Pakistan Journal of Life and Social Sciences
www.pjlss.edu.pk

https://doi.org/10.57239/PJLSS-2024-22.2.00150

RESEARCH ARTICLE

Viability of Ecotourism in Tinorian River, Iloilo: Inputs for a Strategic Development Framework for Fisherfolk Communities

Manalo, John Vincent I.[1*], Bito-onon, Jescel B.[2], Villanueva, Caryl Jade C.[3], Demo-os Jr., Rolindo B.[4], Villanueva, Roy C.5, Siason, Jr., Nordy D.[6]

[1,2,3,4,5,6] Iloilo State University of Fisheries Science and TechnologyShan

ARTICLE INFO

Received: Oct 26, 2024

Accepted: Dec 11, 2024

Keywords

Community-Based Ecotourism

River Cruising

Bio-Physical Assessment

Strategic Tourism Development Framework

Sustainable Tourism

***Corresponding Author:**

johnvincentmanalo13@gmail.com

ABSTRACT

The Tinorian River in Barotac Nuevo, Iloilo, has been identified as a potential site for community-based ecotourism due to its rich historical and cultural heritage and abundant seafood resources. However, a pre-assessment indicated that the river is experiencing environmental degradation due to anthropogenic activities. The need for a Strategic Tourism Development Plan was emphasized to mitigate these threats. This study aimed to assess the viability of various ecotourism activities to inform the creation of a comprehensive Strategic Tourism Development Framework. The research involved a detailed bio-physical assessment, sediment analysis (river health assessment), mangrove mapping, fishpond zoning, and assessment of knowledge, skills, and practices (KSP) of fisherfolks and community members. Data were collected using a combination of standardized and researcher-made assessment tools. The findings revealed that the Tinorian River holds significant potential for sustainable ecotourism activities. This potential offers substantial benefits across social, economic, and environmental dimensions. In response to these findings, a strategic tourism development framework was formulated. This framework includes initiatives for capacity building, the construction of eco-friendly tourism infrastructure, and community training programs. The goal of this framework was to promote sustainable community-based ecotourism and this was achieved through targeted extension projects and the organization and empowerment of the Tinorian River community. This strategic approach aimed to balance environmental conservation with tourism development, ensuring the long-term ecological health of the river and fostering socio-economic growth for the local community.

INTRODUCTION

The Philippines is considered as one of the top 25 biodiversity hotspots in the world because of the high percentage of endemic plants and animals threatened by extinction. Recognizing the country's diverse natural and cultural resources, an Executive Order (EO) No. 111 was issued on the 17th of June 1999, establishing the guidelines for ecotourism development in the Philippines. The EO likewise created the National Ecotourism Development Council as a policy-making body and the National Ecotourism Steering Committee (NESC) and Regional Ecotourism Committees (RECs) as operating arms. In addition, the EO called for the formulation of the National Ecotourism Strategy (NES) to provide an integrated management plan for developing ecotourism (National Ecotourism

Strategy, 2002). Under the Republic Act 9593 or the Tourism Act of 2009, the country's tourism sector, the Department of Tourism (DOT), positions itself as the primary catalyst in developing a highly competitive and environmentally sustainable tourism industry focused on creating inclusive growth. Through the National Tourism Development Plan (NTDP) of the 2016-2022 Monitoring and Evaluation Framework, higher education institutions play a vital role in developing and implementing strategic actions and action programs guided by the Tourism Guidebook for LGUs.

Iloilo State University of Fisheries Science and Technology (ISUFST) , a state university in Tiwi, Barotac Nuevo, Iloilo, through its Fisheries and Tourism Management programs in both undergraduate and graduate programs, contributes to the DOT's goals through research and development in the local and national level. The institution is strategically located in a community-based tourism development area identified by the municipal tourism office and surrounded by mangroves, rivers, lakes, ponds, and brackish water systems. Rivers manifest a large portion of the site, and Tinori-an is considered to be the longest and most significant in terms of area dimension.

Tinori-an River was deemed a potential ecotourism site in Barangay Tinori-an, the municipality of Barotac Nuevo, Iloilo. The river starts at Barangay Tinori-an and ends in Barangay Pantalan, the next town of Anilao. It boasts a 6 km long line of river showcasing the abundance of mangrove trees, river, and coastline. According to Padohinog et al. (2011), the river is a potential ecotourism destination. Its rich flora and aquatic life forms are among its components. A preliminary assessment of its mangrove ecosystem and oyster cultures was conducted.

As a result, the ISUFST has the potential to be one of the community-based sustainable ecotourism sites in the fourth district of Iloilo, where the culture, the tradition of the community, and its natural attractions are potential tourism products. Community-based ecotourism supports the conservation of the environment, improves the quality of life, and promotes culture and tradition. The town's diversified natural and cultural tourism products attract local and foreign tourists. Specifically, its marine environment has rich species of flora and fauna.

Efforts have been undertaken to consolidate the gains already made and adopt a more strategic and innovative approach to exploring new opportunities to pursue inclusive growth. This will be done by expanding community participation across the full range of facilities and services planned in the tourism circuits and development areas. Continuity is the cornerstone of the new Plan, with a particular focus on what is achievable as well as on building on the momentum of what has already been initiated through the efforts of the numerous stakeholders comprising the tourism industry (NTDP 2016-2022).

Designing a strategic development framework based on the results of the viability assessment of the Tinori-an River is deemed crucial. This framework will guide the development of the Tinori-an River Community-Based EcoTour, which aims to promote sustainable tourism and resource conservation. The assessment, which evaluates the river's physical, environmental, economic, and social factors, provides the foundation for addressing global challenges such as climate change and the threats to natural attractions. The strategic framework will also support policy-making and recommendations aligned with the National Ecotourism Strategy (NES, 2002) and the National Tourism Development Plan.

Objectives of the Study:

a. To conduct the Bio-Physical Assessment of Tinori-an River

a.1. Bio-aquatic inventory

a.2. Mangrove Mapping

a.3. River Health Assessment

a.. Fishpond Assessment

b. To assess the viability of river cruising as an ecotourism activity by analyzing the knowledge, skills, and practices (KSP) that will be used as the basis for designing a strategic tourism development framework.

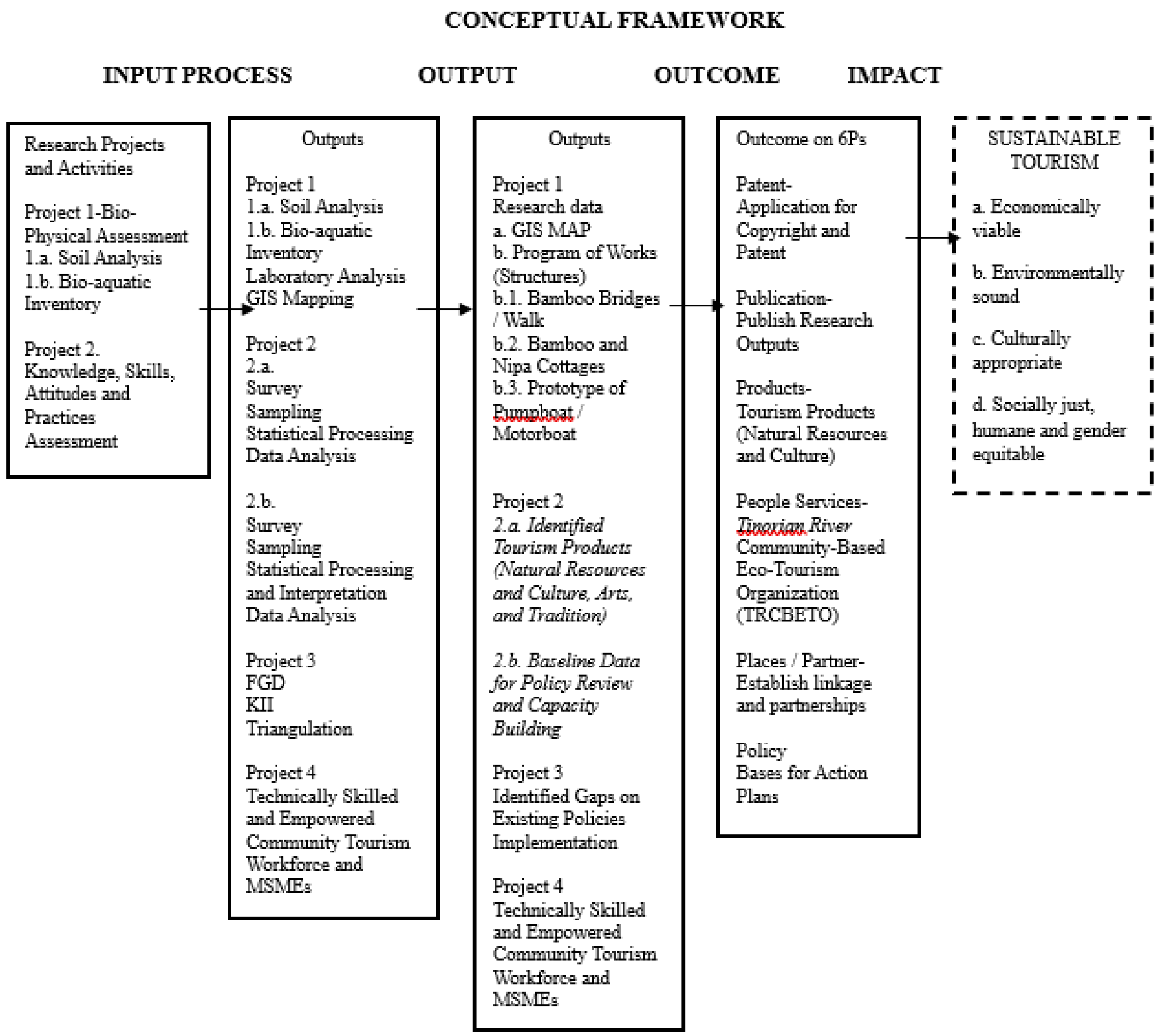


Figure 1. Schematic Working Concept

LITERATURE REVIEW

Ecotourism has emerged as a promising approach to sustainable development, integrating environmental conservation with community participation and economic opportunities (Fennell, 2019). In Barangay Tinorian, situated along the Tinorian River, ecotourism offers a unique opportunity to showcase the area's natural beauty and cultural heritage while fostering conservation efforts. This literature review examines key concepts and findings from existing studies relevant to ecotourism development, stakeholders' knowledge, skills, attitudes, and practices (KSP), and community-based conservation initiatives.

Ecotourism is widely recognized as a sustainable alternative to conventional mass tourism, emphasizing responsible travel to natural areas that conserve the environment and improve the well-being of local communities (Weaver & Lawton, 2019). Sustainable ecotourism development requires a holistic approach that considers environmental, social, and economic dimensions, balancing conservation objectives with the needs and aspirations of residents (Tosun & Jenkins, 2016). By promoting environmental awareness, supporting conservation efforts, and generating income for local communities, ecotourism can contribute to biodiversity conservation and poverty alleviation (Duffy, 2019).

Stakeholder engagement and community participation are essential for the success of ecotourism initiatives, as they promote local ownership, enhance social capital, and foster collaborative decision-making processes (Ribeiro et al., 2020). Engaging stakeholders, including residents, indigenous communities, government agencies, and non-governmental organizations (NGOs), ensures that ecotourism development aligns with local needs and priorities (Simpson & Seddighi, 2019). Community-based ecotourism initiatives empower local communities to manage and benefit from tourism activities, fostering a sense of pride and stewardship over their natural and cultural heritage (Lindberg & McKercher, 2018).

Effective ecotourism development requires stakeholders to possess the knowledge, skills, and capacities to sustainably plan, implement, and manage tourism activities (Fennell, 2019). Knowledge of environmental conservation principles, business management practices, and relevant laws and regulations is essential for guiding ecotourism initiatives and ensuring compliance with legal requirements (Diamantis et al., 2021). Skills in areas such as biodiversity conservation, waste management, and interpretation enhance stakeholders' ability to deliver high-quality ecotourism experiences while minimizing environmental negative impacts (Blangy et al., 2020). Capacity-building initiatives, including training programs, workshops, and technical assistance, enhance stakeholders' capacities and promote sustainable ecotourism development (Mbaiwa & Stronza, 2011).

Positive attitudes towards environmental conservation and sustainability are fundamental for fostering community support and participation in ecotourism initiatives (Kaltenborn et al., 2019). Attitudinal factors, such as environmental awareness, appreciation of nature, and cultural pride, influence stakeholders' willingness to engage in conservation efforts and adopt sustainable practices (Mowforth & Munt, 2015). Encouraging stakeholders to embrace ecotourism to promote conservation and cultural heritage fosters a sense of responsibility and stewardship over natural resources, contributing to the success and sustainability of ecotourism initiatives (Andereck & Vogt, 2000).

Mangrove forests are distributed across tropical and subtropical regions, with notable expanses in South Asia, Southeast Asia, and Brazil. A combination of environmental factors, including soil composition, salinity, tidal regimes, and sedimentation processes, influences the distribution patterns of mangroves. For instance, studies in South Asia have highlighted that mangrove forests in this region cover about 6% of the global mangrove area, with significant ecological contributions (Blasco & Aizpuru, 2002; Dahdouh-Guebas et al., 2005; Duke et al., 2007). These forests are vital for coastal protection, particularly in regions like India and Bangladesh, where they mitigate the impact of natural disasters such as tsunamis (Giri et al., 2007b; Bahuguna et al., 2008; Danielsen et al., 2005).

In Odisha, India, the structure of mangrove forests varies significantly across river estuaries, influenced by both natural and anthropogenic factors (Panda et al.). In Brazil, the mangroves of the São João River estuary exhibit structural diversity driven by tidal influences and sediment deposition (Calegario et al.). Similarly, in Papua New Guinea's Fly River estuary, mangrove productivity is closely linked to sediment and nutrient input from tidal waters (Robertson et al.).

In Malaysia, the distribution and rarity of mangrove species like Rhizophora apiculata and Bruguiera gymnorhiza are influenced by substrate type and salinity gradients, with R. apiculata favoring tidal zones with fine muddy substrates (Swaine & Whitmore, 1988; Wilcox, 1995). The species composition in the Sundarbans, the world's largest mangrove forest, is similarly structured by salinity and tidal influences, with distinct zonation patterns observed across different ecological zones (Chaffey et al.).

Mangrove species distribution is primarily determined by salinity, tidal inundation, and substrate type. Species like Sonneratia alba and Avicennia alba are pioneer species, typically found in seaward zones with sandy or mixed substrates, where they play a key role in stabilizing newly accreted land (Tomlinson, 1986; Saenger, 2002). In contrast, species like Rhizophora mucronata and Bruguiera gymnorhiza are more common in interior or landward zones, where they thrive in muddy substrates with higher organic content (Robertson & Alongi, 1992; Saenger, 2002).

Mangrove forests are critical for carbon storage, with their above-ground and below-ground biomass contributing significantly to global carbon stocks (Donato et al., 2012). The high carbon content, coupled with the role of mangroves in supporting biodiversity, underscores their importance in climate regulation and conservation initiatives such as REDD+ (Nathan et al.). Additionally, the structural complexity of mangrove root systems enhances sediment trapping, which is crucial for coastline stabilization and the formation of new land (Lara et al., 2009; Larsen, 2019; Perillo, 2019).

The distribution patterns of mangrove species are closely linked to tidal dynamics and hydroperiods, determining the frequency, duration, and depth of flooding. These factors influence species distribution and the overall health and resilience of mangrove ecosystems (Saenger, 2002; Woodroffe et al., 2016). For example, Watson (1928) and Baltzer (1969) emphasized the importance of tidal conditions in mangrove zonation, particularly about species such as Rhizophora and Avicennia, which have specific elevation and inundation requirements.

Human activities, including deforestation, land reclamation, and pollution, have significantly impacted mangrove forests, leading to habitat loss and fragmentation. However, conservation efforts, including reforestation and protected area designation, have shown some success in mitigating these impacts. In South Asia, for example, increased awareness and conservation initiatives have reduced net deforestation rates, although challenges remain (Blasco & Aizpuru, 2002).

METHODOLOGY

The study on the viability of community-based ecotourism along the Tinorian River in Iloilo, Philippines, incorporated a mixed-methods research design, blending both qualitative and quantitative approaches. Researchers engaged in field surveys, environmental assessments, stakeholder interviews, and community consultations to gather comprehensive data. Their work focused on a 6-kilometer stretch of the river, extending from Barangay Tinorian in Barotac Nuevo to Barangay Pantalan in Anilao, chosen for its rich biodiversity and potential for river-based ecotourism, including mangrove forests, diverse aquatic life, and various local seafood products.

A bio-aquatic inventory was conducted across twelve strategically selected sites along the Tinorian River, with each site representing different river segments—upstream, midstream, downstream, and the river mouth. Marine resources, such as shellfish, fish, crustaceans, and bottled seafood products, were collected using standardized techniques to assess the river's biodiversity and its potential for ecotourism. The frequency distribution of these species was recorded and analyzed using descriptive statistics, and GIS mapping was employed to visualize their spatial distribution.

Mangrove mapping involved dividing the river into two main areas—Anilao and Barotac Nuevo—further categorized into upstream, midstream, and downstream stations. Researchers used Google Maps and GPS to determine site locations accurately. At each station, a 10m x 10m quadrat was established at varying distances from the riverbank to assess the mangrove community structure. They counted mangrove seedlings, saplings, and trees, and recorded data on tree height, basal area, and crown size. The diversity of the mangrove community was analyzed using the Shannon-Weiner diversity index, with results summarized through descriptive statistics.

Sediment analysis for river health assessment involved sampling at twelve river sites and fifteen adjacent pond sites. Researchers collected sediment samples and analyzed them for total organic matter, grain size distribution, and moisture content. Water quality parameters, including temperature, pH, dissolved oxygen, salinity, turbidity, and depth, were measured using a multiparameter water meter. Descriptive statistics were used to summarize the data, and two-tailed t-tests in SPSS were applied to compare sediment and water quality between river and pond sites.

The knowledge required for this study included an understanding of mixed-methods research, ecotourism concepts, biodiversity and conservation, marine and aquatic life, mangrove ecosystems, sediment and water quality analysis, statistical analysis, and geospatial mapping. Skills involved field survey techniques, data collection, geospatial mapping, mangrove assessment, water quality testing, statistical analysis, and environmental assessment reporting. The practices employed emphasized sustainable ecotourism development, biodiversity monitoring, community engagement, environmental conservation, sediment and water quality monitoring, adaptive management, and knowledge sharing for capacity building among local communities and stakeholders.

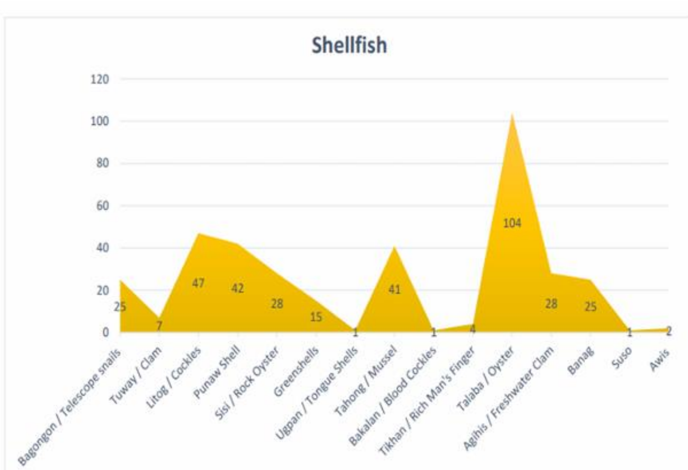
Ethical Considerations

Ethical approval was obtained from the relevant institutional review board, with informed consent secured from all participants. Confidentiality and privacy were maintained throughout the research process. The study's limitations include potential sampling biases due to purposive sampling and the inherent self-reporting bias in survey data. Additionally, the findings are context-specific to Barangay Tinorian and may not be generalizable to other areas. To ensure validity and reliability, survey instruments were pre-tested, and data collectors were thoroughly trained. Triangulation of quantitative and qualitative data was employed, along with member checking and peer debriefing to enhance the study's credibility.

RESULTS AND DISCUSSIONS

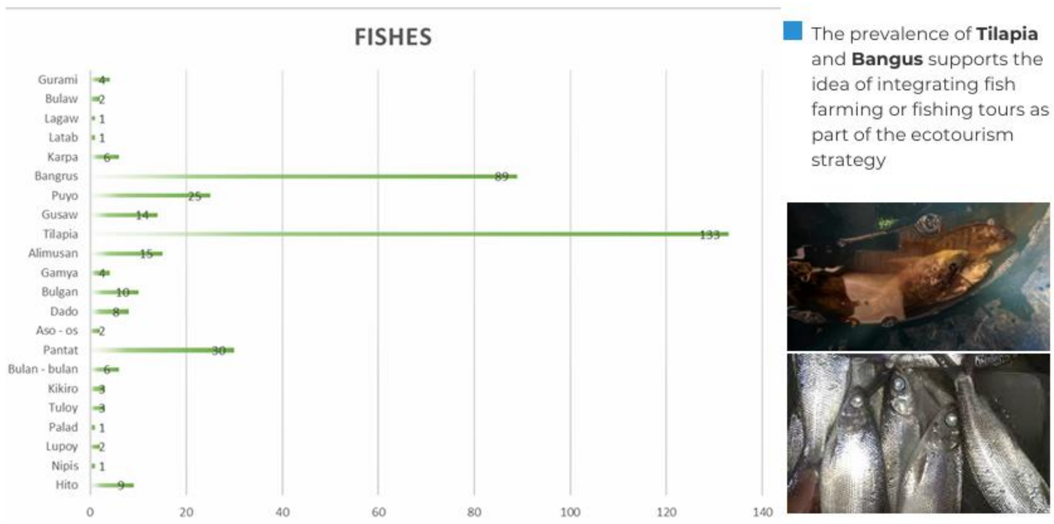
Frequency Distribution of Bio-aquatic Resources in Tinorian River

The study assessed the frequency of various marine resources harvested from the Tinorian River, focusing on four main categories: shellfish, fish, crustaceans, and bottled seafood products. The data reveal the diversity and abundance of aquatic life in the river, which has implications for both ecological health and potential ecotourism activities.

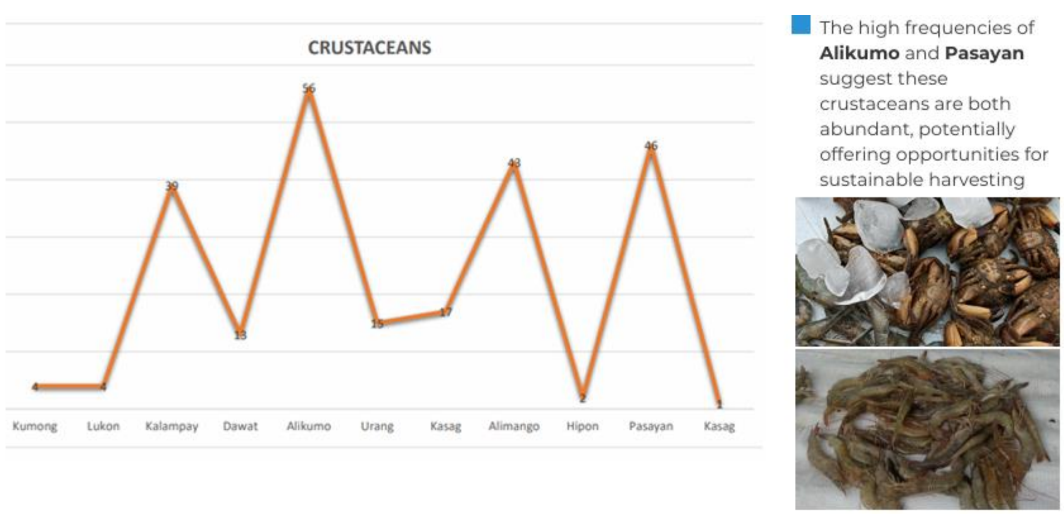


Indicates that these species are abundant and may be key resources for both local consumption and potential ecotourism activities

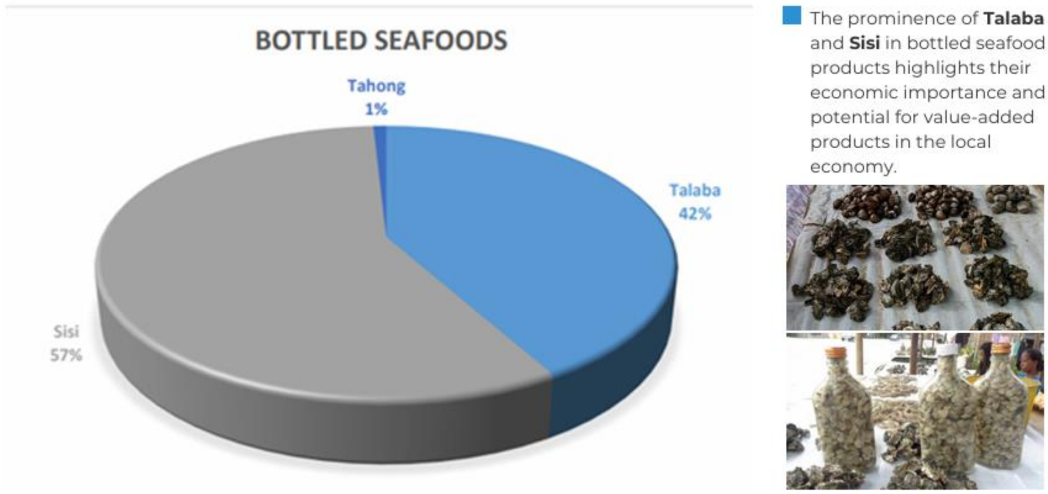
The results show that Punaw (40 occurrences) was the most frequently collected shellfish, followed closely by Talaba (f=37) and Litog (f=36). Tahong (f=13) and Sisi (f=10) were less frequently encountered, with Bagongon (f=6), Tuway (f=4), Tikhan (f=4), Ugpan (f=1), and Bakalan (f=1) showing much lower frequencies. The high frequency of Punaw and Talaba indicates that these species are abundant and may be key resources for both local consumption and potential ecotourism activities such as shellfish gathering or tasting experiences. The lower frequencies of other shellfish like Ugpan and Bakalan suggest either they are less common or less targeted by local fishermen, possibly due to their market value or difficulty in harvesting.



Among the fish species, Tilapia (f=39) and Bangus (f=30) were the most frequently caught, indicating their abundance in the river. Alimusan (f=15) and Gusaw (f=14) followed, while other species such as Bulgan (f=9), Carp (f=6), Bulan2 (f=4), Kikiro (f=3), and Gamia (f=3) showed moderate to low frequencies. Rarely caught species included Aso-os (f=2), Puyo (f=2), Hito (f=1), Nipis (f=1), Lupoy (f=1), Palad (f=1), Tuloy (f=1), Pantat (f=1), and Dado (f=1). The prevalence of Tilapia and Bangus suggests that these species are well-suited to the river's conditions and are likely important for local fisheries. Their presence also supports the idea of integrating fish farming or fishing tours as part of the ecotourism strategy. However, the lower frequencies of other species suggest a need for conservation efforts to ensure that the less common species are protected and their populations are not further diminished.



Pasayan (f=38), Alimango (f=36), and Kasag (f=17) were the most frequently harvested crustaceans. Other species such as Alikumo (f=14), Dawat (f=13), Urang (f=13), Kalampay (f=6), Lukon (f=4), Kumong (f=4), and Hipon (f=2) showed lower frequencies. The high frequencies of Pasayan and Alimango suggest these crustaceans are both abundant and valuable, potentially offering opportunities for sustainable harvesting and ecotourism activities like crab-catching tours. The lower frequency of Hipon and other species may indicate they are either over-harvested or naturally less abundant, requiring careful management to ensure sustainable use.



The study also recorded the frequency of different bottled seafood products, with Talaba (f=30) and Sisi (f=29) being the most frequently processed. Tahong (f=16) was less common. The prominence of Talaba and Sisi in bottled seafood products highlights their economic importance and potential for value-added products in the local economy. Promoting these bottled products could be an integral part of the ecotourism framework, offering tourists unique local delicacies while supporting local livelihoods. However, ensuring the sustainable harvesting of these resources is crucial to prevent depletion due to increased demand.

MANGROVE MAPPING

Species Composition

There are 39 true mangroves in the Philippines (Primavera, 2004). In this study, Tinori-an river comprised 9 mangrove species under 5 genera belonging to 4 different families, namely: Avicenniaceae, Euphorbiaceae, Rhizophoraceae, and Sonneratiaceae, as classified by Tomlinson (1986) and Spalding et al., (2010)

Table 2: Species composition of mangroves in Barotac Nuevo and Anilao.

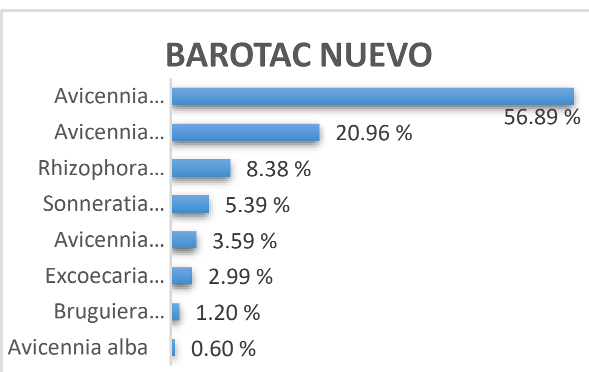
No	Local Name	Scientific Name	Upstream		Midstream		Downstream	
			Btac. Nuevo	Anilao	Btac. Nuevo	Anilao	Btac. Nuevo	Anilao
1	Bungalon	Avicennia alba	*	*		*		
2	Bungalon	Avicennia marina	*	*	*	*	*	*
3	Bungalon	Avicennia officinalis	*	*	*		*	
4	Bungalon	Avicennia rumphiana			*			
5	Pototan	Bruguiera sp.	*	*		*		
6	Lipata	Excoecaria agallocha		*		*	*	
7	Bakhaw lalaki	Rhizophora apiculata		*	*	*		*
8	Bakhaw babaye	Rhizophora mucronata		*		*		
9	Pagatpat	Sonneratia alba			*		*	*

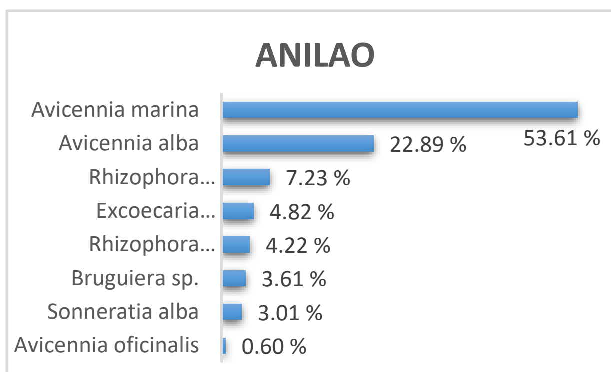
The results in Barotac Nuevo were obtained by Benban (2022). The species identified in the Barotac Nuevo are Avicennia officinalis, Avicennia marina, Avicennia rumphiana, Avicennia alba, Bruguiera sp., Rhizophora apiculata, Excoecaria agallocha, and Sonneratia alba. Both A. officinalis and A. marina species are present in all sampling sites (upstream to downstream), as shown in Table 2. A. alba and Bruguiera sp. are specifically documented upstream, while A. rumphiana and R. apiculata at the midstream and E. agallocha, downstream. S. alba species are present midstream and downstream. A. rumphiana, is known to be in a vulnerable conservation status, facing a very high risk of extinction in the wild due to rapid population decline, while the rest are the leased concerned based on the International Union of Conservation of Nature (IUCN) Red List Categories 2010. Avicennia rumphiana is a lone species in the midstream of Barotac Nuevo; Raganas et al. (2020) stated that the growth of A. rumphiana favored in the estuarine was seawater and freshwater mixed.

In Anilao, these species are classified: Avicennia officinalis, Avicennia marina, Avicennia alba, Bruguiera sp., Rhizophora apiculata, Rhizophora mucronata, Excoecaria agallocha, and Sonneratia alba. Avicennia marina and Rhizophora apiculata sighted their occurrence in all collection stations (Upstream, Midstream, and Downstream). Avicennia alba, Rhizophora mucronata, Bruguiera sp., and Excoecaria agallocha are recorded upstream and midstream, while Sonneratia alba and Avicennia officinalis are documented downstream and upstream, respectively. Tomlinson (1986) stated that A. officinalis usually grows in low-lying coastal areas frequently inundated by tidal water. Wee et al. (2017) articulated the ability of S. alba to withstand higher inundation and salinity, which results in its niche occupancy at lower intertidal zones. R. mucronata is only present upstream and downstream of Anilao**;** the natural habitat of Rhizophora mucronata is estuaries, tidal creeks, and flat coastal areas subject to daily tidal flooding. It seems more tolerant of inundation than other mangrove species (Batool et al., 2014).

DISTRIBUTION OF MANGROVE SPECIES

In Barotac Nuevo, A. marina has the highest count of trees, comprising 56.89%. Most numerous



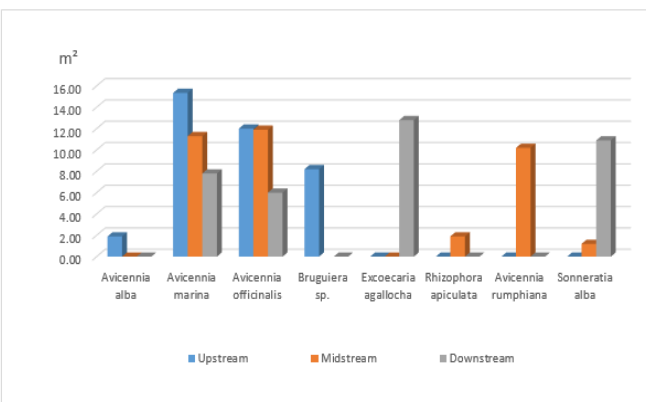


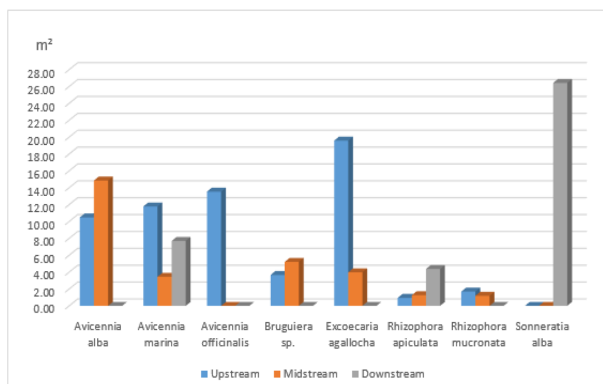
counts of A. marina are in quadrat two downstream. Avicennia officinalis, with 20.96%, though recorded as second highest in the number of trees, is evenly distributed; recorded data shows its presence in all quadrats from upstream to downstream, with the most numerous counts in quadrat 3, upstream. R. apiculata, 8.38% of the total population sample, is limited at the midstream of the river but has an overlapping distribution at quadrats 2 and 3. Avicennia rumphiana has 3.59%; these species are limited at the midstream of the river but have an overlapping distribution, present in quadrants 1 and 2. Avicennia alba is restricted to the upstream of the river with a minor distribution of 0.6% and can only be found at quadrat 1. Bruguiera sp., with 1.2 %, is limited at quadrat 2. Excoecaria agallocha is only found at quadrat one downstream with 2.99% of the total sample population. Sonneratia alba species have 5.39%, with uneven distribution, and are present at midstream, quadrat 2, and quadrat 1 and 3 downstream (Benban,2022).

In Anilao, the highest number of trees, comprising 53.61%, belonged to A. marina. A. alba recorded 22.89% and became the second highest in the count of trees. R. mucronata forms 7.23% of the total population sample. E. agallocha is composed of 4.82% of the total of trees. R. apiculata only consists of 4.22% of the population of trees but is present in all sampling sites. Bruguiera sp. also has a 3.61% count of trees and sight occupancy upstream and midstream. Sonneratia alba has 3.1%, and these species are limited downstream of the river, while A. officinalis has 0.60%. Avicennia marina is distributed throughout the area of two sampling sites; studies taken from dry zone forests in Sri Lanka revealed that A. marina has is resistance towards environmental conditions and thus has a tendency to be widespread throughout the country's mangrove ecosystem (Arulnayagam, 2020; Nigamuni & Subasinghe, 2015; Ellepola & Ranawana, 2015) and dominant mangrove species in all study locations, Avicennia marina is an essential mangrove species because it can grow and reproduce across a wide range of climatic edaphic, and tidal conditions (Maguire et al., 2002). Mangrove zonation can be conveniently considered geographic scales: regional, estuarine (from the river mouth to upstream), and intertidal (from the low-intertidal zone to the high-intertidal zone) (Duke et al., 1998). Salinity has been the most investigated factor for its effects on mangrove distribution (Smith & Duke, 1987; Ball & Pidsley, 1995; Costa et al., 2015; Barik et al., 2018), and the distribution of mangrove species can be explained primarily by salinity gradients in most cases (Ukpong, 1994; Ball, 1998). Physiologically, interspecific differences in salt tolerance among mangrove species control both responses to the salinity gradient and competitive interactions along the gradient (Ball & Pidsley, 1995; Ball, 1996). At the estuarine scale, mangrove distribution patterns have been reported for many rivers (Bunt et al., 1982; Smith & Duke, 1987; Duke, 1992; Ball & Pidsley, 1995; Duke et al., 1998; Costa et al., 2015; Tomlinson, 2016).

TREE STRUCTURE

BASAL AREA

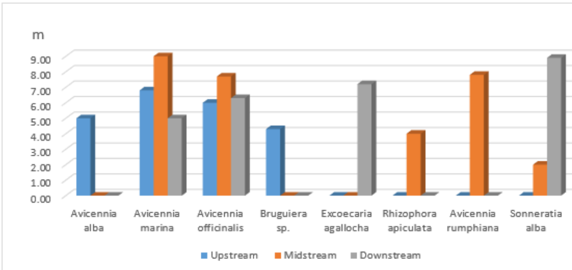


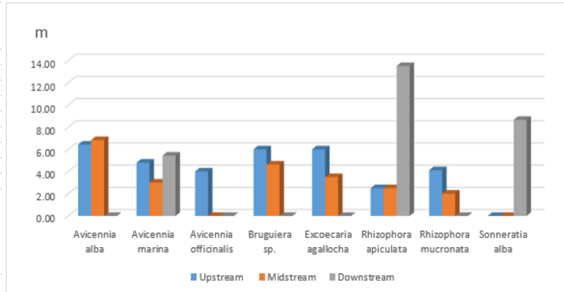


In Barotac Nuevo, Avicennia marina had the largest recorded average basal area of 15.35 m^2 upstream, followed by Excoecaria agallocha with 12.75 $m^{2,}$ downstream. The largest recorded basal area, 276 cm, is A. officinalis (Sreelekshmi et al., 2018) in quadrat three upstream. The smallest basal area is Rhizophora apiculata species in quadrat 2, midstream, with a recorded data of 7 centimeters. Older mangrove species are mostly found upstream, as shown in the figure above.

In Anilao, the largest recorded basal area is Sonneratia alba, which can be found downstream at an average of 26.42 m^2. Sonneratia alba grew in salinities ranging from fresh water and seawater, with growth being maximal in 5 to 50% seawater (Ball & Pidsley, 1995). Followed by Excoecaria agallocha, comprising 19.58 m^2. The smallest basal area is Rhizophora apiculata, with an average of 0.95 m^2 upstream.

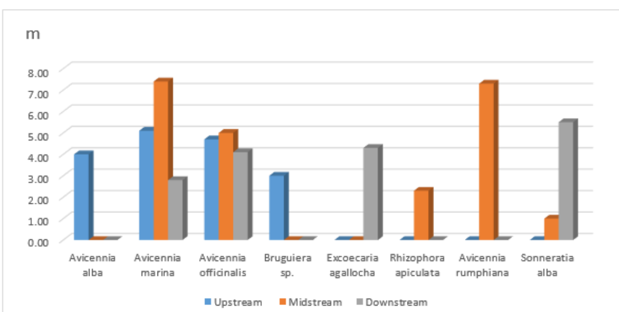
HEIGHT

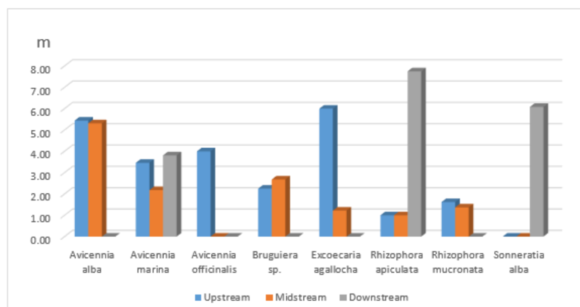




In Barotac Nuevo, midstream mangroves where mostly high trees are documented, relative to this, Avicennia marina had the highest average tree height. The highest mangrove trees are Avicennia marina and Avicennia officinalis, found in quadrat three midstream, and Sonneratia alba in quadrat three downstream, about 9 meters tall. A. marina is one of the tallest mangrove species, and the shortest tree (Sinfuego & Buot, 2013) is about 1 meter tall and is found in quadrat one downstream. Mangrove tall trees were mainly found downstream of Anilao. Rhizophora apiculata has the highest average tree height of 13.5 meters. Duarte et al. (1998) state that the growth of Rhizophora apiculata is enhanced in the river mouth, followed by Sonneratia alba, with an average tree height of 8.65 meters. The most miniature mangrove tree with an average height of 2 meters was Rhizophora mucronata in midstream.

CROWN

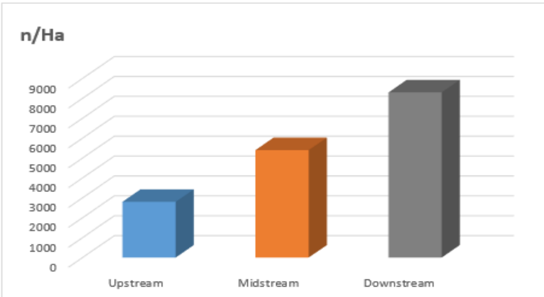


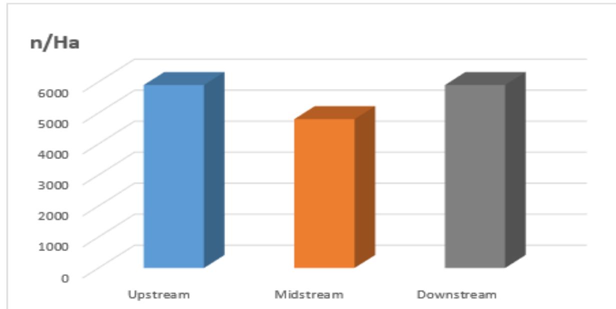


In Barotac Nuevo, mangrove vegetation in the midstream is thickly dominated by Avicennia marina, which implies it has the wildest average crown cover (Cudiamat & Rodriguez, 2017) of 7.5 meters wide, followed by Avicennia rumphiana with an average crown cover of 7.33 meters.

The most comprehensive crown cover in Anilao is Rhizophora apiculata, with an average of 7.75 m wide, followed by Sonneratia alba, with a 6.08 m average crown cover, where both settle downstream. The mangrove forests Rhizophora were moderate to highly productive of litter, had the most excellent canopy cover, were the tallest, and had the most significant surface area of ground structures in the river estuary (Conacher et al., 1996). Downstream impacts may also increase the risk of eutrophication, irrigated agriculture, and its associated run-offs of nutrients, herbicides, pesticides, fungicides, and pollutants, and future changes in precipitation, including extreme events (Plagányi et al., 2024). Nevertheless, downstream of Anilao, the mangrove ecosystem productivity was documented as the largest average basal area, which possessed the most comprehensive crown cover and highest height of the tree. Slower water flow characterized downstream regions, enabling sediments to settle. Slowing water movement efficiently speeds up the settlements of fine sediment particles trapped by mangroves (Wolanski, 1995; Young & Harvey, 1996). The development of mangrove habitats is also contributed by the accumulation of sediments (Alongi, 2008). Conversely, in Barotac Nuevo, the largest basal area was found upstream, while in midstream, it was recorded as the highest height of the tree and possessed the most comprehensive crown cover. Upstream watersheds are critical in developing the total inland river basin's socio-economic and sustainable ecological state (Su et al., 2020)

DENSITY OF MANGROVE

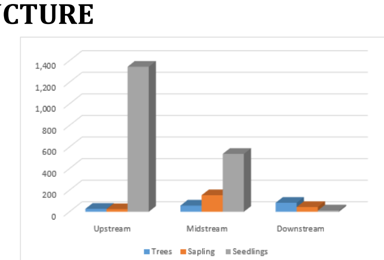


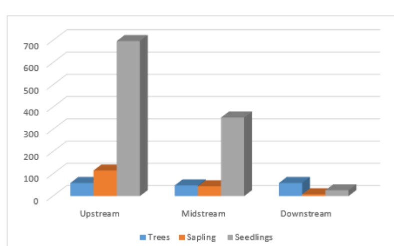


The seaward topography of the river created a vast habitat for mangroves, resulting in the downstream having the highest density among the three sampling sites. It is dominated by A. marina, which is also abundantly distributed in the midstream area. Riverbanks toward the landward area have a narrow topography where most fishponds are located. Upstream has the least density with a wide distribution of Avicennia officinalis. The environment with favorable conditions for mangrove growth located downstream of Barotac Nuevo has the highest density among all three sampling stations. Fan et al. (2014) suggest that the river transmits the chemical features of the upstream and midstream areas downstream or near the river mouth. In the upstream region of the river, the soil particles are eroded and transported to the downstream region (Kinjo et al., 2005). Ranaivoson (1998) stated that river deposits accumulate toward the sea, while mangrove forests extend downstream, and the soil elevation increases, moving toward inland areas.

The river system influences the geographical distribution of mangrove vegetation, exchange of seawater flow, and tidal mixing. The highest density was upstream and downstream, against the flow direction and where the river joins the sea. Upstream is the most diverse mangrove forest in all sites, making up seven different mangrove species in this area. Upstream and downstream has the highest density of mangroves in Anilao, creating a unique ecosystem that supports mangrove forests. Dietrich and Dunne (1993) claim that the upstream is the limit of concentrated water flow and is often characterized by narrower channels (Knighton, 1998), while downstream is in the direction of water flow, where rivers ultimately discharge into the sea (Montgomery & Buffington, 1997). Knighton (1998) indicates that the upstream region influences downstream characteristics, including sediment load, ecological habitats, and water quality. The Tinorian River received considerable input of seawater and rapid current of fresh water; a few are from neighboring ponds. The mangrove zone and landscape are influenced by sea tide, sea currents (Shiau et al., 2017a; Cheng et al., 2019), and freshwater supply (Barreto et al., 2016; Dai et al., 2018; Xiong et al., 2018). Sea tide is the first indicator of suitable habitat for mangroves in Indonesia's Segara Anakan Lagoon (SAL) (Hilmi et al., 2021). Kadoya et al. (2014) stated that mangrove plants rely mainly on river and sea water currents for their diaspore dispersal. River current and water depth are the second indicators for suitable conditions supporting mangrove life (Hilmi et al., 2021).

AGE STRUCTURE





The structural attributes of the Tinorian River's mangrove composition reflect an uneven-aged mangrove forest. The diameter distribution of both trees and saplings represents an even uneven-aged mangrove forest (Trettin et al., 2016). In Barotac Nuevo, mangrove tree populations are highest downstream with 83 trees, followed by midstream with 57 trees, and upstream has the least number of 27 trees. Saplings dominate midstream, with 153 counts of different species of mangroves belonging to Rhizophoraceae and Sonneratiaceae. Downstream, 44 counts of mixed species of the family Avicenniaceae and Rhizophoraceae exist. The fewest saplings are recorded upstream, with 24 counts, mostly Avicenniaceae. The highest count of seedlings is found at the upstream part of the river, with several 1,344 dominated by Avicenniaceae and Sonneratiaceae. Midstream has 536 seedlings of the most diverse sampling site, with most families of Avicenniaceae, Sonneratiaceae, and Rhizophoraceae. Downstream has the least number of seedlings with 12 counts and belongs to families of Avicenniaceae and Rhizophoraceae.

In Anilao, the highest mangrove tree population is found upstream and downstream, with the exact count of 59 trees, while midstream had 48 trees. Regarding dominance of saplings, upstream has the highest number with 115 counts after midstream with 44 saplings, followed by downstream involving 8 saplings. Upstream has the highest total of seedlings, with 697 counts, 353 seedlings found in midstream, and downstream, with 26 counts. Many seedlings are in the upstream areas of two sampling sites. The population of growth trees is abundant downstream and upstream of Anilao, while in Barotac Nuevo, mangrove trees thrive only downstream. Higher nutrient concentrations in downstream regions are often due to runoff from upstream areas. Numerous counts of saplings were found midstream of Barotac Nuevo and upstream in Anilao. Tamai et al. (1998) stated that the chance of seedlings becoming established at a site depended on the topography of the forest floor.

Mangrove species at the seedling stage using 1m x 1m sub-plots were found in Barotac Nuevo with 1,892 individuals and 1,076 individuals in Anilao in three streams. If this value is converted to per hectare area, it has a density of 18 9200 individuals/ha in Barotac Nuevo and 10 7600 individuals/ha in Anilao. By Decree of the Director General of Forestry No. 60 Kpts/DJ/I/1978 regarding mangrove forest management, it is stated that mangrove communities have normal natural regeneration if they have 1000 individual seedlings/ha.

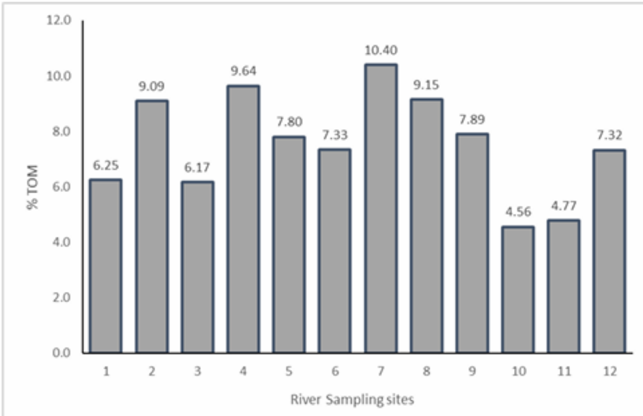
Mangrove Diversity

The Species Diversity using the Shannon-Weiner Diversity Index of mangroves yielded a result of 1.34 in Barotac Nuevo and 1.09 in Anilao. This summarizes the mangrove community structure along the Tinorian River, indicating that it is diverse with abundant mangroves and rich species. Padojinog et al. (2011) documented the predominant species of little egret (Egretta garzetta), maritime kingfishers (Todiramphus chloris), and a small population of the vast (Egretta alba) sight their occurrence along the Tinorian River. Despite low diversity indices, Tinorian River has a rich ecosystem with a diverse species of mangrove community structure; this abundance of its resources supports fisherfolks in their livelihood and the marine ecosystem.

Relative Values	Shannon-Wiener Index (H')
Very High	3.50 - 4.00
High	3.00 - 3.49
Moderate	2.50 - 2.99
Low	2.00 - 2.49
Very Low	1.99 and below

Modified Fernando (1998) Diversity scale

River Health Analysis

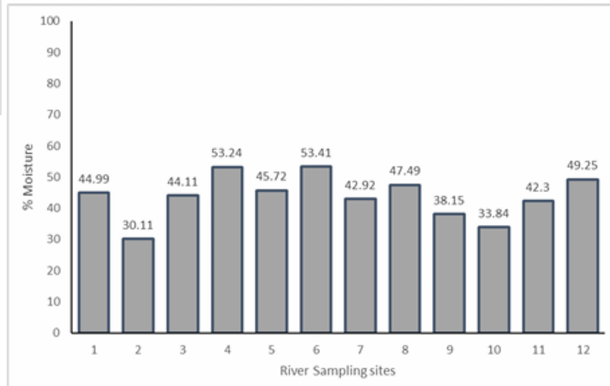


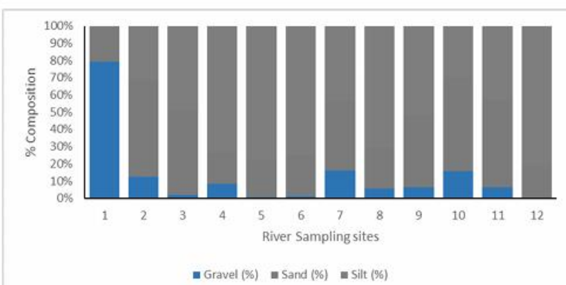
TOTAL ORGANIC MATTER (%TOM) ON THE RIVER SITES

- The river sites likely exhibit different %TOM levels due to the continuous flow of water, which affects sediment deposition and organic matter accumulation. Rivers often receive organic inputs from various sources, including upstream agricultural runoff, decaying vegetation, and effluents.

MOISTURE CONTENT: SEDIMENT ANALYSIS

- This condition supports a healthier riverine ecosystem and is conducive to sustaining diverse aquatic species. However, it also implies that sediment management practices must consider the implications of lower moisture levels, such as potential impacts on the sediment's capacity to retain nutrients and support microbial communities.





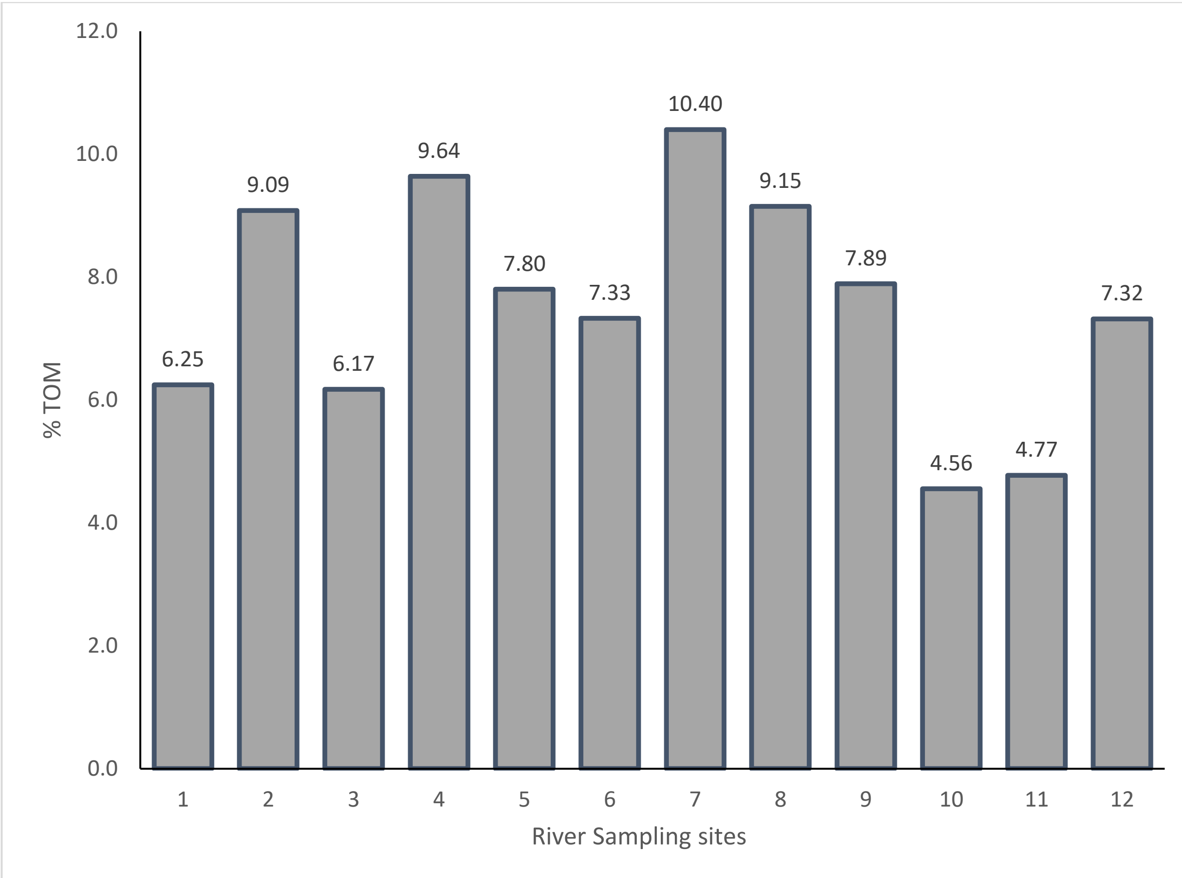
GRAIN SIZE COMPOSITION IN RIVER SITES

- The gravel found in these sites primarily consists of broken bivalve shells. This suggests that the river's sedimentary environment includes elements of biological origin, which can influence habitat conditions and ecological functions.

RIVER					PONDS				
Site	*Temperature (°C)*	*Salinity (ppt)*	*Dissolved Oxygen (mg/L)*	*pH*	*Site*	*Temperature (°C)*	*Salinity (ppt)*	*Dissolved Oxygen (mg/L)*	*pH*
1	28.45	0.21	3.92	10.32	A	27.87	1.14	2.01	9.18
2	29.11	0.3	3.71	10.46	B	28.26	1.54	2.69	10.2
3	29.89	0.4	3.96	10.51	C	27.83	0.94	1.96	9.68
4	29.08	3.35	2.96	10.25	D	27.84	1.02	1.79	9.89
5	29.25	5.35	2.85	10.51	E	27.9	2.74	1.7	9.75
6	29.56	6.48	2.84	10.91	F	28.96	8.51	1.85	9.96
7	29.4	8.24	4.08	10.04	G	28.74	7.91	1.69	9.82
8	29.65	8.47	2.82	10.25	H	29.16	8.55	1.31	9.74
9	30.04	8.81	2.96	10.45	I	29.35	7.21	1.25	9.72
10	30.08	10.74	3.11	10.44	J	29.45	6.25	1.2	9.64
11	30.26	11.83	3.17	10.23	K	29.64	6.59	1.49	9.54
12	30.26	11.76	3.14	10.1	L	30.07	12.7	1.93	9.61
					M	30.65	24.65	2.13	9.59
					N	30.36	24.96	2.53	9.84
					O	30.28	32.5	2.77	10.29
Mean	**29.59±0.55**	**6.33±4.39**	**3.29±0.48**	**10.37±0.23**		**29.09±0.99**	**9.81±9.85**	**1.89±0.49**	**9.76±0.27**

WATER QUALITY PARAMETERS

- The study highlights the significant impacts of fisheries and anthropogenic activities on sediment organic matter (OM) loads and water parameters. High levels of OM and low dissolved oxygen (DO) concentrations in the river indicate that these activities are influencing sediment and water quality.

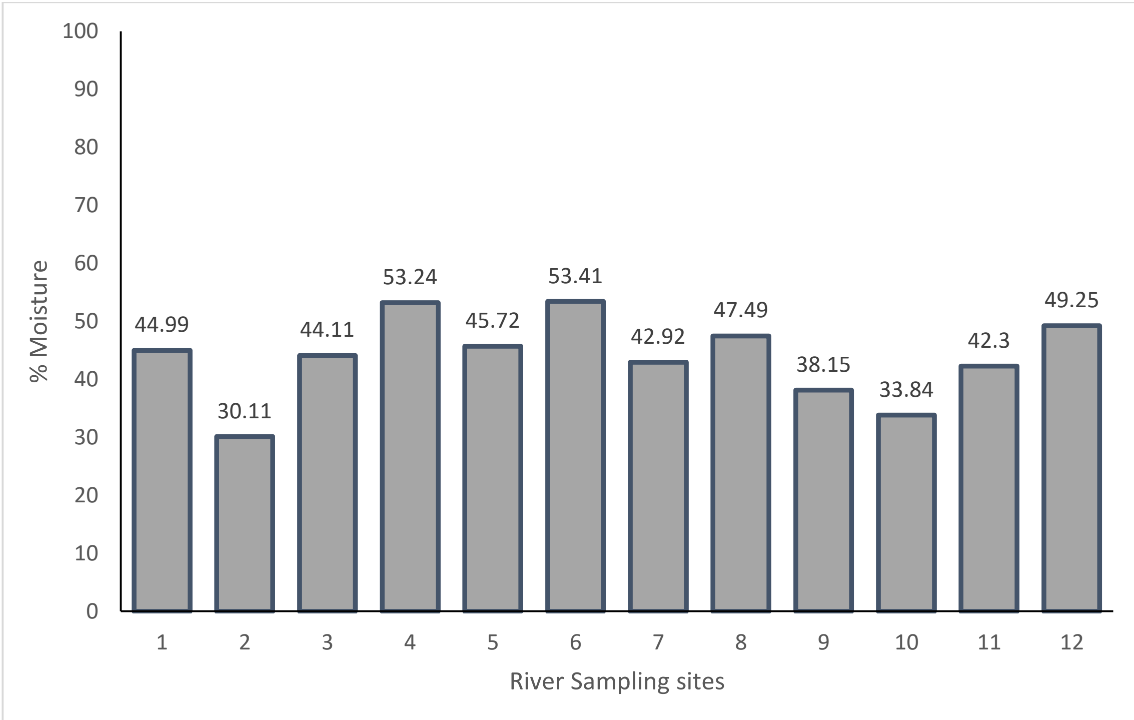


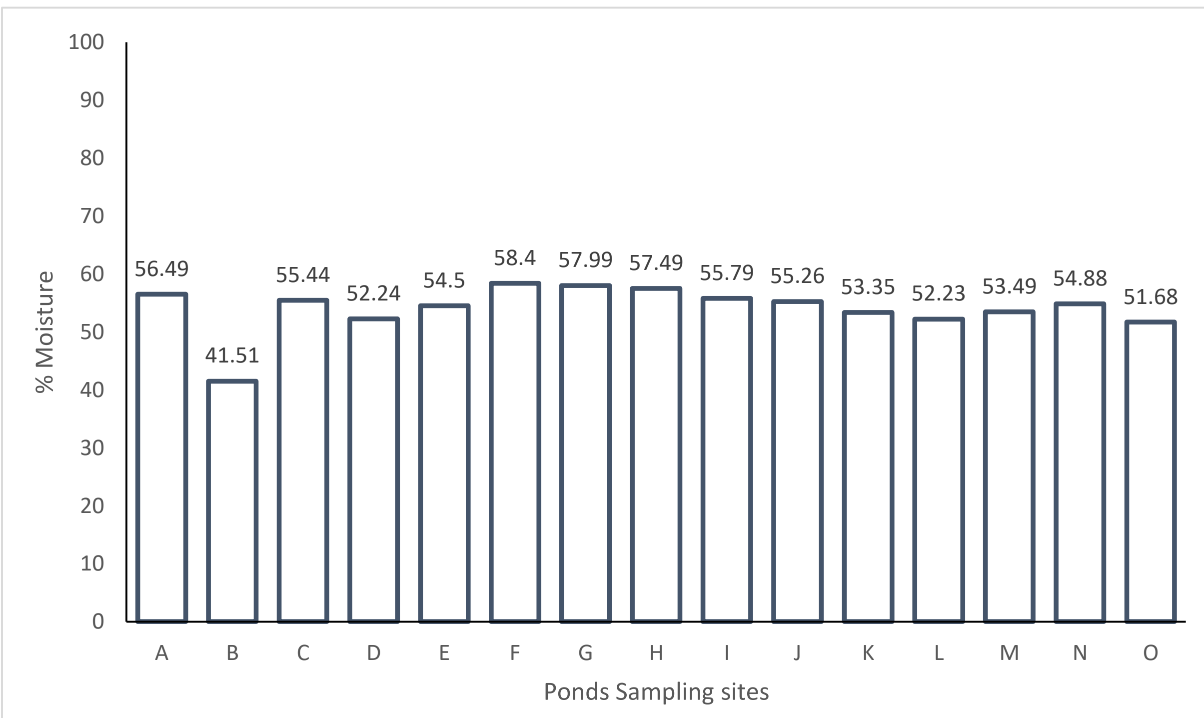
The analysis of Total Organic Matter (%TOM) between the river and pond sites reveals a significant difference, as indicated by the p-value of 0.03 obtained from the two-tailed t-tests assuming equal variances ($\alpha = 0.05$). This p-value, being less than the alpha level of 0.05, confirms that the difference in %TOM between the river and pond sites is statistically significant. The %TOM is a critical indicator of organic content in sediments, which directly influences the quality of the aquatic environment and the health of the ecosystem. The significant difference in %TOM between the river and pond sites suggests distinct environmental conditions and organic matter dynamics in these two settings.

River Sites

The river sites (represented as gray in the analysis) likely exhibit different %TOM levels due to the continuous flow of water, which affects sediment deposition and organic matter accumulation. Rivers often receive organic inputs from various sources, including upstream agricultural runoff, decaying vegetation, and effluents. The dynamic nature of river systems, characterized by flowing water, sediment transport, and periodic flooding, may result in more variable and potentially lower %TOM levels compared to pond environments.

In contrast, the pond sites (represented as white) are more static aquatic environments, where organic matter is less likely to be washed away and is more prone to accumulate over time. The ponds' enclosed nature, along with the controlled inputs like fertilizers used to promote the growth of natural food for aquaculture, likely contributes to higher %TOM levels. The buildup of organic matter in pond sediments can be beneficial for supporting aquaculture by enhancing the availability of natural food sources like "lablab" and "lumot." However, excessive organic accumulation may lead to issues such as hypoxia, particularly in deeper layers of the sediment, which could adversely affect fish health and pond productivity





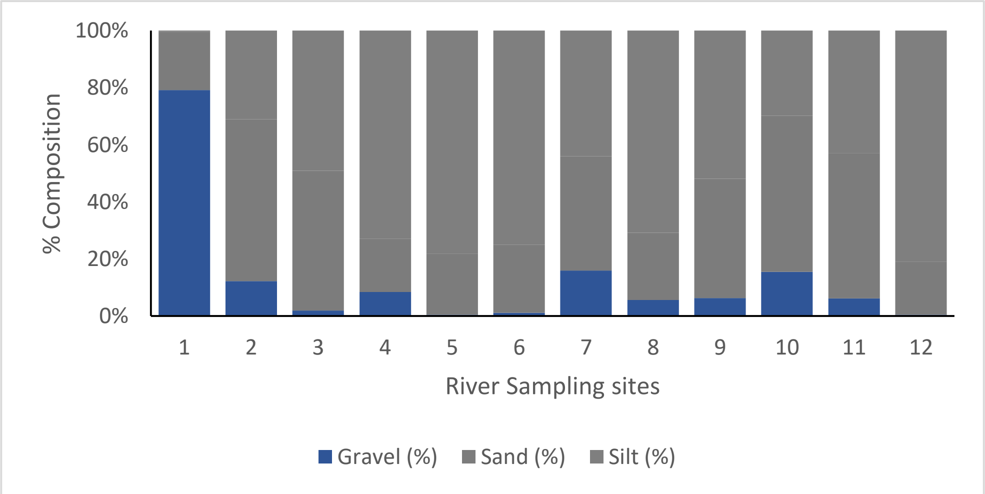
The analysis of sediment moisture content (%Moisture) between river and pond sites, with a p-value of 0.0003 obtained from two-tailed t-tests assuming unequal variances ($\alpha = 0.05$), indicates a significant difference between these two environments. Given that the p-value is substantially lower than the alpha level of 0.05, we can confidently assert that the observed difference in %Moisture is statistically significant.

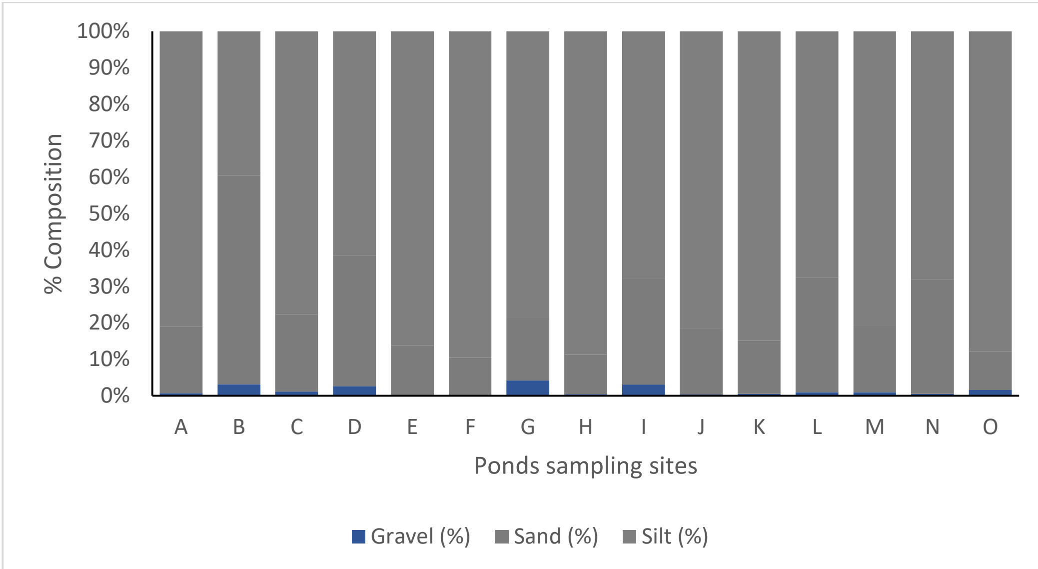
Moisture Content Differences

In river environments (depicted in gray), the moisture content of sediments is influenced by the constant flow of water and sediment dynamics. Rivers experience regular disturbances from water movement, which affects sediment deposition and moisture retention. Flowing water tends to keep sediment particles relatively well-mixed and prevents excessive buildup of moisture. This dynamic process often results in lower %Moisture in river sediments compared to the more stable environments of ponds. For rivers, lower %Moisture in sediments can be advantageous for maintaining proper aeration and reducing the risk of anaerobic conditions, which can be detrimental to aquatic life. This condition supports a healthier riverine ecosystem and is conducive to sustaining diverse aquatic species. However, it also implies that sediment management practices must consider the implications of lower moisture levels, such as potential impacts on the sediment's capacity to retain nutrients and support microbial communities.

Pond environments (depicted in white), on the other hand, are characterized by stagnant water, which leads to the accumulation of organic and inorganic materials. In ponds, sediments are less affected by the physical disturbances seen in rivers, leading to higher moisture retention. The reduced water movement allows sediments to retain more moisture over time, contributing to higher %Moisture levels. Additionally, ponds often experience seasonal variations in water levels and sediment inputs, which can further influence moisture content. In contrast, higher %Moisture in pond sediments suggests that ponds are more prone to moisture retention, which can affect the pond's overall sediment quality and the efficiency of organic matter decomposition. While higher moisture content can support the growth of aquatic plants and natural food sources for fish, it also increases the risk of problems such as excessive organic buildup, nutrient release, and potential hypoxic conditions if not properly managed. Effective pond management should focus on balancing moisture content with organic matter inputs to avoid negative impacts on water quality and aquatic health.

For ecotourism, understanding the differences in %Moisture between river and pond sites is crucial for managing the environmental health of these ecosystems. For riverine ecotourism, ensuring low moisture levels can help maintain clear water and healthy habitats. For pond-based ecotourism, managing higher moisture levels is key to preventing issues related to organic buildup and maintaining a pleasant and sustainable environment for visitors. In summary, the significant difference in %Moisture between river and pond sites highlights the distinct environmental characteristics of these aquatic systems. Proper management practices tailored to the unique conditions of each environment are essential for maintaining ecosystem health and supporting sustainable practices, whether for aquaculture or ecotourism.





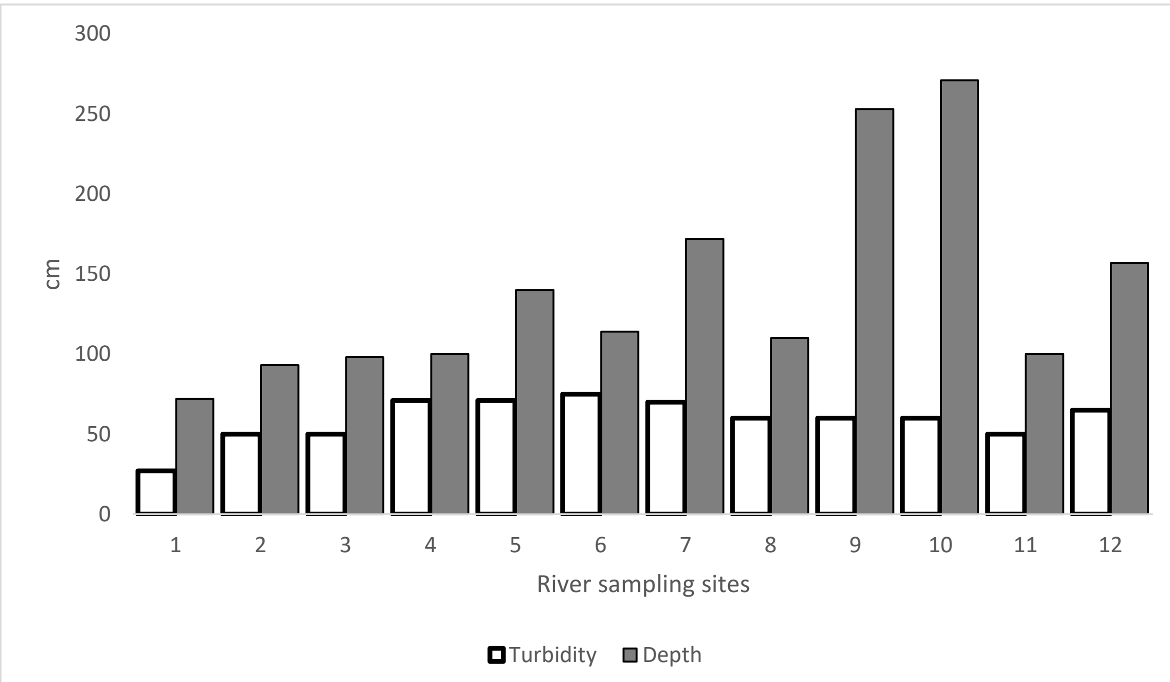
The grain size composition analysis of sediment samples from various sites along the Tinorian River and adjacent ponds reveals distinct differences in sediment characteristics, which have important implications for both ecological processes and management practices.

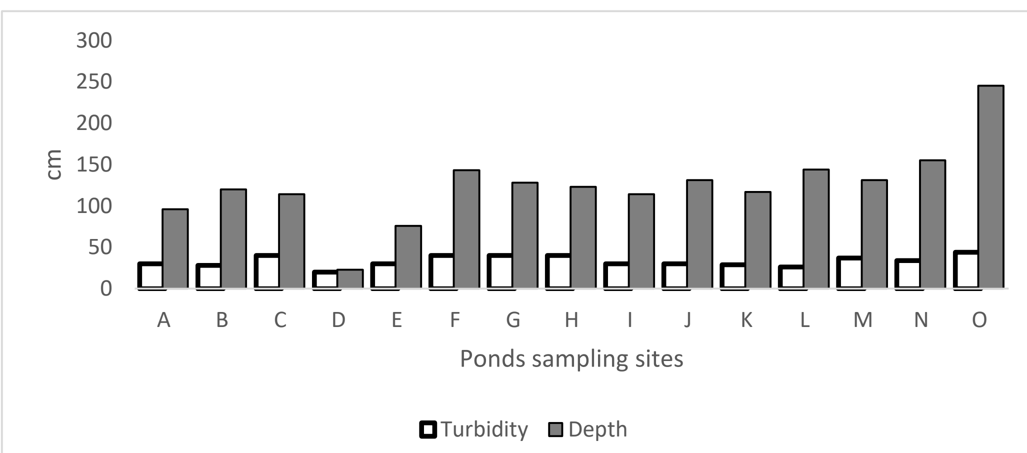
Grain Size Composition in River Sites

For Sites 2 to 11 along the Tinorian River, the predominance of sand and silt indicates a relatively fine sediment environment. Sand and silt are typical in river systems where finer particles are transported and deposited by water flow. Sand, with its relatively coarse nature, can facilitate good water drainage and aeration, which is beneficial for many aquatic organisms. Silt, on the other hand, can lead to fine sediment accumulation that might impact water quality and habitat structure if present in excess. The gravel found in these sites primarily consists of broken bivalve shells. This suggests that the river's sedimentary environment includes elements of biological origin, which can influence habitat conditions and ecological functions. Broken shells can contribute to the structural complexity of the riverbed, providing habitat for various aquatic organisms and influencing sediment stability. However, excessive shell debris can also affect sediment dynamics and water flow patterns.

In the pond sites, the sediment is predominantly composed of sand and silt. The uniformity in grain size composition across all pond sites indicates a relatively stable sediment environment with limited disturbance compared to the dynamic conditions of river sites. The dominance of sand and silt in ponds suggests a more subdued sediment transport and deposition process, with less variation in sediment types. The diverse grain size distribution in river sediments, particularly the presence of gravel and broken shells, highlights the river's dynamic sedimentary processes and its role in shaping aquatic habitats. Effective river management should consider these variations to support ecological functions, such as nutrient cycling and habitat formation. Additionally, the presence of gravel and bivalve shells should be monitored to ensure that they do not adversely affect water flow or sediment stability. In pond environments, the consistent composition of sand and silt suggests that sediment management practices should focus on maintaining sediment stability and avoiding excessive accumulation of fine particles. Pond management strategies should address potential issues related to siltation and ensure that sediment characteristics support the desired ecological functions and water quality conditions.

RIVER					PONDS				
Site	*Temperature (°C)*	*Salinity (ppt)*	*Dissolved Oxygen (mg/L)*	*pH*	*Site*	*Temperature (°C)*	*Salinity (ppt)*	*Dissolved Oxygen (mg/L)*	*pH*
1	28.45	0.21	3.92	10.32	A	27.87	1.14	2.01	9.18
2	29.11	0.3	3.71	10.46	B	28.26	1.54	2.69	10.2
3	29.89	0.4	3.96	10.51	C	27.83	0.94	1.96	9.68
4	29.08	3.35	2.96	10.25	D	27.84	1.02	1.79	9.89
5	29.25	5.35	2.85	10.51	E	27.9	2.74	1.7	9.75
6	29.56	6.48	2.84	10.91	F	28.96	8.51	1.85	9.96
7	29.4	8.24	4.08	10.04	G	28.74	7.91	1.69	9.82
8	29.65	8.47	2.82	10.25	H	29.16	8.55	1.31	9.74
9	30.04	8.81	2.96	10.45	I	29.35	7.21	1.25	9.72
10	30.08	10.74	3.11	10.44	J	29.45	6.25	1.2	9.64
11	30.26	11.83	3.17	10.23	K	29.64	6.59	1.49	9.54
12	30.26	11.76	3.14	10.1	L	30.07	12.7	1.93	9.61
					M	30.65	24.65	2.13	9.59
					N	30.36	24.96	2.53	9.84
					O	30.28	32.5	2.77	10.29
Mean	**29.59±0.55**	**6.33±4.39**	**3.29±0.48**	**10.37±0.23**		**29.09±0.99**	**9.81±9.85**	**1.89±0.49**	**9.76±0.27**

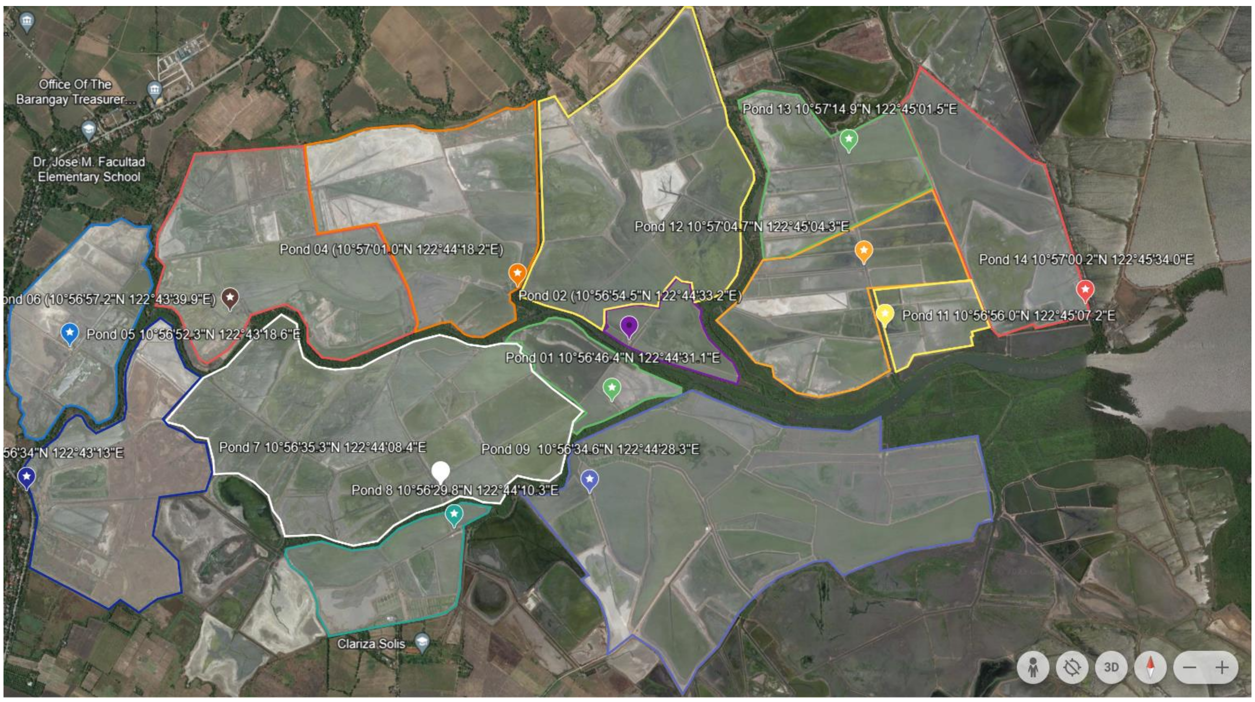




Baseline Data on Impacts of Fisheries and Anthropogenic Activities

The study highlights the significant impacts of fisheries and anthropogenic activities on sediment organic matter (OM) loads and water parameters. High levels of OM and low dissolved oxygen (DO) concentrations in the river indicate that these activities are influencing sediment and water quality. Elevated OM can result from organic waste and nutrient loading, which, in turn, contributes to oxygen depletion. The low DO levels observed in the river further highlights the need for intervention to improve water quality.

The river's high OM and low DO concentrations suggest compromised habitat health. Excessive OM can lead to eutrophication, promoting algal blooms that deplete oxygen levels and disrupt aquatic ecosystems. Low DO levels impair the health of aquatic organisms, affecting biodiversity and overall ecosystem function. The study's findings underscore the urgency of addressing these issues to restore and maintain the ecological balance of the Tinorian River.



Fishpond Profiling

The demographic data collected from the fishpond caretakers in the study area reveals that all caretakers are male. This indicates a gender-specific role in fishpond management, which is consistent with cultural norms in many rural areas where men traditionally engage in aquaculture and related activities. The average household size among these caretakers is six, which is typical for rural Filipino households and suggests a reliance on aquaculture as a significant source of livelihood for relatively large families. The fishponds assessed are spread across multiple barangays in the municipalities of Barotac Nuevo and Anilao, specifically in Brgy. Tinori-an and Tiwi in Barotac Nuevo, and Brgy. Culob, Badiang, Serallo, and Pantalan in Anilao. The distribution of fishponds across these barangays suggests that aquaculture is a widespread practice in these areas, likely due to favorable conditions such as proximity to water sources and appropriate land use for fish farming.

Fishpond Management Practices

All the fishponds profiled are engaged in monoculture, specifically focusing on the cultivation of milkfish (Chanos chanos). The practice of monoculture can be advantageous due to the specific optimization of resources and management practices tailored to a single species, allowing for better control over the production process and potentially higher yields. However, it also presents risks such as increased vulnerability to diseases that can affect the entire crop.

A significant finding is that 10 out of the 14 ponds are utilizing natural food sources like "lablab" (a type of benthic algae) and "lumot" (filamentous algae). The reliance on natural food indicates an environmentally friendly approach to aquaculture, which reduces the need for commercial feeds and potentially lowers the cost of production. This practice aligns with sustainable aquaculture principles by promoting a natural ecosystem within the ponds, which can enhance water quality and fish health.

All fishponds are using fertilizers to promote the growth of natural food. The application of fertilizers is a common practice in aquaculture to enhance the productivity of natural food sources. However, the type and amount of fertilizer used need to be carefully managed to avoid negative environmental impacts, such as nutrient runoff that could lead to eutrophication in adjacent water bodies.

Harvest and Culture Periods

The harvest frequency among the fishponds varies from 1 to 3 times per year, reflecting the different management strategies and market demands. The culture period for milkfish in these ponds is divided into two stages:

A. **Fry Stage:** Lasting between 1 to 2 months, this initial stage involves rearing the young fish until they are robust enough to be transferred to the grow-out phase.

B. **Nursery and Grow-out Stage:** This stage extends over 3 to 5 months, during which the milkfish are raised until they reach marketable size.

The culture periods reported are consistent with standard practices for milkfish aquaculture in the region, balancing the need for efficient production with the biological growth cycles of the fish. The varying harvest frequencies indicate a flexible approach to market conditions, where some ponds may opt for multiple smaller harvests to meet local demand or to manage cash flow, while others may focus on fewer, larger harvests to maximize yield and income at specific times of the year. The profiling of fishponds in the study area provides valuable insights into the practices and challenges faced by local aquaculture practitioners. The predominance of monoculture and the use of natural food sources suggest a traditional yet sustainable approach to milkfish farming. However, there are potential risks associated with monoculture, such as disease outbreaks, which could have devastating effects on production. The reliance on fertilizers, while beneficial for natural food production, also highlights the need for careful management to prevent environmental degradation. Moreover, the variability in harvest frequency and culture periods reflects the adaptability of fishpond operators to market demands and environmental conditions. This flexibility is crucial for the sustainability of aquaculture in these areas, as it allows farmers to respond to changing economic and environmental conditions. In conclusion, the fishponds in Brgy. Tinori-an, Tiwi, Culob, Badiang, Serallo, and Pantalan are engaged in practices that are both economically and environmentally significant. Continued support and education on sustainable practices, particularly in managing the risks associated with monoculture and fertilizer use, will be essential for the long-term viability of these aquaculture operations.

KNOWLEDGE, SKILLS, AND PRACTICES (KSP)

The study revealed moderate levels of knowledge among stakeholders regarding environmental conservation in community-based ecotourism. While foundation awareness exists, further education is needed to deepen understanding and promote active participation. Stakeholders demonstrated high technical skills relevant to ecotourism development, but there is room for refinement, particularly in biodiversity conservation and waste management. Positive attitudes towards environmental conservation and ecotourism were prevalent among stakeholders, fostering community support. However, actual engagement in ecotourism practices was moderate, indicating a need for practical training and experiential learning.

The findings emphasized the importance of targeted capacity-building initiatives to address identified gaps in KSP. Enhancing stakeholders' knowledge, particularly regarding environmental conservation laws and business literacy, is crucial for sustainable operations. Skills development should focus on specialized areas such as biodiversity conservation and waste management to improve the quality of ecotourism initiatives. Efforts to sustain positive attitudes towards ecotourism and environmental stewardship are essential for long-term success.

The study aimed to assess the knowledge, skills, and practices among stakeholders of Barangay Tinorian, particularly in relation to ecotourism development along Tinorian River. The results revealed varied levels of proficiency and engagement among community members in different aspects of ecotourism.

Knowledge Assessment

a. Knowledge on Environmental Conservation in Community-Based Eco-Tourism (CBET): The mean score of 2.68 indicates a moderate level of knowledge and understanding among stakeholders regarding environmental conservation within the context of community-based ecotourism. This suggests a foundation awareness of conservation principles but highlights the need for further education and awareness campaigns to deepen understanding and promote active participation in conservation efforts. While there is a baseline understanding, there is room for improvement in terms of awareness and comprehension of key concepts related to sustainable tourism management.

Table 1. Knowledge Assessment on Environmental Conservation in CBET

Statement	Mean	Std. Deviation
Q1. Climate change is a long-term change in the average weather patterns that have come to define Earth's local, regional, and global climates.	2.85	0.383
Q2. Global warming is the long-term heating of Earth's surface observed since the pre-industrial period (between 1850 and 1900) due to human activities, primarily fossil fuel burning, which increases heat-trapping greenhouse gas levels in Earth's atmosphere.	2.82	0.490
Q3. Tourism Industry is an important element of the national economy that must be harnessed as an engine of socioeconomic growth.	2.81	0.467
Q4. The Tourism Industry is of national interest and can be a tool for cultural affirmation to generate investment, foreign exchange and employment, and to continue to mold an enhanced sense of national pride for all Filipinos.	2.85	0.376
Q5. Philippine Tourism Industry has been marketed and promoted by the government, i.e. WOW Philippines, It's more fun in the Philippines?	2.70	0.493
Q6. "Tourism enterprises" refers to facilities, services and attractions involved in tourism, such as travel and tour services and tourist transport services, whether for land, sea or air transportation.	2.78	0.413
Q7. "Tourism enterprises" also refers to facilities, services and attractions involved in tourism, such as tour guides; adventure sports services involving such sports as mountaineering, spelunking, scuba diving and other sports activities of significant tourism potential**.**	2.73	0.510
Q8. Convention organizers; accommodation establishments, including, but not limited to, hotels, resorts, apartelles, tourist inns, motels,	2.69	0.526

pension houses and home stay operators are considered as Tourism Industry.		
Q9. . Tourism estate management services, restaurants, shops and department stores, sports and recreational centers, spas, museums and galleries, theme parks, convention centers and zoos are Tourism Industry.	2.79	0.445
Q10. "Primary tourism enterprises" refers to travel and tour services; land, sea and air transport services exclusively for tourist use.	2.72	0.528
Q11. Accommodation establishments; convention and exhibition organizers; tourism estate management services are considered as Primary Tourism Enterprises.	2.66	0.551
Q12. Tourism activities have negative impacts on the environment, i.e. carbon emission, over consumption of water and energy, land degradation, loss of habitat of flora and fauna, etc.	2.42	0.734
Q13. Tourism Industry is dependent upon environment and natural resources.	2.65	0.526
Q14. The damage on the environment will affect the tourism industry.	2.67	0.504
Q15. Tourism industry is a climate-sensitive sector.	2.57	0.597
Q16. Green Practices are environmental friendly actions, which can help to environment protection and sustainability development.	2.75	0.471
Q17. Companies should engage in "Corporate Social Responsibility" (CSR) that would enhance the society and the environment.	2.75	0.483
Q18. Accreditation in the Department of Tourism as a tourism enterprise will enhance the image of the business.	2.75	0.483
Q19. Carbon dioxide emitted by vehicles and the like.	2.55	0.660
Q20. Clearing of forests and widespread loss of vegetation increase carbon emission.	2.66	0.591
Q21. Irresponsible use of natural resources can damage the environment.	2.62	0.591
Q.22. Clean and healthy environment is good for the physical and mental wellness of an individual.	2.78	0.472
Q23. Maintenance and protection of the environment and its resources is everybody's concern and responsibility.	2.79	0.426
Q24. Existing company policy on Green Practices.	2.78	0.449
Q25. Creation/existing Green Practices Team in the company.	2.75	0.503
Q26. Company is a partner to agencies, i.e. Department of Environment and Natural.	2.75	0.483
Q27. Resources (DENR), Department of Tourism (DOT), LGUs and other stakeholders on activities related to environment and tourism	2.75	0.483

Q28. Observance of green practices of tourism industry will help conserve and protect the environment for sustainable tourism?	2.74	0.507
Q29. Company is an ISO certified.	2.72	0.517
Q30. Company has been recognized or awarded as one of the best implementers of green practices in tourism industry.	2.51	0.662
Grand Mean	2.68	0.557

b. Knowledge on Business Literacy

The study utilized the Business Literacy Questionnaire (Adapted from Manalo and Gabayeron, 2023) to assess stakeholders' knowledge on business principles relevant to ecotourism. This dimension likely contributes significantly to the overall skills and practices observed among stakeholders, influencing their ability to effectively manage ecotourism enterprises and ensure sustainable operations.

Table 2. Knowledge on Business Literacy

Statements	Mean	Std. Deviation
1. I know the organizations goals and objectives (both measurable and global).	3.88	1.004
2. I know how to read and explain one or more of the financial statements (income statement, balance sheet, cash flow statement) and understand the key measures of success for their organization	3.75	1.035
3. I know how my work/job impacts the organization’s goals and objectives, financial statements, and key measures	3.97	0.956
4. I can understand what is written in an income statement	3.82	1.018
5. I know the key elements of a balance sheet.	3.70	1.024
6. I know and understand the difference between profit and cash and why that difference is important	3.80	0.968
7. I know the basics of the cash flow statement.	3.68	1.049
8. I know what capital budgeting and decision-making is	3.76	1.084
9. I understand the key numbers contained in the statement or how to manage their area using the statement.	3.67	1.007
10. I understand the connection between their work and revenue, expenses, and profit.	3.67	1.037
11. I understand the impact expenses have on the success of the company and understand their role in controlling those expenses	3.68	1.027
12. I know and understand the percentage of sales that goes to salary, benefits, materials, and so on.	3.80	0.976
13. I understand the financial impact of non-financial business practices; they understand how everything fits together to achieve success	3.58	0.955

C. Tourism Technical Skills

Stakeholders demonstrate a high level of skills, as indicated by the mean score of 4.35. This suggests that community members possess the technical abilities required for implementing ecotourism initiatives effectively. However, further refinement and specialization of skills may enhance the quality and efficiency of ecotourism operations. Stakeholders exhibit a high level of skills, particularly in technical areas relevant to ecotourism development. This proficiency suggests that community members possess the technical abilities required for implementing ecotourism initiatives effectively. However, there is room for refinement and specialization of skills to enhance the quality and efficiency of ecotourism operations. Capacity building initiatives should focus on skills development in areas such as biodiversity conservation, waste management, and visitor interpretation to further reinforce stakeholders' expertise and promote excellence in ecotourism management.

D. Practices

The mean score of 1.6 suggests a moderate level of engagement in ecotourism practices among stakeholders. While there is evidence of some involvement, such as preliminary assessments of the river ecosystem, there is still room for enhancement in terms of actual implementation and integration of sustainable practices into daily operations. While stakeholders demonstrate moderate engagement in ecotourism practices, there is room for improvement in translating theoretical knowledge into tangible conservation actions on the ground. While preliminary assessments of the river ecosystem have been conducted, there is a need for greater integration of sustainable practices into daily operations. Capacity-building initiatives should prioritize practical training sessions and experiential learning opportunities to encourage stakeholders to actively implement ecotourism practices and contribute to the conservation and management of natural resources effectively. By bridging the gap between knowledge and practices, stakeholders can play a more significant role in promoting sustainable tourism development and environmental stewardship in Barangay Tinorian.

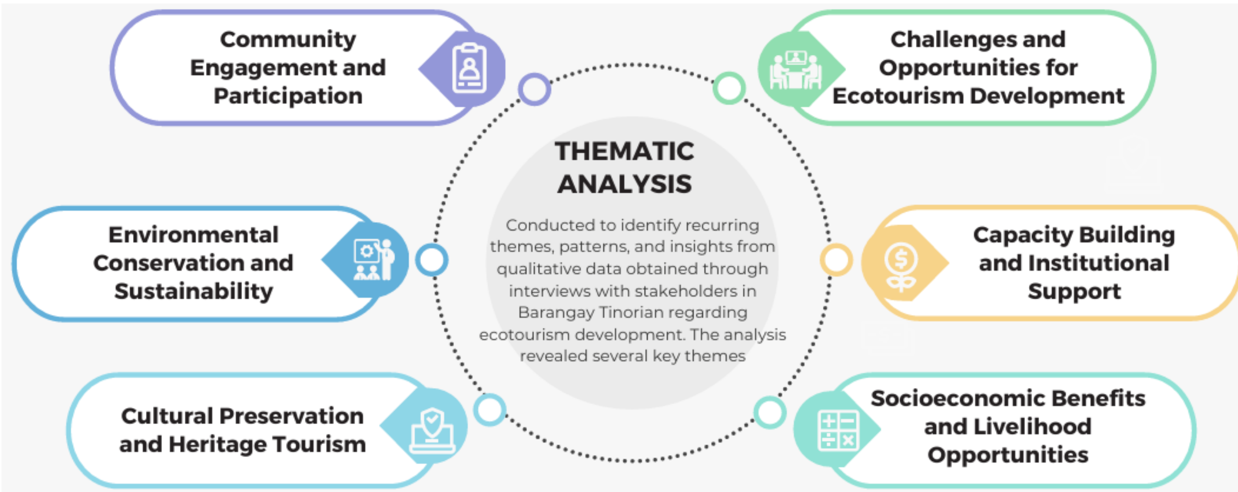
Table 4: Green Practices Assessment

Statements	Mean	Std. Deviation
1. The community conducts orientations/learning events on the policy on Green Practices including environmental and tourism laws.	1.26	0.475
2. The community sends personnel to attend learning events/fora on environmental and tourism relates laws.	1.23	0.441
3. Creates/existing Green Team in the community.	1.29	0.489
4. Observes power saving techniques, i.e. unplug appliances, device, gadgets, equipment when not in use.	1.22	0.454
5. Installed motion detection lights that turn off when everyone leaves the room.	1.26	0.475
6. Use of solar power.	1.51	0.739
7. Use of LED lights.	1.24	0.463
8. Use of key cards in rooms that serve as control switches.	1.75	0.771
9. Low-flow showerheads and toilets.	1.79	0.785
10. Reduced chemical and laundry supplies.	1.46	0.661

11. Linen reuse programs.	1.47	0.649
12. Availability of online booking.	1.77	0.849
13. Conducts of Tree Planting Activities with other agencies and institutions	1.32	0.571
14. Implementation of vertical green garden and placement of indoor plants.	1.42	0.608
15. Establishment of green spaces, i.e. mini park; mini garden.	1.42	0.568
16. Establishment of composting station for biodegradable wastes, i.e., banana peels, coffee grinds, apple cores, etc.	1.38	0.602
17. Paperless initiatives, i.e., receipts, reports, employees memo, etc. are converted to digital format.	1.55	0.672
18. Installation of bike racks.	1.78	0.747
19. Green transportation, i.e., encouraging employees to use bicycles, public transportation and electric vehicles.	1.52	0.638
20. Some of the vehicles of the company use hybrid or electric vehicles.	1.58	0.657
21. The community observes green procurement, i.e., purchases from a supplier or company that is highly environment conscious, manufactures goods with ecological consciousness and eco-friendly products, with green certification or environmental rating.	1.35	0.511
22. Use of less fragile table wares.	1.37	0.530
23. Avoid usage of plastic cups, spoons, and forks.	1.43	0.622
24. No straw policy on beverages.	1.49	0.626
25. Observance of Reduce, Reuse and Recycle.	1.28	0.532
26. Support to local economy, i.e., buying/using locally produced products, buy fair trade and organic products.	1.31	0.480
27. Placed/pasted reminder stickers on conspicuous places on green practices, i.e., Conserve Water, Every Drop Counts; Let's Live Green; Be Proactive – As part of our efforts in saving the environment, hanged towels mean that you would like to reuse your towel.	1.25	0.533
28. Installed/constructed rain-water harvesting and water collected is treated for use.	1.42	0.645
29. Black water recycling strategy, i.e., sewage is	1.49	0.662

treated then recycled water is purified water used.		
30. Adopts National Greening Program site/s of DENR 6 or other projects of the agency; i.e., MOA to protect and conserve a particular area.	1.27	0.479

THEMATIC ANALYSIS



Thematic analysis was conducted to identify recurring themes, patterns, and insights from qualitative data obtained through interviews with stakeholders in Barangay Tinorian regarding ecotourism development. The analysis revealed several key themes, each offering valuable insights into stakeholders' perspectives, experiences, and suggestions for improving ecotourism initiatives in the region. The following themes emerged from the data:

Community Engagement and Participation. Stakeholders expressed a strong desire for increased community involvement in ecotourism development efforts. Participants emphasized the importance of community engagement in decision-making processes, highlighting the need for inclusive planning and consultation with local residents, indigenous communities, and other stakeholders. Suggestions for enhancing community participation included establishing community-based organizations, fostering partnerships between local government and grassroots organizations, and implementing mechanisms for community input and feedback.

Environmental Conservation and Sustainability. Environmental conservation emerged as a central theme in stakeholders' discussions on ecotourism development. Participants expressed concerns about the degradation of natural resources and ecosystems due to unsustainable practices and over exploitation. There was a consensus among stakeholders on the importance of prioritizing conservation efforts, such as reforestation, watershed management, and biodiversity protection, to ensure the long-term sustainability of ecotourism initiatives. Suggestions for promoting environmental conservation included implementing ecotourism codes of conduct, raising awareness about conservation issues, and enforcing regulations to mitigate environmental impacts.

Cultural Preservation and Heritage Tourism. Participants highlighted the significance of cultural preservation and heritage tourism in ecotourism development. Stakeholders emphasized the need to showcase the cultural diversity and traditional practices of local communities while promoting responsible tourism. Suggestions for integrating cultural preservation into ecotourism initiatives included organizing cultural festivals and events, offering authentic cultural experiences for visitors, and supporting local artisans and cultural practitioners. Participants also emphasized the importance of respecting indigenous rights and promoting indigenous-led ecotourism ventures.

Socioeconomic Benefits and Livelihood Opportunities. Stakeholders discussed the potential socioeconomic benefits of ecotourism for local communities, including income generation, job creation, and poverty alleviation. Participants identified ecotourism as a viable livelihood option for residents, particularly those living in rural and marginalized areas. Suggestions for maximizing socioeconomic benefits included providing training and capacity-building opportunities for local entrepreneurs, promoting community-based tourism enterprises, and establishing ecotourism cooperatives to ensure equitable distribution of profits. Participants also emphasized the importance of sustainable tourism practices to safeguard livelihoods and protect community resources.

Challenges and Opportunities for Ecotourism Development. Stakeholders identified various challenges and opportunities for ecotourism development in Barangay Tinorian. Challenges included limited infrastructure and access to basic services, lack of marketing and promotion, inadequate funding and investment, and competing interests for land and resources. However, participants also highlighted opportunities such as natural attractions, cultural heritage, and community resilience as strengths that could be leveraged for ecotourism development. Suggestions for overcoming challenges and capitalizing on opportunities included developing ecotourism master plans, securing funding from government and private sources, and strengthening partnerships with stakeholders.

Capacity Building and Institutional Support. Participants underscored the importance of capacity building and institutional support for ecotourism development in Barangay Tinorian. Stakeholders emphasized the need for training programs, technical assistance, and mentorship to enhance the skills and knowledge of local residents involved in ecotourism initiatives. Suggestions for capacity-building initiatives included offering training in ecotourism management, sustainable practices, hospitality services, and entrepreneurship. Participants also called for greater support from government agencies, non-governmental organizations (NGOs), and development partners to provide funding, technical expertise, and policy support for ecotourism projects.

CONCLUSIONS

The findings demonstrate that the Tinorian River is rich in marine biodiversity, particularly in shellfish, fish, and crustaceans. The abundance of key species like Punaw, Talaba, Tilapia, Bangus, Pasayan, and Alimango provides a solid foundation for developing community-based ecotourism activities such as guided fishing tours, shellfish gathering, and crab-catching excursions. Additionally, the production of bottled seafood products like Talaba and Sisi presents opportunities for local entrepreneurs to capitalize on ecotourism by offering unique, locally-made goods to visitors. However, the lower frequency of certain species signals the need for conservation measures to ensure that ecotourism development does not compromise the river's ecological health. The Strategic Tourism Development Framework should include guidelines for sustainable harvesting practices, habitat protection, and community education to maintain the biodiversity and productivity of the Tinorian River while promoting tourism.

The study summarized the mangrove community structure along the Tinorian River, indicating that it is diverse with abundant mangroves and rich species. Padojinog et al. (2011) documented the predominant species of little egret (Egretta garzetta), maritime kingfishers (Todiramphus chloris), and a small population of the vast (Egretta alba) sight their occurrence along the Tinorian River. Despite low diversity indices, Tinorian River has a rich ecosystem with a diverse species of mangrove community structure; this abundance of its resources supports fisherfolks in their livelihood and the marine ecosystem.

The analysis of grain size composition reveals significant differences between river and pond sites, reflecting the distinct sedimentary environments of these aquatic systems. Understanding these differences is crucial for managing sediment-related issues, supporting ecological health, and ensuring the sustainability of both river and pond ecosystems. The study's baseline data and identified impacts emphasize the need for targeted management actions to address the high OM load and low DO levels in the Tinorian River. Further research on biological indicators, heavy metals, water productivity, and sediment parameters will enhance understanding and support effective management strategies. Additionally, the inclusion of the Tinorian River in regulatory frameworks will ensure comprehensive monitoring and protection of this vital water resource. The significant difference in %TOM between the river and pond sites has implications for both environmental management and the sustainability of aquaculture practices in the area. For the river, managing organic inputs to maintain balanced %TOM levels is crucial for preserving water quality and supporting biodiversity, both of which are essential for ecotourism. High organic matter in river sediments can lead to problems such as nutrient overloading, algal blooms, and degradation of aquatic habitats, all of which could negatively impact the aesthetic and ecological value of the river for ecotourism. For the ponds, while higher %TOM can be beneficial for sustaining natural food chains, it also necessitates careful monitoring and management to prevent negative impacts on water quality and fish health. Sustainable aquaculture practices should focus on balancing organic inputs with the pond's natural capacity to process and recycle organic matter, ensuring long-term productivity without causing environmental harm. In conclusion, the significant difference in %TOM between the river and pond sites underscores the need for tailored management strategies that consider the unique ecological dynamics of each environment. By addressing the specific challenges associated with %TOM in rivers and ponds, stakeholders can enhance both the ecological sustainability and economic viability of these aquatic systems, contributing to the broader goals of sustainable development in the region.

Enhancing the knowledge, skills, attitudes, and practices of stakeholders is essential for promoting ecotourism development and environmental conservation in Barangay Tinorian. Targeted capacity-building initiatives should be implemented to address identified gaps and empower community members to become stewards of their natural and cultural heritage. By bridging the gap between knowledge and practices, stakeholders can play a more significant role in promoting sustainable tourism development and environmental stewardship in the region. Bridging the gap between knowledge, skills, attitudes, and practices is essential for promoting ecotourism development and environmental conservation in Barangay Tinorian. Targeted capacity-building initiatives should empower stakeholders to become effective stewards of their natural and cultural heritage. By fostering a culture of sustainability and community engagement, ecotourism can contribute to the well-being of both residents and the environment in Barangay Tinorian.

The study reveals a moderate level of knowledge among stakeholders regarding environmental conservation within the context of community-based ecotourism. While there is a foundational awareness of conservation principles, further education and awareness campaigns are needed to deepen understanding and promote active participation. Additionally, stakeholders would benefit from additional training on business literacy and environmental conservation laws to ensure legal compliance and sustainable operations.

Stakeholders demonstrate a high level of technical skills relevant to ecotourism development, suggesting proficiency in implementing initiatives effectively. However, there is room for refinement and specialization, particularly in areas such as biodiversity conservation and waste management. Capacity-building initiatives should focus on skills development to enhance the quality and efficiency of ecotourism operations.

While stakeholders demonstrate moderate engagement in ecotourism practices, there is room for improvement in translating theoretical knowledge into tangible conservation actions. Practical training sessions and experiential learning opportunities are needed to encourage stakeholders to implement ecotourism practices and contribute to conservation efforts effectively actively.

Thematic analysis of qualitative data from stakeholder interviews revealed several key themes related to ecotourism development in Barangay Tinorian. These themes provide valuable insights into stakeholders' perspectives, experiences, and recommendations for promoting sustainable ecotourism initiatives in the region. By addressing the identified themes and implementing stakeholders' suggestions, policymakers, local government agencies, and community leaders can work together to harness the potential of ecotourism for environmental conservation, cultural preservation, and socioeconomic development in Barangay Tinorian.

RECOMMENDATIONS

Microbenthic Fauna as Biological Indicators. Microbenthic fauna could serve as effective biological indicators of habitat health and water quality. Their presence, abundance, and diversity can reflect the ecological status of the river and help in assessing the impacts of anthropogenic activities.

Assessment of Heavy Metals. Assessing heavy metal concentrations in sediments and water is critical, as these pollutants can accumulate in aquatic organisms and pose health risks to humans and wildlife. Identifying and monitoring heavy metal levels will provide insights into potential sources of contamination and help in managing pollution.

Productivity of Water. Evaluating the productivity of water through measurements of phytoplankton and zooplankton abundance can offer additional information on the ecological status of the river. Changes in primary and secondary productivity can influence nutrient cycling and overall ecosystem health.

Assessment of Total Suspended Solids (TSS) and Total Dissolved Solids (TDS). Measuring TSS and TDS provides insights into sediment and nutrient loading, which affects water clarity and quality. These parameters are essential for understanding sediment transport dynamics and their impact on aquatic habitats.

Inclusion of Tinorian River in DENR-EMB Classification. Given the river's environmental challenges and the findings of this study, it is recommended that the Tinorian River be included in the classification of water bodies by the Department of Environment and Natural Resources-Environmental Management Bureau (DENR-EMB). Proper classification will facilitate targeted management and regulatory measures to address the river's specific issues and ensure long-term environmental protection.

Develop Targeted Capacity-Building Programs. Design and implement targeted capacity-building programs aimed at enhancing stakeholders' knowledge and skills in key areas relevant to ecotourism development. These programs should focus on environmental conservation principles, business management practices, and technical skills such as biodiversity conservation and waste management. Collaborate with local educational institutions, government agencies, and NGOs to provide training workshops, seminars, and certification programs tailored to the needs of stakeholders.

Promote Community Engagement and Participation. Foster community engagement and participation in ecotourism decision-making processes to ensure that initiatives align with local needs and priorities. Establish community-based organizations or committees tasked with overseeing ecotourism development and representation of diverse stakeholder groups. Encourage active involvement of residents, indigenous communities, youth groups, and women's associations in planning, implementation, and monitoring of ecotourism activities.

Enhance Environmental Conservation Efforts. Strengthen environmental conservation efforts through the implementation of ecotourism codes of conduct, habitat restoration projects, and biodiversity conservation programs. Collaborate with environmental organizations, conservation groups, and government agencies to establish protected areas, wildlife corridors, and sustainable tourism zones. Raise awareness among stakeholders about the importance of preserving natural resources and ecosystems for future generations.

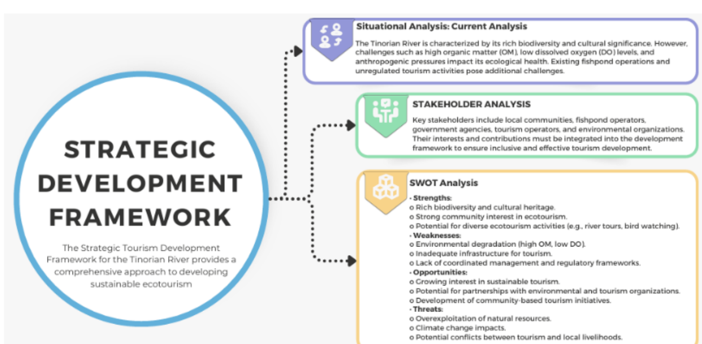
Support Cultural Preservation and Heritage Tourism. Promote cultural preservation and heritage tourism initiatives that showcase the unique traditions, customs, and cultural heritage of Barangay Tinorian. Develop ecotourism products and experiences that highlight local craftsmanship, traditional practices, and indigenous knowledge systems. Collaborate with cultural experts, heritage conservationists, and community leaders to safeguard intangible cultural heritage and promote cultural tourism as a means of socioeconomic empowerment.

Facilitate Socioeconomic Development and Livelihood Opportunities. Create opportunities for socioeconomic development and livelihood diversification through ecotourism entrepreneurship, micro-enterprise development, and skills training programs. Support local entrepreneurs, cooperatives, and small-scale enterprises engaged in ecotourism-related activities, such as eco-lodges, community-based tours, and handicraft production. Foster linkages with the tourism value chain to maximize economic benefits for residents while minimizing negative social impacts.

Strengthen Institutional Support and Policy Frameworks. Advocate for institutional support and policy frameworks that prioritize sustainable ecotourism development and environmental conservation. Collaborate with local government agencies, policymakers, and regulatory bodies to formulate ecotourism master plans, zoning regulations, and licensing requirements that promote responsible tourism practices. Allocate financial resources and technical assistance for ecotourism infrastructure development, marketing campaigns, and destination management initiatives.

Monitor and Evaluate Ecotourism Impacts. Establish monitoring and evaluation mechanisms to assess the environmental, social, and economic impacts of ecotourism activities over time. Conduct regular assessments of ecotourism indicators, such as visitor numbers, revenue generation, ecological carrying capacity, and community well-being. Use participatory approaches, community-based monitoring, and citizen science initiatives to involve stakeholders in data collection, analysis, and decision-making processes.

Results of the study were used to recommend a Strategic Tourism Development Framework for the Tinorian River which outlines a sustainable approach to ecotourism that integrates environmental conservation, community empowerment, and infrastructure development. Emphasizing the river's rich biodiversity and cultural heritage, the framework seeks to promote ecotourism activities while safeguarding ecological health. Key strategies include capacity-building initiatives for local stakeholders, the construction of eco-friendly infrastructure, and the implementation of conservation practices to address environmental challenges such as high organic matter and low dissolved oxygen levels. This balanced approach aims to foster sustainable tourism that benefits both the community and the natural environment.



Strategic Tourism Development Framework for the Tinorian River, Iloilo, Philippines

REFERENCES

Bahuguna, A., Nayak, S., & Roy, P. S. (2008). Impact of the 2004 tsunami on the coastline of India. *Current Science, 94*(1), 25-31.

Blasco, F., & Aizpuru, M. (2002). Mangroves of South and Southeast Asia as potential carbon sinks. *Climatic Change, 55*(3), 335-347.

Butler, R. W. (1999). Sustainable tourism: A state-of-the-art review. *Tourism Geographies, 1*(1), 7-25. https://doi.org/10.1080/14616689908721291

Calegario, G., Moreira de Barros Salomão, M. S., Rezende, C. E., & Bernini, E. (2020). Mangrove forest structure in the São João River Estuary, Rio de Janeiro, Brazil. *Estuarine, Coastal and Shelf Science, 239*, 106761.

Dahdouh-Guebas, F., Jayatissa, L. P., Di Nitto, D., Bosire, J. O., Lo Seen, D., & Koedam, N. (2005). How effective were mangroves as a defence against the recent tsunami? *Current Biology, 15*(12), R443-R447.

Dale, V. H., & Polasky, S. (2007). Measures of the effects of agricultural practices on ecosystem services. *Ecological Economics, 64*(2), 286-296. https://doi.org/10.1016/j.ecolecon.2007.05.009

Danielsen, F., Sørensen, M. K., Olwig, M. F., Selvam, V., Parish, F., Burgess, N. D., ... & Quarto, A. (2005). The Asian tsunami: A protective role for coastal vegetation. *Science, 310*(5748), 643.

Donato, D. C., Kauffman, J. B., Murdiyarso, D., Kurnianto, S., Stidham, M., & Kanninen, M. (2012). Mangroves among the most carbon-rich forests in the tropics. *Nature Geoscience, 4*(5), 293-297.

Dredge, D., & Jenkins, J. (2003). Destination place identity and regional tourism policy. *Tourism Geographies, 5*(4), 383-407. https://doi.org/10.1080/1461668032000129147

Giri, C., Ochieng, E., Tieszen, L. L., Zhu, Z., Singh, A., Loveland, T., ... & Duke, N. (2007). Status and distribution of mangrove forests of the world using earth observation satellite data. *Global Ecology and Biogeography, 20*(1), 154-159.

Lara, R. J., Cohen, M. C. L., & Menezes, M. P. (2009). Hydrodynamic factors controlling the mangrove colonization in the Amazonian coastal zone. *Estuarine, Coastal and Shelf Science, 85*(3), 245-252.

Larsen, L. G. (2019). Ecohydraulics of river deltas and their wetlands. *Annual Review of Fluid Mechanics, 51*, 479-508.

Nathan, T., Lucas, R., & Bunting, P. (2016). Distribution and drivers of global mangrove forest change, 1996–2010. *Global Ecology and Biogeography, 25*(6), 729-738.

Panda, S. P., Subudhi, H., & Patra, H. K. (2021). Mangrove forests of river estuaries of Odisha, India. *Journal of Coastal Conservation, 25*(1), 1-15.

Robertson, A. I., Daniel, P. A., & Dixon, P. (1992). Mangrove forest structure and productivity in the Fly River estuary, Papua New Guinea. *Marine Ecology Progress Series, 72*(1), 109-121.

Ritchie, J. R. B., & Crouch, G. I. (2003). *The competitive destination: A sustainable tourism perspective*. CABI Publishing.

Saenger, P. (2002). *Mangrove ecology, silviculture and conservation*. Kluwer Academic Publishers.

Scheyvens, R. (1999). Ecotourism and the empowerment of local communities. *Tourism Management, 20*(2), 245-249. https://doi.org/10.1016/S0261-5177(98)00069-7

Twilley, R. R., Snedaker, S. C., Yáñez-Arancibia, A., & Medina, E. (1996). Biodiversity and ecosystem processes in tropical estuaries: Perspectives of mangrove ecosystems. In H. A. Mooney, J. H. Cushman, E. Medina, O. E. Sala, & E. D. Schulze (Eds.), *Functional roles of biodiversity: A global perspective* (pp. 387-416). John Wiley & Sons.

Wilcox, D. A. (1995). Wetland and aquatic macrophytes as indicators of anthropogenic hydrologic disturbance. *Natural Areas Journal, 15*(3), 240-248.