International Journal of Forest, Animal and Fisheries Research (IJFAF)
ISSN: 2456-8791
[Vol-9, Issue-3, Jul-Sep, 2025]
Issue DOI: https://dx.doi.org/10.22161/ijfaf.9.3
Article DOI: https://dx.doi.org/10.22161/ijfaf.9.3.2

Ecological and Socioeconomic Consequences of Overfishing for Fish Stocks and Human Livelihoods

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Received: 15 Aug 2025; Received in revised form: 11 Sep 2025; Accepted: 19 Sep 2025; Available online: 29 Sep 2025

***Abstract*— *Overfishing has emerged as one of the most pressing anthropogenic threats to marine ecosystems and global food security. Despite decades of scientific warnings, international agreements, and management reforms, the trajectory of global fish stocks continues to deteriorate in many regions. This review synthesises the multifaceted consequences of overfishing, examining both the ecological unravelling of marine food webs and the profound socioeconomic disruptions visited upon coastal communities. We critically analyse the mechanisms driving stock collapse, including the perverse incentives of capacity-enhancing subsidies, the systematic underestimation of fishing mortality in stock assessments, and the accelerating synergistic pressures of climate change. Drawing on recent FAO data, regional case studies, and emerging stock assessment methodologies, this review argues that the current crisis is not merely a failure of fisheries science but a fundamental governance failure rooted in short-term economic priorities and institutional inertia. We examine promising pathways forward, including ecosystem-based fisheries management, rights-based approaches, marine protected areas, and community-led governance, while acknowledging the persistent implementation gaps that have stymied progress. The conclusion situates overfishing within the broader blue economy discourse and calls for a paradigm shift from extraction-oriented management to a truly precautionary, justice-centred approach that prioritises long-term ecological resilience and human well-being.*

***Keywords*— Overfishing, fish stock collapse, illegal, unreported and unregulated fishing, fisheries management, coastal livelihoods, food security, marine conservation, blue economy.**

I. INTRODUCTION

The oceans, covering more than seventy percent of our planet, have long been imagined as boundless repositories of abundance, their fish stocks inexhaustible and their capacity for regeneration limitless. This myth of the inexhaustible sea has proven to be one of the most costly misconceptions in human history. For decades, industrial fishing fleets equipped with advanced technologies sonar, satellite navigation, massive freezer trawlers, and spotter aircraft have systematically combed the world's oceans, extracting marine life at rates far exceeding natural reproduction [1]. The consequences of this relentless extraction are now starkly evident: global fish stocks are in precipitous decline, marine ecosystems are being fundamentally restructured, and the coastal communities that have depended on fishing for millennia are facing an unprecedented crisis of livelihood loss, food insecurity, and cultural disintegration.

The scale of the problem is staggering. According to the United Nations Food and Agriculture Organisation's State of World Fisheries and Aquaculture 2024 (SOFIA), global aquatic food production reached 185.4 million tonnes in 2022, but the proportion of sustainably fished marine stocks dropped to 62.3 per cent, a decline of 2.3 per cent from 2019 [2]. The remaining 38 percent of stocks are defined as overfished, up from 35 percent in 2019, representing a troubling upward trend that has continued for nearly two decades. More alarmingly, a 2024 study published in Science found that previous assessments may have substantially underestimated the true extent of stock collapse. Analysing data from 230 fish stocks encompassing 128 species, Froese and Pauly demonstrated that within the overfished category, 85 per cent more stocks have likely collapsed defined as falling below 10 per cent of original biomass than previously estimated [3]. This suggests that the global fisheries crisis is far more severe than official statistics indicate.

The economic dimensions of this crisis are equally concerning. Illegal, unreported, and unregulated (IUU) fishing alone is responsible for the loss of an estimated 11 to 26 million tonnes of fish annually, valued at $10 to $23 billion USD [4]. These illicit activities not only undermine legitimate fisheries management but also exacerbate poverty, fuel human rights abuses, including forced labour and modern slavery, and destabilise regional security. In West Africa, losses to IUU fishing were estimated at $2.3 billion annually as of 2016, money that could otherwise support local economies and food systems [5]. Meanwhile, approximately 600 million people globally rely on aquatic food systems for their livelihoods, and 3.3 billion people depend on aquatic foods for at least 20 per cent of their animal protein intake [6].

The scientific literature on overfishing has evolved substantially over the past half-century. Early warnings emerged from fisheries biology, with foundational work by Schaefer (1954) and Beverton and Holt (1957) establishing the theoretical framework for maximum sustainable yield (MSY). However, the dramatic collapse of the Northern Atlantic cod fishery off Newfoundland in 1992 served as a global wake-up call. The cod collapse, which resulted in the closure of a centuries-old fishery and the displacement of over 30,000 fishers and plant workers, demonstrated that even apparently robust fish stocks could be driven to commercial extinction within a remarkably short timeframe [7]. Subsequent research by Myers and Worm (2003) showed that global industrial fisheries had reduced large predatory fish populations by 90 percent from pre-industrial levels, a finding that fundamentally reshaped scientific and public understanding of ocean health.

More recent scholarship has broadened the analytical lens to encompass ecosystem-based approaches. The concept of "fishing down the food web," articulated by Pauly and colleagues (1998), revealed that as large, high-trophic-level species become depleted, fisheries increasingly target smaller, lower-trophic-level species, progressively simplifying marine food webs. This process, often masked by stable total catch volumes, represents a profound degradation of ecosystem structure and function. Subsequent work has documented cascading effects: the removal of apex predators such as sharks and groupers leads to proliferations of mesopredators and herbivores, which in turn can decimate kelp forests, seagrass beds, and coral reefs, fundamentally altering habitat structure and reducing biodiversity [8].

The interactions between overfishing and climate change have emerged as a particularly urgent area of investigation. Warming ocean temperatures are shifting species distributions poleward, disrupting historical fishing patterns and complicating transboundary management. Ocean acidification, driven by increased atmospheric CO_2, impairs calcification in shellfish and disrupts food webs. A growing body of research demonstrates that these stressors interact synergistically: overfishing reduces the resilience of marine populations to climate impacts, while climate change exacerbates the effects of overfishing by reducing recruitment success and altering habitat suitability [9]. Modeling studies of the Eastern Ionian Sea projected that under high-emission scenarios, stressor interactions shift from antagonistic to synergistic by the latter half of the century, resulting in nonlinear declines in biomass across most functional groups [10].

II. ECOLOGICAL CONSEQUENCES: FROM STOCK COLLAPSE TO ECOSYSTEM REORGANIZATION

2.1 The Dynamics of Stock Collapse

The collapse of a fish stock is not typically a sudden event but rather the endpoint of a predictable sequence: initial overexploitation, declining catch-per-unit-effort, increased fishing effort to maintain catches, further depletion, and ultimately, a crash below viable reproductive thresholds. This sequence has been documented across numerous fisheries worldwide, from Peruvian anchoveta to Atlantic bluefin tuna. The underlying mechanism is straightforward but often ignored in management: when fishing mortality exceeds the maximum sustainable yield for an extended period, the stock's reproductive capacity is progressively eroded, leading to recruitment overfishing [11].

Recent advances in stock assessment have revealed that traditional models may systematically underestimate the severity of this process. The 2024 study by Froese and Pauly that analyzed 230 fish stocks found that previous assessments overestimated fish abundance and their ability to rebound after depletion, resulting in what the authors termed "phantom recoveries" stocks appearing healthy when they were actually continuing to decline [3]. This methodological bias has profound implications. When managers believe stocks are healthier than they truly are, they set higher quotas, perpetuating overfishing and delaying necessary corrective action. The research further suggested that nearly a third of stocks classified by FAO as "maximally sustainably fished" are actually overfished, indicating that official statistics may substantially understate the crisis.

Kell and colleagues (2024) systematically examined the limitations of traditional stock assessment paradigms, demonstrating the critical importance of model validation and uncertainty quantification [12]. Their analysis of integrated stock assessment models showed that prediction skill the ability to accurately forecast stock status varies considerably across model types and data availability scenarios. They advocated for a management strategy evaluation approach that explicitly incorporates uncertainty and tests management procedures under a range of plausible future conditions. This is particularly crucial for data-limited fisheries, which constitute the majority of global fisheries and are often managed using simplified approaches that may not capture complex population dynamics.

Table 1 presents a comparative analysis of major stock collapses over the past half-century, illustrating the diversity of contexts and outcomes.

Table 1. Comparative Analysis of Major Fish Stock Collapses, 1960–2024

Fishery/Location	Peak Catch (Year)	Status (2024)	Primary Drivers	Socioeconomic Impact	Recovery Status
Northern Cod (Canada)	810,000 t (1968)	Collapsed	Overfishing, assessment error	~30,000 jobs lost	Minimal recovery
Peruvian Anchoveta	12.3M t (1970)	Recovering	Overfishing + El Niño	GDP decline 8%	Partial recovery
Atlantic Bluefin Tuna (Eastern)	50,000 t (1996)	Recovering	Overfishing, IUU fishing	Severe	Improving
Baltic Sea Cod (Eastern)	400,000 t (1980s)	Collapsed	Overfishing + eutrophication	Widespread livelihood loss	Little recovery
Argentine Hake	1M t (1990s)	Overfished	Overfishing, weak enforcement	Food security threat	Stabilized but low
West African Sardinella	~300,000 t (2000s)	Declining	Overfishing + IUU + climate	Up to 70% catch reduction	Critical

Sources: FAO SOFIA 2024 [2]; Froese & Pauly 2024 [3]; Kell et al. 2024 [12]; Low Impact Fishers of Europe 2024 [13].

2.2 Trophic Cascades and Ecosystem Reorganization

Beyond the fate of individual target species, overfishing triggers cascading effects that propagate through marine food webs, often with unpredictable and irreversible consequences. The removal of large predatory fish sharks, tunas, groupers, cod releases mesopredators (smaller predators such as snappers and jacks) from top-down control, allowing their populations to expand. These mesopredators in turn exert increased predation pressure on herbivorous fish and invertebrates, which can lead to the collapse of grazing control over macroalgae, triggering phase shifts from productive coral- or kelp-dominated systems to less productive algal-dominated states [8].

A recent study of the Aegean Sea documented a steady decline in the mean weighted trophic level of catches from 1982 to 2020, indicating the progressive overexploitation of large, high-trophic-level predatory organisms [14]. This "fishing down the food web" pattern resulted in increases in intermediate trophic levels followed by subsequent declines in low-trophic-level species, suggesting a cascading destabilization of food web structure. The authors warned that the additive and interactive effects of overexploitation and climate change may jeopardize the health of marine resources and the sustainability of fishing operations in unpredictable ways.

The Mediterranean Sea provides a particularly instructive case. Overfishing has reduced the region's large predators to a fraction of their historical abundance, leading to proliferations of gelatinous zooplankton (jellyfish), which compete with fish larvae for food and can directly consume fish eggs [15]. These jellyfish blooms have become increasingly frequent and severe, disrupting fisheries, clogging power plant intakes, and affecting tourism. Moreover, the decline of herbivorous fish in some Mediterranean ecosystems has been linked to the proliferation of macroalgae that overgrow and smother seagrass meadows, reducing nursery habitat for juvenile fish and accelerating coastal degradation.

2.3 Habitat Destruction and Bycatch

Overfishing is not solely a matter of removing target species; it is also associated with destructive fishing practices that damage the physical structure of marine habitats. Bottom trawling, in which heavy nets and metal doors are dragged across the seafloor, has been compared to clear-cutting forests. A single pass of a bottom trawl can remove up to 20 percent of the seabed fauna and flora, while repeated trawling can reduce complex biogenic habitats such as cold-water coral reefs, sponge beds, and seagrass meadows to barren, featureless sediment plains [16]. These habitats provide essential refuge, feeding, and nursery grounds for countless marine species, and their destruction compounds the effects of overfishing by reducing the capacity of ecosystems to support fish production.

Bycatch the incidental capture of non-target species represents another critical dimension of overfishing's ecological footprint. Global bycatch is estimated at approximately 40 percent of total marine catch, amounting to tens of millions of tonnes annually [17]. This includes not only juvenile fish of target species but also sea turtles, marine mammals, seabirds, and sharks, many of which are already threatened or endangered. The North Atlantic right whale, for instance, numbers fewer than 350 individuals, with entanglement in fishing gear being a leading cause of mortality. Similarly, the vaquita, a small porpoise endemic to the Gulf of California, has been driven to the brink of extinction primarily by entanglement in gillnets set for the endangered totoaba fish. These examples underscore the ways in which overfishing transcends target species to affect entire assemblages of marine life.

III. ECONOMIC AND SOCIAL DIMENSIONS: LIVELIHOODS AT RISK

3.1 Global Food Security and Nutrition

Fish and other aquatic foods provide essential nutrition for billions of people worldwide. In many low-income countries, particularly in Africa and Asia, fish accounts for more than 50 percent of animal protein intake and provides critical micronutrients iron, zinc, calcium, vitamin A, and omega-3 fatty acids that are difficult to obtain from other sources [18]. For coastal communities and small island developing states, the dependence is even more pronounced: fish can constitute 70-80 percent of animal protein consumption.

Overfishing directly undermines this nutritional foundation. As stocks decline, the availability of affordable fish decreases, prices rise, and poorer households are priced out of a nutrient source they have historically relied upon. This nutritional transition can have lifelong consequences, particularly for pregnant women and young children, for whom adequate micronutrient intake is critical for cognitive development, immune function, and overall health. A modeling study published in *Current Biology* in 2019 estimated that protecting more of the ocean through marine protected areas could reduce the risk of malnutrition for up to 3 million people worldwide, underscoring the direct link between fisheries management and public health [19].

In West Africa, where fish provides about 40 percent of animal protein in countries such as Nigeria, the combined pressures of overfishing and climate change have led to sharp declines in catch. A 2022 report by the Environmental Justice Foundation found that 57 percent of fish populations exploited in Senegal were in steady decline, with some stocks considered to have collapsed entirely [20]. The implications for food security are severe: when locally caught fish become scarce, households either reduce consumption or shift to cheaper, less nutritious alternatives, or they rely on imported fish, which is often more expensive and may come from poorly managed fisheries elsewhere.

3.2 Livelihood Loss and Community Disruption

Approximately 600 million people depend on fisheries and aquaculture for their livelihoods, including roughly 120 million people engaged directly in capture fisheries and many more in processing, distribution, and ancillary services [6]. The majority of these are small-scale fishers operating from small boats with traditional gear, often in artisanal or subsistence fisheries that receive minimal government support and are highly vulnerable to stock declines.

The economic impacts of overfishing are acutely felt in these communities. In the Philippines, where an estimated 1.9 million small-scale fishers operate, government data indicate that 88 percent of fish stocks are overfished or depleted, and total production fell from 2.6 million metric tons in 2010 to 1.9 million metric tons in 2023 [21]. This decline translates directly into reduced incomes, increased poverty, and forced migration. Fishers report spending more time at sea for lower returns, with many forced to take on debt or seek alternative employment in construction, domestic work, or other informal sectors. The erosion of fishing livelihoods also undermines social cohesion and traditional knowledge systems that have been passed down through generations.

In Southeast Asia, which produces more than half of the world's fish, a nine-month investigation spanning Thailand, the Philippines, and Indonesia documented the hidden human cost behind the global seafood supply chain [22]. The report revealed overcrowded ports, migrant workers subjected to exploitation and forced labor, and coastal communities watching their resources gradually diminish. The crisis is not only environmental but a social balance falling apart, with industrial fleets operating with minimal oversight while small-scale fishers struggle to survive.

In West Africa's Gulf of Guinea, coastal fishing communities are under severe economic stress due to significant declines in small pelagic fish catches, which constitute their principal livelihood. A white paper from the Salata Institute in 2024 estimated that roughly 15 percent of the GDP of the Economic Community of West African States depends on fishing and aquaculture, and the losses from overfishing and IUU fishing are devastating local economies [23]. In some areas, up to 75 percent reductions in catch have been reported, forcing fishers to travel farther from shore, incurring higher fuel costs and greater safety risks, or to abandon fishing entirely.

3.3 Distributional Inequities: Industrial vs. Artisanal Fisheries

The social impacts of overfishing are not evenly distributed. Large-scale industrial fleets, often equipped with advanced technologies and substantial capital reserves, are better able to adapt to changing conditions by shifting target species, moving to new fishing grounds, or investing in processing and freezing capabilities. Small-scale fishers, by contrast, typically lack these adaptive capacities. They are tied to local waters, dependent on specific species, and have limited access to credit, insurance, or alternative livelihoods.

This distributional inequity is exacerbated by governance structures that often favor industrial interests. In many countries, fisheries policies are shaped by powerful industry lobbies that argue for high quotas and minimal restrictions in the name of economic efficiency and job preservation. Meanwhile, small-scale fishers who are often more numerous but less politically organized are marginalized in decision-making processes, despite the fact that they typically use more selective, lower-impact fishing methods and provide essential nutrition to local populations.

In the Philippines, weak regulatory enforcement and low registration rates among subsistence fishers have allowed illegal commercial fishing in municipal waters, which are legally reserved for small-scale fishers. This encroachment by industrial vessels, often operating at night to avoid detection, directly competes with local fishers for dwindling resources [24]. The result is a classic "tragedy of the commons" scenario in which the absence of effective governance leads to overexploitation, with the most vulnerable actors bearing the greatest costs.

IV. GOVERNANCE AND MANAGEMENT FRAMEWORKS: A CRITICAL ASSESSMENT

4.1 The Architecture of Fisheries Governance

The international legal framework for fisheries management is complex and fragmented, comprising numerous treaties, conventions, and regional bodies. The United Nations Convention on the Law of the Sea (UNCLOS), adopted in 1982, established the basic architecture, including the concept of Exclusive Economic Zones (EEZs) extending 200 nautical miles from shore, within which coastal states have sovereign rights over marine resources [25]. On the high seas beyond national jurisdiction, management is delegated to Regional Fisheries Management Organizations (RFMOs), of which there are approximately 17 worldwide.

The 1995 UN Fish Stocks Agreement (UNFSA) strengthened this framework by establishing principles for the conservation and management of straddling and highly migratory fish stocks, including the precautionary approach and the obligation to apply ecosystem-based management. However, implementation has been uneven. Many RFMOs have been criticized for weak enforcement, politicized decision-making, and a tendency to set quotas above scientific advice. A 2010 global evaluation of RFMOs found that only a minority had fully implemented the precautionary approach or adopted effective compliance and enforcement mechanisms [26].

At the regional level, the European Union's Common Fisheries Policy (CFP) represents one of the most comprehensive fisheries management systems in the world. The CFP underwent major reforms in 2013, introducing legally binding targets to end overfishing, rebuild stocks, and implement ecosystem-based management. However, a 2024 assessment by the Scientific, Technical and Economic Committee for Fisheries (STECF) found that while progress has been made in some areas the proportion of overfished stocks in the Northeast Atlantic has declined implementation remains incomplete [27]. EU Fisheries Ministers have continued to set quotas exceeding scientific advice for several species, including Pollack and Kattegat Cod, despite legal obligations to end overfishing by 2020 [28]. In a striking example of disregard for science, ministers set a bycatch quota for Celtic Sea cod of 644 tonnes, exceeding the estimated total population of 585 tonnes a decision described by marine policy experts as "beyond absurd" [28].

Table 2 summarizes the key international and regional governance instruments and their effectiveness.

Table 2. Key International and Regional Fisheries Governance Instruments

Instrument	Year	Jurisdiction	Key Provisions	Effectiveness Assessment
UNCLOS	1982	Global	EEZs (200 nm), high seas freedoms	Foundational but weak on enforcement
UN Fish Stocks Agreement	1995	High seas/straddling stocks	Precautionary approach, ecosystem-based management	Partial implementation
FAO Code of Conduct	1995	Voluntary global	Responsible fishing practices	Widely endorsed but non-binding
Port State Measures Agreement	2009	Port states	Deny port access to IUU vessels	Ratified by 70+ states, limited impact

WTO Fisheries Subsidies Agreement	2022	WTO members	Prohibit harmful subsidies	New, implementation pending
EU Common Fisheries Policy	2013 (reform)	EU waters	MSY targets, landing obligation	Mixed; progress but persistent overfishing
SDG Target 14.4	2015	UN members	End overfishing by 2020	Not achieved, deadline extended

Sources: FAO [2]; Seas At Risk 2024 [28]; WTO [29]; United Nations [6].

4.2 Subsidies: Fueling the Overcapacity Crisis

One of the most perverse drivers of overfishing is the system of government subsidies that support fishing operations. Globally, fisheries subsidies are estimated at $35 billion annually, of which approximately $20 billion are classified as "capacity-enhancing" subsidies that directly contribute to overfishing by making it profitable to fish even when stocks are depleted [30]. These include fuel subsidies, boat construction and modernization grants, and price support mechanisms that mask the true economic costs of fishing.

The World Trade Organization (WTO) concluded a landmark Fisheries Subsidies Agreement in 2022, which for the first time prohibits subsidies that contribute to overfishing and overcapacity. The agreement also includes special provisions for developing countries and small-scale fishers. However, implementation has been slow, with the required two-thirds of WTO members yet to ratify the agreement as of 2024 [29]. Even when fully implemented, the agreement's effectiveness will depend on monitoring, transparency, and enforcement mechanisms that remain underdeveloped.

The elimination of harmful subsidies is not merely an economic or trade issue; it is a fundamental prerequisite for sustainable fisheries management. When subsidies mask the true cost of fishing, they artificially lower the price of fish, encourage overinvestment in fishing capacity, and delay the market signals that would otherwise drive consolidation and reduction in fishing effort. Phasing out capacity-enhancing subsidies would not only reduce fishing pressure but also level the playing field between industrial and artisanal fishers, who typically receive far fewer subsidies.

4.3 Marine Protected Areas and Spatial Management

Marine Protected Areas (MPAs) have emerged as a cornerstone of marine conservation, with the Convention on Biological Diversity's target of protecting 30 percent of the ocean by 2030 (the "30×30" target) galvanizing global action. However, the effectiveness of MPAs for fisheries management is contested. A 2024 analysis found that over 90 percent of MPAs allow fishing, and thus their potential benefits to fisheries are less likely to be realized [31]. The public, the analysis argued, is being misled about progress in marine conservation when "paper parks" protected on maps but lacking enforcement are counted toward area-based targets.

No-take MPAs, where all extraction is prohibited, have been shown to increase fish biomass, diversity, and individual size within their boundaries, with spillover effects benefiting adjacent fisheries. A global study of 34 countries published in 2024 found that ocean protection delivers overlooked economic benefits to fishing and tourism [32]. However, the establishment of no-take MPAs often faces opposition from fishing communities who fear loss of access to traditional grounds. A study examining both no-take and multiple-use MPAs concluded that both types can improve fish populations, but that stakeholder engagement and adaptive management are critical to achieving positive outcomes [33].

The effectiveness of MPAs is also contingent on broader fisheries management measures. Without complementary controls on fishing effort outside protected areas, MPAs may simply displace fishing pressure to unprotected areas, potentially exacerbating overexploitation elsewhere. Moreover, MPAs cannot address climate-driven shifts in species distributions; as warming oceans push fish poleward, static protected areas may become increasingly misaligned with the habitats they were designed to protect.

4.4 Community-Based Management and Rights-Based Approaches

In contrast to top-down regulatory approaches, community-based fisheries management (CBFM) has gained traction as a model that aligns conservation incentives with local livelihoods. CBFM involves delegating management authority to local communities, who then have the responsibility and the incentive to manage resources sustainably. This approach has been particularly successful in contexts where communities have strong customary tenure systems, social cohesion, and technical support from government or NGOs.

A 2024 paper on community-based management in Asia and Africa documented how locally elected management committees, supported by training and transparent governance structures, can achieve measurable ecological and social outcomes [34]. In Cambodia's Tonle Sap lake, community-led conservation efforts have revived fish stocks through the enforcement of closed fishing seasons and the establishment of community fish refuges, demonstrating that local stewardship can be effective even in heavily pressured systems [35].

Rights-based fisheries management including individual transferable quotas (ITQs) and territorial use rights in fisheries (TURFs) represents another approach to aligning incentives with sustainability. By allocating secure, exclusive harvesting rights to individuals or communities, rights-based systems are intended to eliminate the race-to-fish dynamics that drive overcapacity and encourage long-term stewardship. The Alaskan pollock fishery is often cited as a success story: with ITQs implemented in the 1990s, the fishery has maintained healthy stock levels while generating substantial economic value [36]. However, rights-based approaches are not panaceas. They can concentrate wealth, marginalize small-scale fishers who lack capital to purchase quota, and may be difficult to implement in data-poor, multi-species small-scale fisheries that characterize much of the developing world.

V. REGIONAL CASE STUDIES: FAILURES, SUCCESSES, AND LESSONS LEARNED

5.1 West Africa: The Scourge of IUU Fishing and Industrial Encroachment

West Africa presents one of the most dire examples of overfishing's human and ecological consequences. The waters of the Gulf of Guinea are among the most productive in the world, supporting rich fisheries that have sustained coastal communities for centuries. Yet today, these fisheries are in crisis. Industrial foreign fleets, often operating under opaque licensing arrangements or engaged in outright illegal fishing, have decimated fish stocks, while climate change further disrupts fish distribution and productivity.

A 2020 assessment of 26 fish and invertebrate populations in the EEZs of eight West African countries found that most are likely overfished or at risk of being overfished [37]. Stocks such as cassava croaker off Liberia, bonga shad in The Gambia, European anchovy in Mauritania, and round sardinella in Senegal showed clear signs of overexploitation. In the case of cassava croaker, current biomass was only 34 percent of its level in 2009, which was already much reduced from original abundance, corroborating the species' IUCN Red List classification as endangered.

The socioeconomic impacts are devastating. In Senegal, a 2022 report found that 57 percent of fish populations were in decline, with some stocks collapsed entirely [20]. Artisanal fishers, who comprise the vast majority of Senegal's fishing sector, report drastically reduced catches, forcing many into debt or migration. The Environmental Justice Foundation documented how industrial and illegal fishing have robbed West African nations of traditional sources of nutrition and income, contributing to rising food insecurity and poverty. The situation has become so severe that the Economic Community of West African States (ECOWAS) estimated that roughly 15 percent of regional GDP depends on fishing and aquaculture, and the losses from overfishing and IUU fishing are threatening national economies [23].

Efforts to combat IUU fishing in the region have intensified in recent years. The "Operation Swordfish" initiative, involving Senegal, Mauritania, Gambia, and Cape Verde, has mobilized offshore patrol boats and coastal surveillance networks to intercept illegal fishing vessels [38]. However, the vastness of the region's waters, limited enforcement capacity, and the sophistication of illegal operators mean that IUU fishing continues at alarming levels. The FAO estimated that West Africa loses over $2.3 billion annually to IUU fishing resources that could otherwise support local food systems and development priorities [5].

5.2 Southeast Asia: Overfishing, Exploitation, and the Global Seafood Chain

Southeast Asia produces more than half of the world's fish, yet its waters are among the most heavily exploited and contested on the planet [22]. The region's fisheries are characterized by intense competition between industrial fleets, small-scale fishers, and foreign vessels, often operating with minimal regulation and oversight. A nine-month investigation spanning Thailand, the Philippines, and Indonesia documented a crisis that is at once environmental and human: overfishing has depleted stocks, while the global seafood supply chain relies on labor exploitation, including forced labor and modern slavery, particularly on long-distance fishing vessels [22].

The Philippines provides a stark illustration of the crisis. Government data indicate that 88 percent of fish stocks are overfished or depleted, and total production fell from 2.6 million metric tons in 2010 to 1.9 million metric tons in 2023 [21]. This decline represents an estimated annual loss of 45 million kilograms of fish. The causes are multiple: illegal commercial fishing in municipal waters, weak regulatory enforcement, habitat destruction, and climate change. Small-scale fishers, who use more sustainable methods such as hand-lining and cast nets, have struggled for years with encroachment by commercial vessels that operate illegally in waters reserved for municipal fishers [24].

Indonesia's Bajau sea nomads, whose unique way of life has depended on the sea for generations, have been forced to move to land as fish stocks decline. Rising temperatures, changing fish migration and mating patterns, and overfishing have disrupted the food chain, making traditional fishing livelihoods increasingly untenable [39]. The Bajau are not alone; across the region, coastal communities are experiencing a slow-motion unraveling of their cultural and economic foundations.

5.3 The Baltic Sea: Cod Collapse and the Limits of Single-Species Management

The Eastern Baltic cod stock, once one of the largest and most productive in Europe, collapsed despite historically low fishing pressure in recent years [13]. In July 2019, the European Commission introduced emergency measures effectively closing the cod fishery to save the stock from impending collapse. Five years later (as of 2024), the stock has not recovered. Scientists have documented that cod are now smaller, with lower condition factors, and that recruitment the number of juvenile fish surviving to adulthood has plummeted [40].

This collapse illustrates the limits of traditional single-species management. Overfishing was undoubtedly a contributing factor in earlier decades, but the stock's failure to recover despite reduced fishing pressure points to additional stressors. Eutrophication nutrient pollution from agriculture and wastewater has contributed to widespread oxygen depletion (hypoxia) in the Baltic Sea's deep basins, reducing available habitat for cod and other demersal species. Climate change is exacerbating these conditions, with warming waters increasing stratification and further reducing oxygen levels. The cod are also facing food web disruptions: the decline of cod has led to increases in sprat and herring, which compete with cod larvae for zooplankton prey, creating a feedback loop that hinders recovery.

The Baltic cod case underscores a critical lesson: effective fisheries management cannot operate in isolation from broader ecosystem management. Addressing overfishing is necessary but not sufficient for stock recovery when habitat degradation, pollution, and climate change continue to undermine ecosystem health. This calls for integrated, ecosystem-based approaches that account for multiple stressors and their interactions.

5.4 Success Stories: Alaska Pollock and the New Zealand Hoki Fishery

Despite the predominantly bleak picture, there are success stories that offer hope and valuable lessons. The Alaska pollock fishery, the largest certified sustainable fishery in the world by volume, is widely regarded as a model of effective fisheries management

[36]. Federal assessments consistently show that the stock is not overfished, and overfishing is not occurring. This success is attributed to several factors: a science-based quota system informed by regular stock assessments, individual transferable quotas (ITQs) that align incentives with long-term stewardship, comprehensive monitoring and enforcement, and a management framework that incorporates precautionary buffers to account for uncertainty [41].

The New Zealand hoki fishery similarly demonstrates that recovery from overfishing is possible. In the 1990s, hoki stocks were severely depleted due to overfishing and poor management. Through a combination of quota reductions, science-based rebuilding plans, and the introduction of a Quota Management System (QMS), the stock recovered to sustainable levels, and the fishery was certified as sustainable by the Marine Stewardship Council [42]. These examples demonstrate that with political will, scientific capacity, and appropriate institutional design, even severely depleted stocks can be rebuilt.

However, these success stories also highlight the enabling conditions that are often absent in developing country contexts: strong governance institutions, substantial scientific capacity, effective enforcement, and political stability. The challenge is to adapt the principles underlying these successes science-based quotas, rights-based management, monitoring and enforcement, stakeholder engagement to diverse social, economic, and political contexts.

VI. KNOWLEDGE GAPS AND FUTURE RESEARCH PRIORITIES

Despite decades of research, significant knowledge gaps remain. First, stock assessment methodologies for data-limited fisheries which constitute the majority of global fisheries, particularly in developing countries require continued refinement. Traditional methods that rely on extensive time series of catch and abundance data are not applicable where such data do not exist. Emerging methods that use life-history traits, length-frequency data, or catch-only models offer promise but require validation and capacity building for widespread application [43].

Second, the interactions between overfishing and climate change remain poorly understood, particularly with respect to tipping points, nonlinear dynamics, and synergistic effects. Most fisheries management assumes stationarity that the underlying biological relationships remain constant over time but climate change is fundamentally altering this assumption [44]. Future research must develop climate-adaptive management frameworks that account for shifting species distributions, changing productivity, and increased uncertainty.

Third, the social dimensions of overfishing remain under-researched relative to the ecological dimensions. While the impacts on livelihoods and food security are increasingly documented, the mechanisms by which communities adapt or fail to adapt to stock declines, the role of social networks and institutions in mediating resilience, and the effectiveness of alternative livelihood programs all require further investigation [45]. Research that integrates ecological, economic, and social dimensions within a coupled social-ecological systems framework is essential for developing effective and equitable management solutions.

Fourth, the effectiveness of management interventions including MPAs, rights-based systems, and community-based management requires rigorous evaluation across diverse contexts. While individual case studies provide valuable insights, comparative, multi-site studies that control for confounding variables are needed to identify which interventions work where, and under what conditions [46].

VII. CONCLUSION: TOWARD A TRANSFORMATIVE BLUE ECONOMY

The evidence reviewed in this article presents an unambiguous conclusion: overfishing is a crisis of global proportions, with profound consequences for marine ecosystems and the human communities that depend on them. Despite decades of scientific warnings, international agreements, and management reforms, the trajectory of global fish stocks continues to deteriorate in many regions. The proportion of overfished stocks has increased steadily over the past half-century; recent assessments suggest that official statistics may substantially understate the true extent of stock collapse; and the combined pressures of climate change are amplifying the effects of overfishing in ways that current management systems are ill-equipped to address.

Yet this crisis is not inevitable. The success stories documented here Alaska pollock, New Zealand hoki, community-managed fisheries in Cambodia demonstrate that recovery is possible when political will, scientific capacity, and appropriate institutional design align. The challenge is to scale these successes globally, adapting their principles to diverse contexts while addressing the structural drivers of overfishing: capacity-enhancing subsidies, weak governance, and the misalignment of economic incentives with ecological sustainability.

The concept of the "blue economy" has gained prominence as a framework for reconciling economic development with ocean sustainability. But as currently operationalized in many contexts, the blue economy risks becoming a new frontier of extraction prioritizing industrial fisheries, aquaculture, and seabed mining over the traditional livelihoods and food security of coastal communities. A truly sustainable and just blue economy must be built on a foundation of ecological integrity: rebuilt fish stocks, protected habitats, and resilient ecosystems. It must prioritize the needs of the 600 million people who depend on aquatic food systems for their livelihoods, particularly the small-scale fishers who are often the most vulnerable to stock declines and the least represented in decision-making. And it must embrace a precautionary, ecosystem-based approach to management that accounts for uncertainty, respects ecological limits, and integrates climate adaptation.

The window of opportunity for transformative action is narrowing. Overfishing has already pushed many stocks to the brink, and climate change is poised to accelerate and compound these impacts. Yet the ocean remains remarkably resilient. When pressure is reduced, fish populations can recover; when habitats are protected, biodiversity can rebound; when communities are empowered, they can steward resources sustainably. The path forward requires not incremental reform but a fundamental paradigm shift from extraction to regeneration, from short-term profit to long-term resilience, and from a tragedy of the commons to a triumph of collective stewardship. The choice, ultimately, is ours.

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