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Analysis of Artisanal Fishery Activities in a Nigerian Coastal Area: Insights into Catch Effort and Cost-Revenue Structures

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Abstract: This study aimed to examine the fishing activities and associated economic dynamics in Ilaje coastal area of Badagry, Lagos, Nigeria, from 2020 to 2022. Data were collected on fish catch, fishing effort, and gear-specific economic performance, including production volumes, revenue, and return on investment (ROI), to assess trends in coastal area productivity and fishing sustainability. A significant decline in annual fish catch during the sampling period, from 417 fish in 2020 to 57 fish in 2022, alongside reduced fishing days, boats, and catch per unit effort (CPUE), highlights concerns about declining fish stocks and coastal area productivity. Among fishing gears, traps accounted for the highest production (2,525,030 kg) and profitability (3,255,563 Naira), supported by their widespread use (724 canoes) and moderate operational costs. Iken fishery, despite fewer canoes (121), demonstrated efficiency with the highest average catch per day (22 kg) and substantial revenue (2,376,000 Naira). The total estimated fish production across all gear types reached 5,263,730 kg. While gear-specific ROI values were robust—led by traps at 1,978.41%—the decreasing CPUE underscores a need for sustainable fishing practices to balance profitability with resource conservation.

1. Introduction

Fisheries in tropical lagoons are vital to the livelihoods of many communities in Southwest Nigeria, providing food, employment, and income. This ecosystem is highly productive, serving as breeding and nursery grounds for various commercially valuable fish species, such as *Oreochromis niloticus* (Tilapia), *Clarias gariepinus* (African catfish), and *Pseudotolithus elongatus* (croakers) (Zabbey *et al.*, 2019). Artisanal fisheries dominate in these regions, characterized by small-scale operations that rely on traditional gear and methods. However, the growing pressure on these resources due to population growth, urbanization, and climate change threatens their sustainability. Effective management of these fisheries is crucial to maintaining their ecological balance and socio-economic benefits.

The tropical lagoons of Southwest Nigeria, including Lagos, Epe, and Lekki Lagoons, play a crucial role in artisanal fisheries by providing essential ecosystem services such as fishery resources, water filtration, and habitat for biodiversity. Lagos Lagoon, the most commercially significant, supports high fishing effort but faces overexploitation and pollution challenges (Abdulraheem *et al.*, 2021; Samuel

et al., 2024). Epe Lagoon, known for its tilapia and catfish productivity, sustains local livelihoods but faces seasonal fluctuations and habitat degradation, while Lekki Lagoon, though relatively less impacted by urbanization, experiences declining fish stocks due to unregulated fishing practices and climate change effects (Abdulraheem *et al.*, 2021). Management challenges across these lagoons include weak enforcement of fishing regulations, habitat destruction from coastal development, and conflicts between artisanal and industrial fishers (Takyi *et al.*, 2022). Addressing these issues requires integrated co-management strategies, habitat restoration, and improved policy implementation to sustain fisheries and ecosystem functions.

The economic dynamics of fisheries, including production costs, revenue, and catch per unit effort (CPUE), are essential for understanding their sustainability and profitability. CPUE, a widely used indicator in fisheries science, measures the efficiency of fishing effort and provides insights into resource abundance and stock health (Pascoe *et al.*, 2024; El-Gharbawy *et al.*, 2024; Nasri *et al.*, 2024). High production costs, such as those associated with fuel, labor, and fishing gear, can reduce the profitability of artisanal fisheries. In contrast, fluctuations in revenue, influenced by market prices and fish availability, further complicate the economic stability of fishers. These challenges are exacerbated by overfishing, illegal fishing practices, and environmental degradation, which negatively impact CPUE and threaten the long-term viability of fisheries in Nigeria's tropical lagoons.

Understanding the interplay between fish production costs, revenue, and CPUE is critical for developing sustainable fisheries management strategies. Such insights help identify economic inefficiencies, assess the impacts of fishing activities on resource sustainability, and inform policy decisions to promote equitable and responsible resource use. Previous studies in similar contexts have highlighted the importance of data-driven approaches to fisheries management, advocating for measures such as regulated fishing efforts, improved gear technology, and community-based co-management (Tilley and Roscher, 2020; Nasri *et al.*, 2024; Emmanuel *et al.*, 2023). This study focuses on evaluating these economic parameters within a tropical lagoon in Southwest Nigeria, aiming to contribute to the sustainable development of fisheries and the well-being of dependent communities.

The artisanal fisheries sector in tropical lagoons of Southwest Nigeria faces growing challenges, including high production costs, declining revenue, and reduced CPUE. These challenges are compounded by overfishing, habitat degradation, and inadequate resource management, which threaten the sustainability of fisheries and the livelihoods of fishers (Pomeroy *et al.*, 2016). Traditional fishing gear, such as drift nets, beach seines, and non-selective traps, can exacerbate overfishing by capturing juvenile and non-target species, leading to stock depletion and ecosystem imbalance (Emmanuel *et al.*, 2010; Rossi, 2022). Bycatch of endangered or commercially unviable species also reduces biodiversity and threatens marine food webs. Gear modifications, such as increasing mesh size, using escape panels, and adopting selective traps, can improve species selectivity, allowing juvenile fish to escape and reducing unintended captures (Emmanuel *et al.*, 2023). Despite the sector's socio-economic importance, there is limited empirical data on the economic dynamics of fish production in these lagoons, leaving significant gaps in understanding how these factors interact to influence profitability and resource sustainability. Without such insights, efforts to address inefficiencies and promote sustainable fishing practices are hindered, potentially leading to further economic and environmental deterioration.

This study aimed to evaluate the economic viability and sustainability of artisanal fisheries in Ilaje coastal area of Badagry in Southwest Nigeria by analyzing key economic indicators. Specifically, the study seeks to estimate the production costs associated with artisanal fisheries, assess the revenue generated from fish production activities, and analyze the catch per unit effort (CPUE) as a measure of

fishing efficiency and resource abundance. This study will contribute to understanding the profitability and efficiency of fishing operations and highlights areas for improvement in resource management. The findings will inform policymakers, fishery managers, and stakeholders in developing evidence-based strategies for sustainable fisheries.

2. Methodology

2.1 Study area

The study was conducted in the Ilaje Community, Badagry, Lagos, Nigeria. Ilaje, an artisanal fishing community established in 1991 by Ilaje settlers, is a coastal settlement along the Atlantic Ocean shoreline. Badagry, a coastal town in Lagos State, is located approximately 57 km from Lagos at Latitude 6° 23' to 6° 28' N and Longitude 2° 42' to 3° 23' E (Osodein and Anetekhai, 2020).

2.2 Method of data collection

The community was sampled monthly from 2020 to 2022, during which fishing operations were observed, and data were collected using structured questionnaires, personal interviews, and direct participation in fish measurement. A total of 168 respondents were randomly selected to complete structured questionnaires, while 77 fisher folk were purposively chosen for focus group discussions within the communities. Additionally, key informants and other individuals at the shore and within the community were interviewed. Informed consent was obtained from all participants, ensuring confidentiality and voluntary participation. The number of fishing gears used in the village was documented, and the weight of the fish was measured using a Citizen model weighing balance, with the fish placed on the top tray and the readings recorded for each catch. The following formulae were used to calculate the fishing parameters:

- $Catch\ Per\ Unit\ Effort\ (CPUE) = \frac{Total\ Catch\ (in\ weight\ or\ number)}{Fishing\ Effort}$ (Yusuf and Abdulkarim, 2015)

  CPUE is the entire quantity of fish trapped by experimented fishers each month after arrival/landing.
- $Total\ Cost = Fixed\ Costs\ (e.g. cost\ of\ boats) + Variable\ Costs\ (e.g. maintenance)$
- $Total\ Revenue = Price\ per\ unit\ of\ fish\ X\ Quantity\ of\ fish\ sold$
- $Net\ Profit = Total\ Revenue - Total\ Cost$
- $Return\ on\ Investment\ (ROI) = \frac{Net\ Profit}{Total\ Cost}$ (Shively and Galopin, 2015)

2.3 Data analysis

Descriptive statistics were employed to analyze and present the results of the study. The analysis and visualization of the data were carried out using Microsoft Excel (2010), which facilitated the organization, calculation, and tabular representation of the findings for clear and concise interpretation.

3. Results and Discussion

3.1 Catch per Unit Effort (CPUE)

Table 1 presents the annual fish catch in Ilaje coastal area of Badagry, Lagos, Nigeria, categorized by fishing gear type across three years (2020–2022). During the sampling period, the total fish catch decreased significantly from 417 in 2020 to 335 in 2021 and further to 57 kg in 2022. When normalized for fishing effort, the CPUE showed a consistent decline, indicating a potential reduction in resource

abundance rather than fishing effort alone. The use of gillnets increased from 20 fish in 2020 to 56 in 2021 but dropped to 17 in 2022. Cast net catches were highest in 2021 with 212 fish, followed by a decrease to 178 in 2020 and a further decline to 25 in 2022. Traps showed an increase from 54 fish in 2020 to 72 in 2021 but then dropped to 19 in 2022. Hook-and-line catches remained low throughout the period, with 19 fish in 2020, 10 in 2021, and 6 in 2022. Iken fisheries consistently had the smallest catch, with 32 fish in 2020, 24 in 2021, and 5 in 2022.

The trends observed in Ilaje coastal area of Badagry are consistent with broader patterns documented in similar studies. A study by Zabbey *et al.* (2019) reported a gradual decline in fish catches in Nigerian coastal lagoons, which was attributed to both environmental changes and intensified fishing activities. In another study by Olopade *et al.* (2017) on fishing gears in Bonny River, it was noted that the use of cast nets typically results in higher catches during peak fish seasons, although catches tend to decrease when overfishing or resource depletion occurs. The decrease in fish catch in Ilaje coastal area of Badagry, particularly with traps and hook-and-line gear, may reflect similar environmental pressures observed in previous studies, such as reduced fish stocks due to overfishing or habitat degradation (Oyedola, 2020).

Table 1. Annual fish catch data by gear type in Ilaje coastal area of Badagry, Lagos, Nigeria

Year	No of fish	Gillnet	Cast net	Traps	Hook-and-line	Iken
2020	417	20	178	54	19	32
2021	335	56	212	72	10	24
2022	57	17	25	19	6	5

Table 2 shows the annual fish catch and CPUE in Ilaje coastal area of Badagry from 2020 to 2022. Total fish catch decreased significantly from 63,859.41 kg in 2020 to 48,234.09 kg in 2021 and further to 6,558.07 kg in 2022. This decline is associated with a marked reduction in fishing effort, as the number of fishing days decreased from 37 in 2020 to 31 in 2021 and just 9 in 2022. Similarly, the number of active boats dropped from 1,105 in 2020 to 835 in 2021 and 114 in 2022. The CPUE, calculated as catch per boat per day, showed a significant decline over the study period. In 2020, the CPUE was 57.8 kg/boat/day, which dropped to 57.8 kg/boat/day in 2021 and further declined to 7.2 kg/boat/day in 2022. While the declining CPUE suggests potential overexploitation of fish stocks or reduced fish productivity, the concurrent reduction in fishing effort also contributed to the observed trends.

The trends observed in Ilaje coastal area of Badagry align with similar findings in other Nigerian coastal waters. A study by Adewale *et al.* (2024) on the CPUE in Lagos coastal lagoons reported a gradual decline in fish catches and CPUE over several years. This decline was attributed to overfishing, environmental degradation, and climate change, all of which negatively affected fish populations. Osodein and Anetekhai, (2020) similarly noted a reduction in CPUE in Nigerian lagoons, which they attributed to a combination of reduced fishing effort, lower fish availability, and poor environmental conditions. The significant drop in CPUE from 2,137 kg/hr in 2020 to 520 kg/hr in 2022 is consistent with findings from Abdulraheem (2021), who observed a sharp reduction in fishing efficiency in Nigerian inland and coastal fisheries due to declining fish stocks and shifting environmental conditions. This reduction in CPUE and fish catch suggests that, similar to other regions, Ilaje area may be experiencing the combined effects of overfishing and environmental stressors, which are causing a decline in both the total fish catch and fishing efficiency over time.

Table 2. Annual fish catch and Catch Per Unit Effort (CPUE) in Ilaje coastal area of Badagry

Year	No. of Fishing days	Total weight of fish caught (kg)	Number of Boats	CPUE (kg/hr)
2020	37	63859.41	1105	2137
2021	31	48234.09	835	1791
2022	9	6558.07	114	520

3.2 Fish Production Cost and Revenue

Table 3 presents the distribution of fishing gear and average catch in the Ilaje coastal area of Badagry. Traps are the most widely used, with 724 canoes, followed by Cast net (562) and Gillnet (425). Despite having fewer canoes (121), Iken fishery records the highest average daily catch at 22 kg, surpassing Traps (15.51 kg), Cast net (12.02 kg), and Gillnet (10.1 kg). Hook-and-line and pole-and-line yield the lowest catches, at 8 kg and 8.1 kg per day, respectively. Fishing effort is relatively uniform for Gillnet, Cast net, and Traps, each averaging 20 fishing days per month, while Hook-and-line and pole-and-line operate for 18 days. Annual production estimates show that Traps lead with 2,525,030 kg, followed by Cast net (1,486,153 kg) and Gillnet (944,400 kg). Iken fishery, despite fewer canoes, is projected to produce 2,396,000 kg due to its high catch rate. The total estimated fish production across all gear types is 5,263,730 kg, highlighting the large-scale artisanal fishing activities in the region.

The production estimates presented in Table 3 are consistent with findings in similar studies on fishing gear efficiency and production in Nigerian lagoons. A study by Olopade *et al.* (2017) found that Traps and Cast nets were the most productive fishing gears in several Nigerian coastal areas, reflecting their higher average catches per day, which is consistent with the higher production estimates for these gears in Ilaje coastal area of Badagry. Bonjoru *et al.* (2023) also observed that gears like Traps and Gillnets typically result in higher catches and, subsequently, higher production estimates in upper Benue river Basin. In contrast, Hook-and-line and pole-and-line tend to generate lower production estimates, which align with Boro and Agbugba (2022), who reported lower catches for these gears in Nigerian coastal waters, often attributed to the more labor-intensive nature of their use. The exceptional performance of Iken fishery in terms of average catch per day (22 kg) and production estimate (2,396,000 kg) is noteworthy and suggests the potential for this gear type to become a dominant method of fishing in the coastal area, a finding that has been reported in other studies (e.g., Akintola and Fakoya, 2017) which highlighted the efficiency of specific local fishing techniques.

Table 3. Fishing gear and production estimates in Ilaje coastal area of Badagry, Nigeria

Fishing gear	No. of canoes	Average catch(kg) /day(8man-hr)	Average no. of fishing days per month	Fishing month/year	Production estimate (kg)
Gillnet	425	10.1	20	11	944,400
Cast net	562	12.02	20	11	1,486,153
Traps	724	15.51	20	11	2,525,03
Hook-and-line	113	8	18	10	162,720
Pole-and- line	109	8.1	18	9	143,030
Iken fishery	121	22	N. A	9	23,96
	2,054				5,263,730

N.A =Not applicable

Table 4 provides the analysis of the capital investment, operational costs, annual revenue, and profitability for six types of fishing gears used in Ilaje coastal area of Badagry, Nigeria. Gillnet and cast net require the highest capital investment (248,800 Naira each), while traps (141,500 Naira) and hook-and-line (151,500 Naira) require lower investments. Iken fishery, with a capital investment of 189,000 Naira, falls within a moderate range. Operational costs cover canoe maintenance, net repairs, and labor, but fuel and lubrication costs are absent, indicating the use of manual fishing methods. Labor costs vary, with traps incurring the highest (1,137.4 Naira) and hook-and-line the lowest (480 Naira). Revenue is influenced by catch volume and fish prices. Iken fishery yields the highest annual revenue (2,376,000 Naira) due to its high daily catch (22 kg per canoe), while hook-and-line generates the least (1,440,000 Naira) with a daily catch of 8 kg. Traps and cast nets also contribute significantly, with revenues of 3,412,200 Naira and 2,644,400 Naira, respectively. Traps yield the highest profit (3,255,563 Naira), followed by cast net (2,369,989 Naira) and Iken fishery (2,167,458 Naira). Traps also exhibit the highest ROI (1,978.41%), followed by gillnets (610.15%), highlighting their strong profitability.

The profitability of fishing gears in coastal area of Badagry aligns with findings from similar studies on fishing gear economics in Nigerian coastal areas. Abdulraheem, (2021) observed that higher capital investments in fishing gear, such as gillnet and cast net, generally lead to higher returns due to their efficiency in catching larger volumes of fish, which is consistent with the findings here. Additionally, Bolarinwa and Adegeye (2019) reported that gear types with lower operational costs and higher catch rates, such as traps and Iken fishery, tend to have the highest profitability and ROI, supporting the conclusion that Traps and Iken fishery yield the highest profits in this study. Rodrigues *et al.* (2019) reported that fishing gears with lower initial capital investment, such as hook-and-line, tend to generate lower revenues but still remain profitable due to lower operational costs.

Table 4. Cost, revenue, and profit analysis of fishing gears in Ilaje coastal area of Badagry, Nigeria

Cost and Revenue	Gillnet	Cast net	Traps	Hook-and-line	Pole-and- line	Iken
A. Capital Investment or Fixed Cost						
Canoes	152,300	152,300	85,000	85,000	85,000	102,500
Fishing gear	95,000	95,000	55,000	65,000	65,000	85,000
Paddle	1500	1500	1500	1500	1500	1500
Sub-total(A)	248,800	248,800	141,500	151,500	151,500	189,000
B. Operational or Variable Cost						
Fuel and lubrication	Nil	Nil	Nil	Nil	Nil	Nil
Canoe repair (10% Cost)	15,230	15,230	8,500	8,500	8,500	10,250
Engine repair (15% Cost)	Nil	Nil	Nil	Nil	Nil	Nil
Net repairs (10% cost)	9500	9500	5500	6500	6500	8500
Labour (1/3 of revenue)	740.7	881.5	1137.4	480	437.4	792
Sub-total(B)	25,471	25,612	15,137	15,480	15,437	19,542
C. Annual Revenue						
Average catch (Kg/Canoe/day)	10.1	12.02	15.51	8	8.1	22
Annual catch (Kg)C2	2,222	2,644.40	3,412.20	1,440	1,312.20	2,376.00
Average price of fish/Kg.C3	1000	1000	1000	1000	1000	1000
Total Annual revenue(N)C4.c2*c3	2222000	2644400	3412200	1440000	1312200	2376000
Profit or loss(C4-A-B)	1,947,729	2,369,989	3,255,563	1,273,020	1,145,263	2,167,458
Return on investment	610.15%	763.66%	1978.41%	662.38%	586.04%	939.34%

Conclusion

The findings reveal a decline in fish abundance and fishing efficiency in Ilaje coastal area of Badagry over three years, raising critical concerns about sustainability. Traps and Iken fishery emerged as the most productive and profitable fishing methods, highlighting their importance in the local fishing economy. The observed decline in catch volume and CPUE suggests potential overexploitation due to increasing fishing pressure and environmental challenges, such as habitat loss or pollution, consistent with trends observed in other tropical coastal systems. Effective management strategies, including gear regulation, habitat restoration, and enforcement of sustainable fishing practices, are essential to prevent further depletion of fish stocks and ensure the long-term viability of fisheries in the region. This study contributes valuable insights to the literature on small-scale fisheries management and underscores the urgent need for proactive resource conservation policies.

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