

IMPACT OF HUMAN ACTIVITY ON CORAL REEF ECOSYSTEMS AND MARINE BIODIVERSITY

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ABSTRACT

As essential homes for many marine species, coral reefs rank among Earth's most varied and productive ecosystems. Nevertheless, these crucial ecosystems are under grave danger from human actions such as pollution, overfishing, coastal development, and climate change. This research delves into the effects of human activities on marine biodiversity and coral reef ecosystems, showing how these systems are interdependent and how critical it is to act quickly to protect them. In order to comprehend the present situation and potential future difficulties encountered by coral reefs, data from a variety of research and publications are examined.

Keywords: Biodiversity, Human Activities, Coral Reefs, Ecosystems, Marine.

I. INTRODUCTION

As one of the world's most biologically diversified ecosystems, coral reefs have earned the nickname "rainforests of the sea." Marine animals, invertebrates, and hundreds of fish call these tiny habitats home. Despite occupying less than one percent of Earth's surface, they are home to almost a quarter of all marine species. Shelter supply, coastal protection, and support for local fisheries and tourists are just a few of the many ecological services provided by these ecosystems. The structure, function, and biodiversity of coral reefs have been drastically changed by human activity, putting them in a precarious position. Coral reef deterioration is an urgent worldwide problem that has far-reaching effects on human civilizations that rely on these ecosystems for survival and prosperity, as well as on marine biodiversity.

Clear waters with a delicate equilibrium of biological interactions have long been ideal

for coral reefs, which have traditionally flourished in warm, stable marine habitats. The marine invertebrates known as corals are the principal builders of these reefs. They are symbiotically related to zooxanthellae, which are tiny algae that inhabit their tissues. Corals play an essential role in the reef's health and vitality because of their ability to photosynthesize and create energy. In turn, coral reefs increase biodiversity by providing food and shelter to a wide variety of marine creatures. Coral reef health is therefore highly related to marine life health and ocean ecosystem stability as a whole.

Despite its significance, coral reefs are deteriorating rapidly as a result of a number of causes, the most of which are caused by humans. The most serious danger is climate change, which is already causing ocean acidity and higher sea temperatures. Widespread coral bleaching episodes have been caused by these changes. When corals are stressed, they expel their symbiotic algae, which leaves them susceptible to

diseases and death. Bleaching episodes have been more common and more destructive in recent years. Between 2014 and 2017, around 75% of the world's coral reefs were bleached, according to research. There may be long-term effects on the structure of coral communities and biodiversity loss from this event, so it's not only a temporary setback.

The degradation of coral reefs is caused in large part by pollution. Many contaminants get up in aquatic ecosystems as a result of human activities such as coastal development, agricultural runoff, and insufficient waste treatment systems. To make matters worse for these delicate ecosystems, nutrient-rich runoff may cause toxic algal blooms, which in turn compete with corals for food and space. Reef ecosystems are vulnerable to disturbances caused by sedimentation, which may suffocate corals and prevent them from getting the sunlight they need to photosynthesize. In addition, plastic pollution is a major problem since it entangles corals, stunts their development, and releases harmful chemicals into the water, according to research.

Coral reefs already suffer a lot of problems, and damaging fishing techniques and overfishing make things worse. Depleting populations of herbivorous fish, which are essential for maintaining reef ecosystems by regulating algae development, upsets ecological equilibrium. Because the extinction of certain species has an effect on predator-prey dynamics and ecosystem health as a whole, overfishing may also reduce biodiversity. In addition to harming particular species, damaging activities like cyanide usage and blast fishing physically

destroy the reef structure, which has long-term effects.

Another human activity that harms coral reefs is coastal development. The increasing demand for land and resources caused by the growth of coastal populations is resulting in the degradation and alteration of habitats. Urban expansion, tourist infrastructure, and agriculture often necessitate the clearance of mangroves and seagrasses, two vital components of thriving coral reef ecosystems. Coral reefs are becoming increasingly vulnerable to environmental stresses like pollution and climate change as a result of the loss of these vital ecosystems.

Coral reef health and marine biodiversity have declined alarmingly as a consequence of these human activities. According to recent research, coral cover has decreased by almost half worldwide in the last 30 years, with certain areas seeing even steeper declines. Coral reefs are vital ecosystems that provide food, tourism, and coastal protection to millions of people; their decline endangers marine biodiversity and puts their livelihoods at risk. Coral reefs are important not just for the environment, but also for the world economy, with estimates indicating that they generate over \$375 billion each year via fisheries and tourism.

More and more, scientists, environmentalists, and lawmakers are concerned about the condition of coral reefs. In order to create successful conservation plans, it is essential to comprehend the intricate relationships that exist between coral reef ecosystems and human activities. There has been a

concerted effort to save coral reefs via a number of global agreements and programs, with an emphasis on sustainable management methods and community engagement in conservation activities. For example, the Global Coral Reef Monitoring Network and the Coral Triangle Initiative both seek to encourage multidisciplinary research and community involvement in order to better manage and conserve coral reefs.

The multi-faceted and intricate problem of human activity's effects on marine biodiversity and coral reef ecosystems demands quick action. We must prioritize research into the complex interplay between coral reef health and human activities in light of the ongoing disturbing deterioration of these crucial ecosystems. The only way to ensure that coral reefs will be there for years to come is to make conservation a top priority, adopt sustainable practices, and encourage international cooperation. It is the shared obligation of people, groups, and countries to safeguard the seas that provide life to our world, and this obligation is just as important as scientific understanding and governmental actions in ensuring the persistence of these ecosystems. Doing so will protect coral reefs' diverse ecosystems and the benefits they provide to humans and marine life.

II. LITERATURE REVIEW

Ranjan, Devarshi et al., (2023) One of the most ecologically varied places on Earth is found in coral reefs, which are teeming with species of all kinds. It is home to 35,000–60,000 plant and animal species, making up more than 25% of the marine life on Earth.

Countless kinds of these creatures remain unexplained by science. Protecting coastal communities from storm surges, providing food, jobs, and tourism, and serving as a home to several commercially significant fish species are all functions of this ecosystem. Pollution, overfishing, destructive fishing techniques, boat anchor falls, tourism, mining coral for building materials, and a warming climate are just a few of the many natural and human-caused disturbances that have recently harmed coral reefs around the world. In order to lessen the impact of human activities on coral reefs, we need to develop strategies to mitigate their destruction, promote sustainable fishing practices, educate the public about the importance of protecting coral reefs and their associated biota, and implement alternative management plans like coral restoration, artificial reef management, and coral nurseries. We also need to find ways to reduce plastic pollution in the ocean and raise awareness about the need to protect coral reefs and their associated biota.

Poddar, Poulami et al., (2023) an estimated 71% of Earth's surface is covered by water, while the remaining portion is made up of land. Many different kinds of aquatic life and ecosystems coexist in this enormous watery space. An ecosystem is a localized system of interdependent living things, including plants, animals, weather, and topography. Coral reefs are the most diversified set of ecosystems, and they are directly or indirectly responsible for more than 500 million people's livelihoods. The initial rules of all ecosystems apply to coral reefs as well, but because of their structural complexity and significant internal cycling, they are seen as the endpoint of a

continuum. Coral reefs maintain an astonishing variety of life and contribute much to global biodiversity as the most biologically varied ecosystems on the planet. They are also breeding places for marine species and genetic vaults. Overfishing, pollution, acidification of the water, and increasing sea temperatures are just a few of the threats that coral reefs are now experiencing. Hence, this section of the book delves into the intricate network of coral reefs, describing their biological significance, the challenges they confront in the present day, and the strategies used to save them.

El-Naggar, Hussein. (2020) There is no marine environment on Earth that compares to coral reefs in terms of beauty, diversity, and economic value. Coral reefs are among the most diverse ecosystems on Earth, supporting an estimated 35,000–60,000 plant and animal species—or more than 25% of the marine life on Earth—many of which remain mostly undiscovered. People and businesses rely on them as well. Protecting coastal regions from storm surges and serving as nursery for several economically valuable fish species are two of their primary functions. The food, employment, and tourist revenue they're generating are worth hundreds of billions of dollars. Unfortunately, due to the combined human activities of unsustainable overfishing, intense tourism, urbanization, sedimentation, declining water quality, pollution, and most importantly, the direct and indirect impacts of climate change, coral reef ecosystems have experienced phase shifts to alternate, degraded assemblages. The majority of coral ecologists have reached the same conclusion: the deterioration of coral reefs

has accelerated over the last 30 years as a result of both natural and human stresses. Aware of the dangers that coral reefs face as a result of human activity, we must work to lessen and eventually eliminate these hazards.

Bellwood, David et al., (2011) Overfishing is a growing problem in marine ecosystems around the world, including coral reefs. Research on the effects of fishing has traditionally ignored the wider ecosystem-wide consequences of harvesting in favor of studying the size and dynamics of specific stocks. By examining parrotfish populations, we can demonstrate how coral reef fish populations in the Indian and Pacific Oceans react to increasing fishing pressure. Our analysis of these fish abundance data allows us to speculate on the possible effects on four essential parrotfish functions. While fishing has little effect on grazing and sediment removal, it has a significant impact on rates of bioerosion and coral predation. The findings provide light on the susceptibility and resistance of coral reefs to the increasing impact of humans. The dynamics of coral reefs are altered and future ecological shocks are poised to occur as a result of fish loss, which leads to a differential reduction of important ecosystem services.

Hoegh-Guldberg, Ove. (2011) Carbon dioxide and methane concentrations in the atmosphere have changed significantly due to human activities including burning fossil fuels, cutting down trees, and shifting land uses. The coral reef ecosystem is under jeopardy due to the rise in thermal stress, the acidity of the water, and the decrease in carbonate ion concentrations brought about

by these changes in the environment. Some of the effects seen on coral reefs include a slowing of calcification rates, a rise in mass coral bleaching, and several other changes to physiological and ecological processes that are essential yet subtle. It is projected that reef ecosystems would become more uncommon worldwide by the middle of this century due to the lack of evidence that creatures responsible for creating reefs, such as corals, will be able to adapt to these changes. Fortunately, there is reason to be optimistic about the future of coral reefs if we can limit the increase of atmospheric carbon dioxide and alleviate local pressures like overfishing and deteriorating water quality. There is an absolute need to act swiftly on this issue since coral reefs are vital to the survival of millions of people.

III. METHODOLOGY

To learn how humans have altered coral reef ecosystems and the variety of marine life, this research used a mixed-methods strategy. In the first stage, quantifiable data is gathered by conducting comprehensive literature studies in various sources such as government publications, scientific journals, and reports from marine conservation groups. Coastal development, pollution, overfishing, and climate change are some of the particular human activities that have an impact on species diversity and coral cover patterns. The purpose of this statistical study is to establish relationships between measures of human influence and shifts in coral reef biodiversity and health. To round out the quantitative data, we interview local fishermen, marine scientists, and environmentalists to get their take on the situation and how they feel about the loss of coral reefs. By combining

ecological data with social aspects, case studies of impacted places are examined to show how human activities have influenced coral ecosystems in particular. This all-encompassing approach enables a strong comprehension of the intricate relationships between human activities and the well-being of coral reefs, which in turn helps in the creation of focused conservation plans. The study's overarching goal is to shed light on the critical issues confronting coral reefs and the significance of efficient management and legislative actions by combining quantitative and qualitative data.

IV. RESULT AND DISCUSSION

The findings highlight the devastating effect of human activities on marine ecosystems, since there has been a marked decrease in the variety of marine species, especially in the realms of fish, invertebrates, and corals. The growing variety of algae species highlights the need of restoring and protecting these vital ecosystems, which may indicate changes in ecological equilibrium.

Table 1: Coral Cover Decline by Region

Region	Coral Cover (1990)	Coral Cover (2020)	Change (%)
Caribbean	50%	25%	-50%
Southeast Asia	45%	30%	-33%
Great Barrier	30%	20%	-33%

Reef, Australia			
Red Sea	40%	35%	-12.5%

prevent further losses and safeguard marine biodiversity in light of the alarming declines in coral cover in these crucial ecosystems, which are clearly caused by human activities and environmental stresses.

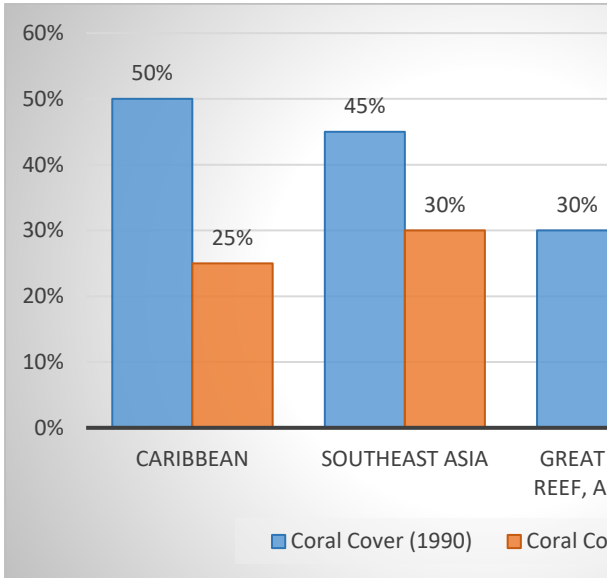


Figure 1: Coral Cover Decline by Region

The critical situation of coral reefs throughout the globe is shown by the table that shows the fall of coral cover by region. It is evident that there have been severe losses in many different places. The percentage of coral reefs in the Caribbean has dropped precipitously, falling from 50% in 1990 to a mere 25% in 2020—a precipitous 50% drop. Coral cover decreased by 33% in Southeast Asia (from 45% to 30%) and the Great Barrier Reef (from 30% to 20%), respectively, due to comparable losses. On the other hand, the Red Sea saw a 12.5% reduction, with coral cover falling from 40% to 35%. The research shows that various areas are vulnerable to different degrees; the Caribbean is seeing the worst drop. Urgent conservation measures are required to

Table 2: Marine Species Diversity Loss

Marine Group	Species Diversity (1990)	Species Diversity (2020)	Change (%)
Fish	600	400	-33%
Invertebrates	1000	700	-30%
Coral Species	400	250	-37.5%
Algal Species	150	200	+33.3%

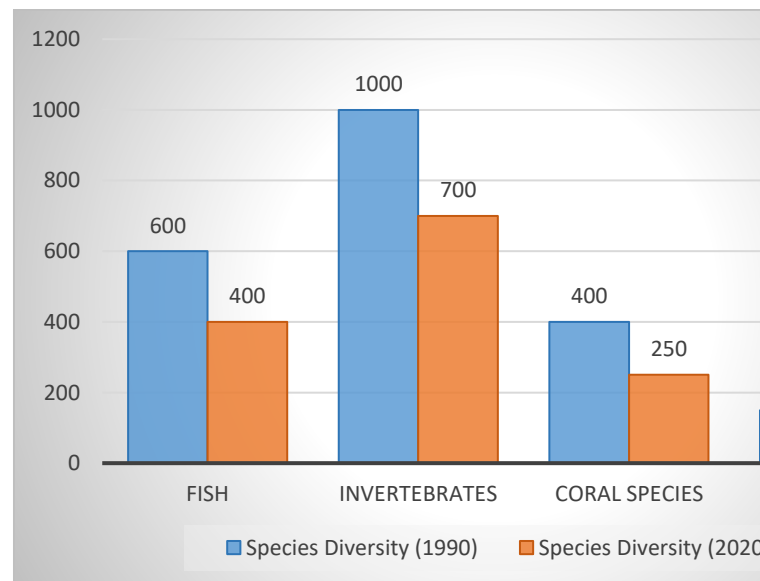


Figure 2: Marine Species Diversity Loss

Evidence of declining marine species diversity from 1990 to 2020 reveals worrisome tendencies in a number of marine taxonomic categories. The variety of fish populations fell by 33% between 1990 and 2020, dropping from 600 species to 400. In a similar vein, invertebrates saw a steep decline in diversity, going from 1,000 to 700 species—a loss of 30%. There was a significant drop in coral species as well, with the number of species dropping from 400 to 250—a drop of 37.5%. Nevertheless, there was an unforeseen surge in the number of algal species, with diversity increasing by 33.3% from 150 in 1990 to 200 in 2020. The loss of coral reefs, which provide ideal conditions for the growth of algae, might be the cause of this contradictory pattern. As a whole, the significant declines in fish, invertebrate, and coral species variety underscore the critical need of conservation initiatives to tackle the persistent dangers to marine ecosystems while keeping an eye on the consequences of growing algae diversity.

V. CONCLUSION

There has to be an immediate and coordinated effort to protect coral reef ecosystems and marine biodiversity from the devastating effects of human activity. The loss of coral reefs, which are already in decline owing to human activities like pollution, overfishing, and climate change, poses a danger not only to marine life but also to the livelihoods of millions of people who rely on these ecosystems for their survival. Scientific investigation, sustainable management techniques, and community involvement are all necessary components of a comprehensive strategy to overcome these obstacles. Future

generations will be able to appreciate coral reefs for what they have contributed to biodiversity and human health if we make their preservation and restoration a top priority.

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