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Utilization of Local Ecological Knowledge for Optimization of Fish Catches: A Literature Review

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ABSTRACT

Local ecological knowledge (LEK) plays a vital role in fisheries management by providing valuable insights into ecosystem dynamics, species behavior, and sustainable fishing practices. This study explores the use of LEK in fisheries, particularly its impacts on catch efficiency, sustainability, and integration into fisheries policy. Data for this review were drawn from 2014 to 2025, focusing on highly reputable scientific journal articles indexed in Scopus (Q1–Q4), to assess the role of LEK across diverse fishing communities worldwide. Findings indicate that LEK can increase catch efficiency by up to 30% compared to practices that rely solely on conventional methods. Moreover, integrating LEK with scientific data has proven highly effective in marine biodiversity conservation, particularly in protected areas where local knowledge supports adaptive management strategies. Despite its potential, several challenges hinder the effective implementation of LEK. A major obstacle is the declining transmission of traditional knowledge to younger generations, who are increasingly reliant on modern fishing technologies. Climate change further complicates matters by altering established ecological patterns, requiring adaptive strategies to continually update LEK. Additionally, limited government support and the minimal inclusion of LEK in formal fisheries policies prevent its full recognition as a legitimate resource for sustainable fisheries management. Opportunities exist, however, to enhance fisheries sustainability through collaboration between scientists, policymakers, and fishing communities. Initiatives such as training programs, participatory management frameworks, and integrating LEK into decision-making processes can strengthen both fisheries governance and community resilience. This study underscores the importance of recognizing and preserving LEK as a critical tool for achieving long-term sustainability in global fisheries.

INTRODUCTION

Local ecological knowledge (LEK) is information obtained from the experiences and observations of local communities regarding the environment and natural resources around them. LEK is crucial in fisheries resource management because it can provide in-depth insights into fish behavior, migration patterns, and ecosystem relationships that conventional scientific data cannot always explain. According to **Berkström *et al.* (2019)**, LEK can assist in seascape management by identifying important areas for the survival of fish species. For example, fishing communities in a particular area may know specific locations where fish congregate during certain seasons, which can vary from one location to another. This suggests that integrating LEK into fisheries policies can improve the effectiveness of fisheries resource management and sustainability.

The importance of LEK is also evident in the context of food security. Communities that depend on fisheries often have in-depth knowledge of fish species and the ecosystems that support them. A study by **Brodie *et al.* (2024)** showed that small fishing communities in Tanzania used their LEK to identify optimal fishing times and locations, contributing to local food security. For example, they can determine that certain fish are more likely to be caught during the full moon or in areas with particular currents. Using this knowledge, fisheries managers can design more adaptive and responsive strategies to environmental changes, such as shifts in water temperature or salinity, which can affect fish migration patterns.

The trend of declining fish stocks is a pressing global issue that must be addressed. A study by **Macedo *et al.* (2025)** revealed that fish stocks in West Africa have experienced significant declines over the past few decades. The study noted that this decline is caused by overfishing, climate change, pollution, and habitat destruction. Data show that some fish species vital to local communities, such as pelagic fish, have decreased by up to 70% in recent years. This decline has negatively impacted marine ecosystems and the livelihoods of coastal communities that depend on fish for income and food.

This decline has also led to increased competition among fishermen, which can drive unsustainable fishing practices. For instance, fishermen struggling to meet their daily needs may be forced to fish beyond permitted limits or use destructive gear. Therefore, applying LEK in fisheries management is increasingly important as a tool to understand local dynamics and respond to emerging challenges. By utilizing LEK, managers can design more targeted and sustainable interventions.

Local communities often possess accurate knowledge of ocean conditions and fish stocks, which can be a valuable source of information for resource managers. For example, in the context of fisheries in Indonesia, research shows that traditional fishermen have a deep understanding of fish migration patterns and environmental conditions that support the presence of certain species **(Silvano *et al.*, 2022)**. This knowledge includes information on the best fishing times and the most effective bait types. By integrating local knowledge into management policies and practices, a more holistic and sustainable approach can be created. This will help maintain fish stocks while supporting the well-being of coastal communities that rely on these resources.

One concrete example of applying LEK in fisheries management is the community-based management program implemented in several regions. In this program, local communities are involved in decision-making regarding fisheries resource management. They are encouraged to share their knowledge of the local ecosystem, including information on fish species, migration patterns, and threats faced. As a result, the resulting policies become more relevant and practical because they are based on a deep understanding of the local context. Moreover, community involvement also increases a sense of ownership of the resources they manage, thereby encouraging more responsible practices.

From an analytical perspective, it is crucial to examine how LEK can serve as a bridge between traditional knowledge and modern science. The objective of this review paper was to comprehensively examine the role and utilization of local ecological knowledge (LEK) in the capture fisheries sector, particularly in improving catch efficiency, supporting resource sustainability, and strengthening food security in coastal communities. This study seeked to identify how integrating traditional knowledge held by fishing communities with modern technologies—such as Geographic Information Systems (GIS) and scientific data-based monitoring—can bridge the information gap in fisheries management. By analyzing Scopus-indexed scientific literature from 2014 to 2025, this paper also aimed to provide recommendations for collaborative strategies between fishers, scientists, and policymakers to produce adaptive, inclusive, and evidence-based fisheries management models.

Several studies have demonstrated that combining LEK with modern technology can result in more effective management strategies. For example, **Mellado *et al.* (2013)** described the integration of local and scientific knowledge in marine protected area management; **Berkström *et al.* (2019)** demonstrated the use of LEK alongside scientific data to identify critical areas for species sustainability; **Jyoti Nath *et al.* (2020)** reviewed the application of GIS in fisheries, including the integration of LEK data for mapping fish distribution; **Silvano *et al.* (2022)** emphasized that integrating local knowledge with modern fisheries science enriches the understanding of fish resource dynamics; and **Macedo *et al.* (2025)** highlighted fisheries policies based on a combination of LEK and official fish landing data to respond to stock declines.

Many studies have shown that combining these two types of knowledge can result in more effective management approaches. For example, modern monitoring technology combined with local knowledge can improve the accuracy of predicting fish migration patterns. Thus, LEK functions both as a source of information and as a tool to enhance community capacity in addressing challenges related to fisheries resources. With this more inclusive approach, fisheries resource management is expected to be more sustainable and provide greater benefits to coastal communities. The integration of LEK into fisheries policy can help maintain fish stock sustainability while contributing to food security and community economic well-being. Therefore, it is essential for policymakers and resource managers to continue to explore and utilize the knowledge held by local communities for a more sustainable future in fisheries.

MATERIALS AND METHODS

Data collection

Data were collected through a comprehensive literature-based approach, focusing on Scopus-indexed journal articles accessed via Google Scholar and ResearchGate, particularly those classified within Q1 to Q4 categories. This methodology enabled researchers to explore and analyze a wide range of relevant sources, including journal articles, research reports, and case studies related to local ecological knowledge (LEK) and its impact on fisheries catches. The collected data included information on the application of LEK by fishers and the resulting catch outcomes derived from such practices.

Horizon time

The time horizon for this study spans from 2014 to 2025. This ten-year period was selected because it reflects the most recent trends and developments, particularly regarding the application of ecological knowledge in the fisheries sector.

Article selection within this systematic literature review (SLR) followed the preferred reporting items for systematic reviews and meta-analyses (PRISMA) framework, which consists of several sequential stages (Fig. 1). The PRISMA approach was chosen because it provides structured guidance for conducting systematic reviews, including assessing research quality, organizing data, and analyzing relevant literature **(Satiti *et al.*, 2024)**.

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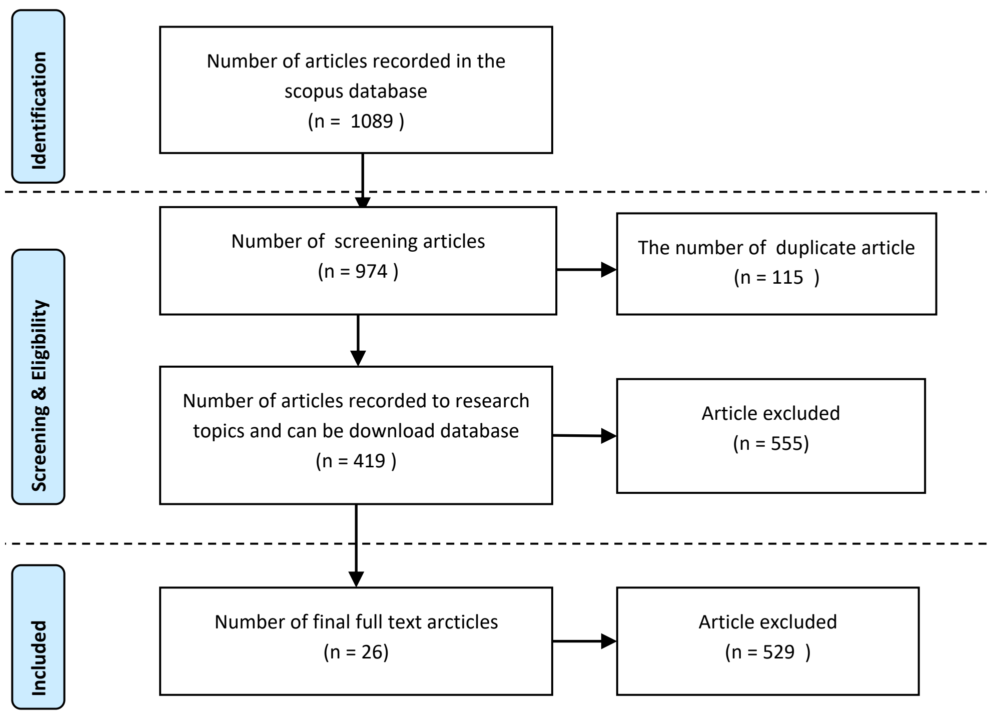

Fig. 1. Article selection process

Stage 1: Identification

The inclusion criteria focused on local ecological knowledge (LEK), fishing technology, and document types that had undergone a rigorous peer-review process and were available in full text. Only journal articles written in English and included in predetermined databases were considered. Data collection involved recording the title, abstract, year, keywords, and publisher.

These keywords were stored in a comma-separated values (CSV) file, exported to Microsoft Excel, and processed according to the research requirements.

At this stage, 1,089 articles from various journals and publishers were identified. Of these, 115 duplicate records were removed.

Stage 2: Screening and eligibility

After the removal of duplicates, 974 articles remained for further screening. Following the application of eligibility criteria, 419 downloadable articles directly relevant to the research topic were retained, while 555 articles were excluded.

Stage 3: Inclusion

In the final stage, 26 articles were identified as highly relevant and included in this systematic review. A total of 529 articles were excluded for being inappropriate or irrelevant to capture fisheries studies.

RESULTS AND DISCUSSION

The time horizon used in this study covers the period from 2014 to 2025. This period was selected because it includes the most recent and relevant research reflecting current trends and developments in the use of local ecological knowledge (LEK) in the fisheries sector. This research discusses the utilization of LEK, its challenges and applications, opportunities for optimizing catches, integration models in data-based fisheries management systems, and policies and regulations for empowering LEK.

1. Utilization of LEK

The use of local ecological knowledge (LEK) in the fisheries sector has proven effective in increasing catches and ensuring the sustainability of marine resources. LEK encompasses local communities' deep understanding of ecosystems, fish behavior, and migration patterns, developed and passed down over generations.

One example of LEK application in fisheries technology can be seen in the study by **Paillin *et al.* (2024)**, which highlights how fishing communities worldwide use time-tested traditional techniques to increase efficiency. In Indonesia, for instance, fishermen often rely on generational knowledge of fish migration patterns to determine optimal fishing times and locations. Similarly, **Ndiba and Lampe (2024)** showed that fishermen on Bangkurung Island, Banggai Laut, use LEK to identify trap locations based on natural indicators such as coral reefs, seawater color, wave patterns, and surface foam. This knowledge not only increases demersal fish catches but also supports environmentally friendly practices.

A case study in Tanzania demonstrated that integrating LEK with modern scientific data improved fisheries management outcomes. Fishermen who combined these approaches increased their catches by up to 30% compared to those relying only on conventional methods **(Berkström *et al.*, 2019)**. This highlights the value of recognizing LEK as a legitimate and valuable source of information for fisheries decision-making.

LEK also plays a key role in managing marine protected areas. For example, local ecological knowledge has informed policy design in marine national parks, resulting in strategies that both conserve biodiversity and reflect community needs **(Mellado *et al.*, 2013)**.

To maximize LEK's potential, however, government and institutional support is essential—particularly in providing training and technological access that integrate local knowledge with scientific data. Collaboration between fishers and scientists is therefore critical for developing innovative, sustainable fisheries solutions. As **Macedo *et al.* (2025)** emphasized, combining local knowledge with modern technology is key to optimizing catches, ensuring food security, and maintaining marine ecosystem sustainability for future generations.

2. Challenges in implementation

Despite its benefits, implementing LEK faces several challenges. One major issue is declining knowledge transmission among younger fishers, who increasingly rely on modern technologies. **Silvano *et al.* (2022)** observed that younger generations often overlook traditional knowledge, leading to the erosion of important skills for fisheries sustainability.

Climate change also threatens the reliability of LEK. **Brodie *et al.* (2024)** noted that shifting weather patterns and extreme sea temperatures disrupt established ecological patterns, altering fish migration and resource availability. In this context, LEK must be continually updated and adapted to remain relevant.

A further obstacle is the limited recognition of LEK in formal policies. Many governments fail to include local communities in decision-making, creating dissatisfaction and potential conflict **(Henke *et al.*, 2025)**. Scholars argue that policies should explicitly acknowledge LEK through participatory mechanisms, enabling fishers to actively contribute their knowledge and experience **(Mellado *et al.*, 2013; Rahmi, 2017)**. Integrating LEK with scientific data—through tools like GIS or community-based monitoring systems—can enhance decision-making, provided fishers are supported with training and access to technology **(Teniwut *et al.*, 2017)**.

Without these measures, the gap between governments, scientists, and fishing communities will persist, limiting the effectiveness of fisheries management.

3. Opportunities for optimizing catches

There are significant opportunities to improve catch optimization by integrating LEK with modern technology. **Reddy (2018)** emphasized the role of Geographic Information Systems (GIS) in fisheries management. GIS can help fishermen map productive fishing areas, analyze environmental data, and improve decision-making.

By combining scientific survey data with local knowledge, GIS can reveal migration patterns and environmental changes that might otherwise go unnoticed. This integration supports more effective, sustainable fishing strategies **(Jyoti Nath *et al.*, 2020)**.

To capitalize on these opportunities, training programs in GIS and related technologies should be provided to fishermen. Such programs, developed collaboratively by scientists, policymakers, and communities, can foster positive synergies in fisheries management.

Another opportunity lies in strengthening collaboration between researchers and fishermen. By establishing platforms for knowledge exchange, researchers gain insights into local conditions while fishermen access scientific expertise. This mutual learning can generate innovative solutions that improve catches and ensure sustainability.

4. Models in data-based fisheries management systems

Sustainable fisheries management requires integrating LEK with scientific data to achieve optimal catches. LEK provides insights into fish behavior, migration, and ecosystem interactions often overlooked by conventional science. According to **Berkström *et al.* (2019)**, this knowledge is particularly valuable in resource management contexts.

In Tanzania, for instance, fishing communities have collaborated with scientists to identify critical habitats for species survival. **Brodie *et al.* (2024)** demonstrated that LEK helps detect environmental changes influencing catches, enabling managers to formulate more adaptive policies. Similarly, integrating LEK with GIS has allowed researchers to map fish distribution and hotspots. **Jyoti Nath *et al.* (2020)** found that this combination improves catch efficiency while promoting sustainability.

However, integration faces challenges. Policies that ignore LEK often fail to reflect ecological realities, leading to resource declines **(Macedo *et al.*, 2025)**. Thus, building stronger bridges between policymakers, scientists, and communities is crucial for inclusive and adaptive management.

5. Policies and regulations in empowering LEK

Empowering LEK within fisheries management policies is vital for sustainability. Policies that formally recognize LEK encourage community participation, creating stronger ownership and responsibility for resources. **Mellado *et al.* (2013)** showed that integrating LEK into marine conservation strategies yields locally appropriate and effective outcomes.

In Indonesia, for example, East Lombok fishing communities have influenced sustainable fishing regulations through participatory approaches. **Rahmi (2017)** documented how fishers' knowledge of migration patterns and ecosystems informed government policy. Similarly, **Teniwut *et al.* (2017)** found that communities with robust LEK adapted more effectively to environmental changes, maintaining both fisheries resources and livelihoods.

Nevertheless, challenges persist. Existing policies often lack the flexibility to accommodate evolving local knowledge. As **Pukkalla and Mohan (2020)** argued, LEK is dynamic and changes with environmental and social conditions; thus, regulations must adapt accordingly.

Empowering LEK through participatory policies, capacity-building programs, and integration into data-driven systems is therefore essential for achieving both resource sustainability and community welfare.

CONCLUSION

Local ecological knowledge (LEK) plays a crucial role in sustainable fisheries management. Its application not only increases fishing efficiency but also supports the maintenance of marine ecosystem balance. Previous research has demonstrated that integrating LEK with scientific data and modern technologies—such as Geographic Information Systems (GIS)—can improve catches while strengthening food security in coastal communities.

Despite these benefits, the effective implementation of LEK faces persistent challenges. These include the declining transmission of knowledge among younger fishers, disruptions caused by climate change to established fish migration patterns, and limited governmental recognition of LEK within fisheries policies. Addressing these issues requires a more inclusive management approach that positions local fishers as primary stakeholders.

Significant opportunities exist to optimize fisheries productivity by enhancing collaboration among fishers, scientists, and policymakers. Strengthening fishers' capacity to apply modern technologies, coupled with the adoption of policies that formally integrate LEK, represents a strategic pathway toward sustainability. Embedding LEK within data-driven fisheries management systems provides an adaptive framework that not only improves catch efficiency but also safeguards marine ecosystems for future generations.

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