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Research Article

# Management and Conservation of Aquatic Biodiversity

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**Abstract**

The inland fisheries industry is crucial to the country's socioeconomic growth, and the inland water resources are home to a wealth of aquatic species. India is the world's second-largest fish producer, and the country's fishing industry has seen a dramatic paradigm change from one dominated by the sea to one centered on the country's vast interior waterways. Pollution, water abstraction, flow alteration, eutrophication, the spread of invasive alien species, climate change, urbanization, etc. are all contributing to the degradation of inland aquatic resources. The loss of aquatic biodiversity poses a serious threat to India's food, nutritional, and economic security, and must be addressed immediately. The current research has led to suggestions for protecting India's aquatic resources, particularly those of high biodiversity and ecological value.

**Key words:** Aquaculture, Aquatic, Biodiversity, Fisheries, Conservation

## INTRODUCTION

India's aquatic genetic resources include 9,456 species, or 9.7 percent of the country's overall animal species count (97,708. A total of 5,923 species of arthropods, 422 species of nematodes, 419 species of rotifers, 217 species of mollusks, 167 species of annelids, and 163 species of Platyhelminthes may be found in freshwater. There are 1,047 fish species, 275 amphibian species, 243 bird species, 46 reptile species, and 6 mammal species in the Phylum Chordata. There are 113 saltwater, 936 freshwater, and 462 non-native finfish species in the inland waters. There are about 265 fish species in the Gangetic River system, 126 in the river Brahmaputra, and more than 76 in the rivers of the peninsula. Some of the most recognizable animals in the world, such the Gharial and the Irrawaddy dolphin, make their homes in the inland seas.

Freshwater, saltwater, and marine environments all contribute to the richness of aquatic biodiversity. Aquatic life has long served as a vital resource for human cultures, providing necessities like food and medicine as well as commercial and industrial purposes. The aquatic ecosystem provides unfathomable and enormous economic value.

In order to manage ecosystems in a way that is both ecologically sound and successful, it will be necessary to provide a solid logic, reasoning, and framework for dealing with the constraints of scientific knowledge. Social and political forces that encourage disjointed, uncritical, short-sighted, inflexible, and overly optimistic assessments of resource status, management capabilities, and the consequences of decisions and policies must be factored in to prevent irreversible or massive environmental mistakes.

Human activities have a catchment-wide impact on aquatic resources, and many of the landscape changes humans routinely induce cause irreversible damage (e.g., some species introductions, extinctions of ecotypes and species) or give rise to cumulative, long-term, large-scale biological and cultural consequences. The potential of future management to sustain biodiversity and restore historical ecosystem functions and values in aquatic ecosystems is severely constrained by biotic impoverishment and environmental disturbance induced by previous management and natural occurrences. Identifying catchments and aquatic networks where ecological integrity has been least damaged by prior management and jointly developing means to ensure their protection as reservoirs of natural biodiversity, keystones for regional restoration, management models, monitoring benchmarks, and resources for ecologic resilience is essential for providing for rational, adaptive progress in ecosystem management and reducing the risk of irreversible and unanticipated consequences.

## LITERATURE REVIEW

Ward D, Melbourne-Thomas J, Pecl GT, Evans K, Green M, McCormack PC, Novaglio C, Trebilco R, Bax N, Brasier MJ, Cavan EL, Edgar G, Hunt HL, Jansen J, Jones R, Lea MA, Makomere R, (2022), Life on Earth would not be possible without marine habitats and the biodiversity they provide. The generation of food and energy, as well as the management of global oxygen and carbon cycles, are all essential services provided by marine ecosystems. However, marine ecosystems are quickly deteriorating as a result of climate change and the irresponsible use of marine resources. Protecting marine ecosystems so that they can keep providing essential resources for the world's growing population is, therefore, a critical problem for the future. In this paper, we utilize foresighting and hindsighting to examine two potential futures up to 2030: a business-as-usual trajectory (i.e., the continuation of existing trends) and a more sustainable yet technically attainable future in accordance with the UN Sustainable Development Goals. We isolate critical factors that set apart these potential outcomes and utilize them to plot a course of action that will lead us to a better, more sustainable future. Establishing integrative (i.e. spanning jurisdictions and sectors), adaptive management that promotes fair and sustainable stewardship of maritime habitats will be crucial to reaching the more sustainable future.

Thornton, A., Amon, D.J., & Herbert-Read, J.E. (2022), Marine and coastal ecosystems are undergoing rapid and profound changes that threaten their rich biodiversity. Overexploitation, climate change, and pollution are all well-known causes of these changes; however, there are other developing challenges that are less well understood and acknowledged, but might have significant implications on marine and coastal ecosystems if they are properly addressed. We assembled a group of 30 experts in marine and coastal systems from a variety of fields to conduct the first-ever Marine and Coastal Horizon Scan, with the goal of identifying emerging challenges that will have a major impact on the health and preservation of these ecosystems over the next decade. From an initial list of 75 concerns supplied by participants, the top 15 were narrowed down using a modified Delphi voting method.

Brooks, W.R., Rudd, M.E., Cheng, S.H. *et al.* (2020), The ecosystem services provided by tropical coastal marine ecosystems (TCMEs) include carbon storage, coastline protection, and food provision. As more people move to coastal regions, pressure will increase on these ecosystems from development as well as from larger environmental changes linked with climate change, such as rising sea levels and ocean acidification. Conservation groups are paying more attention to TCMEs, and many initiatives have been launched to encourage the preservation and sustainable growth of these areas. However, little is known about the effects of these initiatives on either human populations or ecosystems. Conservation interventions in TCMEs, such as those implemented to protect coral reefs, mangrove forests, and seagrass beds, are the focus of this comprehensive mapping project.

Authors: Penaluna, Olson, and Flitcroft (2017); Penaluna, Deanna H., and Rebecca L. We need a more in-depth look at the effects on ecological integrity and ecosystem services as the variety of aquatic ecosystems rapidly declines across multiple continents. We discuss the downstream and upstream effects of forest aquatic biodiversity on ecosystem services. We provide a synopsis of the elements that structure the assembly of forest aquatic biodiversity in natural systems and how these parameters shift in response to natural disturbances and human-derived stresses. We see forested aquatic ecosystems as a portfolio, with a variety of assemblages and life-history strategies happening at different sizes due to a patchwork of habitat conditions and historical disturbances and stresses. Keeping these diverse assemblages' stable calls for a holistic understanding of the interconnected nature of ecosystem structure, function, service, and management in the context of modern stresses. Activities that threaten aquatic ecosystems and biodiversity may pose a threat to the health of forest ecosystems because of the various ecosystem services that aquatic biodiversity offers to forests.

A. Gopalakrishnan, and J. K. Jena (2012), As of this moment, only roughly two million of the estimated 10–30 million species in the world have been formally named. Humanity relies heavily on the products and services provided by the ecosystems that depend on this vast and valuable biodiversity. While India's aquatic germplasm resources are diverse and include species of both animals and plants, it is the country's finfish and shellfish that have the most practical and theoretical significance for fisheries and farming. These water sources not only aid in the genetic advancement of aquacultured species, but also have the potential to make a major financial contribution to the nation's well-being. Despite biodiversity's critical function, all of its component species are under jeopardy, particularly as a result of a variety of human-caused problems. In this paper, we've tried to take stock of the methods, genetic technologies, and operational paradigms that bear on resource management, and we've sketched out the prospects for future research into sustainable fish production that can help alleviate national hunger.

**Conservation of Aquatic Biodiversity**

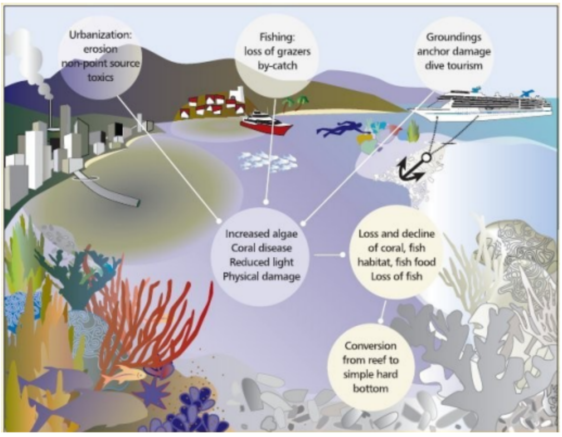


**Figure 1: Conservation of Aquatic Biodiversity**

The southern Appalachian streams are home to a diverse and unique fauna, including many endemic species, and drain geologically ancient (>250 million years old) landscapes. Neither the Pleistocene Ice Age nor the rising of the sea level disrupted the area's lengthy evolutionary history.

There is more aquatic life here than in any other temperate location, and it even compares well to tropical ecosystems. Up to half of certain taxonomic families of aquatic invertebrates are yet to be described, suggesting that their diversity exceeds that of any other location in North America. The Southeast is home to 269 of the 297 species of mussels known in the United States. There are over 350 different fish species, and about 18% of them are critically endangered.

Aquatic resource managers have significant problems due to the area's rich fauna and its position in a terrain that is continually changing. Individual aquatic species, aquatic groups, and environments dependent on moving water may be difficult to preserve. The zoogeography, distribution, and biology of the southeastern fish fauna, and to a lesser degree other aquatic creatures, have been extensively studied during the last century. There is a danger to this variety. There are several vulnerable or endangered species across all categories of animals. Habitat loss and degradation, as well as invasive species, pose the greatest danger to the region's biodiversity.

**Subsection found in Conservation of Aquatic Biodiversity**

*Imperiled Aquatic Species*

*Habitat Alteration and Loss*

*Introduced Species in Aquatic Systems*

All species that are now considered to be in danger of becoming extinct fall under the umbrella term "imperiled" in this context. This includes species that are currently classified as threatened, endangered, or of special concern. The U.S. Fish and Wildlife Service (FWS) has formally categorized T&E species as "threatened" or "endangered" (T&E) under the Endangered Species Act of 1973. Species of special concern (SC) are those that have been identified by NatureServe as having globally restricted ranges (G1, G2, or G3) but have not yet through the legislative listing procedure. The southern Appalachians are home to several endangered species that have seen their populations dwindle as a result of habitat loss and modification.

The southern Appalachian area is home to several endangered fishes, mollusks, reptiles, amphibians, and invertebrates, some of which are federally protected or critically endangered elsewhere.

**Ecosystem approach**

The value of aquatic biodiversity in rural economies cannot be overstated. But it is under danger from both internal and external sources, including overfishing, harmful fishing techniques, and the introduction of alien species, as well as habitat loss and degradation, which are mostly caused by land-based activities. As such, the FAO Aquaculture Management and Conservation Service initiated a program to create an inventory and valuation of inland aquatic biodiversity used by rural communities in natural and modified ecosystems, with an emphasis on traditional knowledge, sustainable use, enhancement, and gender issues.

Integrating environmental factors into capture fisheries management strategies and processes is critically needed to enhance fish stock conservation and sustainable usage. FAO has published a series of recommendations for ecosystem-based approaches to fisheries management.

**FAO Code of Conduct for Responsible Fisheries**

Several initiatives concerning aquatic biodiversity are being carried out by the FAO Fisheries and Aquaculture Department. These initiatives are crucial to the future of fisheries and aquaculture. The framework for FAO's fisheries work is provided by the 1982 United Nations Convention on the Law of the Sea (UNCLOS 1982) and the FAO Code of Conduct for Responsible Fisheries (CCRF 1995).

**Fig 2**: **Conservation of Aquatic Biodiversity in Vietnam**

Vietnam's government has enacted rules and regulations for the management and protection of aquatic resources, and it has also taken a number of steps to raise awareness of the importance of aquatic biodiversity. However, further work is required. Several factors contribute to the decline in aquatic biodiversity, including overfishing, the use of pesticides and explosives to capture fish, the building of dams that block access to breeding grounds, and the lack of proper planning for the development of aquaculture, as seen by the current uptick in shrimp farming in coastal regions.

The national action plan for biodiversity conservation that was implemented in 1996 included a national aquatic biodiversity conservation project that ran from 1996 to 2000. The project's goals included establishing an ex-situ live gene bank for farmed freshwater species/strains and certain native species, and promoting aquaculture's long-term viability. Three locations of the Research Institute for Aquaculture have begun live gene banking of freshwater species. Most of the species that have been kept alive have had their karyotypes and physical characteristics catalogued in a primary data bank. Cryopreservation, isozyme, and DNA analysis have all been mastered by personnel via enhanced facilities and training. However, there are challenges associated with ex-situ gene banking, such as the requirement for huge pond areas, high-quality diets, and careful stock management to preserve the quality of stocks.

For the period of 2001–2005, the National Aquatic Biodiversity Conservation Project (NABCP) has three main components: Building a gene data bank, including characterization of growth performance, breeding, karyotype, and markers of isozyme and DNA; (ii) live gene banking of aquatic animals, with priority given to commonly cultured species/strains and seriously threatened indigenous species in both fresh and brackish water; and (iii) assessing aquatic resources to identify threatened indigenous species and relevant holistic approaches for natural preservation and enhancement.

**In India:**

The world's biodiversity is under danger. In comparison to the mammalian background extinction rate during the previous 65 million years—that is, since the mass extinction that killed the dinosaurs—the worldwide mammalian extinction rate of 0.35% of species lost every century since 1600 is estimated to be between 17 and 377 times higher. The table below shows that India's rich biodiversity is under danger.

| | Number of Indian species (Percent of world total) | Percent of Indian speciesevaluated | Species threatened inIndia as percent of those evaluated | Number extinct (percent of those evaluated) |
|---|---|---|---|---|
| Amphibians | 207 (4%) | 79% | 57% | unknown |
| Freshwater fish | 700 | 46% | 70% | unknown |

The Western Ghats and the northeastern region of the country both have very high biodiversity. This is due of the prevalence of tropical rainforests, which are among the most species-diverse ecosystems on Earth. Both of these locations are considered biodiversity hotspots, or concentrated regions with very high species diversity. More unique, or "endemic," species may be found in the Western Ghats than in the Eastern Himalayas.

The reduction in habitat size, the fragmentation of habitats, and the degradation of habitat quality pose the greatest threats to species. The likelihood of extinction is increased by fragmentation because isolated subpopulations may perish without being replaced. Due to their reduced genetic diversity as a consequence of isolation, tiny subpopulations are more vulnerable to extinction due to stochastic decline. These dangers pose a greater risk to species that have small, fragmented ranges to begin with.

Diversion of ground water, which dries out streams and other water bodies, siltation, and contamination from pesticides and other chemicals all contribute to the deterioration of aquatic and semiaquatic species' habitat quality. Exotic species, which may act as predators or rivals, are another concern to freshwater fish.

**Conservation of aquatic biodiversity: (in India)**

Since non-native fishes may have a devastating effect on aquatic ecosystems, strict rules should be established for their introduction. The National Committee on entrance of Aquatic Species in Indian Waters in New Delhi must approve the entrance of alien fish species into Indian waters. The import's usefulness and any possible damage the introduction of a new species may do to India's ecosystem will be investigated by a committee, whose members include the commissioner of fisheries development and the exports commissioner. Despite this, the illegal import and trading of exotic fishes, such as whatever species of the predatory aquarium fish piranha, persists unabatedly due to a lack of efficient techniques and political will to enforce the law. The current legal framework and associated implementation process should be revised in light of the circumstances. The danger of introducing new species may be reduced by adopting a code of conduct that adheres to the recommendations of organizations like the European Inland Fisheries Advisory Commission (EIFAC) and the International Council for the Exploration of the Sea (ICES). Importing aquatic organisms requires strict adherence to appropriate quarantine requirements.

Unless effective conservation measures are taken, the loss of aquatic biodiversity is likely to increase due to the rapid increase in human population and the increasing dependence on aquatic resources such as water and the continuing introduction of exotic species in natural water bodies. Extensive research should be launched to pinpoint the effects of all imported species in different bodies of water, and then measures should be taken to eliminate the harmful species.

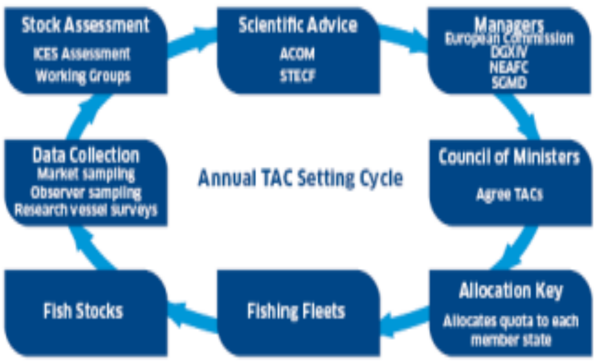


**Fig – 3: Important Measures for Managing Fisheries**

**Fishery Regulations**

Set catch limits well below the maximum sustainable yield

Improve monitoring and enforcement of regulations

Economic Approaches

Sharply reduce or eliminate fishing subsidies

Charge fees for harvesting fish and shellfish from publicly owned offshore waters

Certify sustainable fisheries

Protected Areas

Establish no-fishing areas

Establish more marine protected areas

Rely more on integrated coastal management

Consumer Information

Label sustainably harvested fish

Publicize overfished and threatened species

**Protecting Wetlands**

Legally protect existing wetlands

Steer development away from existing wetlands

Use mitigation banking only as a last resort

Require creation and evaluation of a new wetland before destroying an existing wetland

Restore degraded wetlands

Try to prevent and control invasions by nonnative species

**Conservation Strategies**

Human-caused environmental changes, overfishing, habitat destruction, invasive species, and other causes pose serious threats to aquatic ecosystems and biodiversity. There has been a disturbing loss of ecosystems and species vital to human survival and environmental stability. Aquatic biodiversity conservation techniques need to be implemented immediately to ensure the survival of these imperiled ecosystems and species for future generations.

Protecting biological resources in a manner that conserves habitats and ecosystems is a basic goal of aquatic conservation techniques that should help promote sustainable development. Broad-based management methods are necessary for successful biodiversity conservation. There are several ways to do this, such as:

ADMAs, or Aquatic Diversity Management Areas, were initially suggested by Moyle and Yoshiyama (1994) as a methodical strategy for managing watersheds with the overarching objective of preserving aquatic biodiversity. There is a wide spectrum of ADMAs, from specific species protection laws to comprehensive biodiversity initiatives. In order to manage ADMAs effectively, all human activities that contribute to habitat degradation must be ceased or drastically reduced. In the Sierra Nevada, this idea has been put to use.

Marine reserves are areas of the ocean where some activities, such as fishing, are prohibited for the purpose of preserving marine life and its ecosystems. In addition to reviving dwindling fish stocks, marine reserves have the potential to be utilized for teaching, leisure, and tourism. There is a lot of overlap between marine reserves, marine sanctuaries, marine parks, and marine protected areas.

By combining conservation, economic, and social demands in a given region, bioregional management is able to control the elements that have an impact on aquatic biodiversity. Both smaller biosphere reserves and bigger reserves fall within this category. Biosphere reserves have a primary protected habitat(s) and surrounding buffer zones, and are typically limited in size. In these bio-reservation areas, things like fishing, hunting, harvesting, and development are severely restricted. In comparison, the ranges and variety of habitats protected by nonbiosphere reserve areas (such the Florida Keys National Marine Sanctuary) are substantially greater. Stellwagen bank and Monterey Bay are two more examples of National Marine Sanctuaries.

The World Resources Institute reports that the major strategy of safeguarding freshwater biodiversity has been the identification of certain species as vulnerable or endangered. Species that are threatened are those that might become endangered if conservation efforts aren't made. In order to prevent extinction, endangered species legislation is in place to save endangered plants and animals. When a species is "listed," it is given international protection and becomes part of national recovery projects. Violators of laws protecting rare and vanishing species face lengthy prison terms in addition to heavy fines. Visit the Endangered Species Protection Program of the Environmental Protection Agency (EPA), the Endangered Species Act, or the Endangered Species Program of the United States Fish and Wildlife Service (USFWS) for further details.

Since rivers and streams often cross political boundaries, it may be difficult to enforce conservation and resource management. This is when local watershed organizations come in. In recent years, however, the situation has improved because to the efforts of local watershed organizations to safeguard lakes and smaller sections of watersheds.

Freshwater Initiatives (FWI) is a program launched by The Nature Conservancy to protect and restore freshwater ecosystems. The FWI aims to dramatically enhance freshwater conservation throughout the United States and internationally via three initiatives: watershed action, water science, and water education.

Many targeted initiatives have been set up to safeguard various forms of life. The USDA Forest Service, for instance, launched the state-federal partnership initiative Bring Back the Natives. The river ecosystem and its accompanying animals are the focus of this initiative. The U.S. Forest Service and the Bureau of Land Management are responsible for the land in question.

Aquatic areas that have been harmed or have seen habitat loss or degradation may be recovered via restoration and mitigation efforts. The salmon populations in the Pacific Northwest are only one example of a declining species that might benefit from restoration efforts. Restoration of natural flow patterns and discharge regimes, as well as the creation of riparian buffer zones, are two examples of the management strategies being implemented in riverine environments. Many wetland habitats have been lost to dredging operations in recent years, and habitat restoration has been carried out in many locations to compensate for these losses.

Wastewater discharge laws, such as NPDES, fisheries conservation measures, fisheries management councils, and fishing bans are all examples of regulatory measures. Examples include the conservation and management of U.S. marine fishery resources, which are primarily overseen by NOAA and the National Marine Fisheries Service (NMFS) under the Magnuson-Stevens Fishery Conservation and Management Act of 1976 and the related 1996 Sustainable Fisheries Amendment. Regulative measures, such as the collecting of the most accurate scientific data, play a significant role in the development of sustainable fisheries.

Millions of people's daily routines and consumption habits create the need for clean water and the dangers it faces. It will need the efforts of many people to overcome these obstacles. Many municipalities and governmental bodies on both the state and federal levels have already begun their own efforts. Volunteers from the general public are also quite active. Anyone may take action to make drinking clean water a normal part of life.

## CONCLUSION

For human progress, poverty alleviation, and biodiversity, inland water bodies' ecological services are vital. The richness and diversity of India's aquatic resources and aquatic genetic resources are threatened by the cumulative effects of many human activities. According to the CEBPOL program's policy analysis research, unused water bodies including wetlands, tanks, canals, and beels should be restored and replanted in order to provide local people with a sustainable source of income. The collection of wild stocks from inland water bodies should be limited, fish passes should be provided during projects that cross dams and rivers, the spread of aquatic invasive alien species should be managed, etc. These are just some of the regulatory measures that could be strengthened. Policymakers would benefit from a detailed inventory of the native aquatic species found in unspoiled areas, as well as an evaluation of the importance of the biodiversity found in inland water bodies. Biodiversity Management Committees should help record and conserve aquatic genetic resources for human well-being, and the Biological Diversity Act should be better enforced at the local level.

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