A fishery in distress: an analysis of the small pelagic fishery of Ghana

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Abstract

The small pelagic fishery contributes substantially to Ghana’s fish production and plays important role in food and nutritional security. However, the resource is under serious threat due to destructive fishing practices, illegal, unreported and unregulated fishing (IUU), overcapacity of fishing fleets, population growth and climate change. This paper aims to analyse the small pelagic fishery in terms of; mapping of the chain, landings, imports and export, role in food security and management measures to sustain the fishery.

Annual landings and imports of five important small pelagic species were obtained from the database of Fisheries Scientific Survey Division of the Fisheries Commission of Ghana and analysed for the period 1998–2018. In terms of production, 55% of small pelagic stocks are landed fresh by the artisanal canoes, while 26% come from the inshore fleet, 4% from industrial fleet and 15% from imports. These are traded in their fresh (65%), frozen (17%) or processed (18%) forms to several actors along the supply chain on national and international markets. The round sardine and anchovy dominated landings while the Atlantic chub mackerel was characterised by a gradual decrease over the period. Per capita small pelagic fish consumption fluctuated over the period analysed. Imports of small pelagic fish were relatively higher than exports. The decline of these stocks of commercial importance could lead to a domino effect.
that could diminish the overall contributions to the economy through reduced commercial exports, while at the same time increasing the need for imports, thus threatening the livelihoods and increasing the poverty level of millions of people engaged in the sector and the food security of the nation. Fisheries management authorities should, therefore, as a matter of urgency strengthen fisheries management measures by making clear and bold decisions to reverse the stock decline and to mitigate impacts on society.

**Keywords:** small pelagics; fish stocks; food security; overcapacity, Ghana

1. Introduction

Small pelagic fish such as sardines, herrings and anchovies are a group of species that are prevalent in coastal marine ecosystems, and are predominantly abundant in upwelling regions [1,2]. They are also known as ‘forage fish’ [3,4] because they serve as important prey food for pelagic and demersal predators [5,6]. The group are short-lived species characterised by small size, rapid growth, large biomass and intense shoaling behaviour [4]. Their vertical distribution ranges from 20 to 200 m of the epipelagic zone in coastal waters and oceans and range in size from 7–25 cm in length [7,8]. In terms of landings, small pelagics constitute 25% of world landings, mainly through anchovy, sardinella, sardine, mackerel and herring [9]. The stocks of these small pelagic fish, however, are extremely influenced by changes in ocean climate and have experienced considerable fluctuations in their distribution and abundance over decadal time [2] although overfishing has been recognized as a major contributor to the decline of several stocks [10,11,12,13]. Despite their low value in the international food trade, they contribute substantially to the food security and livelihood support of several poor coastal communities and provide direct and indirect local employment [4].

Besides their significant socio-economic importance, small pelagic fish, play key roles in marine pelagic ecosystems, constituting the focal pathway by which energy and nutrients are transported from lower to upper levels [14]. The food web of many of the prolific ocean ecosystems particularly in coastal upwelling regions is characterized by a ‘wasp-waist’ richness pattern where the intermediate levels, are mostly made up of a few small pelagic fish species [15]. Hence, these small and forage fishes play a central role in the trophic dynamics of marine ecosystems, either by exerting top-down control on their prey or bottom-up control on their predators [3].

Given the widespread declines in fish stocks and the potential threat to food security, this paper sought to gain a better understanding of the trends of the small pelagic fishery for
the period 1998-2018 and arrive at policy recommendations for effective management of the fishery and the sustainable utilisation of the resource in Ghana. The study focused on several parameters: mapping of the chain, annual landings, landings and effort, import and export, food security implications, and management and monitoring of the small pelagic fishery.

2. The small pelagic fishery of Ghana

2.1. Ghanaian marine fisheries (a background)

Ghanaians depend highly on the marine resources for food and livelihood. Ghana’s marine fisheries sector comprises three main sub-sectors: the artisanal, inshore and industrial subsectors. The artisanal sector is a small-scale fishery characterized by the use of non-motorized or motorized canoes and several fishing gears. The main fishing gears used by the artisanal fishers include purse seines (Poli/Watsa), gillnets (Ali nets), beach seines and set nets whiles other canoe operators specialize in hook and line gears to target demersal fish species [7,16,17]. Like other small-scale fisheries in other parts of the globe, the artisanal sector, is the most important sector in terms of fish landings. However, they are found to be understudied politically and are economically marginalized [18,19,20]. The inshore fleet is dual-purpose and used for both purse seining and bottom trawling [21]. They operate as purse seiners during upwelling periods and switch to trawling for the rest of the year. The sector is bound by law to fish beyond 50 m depth of Ghana’s Exclusive Economic Zone (EEZ), however, they often fish between 30–50 m depth where they compete with the canoe fleet [22,23]. The industrial sector comprises large, steel-hulled foreign-built trawlers, shrimpers, tuna pole and line vessels and purse seiners mostly made up of 30–200 Horse-power (Hp) diesel engines.

The marine fisheries sector is vital and a stronghold to the Ghanaian economy. The sector plays a significant role in wealth creation and sustainability of the national economy. It constitutes the main livelihood for the majority of the people living along the coastal areas. The sector employs about 10% of the population either directly or indirectly and contributes about 1.5% to the national Gross Domestic Product (GDP) [24]. In addition, the sector is estimated to generate over US$1 billion in revenue per annum through the various fishing agreements, licenses and exports [25]. Fish has become the cheapest source of protein for the poor, thus playing important role in food and nutrition security in the country. The sector also plays a role in women empowerment. Fishing is done by men while post-harvest activities (fish processing, fish retailing, and trading) are often done by women [26].
2.2. *The small pelagic fishery*

Of the three main marine fisheries subsectors, the artisanal sector predominantly targets the small pelagic resources. The majority of the motorised canoes propelled by 25–40 Hp outboard engines catch small pelagics almost all year round using purse seines, encircling gillnets and beach seines [17,22]. The small pelagic fish also locally known as ‘The People’s fish’ are the most important marine resources because they are more affordable and available than other fish species in the coastal waters of Ghana, thus aiding in food security [27]. Although these small pelagic resources are of relatively low commercial value, they form the backbone of the artisanal fisheries in the country and their fisheries employ the greatest number of local fishers (107,518 fishers) in the marine fisheries sector in Ghana [28]. The sardinellas (round and flat sardines), European anchovy and Chub mackerel are the most significant small pelagic fish species along the coast of Ghana and in the Western Gulf of Guinea [16].

The abundance and distribution of these small pelagic fish stocks particularly the sardinellas are controlled by various environmental factors, prominent among them is the coastal upwelling [13,29,30]. Normally, at the onset of the coastal upwelling in July the sardinella populations migrate towards coastal areas, becoming available to the artisanal fishers [16,31]. The abundance of the sardinella population decreases towards the end of the upwelling season in October and in December the population returns to deep-waters for wintering [31]. These forage fishes are valuable fish species in their own right, constituting about 55% of total marine catches in Ghana [27], underpinning the economy and food security of the country. The catch of small pelagics is processed for local consumption, either smoked or dried.

3. **Material and methods**

3.1. **Study area**

With a marine coastline of 550 km stretch, and a total continental shelf of over 24,300 square kilometres the coast of Ghana has been divided into Volta, Greater Accra, Central and Western regions (Fig. 1). Along the coast of Ghana exists several traditional canoes and semi-industrial vessels that land multi-species of fish; whereas industrial vessels land specific pelagic and demersal fish species.
3.2. Sources of data

3.2.1. Fishery-dependent data

Landing statistics since they typically do not include illegal, unregulated, and unreported landings, can be misleading and sometimes underestimated. In this study landings data was obtained from the database of the Fisheries Scientific Survey Division (FSSD) of the Fisheries Commission (FC) of Ghana who has the mandate to collect basic data from sampling fleet of canoes, inshore purse seiners and trawlers as well as industrial trawlers along the coastal regions of Ghana (Fig. 1). Data collected are therefore reasonably credible since a standard survey technique was used and several of the same fisheries officers engaged in the surveys for many years [32]. Annual landings of five important (by weight) species of small pelagic fishes; Round sardine (Sardinella aurita), Flat sardine (Sardinella maderensis), European anchovy (Engraulis encrasicolus), Atlantic horse mackerel (Trachurus trachurus) and Atlantic chub mackerel (Scomber japonicus) in the coastal waters of Ghana were extracted and analysed between 1998 and 2018. Data on numbers of canoes were extracted from the Canoe Frame survey, 2016 [28].

3.2.2 Document analysis
A number of publications produced by individuals, organizations and projects were analysed as secondary data sources (i.e., Ministry of Fisheries and Aquaculture Development, Fisheries Commission, Ghana Export Promotion Authority, West African Regional Fisheries Programme, Customs Excise and Preventive Service, Ghana Statistical Service, Ministry of Trade and Industry, Sea Around Us, Ghana Sustainable Fisheries Management Project, Food and Agricultural Organization).

3.2.3. Field visits and interactions
Between June 2019 and December 2019, monthly visits and interactions were carried out in the coastal regions. The aim was to get fishermen, canoe operators and fish processors perspective about the small pelagic fishery. Data was collected the following; number of active and non-active canoes, number of non-fishing days, methods used in processing small pelagics, knowledge about the fishery, and observing fishermen mending their nets, repairing their canoes, etc.

3.3. Data analysis
Data obtained from FSSD were entered and stored in Microsoft Excel. Data gleaned and used in this study is based on quantity and on annual time-scales. Time-series graphs were plotted to determine the trends in the landings over the time period analysed. The per capita fish consumption (PCC) estimated for the small pelagic was expressed as:

\[
\text{Per capita consumption of small pelagics (including imports)} = \frac{\text{production} + \text{imports} - \text{exports}}{\text{population}} \quad (1)
\]

\[
\text{Per capita consumption of small pelagics (excluding imports)} = \frac{\text{production}}{\text{population}} \quad (2)
\]

4. Results

4.1. Graphical representation
The flow of small pelagic resources from the point of production to consumption is shown in Figure 2. In terms of production, 55% of small pelagic stocks are landed fresh by the artisanal canoes, while 26% come from inshore, 4% from industrial fleets and 15% from imports. These are traded in their fresh (65%), frozen (17%) or processed (18%) forms to several actors along
the supply chain on a national and international level. The national market is the main market for small pelagic products. About 85 000 t of small pelagic resources are consumed annually at the subsistence level. Besides the national market, small pelagics are also destined to both regional and international markets including Togo, Ivory Coast, China, USA, UK, Netherlands, Belgium. About 30% of small pelagic resources transformed (canned) is exported to the international market. Additionally, the country imports about 60 000 t of small pelagic fish annually to supplement fish consumption in Ghana. This signifies the important role small pelagic plays in food security and the nutritional needs of several people in Ghana.

4.2. Annual landings

Annual total fish landings recorded its maximum level in 2000 at 379,793 metric tons and decreased to 202,743 metric tons in 2018 (Fig. 3). Landings of small pelagics followed a similar decreasing trend over the period analysed, decreasing from a high of 237,457 metric tons in 2000 to 135,639 metric tons in 2018. The small pelagic stocks contributed about 66% to total marine fish landings in 2018.
Figure 2: Graphical representation of the small pelagic fish chain (Source: Authors)

Caption:

- Main route from Ghana to Europe, USA and other parts of the world
- Main route to domestic markets
Figure 3: Total fish landings and small pelagic fish stocks in Ghana (source: Plotted based on data from Fisheries Scientific Survey Division database)

Figure 4 illustrates the evolution of the total landings of the important small pelagic species in Ghana between 1998 and 2018. The trends indicated that landings of the small pelagic species have largely demonstrated a continuous decline over the past two decades. The largest catch of round sardine (*Sardinella aurita*) was recorded in 2000 with 102,042 metric tons landed. Since then, there has been a drastic decline in the landings of this species. Landings of the anchovy fluctuated over the period however, landings increased significantly after 2016. Landings of the Atlantic horse mackerel showed an increasing trend up to 2014 where 23,000 metric tons were landed and this was followed by a decrease in recent years. Landings of the Chub mackerel also decreased from 30,160 metric tons in 1998, reaching the minimum level in 2018 at 3,662 metric tons.
4.3. Landings and effort

Annual landings of the small pelagic fishes have plummeted year after year with an increasing number of canoes to more than 11,000 in 2016 (Fig. 5). The largest number of canoes was recorded in 2013 at 12,728, during this same period landings of small pelagic fishes decreased to 75,740 metric tons from a high of 190,000 in 1997.
Figure 5: Landings of small pelagic stocks and effort in number of canoes targeting small pelagics Ghana, 1997-2016 (Source: Plotted based on data from Fisheries Scientific Survey Division database)

4.4. Imports and Exports
Imports of small pelagic fish were relatively higher than exports. Imports of small pelagics were particularly composed of frozen sardines and mackerels whiles exports were made up of canned products (Table 1).

Table 1: Small pelagic import and export quantities (tons)

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<tr>
<td>Import</td>
<td>28900</td>
<td>27472</td>
<td>26683</td>
<td>21285</td>
<td>20906</td>
<td>25354</td>
<td>25805</td>
<td>22755</td>
<td>22222</td>
</tr>
<tr>
<td>Export (canned sardines, mackerels)</td>
<td>543</td>
<td>1,510</td>
<td>2153</td>
<td>1753</td>
<td>2075</td>
<td>1920</td>
<td>1843</td>
<td>2892</td>
<td>2712</td>
</tr>
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Source: Fisheries Scientific Survey Division, 2020

4.5. Food security implications
Changes in per capita consumption (PCC) of small pelagic fishes with and without imports estimated between 2008 and 2018 is shown in Figure 6. Per capita small pelagic fish consumption fluctuated over the period analysed. The highest value recorded for PCC was in 2010 (6.8 kg for PCC including imports and 5.8 kg for PCC excluding exports) whiles the lowest values were recorded in 2013 (4.1 kg for PCC including imports and 3.2 kg for PCC
excluding exports). However, the increasing trend observed in the PCC (including imports) is as a result of the import of small pelagic fishes to supplement local production.

![Graph showing changes in per capita consumption of small pelagic fishes](image)

**Figure 6**: Changes in per capita consumption of small pelagic fishes (Source: Plotted based on data from Fisheries Scientific Survey Division database)

### 4.6. Management and monitoring of the small pelagic fishery

The Fisheries Commission primarily manages and monitors commercial fishing to ensure fish resources and the fishing industry are viable now and into the future. Commercial fishing for small pelagics is guided by a number of policy framework which is based on the broader Fisheries Act, 2002 (Act 625), Fisheries (Amendment) Act, 2014 (Act 880) Fisheries Regulations, 2010 (L.I. 1968) and Fisheries (Amendment) Regulations, 2015 (L.I. 2217) originally implemented by the government of Ghana [25, 30]. These provide a comprehensive constitutional and policy framework to ensure the sustainable exploitation and management of the fisheries resource. Ghanaian fisheries are technically open access, however, permission to enter the sea through licensing is a legal requirement for all fishing fleets [11, 41].

### 5. Discussion

Small pelagics flow through several channels from production to consumption. At every channel, there is value addition and creation of opportunities (i.e. employment, income generation and poverty reduction) for thousands of people along the chain. Small pelagics are also destined for regional and international markets, thereby bringing economic benefits to the country. However, 60 000 t of small pelagic is imported annually to supplement domestic
consumption valued at $311 million in 2018 [33]. Ghana has the potential to be a net exporter of fish. However, due to unsustainable fishing practices, pollution of water bodies and decline of the small pelagic fishery, this cannot be achieved even in the near future.

The downward trend in landings of small pelagic stocks recorded in this study showed the stocks have declined compared to the 1990s when there was a remarkable growth in the sector. Landings have declined some 42% as the fishing effort has increased (Fig. 5). This corroborates studies reported by [11,13,32]. Whiles landings of these small pelagics declined intensely in 2018, they contributed about 67% to total fish landings in that same year. This reflects the significance of these forage fishes to the marine fisheries sector in Ghana.

In contrast to the collapse of a single dominant species recorded in the 1970s [32], the current decline is notable in four of the five major species analysed during the period. The pattern of landings for the small pelagics during the period was predominantly influenced by harvests of sardines and anchovy. Landings of the round sardinella decreased 71% from a high of 102,042 in 2000 whiles that of the flat sardinella and chub mackerel decreased by 57% and 83%, respectively. This drastic decline in landings is a product of overfishing caused by overcapacity of fishing fleets, which is more conspicuous in the artisanal sector. The artisanal sector which is the backbone of the fisheries industry in Ghana is open access [11] and the number of canoes have increased dramatically over the past decade. This dramatic increase in artisanal canoes has been driven by government subsidies to the sector, specifically premix fuel subsidies, therefore, attracting additional entrants into the fishery [11,13]. Too many canoes and excessive fishing pressure on already stressed stocks have exacerbated the downward trend recorded in the small pelagic landings. The decline has also coincided with an increase in illegal, unreported and unregulated (IUU) fishing, most notably the targeting of juveniles and small pelagic fish by industrial vessels for transshipment at sea to artisanal canoes (known as “saiko”) [17,34]. Despite being illegal, ‘saiko’ has become an attractive and a preferred fishing trade for both the industrial and artisanal fishing fleets, contributing to the rapid decline of ‘The People’s fish’ in Ghanaian waters. Several other concerns have been issued on the potential negative ecological, social and economic impacts of the expansion of Distant Waters Fishing Nations fishing vessels, particularly the Chinese industrial vessels and their involvement in saiko trade and other forms of illegal fishing in the EEZof Ghana [34,35]. Other factors that have intervened to cause this decline include but not limited to light fishing, the use of destructive gears and poor fisheries monitoring [11,36,37]. These illegalities have put
additional pressure on the stocks and climate variability have intensified their effects both locally and sub-regionally.

The small pelagic stocks are essential resources and the extent of resource extraction leading to this substantial decline has several implications on the ecosystem and socio-economic development of the country. Ecologically, the decline in the small pelagic fish may disrupt the marine food web and have severe implications on marine biodiversity. Also, as stated earlier, millions of people depend on the small pelagic fish and its fisheries for their livelihood and nutritional needs. The decline of these fish stocks, therefore, threatens food security and livelihoods of those who depend on them. With virtually no fish left to be caught in the sea, fishermen are bound to lose their livelihood. It poses a serious threat to these people by increasing levels of chronic hunger, severe malnutrition and stunted growth in children and poverty [20,38,39], thereby hampering the country’s effort in achieving SDG 2: No hunger.

The highest import of fish was recorded in 2010 with exports recording less than 1000 mt in that same year. FAO reported that in 2010, fish imports reached US$ 108 million whereas fish exports earned US$ 65 million in that same year [40]. With the dramatic decline in small pelagic fishes in recent years and the need to sustain per capita consumption, import of these fishes is further expected to rise substantially. This may have dire consequences on the economy. Also, revenues generated from landings, licensing and related processing activities, trade and exports would be greatly affected. Although exports of small pelagics have been relatively lower and seem like a lost economic opportunity to the country, the consumption of about 80% of small pelagics from total landings in the country could be viewed as a blessing because fish would be made available to ameliorate the food security and nutritional status of Ghanaians.

Despite the existence of the Fisheries Regulations, Fisheries Act, 2002 [41,42] and other policy frameworks the small pelagic fishes have recorded a consistent decline in terms of yield over the past two decades in Ghana [13,32,43,44]. Also, the frequency of illegal fishing activities, non-compliance to laws, and low levels of commitment reflects the ineffectiveness of the regulations implemented by management. Managed properly, the small pelagic fish resources contribute significantly to employment, food security and poverty reduction to several people along the coast of Ghana. However, to date, these valuable fishes have been managed poorly and teeters on the edge of collapse.
Conclusions

The small pelagics flow through several channels from production to consumption and provides several opportunities along the chain. Nevertheless, the current status and trends in small pelagic fish landings suggest stocks are depleting. The round sardine, by far the dominant landed species, has declined dramatically while canoe fleet size has increased. Such a decline in small pelagic landings on this scale may be mitigated when fisheries scientists, fisherfolks, experts, politicians and other stakeholders in the industry comprehend the implications of excessive fishing operations. Several studies and stakeholder national workshops have reported overfishing as the primary issue linked to such declines and necessitate the urgent need to reduce fishing capacity to suitable levels. What the small pelagic fisheries need are pragmatic management measures and policies that would ensure complete compliance with fisheries regulations and an indication of how much fishing is permissible and required. The Ministry of Fisheries and Aquaculture Development (MoFAD) and the Fisheries Commission, spurred on by the declines, initiated its first phase towards effectively mitigating overcapacity and fishing pressure by implementing a one-month closed season for all artisanal and semi-industrial fleets in Ghanaian waters in 2019. Fisheries management systems, including co-management, must therefore be strengthened by modifying measures such as limiting restrictions to spawning areas; strengthening licensing systems, limiting entry into the fishery; increasing gear selectivity and the removal of destructive gears; reducing IUU fishing and scraping off premix fuel and other harmful subsidies; and by embracing, relevant, precautionary scientific advice to avert and reverse the resource decline.

Fisheries managers have expounded that managing fishing effort in artisanal fisheries may be problematic due to difficulties in enforcement and because the artisanal fishers are often among the deprived, without an alternative source of livelihood [45]. As such, government officials may resort to making decisions with short-term impact, when long-term decisions may be beneficial. Solving this fisheries crisis would be challenging and would require collective effort of stakeholders to be effective in reversing the resource decline and restoring our waters with an abundant supply of fish species.
Policy recommendations

To halt the decline and improve landings of the small pelagic fishery, the following are being recommended:

1. Fortify fisheries enforcement unit to ensure effective monitoring and surveillance to eradicate saiko and other forms of illegal fishing.

2. Limit entry into the fishery through restricted licensing particularly for artisanal fisheries as required by Fisheries Act 625 (2002)

3. Amend the timing of closed seasons to coincide with the peak breeding season of small pelagics and extend the duration of the closed season for both artisanal and industrial sectors

4. Increase frequency of stock assessments of the small pelagic species particularly for sardinellas and anchovy

Authorship Contribution Statement


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Competing interest statement

The authors have no competing interests to declare

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