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The global menace of "Abandoned, Lost or Otherwise Discarded Fishing Gear" (ALDFG): best practice to manage ALDFG in Ghana's fisheries sector

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THE GLOBAL MENACE OF "ABANDONED, LOST OR OTHERWISE DISCARDED FISHING GEAR" (ALDFG): BEST PRACTICE TO MANAGE ALDFG IN GHANA'S FISHERIES SECTOR

By

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Declaration

I certify that all the material in this dissertation that is not my own work has been identified, and that no material is included for which a degree has previously been conferred on me.

The contents of this dissertation reflect my own personal views, and are not necessarily endorsed by the University.

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(Date): 20/09/2022

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Abstract

Title of Dissertation: The Global Menace of "Abandoned, Lost or otherwise Discarded Fishing Gear" (ALDFG): Best Practice to Manage ALDFG in Ghana's Fisheries Sector.

Degree: **Master of Science**

The concern for Abandoned Lost or otherwise Discarded Fishing Gear (ALDFG) which is a sea-based source of marine litter is on the rise globally. ALDFG includes all fishing equipment that will otherwise be used by fishers but is left in the marine environment. There is little or no research on ALDFG in the marine environment in Ghana, a coastal nation with a relatively large fishing industry. The sector is challenged with IUU issues and majority of fishers in the small-scale sector use monofilament net which breaks away easily. This study aims to explore the strategies to adopt to manage ALDFG from polluting the marine environment in Ghana. The study gathered opinions of maritime stakeholders through a semi-structured interview on ways the issue of ALDFG in Ghana. The information gathered were analysed and presented in themes. The research concludes by discussing the findings from the analysis of the results and recommendations to assist in managing the issue of ALDFG in Ghana.

KEYWORDS: Marine litter, ALDFG, Derelict fishing gear, entanglement

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List of Abbreviations

ALDFG	- Abandoned, Lost or otherwise Discarded Fishing Gear
CSO	- Civil Society Organisations
ECOWAS	- Economic Community of West Africa States
EEZ	- Exclusive Economic Zone
EJF	- Environmental Justice Foundation
FAO	- Food and Agriculture Organisation
GESAMP	-Group of Experts on the Scientific Aspects of Marine environment Protection
GGGI	- Global Ghost Gear Initiative
IMO	- International Maritime Organisation
IUCN	- International Union for Conservation of Nature
IUU	- Illegal, Unreported and Unregulated Fishing
NFS	- Net Free Sea
NGOs	- Non-Governmental Organisations
NPMP	- National Plastic Management Policy
MARPOL Annex V	- International Convention for the Prevention of Pollution from Ships
MMDAs	- Metropolitan, Municipal and District Assemblies
UN	- United Nations
UNCLOS	-United Nations Convention on the Law of the Sea
UNEP	- United Nations Environmental Programme
UNGA	- United Nations General Assembly
UNSDG	- United Nations Sustainable Development Goal

1 **INTRODUCTION**

The ocean provides several ecosystem goods, services and cultural benefits to humans, these include food, maritime transport and climate regulation. (UNESCO, 2022; Barbier, 2017). However, anthropogenic activities threaten the conservation and protection of the ocean and its biodiversity. These threats impact on maritime sectors such as fisheries, maritime transport and tourism. Some of these threats include destructive fishing activities, pollution and ocean acidification (UNESCO 2022; Barbier, 2017).

Over the past years, the oceans have been featuring prominently in environmental action plans to improve management and conservation measures to safeguard its health. The abundance of plastic litter and other debris; and the challenges they cause have also intensified the focus. With reports suggesting the presence of plastics in the food chain, water and air could impact well-being of humans (OECD, 2022). Currently, through the United Nations Environment Assembly (UNEA) a new legally binding international framework on plastic pollution is being negotiated. The plastic treaty is considering actions along the life cycle of plastics to curb the menace (UNEP, n.d.)

This study focuses on Abandoned, Lost and Otherwise Discarded Fishing Gear (ALDFG), a type of marine litter found to persist in the ocean. ALDFG is introduced into the marine environment from fisheries related activities. This form of litter poses ecological and socioeconomic impact on marine life and users of the ocean (GESAMP, 2021). The focal area where this study of ALDFG was conducted is Ghana. It is important to note that there is information paucity on the issue of ALDFG in the country the study was undertaken. Most of the research on marine litter have been on plastics.

2 BACKGROUND TO ALDFG AS A MARINE LITTER

Marine litter consist of man-made objects that are introduced directly or indirectly into the marine environment and stays there for a long period. Marine litter found in the ocean emanates from land and sea-based sources (UNEP, 2009; UNESCO, 2022). It finds its way into the marine environment through runoffs from land, activities of recreational users and other maritime activities among others. Marine litter consequently causes environmental, health, economic and aesthetic problems. The litter consists of various forms of objects such as;

- Plastics including polyethylene bags, bottles, straws, lighters, foam, fishing nets, ropes, other fisheries related equipment and styrofoam (polystyrenes) usually used for buoys.
- Metals including food cans, hooks and wires from fishing vessels, anchors and other categories of manufactured items among others (NOAA, 2007; Chiba et al., 2018; Goodman et. al., 2021).

Some of these litter either float, collect on the seafloor bottom or are washed ashore along the beaches. Due to majority of the marine litter being plastic products, they take long to biodegrade. As a result, the ocean is gradually accreting macro-plastic and micro-plastic debris at the sea floor and in the water column. (Barnes et al., 2009; Woodall et al., 2014; Chiba et al., 2018; Chassignet et al., 2021).

In the same vein, it is worth noting that efforts are being made to reduce plastics from polluting the environment. Worldwide, about 120 countries have instituted policies on plastics comprising bans, incentives and taxes on single-use plastics (OECD, 2022). Some of these actions aid in minimising the littering of plastics that eventually find their way into the marine environment (OECD, 2022). The policy actions have correspondingly advanced innovations in the development of biodegradable, plastic lifecycle options, renewable plastics and other sustainable solutions. (OECD, 2022; Mazhandu et al., 2020).

Reports suggest that sea-based sources of marine litter account for a significant percentage of marine litter with the estimated volumes changing with respect to the countries (GESAMP, 2021). The litter originates from inter alia maritime transport, offshore mining and fishing activities. It is estimated that about 65% of the sea-based sources of marine litter is generated by the fisheries sector (GESAMP, 2021), even though estimation is associated with uncertainties.

An Abandoned, Lost or otherwise Discarded Fishing Gear (ALDFG) in the ocean causes harm to wildlife, marine ecosystems and other economic activities that occur in the marine environment. For instance, a derelict fishing gear has the tendency to continue trapping marine organisms; hence the term '*ghost fishing'*. It is estimated that about 5-30% of global harvested fish stocks are killed by ghost gear (Gilman, 2015; NOAA, 2022).

2.1 Composition of ALDFG Materials

ALDFG includes nets, pots, traps, hook and lines used by fishers to trap and harvest marine fisheries resources. It may also include fish aggregating devices used for attracting fish. ALDFG may also include gear components such as buoys, floats, sinkers (weight for sinking gear), ropes and twines (Mouat et al., 2010; Kuhn et al., 2015; Scheld et al., 2016). Most of the components used to design the fishing gear is usually manufactured from synthetic fibres or polymers such as polyamide (nylon), polyester, polyethylene and polypropylene. Nylon nets have good breaking strength and are effective at catching fisheries resources hence they are commonly used in the fisheries industry (Thomas and Manju, 2017; Boopendranath 2002; Sala et al., 2018; Bertelsen & Ottosen, 2016). There are two categories of filament yarns for these synthetic net and thread, the (1) Monofilament and (2) Multifilament; which is differentiated by the thickness of the filament. The monofilament is less thick hence not easily detectable in water, efficient but less durable. These synthetic fishing gear

take a much longer time to biodegrade (Gilman et al, 2015; Moore, 2008; Sala et al., 2018; Cerbule et al., 2022; Bertelsen & Ottosen, 2016).

2.2 Drivers of ALDFG

Fishing gear is usually derelict at sea as a result of a number of factors including poor weather conditions such as storms or ocean currents, gear damage through conflicts with other users of the maritime space; operator error and equipment failure (Macfadyen, 2009; Goodman et al., 2019). The gear could also get caught on features at the bottom of the water such as rocky reefs and snap. (Macfadyen, 2009; Goodman et al. 2019). There are also reports of fishing gear being left at sea deliberately when they are worn-out or being thrown overboard to avoid detection by fisheries enforcement units undertaking routine inspections on sanctioned gear. Or because there are no available disposal facilities at the ports or landing areas. Additionally, there is the possibility of the gear finding its way in the sea because space must be created for fish caught when there is no space in the hatch this is termed intentional discard (FAO, 2009; Richardson et al., 2018; GGGI, 2020; Gilman et al., 2022). The size of derelict fishing gear varies in size from a patch of the net ripped from the whole gear unit to a complete gear that could be a trawl or purse seine net from an industrial commercial fishery operator (Gall et al., 2015; Donohue et al., 2001).

2.3 Ecological Impacts

Concerns have been raised on the possible ecological impacts ALDFG could have on the marine ecosystem. Some the derelict fishing gear have been known to drift in the water ensnaring marine life and catching targeted and non-targeted fish species. Werner et al., 2016 reported that up to 45% of IUCN red list of threatened species have interactions with derelict fishing gear. Also, according to Duncan et al., 2017, about

eighteen peer reviewed articles have cited global incidence of marine turtle entanglements in ALDFG related materials. Most of these turtles either became disfigured or died as a result. Also, ALDFG may impede the ability of the marine mammals and turtles to swim freely in their environment as they drag ALDFG along through the water column especially when it is heavy (Moore et al., 2009; Allen et al., 2012; Duncan et al., 2017). Similarly, marine turtles' encounters with ALDFG have been observed at all life stages, which could adversely impact global populations of already threatened or vulnerable species (Ryan et al., 2016; Hamann et al., 2011). A number of reports have highlighted human interventions in releasing seabirds, and various marine life to relieve them from the discomfort of being stuck in ALDFG (Duncan et al., 2017). This situation could negatively impact fisheries resources by decreasing fish yields since the derelict nets with already trapped fish act as continuous bait until its unable to fish (Gilman et al., 2015; Goodman et al., 2019; 2021). Many species including endangered avifauna and marine organisms may either ingest or get entangled in ALDFG causing mortalities. Drifting ALDFGs could similarly transfer toxins and micro-plastics which may enter the food web and/or spread invasive species due its transboundary nature (Pettipas et al., 2016; Wright et al., 2021; GGGI, 2020). Biofouling can occur as ALDFG debris drifts from different regions along ocean currents causing adverse ecological impact in the environment the ALDFG ends up at (Donohue et al. 2001). Goodman et al., (2021), observed that almost 50 % of derelict gear recovered had three or lesser biofouling species. The spreading of microalgae may cause harmful algal blooms, habitat changes and damage. Also, sensitive benthic environments could be covered with macro and micro-plastics from ALDFG affecting ecosystem wellbeing (Gilman et al. 2016; UNEP, 2016). Sinkers (fishing weights) attached to the fishing gear in order for them to sink are usually lead. The phenomenon of ALDFG can increase the levels of lead in the environment which may bio-accumulate in the species around hotspot areas of ALDFG accumulation (Moore, 2008; UNEP, 2016; Scheld et al., 2016; Landrigan et al., 2020; Galgani et al., 2019).

2.4 Socio-Economic Impacts

ALDFG is believed to have economic and social effects, ranging from obstructing vessel navigation routes, to entangling recreational users and in-use fishing gear (Richardson et al., 2019b, Macfadyen et al., 2009; Hong et al., 2017). The cost involved to undertake emergency rescue operations when propellers and shafts of vessels get entangled or divers are trapped can be expensive. Entanglement of ship propellers can considerably decrease its stability and manoeuvrability. Such situations have the possibility to put the crew and passengers on board the vessel in danger, especially when the weather at-sea is turbulent. This could lead to injury or death; but more often, the type of damage caused to the vessel would have economic implications due to the necessity to repair the vessels (Gilman et al., 2015; Mouat et al., 2010). The impediment ALDFG causes to navigation and fishers can add to fuel and servicing cost, and time spent at sea (Macfadyen et al., 2009).

3 PROBLEM STATEMENT AND RESEARCH AIM

The marine environment of Ghana like most parts of the world is confronted with marine litter issues with a major component being plastics (NIMS, 2020; Musah, 2021). This could affect the resilience of the marine environment and blue economy prospects. The issue of Abandoned, Lost or otherwise Discarded Fishing Gear has not gained much prominence in Ghana, thus data to show the extent of derelict gear in Ghana's waters is a major challenge. This notwithstanding, it is common to observe derelict gear wash ashore along the beaches (EJF-Ghana, personal communication). Most of the gear is monofilament nets which are largely used by the fishers in the artisanal sector. The price of the monofilament encourages its usage compared to that of the multifilament net (CRC, 2013). A number of research assessing beach litter composition along some beaches at some coastal areas and lagoons in Ghana have also reported of ropes and nets being present though not too significant (Van Dyck et al.,

2016; Nukpezah et al., 2022). Also, the turnover of worn-out gear from the small-scale fisheries is likely to be high, considering the level of technology, fishing gear design and fishing effort of the sector (CRC, 2013).

The Environmental Justice Foundation (EJF)-Ghana a Non-Governmental Organisation (NGO) whose work is to ensure environment justice, protect the natural environment, the people and wildlife that depend upon it, has recently undertaken work on ALDFG. EJF-Ghana has a number of projects in Ghana including a turtle conservation programme, fisheries related issues, empowering fishers to report illegalities, among others. EJF has through its activities with the coastal communities recognised the need to undertake an initiative on ALDFG and is currently conducting a one-year pilot of Net Free Sea (NFS) in Ghana to recycle fishing nets and help reduce net waste (EJF-NFSPP, 2020). The project is being piloted in the following fishing communities Winneba, Cape Coast, Biriwa, Moree, Abandz, Senya, Gomoa Fetteh, Nyanyano. The aim of the project is to rid Ghana's waters of destroyed, discarded/unwanted fishing nets and its harmful impacts on marine environment by buying fishing nets from fishers and raising awareness on ALDFG at the fishing communities and on their social media handles (EJF-NFSPP, 2020; EJF-Ghana, personal communication).

Ghana to a party to several international and regional instruments some of which include United Nations Convention on the Law of the Sea (UNCLOS), Convention for Cooperation in the Protection and Development of the Marine and Coastal Environment of the West, Central and Southern Africa Region (Abidjan Convention). (FAO, 2022). This research seeks to explore the strategies to manage ALDFG from polluting the marine environment in Ghana. Addressing ALDFG will also support the achievement of the United Nation's Sustainable Development Goal (UNSDG) Target 14: Life below water specifically UNSDG 14.1 which calls for avoidance and substantial decrease of marine pollution of all kinds, including marine debris, by 2025 (UN, 2022). This will assist in efforts to protect and conserve biological resources in the ocean and improve its resilience.

3.1 Research Objective

The objective of the study is to understand whether ADLFG is part of a management regime within the fisheries sector in Ghana. It will also propose recommendations based on best practices to help marine managers manage ALDFG in the marine environment in Ghana to reduce its impact on marine life.

3.2 Research Questions

The research will try to answer the following questions;

i. Is ALDFG part of a management regime within the fisheries sector in Ghana?

ii. What are the possible challenges to be faced in effort to manage ALDFG in Ghana?

iii. What are the roles the various stakeholders could play in effort to manage ALDFG in Ghana?

4 OVERVIEW OF GHANA MARINE FISHERIES AND ITS NEXUS WITH ALDFG

Ghana is a coastal nation in West Africa positioned at latitudes 4° N and 11° N and longitudes 3° W and 1° E. The country's 550 km coastline stretches from Aflao on the East to Half Assini on the West. The exclusive economic zone claimed is highly productive since it forms part of the Guinea Current Large Marine Ecosystem (Adinortey et al., 2016; Koranteng 2001; FAO, 2022).

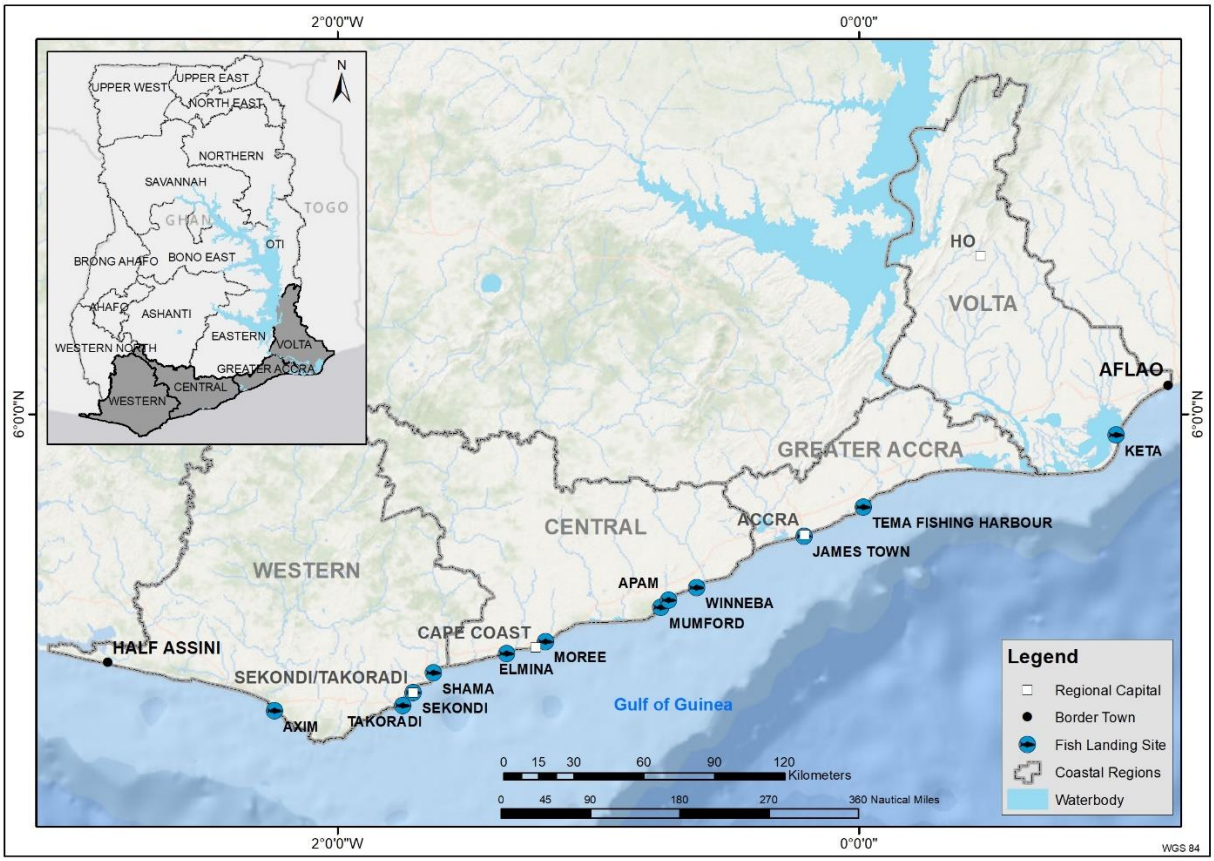

Figure 1 Map of Ghana showing the four coastal Regions: Sourced from EPA

There are four coastal regions where fishing is the major occupation of the people that inhabit these coastal communities. The fisheries sector contributes about 4.5% to the economy of the country (Nunoo et al., 2014; FAO, 2022). The marine ecosystem like most countries worldwide is threatened by Illegal, Unreported and Unregulated (IUU) fishing activities and pollution of all forms (NIMS, 2020; MESTI, 2020). There is an

increase in marine litter especially plastic with reports of a decline in the country's ocean health index of Ghana since 2017 (Musah et al., 2021).

Ghana in efforts to address the issue of ever-increasing plastic waste has developed a National Plastic Management Policy (NPMP) aimed at ensuring coherence among existing public and private sector frameworks (MESTI, 2020). The policy has outlined strategic actions to achieve its focus areas. It is meant to direct the activities of government, industry and other entities involved in the production, import, export, use, management, recycle and disposal of plastics, addressing adverse effects posed by plastic on the environment and human health. The policy provides actions along the entire life cycle and value chain of plastic (NPMP, 2020).

The marine fisheries sector in Ghana comprises of three sub-sectors: industrial (trawler and tuna fleet), semi-industrial (inshore fleet) and artisanal or small-scale (canoe fleet) (Amador et al., 2006; FC, 2019). The fishing industry is large with about 14,275 small-scale artisanal fisheries canoes, 129 industrial vessels and 403 semi-industrial vessels and a vibrant inland fishing and aquaculture cage farming sector (FC, 2019). Numerous active and passive gear types are used by fishers in the sector including hook and line, purse seine, bottom trawl, beach seine, drift gill net (nyimfa nyimfa), cast net, surface gill nets (Ali), bottom set gill nets (tenga) among others. The gear types are designed to suite the species targeted by the fishers. Most of the fishing gear and fleets from the small-scale sector use traditional low-technology and techniques (Aheto et al., 2012; Nunoo et al., 2014; FC, 2019). The level of input in the sector could make the risk of ALDFG acute in Ghana especially considering the size of the small-scale fisheries fishing fleet; most of which use monofilament nets which are made of plastic and the sustainability concerns of these gear (CRC, 2013).

Figure 2 Shows derelict fishing net mixed up with other marine litter at a beach in Ghana: Sourced from The World

5. INTERNATIONAL, REGIONAL AND NATIONAL RESPONSE TO CURB ALDFG

This section briefly outlines some frameworks that will be worthwhile in the governance of ALDFG. These instruments address the issue of pollution in general.

5. 1 Major International Instruments and Initiatives of Relevance to ALDFG Governance

Internationally, the 1982 United Nations Convention on the Law of the Sea (UNCLOS) is the overarching legal framework on matters of the sea. Within the framework are provisions on marine environmental protection with specific focus on pollution. According to Art. 1(4) of UNCLOS "pollution of the marine environment" is defined as the “introduction by man, directly or indirectly, of substances or energy into the marine environment, including estuaries, which results or is likely to result in such deleterious effects as harm to living resources and marine life, hazards to human health, hindrance to marine activities, including fishing and other legitimate uses of the sea, impairment of quality for use of sea water and reduction of amenities”.

Therefore, ALDFG is included under the scope of UNCLOS and falls under the obligation established in Art. 194 UNCLOS.

Furthermore, Annex V of the International Convention for the Prevention of Pollution from Ships (MARPOL) 73/78 establishes zero discharge obligations in relation to all waste covered under the material scope of MARPOL Annex V. The material scope also includes ropes and fishing gear (IMO, 2019a).

The potential effect ALDFG could have on the marine ecosystem and ultimately on humans has led to combined international efforts by United Nations Agencies and civil society groups (GESAMP, 2019). These concerns have dominated various international environmental fora prompting the United Nations General Assembly (UNGA) to introduce a resolution which aims at mandating and requiring members of the international community to take action in support of implementing United Nations Sustainable Development Goal (UNSDG) 14. Hence, the UNGA resolution enjoined on members to adopt measures to reduce ALDFG and marine litter in general as target UNSDG 14.1 focused on pollution of all types (UNEP- GPML, 2022).

Subsequently, a number United Nations specialized agencies particularly United Nations Environmental Programme (UNEP), Food and Agriculture Organisation (FAO), United Nations Educational Scientific and Cultural Organisation (UNESCO) and International Maritime Organisation (IMO) have individually or jointly partnered to enact several international instruments and guidelines to effectively mitigate sea-based sources of marine litter (Macfadyen et al., 2009; Gilman et al., 2016). The synergies have encouraged projects and programmes across the globe creating awareness and helping countries develop best practices to ensure prevention, mitigation and remediation approaches to address ALDFG and marine plastic litter (IMO, 2019a).

To further these actions, a joint Group of Experts on the Scientific Aspects of Marine environment Protection known as (GESAMP) have been established to provide an expansive understanding of sea-based sources of marine litter. The GESAMP group researches on marine litter issues to assist with the development of action plans and

measures to alleviate the problem of ALDFG and marine litter as a whole (IMO, 2019b). The international efforts to tackle this issue also encourages regional strategies and nations to incorporate ALDFG into national schemes. The FAO and IMO GloLitter partnership project support developing countries through capacity building, legal reforms, to assist countries in managing marine litter from fisheries and shipping sectors. The project also looks at how to reduce the use of plastics and the opportunities to re-use and recycle them (IMO, 2019c). Below are further instruments in relation to pollution and conservation of the marine environment.

Table 1 Other existing international instruments on pollution and conservation of marine environment

Instrument	Mandate	Status in Ghana
1972 Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Dumping Convention)	"To protect the marine environment from pollution caused by the deliberate disposal at sea of waste or other matter from vessels, aircraft platform or other man-made structures."	Ratified
London protocol	"Provides the precautionary framework needed for parties to effectively prevent pollution of the sea caused by dumping of waste and other matter, incineration and new activities such as marine geoengineering."	N/A

1979 Convention on the Conservation of Migratory Species of Wild Animals (CMS) (Bonn Convention)	Aims to conserve terrestrial, marine and avian migratory species throughout their range.	Party 01/04/1988
1992 Convention on Biological Diversity (CBD)	Aims to conserve biological diversity, ensure the sustainable use of the components of biological diversity; and the fair and equitable sharing of the benefits arising from use of genetic resources.	Ratified 27/11/ 1994
1995 FAO Code of Conduct for Responsible Fisheries	It provides principles and standards applicable to the conservation, management and development of all fisheries.	FAO Member State
2019 FAO Voluntary Guidelines for the Marking of Fishing Gear (VGMFG; 2019)	It is a tool that to help improve the state of the marine environment by preventing and reducing abandoned, lost or otherwise, discarded fishing gear (ALDFG) and facilitating the identification	FAO Member State

	and recovery of such gear.	
(2015-2030) United Nations Agenda 2030 for Sustainable Development	Aimed at a global action to end poverty, protect the planet, and ensure that by 2030 all people enjoy peace and prosperity.	UNGA Member State

5.2 Major Regional Instruments of Relevance to ALDFG Governance

To advance cooperation among nations with related marine environment challenges, there are regional conventions and their accompanying protocols; large marine ecosystem activities and programs, and activities by regional economic organizations or regional fisheries bodies. One of such regional conventions that Ghana can be associated with is the 1984 Convention for Cooperation in the Protection and Development of the Marine and Coastal Environment of the West, Central and Southern Africa Region (Abidjan convention) (Barnes-Dabban, & Karlsson-Vinkhuyzen, 2018; UNEP, n.d.). This regional ocean governance regime provides measures to combat pollution from all sources or recommending environmental management in conformity with the objectives of the Convention. Art 2 (1) defines "Pollution" as termed in the 1982 UNCLOS (Abidjan Convention, 1984).

Another framework within Ghana's area is the Economic Community of West Africa States (ECOWAS) - Integrated Maritime Strategy (EIMS) (ECOWAS-EIMS). This focuses on the main challenges of the maritime field and encourages co-operation within the Region. It addresses five strategic objectives which are; strengthen maritime governance maritime security and safety, maritime environmental management, optimise the ECOWAS maritime economy and promote maritime awareness and research. The strategic objective on maritime environment management which recognizes the pressing need to take actions to manage more effectively threats to the

marine environments and to avoid, decrease, fight and control pollution from sources in the ECOWAS Region (ECOWAS-EIMS, 2014).

5.3 Relevant National Marine Environmental Legislations

Ghana is party to the several binding and non-binding international frameworks some of which have been earlier mentioned (FAO, 2022). Hence has the obligation to implement these frameworks at the national level.

Ghana's 2016 Maritime Pollution Act 932 provides the legal framework for the prevention, regulation and control of pollution that may occur as an aftereffect of maritime activities within Ghana's maritime area (MESTI, 2022; MESTI, 2020; GMA, 2019). This Act combines most of the marine pollution conventions ratified by Ghana. Similarly, the National Plastic Management Policy (NPMP) developed by the Ministry of Environment, Science, Technology and Innovation is driven by the rationale of the concern by the United Nations Environment Assembly (UNEA) Resolution 1/6 on Marine Plastic Debris and Micro-plastic; and recognising the environmental crisis plastics especially micro-plastics pose (MESTI, 2022; NPMP, 2020). Another action taken to reduce plastics is the establishment of the Ghana National Plastic Action Partnership (NPAP) to foster a multi-stakeholder cooperation to realise a zero plastic into the oceans and waterways (MEST, 2022).

The Fisheries Act 625, 2002 and the amended Act 80, 2014; provides legal bases for the regulation and management of fisheries, the industry's development; sustainable exploitation of fishery resources and other relates matters. The Fisheries Regulation, 2010 and its amended 2015, provides the modalities for fishery plans, fishing nets and other related matters.

Environmental Protection Agency Act 490 Part I & II, 1994, provides the needed bases for the regulation and protection of the environment.

5.4 Activities of Civil Society at Global and Regional Level

There are a number of ongoing initiatives worldwide due to the sensitivity and risk derelict gear pose. Some civil society groups like Global Ghost Gear Initiative embark on campaigns focused on retrieving nets at sea; and also raise global awareness (GGGI, 2022). The Global Ghost Gear Initiative (GGGI) has been working with partners across the globe on projects aiming at gathering facts to help build a baseline, remove gear from the ocean, test innovative technologies to improve gear tracking and prevent future gear loss among others. GGGI activities contributes in creating evidence about ALDFG prevalence and exploring preventive measures (GGGI, 2022; OC, 2022).

Besides due to the transboundary nature of the marine environment, to successfully combat the issue of ALDFG and plastic litter in general will require active involvement of all Coastal States. Hence these consolidated efforts have gradually urged countries on to include fishing gear management in policies and frameworks particularly those made of plastic.

6 RESEARCH METHODOLOGY

This chapter discusses the approaches employed to achieve the specific objectives of this study. It covers the design of the study, sampling procedure, data collection, and analysis of the data. The research was qualitative using semis-structured key informant interviews. The primary information was sourced from participants who shared their work experiences and or knowledge on ALDFG.

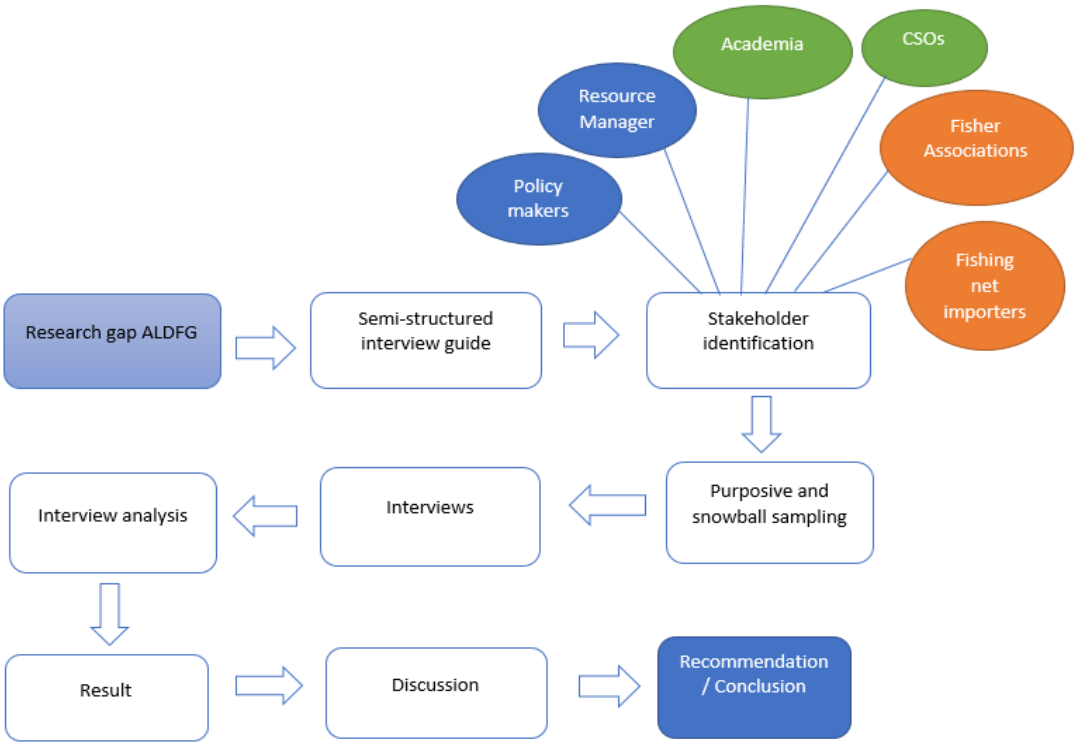

Figure 3 A flow diagram showing a summary of the research methodological process

6.1 Research Design

This research adopted an exploratory qualitative research method for the purposes of obtaining the views of stakeholders in the maritime sector of Ghana on ALDFG and how this issue can be managed. Hence a semi-structured interview was undertaken (Noor, 2008).

6.2 Sampling of Participants

A purposive sampling approach was adopted to solicit responses from participants from organisations that are stakeholders in the maritime sector in Ghana (Naderifar et al., 2017; Rai & Thapa, 2015). To obtain variation in the information, efforts were made to interview at least two participants from the same organisation and to obtain a

broader understanding on perceptions on Abandoned, Lost and otherwise Discarded Fishing Gear as a marine litter (Vasileiou et al., 2018; Spencer et al., 2004; Naderifar et al., 2017). Also, the snowball technique of referral was adopted to recruit others in the maritime domain willing to participate in the research (Naderifar et al., 2017). Merging both sampling techniques enhanced timely recruitment of participants. A stakeholder analysis also aided in informing the organisations identified for this research. This analysis considered the critical stakeholders with active or passive influence on efforts to solve the issue of ALDFG, how the issue of ALDFG will affect them, projects and activities regarding ALDFG (Reed et al., 2009).

The criteria below were used to sample the participants;

i. The significance and mandate of the organisation in the maritime sector of Ghana with regards to ALDFG.

ii. The individual's unit in the organisation and how they are linked directly or indirectly to the marine environment and or may be concerned with ALDFG.

Interview of Government Officials

The government institution comprised of Fisheries Commission, Ghana Marine Police, Ghana Maritime Authority, Ministry of Fisheries and Aquaculture Development, Ministry of Environment, Science, Technology and Innovation, the Wildlife Division of the Forestry Commission, Environmental Protection Agency. They had differing roles they play in their organisation with regards to the maritime domain.

Interview with Academics

A number of academic institutions with maritime related programmes were also contacted.

Interview of Fisheries Industry Representatives

This included fishing input dealers, National and/or Regional fisher association representatives from the three categories of the marine fisheries sector in Ghana.

Interview of Civil Society Organisations

This covered Non-Governmental Organisations whose activities are connected to the fisheries sector.

6.3 Data Collection

Three sets of semi structured question guides were developed comprising of open-ended questions to obtain primary data. The open-ended questions allowed the participants to express their views on the issue of Abandoned, Lost or otherwise Discarded Fishing Gear (Covell et al., 2012). One five-point Likert Scale question was incorporated to introduce context and measure participants' opinion (Joshi et al., 2015). The participants were selected purposively taking into consideration their stake and mandate in the maritime domain in Ghana (Naderifar et al., 2017). The stakeholders targeted included resource managers, policy makers, fisheries industry representatives, Non-Governmental Organisations and researchers. Specified below is which set of semi-structured question was developed for a targeted stakeholder;

i. Semi- structured interview question Set 1 was intended for participants from government agencies, Non-governmental Organisations etc.

ii. Semi-structured interview question Set 2 was intended for participants from fisher associations to provide extra context and key perceptive.

iii. Semi-structured interview question Set 3 was intended for participants from fishing net dealers and importers to provide further background and important insights.

The interview questions were piloted with two fellow students who had knowledge on the subject. The trial helped to determine whether the interview questions were clear and answered the research questions; it also assisted in the estimation of interview

duration. The research and interview question guide were submitted to the World Maritime University Research Ethics Committee (REC) of which approval was granted on June 17, 2022; before reaching out to participants. The participants were contacted either by e-mail, WhatsApp message and telephone. A request for an interview was sent to them and attached was a consent form, ethical consideration and information regarding the research. This gave the participants the chance to have an idea about the topic area, the estimated duration of the interview and confidentiality terms. The interviews were conducted on the date and time conveniently proposed by the participants. The interviews were conducted between the periods of June 26, 2022 to August 31, 2022. The interviews were held either on zoom or WhatsApp call depending on what was accessible to the participants and their approval was requested to record the conversation. All the participants agreed to be recorded with the exception of three. Notes were also taken during the interview for easy referencing and also to record the conversation of those who did not agree to be recorded. Follow-up questions were asked when a response to a question required more information. The recordings and transcribed information were saved in a separate folder. Most of the interview lasted within the estimated time expect for a few that could be attributed to internet connection and an extensive interaction.

6.4 Data Analysis

The recordings obtained from the interview were transcribed using Avrio and the ones in the local dialect were translated into English. The recordings transcribed with the Application where manually checked to make corrections to some words the application transcribed wrongly and missing words. The responses from the participants were coded and categorised under themes for easy analysis. The Likert 5-point scale was result was presented in graph by using Microsoft Office Excel. Results were evaluated using qualitative approaches.

6. 5 Research Limitations

The style of the research questions meant a qualitative semi-structured questions was best to obtain answers. The interview results should be considered with thoughtfulness due to the sample size There were challenges with reaching to other possible stakeholders including recycling companies and some other government organisations due to bureaucratic processes, individuals not being willing to participate or the contact numbers not being reached. Also, not all the participants had prior knowledge on the topic of ALDFG. These factors could introduce bias in the research. Access to information was a challenge. Also, the internet connection also proofed to be a problem and prolonged some of the interview time frame.

7. RESULTS

This chapter analysis the views of the participants regarding ALDFG and its management, in all a total of 28 interviews were conducted. The analysis here is based on their responses grouped into thematic areas in effort to answer the research questions. Result from interview question guide Set 1 was represented separately from that of interview question guide Set 2&3.

7.1 Information on Participants

In total twenty-eight individuals agreed to partake in this study, of whom twenty-one participants were interviewed with interview question guide set 1, six participants with question guide set 2 and one participant with question guide set 3. The breakdown of the representation from the various organisation and fishery industry representatives is provided at the appendix. Four out of the twenty-one participants were female, representing 19.05 % of the sample size of interview question guide set 1; while that of interview question guide set 2 and 3 were all males.

For the sake of anonymity, the participants have been coded as either A or B with a numerical number attached to identify them individually according to how they were

interviewed. Participants coded as ‘A’ are those who were interviewed with question set 1 and those coded ‘B’ were interviewed with question guide set 2 and 3. For example, A1 will denote participant who was the first to be interviewed with question set 1. Also, for confidentiality purpose the organisations and their duties would be kept reserved. The list of participants, their organisation and the set of interview question used can be found in the appendix.

7.2 Result Analysis of 5-point Likert Scale

The twenty-one participants who were interviewed with question guide set 1, rated the level of threat they perceived ALDFG poses in the marine environment of Ghana. The graph below shows the frequency on the 5-point Likert Scale question obtained from the twenty-one participants.

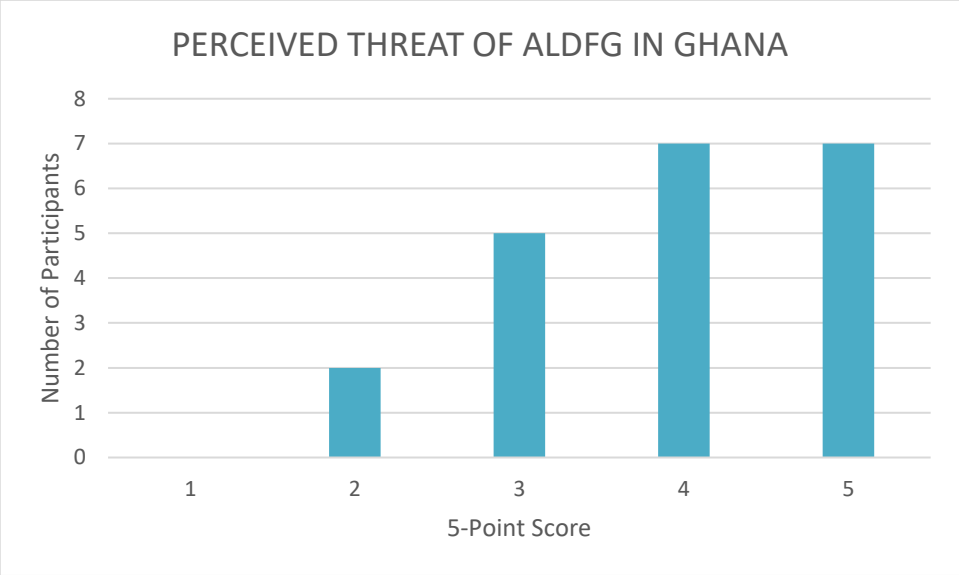

Figure 4 A graph showing the distribution of participant set 1 response on threat level of ALDFG

Out of the twenty-one participants who were either from government agencies, academia or NGOs, 33.33% perceived ALDFG as an extreme threat, another 33.33% as a threat, 23.81% as a medium threat and 9.52% as a low threat in the marine

environment of Ghana. This meant that a significant number of this set of participants saw ALDFG as a threat and agreed to the fact that there is a need to address the issue.

7.3 Thematic Analysis

Themes were developed for the different interview question guide sets to create a distinction between their viewpoints

7.3.1 Thematic Areas for Interview Question Guide Set 1

The following themes in the table below were developed from the interaction with participants who the set 1 questions were used to guide the discussions. When referring to all 21 participants as a group they will be known as participant set 1. The table also shows the research questions the themes attempted to answer.

Table 2 List of themes from interview question set 1

S/N	Theme	Research Question
1	Education and awareness creation	RQ 1
2	Governance	RQ 1
3	Enforcement	RQ 1
4	Monitoring	RQ 1 & 3
5	Organizational capacity	RQ 2
6	Political will	RQ 2
7	Collaboration	RQ 3
8	Research	RQ 3

RQ1. Is ALDFG part of a management regime within the fisheries sector in Ghana?

Theme 1: Education and awareness creation

Mitigation measures are ways to prevent, reduce or control ALDFG from prevailing in Ghana's waters. During the interview a number of actions were suggested on how best the issue of ALDFG can be mitigated. The general consensus among participant Set 1 indicated that they all saw the need to educate and create awareness on ALDFG and marine litter in general. Taking in account all aspects of fishing accessories not just the monofilament nets. For example, A3 made mention of the fact that "*before developing any management measures, it is important to elevate ALDFG to encourage the need to address it with the necessary actions*". Furthermore, an extract from A12 also reinforces the need for education to understand the menace of ALDFG and increase political awareness.

Theme 2: Governance

Governance comes with different approach or an amalgamation of all the approaches. Most of participant Set 1 alluded to the need to establish an appropriate and coherent regime on ALDFG. 15/21 of participant Set 1 advocated for some form of governance specific on fishing gear mana; and that fishing materials be regulated from the point it enters the Ghana's ports to the end of life/use. Participant A4 suggested that " the country should have a specific domestic regulation and by extension a West African legislation on what type of gear is used, how it should be used, the length the composition of the materials it is made of all these should be regulated". An extract from participant A21 "*When your product is proven to have environmental externalities you must be responsible for managing the issues arising from your products*". Also 14/21 of participant Set 1 made mention of improvement in the quality of nets used, instituting incentives and exchange of net initiatives. For instance,

participant A15 stated that "*changes in the law to ensure environmentally friendly materials and ensure the design of gear is less destructive*".

Theme 3: Enforcement

The issue of enforcement was raised by 11/21 of participant Set 1, they hammered on how critical it was to ensure that the laws regarding monofilament nets be implemented since the use of such nets increases the chances of having them being derelict in the marine environment of Ghana. The fisheries laws of Ghana prohibit the use of monofilament nets in the marine sector. A1 stated that "*most of the accidents at sea issues between the industrial fishers and artisanal fishermen has to do with monofilament nets, due to gear conflicts these nets are torn and get lost"*. A quote from A21 "*It has been observed the monofilament nets break easily or get worn out hence are highly polluting fishing nets".*

RQ2. What are the possible challenges to be faced in the effort to mitigate ALDFG in Ghana?

Theme 4: Monitoring

All of participant Set 1 suggested the need for monitoring the actions put in place, to assess how effective they have been. As observed by Participant A7 "*There will be a need to establish performance monitoring indicators to measure the actions adopted*". Some also proposed the inclusion of ALDFG issues to the task of fisheries observers and the fisheries enforcement unit.

Theme 5: Political will

Other participants thought policy makers must recognise ALDFG as a threat for these institutions to work towards it mitigation. 18/21 of the participant A were of the opinion that addressing the issue will have to be led by the Fisheries and Aquaculture Development Ministry and Fisheries Commission. Taking into consideration that these two agencies are in constant communication with the industry players that import of

fishing items as well as fishers. A6 emphasized that "*Until this ALDFG is highlighted to attract the attention of the political establishment it will not be an issue to trigger a policy or a legislation to that effect*".

Theme 6: Organisational Capacity

All of participant Set 1 were of the view that the government institution tasked to manage this issue must have the potential to raise adequate resources. 8/21 raised questions about the number of staff available to the Fisheries Commission to carry out the task of ALDFG management. There was a general belief that funding initiatives to address ALDFG will be a major challenge. An excerpt from A17 "*The challenge that always comes up is the financial one, financial funding. How do you fund this research? How do you fund the operations of removing these fishing gear from the ocean?*".

RQ 3. What are the roles the various stakeholders could play in effort to mitigate ALDFG in Ghana?

Theme 7: Collaboration

16/21 of participant Set 1 considered a collaborative approach as the best practice to manage ALDFG issues in the marine environment of Ghana; in order to ensure the problem is well tackled. They were of the opinion that within the governmental sector various capacities can be put together to assist in solving the issue. For example, A7 describes this problem is a multi-sectorial challenge and recommended the formation of a committee comprising of all the relevant government agencies to ensure a comprehensive action plan.

Theme 8: Research

Ghana currently imports all or most of the fishing materials used in the fisheries industry. The suggestions of the participants were to make it possible to have an inventory of fishing materials; from the quantities imported, those they are being sold to, the reporting of lost nets and collection points for worn out nets. 11/ 21 of participant Set 1 stated the need to research on the issue to understand it in the context

of Ghana. To get a clearer appreciation of the problem, identify hotspots and the drivers. Hence the action plan should be developed based on the best available information on the amount and composition of ALDFG. To develop an action plan would have to be underpinned by science for evidence-based decision making.

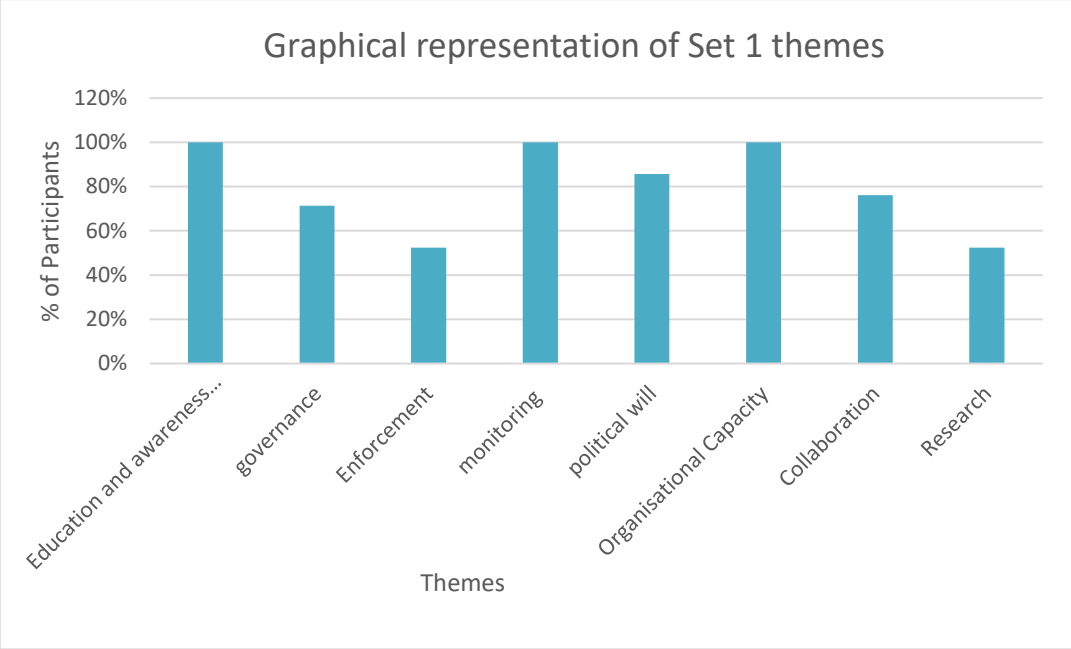

Figure 5 Graph shows the percentage of participant set 1 per theme

The bar chart above shows the percentage number of participants that share their view in relation to the themes developed for participant Set 1.

7.3.2 Thematic Areas for Interview Question Set 2 and 3

The following themes in the table below were developed from the interaction with participant's who the set 2 and 3 questions were used to guide the discussions. They comprised of fisher representative from at the national and regional level; and fishing input dealers and importer's Association. When referring to all seven as a group will be known as participant Set 2&3.

Table 3 List of themes from interview question set 2&3

S/N	Theme	Research Question
1	Education and awareness creation	RQ 1
2	Management of nets	RQ 1
3	A retrieval procedure	RQ 1
4	Drive the change	RQ 3

This result signifies themes that attempt to answers the research questions.

RQ1. Is ALDFG part of a management regime within the fisheries sector in Ghana?

Theme 1: Education and Awareness

All of participant Set 2&3 were of the view that more awareness needed to be created to give better understanding of the issue. For instance, B4 mentioned that "*they looked at the economic aspect of losing the nets but in recent times they are appreciating the issues of pollution and ghost fishing*".

Theme 2: Management of nets

There was a general consensus among all of participant Set 2&3 that, there is a market for worn out multifilament nets even though there is a reduction in the trade in recent times. Some of the worn-out nets were reused as sponge, fencing of gardens and farms. B5 for instance stated "*There is no regime that deals with managing worn-out nets hence it becomes more of an individual discretion as what exactly you want to do with your nets".* B5 further suggested "*it will be important to include the municipal assemblies in the fisheries management community to assist in the management of ALDFG and its recycling*". 4/7 of participant Set 2&3 explained that there is a

possibility to lose nets at sea due to weather or conflicts with other vessels. Hence it will be necessary to retrieve such nets.

Theme 3: Recovery

4/7 of participant Set 2&3 referenced the need to involve the Navy since they have divers to assist them retrieve their nets. They cited when they sometimes loss their nets as a result of currents and bad weather conditions, they usually report to their chief fisherman who in turn informs their colleagues at nearby fishing communities. When other fishers who have heard the information spot the nets and are able to retrieve it is returned to the owner. But when the net gets snagged on objects those who can dive get under the water and cut off the snagged portion. The salvaged part of the net if usable is mended but the snagged portion is left in the sea.

RQ 3. What are the roles the various stakeholders could play in an effort to mitigate ALDFG in Ghana?

Theme 4: Drive the change

3/7 of participant Set 2&3 agreed to the need for them (associations) to create awareness among the fishers for them to have a better understanding of the issue. 2/7 of participants Set 2&3 considered the idea of reaching out to recycling companies to see how best some of the nets can be recycled into other things especially the monofilament nets. For instance, B4 stated "*We are looking at other avenues that will allow the nets to be sold especially the monofilament nets which are left at the beaches*". 2/7 of participant Set 2&3 thought of the need to organise beach clean-ups to clear not just the nets at the beaches but also plastics in general.

The bar chart below shows the percentage number of participants that share their view in relation to the themes developed for participant Set 2&3

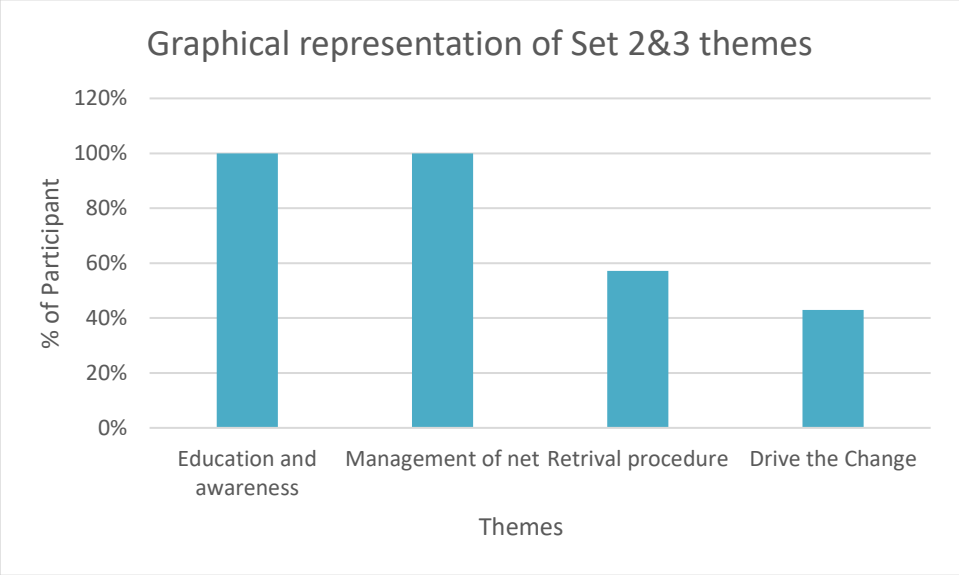

Figure 6 Graph shows the percentage of participant set 2&3 per themes

After analysis of the interviews the themes that were pronounce was education and awareness creation, collaboration

8 DISCUSSIONS

During this section the result will be further discussed into detail and other major findings that sought to answer the research questions; 1) Is ALDFG part of a management regime within the fisheries sector in Ghana?, 2) What are the possible challenges to be faced in effort to manage ALDFG in Ghana?, 3) What are the roles the various stakeholders could play in effort to manage ALDFG in Ghana?

8. 1 Discussion of Findings

Ecological and Socioeconomic Impacts

As previously outlined, research has shown that ALDFG can result in both ecological and socioeconomic impacts. Through the research it was recognized that, though anecdotal, there is evidence that ALDFG is occurring in Ghana's maritime space. Extensive research on ALDFG indicates that these derelict gear impact on marine life

and habitats. Ghana's marine environment has important habitats and areas of ecological significance some of which include a unique cold-water coral and reef morphology (Buhl-Mortensen, 2017, Okpei et al., 2020). Also, there are about nine confirmed nesting sites for olive riley turtles. This species of turtle according to IUCN is listed as vulnerable due to its decreasing populations (Agyekumhene & Allman, 2020). What is more, a report from Nunoo & Asiedu (2013), indicates there are dwindling fish stock linked with fishing pressure and IUU related activities. The claims on ALDFG occurrence in Ghana's waters can also serve as an extra threat to the already declining populations of turtles and fish stocks; and disturb the growth of the corals. Calling to mind Ghana's commitment to the Abidjan Convention, the CBD and achievement of the Aichi targets there will be a need for steps to be taken to ensure biodiversity conservation.

Socioeconomic impacts resulting from ALDFG may affect both stakeholders in the fishing industry as well as other maritime sectors. Frequent net losses by fishers will likely result in increased operational costs as noted by a number of interview participants from Set 2&3 of the interviews. The cost of repurchasing nets before they have reached end-of life was flagged as a challenge by several interviewees. They all cited that at some point one may lose nets due to weather conditions at sea, gear conflict with other vessels or being snagged to objects on the seafloor as described by Macfadyen et al., 2009. In Ghana areas for oil exploration are designated as no fishing zones, hence fishing nets found around the operational areas of offshore companies may have drifted to these areas. Participant A6 recalled that in "*2012 or 2013 one of the oil companies was shooting a seismic and because of this net issue, it affected their work. They had to prolong the duration of their work because of this net getting entangled with their seismic vessel it cost them a lot".* Having such obstructions occur more frequently could lead to increased costs during the oil company's operation, and may affect their operational budget.

Governance

Another emerging theme from the research is the need for policies and collaboration. It is also important to note that majority of the themes can be elements found in a good governance approach. Participant A12 noted "*I think this is the problem with most Ghanaian institutions most at times they have overlapping mandates and each organisation wants to prove that this is my area and once they are working individually, they do not achieve the desired result. And with this issue it will be a challenge for an organisation to work alone"*. According to Tsamenyi 2013, overlaps in functions and duties of marine institutions governing the ocean causes shortfalls in governance and management structures in Ghana. The issue of ALDFG is an environmental governance challenge, for that matter addressing it goes beyond establishing laws (Bennett & Satterfield, 2018). To ensure the management of ALDFG is properly done there will be a need for a joint working arrangement among the marine institutions. Furthermore, a stakeholder analysis must be conducted to identify all stakeholders outside of government institutions to enrich and broaden discussions to find innovative solutions and initiatives. If not, certain relevant context may be missed. For instance, as noted by *A21 "Looking at the plastic policy I have not seen the mention of abandoned fishing nets especially the plastic nets"*. It will also be necessary to expand the involvement and participation of these key societal actors to ensure the support of measures that will be sustainable and effective. An environmental governance framework could be used as a guide to create a sustainable solution that is beneficial and practical for all (Lopes & Farias, 2022; Hu, 2021; Bennett & Satterfield, 2018).

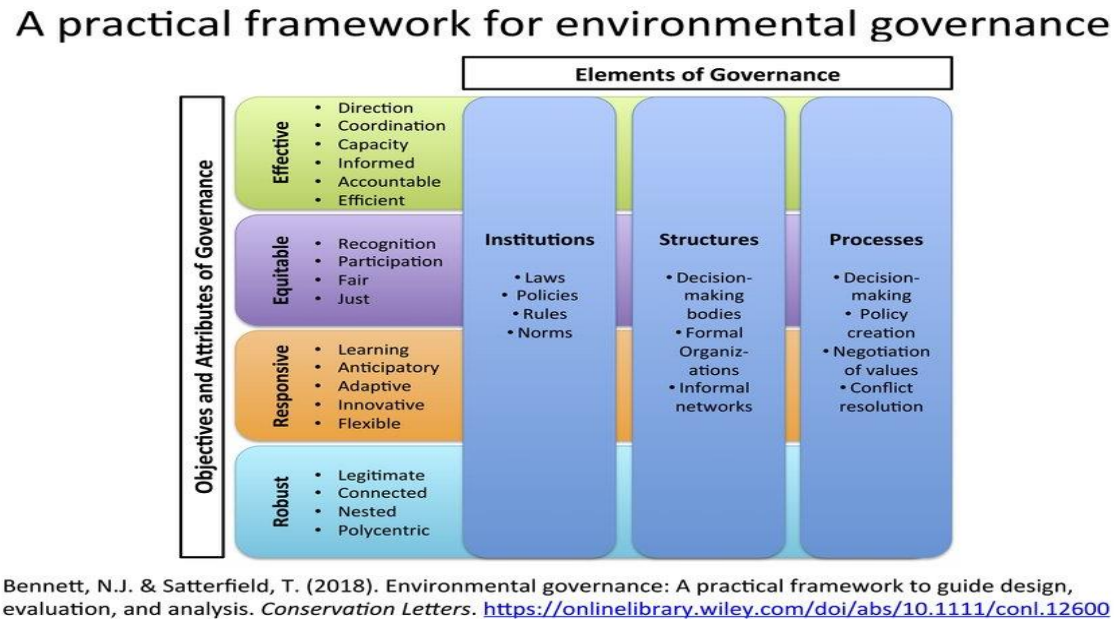

Figure 7 Environmental governance framework: sourced from Bennett & Satterfield (2018)

A comprehensive governance approach will also make the various roles of the stakeholders well outlined and coordinated to have a whole-life-cycle approach to solving ALDFG in Ghana's waters. When the resources of all the marine agencies are pooled together for a joint action there will be more resources to execute plans. To ensure funds to sustain programmes and actions, United Nations Integrated National Financing Frameworks (INFFs) which was developed to aid policy makers in financing strategies (UN, n.d.). Hence assisting to address the issues of organisational capacity and ensuring a cost-effective measure.

Another major concern raised by some participants was how gear waste will be managed including having access to companies that can recycle. A key agency to include is the local assemblies (Metropolitan, Municipal and District Assemblies, (MMDAs). The Fisheries Act 625, sub-part III section 52 (2b) allows for canoes to be registered with the Fisheries Commission through the District Assemblies. This provision means the local assemblies have a stake in fisheries management and by extension, the potential management of ALDFG waste. Their inclusion in discussions can assist in the provision of waste disposal facilities at strategic areas along the coastline and also access to recycle companies. Under MARPOL Annex V provision

vessels should dispose of their waste at designated port facility. However, the majority of Ghana's fishing fleet will be exempted since most of them are smaller than the mandated size. That notwithstanding, Ghana's national laws with regards to MARPOL Annex V can be developed to fit Ghana's context, with adequate provision made to encourage proper disposal (IMO, 2019e).

Whatever governance arrangement is put in place must be appropriate for the management of ALDFG. The governance approach apart from the legal regimes should integrate economic and voluntary instruments developed after a comprehensive assessment of the environment and the value chain has been conducted (OECD, n.d.). The economic instruments should encompass incentives to motivate fishers to return worn-out or encountered nets at sea and importers or traders of nets assume responsibility for the environmental impacts. The measures developed and implemented must be measurable and consistent with other regimes. For instance, Ghana's National Plastic Policy aims to establish an Extended Producer Responsibility Scheme. This provision could be considered to ensure fishing material importers and dealers are accountable for their products (NPMP, 2020).

The Fisheries Regulation 2010, section 25 makes provision for fishing gear to have makers to ensure submerged or surface gear is visible to reduce accidents at sea. The marking is done by the fishers themselves and not standardised. Reforms to the rules can be made to implement gear marking recommendations in the FAO Voluntary Guidelines for the Marking of Fishing Gear (FAO, VGMFG; 2019). The FAO, VGMFG tool will assist in identifying and locating fishing gear for retrieval, combat IUU fishing and aid in the fisheries management (FAO, 2019; He & Suuronen, 2018). Also, Global Ghost Gear Initiative-Best Practice Framework for the Management of Fishing Gear (GGGI-BPF) among other relevant strategies can be used as models towards developing an action plan that suites Ghana's peculiar situation (GGGI, 2020).

Another theme is enforcement, with anecdotal findings from the research suggesting that ALDFG in the marine environment in Ghana may be more common among fishers who use monofilament nylon nets. According to regulation 8 of Ghana's Fisheries

Regulation 2010, monofilament set nets are not to be used in the marine waters but allowed in the riverine systems. This signals a need for stronger monitoring and enforcement to ensure rules pertaining to monofilament net usage and broader fisheries management laws are adhered to in order to drive ALDFG solutions.

From the interviews some participants spoke of a fishing gear exchange programme. It will be important that structures are set to regulate, monitor and trace fishing nets usage in the country and a massive education undertaken prior to rolling out a gear exchange programme Particularly because when the exchange programme is over and the nets of the fishers gets worn-out; there could be a possibility of them going back to monofilament nets, since they nets are relatively cheaper on the market compared to the multifilament polyester net (CRC, 2013).

Education and awareness creation / Political will

This theme is one of the tools in voluntary instruments under governance but separated due to its significance. The flow of knowledge, capacity building and use of social marketing tools will be paramount in the entire process leading up to and the overall success of management of ALDFG. Promoting the need to solve ALDFG and the political resolve to do so. There is some degree of education and awareness programmes being conducted by some CSOs notably the EJF-Ghana; Net Free Seas Project. Through the interview it was mentioned that they were playing a key role in the National Plastic Action Partnership (NPAP) discussions since ALDFG has been explicitly stated in the policy (EJF-Ghana, personal communication). Some of the fisher representatives also had some form of awareness and mentioned they have been educating their members on the threats ALDFG poses to the environment. Likewise, an understanding of ALDFG in totality not just as a problem arising from monofilament users but the entire fisheries sector, i.e. from the Styrofoam used in packaging, to lines and ropes as well as complete gear units (Goodman et al., 2021).

Education and community based social marketing tools will grow the sense of responsiveness to the environmental issues associated with ALDFG and how it may impact their livelihood. An appreciation of the problem by the fishers will assist in the

introduction of voluntary industry driven initiatives on ALDFG management and compliance.

Research

A proper inventory and reporting system can also be developed to provide the necessary data to assist with policy making and traceability of fishing inputs. All fishing materials must be quantified from dealers and at the recycle point. Furthermore, research is needed to develop baselines for further actions to be taken in efforts to address the problem. Such research can assist in understanding the real quantities that get lost as well as; gear usage and replacement periods. Capacity building in gear technology can aid in promoting best standards and designs resulting in less destructive gear and/or mechanisms for avoiding ghost fishing (FAO, 2019). Future research may also consider the use of biodegradable alternatives to plastic netting.

Repurpose of worn-out nets

A major finding was fact that fishers at times sold their worn-out nets especially the multifilament cotton/polyester nets for the purposes of fencing farms, gardens or used as sponge. This meant that there is some form of reuse of nets but this will have to be supported with other initiatives like the Net Free Seas Project. It will also promote innovative solutions among fishers and the public to find sustainable use for the worn-out nets and other opportunities. Also, it is important that these repurposed nets after they have outlived their usefulness are properly disposed and or recycled.

Figure 8 Sample repurpose ideas for ALDFG: Sourced from Art Project

9. RECOMMENDATION

This section of the paper tries to propose some useful recommendations that Ghana could explore in effort to manage the issue of ALDFG.

9.1 Recommendations

Education and awareness creation: this will need to be the foremost and crucial approach to tackling the problem and instigate behavioural changes (Richard et al., 2018). Information gathered during the interviews showed that, worn-out fishing gear that is not sold find their way at the beaches or are burnt.

Collaboration among all stakeholders interested in waste, fisheries, marine environment, wildlife, research among others must all be involved. This will widen the scope of ideas and help cover all the possible areas in the whole life cycle of a fishing gear from the time it enters the country to when it is reused and or recycled.

Ghana should also strive to work towards cooperating with her neighbours on this issue more so because the problem knows no maritime boundaries.

Law and Policy: A gap analysis could be done to determine if there is a need for new or amended legislation. The regime should be comprehensive regulation ensuring a systems approach of environment, economic and social wellbeing is integrated for a sustainable marine economy. The governance regime should be explicit about ALDFG and other pollutants and comprehensive rules on the management of fishing gear. The regime should also provide support to plans and voluntary initiatives and set out technical standards governing gear design and construction materials. Fishing gear modifications should also be considered. Enforcement and improvement of measures regarding the marking of fishing gear and other fisheries management measures should assist in decreasing the occurrence of ALDFG associated with certain drivers (Richardson et al., 2018).

Spatial management: There are various form of codes, tracers and identification tags used for marking fishing gear. An electronic net tagging system could also be adopted to allow for the identification of owners, and tracking of lost or abandoned gear; to minimise ALDFG occurrence. The electronic tags or GPS tags can be used to also take data on fishing grounds and IUU monitoring to assist with fisheries management in general (GGGI, 2020; FAO, 2019; He & Suuronen, 2018). Further, marine spatial planning may also be considered as means to reducing gear conflicts.

Waste management: there are over three hundred landing sites used by the artisanal fishers and two main ports for the semi-industrial and industrial fishers. Providing collection bins (disposal facilities) at the two main ports and strategic locations among the three hundred and four landing sites will also aid in tackling the issue (FAO, 2022). Fishing vessels that fall within the waste management requirement in MARPOL Annex V will need to be monitored to ensure compliance and provisions set to ensure domestic laws cover smaller vessels and canoes. How worn-out or retrieved fish gear waste will be managed will be critical to arresting the problem of ALDFG impacts in the marine environment (Richardson et al., 2018).

A reporting system should be designed to keep records of worn-out gear returned by fishers, their reported cases of accidental lost at sea and recovery of found nets. This report should be synchronised with the inventory on input brought in to the sector to help validate the estimated volumes.

Gear retrieval: A retrieval programme should be instituted and an assessment of the marine environment for locations of where ALDFG has accrued can be done by using remote systems and sonars in the surveys.

Drawing on insight from cost benefit analysis an economic decision-support system on fishing gear collection and recycling and retrieval plans must be conducted to ensure sustainability of projects such gear exchange; and business models designed to incentivise fishers to return and retrieve fishing nets (Savels et al., 2022).

10. CONCLUSION

The aim of this study was to explore the strategies to manage ALDFG Ghana's the marine environment through the use of a semi-structured interviews of key stakeholders in the marine sector. From the information gathered through these interviews, the following conclusions have been made:

To begin with, it appears ALDFG occurring in Ghana's marine environment with some of the key driver's being lack of disposal site, gear conflict and weather conditions at sea. The overlapping mandates of the marine institutions will require that they cooperate or a joint body is setup to manage ALDFG and other inter-sectoral challenges pertaining to ocean governance. The government institutions must also partner with NGOs, media and other societal actors to increase activities along the coast aimed at managing this threat. Ongoing initiatives such as the net buying schemes and public sensitisation by NGOs offer opportunities for partnership building between the government, industry and the NGO community. Education and awareness creation initiatives currently being undertaken by NGO groups will need to be

intensified along the entire coastline. The fisheries sector must be well managed; and monitoring control and enforcement measures enhanced. This will prevent some of the contributing factors to ALDFG for instance the use of monofilament net in the marine environment which is illegal. Efforts must be made to cooperate and coordinate with neighbouring countries to enhance marine sustainable management and development with the region. Mangers must also establishment a performance monitoring indicator to measure progress and achievements.

Lastly, this research serves as a step to understanding ALDFG issues in Ghana. There are significant research gaps therefore it is anticipated that this study will advance efforts in research on this topic area. Suggested future research may be focused on assessing ALDFG environmental and socio-economic costs and the cost benefit analysis of ALDFG prevention and reduction measures. As well as other relevant research to holistically manage this challenge.

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Appendices

Appendix 1 Table showing the organisations and number of participants interviewed

Organisation	Number of Participants
Fisheries Commission	4
Ghana Maritime Authority	4
Environmental Justice Foundation-Ghana	2
Environmental Protection agency	2
Ministry of Fisheries and Aquaculture Development	1
Forestry Commission, Wildlife Division	1
Ministry of Environment, Science, Technology and Innovation	1
Marine Police	1
Public University Institution	1
Friends of the Nation	1
Hen Mpoano	1
Tetra Tech	1
Centre for Sustainable Cycles	1
Total participants for Set 1	21

Appendix 2 Table shows fisheries industry representatives and the number of participants interviewed

Fisheries Industry representative	Number of Participants

Canoe and fishing gear owners' association of Ghana (national and one of the regional chapters)	3
Ghana Inshore fishers' association (one of the regional chapters)	1
Ghana Tuna Association	1
Ghana National Canoe Fishermen Council	1
Association of Importers and Distributors of Fishing Gear	1
Total participants	7

Appendix 3 Table provides details on participants that were interviewed

S/N	Participant code name	Gender	Organisation	Position	Number of years with organisation	Date of interview	Interview question set
1	A1	M	Government Official, Resource Manager	Senior Management	16 years	26/06/2022	Set 1
2	A2	M	Government Official Resource Manager	Middle Management	13 years	12/07/2022	Set 1
3	A4	M	Government Official Resource Manager	Middle Management	8 years	19/07/22	Set 1

4	A6	M	Government Official Resource Manager	Senior Management	11 years	26/07/2022	Set 1
5	A8	F	Government Official Resource Manager	Middle Management	10 years	30/07/2022	Set 1
6	A9	M	Government Official Policy Maker	Senior Management	8 years	30/07/2022	Set 1
7	A10	M	Government Official	Senior Officer	8 years	31/07/2022	Set 1
8	A12	M	Government Official Resource Manager	Middle Management	12 years	31/07/2022	Set 1
9	A14	F	Government Official Resource Manager	Middle Management	12 years	07/08/2022	Set 1
10	A16	M	Government Official Resource Conservation	Senior Management	25 years	12/08/2022	Set 1

11	A17	M	Government Official Resource Manager	Middle Management	15 years	15/08/2022	Set 1
12	A18	M	Government Official Resource Manager	Middle Management	10 years	19/08/2022	Set 1
13	A19	M	Government Official Resource Manager	Senior Management	24 years	22/08/2022	Set 1
14	A20	M	Government Official Policy Maker	Middle Management	6 years	31/08/2022	Set 1
15	A11	M	Academia	Senior Lecturer	13 years	31/07/2022	Set 1
16	A3	M	NGO	Fisheries management Specialist	6 months	18/07/22	Set 1
17	A5	F	NGO	Middle Management	4 years	22/07/2022	Set 1

18	A7	M	NGO	Senior Management	9 years	27/07/2022	Set 1
19	A13	M	NGO	Project officer and policy advisor on fisheries issues	5 years	01/08/2022	Set 1
20	A15	F	NGO	Senior Programmes Manager	7 months	11/08/2022	Set 1
21	A21	M	NGO	Senior Management	6 years	31/08/2022	Set 1
22	B1	M	Fishing Industry Representative / Regional	Executive	20 years	12/07/2022	Set 2
23	B2	M	Fishing Industry Representative /Regional	Executive	29 years	12/07/2022	Set 2
24	B3	M	Fishing Industry Representative /Regional	Executive	16 years	12/7/222	Set 2

25	B4	M	Fishing Industry Representative/ National	Executive n	20 years	19/07/22	Set 2
26	B5	M	Fishing Industry Representative/National	Executive r	35 years	22/07/22	Set 2
27	B7	M	Fishing Industry Representative/ National	Executive s	35 years	30/07/2022	Set 2
28	B6	M	Fishing Industry Representative	Executive	10 years	22/07/2022	Set 3

Appendix 4: Interview Questions Guide for Participant Set 1

1- What is the name of your organisation?

2- How many years have you been with the organisation and your current positon?

3- What is the organisation's key responsibility?

4- How familiar are you with ALDFG issues in the marine environment either at the global, regional or national level?

5- On a scale of 1 to 5 {1= no threat, 5= extreme threat}, how much of a problem do you perceive ALDFG in Ghana? And why?

[1] [2] [3] [4] [5]

6- Is it necessary to address the issue of ALDFG in Ghana? If yes, what will you propose?

7- Do you have any knowledge on legislations or policies regarding ALDFG management in Ghana? If yes,

8- If ALDFG is to be addressed in Ghana what will be the possible political, institutional and operational challenges and how can these challenges be surmounted?

9- What role can your organization play in efforts to manage ALDFG in Ghana? And which other agency/industry stakeholder needs to be involved?

10- Are there benefits to be derived from addressing ALDFG in Ghana? If yes, what are these benefits?

11- What management measures should be adopted to improve monitoring, evaluation and enforcement systems to ensure importers, fishers, fishing vessel operators and other users of fishing materials are accountable to ALDFG issues in Ghana?

12- What can be the short- and long-term recommendations on ALDFG management in Ghana?

13- Any additional comments or suggestions?

Appendix 5 Interview Questions Guide Set 2

1- What is the name of your fisher association?

2- How many years have you been a fisher?

3- Do you have any knowledge or experience with ALDFG in the marine environment of Ghana?

If yes,

Do you perceive ALDFG to be a problem in your daily activities and/or in the marine environment in Ghana?

4- How do you manage nets when they are worn-out or lost at sea?

5- Is it relevant to institute measures to manage ALDFG in Ghana?

6- Are you usually consulted during the formulation of laws or policies in the fisheries sector?

7- What role can you play in efforts to eradicate ALDFG from Ghana's waters?

8- Any additional comment?

Appendix: 6 Interview Questions Guide Set 3

FISHING INPUT IMPORTERS

1- What is your role in the fisheries sector of Ghana?
2- How many years have you been in the sector?
3- How familiar are you with ALDFG issues in the marine environment either at the global, regional or national level?
4- Will you consider ALDFG as a potential threat to the marine environment in Ghana?
   If yes, why?
5- What role can you play in efforts to mitigate pollution from ALDFG in Ghana's waters?
6- Any additional comment?

Interview Consent form

Dear Participant,

Thank you for agreeing to participate in this research interview, which is carried out in connection with a Dissertation which will be written by the interviewer, in partial fulfilment of the requirements for the degree of Master of Science in Maritime at the World Maritime University in Malmo, Sweden.

The topic of the Dissertation is 'The Global Menace of "Abandoned, Lost or Discarded Fishing Gear" (ALDFG): The Best Practice to Manage ALDFG in Ghana's Fisheries Sector'**.**

The information provided by you in this interview will be used for research purposes and the results will form part of a dissertation, which will be published online and made available to the public. Your personal information will not be published. You may withdraw from the research at any time, and your personal data will be immediately deleted.

Anonymised research data will be archived on a secure virtual drive linked to a World Maritime University email address. All the data will be deleted as soon as the degree is awarded.

Your participation in the interview is highly appreciated.

Student's name	Linda Bana
Specialization	Ocean Sustainability, Governance and Management
Email address	w1010961@wmu.se

* * *

I consent to my personal data, as outlined above, being used for this study. I understand that all personal data relating to participants is held and processed in the strictest confidence, and will be deleted at the end of the researcher's enrolment.

Name: ……

Signature: ……

Date: ……

Appendix: 7 EJF-Ghana Net Free Seas Project; awareness creation on Twitter handle