USAID | GHANA
FROM THE AMERICAN PEOPLE

SUSTAINABLE FISHERIES MANAGEMENT PROJECT (SFMP)

A Guide on Illegal Fishing Activities in Ghana

April 2018

THE UNIVERSITY OF RHODE ISLAND GRADUATE SCHOOL OF OCEANOGRAPHY
COASTAL RESOURCES CENTER
CRC

UNIVERSITY OF CAPE COAST
VERITAS NOBIS LUMEN

UCC FORENSICS

CENTRE FOR COASTAL MANAGEMENT
CCM
University of Cape Coast-GHANA

This publication is available electronically in the following locations:

The Coastal Resources Center

http://www.crc.uri.edu/projects_page/ghanasfmp/

Ghanalinks.org

https://ghanalinks.org/elibrary search term: SFMP

USAID Development Clearing House

https://dec.usaid.gov/dec/content/search.aspx search term: Ghana SFMP

For more information on the USAID/Ghana Sustainable Fisheries Management Project, contact:

USAID/Ghana Sustainable Fisheries Management Project
Coastal Resources Center
Graduate School of Oceanography
University of Rhode Island
220 South Ferry Rd.
Narragansett, RI 02882 USA
Tel: 401-874-6224 Fax: 401-874-6920
Email: info@crc.uri.edu

Citation: Afoakwah, Richmond, Osei, Mensah Bonsu Dan and Effah, Elizabeth. (2018). A Guide on Illegal Fishing Activities in Ghana. USAID/Ghana Sustainable Fisheries Management Project. Narragansett, RI: Coastal Resources Center, Graduate School of Oceanography, University of Rhode Island. Prepared by the University of Cape Coast, Ghana. GH2014_SCI048_UCC 64 pp.

Authority/Disclaimer:

Prepared for USAID/Ghana under Cooperative Agreement (AID-641-A-15-00001), awarded on October 22, 2014 to the University of Rhode Island, and entitled the USAID/Ghana Sustainable Fisheries Management Project (SFMP).

This document is made possible by the support of the American People through the United States Agency for International Development (USAID). The views expressed and opinions contained in this report are those of the SFMP team and are not intended as statements of policy of either USAID or the cooperating organizations. As such, the contents of this report are the sole responsibility of the SFMP team and do not necessarily reflect the views of USAID or the United States Government.

Cover photo: Fishermen with a petrol-powered generator on board a canoe for light fishing

Photo credit: Abekhe Shofune Dorcas

Detailed Partner Contact Information:
USAID/Ghana Sustainable Fisheries Management Project (SFMP)
10 Obodai St., Mempeasem, East Legon, Accra, Ghana

Maurice Knight	Chief of Party maurice@crc.uri.edu
Kofi Agbogah	Senior Fisheries Advisor kagbogah@henmpoano.org
Nii Odenkey Abbey	Communications Officer nii.sfmp@crcuri.org
Bakari Nyari	Monitoring and Evaluation Specialist hardinyari.sfmp@crcuri.org
Brian Crawford	Project Manager, CRC brian@crc.uri.edu
Ellis Ekekpi	USAID AOR (acting) eekekpi@usaid.gov

Kofi.Agbogah
kagbogah@henmpoano.org
Stephen Kankam
skankam@henmpoano.org
Hen Mpoano
38 J. Cross Cole St. Windy Ridge
Takoradi, Ghana
233 312 020 701

Andre de Jager
adejager@snvworld.org
SNV Netherlands Development Organisation
#161, 10 Maseru Road,
E. Legon, Accra, Ghana
233 30 701 2440

Donkris Mevuta
Kyei Yamoah
info@fonghana.org
Friends of the Nation
Parks and Gardens
Adiembra-Sekondi, Ghana
233 312 046 180

Resonance Global
(formerly SSG Advisors)
182 Main Street
Burlington, VT 05401
+1 (802) 735-1162
Thomas Buck
tom@ssg-advisors.com

Victoria C. Koomson
cewefia@gmail.com
CEWEFIA
B342 Bronyibima Estate
Elmina, Ghana
233 024 427 8377

Lydia Sasu
daawomen@daawomen.org
DAA
Darkuman Junction, Kaneshie Odokor Highway
Accra, Ghana
233 302 315894

For additional information on partner activities:

CRC/URI:	http://www.crc.uri.edu
CEWEFIA:	http://cewefia.weebly.com/
DAA:	http://womenthrive.org/development-action-association-daa
Daasgift:	https://www.facebook.com/pages/Daasgift-Quality-Foundation-FNGO/135372649846101
Friends of the Nation:	http://www.fonghana.org
Hen Mpoano:	http://www.henmpoano.org
SNV:	http://www.snvworld.org/en/countries/ghana
Resonance Global:	https://resonanceglobal.com/

ACRONYMS

DDT:	Dichlorodiphenyltrichloroethane
ECD:	Electron Capture Detector
EEZ:	Exclusive Economic Zone
FAO:	Food and Agriculture Organization
GC:	Gas Chromatography
GMA:	Ghana Maritime Authority
GRT:	Gross Registered Tonnage
IUCN:	International Union for Conservation of Nature
IUU:	Illegal, Unreported and Unregulated
L.I:	Legislative Instrument
LC:	Liquid Chromatography
LoD:	Limits of detection
LoQ:	Limits of quantitation
MS:	Mass Spectrometry
NGO:	Non-governmental organization
QA:	Quality Assurance
QC:	Quality Control
QuEChERS:	Quick Easy Cheap Effective Rugged Safe
RDT:	Rapid Diagnostic Test
SOP:	Standard Operating Procedure
SPE:	Solid Phase Extraction
UV/Vis:	Ultraviolet/Visible detector

FOREWORD AND ACKNOWLEDGEMENTS

Illegal fishing takes place when vessels or fishers operate in violation of the fisheries laws of a country. Factors responsible for illegal fishing practices are similar to those behind other types of international environmental crime. That is, a high rate of economic return for those involved, and the failure of governments to regulate efficiently, or enforce national or international laws e.g. because of lack of technical capacity, or poor governance structures in place. Since no one is reporting catches of illegal fishers, their level of fishing cannot be accurately quantified. Therefore, reliable estimates of total extractions cannot be guaranteed and fish stock assessments are undermined. The practice weakens management measures directed at conserving fish stocks and ensuring their long-term sustainability for food security. The Government of Ghana is presently putting in place measures to reduce illegal fishing practices through several means. One of them is by strengthening the fisheries legislation by adopting new regulations and legislative reforms which will, among others, impose severe sanctions on illegal fishers and punish offenders. It also includes the introduction of new control measures on Ghana-flagged vessels that intend to fish in neighboring countries.

The Monitoring, Control and Surveillance (MCS) Division of the Ministry of Fisheries and Aquaculture Development implemented the vessel monitoring systems (VMS) to provide information on real time position of fishing vessels on the sea. Commercial fishing boats have been registered and placed into appropriate categories to ensure sustainable fishing in Ghana's Exclusive Economic Zone (EEZ). The Ghana Navy as part of protecting the territorial integrity of the country has partnered with the Ministry of Fisheries and Aquaculture Development to fight illegalities at sea particularly pair trawling; and also have helped to enforce the activities of the MCS. In recent times, a Marine Police Division has been created within the Ghana Police Service to help with fisheries law enforcement. Significant among the challenges faced by these institutions is the lack of capacity to enforce our fisheries laws. The problem with these efforts is that, they have largely targeted large scale fishers (local and foreign). Unfortunately, illegal fishing is very pervasive among artisanal fishers as well. The use of nets of wrong mesh sizes, dynamite, poisons and light for fishing have been the bane of artisanal fisheries in Ghana. Fishermen associations are being sensitized, on the effects of these practices on the sustenance of their livelihoods.

This guide will serve the professional and practical needs of stakeholders i.e. fishers, processors, fisheries management committees, and fisheries officers in Ghana committed to addressing illegal fishing in Ghana. It is a product of scientific and traditional knowledge, written in a non-technical language for the benefit of users.

We are thankful to the USAID/Ghana Sustainable Fisheries Management Project of the University of Rhode Island for funding this project. My appreciation also goes to the authors at the Department of Forensic Sciences and the Centre for Coastal Management, both of the University of Cape Coast for developing this guide.

Denis W. Aheto (PhD)

Associate Professor and Director

Centre for Coastal Management

University of Cape Coast, Cape Coast.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Page

EXECUTIVE SUMMARY

The activities in the marine sector range from artisanal canoe operations through inshore to industrial operation. The Ghanaian fishing industry is strongly endowed with significant and valuable stocks of fish, producing 430,000 tonnes of fish annually. Thus, the fishing industry in Ghana remains an attractive sector for both local and foreign fisher-folk, making it a major source of employment, livelihood and a way of life. However, the fisheries resources have experienced a state of overfishing as a result of excess fishing capacity (number of boats) and increase in the number of fishermen.

Light fishing has become extremely rampant in the Exclusive Economic Zone of Ghana. Fishers use the light to attract fish for easy capture. Some fish may, however, evade capture making light fishing alone insufficient for the intended purpose. The use of other illegal methods aimed at killing or immobilizing the fish, thus, come in handy. In this process, fishers use chemicals including, DDT and Carbide and explosives, mainly dynamite. The use of petrol and diesel has also been recorded. All of these either kill or incapacitate the fish, aiding easy capture. A mixture of powdered detergent and *gari* (a fine to coarse granular flour of varying texture made from cassava tubers), has proven potent in this venture. Other fishers use a mixture of powdered detergent, *gari* and petrol. All of these practices render the fish dangerous for human consumption. The use of illegal fishing gear and materials such as undersized nets and nets made of monofilaments which are able to capture matured and immature fish including fingerlings have also contributed to the dwindling stock of fish in Ghanaian waters.

Notwithstanding the dangers associated with illegal fishing, the practice is very ripe in the nation. Several factors motivate and/or influence the practice of illegal fishing activities including weak law enforcement, depletion of fish stock, increasing demand for fish and invasion of the fisheries sector by the so-called "profit-only-oriented" private business persons.

Marine mammals and sharks are protected species because of their reducing numbers. It is thus illegal to capture these animals without prior permission from regulatory authorities. In the western coast of Ghana, however, the capture of dolphins and sharks is proliferating. Fishers have ready market for the dolphins and sharks, thus motivating their capture.

In this project, local knowledge on illegal fishing methods were collected from individuals whose main work is within the fishing industry, utilising community engagements via focus groups, informants and administration of structured questionnaires where possible. Light fishing, and the use of chemicals such as DDT, carbide and powdered detergent were found to be most prominent among the illegal fishing methods employed in the four project sites namely; Axim, Dixcove, Elmina and Sekondi. Explosives, including carbide were also found to be used, albeit on a smaller scale, but generally in conjunction with light fishing. Methods for fish sample collection, processing, presentation to accredited laboratories including chain of custody, instrumental analysis and interpretation of results have also been proposed.

The making of this guide is timely as the government of the republic of Ghana takes steps to arrest the dwindling fate of the fisheries industry.

INTRODUCTION

Illegal fishing takes place when administrative norms in fisheries management are breached. This may be minor or serious and may attract a small, medium or heavy fine. Generally, illegal fishing activities are not accompanied by criminal prosecution, unless it is also accompanied by the breach of a criminal law. In recent times, Ghana has been noted among a list of countries who fail to tackle illegal fishing carried out by their fleets. Especially for those that occur in artisanal fishing zones, the effects lead to depletion of fish stocks thus making these zones less productive, resulting in low profitability and food insecurity in fishing communities.

The lack of transparency associated with illegal fishing such as fish transshipment is a threat to effective marine conservation. For instance, Ghana is unable to effectively monitor the amount of fish caught from its waters and transshipped onto other vessels, therefore making it very difficult to establish the extent to which marine fisheries resources are exploited in the country. This means that management plans are not based on accurate data and the country incorrectly evaluates fishing effort and catch levels. The impacts therefore, of fishing on sensitive marine species cannot be fully accounted for.

The purpose of this guide is to inform fisheries stakeholders, fisheries committees, fisheries enforcement personnel and marine police on how to detect whether fish has been caught with illegal methods; and describe both qualitative and scientific methods that can be used to carry out a positive identification or not. The guide also describes what evidence would need to be collected, as well as how and what testing would be needed, to provide valid evidence in criminal cases against individuals using chemicals or other illegal methods or in possession of illegally caught fish. It also describes how fish samples need to be collected and preserved in the field and sent to accredited laboratories for scientific testing and also how a chain of custody of such evidence needs to be documented for such samples to be used as evidence in a court of law. It describes the laws that prohibit use of chemicals and other illegal fishing methods and penalties associated with use and/or possession of such illegal products.

The guide combines both scientific knowledge as well as local knowledge collected from key informants in the fishing industry about how fish caught with illegal methods can be detected. Prior to data collection, stakeholders in the fishing industry within four study sites (Axim, Sekondi, Elmina and Dixcove) were engaged on the objectives of this work and permission sought for entry into their communities. These consisted of non-governmental organizations (NGOs; Hɛn Mpoano and Friends of the Nation), chief fishermen at each site, fishermen and fishmongers. Focus group discussions were held within the fishing communities to solicit local knowledge on illegal fishing and its attendant effects. Where appropriate, structured questionnaires were administered to collect specific information. Validation meetings of the draft guide held with a small group of stakeholders, technical experts and enforcement personnel were revised into the final version.

This manual is intended to contribute immensely to the development of fisheries, and the value chain in Ghana, improve profitability; and gains to fisheries law enforcers, fishermen, and fish processors would be quantitatively demonstrated.

THE FISHING INDUSTRY IN GHANA

Fisheries play a crucial role in supporting livelihoods and food security in Ghana. While there is a sizable industrial fishing fleet, more than two-thirds of Ghana's total marine fish catch is accounted for by artisanal fishers. These fishers now share Ghana's marine domain with the country's emerging oil sector, an industry that has raised hopes of a significant economic boost for the country while at the same time eliciting concerns around potential environmental and social impacts. The fisheries sector plays a significant role in the socioeconomic development of Ghana. Bordered on the south by the Gulf of Guinea, Ghana spanning an area of 238 500 km^2, has a narrow continental shelf with a total area of about 24 300 km^2. Ghana has a territorial sea of 12 nautical miles (nm) a contiguous zone of 24 nm and an Exclusive Economic Zone (EEZ) of 200 nm, covering an area of 225 000 km^2. With this combination of valuable attributes, and a 550-kilometre coastline which stretches from Aflao in the East to Half Assini in the West, Ghana's fisheries sector contributes significantly towards sustainable livelihoods, food security and poverty reduction. Ghana's fishing industry started in the 1700s as an artisanal fishery with very simple and inefficient gear, craft and methods, operating close to coastal waters, lagoons, estuaries and rivers. Currently, the sector is based on fishery resources from the sea and, to a lesser extent, inland fisheries and aquaculture. While marine species are fished in the abundant territorial marine waters, freshwater fish are sourced from Lake Volta, rivers, reservoirs and inland aquaculture systems.

Ghana's fisheries sector consists of a varied and vigorous spectrum of fishing activities, ranging in scope from subsistence to semi-industrial, to industrial fisheries. Within this broad range, fish stocks are harvested from rivers, lakes, coastal lagoons and shallow seas and offshore waters in the Atlantic Ocean. Six different sources of domestic fish supply, including marine fishery, lagoon fishery, Lake Volta, other inland fisheries, aquaculture and imports, can be obtained in Ghana. The fishing operations in Ghana consist of three subsectors: industrial, semi industrial and artisanal (canoe) subsectors. The craft type employed in Ghana's marine capture fishery includes dugout canoes, canoes with outboard motors, trawlers, and large steel-hulled foreign-built vessels used for industrial fishing. The dugout canoes and canoes fitted with outboard motors are mostly used by the artisanal fishers while trawlers and steel-hulled vessels are used mainly in the semi-industrial and industrial marine fisheries. There is currently a total of 12 000 marine artisanal canoes operating along the coast, 150 semi-industrial vessels and 84 licensed industrial trawlers in Ghana's marine waters. About 6 405 of the artisanal canoes are motorized. Many larger fishing vessels are also motorized with 40 horsepower outboard engines whereas smaller canoes still use sail power. Larger canoes, mainly motorized, specialize in hook and line, and use ice to preserve high-value fish in insulated containers, with some using electronic fish finding devices such as echo-sounders.

Artisanal Canoe Sector

Artisanal fishing or subsistence fishing includes various small-scale, low-technology, low-capital, fishing practices undertaken by individual fishing households. Many of these households are of coastal or island ethnic groups. These households make short (rarely overnight) fishing trips close to the shore. Their produce is usually not processed and is mainly for local consumption. Artisanal fishing uses traditional fishing techniques such as beach seine, hook and line, cast nets and small traditional fishing boats. Artisanal fishing may be undertaken for both commercial and subsistence reasons. It contrasts with large-scale modern commercial fishing practices in that it is often less wasteful and less stressful on fish populations than modern industrial fishing. Due to its diffused nature, the total volume and

economic benefit of artisanal fishing is poorly documented but may be approximately equal to that of industrial fishing. Though the definition as to exactly what qualifies as "artisanal" fishing is quite variable, the Food and Agriculture Organization (FAO) defines it as: traditional fisheries involving fishing households (as opposed to commercial companies), using relatively small amount of capital and energy, relatively small fishing vessels (if any), making short fishing trips, close to shore, mainly for local consumption. In practice, definition varies between countries, e.g. from gleaning or a one-man canoe in low income developing countries, to more than 20 m trawlers, seiners, or long-liners in developed ones.

Artisanal fisheries can be subsistence or commercial fisheries, providing for local consumption or export. They are sometimes referred to as small-scale fisheries. The line between what is artisanal and what is industrial can be quite blurry at times so it is best to look at it as a sliding scale and not just black and white. By comparing the size of the boats used with the amount of capital invested per man on-board it is easier to see these divisions. Meaning that even a large wooden canoe, that is man powered and using headlines would qualify as artisanal due to the small technological investment. While a small ultra-light boat equipped with the latest global positioning systems, downriggers, and sonar could still qualify as industrial. The key feature that differentiates the industrial and artisanal fishing is their purpose in fishing.

The main goal of an industrial fishery is to catch as many fish as possible for economic gain. This kind of fishing carries with it various risks so as overfishing of a fish population causing the fishery to crash, among several other dangers. Though artisanal fishers can sell a portion of their catch at markets, they primarily subsistence fish. That is, they go fishing to catch enough food to feed their families and sell some to make profit. This smaller scale, more ecologically friendly goal, carries with it less of a risk of endangering fish populations, though that is not to say that all artisanal fisheries are "better" than all industrial fisheries. Artisanal fisheries do not pose a great risk to several ecosystems and marine species. Often it is what technology is used, how it is employed, and how the fishery is managed that defines how eco-friendly an artisanal fishery is.

Fishing gear commonly used in the artisanal fishery includes purse seines ("*poli/watsa*"), beach seines, drift gill nets, and surface set nets. Artisanal fishers also employ various forms of bottom set-nets, and hook and line ("*lagas*"). Fishing vessels equipped with either drift gill nets or hook and line usually operate beyond 50-metre depth water zone. Specifically, those fishing with hook and line ("*lagas*") have on board ice, food and fishing aids such as fish finders and Global Positioning System (GPS). Artisanal marine fishing accounts for about 80 percent of total annual marine fish catch by volume.

Figure 1. Artisanal Canoes

Semi-Industrial Sector

The Semi-industrial (inshore) fishery uses locally-built wooden boats measuring 9-12 meters in length and fitted with 30-90 horsepower engines are engaged in the exploitation of the fisheries resources. Most vessels are dual-purpose, being able to use trawls or purse seines. These vessels operate during the upwelling seasons using purse seines mainly in the inshore waters at depths of 30-50 m where they compete with the artisanal fishing fleet. In the process, they land about 2 percent of the total marine output.

Figure 2. Semi industrial fishing vessels (www.pulse.com.gh)

Industrial Sector

The industrial fishing fleet operates offshore at depths of 50 -75 m and they are fitted with 30-200 horsepower diesel engines and equipped with purse seine or pole and line live-baited with anchovy, with which they exploit tunas (skipjack, yellowfin and bigeye) and high-value cephalopods which are frozen at sea for export. They comprise large, steel-hulled foreign- built trawlers; tuna pole-and-line vessels and purse seiners, and shrimpers. Industrial fishers contribute about 6 percent of the total marine production.

Figure 3. Industrial fishing vessels (https://stopillegalfishing.com/case-studies/)

For more information on fishing gears in use in Ghana see Annex 1.

ILLEGAL FISHING METHODS IN GHANA

The activities in the marine sector ranges from artisanal canoe operations through inshore to industrial operation. Both pelagic and demersal fishery resources are exploited by the artisanal, inshore and industrial vessels. The fisheries sector provided about 200,000 direct jobs and over 2 million jobs in the indirect industries (fish processing, marketing, transportation, boat building etc.). However, the fisheries resources have experienced a state of over fishing as a results of excess fishing capacity (number of boats) and increase in the number of fishermen. In recent times, there are very high number of fishers obtaining very little returns. Indeed, many experts agree that the exploitation limit of marine resources has been reached, if not exceeded and that this over capacity of fleets, excessive fishing quotas, illegal fishing practices and the generally poor management of most fisheries are to blame. This is to say, weak governance, illegal fishing methods among others have contributed to the depletion of fish stocks in Ghana. Some fishermen have adopted the use of unsustainable fishing methods including but not limited to light fishing, carbide fishing, dynamite fishing, use of insecticides and other obnoxious substances that is contributing to the decline in fish.

The rich African coastal waters have long been looted by foreign fleets, fishing illegally. Now global initiatives are gathering forces that aim to end such plunder to protect the livelihoods of coastal communities. For these initiatives to succeed, however, many more countries around the world need to participate. Illegal fishing is a theft from national revenues, no less than non-renewable petroleum and metals. Africa's renewable fishery resources are a potential source of wealth and opportunity. Governed wisely, they could support livelihoods, promote food security, generate export earnings and support vital ecological systems. In the absence of effective national institutions and international cooperation, however, Africa's fishery resources have been combining the power and personal fortunes of ruling elites, and enriching foreign traders. West Africa alone loses $1.3 billion per year due to illegal fishing. Apart from draining the region of revenue, overfishing reduces fish stocks, lowers local catches and harms the marine environment. It destroys communities, who lose opportunities to catch, process and trade in fish. Illegal fishing is a major issue of concern along the coast of Africa which Ghana is no exception. Illegal fishing in Ghana threatens both fish stocks and the people who depend on them. This type of fishing occurs when vessels or harvesters operate in violation of the laws of fishers. This applies to fisheries that are under the jurisdiction of a coastal state or high sea fisheries regulated by national fisheries management. The drivers behind illegal fishing are similar to those behind many other environmental crimes. Some of the drivers include; fisher's desires for many species of fish, particularly those that are overexploited and thus in short supply, are of high financial value. The desire to generate more money due to high economic hardship and also to clear debt from investors drives the illegal fishing in Ghana.

These illegal fishing practices may then show a high chance of success i.e. a high rate of return from the failure of government to regulate adequately or to enforce national laws. A major driver of illegal fishing practice in Ghana is the failure if government to exercise effective regulation. Catches from illegal fishing made by fishers are not reported and their level of fishing cannot be accurately quantified. However, industry observers believe illegal fishing occurs in most fisheries and account for up to 30% of total catches in some important fisheries. Some these illegal fishing methods employed in Ghana are described below:

Use of Chemicals (DDT and Carbide) and Explosives (Dynamite) in Fishing

Dynamite fishing is one of the methods of catching fish. This is an activity using an explosive device set off under water to kill fish. The underwater shock waves produced by the explosion stun the fish and cause their swim bladder to rupture. The dead fishes floating on the surface are then simply scooped up using their nets. The explosives completely destroy the underwater environment, leaving it as rubble. It indiscriminately kill large number of fish and marine organisms in the vicinity and can damage or destroy their ecosystem. This type of fishing has contributed to massive destruction of fish habitats. Dynamites are constructed using a glass bottle with layers of powdered potassium nitrate and pebbles or an ammonium nitrate and kerosene mixture. Such devices though may explode prematurely without warning, have been known to injure or kill the person using them. Some fishers have lost their lives and parts of their body as a result of this type of fishing. Dichlorodiphenyltrichloroethane (DDT) is a pesticide that was once widely used to control insects that carry diseases such as malaria and typhoid but is now used in only a few countries to control malaria. DDT is highly persistent chemical called organophosphate. DDT is problematic because it enters the food chain and bioaccumulation occurs. When DDT is sprayed or poured into water bodies, it affects various fish species whose eggs are developing and it may affect development. It is a chemical known to be carcinogenic and affects the reproductive development of fishes.

Some fishing communities along the coast of Ghana have resorted to the use of chemicals such as DDT and carbide. Some fishermen in a discussion mentioned this is mostly done by fishers in the western and central coast of Ghana. Fishes caught by the use of these illegal means are brought to the shore dead and discolored with broken flesh and sunken eyes, an indication that they are not fresh and caught by illegal means. The practice is generally wide spread along the west coast of the country. According to fishermen and fish processors interviewed, the use of chemicals such as DDT, carbide and explosives like dynamite may pose a serious health hazard to the fish consumers. Some fish processors indicated they had dire consequences on the fingers of some processors. It has been reported by health experts that eating food with large amount of DDT over a short time will most likely affect the nervous system. According to them, swallowing large amount of these chemicals especially DDT results in excitability with tremors and seizures. They may experience sweating, headache, nausea, vomiting and dizziness. In a focused group discussion, these health issues were mentioned by fishers, an indication that the effect of these chemicals on the health of fishers are already being felt. Some elders and chief fishermen mentioned that, if DDT is banned from fishing, the effect on their health will go away but their fellow fishermen are not ready to quit.

Chemical and explosive fishing are done together with light fishing as stated by fishermen. The light is used to attract the fish while the DDT, carbide and dynamite are used to increase the catch. Apart from the health implications for fish consumers and processors, the practice is also deepening poverty among fishermen and fishmongers, largely women as the quality and quantity of fish are adversely affected after smoking. Some fishmongers mentioned they incur huge debts as a result and explained that an illegal method of fishing causes fishes to rot soon after catch. Fishes caught with these methods break into pieces when exposed to smoke and heat, thereby affecting prices and sales. They mentioned that, these fishes taste sour and feels itchy in the mouth and tongue when eaten. Fishers mentioned the fact that some of these activities are encouraged by some government officials. They also stated that, unfortunately they cannot stop their people because they also need to survive. However, they are ready to stop if government is able to stop all fishermen from the

practice. They stated that if government enforces the laws effectively, they are willing to stop the illegal fishing methods.

Fish quality is compromised when light fishing is combined with chemicals and explosives.

Formalin is a solution in water of gas formaldehyde (H_2O). The liquid is used as an embalming fluid and for preservation of animal specimens and tissue samples. Some fishermen use DDT to kill the fish, collect them and preserve them with formalin before landing them to make them last longer. A discussion with fishers indicates that the practice is rising because fishers have little knowledge on the effects of the use of formalin in the preservation of fish and deteriorating feature of the fishing industry. The formalin is normally added to the water used as ice to preserve fishes. Some fish processors mentioned that, they could smell the formalin when the fish is landed and refuse to buy them. They also stated that fishes preserved with formalin when eaten have corrosive effect in the mouth, tongue and esophagus thus causing pain, vomiting and sometimes bleeding. They also suffer some ill effect through inhalation of the vapor.

Figure 4. **Some fishes caught with dynamite and *chemicals (notice the red eye and laceration/torn tissues).***

Use of a Mixture of Powdered Detergent and Gari

The use of powdered detergent and *gari* is another illegal fishing method employed by fishermen to land more fish. The *gari* serves as food to attract the fish while the powdered detergent suffocates the fish and also reduces the surface tension of water, making fish movement difficult. Fishes are weakened and fishermen catch them with their net.

The Use of Petrol or Diesel

This method is used by some fishermen along the coast. In this method, they pour some petrol or diesel on the surface of the sea and this makes the water very clear and transparent for them to identify fishes under the water and catch them. The fishers mentioned that this method is done when they are on the high seas. It is not clear whether this phenomenon may be related to changes in the refractive index of the water following release of these fuels on the surface.

Use of a Mixture of Powdered detergent, Gari and Petrol

Fishers mix powdered detergent, *gari* and petrol for fishing. In this approach, the gari serves as food to attract the fishes. However, when fishes ingest the mixture, they are weakened and unable to move because of the powdered detergent and petrol ingested. Fishers cast their nets to catch them.

Figure 5. Mixture of detergent and *gari* in a bowl for fishing.

Light Fishing

Light fishing is a type of fishing which uses light attached to a structure above water or suspended underwater to attract both fish and members of the food chain to specific areas in order to harvest them. Just as fishermen seek conditions where the chance of catching fish is

optimized, fishes seek areas where the chance of food is optimal. In Ghana, fishermen in the coastal regions have adopted light fishing as a quick method of catching fish by using generators and 1 000 Watts bulbs which are often laid into the sea. The light and heat produced by the bulb is used normally to attract the fishes so that when the fishermen cast their nets, they will catch them in large quantities, including fingerlings.

Light fishing currently along the coast of Ghana is done together with the use of chemicals and dynamite to optimize the catch for more income. During fishing, the light is placed underwater to attract the fish, whiles the chemicals and dynamite are used to kill and stun the fish for a large catch. According to the fishermen, some of the fish which have been exposed to the chemicals escape and eventually end up dying, sinks to the bottom of the sea. In a discussion with them, some leaders express the fact that the dead fish that sinks to the bottom of the sea may affect the environment in which the fishes live. They believe that these chemicals are poisonous and may affect fish and other marine species health conditions as well as the quality of the water. During light fishing, fishermen usually use a small canoe. The generators, light and other accessories for the light fishing are placed in it and operated by two crew members. They mentioned that when light is used to catch the fish, it does not affect the appearance and quality of fish. It is when the chemicals are used in fishing that the fish appearance and quality are affected. Light attractors, when used for fishing, attracts all kinds of fishes irrespective of their sizes. The practice, however, threatens the sustainability of the fish stock and fishing occupation.

Figure 6. An artisanal canoe carrying petrol-powered generator (in a daughter boat) and 1,000 watt bulb for light fishing.

Figure 7. Equipment used for light fishing and fishes caught with light

Transshipment

Trans-shipment of fish is another illegal activity carried out by fishers. In Ghana, it is commonly referred to as "Saiko" fishing. (See Figures 8 and 9). Saiko fishing is an illegal system of fishing where foreign trawlers stay on the sea for longer periods doing licensed fishing but catch unauthorised fishes and sell them as by-catch. Fishers mentioned that it poses a lot of threat to their fishing business since it has created some kind of competition between them and Chinese vessels. The practice according to fishermen prevents fishes from growing to their matured sizes. The practice is reported to have reached an alarming rate as the country spends millions of Cedis in addressing its impact on the industry. Saiko fishing has been accepted by almost all the fishing communities along the coast of Ghana. Some inshore and industrial vessels are engaged in Saiko fishing. The practice is a lucrative venture in many coastal countries, especially those without effective law enforcement regarding their Exclusive Economic Zones. Transshipment is the transfer of fish consignments from a fishing vessel to another vessel or canoe. This can take place in the port or at sea. Fishermen's perspective is that IUU fishing is highly attractive as they pay no taxes or duties on these catches. A further reason why IUU fishing takes place on such a large scale is that it can often be practiced with impunity.

Figure 8. Transshipment of fish from an Industrial vessel onto artisanal canoes (www.franciscoblaha.info)

Figure 9. Fishes caught through Saiko fishing (citifmonline.com)

Cyanide Fishing

Cyanide fishing is a method of collecting live fish, mainly used to catch fish which involves the spraying of sodium cyanide mixture into the water in order to stun the fish. The practice does not only affect the targeted population but also affect other marine organisms.

This method was initially developed to stun and capture fish for aquariums but it has been employed by fishers in catching fish for food. In Ghana, the practice is part of the chemical fishing approaches, according to fishermen. The fishermen mentioned that it is practiced along the western and central coast, especially in Komenda.

Use of Unauthorized Mesh Size

This involves the use of monofilament nets with mesh size less than seventy-five millimeters in stretched diagonal length in a river system or marine waters as stated in the Fisheries Act. The fishermen mentioned that some of their colleagues use this type of fishing nets during fishing but hide them. They also stated that these kind of nets are also used by the Chinese vessels and mostly land juvenile fishes.

Killing of Marine Mammals and Endangered Species

Another illegal fishing activity observed along the coast during the research was the killing of marine mammals and sharks. This practice was observed along the western coast of Ghana. The practice is illegal because these species have been reported to be endangered and must be conserved, not killed. In a discussion with some fishers, the meat of these fishes is a delicacy and also sells well to earn a lot of income that is why they catch them.

Figure 10. Pictures of dolphins and a shark killed at the beach of Dixcove

The illegal fishing practices are gradually collapsing the fishery of Ghana with its impact on fishes, ecosystems and the health of the people. It is sad to say, but the truth is eating fish landed along our coast today is dangerous and harmful to our health than before. Fish was consumed in Ghana with the notion of getting omega-3 fatty acids which are essential nutrients for our health. These acids which our bodies cannot produce but can be obtained from eating fish and other foods, can now be exchanged with cancer on consuming fish landed along our coast. This poses a lot of risk generally for the population in Ghana since it is the cheapest source of protein for the people especially the local fishers. These illegal fishing practices also pose a lot of threat to the ecosystem, biology of fish and the fishing industry in general. It is therefore critical for the government of Ghana to address the issue with urgency for the sustainability of the fishing industry and the people as far as their health is concerned.

Table 1. Summary of the impact of illegal fishing methods on the quality of fish.

Illegal Fishing Methods	Appearance/Texture	Quality of Fish
Use of Chemicals (Carbide, cyanide, DDT, detergent, Formaldehyde etc.) and explosives (Dynamite)	• Discolored with broken flesh • Sunken eyes/Reddish eyes • Absence of scales with dark sticky gills • Bad odor on fish and water around fish	• Not fresh • unhealthy for human consumption
Light Fishing	• Clear/Bright eyes • Clear/Normal coloration of fish • Reddish gills • Most land juvenile fish	• Fresh • Healthy to eat NB Fishing with light has no effect on the quality of fish. Quality is however compromised when light fishing is combined with chemicals and explosives
Saiko Fishing	• Mixed species of fish • Sunken eyes • Dark slimy gills • Discolored flesh with broken tissues • Mostly small/juvenile fish • Fish with bad odor/unpleasant smell	• Not fresh • Most with bad odor • Not healthy for human consumption

LAWS REGULATING FISHERIES PRACTICE IN GHANA

The Ghanaian fishing industry is strongly endowed with significant and valuable stocks of fish. Ghana produces 430 000 tons of fish annually. Thus, the fishing industry in Ghana remains an attractive industry for both local and foreign fisher-folk, making it a major source of employment, livelihood and a way of life. Marine fishing in Ghana is overexploited, requiring a number of laws and regulations to sanitize the industry. The predominant laws, regulating the activities of the fisheries sector include:

- The Fisheries Act 2002 (Act 625)
- Fisheries (Amendment) Act 2014 (Act 880)
- Fisheries Regulations 2010 (L.I 1968)
- Fisheries (Amendment) Regulations 2015 (L.I 2217)

What Constitutes Illegal Fishing?

In most instances when we talk about illegal fishing, people think about the use of illicit tools and practices such as light fishing and using dynamite to catch fish. That is partly true. But illegal fishing goes beyond these. The Ghanaian fisheries industry is regulated by Laws and any act or practice that contravenes the Laws is deemed illegal or unlawful. Unlawful fishing activities is normally divided into three categories namely;

1. Unreported fishing;
2. Unregulated fishing and;
3. Illegal fishing.

Unreported fishing is said to have occurred when licensed vessels do not report their catch to national or regional authorities. Under this, there is **non-reporting** where catches are not reported at all and **under-reporting** where full catches are not declared.

Unregulated fishing is said to have occurred when unregistered/unlicensed vessels fish in national/regional fisheries waters.

In the context of this manual, we will define illegal fishing as using unauthorised fishing methods to catch fish.

Unreported and unregulated fishing are normally conducted by industrial and semi-industrial vessels that are required to report fish landings but do not, or fish in areas or for species without a proper fishing license from an authorized party. These vessels from time to time also engage in illegal activities by fishing in prohibited zones, with illegal gear, or by falsifying their catch data. The artisanal fleet, although required by law to be licensed, has not yet been licensed yet and only recently has the Fisheries Commission taken the initiative to register fishing canoes, a pre-cursor to licensing. Canoes that trans-ship fish from industrial vessels to shore are not registered and licensed as fishing vessels since they carry no fishing gear. These vessels conduct illegal activities as trans-shipment is illegal in Ghana without written permission from the proper authorities - the Fisheries Commission. These vessels also fall under the un-registered category but not unregistered fishing as they do not fish. Their catch also is unrecorded as part of the official statistics collected by the Fisheries Commission.

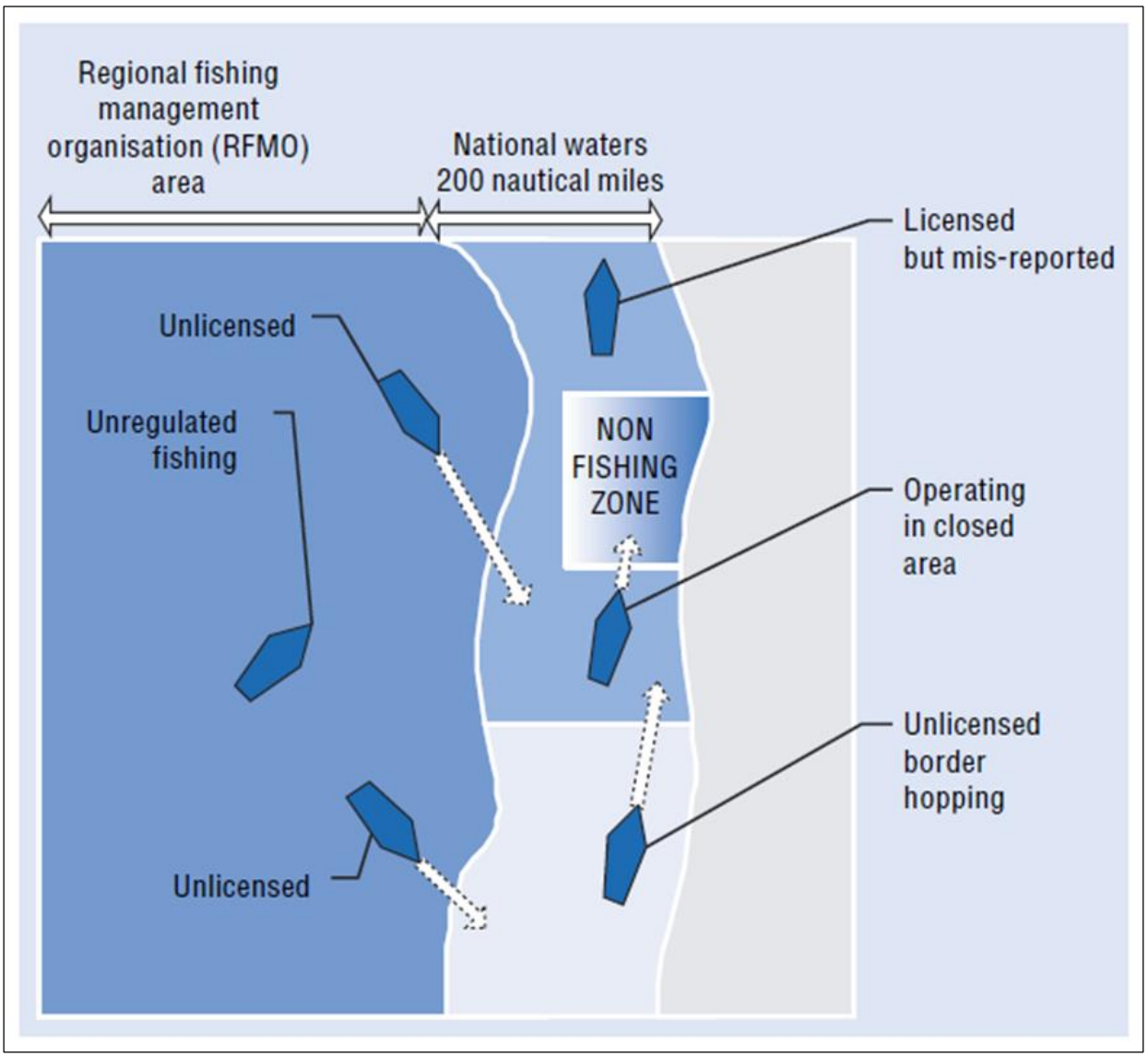

Figure 11: Diagrammatic representation of IUU (mylongjourney.wordpress.com)

Illegal Unreported and Unregulated (IUU) fishing is widespread in Ghana. In 2014, the European Commission warned Ghana and two other nations against continuous illegal fishing. Stringent measures, therefore, need to be put in place to reduce the rate of illegal fishing in Ghana. The first step to ensuring this reduction is to register vessels operating in the fisheries waters of Ghana and subsequently regulating the activities of the vessels.

South Korea, Ghana and Curaçao must act quickly to combat illegal fishing

Like 0 Tweet Pin it G+1 0 Share

Posted on 23 July 2014

Brussels, Belgium: The European Commission today gave South Korea, Ghana and Curaçao six more months to improve efforts to stop illegal fishing by their vessels. In November 2013 the three countries had been given yellow card by the European Commission and risk facing trade sanctions unless they cooperate in combating Illegal, Unreported and Unregulated (IUU), or pirate fishing.

A coalition of NGOs working to combat IUU fishing said:

"Today's decision of the European Commission to give six more months to South Korea, Ghana and Curaçao can only be accepted if their governments give concrete proofs of combating illegal fishing. Real improvements will be measured not only by policies and regulations but by putting reforms into practice.

The EU system of 'yellow' and 'red' cards and the consequent ban of import of seafood products from suspected countries are important steps in the global fight against illegal and pirate fishing."

Figure 12. News article on Illegal Fishing in Ghana (wwf.panda.org)

Registration of Vessels

Industrial and semi-industrial vessels cannot operate in the fisheries waters of Ghana without prior licensing. In order to ensure that the fishing capacity and effort are aligned with available fish stock, the Fisheries Act 2002, Act 625 provides for the registration and licensing of industrial and semi-industrial fishing vessels.

The Ministry of Fisheries and Aquaculture Development and Fisheries Commission provide the guidelines for the registration and licensing of fishing vessels in Ghana as follows:

A. HOW TO ACQUIRE AND REGISTER A LOCAL INDUSTRIAL VESSEL

Before acquiring an industrial vessel;

1. Register a company in Ghana at the Registrar General's Department and obtain the certificate of registration, certificate to commence business and company's code. Shareholding should be 100% Ghanaian for Local Industrial vessels and at least 50% Ghanaian for tuna vessel operations [Section 47 of Fisheries Act 2002, Act 625].
2. Apply for a permit for importation of vessel from the Hon. Minister responsible for Fisheries. The following documents should be attached to the application:

    2.1 a bill of sale/hire purchase agreement in conformity with the Hire Purchase Act 1974 (NRCD 292);

    2.2 a copy of the registration certificate, certificate to commence business and company code (Fishing should be one of the activities to be carried out by the company);

    2.3 class certificate;

    2.4 survey report and refurbishment certificate where applicable;

    2.5 trawl vessels must not be more than 10 years and tuna vessels 15 years of built (Section 7 of Ghana Shipping Act 2002, Act 645);

    2.6 tonnage certificate of the vessel;

    2.7 oil pollution prevention certificate;

    2.8 deletion certificate from the previous registry; and

    2.9 any other relevant document that the Commission may determine.

3. Gross Registered Tonnage (GRT): The GRT of a trawler and a shrimper should not exceed 300 and 200 respectively and for a tuna vessel, should not exceed 1,000 for tuna purse seiners and 500 for a tuna pole and line.
4. Application with documents is sent to Hon. Minister responsible for Transport for advice on the sea worthiness of the vessel. Minister responsible for Transport replies to Minister responsible for Fisheries as to whether the said vessel should be allowed into the country or not.
5. Minister responsible for Fisheries may grant the permit for the importation of the vessel if approved. Validity period of a permit is one (1) year from the date of issue. Permit is not transferable.
6. When the vessel is imported, an application is made to the Registrar of Ships for registration under the national flag. It is issued with a Certificate of Registration and an official number which is boldly embossed on the vessel. A change of the name of a vessel shall not be made without the consent of Ghana Maritime Authority (GMA) [Section 16 of the Ghana Shipping Act 2003, Act 645].

After acquiring the vessel, the following procedure is followed to register it.

1. Application for fishing registration and licensing is made to the Director, Fisheries Commission. The application is referred to the Fishing License Evaluation Committee of the Fisheries Commission for vetting and approval.
2. Fishing registration number is then issued to the vessel after submission of the following documents and inspection of the vessel by Fisheries Commission, this number must be boldly written on both bows of the vessel in conformity with Regulation 5 of the Fisheries Regulations 2010 (LI 1968). The following are lists of requirements for registration:

    2.1 a certificate of incorporation, certificate to commence business, and articles of association of the company as registered under the Companies Code, 1963 (Act 179);

    2.2 Bill of Sale or Hire Purchase Agreement in conformity with the Hire Purchase Act 1974 (NRCD 292);

    2.3 the certificate of Ghanaian registration of industrial vessel;

    2.4 Bank of Ghana approval for financial aspects of the Purchase Agreement where applicable;

    2.5 a recent color photograph of not more than six months of the vessel if foreign built;

    2.6 crew composition;

    2.7 bare boat charter agreement;

    2.8 deletion certificate;

    2.9 valid certificates of insurance of vessel and of crew;

    2.10 particulars of a recognized local representative of a foreign insurance company, where the vessel and crew are insured by the foreign insurance company;

    2.11 valid survey certificate of vessel and its machinery dated not more than six months to the date of application;

    2.12 safety certificate, call sign and mobile maritime satellite identification number;

    2.13 International Tonnage Certificate; xiv. Oil pollution prevention certificate; and

    2.14 Any other relevant document and information needed for research and planning that the Commission may determine [Regulation 2(2) of the Fisheries Regulations 2010 (LI 1968)].

Fishing license is then issued upon payment of license fees which vary according to type and GRT of the vessel.

Figure 13. A registered industrial vessel displaying registration number (fis.com)

B. HOW TO CONSTRUCT AND LICENSE A SEMI-INDUSTRIAL VESSEL

1. Application to build a fishing vessel is sent to the Minister responsible for Fisheries for approval in consultation with the Minister responsible for Transport and the Minister responsible for Industries,
2. Upon approval the applicant then commissions a licensed surveyor to design and build the fishing vessel under the supervision of Ghana Maritime Authority (GMA) [Section 6 of the Ghana Shipping Act, 2003; Act 645].

After the semi-industrial vessel has been constructed the following procedure is followed to register and license it:

1. Application for registration and licensing of fishing vessel is to be submitted to the Director, Fisheries Commission.
2. Fisheries registration number is then issued to the vessel after submission of the following documents and inspection of the vessel by Fisheries Commission:

    2.1 a certificate of incorporation, certificate to commence business, and articles of association of the company as registered under the Companies Code, 1963 (Act 179); where applicable;

    2.2 certificate of Ghanaian registry of semi-industrial vessel by competent authority;

    2.3 certificate of supervision of construction of semi-industrial vessel by the competent authority;

    2.4. a recent color photograph of not more than six months of the vessels;

    2.5. particulars of a recognized local representative of a foreign insurance company, where the vessel and crew are insured by the foreign insurance company;

    2.6. valid survey certificate of vessel and its machinery dated not more than six months to the date of application; and

2.7. any other relevant document and information needed for research and planning that the Commission may determine [Regulation 2 of the Fisheries Regulation 2010 (LI 1968)].

3. *Fishing licence is* then issued upon payment of licence fees which vary according to the GRT of the vessel. 3.3.2 Fishing licence is renewable quarterly, bi-annual or annually or within such period as Commission may recommend and shall expire:

   3.1 in respect of an annual licence ending 31st December in the year in which it is issued; or

   3.2 in respect of a quarterly licence on 31st March, 30th June, 30th September or 31st December in the year in which it is issued [Section 74 of Fisheries Act, 2002, Act 625].

Figure 14. A registered semi-industrial vessel displaying registration number (www.alamy.com)

A registered vessel must bear the registration number allotted to it by the Commission. According to the Fisheries Regulations 2009, the registration number of a vessel shall be;

a. Inscribed in block letters and numbers on the vessel. The number shall be inscribed in black on white background or white on black background
b. Prominently displayed on the side, superstructure, port side and star board side of the craft as high as possible above the waterline to make it visible to other fishing vessels or from the air
c. Placed in such a way that it will not be obscured by the fishing gear when stowed or in use.

PROHIBITIONS IN THE FISHING INDUSTRY AND PENALTIES

The registration number of a vessel (both Industrial and Semi-Industrial) cannot be sold, bought, transferred or inscribed on another vessel. Anyone who does so commits a crime and may be fined GH₵600 (i.e. 50 penalty units) or imprisoned for a maximum of 3 months or be fined and imprisoned.

It is prohibited for a fisherman to perform the following:

1. Use light to attract fish. As a result, it is prohibited to carry portable generators, switchboard, 1000 watt bulb and long cable to facilitate light production
2. Use any other prohibited fishing method which renders fish more easily caught for the purpose of aggregating fishing. Thus using chemicals and explosives which will immobilise the fish to aid bumper catch is unlawful
3. Operate pair trawling.

Any fisherfolk who carries a portable generator or a switch board or a 1000 watt bulb or performs any activity which renders fish more easily caught commits an offence. That person may be convicted to a fine of four hundred penalty units (equivalent to GH₵4,800) or the person will be imprisoned for a maximum period of twelve months or the person will be fined and imprisoned as well.

Figure 15. Artisanal canoe carrying portable generator, switchboard and two 1000 watt bulbs

Though light fishing is prohibited in Ghana, fishermen are permitted to carry light on their vessels at night. The approved light that can be carried, depends on the size of vessel used.

A motor fishing vessel exceeding twelve meters in waterline length shall carry the following lights between sunset and sunrise:

1. When the vessel is underway;

    a. a white light showing ahead from 22 ½0 abaft the starboard beam to 22 ½0 abaft the port beam;

    b. a green light carried below the white light showing from right ahead to 22 ½0 abaft the starboard beam;

    c. a red light carried below the white light showing from right ahead to 22 ½0 abaft the port beam; and

    d. a white light at stern showing from right abaft to 67 ½0 on either side of the vessel.

2. When the vessel is trawling, a tricolor lantern;

    a. showing a white light ahead from 22 1/2 0 on the starboard bow to 221/20 on the port bow;

    b. showing a green light from 221/20 on the starboard bow to 221/20 abaft the starboard beam; and

    c. showing a red light from 221/20 on the port bow to 221/20 abaft the port beam; and (iv) white light showing all-round the horizon.

A motor fishing vessel of not more than twelve meters but exceeding eight meters shall carry the following lights between sunset and sunrise:

1. When under way;

    a. a white light showing ahead from 22 ½0 abaft the port beam;

    b. a green light carried below the white light showing from light ahead to 22 ½0 abaft the port beam;

2. when trawling or at anchor;

    a. a white light showing all-round the horizon.

A motor fishing vessel of not more than eight meters in waterline length or a fishing vessel including a canoe not being a motor fishing vessel when under way or at anchor between sunset and sunrise shall carry a wide light showing all-round the horizon.

Depending on the type of fish to be caught, there are approved net sizes to be used. This is to ensure that juvenile fish are not caught so that the fish stock will be maintained.

A mesh size is defined as the maximum inside measurement between the two opposite knots of a stretched mesh. The mesh size is to be measured when the nets are wet and by an approved flat gauge or with a pair of calipers.

For a trawl net, the minimum mesh size should be sixty millimeters (60mm).

For a shrimp trawl net, the minimum mesh size should be fifty millimeters (50mm).

Nets used for small pelagic purse seine should have a minimum mesh size of twenty-five millimeters (25mm).

The minimum mesh size for large pelagic purse seine-nets is hundred millimeters (100mm).

Figure 16. Seized under-sized fishing nets (pulse.com.gh)

Figure 17. An enforcement officer measuring the mesh size of a fishing net (citifmonline.com)

Any fisherman who is found to have used an unapproved net (i.e. a fishing net with mesh size less than the minimum approved size) commits an offense. That person may be convicted to a fine of GH₵600 (equivalent to 50 penalty units) or be imprisoned for three months or be fined and imprisoned as well. Any fish caught with the unapproved net will also be seized.

Figure 18. Enforcement officers disposing of seized under-sized nets (pulse.com.gh)

Figure 19. Seized gears used for illegal fishing (ghanabusinessnew.com)

Consequent to the mesh size, the size of fish a fisherman catches cannot be less than the prescribed length. The minimum landing size of commercially important fish species as prescribed in Table 2 below.

Any fisherman who catches any fish species which is less than the minimum prescribed size commits an offence. That person may be convicted to a fine of GH₵600 (equivalent to 50 penalty units) or be imprisoned for three months or be fined and imprisoned as well. Any fish caught with the unapproved net will also be seized.

Marine mammals like dolphins are endangered species. Their numbers have reduced drastically. Some other species of fish like sharks have also become endangered. These marine organisms are therefore to be conserved in order to keep their species alive. As a result, it is prohibited for a person to fish for these marine mammals and sharks without prior approval from the Director of Fisheries. In the western coast of Ghana especially, fishermen keep fishing for these mammals and sharks because of their commercial value. (Figure 20).

Table 2. List of Minimum size limits for various species of fish in Ghana.

Scientific Name	Common English Name	Minimum Size
Panulirus regius	Spiny Lobster	12 cm
Pagellus bellottii	Red Pandora	14 cm
Dentex canariensis	Canary dentex	22 cm
Sparus caeruleostictus	Blue spotted seabream	18 cm
Sepia officinalis	Cuttlefish	14 cm
Lutjanus fulgens/goreensis	Red snappers	16 cm
Galeoides decadacytlus	Threadfin	16 cm
Pseudotolithus senegalensis	Cassava fish	18 cm
Pseudupeneus prayensis	Red Mullet	14 cm
Epinephelus aeneus	Grouper	42 cm
Sphyraenna spp	Barracudas	30 cm
Pomadasys incises	Roncador	14 cm
Pomadasys jubelini	Burro	18 cm
Chloroscombrus chyrsurus	Bumper	10 cm
Decapterus punctatus	False mackerel	10 cm
Sardinella aurita	Round sardine	18 cm
Sardinella maderensis	Flat sardine	18 cm
Brachydeuterus auritus	Burrito	14 cm
Scomber japonicus	Chub mackerel	18 cm
Caranx rhocus/crysos	Scad mackerel	21 cm
Engraulis encrasicolus	Anchovy	6 cm
Thunnus obesus	Bigeye tuna	55 cm
Thunnus albacares	Yellow fin	55 cm

Figure 20. Fishers land a marine mammal (Dolphin)

Figure 21. Fishers land a shark

It is possible sometimes for a fisherman to catch undersized fish or gravid lobsters or other crustaceans. In the incidence of catching any prohibited fish such as undersized fish, the fisherman is supposed to return the catch to the place from where it was caught. This should be done in a manner that will cause very little or no harm to the catch.

MOTIVATION FOR ILLEGAL FISHING

Notwithstanding the dangers associated with illegal fishing, the practice is very ripe in the nation. Several factors promote the practice of illegal fishing activities. Some of the motivating factors include:

Weak Law Enforcement

As indicated in the previous chapter, there are adequate laws regulating the activities of fishers in Ghana. The predominant laws, regulating the activities of the fisheries sector include;

- The Fisheries Act 2002 (Act 625)
- Fisheries (Amendment) Act 2014 (Act 880)
- Fisheries Regulations 2010 (L.I 1968)
- Fisheries (Amendment) Regulations 2015 (L.I 2217)

The enforcement of the above listed laws are extremely weak. Activities of law enforcement personnel are sporadic. Enforcement agencies do not have adequate personnel to police the fisheries sector. Corruption and gaps in the prosecution of fisheries offenses do not help the battle against illegal fishing.

Figure 22. Enforcement officers arrest fishers involved in illegal fishing (graphic.com.gh)

Depletion of fish stock

Since 2007, there has been a drastic decline in the fish stock in the exclusive economic zone of Ghana, most likely due to overfishing. Thus, fishers who do not use illegal methods to attract and immobilise fish normally do not have good landings. Most fishers, therefore, resort to

illegal fishing activities to be able to land fish. In the same period, the number of industrial, semi-industrial and artisanal vessels/canoes has drastically increased, increasing the fishing capacity. The decline of fish stock, coupled with increasing fishing capacity, will further deplete the fish stock. Invasion of Fisheries by Non-fisher investors Fishers have expressed a worrying trend of invasion of the sector by private non-fisher (so-called profit-only-oriented) business persons. These businessmen procure boats/canoes and all necessary gear for fisherfolk who in turn render accounts of landings to the businessmen. The businessmen, without regard to existing laws, impress on the fishers to make more catches so that they can make profit from their investments. This situation forces the fishers to resort to illegal activities to land more catches to please their employers.

Increasing Demand for Fish

Fish remains an affordable source of protein in Ghana, making it a highly demanded commodity. The fisheries sector is, hence, a lucrative sector once the fisher is assured of landing fish. Illegal fishing is less expensive. Fishers who are involved in these activities use less resources and yet land more fish compared to their counterparts who do not engage in illegal fishing. This makes the "illegal" fish less expensive than the ones landed with legal methods. Consequently, fishers who hitherto used legal methods are compelled to venture into illegal fishing activities to keep up with the competition.

EVIDENCE COLLECTION, PRESERVATION AND SUBMISSION TO ACCREDITED LABORATORIES

The quality of evidence collected in criminal investigations have a direct relationship with the outcome of the case in criminal jurisprudence. The onus lies on the prosecution to always prove beyond reasonable doubt, before a competent court, that an offence (crime) was committed in order to secure a conviction. It is therefore important to secure, collect, preserve and present evidence such that, its integrity is assured and can stand the test of examinations and counter (cross) examinations.

Photography

This forms part of the documentation process vital in any criminal investigation. The officer collecting fish samples as evidence is required to take midrange and close-up images of the evidence before collecting them for proper packaging and submission to a laboratory. The pictures taken will serve as proof of the initial state of the fish samples. This procedure shall be repeated in the laboratory before sample preparation and subsequent instrumental analysis.

Selecting fish sample

Fish caught with various methods like DDT, carbide, dynamite or any other combinations are brought to the shore discolored with shredded flesh, red and sunken eyes, among others. These features are important indicators that the specific catch was illegal and may provide useful information in requesting further laboratory analysis. Fish samples suspected to have been preserved with chemicals, on the other hand, may not have or show the above features. In such situations, an informant's knowledge of the chemicals employed for this purpose or the smell of such chemicals during sample collection is vital.

Sample Handling

It is important the sampler avoids contamination of a sample by using aseptic means or by not mixing it with other samples (e.g. fish potentially caught with illegal methods brought to the shore by a different boat) associated with an investigation. A person collecting the samples should always wear clean gloves to handle and prepare each sample. Containers for sample collection (ice-chest) should be clean and free of any chemical used in illegal fishing.

Sample Collection and Preservation

Fresh fish samples from a specific catch brought to the shore should be processed and presented for further analysis in the laboratory as follows:

- Label a clean ice chest with a permanent marker. The ice chest should not have any trace of chemicals employed for illegal fishing [*develop sample collection ice chest]
- Collect into sterile polyethylene bags at least one sample each of fish showing physical features of being illegally caught and those without such features that has been brought to shore from the same catch.
- Using clean nitrile gloves, put fish samples in sterile bags, seal and place on ice in a closed ice-chest.
- Package must be sealed using a prescribed tape
- Information pertaining to the evidence technician (investigator) (i.e. initials, date, time) must be written across the seal in permanent marker to ensure chain of custody.
- Complete an evidence collection form (Table 3) and submit together with the samples.
- Samples that cannot be submitted immediately to the laboratory must be kept frozen.

Chain of Custody

Chain of custody is a document detailing notes from the point of evidence collection (crime scene) to where the evidence is received (e.g. laboratory). Thus at any point in time, it should be

possible to obtain a complete track of people who handle the evidence from the crime scene to court. A chain of custody form (Table 4) must be completed at every stage during the investigation so that anything that cannot follow the time log and trace history will mean that the chain of custody is broken. The form must be filled in with permanent ink to allow for detection of any alterations.

Table 3. EVIDENCE COLLECTION FORM

EVIDENCE COLLECTION FORM			Case # USAID/DFAS/UCC –	
TYPE OF CRIME:			DATE/TIME:	REPORT COMPLETED BY
SHORE DETAILS Artisanal Semi-Industrial Industrial Other				
Vessel Details				
Name	Type		Registration No.	Phone (if any)
Suspect(s):				
Net type (if known)				
Fish Sample Details				
Sample ID				
Sample Method	Individual composite			
Species				
Local Name (if known)			**Ageing Method**	
Length (mm)	**Weight** (g)	**Sex**	**Age****	
Tissue Type Collected***	RF LF BF WB			
Visible feature(s) of illegal catch				
Item Number / Quantity	Describe Item (Use as much detail as possible)			
1 / 3	E.g. three sample of preserved tuna LF			
2				
3				
4				
Laboratory Analysis Details Place the Item Number (s) from Above to designate requested lab test Check box if additional items are on an additional form:				
DDT	Carbide	Dynamite	Formalin	
Detergent	Pesticide	Heavy metal	Formaldehyde	
Other:				
Narrative / Notes:				

****** Aging method: **O** = Otolith; **S** = Scale; **F** = Fin; **S** = Spine; NR = Not Recorded

***Tissue Type collected: **RF** = Right Fillet; **LF** = Left Fillet; **BF** = Both Fillets; **WB** = Whole Body.

Table 4. CHAIN OF CUSTODY FORM

CHAIN OF CUSTODY FORM	**CASE #** (should match evidence form) USAID/DFAS/UCC -

ITEM NUMBER	QUANTITY	ORIGIN NAME AND SIGNATURE OF EVIDENCE COLLECTOR:	DESTINATION OF EVIDENCE DELIVERY NAME AND SIGNATURE OF RECIPIENT:	DATE	TIME

ADDITIONAL CASE INFORMATION

SCIENTIFIC IDENTIFICATION OF FISH CAUGHT ILLEGALLY WITH CHEMICALS

Certain physical features can be helpful in determining whether the fish was caught with prohibited chemicals. However, providing such details cannot secure a conviction in a court of law because diseased fishes, among others, may also exhibit same physical signs suggestive of illegal fishing. Once samples are collected and prepared, they should be submitted to an accredited facility (laboratory) which will establish scientifically, that chemicals were employed in fishing. For preserved (smoked, air/sundried, chemical) samples which may not show any outward signs of illegal activity, only laboratory tests can confirm chemical use.

Laboratory determination of chemicals used in illegal fish can be determined by analyzing fish tissues or the "fish-drain". The term "fish-drain" refers to tissue fluids from fish once it has been taken from its habitat. It contains water (and any chemical) from the environment from which it was caught, and/or may be as a result of a "dry-out" process in which fluid is lost from the tissues when the fish is out of water or melting ice if it was frozen.

Chemicals and Explosives used in Illegal Fishing in Ghana

Typically, chemicals employed for illegal fishing activities include Dichlorodiphenyltrichloroethane (DDT); Calcium Carbide (carbide); Formalin; Formaldehyde; Cyanide; Pesticides and Detergents (powdered). The explosive used is generally dynamite. Fishes may also contain heavy metals such as Mercury, especially in areas where illegal mining activities are prominent. In general, these chemicals are not supposed to be present in fish samples, therefore their detection should be confirmatory, without recourse to the specific concentrations determined following instrumental analysis.

Sample Preparation

Preparation of sample for subsequent instrumental analysis shall follow the scheme as shown in the Figure 23 below:

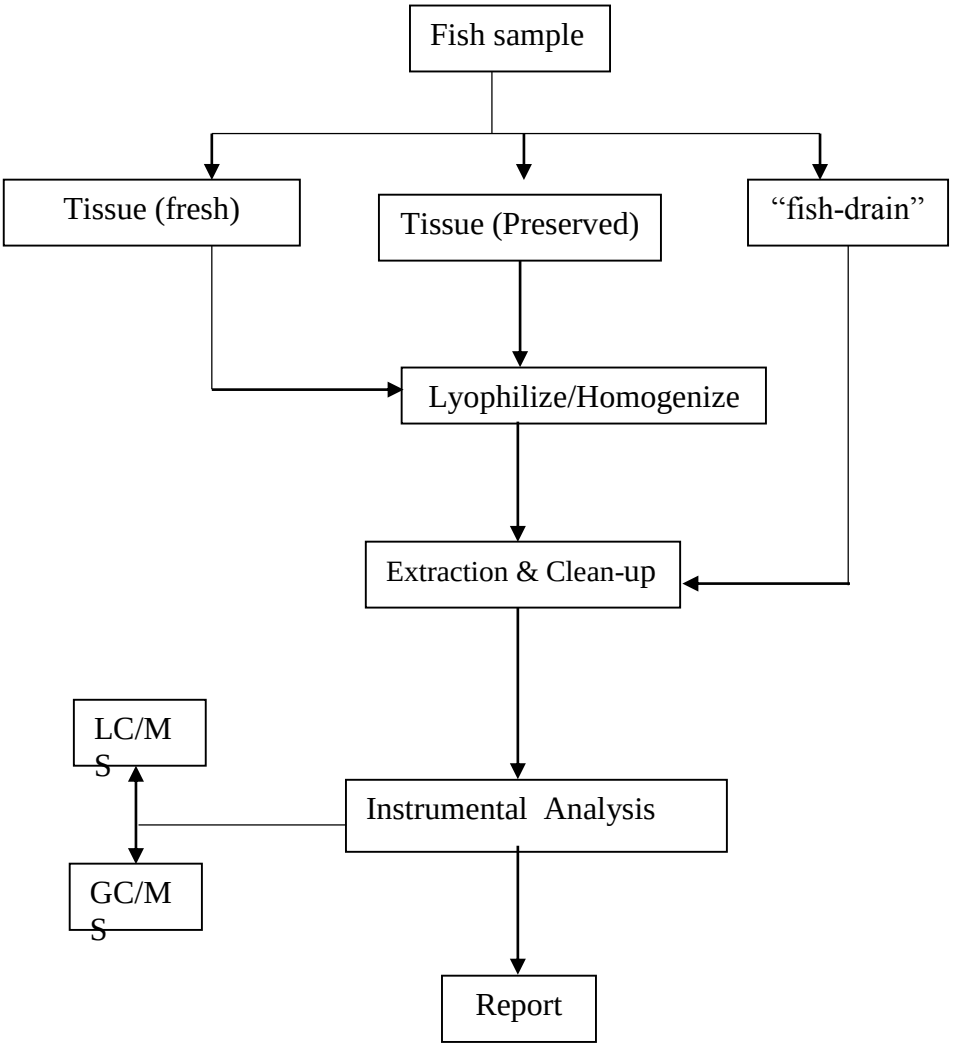

Figure 23. General scheme for laboratory determination of chemicals used in illegal fishing activities in Ghana.

Tissue Preparation

It is highly recommended that all samples are kept on ice until tissue preparation begins. Tissues should be prepared for subsequent analysis within 48 hours of sample collection. Wash and rinse hands thoroughly in tap water, then in deionized water prior to tissue preparation. Use only powder-free disposable gloves when handling fish samples. To prevent cutting injuries while dissecting fillets, protective gloves may be worn under the disposable gloves. Use knives with stainless steel blades and prepare specimen on glass cutting boards.

Thirty (30) grams of tissue from target fillet or composite is required for further tests. For composite samples, however, all tissue must be from the same species with approximately similar sizes. Store samples in a laboratory freezer at -20^{o}C until they can be lyophilized.

Sample Lyophilization and Homogenization

Lyophilization

The suggested procedure for Lyophilization is shown in the scheme below:

Open a clean whirlpak® (or designated plastic envelope) and measure its weight, $\mathbf{W_1}$ in grams
Put diced fish fillets or whole body (previously frozen) into the opened whirlpak®, labelled with sample ID and record the weight $\mathbf{W_2}$
Arrange samples on designated trays and place in the freeze dryer
Begin lyophilization process in the freeze dryer according to the manufacturer's recommendations
Upon completion of the cycle, weigh samples and determine percentage moisture content. A ≥ 70% moisture loss is ideal for homogenization of fish tissues.

Homogenization

Sample homogenization must be performed using a blender dedicated for this purpose. Use an appropriate blender cup size depending on the sample volume (from previous lyophilization step). For instance, fillets can be homogenized in small blender cups while large blender cups will be appropriate for whole body samples. If subsamples were made to ease lyophilization for specific samples, they should be combined for homogenization.

Blend samples such that no lumps (non-homogenized masses) are visible upon stirring with a clean stainless spoon for verification. When homogenization is complete, samples should be placed back into the original container for processing and storage.

Extraction and clean-up

Process samples in sets of about 5 to 20 samples including all the necessary QA/QC samples. Thaw and thoroughly mix fish tissue previously homogenized according to the procedure described above. Weigh 10 g of tissue into 50 mL Teflon centrifuge tubes or contaminant-free beaker and add appropriate solvents. Regarding "gut-drain" however, the extraction process proceeds directly (see figure 7.1). The following can be done:

1. Soxhlet extraction with hexane; clean-up with Florisil
2. Extract with petroleum ether/ethyl acetate; clean-up with Florisil
3. QuEChERS method, followed by Solid Phase Extraction (SPE).

Instrumental Analysis

Liquid/Gas chromatography with UV/Vis, ECD or MS detection can be used for qualitative and quantitative measurements of chemicals in fish tissues. Chemical compounds that may have been used in illegal fishing can be identified by comparing peak retention times between samples and standard chromatograms. When LC/GC–MS is employed, structural elucidation is possible by running chromatograms through databases.

Quality Control/Assurance

Samples should be delivered to the analytical laboratory, along with a completed evidence collection form, following the protocols outlined in this manual. A chain of custody should be

assigned to samples submitted. Prepared samples should be completely analysed within six months.

If required, replicate samples can be collected by submitting two independent samples of homogenized tissues from same samples for analysis.

Interferences from sample preparation (matrix), glassware and reagents should be routinely monitored by running method blanks. The method blank is run through the entire extraction process along with the samples, except that it consists only of the compound (solvent) that is mixed with fish tissue before extraction.

Rinsate blanks refers to deionised water sample collected by rinsing the equipment that typically comes in contact with the fish tissues during homogenization. Rinsate blanks should also be submitted for analysis.

Interpretation of Results

Results, both qualitative and quantitative, from instrumental analysis of samples must be presented for each species determined. Since, ordinarily, these chemicals or their metabolites (analogues) are non-constituent elements in fish tissues, a trace level determination should suffice for criminal prosecution.

Recommendations

- The laboratory analytical method presented here is only suggestive. For a method employed for analysis of chemicals, intended to be able to stand as evidence in a court of competent jurisdiction, the method must satisfy an admissibility criterion. This can only be achieved by rigorous method development and validation, which has not been done in this instance. Most importantly, the specificity/sensitivity, including the limits of detection (LoD) and quantitation (LoQ) of the method must be established.
- A standard operating procedure (SOP) for simultaneous analytical determination of chemicals used in illegal fishing activity, encompassing sampling for laboratory analysis should be developed using this manual as a template.
- A rapid diagnostic test (RDT) could simply be used for analytical determinations of these compounds. It is recommended that research into developing an RDT to determine whether or not the fish was caught illegally, on site, using the "gut-drain" be undertaken.
- When chemicals are introduced into an environment or exposed to heat, they undergo changes. It is important to ascertain the changes these chemicals undergo in fish tissues within their environment as well as when they are exposed to heat in effort towards their preservation. This will be useful as analytical methods could now be developed to target metabolites and/or analogue to enable a back-trace to the original compound(s) used.

BIBLIOGRAPHY

Almaden, Catherine Roween. (2017). A Case Study on the Socio-Economic Conditions of the Artisanal Fisheries in the Cagayan De Oro River. International Journal of Social Ecology and Sustainable Development (IJSESD). IGI Global. 8 (2). ISBN9781522514206. doi:10.4018/IJSESD.2017040102.

ATLAFCO (COMHAFAT). 2012. Fishery and Aquaculture Industry in Ghana. Bank of Ghana (2008).The Fishing Subsector and Ghana's Economy. https://www.bog.gov.gh/privatecontent/Research/Sector Studies .

B&FT Online. (2015). Fish imports gap widens. http://thebftonline.com/business/agribusiness/14001/Fish-imports-gap-widens.html .

Bjorndal Trond, Child Anna and Lem Audun (eds.) (2014). FAO Fisheries and Aquaculture Technical Paper 581. Value chain dynamics and the small-scale sector. Policy recommendations for small-scale fisheries and aquaculture trade. http://www.fao.org/3/a-i3630e.pdf .

CIA, (2016).Ghana. https://www.cia.gov/library/publications/resources/the-world-factbook/geos/gh.html. Accessed April 19, 2018.

Cinner, J.E. and McClanahan, T.R. (2006). Socioeconomic factors that lead to overfishing in small-scale coral reef fisheries of Papua New Guinea. Environmental Conservation 33: 73-80 doi 10.1017/s0376892906002748.

Commonwealth Network. (2015). Find Fisheries expertise in Ghana. http://www.commonwealthofnations.org/sectors-ghana/business/fisheries/ .

Ella, Syafputri. (2014). "Almost Half of Illegal Fishing in the World Occur in Indonesia". https://en.tempo.co/read/news/2014/07/19/056594269/Almost-Half-of-Illegal-Fishing-in-the-World-Occur-in-Indonesia

European Commission. (2015). Fighting illegal fishing: Commission warns Taiwan and Comoros with yellow cards and welcomes reforms in Ghana and Papua New Guinea. http://europa.eu/rapid/press-release_IP-15-5736_en.html .

FAO. (2005-2011). Fisheries and Aquaculture topics. Small-scale and artisanal fisheries. Topics Fact Sheets. Text by Jan Johnson. In: FAO Fisheries and Aquaculture Department[online]. Rome. Updated 27 May 2005. [Cited 19 November 2011]. http://www.fao.org/fishery/topic/14753/en .

FAO. National Aquaculture Sector Overview – Ghana. http://www.fao.org/fishery/countrysector/naso_ghana/en. Accessed April 19, 2018,

Fox, H. E., Pet, J. S., Dahuri, R., and Caldwell, R. L. (2003). Recovery in rubble fields: long-term impacts of blast fishing. *Marine Pollution Bulletin*, 46(8), 1024-1031. Retrieved October 25 2009, from ScienceDirect.

Garcia, S.M. (2009). "Glossary". In Cochrane, K. and Garcia, S.M. A fishery manager's handbook. FAO and Wiley-Blackwell. pp.473–505.

Government of Ghana. 2015. Fisheries (Amendment) Regulations.

Government of Ghana. 2002. Fisheries Act

Government of Ghana. 2010. Fisheries Regulations.

Government of Ghana, Ministry of Fisheries and Aquaculture Development. (2013). Guidelines for the registration and licensing of fishing vessels (industrial and semi-industrial) in Ghana.

Jacquet, J. and Pauly, D. (2008). Funding priorities: Big barriers to small-scale fisheries. *Conservation Biology* 22: 832-835 doi 10.1111/j.1523-1739.2008.00978.x.

Lewis, J.A. (1996). "Effects of underwater explosions on life in the sea". Australian Department of Defence, DSTO-GD-0080.

Toor, Amar (2014). "Google-backed initiative will pinpoint illegal fishing in near-real-time". The Verge. Retrieved November 14, 2014.

World Wildlife Fund: Fishing problems: Illegal fishing. https://www.worldwildlife.org/threats/illegal-fishing# Accessed April 19, 2018.

ANNEX 1: TECHNIQUES USED IN THE FISHING INDUSTRY IN GHANA

Ghanaian fisheries can be as varied as commercial fisheries to artisanal and they often use similar techniques for the capture of their target species. As such, in order to better understand issues of illegal fishing you must understand how most fisheries work in general. Below is a description of some of the most common techniques used in fishing in Ghana.

Hook and Line

The technique that typically immediately comes to mind when one thinks of fishing. Using this technique, a single person uses relatively small numbers of lines and hooks to catch fish. This ranges from a single line with a hook on the end which is brought up by hand, to using a rod for the same purpose, all the way to the more advanced systems used for trolling such as downriggers. Though the technology varies greatly they all work on the same principle. Basically a single fisher is in direct control of a small number of lines each containing only a few hooks (as compared to long lining described below). These hooks can be baited or have lures designed to catch only specific kinds of fish, helping to reduce bycatch.

Hooks can vary in size so that by using large enough hooks the fishermen can avoid catching juveniles of their target species, which in itself can help maintain the population's numbers. Since each line is manually brought up directly after a fish takes the bait they spend relatively little time on the line and if when brought up are deemed not to be what they are after, whether it be bycatch, improper size or sex they can be immediately released and typically have a reasonable chance of survival. This technique is one of the most eco-friendly in the sense that it has less of an impact largely due to the features described above and the relatively small scale at which it affects a population. That is not to say that if used in excess this technique is not capable of causing as much stress of the fish population as any other technique.

Trolling lines

In Ghana, this gear is a single line made up of white nylon multifilament and hooks with artificial bait. It is operated by hand line fishermen on their way to and from the fishing ground. (Figure 24).

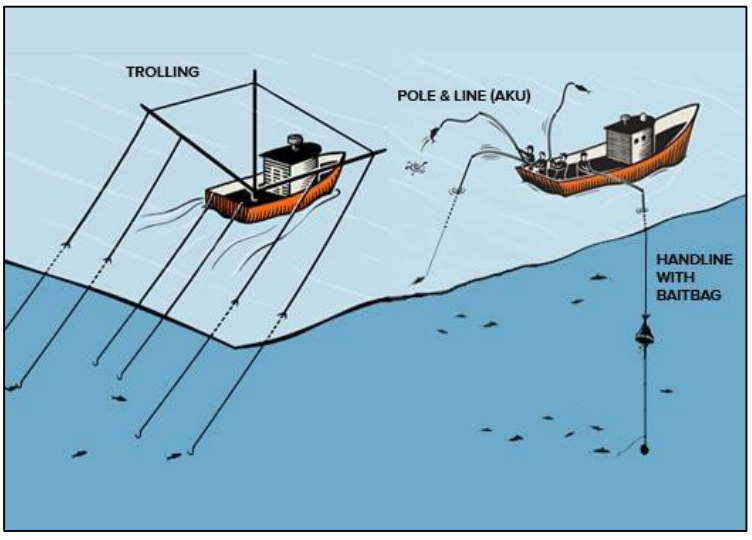

Figure 24. Demonstration of some hook and line fishing approaches (https://thisfish.info/fishery/albacore-tuna-pole-and-line-bay-of-biscay/)

Purse Seining

Purse seining is used to capture large schools of pelagic fish by encircling them with a large net. A small boat pulls the net off of the larger stationary one, and surrounds the school before coming back to the large ship. (Figure 25). Along the bottom, deepest part, of the net runs a line

that can be pulled tight causing the bottom of the net to close much like a purse, which traps all fish inside from escaping.

The larger vessels can then draw in the net and take the captured fish on-board. Some smaller purse seines actually take the entire catch to shore while the fish remain in the seine. This is especially useful in remote areas without a port. A downside to this technique is that it catches everything inside the purse, including some non-target species that feed on these schools such as billfish and dolphins. Modern practices have reduced this added risk by lowering parts of the net and allowing the non-target species to escape (FAO, 2011).

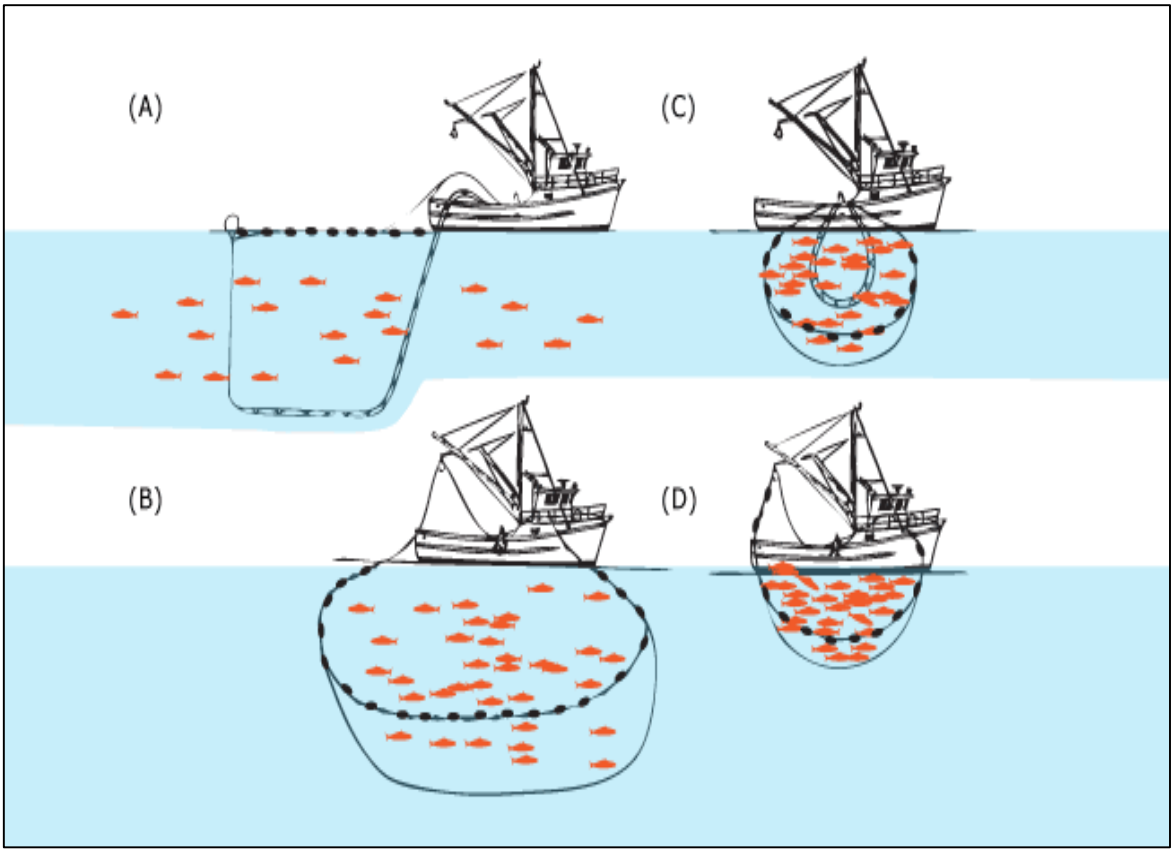

Figure 25. Closed Purse Seine with catch (www.montereyfish.com/pages/methods/p_seining.html)

(A) A net with weights and buoys is laid out, forming a screen of net around the catch. (B) The drawstring cable at the weighted bottom of the net is cinched, or drawn in, closing the bottom. (C) The catch and the gear is drawn toward the boat. (D) Once the fish is concentrated in the purse, smaller meshed nets called brailers or fish pumps transport the fish from the seine to the boat.

Purse seines are walls of netting used to encircle entire schools of fish such as sardines, mackerel, squid, and some tuna, at or near the surface. A drawstring cable is threaded through the bottom of the net. When the cable has pulled the netting tight, enclosing the fish in a pouch, the catch is hauled onboard with a dip net in a process called brailing.

Gill Nets

As their name implies, gill nets capture fish by taking advantage of a fish's gills. Basically, as a fish is swimming around it encounters the net. (Figure 26). The mesh size of a gill net is completely uniform which makes it very selective for certain sized fish. If the fish is too small it simply goes through the mesh without any consequence, while if a fish is too large it cannot fit its head through the mesh deep enough to reach its gills so it is not trapped. However, if a fish is small enough so that it can fit its head and deep enough to reach its gills but too large for the

rest of its body to fit through, it become stuck. The gills of a fish are angled backwards so that if the fishes tries to swim backwards to free itself from the net the mesh enters the slit, where water exits, between the outer portion of the gill (the operculum) and the rest of the body effectively capturing the fish until the fisher pulls it out. Since the mesh can be size specific it can avoid capturing juvenile fish which have yet to reproduce and it avoids capturing larger fish that can be important in keeping the fish population plentiful since larger fish have more reproductive success. Gill nets, especially the recent illegal drifting gill nets are the cause of some of the most severe seabird bycatch, but in some fisheries they still pose a serious risk for marine mammals, such as dolphins.

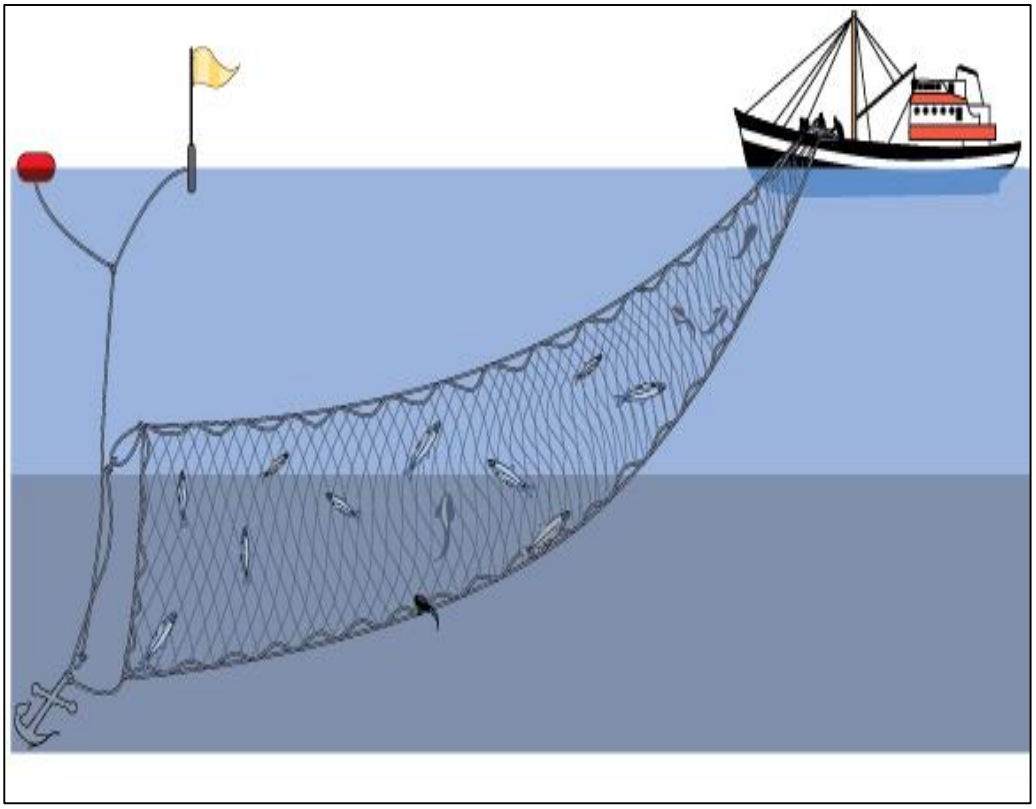

Figure 26. Gill net with some entangled fish (https://alfa-img.com/show/gill-net-fishing-boats.html)

Long Line

Long lining can best be described as a massive scale hook and line operation. Here a single long line is let off from a boat and periodically other lines run off of this main line where one to several baited hooks or lures are attached. (Figure 27).This process is continued for very long distances, upwards of 40 miles, though typically much smaller for small-scale artisanal fishing. This technique is relatively inexpensive and not very labor intensive as machines are used for hauling the line in and out and large tracts of water can be covered fairly easily.

Many of the issues seen in hook and line fishing are also seen here. But the issue of bycatch is considerably more prevalent due to the larger scale. A huge issue is catching sea turtles, marine mammals, and seabirds on the hooks, where in the time that it takes to be brought to the surface they can suffocate. Circle hooks have reduced this issue, especially for sea turtles but it is still a problem, while hanging streamers from lines reduce seabird mortality.

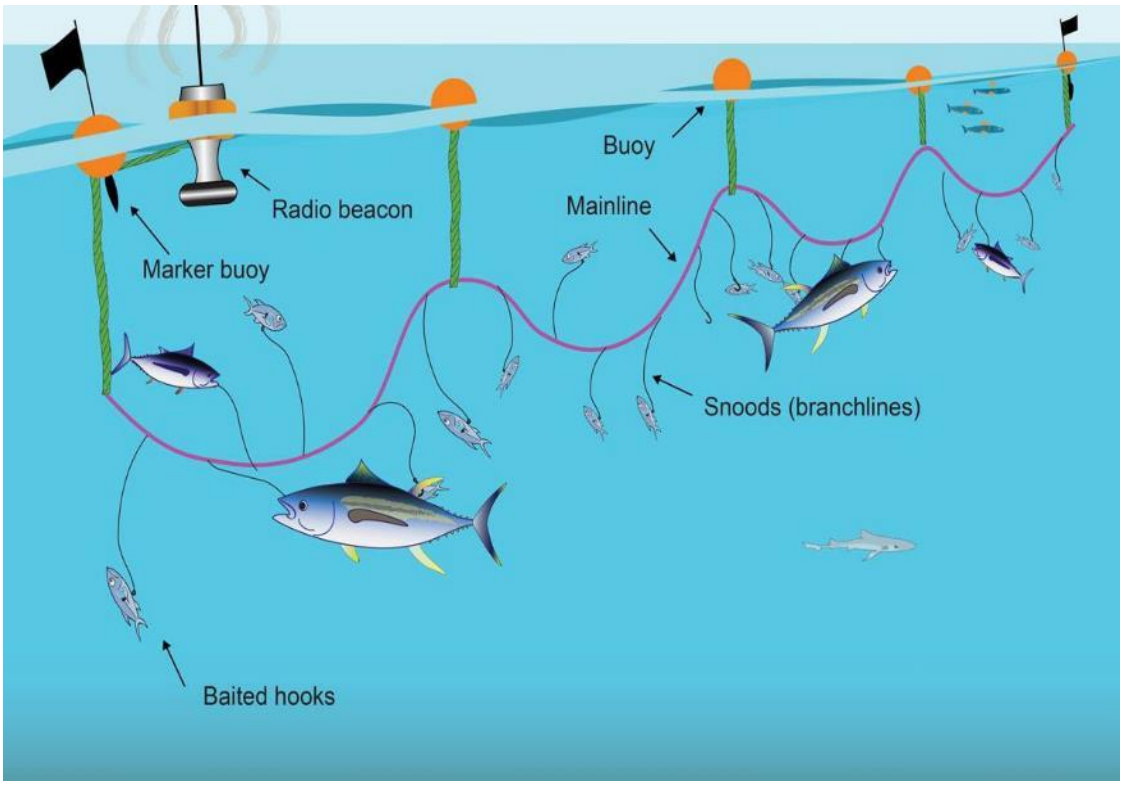

Figure 27. Longlines used in catching large tunas and pelagic species (www.afma.gov.au)

Trawling

Trawling is a method of fishing that involves pulling a fishing net through the water behind one or more boats. The net that is used for trawling is called a trawl. (Figure 28).The boats that are used for trawling are called trawlers or draggers. Trawlers vary in size from small open boats with as little as 30 hp (22 kW) engines to large factory trawlers with over 10 000 hp. Trawling can be carried out by one trawler or by two trawlers fishing cooperatively (pair trawling). Trawling can be divided into bottom trawling and mid-water trawling, depending on how high the trawl (net) is in the water column. Bottom trawling is towing the trawl along (benthic trawling) or close to (demersal trawling) the sea floor. Midwater trawling is towing the trawl through free water above the bottom of the ocean or benthic zone. Mid-water trawling is also known as pelagic trawling. Mid-water trawling catches pelagic fish such as anchovies, shrimp, tuna and mackerel, whereas bottom trawling targets both bottom-living fish (ground fish) and semi-pelagic fish such as cod, squid, halibut and rockfish. The gear itself can vary a great deal. Pelagic trawls are typically much larger than bottom trawls, with very large mesh openings in the net, little or no ground gear, and little or no chaffing gear. Additionally, pelagic trawl doors have different shapes than bottom trawl doors, although doors that can be used with both nets do exist. When two boats are used (pair trawling), the horizontal spread of the net is provided by the boats, with one or in the case of pelagic trawling two warps attached to each boat. However, single-boat trawling is more common. Here, the horizontal spread of the net is provided by trawl doors (also known as "otter boards"). Trawl doors are available in various sizes and shapes and may be specialized to keep in contact with the sea bottom (bottom trawling) or to remain elevated in the water.

In all cases, doors essentially act as wings, using a hydrodynamic shape to provide horizontal spread. As with all wings, the towing vessel must go at a certain speed for the doors to remain standing and functional. This speed varies, but is generally in the range of 2.5–4.0 knots. The vertical opening of a trawl net is created using flotation on the upper edge ("floatline") and weight on the lower edge ("footrope") of the net mouth. The configuration of the footrope varies based on the expected bottom shape. The more uneven the bottom, the more robust the footrope

configuration must be to prevent net damage. This is used to catch shrimp, shellfish, cod, scallops and many others. Trawls are funnel-shaped nets that have a closed-off tail where the fish are collected and is open on the top end as the mouth. Trawl nets can also be modified, such as changing mesh size, to help with marine research of ocean bottoms.

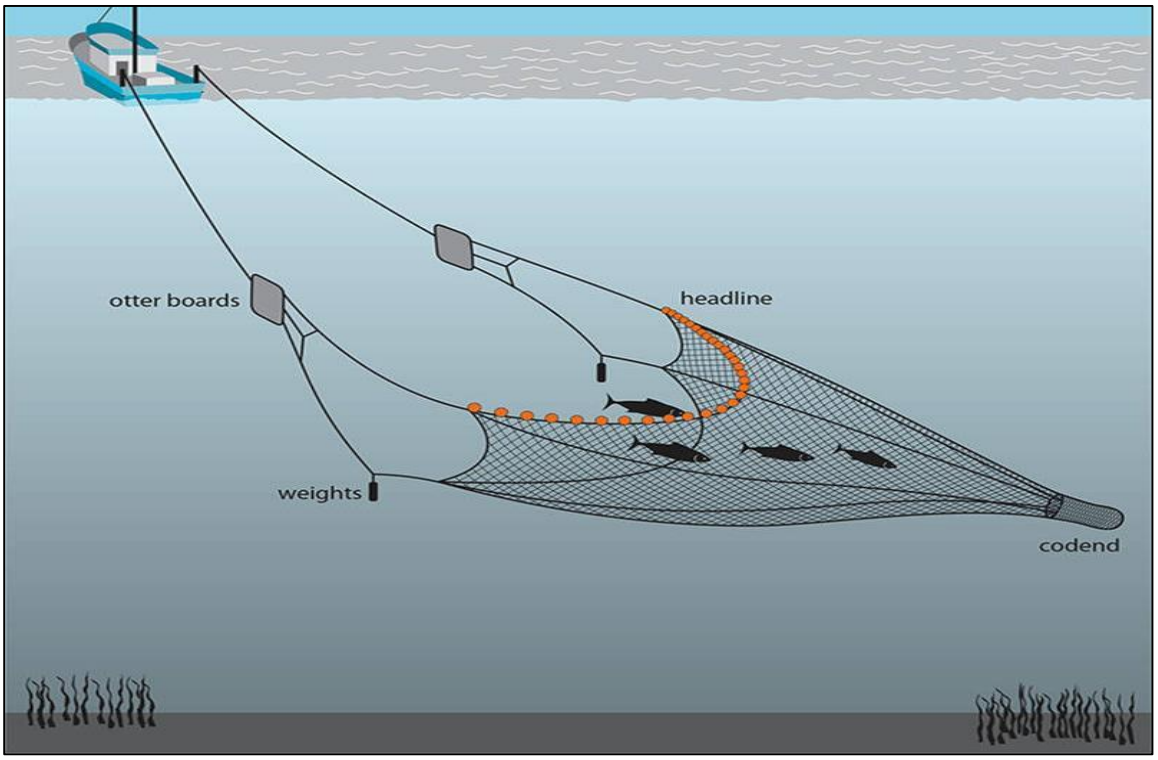

Figure 28. Trawl net used in fishing (fishingnets.bossgoo.com/.../polyethylene-beam-trawl-net-26403454.html)

Beach Seine

A beach seine is a seine net operated from the shore. (Figure 29). The gear is composed of a bunt (bag or lose netting) and long wings often lengthened with long ropes for towing the seine to the beach. The head rope with floats is on the surface, the footrope is in permanent contact with the bottom and the seine is therefore a barrier which prevent the fish from escaping from the area enclosed by the net. Two basic types of gear can be distinguished: seine nets without a bag and seine nets with a bag. The first one do have, however, a central part with smaller mesh and more slack, which retains the fish caught. In the second one the fish are retained in the bag. It is not necessary for the bag to be exactly in the centre and in this case the wings are not of equal length. No specific gear handling equipment is required for fishing operations but a large number of people for towing the seine to the shore. In some cases, wooden-made capstan can be fixed on the beach for facilitating the hauling of the seine to the shore. Beach seines are usually set from a boat (in general a small boat, in many cases without engine) setting the first towing line is fastened ashore, then the line, the first wing, the bag, second wing and second line is set out in a wide arc and brought back to the beach. The bottom and surface act as natural barriers which prevent the fish from escaping from the area enclosed by the net. The drag lines are towed simultaneously from the beach. The fish is herded in front of the bag or bunt. For successful operations it is suitable that the ground rope reaches the beach first, to bring the gear underneath the fish. This is the most commonly operated method along the sea shores of the Ghanaian coast. It has a pair of long wings, shoulders and a central bunt.

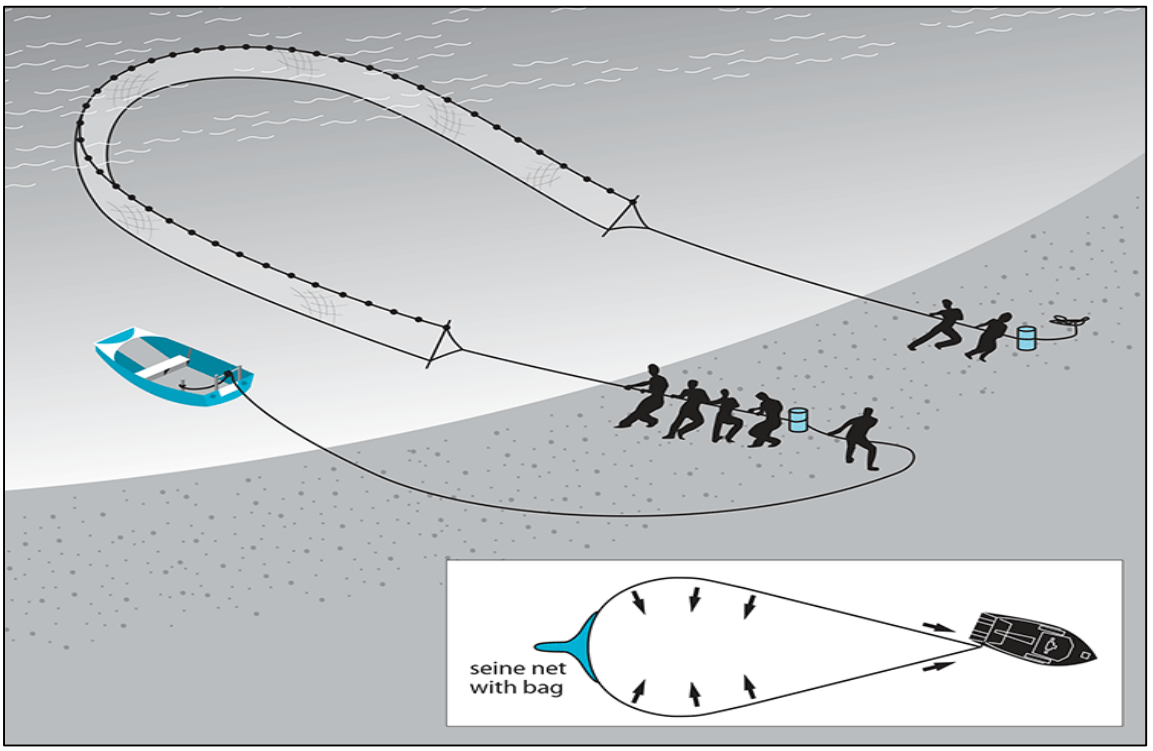

Figure 29. Beach seine fishing (www.fish.gov.au)

Traps and Ports

This technique is far more common and varied in artisanal fishing than it is in industrial fishers. For other species such as crabs, lobsters, and a few fish species traps are rarely used in these larger scale operations. But for an artisanal fisher it provides a relatively easy way to catch the target species. Though the design of a trap varies greatly depending on the location and what is being caught, the design is basically the same. The organism swims through an opening whether due to just passive swimming or attracted to some sort of food, and is unable to escape. These traps tend to be designed to target specific species, due to size, bait, or position in the ecosystem and often exclude juvenile fish either through the mechanism of the trap or due to escape holes designed to let smaller fish out. The fish remains in the trap until the fisherman returns to check his trap. This means that if a non-target species was captured other than an increase in stress during the capture it can be released with high likelihood of being perfectly healthy. Due to how the traps work and their small scale they are one of the cleanest techniques available but are limited in the extent of their use. It is mostly constructed with wood, metals, bamboos etc. In Ghana, women and children mostly use it to catch shrimps, crabs and fish. There are four different types of traps used in Ghana to catch various species.

These include:

V-Shaped Shrimp Trap: This is a special trap used in the Keta estuary. It is constructed with mangroves or bamboo scantling and consists of two walls about 7-10m long and 1-1.5m high.

Crab Trap: This is a small trap, woven with thin sticks from coconut branch leaves. It is about 0.4m long and 0.3m wide and 0.2m high in front. It is wider at the rear but also sometimes flatter. The trap is normally baited and set at the bottom with two fixed sticks on the sides and crossed above to keep the trap in position. These traps are mostly used to catch crabs.

Crab pot: This is popularly used for catching the lagoon crab. There are two types, one with rings at the top and base and the other with a ring at the top only. Both types have three bridles to which a short line of about 1m is fixed with a small cork at one end. The floating cork shows the position of the trap. The baited pot collapse flat on the bottom when set and is retrieved from the water by pulling the cork line. Bait is either used to catch a big fish like shark etc.

Fish, Crab, Shrimp Trap: This is a commonly used gear in lagoon fishing. A barrier is constructed with mangrove and palm branches across shallow sections of the water. Holes of about 30-50cm diameter are made in it at the base at about 1-15m intervals Woven traps are set in the holes against the flow of water, fish and crab are guided by the barrier into types. (Figure 30).

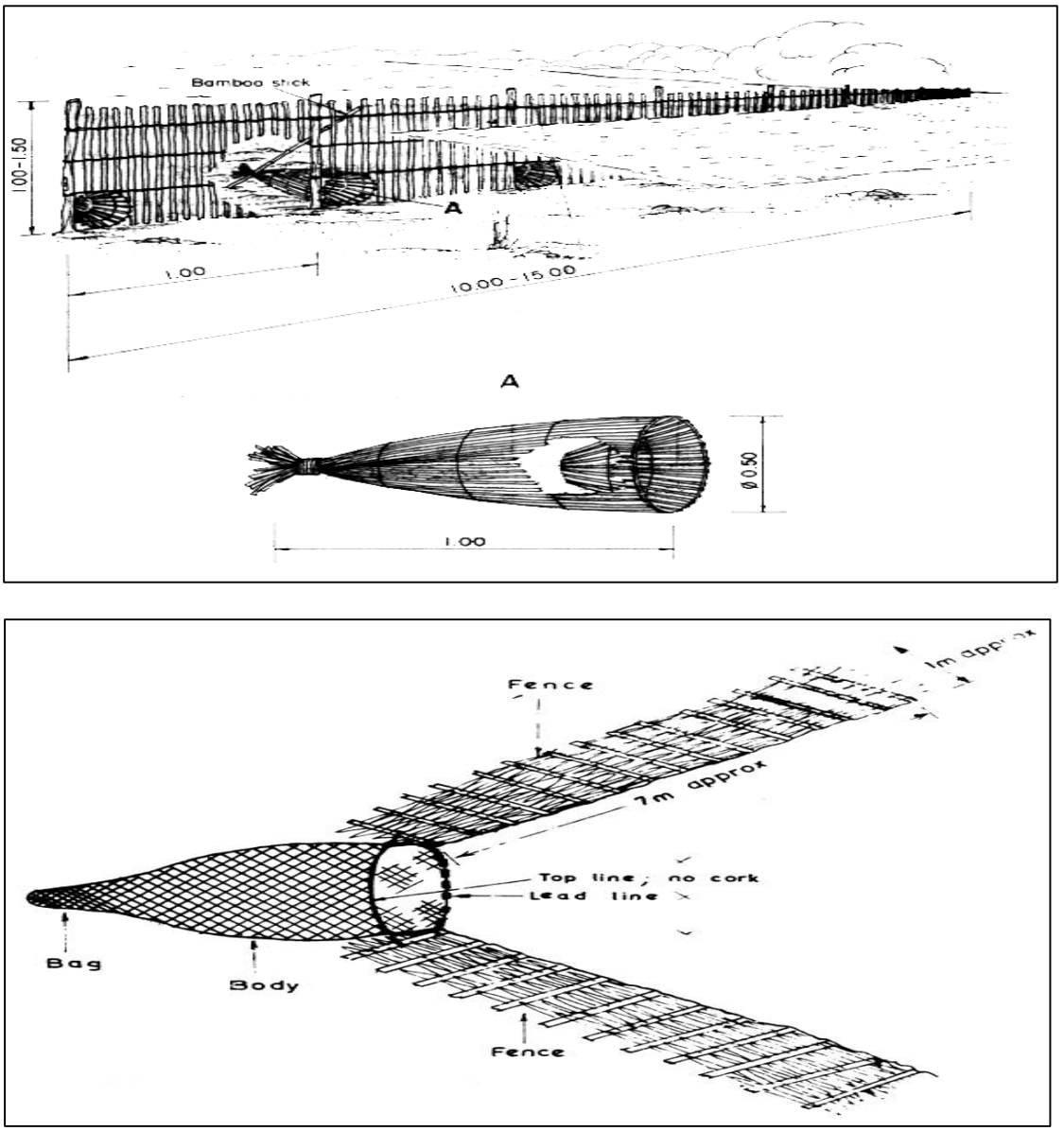

Figure 30. Traps used for fishing (www.fao.org/docrep/003/R0395E/R0395E06.htm and www.fao.org/3/a-ad794b/AD794B02.htm)

Cast Nets

Cast nets are conically shaped with or without inverted pockets around the lip of the net. The nets are thrown from the shore or from a canoe to catch fishes swimming close to the surface by falling on them and closing when the thrown line is pulled taut. They are mostly used in shallow waters. There are two types of cast net used in Ghanaians waters, one with pockets and the other without pockets. The pockets cast nets are normally used for fishing in rivers and lagoons. Its mesh size ranges between 25-45mm. This net is used for fishing by the fishermen standing at the bank, in the water or on a canoe crewed by one or two fishermen. The cast nets without pocket is operated from a canoe in inshore waters by 3 or 4 fishermen. (Figure 31).

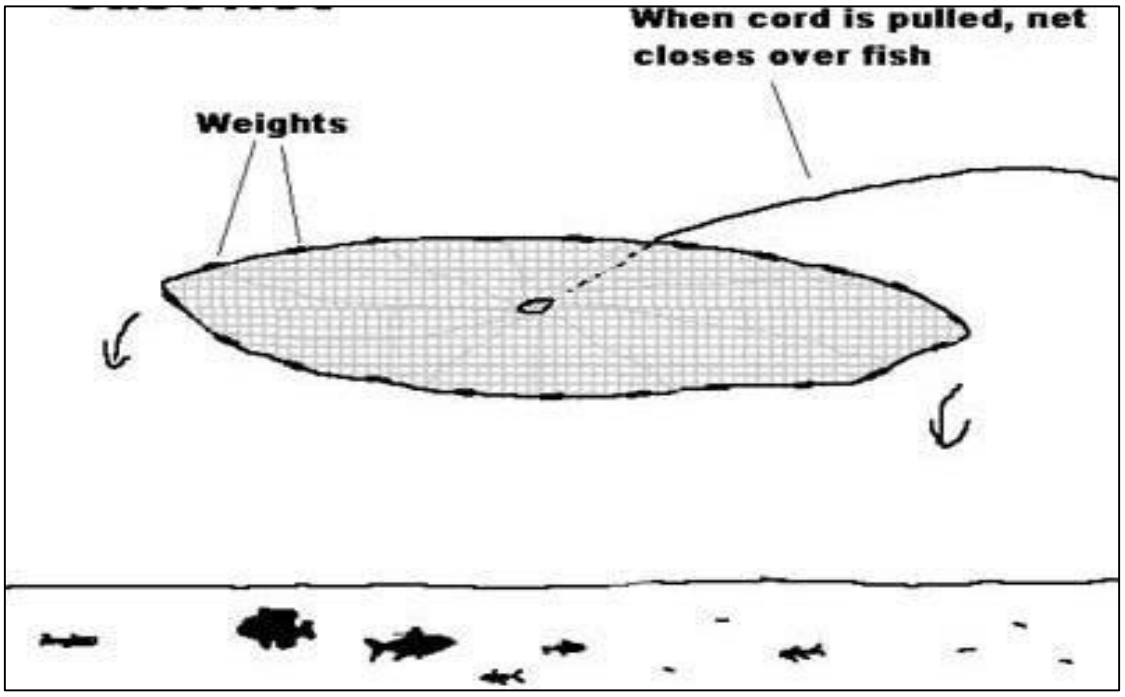

Figure 31. Cast net used for fishing (www.landbigfish.com/articles/default.cfm?ID=2275)

Drift Nets

These nets are used on the surface or at a certain distance below the water. They drift freely with the current, often with the craft to which they are attached. There are about 3 distinct types in this group for the Ghanaian fishery, namely the *Ali net, flikilo-yaa* and the *anifa*. The Ali net is a very important fishing net in the Accra and Central region of Ghana. It is operated mainly during the night between a depth of 25-50m. The net is set any time after sunset and hauled and set several times during the nights. The *Flikilo-yaa* is mostly used by fishermen in the Ningo and Kpone areas of the Greater Accra Region and Nakwa, Otnam in the Central Region of Ghana. It is operated in about 20-50m depth of water, employing sail or

outboard driven canoes. Usually, each fisherman owns two nets which are joined together to form a fleet, the net is hauled and set several times to catch more fish.

The *Anifa-anifa* is an offshore large mesh driftnet measuring 100 - 450 m long and 15-20 m deep. Fishing is mostly carried out at night and a round trip is made. It is operated with outboard driven canoes manned by 4 - 6 fishermen. It is commonly used by people of Kpone, Prampram, Ningo, Shama, Dixcove and Axim. (Figure 32).

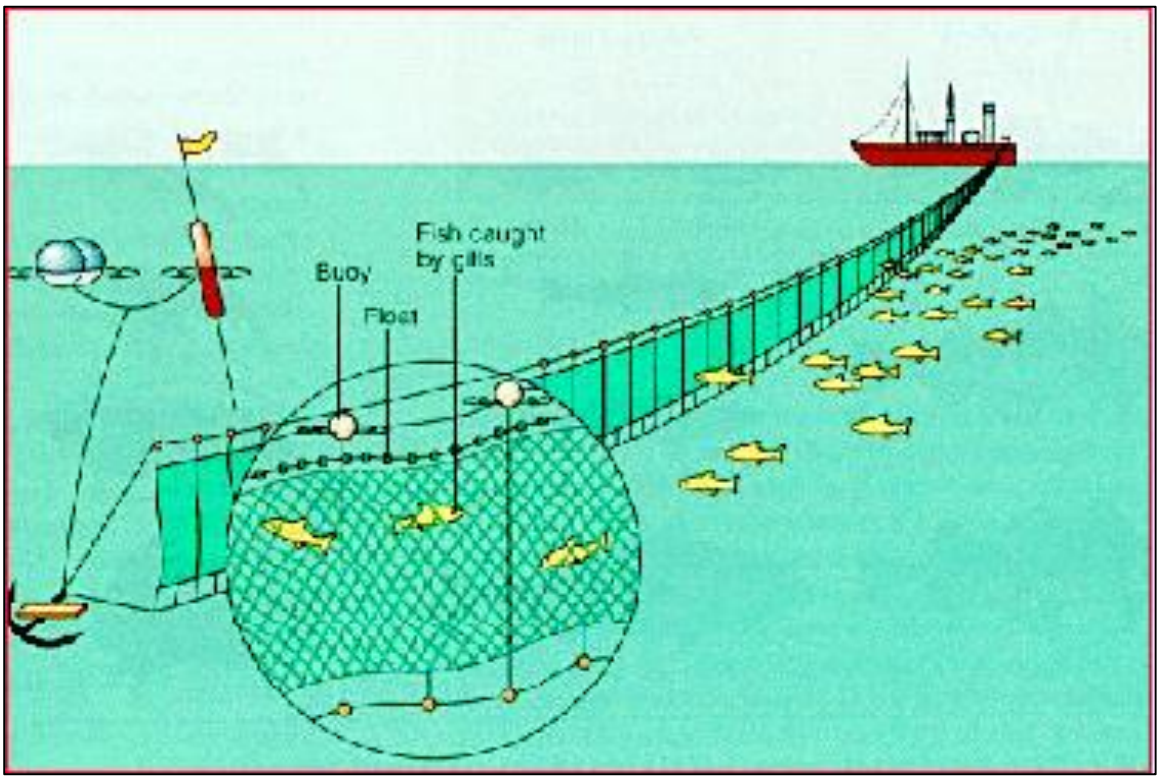

Figure 32. Drift net fishing (web.mit.edu)

Encircling Gillnet

This gear is generally used in shallow waters with the float line at the surface. A school of fish is encircled with the net and various means are used to frighten the fish and drive them into the net. (Figure 33).

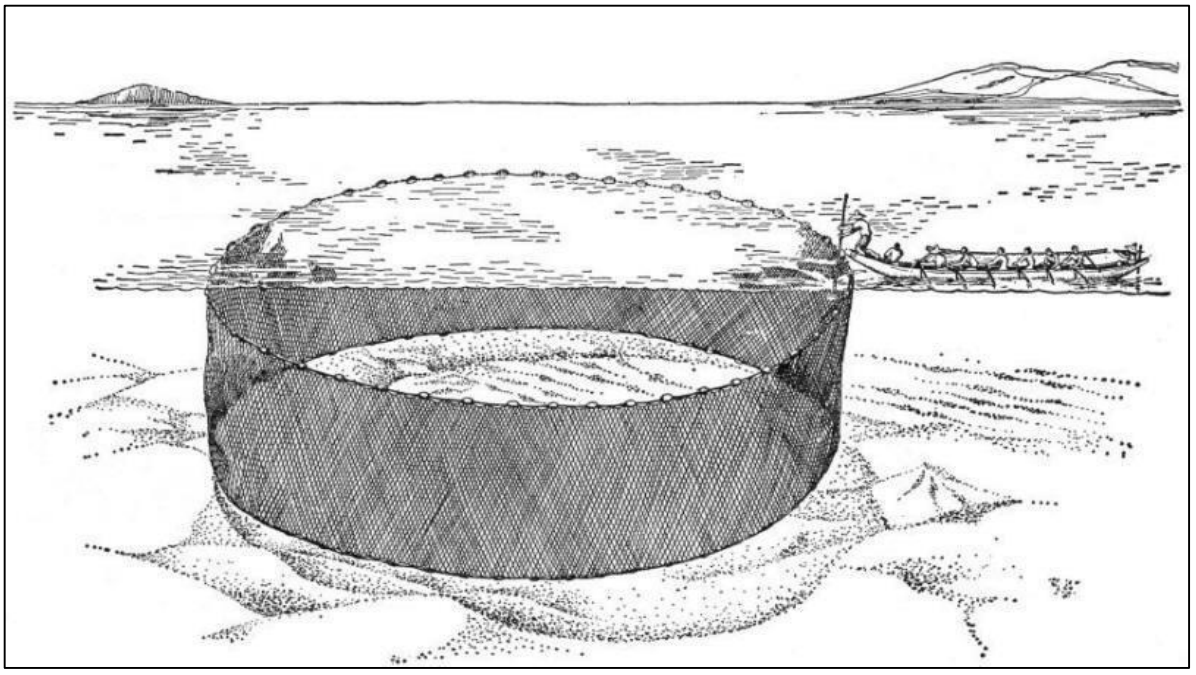

Figure 33. Encircling gill nets (www.briancoad.com)

Bottle Fishing

This is done in the small lagoons during the dry season when the water level is very low. It involves the use of ordinary bottles. A hole of about 3-4cm in diameter is made on the side near the top. Small quantities of fish, *gari* is put inside and a thick stick of about 1m long is stuck into the bottles. The bottles are fixed vertically to the sea bed with the end of the stick showing above the water as a marker. Fishes are attracted to eat the food in it and are trapped. The bottle is retrieved and fish in the bottles are collected. This normally captures a single tilapia.

The artisanal fishery in Ghana is characterized by the use of several gears. These include purse seine nets, beach seine nets, set nets, drifting gillnets and hook and line. These gears are operated from dugout canoes. There are over 11,200 canoes and more than 124,000 fishers operating actively from over 16 300 landing sites located along the entire 550 km length of the coastline. About 50 percent of these canoes are powered by outboard motors with engine power of up to 40 horsepower.

The inshore and industrial fishery uses motorized canoes, which is specialized in hook and line, trawling using insulated containers and ice to preserve high valued fish. Some of these canoes are equipped with electronic fish finding devices such as echo sounders. Marine fishing enterprises in Ghana range from the very small scale (one-man) canoes through to the industrial vessels operating offshore in international waters. The Ghanaian coastal fishing fleet can be divided into four sectors: by far the largest is the small-scale fleet of artisanal canoes totaling some 8 641 vessels and employing an estimated 101 000 fishers as crew. An estimated 58.7% of the canoe fleet has outboard motors.

ANNEX 2. PICTORIAL SCENES ON INITIAL CONSULTATIONS

Figure 34. Project personnel in a group picture with staff of HƐn Mpoano.

Figure 35. Community entry meetings with Chief fishermen and fishers.

Figure 36. Project personnel in community entry meeting with fishers in Axim.

Figure 37. Project personnel in a group picture with fisher folk in Axim.

Figure 38. Chief fisherman of Dixcove and other fishers during a focus group discussion.

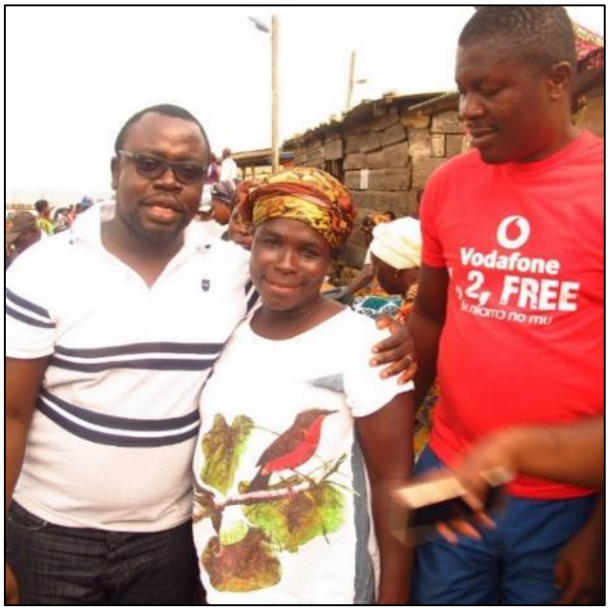

Figure 39. Key informant interviews with fishers