Potential for aquatic cultural services in fresh water for fresh water- based ecotourism, Vawnikulam reservoir, in Mullaitivu, Sri Lanka

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Abstract

Freshwater-based tourism comprises both tourism and an ecotourism component. The current study evaluates the diversity of freshwater fish in water resources that may suffer from freshwater-based tourism (Ecotourism) within the zone and investigates conceivable opportunities for such ecotourism in Vawnikulam major reservoir in Mullaitive district, Sri Lanka. The Mullaitive district has distinctive topographical highlights that have a high potential for fresh water resources. These highlights include three major tanks, sixteen medium tanks, and more than 100 minor tanks. There are just 21,399 land-based freshwater bodies, 8% of the total land area, and no significant perennial rivers that can be used to irrigate crops. This study used a mix of primary (qualitative and quantitative) and secondary information sources. Multi-gillnet rods and hooks were chosen as the material for the particular harvest strategy, which was utilized to gather the sample. From January to December 2022, the Vawnikulam major reservoir within the Mullaitive district was considered. Fish diversity, relative abundance, and diversity indices were determined and applied to analyze the potential for ecotourism based on freshwater resources. During the study period, 28 species including 11 families were recorded. According to national conservation status (NCS) ,7 Endemic (E) species 14 Native species (NA), 6 Introduced species, and 1 species were Near threatened (NT) were identified. In order to disentangle the pathways of fresh water as aquatic cultural services and create fresh water-based ecotourism activities that can develop in Mullaitive district, Sri Lanka, this investigation distinguished the travellers within the considered area. It also analyses appropriate freshwater-based ecotourism activities.

Keywords: Mullaitivu; Topographical; Ecotourism; Vawnikulam major reservoir; Endemic (E); Near threatened (NT); Native species (NA); National Conservation Status (NCS)

1. Introduction

The growing popularity of ecotourism frequently corresponds to the need for more fresh water resources to fulfill the enormous water demands of the tourism sector. Travelling to natural places while protecting the environment and enhancing local quality of life is referred to as ecotourism, according to the International Ecotourism Association [2]. The demand for tourism services is steadily increasing, and the ecotourism industry is growing on a global scale [12]. The new face of tourism is ecotourism, which is low-impact nature travel that supports the preservation of species and habitats directly through conservation efforts or indirectly by providing the local community with a stable source of income that encourages them to value and safeguard the local wildlife heritage [39].

The potential for Sri Lanka to grow as an ecotourism destination is great [3, 40]. Considering having adequate resources, Sri Lanka's ecotourism industry still contributes a modest portion to the country's overall revenue. This is a result of the fact that some people may still avoid the Northern Province out of nervousness about what they have experienced in the past. In this post-war developing context, ecotourism is suited as a win-win option for sustainable development [4, 5], and plays a significant role in maintaining local cultural identity, biodiversity, and natural resources [29, 6].

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Nowadays, recreational fishing is considered a vital component of ecotourism, which involves visiting places with pristine wildlife and related activities, beautiful primary attractions, and the ability to provide financially viable possibilities for the development of nearby communities. Furthermore, ecotourism gives visitors the ability to participate in educational activities and demonstrations, which piques their interest in the environment and its resources. It's the practice of harvesting fish in both artificial and natural bodies of water for amusement or competition.

The use of a rod, reel, line, hooks, and any one of a broad variety of baits is the most popular method of recreational fishing. Fish that are endemic and native to the area are not fully acclimated to lacustrine conditions. Therefore, relying solely on local fish species will not result in a sufficient catch. Exotic species thus have a significant role in reservoir fisheries [11]. There are about 137 species of freshwater fish in Sri Lanka, comprising 90 true freshwater species, 53 endemic species, 23 estuarine species, and 24 alien species. The majorities of the island's exotic fish species are firmly established and constitute the vast majority of the fish biomass [3]. For the benefit of future generations, water bodies (such as tanks and reservoirs) used for tourism must be routinely monitored and managed to protect their unique cultural, natural, and ecological characteristics. Ecotourism activities include swimming, sailing, canoeing, boat tours for observing pure nature, and other pursuits involving freshwater or the surroundings [36].

Likewise, ecotourism Freshwater conditioning includes relaxing in serene natural surroundings, engaging in nature remedies in tanks, lakes, and aqueducts, and studying the foliage and wildlife around. Figures of trippers are ready to engage in similar conditioning, which is being promoted by several countries throughout the world. Sri Lanka also has a variety of fresh water bodies in the dry zone. Multiple smaller reservoirs can be found across the country's dry zone [14]. Beginning in the early 1980s as a subset of adventure tourism and ecotourism, fresh water tourism began to make use of multitudinous fresh water parcels in fat nations, including America, Canada, England, New Zealand, and Australia. Likewise, these countries have made significant progress in this area. After that, this moxie was spread to Asia, Africa, South America, and, to a lesser extent, Africa, which led to the expansion of the fresh water tourism industry in these regions.

1.1. Benefits of fresh water-based ecotourism

Freshwater-based ecotourism offers several benefits for both the environment and local communities. Freshwater ecosystems, including rivers, lakes, and wetlands, are often rich in biodiversity. Ecotourism can provide incentives for the protection and conservation of these ecosystems, as it creates economic value from intact natural environments. This helps maintain critical habitats for various species [13, 27]. Freshwater ecotourism can stimulate local economies by generating revenue through activities such as fishing, wildlife watching, and nature-based tourism. This, in turn, can lead to the development of local infrastructure and the creation of jobs in the tourism industry [37]. Ecotourism often involves interactions with local communities, offering tourists the opportunity to learn about indigenous cultures and traditional practices. This cultural exchange can promote understanding and respect for diverse ways of life [15]. Freshwater ecotourism can serve as an educational platform, raising awareness about the importance of conserving these ecosystems. Tourists can gain a deeper understanding of the local flora and fauna, as well as the environmental challenges faced by these regions. [9]. Tourism in freshwater ecosystems can contribute to scientific research and monitoring efforts. Local ecotourism operators and researchers can collaborate to collect data on the health and status of these ecosystems, helping inform conservation initiatives [20], by promoting sustainable practices, freshwater ecotourism can encourage the responsible use of natural resources. Regulations and guidelines can be put in place to ensure the long-term health of the ecosystems and the communities that depend on them. [7, 29].

The presence of ecotourism activities in freshwater environments can lead to increased political support for conservation efforts. Local and national governments may priorities the protection of these areas due to their economic and cultural significance. [19] In some cases, freshwater ecotourism can indirectly lead to efforts to improve water quality in rivers and lakes, as cleaner and healthier ecosystems are more attractive to tourists [24], for local communities, freshwater ecotourism can offer an alternative or additional source of income, reducing dependence on activities that may harm the environment, such as deforestation or unsustainable agriculture [18]. It is essential to note that the benefits of freshwater ecotourism can be maximized when implemented with a strong commitment to sustainability and responsible tourism practices. Careful planning and management are necessary to ensure that tourism does not harm the very ecosystems it seeks to celebrate and conserve. It is important to note that the success of freshwater-based ecotourism in developing countries depends on responsible and sustainable practices that minimize negative impacts on the environment and local communities. National Ecotourism Policy Plan is being formulated to promote Sri Lanka as a unique ecotourism destination. In addition, the Institute of Policy Studies (IPS) of Sri Lanka, the research agency, had presented a comprehensive plan to promote and manage nature tourism in Sri Lanka [22]. Sustainable ecotourism planning and management are crucial to realizing these potential benefits while preserving the integrity of freshwater ecosystems for future generations [16].

Objectives

By assessing the diversity of fresh water fish in the Vawnikulam major reservoir, Mullaitive, Sri Lanka, this study's overall ideal was to estimate the diversity that could support fresh water based ecotourism in the vicinity.

The specific objects were to:

- To determine the range of fresh water fish species that have a high potential for promoting freshwater-based ecotourism; and
- To make recommendations for developing sustainable ecotourism, specifically Fresh water based ecotourism is study area.

2. Methodology

Given the exploratory nature of the research, primary and secondary sources were used for qualitative and quantitative investigations. In terms of primary sources such as standard information collection, observations, and field visits, at the same time, secondary sources such as media, including scholarly writing, daily papers, government reports, official reports, and promotional materials, will be used.

2.1. Qualitative Analysis of Secondary Sources

Mullaitivu Area (90° 14’ N, 80° 32’ E) was illustrated as a district in 1979 and is found within the Northern Province of Sri Lanka. Jaffna and Kilinochchi districts to the north, the Indian Ocean to the east, Trincomalee and Vavunia districts to the south, Mannar district to the west, and a little portion to the south bound the district. The district's total land area is around 2,616.9 square kilometers. This district is found within the Dry Zone of Sri Lanka. The normal yearly precipitation in this range shifts between 1200 mm and 1900 mm, indicating a bimodal precipitation design. The temperature in Mullaitivu Locale ranges from 23 °C to 39 °C. The north-eastern rainstorm season endures from early October to January and is the wettest and coldest time of the year [28].

2.1.1. Fresh Water Resources in Mullaitive District

The area has three major reservoirs: 16 medium tanks and over 100 little tanks, with command ranges of 5,791 ha, 2,794 ha, and 5,098 ha, respectively. There are no major perennial waterways accessible to supply water systems for cultivation. Mullaitive area consists of 21,399 land-degree (ha) fresh water bodies and 8 rates (%) out of the total to be utilized.

2.2. Primary data collection

2.2.1. Data count method

The study was conducted in the large perennial reservoir of Vawnikulam (Figure 1) in Mullaitive district, Northern Province, Sri Lanka. Vawnikulam major reservoir with ranges of 1,275 (ha), at Full Supply Level (FSL) respectively. A selective gathering strategy was utilized for collecting fish and prawns caught by multi-mesh gillnets (50.8 mm, 63.5 mm, 88.9 mm, 101.6 mm, 114.3 mm, 127 mm, 152.4 mm, and 177.8 mm, hitch to tie) and rods and hooks. Study period from January to December 2022. These gillnets were set in almost all parts of each reservoir by local fishermen within the evenings around 4.00 p.m. to 6.00 p.m. and collected on the following day morning around 5.00 a.m. to 9.00 a.m. It was the same mesh estimate. All fish and prawn species were sorted and distinguished by species level [30].

2.2.2. Study area profile

The Vawnikulam tank (09°05’19”N 80°20’54”E), located in Mullaitivu, Sri Lanka, and is a perennial fresh water reservoir. It plays a crucial role in freshwater fishing, agricultural irrigation, and water supply. The Vavunikulum forest centers on the Vavunikulum tank. The region still consists of scrub jungle, with some areas having large trees and dense forest cover surrounding the tank. The tank on Pali Aru was earlier known as Peli Vapi. The restoration of the tank which have a catchment area of 228 km^2, commenced in 1954s, with the support of the Australian government by the late 1960s, the tank's bund was 2 miles (3 km) long and 24 feet (7 m) high, while the tank's storage capacity was 35,300 acre·ft (43,541,909 m3), and its water spread area was 3,150 acres (1,275 ha). The Vavunikulum Sanctuary is situated nearby the villages Pandiyankulam and Panankamam, featuring a natural landscape that adds aesthetic value to ecotourism.

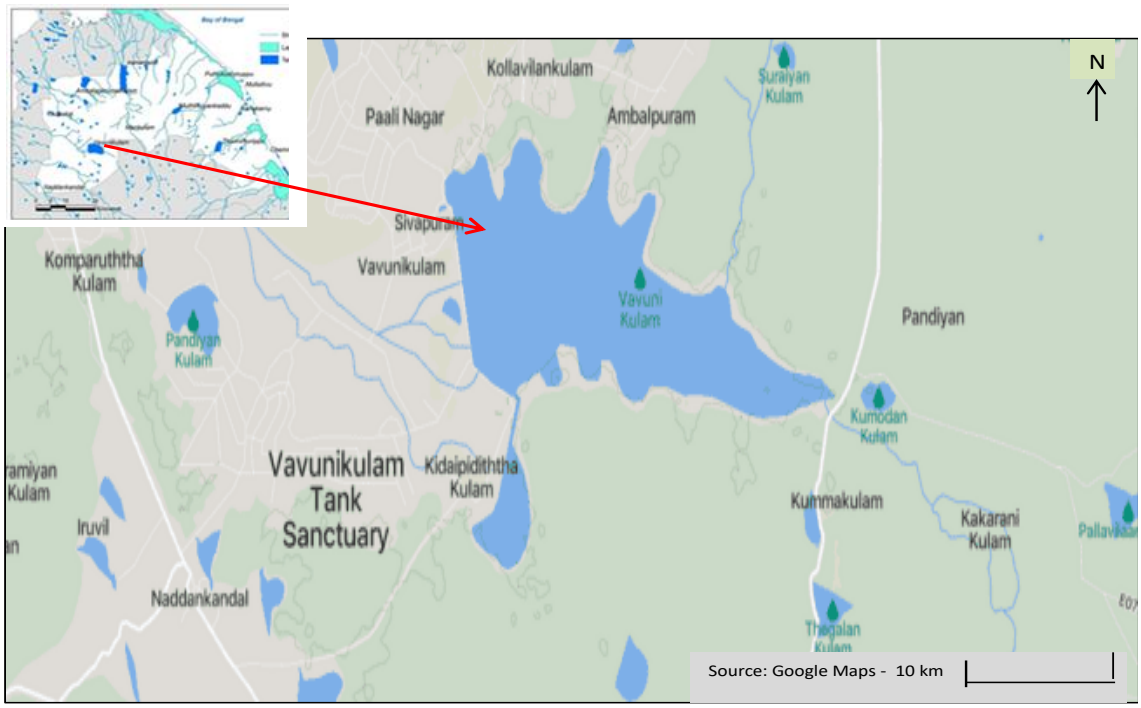

Figure 1 Data collection sites at Vawnikulam tank in Mullaitive district.

2.3. Statistical Analysis

2.3.1. Relative Abundance

The relative abundance of each species was calculated using equation (1)

Relative abundance = (ai/A) 100 % ..... (1)

Where,

ai = the number of individuals caught In the i^{th} species

A = the total number of individuals

2.3.2. Shannon-Weiner diversity index (H')

Shannon-Weiner diversity index (H') [35] was calculated by the equation (2)

$H' = -\sum Pi\ s\ i{=}1 * ln\ Pi$ ..... (2)

Where,

S = the total number of species

Pi = the relative cover of ith species.

2.3.3. Species richness

Species richness was calculated by using Margalef index (d) [25], using the equation (3)

d = (S-1)/ ln (N) ..... (3)

Where,

S = the total species

N = the total individuals.

2.3.4. Shannon Evenness of Species

Evenness (J') was calculated using Shannon's Diversity index using the equation (4)

$J' = H'$ ln/ S …… (4)

Where,

S = the total number of species

H'=Shannon index

J'= Evenness

2.3.5. Dominance index

The dominance index [17] was measured to identify whether particular species was dominating in the specific aquatic resource. Dominance index was calculated by using equation (5)

$D = \sum (ni-1)\ (N-1)\ Si$ …… (5)

Where,

ni = the number of individuals of species I

N = the total number of individuals, Si = total number of species

3. Results and discussion

A total of 27 finfish species and 1 freshwater prawn species (Appendix) were observed in Vawnikulam major reservoirs; 14 native species, 6 introduced species, 1 is near threatened and 7 endemic species were included in 11 families according to national conservation status [21]. The family Cyprinidae was dominant. Oreochromis niloticus demonstrated the highest relative abundance of 60.2% in Vawnikulam reservoirs. [1], observed 30 species in Minneriya reservoir, 21 species in Udawalwe reservoir, and 18 species in Victoria reservoir, with 12 diverse families dominated by Cyprinidae. [10], detailed that species composition within the capture significantly changed after stocking with Indian major carps, where O. niloticus contributed to 80–90% some time recently in 2004 and Similarly, O. niloticus (81.7%) was the prevailing species in Ampara reservoir in 2009. Species richness was recorded at 3.0218 in the study area. This suggests that in this reservoir, the fish species were more or less equally abundant or equitably distributed. According to the results, Vawnikulam reservoir is most appropriate for fishing activities regarding freshwater-based ecotourism due to the diversity and abundance of relative fish species.

3.1. Relative Abundance of fish species in vawnikulam reservoir

Abundance is defined as "a measure of the number or frequency of individuals of the same species," whereas diversity demonstrates "the number of species present (species richness) and their abundance (species evenness) in an area or in a community" [8]. The correlation between species diversity and community stability stresses the need to preserve the greatest richness among biological communities [33]. The species abundance distribution (SAD) characterizes the distribution of abundances of all species within a sample or ecological community. The observation that most species are relatively rare with only a few being common was often described as one of the few ecological laws [26]. The most abundant species in the present study areas were Black- headed Ibis, Little Egret, Great Egret and Little Cormorant.

The relative abundance of fish species in a particular area or ecosystem refers to the proportion of each species within the fish [34] community. It is typically expressed as a percentage or a ratio of the number of individuals of a specific fish species to the total number of fish individuals in that area. This information is crucial for understanding the composition

and dynamics of fish populations and is often used in fisheries management, ecological research, and conservation efforts. The relative abundance of fish species can vary significantly depending on factors such as habitat, environmental conditions, human activities, and the life history of the species involved.

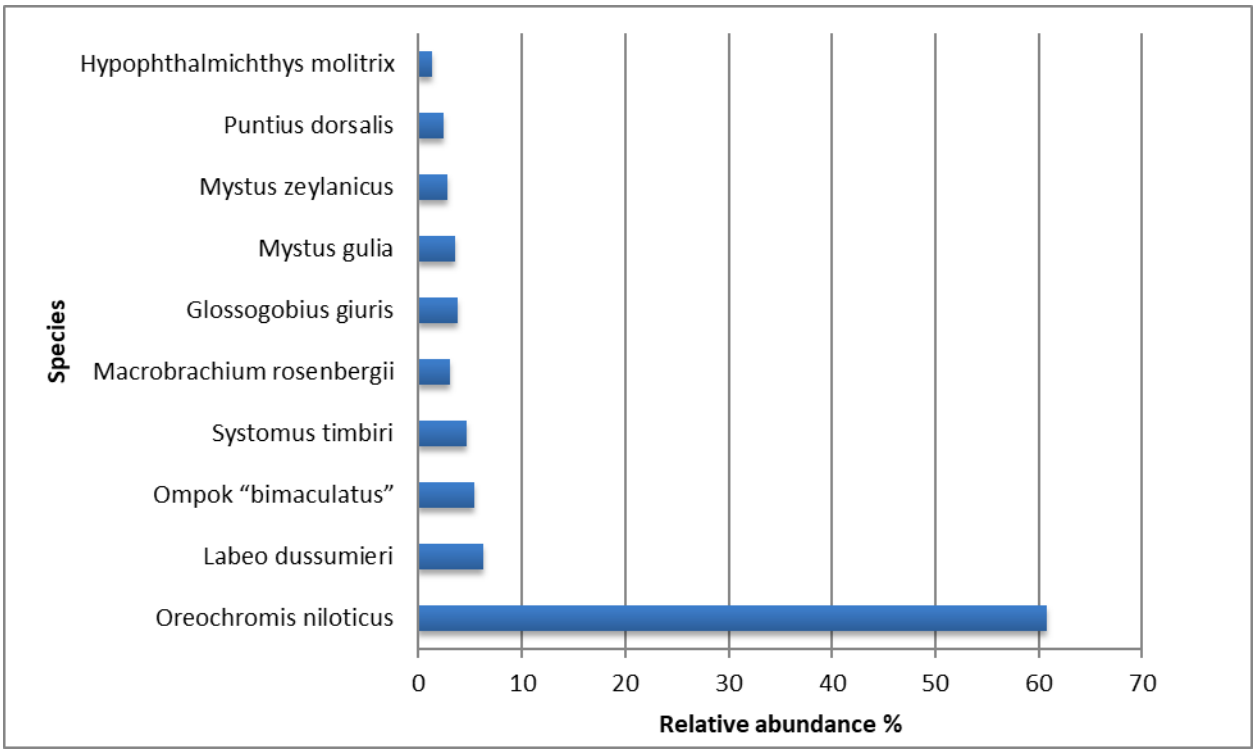

Figure 2 Relative Abundance of 10 most common fish species of vawnikulam reservoirs - (sorted by abundance).

3.2. Calculated values of diversity indices

Table 1 Calculated result of Diversity indices

Number	Diversity indices	Calculated values
1	Shannon index	1.8755
2	species richness	3.0218
3	Evenness	0.5569
4	Dominance	0.3570

The Shannon-Wiener index was created from data hypotheses and is based on estimation uncertainty. The level of uncertainty in predicting the nature of random samples was related to community diversity. When community diversity is low (one species prevails), prediction uncertainty is low. A randomly selected species is most likely to be the dominant species. The Shannon Diversity Index is a measure of biodiversity in a particular ecosystem or community, in Vawnikulam major reservoirs. The index takes into account both the number of species (species richness) and their relative abundance (species evenness) in the ecosystem. A higher Shannon Diversity Index value indicates greater species diversity in the community.

In this study, Shannon Index value of 1.8755 with 28 fish species. This value suggests a moderate level of diversity in the community. The interpretation of this result in the context of freshwater-based ecotourism can have several implications: A diverse community of fish species can make the freshwater tank more attractive for ecotourism. Visitors may be drawn to see a wide range of fish species, which can enhance the ecotourism experience. The presence of a variety of fish species can provide educational opportunities for tourists. Guides and educators can use this diversity to teach visitors about the importance of preserving freshwater ecosystems and the need for conservation. A moderately high Shannon Index suggests that the ecosystem is relatively healthy, with a balance of species. This can be a positive indicator for ecotourists, as they may perceive the ecosystem as stable and worth preserving. Ecotourism can contribute

to the conservation of freshwater ecosystems. Tourist revenue can support local conservation initiatives; helping to protect and preserve the habitat for the diverse fish species. The diversity of fish species in the freshwater tank can also provide opportunities for scientific research and monitoring. Researchers can use this information to study the health of the ecosystem, track changes over time, and better understand the interactions between different species. It is important to note that the Shannon Diversity Index is just one of many metrics used to assess biodiversity. Ecotourism stakeholders should also consider other factors, such as water quality, habitat preservation, and responsible tourism practices, to ensure that the ecosystem is not negatively impacted by tourism activities. In summary, a Shannon Index value of 1.8755 in a freshwater tank with 28 fish species can be seen as a positive attribute for freshwater-based ecotourism, as it indicates a moderate level of species diversity and can enhance the educational and conservation value of the ecosystem for tourists. The number of species, or richness, and the distribution of individuals among species are the two components of species diversity [23].

The high dominance index included exceedingly specific harvest strategies, and low dominance included less specific harvesting methodologies practiced by fishers. Fishermen in larger reservoirs generally practiced highly particular harvest methodologies, especially for O. niloticus. The dominance index was recorded at 0.3570 and suggests that there is a moderate level of dominance within this ecosystem. A Dominance Index value of 1 would mean that one species completely dominates the ecosystem, while a value of 0 would imply that all species are equally abundant. Dominance indices are unfavorably correlated with alpha diversity indices (species lavishness, equality, differing qualities, and irregularity). More overwhelming communities are less diverse. A community with high diversity will have a low dominance value. The Dominance Index is a measure commonly used in ecology to assess the relative abundance and dominance of species in a particular ecosystem. It quantifies the degree to which a few species dominate an ecosystem in terms of their abundance compared to other species. A moderate Dominance Index suggests that there is a balance between different species in the freshwater tank. This could be seen as a positive aspect of ecotourism, as visitors may be interested in seeing a diverse range of species rather than just a few dominant ones. The diversity of species in the ecosystem can provide opportunities for education and research in ecotourism. Visitors and researchers may be interested in studying the interactions between different species and their behaviors. A Dominance Index can also be an indicator of the health of the ecosystem. A moderate value indicates that there isn't extreme dominance by a single species, which can be a sign of a balanced and healthy ecosystem, potentially making it more attractive for ecotourism. If the Dominance Index were to change over time, it could signal shifts in the ecosystem's dynamics. This information could be used to guide conservation efforts or management strategies to maintain or enhance the biodiversity for ecotourism purposes. The specific role of this value in freshwater ecotourism would depend on the objectives and priorities of the ecotourism operation in that area.

Shannon evenness was recorded at 0.5569, which remains a moderate value in Vavunikulum since the target is highly towards O. niloticus [32]. Species evenness is highest when all species in a sample have the same abundance. Evenness approaches zero as relative abundances vary. Species evenness can also be depicted using indices, such as the J' of [31]. While a lower value suggests that some species are more dominant, leading to less evenness. In the context of a freshwater tank with a calculated Shannon Evenness value of 0.5569 for 28 species, a higher Shannon Evenness value implies that there is a more balanced distribution of species in the ecosystem. This can be attractive to ecotourists as it indicates a diverse range of species, potentially offering a richer and more interesting experience for visitors. Tourists often seek experiences that allow them to observe and appreciate a variety of wildlife. A higher Shannon Evenness value can be an indicator that ecotourists are more likely to encounter a wide range of species during their visit, making their experience more rewarding. A high Shannon Evenness value may also signal a healthy and well-balanced ecosystem. This can encourage ecotourism efforts to support and promote conservation and preservation of the freshwater habitat. Conservation efforts can be a significant aspect of ecotourism activities. For researchers and scientists working in freshwater ecology, a balanced ecosystem with high evenness can be a valuable location for studying species interactions, behaviors, and ecological processes. This can contribute to scientific knowledge and further enrich the ecotourism experience by offering insights into the ecosystem. Shannon Evenness value of 0.5569 in a freshwater tank suggests a relatively even distribution of species, which is often considered a positive feature for freshwater ecotourism. However, the specific implications and strategies for utilizing this value in ecotourism would depend on the goals and priorities of the ecotourism operation in that area.

3.3. Contribution to Conservation

Freshwater-based ecotourism can play a crucial role in environmental conservation by raising awareness, generating funds for conservation efforts, and promoting sustainable practices. Here are some ways in which freshwater ecotourism can contribute to environmental conservation: Ecotourism provides opportunities for people to connect with and learn about freshwater ecosystems, their importance, and the threats they face. Tour operators and guides can educate visitors about the need for conservation, the significance of these environments, and the challenges they

confront. Revenue generated from ecotourism can be directly invested in conservation efforts. This can include funding for habitat restoration, research projects, and the protection of key freshwater ecosystems. Entrance fees, permits, and contributions from tourists can support these initiatives. Ecotourism operators can set examples of sustainable practices, such as responsible waste disposal, energy conservation, and water management. They can also encourage visitors to follow eco-friendly guidelines, minimizing their impact on the environment. Freshwater ecotourism often involves local communities, providing them with economic incentives to protect and conserve their natural surroundings. By engaging with local residents, ecotourism can create a shared sense of responsibility for safeguarding these areas. Ecotourism can also support scientific research and monitoring efforts. Data collected from tourists and tour guides can contribute to a better understanding of these ecosystems, helping scientists and conservationists make informed decisions. The presence of ecotourism can encourage the development of protective regulations and management plans for freshwater ecosystems. This can help ensure that these areas are preserved and not exploited for short-term gains. Properly managed ecotourism can help strike a balance between economic development and environmental conservation. It can be a source of income for local communities while preserving the ecosystems on which they depend. Tourists who experience the beauty and value of freshwater ecosystems may become advocates for conservation. They can influence policies and politicians, encouraging a more conservation-minded approach at local, national, and international levels. Freshwater ecotourism businesses often collaborate with environmental organizations, government agencies, and other stakeholders. These partnerships can leverage resources and knowledge to further conservation goals. Tour operators and guides can educate visitors about the importance of responsible wildlife viewing. This includes maintaining a safe distance, not disturbing wildlife, and using optical aids like binoculars to reduce human impact. However, it's crucial that freshwater ecotourism is managed responsibly to ensure its positive impact on environmental conservation. This includes setting limits on the number of visitors, maintaining strict guidelines for behavior, and respecting the natural habitats and wildlife. Over-tourism and improper management can have negative consequences, so it's essential to strike a balance between economic interests and environmental protection.

3.4. Recommendations

Vawnikulam major reservoir shows Moderate fish diversity. Moderate fish diversity in a freshwater ecosystem can play a significant role in promoting freshwater-based ecotourism. Here are several ways in which moderate fish diversity contributes to the attractiveness of such ecotourism destinations: Freshwater ecosystems with a variety of fish species offer opportunities for recreational fishing, which can be a major draw for tourists. Anglers are often attracted to destinations with diverse fish populations, as it increases the chances of catching different types of fish. Many fish species are visually appealing, and their presence can enhance the scenic beauty of freshwater environments. Tourists may be drawn to these destinations for the opportunity to see and photograph the colorful and diverse fish species. Tour operators can offer educational and ecological tours that focus on the various fish species present in the ecosystem. Visitors can learn about the biology, behavior, and conservation of these fish, adding an educational aspect to their experience. In addition to fish, freshwater ecosystems often support a variety of other wildlife, including birds, amphibians, and reptiles. A diverse fish community can attract a broader range of wildlife, making the area more appealing to nature enthusiasts and birdwatchers. The presence of moderate fish diversity can highlight the importance of biodiversity conservation efforts. Ecotourism destinations can promote responsible tourism practices and contribute to the preservation of these ecosystems and their fish populations. Freshwater-based ecotourism can stimulate local economies through tourism-related activities such as guided tours, accommodations, restaurants, and the sale of fishing permits and equipment. Moderate fish diversity can create a sustainable income source for local communities. Research institutions and conservation organizations may be interested in studying the fish populations and ecosystem health in these destinations. The revenue generated from ecotourism can support research and educational initiatives. Promoting responsible and sustainable tourism practices is essential to protect the freshwater ecosystem and its fish populations. Ecotourism can serve as a platform to raise awareness about the importance of conservation and responsible tourism. It is crucial to manage and regulate ecotourism activities to ensure that they have a minimal impact on the environment and fish populations. Conservation efforts, including habitat preservation and the protection of critical spawning areas, should be integrated into ecotourism strategies to maintain the moderate fish diversity in freshwater ecosystems over the long term with following activities.

Freshwater-based ecotourism activities are recreational and educational experiences that take place in and around freshwater ecosystems such as rivers, lakes, wetlands, and streams. These activities aim to promote environmental conservation, awareness, and appreciation of the natural beauty and biodiversity of these habitats. Some of the main freshwater-based ecotourism activities include

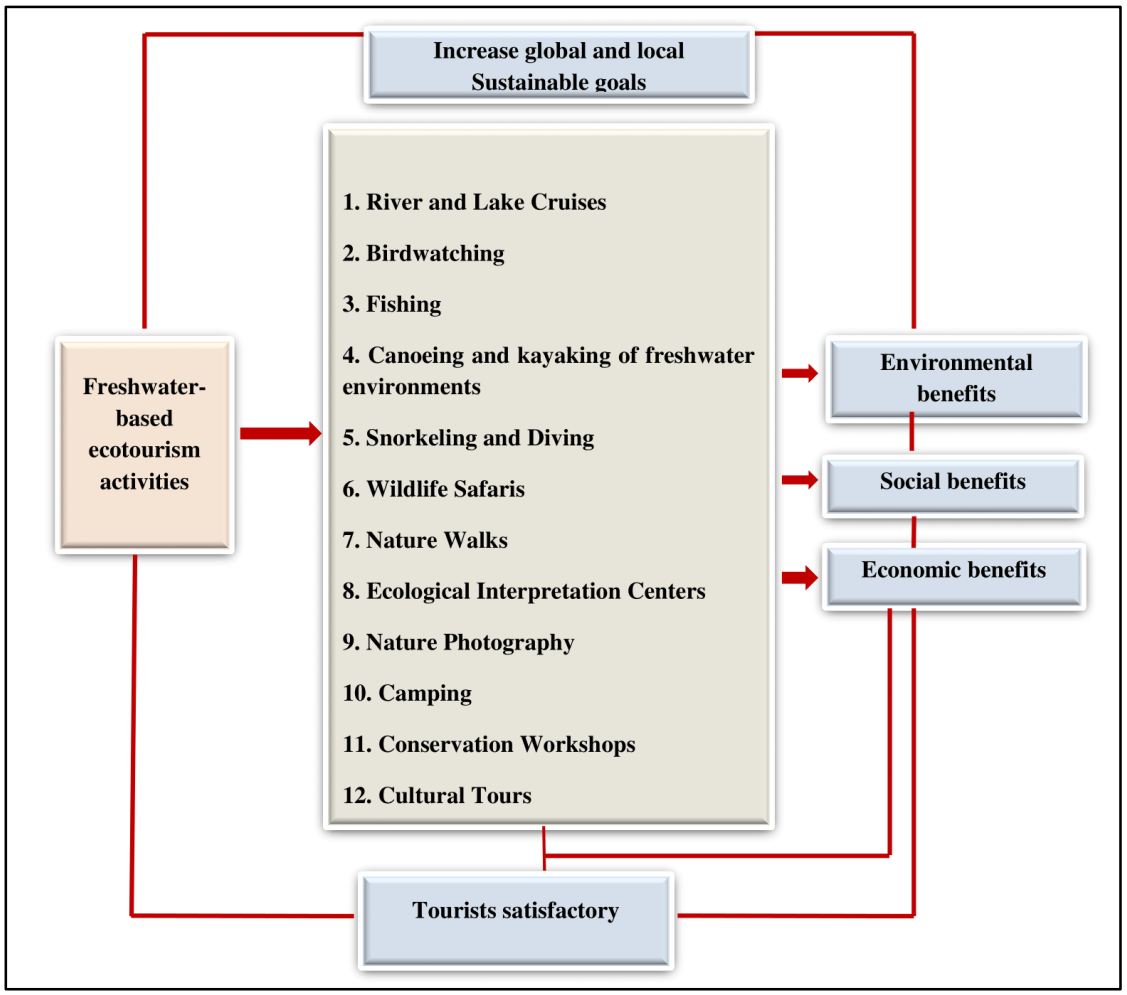

Figure 3 Flowchart for the interactive processes of Fresh water- based ecotourism

It is important to choose ecotourism activities that prioritize the well-being and preservation of freshwater ecosystems, respect local regulations, and minimize negative environmental impacts. Responsible ecotourism helps raise awareness about the importance of freshwater ecosystems and supports their conservation efforts.

4. Conclusion

The selected study area had great strengths in terms of fish diversity, which is valuable for fisheries and provides favorable conditions for fish abundance and diversity. High species numbers were observed in the Vawnikulam large reservoir, which was dominated by intriguing species, in spite of the fact that O. niloticus had the highest abundance within the capture. More particularly, the strengths of Mullaitivu District incorporate attractive freshwater fish diversity compared to competitor freshwater areas such as Vawnikulam and other large and medium reservoirs. There's the plausibility of fishing and other freshwater-based ecotourism activities within a short time. Most of these do not, however, have a high traveler volume, creating an opportunity for freshwater tourism enthusiasts that do not appreciate crowded areas. Subsequently, it can be concluded with the comment that Mullaitivu District would make a perfect fresh water ecotourism destination with its progressed fish diversity and adequate fresh water bodies, which supply extraordinary potential to become one of the most competitive universal fresh water-based ecotourism destinations in the world.

Compliance with ethical standards

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Disclosure of conflict of interest

Authors have declared that no competing interests exist.

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Appendix 1 - Fish Species recorded in Vavunikulum perennial reservoir

National conservation status - (NCS): Global conservation status (GCS): Endangered (EN): Vulnerable (VU): Near Threatened (NT): Least Concern (LC): Not Evaluated (NE): Native (NA) [21].

no	Species	Family	English names	Sinhala names	Conservation status	
					GCS	NCS
1	*Amblypharyngodon melettinus*	Cyprinidae	Silver carplet	Soraya	LC	Endemic
2	*Anabas testudineus*	Anabantidae	Climbing perch	Kaavaiya	LC	NA
3	*Anguilla bengalensis*	Anguillidae	Long-finned eel	Pol mal anda	NT	NA
4	*Anguilla bicolor*	Anguillidae	Level-finned eel	Kalu anda	NT	NA
5	*Anguilla mamarota*	Anguillidae	Giant mottled eel	Giant Aandha	LC	NA
6	*Etroplus suratensis*	Cichlidae	Green chromide	Koralia	LC	NA
7	*Pseudetroplus maculates*	Cichlidae	Orange chromide	Rallia	LC	NA
8	*Glossogobius giuris*	Gobiidae	Bar-eyed goby	Maha gan weligouva	LC	NA
9	*Labeo heladiva*	Cyprinidae	Sri Lanka labeo	Hiri kanaya	LC	Endemic
10	*Mystus gulio*	Bagridae.	long-whiskered catfish	Māna ankutta	LC	NA
11	*Mystus zeylanicus*	Bagridae	Sri Lanka mystus	Pat ankuṭṭa	LC	Endemic
12	*Ompok "bimaculatus"*	Siluridae	Butter catfish	Walapotta	NT	NA
13	*Puntius dorsalis*	Cyprinidae	Long-snouted barb	Bim- tolla	LC	Endemic
14	*Systomus timbiri*	Cyprinidae	Green tiger barb	Thimbiri petiya	NT	Endemic
15	*Channa kelaartii*	Channaidae	Brown snakehead	Paradel kanaya	NT	Endemic
16	*Channa punctata*	Channaidae	Spotted snakehead	Mada kanaya	LC	NA
17	*Channa striata*	Channaidae	Murrel	Loola	LC	NA
18	*Clarias brachysoma*	Clariidae	Walking catfish	Magura	NT	Endemic
19	*Heteropneustes fossilis*	Heteropneustidae	Stinging catfish	Hunga	LC	NA
20	*Hyporhamphus limbatus*	Hemiramphidae	Congaturi halfbeak	Moralla	LC	NA
21	*Labio catla*	Cyprinidae	Catla	Catalov	LC	-
22	*Labeo rohita*	Cyprinidae	Roho labeo	Rohu	LC	-
23	*Cirrhinus mrigala*	Cyprinidae	Mrigal carp	Mirigal	LC	-
24	*Cyprinus carpio*	Cyprinidae	Common carp	Mirror carp	VU	-
25	*Hypophthalmichthys molitrix*	Cyprinidae	Silver carp	Silver carp	NT	NT
26	*Oreochromis mossambicus*	Cichlidae	Mozambique tilapia,	Tilapia	VU	-
27	*Oreochromis niloticus*	Cichlidae	Nile tilapia	Tilapia	LC	-
28	*Macrobrachium rosenbergii*	Palaemonidae	Giant river prawn	Karadu issa	LC	NA

Author's short biography

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