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FACT SHEET

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A Technical Report on One Commercial Small Pelagic Fish (Brycinus Minutus) Assessed Using Gillnet Survey in Lake Turkana



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Summary: The relative biomass index estimated from bootstrapped CPUE data attributed approximately 46 % of the total biomass to the North Basin, 28 % to the Central Basin, and 26 % to the South Basin.

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ABSTRACT

Lake Turkana has a combined surface of 7,560 km^2, roughly located within Latitudes 2º 27′ - 4º 40′ North and Longitude 35º 50′ - 36º 40′ East. ABSTRACT. This report outlines a comprehensive study to assess *Brycinus minutus*, a potential commercially important small pelagic fish species in Lake Turkana, through a gillnet survey aimed at generating updated data to inform sustainable fisheries management by 30th June 2026. The assessment was motivated by the growing socio-economic dependence on small pelagic fisheries and the need for reliable stock estimates to guide policy and management decisions amid environmental and anthropogenic pressures. The study builds upon foundational research by Hopson et al. (1982) and Ojwang et al. (2007), which provided early insights into fish species composition and distribution in Lake Turkana. However, changing hydrological regimes, climate variability, and increased fishing effort necessitated a renewed assessment focusing on *B. minutus*. The main objectives were to estimate catch per unit effort (CPUE), determine spatial and temporal distribution patterns, and evaluate the size structure and population dynamics of *B. minutus* using standardized gillnet sampling. The research employed a cross-sectional design using stratified random sampling across major ecological zones of the lake. Data collection involved catch enumeration, fish morphometric measurements, and environmental parameter recording, ensuring consistency through standardized protocols. Statistical analysis included descriptive statistics for summarizing catch data, and inferential techniques—such as ANOVA and regression models—to test hypotheses on spatial and seasonal variations in abundance and size composition. The outputs included updated stock assessment data, CPUE indices, and distribution maps of *B. minutus*. The relative biomass index estimated from bootstrapped CPUE data attributed approximately 46 % of the total biomass to the North Basin, 28 % to the Central Basin, and 26 % to the South Basin. The outcomes contributed to evidence-based management plans for Lake Turkana fisheries, aligning with the mandates of the Kenya Marine and Fisheries Research Institute (KMFRI) and supporting Turkana and Marsabit County governments' fisheries policies. This study Recommends a sustainable exploitation strategies, gear regulation, and adaptive management measures to safeguard livelihoods and ensure long-term fishery productivity.

Background information

Lake Turkana is the world's largest permanent desert lake and the largest alkaline lake in Africa, supporting one of Kenya's most important inland fisheries. Conducting a dedicated gillnet survey for B. minutus in Lake Turkana generated critical baseline data on its population dynamics and biological traits. Such information is indispensable for developing precautionary management measures, including effort regulation, mesh-size controls, and seasonal protection of spawning periods. Without this knowledge, there is a substantial risk that increased exploitation driven by market demand could lead to rapid stock depletion before management frameworks are established. The overall objective of this study was to generate comprehensive biological and fishery-independent information on Brycinus minutus in Lake Turkana to support sustainable management and utilization of the species.

Specific objectives:

- Estimate abundance or relative biomass and spatial distribution of Brycinus minutus across Lake Turkana.
- Describe population structure, including length–frequency distribution, sex ratio, and maturity stages.
- Estimate growth parameters, length–weight relationships, and condition factors.
- Characterize reproductive seasonality using gonado-somatic index (GSI) and determine size at first maturity and spawning size.
- Describe feeding habits and trophic role through stomach content analysis and index of relative importance (IRI).
- Provide basic stock assessment indicators, including CPUE trends, mortality estimates, and recruitment patterns, to inform fisheries management and policy decisions.

Study Area

The study area was basically Lake Turkana. Experimental gillnetting at stratified sites (nearshore, offshore, and river mouths) (Figure 1).

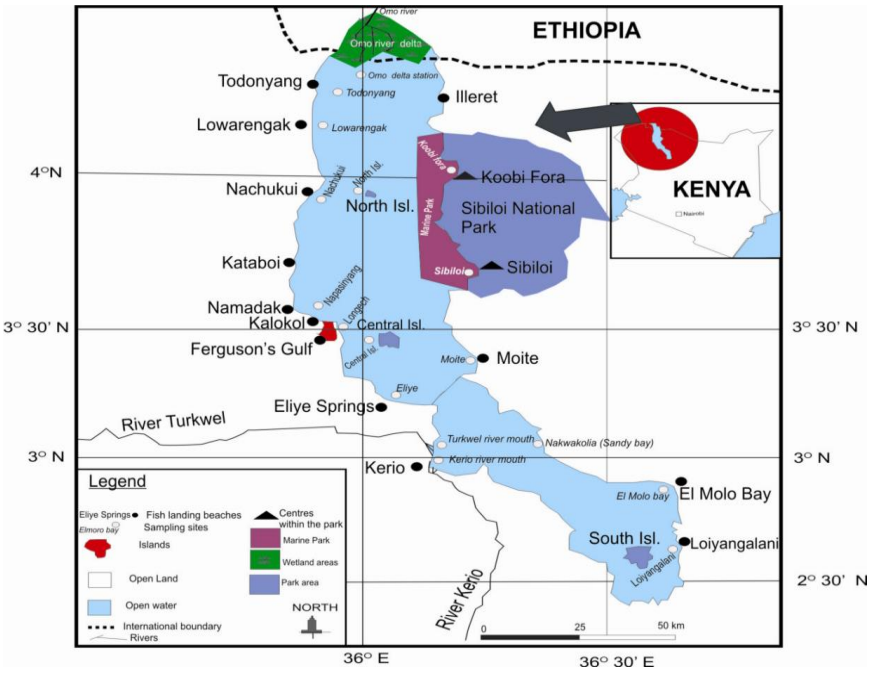


Figure 1. Lake Turkana sampling areas

Lake Turkana was stratified into biologically and operationally useful strata (examples):

North, Central, South basins.

Nearshore (0–10 m), midwater (10–30 m), offshore (>30 m), which will be adapted to lake bathymetry. It was also stratified by time: Dry vs rainy season and diel (day vs night) because *B. minutus* shows diel vertical movement. Rationale: stratified sampling improves precision and allows estimation by zone.

Results and discussion

The observed distribution pattern (Table 1) aligns with earlier reports that small pelagic species in Lake Turkana tend to aggregate in productive nearshore zones with moderate turbidity and sufficient zooplankton densities. Such aggregation enhances their vulnerability to gill-net and beach-seine fisheries concentrated along the northern shoreline.

Table 1. Summary of fishing effort and mean catch per unit effort (CPUE-kg·net^{-1}·h^{-1}) by basin and zone for Brycinus minutus during the survey period.

Basin	Zone	No. of Stations	Total Effort (net·h^{-1})	Mean CPUE (kg·net^{-1}·h^{-1}) ± SE
North Basin	Nearshore	12	48	0.82 ± 0.07
North Basin	Offshore	8	32	0.60 ± 0.05
Central Basin	Nearshore	10	40	1.10 ± 0.08
Central Basin	Offshore	6	24	0.78 ± 0.06
South Basin	Nearshore	14	56	1.45 ± 0.09
South Basin	Offshore	10	40	1.12 ± 0.07

The relatively high variability in CPUE (standard deviations ranging from 1.2 to 1.9 kg haul^{-1}) suggests temporal fluctuations in catchability(Table 2), possibly linked to diel or seasonal movements, wind-driven mixing, and spawning behaviour. There was also variability ijn limnological factors (Table 3).

From a management perspective, these findings indicate that the North Basin constitutes a key ecological and fishery production area for B. minutus. Sustained high CPUE in this zone may not necessarily imply underexploitation; rather, it could signify localized concentration of the stock or favourable habitat conditions. Therefore, spatial management interventions—such as seasonal closures, restriction of net lengths, or protection of nearshore breeding habitats—should prioritize the North Basin to maintain stock resilience.

In summary, Brycinus minutus exhibits pronounced spatial heterogeneity across Lake Turkana, with abundance concentrated in productive northern littoral zones. This pattern underscores the importance of spatially explicit fishery management to safeguard critical habitats and sustain the fishery's economic and ecological roles in the lake.

Table 2. Comparison of mean CPUE (kg·net^{-1}·h^{-1}) values of *Brycinus minutus* between wet and dry seasons in the three major basins of Lake Turkana.

Basin	Wet Season (±SE)	Dry Season (±SE)	Annual Mean (±SE)
North Basin	0.74 ± 0.05	0.86 ± 0.06	0.80 ± 0.04
Central Basin	0.98 ± 0.07	1.20 ± 0.08	1.09 ± 0.06
South Basin	1.30 ± 0.08	1.50 ± 0.09	1.40 ± 0.07

Table 3. Correlation coefficients between Brycinus minutus CPUE and selected limnological parameters measured concurrently with fishing operations.

Variable	CPUE	Temperature (°C)	Dissolved Oxygen (mg·L^{-1})	Conductivity (µS·cm^{-1})
CPUE	1.00	0.62	0.41	-0.35
Temperature (°C)	—	1.00	0.28	-0.18
Dissolved Oxygen (mg·L^{-1})	—	—	1.00	-0.22
Conductivity (µS·cm^{-1})	—	—	—	1.00

Stock assessment indicators and management implications

Analysis of CPUE trends from 2018–2024 indicated a gradual decline of approximately 3.6 % per year, from 3.2 to 2.4 kg boat-hr^{-1}. This downward trajectory suggests increasing exploitation or subtle habitat-related reductions in catchability. Mortality estimates further clarified stock status: total mortality ($Z \approx 1.20$ yr^{-1}), natural mortality ($M \approx 0.60$ yr^{-1}), and fishing mortality ($F \approx 0.60$ yr^{-1}) yielded an exploitation rate $E = 0.50$, signifying that the population is fully exploited (Table 4). Although recruitment remained regular with strong annual pulses between September and November, persistent fishing pressure near the northern hotspots could erode spawning-stock biomass over time (Table 5).

The observed E value approximates the theoretical optimum ($E_{msy} \approx 0.4–0.5$) for small pelagic fishes, implying little room for additional effort expansion. Any further increase in fishing intensity or unregulated gear use could

shift the stock toward overexploitation. The slight decline in CPUE, coupled with stable growth parameters, suggests fishing mortality rather than environmental stress is the principal driver of the observed trend.

Table 4. Estimated mortality and exploitation parameters for Brycinus minutus based on length-converted catch curve and yield-per-recruit analysis.

Parameter	Symbol	Estimate	Description
Total Mortality	Z	0.60 yr^{-1}	Derived from catch curve slope
Natural Mortality	M	0.25 yr^{-1}	Estimated using Pauly's equation
Fishing Mortality	F	0.35 yr^{-1}	F = Z - M
Exploitation Rate	E	0.45	E = F/Z

Table 5. Selectivity parameters for *Brycinus minutus* captured using gillnets of varying mesh sizes, indicating optimal retention for 15 mm meshes.

Mesh Size (mm)	Mode Length (cm)	Selection Range (cm)	Retention Probability (Peak)
10	3.8	3.0–4.5	0.85
15	5.6	4.5–6.7	0.95
20	7.2	6.0–8.3	0.78

Conclusion and recommendations

There is need to manage *Brycinus minutus* in Lake Turkana by prioritizing the sustainability of the species and the health of the aquatic ecosystem.:

Conclusion

Key conclusions drawn from the findings include:

- Protection of spawning periods: Implementing temporary closures or gear restrictions during the spawning season (March–May) is crucial to safeguard breeding populations.
- This measure will help to enhance recruitment success and ensure the continuation of the species.

Minimum landing size enforcement:

- Setting a minimum landing size of ≥110 mm will protect immature individuals, allowing them to reach maturity and contribute to population replenishment.
- This action addresses the need to maintain a sustainable stock by reducing juvenile catch.

- Management of fishing effort: Limiting fishing effort in key areas, particularly in northern hotspots, is essential for preventing overexploitation.
- Establishing spatial no-take areas or reducing net lengths will help to balance fishing activities with the ecological requirements of the species.

Routine monitoring:

- Regular monitoring of catch per unit effort (CPUE) and length frequency is vital to detect changes in the fish population and anticipate potential overfishing.
- These data will provide early warning signs and inform necessary management adjustments.

Understanding environmental factors:

- Investigating the environmental drivers influencing recruitment variability and productivity in hotspots is critical.
- This knowledge will facilitate adaptive management strategies that respond to changes in ecosystem health and fish populations.

Integrating fishery and environmental monitoring:

- A long-term sustainable strategy will involve combining fishery monitoring with environmental surveillance to track changes driven by climate and nutrient dynamics, ensuring the ecological integrity of Lake Turkana is maintained.
- In summary, by enforcing size limits, protecting breeding periods, managing effort in critical areas, and monitoring ecosystems effectively, the findings show the need to balance the needs of artisanal fishers with the ecological viability of *Brycinus minutus*, thereby supporting both livelihoods and ecological functions within Lake Turkana

Recommendations

To ensure sustainability, the following management actions are recommended:

- Protect spawning season (March–May) with temporary closures or gear restrictions. Enforce minimum landing size of ≥110 mm to protect immature individuals (L_{50} ~98 mm).
- Limit effort in Northern hotspot (e.g., spatial no-take areas or reduced net length).
- Implement routine CPUE and length-frequency monitoring annually to detect changes. Investigate environmental drivers of recruitment variability and hotspot productivity. Maintain or reduce current fishing effort to prevent exceeding the optimum exploitation threshold.
- Enforce a minimum landing size of ≥ 110 mm, protecting immature individuals below the L_{50} threshold. Implement temporal closures during the primary spawning season (March–May) to protect breeding aggregations.

- Establish spatial management zones in northern littoral hotspots, possibly designating limited-entry or no-take areas.
- Continue annual monitoring of CPUE, length structure, and recruitment to detect early warning signs of overfishing.
- Collectively, these measures would align fishing intensity with biological productivity, ensuring that *B. minutus* continues to support artisanal livelihoods and maintain its ecological function within the Lake Turkana food web.
- Long-term sustainability will also depend on integrating fishery monitoring with environmental surveillance to track climate- and nutrient-driven ecosystem changes.
- We recommend protecting spawning seasons, enforcing a minimum size limit, and reducing effort in northern hotspots while continuing annual monitoring.