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

Issah Seidu[a, d*]; Lawrence K. Brobbey[b]; Emmanuel Danquah[a]; Samuel K. Oppong[a]; David van Beuningen[c]; Moro Seidu[d] and Nicholas K. Dulvy[e]

[a] *Department of Wildlife and Range Management, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana*

[b] *Department of Silviculture and Forest Management, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana*

[c] *Western Indian Ocean Shark and Ray Conservation Program, Wildlife Conservation Society, New York*

[d] *AquaLife Conservancy, P.O. Box SN 228. Santasi-Kumasi*

[e] *Department of Biological Sciences, Simon Fraser University, Burnaby, BC, Canada V5A 1S6*

*Corresponding author

Issah Seidu

Department of Wildlife and Range Management

Kwame Nkrumah University of Science and Technology

PMB, Kumasi – Ghana

+233244415575

antwiseidu88@gmail.com

Abstract

Small-scale shark fisheries support the livelihoods of a large number of coastal communities 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, and fins 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 58.5% of the total household income of respondents. Other important economic activities were fish processing (16.0%), fish retailing (13.3%), and small businesses (2.5%). One-third and often two-thirds of respondents generated between 80-100% of their income from shark fisheries: Axim (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. 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. Overexploitation of these species will compromise food ecosystem functionality and security. Thus, any shark management strategy needs to urgently restraint mortality to sustainable levels, which, in the short-term, must take into consideration the preferred livelihood fallback options outlined by fishers and traders, and implement them to ensure the long-term benefits 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 fishery sector directly or indirectly employs 2.6 million people, comprising 10% of the total population (Nunoo et al., 2015). The fishery 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 (MoFAD, 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 fishing 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, which results in low population growth rates (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; Gelber, 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, Barrowclift 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 (Gelber, 2018). Although these studies provide initial data on trade in shark fins (Gelber, 2018) and meat as well as livelihood strategies of fishers (Barrowclift 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 (*Negaprion 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

142 fishing bans are some of the fisheries management strategies that have been implemented to slow
143 and reverse the effect of large-scale overfishing on shark populations (Ward-Paige et al., 2012).
144 However, implementation of these measures has the potential to adversely impact regions with
145 significant shark fisheries and stakeholders who directly depend on shark and other marine
146 resources for their livelihoods. Thus, exploring potential effects of fishing bans or closures on
147 fishers' behavior, especially fallback livelihood options they prefer to rely on, is not only
148 important to ensure the welfare of fishing communities, but also to increase the chance of
149 success of shark protection if management authorities are to implement such measures to
150 mitigate shark decline in Ghana.

151 Ghana is among the major artisanal fishing nations, with long history of catching sharks since
152 1700s (Jorian, 1988). Since the late 1950s, shark landings have been increasingly erratic in
153 Ghana, peaking in 1975 with 11,478 tons (FAO, 2017). In the last decade, the total reported
154 shark catches fluctuated considerably. The catch peaked up to 10,000 tons in 2013 and dropped
155 to 8,152 tons in 2015 (FAO, 2020). Since 2015, however, the catch estimate trends indicate a
156 sharp decline in shark landings (FAO, 2020). The decline in shark catch corroborates a recent
157 study on Local Ecological Knowledge of fishers that indicates a remarkable decline in shark
158 catches since the 2010s, suggesting that sharks are overexploited in Ghanaian waters (Seidu et
159 al., in review).

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

171 shark fisheries is necessary for planning management interventions for the sustainable utilization
172 of sharks.

173

174 **2. Methodology**

175 We first described the analytical framework for the study. Second, we described the socio-
176 economics, geography and historical catch trends of sharks in Ghana as well as the study areas
177 for the study. Third, we described the data collection methods and finally, we detailed our data
178 analysis methods.

179

180 **2.1 Analytical framework**

181 The analytical framework of the study was based on the Sustainable Livelihood Approach (SLA)
182 (Figure 1). The SLA is founded on the premise that people require a range of strengths (here
183 called "capitals") to achieve positive livelihood outcomes (DFID, 2000; Ellis, 2000; Scoones,
184 1998). At the heart of the framework is the livelihood strategy, made up of natural resource-
185 based (e.g., fishing, collection of aquatic resources, livestock farming) and non-natural resource-
186 based (e.g., trading, artisanship, services) livelihoods in rural settings. The SLA identifies five
187 types of capitals upon which the choice of a household to pursue a particular livelihood strategy
188 is built, namely, natural, human, social, financial, and physical capital. Mediating institutions
189 (e.g., policies, customs, taboos, and rules) determine access to various capitals and the choice of
190 households to build a particular livelihood strategy. Mediating institutions further have direct
191 influence on livelihood outcomes (e.g., whether fishers are able to achieve a feeling of inclusion
192 and well-being) (DFID, 2000). The livelihood outcomes in turn have influence on these
193 mediating institutions. External factors such as seasonality, critical trends, and shocks over
194 which people have limited or no control, have influence on the wider availability of capitals and
195 livelihoods of households (both livelihood strategy and outcome). Livelihood strategies
196 undertaken by fishers may result in improved income levels, increased well-being, satisfaction,
197 or sustainable use of fishery resources (livelihood outcomes). For instance, fishers may improve
198 their income through diversifying their livelihood strategies, which will invariably reduce
199 pressure on fishery resources resulting in sustainable use of the resources. Finally, the resulting

200 livelihood outcome of fishers' households invariably influences their capital through investment
201 in education of household members or financial savings.

202 Information presented in this study mostly emphasizes the livelihood strategies and livelihood
203 outcomes (income level and wellbeing) of the SLA analytical framework as highlighted in
204 Figure 1. Other components of the framework including livelihood capitals, vulnerability, and
205 mediating institutions have been addressed in our previous papers (Seidu et al., submitted).

206

207 **2.2 Study Area**

208 Ghana is a Western African nation bordered by the Burkina Faso to the north, Republic of Côte
209 d'Ivoire (Ivory Coast) to the west, the Togolese Republic (Togo) to the east, and the Gulf of
210 Guinea to the south. Ghana lies along the Gulf of Guinea (30 5´ W and 1010´ E and 40 35´N and
211 110 N) and has an area of about 239,000 km^2. Ghana's coastline is approximately 550 km long
212 with about 90 lagoons and associated wetlands. The coastal zone covers 6.5% of land area but is
213 inhabited by a quarter of the population (deGraft-Johnson et al., 2010) and is split into three
214 geomorphic units. The West Coast extends from the Ghana-Côte d'Ivoire border to the Ankobra
215 River estuary. The Central Coast from the Ankobra estuary to Tema has rocky headlands and
216 sandbars enclosing coastal lagoons. The East Coast stretches from Tema to the Ghana-Togo
217 border where the shoreline is sandy; this area is characterized by considerable erosion.
218 Generally, the marine resources of Ghana encompass over 347 fish species, belonging to 82
219 taxonomic families (deGraft-Johnson et al., 2010).

220 The study was conducted in three coastal communities in the Western Region, along the West
221 Coast, namely, Axim, Dixcove, and Shama (Figure 2, Table 1), which are the hotspots of shark
222 fisheries in Ghana. The communities were chosen based on three major reasons – that is, fishing
223 is exclusive to artisanal fishers; sharks form a significant catch and characterized with local shark
224 fin trade; and fishers were willing to cooperate with the researchers for both landing and
225 interview data. The Axim, Dixcove, and Shama communities fall within the Nzema East
226 Municipality, Ahanta West, and Shama Districts respectively. –Axim community, with a mean
227 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 a mean annual rainfall 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 ask them to comment on how shark fishery affects their livelihood strategies 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 (the person in charge of fish landing stations) and their elders (people who support chief fishers in deliberation and decisions taking at a particular fishing landing station) 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 the 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% (categorized as; 0–20, 21–40, 41–60, 61–80, 81–100). Subsistence consumption of shark products were recorded and categorized as often (i.e., once or more per week); sometimes (once per month); rarely (once or only a few times per year); and never (never at all). As a measure of fishers and traders 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 (people who own canoe vessels) in their respective canoe business (Gelber, 2018; I. 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 method, also known as referral or chain sampling, is used when potential participants are difficult to find (Newing, 2010). In this sampling scheme, 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 state the average price of eight commercially important and well-known shark species in their communities over a 15-year period. To facilitate the interview, four 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) 2018-2020, 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 were collected during daylight hours at the three communities from March to June 2020. We recorded the species, size in cm (especially the precaudal length, as fins were often removed from the specimen), and the sale price of each specimen in Ghana Cedis (USD 1= GH¢ 5.77). When possible, we stood close by 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 n = 95; Shama n = 168). Sale prices were recorded for 713 specimens (Axim, n = 395; Dixcove n = 111; Shama n = 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 MS Excel spreadsheet and further presented in tables and figures.

The selling prices of sharks were mostly based on their sizes (primarily the precaudal length, after the fins had been removed), 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 2). Many of the respondents (n = 35) were between the ages of 36-45 years. Most respondents (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. The range of occupations of respondents also varies significantly among the study communities.

3.2. Fishing practices

All the study sites have both a multi-gear and multi-canoe fishery. The gears used by fishers are dependent on the size of canoe, fishing grounds (i.e., oceanic or coastal) and in many instances the finances of the canoe owners. The gear types predominantly used in these communities

include longlines, handlines and trolling lines, purse seine nets, ring nets, drift gillnets, and bottomset gillnets. Sharks and rays are caught with two major gear types; drift gillnets complemented with longlines and bottom-set gillnets respectively. Baited hooks ranging from 110 to 250 are deployed as secondary longline gears, which are set alongside the drift gillnet in the same fishing grounds. These types of fishing gears are now widely used in the Axim, Dixcove and Shama communities and are used to target sharks and other pelagic species. Wooden canoes are the only vessels used by artisanal fishers in Ghana. Artisanal elasmobranch fishers use three types of canoe; large, medium and small (Table 3). Details of the fishing operations of the various types of canoe mostly used in the fishing communities and Ghana have been provided in table 3.

3.3 Reviews of Institutional frameworks on fishing and shark fishery in Ghana

Ghana has ratified a number of international and regional wildlife and fisheries frameworks that are relevant for the conservation of wildlife and fisheries resources. Regulations that apply to Ghana's marine megafauna are limited to dolphins and sea turtles. Regulatory action in Ghana is complicated by the socio-economic vulnerability of coastal fishing communities. However, the country has demonstrated its commitment to sustainable fishing as party to the 1982 United Nations Convention on the Law of the Sea (UNCLOS), the International Commission for the Conservation of Atlantic Tuna (ICCAT) and the Ministerial Conference on Fisheries Cooperation among African States Bordering the Atlantic Ocean (ATLAFCO). Ghana, as a member of the World Trade Organization (WTO), is subjected to the regulations governing fish trade and a signatory to a number of multilateral environment agreements including the 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES); the 1979 Convention on Migratory Species of Wild Animals (CMS) and the CMS Memorandum of Understanding on the Conservation of Migratory Sharks; and the 1992 Convention on Biological Diversity (CBD). Ghana is also a member of the Fisheries Committee for the West Central Gulf of Guinea (FCWCGG). The FWCGG is the regional body mandated to work towards a regional collaboration on management of the shared stocks and the regional integration of the national fisheries policies. Though the 1999 Food and Agricultural Organization International Plan of Action for the Conservation and Management of Sharks (IPOA-Sharks) is a voluntary and non-

binding legal instrument, it was adopted to ensure the long term sustainable use of sharks by embracing the precautionary approach and calls upon maritime states to develop their tailored National Plan of Action for the Conservation and Management of Sharks (NPOA-Sharks). However, Ghana is yet to develop its own NPOA-Sharks.

Shark fisheries are not strictly regulated in Ghana. At the national level, the management of Ghanaian fisheries fall under the ambit of the Ministry of Fisheries and Aquaculture Development (MoFAD), which in turn delegates functions, including implementation, to a semi-autonomous body; the Fisheries Commission (FC). The FC was established under the Fisheries Commission Act of 2002 (Act, 625). The FC uses the Fisheries Regulation (L.I. 1968) and the Fisheries Law (PNDCL 256, 1991) to regulate the fishery sector in Ghana.

The Fisheries Act, 2002 (Act 625) is the main regulation of the fisheries sector of Ghana, which application is intended through the Fisheries Regulation, 2010 (L.1. 1968). The Act consolidates all the foregoing laws on fisheries, Decrees, Laws, Legislative instruments and other subsidiary/ subordinate legislation on the fisheries sector that are still in force. The Acts sets out to integrate international agreements into the country's national legislation. It sets out provisions for the regulation and management of fisheries, the development of the fishing industry, and the sustainable exploitation of fishery resources. Details of the laws and regulations relating to the management of fishery activities in Ghana are listed in Table 4.

Further, notwithstanding national law, fisheries activities are also under the responsibilities of traditional, customary authorities, like chief fishers and local fishing councils, who manage local fisheries and mediate conflict among fishers. The chief fishers and elders have their rules, taboos and norms, which support the regulation of fishing activities. Such taboos include prohibition of fishing on Tuesdays and the taboo on the catch and trade of whale sharks *Rhincodon typus* in some communities in Western Ghana.

3.4 Livelihood strategies

Fishing was the primary source of income and accounted for 58.5% of the total income of respondents (Table 5). Fish processing (16.0%) was the second most important livelihood strategy, followed by fish retailing (13.3%) and small businesses (2.5%). 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 5). In Axim and Dixcove, fish processing was the second most important livelihood activity after fishing. In contrast, fish retailing was the second most important source of 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.

3.5 Income from shark fisheries

Many fishers and traders generated between 80-100% of their income from shark fisheries. Most of the respondents in Axim (65% of 23 respondents) and Dixcove (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.

3.6 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 sharks (*Carcharhinus leucas*) and Hammerhead sharks (*Sphyrna* spp) were favored for consumption but other available species were also often eaten, including 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, 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).

3.7 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, mentioned some 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 (transport business own by the state) 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)

464 also reported that they need to acquire the skills and technical know-how before they can kick-
465 start their preferred livelihood options. However, five fishers who recounted having enough
466 capital to start farming were increasingly concerned about the general unsuitable environment
467 characterizing the sale of farm products and were afraid to lose their capital when they invest in
468 farming.

469

470 **3.8 Dynamics of trade in shark fins**

471 A total of 15 respondents, who were mainly canoe owners, participated in the interview on shark
472 fin trade as canoe owners are the ones solely responsible for the sale of fins in their respective
473 canoe businesses. Fishers' perceptions on price dynamics over a 15-year period from 2005 to
474 2020 revealed that prices of all shark species had sharply reduced from 2011 to 2013 and
475 increased 2-3-fold from 2014 to 2015 and continued to increase to 2018 (Table 6 and Figure 6).
476 After 2018, however, prices remained virtually stable until 2020, as indicated by all canoe
477 owners. The price of fins is mostly determined by buyers and marginally increases with time.
478 Bull Shark, Hammerhead sharks, and Milk Shark (*Rhizoprionodon acutus*) consistently had the
479 most valuable fins. Conversely, Blue Shark, Tiger Shark, and Thresher Shark are consistently the
480 least valuable sharks in the local fin market. We initially anticipated some variation among
481 respondents and communities but this was not the case as fishers indicated that prices of shark
482 fins differ marginally among fishers and communities. Fishers reported that the local shark fin
483 market is characterized by small number of foreign merchants who operate across all three study
484 communities and therefore offer virtually similar prices.

485 When asked about the details of buyers and factors that determine the price of shark fins, 67% of
486 fishers recounted that they sold their fins to foreign merchants from Benin, Guinea, Mali and
487 Senegal. Two canoe owners stated that they sell their fins to a Nigerian and has done so for the
488 past six to eight years. Only one fisher from Axim claimed to sell his fins to a Chinese merchant
489 since 2019. He indicated that the Chinese merchant used to conduct his business at Apam in the
490 Central Region of Ghana but has recently relocated to Axim as the fin trade is booming there.
491 Most foreign buyers do not stay within these shark fisheries communities, but rather they mostly
492 stay on the outskirts of the various communities where canoe owners send their fins to them for
493 sale. In certain circumstances, these foreign merchants go to the communities to buy the fins,

494 especially when a canoe owner gets large quantities of fins and is unable to transport to the
495 buyer's station.

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

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

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

520 When queried about their satisfaction with the income they derived from the sale of fins, nine
521 fishers stated that they are very satisfied or satisfied with the price and income they get from the
522 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.

3.10 Trade in shark meat

3.10.1 Trade data from landing sites survey

Fins of medium- to large-sized sharks were removed, with the remainder auctioned in parts or whole, while smaller sharks were sold whole without the fins removed. 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 7. 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 7).

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 (K = 7.12, p= 0.027), Spinner Shark (K = 6.13, p = 0.046)

and Sand Tiger Shark (K = 9.64, p = 0.008) among the various communities (Table 6). 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); while Sand Tiger Shark varied between Axim and Dixcove (p = 0.012) as well as Shama (p = 0.019).

3.10.2 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, Bull Shark and Mako sharks are the most valuable sharks, while Thresher sharks, Tiger Shark and Blue Shark 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

583 them. The merchant processed the meat in the form of smoking and salting and/or sun drying,
584 which are sold in local markets as dried meat called "Kako". Most traders stated that they sell
585 their meat to local consumers in their various communities and outside their communities,
586 especially in Takoradi, the regional capital, or Kumasi in the Ashanti Region, Tema and Accra in
587 the Greater Accra Region, and Sefwi in the Western North Region of Ghana. Only four
588 merchants recounted selling frozen shark meat to foreign nationals, mostly Chinese and
589 Togolese, and have been doing that for more than two years. However, the traders were not
590 aware whether these foreign nationals export the meat to other countries.

591

592 **3.11 Satisfaction level of fishing and income from shark meat**

593 As a measure of fishers and traders wellbeing in the shark fisheries, they were asked to indicate
594 their satisfaction in the income they derived from shark meat and their work as a whole. Over
595 60% of fishers indicated that they are dissatisfied or very dissatisfied with the income they get
596 from selling their meat (Figure 7a), while over 90% of traders were satisfied or very satisfied
597 with their income derived from shark fisheries (Figure 7b). Dissatisfied fishers gave emotive
598 responses to show how disgruntled they are with the prices traders offer to them. Many stated
599 that catching sharks has become increasingly difficult and their work is now demanding more
600 finances, energy and time and these are usually not taken into account when traders are buying
601 their meat. In addition, 75% and 95% of fishers and traders respectively are satisfied or very
602 satisfied with their work in fishing and trading shark meat. Most respondents reported that
603 fishing-related livelihood activities are the only job they have learned and also their last
604 livelihood resort to fall on for now, and that they are left with no option but to be okay with it. A
605 trader stated that she learned how to process and trade shark and other bony fish since her
606 childhood and that was the only training her parents gave her; but she is satisfied with her work
607 because it at least offers her an income to pay her children's school fees and house rent.

608 There was no difference in satisfaction with income derived from shark meat by educational
609 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 =
610 8.14, df = 15, p = 0.920). However, there was a significant effect of occupation on income
611 satisfaction from shark meat (X^2 = 4.69, df = 3, p = 0.016), with traders exhibiting more
612 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, and is one of the few from West Africa. Artisanal fishers in the study communities are considered to have limited 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 minimal alternative livelihood options, including crop farming, livestock rearing, teaching, and trading in non-farm items. Sulu et al. (2015) analyzed a range of livelihood strategies adopted in the Malaita Province, Solomon Islands, and found that all respondents were engaged in multiple livelihoods activities, with fishing and gardening reported to be the most important livelihood streams. 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 the study 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. Even though many respondents did not have formal education, salary work was significant secondary income sources for fishers in other parts of Ghana (Asiedu & Nunoo, 2013), which contrast the findings of the present study. Further, in New Caledonia, salaried income work was an important secondary income source for fishers, and this was as a result of a high level of industrial development and a large mining sector in the country (Purcell et al., 2016).

Fishers and traders would mostly turn to non-fishing related livelihood activities, which include small business, transportation and artisanship 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 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

673 in the study communities. Generally, the regular consumption of shark meat among fishers and
674 traders suggest that shark meat represents substantial source of protein in the diets of the study
675 communities and therefore over-exploitation of the shark stock may directly impact food
676 security. In efforts to address food security, shark meat was promoted in the late 1950s as
677 alternatives to augment the contemporaneous decline of bony fish, which has led to its wide
678 utilization (Lehr, 2015). Currently, shark meat is widely traded and utilized as a cheap source of
679 protein in many poorer communities in developing countries including Ghana (Bornatowski et
680 al., 2013). Similar to the consumption pattern of shark meat in Ghana, Glaus et al., (2019)
681 reported that Fiji's small-scale coastal shark fisheries are driven to mainly meet dietary needs.
682 They reported that 79.3% of fishers that retain sharks utilized them as food source and/ or for
683 cultural purposes and 19.8% sold shark products. Even in developed countries like Oman sharks
684 are widely consumed and have formed the basis of many traditional food dishes (Henderson et
685 al., 2006). Further, in the United Arab Emirates, fishers confirmed that the consumption of
686 sharks has been integrated in their culture and has traditionally been consumed (Jabado et al.,
687 2015).

688 Many fishers and traders generated between 80-100% of their income from shark fisheries, with
689 most of these fishers from Axim and Dixcove. Shark fisheries are increasingly representing a key
690 source of employment and providing major income for fishers in these communities. The high
691 monetary incentive is the major driver of proliferation in shark exploitation in Ghana, as fishers
692 are getting double their usual income in the form of sale of shark fins and meat. In agreement
693 with these findings, Barrowclift et al. (2017) reported that most of fishers in Zanzibar that caught
694 and sold elasmobranchs generated between 41-60% of their income from sharks, and 31% of
695 merchants also got 61-80% of their income from selling elasmobranchs. In Ghana, Gelber (2018)
696 found that the shark fin trade is the main income source for 80% of middlemen and 38% of
697 canoe owners of the study population.

698 The fin prices of commercial shark species were found to be high between 2005 and 2010; the
699 period where fishers reported that they experienced a dramatic decline in the catch of sharks and
700 other large pelagic species. The decline in shark catch may have resulted in the high prices of
701 fins, as demand might have been high in this period. Fishers started noticing a significant drop in
702 fin prices in 2011, and the prices continuously remained lower until the end of 2013. Similar to

our findings, fishers in Eastern Indonesia perceived changes in prices of shark fins over a 20 year period from 1992/93 to 2012/2013 and indicated that the prices steadily increased in 2002/2003, and decreased for all species in 2012/2013 (Jaiteh et al., 2017). Fishers in Eastern Indonesia gave diverse reasons for the fall in shark fin prices, including awareness campaigns targeting consumers in China, increasing demand for live reef fish at Chinese banquets, and international campaigns concerning the consumption of shark fin (Jaiteh et al., 2017), which contrast the reasons being given by shark fishers in Western Ghana. According to fishers in Ghana, from 2011 to 2013 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 (Gelber, 2018). 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 oceanic habitats and spent over six days at sea 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. In contrast to the current study, Glaus et al. (2019) documented a reduction in shark fin trade in 2017 in Fiji and linked the changes to the closure of the local sea cucumber market, which hampered the frequent visit of middlemen who used to encouraged shark targeting in the various fishing villages. Furthermore, annual shark fin income was estimated to have fallen by 75% following the sea cucumber fishery closure in that same year in Papua New Guinea (Vieira et al., 2017).

The prices of shark fins in Western Ghana were reported to vary among species. For example, the fins of Hammerhead sharks and Bull Shark were reported to be of high quality and therefore priced higher, while Tiger Shark and Thresher sharks were the least valuable species in the study

734 communities. Similar to our findings, the lower caudal fins of Hammerhead sharks and Blue
735 Shark and the fins of Shortfin Mako (*Isurus oxyrinchus*) have been cited to possess the best
736 quality fin needles for human consumption by traders and regarded as among the most valuable
737 fins in the international market (Clarke et al., 2007). Several factors influence the commercial
738 value of shark fins globally, which include fin needles, type of fin (dorsal or caudal), the general
739 appearance (thickness, color, length, and needle texture) and the species type (Clarke et al.,
740 2007; Vannuccini, 1999) of which the latter is mostly known and used by fishers and merchants
741 during fin trading in the study communities. Other factors reported by fishers as having an
742 influence on the price of shark fins were dry weight, demand, and season. Though these factors
743 were not statistically analyzed and inference on the prices was beyond the scope of this study,
744 the data reported by fishers demonstrates the importance of fishers' knowledge in understanding
745 the complex drivers influencing their fishing business and operations.

746 Further, the variation in prices of meat of Blue Shark, Silky Shark, Spinner Shark, and Sand
747 Tiger Shark among the study communities may be attributed to the size differences of the
748 specimen landed and sold. Sizes of shark species is an important factor that affects the prices of
749 specimen, as larger specimens are given priority and priced higher. The mean size of Spinner
750 Shark and Blue Shark was smaller in Dixcove while the mean size of Silky Shark and Tiger
751 Shark were larger in Axim and Shama respectively, hence the variation in price among the
752 communities (see Table 4). Additionally, the 'quality' of the meat for consumption was reported
753 to vary among species and therefore to influence the price of sharks as well. For example,
754 species such as Mako sharks, Thresher sharks, and Hammerhead sharks are considered high
755 quality and priced higher by fishers and traders, which concurs with the international shark meat
756 market (Hanfee, 2001; Lehr, 2015; Rose, 1996). Similarly, fishers in the United Arab Emirates
757 reported several species of sharks they considered most valuable, which included Hammerhead
758 Sharks (Jabado et al., 2015). In contrast to the sale prices in Ghana, Bull shark were reported to
759 fetch the highest price, resulting from their larger sizes in Zanzibar (Barrowclift et al., 2017).
760 Further, Vannuccini (1999) reports that the spiny dogfish *Squalus acanthias,* sold in Italy for
761 US$8.13– 9.91 per kg, was the most expensive shark species. Other interacting factors such as
762 level of demand and season are also noted by fishers and traders to cause variation in shark
763 prices in the study communities and this concurs with the study of Barrowclift et al. (2017).

764 Fishing marine resources contribute significantly to the degradation of the world's marine
765 ecosystems and fishing pressure could possibly be reduced if primary actors, especially fishers in
766 the industry, are induced to move out (Bavinck et al., 2012). Whether fishers may be inclined to
767 do so or not, mainly depends partially on their wellbeing or satisfaction on their job and the
768 profitability of their fallback options. Comparative studies have thrown light on the level of
769 fishers' satisfaction on their professions. For example, Ruiz (2012) found that fishing is
770 satisfying as an occupation, yet fishers can be dissatisfied about their earnings. Similar to our
771 findings, most fishers in the present study were dissatisfied with the income earned from shark
772 fisheries. This was because they expected a standard price for shark specimens but are mostly
773 offered lower prices by traders. Fishers mostly compare their cost, time, and energy they expend
774 on catching sharks and expect the prices to be higher than what they are offered by traders. The
775 satisfaction of these primary actors in the shark fisheries industry is linked to the inadequate
776 livelihood opportunities for fishers and traders in the study communities in, which they are
777 invariably forced to stay and accept their occupation. Fishers have a high investment of their
778 time in the fishery and often have few other viable livelihood options (Purcell et al., 2016). Most
779 fishers may wish to switch job but the opportunities available are narrowed and most of them are
780 not favorable to them owing to their training and level of education. The wellbeing of fishers,
781 including their level of satisfaction, is advocated as an important consideration for development
782 policy (Hair et al., 2016; Koczberski et al., 2006) and further offers more holistic means of
783 assessing the social impacts of change in fisheries (Coulthard, 2012). Additionally, an insight of
784 job satisfaction among the fishers and traders will support in developing management strategies
785 that can offer required alternative work for these actors displaced by interventions for reductions
786 in effort (Bavinck et al., 2012).

787

788 **5. Conclusions and recommendations**

789 Our study revealed that fishers and traders in shark fisheries in Western Ghana have marginal
790 livelihood opportunities, with most respondents depending solely on fishing-related activities as
791 their primary source of income. Secondly, shark fisheries contribute a significant income to these
792 fishing communities, and shark meat is regularly used in the diet of both fishers and traders.
793 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 are limited with livelihood options and see fishing and trading of shark meat as their last safety-net and thus, are inclined 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 shark populations. Thus, any management strategy would do well to consider various fallback livelihood streams outlined by fishers and traders. Failing to provide such incentives could result in opposition from fishers against any management intervention. However, the benefits of long-term higher sustainable yields would be worth the transition challenges.

Funding

This work was supported by the Swiss Shark Foundation/ Hai-Stiftung, Save Our Seas Foundation and Flying Sharks.

Acknowledgements

Special thanks go to the Zoological Society of London EDGE of Existence Program team members for their training, advice and mentoring. My heartfelt appreciation to Benard Seret for his immense contribution, mentoring, advice, and guidance for the species identifications and towards the successful completion of the study. Finally, the authors are grateful to Bukari Saphianu, Paul Tehoda, Emmanuel Amoah, Clement Sullibie Saagulo Naabeh and Adomako Ohene as well as the local volunteers Isaac Assefuah, Kingsford Osei, Jona, Timothy Amiah and Ben Adjei for their role in field data gathering. We are grateful to the staff of the Western

Regional Fisheries Commission, chiefs, Chief fishers and their elders, fishers, traders and people of the five study communities for their cooperation and support in making this study possible.

References

Alexander, L., Agyekumhene, A., & Allman, P. (2017). The role of taboos in the protection and recovery of sea turtles. *Frontiers in Marine Science*, *4*, 237.

Allison, E. H., & Ellis, F. (2001). The livelihoods approach and management of small-scale fisheries. *Marine policy*, *25*(5), 377-388.

Amador, K., Bannerman, P., Quartey, R., & Ashong, R. (2006). Ghana canoe frame survey 2004. *Marine Fisheries Research Division, Accra, Technical Paper (34)*, *43*.

Andrew, N. L., Béné, C., Hall, S. J., Allison, E. H., Heck, S., & Ratner, B. D. (2007). Diagnosis and management of small-scale fisheries in developing countries. *Fish and Fisheries*, *8*(3), 227-240.

Asiedu, B., & Nunoo, F. K. (2013). Alternative livelihoods: A tool for sustainable fisheries management in Ghana. *International Journal of Fisheries and Aquatic Sciences*, *2*(2), 21-28.

Asiedu, B., Nunoo, F. K. E., Ofori-Danson, P. K., Sarpong, D. B. & Sumaila U. R. (2013). Poverty Measurements in Small-scale Fisheries of Ghana: A Step towards Poverty Eradication. *Current Research Journal of Social Sciences*, 5(3): 75-90.

Barrowclift, E., Temple, A. J., Stead, S., Jiddawi, N. S., & Berggren, P. (2017). Social, economic and trade characteristics of the elasmobranch fishery on Unguja Island, Zanzibar, East Africa. *Marine Policy*, *83*, 128-136.

Bavinck, M., Pollnac, R., Monnereau, I., & Failler, P. (2012). Introduction to the special issue on job satisfaction in fisheries in the global south. *Soc Indic Res*,109, 1–10.

Béné, C., Macfadyen, G., & Allison, E. H. (2005). *Increasing the contribution of small-scale fisheries to poverty alleviation and food security* (No. 481). Food & Agriculture Org.

BNP (2008). Small-scale capture fisheries: a global overview with emphasis on developing countries: a preliminary report of the Big Numbers Project. Rome: FAO and World Fish Center.

Bonfil, R. (2000). Trends and patterns in world and Asian elasmobranch fisheries. In *Elasmobranch biodiversity, conservation and management: Proceedings of the International Seminar and Workshop, Sabah, Malaysia*, 15–24.

872 Bornatowski, H., Braga, R. R., & Vitule, J. R. S. (2013). Shark mislabeling threatens
873 biodiversity. *Science*, *340*(6135), 923-923.

874 Clarke, S. (2004). Shark Product Trade in Hong Kong and Mainland China and Implementation
875 of the CITES Shark Listings. *TRAFFIC East Asia*, *TRAFFIC East Asia*, Hong Kong,
876 China.

877 Clarke, S., Milner-Gulland, E. J., & Bjørndal, T. (2007). Social, economic, and regulatory
878 drivers of the shark fin trade. *Marine Resource Economics*, *22*(3), 305-327.

879 Coulthard, S. (2011). More than just access to fish: the pros and cons of fisher participation in a
880 customary marine tenure (Padu) system under pressure. *Marine Policy*, *35*(3), 405-412.

881 Coulthard, S. (2012). What does the debate around social wellbeing have to offer sustainable
882 fisheries? *Current Opinion in Environmental Sustainability*, *4*(3), 358-363.

883 CRC, Coastal Resources Center (2010). Report on Characterization of Coastal Communities and
884 Shoreline Environments in the Western Region of Ghana. Integrated Coastal and
885 Fisheries Governance Initiative for the Western Region of Ghana. Coastal Resources
886 Center, University of Rhode Island,425p.

887 CRC, Coastal Resources Center (2013). Solving the Fisheries Crisis in Ghana: A Fresh
888 Approach to Collaborative Fisheries Management. USAID-URI Integrated Coastal and
889 Fisheries Governance (ICFG) Initiative. Coastal Resources Center, Graduate School of
890 Oceanography, University of Rhode Island. 20p.

891 deGraft-Johnson, K. A. A., Blay, J., Nunoo, F. K. E., & Amankwah, C. C. (2010). Biodiversity
892 threats assessment of the Western Region of Ghana. *The integrated coastal and fisheries*
893 *governance (ICFG) initiative Ghana*.

894 DFID (2000). Sustainable Livelihoods Guidance Sheets. UK DFID Department for International
895 Development: London.

896 Diop, M., & Dossa, J. (2011). 30 Years of shark fishing in West Africa: development of
897 fisheries, catch trends, and their conservation status in Sub-Regional Fishing Commission
898 member countries. Report to FIBA.

899 Dulvy, N. K., Davidson, L. N., Kyne, P. M., Simpfendorfer, C. A., Harrison, L. R., Carlson, J.
900 K., & Fordham, S. V. (2016). Ghosts of the coast: global extinction risk and conservation
901 of sawfishes. *Aquatic Conservation: Marine and Freshwater Ecosystems*, *26*(1), 134-153.
902 Dulvy, N. K., Fowler, S. L., Musick, J. A., Cavanagh, R. D., Kyne, P. M., Harrison, L. R., ... &
903 Pollock, C. M. (2014). Extinction risk and conservation of the world's sharks and
904 rays. *elife*, *3*, e00590.

905 Dulvy, N. K., Metcalfe, J. D., Glanville, J., Pawson, M. G., & Reynolds, J. D. (2000). Fishery
906 stability, local extinctions, and shifts in community structure in skates. *Conservation*
907 *Biology*, *14*(1), 283-293.

908 Dulvy, N. K., Simpfendorfer, C. A., Davidson, L. N., Fordham, S. V., Bräutigam, A., Sant, G., &
909 Welch, D. J. (2017). Challenges and priorities in shark and ray conservation. *Current*
910 *Biology*, *27*(11), R565-R572.

911 Ellis, F. (2000). *Rural livelihoods and diversity in developing countries*. Oxford university press.

912 FAO (2017). Global Capture Production 1950-2015. Fisheries and Aquaculture Department.
913 http://www.fao.org/fishery/statistics/global-production/en

914 FAO (2020). Fisheries and aquaculture software. FishStat Plus - Universal software for fishery
915 statistical time series. In: FAO Fisheries Division [online]. Rome.
916 http://www.fao.org/fishery/

917 FAO (2014). The state of world fisheries and aquaculture: opportunities and challenges. Rome,
918 Italy.

919 Fernandez-Carvalho, J., Imhoff, J. L., Faria, V. V., Carlson, J. K., & Burgess, G. H. (2014).
920 Status and the potential for extinction of the largetooth sawfish Pristis pristis in the
921 Atlantic Ocean. *Aquatic Conservation: Marine and Freshwater Ecosystems*, *24*(4), 478-
922 497.

923 Gelber, M. J. (2018). Plenty of Fish in the Sea? Shark Fishing and the Fin Trade in Ghana: A
924 Biting Review (Master thesis). University of Florida, in Gainesville, USA.

925 Glaus, K. B., Adrian-Kalchhauser, I., Piovano, S., Appleyard, S. A., Brunnschweiler, J. M., &
926 Rico, C. (2019). Fishing for profit or food? Socio-economic drivers and fishers' attitudes
927 towards sharks in Fiji. *Marine Policy*, *100*, 249-257.
928 GSS, Ghana Statistical Services (2014). 2010 Population and housing census: District analytical
929 report. Ghana: Accessed June, 8, 2019.

930 Hair, C., Foale, S., Kinch, J., Yaman, L., & Southgate, P. C. (2016). Beyond boom, bust and ban:
931 the sandfish (Holothuria scabra) fishery in the Tigak Islands, Papua New
932 Guinea. *Regional Studies in Marine Science*, *5*, 69-79.

933 Hammer, O., Harper, D. A. T., & Ryan, P. D. (2001). PAST: Paleontological Statistics Software
934 Package for education and data analysis, Version 2.03. Paleontologia Electronica, 4 (1),
935 9. *Encontrado em*, *3*.

936 Hanfee, F. (1999). Management of shark fisheries in two Indian coastal states: Tamil Nadu and
937 Kerala. *FAO Fisheries Technical Paper (FAO)*.

938 Henderson, A. C., McIlwain, J. L., Al-Oufi, H. S., & Ambu-Ali, A. (2006). Reproductive
939 biology of the milk shark Rhizoprionodon acutus and the bigeye houndshark Iago
940 omanensis in the coastal waters of Oman. *Journal of fish biology*, *68*(6), 1662-1678.
941 Jabado, R. W., Al Ghais, S. M., Hamza, W., & Henderson, A. C. (2015). The shark fishery in the
942 United Arab Emirates: an interview based approach to assess the status of sharks. *Aquatic*
943 *Conservation: Marine and Freshwater Ecosystems*, *25*(6), 800-816.
944 Jaiteh, V. F., Loneragan, N. R., & Warren, C. (2017). The end of shark finning? Impacts of
945 declining catches and fin demand on coastal community livelihoods. *Marine Policy*, *82*,
946 224-233.
947 Jorian, P. (1988). Going out or staying home: seasonal movements and migration strategies
948 among Xwla and Anlo-Ewe fishermen. *Journal of Maritime Anthropological*
949 *Studies*, *1*(2), 129-155.
950 Koczberski, G., Curry, G., Warku, J., & Kwam, C. (2006). Village-based marine resource use
951 and rural livelihoods: Kimbe Bay, West New Britain, Papua New Guinea. *Agricultural*
952 *Systems*, *85*, 324-339.

Lehr, H. (2015). Traceability study in shark products. *Report prepared for the CITES Secretariat*.

McClenachan, L., Cooper, A. B., & Dulvy, N. K. (2016). Rethinking trade-driven extinction risk in marine and terrestrial megafauna. *Current Biology*, *26*(12), 1640-1646.

Mensah, J. V., & Antwi, B. K. (2002). Problems of artisanal marine fishermen in Ghana: the way ahead. *Singapore Journal of Tropical Geography*, *23*(2), 217-235.

MoFAD. Ministry of Fisheries and Aquaculture Development, (2015) Fisheries Management Plan of Ghana: a national policy for the management of marine fisheries sector 2015–2019. Accra: Government of Ghana. https://www.mofad.gov.gh/fisheries-management-plan-of-ghana-2015-2019/

MoFAD, Ministry of Fisheries and Aquaculture Development, (2017) Fisheries Management Plan of Ghana: a national policy for the management of marine fisheries sector 2015–2019. Accra: Government of Ghana. https://www.mofad.gov.gh/fisheries-management-plan-of-ghana-2015-2019/

Naderifar, M., Goli, H., & Ghaljaie, F. (2017). Snowball sampling: A purposeful method of sampling in qualitative research. *Strides in Development of Medical Education*, *14*(3), 1-6.

Newing, H. (2010). *Conducting research in conservation: social science methods and practice*. Routledge.

Nunoo, F. K. E., Asiedu, B., Olauson, J., & Intsiful, G. (2015). Achieving sustainable fisheries management: A critical look at traditional fisheries management in the marine artisanal fisheries of Ghana, West Africa. *Journal of Energy and Natural Resource Management (JENRM)*, *2*(1), 15-23.

Nyemah, R. G., Dehlor, S. A., & Akakpo, G. S. (2017). Assessing Ghana's Fishing Industry: A Case Study of Some Selected Fishing Communities in the Greater Accra Region. *World Journal of Social Sciences 7*(2), 65 – 77.

979 Pardo, S. A., Kindsvater, H. K., Reynolds, J. D., & Dulvy, N. K. (2016). Maximum intrinsic rate
980 of population increase in sharks, rays, and chimaeras: the importance of survival to
981 maturity. *Canadian journal of fisheries and aquatic sciences*, *73*(8), 1159-1163.
982 Pollnac, R. B., & Poggie, Jr, J. J. (2006). Job satisfaction in the fishery in two southeast Alaskan
983 towns. *Human organization*, *65*(3), 329-339.

984 Purcell, S. W., Ngaluafe, P., Foale, S. J., Cocks, N., Cullis, B. R., & Lalavanua, W. (2016).
985 Multiple factors affect socioeconomics and wellbeing of artisanal sea cucumber
986 fishers. *PloS one*, *11*(12), e0165633.

987 Rose, D. A. (1996). An overview of world trade in sharks and other cartilaginous fishes. A
988 TRAFFIC Network report.

989 Ruiz, V. (2012). Job satisfaction among fishers in the Dominican Republic. *Social indicators*
990 *research*, *109*(1), 81-94.

991 Scoones, I. (1998). Sustainable rural livelihoods: a framework for analysis. IDS Working paper
992 72. Institute for Development studies, University of Sussex, UK.

993 Smith, C. L., & McKelvey, R. (1986). Specialist and generalist: roles for coping with
994 variability. *North American Journal of Fisheries Management*, *6*(1), 88-99.

995 Sulu, R. J., Eriksson, H., Schwarz, A. M., Andrew, N. L., Orirana, G., Sukulu, M., ... & Beare,
996 D. (2015). Livelihoods and fisheries governance in a contemporary Pacific Island
997 setting. *PLoS One*, *10*(11), e0143516.
998 Trimble, M., & Johnson, D. (2013). Artisanal fishing as an undesirable way of life? The
999 implications for governance of fishers' wellbeing aspirations in coastal Uruguay and
1000 southeastern Brazil. *Marine Policy*, *37*, 37-44.

1001 Vannuccini, S. (1999). *Shark utilization, marketing and trade* (No. 389). FAO Fisheries
1002 Technical Paper No. 389. FAO, Rome, Italy. 470 pp.
1003 Vannuccini, S. (1999). *Shark utilization, marketing, and trade* (No. 389). Food & Agriculture
1004 Organization.

1005 Vieira, S., Kinch, J., White, W., & Yaman, L. (2017). Artisanal shark fishing in the Louisiade
1006 Archipelago, Papua New Guinea: Socio-economic characteristics and management
1007 options. *Ocean & coastal management*, *137*, 43-56.
1008 Ward-Paige, C. A., Keith, D. M., Worm, B., & Lotze, H. K. (2012). Recovery potential and
1009 conservation options for elasmobranchs. *Journal of Fish Biology*, *80*(5), 1844-1869.
1010 Zar, J. H. (2010). *Biostatistical analysis*. Prentice-Hall/Pearson Education India.

1011
1012
1013
1014
1015
1016
1017
1018
1019
1020
1021
1022
1023
1024
1025
1026
1027
1028
1029
1030
1031

1032 **Tables**

1033 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

1034 Source population data: Ghana Statistical Service (2014). Source of mainstay data: CRC (2010)

1035

1036

1037

1038

1039

1040

1041

1042

1043

1044

1045

1046

1047

1048

1049

1050

Table 2. Socioeconomic characteristics of respondents

Socioeconomic characteristics	Axim (*n* = 23)	Dixcove (*n* = 22)	Shama (*n* =4 0)	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; 4. *p*-values represent significant differences in the socio-economic variables of respondents among the various study communities.

1061 Tale 3. Fishing operations and gears types used by the various type of canoes in the study
1062 communities and Ghana

Fishing operations	Canoe types		
Canoes used	Large	Medium	Small
Size of the canoe	16-25 m long and 2-4 m wide	9-15 m long and 1-2 m wide	4-8 m long and 1-2 m wide
Outboard motor engine capacity	40 HP	15 HP, 25 HP, 30 HP or 40 HP	8 HP, 25 HP or 40 HP
Gears mostly used	Drift gillnets	Drift gillnet, bottomset gillnets, and ring nets gears	bottomset gillnets
# of crews	4-8	4-8	3-6
# of fishing trips in a month	4 times	5-6 times	6-7 times
Distance covered (km)	129- 290	32-80	9- 16
Trip duration	6 days	2-4 days	1- 2 days
# of nets used	20- 32 nets	15- 20 nets	15- 25 nets

1063
1064
1065
1066
1067
1068
1069
1070
1071
1072
1073

1074 Table 4. Laws and regulations governing Ghanaian fisheries

Laws and regulations	Brief description
Fishery Act 2002 (Act 625)	Prohibits the use of local, industrial or semi-industrial fishing vessel and the use of canoes without license and stipulates the process, application and qualification of acquiring a license. Regulates artisanal fishery. Ban large semi-industrial vessels or industrial fishing vessels from fishing inside the Inshore Exclusive Zone (IEZ). Declaration of closed seasons, including their duration for fishing in specified areas of the coastal waters. Specified the types and sizes of devices and nets that are prohibited for fishing activities. Ban the use of any fishing method that aggregate fish either by light attraction, use of bamboo for purposes of aggregating fish, or use of explosives, or any obnoxious chemicals for fishing, or operating pair trawling. Ban the use of un-prescribed mesh net sizes for fishing.
Fishery Regulation 2010	Regulates fishing vessels, gears and equipment and the issuing of fishing licenses. Prohibits fishing methods such as light attraction, portable generators, switchboards, and paired trawling. Bans all multifilament set-nets and monofilament set-nets of mesh size of less than 50 mm and 75 mm, respectively, in stretched diagonal length in the marine waters. Stipulates minimum landing size of commercially important species.
Fisheries Amendment Act of 2014 (ACT 880)	An Act to amend the Fisheries Act, 2002 (Act 625) to give effect to international conservation and management obligations, to empower the Minister of Fishery and Aquaculture Development to make Regulations to combat Illegal, Unreported and Unregulated fishing in accordance with the international obligations of the Republic and to provide for related matters.
Ministerial Directives in 2016	Directs all fishing vessels to maintain a minimum sanitary condition on board the fishing vessels.
Ministerial Directives in 2016	Declared closed seasons for industrial trawlers for the periods 1st – 30th November 2016 and 1st February – 31st

Laws and regulations	Brief description
	March 2017.
Fisheries Amendment Regulation 2015 (L.I. 2217)	Stipulates the various requirements for the registration of a fishing vessel as a Ghanaian fishing vessel.
Fisheries Management Plan of Ghana, 2015	Imposes license conditions to reduce the number of fishing days of various vessels available. Declares closed seasons for two months, up to four months from May- June and/ or November- December (to be determined). Increase the traditional one day fishing holiday per week to two days. Controls new entrants to the fishery sector. Implement co-management for artisanal fishery. Strict compliance with ICCAT. Strict adherence to licensing and monitoring of vessels. Stipulates the creation of marine habitat protection areas to protect nursery areas and spawning grounds, mainly in estuaries and mangrove areas.
Ministerial Directives in 2021	Declared closed seasons for artisanal and inshore fleets for periods of 1st to 30th July, 2021 and industrial fleets from 1st to 31st August, 2021.

1087 Table 5. 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

1088 1. Chi-square test for all statistical tests; 2. *p*-values represent significant differences in mean income
1089 generated from the various livelihood strategies of respondents among the various communities.
1090
1091
1092
1093
1094
1095
1096
1097
1098
1099
1100
1101

1102 Table 6. 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

1103 Note: as of the time of data collection, USD 1 was equivalent to GH¢ 5.77

1104

Table 7. 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; 3. *p*-values represent significant differences in mean price of shark specimen among the various communities.

Figure legends

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)

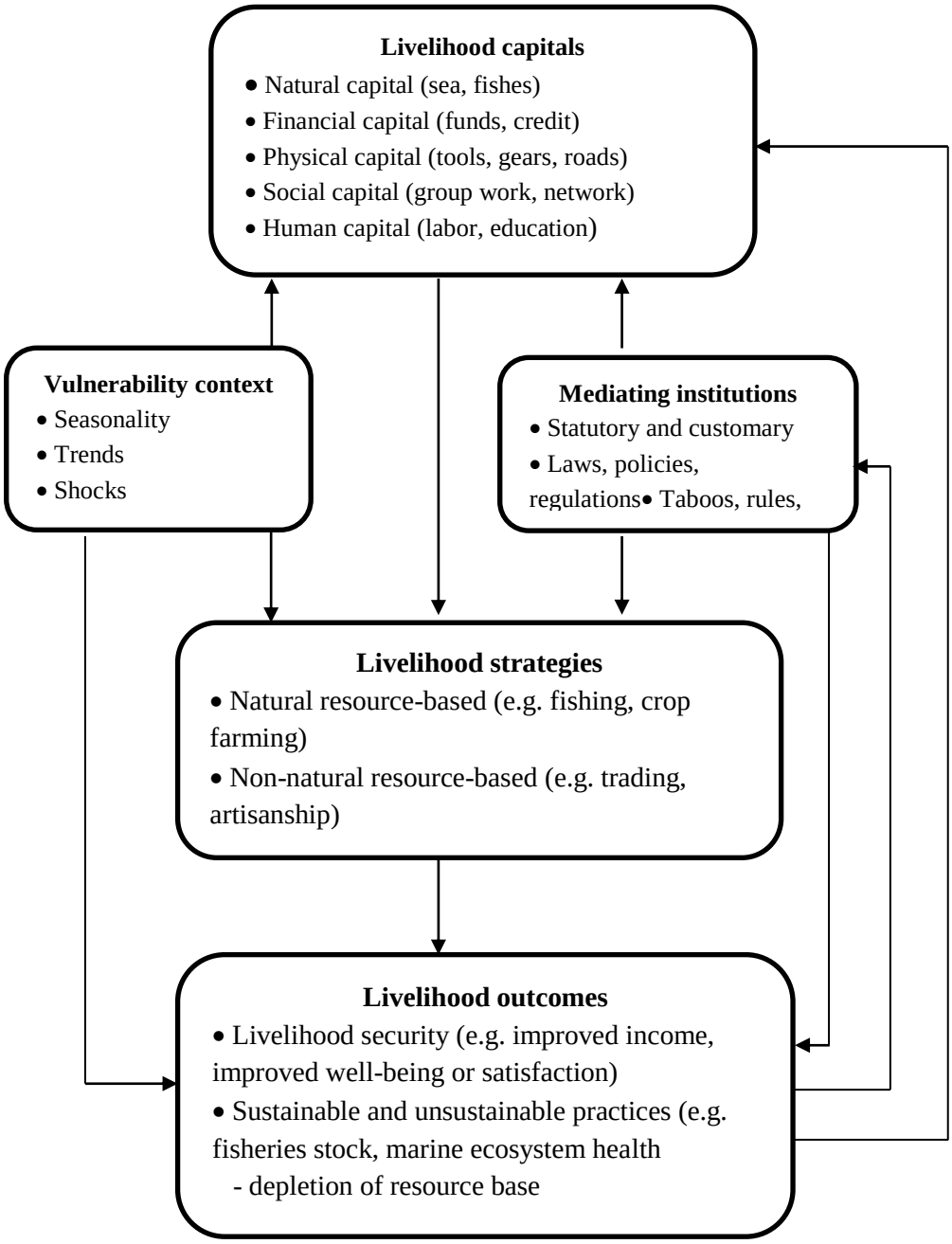
Figure 4. Frequency of subsistence consumption of sharks by fishers and traders. Stacked bars represent the consumption of sharks of the study communities in Axim (n = 23), Dixcove (n = 22), and Shama (n = 40)

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

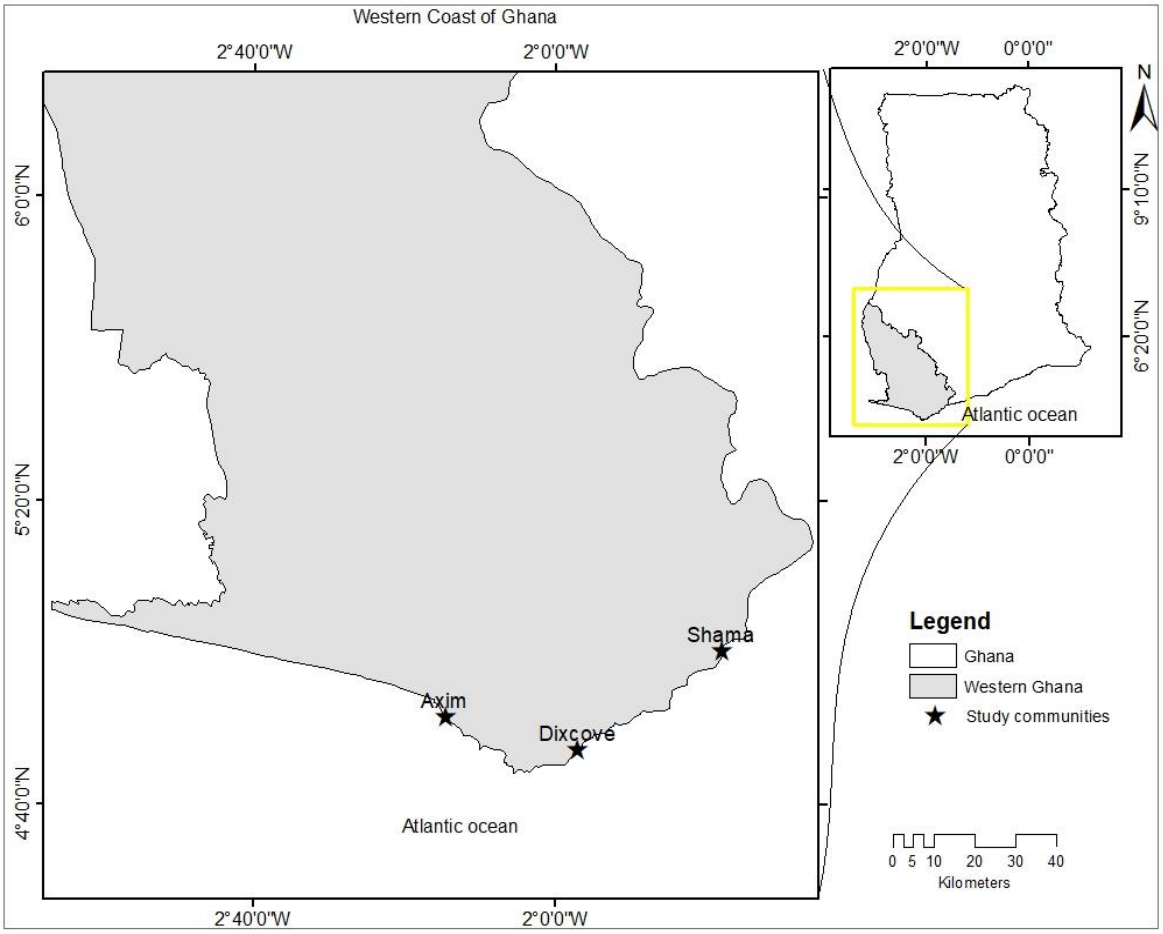
Figure 6. Trends in the prices for a kilogram of fins for eight shark species

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

Figure 1



1162 Figure 2



1163

1164

1165

1166

1167

1168

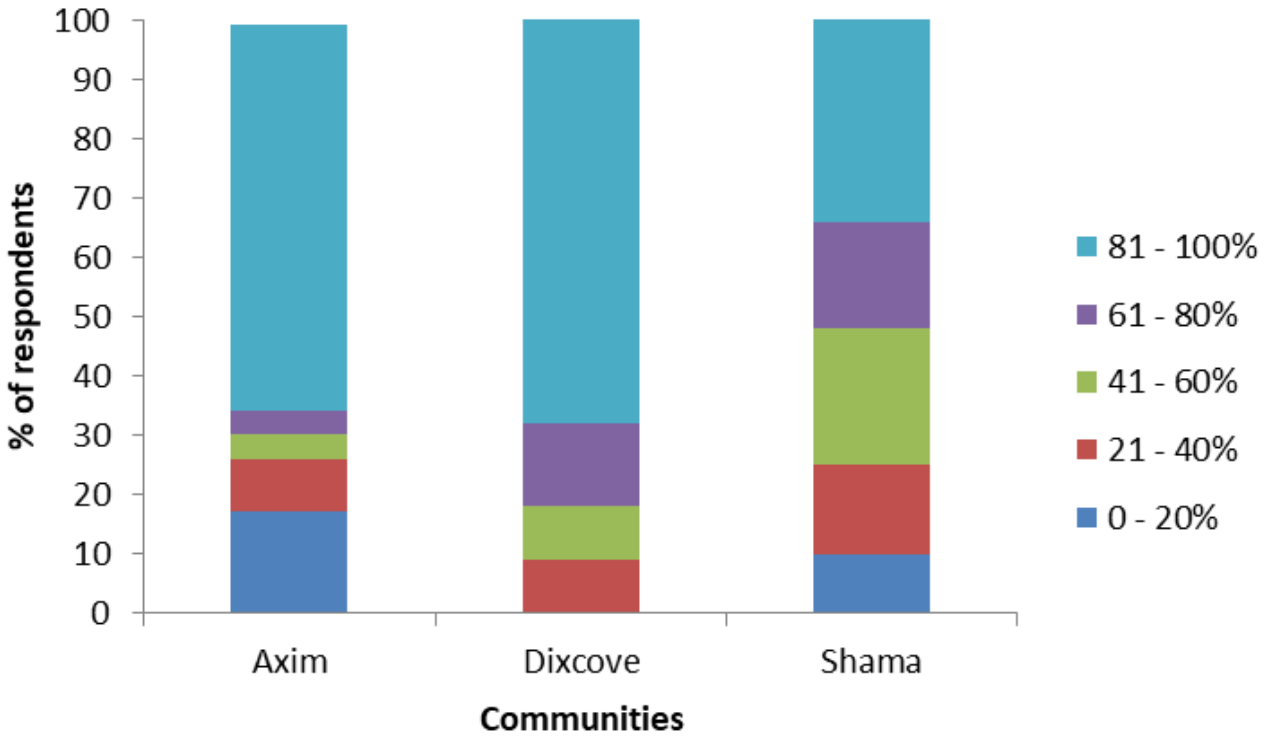
1169

1170

1171

1172

1173 Figure 3



1174

1175

1176

1177

1178

1179

1180

1181

1182

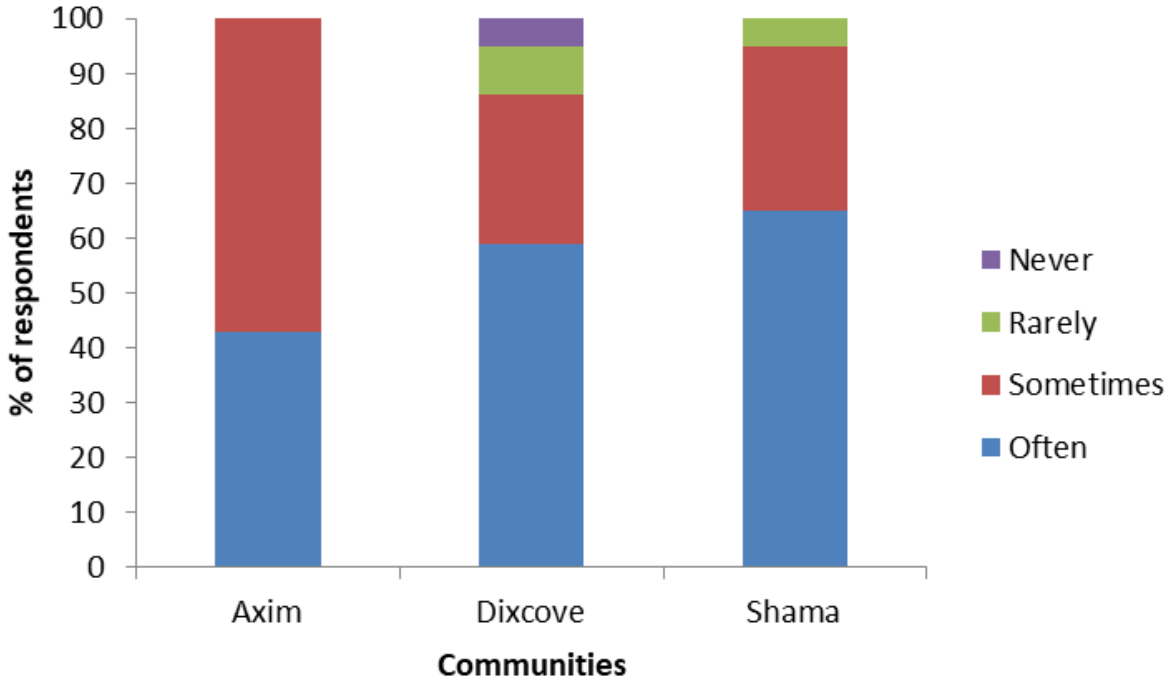
1183

1184

1185

1186

1187 Figure 4



1188

1189

1190

1191

1192

1193

1194

1195

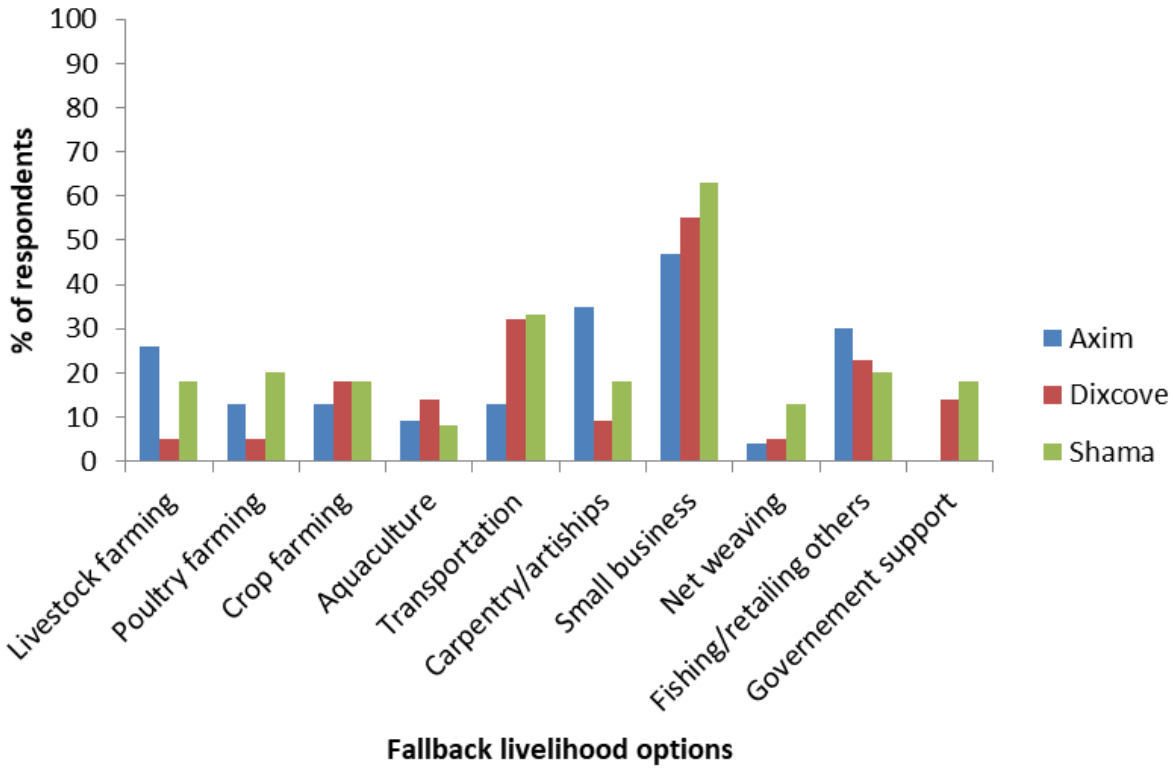
1196

1197

1198

1199

1200 Figure 5



1201

1202

1203

1204

1205

1206

1207

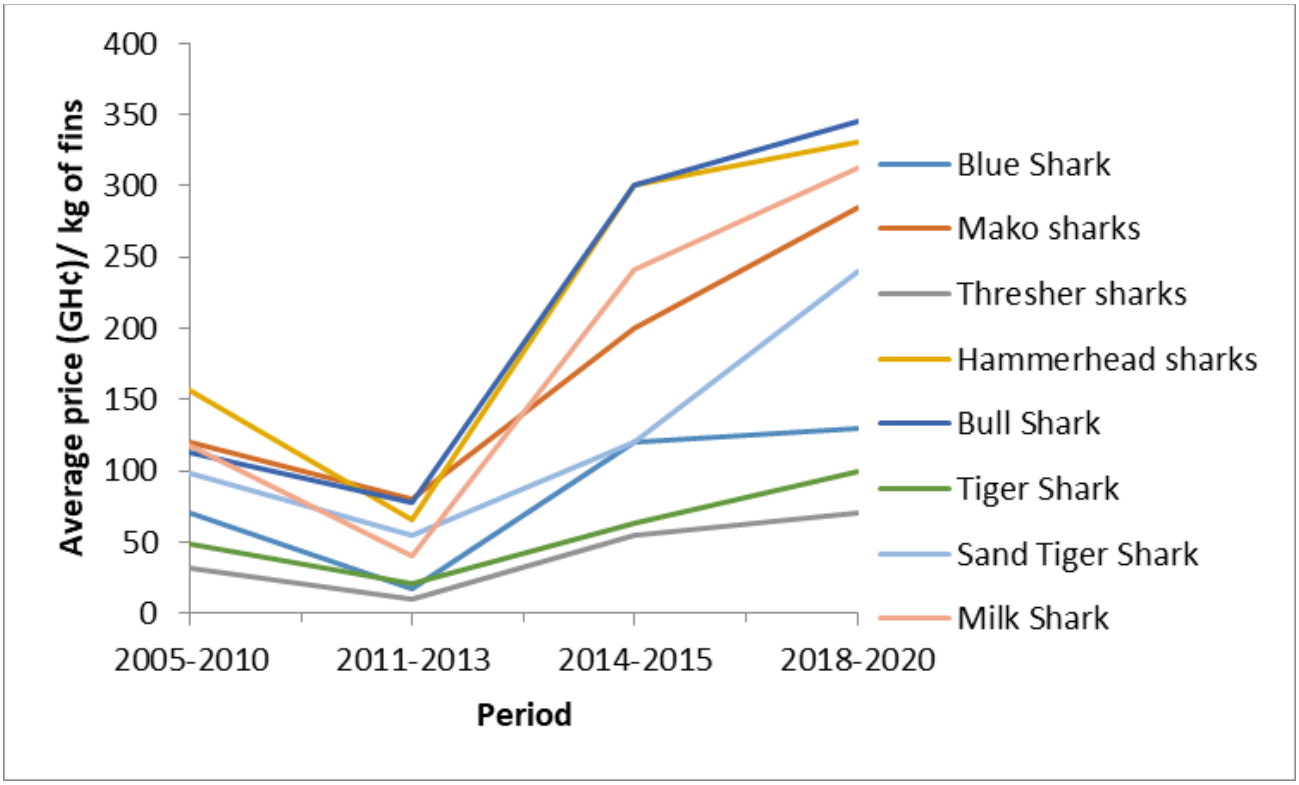
1208

1209

1210

1211

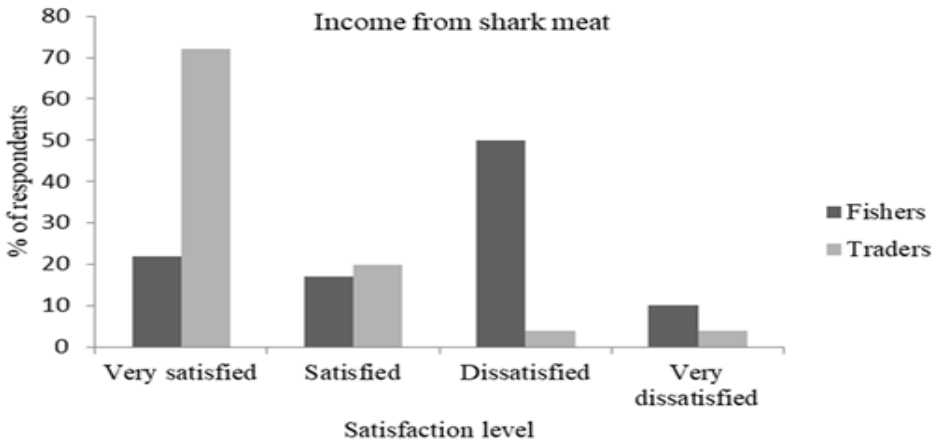
1212 Figure 6



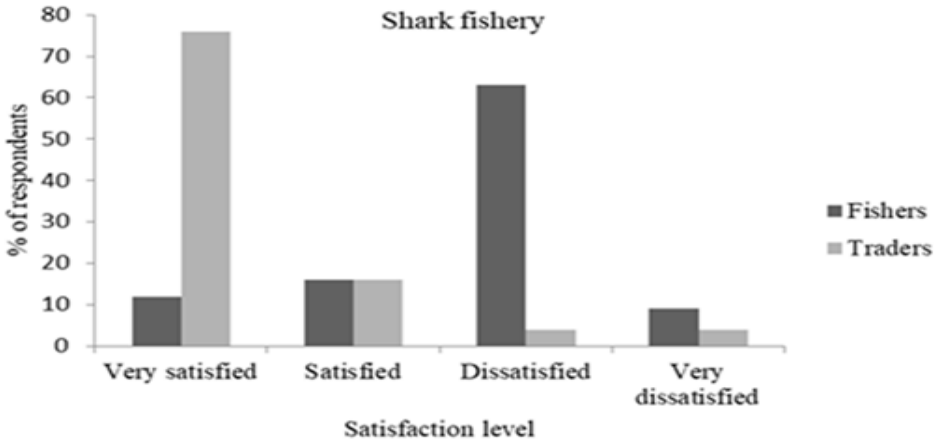
1213
1214
1215
1216
1217
1218
1219
1220
1221
1222
1223
1224
1225

1226 Figure 7

a



b



1227

1228