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***Research article***

# Catch composition and size distribution: A comparative study of drift gillnets and fixed gillnets in the Black Volta, Ghana

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**Abstract:** Inland fisheries are a major contributor to many developing countries, providing employment, nutrition, and income to numerous households. Unfortunately, it is lacking in the areas of research, policy, and sustainable management. In Ghana, the inland fishery revolves around the Volta Lake. The objective of this study therefore was to comparatively assess the size catches and catch composition of fixed gillnets and driftnets of the same mesh sizes on the Stratum VII of the Volta Lake, also known as the Black Volta. The study concentrated on four commercial fish species, viz., *Oreochromis niloticus*, *Synodontis nigrita*, *Labeo coubie*, and *Chrysichthys nigrodigitatus*. There were no significant differences in the catch sizes of both gears among all the target species, except *L. coubie*. *Chrysichthys nigrodigitatus,* however, had an obvious opposing skewness of catch size distribution under the two fishing gears. The difference in the median size of catches was not significant under statistical testing. The percentage catch composition showed that *L. coubie* was caught more by the fixed gillnet (43%), while *O. niloticus* was the highest for driftnet (36.1%). *C. nigrodigitatus* was the least for both, recording 8.1% and 9.5% for driftnet and fixed gillnet, respectively. This study shows the complexity of multi-species and multi-gear fisheries like the Volta Lake. Hence, there is a need for thorough assessment and data collection for meaningful and sustainable management decision-making.

**Keywords:** catch composition, fishing, Volta Lake, Van

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## Introduction

Gillnets have played a crucial role in global fisheries for an extensive period, with an ancient history dating back to prehistoric times (Sahrhage & Lundbeck, 2012). These nets capture fish through gilling, wedging, snagging, and entangling (He, 2006). Their adaptability, allowing customization based on fishing requirements, distinguishes them. Anglers can adjust factors such as the number of floats, hanging ratio, and leads to target specific species in particular habitats. Gillnets are separated into set-gillnets, fixed-gillnets, and drift-gillnets, with the former being stationary and the latter drifting with currents or being towed by a fishing boat (Misund et al., 2002)

Issues surrounding drift gillnets primarily revolve around their efficiency and non-exclusivity. Their efficiency in catching smaller fishes makes them susceptible to overfishing with increased fishing efforts, posing a threat to fishery sustainability. Gillnets, particularly drift gillnets, face challenges due to their non-exclusivity, resulting in unintended catches of non-target species, leading to concerns about sustainability and environmental impact (Misund et al., 2002). This issue prompted regulations and bans in various countries (Sala, 2016).

In the context of Ghana, inland fisheries predominantly revolve around the Volta Lake, Africa's largest inland water body and a third of its kind globally. Spanning 8,500 $km^2$ with a shoreline of 5,500 km, the lake accounts for 85-9% of Ghana's total inland water surface area (Béné, 2007; Mensah et al., 2006). Its fishery employs around 100,000 people and supports an estimated 300,000 individuals through its various services (Braimah, 1995; Vanderpuye, 1984). Fishers adeptly adjust their gear choices based on resource dynamics, habitat specifics, and the type of resource being targeted in the fishery on the Volta Lake, which epitomizes a multispecies and multi-gear paradigm (Silvano & Valbo-Jørgensen, 2008). Among the diverse array of fishing gear employed, gillnets, encompassing both drift and fixed nets, emerge as dominant (Kolding et al., 2015). Since fixed gillnets and driftnets operate similarly but differ in their usage, this study seeks to assess the potential disparities in catch sizes between the two within the Black Volta.

## Materials and Methods

We conducted the study in Buipe, a landing site within stratum VIII of the Volta Lake, famously known as the Black Volta. This location, doubling as a marketplace, serves as a hub for the trade of fresh and processed catches sourced from the Black Volta. Buipe is the capital town of the Central Gonja District in Ghana, situated at latitude 08°47'N and longitude 01°32'W. The district, boasting a population of approximately 87,877, is agriculturally oriented, with 74.2 percent of households engaged in agricultural activities. Specifically, 47.5 percent are involved in animal production, and within this subset, 1.2 percent partake in inland capture fisheries (Ghana Statistical Service [GSS], 2012).

The climatic conditions in the district span an annual temperature range of 17°C to 35°C. Characterized by seasonal rains from May to October, the region experiences a mean annual rainfall of 1,144mm, with peak rainfall typically occurring between June and August. The district hosts two major rivers, the Black and White Volta, which traverse Buipe and Yapei, respectively. These water bodies play pivotal roles in irrigation, transportation, domestic use, and fish nutrition, supporting livelihoods across communities (GSS, 2012). Fishers in the study area operate the fishery on an open-access basis, using a diverse array of fishing gear observed during the study period—traps, gillnets, cast nets, and hook and line. Fishermen alternate between gear types, adapting to fluctuations in the lake's water level and current.

Driftnet fishing primarily occurs in the early mornings, while gillnets and traps are set during sunset and withdrawn in the early morning.

### *Data Collection & Analysis*

Specimens of target fish species were collected from fishers undertaking driftnet and fixed gillnet fishing at the landing site. For a thorough comparative study, samples were limited to 32mm, 51mm, and 57mm mesh sizes for both fishing modes, since these were commonly used both ways. A total of 616 fish specimens were documented, comprising 161 *Oreochromis niloticus*, 170 *Synodontis nigrita*, 229 *Labeo coubie*, and 56 *Chrysichthys nigrodigitatus*. These samples were identified to their species level using a fish identification manual by Dankwa et al. (1999). The total length (TL) was measured from the snout's tip to the caudal fin's end to the nearest 0.1cm using a measuring board. Additionally, a digital balance with an accuracy of 0.1g was used to measure the wet weight of sampled species. Specimens showing signs of deterioration were excluded from the dataset. Each specimen's mesh size and the type of gear (driftnet or fixed gillnets) responsible for the catch were recorded. The dataset was recorded, organized, and stored in Microsoft Excel 2016. To ensure the robustness of our findings, a Shapiro–Wilks test was conducted to assess the normality of the size distribution for each target species. Subsequently, the Mann-Whitney U-test was used to assess the differences among the median length catches of the two fishing methods. The analysis and graphical depiction of the results were done using R software (R Core Team, 2020) and the ggplot2 package (v3.3.3; Wickham, 2016).

## Results & Discussion

### *Length Distribution of Fish Species*

Examining the length distribution of four target species, *C. nigrodigitatus, L. coubie, O. niloticus, and S. nigrita* caught using fixed gillnets and driftnets revealed intriguing patterns. For *C. nigrodigitatus*, Mann-Whitney U-test results indicated no significant differences in lengths between fixed gillnets and driftnets ($p = 0.1157$). *L. coubie* exhibited significant differences ($p < 0.001$), with driftnets capturing larger fish. *O. niloticus* showed no significant differences in lengths between the two gear types ($p = 0.7663$). *S. nigrita* also displayed no significant differences ($p = 0.5577$). The mode of fishing (driftnets or fixed gillnets), except in *L. coubie*. Both gears may have similar mesh sizes, which could explain the lack of difference and their selectivity. The mesh size of a given gillnet is known to play a major role in their selectivity. The size of a fish caught is relative to the mesh size of the gear and other factors (Holst et al., 1998). As such gillnets of equal mesh sizes are expected to catch fishes of similar sizes under similar conditions. The results show that the additional factor (active fishing method), which could have influenced driftnets was not significant enough to cause a statistical difference in the median size of *O. niloticus, S. nigrita, and C. nigrodigitatus*. Nonetheless, the contrasting size distribution between driftnets and fixed gillnets for *C. nigrodigitatus* is worth noting (Figure 1). *C. nigrodigitatus* had a negatively skewed length distribution for driftnets as against a positively skewed length distribution for fixed gillnets. This indicates that each gear may be targeting different size classes of the target species. Such incidents could be attributed to other equally important factors that can influence the size selection of gillnets. These factors could be gear-dependent, fish-dependent, or environment-dependent (Holst et al., 1998).

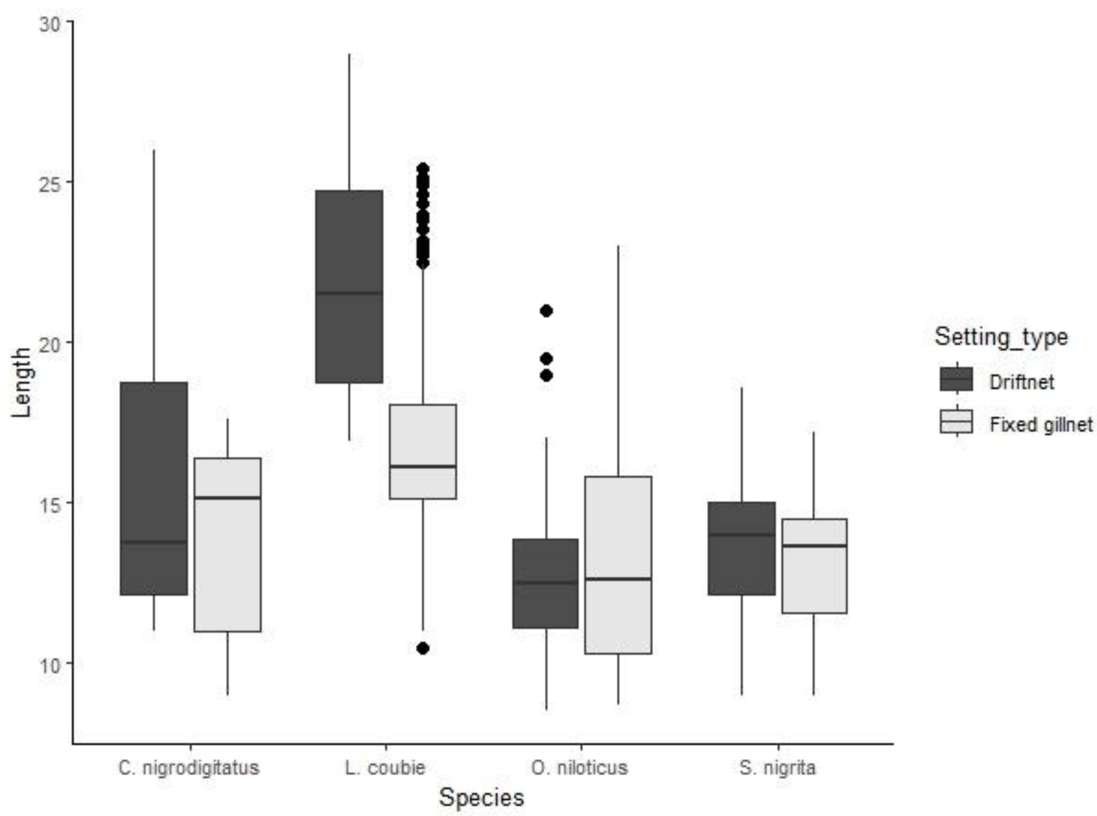


**Figure 1.** Length distribution of driftnet and fixed gillnet for target species

According to Wardle (1986), the ability of fishing gear to capture a fish is strongly influenced by the behaviour and the present distribution of the target species. In addition, water currents can also influence the general activity and feeding behaviour of fish (Stoner, 2004). The depicted opposite skewness in the distribution of some of the target species could have been caused by a mix of these factors and the selectivity of their meshes.

In the case of *C. nigrodigitatus*, the size catches for the driftnets were below their median of 13.15 cm, while those of the fixed gillnets were the opposite, with a median catch of 15.15cm. These results suggest that the driftnet targeted smaller-sized C. nigrodigitatus, while larger fish avoided being caught (Figure 1). The feeding habits of this species could have influenced these results. According to Reed et al. (1967), adult *C. nigrodigitatus* prefers shallow waters, where they can feed on detritus, insects, and seeds. This shows that they are drawn to the flooded, shallow edges of the lake, where fixed nets are set. This makes them vulnerable to fixed nets as opposed to driftnets. This may be the reason for the opposite size distribution of this species. Nonetheless, this influence was not significant enough under statistical testing.

The length distribution of *S. nigrita* and *O. niloticus* was relatively similar under both driftnets and fixed gillnets (Figure 1). Both species are known to be opportunistic feeders, taking advantage of changes in food abundance. They also have a wider food range as well. Shinkafi, Argungu, and Akanbi (2010) reported that *S. nigrita,* in the River Rima-Nigeria, fed mainly on plankton, plants, insects, and detritus. A similar feeding habit and a food source were also reported in a stomach content analysis of *O. niloticus* (Oso et al., 2006; Tesfahun & Temesgen, 2018). These show that they are equally exposed to either of the fishing techniques, which could have resulted in the similarities in the length-catch distribution of both fishing gears.

*Labeo coubie* was the only species with a significant difference between the median size caught for the two gears ($p$ < 0.001). Sizes from driftnets were relatively bigger compared to those of fixed gillnets. *L. coubie* is reported as an omnivorous/detritivore fish, feeding on detritus, plants, insects, algae, copepods, rotifers, and others (Ayotunde et al., 2007; Ikpi et al., 2010). This shows that the species has access to a wide range of food sources and takes advantage of what is available. Such a feeding habit makes them equally vulnerable to both gears. In that regard, the only tangible reason for larger catches in driftnets may have to do with the added factor of water currents carrying the driftnets.

According to Stewart & Ferro (1985), water current can affect the shape of the webbing of a gillnet, influencing its mode of fishing. Dickson (1989) also attested that residual water current could affect the catch rate of bottom set gillnet. Driftnets were only used in this study when the residual current was higher. One major factor that affects the catch size and size distribution between gillnets is the hanging ratio (Holst et al., 1998). The current of the water may have caused slag in the meshes of the driftnets. This may increase the rate at which it entangles fish. Furthermore, the shape of a fish is also known to affect the selectivity of a gillnet. The fusiform shape and broad dorsal fin of this species may increase entanglement as they become caught unaware by an accelerating driftnet. Such an incident could have also impacted the size of the catches of the driftnets, causing larger sizes of this species to be caught. No studies have however confirmed this claim. Both gears did not record the hanging ratio, so it cannot be used to confirm this assertion. However, its influence on the results could be regarded as minimal since there was no significant difference in the catch sizes for most of the target species.

***Target Species Composition of the Fishing Methods***

Fixed gillnets predominantly captured *L. coubie* (43%), followed by *S. nigrita* (25.2%) and *O. niloticus* (22.3%). Driftnets, on the other hand, were most effective in catching *O. niloticus* (36.1%), followed by *S. nigrita* (33.7%), and *L. coubie* (22.1%). *C. nigrodigitatus* was the least caught by both gears, at 9.5% and 8.1% for fixed gillnet and driftnet, respectively. The catch composition of the target species among the two nets differs mainly in the catches of *O. niloticus* and *L. coubie*. Driftnets had a higher percentage of *O. niloticus* catches, while fixed gillnets caught more *L. coubie* (Figure 1 and 2).

This result has to do with their level of exposure and vulnerability to the gear. *Oreochromis niloticus* is reported to dwell in 0-20m of the water column (Wudneh, 1998). This species is also known to be omnivorous, planktivorous, and an opportunistic feeder (Teferi et al., 2000). The influx of nutrients during the rainy season causes plankton to bloom within lakes, making them an easy food source for this species (Wondie et al., 2007). Moving into the water column to feed exposes them to the driftnets, increasing their vulnerability. Researchers have also reported that *L. coubie* is a pelagic dweller with a wide spectrum of omnivorous benthopelagic feeders. Stomach content analysis revealed that plant materials accounted for the highest frequency of occurrence at 47.62 percent in L (Adadu et al., 2014). Ayotunde et al. (2007), also asserted that worms and plant materials formed a major part of the fish diet. This means that the species is attracted to the shallow edges of the lake where plants, insects, and worms are abundant. They are then trapped within the meshes of the fixed gillnets.

The least caught fish species among the five target species was *C. nigrodigitatus*. *Chrysichthys* spp. are omnivorous detritivores (Offem et al., 2008; Yemat et al., 2009). Idodo-Umeh (2003) also suggested that *C. nigrodigitatus* could be classified as a benthic feeder and mesopredator. These feeding habits, allow them to evade these fishing gears since none of these gears was meant to fish at the bottom of the lake. Studies show that *S. nigrita* is a wide-spectrum omnivorous feeder, and also exhibits seasonal variation in feeding habits. Its morphological factors such as ventral mouthparts, enable it to feed on detritus, while the horny structures and barbules around its mouth enable it to filter feed and gnaw on plants as well (Olojo et al., 2003). The study period coincided with the rainy season, which is known for the influx of nutrients and abundance of plankton. It is therefore tangible to say that the species would be attracted to both the shallows and the pelagic water zone, making them vulnerable to both fishing gears. The observed results in catches further emphasize the need for context-specific fisheries management strategies. The research contributes valuable information to the ongoing discourse on sustainable fishing practices and underscores the importance of adapting regulations to local contexts for effective conservation and fisheries management.

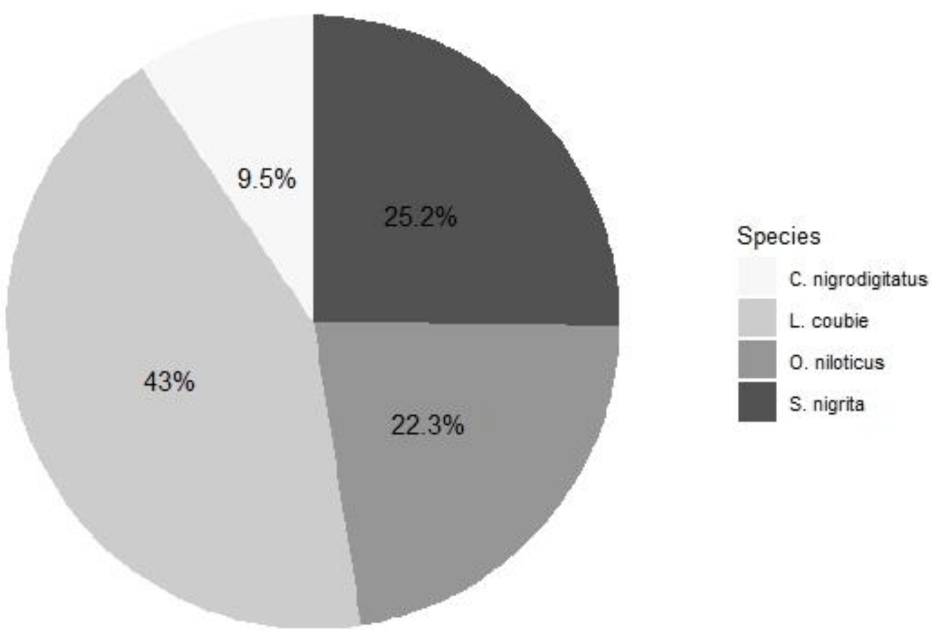


**Figure 2.** Percentage catch composition of target species for fixed gillnet

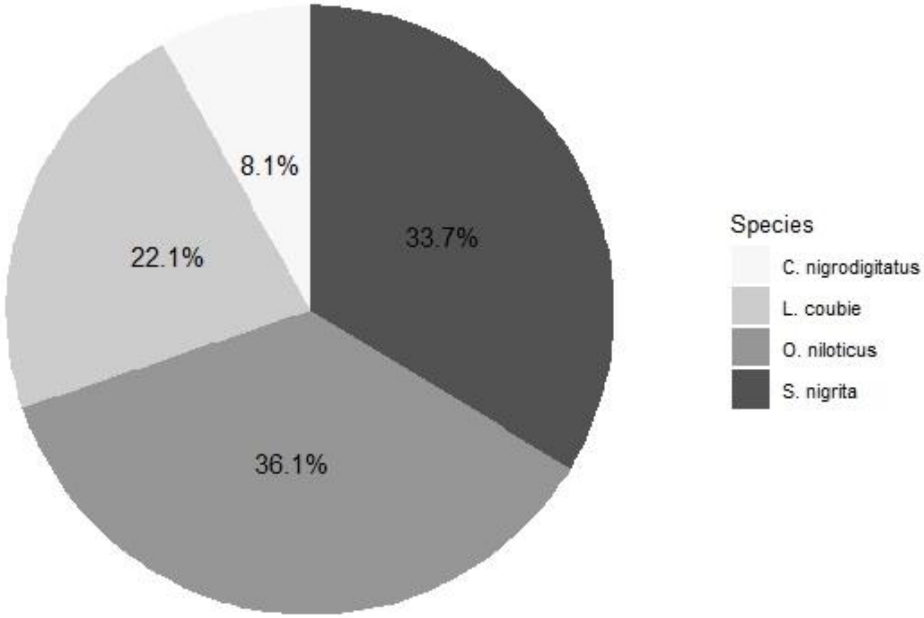


**Figure 3.** Percentage catch composition of target species for driftnet.

## Ethical Approval

All applicable international, national, and/or institutional guidelines for the care and use of animals were followed.

## Conflicts of Interest

The author declares that he has no conflict of interest.

## Funding Statement

The author does not declare any fund.

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