Fishing for survival: importance of shark fisheries for the livelihoods of coastal communities in Western Ghana

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Abstract

Small-scale shark fisheries support a large number of coastal community livelihoods in developing countries. Shark meat comprises a cheap source of protein and is traded locally in many parts in developing countries, while the skins, oil, fins and gill rakers are exported to the international market. This study addresses a gap in literature regarding the importance of elasmobranchs to key shark-fishing communities and the degree to which trade in shark products (meat and fins) vary in time and among fishing communities in Ghana. We interviewed 85 fishers and traders involved in shark fisheries in Axim, Dixcove, and Shama communities using semi-structured questionnaires. Fishing was the primary source of income and accounted for 59.9% of the total household income of respondents. Other important economic activities were fish processing (15.2%), fish retailing (14.8%), and small businesses (2.9%). One-third and often two-thirds of respondents generated between 80-100% of their income from shark fisheries: Axim (n = 65%), Dixcove (68%), and Shama (35%). Shark meat consumption was common among fishers and traders and represents a substantial source of protein in the diet of the study communities. Overexploitation of these species may compromise food security. Hammerhead Sharks (*Sphyrna* spp) and Bull Shark (*Carcharhinus leucas*) have the most valuable fins and meat. Further, 75% and 95% of fishers and traders respectively see fishing and trading of shark meat as their last safety-net and, therefore, tend to be satisfied with their jobs. Non-fishing related livelihood streams including small businesses and transportation were the major fallback activities both fishers and traders preferred to rely on if there is a ban on the exploitation of sharks in Ghana. Thus, any shark management strategy must take into consideration the preferred livelihood fallback options outlined by fishers and traders, and implement them to ensure the success of the intervention.

Keywords: Artisanal fisheries; Fallback options; Household income; Livelihood strategies; Fishers' satisfaction

1. Introduction

The economies of developing countries heavily depend on natural resources-based livelihood strategies, with fisheries contributing significantly to the economy (BNP, 2008). For instance, the United Nations Food and Agriculture Organization (FAO) and the World Fish Centre-Big Numbers Project (BNP) (2008) estimated that between 93 and 97 million rural households in developing countries worldwide are involved in fishing and its related activities. An estimated 12.3 million people in Africa are actively involved in fishing as either fishers, processors or traders (FAO, 2014). The fisheries sector accounts for more than US$ 24 billion or 1.3% of the joined GDP of all African nations and also supports 30% of Africa's nutrition and food security (FAO, 2014). In Ghana, the fishing sector directly or indirectly employs 2.6 million people, comprising 10% of the total population (Nunoo et al., 2015). The fishing sector is estimated to support about 3% of Ghana's GDP and 5% of Agricultural GDP (Nyemah et al., 2017). The sector also contributes 60% of animal protein consumed in Ghana with average per-capita consumption between 20 and 25 kg per annum (Nunoo et al., 2015).

The inshore artisanal fishery is a major source of Ghanaian fish production, accounting for 80% of the total annual fish supply (Ministry of Fisheries and Aquaculture, 2017). The main aim of artisanal fishers is to continue to supply fish to meet their household needs and for domestic markets. The artisanal fishery operates actively in over 300 landing sites in several coastal communities along the 550 km coastline of Ghana and supports approximately 124,000 fishers (Amador et al., 2006; CRC, 2013). A number of coastal communities in Ghana engage in subsistence farming, small trade, artisan works, factory work, mining, and sand mining as their livelihood strategies and these are mostly undertaken concurrently with fishing-related activities (Mensah & Antwi, 2002). However, recent studies have found that artisanal fisheries are the most important livelihood strategies for coastal communities in Ghana. For example, Asiedu and Nunoo (2013) report that between 80% and 97.7% of fishers from the studied population depend on fishing as their sole occupation in the Ghanaian coastal communities of Small London, Kpong, Ahwiam, and Elmina. Similarly, Asiedu et al. (2013) report that artisanal fishery contributes 80% and 85% to the total household income of fishers in the Ahwiam and Elmina communities, respectively.

Livelihoods of many artisanal fishing communities in sub-Saharan Africa are under threat, as the region continues to put increasing pressure on fish resources for sustenance and income, which poses many challenges for long term sustainability of the resources for food security (Andrew et al., 2007; Béné et al., 2005). This has caused many fishers to resort to diverse strategies to maintain or improve their livelihoods. The adopted strategies include geographical mobility, utilizing different methods of fishing, fishing in different locations, and adjustment from specialist to generalist fishing operations (Allison & Ellis, 2001; Smith & Mckelvey, 1986). The latter is the most common strategy among Ghanaian artisanal fishers in an effort to maintain high levels of catch in the wake of continuous declines of their formerly preferred teleost stocks (MoFAD, 2015). These generalist fishers invariably use diverse fishing gears or modify their fishing operations to target bony fishes, marine invertebrates, and other vulnerable marine megafauna (I. Seidu, pers. obs.). Elasmobranchs (sharks, rays, and skates) are among the marine megafauna that are particularly susceptible to capture in diverse fishing gears and across a magnitude of fishing operations, with fisheries posing the greatest source globally to non-natural mortalities within this group (Bonfil, 2000; Dulvy et al., 2000; Dulvy et al., 2014).

Elasmobranchs typically have a relatively slow life history due to their large body size, late maturity, slow growth, and low fecundity (Pardo et al., 2016). These traits make them exceptionally vulnerable to overfishing and typically result in decreased chances of recovery from population decline (Barrowclift et al., 2017; Dulvy et al., 2000). Traditionally, elasmobranchs primarily constituted bycatch until the rise in international demand and prices for their products, particularly for fins in the mid-1980s, which incentivized many coastal communities to target sharks and rays (Clarke, 2004). Shark fins are now rated as one of the most expensive fish products worldwide resulting in some sharks and rays being the most valuable traded wildlife (McClenachan et al., 2016). Although there has not been a robust estimate of the number of people involved in small-scale elasmobranch fisheries worldwide, this activity has been recognized to support a large number of rural coastal community livelihoods in developing countries (Bonfil, 2000). Elasmobranch meat is traded locally in many parts in developing countries and can form a cheap source of protein for the people, for example, in Southern Brazil (Bornatowski et al., 2013).

Recent studies in the sub-Saharan African region have demonstrated shark fisheries as an important livelihood strategy for coastal communities (Barrowclift et al., 2017; Diop & Dossa, 2011; Gerber, 2018). For example, in the Sub-Regional Plan of Action for Sharks (SRPOA-Sharks) project, Diop & Dossa (2011) indicate that shark fishing provides an estimated 13,000 direct jobs to fishers, processors, and fish smokers in 2008 of, which 7% was generated by artisanal fishing in the Sub-Regional Fisheries Commission Zone. In Zanzibar, East Africa, Borrowclift et al. (2017) report that elasmobranchs contributed 41-60% of the total income of fishers who caught and sold sharks. They also report that 31% of merchants obtained between 61-80% of their income from selling elasmobranchs. Additionally, in Ghana, trade in shark fins is the main source of income for 80% of middlemen and 38% of canoe owners of the study population (Gerber, 2018). Although these studies provide initial data on trade in shark fins (Gerber, 2018) and meat as well as livelihood strategies of fishers (Borrowclift et al., 2017), the historical trade dynamics of fins and the local consumption pattern of shark meat have not been documented. Since most rural coastal communities depend on shark meat for their protein requirements, enquiries about consumption of shark meat is relevant for designing management strategies for the sustainable benefit of the rural communities. Further, comparatively, few studies have investigated the wellbeing and income satisfaction in artisanal fisheries, which employs over 90% of fishers globally (FAO, 2014; Purcell et al., 2016). Fishers' satisfaction may be influenced mainly by income and happiness, and none-monetary factors such as adventure and self-actualization (Pollnac & Poggie, 2006; Coulthard, 2011). Satisfaction impacts the health of fishers and the relationship between fishers and management institutions, and offers opportunity to target training and development programs for fisheries (Ruiz, 2012; Trimble & Johnson, 2013).

Additionally, many species of elasmobranch are considered threatened as a result of direct impact from target and bycatch fisheries worldwide (Dulvy et al., 2014; 2017) and such is the case of the shark fauna in Ghana. Most fishers in a previous study reported that shark species such as Hammerhead sharks (*Sphyrna* spp), Thresher sharks (*Alopias* spp), Lemon Shark (*Nagaprion brevirostris*), and Mako sharks (*Isurus* spp) among others, have declined in recent years (Seidu et al., Submitted). With the current fishing pressure, it is likely most shark populations will continue to decline and some may even go extinct if effective management measures are not urgently instigated, as has occurred for sawfishes in the region (Dulvy et al.,

2016; Fernandez-Carvalho et al., 2014). Following international concern over rapidly dwindling shark populations, several mitigation measures are advocated by biologists and conservationists. Spatial closures, such as marine protected areas (MPAs) and no take marine reserves as well as fishing bans are some of the fisheries management strategies that have been implemented to slow and reverse the effect of large-scale overfishing on shark populations (Ward-Paige et al., 2012). However, implementation of these measures has the potential to adversely impact regions with significant shark fisheries and stakeholders who directly depend on shark and other marine resources for their livelihoods. Thus, exploring potential effects of fishing bans or closures on fishers' behavior, especially fallback livelihood options they prefer to rely on, is not only important to ensure the welfare of fishing communities, but also to increase the chance of success of shark protection if management authorities are to implement such measures to mitigate shark decline in Ghana.

Given these considerations, this study aims to address a significant data gap on the economic impact of shark fisheries to fishers' and traders' livelihoods, and assesses the trade dynamics of shark products in major shark-fishing communities in Ghana. We specifically tackle the following questions: (i) what are the existing livelihood strategies and how is shark fishery contributing to artisanal fishers and traders' household income and sustenance? (ii) What are the fallback livelihood options available to fishers and traders in the advent of a ban on shark exploitation in Ghana? (iii) How have the sales prices of commercially important shark products (fins and meat) change over time? and (iv) Are fishers and traders satisfied with the income they obtained from shark products and their work? The findings are essential in targeting policy interventions in livelihood enhancement, food security, and poverty reduction. In addition, understanding the livelihood strategies, fallback options, and wellbeing of primary actors in shark fisheries is necessary for planning management interventions for the sustainable utilization of sharks.

2. Methodology

We first described the analytical framework for the study. Second, we described the study areas for the study. Third, we described the data collection methods and finally, we detailed our data analysis methods.

2.1 Analytical framework

The analytical framework of the study was based on the Sustainable Livelihood Approach (SLA) (Figure 1). The SLA is founded on the premise that people require a range of strengths (here called "capitals") to achieve positive livelihood outcomes (DFID, 2000; Ellis, 2000; Scoones, 1998). At the heart of the framework is the livelihood strategy, made up of natural resource-based (e.g., fishing, collection of aquatic resources, livestock farming) and non-natural resource-based (e.g., trading, artisanship, services) livelihoods in rural settings. The SLA identifies five types of capitals upon, which the choice of a household to pursue a particular livelihood strategy is built, namely, natural, human, social, financial, and physical capital. Mediating institutions (e.g., policies, customs, taboos, and rules) determine access to various capitals and the choice of households to build a particular livelihood strategy. Mediating institutions further have direct influence on livelihood outcomes (e.g., whether fishers are able to achieve feeling of inclusion and well-being) (DFID, 2000). The livelihood outcomes in turn have influence on these mediating institutions. External factors such as seasonality, critical trends, and shocks over, which people have limited or no control, have influence on the wider availability of capitals and livelihoods of households (both livelihood strategy and outcome). Livelihood strategies undertaken by fishers' may result in improved income level, increased well-being, satisfaction, or sustainable use of fishery resources (livelihood outcomes). For instance, fishers may improve their income through diversifying their livelihood strategies, which will invariably reduce pressure on fishery resources resulting in sustainable use of the resources. Finally, the resulting livelihood outcome of fishers' households invariably influences their capital through investment in education of household members or financial savings.

Information presented in this study mostly emphasizes the livelihood strategies and livelihood outcomes (income level and wellbeing) of the SLA analytical framework as highlighted in

Figure 1. Other components of the framework including livelihood capitals, vulnerability, and mediating institutions have been addressed in our previous papers (Seidu et al., submitted).

2.2 Study areas

The study was conducted in three coastal communities in the Western Region, namely, Axim, Dixcove, and Shama (Figure 2, Table 1), which are the hotspots of shark fisheries in Ghana. The communities were chosen based on three major reasons – that is, fishing is exclusive to artisanal fishers; sharks form a significant catch and characterized with local shark fin trade; and fishers were willing to cooperate with the researchers for both landing and interview data. The Axim, Dixcove, and Shama communities fall within the Nzema East Municipality, Ahanta West, and Shama Districts respectively. The communities are located in west coast (≈95 km) and extend from the Ghana-Côte d'Ivoire border to the Ankobra River estuary (deGraft-Johnson et al., 2010). Axim community with annual precipitation of 1,979 mm exhibits the highest average rainfall pattern in Ghana (GSS, 2014), which favors crop farming activities. Dixcove and Shama have annual rainfall pattern of 1,700 mm and 1,820 mm respectively.

2.3 Data collection

Data collection started in February 2020 and ended in August 2020. Data were collected using a semi-structured questionnaire that was designed to gather both qualitative and quantitative information. The questions for the interview were pre-tested for clarity in Shama and Axim with ten fishers (five from each community) in February 2020, as shark meat and fin trade are prevalent in these two communities. This gave an opportunity for us to make the necessary changes to reflect the local context of the study communities. Aside from administering all interview questions to respondents, we also specifically asked them to comment on how the survey questions reflected their livelihood strategies, shark fisheries, and trade dynamics and the influence of sharks on their income.

A non-probability convenience sampling approach (Alexander et al., 2017) was employed to select fishers and traders for the interview. The convenience sampling approach also referred to as availability sampling is based on the availability and willingness of respondents to participate

in the interview (Naderifar et al., 2017; Newing, 2010). Thus, the number of respondents interviewed in each community depended on the availability and willingness of fishers and traders to participate in the interview. This sampling scheme was chosen because most fishers and traders were aware of the global controversies surrounding sharks and the fin trade, which made it difficult for most of them to open up to researchers. Face-to-face interviews were conducted with a total of 85 respondents, comprising 58 fishers and 27 traders in the three study communities. Interviews were conducted at the landing sites for fishers and mostly at the homes of traders. The interview lasted between 45 and 60 minutes per respondent. Interviews were conducted during the morning (08:00- 10:00), afternoon (12:00-13:00) and early evenings (16:00-18:00) in the landing sites and homes of respondents. The questionnaires were administered in local languages (Asante Twi, Fante, Nzima or Ahanta) by the first author, with assistance from local volunteers in their respective communities who served as interpreters when necessary, especially with the Nzima and Ahanta languages.

Data were collected with the permission from chief fishers and their elders in their various landing communities. We preceded the interview by asking participants to give an oral consent to be interviewed. We informed every respondent of the purpose of the interview, the confidentiality of information provided, and the right to omit uncomfortable questions or withdraw from the interview at any stage, prior to the interview. Some respondents did not agree to be interviewed when we approached them. Five fishers immediately asked for permissions to withdraw from the interview when they were asked about shark trade even though they initially agreed to be interviewed. The information obtained from these respondents was expunged from the final analysis. We read questions from a semi-structured, standardized, questionnaire, which were identical across interviews and communities. Questions were mostly repeated and / or altered to ensure comprehension by respondents. Photo identification sheets were also used to confirm species names with respondents, when necessary.

The questions were used to elicit both qualitative and quantitative data on demographics, socio-economic attributes, livelihood strategies and fallback options from respondents. For the livelihood strategies, our pilot study revealed that both fishers and traders were unwilling to disclose their average income they earned from the livelihood stream they engaged in. We therefore asked respondents to state the average amount of income they obtained from their

livelihood streams using a qualitative ranking scheme from 0–100%. Subsistence consumption of shark products categorized as often; (once or more per week); sometimes; (once per month); rarely; (once or few per year); and never (never at all) was also captured. As a measure of fisher and trader well-being, we also captured information on their satisfaction with their work and income derived from shark fisheries. This was categorized as very satisfied, satisfied, dissatisfied, and very dissatisfied.

Questions were equally designed to collect data on main uses and sale prices of commercially important shark products (i.e., meat and fins), trade dynamics (including where the meat and fins are sold), and changes in the average prices of shark fins. The sales of shark fins are the sole responsibilities of the canoe owners in their respective canoe business (Gelber, 2018; Seidu, pers. obs.). We therefore used the snowball sampling scheme to track down canoe owners and asked them about the shark fins and trade dynamics in their respective communities. The snowball sampling referred as referral or chain sampling is used where potential participants are difficult to find (Newing, 2010). This sampling scheme is where research participants recruit other respondents for the study (Naderifar et al., 2017). Only 15 canoe owners (five from each community) participated in the interview, and provided information on the trade dynamics of shark fins. We specifically asked them to give us the average price of eight commercially important and well-known shark species in their communities over a 15-year period. To facilitate the interview, time periods were chosen together with events in, which canoe owners were most likely to remember. These time periods were: i) 2005-2010, when fishers noticed a significant decline in sharks and pelagic fish species catch; ii) 2011-2013, where there was an embargo on the trade in shark fins; iii) 2014-2015, where the embargo on fin trade was lifted; and iv) 2018 to 2020, when data was collected. The average price for each shark species during each time period was used in the analysis.

In addition, we observed and collected catch and trade data on shark species in landing sites and used the data for our analysis on the changes in shark meat trade among the various communities. Shark trade data was collected during daylight hours at the three communities from March to June 2020. We recorded the species, size (especially the precaudal length (in cm) after the specimen were finned), and the sale price of each specimen in Ghana Cedis (USD 1= GH¢ 5.77). When possible, we stood close while fishers and traders negotiated on the prices of the

specimen, or alternatively asked them about the prices after we recorded their sizes. A total of 397 shark specimens were sampled and their sizes recorded (Axim, *n* = 134; Dixcove 95; Shama 168). Sale prices were recorded for 713 specimens (Axim, *n* = 395; Dixcove 111; Shama 207).

2.4 Data analysis

All interview data were translated to English and were coded and analyzed using the Statistical Package for Social Sciences (SPSS) software, version 20. The Shapiro-Wilk test was used to test for normality in the data, prior to analysis (Zar, 2010). Chi-square contingency tests were used to test for significant associations between the relative income of the various livelihood streams among the study communities. The effect of gender, occupation, educational level, ethnicity and age group of respondents on relative income derived from shark fisheries and respondents' satisfaction with income from shark meat and their work were also tested using Chi-square contingency tests. The qualitative data were coded and analyzed using basic descriptive statistics in Excel spreadsheet and further presented in tables and figures.

The selling price of sharks was mostly based on their sizes (mostly, the precaudal length, after it has been finned), as no mechanism was put in place to weigh the specimen in the various landing sites. Thus, price per unit size (GH¢/cm) was computed for a total of 713 shark specimens in the three communities. Shark species that were less than 10 sale values were expunged from the analysis due to the low sample size. Prices at first sale and size data were tested to investigate if there were significant differences among the communities. Differences in price/cm of individual shark species among the three communities were tested with Kruskal Wallis tests and further compared with Bonferroni pairwise tests if there were significant differences among the communities. Statistical tests were conducted using PAST version 3.12 (Hammer et al., 2001), with a significance level of 5%.

3. Results

3.1 Socioeconomic characteristics of sampled respondents

The average household size was 3.59 ± 1.26 people (Table 1). Many of the respondents (*n* = 35) were between the ages of 36 - 45 years. Most respondents (*n*= 81%) belong to the Fante ethnic group (Table 2). The ethnicity of respondents varies significantly among the study communities with all respondents from Shama belonging to the Fante ethnic group. There was a significant difference in educational level of respondents among the communities, with most respondents having no formal education.

3.2 Livelihood strategies

Fishing was the primary source of income and accounted for 59.9% of the total income of respondents (Table 3). Fish processing (15.2%) was the second most important livelihood strategy, followed by fish retailing (14.8%) and small businesses (2.9%). There were no significant differences in the mean income of all the livelihood strategies among the study communities, except fish processing (X^2= 34.44, *df*= 18, *p*= 0.011), which was higher in Dixcove compared to other communities (Table 3). In Axim and Dixcove, fish processing was the second most important livelihood activity after fishing. In contrast, fish retailing was the second primary income in Shama.

Across all communities, 67% of respondents only had one livelihood activity while 26% had two livelihood streams. Only 6% of respondents had more than two livelihood strategies even though they get less income from them compared to fishing-related activities.

3.3 Income from shark fisheries

Many fishers and traders generated between 80-100% of their income from shark fisheries. Most of the respondents in Axim (*n*= 65% of 23 respondents) and Dixcove (*n*= 68% of 22 respondents) received between 80-100% of their income from sharks. However, at Shama, only 35% of 40 respondents generated between 80-100% of their income from sharks. The remaining fishers and traders had income from sharks at different income ranges (Figure 3). Gender, occupation, educational level and ethnicity of respondents did not have any statistically

significant influence on the range of income generated from shark fisheries. However, age of respondents had a significant effect on income produced from shark fisheries (X^2= 41.36, *df*= 20, *p*= 0.003), with 36-45-year-old respondents deriving more income from sharks than any other age group.

3.4 Subsistence consumption of shark meat

Consumption of Shark meat was common in the three study communities (Figure 4). More than 80% of fishers and traders in each community ate sharks "often" or "sometimes". Sixty-five percent of respondents at Shama stated that they often eat shark. Bull Shark (*Carcharhinus leucas*) and Hammerhead sharks (*Sphyrna* spp) were favored for consumption but other available species were often eaten. These include Blue Shark (*Prionace glauca*), Mako sharks (*Isurus* spp), and other requiem sharks (*Carcharhinus* spp). Many respondents (57%) in Axim ate shark "sometimes" and mostly preferred Sand Tiger Shark (*Carcharias taurus*) and Hammerhead sharks (*Sphyrna* spp). These fishers normally eat shark meat on Sundays and/or Tuesdays during fishing holidays and often ate Blue Shark and other requiem sharks (*Carcharhinus* spp), as they are easily available in their respective communities. At Dixcove and Shama less than 10% of fishers and traders reported rarely eating sharks. Two of these fishers reported that they used to eat sharks often but now they no longer eat shark meat due to medical reasons, as their physicians have barred them from eating more meat. Only one trader had never eaten sharks before and attributed it to the nauseating way in, which they are processed (i.e. the salting and/or smoking process).

3.5 Fallback livelihood options of fishers and traders

Fallback livelihood options are activities that fishers and traders would pursue to generate most of their income if there should be a ban on shark fishing and trading in Ghana. Non-fishing related livelihood streams were the major fallback activities both fishers and traders preferred to rely on if they could no longer engage in shark fisheries. Small businesses were the most common fallback livelihood option reported among the study communities (Figure 5). Some respondents, especially traders, defined small businesses they would like to engage in as purchasing and selling of food items and other assortments in kiosks. Some fishers would like to

acquire capital to purchase and sell clothing, men's underwear, shoes, and slippers in the capital city and other nearby markets. Transport business was the next important alternative livelihood option for some respondents, followed by artisanship like carpentry, barbering, and others. Some fishers were interested in driving taxis if they could get the skills in driving and money to purchase their own cars. Other respondents noted that they will be willing to work in the state transport cooperation or other transport corporations in the country as cleaners, drivers, and conductors. Some respondents expressed their interest in exploiting and trading in other commercially important species like sardinellas, tunas, turtles, rays, anchovies, and cetaceans. They stated that they will modify their gears to target these species if there should be a moratorium on the harvest of sharks. Fewer than 20% of respondents from Dixcove and Shama stated that they will rely on government's support, aquaculture and poultry farming (Figure 5).

When asked about the tools they require to implement these livelihood options, especially the non-fishing related activities, most respondents (68%, *n*= 58) stated funding as the major requirement they need before initiating these livelihood streams. Few respondents (35%, *n*= 30) also reported that they need to acquire the skills and technical know-how before they can kick-start their preferred livelihood options. However, five fishers who recounted having enough capital to start farming were increasingly concerned about the general unsuitable environment characterizing the sale of farm products and were afraid to lose their capital when they invest in farming.

3.6 Dynamics of trade in shark fins

A total of 15 respondents, who were mainly canoe owners, participated in the interview on shark fin trade as canoe owners are the ones solely responsible for the sale of fins in their respective canoe businesses. Fishers' perception on price dynamics over a 15-year period from 2005 to 2020 revealed that prices of all shark species had sharply reduced from 2011 to 2013 and increased astronomically from 2014 to 2015 (Table 4 and Figure 6). Prices of shark fins increased between 2014 and 2018. After 2018, however, prices remained virtually stable until 2020, as indicated by all canoe owners. The price of fins is mostly determined by buyers and marginally increases with time. Hammerhead Sharks and Bull Shark consistently had the most valuable fins. Conversely, Thresher Sharks, Tiger Shark and Blue Shark are consistently the least

valuable sharks in the local fin market. We initially anticipated some variation between respondents and communities but this was not the case as fishers indicated that prices of shark fins differ marginally among fishers and communities. Fishers reported that the local shark fin market is characterized by small number of foreign merchants who operate across all three study communities and therefore offer virtually similar prices.

When asked about the details of buyers and factors that determine the price of shark fins, 67% of fishers recounted that they sold their fins to foreign merchants from Benin, Senegal, Guinea, and Mali. Two canoe owners stated that they sell their fins to a Nigerian and has done so for the past six to eight years. Only one fisher from Axim claimed to sell his fins to a Chinese merchant since 2019. He indicated that the Chinese merchant used to conduct his business at Apam in the Central Region of Ghana but has recently relocated to Axim as the fin trade is booming there. Most foreign buyers do not stay within these shark fisheries communities. They mostly stay at the outskirt of the various communities of, which canoe owners send their fins to them for sale. In certain circumstances, these foreign merchants go to the communities to buy the fins, especially where a canoe owner gets significant fins and is unable to transport to the buyer's station.

Many fishers also stated that in rare situations, Ghanaian middlemen travel from one fishing community to another to buy fins from canoe owners. The prices they offer are relatively low compared to that of the foreign nationals. Fishers mentioned that they prefer to sell their fins to foreign nationals as they have built long standing relationships with them and they offer them good prices. Most fishers (87%, n=13) reported that they mostly sell their fins from one to ten different buyers and have been doing so for over five to fifteen years now.

With the question of what the buyers do with the fins, 60% of fishers reported that they do not know who the buyers sell the fins to and/or what they do with it, and do not care to know because that is not their business. They stated that they were only interested in the money they receive from their sale and whatever the buyers do with their fins should not be their concern. Only three respondents stated that the buyers export the fins to China and other European countries and further said they are used for medications and as food in these countries.

Fishers reported that even though the prices are fixed some qualities are considered before the merchant buys the fins at that fixed price. For example, if the fins have not been properly sun-dried, the buyer will reduce the price on the fins. The dry weight and species type also affect the prices of fins. Fishers further recounted that seasons and level of demand for shark fins, especially in periods where there is scarcity of fins, affect the local market prices. Fishers were quick to add that scarcity of fins occur when there is shortage of premix fuel, which halts their fishing operations and in these periods if you get enough fins, you are likely to negotiate with the buyers for an increase in price. Further, ability of a buyer to finance fishing trips is also another factor reported to affect fins prices. Most foreign merchants sponsor the activities of shark fisheries by providing quick loans to canoe owners. The canoe owners pay back the loans after they get substantial shark catches, with the buyers paying a reduced price for the fins, as a form of deducting interest on the loans.

When queried about their satisfaction with the income they derived from the sale of fins, nine fishers stated that they are very satisfied or satisfied with the price and income they get from the sale of shark fins. These fishers recounted that the sale of shark fins gives them additional money to support their operations and stated that sharks are now increasingly becoming more lucrative than bony fish, as they get double income from the sale of fins and meat from sharks. Five fishers stated that they are dissatisfied with the price the buyers offer to them. Only one fisher reported that he is very disgruntled with the prices of fins as he feels the buyers are cheating them. He stated that he does not understand why for the past three years fin prices have not been increased, notwithstanding the increases in the price of fuel and the Ghana Cedis to the dollar exchange rate. He further stated that a merchant from Guinea once told him the prices of fins increases with the dollar exchange rate and sometimes with the fuel increment when he began selling fins, but later found that out not to be true.

3.7 Trade in shark meat

3.7.1 Trade data from landing sites survey

Large- to medium-sized sharks were finned, with the remainder auctioned in parts or whole, while smaller sharks were sold whole without finning in the study communities. The selling price of sharks was mostly based on their sizes (mostly, the precaudal length, after it has been

finned), as no mechanism was put in place to weigh the specimen in the various landing sites. After buying the specimen, traders would slice the meat into smaller pieces and then transport them to their various destinations. The prices at first sale of 713 specimens comprising nine shark species landed at the three study communities are documented in Table 5. Hammerhead sharks (*Sphyrna* spp) provided fishers with the highest mean price/length (cm), ranging from GH¢ 572/cm in Shama, to GH¢ 227.5/cm in Axim and GH¢ 216.7/cm in Dixcove. In Axim, Thresher sharks (*Alopias* spp) were the second highest valued species, averaging GH¢ 192.5/cm, followed by Mako sharks (*Isurus* spp) (GH¢ 175.7/cm) and Silky Shark (*Carcharhinus falciformis*) (GH¢ 176.4/cm). Conversely, Tiger Shark (*Galeocerdo cuvier*) (GH¢ 219.2/cm) was the second most valuable shark in Dixcove, followed by Bull Shark (*Carcharhinus leucas*) (GH¢ 147.5/cm), and Spinner Shark (*Carcharhinus brevipinna*) (GH¢ 105.0/cm). In Shama, Mako sharks (GH¢ 293.9/cm) exhibited the second highest mean price/cm, followed by Thresher sharks (GH¢ 200.0/cm), and Sand Tiger Shark (*Carcharias taurus*) (GH¢ 182.5/cm) (Table 5).

The prices of shark meat were further analyzed to investigate if there were any statistically significant differences in the price at first sale among the various study communities. There was a statistically significant difference in the mean price/cm of Blue Shark (*Prionace glauca*) (K= 44.31, p= 2.070 E-14), Silky Shark (*Carcharhinus falciformis*) (K= 7.12, p= 0.027), Spinner Shark (*Carcharhinus brevipinna*) (K= 6.13, p= 0.046) and Sand Tiger Shark (*Carcharias taurus*) (K= 9.64, p= 0.008) among the various communities (Table 5). Dixcove community differed significantly in the mean price/cm of Blue Shark in the Bonferroni pairwise comparison with Axim (p <0.001) and Shama (p= 2.011 E-12). Similarly, the mean price/cm of Silky Shark differed significantly in the pairwise comparison between Axim and Dixcove (P= 0.020); the price of Spinner Shark varied significantly between Shama and Axim (P= 0.026) as well as Dixcove (p= 0.056); while Sand Tiger Shark varied between Axim and Dixcove (P= 0.012) as well as Shama (p= 0.019).

3.7.2 Determinants of prices of shark meat

Generally, fishers reported that the price of shark meat is mostly dependent on the type of species and their sizes. Fishers stated that with equal sizes, Hammerhead Sharks (*Sphyrna* spp), Bull Shark (*Carcharhinus leucas*) and Mako sharks (*Isurus* spp) are the most valuable sharks,

while Thresher sharks (*Alopias* spp), Tiger Shark (*Galeocerdo cuvier*), and Blue Shark (*Prionace glauca*) are the least valuable in the local shark meat market. The level of demand and season were also other factors that affect the prices of shark meat. During traditional festive periods such as Kundum festival in Axim or Dixcove and Pra Nye-Eyi festival in Shama, fishers are mostly barred from going to the sea from one to two weeks and this affects the supply of shark meat in the local markets. Further, continuous shortages of premix fuel always halt the operations of fishers and thus, during these periods prices of shark meat are generally high for fishers who land sharks.

When asked about the changes in price of shark meat, most fishers and traders (62% of 85 respondents) indicated that they adjust prices of shark meat every time. Fishers confirmed that prices can either increase or decrease depending on their catch and the quantity a merchant buys from them. Only 29% of respondents stated that they change the prices of their meat every year or in season. Fishers also noted that the relationship with their buyers can affect the variations in price of their products. For instance, a trader noted that the prices of shark meat sold to local community members are less expensive than the prices they sell in other towns and regions in the country.

Most fishers sell their meat to two to five different merchants, with the highest bidder getting the product at the various landing sites. Only 31% of fishers sold their meat to a single merchant and in most cases such merchants happen to be their wives. In most cases, the wives provide a loan to support their husbands' fishing operations, which is repaid in kind by selling the meat directly to them. The merchant processed the meat in the form of smoking and salting and/or sun drying, which are sold in local markets as dried meat called "Kako". Most traders stated that they sell their meat to local consumers in their various communities and outside their communities, especially in Takoradi, the regional capital, or Kumasi in the Ashanti Region, Tema and Accra in the Greater Accra Region, and Sefwi in the Western North Region of Ghana. Only four merchants recounted selling frozen shark meat to foreign nationals, mostly Chinese and Togolese, and have been doing that for more than two years. However, the traders were not aware whether these foreign nationals export the meat to other countries.

3.8 Satisfaction level of fishing and income from shark meat

As a measure of fishers and traders wellbeing in the shark fisheries, they were asked to indicate their satisfaction in the income they derived from shark meat and their work as a whole. Over 60% of fishers indicated that they are dissatisfied or very dissatisfied with the income they get from selling their meat (Figure 7a), while over 90% of traders were satisfied or very satisfied with their income derived from shark fisheries (Figure 7b). Dissatisfied fishers gave emotive responses to show how disgruntled they are with the prices traders offer to them. Many stated that catching sharks are increasingly becoming difficult and their work is now demanding more finances, energy and time and these are usually not taken into account when traders are buying their meat. In addition, 75% and 95% of fishers and traders respectively are satisfied or very satisfied with their work in fishing and trading shark meat. Most respondents reported that fishing-related livelihood activities are the only job they have learned and also their last livelihood resort to fall on for now, and that they are left with no option but to be okay with it. A trader stated that she learned how to process and trade shark and other bony fish since her childhood and that was the only training her parents gave her; but she is satisfied with her work because it at least offers her an income to pay her children's school fees and house rent.

There was no difference in satisfaction with income derived from shark meat by educational level (X^2= 14.84, df= 9, p=0.095), ethnicity (X^2= 10.55, df= 6, p= 0.103) and age group (X^2 = 8.14, df= 15, p= 0.920). However, there was a significant effect of occupation on income satisfaction from shark meat (X^2 = 4.69, df= 3, p= 0.016), with traders exhibiting more satisfaction than fishers. Further, there were no significant differences in satisfaction with the work of fishing and trading fish between gender (X^2= 1.88, df= 3, p= 0.059), or among occupation (X^2= 2.19, df= 3, p= 0.053), educational level (X^2= 9.21, df= 9, p= 0.418), ethnicity (X^2= 5.67, df= 6, p= 0.461), and age group of respondents (X^2= 15.35, df= 15, p= 0.427).

4. Discussion

Our study is the first to characterize the livelihood strategies of shark fishers and traders and highlights the price dynamics of shark products in Ghana. Artisanal fishers in the study communities are considered to have marginal livelihood opportunities. Most shark fishers and traders depend solely on fisheries-related livelihood strategies, while few had other alternative livelihood activities even though they generate less income from them. This finding corroborates the study by Barrowclift et al. (2017) regarding shark fishers and merchants in Zanzibar, where fishing was reported to be the primary occupation and main income source, with few fishers relying on secondary livelihood streams. In Ghana, Aseidu and Nunoo (2013) report that between 80% to 98% of fishers in Small London, Kpong, Ahwiam and Elmina depend on fishing as their primary occupation and main source of income, while few (4-20%) had other marginal alternative livelihood options, including crop framing, livestock rearing, teaching, and trading in non-farm items. Generally, most available alternative income sources in the communities may entail unattractive returns on labor; a phenomenon that forces fishers and traders to expend almost all their time and energy on fishing-related strategies, which are deemed as lucrative in these communities. Fishers and traders from Axim enjoy greater access to crop farming than those in Dixcove and Shama, owing to differences in soil and rainfall patterns (see Table 1); a reason why crop farming was among the secondary livelihood options in Axim community. Soil in Axim is fertile and combined with the high rainfall pattern favors farming activities in this area, which is among the mainstay of the people of Axim (GSS, 2014). Small-scale businesses and artisanship like barbering, masonry, hair dressing, carpentry, and others were secondary income sources for some respondents in Axim and Shama, likely related to having high levels of industrial development, which provide an enabling environment for such livelihood opportunities. Axim and Shama are capital towns in their respective districts, which are characterized with high population densities and significant levels of infrastructure development, with both private and government work opportunities (GSS, 2014). Prior to the survey, it was therefore expected that the relative infrastructure development in these communities will instigate many fishers and traders to rely partially on salary work for their alternative income source. However, only one fisher from Shama was a government worker and was receiving a monthly salary. This is as a result of high illiteracy rates of many fishers and traders, which disqualify them from applying for opportunities in government or private work that entails

formal education. In contrast to this finding, teaching, and salary work were significant secondary income sources for fishers in other parts of Ghana (Asiedu & Nunoo, 2013).

Fishers and traders would mostly turn to non-fishing related livelihood activities, which include small business, transportation and artisanships as fallback livelihood options should there be a moratorium on shark fisheries. Restriction of fishers from shark fisheries may reduce fishing pressure, in the light of declining shark stocks (Ward-Paige et al., 2012). However, this study also revealed that a significant number of fishers would simply switch to target other marine fish resources. The other marine resources stated by fishers such as turtles, rays, anchovies, and cetaceans are already threatened with extinction globally and require measures to safeguard them. This indicates that fisher's co-depend on various marine resources in small-scale fisheries because of the ease of shifting to other species, especially in light of marginal economic returns or restrictions on fishing certain stock (Purcell et al., 2016). Thus, a holistic approach needs to be adopted to simultaneously manage artisanal fisheries to encompass all economically important stocks, which may experience reduced fishing pressure, even when other stocks are the main target.

Similar to expectations that subsistence consumption of shark meat is prevalent in developing countries (Bornatowski et al., 2013), we found consumption common among fishers and traders in the study communities. Generally, the regular consumption of shark meat among fishers and traders suggest that shark meat represents substantial sources of protein in the diets of the study communities and therefore over-exploitation of the shark stock may directly impact food security. In efforts to address food security, shark meat was promoted in the late 1950s as alternatives to augment the contemporaneous decline of bony fish, which has led to its wide utilization (Lehr, 2015). Currently, shark meat is widely traded and utilized as a cheap source of protein in many poorer communities in developing countries, including Ghana (Bornatowski et al., 2013). Many fishers and traders generated between 80-100% of their income from shark fisheries, with most of these fishers from Axim and Dixcove. Shark fisheries are increasingly representing a key source of employment and providing major income for fishers in these communities. The high monetary incentive is the major driver of proliferation in shark exploitation in Ghana, as fishers are getting double their usual income in the form of sale of shark fins and meat. In agreement with these findings, Borrowclift et al. (2017) reported that

most of fishers in Zanzibar that caught and sold elasmobranchs generated between 41-60% of their income from sharks, and 31% of merchants also got 61-80% of their income from selling elasmobranchs. In Ghana, Gelber (2018) found that the shark fin trade is the main income source for 80% of middlemen and 38% of canoe owners of the study population.

The fin prices of commercial shark species were found to be high between 2005-2010; the period where fishers reported that they experienced a dramatic decline in the catch of sharks and other large pelagic species. The decline in shark catch may have resulted in the high prices of fins, as demand might have been high in this period. Fishers started noticing a significant drop in fin prices in 2011, and the prices continuously remained lower till the end of 2013. According to fishers, during these years, there was an embargo on the trade in shark fins in Ghana, and merchants from neighboring West African countries migrated to their home countries. Several Ghanaian middlemen in these communities started buying and hoarding fins at very cheap prices during these periods. The moratorium on the trade on shark fins was thought to have occurred due to a number of reasons, including an investigation into the increasing cases of narcotics there were smuggled in fin cargo, of which the government of Ghana was concerned about. Some canoe owners also related the ban on trade of shark fins to health issues, stating that there was spread of diseases owing to consumption of shark fins and this resulted in the ban on its exportation to China and other European countries. In 2014/2015, the fin trade ban was lifted and buyers started trading in shark fins and the prices increased exponentially as more buyers from neighboring West African countries moved into these communities to buy shark fins. In these periods, the demand for shark meat and fins was high but most fishing operations halted owing to long, incessant shortages of premix fuel. Only a few fishers were able to embark on long fishing trips to catch sharks and these fishers got high prices for their fins. The prices of fins have since been increasing marginally from 2015 till 2017, and since 2018 the prices have virtually remained stable.

The prices of shark fins were reported to vary among species. For example, the fins of Hammerhead sharks (*Sphyrna* spp) and Bull Shark (*Carcharhinus leucas*) were reported to be of high quality and therefore priced higher, while Tiger Shark (*Galeocerdo cuvier*) and Thresher sharks (*Alopias* spp) were the least valuable species in the study communities. Similar to our findings, Hammerhead sharks and Blue Shark ((*Prionace glauca*) lower caudal fins and the fins

of Shortfin Mako (*Isurus oxyrinchus*) have been cited to possess the best quality fin needles for human consumption by traders and regarded as among the most valuable fins in the international market (Clarke et al., 2007). Several factors influence the commercial value of shark fins globally, which include fin needles, type of fin (dorsal or caudal), the general appearance (thickness, color, length, and needle texture) and the species type (Clarke et al., 2007; Vannuccini, 1999) of, which the latter is mostly known and used by fishers and merchants during fin trading in the study communities. Other factors reported by fishers as having an influence on the price of shark fins were dry weight, demand, and season. Though these factors were not statistically analyzed and inference on the prices was beyond the scope of this study, the data reported by fishers demonstrates the importance of fishers' knowledge in understanding the complex drivers influencing their fishing business and operations. Further, the variation in prices of meat of Blue Shark, Silky Shark (*Carcharhinus falciformis*), Spinner Shark (*Carcharhinus brevipinna*), and Sand Tiger Shark (*Carcharias taurus*) among the study communities may be attributed to the size differences of the specimen landed and sold. Sizes of shark species is an important factor that affects the prices of specimen, as larger specimens are given priority and priced higher. The mean size of Spinner Shark and Blue Shark were smaller in Dixcove while the mean size of Silky Shark and Tiger Shark (*Galeocerdo cuvier*) were larger in Axim and Shama respectively, hence the variation in price among the communities (see Table 4). Additionally, the 'quality' of the meat for consumption was reported to vary among species and therefore to influence the price of sharks as well. For example, species such as Mako sharks (*Isurus* spp), Thresher sharks (*Alopias* spp), and Hammerhead sharks (*Sphyrna* spp) are considered high quality and priced high by fishers and traders, which concurs with the international shark meat market (Hanfee, 2001; Lehr, 2015; Rose, 1996). Other interacting factors such as level of demand and season are also noted by fishers and traders to cause variation in shark prices in the study communities.

Fishing marine resources contribute significantly to the degradation of the world's marine ecosystems and fishing pressure could possibly be reduced if primary actors, especially fishers in the industry, are induced to move out (Bavinck et al., 2012). Whether fishers may be inclined to do so or not, mainly depends partially on their wellbeing or satisfaction on their job and the profitability of their fallback options. Comparative studies have thrown light on the level of fishers' satisfaction on their professions. For example, Ruiz (2012) found that fishing is

satisfying as an occupation, yet fishers can be dissatisfied about their earnings. Similar to our findings, most fishers and traders were satisfied or very satisfied with their occupations. However, more than half of fishers were dissatisfied with the income they earned from shark fisheries because they expected a standard price for shark specimens but are mostly offered lower prices by traders. Fishers mostly compare their cost, time, and energy they expend on catching sharks and expect the prices to be higher than what they are offered by traders. The satisfaction of these primary actors in the shark fisheries industry is linked to the inadequate livelihood opportunities for fishers and traders in the study communities in, which they are invariably forced to stay and accept their occupation. Most fishers may wish to switch job but the opportunities available are narrowed and most of them are not favorable to them owing to their training and level of education. The wellbeing of fishers, including their level of satisfaction, is advocated as an important consideration for development policy (Hair et al., 2016; Koczberski et al., 2006) and further offers more holistic means of assessing the social impacts of change in fisheries (Coulthard, 2012). Additionally, an insight of job satisfaction among the fishers and traders will support in developing management strategies that can offer required alternative work for these actors displaced by interventions for reductions in effort (Bavinck et al., 2012).

5. Conclusions and recommendations

Our study revealed that fishers and traders in shark fisheries in Western Ghana have marginal livelihood opportunities, with most respondents depending solely on fishing-related activities as their primary source of income. Secondly, shark fisheries contribute a significant income to these fishing communities, and shark meat is regularly used in the diet of both fishers and traders. Thirdly, non-marine fishing-related occupations, which include small business, transportation and artisanship, were the major fallback livelihood options both fishers and traders preferred to rely on if they are restricted from shark fisheries, but they require funding and adequate skills for their implementation. Fourthly, prices of shark fins reduced significantly between 2011 and 2013, but sharply increased in 2014/2015. The price of fins steadily increased until 2018, and has remained virtually stable till 2020. Hammerhead sharks (*Sphyrna* spp) have the most valuable fins and meat in the study communities. Fifth, over half of fishers were disgruntled with the income they get from selling shark meat, while most traders were satisfied with their income

from sharks. Finally, most fishers and traders see fishing and trading of shark meat as their last safety-net and therefore tend to be satisfied with their jobs.

Inadequate alternative economic activities for fishers and traders of sharks may impede any management interventions to mitigate the impacts of their activities on the stock of sharks. Thus, any management strategy on the shark stock must take into consideration the various fallback livelihood streams outlined by fishers and traders. Failing to provide such incentives could result in opposition from fishers against any management intervention.

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Tables

Table 1. Characteristics of the study communities

Community	District Assembly	Mainstay	Population	Number of canoes	Dominant ethnic group
Axim	Nzema East Municipal	Fishing and farming	27,719	220	Nzema and Fante
Dixcove	Ahanta West	Fishing, farming, and petty trading	30,000	201	Ahanta
Shama	Shama District	Fishing, petty trading	23,699	265	Fante

Source population data: Ghana Statistical Service (2014). Source of mainstay data: CRC (2010)

Table 2. Socioeconomic characteristics of respondents

Socioeconomic characteristics	Axim (*n*= 23)	Dixcove (*n*= 22)	Shama (*n*=40)	Total (*n*= 85)	*p*-value
Household size (mean)	3.78 (1.09)	3.73 (1.12)	3.40 (1.41)	3.59 (1.26)	0.478
No. of dependent household members (mean)	3.04 (1.30)	2.73 (1.16)	2.70 (1.32)	2.80 (1.27)	0.963
Age of respondents					0.377
17 – 24	1	0	1	2 (2%)	
25 – 35	3	6	7	16 (19%)	
36 – 45	12	11	12	35 (41%)	
46 – 55	6	2	10	18 (21%)	
56 – 65	1	2	6	9 (11%)	
66 – 75	0	1	4	5 (6%)	
Occupation					0.020
Fishery	19 (22%)	10 (12%)	29 (34%)	58 (68%)	
Trading	4 (5%)	12 (14%)	11 (13%)	27 (32%)	
Education level					0.033
Illiterate	9	19	22	50 (59%)	
Junior school	10	1	13	24 (28%)	
Senior High	4	1	4	9 (11%)	
Tertiary	0	1	1	2 (2%)	
Ethnic groups					0.000
Ahanta	0	6 (7%)	0	6 (7%)	
Fante	15 (18%)	14 (16%)	40 (47%)	69 (81%)	
Nzima	8 (9%)	2 (2%)	0	10 (12%)	

1. Percentage sign (%) represents percentage of total respondents for each socio-economic variable; 2. Standard deviation in parenthesis without percentage sign (%); 3. Chi-square test for all statistical tests

Table 3. Mean income from livelihood strategies of respondents in the study communities

Livelihood strategies	Average income	Share of income sources (%) Axim	Dixcove	Shama	*P*- value
Livestock farming	0.6	0.0	0.9	0.8	0.272
Poultry farming	0.2	0.0	0.0	0.5	0.566
Crop farming	2.3	3.5	3.2	0.3	0.355
Aquaculture	0.4	0.0	0.0	1.3	0.680
Salary work	0.4	0.0	0.0	1.3	0.566
Rural transportation	0.2	0.0	0.0	0.7	0.680
Barbering, carpentry, and other artisanship	4.1	6.9	0.2	5.0	0.581
Small businesses	2.5	3.5	1.6	2.5	0.744
Fishing	58.5	72.2	46.4	57.0	0.072
Fish processing	16.0	7.3	29.5	11.2	0.011
Fish retailing	13.3	6.2	17.7	16.0	0.307
Net weaving and repairing	1.4	0.4	0.5	3.4	0.781

1. Chi-square test for all statistical tests

Table 4. Average prices per dry kilogram of fins paid to canoe owners in the study communities

Shark species			Average prices per period (GH¢)			
Common name	Scientific Name	Local name	2005-2010	2011-2013	2014-2015	2018-2020
Blue Shark	*Prionace glauca*	Gogorow	70	17	120	130
Mako Sharks	*Isurus* spp	Edu	120	80	200	285
Thresher Sharks	*Alopias* spp	Polley	32	10	55	70
Hammerhead Sharks	*Sphyrna* spp	Anto	156	65	300	330
Bull Shark	*Carcharhinus leucas*	Esuoa	113	78	300	345
Tiger Shark	*Galeocerdo cuvier*	Epoagyina moah	48	21	63	100
Sand Tiger Shark	*Carcharias taurus*	Ewiabere	98	55	120	240
Milk Shark	*Rhizoprionodon acutus*	Semin	117	40	241	313

Note: as of the time of data collection, USD 1 was equivalent to GH¢ 5.77

Table 5. Mean precaudal length (cm) and price (GH¢/cm) of nine shark species recorded in the three study communities in Western Ghana between 15 March and 11 June 2020

Shark species		Mean length per community (cm)			Mean price per community (GH¢/cm)			
Common name	Scientific name	Axim	Dixcove	Shama	Axim	Dixcove	Shama	*P* value
Blue Shark	*Prionace glauca*	174.4 (58)	167.4 (46)	176.6 (120)	115.1 (150)	148.2 (54)	106.2 (144)	2.066 E-10
Silky Shark	*Carcharhinus falciformis*	157.8 (6)	129.6 (7)	147.0 (6)	176.4 (7)	61.3 (8)	96.0 (5)	0.027
Mako sharks	*Isurus* spp	154.4 (27)	132.0 (10)	173.3 (14)	175.7 (30)	139.6 (11)	293.9 (18)	0.059
Hammerhead sharks	*Sphyrna* spp	161.0 (8)	179.5 (4)	213.8 (5)	227.5 (6)	216.7 (6)	572.0 (5)	0.126
Tiger Shark	*Galeocerdo cuvier*	155.0 (3)	173.0 (4)	211 (4)	147.7 (7)	219.2 (9)	280.0 (7)	0.172
Thresher sharks	*Alopias superciliosus*	170.0 (11)	192.7 (6)	228.6 (7)	192.5 (12)	138.8 (8)	200.0 (10)	0.538
Bull Shark	*Carcharhinus leucas*	143.9 (7)	130.8 (6)	106.7 (3)	136.0 (5)	147.5 (10)	179.2 (6)	0.562
Spinner Shark	*Carcharhinus brevipinna*	152.0 (9)	115.3 (8)	159.8 (5)	51.8 (11)	105.0 (10)	108.0 (5)	0.046
Sand Tiger Shark	*Carcharias taurus*	156.2 (5)	158.3 (4)	136.8 (4)	56.0 (3)	121.0 (5)	182.5 (7)	0.008

Note: 1. The number of specimens used to calculate mean values is reported in parentheses. 2. As of the time of data collection, USD 1 was equivalent to GH¢ 5.7

Figures legend

Figure 1. Analytical framework of sustainable livelihoods. Adapted from DFID, (2000), Ellis (2000) and Scoones (1998, 2015)

Figure 2. Map of Western Ghana showing the three study communities

Figure 3. Income generated from shark fisheries in the study communities of Axim (*n*= 23), Dixcove (*n*= 22), and Shama (*n*= 40)

Figure 4. Frequency of subsistence consumption of sharks by fishers and traders. Stacked bars represent the consumption of sharks of the study communities in Axim (*n*= 23), Dixcove (*n*= 22), and Shama (*n*= 40)

Figure 5. Preferred livelihood fallback options of fishers and traders if they could no longer harvest and sell sharks

Figure 6. Trends in the prices for a kilogram of fins for eight shark species

Figure 7. Fishers' and traders' satisfaction with income derived from fishing and selling shark meat

Figure 1

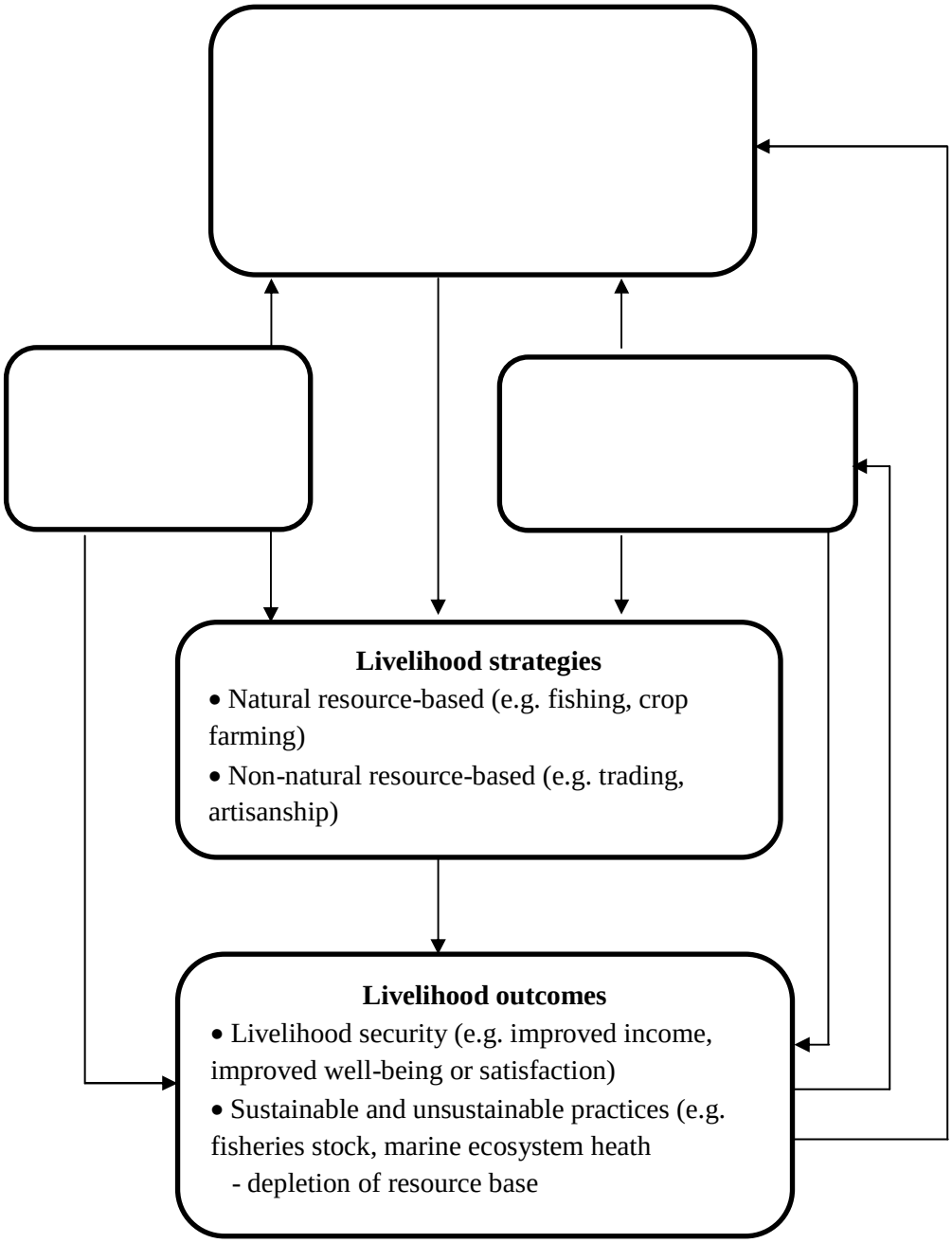

Livelihood strategies
• Natural resource-based (e.g. fishing, crop farming)
• Non-natural resource-based (e.g. trading, artisanship)
Livelihood outcomes
• Livelihood security (e.g. improved income, improved well-being or satisfaction)
• Sustainable and unsustainable practices (e.g. fisheries stock, marine ecosystem heath
- depletion of resource base

Figure 2

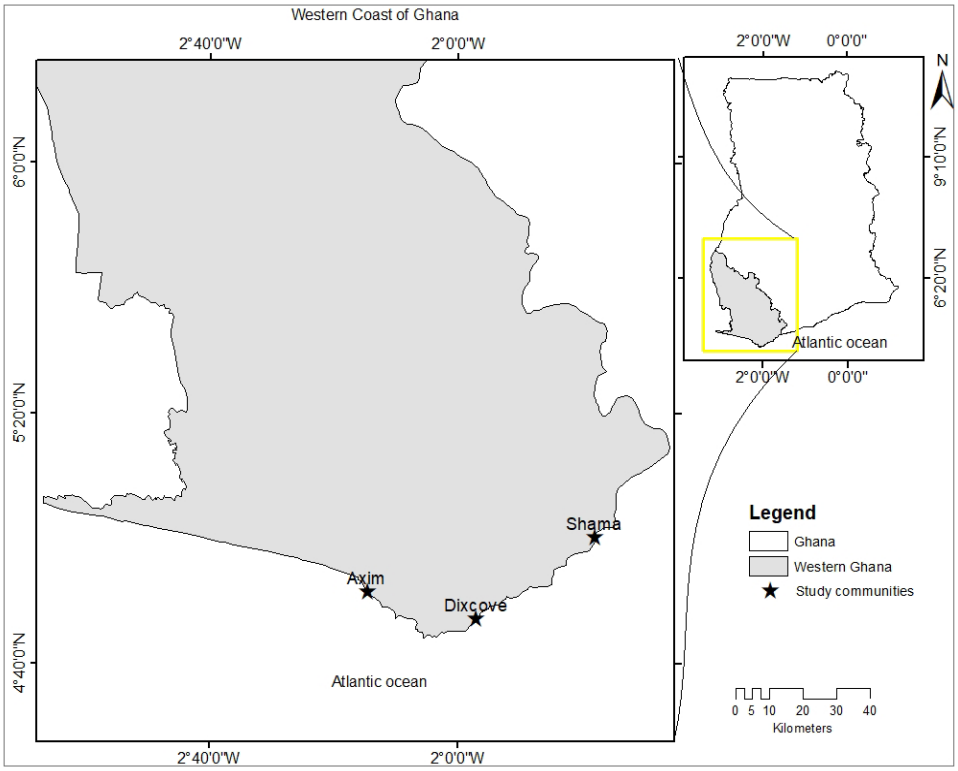

Western Coast of Ghana
2°40'0"W
2°0'0"W
6°0'0"N
5°20'0"N
4°40'0"N
Shama
Axim
Dixcove
Atlantic ocean
2°0'0"W
0°0'0"
N
9°10'0"N
6°20'0"N
Atlantic ocean
Legend
Ghana
Western Ghana
Study communities
0 5 10 20 30 40
Kilometers

Figure 3

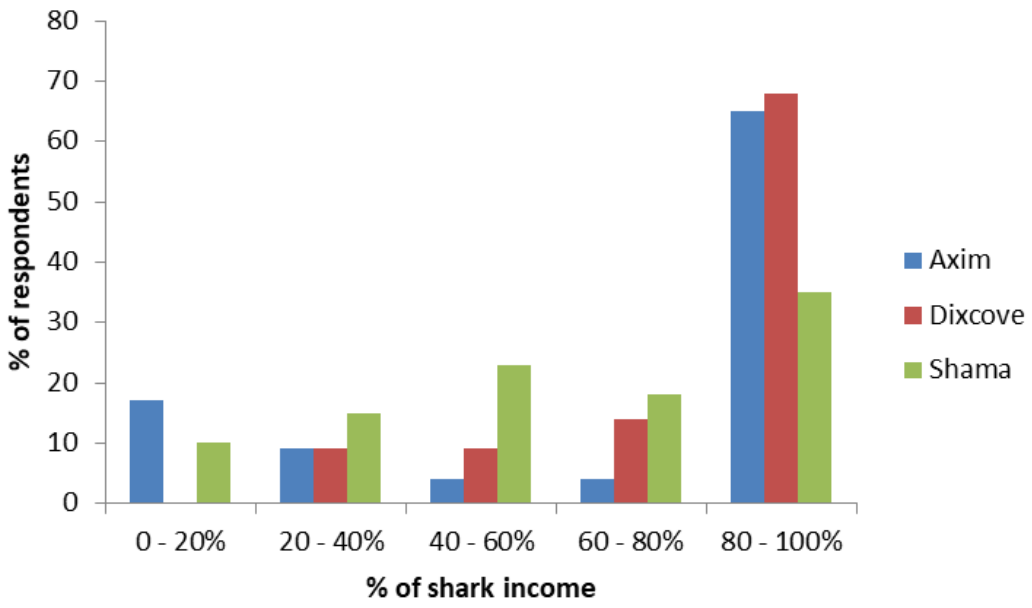

80
70
60
50
40
30
20
10
0
% of respondents
0 - 20%
20 - 40%
40 - 60%
60 - 80%
80 - 100%
% of shark income
Axim
Dixcove
Shama

Figure 4

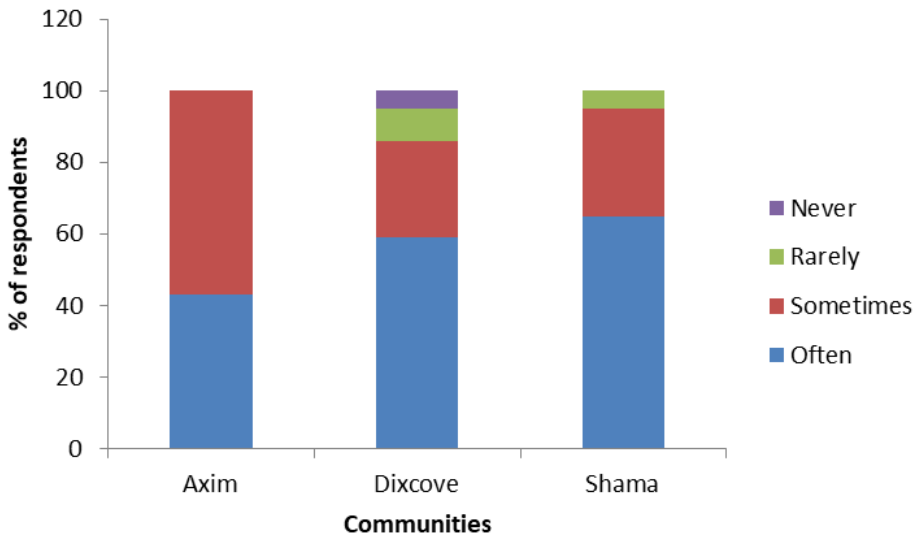

120
100
80
60
40
20
0
% of respondents
Axim
Dixcove
Shama
Communities
Never
Rarely
Sometimes
Often

Figure 5

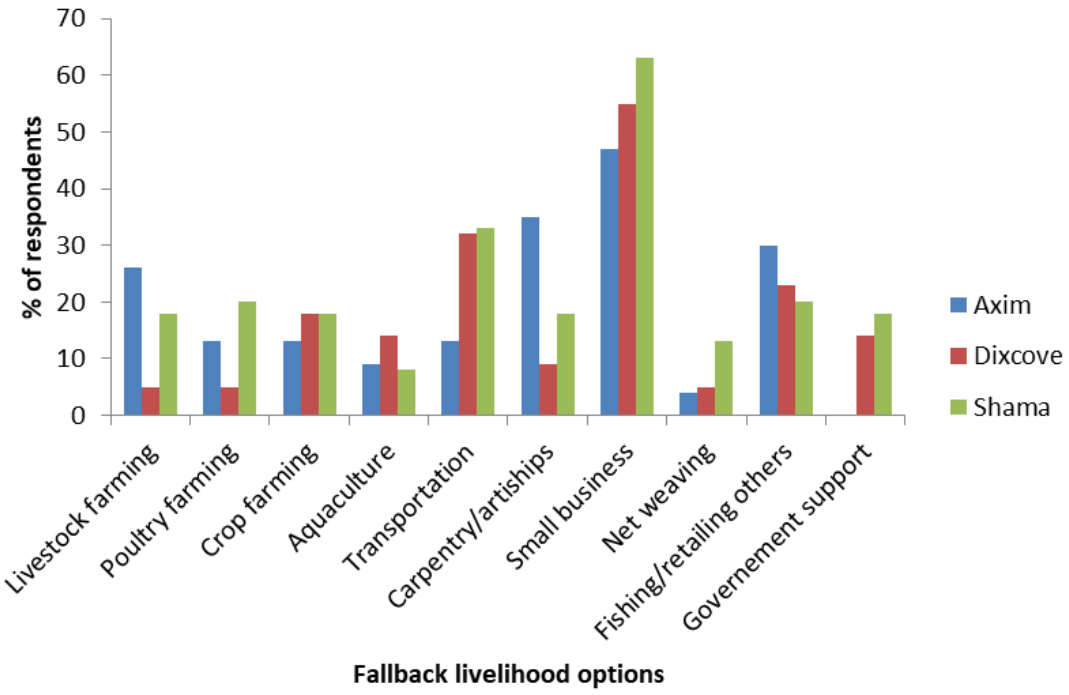

70
60
50
40
30
20
10
0
% of respondents
Livestock farming
Poultry farming
Crop farming
Aquaculture
Transportation
Carpentry/artisships
Small business
Net weaving
Fishing/retailing others
Governement support
Fallback livelihood options
Axim
Dixcove
Shama

Figure 6

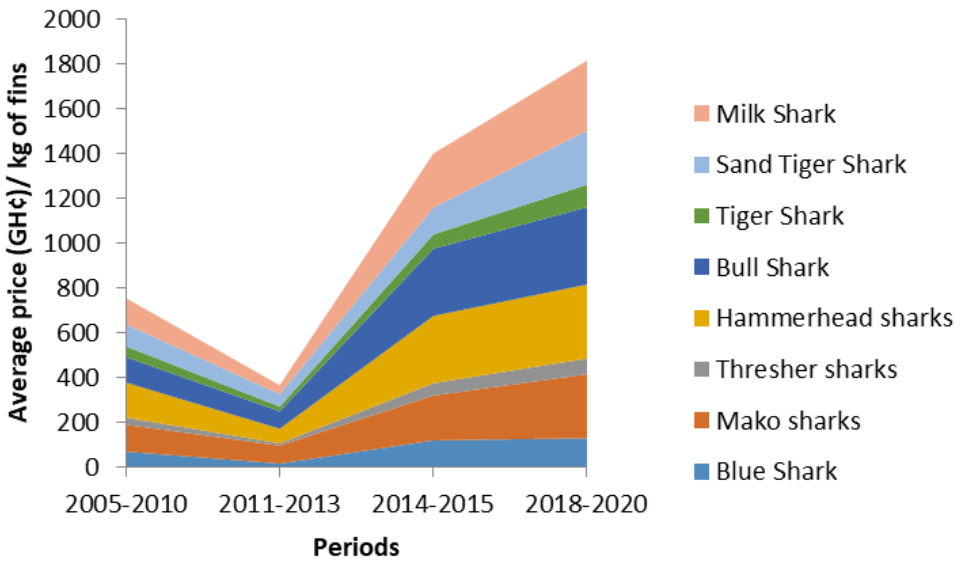
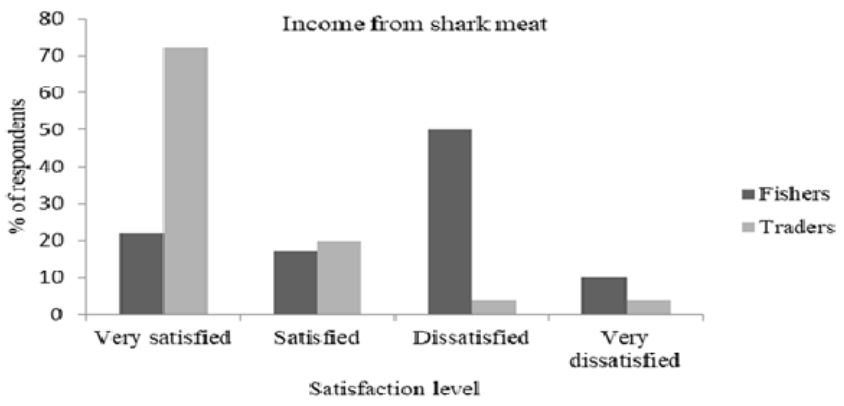
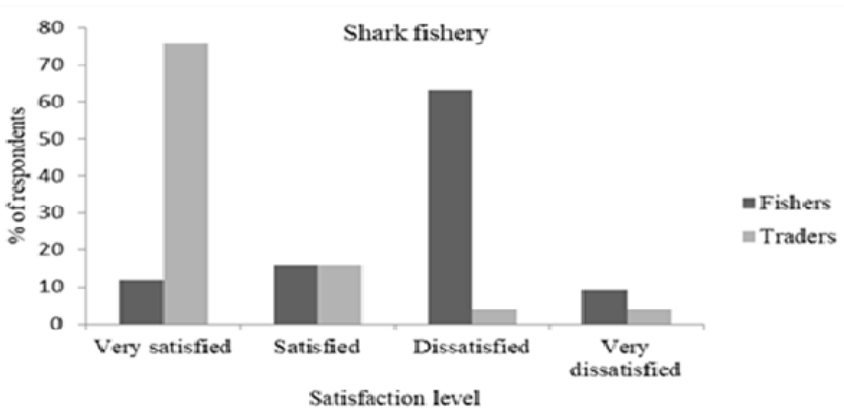

2000
1800
1600
1400
1200
1000
800
600
400
200
0
Average price (GH¢)/ kg of fins
2005-2010
2011-2013
2014-2015
2018-2020
Periods
Milk Shark
Sand Tiger Shark
Tiger Shark
Bull Shark
Hammerhead sharks
Thresher sharks
Mako sharks
Blue Shark

Figure 7

a


Income from shark meat
% of respondents
80
70
60
50
40
30
20
10
0
Very satisfied
Satisfied
Dissatisfied
Very dissatisfied
Satisfaction level
Fishers
Traders

b


Shark fishery
% of respondents
80
70
60
50
40
30
20
10
0
Very satisfied
Satisfied
Dissatisfied
Very dissatisfied
Satisfaction level
Fishers
Traders