International Journal on Multidisciplinary and Applied Research
https://doi.org/10.63236/ijmar.1.2.4
Date received: 01/10/25; revised: 16/10/25; accepted: 04/12/25; published: 31/12/25

Towards Resilient Ecosystems and Livelihoods: A PESTLE Examination of Lake Victoria's Fisheries

Reza Sayani
City of London School,
England. EC4V 3AL

Corresponding author: Reza Sayani**,** rezasayani@icloud.com

Abstract
Lake Victoria, shared by Uganda, Kenya, and Tanzania, underpins the livelihoods of over 40 million people; however, it faces severe ecological and governance crises following the introduction of the Nile perch (*Lates niloticus*). This paper conducts a systematic PESTLE (political, economic, social, technological, legal and environmental) review of the lake's fisheries to examine how ecological, economic and institutional dynamics interact to shape resilience. Using predefined search strings across an academic database (Scopus), 4685 records were screened and 750 documents (peer-reviewed articles, policy reports, datasets and news sources) were retained. Thematic content analysis was used to code material into PESTLE domains and derive cross-cutting patterns. Three core vulnerabilities emerge: primary-commodity dependence on Nile perch exports, fragmented and politicised transboundary governance, and social pressures intertwined with accelerating environmental degradation. The paper proposes a portfolio of interventions, including livelihood diversification (aquaculture, value-added processing and non-fishing enterprises), strengthened community-based enforcement, and regionally harmonised regulatory frameworks under the Lake Victoria Basin Commission (LVBC) and Lake Victoria Fisheries Organisation (LVFO). By linking a structured documentary review with a PESTLE lens, the study clarifies key leverage points for reconciling ecological integrity, economic security, and regional cooperation in Lake Victoria's fisheries.

Keywords: Lake Victoria, biodiversity, PESTLE analysis, Nile perch, fishing.

1. Introduction

One of the most important natural resources are freshwater lakes, which provide essential ecosystem services valued at USD 1.3 to USD 5.1 trillion annually (Horne et al., 2024). The largest lake in Africa and the second largest freshwater lake in the world, Lake Victoria spans Uganda, Kenya, and Tanzania and has a surface area of approximately 59,947 km² (Britannica, 2025; Great Lakes of Africa, 2016; Wikiwand,

2020). This vast freshwater ecosystem provides freshwater, food security, agricultural irrigation, transportation, and economic livelihoods for approximately 40 million people. As a result, it is the foundation of regional development in East Africa (African Centre for Aquatic Research and Education, 2025; Great Lakes of Africa, 2016; KfW Development Bank, 2023; World Bank, 2016).

The significance of Lake Victoria extends far beyond its impressive size. The lake, which is home to over 500 species of endemic cichlid fish, was once a hotspot for biodiversity and is now one of the world's most striking examples of evolutionary diversity and adaptive radiation (Seehausen et al., 2008; Verheyen et al., 2003). These interconnected food webs that have supported local communities over the years are supported by the lake's vast wetland systems and complex aquatic ecosystems, which also filter water naturally (Besjournals, 2025; Harper et al., 2003). Lake Victoria is more than only an economic resource for indigenous groups such as the Luo and Kuria groups; it is a vital part of their cultural identity, customs, and spiritual beliefs that have been passed down through the generations (101 Last Tribes, 2011; Vocal Media, 2025; Village Volunteers, 2011).

2. Literature Review

Ecological Changes

The ecological integrity of this essential freshwater system as well as the socioeconomic stability of the people who depend on it are presently at risk owing to challenges that were once unthinkable. Although the introduction of the Nile perch in the 1950s initially boosted commercial fisheries and generated substantial amount of export revenue, reaching around €169 million by 2003, it has also caused the collapse of the ecology (Food and Agricultural Organisation [FAO], 1962; FOA, 2004; LinkedIn, 2024; Oxford Academic, 2005; Vedantu, 2025). The Nile perch has wiped out 90% of native cichlids in the past 50 years, driving more than 200 endemic cichlid species to extinction (Fondazione Slow Food, 2018; Imamoto et al., 2024; Tyers et al., 2024). The fact that less than 1% of fish caught in Lake Victoria today are the once-abundant native species is one of the most striking examples of biodiversity loss in freshwater ecosystems worldwide (Fondazione Slow Food, 2018; Ogutu-Ohwayo et al., 2005).

Governance Aspects

A complicated network of these interrelated issues encompassing ecological, economic, social, and governance aspects has been brought about by the transformation of the fisheries industry at Lake Victoria. What economists refer to as "primary product dependency" has resulted from economic reliance on Nile perch exports, resulting in local fishing communities being unable to benefit from the industry and making them highly susceptible to market swings (Gibbon, 1997; LinkedIn, 2024). Despite their direct involvement in the extraction of resources, lakeside communities have become increasingly marginalised as a result of the declining terms of trade for exporters of primary commodities, as demonstrated by this economic structure, which is an example of the Prebisch-Singer hypothesis (Arezki et al., 2014; Harvey et al., 2010).

Significant governance shortcomings which are a result of the transboundary nature of the lake exacerbate these ecological and economic difficulties. Lake Victoria needs coordinated management strategies that cut across national borders considering that it is a shared resource among three independent countries (United Nations Water, 2022). The LVFO and the LVBC are two examples of current institutional frameworks that suffer owing to limited legal authority, inconsistent enforcement, and fragmented mandates (East African Legislative Assembly, 2024; Wikipedia LVFO, 2012). Kenya, Uganda, and Tanzania have very different national regulations, leading to regulatory "leakage" where various state and non-state actors regularly exploit areas with the least enforcement, undermining conservation efforts by these institutional bodies (Great Lakes of Africa, 2016).

Socio-Economic Aspects

The crisis in Lake Victoria has significant social facets as well. As export-oriented fisheries have made traditional food fish scarce and costly, communities that have been dependent on a variety of fishing methods and fish species for both subsistence and cultural purposes historically now face food security challenges (Village Volunteers, 2011; Vocal Media, 2025). According to research, 89.4% of fishermen in the Kenyan portion of Lake Victoria do not have alternative sources of income, which leaves them extremely vulnerable in the event that fish stocks deplete, or market conditions worsen (Abila & Jansen, 1997). Precarity in the economy has led to a rise in illegal fishing practices, such as the use of small mesh nets to catch juvenile fish, which hinders the recovery of the population and feeds the cycle of resource depletion (Great Lakes of Africa, 2016; LinkedIn, 2024).

Impact From Existing Studies

These interrelated problems are further exacerbated by environmental degradation. Widespread eutrophication has been created by industrial pollution, urban waste, and agricultural runoff. This has resulted in algal blooms that deplete the oxygen levels and create "dead zones" that are unsuitable for supporting aquatic life (Great Lakes of Africa, 2016; Harper et al., 2003; Njiru et al., 2007; World Bank, 2016). While invasive species such as water hyacinth obstruct waterways and interfere with ecosystem function, climate change adds more stressors by changing temperature and precipitation patterns (Great Lakes of Africa, 2016; KfW Development Bank, 2023).

Considering these complex issues, this study examines a crucial research question: How can the riparian communities of Lake Victoria diversify their economies beyond Nile Perch fisheries while maintaining ecological sustainability and regional collaboration? This inquiry acknowledges that solving the sustainability crisis in Lake Victoria necessitates a shift from the current patterns of over-reliance on resources towards more integrated solutions that concurrently restore ecological balance, generate alternative economic opportunities, and promote productive cooperation between Tanzania, Kenya, and Uganda.

PESTLE Framework

Three specific goals are pursued by the research in order to answer this central question, using a systematic PESTLE framework:

(i) Analyse the political, economic, social, technological, legal, and environmental factors that have contributed to the current unsustainable situation.
(ii) Identify viable strategies for diversifying lakeside livelihoods in a sustainable manner while preserving ecological integrity; and
(iii) Assess the significance of improved intergovernmental cooperation in managing Lake Victoria as a shared transboundary resource.

This study employs a thorough literature-based analysis to examine Lake Victoria's sustainability issues from various aspects. The study first provides essential background information on the lake's ecological, economic, and cultural significance before detailing the systematic methodology employed. Findings from the six PESTLE dimensions, namely political, economic, social, technological, legal, and environmental factors collectively influence present management outcomes are presented in the results section. While the conclusion provides specific recommendations for policy reform and future research directions, the discussion synthesises these findings to identify important interactions and intervention leverage points.

By using this integrated approach, the study aims to contribute to practical policy discussions about sustainable development in the Lake Victoria basin as well as scholarly understanding of transboundary freshwater governance issues. Recent initiatives, such as the 2024 trilateral border governance agreement, indicate riparian states' increasing recognition that the challenges facing Lake Victoria call for coordinated, multinational responses that strike a balance between ecological conservation, economic development, and social equity. This makes the research especially pertinent.

Approach of this Work

Although much has been done regarding the ecological change and export-oriented fisheries of Lake Victoria, there are still three gaps. To begin with, most of the literature deals with ecological effects or governmental issues in detachment, providing little synthesis of the interaction among political, economic, social, technological, legal and environmental forces. Second, available reviews and policy appraisals rarely use a structured approach such as PESTLE to package evidence in various document types (scientific literature, policy reports, and grey sources) and timeframes. Third, very little emphasis has been placed on the livelihood diversification and resilience of the riparian communities as a combined effect of transboundary fisheries management.

This paper will fill these gaps in the literature by mapping the political, economic, social, technological, legal and environmental pressures in an integrated manner while the conclusions can give some practical guidelines to be followed by regional organizations (such as LVBC and LVFO) and national fisheries authorities to harmonize rules, aiming to achieve enforcement and design livelihood transition

programmes. The analysis also provides a framework that can be used towards other systems experiencing the same commodity pressures on transboundary freshwater systems.

3. Methodology

Research Design

This paper employed a PESTLE analytical framework, analysing political, economic, social, technological, legal, and environmental factors to systematically evaluate the obstacles and dynamics influencing the management of Lake Victoria. The PESTLE framework was chosen for its ability to thoroughly encompass the complex and interconnected aspects of issues affecting the lake's sustainability. Since this is a literature-based study, a range of secondary sources were used to gather data. These included peer-reviewed scientific articles, institutional reports from organisations such as the LVBC, the LVFO, the East African Community (EAC), and the United Nations (UN), as well as available news articles and datasets. The research focused solely on the Nile perch fishery and associated ecological and governance challenges in Uganda, Kenya, and Tanzania. Rwanda and Burundi are also part of the Lake Victoria basin; however, they do not play a significant role in the fishing industry; hence, they were excluded from this study.

The research methodology was predominantly qualitative, utilising thematic synthesis and content analysis of textual sources to determine and interpret significant factors within the PESTLE domains. Quantitative data obtained from reports and datasets were amalgamated to furnish contextual evidence and bolster qualitative findings. It is recognised that certain quantitative data, including enforcement and illegal fishing statistics, may be incomplete or sourced from secondary reports, thereby imposing constraints on the comprehensiveness of quantitative analysis. This method offers a systematic and reproducible framework for comprehending the intricate socio-ecological and governance aspects of Lake Victoria's fisheries, acknowledging the limitations associated with dependence on secondary data.

Source and Search Strategy Of Data.

The paper has been based on the Scopus database (Elsevier) to a large extent since scholars in the social sciences, environmental studies as well as energy research find it to be a fairly comprehensive repository of peer-reviewed work. It has a wide coverage of the journals that were applicable to Lake Victoria, which made it a viable starting point. It was therefore used it owing to the breadth of its indexes as well as the uniformity of its metadata.

This retrieved the content that had Lake Victoria in the title, abstract or key fields, and was within the disciplinary areas that were selected (social sciences, multidisciplinary studies, arts and humanities, energy, and economics) and was written in English. The initial scan yielded 4,685 records.

Eligibility and Screening (PRISMA)

The screening procedure was done according to the simple logic of PRISMA, primarily to ensure the transparency of the selection procedures. The inclusion criteria were also purposely inclusive: peer-reviewed articles, reviews, conference papers, and book chapters in Scopus database. Substantive interest in Lake Victoria (fisheries and ecology to livelihoods or governance) and fully indexed bibliographic fields also formed part of the study.

The exceptions were simpler. Research that focused on the biomedical or clinical fields, simply showing the lake as a geographic marker was sidelined. In addition, non-English publications were excluded, as well as those of which the metadata was not complete - this was a more common occurrence than anticipated; every so-called entry had parts of the metadata missing or only half-complete abstract fields.

The process of work was as follows:

a. Identification: 4,685 records were obtained in Scopus.
b. To capture both the historical transformation and contemporary governance debates, the search was limited to documents published between 1990 and 2025, with particular emphasis on work from 2000 onwards when Nile perch exports and governance reforms intensified.
c. Deduplication: none eliminated, because the search was based on a single database.
d. Title and abstract filtering: 3,935 records were filtered out as they did not address this topic of interest, the lake, or its various realms in a meaningful way.
e. Full-text eligibility: 752 records have been frozen; two have been removed owing to language and several others have been filtered out on account of missing metadata content.
f. Final dataset: Initially 4 685 records were screened; of these 752 were assessed and finally 750 publications that were found in the bibliometric analysis were included.

The following steps are depicted in a PRISMA flow diagram (Figure 1).

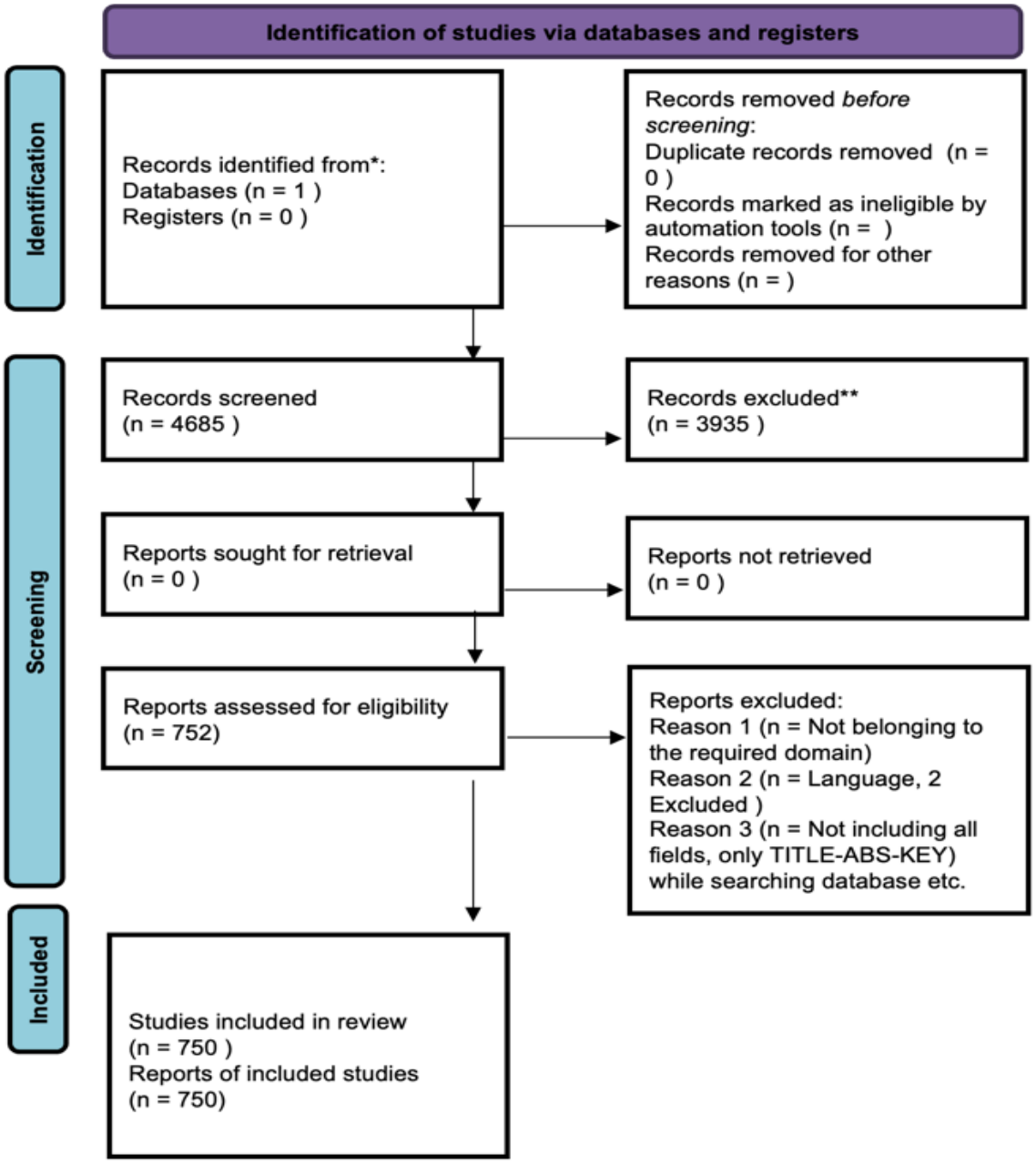

Figure 1: Flowchart for the PRISMA framework

Data preparation

The entire 750 records were brought out in a VOSviewer-friendly format (CSV or RIS). The file was reviewed prior to analysis owing to the presence of any errors related to encoding, and any apparent inconsistency in author and institutional names was removed. A content analysis of these abstracts led to identifying patterns in widely studied themes which were around that of Lake Victoria, which helped in comprehending the challenges and themes which are used for further studies in PESTLE analysis. This thematic analysis was done using axial coding. The themes and indicators are given in Table 1.

Table 1: General themes extracted from axial coding along with the keywords widely found in the literature

Core category / Theme	Role in axial model	Subcodes (examples from text)	Indicator words (examples)	Interpretation
Economic dependence on Nile perch & exports	*Causal condition*	Export orientation, value chains, market volatility, primary commodity dependence	*Nile*, *perch*, *export / markets* (lower counts), *fish/fishing/fisheries* (combined contextually)	Positions the fishery as an export-driven commodity system that shapes incentives and exposes actors to shocks.
Ecological & environmental change	*Context / structural condition*	Eutrophication, pollution, species loss, changing catches/biomass, invasive species	*ecological*, *species*, *catch*, *water*, environment-related terms scattered through PESTLE sections	Provides the biophysical backdrop against which governance and livelihoods have to operate.
Governance & institutional arrangements	*Intervening condition*	Multi-level governance, BMUs, LVFO/LVBC roles, policy incoherence, enforcement capacity	*governance*, *management*, *lvfo*, *commission*, *organisation*, *enforcement*	Mediates how economic and ecological pressures are translated into rules, practices and outcomes.
Regional integration & transboundary issues	*Intervening / contextual condition*	East African Community, regional treaties, policy harmonisation, cross-border coordination	*East African*, *regional*, *community*, *cooperation*	Frames the scale at which solutions are negotiated, emphasising cross-border interdependence and constraints.

Legal & regulatory frameworks	*Structural condition / mechanism*	Fisheries laws, regulations, offences, sanctions, parliamentary oversight, legislative gaps	*legal*, *assembly*, *regulations*, *compliance*, *legislation*	Provides formal mechanisms for control and sanction, whose design and gaps shape actual enforcement dynamics.
Livelihoods & socio-economic vulnerability	*Phenomenon / consequence*	Livelihood dependence, poverty, income insecurity, community wellbeing, health, gender issues	*community*, *communities*, *livelihoods*, *health*, *income*, plus "poverty", "vulnerability" in text	Represents how macro-level dynamics materialise in people's lives and wellbeing.
Technology & fishing practices	*Strategy / operational mechanism*	Gears, boat technologies, industrial vs artisanal, aquaculture and cages	*boats*, *aquaculture*, *technology*, *industrial*, *gear*	Shows the concrete practices through which resources are exploited or potentially diversified.

4. Results and Analysis

The content analysis revealed six interrelated themes. Governance and institutions emerged as the most prominent theme, followed by ecological and environmental change and regional integration and transboundary issues. Legal and regulatory frameworks, livelihoods and socio-economic vulnerability, and technology and fishing practices were referenced less frequently, but consistently across the manuscripts.

Axial coding showed that economic dependence on Nile perch and export value chains functions as a key causal condition, embedded within a context of ecological degradation and environmental stress. Governance arrangements, regional integration and legal frameworks operate as intervening conditions, mediating how these pressures translate into enforcement practices and policy responses. Livelihoods and socioeconomic vulnerability appear primarily as consequences, capturing how macro-level dynamics materialise in community wellbeing, while technology and fishing practices represent strategies in the sense that they are the concrete means through which the fishery is exploited or diversified.

Political Factors: Challenges with governance and institutions

Lake Victoria is generally known as the largest inland fishery in the world and an essential economic resource to the East Africa region and the livelihoods of more than 40-47 million individuals in the basin. Some of the latest economic evaluations of the fisheries of Lake Victoria estimate that this fishery produces about US$600 million every year and has potential of earning US$800 million annually under sustainable management, though benefits are not evenly shared along the value chain and among the riparian states.

It is estimated that the fisheries sub-sector provides employment to over three million individuals, including approximately 200,000 fishers. It is one of the sources of revenue in Kenya, Tanzania and Uganda in the form of food, employment, and foreign exchange earnings contributing approximately 0.5%, 2.5% and 2.6%, respectively. These statistics highlight the extent to which national economies and household incomes are anchored to a relatively small number of commercial species, especially Nile perch, which further amplifies the susceptibility that is created by the reliance on primary commodities.

Frame and catch assessment surveys indicate that the fishing effort has grown significantly in the past two decades. In the Lake, the total number of registered fishers increased to almost 220,000 in 2016, as compared to 129, 000 in 2000, with almost half being based in Tanzania, 30% in Uganda and 20% in Kenya, while the number of fishing crafts amounted to more than 31,000 in 2016. These trends, coupled with the increasing amount of gears (longlines and gillnets) show an increase in competition over a resource that is already being ecological and regulatory stressed, as well as the volatility of income to small-scale fishers due to limited opportunities to store information or to transition to a different source of livelihood.

Governance and Institutional Framework

The Lake Victoria Basin Commission (LVBC)

The LVBC was set up in 2003 as part of the EAC's Lake Victoria Development Programme. It works to coordinate sustainable development across the basin, which includes Kenya, Uganda, Tanzania, Rwanda, and Burundi (Lake Victoria Basin Commission, 2024). The Commission's legal status was limited at first, which made it challenging for it to do its duty. It did not have a corporate identity until 2022, when the Lake Victoria Basin Commission Act was passed (East African Legislative Assembly, 2020). LVBC projects include making plans for climate resilience, setting up plans for oil spills, and setting water quality standards (United Nations & East African Community, 2024). However, limited funding, not enough staff, and dependence on donor aid make it not particularly effective (East African Legislative Assembly, 2021). Also, member states often do not want to adjust their national policies to fit with regional frameworks, which makes it more difficult to govern as a whole.

The Lake Victoria Fisheries Organisation (LVFO)

The FAO started LVFO in 1994. Its main goal is to manage fisheries through scientific research, regional cooperation, and policy advice (LVFO, 2024). Its stakeholders are

ministries of fisheries, beach management units (BMUs), researchers, and businesses that operate on the beach. It is based in Jinja, Uganda. The LVFO makes technical suggestions about how to assess fish stocks, set mesh size limits, and set catch limits. However, implementation is optional and varies among member states (Witte et al., 1989), permitting deviations influenced by national political or economic priorities.

Conflicts and Overlaps

The LVBC and LVFO are both part of the same regional bloc; however, their mandates sometimes overlap and even conflict. The LVFO focuses on regulating fisheries from a technical standpoint, while the LVBC focuses on managing the entire basin, including ecosystems and the livelihoods of the people who live there. This overlap causes bureaucratic confusion and reduces accountability, which is exacerbated by national governments only following some rules (East African Legislative Assembly, 2021; LVBC, 2024). For instance, the LVFO strictly enforces rules about mesh size, while the LVBC focuses on bigger environmental issues. This leads to policy conflicts.

The enforcement results on the lake are varied though the lake has regional bodies such as the LVCO and the LVBC. According to case study evidence, 40-60% of the fishing on Lake Victoria is illegitimate, unrecorded or unregulated which is one of the highest estimated rates of fishing in the world. This may have contributed to a reduction in an estimated Nile perch biomass of approximately 2.3 million tonnes in 1999 to less than 300,000 tonnes in 2008. This is an example of how loopholes in monitoring, control and surveillance and the lack of deterrence have enabled the unsustainable exploitation to continue despite formal regulatory frameworks.

The qualitative studies conducted in beaches of Kenya, Tanzania and Uganda reveal that corruption has penetrated the stakeholder groups, including fishers, fisheries officers, police and the judiciary and is strongly intertwined with the illegal fishing activities. It is the payments to escape the seizure of equipment or prosecution, or payments to obtain the release of the equipment that was seized, that delegitimize and render the co-management arrangements ineffective. This is one of the reasons why the introduction of consecutive BMU reforms and collaborative patrol efforts have failed to gain sustainable compliance though more forceful enforcement methods (including military intervention or suspension of BMUs) have been suggested.

Differences and Fragmentation in the Country

Inconsistency in Regulations

The laws and enforcement of fisheries are very different in Kenya, Uganda, and Tanzania. The LVFO suggests standard mesh sizes, closed seasons, and gear restrictions; however, these are not always followed. Kenya has been criticised for not enforcing mesh-size rules strictly enough, which has led to processors buying undersized fish from Tanzanian waters and hurting conservation (Capmad, 2024; The Exchange Africa, 2024). The minimum sizes for Nile perch (48 cm) and tilapia (28 cm) are stricter in Uganda than in Kenya and Tanzania (Lokina, 2024). Tanzania uses decentralised seasonal bans, while Uganda uses centralised and militarised methods (Lokina, 2010). There are also differences in fishing permits and the enforcement of closed seasons. These differences cause "leakage" in regulations, which enable

fishermen take advantage of the most conflicted areas and thwart conservation efforts in their own regions.

Militarisation and Failures in Enforcement

The Fisheries Protection Unit (FPU) in Uganda was set up in 2017 with military personnel to stop illegal fishing after a great deal of corruption in BMUs (Namaganda, 2023; Uganda Peoples' Defence Forces, 2022). At first, compliance increased, especially among motorised boats; however, it did not last long. The FPU was temporarily shut down in 2019 because of claims of brutality, extortion, and violations of human rights (Feed Business MEA, 2024; Namaganda, 2023). After the FPU, there are still gaps in enforcement because the economic factors that lead to illegal fishing have not been dealt with. Kenya and Tanzania, on the other hand, mostly use BMUs, which are community co-management bodies that are meant to regulate themselves. However, BMUs have trouble enforcing the law because they have limited resources, local power struggles, corruption, and political interference. According to court records, 76% of fisheries prosecutions in 2023 were thrown out, usually because of mistakes in the process or corruption in the courts (United Nations & East African Community, 2024). Central courts have a higher rate of convictions, but they cannot handle many local cases.

Political Competition and the Capture of the Elite

Political interference at home makes it even more difficult for governments to work together. In Tanzania, politicians are trying to get the minimum catch sizes lowered to help processors, even though LVFO and environmental NGOs are against it (Lokina, 2024; The Exchange Africa, 2024). People have criticised Uganda's militarised enforcement for giving regime supporters more control over resources (Namaganda, 2023). This elite capture, along with broken enforcement, leads to "policy leakage," which keeps bad habits going throughout the basin. People generally agree that overfishing is a problem; however, short-term national interests and political cycles often take precedence over long-term sustainability goals.

The environmental pressures are closely connected with social pressure. At the social level, the level of poverty near Lake Victoria is also very high: one of the features of the World Bank mentions that almost half of people living near the lake have to survive on less than US$ 1.25 a day. This income insecurity broadly affects reliance on fishing as a livelihood as a last resort, especially among young people and migrants with few assets or education. This inhibits household absorptive capacity to shocks owing to the changing catches or enforcement campaigns.

Simultaneously, environmental diagnostics underline the blistering of the water quality due to the runoff of various nutrients, raw wastewater and industrial effluents, and the seasonal change in rainfall and temperature due to climate fluctuations. These drivers lead to eutrophication, harmful algal bloom, and hypoxia, which consequently influence the distribution and productivity of important commercial species. Combined with overfishing and invasive species spread, the processes generate a feedback mechanism where the ecological degradation and the livelihood vulnerability mutually enforce each other.

Missed Opportunities and Failures of Institutions

Legal and Operational Limitations

Before it was legally recognised in 2022, the LVBC did not have the power to force policy changes or get regular funding. Even after being given formal power, delays in national budget contributions, not enough staff, and a lack of political interest make things less effective (East African Legislative Assembly, 2021). The LVFO's advisory role is limited by recommendations that are not binding, which leads to countries' only adopting rules that are good for them. This leads to legal patchworks and regulatory gaps between countries.

Problems at the Community Level

The BMUs, which were meant to be community-led ways to govern, have been weakened. Uganda stopped using BMUs in favour of militarised patrols. Kenya and Tanzania's BMUs do not have enough money, training, or freedom (Namaganda, 2023; Uganda Peoples' Defence Forces, 2022). Donor efforts to enhance BMU capacity have encountered significant challenges owing to distrust and scepticism, particularly in the aftermath of episodes of state repression.

Politics and Power Differences in the Region

Rivalries Between Kenya, Tanzania, and Uganda

Even though all EAC members are in the same group, national interests often come before regional ones. Kenya takes advantage of Tanzania's loose mesh size rules to catch small fish, which makes diplomatic tensions worse (Capmad, 2024; The Exchange Africa, 2024). Uganda's militarised enforcement is different from Kenya and Tanzania's community-focused approaches, which makes the region more divided. Nevertheless, collaborative patrols show how individuals can work jointly (Feed Business MEA, 2025). In October 2024, the three countries set up a regional border governance group under the EAC and the International Organisation for Migration (IOM) to make fishing rules more consistent, improve coordination of enforcement, and fight transnational crimes such as fish smuggling and illegal, unreported, and unregulated (IUU) fishing (International Organisation for Migration Kenya, 2024). This project shows how a growing number of individuals are aware of the problems that Lake Victoria faces across borders and how important it is for institutions to work together.

Limited Involvement from Rwanda and Burundi

Even though they are LVBC members, Rwanda and Burundi's roles in fisheries governance are not very important because they are landlocked. However, they do focus on protecting watersheds and pollution in the larger basin framework (Lake Victoria Basin Commission, 2024). As a result, they have little influence in negotiations about fisheries and export standards.

Possibilities for Reform and Regional Integration

There are opportunities to improve the governance of the Lake Victoria Basin, even though there are many problems. The LVBC's new legal status gives it a base for better coordination, but only if it gets more money, staff, and political support. Recent calls from the East African Legislative Assembly (EALA) for unified fisheries policies, joint

surveillance systems, and harmonised legal frameworks show that progress is being made (EALA, 2021). Increasing the power and independence of the BMU, making the courts more consistent, and encouraging open resource management could build trust in the community and put an end to elite capture. Furthermore, regionally financed collaborative enforcement protocols and patrols could mitigate regulatory leakage and transboundary disputes, advancing towards more sustainable and equitable basin management (Feed Business MEA, 2025).

Evolution of ecological impact in Lake Victoria

The introduction of Nile perch in the 1950s for economic gain dramatically reshaped the fish community composition (Njiru et al., 2007). By the late 1970s, predator biomass had soared, comprising 80–90 % of fish catch biomass in central regions, while cichlids declined to less than 1 % of catches. Between 2001 and 2006, Nile perch dominance decreased from 59 % to 39 % of biomass, suggesting some ecological feedback; however, continued cichlid suppression and ecosystem disruption persisted. The removal of algal-grazing cichlids undermined nutrient and oxygen cycling, creating favourable conditions for algal and weed proliferation. This algal bloom compounded previous eutrophication, destabilising thermal and oxygen stratification, extending anoxic zones towards shallower depths. Nile perch also ate other fish such as tilapines and minnows, and when those stocks declined, perch started eating shrimp and other invertebrates. The trophic collapse has diminished aquatic resilience, risking broader ecosystem failure and the potential collapse if remaining equilibrium processes break down. As a result, the ecosystem has been radically simplified, with a few species dominating a previously diverse habitat (Verheyen et al., 2003).

Simultaneously, the proliferation of invasive water hyacinth, facilitated by the same nutrient-rich conditions, reinforces these hypoxic dynamics. Floating mats of hyacinth block sunlight, reducing photosynthesis by submerged aquatic vegetation and further impairing oxygenation. Moreover, dense hyacinth coverage slows surface water mixing and traps organic matter, enhancing localized anoxia beneath the mats. These conditions selectively favour low-oxygen tolerant and often pathogenic organisms, including certain bacteria, protozoa, and invertebrates such as disease-carrying snails, thus shifting the lake's ecological balance toward less desirable or harmful species. Importantly, these feedback loops are compounded by sedimentation from catchment degradation. Deforestation, poor land-use practices, and expanding urban infrastructure have accelerated soil erosion, increasing silt input to the lake. This sediment further reduces photic depth and buries benthic habitats critical for fish reproduction. In turn, this limits the recovery of native fish populations, particularly species that require clean gravel or rocky substrates for spawning, reinforcing their vulnerability and allowing opportunistic or invasive taxa to dominate.

Technological Advancements in Fishing Practices

Over past decades, the introduction of new fishing gear, such as nylon gillnets, motorised boats, echo-sounders (fish finders), and even GPS has made fishing on Lake Victoria far more efficient than in the mid-20th century. These tools have lowered the physical and time-related barriers to fishing, allowing for longer distances to be

travelled, deeper areas to be accessed, and fish schools to be targeted more accurately. Such improved technology has seen a substantial increase in catch capacity, contributing to overfishing. In the 1950s and60s most fishers used rowboats or sail canoes, having access to small-scale net lengths, thereby curbing their ability to fish on a wide and deep scale. As a result, fishing was constrained by physical stamina, wind conditions, and limited navigation tools, resulting in modest catch volumes. Today, motorboats with long drifts of gillnets can catch a great deal more per trip, as the boats can remain on the lake for extended periods, covering vast areas and operating with increased intensity. This shift has often disadvantaged small-scale or subsistence fishers who cannot afford such technologies, thereby contributing to inequalities within the sector and undermining traditional practices of sustainable resource use.

Economic Impact

As the fishing industry is export orientated, fisheries bring money into the country, but often not into local hands. For instance, international exporters and urban entrepreneurs often own the boats or processing facilities, whilst local fishermen are only paid per catch. There is also the phenomenon of fish maw (fish bladder) trade, lucrative in Asian markets but often conducted illicitly, with profits bypassing the local community and going to a few traders. Furthermore, there is the issue of competition from fish imports or fish farming elsewhere. As local stocks declined and prices rose, imported fish such as farmed tilapia from China started appearing in East African markets. This hurts local communities by undercutting their product, yet East Africa must import to meet the protein demand.

Education Issues Within Lake Victoria

Owing to revenue loss from the Lake Victoria region, there is little money to be invested in education. As such, the education levels in local fishing communities are modest. Results indicate that 57% of fisher family members had attained primary level and only 1.1% university level. Fishers' family members could not attain the required educational level owing to lack of funds 67.6% This shows that most fishers in remote areas with few educational facilities have little access to vital knowledge and information, as well as a lack of awareness of sustainable practices and long-term implications of certain behaviours and activities. This is why outreach and training via BMUs or NGOs are critical – teaching fishers about why not to catch juveniles, or the benefits of allowing fish to breed. Training and basic education in these sectors will prevent further unsustainable fishing practices, allowing for the ecosystem to flourish whilst simultaneously retaining an adequate fish stock.

5. Policy Recommendations

Economic diversification is a necessity to ensure sustainable development in the Lake Victoria Region. Below are outlined proposals with specific paths to reduce dependence on Nile perch fishing.

Diversifying Economies of Riparian Nations

Aquaculture Expansion: Encouraging the development of sustainable aquaculture for species such as tilapia or catfish can provide both alternative food sources for the

locals but also diversified catch to sell. Both governments and NGOs can provide training and start-up support to fishing families in order to farm fish, either in ponds or cages. This process must be done carefully to avoid environmental harm, for example, proper siting of cages, using quality feed and regulating feeding times and quantities to reduce pollution. If done well, aquaculture expansion can supply local markets (bringing down fish prices and improving food security) and create new export streams, whilst simultaneously easing pressure on wild fish stocks. However, for this process to be successful, there must be investment into education to prevent further damage to the local economy and the ecology of Lake Victoria (as outlined in the ecological section).

Value-Added Fish Processing: Rather than exporting raw fish, local entrepreneurs could produce value-added products (such as smoked fish, fish fillets, canned fish, fish leather, fish oil supplements). This creates jobs beyond just catching and selling fish as is and can absorb the workforce from fishing if catches are limited. This opportunity also means that more profit stays in the local economy. Governments can incentivise this by providing microloans or facilities for fish processors. Naturally, the value-added processes require a level of skill that needs to be taught, therefore, both a time and capital investment are necessary.

Alternative Livelihoods Outside Fishing: Not everyone can or should remain within the fishing industry in Lake Victoria. There are other sectors, such as tourism, in the form of lakefront tourism with boat trips, or sport fishing tours for catch-and-release anglers (Lake Victoria has record-size Nile perch that could attract anglers worldwide, a revenue stream that incentivises keeping the fish alive). However, this flourishment of tourism also needs stability and infrastructure. In addition, not everyone will leave fishing easily owing to the pride and identity associated with fishing in the area. Another alternative is agriculture. There could be investment from the government or NGOs to improve irrigation and farming techniques so that communities can farm commercially with lake water instead of everyone fishing. This could both diversify food sources and also export potentials. Harvesting water hyacinth may also be a potentially successful path. Initiatives exist to make biofuel briquettes, baskets, or paper out of hyacinth. This simultaneously removes the weed and provides income and could be scaled up as a social enterprise. For each of these potentials outlined, there are challenges (namely in the form of capital investment). However, with community involvement and government support, these can gradually take root.

Ensuring Ecological Sustainability

Habitat Restoration: Protect and rehabilitate critical habitats, for example, replant wetlands and riverside forests to filter runoff. Communities could be paid to tree-plant as an alternative job, tackling both economic diversification and ecological sustainability). Establishing fish breeding sanctuaries (areas off-limits to fishing) can increase fish stocks and reduce the rates of juvenile fish being caught. Such no-take zones have shown success in other fisheries by serving as nursery areas that replenish the lake.

Pollution Control: Each country should invest in wastewater treatment for cities around the lake (Kisumu, Kampala, Mwanza) as even basic stabilisation ponds reduce nutrient flow. This would help to combat the issues of eutrophication within the lake. Promoting sustainable farming practices upstream (such as contour farming, using organic fertilizers, buffer strips along rivers) to reduce fertilizer runoff. This could potentially be achieved by seeking international funding (such as from the Green Climate Fund) for projects that improve water quality, framing it as climate adaptation and health improvement.

Invasive Species Management: Continue and enhance efforts to control water hyacinth, for example, release more weevils, have routine mechanical removal especially in clogged bays, and utilise the removed biomass productively as mentioned. For other invaders, such as scares about Nile tilapia hybrids, or carp introduction, preventative policy is important. For Nile perch, it is impossible to "unitroduce" them, but managing their population via fishing is ironically one way to keep it in check. Therefore, some fishing pressure on Nile Perch should be maintained but in a controlled way so that the population does not crash completely.

Climate Resilience: Prepare for how climate change might alter the lake (for example, more extreme floods or droughts). This could involve early warning systems, flexible management that can adjust during extreme events (such as temporarily banning fishing after a mass fish kill), and diversifying water sources for towns so that they are not solely reliant on the lake if water quality drops.

Fostering Regional Cooperation

Fostering regional cooperation is arguably the most crucial recommendation in this discussion. Without cooperative governance, there would be no proper governance of Lake Victoria.

Harmonise Regulations: As suggested by researchers and EAC reports, establishing uniform fishing regulations (including mesh sizes, size limits, closed seasons) across Kenya, Tanzania, and Uganda is necessary. This can be done through an EAC binding agreement. Once everyone abides by the same rules, there is less incentive to cheat because their neighbour has the same restrictions.

Joint Enforcement Patrols: A multi-national lake patrol unit should be created (perhaps under the LVFO's coordination) with personnel from all three countries that can operate across borders. This could reduce the issue of fishers hiding in border zones. It also builds trust; each country sees the other is equally committed. Donors might fund such an initiative with boats and equipment.

Empower Regional Institutions: The LVBC and LVFO should be given the mandate and resources to enforce or ensure compliance with regulations. For instance, member states could agree that the LVFO's recommendations on quotas or closures become binding after a certain threshold of scientific consensus. Alternatively, the LVBC could be given authority to review and approve any new large projects (such as irrigation

schemes or industrial plants) for their lake impact. This will essentially strengthen these bodies beyond mere advisory roles.

Community Involvement and Co-Management:
It is clear that top-down management policies will not work to ensure sustainable development in the Lake Victoria region. Thus, it is necessary to ensure grassroot co-management and community involvement to invigorate effective governance. Therefore, BMUs Should be reformed and supported, ensuring that they are democratic, free of corruption, and given legal authority. This can possibly be done by limiting the number of fishers via BMU registration (as Dr. Lokina (2024) suggested: when someone leaves the BMU, there does not have to be an immediate succession). This reduces the risk of rushing in a new member that may not be fit for the BMU.

Furthermore, education and awareness campaigns are necessary. A key reason why there has been ineffective governance to ensure sustainable lake stewardship is the lack of education. Engaging local leaders, schools, and media to spread the message of sustainable fishing and lake stewardship (which can be done through culturally tailored messages, namely in local languages, using folk songs or theatre that could be better in line with the communities' roots) can be effective, especially about respecting breeding seasons or not polluting the lake water. Such outreach programmes will aid in mitigating the issues of lack of awareness as outlined in the education impact section.

Policy Support for Transition
Policies are necessary to cushion the transitions for the management of Lake Victoria for those affected. If fishing efforts must be reduced (which they must) to ensure sustainability in the region, there will be excess fishers. Programmes such as buying back of fishing boats and nets or providing a social safety net during the transition could be important. An example is a microcredit scheme to help a fisher start a small farming business. Governments can seek funding for such livelihood transition programmes. Introducing rights-based fishing (such as territorial use rights or catch shares) would instil a sense of ownership. When fishers have a secure stake, they are more likely to fish responsibly. This was hinted at by experts, namely that assigning fishing rights and limiting entry can prevent the "free-for-all" tragedy of the commons situation that is occurring at present, leading to mass resource depletion. It may be complex in a multi-country lake; nevertheless, pilot programmes could be trialled in smaller areas.

Monitoring and Evaluation
It is clearly important to track the outcomes of these recommendations should they be implemented. Interventions, such as new regulations or livelihood projects, would need to be monitored and calibrated to suit the local communities. Adaptive management is key to ensure that these opportunities are best placed for long-term success - learning from what works and what does not, and being willing to change course is necessary. A Lake Victoria report card or annual health report may be helpful to keep attention on key indicators (fish stocks, water quality metrics,

community wellbeing metrics such as income or nutrition). This would create accountability amongst the riparian nations and inform the public. By implementing these diversification strategies and co-operative management policies, the riparian communities can become more resilient and less dependent on a single resource, and the lake's ecology can recover, thereby securing the future for both the people and the environment of Lake Victoria.

6. Discussion

This study finds that the social-ecological system of Lake Victoria is characterised by three fundamental weaknesses that include: (i) increasing economic reliance on a single export product, namely the Nile perch; (ii) disjointed and politicised transboundary governance; and (iii) rising social pressures that are coupled with a deteriorating ecology. Collectively, these dynamics become mutually supportive that create a vicious cycle of livelihood precarity, environmental pressure, and institutional instability. In this section, the authors put these findings into perspective as per the available literature and the modern theoretical frameworks, with special emphasis on areas of congruency, points of departure, and the general implications.

Dependence on Nile Perch Economically

The economy of Lake Victoria has been in a precarious situation where only one export-driven species is involved. This supports previous results where it was found that the lakeside fishing populations are nearly devoid of income-diversification, with one study reporting that 89.4% of fishers did not have alternative livelihoods, making them highly vulnerable to stock crashes or market downturns. This kind of dependency is replicative of the Prebisch-Sanger trend in which commodity exporters suffer deteriorating trade conditions, undermining their long-term strength. The idea of resilience theory is that a low diversity of species or income makes a system less susceptible to disturbances. At Lake Victoria, ecological and economic dominance of Nile perch implies that every shock such as disease, collapsing prices or regulatory closures will paralyze the communities. This risk has been proven to happen: the world market integration around the perch boom made export traders rich and did not benefit household nutrition much since the majority of the income went not to fishing families but to male wholesalers (Geheb et al., 2008).

A political ecology prism brings to the fore the advantages of export-oriented resources to the benefit of a small group of people at the expense of a large number of people who face food insecurity. The same processes in coastal East Africa (Crona et al., 2010) indicate that credit regimes of patron-client lending trap small-scale fishers into a form of unsustainable fishing (rather than diversifying), thereby further decreasing their resilience. These similarities indicate that Lake Victoria is trapped in a time-honoured resource trap: communities continue to be dependent on one specific species, therefore forcing them to over-fish and creating a fragile cycle of dependency. To stop this cycle, there will be the need to diversify consciously and add value more equally to stabilize the livelihoods.

Fragmented Governance

The transboundary nature of the lake has resulted in a miasmic overlapping of rules and feeble institutions. Our discussion reveals that the LVFO and LVBC have ambiguous mandates but lack the power to enforce them effectively, whereas Kenya, Uganda, and Tanzania maintain different national policies. This generates regulatory leakage in which parties can take advantage of jurisdiction that is most accommodating. These remarks are reminiscent of old-time criticism of fractured, unclear governance in the lake. Despite the fact that such a large resource requires coordinated work, polycentric control, a lack of political and institutional freedoms has prevented concerted efforts on numerous occasions. The commons governance framework suggested states that to be able to manage, there must be boundaries and congruent rules (Ostrom, 2009), and the diffuse authority structure of Lake Victoria contravenes these.

Nunan (2020) also demonstrates how the competitive authoritarian politics, lack of local capacity, and corruption are broader political-economic realities to co-management structures such as BMUs. On paper these bodies exist; however, owing to power imbalance and inadequate institutional support, their usefulness is acutely restricted, which is also the lesson of Ostrom (2009) that, without enabling conditions, users cannot self-organize. Even the overfishing has been exacerbated by past state policies such as credit and licensing programmes that favour the large operators. Other cross-country cases provide a pattern of consistent consistency: in most instances where political co-ordination and norms are weak, common resources are eroded. To restore governance in Lake Victoria, new rules will not be enough, but the harmonisation of cross-border policy, the strengthening of the community institutions, and the destruction of political patronage regimes that stand in the way of compliance should be welcomed.

Social-Ecological Degradation and Resilience

The most distressing finding revealed by this study is the loss of health and well-being in the ecological system and the community – a sign of a system losing its resilience. The lake has changed radically ecologically since the 1980s: the introduction of perch of the Nile species killed the majority of endemic cichlids (around 90%), while nutrient pollution caused algal growth and hypoxia. This has contributed to the lack of cheap local fish socially, which exacerbates protein insecurity. These forces are reflected back to the destructive acts such as the use of illegal gears by desperate fishers which, in turn, slow down the ecological recuperation. This cycle has been corroborated by local reports about the process of poverty and environmental decline that supports each other. Based on social-ecological systems perspective, such strengthening feedback indicates that the system is languishing in an unwanted level of stability, on the verge of a tipping point from which it will be difficult to recover. Even very diverse ecosystems may collapse owing to cumulative stress as Kaufman (1992) observed. Reduction of both livelihoods and fish populations has left the system with few buffers which sustain resilience. This has left the lake in an impoverished balance of fewer species, less choices of livelihood, and increased vulnerability. To get out of this kind of trap, it is usually a question of either getting used to it (incremental improvements) or restructuring it (fundamental restructuring). The recovery was only

successful when ecological restoration and community resilience were not considered separately in similarly stressed lakes in Asia. This implies that individual fixes, whether ecological or economic, will not work. What is required is a holistic solution that conserves ecological capacity and provides social support in terms of diversified incomes and food security.

Synthesis

Combined, these results demonstrate that the issue of Lake Victoria is highly inseparable. Lack of diversification of the economy based on Nile perch, poor governance and social-ecological degradation constitute a vicious circle adding to vulnerability. Both of them represent a wider theoretical perspective: commodity chain dependence, commons governance, resilience theory (Folke et al., 2010). Most importantly, the interventions have to be holistic: ecological preservation has to be accompanied by economic options, and national policies should be compliant with each other. Possible ways forward will bridge livelihood and ecosystem resilience, enhance community and transboundary governance, as well as more equitable benefit distributions. These lessons form the basis towards making integrated suggestions towards the conclusion.

7. Conclusion

There are a few limitations that are realized in this study. Primary data were not gathered, and the dependability of results and correctness of the recommendations are dependent on the quality and accuracy of references. Second, the qualitative and documentary research can contribute to a likelihood of missing finer-temporal or spatial patterns such as finer-scale shifts in species abundance or changes in community livelihoods although efforts are made to offset this by synthesizing the ecological and socioeconomic data closely. Future studies could use longitudinal surveillance of the major ecological and economic variables, and on-site focus groups, interviews and participatory evaluations to better estimate the probable outcomes of the suggested policy interventions. Another weakness relates to a political timescale of fisheries governance. The reforming process can be less resistant to change in political leadership and there may be withdrawing and retracting of a policy with short-term incentives or citizen pressure. It has proven to be especially significant in Lake Victoria, in which the governance was characterised by institutional fragmentation, national contradictions and intermittent enforcement at cross-border levels. Even though organizations in the region such as the LVBC and LVFO offer formal cooperation platforms, these organizations have been limited owing to the legal ambiguities, lack of resources and conflicting national interests. These structural obstacles are to be solved by means of harmonised regulatory systems, committed and responsible BMUs, de-politicised management systems and long-term political will of all riparian states. Devoid of such reforms, there is the likelihood that ecological degradation and socioeconomic susceptibility will remain a problem, endangering the livelihoods of over 40 million people relying on the lake. In general, the discussion shows that resilience of the social–ecological system of Lake Victoria will not only require ecological recovery but also the change of governance, legal and regional systems to improve livelihood security by decreasing structural dependency.

7. References

101 Last Tribes. (2011). *Kuria people – Africa*. 101 Last Tribes. https://www.101lasttribes.com/tribes/kuria.html

Abila, R., & Jansen, E. G. (1997). *From local to global markets: The fish exporting and fishmeal industries of Lake Victoria – structure, strategies and socio-economic impacts in Kenya*. International Institute for Environment and Development.

African Center for Aquatic Research and Education. (2025, March 4). *Lake Victoria*. African Center for Aquatic Research and Education. https://www.agl-acare.org/resources/the-african-great-lakes/lake-victoria/

Arezki, R., Hadri, K., Loungani, P., & Rao, Y. (2014). Testing the Prebisch–Singer hypothesis since 1650: Evidence from panel techniques that allow for multiple breaks. *Journal of International Money and Finance, 42,* 208–223.

Besjournals. (2025). *Lake-related ecosystem services facing social–ecological risks*. Besjournals. https://besjournals.onlinelibrary.wiley.com/doi/full/10.1002/pan3.70015

Britannica. (2025, August 27). *Lake Victoria size, map, countries, & facts*. Britannica. https://www.britannica.com/place/Lake-Victoria

Capmad. (2024, October 13). *EAC Zone: Need to fight against overfishing*. Capmad. https://www.capmad.com/agribusiness-en/eac-zone-need-to-fight-against-overfishing/

Crona, B.I., Nyström, M., Folke, C., & Jiddawi, N. (2010). Middlemen, a critical social-ecological link in coastal communities of Kenya and Zanzibar. *Marine Policy, 34*(4), 761–771. https://doi.org/10.1016/j.marpol.2010.01.023

East African Legislative Assembly. (2020). *Lake Victoria Basin Commission Act*. East African Legislative Assembly.

East African Legislative Assembly. (2021). *Committee on agriculture, tourism and natural resources: Report on the on-the-spot assessment of the implementation of projects by the Lake Victoria Basin Commission and the Lake Victoria Fisheries Organisation* [Final report]. East African Legislative Assembly.

East African Legislative Assembly. (2024, February 19–24). *Committee on agriculture, tourism and natural resources: Report on the on-the-spot assessment of the implementation of projects by the Lake Victoria Basin Commission and the Lake Victoria Fisheries Organisation* [Final report].

Food and Agriculture Organization (FAO). (1962). *The Nile Perch question: A general review.* Food and Agriculture Organization. https://www.fao.org/4/t0037e/t0037e09.htm

Feed Business MEA. (2024, October 21). *Uganda's Fisheries Protection Unit faces criticism amid efforts to combat illegal fishing.* Feed Business MEA. https://www.feedbusinessmea.com/2024/10/22/ugandas-fisheries-protection-unit-faces-criticism-amid-efforts-to-combat-illegal-fishing/

Feed Business MEA. (2025, June 8). *East Africa moves to harmonise Lake Victoria fishing rules*. Feed Business MEA. https://www.feedbusinessmea.com/2025/06/09/east-africa-moves-to-harmonise-lake-victoria-fishing-rules/

Folke, C., Carpenter, S.R., Walker, B., Scheffer, M., Chapin, T., & Rockström, J. (2010). Resilience thinking: Integrating resilience, adaptability and transformability. *Ecology and Society, 15*(4), Article 20. https://doi.org/10.5751/ES-03610-150420

Fondazione Slow Food. (2018, December 8). *Lake Victoria haplochromine cichlid fishes*. Fondazione Slow Food. https://www.fondazioneslowfood.com/en/ark-of-taste-slow-food/bukeije/

Food and Agriculture Organization (FAO). (2004). *The state of world fisheries and aquaculture 2004.* FAO.

Geheb, K., Kalloch, S., Medard, M., Nyapendi, A.T., Lwenya, C., & Kyangwa, M. (2008). Nile perch and the hungry of Lake Victoria: Gender, status and food in an East African fishery. *Food Policy, 33*(1), 85–98. https://doi.org//10.1016/j.foodpol.2007.06.001

Gibbon, P. (1997). *Markets, civil society and democracy in Kenya*. Nordic Africa Institute.

Great Lakes of Africa. (2016, May 31). *Lake Victoria*. Great Lakes of Africa. https://www.greatlakesofafrica.org/lake-victoria/

Harper, D. M., Mavuti, K. M., & Muchiri, S. M. (2003). The wetlands of Lake Victoria, new approaches for understanding their role. *Transactions on Ecology and the Environment, 63*, 471–480.

Harvey, D. I., Kellard, N. M., Madsen, J. B., & Wohar, M. E. (2010). The Prebisch–Singer hypothesis: Four centuries of evidence. *The Review of Economics and Statistics, 92*(2), 367–377.

Horne, A., Webb, J. A., Mussehl, M., Lovell, D., Szemis, J., Kaplan, B., … Neave, I. (2024). The global value of freshwater lakes. *Nature Communications, 15*(1), 1657.

International Organisation for Migration Kenya. (2024). *Countering transnational threats on Lake Victoria: Kenya, Tanzania, and Uganda convene to enhance border security and coordination*. International Organisation for Migration Kenya. Retrieved from https://kenya.iom.int/news/countering-transnational-threats-lake-victoria-kenya-united-republic-tanzania-and-uganda-convene-enhance-border-security-coordination

Imamoto, M., Mzighani, S. I., Ngatunga, B. P., Seehausen, O., & Nikaido, M. (2024). Nile perch invasion triggered genetic bottlenecks in Lake Victoria's endemic cichlids. *Molecular Biology and Evolution, 41*(6), msae107.

Kaufman, L. S. (1992). *Catastrophic change in species-rich freshwater ecosystems: The lesson of Lake Victoria*. **BioScience, 42**(11), 846–858. https://doi.org/10.2307/1312084

Kreditanstalt für Wiederaufbau (KfW) Development Bank. (2023, December 31). *Sustainable management of Africa's largest lake.* KfW Development Bank. https://www.kfw-entwicklungsbank.de/Global-commitment/Subsahara-Africa/East-African-Community/Project-information-Lake-Victoria/

Lake Victoria Basin Commission (LVBC). (2024). *LVBC annual review – 2024* (2nd ed.). LVBC.

Lake Victoria Fisheries Organisation. (2024). *Lake Victoria Basin regional aquatic organisms' health strategy 2024–2034* (LVB RAOHS). LVFO.

LinkedIn. (2024, March 29). *The introduction of Nile Perch into Lake Victoria, ecological impacts.* LinkedIn. https://www.linkedin.com/pulse/introduction-nile-perch-lake-victoria-ecological-impacts-socio-economic-q2jpf

Lokina, R. (2024). *Overfishing and the need for unified regulations in the East African Community*. *The Exchange Africa*. https://theexchange.africa/countries/overfishing-eac-states/

Namaganda, A. (2023). *Corruption and enforcement in Uganda's fisheries management*.

Njiru, M., Nyamweya, C., Gichuki, J., Mugidde, R., Mkumbo, O., & Witte, F. (2007). Exotic introductions to the fishery of Lake Victoria: What are the management options? *Lakes & Reservoirs: Research & Management, 12*(4), 277–285.

Nunan, F. (2020). The political economy of fisheries co-management: Challenging the potential for success on Lake Victoria. *Global Environmental Change, 63*, 102101. https://doi.org/10.1016/j.gloenvcha.2020.102101

Ogutu-Ohwayo, R., Balirwa, J., Katunzi, E., Namulemo, G., & Wandera, S. (2005). *Deleterious effects of non-native species introduced into Lake Victoria, East Africa* [PDF]. WorldFish Center Digital Archive.

Ostrom, E. (2009). A general framework for analyzing sustainability of social-ecological systems. *Science, 325*(5939), 419–422. https://doi.org/10.1126/science.1172133

Oxford Academic. (2005, August 31). *Origins of the Nile Perch in Lake Victoria*. Oxford Academic. https://academic.oup.com/bioscience/article/55/9/780/286121

ScienceDirect. (2011). *Wetlands and water quality in Lake Victoria*. ScienceDirect. https://www.sciencedirect.com/science/article/abs/pii/S0921800911000450

Seehausen, O., Terai, Y., Magalhaes, I. S., Carleton, K. L., Mrosso, H. D., Miyagi, R., … Okada, N. (2008). Speciation through sensory drive in cichlid fish. *Nature, 455*(7213), 620–626.

The Exchange Africa. (2024). *Tackling overfishing: Why EAC needs unified regulations*. https://theexchange.africa/overfishing-eac-states/

Tyers, A. M., Tóth, E., Pironon, S., Barwell, L. J., Isaac, N. J., & Outhwaite, C. L. (2024). Testing alternative hypotheses for the decline of cichlid fish in Lake Victoria. *PLOS Sustainability and Transformation, 3*(3), e0000104.

Uganda Peoples' Defence Forces (UPDF). (2024). *Fisheries Protection Unit destroys illegal fishing gear worth…* Retrieved from https://www.updf.go.ug/uncategorized/fisheries-protection-unit-destroys-illegal-fishing-gear-worth-shs-423m/

United Nations Water. (2022). *Transboundary waters.* UN-Water. https://www.unwater.org/water-facts/transboundary-waters

Vedantu. (2025, January 16). *Introduction of Nile Perch in Lake Victoria*. Vedantu. https://www.vedantu.com/question-answer/introduction-of-nile-perch-in-lake-victoria-of-class-9-biology-cbse-5f7eb19de89c675ac6496ded

Verheyen, E., Salzburger, W., Snoeks, J., & Meyer, A. (2003). Origin of the superflock of cichlid fishes from Lake Victoria, East Africa. *Science, 300*(5617), 325–329.

Village Volunteers. (2011). *A cultural guide to the Luo People* [PDF]. Village Volunteers. https://www.villagevolunteers.org/wp-content/uploads/2011/10/Luo-Cultural-Guide1.pdf

Vocal Media. (2025, March 5). *Nam Lolwe and Lake Victoria*. Vocal Media. https://vocal.media/history/nam-lolwe-and-lake-victoria

Wikipedia LVFO. (2012, September 23). *Lake Victoria Fisheries Organization*. Wikipedia. https://en.wikipedia.org/wiki/Lake_Victoria_Fisheries_Organization

Wikiwand. (2020, February 1). *Lake Victoria.* Wikiwand. https://www.wikiwand.com/en/articles/Lake_Victoria

World Bank. (2016, February 28). *Reviving Lake Victoria by restoring livelihoods*. World Bank. https://www.worldbank.org/en/news/feature/2016/02/29/reviving-lake-victoria-by-restoring-livelihoods

This paper may be cited as:

Sayani, R. (2025). Towards resilient ecosystems and livelihoods: A PESTLE examination of Lake Victoria's fisheries. *International Journal on Multidisciplinary and Applied Research, 1*(2), 1-24. https://doi.org/10.63236/ijmar.1.2.4

