GHANA WILDLIFE SOCIETY

Final Report to Anderson Cabot Center for Ocean Life at the New England Aquarium

PROJECT TITLE: Baseline Assessment on Marine Mammal Bycatch along the Coast of Ghana during 2019-2020

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ABREVIATION AND ACRONYMS

APW	Ali Poli Watsa
CPM	Cetaceans Per Month
CPUE	Catch-Per-Unit-Effort
DGN	Drift Gillnet
GWS	Ghana Wildlife Society
LI	Legislative Instrument
MM	Marine Mammals
MoFAD	Ministry of Fisheries and Aquaculture Development
NFMP	National Fisheries Management Plan
UN/CBD	United Nations Convention on Biological Diversity
UN/CITES	United Nations Convention on International Trade in Endangered Species
UN/CMS	United Nations Convention on Migratory Species

EXECUTIVE SUMMARY

The Ghanaian coastal waters are favourable habitat for marine mammals (MM), due to seasonal upwelling, which increases productivity and ensures food availability. Ghana has enacted a number of laws intended to foster the conservation of biodiversity and protection of coastal environments. These include the Fisheries Act, 2002 (Act 625), Fisheries Regulation 2010 (LI 1968), and Wild Animal Preservation Act, 1961 (Act 43). Unfortunately, declining fish catches in recent years are gradually causing fisherfolk to target marine mammals (MM) previously caught as bycatch. Conservation of MM in Ghana therefore requires data on the MM bycatch landings from artisanal fisheries. This project received support from the Anderson Cabot Center for Ocean Life at the New England Aquarium to conduct a MM bycatch assessment along the coast of Ghana between March, 2019 and February, 2020. The primary objective of this assessment was to increase the level of understanding of MM bycatch along the entire coastal line of Ghana, and the socio-economic importance of MM bycatch to fisherfolk. The approach involved the selection of key fishing landing ports along the coast of Ghana, namely: Keta, Ada, Kpone, Apam, Mumford, Elmina, Shama, Dixcove, Axim, and Half Assini. The data sources involved records of the number and types of gear and vessels used for landing the animals, and an evaluation of possible seasonal influences. The most records of landed MM were reported from Dixcove (40%), followed by Shama (26%). A total of ten (10) identifiable MM species, largely made up of toothed whales or dolphins (odontocetes), were identified as landed bycatch during the study period. The species composition was dominated by the short-snouted spinner dolphin *(Stenella clymene),* which constituted 24% of the bycatch mostly by drift gillnets (DGN), followed by long-snouted spinner dolphin (*Stenella longirostris),* which formed 20% of the bycatch. The average estimated mean of landed cetacean catch-per-unit-effort (CPUE) and landed cetaceans per month (CPM) were estimated at 0.027 and 1.09, respectively. These estimates may be considered baseline information for future

assessments of changes in the level of the bycatch landings, because there are no available previous estimates from Ghanaian waters for comparison. Large pelagic fish species were normally landed when MM bycatch occurred. These included the frigate mackerel (*Auxis thazard),* and Indo-Pacific sailfish (*Istiophorus platypterus),* blue shark *(Prionace glauca)* yellowfin tuna *(Thunnus albacares),* skipjack tuna (*Katsuwonus pelamis),* blue marlin (*Makaira nigricans)* and the manta ray *(Manta birostris).* During the socio-economic assessment, we investigated the consumption levels of MM bycatch, perception, and traditional beliefs about MM among fisherfolk, and identification of possible changes in fishing practices to minimize bycatch of MM. The assessment revealed that fishing is the major source of livelihood for local communities, which is traditionally practiced by men due to the strict gender division of labour in fishing communities along the coast. Most respondents (87.9%) were married and therefore consider themselves as having responsibility for feeding their families. The majority had basic education (completion of school at a minimum of 14 years) and 79.5% of respondents had over 16 years working life experience. The use of diverse fishing gears such as "Ali-Poli-Watsa" (APW) (See Appendix 3), hook and line, DGN and set nets, ranging between 0.25 to 19 inches (lateral stretched) were common at the landing sites visited. The majority (97.4%) of respondents indicated sighting MM during their fishing operations, which suggests familiarity with the animals. Fisherfolk with positive attitudes towards MM explained that the occurrence of MM is an indicator of the abundance of pelagic fishes such as sardines, mackerel, and tuna, while those with a negative attitude towards MM complained that dolphins forage on fish caught in their nets and cause heavy economic loss due to the net damage from their foraging behaviours. At Keta, on the eastern coast of Ghana, whales are regarded as lesser gods and revered by the people whereas dolphins are equated to humans. Hence, both type of MMs were not landed. In contrast, there is apparent utilization of dolphin meat as food on the other parts of the coast (central and western), which is sold to fishmongers at average costs ranging between 100-300 Ghana

Cedis (equivalent to about US$20-US$60) for meat weighing between 30-50 kg. The gradual depletion of pelagic fish, cost incurred in mending nets destroyed by MM (especially whales), loans taken from banks, and poverty were some of the arguments raised by the fishers compelling them to illegally retain and ultimately sell accidentally caught MM to offset the losses. The survey revealed that 84.7% of fisherfolk were unaware of the National Fisheries Management Plan (NFMP 2015-2019), which, among other legal mechanisms, seeks to conserve biodiversity in the coastal waters of Ghana. This could be attributed to the high illiteracy rate recorded among the respondents or minimal awareness of the plan.

Practical recommendations on how to facilitate and strengthen the protection of MM include the following:

- Secure livelihoods through investment in training and support for alternative or diversified livelihoods such as aquaculture, vocation (e.g., soap making), and other types of agriculture-related businesses (e.g., poultry, snail farming).

- Improve communications with stakeholders about the role and importance of MM in the maintenance of ecological health of the marine ecosystem. This may be achieved through the collaboration of MoFAD (Ministry of Fisheries and Aquaculture Development) with stakeholders.

- Routine monitoring at key fish landing ports to enable data collection on MM bycatch to further understand trends in the landings.

1. INTRODUCTION

Local communities in Ghana depend on the environment for their livelihood and sustenance. Consequently, their daily activities and increasing demand for natural resources put pressure on already fragile ecosystems. Fishing has been a tradition along the coast of Ghana starting at least 800 years ago, and is currently the main occupation of coastal communities. The fisheries sector generates over $1 billion in revenues each year and provides livelihoods for an estimated 10 percent of the population (MoFAD, 2015). The marine artisanal fleet, consisting of approximately 10,000 canoes, contributed an estimated 73% of marine landings in 2014 (MoFAD, 2015). The artisanal sector employs approximately 100,000 fishermen and over 30,000 fish processors and traders. Thus, the maritime environment and associated natural resources have become a strategic national asset with considerable interest and attention. There are clear signs of overexploitation of important fish stocks resulting in significant economic losses, and conflicts over management strategies threaten the long-term sustainability of the fisheries and their contribution to nutrition and food security.

MM are distributed across all the world's oceans and therefore, wherever fishing operations occur, there is a risk of interaction with them. There is evidence of marine mammal (MM) bycatch occurring in all types of fishing gear-gillnets and entangling nets, hook and lines, traps, trawls, and beach seines. In Ghana, periodic monitoring of artisanal fisheries for MM bycatch in fish landing sites from 1996-2004 provided photographic and specimen evidence to validate the occurrence of 18 species (17 odontocetes and 1 mysticete) in its coastal waters (Van Waerebeek *et al*., 2008). Since the 1980s, dolphins have featured prominently in the "marine bushmeat" industry in West Africa, and Ghana is reported to rank high both in terms of species caught and landed volume as bycatch in the sub-region (Lüber and Toole, 2017). MM are freshly landed after entanglement, killed with piercing lance-like metals,

cutlasses and sticks when retrieved alive (Debra *et al.,* 2010, Van Waerebeek and Ofori-Danson, 1999). MM are also used as bait for catching sharks. According to Debra *et al.* (2010), three species are used--short-snouted spinner dolphin (*Stenella clymene),* pantropical spotted dolphin *(Stenella attenuata),* and common bottlenose dolphin *(Tursiops truncatus)*. Exploitation of MM is partly attributed to the drastic decline of fish catches and their availability as an alternative source of meat. Thus, increased bycatch of MM in the near future may be anticipated with growing decline in fish catches. Fortunately, through the National Fisheries Management Plan of Ghana (NFMP) (2015-2019), the Ministry of Fisheries and Aquaculture Development (MoFAD) declared a closed season for 2019--from the 15th of May through the 15th of June 2019 for the artisanal fishery--which indirectly favours reduction in MM bycatch landings. As part of the implementation arrangements, MoFAD is required by law to enforce the closed season on an annual basis.

Ghana is a party to a number of international conventions and treaties that *inter alia* seek to protect and conserve MM. The relevant national and international legal requirements in place include: Fisheries regulations, 2010 (LI 1968)- Sections 9, 11, 17 and 21; Fisheries Act, 2002- Sections 90-93; Wild Animal Preservation Act, 1961 (Act 43); Environmental Protection Agency Act, 1994, (Act, 490)-Section 28; and Petroleum Commission, 2011 (Act, 821). Relevant international regulations include the United Nations Convention on Biological Diversity (UN/CBD); the United Nations Convention on International Trade in Endangered Species (UN/CITES)-Appendix II; the United Nations Convention on Migratory Species (UN/CMS) and the Abidjan Convention, 1981- Article 11. These initiatives require MM to be treated as bycatch or unintended catch and hence legally require them to be released when captured during fishing operations.

In view of the need to obtain urgent data on the growing bycatch landings from the coastal waters of Ghana, Ghana Wildlife Society (GWS), with support from the Anderson Cabot

Center for Ocean Life at the New England Aquarium, conducted a MM bycatch assessment along the coast of Ghana. This report provides results of a twelve-month (March 2019 to February 2020) assessment of MM bycatch at key fish landing sites along the coast of Ghana.

1.1 Assessment Aim and Objectives

Aim

The aim of this assessment was to increase the level of understanding of MM bycatch and socio-economic contributions of MM to fisherfolk along the entire coastline of Ghana.

Objectives

a. To investigate bycatch and key fishing methods that help establish a baseline for subsequent monitoring of MM in Ghanaian coastal waters

b. To update the species composition of MM bycatch along the coast of Ghana

c. To investigate the socio-economic perceptions about MM within communities along the coast of Ghana

d. To provide new field data for national planning and policy towards conservation of MM in Ghana

2. ASSESSMENT METHODS

2.1 The Coastal Zone of Ghana

Ghana is situated between longitudes 3° 15′ W and 1° 12′ E, and latitude 4° 44′ and 11° 15′ N. The country is bordered on the east by the Republic of Togo, to the west by Ivory Coast, to the north by Burkina Faso and to the south by the Gulf of Guinea. Four administrative regions, namely the Western, Central, Greater Accra and Volta Regions, form the coast of Ghana (see Figure 1). The territorial area of Ghana has a land area of 238,533 km^2 with an Exclusive Economic Zone (EEZ) of 110,000 km^2. The 550 km-long (341 miles) coastline is mostly a low, sandy shore backed by plains and scrub, and intersected by several rivers and streams, most of which are navigable only by canoe. The west coast of Ghana comprises fine sand with gentle beaches backed by coastal lagoons. The central coast represents an embayed coast of rocky headlands and littoral sand barriers enclosing coastal lagoons. The eastern coast is completely sandy and characterized by the deltaic features of the Volta River. Ghana is under the influence of tropical humid climatic conditions and experiences two major seasons, namely the rainy season and dry season, brought about by the harmattan, a dry dusty wind that blows along the northwest coast of Africa. Mean maximum rainfall is about 2000mm/annum while the mean minimum rainfall is 900mm/annum occurring around the southeastern part of Ghana (Accra-Aflao) and in the southwestern portions (Axim). Mean maximum temperature is between 30°C - 35°C, and the minimum mean temperature falls within 21°C - 23°C (Tamale and Wilson, 2003).

2.2 Bycatch Assessment Selected Sites

The study was conducted along the coast of Ghana at selected key fish landing sites. The selected fishing landing stations were: Keta, Ada, Kpone, Apam, Mumford, Elmina, Shama, Dixcove, Axim, and Half Assini (Figure 1).

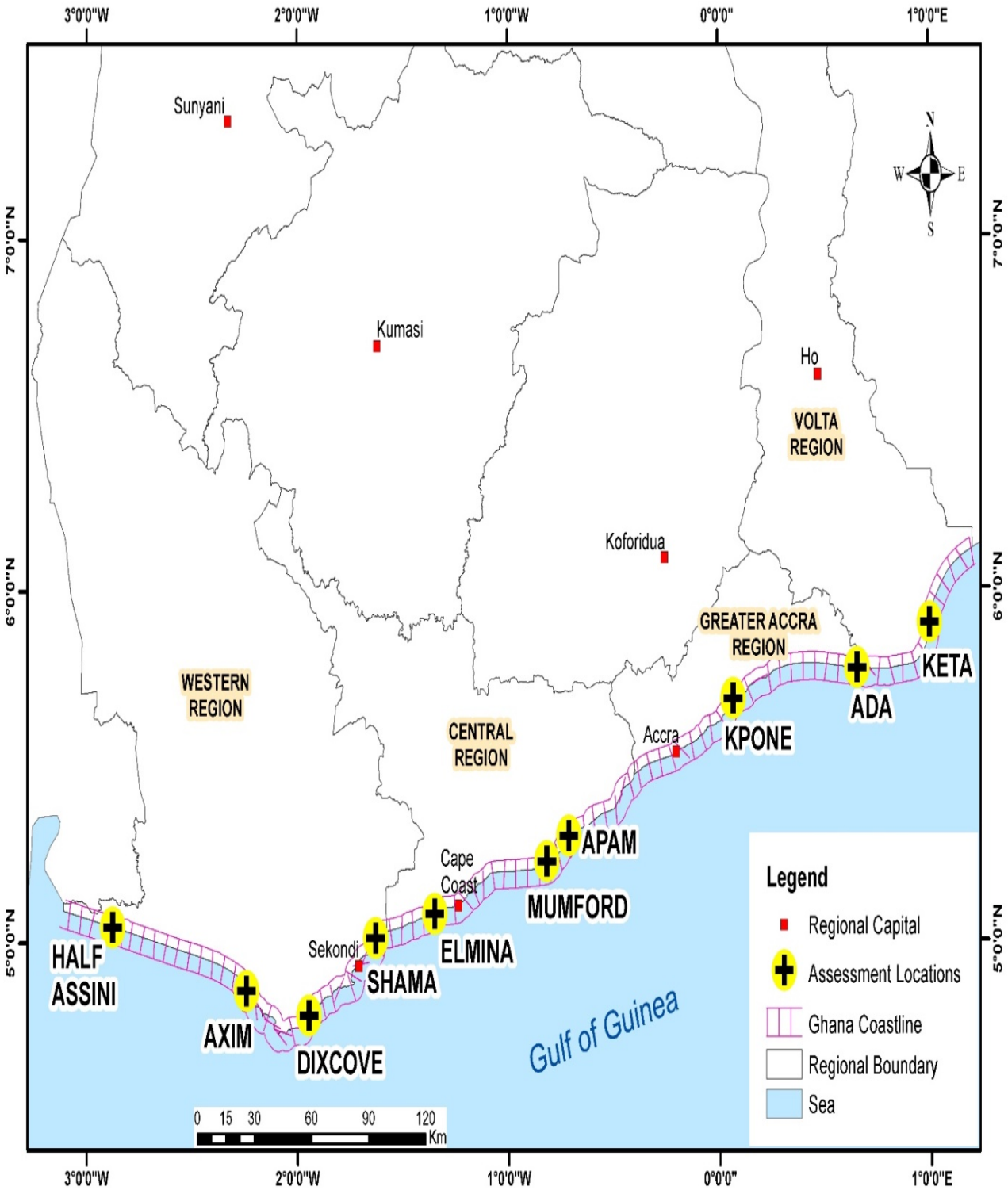

Figure 1: Map showing the distribution of the selected fish landing sites along the coast of Ghana.

2.3 MM Bycatch Landing Assessment

The bycatch assessment plan was designed in collaboration with Fisheries Commission (FC) staff of Ghana. The objective was to conduct one year of MM bycatch assessment during the project period March 2019 to February 2020. The assessment involved documenting MM that were landed on the beaches. Data were collected in collaboration with Fisheries Commission officers stationed at all the selected fishing landing sites. An assessment day consisted of the active monitoring of fisheries landing sites to record MM landings. The data required to be collected by hired FC staff included: location, time of canoe landing, number and type of gear used, daily fishing effort (number of boats, total landings, and catch sizes) (Appendix 1). Records were taken on the position (using a Garmin GPS map 60Cx) of all ten landing stations (Figure 1). Estimates of the monthly MM bycatch landed (numbers per artisanal canoe) at the landing sites were made while recording the fishing gear utilized. The data enabled monitoring of the variation in estimated MM bycatch per month referred to as cetaceans landed per month (CPM) and catch-per-unit-effort (CPUE) during the period. FC officers also used photographic documentation at fish landing sites, to catalogue the landed bycatch, and for identification and authentication using illustrations in Van Waerebeek and Ofori-Danson (1999).

2.4 Socio-economic Assessment

Structured interviews on local perceptions of MM were conducted at the selected study sites through a closed-ended questionnaire (See Appendix 2). These involved face-to-face interviews intended to record candid and in-depth responses. The objective was to understand the socio-economic importance of the landed MM bycatch, and to investigate aspects of traditional beliefs associated with MM in Ghana. Ten landing sites were visited: Keta, Ada, Kpone, Apam, Mumford, Elmina, Shama, Dixcove, Axim, and Half Assini. On

arrival at a landing port the chief fisherman and elders were informed about the project. The project team used advice from FC officers who had local knowledge of the communities to target relevant stakeholders for the interviews. In advance of conducting the interviews, the nature of the assessment and contents of the questionnaire were explained to respondents/fishermen. Participation was voluntary. The closed-ended questionnaire gave fishermen a range of possible answers to choose from, which facilitated data analysis. The questionnaires were administered to fishermen aged 18 years and above as respondents falling within this range were assumed to have better knowledge and understanding of the socio-economic importance of MM. Questionnaires were administered to a total of 190 fishermen. This number was influenced by the willingness of fishermen to speak to the team.

3. ASSESSMENT RESULTS

3.1 Distribution of MM Bycatch by Fishing Sites for the First Four Months (March-June 2019) of the Assessment (Selected Sites)

Figure 2 shows the percentage distribution of the bycatch at the selected sites along the coast of Ghana. According to the figure, most of the bycatch landings were recorded at Dixcove (n=35), which constituted 40% of the bycatch landings. This was followed by Shama (n=19), which formed 21% of the landings, Apam (n=12) constituting 14%, Axim 9% of the landings (n=8), and Elmina (n=6) representing 7%. The least recorded landings were at Mumford (n=3) and Half Assini (n=5) forming 3% and 6%. There were no records of any MM bycatch landings at Keta, Ada, and Kpone during the period.

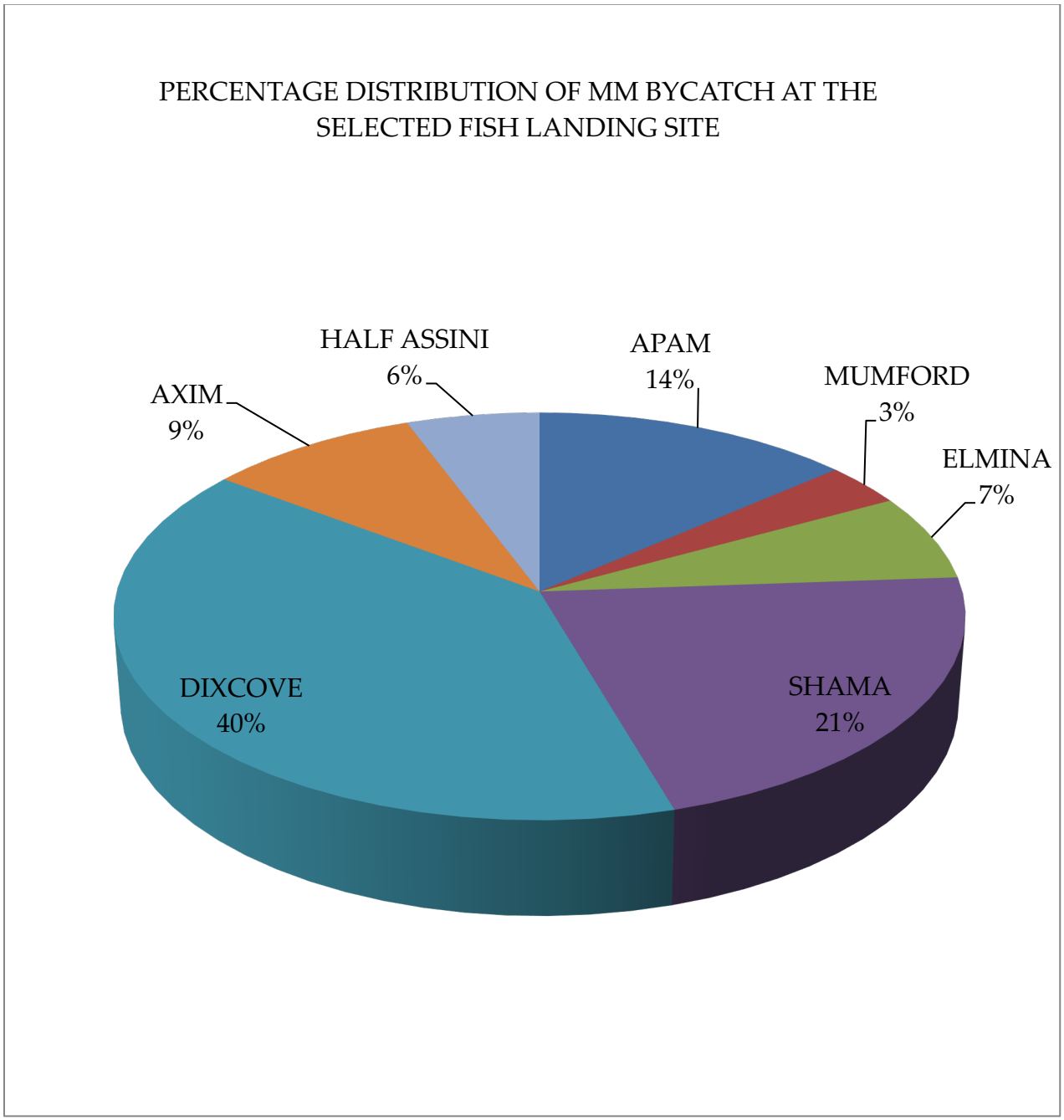

Figure 2: Distribution of MM bycatch by fishing sites.

In view of the paucity of bycatch landings at the eastern coast and selected fishing sites (Keta, Ada, and Kpone) and traditional reverence for the animals (See Section under Socio-economics), further studies excluded these sites from the monthly surveys and analysis.

3.2 Distribution of MM Bycatch by Fishing Sites During the Assessment from March 2019-February 2020 (Selected Sites)

Figure 3 shows the distribution of bycatch according to the selected sites; excluding Keta, Ada, and Kpone, (see section 3.1 for an explanation). Most of the bycatch specimens (Plates 1, 2, and 3) were recorded at Dixcove (n=209), which constituted 53% of the bycatch landings, followed by Shama (n=104), which formed 26% of the total landings, Apam (n=28) and, Axim (n=25) representing 7% each, and Elmina (n=17) representing 4%. The least recorded landings were at Mumford (n=5) and Half Assini (n=9) forming 1% and 2%.

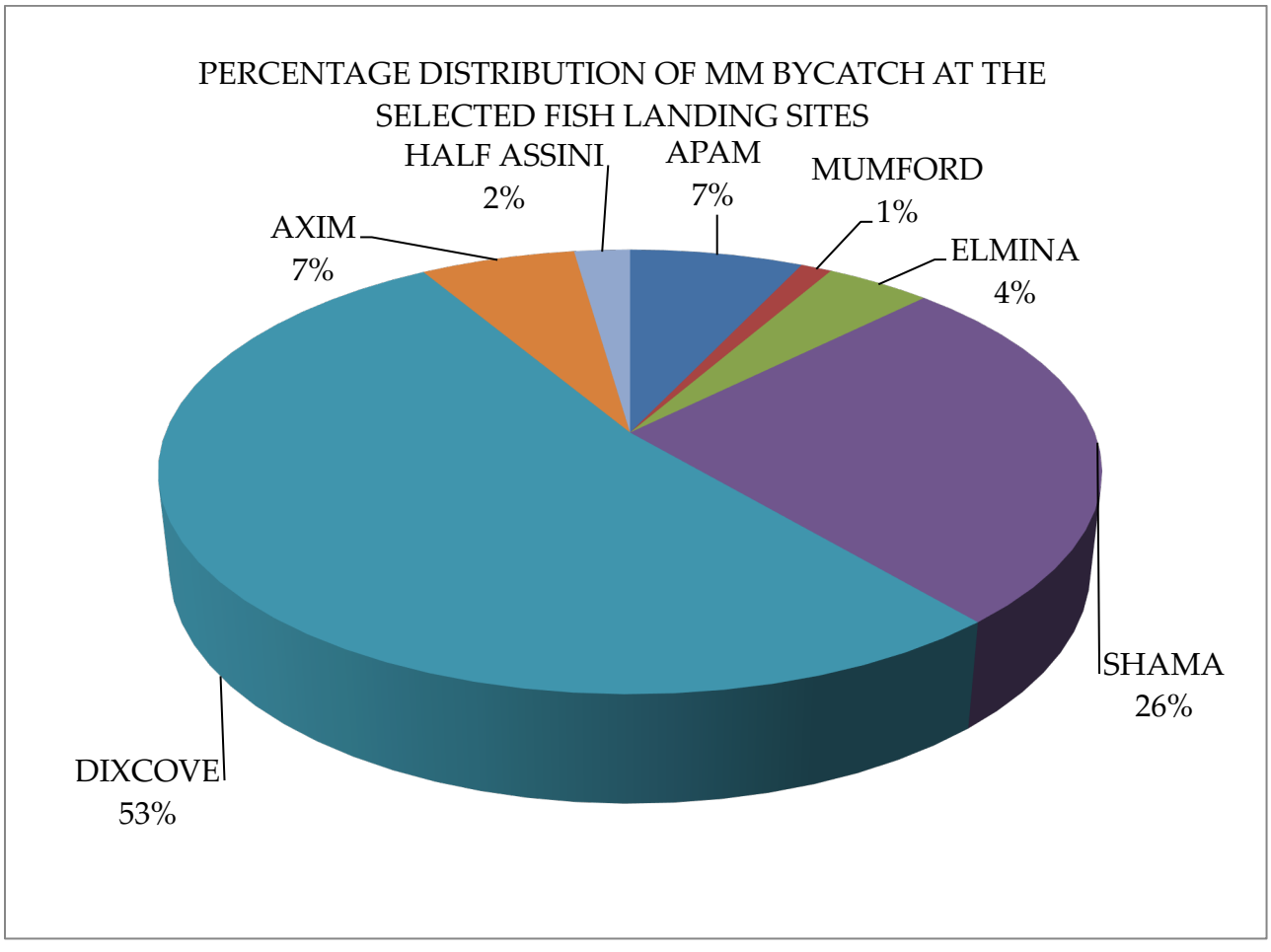

Figure 3: Percent distribution of MM bycatch at the selected fish landing sites.

Plate 1: GWS staff during assessment at Dixcove.

Plate 2: Short-snouted spinner dolphin (*Stenella clymene*) at Dixcove.

Plate 3: GWS volunteer during assessment at Axim.

3. 3 Monthly Variation of MM Bycatch

Figure 4 shows the variation in estimated individual MM bycatch (n=397) of cetaceans per month (CPM). According to the figure, there was a gradual increase in CPM values from March with a peak in October and gradual decline to February. Thus, most of the bycatch was recorded in October (CPM= 1.8). This may be attributed to the peak migration period of MMs, particularly humpback whales (*Megaptera novaeangliae),* into the coastal waters of Ghana (Weir, 2013). However, this requires further study of migration patterns. The month with the next highest CPM (1.7) occurred in September. The lowest CPM was from May with a value of 0.4, which could be attributed to the closure of the fishing season by MoFAD

during this month in 2019. The overall mean CPM was 1.09. The bycatch data were normally distributed when tested for normality using the Shapiro – Wilk test (p-value = 0.731> 0.05). Statistical mean comparison test using a t-test was subsequently run to determine if the differences of the mean across months were significant. A t-test of p-value = 0.00< 0.05 suggests that there was a significant difference in bycatch across the months of the year. This is expected because the CPM varies in response to behavioural changes associated with the time of day and season of the year. On the other hand, the regular occurrence of the MM suggests they are in a suitable environment for them.

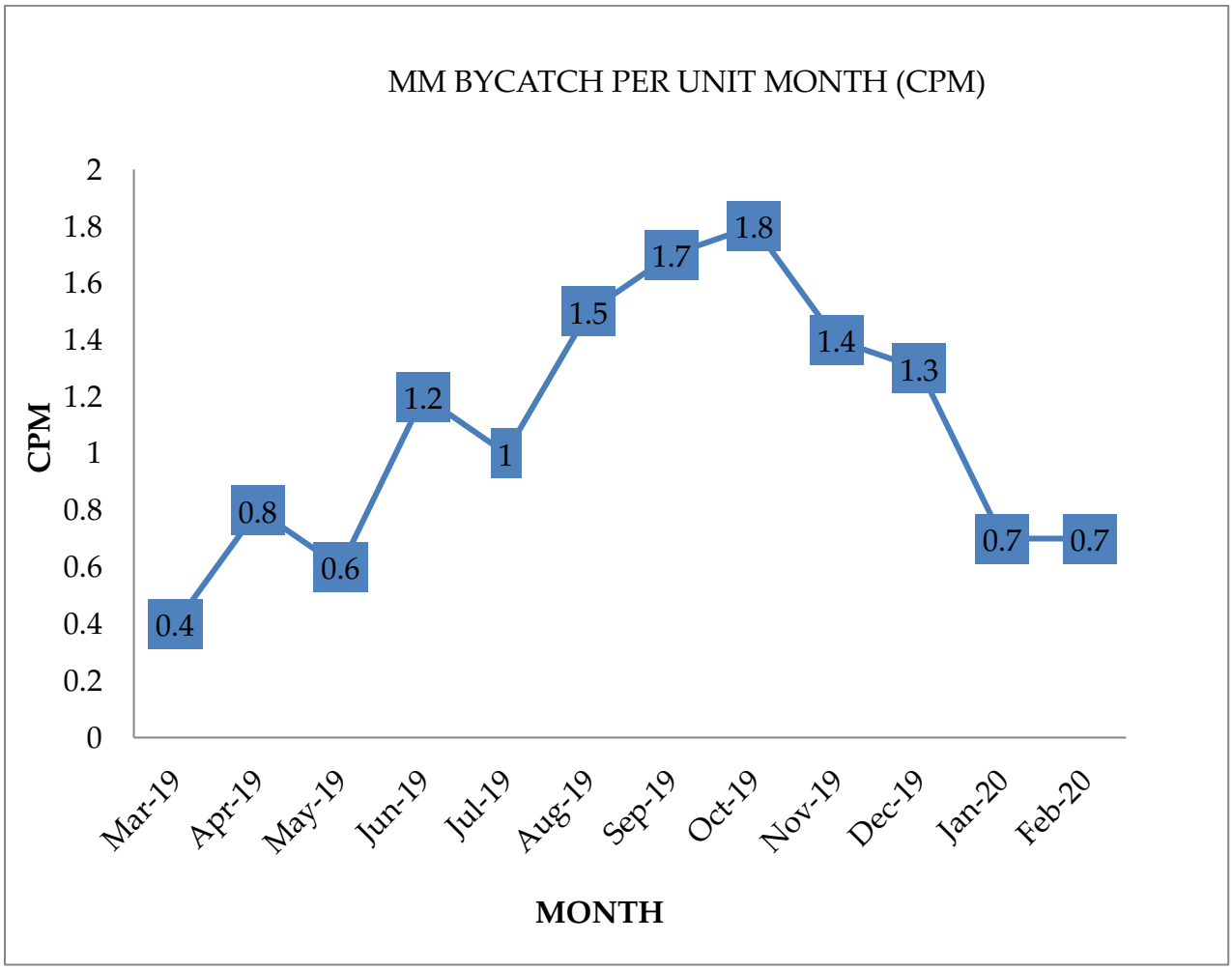

Figure 4: Monthly variation in the estimated MM bycatch per month (CPM).

3. 4 Fishing Effort Recorded Per Month

Figure 5 shows fishing effort as defined by the number of active canoes landing fish at the selected sites. The data show that fishing effort was regular from March to April, implying continuous fishing until the closure in May. The fishing effort was highest in March with a mean fishing effort value of 8.4 canoes per day, followed by the month of April (8.1) and July (8.1) respectively. The lowest effort was recorded in May (3.2) likely due to the closure to fishing during this month by the Ministry of Food and Aquaculture Development (MOFAD) as a management strategy to protect spawning aggregations.

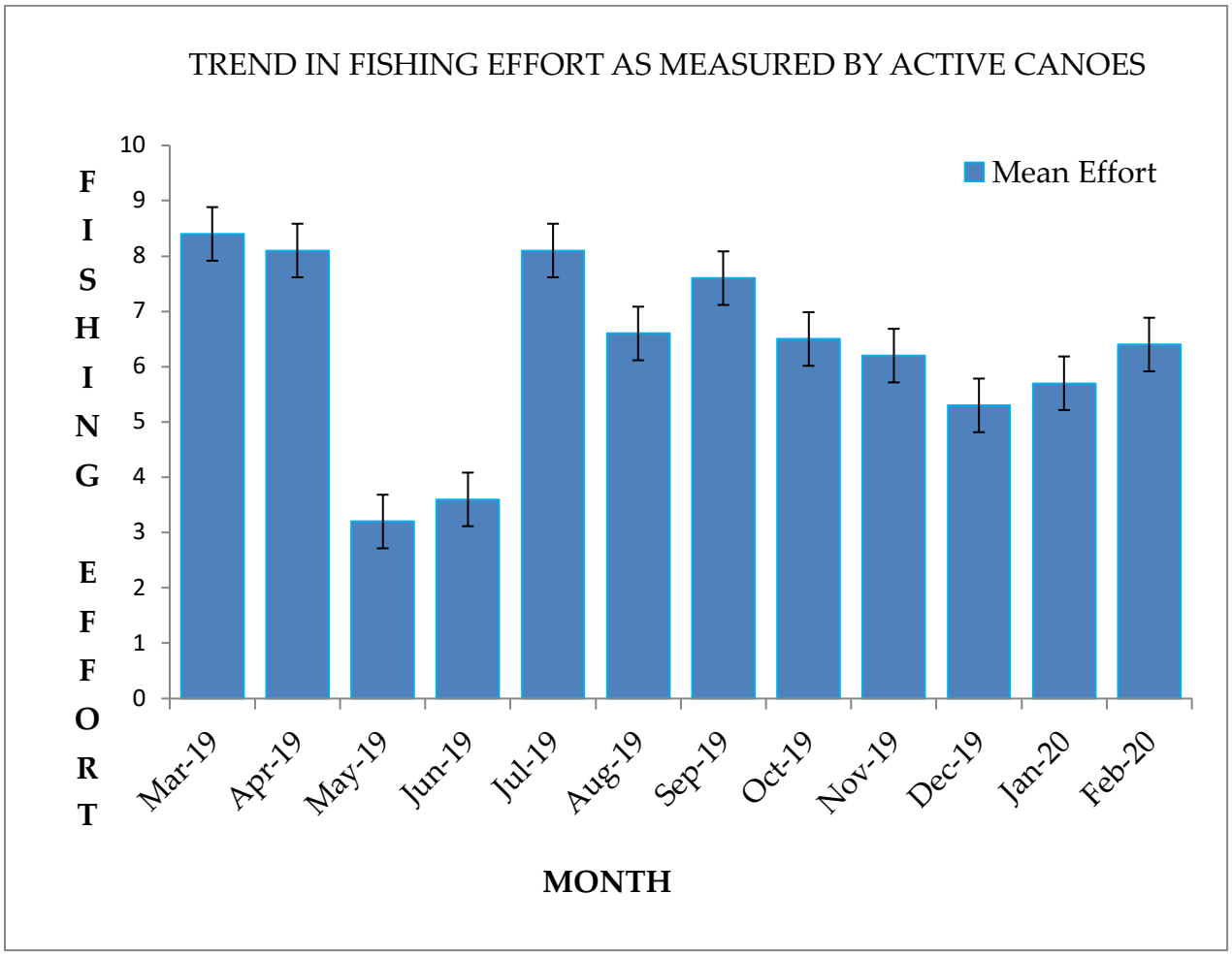

Figure 5: Mean monthly variation in fishing effort as measured by number of active canoes per day at the selected fishing ports.

3. 5 Monthly Catch-Per-Unit-Effort (CPUE)

The data source for the assessment of the CPUE was fisheries-dependent rather than fisheries-independent. Thus, data on otherwise alternative units of fishing effort such as net area fished; number of nets deployed; hours fished and horsepower used in fishing were not adopted. The study therefore used the number of active canoes landing bycatch as the measure of unit of fishing effort. This figure was the basis for estimating the CPUE with the assumption that the number of canoes is directly related to the number of marine mammal bycatch landed. Figure 6 shows the mean monthly variation in estimated MM bycatch per effort, measured as the numbers of MM landed per canoe (effort) per day, generally referred to as catch per-unit-effort (CPUE). According to the figure, the CPUE recorded was highest in October 2019 with an estimated CPUE value of 0.046. The mean CPUE value as recorded was estimated as 0.027.

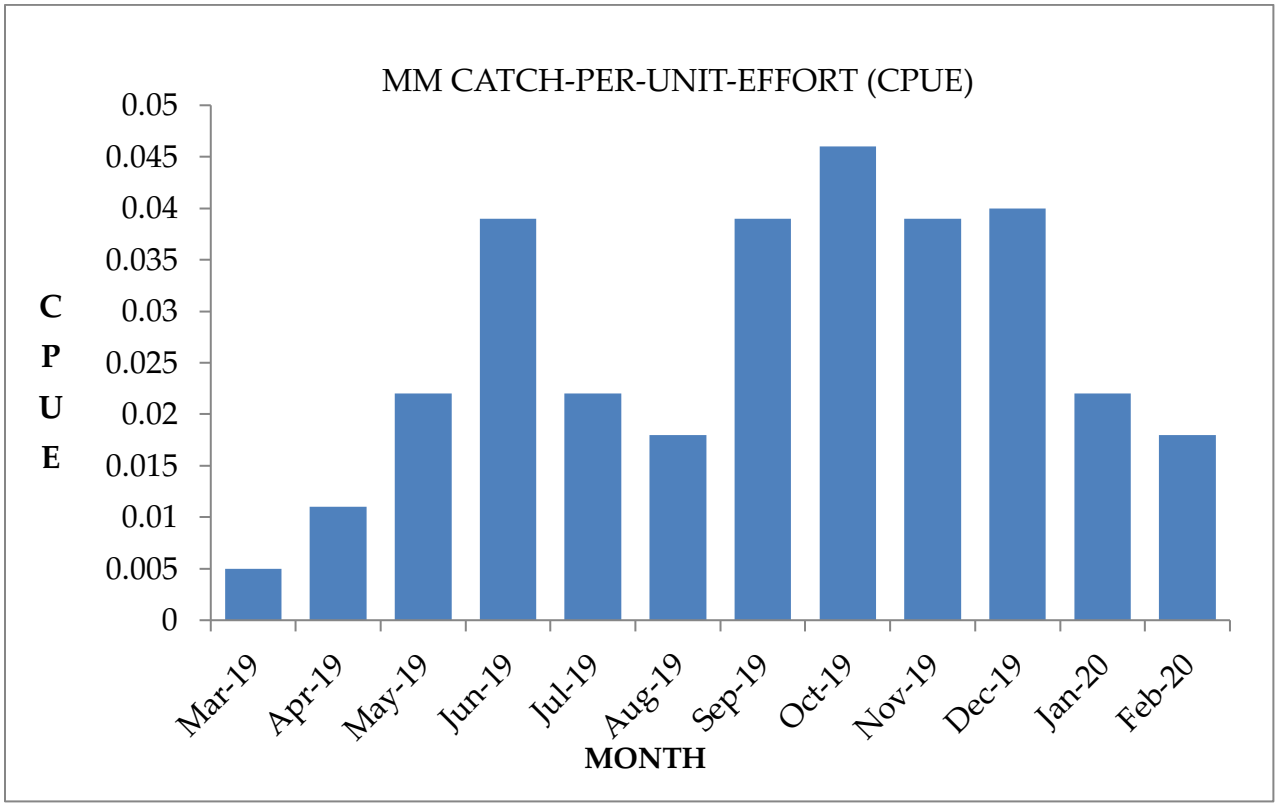

Figure 6: Monthly variation in estimated MM bycatch catch-per-unit-effort (CPUE).

3.6 Species Composition of Landed MM Bycatch During March to February 2020

A total of ten (10) small MM species (mostly toothed whales or odontocetes) were identified as bycatch**.** The most abundant species recorded was the short-snouted spinner dolphin (*Stenella clymene*), which constituted 24% as bycatch mostly by DGN **(**Plate 14, below). Other gears encountered are listed in Appendix 3. This was followed by long-snouted spinner dolphin (*Stenella longirostris*), with 20% of total bycatch landings. Some of the specimens could not be identified because of their condition, including those sliced to pieces (Plate 15). According to available literature reports, the encountered bycatch species are normally distributed in both inshore and offshore habitats (Table 1). This suggests that the artisanal fishers do not limit themselves to the inshore but also utilize offshore fishing grounds in their operations.

Table 1: List of landed MM species identified as bycatch.

NO.	COMMON NAME	SCIENTIFIC NAME	IUCN RED LIST CATEGORY	SEASONALITY	MAIN HABITAT	NUMBER	PERCENTAGE
1	Atlantic spotted dolphin	*Stenella frontalis*	Least Concern Braulik and Jefferson (2018)	Unknown	Coastal/offshore Braulik and Jefferson (2018)	4	1
2	False killer whale	*Pseudorca crassidens*	Near Threatened Baird (2018)	All year	Coastal/offshore Baird (2018)	8	2
3	Fraser's dolphin	*Lagenodelphis hosei*	Least Concern Kiszka and Braulik (2018)	All year	Offshore Kiszka and Braulik (2018)	27	7
4	Long-snouted spinner dolphin	*Stenella longirostris*	Least Concern Braulik and Reeves (2018)	Unknown	Coastal/offshore Braulik and Reeves (2018)	81	20
5	Melon-headed whale	*Peponocephala electra*	Least Concern Kiszka and Brownell (2019)	All year	Offshore Kiszka and Brownell (2019)	32	8

6	Pantropical spotted dolphin	*Stenella attenuata*	Least Concern Kiszka and Braulik (2018)	All year	Coastal/offshore Kiszka and Braulik (2018)	5	1
7	Pygmy killer whale	*Feresa attenuata*	Least Concern Braulik (2018)	All year	Offshore (slope and deep water areas) Braulik (2018)	8	2
8	Rough-toothed dolphin	*Steno bredanensis*	Least Concern Kiszka, Baird, and Braulik (2019)	Unknown	Coastal/offshore Kiszka, Baird, and Braulik (2019)	62	16
9	Short-snouted spinner dolphin	*Stenella clymene*	Least Concern Jefferson and Braulik (2018)	Unknown	Coastal/offshore Jefferson and Braulik (2018)	97	24
10	Short-finned pilot whale	*Globicephala macrorhynchus*	Least Concern Minton, Braulik, and Reeves (2018)	All year	Offshore Minton, Braulik, and Reeves (2018)	39	10
	Unidentified species					34	9
	Total					**397**	**100**

Plate 4-14 shows pictures of key MM species identified from the catches of the local fishers. On the basis of photographic frequency of the species, short-snouted spinner dolphin (*Stenella clymene)* was found to dominate with 24%, followed by long-snouted spinner dolphin *(Stenella longirostris)* at 20%, and Atlantic spotted dolphin *(Stenella frontalis*) and pantropical spotted dolphin (*Stenella attenuata)* recorded as the least.

Plate 4: Fraser's dolphin *(Lagenodelphis hosei*).

Plate 5: Pantropical spotted dolphin (*Stenella attenuata).*

Plate 6: Atlantic spotted dolphin (*Stenella frontalis*).

Plate 7: False killer whale (*Pseudorca crassidens*).

Plate 8: Long-snouted spinner dolphin (*Stenella longirostris*).

Plate 9: Short-snouted spinner dolphin (*Stenella clymene*).

Plate 10: Short-finned pilot whale (*Globicephala macrorhynchus*).

Plate 11: Melon-headed dolphin (*Peponocephala electra*).

Plate 12: Rough-toothed dolphin (*Steno bredanensis*).

Plate 13: Pigmy killer whale (*Feresa attenuata*).

Plate 14: Photo of a pile of DGN fishing net deployed per canoe**.**

3.7 Sliced Bycatch MM Species

During the assessment, the team observed freshly landed MM bycatch sliced with cutlasses at key sites along the study area (See Plate 15 below). However, it is possible that some of the dolphins were sliced at sea aboard the canoes for easier or direct utilization as bait for catching sharks, and possibly to avoid the attention of fisheries authorities at the selected sites. Informal interviews with local communities within the area indicate that dolphin bycatch is used as bait out at sea (without being landed) and also meat for consumption, possibly because of declining fish catches. Thus, there is a need to assess the level at which the dolphins are sliced at sea, that would suggest the bycatch estimates could be higher than values obtained from landed MM at the fish landing ports.

Plate 15: Photo of sliced MM at Shama.

3.8 Fisheries-MM Interactions

In order to investigate the interaction of fish species with MM, this study recorded for any given canoe that landed fish species that were caught together with MM. Table 2 below shows the list of key regular fish species encountered alongside MM bycatch. The fish species were mostly large pelagic representatives such as tunas, sailfish, frigate mackerels, rays and sharks. This suggests the co-existence of MM with these pelagic fish species on the fishing grounds, and catch of MM in the same areas where these species occur. Two (2) of the common fishes encountered are shown in Plates 16 and 17**,** namely the frigate mackerel (*Auxis thazard),* and Indo-Pacific sailfish (*Istiophorus platypterus),* respectively**.**

Table 2: Common fish species caught alongside MM as bycatch.

Family	**Species**	**Common name**
Carcharhinidae	*Prionace glauca*	Blue shark
Scombridae	*Katsuwonus pelamis*	Skipjack tuna
Scombridae	*Auxis thazard*	Frigate mackerel
Scombridae	*Thunnus albacares*	Yellowfin tuna
Scombridae	*Euthynnus alletteratus*	Little tunny
Istiophoridae	*Istiophorus platypterus*	Indo-Pacific sailfish
Istiophoridae	*Makaira nigricans*	Blue marlin
Mobulidae	*Manta birostris*	Manta ray

Plate 16: Frigate mackerel (*Auxis thazard*).

Plate 17: Indo-Pacific sailfish (*Istiophorus platypterus).*

3.9 SOCIO-ECONOMIC CONTRIBUTION OF MM

3.9.1 Major sources of livelihood

The assessment showed that fishing is the major source of livelihood for the fishermen interviewed, accounting for 99.5% of the total respondents (Plate 18). Only 1 respondent mentioned crop farming as a major source of livelihood. According to him, he only engaged in fishing occasionally when the profits from his farming activities were not sufficient.

Plate 18: GWS socio- economic team conducting interviews at Ada, Keta, and Apam.

In a nostalgic tone, one respondent at Dixcove recounts; "About 30 years ago, the fishing was a very lucrative job and fish was in abundance and if you were a fisherman you were a huge support to your family. You didn't even have to go beyond 1 km to catch your desired fish. At that time there was no light fishing and we were not landing small pelagic either. Officials from the fisheries department came to inspect the fish caught and if it was not the required type, they will seize it and get you arrested. But because we do not land large, desired fish like in the past and even pelagic fish, we are compelled to target MM to enable us sustain our livelihood and take care of our families."

3.9.2 Age of respondents

Figure 7 shows the age range of fisherfolk along the coast. From the figure, 33.2% of the respondent falls in the age category of 40-49, followed by the 50 and above category (31.6%). The category less than 30 was the smallest group (11.1%).

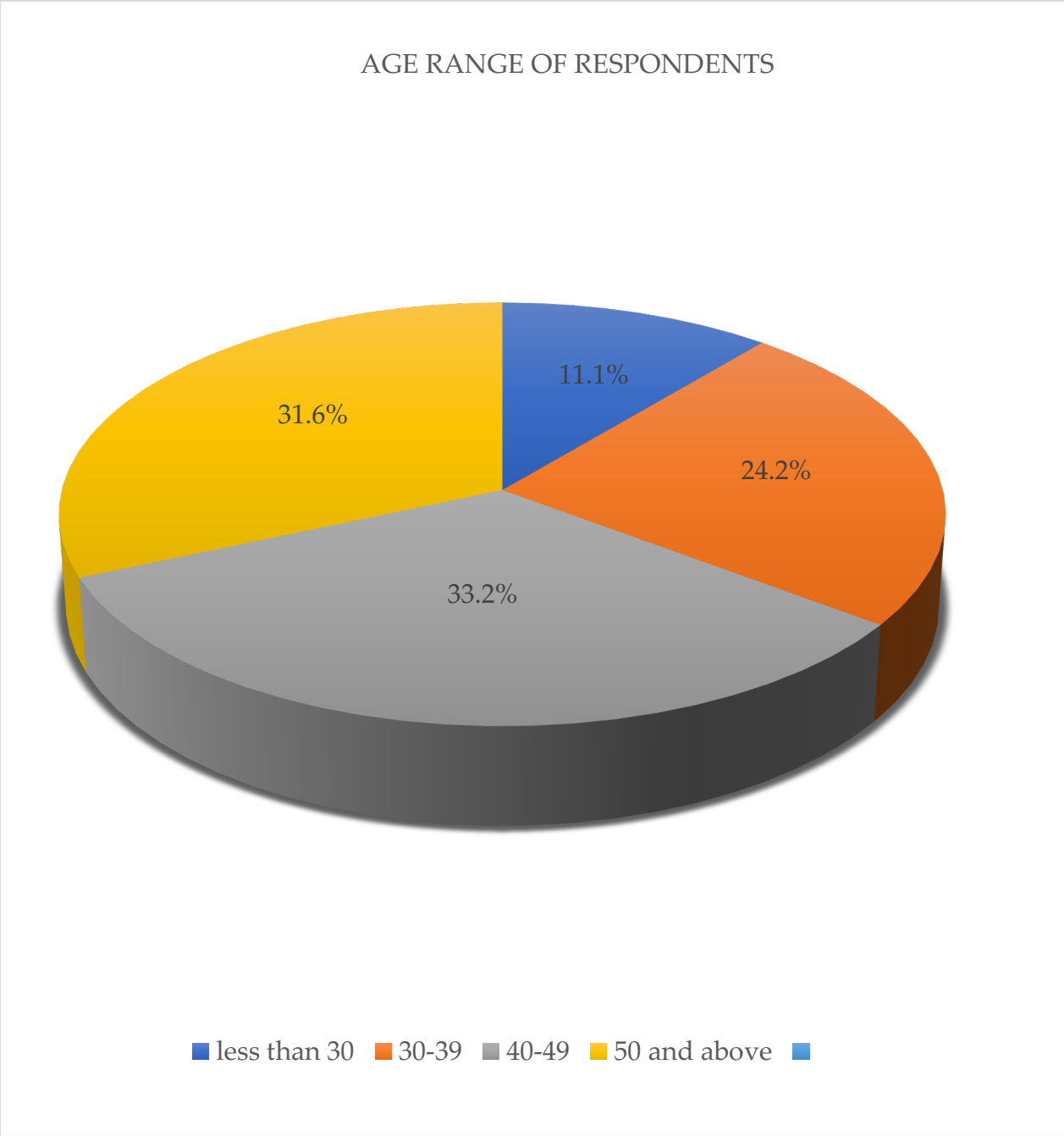

Figure 7: Age of range of respondents in the 10 selected fishing landing sites.

3.9.3 Educational level of fishermen

To determine the literacy status of fisher folk, respondents were asked about the level of education they achieved. Figure 8 shows that 69 people representing 36.3% percent of the respondents were illiterate while a large number, 101 persons representing 53.2%, had basic education (completion of school to a minimum age of 14 years). Interestingly, only one respondent (fisherman) had education up to the post-secondary level. It was not surprising to find that these fishing communities, like other rural populations, have lower levels of literacy and formal education than their urban counterparts.

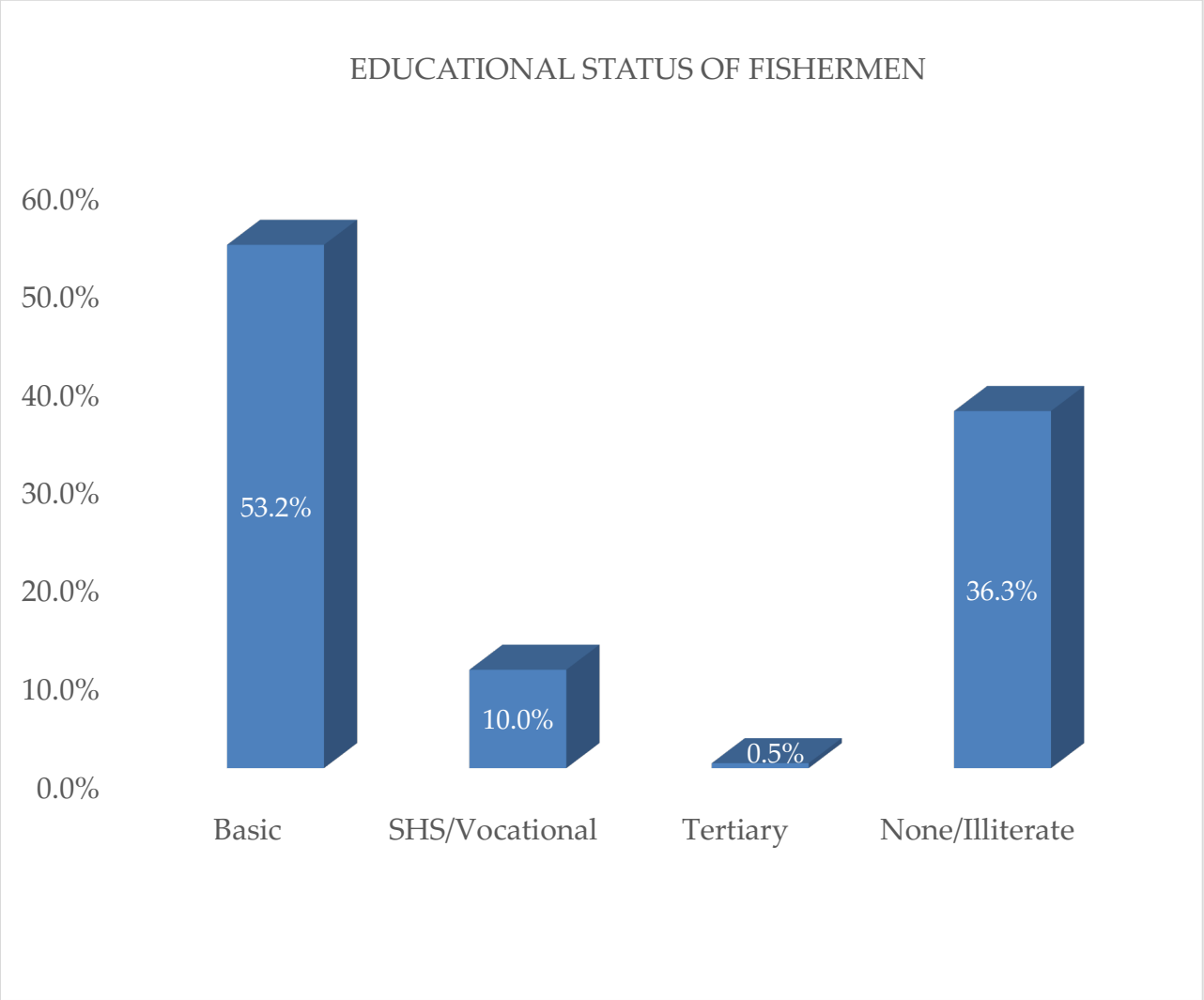

Figure 8: Educational status of fisher folk in the 10 selected fishing landing sites.

3.9.4 Working experience in fishing among respondents

Table 3 shows the number of years fishermen have been involved in fishing activities. According to the table, the majority of the respondents (79.5%) had above 16 years working life experience, indicating that most of them are experienced in the job.

Table 3: Years of working experience in fishing among respondents.

Years category	Frequency	Percent	Cumulative Percent
1-4	7	3.7	3.7
9-12	5	2.6	6.3
13-16	27	14.2	20.5
Above 16	151	79.5	100.0
Total	190	100.0	

3.9.5 Mesh and sizes of gears deployed by fishermen

The 'Ali-Poli-Watsa" (APW) and hook and line were commonly used among fishermen in Mumford, Apam, and Ada Foe. Drift gillnet (DGN) and set nets were commonly used in Dixcove, Keta, and Kpone. At Axim, the gear used by fishermen were DGN and beach seine. At Elmina and Half Assini, set nets and APW were used while DGN was common among fishermen in Sharma. In other words, the types and mesh sizes of gears varied from one fish landing site to the other. The mesh sizes ranged from as small as 0.25 inches to as large as 19 inches (lateral stretched). However, mesh sizes of 1-3 inches were the most common

(Figure 9). The use of diverse fishing gears is common among artisanal fishing communities as asserted by Quagrainie and Chu (2019). All the fishermen interviewed used canoe boats with inboard or outboard engines. The use of monofilament nets with mesh size less than 2.95 inches indicates that the majority (64.2%) of fishermen were violating the Fisheries Act, 2002- Sections 90-93. The implication is that most fishermen are landing juvenile fish leading to a growth in overfishing.

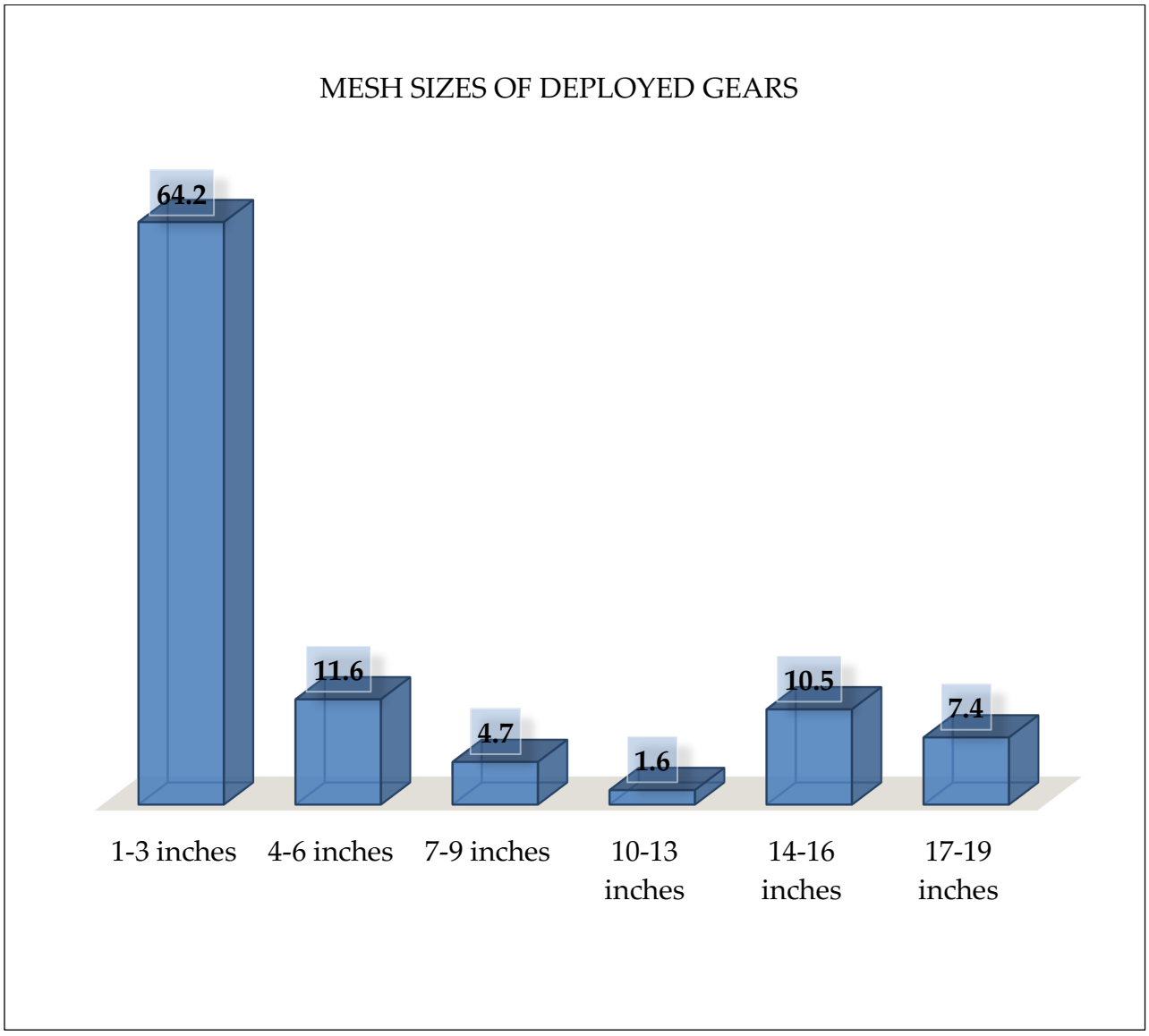

Figure 9: Mesh sizes of recorded gears used by fishermen.

3.9.6 Opinions of fishers on the importance of MM

Figure 10 shows the reported significance of MM to fishermen, especially those at Keta, Kpone, and Ada. 75.8% (n=145), of all respondents mentioned that MM were important to fishing. They explained that the occurrence of MM is related to the abundance of pelagic fishes such as sardines, mackerel, and tuna, and that the species help them in navigating to areas where they can find an abundance of pelagic fishes. 24% (n=45) of respondents were of the view that MM are not important to fishing. They complained that dolphins feed on fish caught in their nets and caused heavy economic loss due to the net damage by dolphins' foraging behaviours. Hence, they are sometimes killed deliberately in retaliation.

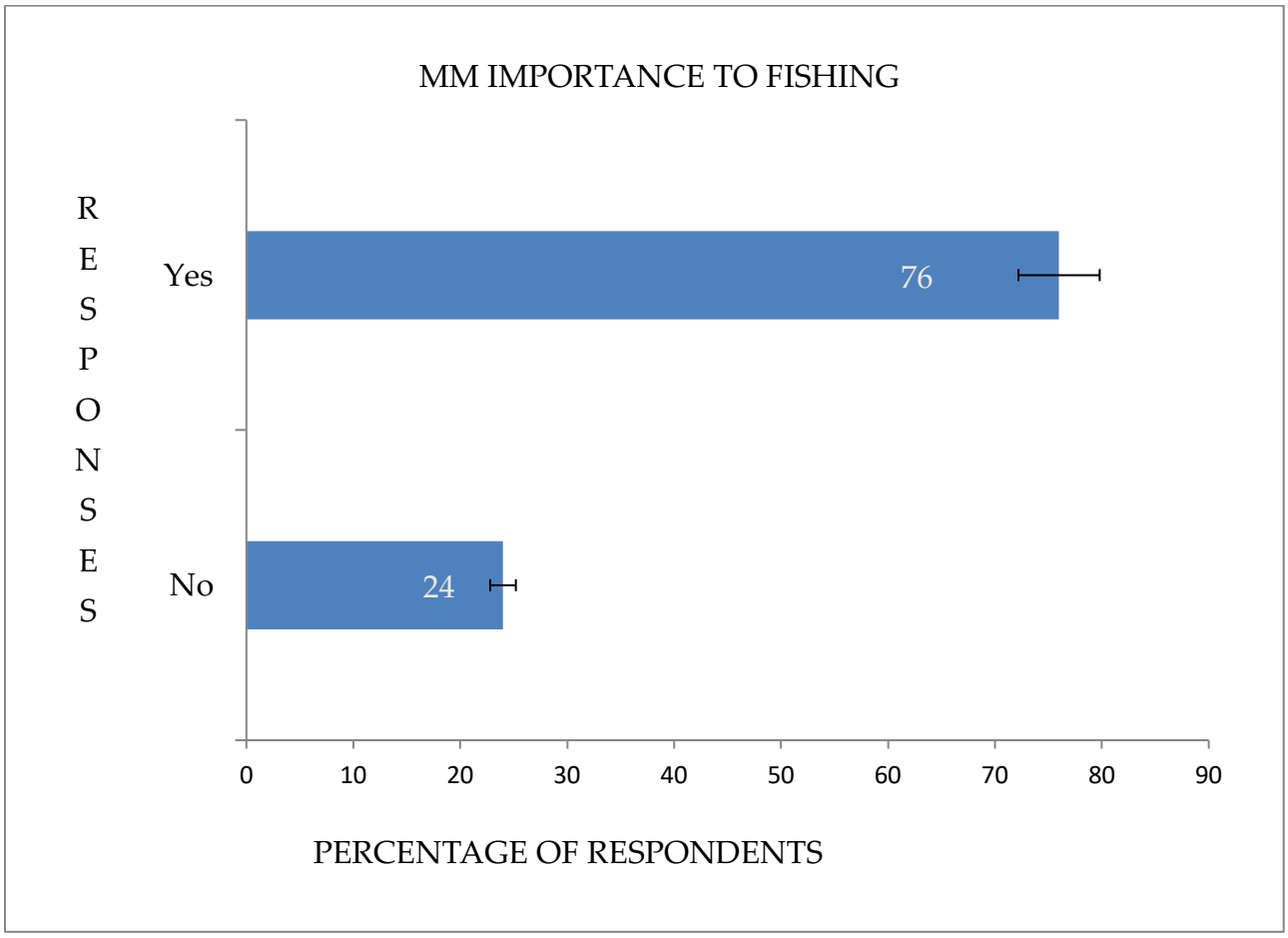

Figure 10: Reponses on whether MM are important to fishing.

3.9.7 Sighting of MM during fishing

Figure 11 shows the percentage of fishermen who reported sightings (97.4%) of MM during fishing. Only 2.6% of respondents indicated that they have never sighted MM during their entire life spent fishing. The result indicates that almost all the fishers have sighted MM during their fishing operations and that MM are commonplace in the coastal waters of Ghana.

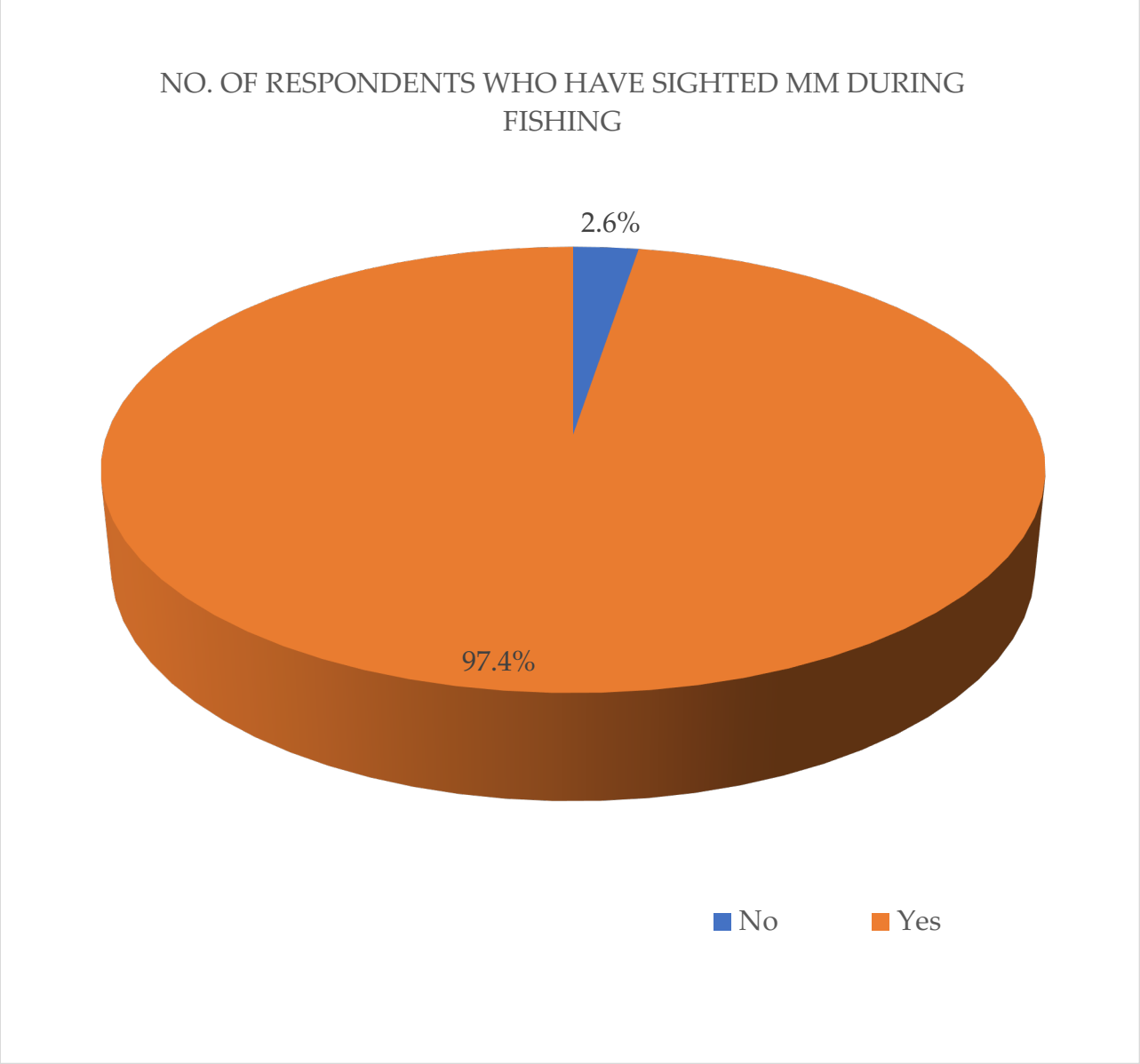

Figure 11: Number of respondents who reported sighting MM.

3.9.8 Number of respondents who have caught MM in their nets

Table 4 shows the number of fishermen who responded to have caught MM in their nets. Out of the total number of 190 respondents, 149 representing 78.4% reported MM in their nets. 21% of the respondents indicated they have never caught MM in their net during fishing.

Table 4: Responses of fishermen (respondents) who have caught MMs in their nets.

Responses	Frequency	Percent	Cumulative Percent
No	41	21.6	21.6
Yes	149	78.4	100
Total	190	100	

3.9.9 Opinions of fishers on whether catch of MM is increasing or decreasing

Table 5 shows respondents' opinions on the catch (increasing or decreasing) of MM at the selected sites. "Don't know" (11 respondents) indicated that they have no idea whether catch of MM is increasing or decreasing. Considering the responses on the importance of MM to fishing, all respondents at Keta thought that catch of MM was decreasing, which can be attributed to the fact that they consider them as lesser gods.

Table 5: Respondents opinions on whether catch of MM is increasing or decreasing.

Name of Community	Do you think catch of MM is increasing?			Total
	No	Yes	Don't know	Total
Apam	15	6	0	21
Mumford	12	5	1	18
Kpone	14	2	5	21
Ada	6	8	4	18
Keta	21	0	1	22
Axim	0	20	0	20
Elmina	4	11	0	15
Half Assini	3	18	0	21
Sharma	0	14	0	14
Dixcove	0	20	0	20
Total	75	104	11	190

3.9.10 Consumption levels of MM bycatch among fishermen

Figure 12 shows the different ways of utilization of MM bycatch by fisherfolk along the coast. According to Figure 12, most of the bycatch is sold to other fisher folks especially those interested in catching shark fin. This is followed by the category of fishermen who sell the majority of bycatch but bring some home. The smallest groups are those fishermen who keep a large quantity at home and sell a small portion. The chief fisherman at Dixcove

explained that the price of the dolphin is dependent on its size, and that an individual weighing about 30-50 kilos is sold between 100-300 Ghana Cedis. Similar prices were recorded at Axim, Elmina, Winneba, Half Assini, Apam, and Mumford. Recognizing the growth in global shark trade, it was not surprising to see most fishermen beginning to venture into the business.

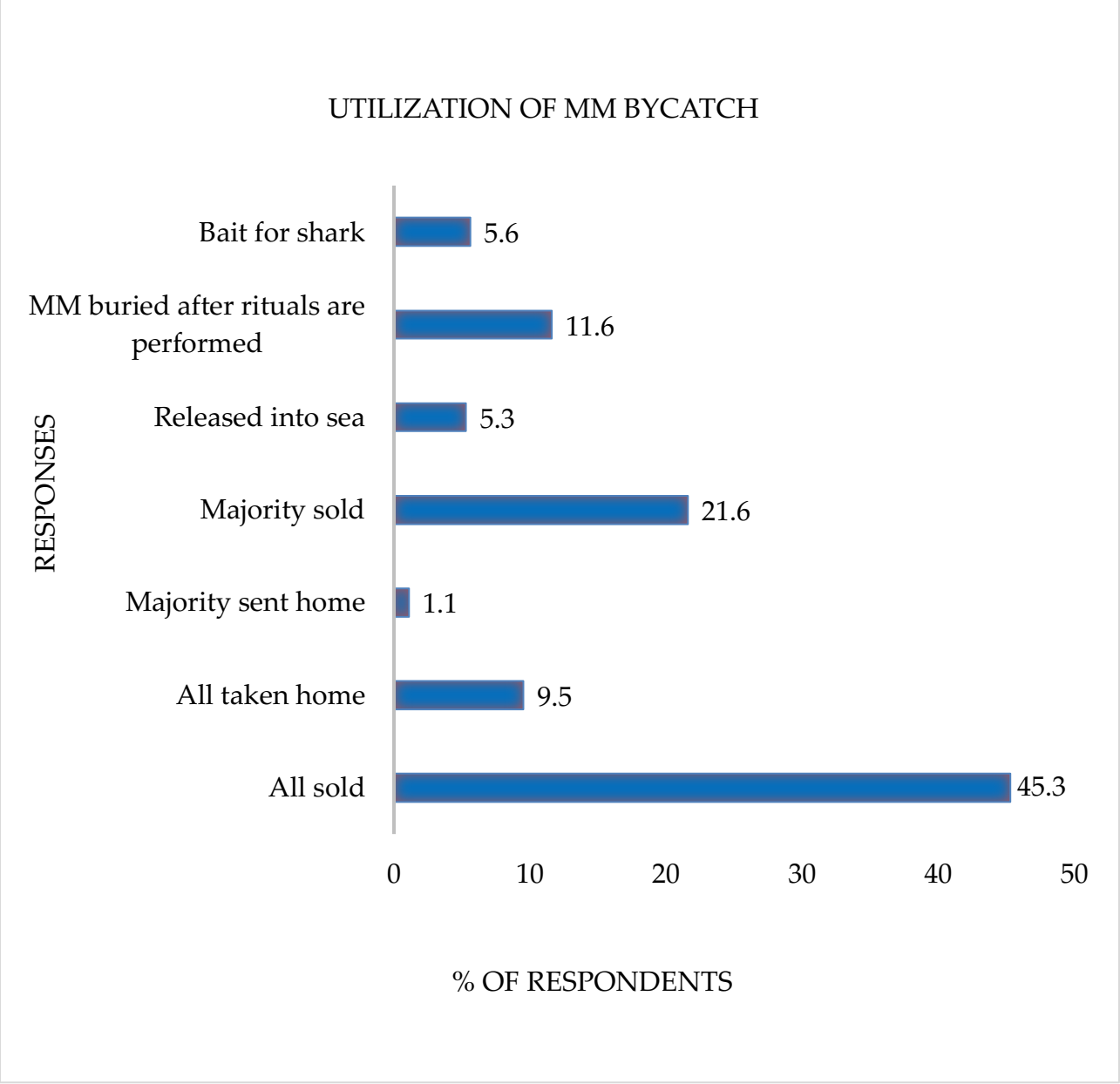

Figure 12: Level of consumption of MM by fishermen.

3.9.11 Opinions of respondents in intervention to minimize bycatch of MM

Based on the information gathered from the survey, the majority of the respondents, representing 43.2%, suggested awareness creation and education on the ecological importance of MM among fisher folk. A few of the respondents, most of them coming from the Keta landing site, stated maintaining the taboo as a means to minimize bycatch while 16.8% mentioned enforcing laws on fisheries to curb the menace. 9.5% of respondents had no clue on interventions that could be taken to minimize bycatch. Other respondents think nothing can be done to address the bycatch problem since their livelihood heavily depends on resources from the ocean (Figure 13).

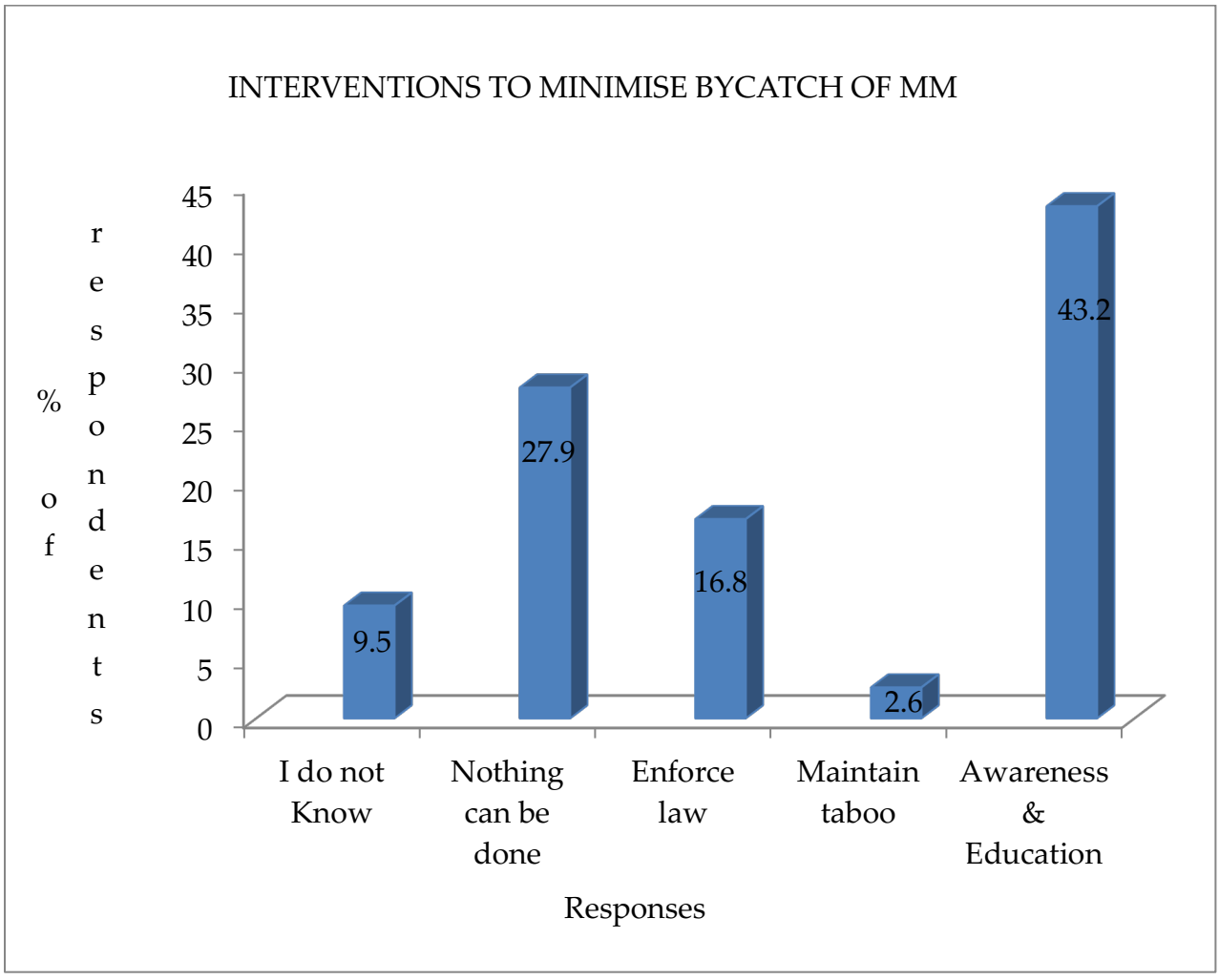

Figure 13: Intervention to minimize bycatch of MM.

From this assessment, it was evident that a large number of fisherfolk (84.7%, Figure 14) was unaware of the National Fisheries Management Plan (NFMP 2015-2019). This could be attributed to the high illiteracy rate recorded among the respondents and low education and awareness of the creation of the plan among fisherfolk. For the few (15.3%) who claimed to know about the NFMP (2015-2019), their knowledge on the plan was scant. They only mentioned a ban on the capture and sale of sea turtles, and the prohibition on the usage of unauthorized mesh size and the use of DDT and light fishing. They were unaware of the roles and responsibilities they played in the plan. This calls for immediate education and raising awareness of the plan by the Fisheries Commission to local fishing communities.

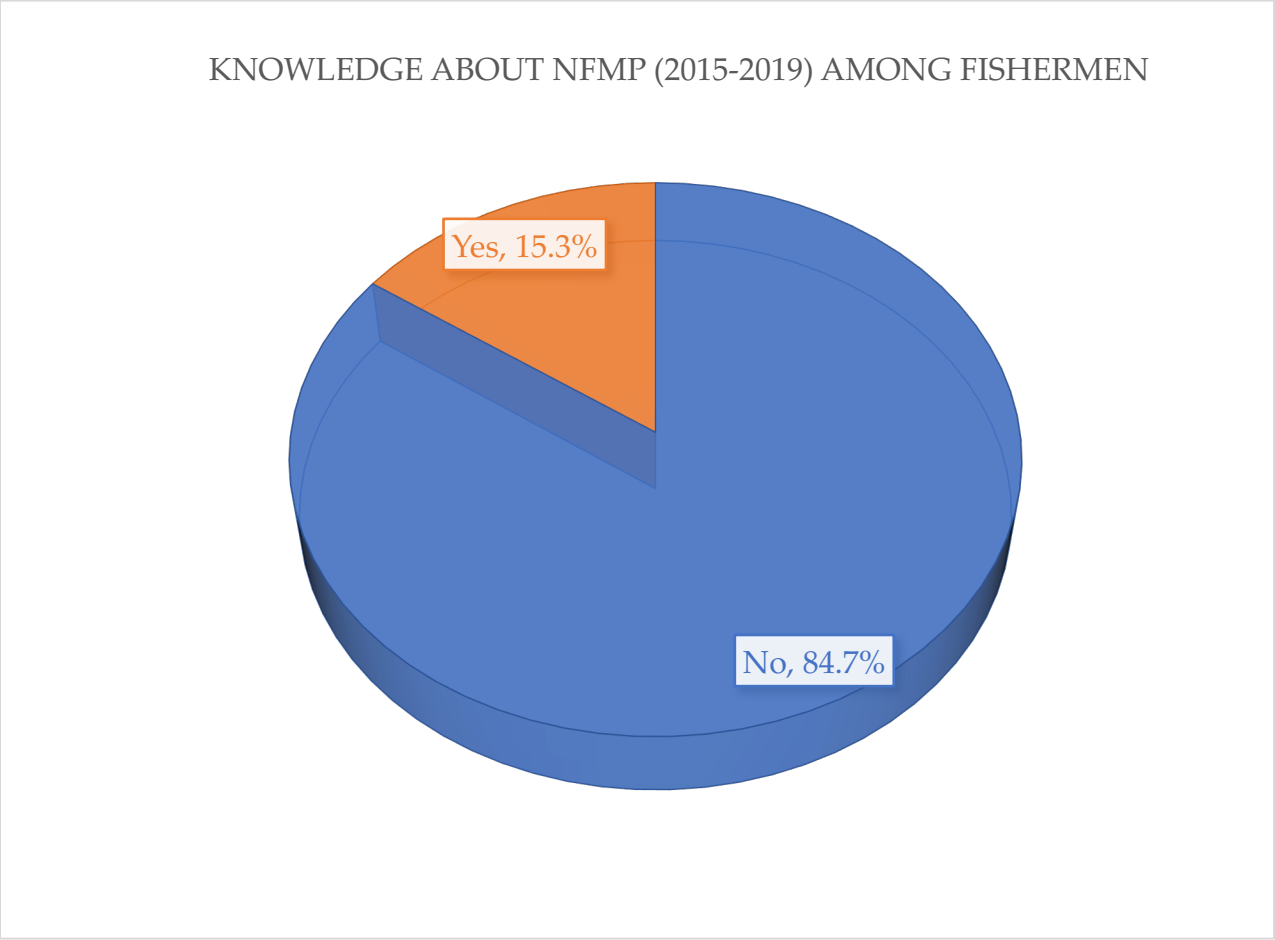

Figure 14: Respondents' knowledge of the National Fisheries Management Plan (2015-2019).

4. DISCUSSION

Ghana has enacted a number of legislations intended to foster conservation of biodiversity and protection of the environment. This body of legislation provides support for the protection of MM and therefore in part meets the requirement for fulfilling the obligations under the conventions and treaties to which the country is party. Legal enactments include the Fisheries Act, 2002 (Act 625), Fisheries Regulation, 2010 (LI 1968), Wild Animal Preservation Act, 1961 (Act 43) Wildlife Preservation Act, 1916 (Act. 43); Environmental Protection Agency Act, 1994 (Act 490); Petroleum Commission Act, 2011 (Act, 821), and Environmental Assessment Regulations, 1999, LI. 1652). However, a survey at key coastal fish landing ports indicated that dolphin bycatch is gradually turning into a targeted fishery. Like most West African countries, there is a paucity of knowledge on their life history, distribution, rate of exploitation, and taxonomic status. This poses a threat to the conservation of these mammals in West Africa. On the basis of the results obtained from this study, MM bycatch landings were found to occur regularly along the western fish landing ports of Ghana whilst the eastern fishing ports (Volta Region) such as Keta, partially show reverence to the animals through traditional taboos, which encourages some level of conservation. In particular, the results indicate that there are regular bycatch landings, particularly in the western fish landing ports at Dixcove (40%) followed by Shama (26%). The lowest bycatch landings were recorded at Mumford (1%). Although the fishing effort was highest in March, followed by the month of April and July, the CPM was highest in October followed by September, suggesting higher bycatch landings during these months. This is confirmed by the corresponding estimates of the cetacean bycatch per canoe per month (CPM) which ranged between 0.027 and 1.09. These values are considered baseline indices for future assessments or monitoring for changes in the level of bycatch landings, because there are no previous estimates from Ghanaian waters for comparison. On the other hand, there was a decline in the fishing effort in May and June due to the closure of fishing

by MoFAD in 2019. This management strategy, if continued in future, should curtail the fishing effort that also produces MM catch. Using the relative frequency of occurrence in the landings as indicator, a total of at least ten (10) dolphin species were identified out of the reported total of eighteen (18) dolphin species in the West African sub-region (Jefferson et al., 1997), implying that about 56% of the dolphin species occurring in the sub-region are represented as bycatch during the assessment period. Altogether, the most dominant species was the short-snouted spinner dolphin (24%) followed by the long-snouted spinner dolphin (20%) with DGN as the principal gear deployed to catch them. This observation is consistent with findings from Ofori-Danson et al. (2003) and Debrah et al. (2010). It also implies that the exploitation of these species has been on-going for close to two decades (or more) with no conservation measures. It is noteworthy that the encountered dolphin species in the landings were both from inshore and offshore habitats (Table 1). This suggests that the artisanal fishers exploit both inshore and offshore waters or possibly all coastal fishing grounds within the jurisdiction of the country for the species. It is not uncommon to observe slicing of dolphin bycatch at the ports. Inquiries with fishers indicated that the slicing of dolphin bycatch also occurs at sea. Total bycatch therefore could be higher than reported here, which requires further assessments, possibly at sea. Monitoring of these canoe-based interactions may be especially important seeing as landed dolphin bycatch tends to co-occur with some commercially important large pelagic fish species, such as tunas, sailfishes, sharks, and rays. At Axim, Half Assini, and Dixcove, dolphins were killed and used by fishermen as bait to catch sharks. This is because shark fins have become a lucrative business in the area due to the high demand by foreign markets, especially in some Asian countries, such as Korea, Japan, and China. Dolphins were often sold to market women/fishmongers who later sold their meat in local markets. On the basis of the interviews and interactions with the fishers, it is apparent that the desire to turn what historically may have been

considered dolphin bycatch into a targeted fishery could partly be attributed to the lack of adequate alternative livelihoods for the fishing communities.

5. CONCLUSION

A total of ten (10) identifiable MM largely made up of toothed whales or dolphins (odontocetes) out of the total eighteen (18) reported species in the West African sub-region (Jefferson et al. 1997) were documented as bycatch. The species composition was dominated by the short-snouted spinner dolphin, which constituted 24% of bycatch mostly by DGN, followed by long-snouted spinner dolphin, 20% of the total bycatch. Along the fishing ports of Ghana, the highest records of the landed MM were recorded at Dixcove (53%), followed by Shama (26%), with Mumford recording the least (1%). The average estimated mean of landed cetacean CPUE and landed CPM was 0.027 and 1.09, respectively. These figures can provide baseline information for future assessments in changes in the level of the bycatch landings, because there are no previous estimates from Ghanaian waters for comparison. The main gear involved in bycatch landings was found to be DGN, which simultaneously harvest commercially large pelagic fish species. These pelagic fish species include the frigate mackerel, Indo-Pacific sailfish, blue shark, yellowfin tuna, skipjack tuna, blue marlin, and the manta ray. A socio-economic survey investigated the importance of MM to fisherfolk in Ghana, including consumption levels, perception, and traditional beliefs about MM, and identification of interventions to minimize marine bycatch of MM by fishermen. The assessment showed that fishing is the major source of livelihood for local communities and is traditionally practiced by men due to the strict gender division of labour in fishing communities along the coast. Most respondents (87.9%) were married, and therefore had much responsibility in their households. The majority had only a basic education level. 79.5% of respondents had fished for more than 16 years. The use of diverse fishing gears

such as APW, hook and line, DGN, and set nets were common. Mesh sizes ranged from 0.25-19 inches. The majority of the respondents reported sighting MM during fishing. Fishermen with a positive perception of MM explained that the occurrence of MM is related to the abundance of pelagic fishes such as sardines, mackerel, and tuna, while those with a negative perception of MM complained that dolphins forage on fish caught in their nets and caused heavy economic loss due to the net damage. At Keta, in the eastern coast of Ghana, whales are regarded as lesser gods and revered by the people, whereas dolphins are equated to humans. Hence, they were not landed. In contrast, there is apparent utilization of dolphin meat as food in other parts of the coast (central and western) which is sold to fishmongers at costs ranging between 100-300 Ghana Cedis (equivalent to about US$20-US$60) for meat weighing between 30-50 kgs. The gradual depletion of pelagic fish, cost incurred in mending nets destroyed by MM (especially whales), loans taken from banks, and poverty were mentioned as factors compelling fishermen to illegally sell accidentally caught MM to offset their losses. The survey revealed that 84.7% of fishermen were unaware of the National Fisheries Management Plan (NFMP 2015-2019) which, among other pieces of legislation, aims to conserve biodiversity in the coastal waters of Ghana. This could be attributed to the high illiteracy recorded among the respondents and low education and awareness about the creation of the plan among fishermen.

6. RECOMMENDATIONS

Some of the practical recommendations on how to facilitate and strengthen the protection of the MM and possibly reduce its bycatch include the following:

- Training of personnel on marine species identification, recording species sightings, and GPS usage.

- In order to increase the level of understanding of the species of encountered MM, it is recommended that routine monitoring should continue by trained staff of the Fisheries Commission or NGOs such as the Ghana Wildlife Society or the Universities and Research Institutions. In this process, records of any changes in species composition and volume of landed bycatch over time should be made and brought to the attention of the Fisheries Commission for redress.

- Investment in training and support for alternative or diversified livelihoods such as aquaculture, vocational (e.g., soap making), and other types of agriculture-related businesses (e.g., poultry, snail farming, and fish farming).

- Improving communications with stakeholders about the role and importance of MM in the ecological health of the marine ecosystem. This may be achieved through collaboration of MoFAD with stakeholders in improved communication campaigns, education programs, and participatory decisions by key stakeholders.

- Enable adoption of comprehensive MM management policy for the country through routine monitoring at key fish landing ports to enable data collection on MM bycatch to further understand trends in the landings, including the growing market for MM bycatch for bait in the shark-fin trade.

- Carry out dedicated observation on MM bycatch landed at the fish landing ports and possibly assess the level of sliced MM aboard canoes while at sea for use as bait for catching sharks.

- Organise and engage fishing communities on the socio-economics and mitigation measures for the reduction of MM bycatch, protection, and conservation.

- Investigate the fishery-dolphin interactions in the coastal waters of Ghana.

ACKNOWLEDGEMENTS

We are grateful for the generous support of the Anderson Cabot Center for Ocean Life at the New England Aquarium for funding this study under NOAA Award ID: NA17NMF00BA321. The teams also appreciate the coordinating activities and useful comments of Mr. Eric Lartey, the Executive Director of the Ghana Wildlife Society.

We are grateful to the Technical Staff of the Fisheries Commission deployed at the fish landing sites who showed interest in this survey and agreed to facilitate collection of relevant data on the bycatch of MM landed along the coast of Ghana.

Last but not least, due cognizance and gratitude go to the fishers, fish processors, and fish traders at the selected fish landing sites who provided useful information on the fisheries and whose knowledge, view and patience enabled the study to obtain relevant data in support of the assessment.

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APPENDICES

APPENDIX 1: MM Bycatch Assessment Data Sheet

GHANA WILDLIFE SOCIETY/COREWAM-GHANA

MM BYCATCH DATA SHEET

Name of Investigator(s): …… (Principal investigator) 2……..……..3……..……

Location (Name of Landing site) ……..… Month..…….……Date……..…… Time (GMT): Start…….....End

No.	Time	Landing Boat		Fishing Gear		Species Measurement			Presence of teeth (Yes/No)	Maturity (Adult/ Juvenile/calf)	General Description: Overall size, shape, colour and patterning, position off dorsal fin and height and shape of blow	Possible species	Photo taken (Yes/No)
		Type of landing Vessel: Canoe = C Semi-Industrial = SI Industrial = I	Number of vessels landing	No of dolphins landed	Gear Utilized	Total Body Length (cm)	Presence of snout (Yes/No)	Snout length (cm)					

Name of species after Identification and Confirmation ……

APPENDIX 2: MM Bycatch Socio-Economics Assessment Data Sheet

MM BYCATCH SOCIO-ECONOMICS ASSESSMENT IN GHANA

Interviewer Name……...Date:….....Name of Landing site:……

PART I: PERSONAL DETAILS

1. Community name…….District/Region…..……Contact number…..……
2. Gender: Male □ Female □
3. Age: <30yrs □ 30-39yrs □ 40-49yrs □ >50yrs □
4. Number of dependents: 0-3 □ 4-6 □ 7-9 □ ≥10 □
5. Educational background: Basic □ Secondary/Vocational □ Tertiary □ None □
6. How long have you stayed here: Less than 1 year □ 1-3yrs □ 4-6yrs □ 7-9yrs □ ≥10yrs □
7. What is your main source of livelihood? a. Fishing b. Farming c. Others

PART II: SOCIO-ECONOMICS OF MM

8. If you fish, how long have you been fishing?
9. What gear do you use? a. Beach Seine b. 'Ali-Poli-Watsa" (APW) c. Set Net d. DGN
10. What type of boat do you use a. Motorized b. Non-motorized (paddle) c. Sail
11. Mesh size gear used……
12. How many days do you go for fishing within a week? ……..……
13. At what month is catch highest? ……
14. Do you know what marine mammals are? Yes or No
15. If you do, what do you know about MM?.....
16. Have you sighted any MM whiles fishing? a. Yes/ No b. Don't remember
17. Do you know any traditional beliefs associated with marine mammals?
    If yes, please share with us
18. In your opinion, are marine mammals important to fishing? Yes/No
    If yes, please state why?.....
    If no, please state why?.....
19. Do you think MM catch is increasing or decreasing? a. Increasing b. Decreasing

PART III: FOOD SECURITY AND PRICING MM

20. Have you caught any MM in your net as bycatch? a. Yes/No b. I don't know

What is/are the names in your local dialect…….....

21. What was done (or is done) to the bycatch MM?.....

a. All sold b. All taken home c. Greater portion taken home d. Greater porting sold

22. If sold, whom did you sell to? a. Middle man b. Market woman c. Others

23. How is it processed for? a. Salted b. Smoked c.Fresh

24. Do you know the market they sell MMs? a. Yes b. No

If you do, please mention the names…….....

25. If sold, do you know whom the end consumers mostly are?.....

a. Ghanaian b. European c. Asia d. American

26. What is the average price per kilogram in Ghana cedis?.....

27. If taken home, what is it used for? a. Eaten b. Traditional medicine c. Spices d. Others

28. If eaten, can you tell me why you chose to eat a MM?.....

a. Additional source of protein b. Cheap sources of protein c. Delicacy d. Others

29. In your opinion, what interventions can be taken to minimize the landing of bycat dolphins?

…….

PART IV: KNOWLEDGE OF THE NATIONAL FISHERIES MANAGEMENT PLAN AND CLOSED SEASON

30. Do you know about the NFMP? a. Yes b. No

31. If yes, what is the NFMP about?.....

32. Do you think the closed season is relevant?.....

If yes/no, why?.....

Any other information

(remarks)……

……

APPENDIX 3: Fishing gears encountered at the selected fishing ports

'Ali-Poli-Watsa' (APW)

Beach Seine

Hook and Line

Set Net