11 July 2026.

⁶³ "Nine Selected Projects Will Drive Local Solutions for Conservation in the MAR – MAR Fund – Protecting the Mesoamerican Reef." *Marfund.Org*, 2026, <https://marfund.org/en/nine-selected-projects-will-drive-local-solutions-for-conservation-in-the-mar/>. Accessed 11 July 2026.

⁶⁴ "REQUEST FOR PROPOSALS 2025 – MAR Fund – Protecting the Mesoamerican Reef." *Marfund.Org*, 2025, <https://marfund.org/en/request-for-proposals-2025/>. Accessed 11 July 2026.

Central American Commission for Environment and Development

This organization is made up of eight countries in Central America: Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Panama, Belize and the Dominican Republic.⁶⁵ It aims to improve the overall development of central america. Focused on environmental, social and economic issues. Adheres to the UN Framework Convention on Climate Change, the Convention on Biological Diversity, and the Convention to Combat Desertification and Drought.⁶⁶

Global Fund for Coral Reefs (GFCR)

The Global Fund for Coral Reefs is the first UN sponsored Trust fund specifically dedicated to Sustainable Development Goal 14: life below water. The fund gathers money from many nations and organisation, including the United Kingdom, the UN partnership Office, the United States, New Zealand. Its budget totals to over one hundred thousand USD. Its objective is to fund initiatives which would build private investment interest in coral reefs. It is currently involved in 25 projects, many of which are multi-country.⁶⁷

Mesoamerican Reef Restoration Network

An organisation based in all four MAR countries, aims to be the “meeting point” between many different organisations aiming to restore, protect and conserve the MAR in order to facilitate the exchange of ideas, experiences and methodologies. The first meeting and formation of the organisation was in 2012, in Chetumal, Mexico. Many other meetings have been arranged, including in 2017, 2019,⁶⁸ with multiple meetings taking place in 2021.⁶⁹

TIMELINE OF EVENTS

⁶⁵ Sistema de la Integración Centroamericana (SICA). “Estados Miembros.” *Sica.int*, 2023, www.sica.int/estadosmiembros.

⁶⁶ Sistema de la Integración Centroamericana (SICA). “Sistema de La Integración Centroamericana (SICA).” *Sica.int*, 2015, www.sica.int/ccad/.

⁶⁷ United Nations Multi-Partner Trust Fund Office. “Global Fund for Coral Reefs.” *Undp.Org*, 2025, <https://mptf.undp.org/fund/fcr00>. Accessed 31 July 2026.

⁶⁸ Staff Coral MAR. “Home RRA-SAM - RRA-SAM/ MAR-RRN - Red De Restauración Del Sistema Arrecifal Mesoamericano.” *RRA-SAM/ MAR-RRN - Red de Restauración Del Sistema Arrecifal Mesoamericano - RRA-SAM/ MAR-RRN*, 15 Oct. 2021, <https://coralmar.org/en/>. Accessed 31 July 2026.

⁶⁹ Staff Coral MAR. “- RRA-SAM/ MAR-RRN - Red De Restauración Del Sistema Arrecifal Mesoamericano.” *RRA-SAM/ MAR-RRN - Red de Restauración Del Sistema Arrecifal Mesoamericano - RRA-SAM/ MAR-RRN*, 28 Apr. 2022, <https://coralmar.org/en/reunion-akumal-2017/>. Accessed 31 July 2026.

DATE	DESCRIPTION OF EVENT
March 1983	The Cartagena Convention is established. ⁷⁰
January 20th 1986	First MPA was established in the MAR (Sian Ka'an Biosphere Reserve) ⁷¹
11 October 1986	The Cartagena Convention Enters into force. ⁷²
1994	Establishment of MPA categorisation framework by the IUCN. ⁷³
6 June 1997	Mexico, Guatemala, Honduras and Belize signed the Declaration of Tulum, helping foster cooperation between the four countries and cementing the MBRs as a transboundary ecosystem. ⁷⁴

⁷⁰ Environment, UN. "Cartagena Convention." *UNEP - UN Environment Programme*, 2017, <https://www.unep.org/cartagena-convention>. Accessed 31 July 2026.

⁷¹ "Sian Kaan Facts." *Www.visitsiankaan.com*, www.visitsiankaan.com/sian-kaan-facts

⁷² Environment, UN. "Cartagena Convention." *UNEP - UN Environment Programme*, 2017, <https://www.unep.org/cartagena-convention>. Accessed 31 July 2026.

⁷³ 30x30 Solutions. "Protected Areas." *30X30 Solutions*, <https://www.30x30.solutions/protected-areas/>. Accessed 31 July 2026.

⁷⁴ Dallison, Thomas. "Don't Miss: Mesoamerican Reef 2022 Health Report - Poor Reef Health and Fish Decline." *ICRI*, 14 Feb. 2023, icriforum.org/mesoamerican-reef-health-report-2022/

28 November 2001	The Sustainable Use of the Mesoamerican Barrier Reef System Project (MBRS Project) was established, supporting transboundary MPAs.
2004	MAR Fund Established
29 June 2006	Completion of the MBRS Project's Goals and its closure. ⁷⁵
2012	First Mesoamerican Reef Restoration network meeting, held in Chetumal, Mexico. ⁷⁶
25 September 2015	Adoption of the Sustainable Development Goal at the United Nations Sustainable Development Summit. ⁷⁷
4 August 2016	The UNEP/EA.2/RES.12 was adopted by the United Nations Environmental Assembly; this was the first UN resolution specifically dedicated towards corals.

⁷⁵ Network, Global Transboundary Protected Areas. "Global Transboundary Protected Areas Network." *Global Transboundary Protected Areas Network*, <https://www.tbpa.net/page.php?ndx=66>. Accessed 10 July 2026.

⁷⁶ Staff Coral MAR. "Home RRA-SAM - RRA-SAM/ MAR-RRN - Red De Restauración Del Sistema Arrecifal Mesoamericano." *RRA-SAM/ MAR-RRN - Red de Restauración Del Sistema Arrecifal Mesoamericano - RRA-SAM/ MAR-RRN*, 15 Oct. 2021, <https://coralmar.org/en/>. Accessed 31 July 2026.

⁷⁷ United Nations Department of Economic and Social Affairs. "Sustainable Development Goals (SDGs)." *United Nations Sustainable Development*, <https://sdgs.un.org/goals>. Accessed 31 July 2026.

19 December 2022	Adoption of the Kunming-Montreal global Biodiversity Framework, setting many significant goals to be completed by 2030, including 30% of oceans protected. ⁷⁸
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RELEVANT UN RESOLUTIONS, TREATIES AND EVENTS

Tulum Declaration

The Tulum Declaration is a joint agreement between the Presidents of Mexico, Guatemala, Honduras and the Prime Minister of Belize in 1997 in the city of Tulum.⁷⁹ Its significance comes from the fact that it was the first time that the MBRS was treated as one large system for the first time, and has become the foundation for all regional cooperation since.⁸⁰ Additionally, it has inspired many further projects by the WWF, Conservation International and the Nature Conservancy, along with millions invested by the World Bank among others.⁸¹

UNEP/EA.2/RES.12

A United Nations Environment Assembly resolution, adopted on the organisation's second session on the 4th of August 2016. It's the first UN resolution specifically dedicated towards coral reefs. It establishes coral reefs as not only a matter of ecology, but also a necessity for the economic and social development of a nation. It also linked coral reef health to the Sustainable Development Goals (SDGs), specifically SDG 14, life below water.⁸²

⁷⁸ CarbonBrief. "COP15 Key Outcomes Agreed at the UN Biodiversity Conference in Montreal." *Carbon Brief*, <https://www.carbonbrief.org/cop15-key-outcomes-agreed-at-the-un-biodiversity-conference-in-montreal>. Accessed 31 July 2026.

⁷⁹ Mesoamerican Reef Restoration Network. "- RRA-SAM/ MAR-RRN - Red de Restauración Del Sistema Arrecifal Mesoamericano." *RRA-SAM/ MAR-RRN - Red de Restauración Del Sistema Arrecifal Mesoamericano* - RRA-SAM/ MAR-RRN, 14 Oct. 2021, coralmar.org/en/gobernanza/

⁸⁰ CONSERVATION AND SUSTAINABLE USE OF THE MESOAMERICAN BARRIER REEF SYSTEMS PROJECT (MBRS) *Infusing the Mesoamerican Barrier Reef System Themes into Primary and Secondary Curricula Mesoamerican Barrier Reef Systems Project Project Coordinating Unit Coastal Resources Multi-Complex Building Princess Margaret Drive Belice City Belice*. 2003.

⁸¹ *Ecoamericas.Com*, 2026, <https://www.ecoamericas.com/issues/article/2007/11/60197e36-8e2e-4dec-9107-67c9b51fce6a>. Accessed 11 July 2026.

⁸² UNEP. Environment Assembly (2nd sess. : 2016 : Nairobi. "2/12. Sustainable Coral Reefs Management :: Resolution /: Adopted by the United Nations Environment Assembly." *United Nations Digital Library System*, UN, 4 Aug. 2016, <https://digitallibrary.un.org/record/3969800?ln=en&v=pdf>. Accessed 11 July 2026.

Kunming-Montreal Global Biodiversity Framework (KM-GBF)

The Kunming-Montreal Global Biodiversity Framework is an international agreement facilitated by the United Nations convention on Biological Diversity, agreed on in 2022. This framework was a major step forward in reaching international consensus on specific common goals to reverse biodiversity loss.⁸³ Importantly, it includes target number 3: 30x30, to protect 30% of the world's area by 2030. This target is particularly important for this topic and should be kept in mind when preparing. This agreement also mandates that all countries must submit their National Biodiversity Strategies and Action Plans (NBSAPs), which are each country's roadmaps on how to achieve the targets set out by the KM-GBF, which 85% of signatories haven't met.⁸⁴

The Cartagena Convention

The Cartagena Convention, agreed upon in March 1983 and put into force on the 11th of October 1986, is the foremost legal document for the protection of corals in the Caribbean region, including Mexico, Guatemala, Honduras and Belize. The convention is accompanied by three protocols⁸⁵: the Oil Spills Protocol, entering into force and being adopted along with the Cartagena Convention, its goal is to strengthen preparedness of signatory countries, and to facilitate collaboration between them in the cases of emergencies in order to prevent major oil spills.⁸⁶ [The Special Protected Areas and Wildlife \(SPAW\) Protocol](#), entering into force on the 18th of June 2000, with the goal of improving the management of protected areas and the conservation of endangered species.⁸⁷ The [Pollution from Land Based Sources and Activities Protocol](#), entering

⁸³ “Un Biodiversity Pledge: Brazils strategy to protect nature and address climate change” *Resilience.Org*, 2026, <https://www.resilience.org/stories/2026-07-08/un-biodiversity-pledge-brazils-strategy-to-protect-nature-and-address-climate-change/>. Accessed 11 July 2026.

⁸⁴ United Nations Secretary General. *Mandate, Specifically Section II (Capacity-Building), Section IX (Marine Environment and Marine Resources), Section XI (Marine Biodiversity and Marine Science), and Section XII (Regular Process for Global Reporting and Assessment of the Marine Environment, Including Socioeconomic Aspects)*. Aug. 2025.

⁸⁵ Environment, UN. “Cartagena Convention.” *UNEP - UN Environment Programme*, 2017, <https://www.unep.org/cartagena-convention>. Accessed 31 July 2026.

⁸⁶ United Nations Environment Programme. “Oil Spills Protocol | the Caribbean Environment Programme (CEP).” *Unep.Org*, 2026, https://www.unep.org/cep/oil-spills-protocol?_ga=2.256948299.1119297799.1785534600-3014112.1781814092. Accessed 31 July 2026.

⁸⁷ ---. “Specially Protected Areas and Wildlife (SPAW) | the Caribbean Environment Programme (CEP).” *Unep.Org*, 2021, https://www.unep.org/cep/what-we-do/specially-protected-areas-and-wildlife-spaw?_ga=2.197835119.1119297799.1785534600-3014112.1781814092. Accessed 31 July 2026.

into force on the 13th of August 2010, sets regional limits on domestic wastewater discharged into water, and requires countries to develop plans to limit agricultural sources of pollution.⁸⁸

PREVIOUS ATTEMPTS TO SOLVE THE ISSUE

Sustainable Use of the Mesoamerican Barrier Reef System (MBRS Project)

The MBRS Project was a regional agreement between all four MBRS countries, Mexico, Guatemala, Honduras and Belize, started on the 28th of November 2001. It focused on supporting 15 MPAs which are situated on or near international borders.⁸⁹ Its goals were to support the coordination of policy across borders, develop capacity, locally and nationally, and to Strengthen existing MPAs.⁹⁰ It completed its goals and closed on the 29th of June 2006, being succeeded by the MAR fund.⁹¹

Resilience based Management (RBM)

An approach that prioritises ecosystems' ability to withstand and recover from damage themselves, over focusing on its current state.⁹² It focuses on identifying different indicators that inform reef resilience, instead of focusing on the current state. Methodology can include ensuring the survival of herbivorous fish or crustaceans in order to combat algae.⁹³ This logic likely

⁸⁸ ---. "What Is Our Pollution or LBS Protocol? | The Caribbean Environment Programme (CEP)." *Unep.Org*, 2026, https://www.unep.org/cep/what-our-pollution-or-lbs-protocol?_ga=2.197835119.1119297799.1785534600-3014112.1781814092. Accessed 31 July 2026.

⁸⁹ Network, Global Transboundary Protected Areas. "Global Transboundary Protected Areas Network." *Global Transboundary Protected Areas Network*, <https://www.tbpa.net/page.php?ndx=66>. Accessed 10 July 2026.

⁹⁰ "Conservation and Sustainable Use of the Mesoamerican Barrier Reef System (MBRS)." *Resilience.Org*, 11 July 2016, <https://iwlearn.net/iw-projects/837>. Accessed 11 July 2026.

⁹¹ MAR Fund. "MESOAMERICAN BARRIER REEF SYSTEMS PROJECT (MBRS) ANNUAL WORK PLAN Period: July 2001 – June 2002 (Revised for Web Publishing)." *MAR Fund*, 22 Aug. 2001, <https://marfund.org/en/wp-content/uploads/2020/03/AWP1.pdf>. Accessed 11 July 2026.

⁹² "What Is RBM? | Reef Resilience." *Reefresilience.org*, 2025, reefresilience.org/resilience/resilience-based-management/what-is-rbm/.

⁹³ Burt, April J, et al. "Supporting Resilience-Based Coral Reef Management Using Broadscale Threshold Approaches." *Scientific Reports*, vol. 15, no. 1, 16 July 2025, <https://www.nature.com/articles/s41598-025-09531-9>. Accessed 11 July 2026.

motivated the Honduras ban on catching herbivorous fish during the spawning season which is from November to April.⁹⁴

Ridge-to-Reef (R2R)

Actions above ground can and do affect the sea below them, pollutants, deforestation construction and their effects can eventually creep down. The logic behind the R2R methodology is to not only battle damage to corals at sea, but also limit the sources of damage from the land.⁹⁵ Policies can include limiting the amount of fertilizer an area of land is allowed to use, this would limit the amount of fertilizer runoff from the fields into the ocean, limiting harmful algae growth, and preventing the creation of dead zones.⁹⁶

POSSIBLE SOLUTIONS

Artificial Reefs (ARs)

Artificial Reefs are man-made structures that mimic the calcium carbonate skeletons of hard corals. These act to replace the role of dissolving coral skeletons, and can either be suspended in the water column, or placed on the sea bed.⁹⁷ Newer biomimetic designs, mimicking the appearance of natural corals are shown to be able to keep even 90% of reefs healthy at a temperature of 36 degrees celcius, a temperature usually dangerously high for corals.⁹⁸ An interesting case in Belize, where hurricane Iris severely damaged corals in the Laughing Bird Caye National Park, leaving only 6% of it covered in coral, after efforts from a local organisation Fragments of Hope, it was brought up to 60% in 2023. To achieve this, they planted over 92,000

⁹⁴ Reef Alliance, Coral. "Honduras Issues Nationwide Fishing Ban to Protect Coral Reefs, Grouper, and Key Marine Species." *Coral Reef Alliance*, 16 July 2025, <https://coral.org/blog/honduras-issues-nationwide-fishing-ban-to-protect-coral-reefs-grouper-and-key-marine-species/>. Accessed 11 July 2026.

⁹⁵ "What Is Ridge to Reef? | SPC-R2R." *Www.pacific-R2r.org*, www.pacific-r2r.org/help/faq/what-ridge-reef.

⁹⁶ Reef Alliance, Coral. "Honduras Issues Nationwide Fishing Ban to Protect Coral Reefs, Grouper, and Key Marine Species." *Coral Reef Alliance*, 16 July 2025, <https://coral.org/blog/honduras-issues-nationwide-fishing-ban-to-protect-coral-reefs-grouper-and-key-marine-species/>. Accessed 11 July 2026.

⁹⁷ "Bioengineering Restoration Solutions: The Benefits of IntelliReefs." *Reef Life Foundation*, 27 Aug. 2020, <https://www.reeflifefoundation.org/post/bioengineering-restoration-solutions-the-benefits-of-intellireefs>. Accessed 11 July 2026.

⁹⁸ emily73903. "Bioengineering Restoration Solutions: The Benefits of IntelliReefs." *Reef Life Foundation*, 27 Aug. 2020, <https://www.reeflifefoundation.org/post/bioengineering-restoration-solutions-the-benefits-of-intellireefs>. Accessed 11 July 2026.

fragments of coral.⁹⁹ However, different reef species can respond differently to different Artificial Reefs, which could cause specific reef species to become much more common, possibly causing imbalances in ecosystems.

Bioengineering

Genetically modifying various species can be beneficial but is full of risk. Although it can allow different organisms to adapt to a changing environment, it can also lower biodiversity by outcompeting other organisms.¹⁰⁰ In general introduction of new species to an ecosystem, no matter whether it is collapsing or not, can be very risky and can have very negative consequences. However, in a controlled environment risks are managed, for example, the still experimental process of using genetically modified micro-algae to treat waste from oil refineries, which could be used to complement out R2R methodology.¹⁰¹

Ocean Alkalinity Enhancement

Ocean Alkalinity Enhancement (OCE) involves adding specific crushed minerals into the ocean which would increase the alkalinity of the ocean, making areas more hospitable for reefs. These minerals would also draw more CO₂ into the sea, transforming it into carbonate ions. This simultaneously lowers the amount of CO₂ in the atmosphere, storing it long term, slowing climate change, and increases the amount of carbonate ions available to corals in order to build/repair reefs. There are multiple other approaches to increasing sea alkalinity, one of which is the aforementioned adding of crushed minerals. Another is using electrolysis to split ocean water into alkaline and acidic streams, the alkaline of which would be re-added into the ocean. This is much more expensive, however allows for a more controlled increase in alkalinity. A third method would be to use industrial waste to increase alkalinity, for example steel slag. However along with this method come risks of contamination. Some risks that come with OCE are that it is a very new technology that is yet to be tested. The scale at which it can be used is still unknown and securing investment could be challenging.¹⁰²

⁹⁹ Lopez, Marco. "Seeing Is Belizing: Community-Led Resilient Reef Restoration." *Climate Tracker*, 31 Aug. 2023, <https://climatetrackercaribbean.org/climate-justice/seeing-is-belizing-community-led-resilient-reef-restoration/>. Accessed 12 July 2026.

¹⁰⁰ Schafer, Meredith G., et al. "The Establishment of Genetically Engineered Canola Populations in the U.S.." *PLoS ONE*, vol. 6, no. 10, 5 Oct. 2011, p. e25736, 10.1371/journal.pone.0025736. Accessed 11 July 2026

¹⁰¹ Hassanien, Alaa , et al. "Genetic Engineering to Enhance Microalgal-Based Produced Water Treatment with Emphasis on CRISPR/Cas9: A Review." *Frontiers in Bioengineering and Biotechnology*, vol. 10, 13 Jan. 2023, 10.3389/fbioe.2022.1104914. Accessed 11 July 2026

¹⁰² Sylvera. "Ocean Alkalinity Enhancement." Sylvera, <https://www.sylvera.com/blog/ocean-alkalinity-enhancement>. Accessed 31 July 2026.

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<https://www.unep.org/news-and-stories/story/what-are-national-biodiversity-strategies-and-action-plans-nbsaps>. Accessed 11 July 2026.

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