

Solutions Beneath the Waves: Economic Measures for Fisheries to Prevent Overfishing and Empower Coastal Communities

Aashni Subramanian

Canadian International School

DOI: 10.46609/IJSSER.2025.v10i07.022 URL: <https://doi.org/10.46609/IJSSER.2025.v10i07.022>

Received: 7 July 2025 / Accepted: 20 July 2025 / Published: 28 July 2025

ABSTRACT

This paper aims to explore the possible implementation of economic incentives to prevent overfishing while supporting coastal communities in India. Numerous studies have been done regarding how to prevent overfishing in coastal areas around the world, but limited studies have been done in the context of India, elaborating on how these measures can be implemented in a manner that balances marine conservation and the livelihoods of coastal communities. Through a comparative literature review, this paper reviews the incentives, including strengths and limitations of each economic tool in different global contexts—and evaluates how they can be adapted to be implemented in India’s fisheries sector. Regarding feasibility, key challenges include informal fishing, low enforcement capacity and resource distribution that is inequitable to the community. The findings reveal that India requires localized adaptations: community-based quota systems, co-managed MPAs, region-specific livelihood alternatives and carefully monitored buyback schemes. If environmental sustainability doesn’t hinder the livelihoods of fishermen and the fishing community, India will be able to chart a path towards blue growth and marine conservation.

Research Question: What are the economic incentives that can prevent overfishing, and how can these measures be tailored to support coastal communities in India?

I. Introduction

Marine ecosystems support millions of people who live near the coast worldwide, providing food security and livelihoods. However, many fisheries are in severe danger: overfishing, habitat degradation, unregulated and unreported (IUU) catch, climate change, and pollution create fish species endangerment and ecosystem decline. India has over 4,500 kilometers of coastline with over 15 million fishers. Small-scale fisheries, who account for over 80% of the marine workforce, are experiencing diminishing returns. For each additional fish they catch, the ‘return’

decreases, causing increasing reliance on nearshore fishers. IUU fishing is still a problem that exists at large because regulation remains weak and not enforced strictly, and many fishers operate informally which makes management less effective.

To overcome these challenges, economic incentives have emerged in the fisheries sector to align ecological and livelihood objectives. Market-based instruments like individual transferable quotas (ITQs) introduce individual responsibility and tradability via the total allowable catch (TAC) systems. According to studies discovered during the literal review, marine protected areas (MPAs) have resulted in ecological recovery potential. Alternate livelihoods, such as blue carbon payments and ecotourism, have generated sustained income while reducing fishing pressure. Fisheries buybacks and conservation agreements offer an alternative away from harmful practices that result in fish depletion and environmental destruction. These economic incentives have succeeded in areas as diverse as New Zealand, the Caribbean, Australia, South Africa and the New England coast regions.

However, India's context is unique: formal catch records are more often than not nonexistent, subsistence and informal fishing is extremely common and enforcement capacity is limited due to resource constraints. As a result, there is a significant research gap in understanding how these economic incentives, which have succeeded in other coastal regions across the world, can be adapted and tweaked to be implemented in India's marine ecosystem. This paper addresses these gaps by asking: what economic incentives can prevent overfishing, and how can these measures be tailored to support coastal communities in India? Using comparative case analysis and context analysis, this research explores four incentive categories—ITQs, MPAs, alternative livelihoods and buyback programs—to evaluate their feasibility and equity implications in India. The structure is as follows: explanations and global implementation of each economic measure, assessment of strengths and weaknesses, analyses of India-specific adaptations and challenges and recommendations for integration.

By evaluating how well-tested economic measures can be implemented for India's small-scale fisheries sector, this study aims to inform policy frameworks, stakeholder strand further research for sustainable marine ecosystem management. Sustainable fishing is not only vital for ecological conservation but also for long-term food security and economic stability in India's coastal regions where communities rely heavily on marine resources for income and nutrition. This research paves a roadmap for India's aspirations for blue growth as well as marine biodiversity co-existing along with social equity.

II. Literature Review

Li (2017) examined the effectiveness of MPAs in the Mnazi Bay Ruvuma Estuary Marine Park in southern Tanzania. Although the MPA introduced gear exchange and alternative income projects, the study revealed that enforcement remained weak due to low state capacity. Moreover, disparities in village-level project benefits generated tensions among stakeholders, undermining the MPA's long-term effectiveness and social acceptance.

Kumar and Singh (2018) focused on the role of marine protected areas (MPAs) in the Caribbean as a policy mechanism to curb overfishing. Their research highlighted that MPAs, which restricted fishing activity in designated zones, led to increased species diversity and healthier fish populations within and surrounding the protected areas. Notably, the ecological benefits were paralleled by economic gains, as local fishermen experienced improved catches outside the reserves, suggesting MPAs can both conserve biodiversity and enhance livelihoods.

Fernandes (2019) evaluated the use of Payments for Environmental Services (PES) in the Caribbean to support marine conservation efforts. These included conservation agreements, buyouts of fishing licenses, sustainable resource management plans, and educational programming. The findings demonstrated that involving fishers in decision-making and offering alternative income sources improved participation and compliance, ultimately leading to healthier fish populations.

Zhou (2019) investigated ecosystem-based fisheries management (EBFM) strategies implemented along the New England coast of the United States. The study emphasized the use of seasonal closures, MPAs, and reduced catch limits, including targeted buyback programs for vessels. Although the initial implementation incurred high short-term costs, over the course of a decade, fish stocks—particularly cod—rebounded. The study concluded that the long-term ecological and economic benefits justified the investment.

Martinez, Gupta, and Rojas (2020) analyzed three distinct economic incentive mechanisms: MPAs, fisheries management programs, and tourism-based alternatives. Their comparative case study demonstrated that assigning exclusive fishing zones to local fishers fostered sustainable practices and community ownership. In addition, eco-tourism initiatives provided viable alternative incomes, further reducing fishing pressure. These integrated approaches contributed to both biodiversity recovery and socio-economic stability.

Naidoo and Patel (2020) explored ITQ implementation in the Benguela Current Large Marine Ecosystem, covering parts of South Africa. In this context, local fishers and companies were allowed to trade quotas, which incentivized compliance with sustainable catch limits. The

authors reported significant population recovery for endangered species such as hake, attributing success to the combination of market-based incentives and stringent regulations.

Smith and Rao (2021) examined the implementation of individual transferable quotas (ITQs) in New Zealand's fisheries, where quotas were allocated based on catch data. These quotas granted fishers the right to harvest a specified portion of the total allowable catch (TAC), which could be bought, sold, or leased. Their study concluded that ITQs provided strong incentives for sustainable fishing behavior, contributing to a substantial reduction in overfishing and long-term fish stock recovery.

Chawla and Kaur (2021) conducted a policy analysis of fisheries management in the Gulf of Thailand. Their study assessed the impacts of ITQs, limited-access fishing licenses, vessel buybacks, and area-based rights. Through extensive government regulation and community engagement, the region experienced fish stock recovery and long-term profit increases. The researchers emphasized that integrated, well-monitored interventions were critical for sustainable outcomes.

Mwangi (2021) provided a critical review of biodiversity conservation mechanisms globally, contrasting market-based tools with non-market-based alternatives. The analysis revealed a predominance of supply-side instruments, such as quotas and habitat protections, over demand-side mechanisms like consumer-driven eco-labeling. The study concluded that accurate valuation of natural resources was essential to designing effective conservation incentives, and that the mix of economic instruments must be tailored to local ecological and institutional conditions.

George and Ahmed (2022) assessed economic incentives in small island developing states, highlighting the effectiveness of buyouts, conservation agreements, and alternate livelihood strategies. By purchasing fishing permits and vessels, governments reduced fishing pressure, while conservation agreements clarified mutual responsibilities between the state and communities. The study found that collaborative frameworks enhanced fisher cooperation and facilitated the adoption of sustainable practices.

III. Methodology

This research uses a comparative case study approach to analyze economic incentives that have been used across the world to prevent overfishing in an effort to promote marine conservation. The objective is to evaluate how these tools, Individual Transferable Quotas (ITQs), Marine Protected Areas (MPAs), alternative livelihoods, and buyback programs, can be adapted to the Indian context, focusing on their sustainability and feasibility to implement. The study relies on data drawn from peer-reviewed journal articles, reports, and policy case studies.

Case studies were selected based on three main considerations: their focus on at least one of the four incentive mechanisms, their relevance to developing regions with enforcement challenges, and the availability of measurable outcomes on ecological and community well-being. Ten case studies were included, featuring examples from New Zealand, the Caribbean, South Africa, Southeast Asia, Mexico, and the United States.

To analyze the data, a comparative framework was applied that considered environmental effectiveness (like biodiversity recovery or fish stock growth), socioeconomic outcomes (including impacts on fishing communities and employment), and implementation feasibility (such as enforcement needs, cost, and local adaptability). The study also looked at whether community participation, policy design, and monitoring methods influenced the success or failure of each case in action.

Learnings from studies helped account for India's unique challenges—informal fishing practices, monitoring limitations and coastal economic dependence. By looking at these cases and their key takeaways in the context of India's diverse marine ecosystem, this methodology offers recommendations for tailoring economic measures to promote marine conservation.

IV. Discussion

1. Individual Transferable Quotas (ITQs)

Individual transferable quotas (ITCs) are an economic incentive that allocate a portion of the total allowable catch (TAC), issued by the government, to individual fisheries. The TAC is usually set on an annual basis based on the stocks of different species of fish available. It is meant to cap the total catch to maintain sustainable levels of fishing and prevent overfishing. It is split up into ITCs to be delegated amongst the fishing community. The owners of the quotas have the freedom to buy, sell or lease quotas, which creates a market for fishing rights.

Global implementation of ITQs has shown varied success. In New Zealand, the quota management systems (QMS) led to increased profitability and stock health of key fish species like snapper and hoki. Similarly, Iceland's ITW systems contributed to the significant recovery of previously overexploited fish populations. In the United States, ITQs—which are called catch shares—are used especially in Alaska to regulate the fishing of halibut and sablefish to enhance sustainability.

The distribution of ITQs amongst the fishing community is meant to prevent the risk associated with just having a TAC on its own. In those cases, fishermen will compete to harvest as much fish as possible before the TAC is reached. The free-for-all nature of the system undermines the equity of fishing rights. This is why ITQs need to be used in order to allocate the TAC. However,

an issue associated with the allocation of ITQs is that it can be inequitable if the quotas are consolidated amongst large fishing companies and not local fishermen.

The barriers to entry are high for new or small-scale operators. The cost of quotas can be too expensive for them especially when large corporations drive up their market price which limits the supply for others. The initial allocation of ITQs is also largely based on historical catch records and this puts small-scale fishers at a disadvantage. Individuals who are new to the fishing community have to rely on the expensive secondary market to buy ITQs for the first time because they don't have a historical catch record.

If such a system were to be implemented in India's coastal region, inequity of the distribution of ITQs would be the most prevalent issue. Many fishermen in coastal communities rely on fishing as their primary source of income. ITQs would only exacerbate the inequity they face compared to large fishing companies especially with the barriers to entry of the ITQs market being so high. It's a possibility that fishermen might not be able to purchase the quotas. In addition to that, many people fish for subsistence rather than commercial purposes and so their catch goes unrecorded. This makes it hard for the TAC to be accurate enough to prevent overfishing since the historic catch records aren't accurate enough. Fisheries in India operate in numerous water bodies such as the Bay of Bengal and the Arabian Sea. The different environments in which fishermen fish in makes it even harder for the TAC to be accurate because it has to factor in environmental conditions and different species present in each area.

The lack of formalization and infrastructure within the country could also pose a potential issue. Some fishermen that live from rural areas aren't registered and therefore can't be allocated ITQs. There are also high levels of Illegal, Unreported, and Unregulated fishing (IUU fishing) which defeats the purpose of ITQs. It would continue to deplete fish stocks regardless of the quotas set.

To prevent marginalization of small-scale fishing communities, a portion of quotes can be reserved for small-scale fishers. The government can also work towards preventing the consolidation of quotas by a singular firm by setting a cap on the maximum number of quotas an entity can hold. Gradual implementation would work the best in this case, where the government can choose to implement ITQS in areas that are severely overexploited and well-monitored. A modified approach of using community-allocated quotas, with which fishing rights are granted to groups rather than individuals, could be equitable towards Indian coastal communities while also introducing a cap on the amount of fish that can be harvested. From there, changes can be made when applying the measure on a broader scale across the coast regions of India.

2. Marine Protected Areas (MPAs)

Marine Protected Areas (MPAs) are designated zones in seas or coastal waters where human activity (such as fishing) is restricted to conserve biodiversity and restore fish stocks. Depending on their classification, MPAs may prohibit all fishing (no-take zones) or allow minimal regulated activities.

Across the globe, MPAs have been successful in both conservation efforts and fisheries recovery: over 8% of the world's ocean is under some form of protection as of 2024. In the United States, the California Marine Life Protection Act Network showed measurable increases in fish size and diversity within the protected areas. Along the same lines, Australia's Great Barrier Reef Marine Park combines biodiversity preservation with controlled and monitored fishing zones to ensure ecological health but also make way for economic activity.

A major barrier that is faced when implementing and enforcing MPAs is local opposition especially when the restrictions disrupt livelihoods of local fishermen communities. Fishermen aren't keen to support measures that limit the areas they can fish in because it reduces their catch and the amount of fish which they can sell for profit. Traditional fishermen often perceive MPAs as exclusionary, especially when they are imposed without sufficient consultation and compensation. It leads to non-compliance and conflict between marine conservation agencies, the government and fishing communities which undermines the conservation goals and reduces social welfare.

These enforcement challenges are especially prominent in countries with limited patrol capacity (due to resource constraints) or high levels of informal fishing. These pressing issues can leave to MPAs that are protected in many but not in enforcement which becomes a widespread occurrence.

In addition, a primary goal of MPAs is to restore fish stocks and these ecological benefits take several years to manifest, requiring a long-term commitment from government and communities as it is a long run policy measure. An MPA can only be successful if there is adequate funding for enforcement agencies and government and coastal communities involved are committed to complying with the regulations.

To improve MPA outcomes in India, there needs to be a shift towards participation by fishing communities. They need to be engaged in decision-making and clear communication needs to be able to help them understand the economic and ecological rationale behind enforcing MPAs to ensure compliance. This can be done through awareness campaigns and even collaborative patrols, where fishermen monitor MPAs to ensure no illegal activities transpire. This way they are able to substitute their fishing livelihood for another livelihood that vouches for the protection of marine ecosystems that are endangered. On the other hand, this also paves the way

for corruption with the possibility that fishermen participating in collaborative patrols are willing to overlook illegal fishing in exchange for a bribe.

That aside, collaborative patrols can't be the solution for the entirety of the fishing community. MPAs can be coupled with Payment for Ecosystem (PES) schemes or eco-compensation programs. Fishers could receive financial or in-kind incentives (gear subsidies and skill training) for their compliance or for engaging in conservation monitoring efforts. In an effort to not cut out fishing practices completely, MPAs can be designed to have certain zones that allow sustainable activities (minimal, regulated amounts of fishing) while restricting fishing completely in core zones that are the most endangered.

3. Alternative Livelihoods

Alternative livelihoods for coastal and fishing communities is an essential strategy for reducing fishing pressure while promoting economic resilience. Overdependence on fishing, especially in overexploited coast regions, leaves communities vulnerable to resource depletion (when fish stock drastically falls) which results in income shocks. By providing sustainable and viable alternative sources of income that don't involve fishing activity, alternative livelihood programs can help India's blue economy achieve its social and ecological goals.

Globally, these are many examples that serve as prime successful livelihood diversification efforts. In Belize, former fishermen were able to transition to tourism roles such as snorkeling guides and eco-lodge employees. In the Philippines, seaweed farming and aquaculture have been promoted as income alternatives.

In an Indian context, coral communities often face barriers to diversifying their income sources because the fishermen community is made up of primarily unskilled labor. They possess limited formal education and have restricted access to credit and training. Some government programs have introduced alternative employment such as ornamental fish breeding, seaweed cultivation or eco-tourism in Tamil Nadu among women self-groups with short-term success in creating supplementary income. However, these programs lacked sustained financial support to make them long-lasting.

To make the alternative livelihoods more viable, India needs to map out local skills and ecological contexts to understand the specific measures and options needed for each coastal region—what works in Kerala might not work in the Andaman Islands. In addition to that, vocational training programs must be put into action and made to address market needs (like crafts, processing, hospitality, or aquaculture).

Microcredit institutions and organizations can play a vital role in enabling entrepreneurship and financial resilience amongst the fishermen communities. Digital platforms and social media can be used to connect eco-tourism initiatives started by former fishermen with tourists to boost their visibility.

4. Buyback Programs and Conservation Agreements

Fishing vessel and equipment buyback programs and conservation agreements are economic measures that are designed to reduce fishing effort and incentivize sustainable practices. Buyback programs are when governments compensate fishers or boat owners to retire their equipment, thereby reducing pressure on fish stocks and aiding in conservation efforts. Especially when bottom trawling has been widely criticized for its destructive impact on benthic habitats and juvenile fish populations. Conservation agreements, on the other hand, are contractual arrangements where fishers receive payments or benefits in return for committing to specific conservation outcomes, such as changing gear, reducing fishing practices or habitat protection.

Internationally, buyback programs have had mixed results. In the United States, the Pacific Groundfish buyback program led to a notable reduction in fishing capacity. In China, the decommissioning of large-scale vessels have been used although questions remain about their enforcement in the long-run. For Mexico, conservation agreements between NGOs and fishing cooperatives have been able to successfully incentivize sustainable practices through conditional payments.

The limitation of buyback programs is that it can undercompensate and take advantage of fishermen while also leaving workers with lack of alternative employment plans. This is why this measure needs to be used in conjunction with the alternative livelihoods measure. Buybacks should be coupled with retraining support such as skills development, aquaculture training, or microenterprise assistance. Moreover, without robust enforcement, decommissioned vessels may simply be sold into the informal sector or repurposed elsewhere.

To make buyback programs more effective in India, several measures are necessary. Valuation of the vessel needs to be fair and also account for the associated livelihood loss, not just for the vessel. Monitoring mechanisms must be in place to ensure that decommissioned vessels do not re-enter illegal or informal operations.

Conservation agreements are important in coast regions where quota systems are hard to enforce. NGOs can play a role in designing conditional incentives tied to behavior rather than output—for instance, rewarding compliance with seasonal closures. When fishers are consulted and adequately compensated, it's more likely that they will be willing partners in conservation.

Figure 1. Summary Table of Economic Incentives for Marine Conservation

Incentive Type	Strengths	Limitations	Assessment of Applicability
Individual Transferable Quotas (ITQs)	Establishes accountability amongst the fishing community, improves resource allocation efficiency and has led to recovery of overfished stocks in countries like New Zealand and Iceland	Risk of quota consolidation by industrial operators, excludes informal and small-scale fishers and high implementation cost	Moderate - Feasible with modification such as community-based quotas, ownership caps and gradual rollouts in areas with stronger monitoring infrastructure
Marine Protected Areas (MPAs)	Proven to increase fish biomass, promotes long-term sustainability and catalyze ecosystem restoration	Delayed socioeconomic benefits, lack of stakeholder inclusion which can create resistance in terms of compliance and weak enforcement capacity	Moderate to High - Effective if designed with tiered zoning, government support and financial support for fishing communities affected
Alternative Livelihoods	Reduced pressure on marine resources, supports income diversification and successful in areas with high ecosystem potential	Low education levels, skill gaps and inconsistent program funding	Low - Lots of time, effort and money required to bridge skill gaps and acquire a sufficient level of funding
Buyback Programs and Conservation Agreements	Reduces unsustainable gear use and provides financial incentives for conservation compliance	Expensive program, may displace fishers with limited skill sets and decommissioned vessels may be sold on the black market and	Moderate - Effective if skill gaps are bridged with retraining schemes, vessel tracking systems are employed and transparent valuation of vessels is strictly abided by to ensure compliance.

V. Conclusion

Marine ecosystems are under increasing stress from overfishing, climate change and unsustainable practices which is why economic measures to ensure marine conservation is achieved to a certain degree is essential. For these responses to work, they need to be informed with local input, conducted with sustained financial and institutional support and assessed with transparency. This paper explored four key economic incentives to balance coastal communities' livelihoods and ecological preservation: Individual Transferable Quotas (ITQs), Marine Protected Areas (MPAs), Alternative Livelihoods, and Buyback & Conservation Agreements. Global cases illustrate the effectiveness of these measures, while India's unique ecological context requires adaptation to be implemented effectively. While each approach has demonstrated success internationally, India's context demands careful adaptation. The comparative analysis (see Table 1) highlights that no single incentive offers a universal solution; rather, an integrated, region-specific approach is required. It is key for policy makers to implement these incentives in a phased and locally tailored manner. ITQs should be introduced through community-based quota systems with measures to combat consolidation. MPAs must engage fishers as active stakeholders. Alternative livelihoods should be implemented with vocational training and financial support based on regional market opportunities. Buyback programs must be paired with transparent valuation, enforcement mechanisms, and transition support to alternative livelihoods. These measures, if implemented in the correct manner, can help India's blue economy grow and expand.

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