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Abstract
Sea cucumbers have become one of the more valuable yet vulnerable marine resources in Tanzania's coastal waters, driven by sustained demand from East Asian markets and the government's growing emphasis on the Blue Economy. This paper presents a literature review of the ecological significance, economic contributions, and pathways to sustainable management of sea cucumbers for Tanzania's coastal communities. Synthesising evidence from peer-reviewed articles, book chapters, and policy reports published between 2016 and 2025, the review finds that sea cucumbers play meaningful ecological roles in sediment health, nutrient cycling, and the functioning of seagrass and coral reef systems, though site-specific research in Tanzanian waters remains limited. Economically, sea cucumbers provide a critical source of cash income for artisanal fishers, with women dominating collection and processing yet capturing few of the benefits due to unequal value chains. The Blue Economy agenda appears to have raised the profile of marine resources but delivered mixed outcomes for small-scale harvesters, revealing a persistent gap between policy rhetoric and local realities. Pathways to sustainable management, including regulatory enforcement, community-based governance, and aquaculture development, each show promise under specific conditions, but none offers a standalone solution. The review concludes that sustainability challenges are as much about governance, equity, and political will as they are about technical interventions. Five policy recommendations are proposed, focusing on enforcement legitimacy, community-based management, low-technology aquaculture, gender equity, and integration with broader coastal livelihood strategies.

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INTRODUCTION

Over the past few decades, sea cucumbers have moved from relative obscurity to becoming one of the more hotly debated resources in coastal marine management. This is particularly true across the Western Indian Ocean, where rising demand from East Asian markets has transformed what was once a modest, locally consumed resource into a highly lucrative export commodity. In Tanzania, this shift has brought both opportunities and considerable tension. On the one hand, sea cucumbers offer coastal communities especially women and youth with limited access to formal employment a rare entry point into cash economies. On the other hand, the intense fishing pressure that accompanies high market value has led to visible declines in wild stocks, raising uncomfortable questions about how long this trade can remain viable (Purcell et al., 2016; Kaplan-Hallam, Bennett, & Satterfield, 2017).

Ecologically, sea cucumbers are far from passive inhabitants of the seabed. They churn and aerate sediments, recycle organic matter, and help maintain the health of seagrass beds and coral reefs habitats that themselves support a wide range of commercially and culturally important species (Purcell et al., 2016; Floren et al., 2021). When sea cucumber populations collapse, the effects are not always immediately obvious, but evidence suggests that sediment quality can deteriorate, algal blooms may become more frequent, and the broader resilience of coastal ecosystems can gradually erode (Mercier et al., 2025). One possible interpretation of this dynamic is that sea cucumbers act as something like an ecological insurance policy easily overlooked until they are gone. The challenge, of course, is that this insurance is being cashed in at an accelerating rate, often without a clear understanding of the long-term consequences.

In Tanzania, the story of sea cucumbers is further complicated by the government's enthusiastic embrace of the Blue Economy agenda. There is genuine optimism that marine resources can drive coastal development, create jobs, and reduce poverty (Uimonen, 2025a; Ndesanjo, 2025). Yet it appears that the Blue Economy framework, at least in its current form, has struggled to reconcile two sometimes conflicting goals: promoting economic growth through resource extraction, and ensuring that this growth does not undermine the ecological systems upon which it depends. Some scholars have pointed out that small-scale fishers and seaweed farmers who have managed coastal resources for generations are often sidelined in policy discussions, while larger commercial interests receive more attention (Mwanyoka et al., 2025; Ndesanjo, 2025). This suggests that governance, rather than biology alone, may be the more binding constraint on sustainability.

Given the precarious state of wild sea cucumber stocks, a number of researchers and practitioners have turned to aquaculture as a potential way forward. China's experience with large-scale sea cucumber farming is well documented, and there are now emerging efforts to adapt these techniques to tropical settings, including Zanzibar and mainland Tanzania (Han, Keesing, & Liu, 2016; Charisiadou et al., 2022). Low-technology approaches, such as community-based pen culture and integration with seaweed farms, have shown some promise in pilot projects. However, it would be premature to treat aquaculture as a simple solution. Significant hurdles remain: reliable hatchery production of juveniles is still inconsistent, technical skills are unevenly distributed, disease outbreaks are poorly understood, and market chains for farmed sea cucumbers are underdeveloped (Omont et al., 2025; Ciriminna et al., 2024). Moreover, there is a lingering concern that aquaculture, if poorly managed, could create new problems such as genetic homogenisation, habitat modification, or economic dependency rather than solving old ones.

Beyond the technical dimensions, the governance of sea cucumber fisheries in Tanzania appears fragmented and under-resourced. Seasonal closures, minimum size limits, and export permitting systems exist on paper, but enforcement is patchy, particularly in remote coastal areas (Baker-Médard & Ohl, 2019; Conand et al., 2022). Illegal harvesting of undersized specimens and the use of destructive fishing methods have been reported repeatedly, yet prosecutions are rare. One possible interpretation is that the formal rules, however well



intentioned, do not align well with the realities of coastal livelihoods where people fish not out of disregard for the law, but because they have few alternatives. Community-based management and co-management arrangements have been proposed as more context-sensitive alternatives, and there are examples from elsewhere in East Africa that suggest such approaches can work (Sabai, 2025). Nevertheless, evidence from Tanzania remains scattered, and it is unclear how readily these models can be scaled or adapted to the specific social and ecological conditions of sea cucumber fisheries.

There are also emerging opportunities that have received relatively little attention in policy discussions. For instance, sea cucumber viscera, often discarded as waste during processing, contain bioactive compounds that could be used in pharmaceuticals, cosmeceuticals, or animal feeds (Muhsin et al., 2023). Similarly, the cultural and narrative dimensions of sea cucumber harvesting, including local knowledge and storytelling, may offer insights into more resilient management practices (Uimonen, 2025b). These less obvious pathways suggest that sustainability is not merely a matter of stricter enforcement or higher technology; it may also depend on reimagining what counts as value in the first place.

Given this complex landscape, what becomes clear is that no single study or disciplinary perspective can adequately capture the full picture. The ecological, economic, and governance dimensions of sea cucumbers in Tanzania are deeply intertwined, yet they have often been examined in isolation. To date, there has been no systematic effort to synthesise the growing but fragmented literature on this topic with a specific focus on Tanzania's coastal communities. This paper therefore attempts to fill that gap by conducting a literature review that brings together evidence on ecological significance, economic contributions, and pathways to sustainable management. Rather than offering sweeping conclusions, the aim is more modest: to identify what is known, what remains uncertain, and where future research and policy efforts might most usefully be directed. In doing so, it is hoped that the review will provide a useful foundation for more integrated, context-sensitive approaches to managing sea cucumber resources approaches that take seriously both the livelihoods of coastal communities and the ecosystems that sustain them.

This review addresses the following questions: (1) What ecological functions do sea cucumbers perform in Western Indian Ocean coastal systems, and how site-specific is the evidence for Tanzania? (2) What are the structure and distributional outcomes of sea cucumber value chains for coastal communities? (3) Which management pathways show evidence of effectiveness, and under what conditions?

METHODOLOGIES

Studying a topic as multifaceted as sea cucumbers in Tanzania presents an immediate challenge: the relevant literature does not reside neatly within a single discipline. Ecological studies sit alongside fisheries economics, which in turn sits alongside ethnographic accounts of coastal livelihoods and policy analyses of Blue Economy agendas. Faced with this disciplinary sprawl, a conventional single-site empirical study would have risked capturing only part of the picture. Consequently, this study adopted a literature review methodology, specifically, a systematic yet flexible review design to synthesise existing knowledge across these diverse fields. The intention was not to generate new primary data, but rather to map, evaluate, and integrate what is already known, with the explicit goal of identifying patterns, contradictions, and gaps that might otherwise remain obscured.

A purely systematic review following the rigid protocols of, say, PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) might seem like the obvious choice. However, such an approach, while rigorous, can inadvertently exclude valuable sources that do not fit neatly into predefined categories, for example, qualitative case studies, policy briefs, or narrative-based anthropological work. Given the interdisciplinary nature of our research question, a more pragmatic strategy was adopted. Systematic literature



review with qualitative synthesis was conducted, following established guidance for reviews in social-ecological systems (Fischer et al., 2021), but the inclusion of non-traditional sources where they offered relevant insights were allowed.

Literature Search Strategy

The literature search was carried out between January and March 2026, using three major academic databases: Google Scholar, Scopus, and Web of Science. These were supplemented by manual searches of key journals that publish on marine resources in East Africa, including Marine Policy, Western Indian Ocean Journal of Marine Science, and Tanzania Journal of Development Studies. In addition, the reference lists of identified papers were examined, a so-called snowballing technique, which proved particularly useful for locating older, foundational studies that citation indexes sometimes miss.

A combination of search terms was used, reflecting the study's three thematic pillars: ecological significance, economic contributions, and sustainable management. The search strings included variations of “sea cucumber” OR “holothur” OR “bêche-de-mer” AND “Tanzania” OR “Zanzibar” OR “Western Indian Ocean” OR “East Africa”. These were then combined with terms such as “ecological role” OR “bioturbation” OR “seagrass”, and separately with “livelihood” OR “fisher” OR “Blue Economy” OR “income”, and finally with “management” OR “governance” OR “aquaculture” OR “community-based”. It is worth noting that the Boolean logic across three databases was not identical; adjustments had to be made for differences in search syntax, which is a minor but real complication in multi-database reviews.

Inclusion and Exclusion Criteria

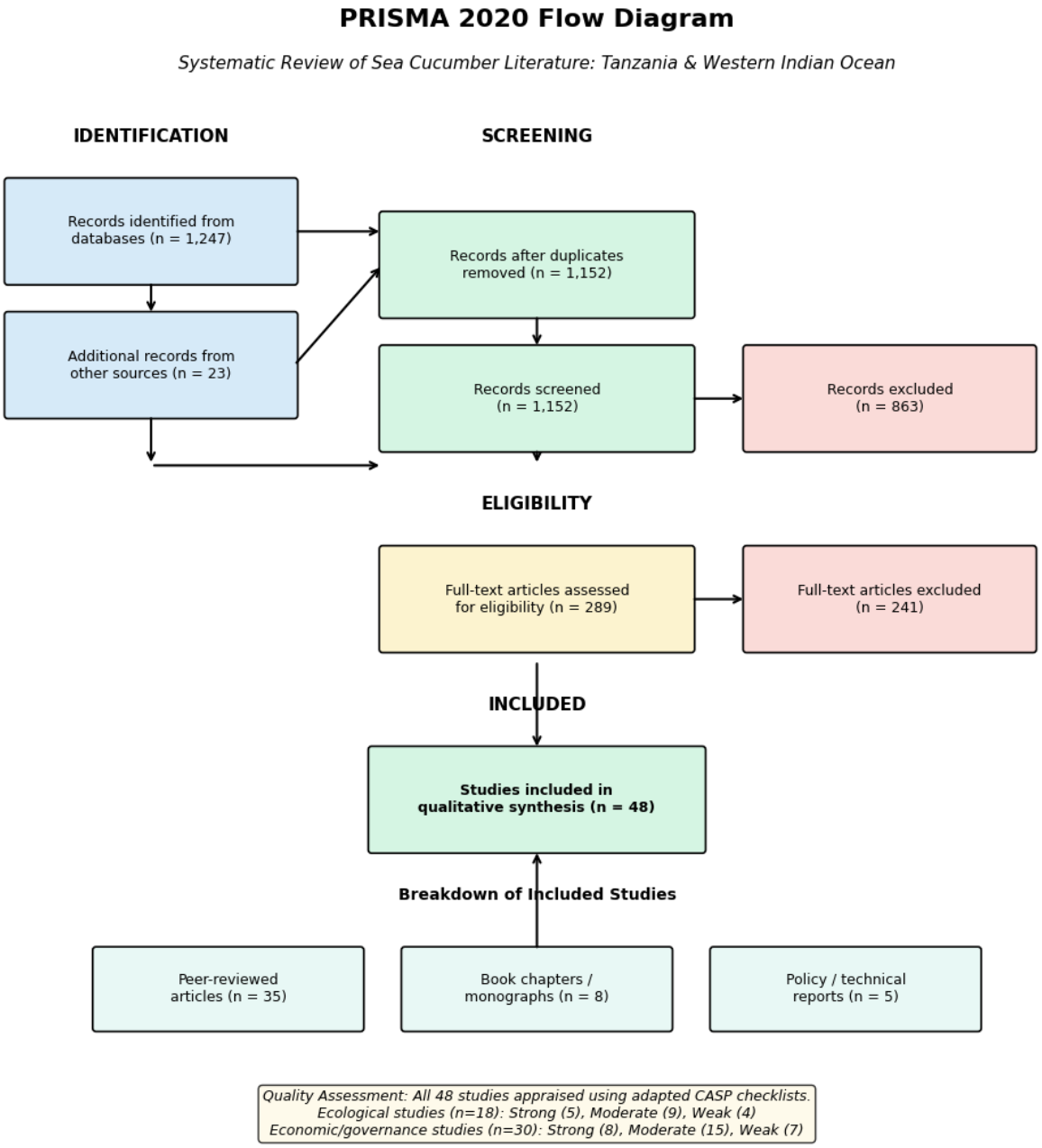
Deciding what to include and what to leave out is rarely as straightforward as methodology textbooks suggest. The following criteria were applied, but with the recognition that some valuable work inevitably tests the boundaries of any rule-based system.

Included sources had to meet three primary conditions. First, they had to address sea cucumbers in a way that was centrally relevant to Tanzania or, where evidence from Tanzania was thin, to comparable coastal systems in the Western Indian Ocean or Southeast Asia. Second, they had to present either empirical findings (qualitative, quantitative, or mixed methods) or sufficiently detailed analytical discussions that could inform synthesis. Third, they had to be written in English, which, while pragmatic for the research team, admittedly excludes relevant work published in Kiswahili or other regional languages.

Sources were excluded if they focused exclusively on sea cucumber biology or aquaculture with no reference to Tanzania or analogous contexts, or if they were purely speculative or lacked any evidentiary basis. Conference abstracts, unpublished theses, and non-peer-reviewed reports were treated cautiously: included only when they offered unique data not available elsewhere, and always with appropriate caveats about their quality.

After applying these criteria, the search yielded 48 sources that were retained for full-text review. Of these, approximately 35 were peer-reviewed journal articles, 8 were book chapters or monographs, and 5 were policy or technical reports from recognised institutions. A full list is provided in the references.

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Thematic Analysis and Synthesis

Given the qualitative and interdisciplinary character of the included literature, thematic analysis was judged the most appropriate analytic technique. This involved reading and re-reading the selected sources to identify recurring themes, but also, and this is often underemphasized, to notice points of disagreement, silence, or ambiguity. The process was iterative rather than linear. Initial themes were derived from the research question itself: ecological significance, economic contributions, and pathways to sustainable management. However, as the review progressed, new themes emerged inductively from the literature. These included, for example, the gendered dimensions of sea cucumber harvesting, the symbolic and narrative roles of sea cucumbers in coastal



communities, and the tensions between Blue Economy rhetoric and local realities. These emergent themes were incorporated into the final analysis because they appeared to offer genuine explanatory value.

To manage this complexity, a thematic matrix was constructed, essentially a large table with sources as rows and themes as columns which allowed for systematic comparison across studies. This was a labour-intensive process, but it revealed patterns that might otherwise have been missed. For instance, it became clear that studies focusing on ecological roles rarely engaged with governance questions, and conversely, policy-oriented studies often treated ecological data as fixed rather than contested. One possible interpretation of this pattern is that disciplinary boundaries are not merely academic conventions; they actively shape what kinds of questions get asked and what kinds of solutions appear plausible.

Limitations

No review methodology is without its limitations, and it would be disingenuous to pretend otherwise. Three limitations deserve acknowledgement. First, the reliance on published literature means that the findings reflect what has been researched and written about, which may not be identical to what is most important on the ground. Publication biases the tendency for journals to publish positive or novel findings rather than null results or replication studies is a known issue in marine science as elsewhere. Second, the focus on English-language sources, while practical, may have introduced a linguistic bias that excludes relevant research published in Kiswahili or French (the latter being relevant for neighbouring countries such as Comoros and Madagascar). Third, the literature on sea cucumbers in Tanzania is still relatively sparse compared to well-studied systems in Asia or the Pacific. This meant that some generalisations had to be drawn from studies conducted elsewhere, and then cautiously applied to the Tanzanian context.

Despite these limitations, the combination of a systematic search strategy, explicit inclusion criteria, and iterative thematic analysis provides a reasonably robust basis for synthesis. The approach does not claim to have captured every possible perspective, but it does claim to have captured the major contours of existing knowledge, and, just as importantly, to have identified where that knowledge remains provisional or incomplete.

A Note on Positionality

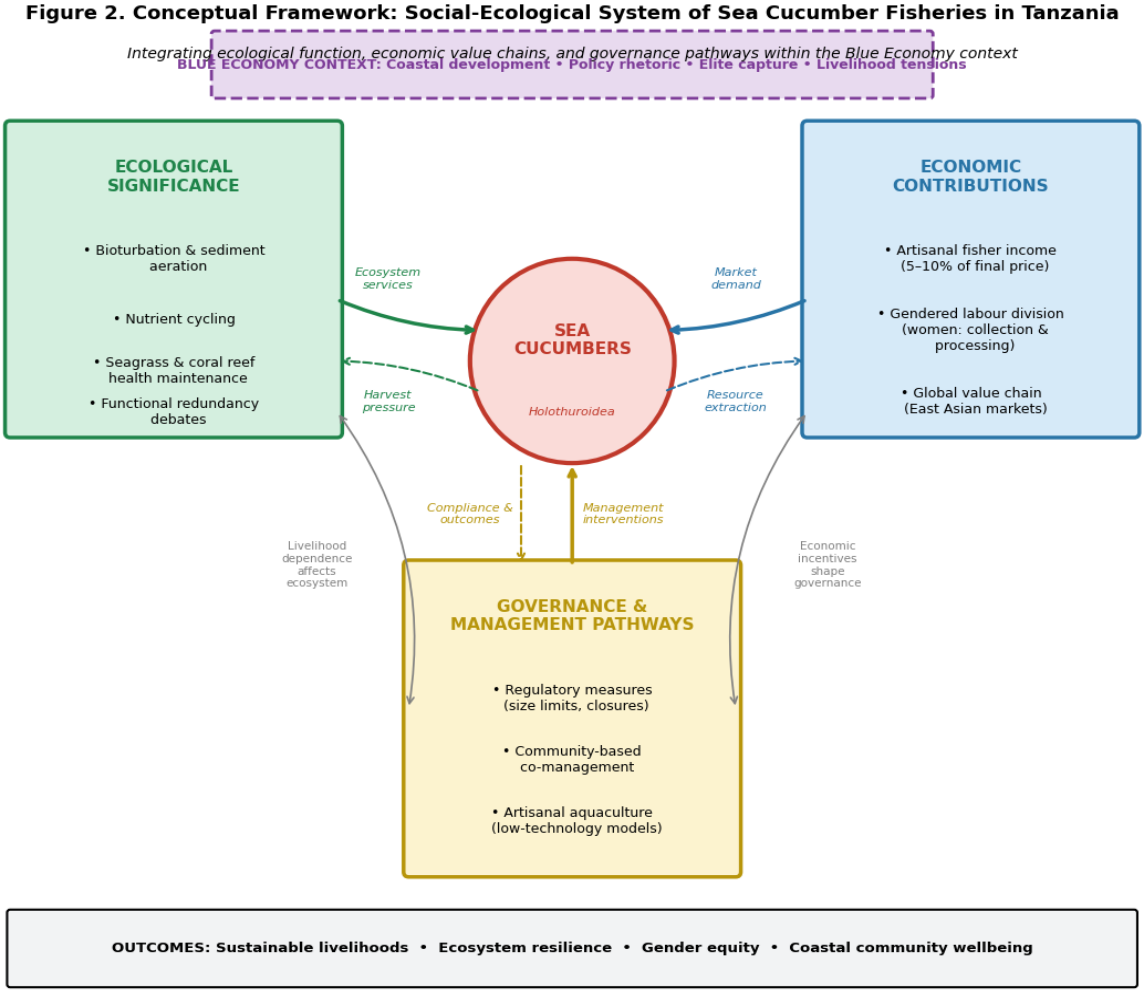
Because this is a literature review rather than primary fieldwork, traditional statements of positionality may seem less relevant. Nevertheless, it is worth noting that the research team includes individuals with backgrounds in marine ecology, development studies, and public policy. This mix of perspectives has undoubtedly shaped which themes were found salient and how ambiguous evidence were interpreted. Rather than treating this as a bias to be eliminated which is probably impossible in any case it was used as a resource, allowing different disciplinary lenses to interrogate each other. Where disagreements arose within the team about the interpretation of studies, these were resolved through discussion and, where necessary, by returning to the original sources. The final synthesis represents the consensus view, but readers should be aware that alternative interpretations are sometimes possible.

RESULTS AND DISCUSSION

Presenting results from a literature review is not the same as presenting findings from a field study. There are no summary statistics from original surveys, no interview transcripts to excerpt, no direct observations to report. Instead, the "results" consist of patterns, themes, and sometimes contradictions that emerged from the synthesis of existing sources. What follows is an attempt to organise this material into a coherent narrative, but the reader should keep in mind that this narrative represents one interpretation among several possible ones.

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Figure 2. Conceptual Framework: Social-Ecological System of Sea Cucumber Fisheries in Tanzania



Ecological Significance: More Than Just Sediment Stirrers

One of the clearer messages from the ecological literature is that sea cucumbers play functional roles that extend well beyond their modest appearance. Purcell and colleagues (2016), in what remains a foundational review, argued that holothurians contribute to bioturbation, nutrient cycling, and the maintenance of sediment permeability. These processes, while not immediately visible to the untrained observer, appear to have measurable effects on seagrass and coral reef health. Floren et al. (2021), in a more recent synthesis focused on tropical seagrass meadows, reinforced this view, noting that sea cucumbers enhance organic matter decomposition and may facilitate the growth of sea grasses by reducing sulphide accumulation in sediments.

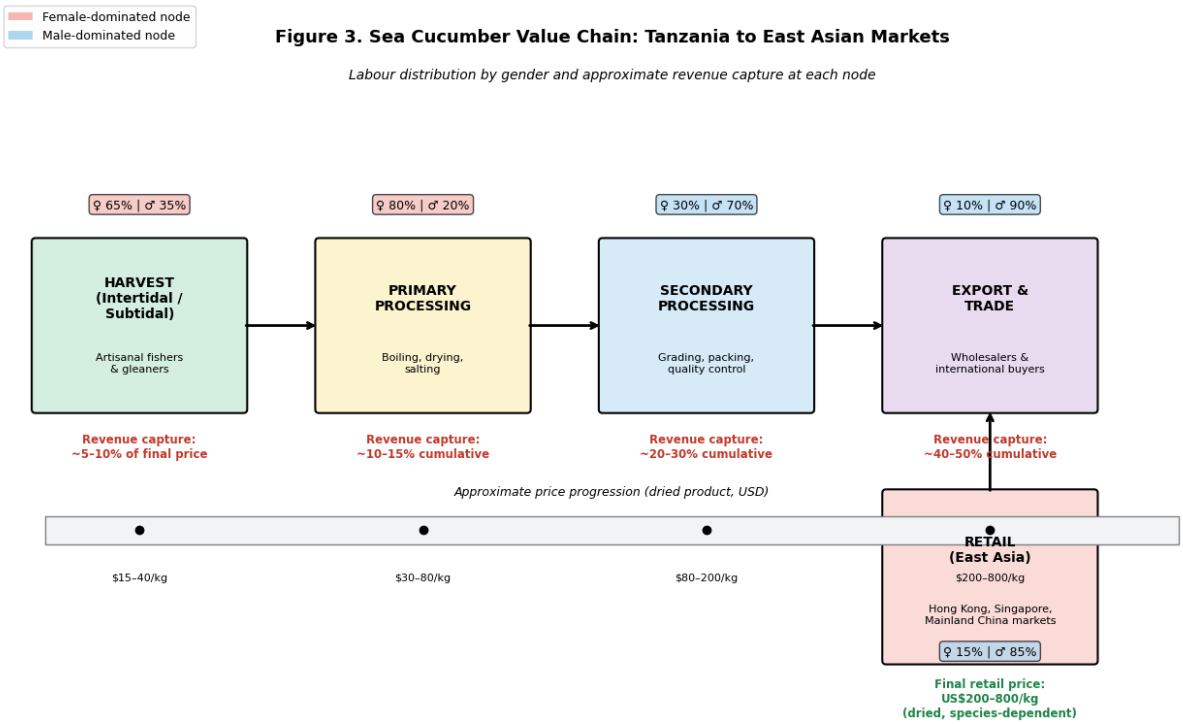
What is less clear, however, is how critical sea cucumbers are relative to other benthic organisms. Literature contains little comparative work that would allow one to say, with confidence, that the loss of sea cucumbers is more ecologically damaging than the loss of, say, certain polychaetes or burrowing crustaceans. One possible interpretation is that sea cucumbers are part of a functionally redundant assemblage, meaning that other organisms could, in theory, compensate for their decline. But redundancy is difficult to prove, and Mercier et al. (2025) have cautioned against if functional compensation will occur automatically, particularly in degraded or species-poor systems. The safer conclusion, it seems, is that sea cucumbers contribute meaningfully to benthic health, but that the magnitude of their contribution likely varies across habitats, seasons, and population densities.

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In the Tanzanian context, site-specific ecological studies are surprisingly rare. Most of what we know about sea cucumber ecology in the Western Indian Ocean comes from studies conducted elsewhere, Australia, the Great Barrier Reef, the Red Sea, and then extrapolated to East African waters. This is not unreasonable, as the basic biology of holothurians is broadly similar across tropical regions. Nevertheless, it does introduce a degree of uncertainty. Local conditions sediment type, tidal regimes, fishing pressure, and the presence of other disturbance factors may alter the functional roles of sea cucumbers in ways that general ecological models do not capture.

Economic Contributions: Livelihood Lifeline or Development Dead End?

The economic story of sea cucumbers in Tanzania is more extensively documented, though still incomplete. Several recent studies have attempted to trace the value chain from hand collection by artisanal fishers to export through Zanzibar and Dar es Salaam to final markets in Hong Kong, Singapore, and mainland China (Uimonen, 2025a; Ndesanjo, 2025). What emerges is a picture of high value at the top end and modest, often precarious, returns at the bottom. Fishermen at the point of harvest receive a fraction of the final retail price, sometimes as little as 5-10%, with the bulk of the value captured by middlemen, processors, and exporters. This pattern is hardly unique to sea cucumbers; it characterises many small-scale fisheries supplying global luxury markets.



What is perhaps more striking is the gender dimension. Women feature prominently in sea cucumber collection, particularly in intertidal zones where hand gathering is possible without diving equipment. They also dominate the processing stage, boiling, drying, and preparing bêche-de-mer for market. Yet women rarely control the revenues from these activities, and they are often excluded from the more lucrative export trade (Uimonen, 2025c). One possible interpretation is that sea cucumber value chains, like many natural resource systems, exhibit a gendered division of labour that systematically disadvantages women despite their significant contributions. Whether Blue Economy initiatives have begun to address this imbalance remains an open question; the available evidence suggests not much has changed (Mwanyoka et al., 2025).

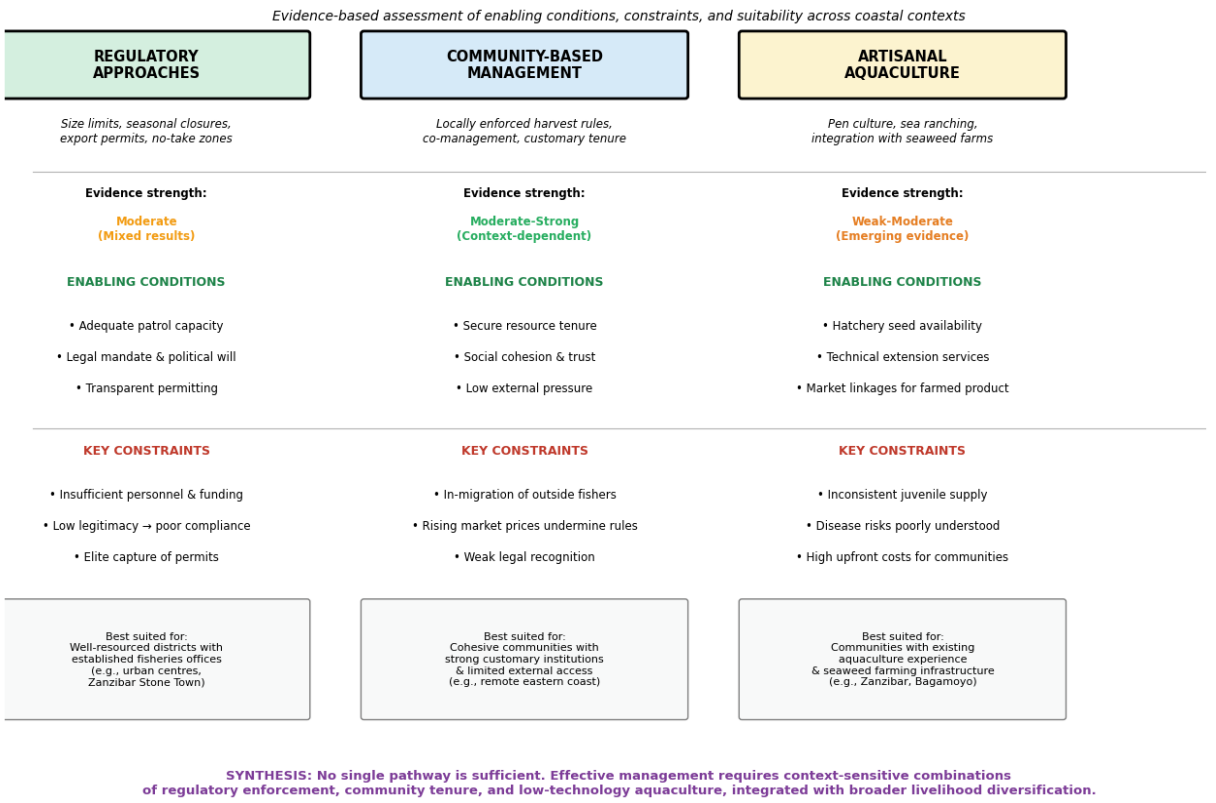
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The Blue Economy agenda itself has received mixed assessments in the recent literature. On the one hand, Ndesanjo (2025) argues that the Tanzanian government's embrace of Blue Economy frameworks has brought unprecedented attention to coastal livelihoods and marine resources. Funding for infrastructure, training, and research has increased. On the other hand, the same author notes that the benefits have been unevenly distributed, with better-connected communities and larger enterprises capturing most of the gains. Smaller-scale fishers, particularly those in remote areas with limited access to markets or information, appear to have seen little improvement in their circumstances. Uimonen (2025d), writing from an anthropological perspective, suggests that the Blue Economy discourse sometimes functions as a form of "development optimism", well-intentioned but detached from the messy realities of coastal life, where seasonal variability, debt, and unpredictable market prices shape daily decisions more powerfully than national policies.

Pathways to Sustainable Management: What Seems to Work, What Does Not

The question of how to manage sea cucumber fisheries sustainably has generated a substantial body of literature, though consensus remains elusive. Broadly, three types of interventions have been attempted: regulatory measures (e.g., size limits, seasonal closures, export permits), community-based management (e.g., locally enforced harvest rules, co-management agreements), and aquaculture development (e.g., hatchery production, sea ranching, grow-out systems).

Figure 4. Management Pathway Effectiveness Matrix for Sea Cucumber Fisheries in Tanzania



Regulatory approaches are common, but enforcement is consistently identified as the weak link. Baker-Médard and Ohl (2019), drawing on fieldwork in Tanzania, documented a familiar pattern: well-designed regulations on paper, but insufficient personnel, funding, and political will to implement them effectively. Fisheries officers are few, patrol boats are scarce, and the coastline is long. Moreover, the authors noted a deeper problem: when regulations are imposed without meaningful consultation, local compliance tends to be low, and resentment can

build. This suggests that regulatory effectiveness depends not merely on the content of rules but on the legitimacy of the rule-making process.

Community-based management has been proposed as a way around this legitimacy problem. Sabai (2025), examining grassroots initiatives on Tanzania's eastern coast, found that some communities have developed informal harvest restrictions that appear to be more consistently followed than official regulations. These local rules are often embedded in broader social norms about resource sharing, reciprocity, and conflict resolution. However, the same study also sounded a cautionary note: community-based systems are not immune to collapse, particularly when external pressures, such as rising market prices or in-migration of outside fishers intensify. One possible interpretation is that community management works best when communities have secure tenure over resources, when they are relatively cohesive, and when external pressures are manageable. Where these conditions are absent, community-based approaches may struggle.

Aquaculture, as noted in the introduction, has generated considerable enthusiasm. The review by Han, Keesing, and Liu (2016) on China's experience is instructive: China has successfully scaled up sea cucumber farming to industrial levels, but this success rested on decades of investment in hatchery technology, disease control, and market development. Translating this model to Tanzania is not simply a matter of technology transfer. The social, economic, and institutional contexts could hardly be more different. Omont et al. (2025), in a recent global review, argued that small-scale, low-tech aquaculture, what they term "artisanal aquaculture", may be more appropriate for developing country contexts than capital-intensive industrial models. Pilot projects in Zanzibar, described by Charisiadou et al. (2022) and Uimonen (2025b), suggest that community-based pen culture and integration with seaweed farming are technically feasible, at least at small scales. Whether these approaches can be expanded without creating new ecological or social problems is less clear.

Contradictions and Unresolved Questions

Synthesising the literature also reveals several contradictions that are worth naming explicitly. First, there is a tension between conservation imperatives and livelihood needs. Ecologists tend to argue about precautionary management, lower harvest quotas, more protected areas, stricter enforcement. Yet for coastal communities with few income alternatives, restricting sea cucumber harvesting without providing viable alternatives may simply displace pressure onto other resources or drive fishing further into illegality. Literature does not offer a clean resolution to this tension, though several authors (e.g., Kaplan-Hallam et al., 2017; Mercier et al., 2025) have called for integrated approaches that combine conservation with livelihood diversification.

Second, there appears to be a gap between policy discourse and on-the-ground realities. Blue Economy documents speak of empowerment, sustainability, and inclusive growth. Yet ethnographic accounts (Uimonen, 2025c; Ndesanjo, 2025) describe a rather different picture: persistent power asymmetries, limited meaningful participation by small-scale fishers in decision-making, and a tendency for benefits to flow upward rather than downward. One possible interpretation is that policy frameworks, however well written, are often captured by elite interests during implementation. Another interpretation, perhaps more charitable, is that the complexities of coastal governance are genuinely difficult to manage, and well-intentioned policies inevitably encounter unforeseen obstacles.

Third, there is a striking lack of longitudinal data. Most studies are cross-sectional, providing a snapshot at a particular moment. This makes it difficult to distinguish short-term fluctuations from long-term trends. Are sea cucumber populations declining steadily, or do they exhibit boom-bust cycles? Has the Blue Economy agenda actually improved livelihoods, or have reported improvements been driven by unrelated factors such as changes in global market prices? The existing literature cannot answer these questions with confidence.



Theoretical Framing

Social-Ecological Systems and Political Ecology

The findings of this review can be usefully interpreted through the lens of social-ecological systems (SES) theory and political ecology. The SES framework (Ostrom, 2009) emphasises that resource governance cannot be understood by examining ecological or social components in isolation; rather, sustainability emerges from the fit between institutions, resource units, and user communities. In the Tanzanian sea cucumber fishery, the misfit between centralised regulatory frameworks and decentralised, livelihood-driven harvesting practices appears to be a primary source of governance failure. Regulations designed at the national level often lack the granularity to accommodate local ecological variability and social norms, resulting in low compliance and weak enforcement.

Political ecology adds a further dimension by drawing attention to power and inequality. The Blue Economy agenda, while ostensibly pro-poor, can be read as a discursive framework that legitimises continued extraction while obscuring distributional inequities (Ndesanjo, 2025). Feminist political ecology, in particular, highlights how the gendered division of labour in sea cucumber value chains is not a natural arrangement but a structural feature of resource governance that channels women into low-remuneration, high-effort nodes (collection and processing) while reserving revenue control for male-dominated trade and export sectors (Uimonen, 2025c). Addressing sustainability without addressing this gendered political economy is unlikely to succeed.

Resilience theory offers a complementary perspective. Sea cucumbers appear to function as keystone contributors to benthic resilience, yet their populations are being eroded by a global market system that treats them as interchangeable commodities. The concept of 'resilience' here is not merely ecological but socio-economic: the capacity of coastal communities to absorb market shocks, policy shifts, and ecological change without collapsing into further resource dependency. The literature suggests that this resilience is fraying, not because communities lack knowledge or will, but because the governance structures within which they operate systematically undermine their agency.

Implications for Coastal Communities

Despite these uncertainties, some tentative implications can be drawn. For coastal communities, sea cucumbers are likely to remain an important, if volatile, source of income for the foreseeable future. The species is too valuable to be ignored, and the barriers to alternative livelihoods are too high for most fishers to switch away entirely. This suggests that management interventions, to be effective, must work with rather than against local incentives. Approaches that criminalise small-scale harvesting without offering alternatives are unlikely to succeed. Approaches that provide technical support, market access, and secure tenure, while also addressing broader issues such as education, health, and infrastructure, stand a better chance.

There is also an emerging argument, visible in the work of Uimonen (2025d) and Sabai (2025), for taking local knowledge seriously. Fishers often have detailed understanding of sea cucumber biology, seasonal movements, and habitat preferences that complement scientific knowledge. Integrating these knowledge systems is not straightforward, there are genuine epistemological differences, but there are also examples of successful co-production of knowledge in other fisheries contexts. Whether such integration can be achieved for sea cucumbers in Tanzania remains to be seen, but the potential seems worth exploring.

Finally, the literature suggests that sustainability is not merely a technical problem solvable by better science or stricter enforcement. It is also a political and ethical problem concerning who gets to decide how resources are used, who benefits, and who bears the costs of conservation. Addressing these questions will require not only more research but also more inclusive and deliberative governance processes. Whether such processes are possible under current political and economic conditions is, perhaps, the most difficult question of all.

CONCLUSION AND POLICY RECOMMENDATIONS

Conclusion

This review set out to synthesise existing knowledge on the ecological significance, economic contributions, and pathways to sustainable management of sea cucumbers in Tanzania's coastal communities. Having worked through the available literature, patchy in places, richer in others, a few conclusions seem reasonably secure, while others remain more tentative.

What appears clear is that sea cucumbers matter, ecologically and economically, in ways that are not always visible to casual observers. They contribute to sediment health, nutrient cycling, and the functioning of seagrass and coral reef systems. Their loss, should it continue unchecked, would likely have cascading effects that extend beyond the species itself, though the precise magnitude of those effects is still difficult to quantify given the limited site-specific research in Tanzanian waters. Economically, sea cucumbers provide a rare source of cash income for some of the poorest coastal households, with women playing particularly significant roles in collection and processing. Yet the value chain is deeply unequal, and most fishers capture only a small fraction of the final market price.

The Blue Economy agenda, for all its promise, appears to have delivered mixed results. It has raised the profile of marine resources and attracted investment, but the benefits have not always reached the small-scale fishers and coastal communities who depend most directly on sea cucumbers. There is a discernible gap between policy rhetoric and local realities, a gap that seems to reflect not bad faith but rather the genuine difficulty of translating high-level frameworks into meaningful change on the ground.

Regarding sustainable management, literature offers no single solution. Regulatory approaches are necessary but insufficient without enforcement capacity and local legitimacy. Community-based management shows promise in specific contexts but is not a panacea. Aquaculture offers potential but remains technically challenging and economically risky at small scales. What emerges instead is a more nuanced picture: effective management likely requires context-sensitive combinations of these approaches, adapted to local ecological conditions, social structures, and economic pressures. There is no one-size-fits-all model.

One conclusion that seems unavoidable is that the knowledge base remains incomplete. Longitudinal data is scarce. Comparative studies across different sites in Tanzania are almost non-existent. The voices of fishers themselves, their knowledge, their concerns, their proposed solutions, are underrepresented in the peer-reviewed literature. This suggests that future research should not simply add more studies of the same type but should diversify the kinds of questions asked and the methods used to answer them.

Finally, and perhaps most fundamentally, this review has found that the sustainability of sea cucumber fisheries in Tanzania is not solely, or even primarily, a technical problem. It is a governance problem, a distributional problem, and a problem of political will. Without addressing who decides, who benefits, and who bears the costs, even the best-designed technical interventions are unlikely to succeed. This is an uncomfortable conclusion, because governance reforms are harder to implement than new regulations or aquaculture projects. But it is the conclusion that the evidence seems to support.

Policy Recommendations

Based on the synthesis presented above, the following recommendations are offered. They are intended not as definitive prescriptions but as considered judgments grounded in the available evidence, judgments that should be adapted to specific local contexts and revisited as new information becomes available.

i. Strengthen enforcement capacity alongside regulatory legitimacy. Current regulations on size limits, seasonal closures, and export permits are weakly enforced due to limited patrol capacity and low local



compliance. Government should increase fisheries patrol coverage in sea cucumber landing sites by at least 40% over the next three years, while simultaneously establishing community-fisheries liaison committees in the five highest-volume landing districts (e.g., Zanzibar, Bagamoyo, Mafia, Lindi, Mtwara) to co-develop rules and rebuild voluntary compliance.

ii. Support community-based management where local conditions enable it. Community-led harvest restrictions appear effective in some coastal areas, particularly where resource tenure is secure and social cohesion is strong. Policy should provide legal recognition, technical assistance, and devolved authority to such initiatives, but only after assessing local institutional readiness using a standardised tenure-security and social-capital index. Pilots should begin in three demonstrably cohesive communities within 24 months.

iii. Invest in low-technology, artisanal aquaculture suited to local contexts. Rather than pursuing capital-intensive industrial models, government and development partners should support research and pilot projects focused on simple, low-cost sea cucumber grow-out systems, specifically pen culture integrated with existing seaweed farming activities using locally available materials. Target: 5 community-managed pilot sites in Zanzibar and mainland Tanzania within 36 months, with explicit monitoring of ecological and social outcomes.

iv. Address gender inequities in sea cucumber value chains. Women dominate collection and processing but capture few of the benefits. Policies should ensure that training, market linkages, and cooperative development explicitly include women, and that revenue-sharing arrangements are made transparent and equitable. A concrete first step would be to mandate gender-disaggregated data collection in all sea cucumber export permitting processes and to establish women-led processing cooperatives with access to low-interest credit through the Tanzania Agricultural Development Bank.

v. Integrate sea cucumber management into broader coastal livelihood strategies. Unsustainable harvesting will persist as long as coastal communities lack viable economic alternatives. Policy should connect fisheries management with investments in basic infrastructure, education, health, and access to credit, reducing dependence on sea cucumbers as a default livelihood. This should be operationalised through district-level Coastal Livelihood Diversification Plans aligned with the National Fisheries Policy and the Tanzania Development Vision 2025.

Final Reflection

This review has attempted to take sea cucumbers seriously, not as a niche curiosity, but as a resource that matters, ecologically and socially, to Tanzania's coastal communities. What emerges is a picture of complexity and contradiction: a species that is both ecologically valuable and economically marginalising; a policy agenda that promises much but delivers unevenly; a body of knowledge that is growing but still full of gaps. There are no easy answers. But perhaps the first step is to acknowledge the complexity itself, and to resist the temptation of simple solutions that ignore the messy realities of coastal life. If this review has done nothing else, it has hopefully made that complexity visible, and in doing so, provided a foundation for more thoughtful, context-sensitive, and equitable approaches to managing sea cucumbers in Tanzania.

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