A Comprehensive Review of Strategies for Animal Biodiversity Conservation in Marine Ecosystems

Mariyam Munir

ABSTRACT

Ocean ecosystems rely on marine ecosystems for their structure and function, which in turn provide people with a wide variety of ecosystem services at the local, global and regional levels. The preservation of the world's carbon and oxygen cycles, the generation of energy and food, and the support of human health are all essential services provided by marine ecosystems. Unfortunately, activities by humans, climate change, and the inappropriate exploitation of marine areas are quickly degrading marine ecosystems. This review delves into new approaches to marine biodiversity conservation, showcasing current trends, effective studies, and study findings. A more all-encompassing strategy for marine life preservation might be developed via future research that fills in the gaps in specific to a species information, cumulative threat assessments, socioeconomic comprehension and sustainability results. This report seeks to provide a thorough review of conservation initiatives and their possible influence on marine biodiversity by assessing existing difficulties and viable treatments.

Keywords: Marine ecosystem, Challenges, Biodiversity Conservation, Strategies

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Introduction

Marine habitats are diverse and productive, as they cover more than 70% of the Earth's surface. Both, aquatic and terrestrial life forms depend on these ecosystems for survival. Human health stored in the ocean is now at the crossroads of its capabilities. This sector has been estimated to produce a total of US$ 1. Five trillion in the year 2010 and estimated to be 2030, the ocean today contributes to 2% of the planet's GDP. Now it takes 5% of the world GDP and 1. Five percent of the world's total working population, according to the Organization for Economic Cooperation and Development in 2016. More and more individuals are seeking answers to climate change from the ocean[1,2] and for the generation of energy.[3] Climate change is also affecting productivity and biodiversity in oceans; several organisms, habitats and ecosystems are already experiencing drastic declines in their populations.[4,5] Other human activities that fuel the reduction in marine diversity include coastal development and destructive fishing practices that threaten habitats like seagrass beds, coral reefs, and mangroves. In the ecosystem, the various types of habitats that form the maritime systems affect the makeup and functioning of these ecosystems.[6] As noted by Carrier-Belleau et al.,[7] keystone species in every habitat influence fishing businesses and the nitrogen cycle, conservation, and other aspects of ecosystem yield.

Justifications for Conservation Strategies

There are only some measures that have to be successful to save marine ecosystems from grave threats that exist at the moment. As it will be seen with the concept of ocean health henceforth, conservation strategies in the ocean bring into question the health of human beings while at the same time over exploiting the ocean resources.[8] The long-term objectives of the save of individuals of specific species and the overall states of populations in ecosystems define the general aims of conservations. These are top predators on which marine ecosystems mainly depend to regulate everything. When they disappear, they may cause the trophic levels that feed off them to go, which may lead to instability of ecosystems. Evaluating these ecosystems on the large scale is often required for their stewardship but the reward to the system's biological and ecosystem diversity could be significant.[9] Being unique and exciting these animals draw focus to issues that would otherwise be overlooked in marine conservation. Life is constantly evolving, and thus problems continue to arise in marine environments. In order to counter them, the approaches used for conservation must be dynamic and underpinned by the most up to date research.

Objectives

In the last few years, the goal of many researchers has been to present an updated synthesis of the targeted subject, which is conserving marine biodiversity.

- In order to distinguish and solve those problems that are critically important for the preservation of marine life.
- So that one can assess present conservation initiatives and considering the results of such schemes.
- To ascertain the impact of newer forms of protection of marine life.

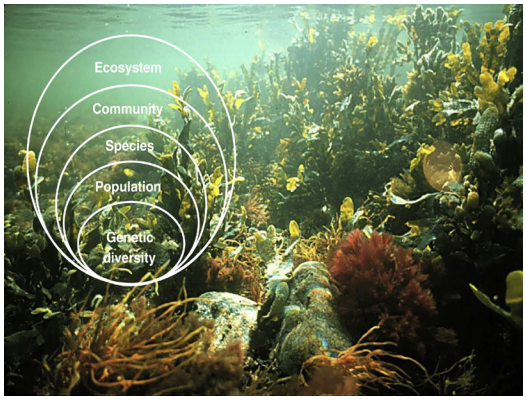

Fig 1 | Interconnected maritime ecosystems[5]

Scope

It would also be a concise summary of the current strategies employed to preserve the marine environment's diverse population of animals. Through accomplishing this study, it is therefore possible to gauge the effectiveness of current strategies in the conservation practice and identify areas of deficiency that may warrant further investigation. Therefore, we can evaluate the ongoing efforts to preserve the seas and design the further actions with the help of the information about numerous threats to the abyss. It will assist in the development of reference conservation programs so that the allocation of funds has the greatest possible impact on the protection of this environment. The second purpose of the review is to contribute to the existing literature addressing preventive measures toward making sure that the seas and their manifold inhabitants are there to be treasured by generation to come.

Major Issues in Marine Biodiversity Conservation

The activities of humans provide several both immediate and unforeseen risks to marine biodiversity. The effects of these dangers are compounded because they are complex, diverse in kind and location, and often linked. Humans have had a steadily rising impact on marine life's variety and abundance during the last 500 years, leading to the extinction or near-extinction of a growing assortment of species.[11] The International Union for the Conservation of Nature (IUCN) Red List has evaluated 16,430 marine species so far, with 1,358 of them identified as susceptible, threatened, or severely endangered (Fig. 2). At least 133 aquatic organisms have gone extinct on a local or regional basis, and numerous are on the decline as a result of increasing human pressures; nevertheless, only 20 maritime species have been found to be extinct on a worldwide scale.

Overfishing and Unsustainable Fishing Practices

The loss of marine life due to overfishing is a major concern. Sea creatures have a long history of being hunted for their flesh, fat, bones, and other organs. As

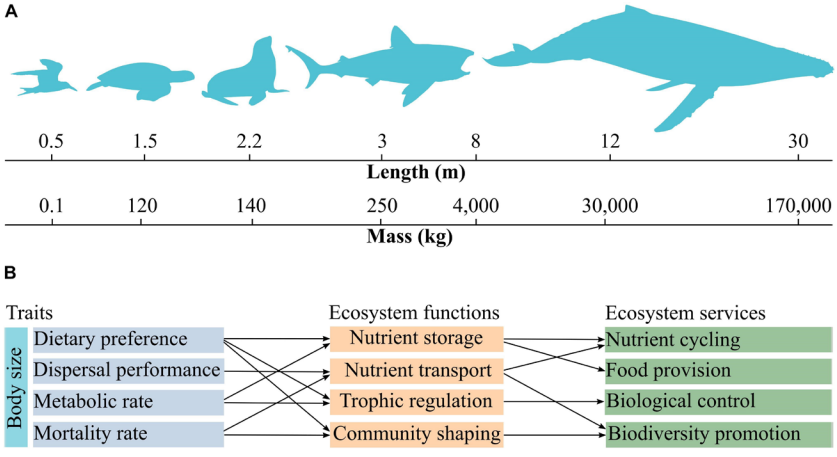

Fig 2 | Key aspects of the methodology pertinent to marine species and the relationship between species and ecosystem processes and goods[10]

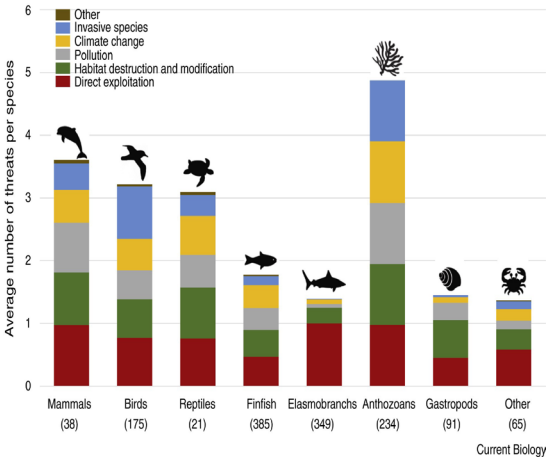

Fig 3 | Review of human-created hazards to species under extinction danger[11]

an example, several cetacean species throughout the world were almost wiped off in the 1800s and 1900s due to whaling.[12] International restrictions have put a stop to commercial whaling, although other nations continue the activity for cultural or scientific reasons.[13] The general health of aquatic ecosystems is affected by the decrease of fish populations, disruption of dietary chains, and exploitation. The sub-Arctic and Arctic populations have also been affected by the hunting of seals for their fur, flesh, and oil.[14] Some large fish species like swordfish and tuna have been subjected to harsh population reduction by overfishing, as found in a study by Schartup et al.[15] Scraping and hooks dragging are other destructive methods of fishing that affect seabed and its inhabitants, and the bycatch is high. There is a great threat that marine ecosystems are facing now, and this is known as bycatch hazards, which mean that fishing gear can also capture other animals besides the targeted species. Trawls, gillnets, & longlines may catch turtles, dolphins, seals & sharks in or above the water damaging or even killing them.[16] Also, marine ecosystem may get trapped to ghost gear, which is lost or discarded fishing equipment, and this may cause harms such infection, loss of mobility, or drowning.[17]

Pollution

Pollutants such as plastics are causing adverse effects to animals, human activities and the environment since the material has chemical properties and a life cycle owing to the breakdown process.[18] One of the significant threats to the marine life is pollution of the seas which include cases of plastic pollution. Sadly, the pollution of plastics is not something that only affects one specific area but is a problem with ripple effects. When marine animals feed on the plastics that contaminate their environment, they get physically harmed and poisoned by chemicals. As mentioned by Jaureguiberry et al.,[19] plastics possess the capability to accumulate toxic materials from the environment onto the body of the plastic, which in turn could be seen in water bodies. It is for this reason that a number of researchers suggest that

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micro-plastics affects each and every trophic level in the sea, be it the tiniest plankton or the largest whales.

Climate Change

Coral bleaching, causing the lower pH of the oceans, the rising water temperatures, altered currents are effects of climate change that threaten marine life greatly. Marine ecosystem life cycles and distribution are effectively at risk when climate change impacts in ocean acidification, sea level rise, current shift, and warmer ocean occur. It has been noted that the ability of calcifying organisms including shellfish & corals to form skeletons & shells gets affected by the increased CO_2 absorption that leads to ocean acidification. Counting among such species, there are seals and polar bears that must depend on sea ice which may be totally eliminated by climate shifts.[20] When warm water drives away zooxanthellae, the host's tissues start to deteriorate, and corals lose their vivid pigmentation, which is life's essence and a symbol of their health Since the mass bleaching episode in 1998, a recurrent phenomenon have observed where corals are starved of heat and nutrients. Fish like sharks and whales for instance may need to alter their feeding grounds because prey populations shift latitudinally as a result of warmer waters.[21] Moreover, problem such as shifting patterns of ocean circulation and movement of marine organisms are disrupted.

Habitat Destruction

The degradation of the marine habitats such as coral reefs, seagrass & mangroves that form the foundation for number of Recipes is caused by habitat destruction which originates from the coastal development, destructive fishing practices, & climate change. Because of the expansion along coastal areas, pollution, and destructive fishing practices, maritime environments are endangered, and the food sources, reproduction grounding, and migration pathways are affected. Thus, the elimination of these ecosystems results in reduction in ecological services and significant loss of diversity. For instance, manta rays and the other ocean's inhabitants may experience a drop in their dwelling and forage as ocean acidification and blast fishing ensue.[22] Species that depend on these habitats for existence have been declining as a trend pointed out in the findings of the study indicates.

Recent Research and Trends in Marine Biodiversity Conservation

Marine Protected Areas (MPAs)

The establishment of Marine Protected places and other similar spatial conservation efforts is an important part of a more holistic strategy for marine conservation that aims to preserve ecosystems, habitats, and places of high biodiversity. The number of ocean regions designated as protected has grown dramatically since the 1960s, with many nations' oceans being home to protected zones of varying sizes and degrees of protection. Despite the fact that just 7.66% of the ocean is under some kind of protection at the moment, more and more nations are rallying behind the Global Ocean Alliance's goal of preserving 30% of sea by 2030.[11] Also, in order to assist maintain marine biodiversity on a global scale, several nations and organizations are working toward a network of marine protected areas (MPAs) that spans different biological and ecological hotspots and allows for communication and cooperation between individual MPAs.[23] Aside from preserving species variety, designated areas often have other positive impacts on the waterways around them. These include improving nearby populations and fisheries as a result of spill-over effects and providing people with benefits via ecosystem services like environmentally conscious tourism as well as greenhouse gas storage.

Restoration Projects

The importance of habitat restoration efforts in maritime conservation has been recognized and is gaining traction. An innovative approach to promoting port decarbonization, minimizing our environmental effect, and promoting ecologically sound operations is the possible integration of marine ecosystem conservation, MNG, & carbon capture and storage in port expansions. Some methods have shown encouraging outcomes; for example, coral gardening[24] involves transplanting pieces of healthy corals to reefs that have suffered damage. Strong collaborations across governments, NGOs, corporations, and communities at large are necessary to overcome obstacles related to funding, sustainability in the long run, and efficient monitoring. Ecosystem services like storing carbon as well as protection of the coast are improved, biodiversity is increased, and degraded coastal regions are revitalized via mangrove restoration programs. We can ensure a better future for our seas and world by encouraging a cooperative and welcoming attitude. Restoring important maritime ecosystems is becoming more dependent on conservation efforts that use restoration ecology concepts.[25]

Technology in Conservation

Conservation efforts for marine biodiversity are being transformed by technological advancements. New conservation strategies are being informed by the rapid advancements in sequencing and analytics, which have made it possible to explore the ocean genome. A non-invasive way to keep tabs on elusive or uncommon species is via the use of genetic technologies like environmental DNA evaluation, which may identify species existence and diversification from water samples.[26] By collecting data on wildlife initiatives, habitat usage, and activities by humans in immediate fashion, satellite navigation and drones have improved maritime wildlife and ecosystem monitoring. More accurate and thorough evaluations of marine ecosystems have been made possible by these advances, which have informed policy choices and focused conservation efforts.

International Collaboration

Since marine conservation issues are transnational in nature, international cooperation is required to solve

them. No country can address and eradicate all kinds of problems affecting their seas on their own.[27] To be specific, if we want to deal with pollutions, make fishery as an efficient business, preserve endangered species of marine life, we need our neighboring countries. It is the ability to come up with sound decisions with regard to the activity if people are going to be operating collectively in an effort to achieve an objective. Research of multinational conservation measures and integrated investigations is demonstrating that international actions can increase effectiveness of procedure for the conservation of marine species.

Participation of the Community and Indigenous Practices

Tremendous achievements have been made in the conservation that embraces local people and indigenous knowledge. In order to join structured or unstructured information and to join knowledge islands, knowledge must first be integrated. Reyes-García and Benyei[28] posited that those projects that are based on the community level have proved to yield more positive impact and are more sustainable because they involve the community in the formulation of the conservation agenda. Due to their kind of ecological rationality, the indigenous people are more suited to adapt to the existing social and environmental changes, hence enhancing social and environmental adaptability.[29] Marine conventional ownership arrangements that indigenous fishing groups of Pacific have established have brought, for instance, increased ecological diversity and preservation of resources. They ensure that resource consumption is regulated, and the critical areas are well protected.

Ecosystem-Based Management

An approach that can be used in a management plan to coordinate an outline for resource management that embraces all the characteristics of an ecosystem including people. To sum up, EBM has been highlighted in the recent frameworks and regulations in terms of its suitability to protect marine ecosystems. The management of complex social-ecological systems, in interaction with appropriate spatial and temporal scales, paying attention to such processes as the dynamics of biological systems and society as a whole, and the integrated management of these structures is another crucial component of EBM.[30] EBM techniques applied toward the conservation of environmental health and the enhancement of the environment's ability to buffer future shocks have been demonstrated to be more effective when the strategies consider ecological connectivity and compounding impacts. That is why EBM is developed based on the current management practices, so it does not require a fast or dramatical evolution. For instance, to understand how EBM can help solve complex environmental concerns, let's discuss about the Baltic Sea in which using of EBM has led to the improvement of water conditions, as well as the repopulation of fish.[31]

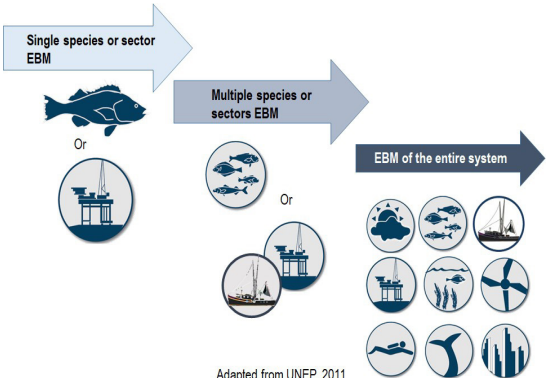

Fig 4 | Continuum of ecosystem-based management

Exploration of Case Studies

Vaquita Bycatch

A highly exemplary example of the status of bycatch is the vaquita, which is described as the smallest and the most endangered marine mammal in the whole wide world. Because the species is accidentally caught in gillnets used for totoaba another critically endangered fish found in the gulf the number of them has plummeted and are now only found in the Gulf of the state of California Mexico Brownell et al.[32]

Leatherback Sea Turtle and Climate Change

As for the sea turtle, one of the most sensitive species to the consequences of global warming may be characterized as the leatherback sea turtle. Due to the temperature sensitive sex determination mechanism, rise in temperatures means that the newborn sea turtles can be produced in skewed sex ratios. Moreover, their nesting beaches are endangered by the processes such as erosion and destruction due to the increase in sea level and storm activities.[33]

Humpback Whale Recovery

As far as conservation efforts go, the humpback whale stands head and shoulders above the crowd. Their populations have returned since the worldwide ban on industrial whaling in 1982, proving the efficacy of regulatory intervention, after being almost wiped out owing to industrial whaling.[34]

Sea Turtle Conservation in Costa Rica

Green turtle numbers in Tortuguero, Costa Rica, have been significantly helped by the community-based conservation initiative. An economically feasible replacement to turtle egg poaching is provided by this initiative, which ecotourism, integrates research & involvement by the community.[35]

Conservation Strategies and their Effectiveness

Strategies

- **Protected Areas**

One of the most effective ways to save marine species is via the creation of underwater reserves that safeguard areas. To help species recover, these zones restrict or

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outright ban activities like fisheries and resource exploitation.[36]

- **Legislation and Regulation**

Elsewhere, rules and regulations at the national and international levels matter much. According to Sahri et al.,[37] the International Commission for Whaling (IWC) oversees whaling operations, while the Convention on International Trade in Endangered Species manages the trade of marine species and their products. The United States Endangered Species Act and the Marine Mammal Protection Act are national statutes that provide further safeguards.

- **Bycatch Reduction**

There are several measures that have been devised to decrease the accidental capture of marine species. These efforts include bycatch quotas, fishing limitations based on space and time, and changes to fishing equipment such turtle's excluder gadgets and bird scaring lines.[38]

- **Community Engagement and Education**

It is essential to include local communities & raise awareness among the public. According to Dressler et al.,[39] glamping and citizen science initiatives are examples of centered around community's conservation programs that may promote responsible use of marine resources while also offering alternate means of subsistence.

Effectiveness

- **Protected Areas**

Effective leadership and implementation are crucial to the effectiveness of MPAs in improving species richness and diversity.[40]

- **Legislation and Regulation**

The preservation of marine ecosystem has achieved great achievements thanks to worldwide treaties and domestic laws. As an example, multiple whale populations have been able to recover because to the International Whaling Commission's prohibition on commercial whaling.[41] But it's still not easy to be compliant and have the law enforced.

- **Bycatch Reduction**

Reducing ecosystem's mortality is possible via bycatch reduction measures. As an example, according to Senko et al.,[42] ocean turtle catch-and-release in prawn trawling fisheries has been drastically decreased due to the introduction of turtle excluder devices. Fishers often oppose and even reject the use of such tactics.

- **Community Engagement and Education**

The effectiveness of conservation initiatives in the long run depends on these endeavors. Despite this, they are often underappreciated, underfunded, and their effects are hard to pin down.

Innovations and Future Strategies for Conservation

Emerging Technologies

There are promising new avenues for marine conservation opened by emerging technologies like environmental DNA, satellite imagery, and artificial intelligence. One area where AI has the potential to improve surveillance and analysis is in marine species identification and tracking.[43] However, electronic DNA (eDNA) offers a potent conservation tool as it can discover and monitor marine species without invasive approaches.[44]

Climate-Smart Conservation

Conservation efforts must be "climate-smart" in light of the fact that marine ecosystems are already feeling the effects of climate change. This means considering the ways in which aquatic organisms and their environments are changing, as well as making adjustments as needed.[45]

Sustainable Blue Economy

In order to promote economic development, better lives, and employment opportunities while simultaneously ensuring the wellness of the marine environment, the 'Blue Economy' idea highlights the responsible utilization of marine resources. It encourages marine-based businesses that may help achieve conservation objectives, such as sustainable fishing, fishing, and tourism.[46]

Rights-Based Approaches

People from indigenous and rural communities often have strong relationships to marine life. Biggs et al.[47] found that one effective conservation technique is to acknowledge and support these societies' responsibilities to regulate their local marine ecosystems. This will encourage stewardship and gain local support.

Conclusion

Conserving marine ecosystems is of the utmost importance because of the ecological role they play as essential parts of our global biodiversity. Despite the many obstacles, like as hunting and climate change, significant conservation initiatives have shown positive results. There are new ways to be protected thanks to emerging creative solutions that use environmentally conscious conservation, the environmentally friendly blue economy, centered around rights approaches, and technological breakthroughs. Concerning species-specific effects, socioeconomic variables, cumulative dangers, and conservation results in the long run, there are still knowledge gaps. In order to alleviate these issues and ensure the long-term viability of these vital species, researchers should conduct multidisciplinary, sociological, cumulative impact, and monitoring studies in the future.

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