**THE MARINE FISHERIES RESEARCH DIVISION (MFRD), TEMA**

**REPORT ON THE OBSERVATIONS OF COMMERCIAL LIGHT FISHING OPERATION IN GHANA, FEBRUARY – JUNE 2004.**

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## 1.0 Introduction

Light fishing operations (LFO) in Ghana is concentrated in the three major coastal municipalities of Greater Accra (Tema), Central (Mumford & Elmina) and Western (Sekondi) Regions; these areas have the port facilities for landing of the catch by the larger inshore vessels that operate the purse seine fishery in Ghana and which predominantly operate the light attraction. Currently there are about 250 registered inshore vessels in the country whose sizes range between 39 – 60 feet , only a small fraction are actually working at the moment due to problems with spare parts and operations.

Light attraction is the technique of aggregating fish by artificial light; and light fishing is the process of fishing the attracted fish by hooking, gill-netting or by any other gear (P.P. Dinglasan, 1972). The light source may be by means of a fire torch, pressure kerosene lamp, gas lit lamp and battery or generator assisted incandescent lamp (FAO Training Series, 1988). Currently the light fishing operations in Ghana use mainly the purse seine gear with a small size generator powering the incandescent lamp. They are minimally mechanized using fish finders, a two-way radio for communication and a diesel driven winch drum to facilitate the search and hauling of the catch.

## 1.1 The Fishery

The species they target are mainly the small *pelagic* fish. *Pelagic* fish are fish that spend most of their time swimming in midwater and the surface of the water. The three most important groups of fish caught with light attraction are:

- Small pelagic fish of the herring group (herring, sardinella, and anchovies)
- Squids
- Mackerels, young fish of the bonito and tuna family and the smaller horse-mackerels (jacks, scads, pompano).

The small pelagic industry in Ghana depend on the surface shoaling of the pelagic species during the cold season or period of water instability (major upwelling), which occurs from mid-June to September when water surface temperature is below 25$^{o}$C. Water surface temperature starts to rise at the onset of the warm season (period of thermocline). This is the period when a temperature gradient barrier forms in the deep to prevent the fish from coming to the surface to shoal, it happens around Sep. to Dec. It is the period when light fishing is most conducive because at these times the fish appear in scattered formation and light would be needed to aggregate them. This is followed by the minor upwelling period in December to January; from then onwards, surface temperature stabilizes at 28-29$^{o}$C (a weaker thermocline) until the start of the next cold season. The periods of upwelling may not be suitable for light fishing due to increased turbidity of the water and also the abundance of production.

During the warm period, surface shoals disappear and are lost to the purse seine fleet. This situation has resulted in two basic characteristics of the industry, namely: -

- A very short fishing season of barely four months ( major season) when fish is caught in abundance but the price is low,
- A very long off-season (warm period) when the price of fish is high but there is very little fishing activity because of the scarcity of surface shoals.

In Ghana the sardinellas (*S. aurita* and *S. maderensis*) and the anchovies *(Engraulis encrasicolus*) constitute the major proportion of the nation's fisheries landings. These species are targeted both by the canoes and inshore vessels and they constitute about 60 percent of the total catch per year, amounting to some 90,000 t.

The sardinellas are abundant all along Ghana's continental shelf but their distribution varies with the environmental regimes. The *S. aurita* prefers cold waters and therefore move closer to the shore during the upwelling period when the temperature falls below 25 $^{o}$ C, whereas the *S. maderensis* prefers warm waters (Zei M., 1967) and is therefore found along the coast all year round, although in lesser concentrations. Sardinellas do not like strong light and, therefore, do not normally come close to the surface of the water in daylight. Neither do they come close to the fishermen's lamps. In visible light they try to stay at a distance where the light is neither too strong nor too weak for them (FAO Training Series, 1988).

**2.0 Background to the Report**

The small pelagic fishery in Ghana is dominated by the canoe fishery; about 80 percent of the total catch of small pelagics in Ghana is produced by the canoe fishers; the inshore fleet covers the other 20 percent (MFRD Statistics, 2003). However, since 1999, intense capitalization in the inshore fleet, coupled with the problems of the industry as outlined in the introduction, has forced them to adopt light fishing as a means to realize economic returns. Incidentally, the light fishing technique was started by the Fisheries Research Unit, now the Marine Fisheries Research Division (MFRD) of the Directorate of Fisheries (DoF), under the FAO / UNDP Technical Assistance Programme. It was done on an experimental basis for commercial operators, both canoe and inshore, at Teshie and Takoradi in 1962. This was aimed at raising the production and earnings in the small pelagic fishery.

**2.1 The Issues**

This development has generated some conflict between the inshore and the canoe operators. The reduced catches over the past couple of years, especially with the canoe fishers, have caused them to accuse the inshore operators of light as the reason for their declining catches. They reason that the light detains the fish further off-shore thus preventing the fish from coming down into their area of operation. There was also the question of quality of the fish caught with the light; most operators in the canoe fishery believe that the process of forcing the fish from the depths suddenly to the surface may be the cause of the eviscerated and bloody appearance of the light attraction landings which subsequently lowers the price of the fish on the market and, by association, lowers the price of the canoe catch. Others even accuse some of the inshore operators of using carbide to cause the fish to stay up in the purse seine nets.

The ramifications of these suspicions have been a general atmosphere of tension in the industry with sporadic skirmishes between the two factions. This situation has been brought to the attention of the Minister of State for Fisheries, Hon. Eddie Akita; who in a swift and responsible reaction ordered a scientific appraisal of the light fishing operations as practiced currently by the inshore fleet in order to find out the truth about the allegations.

**3.0 The Study**

The Minister of State for Fisheries, Hon. Eddie Akita, therefore requested the MFRD of the DoF in the December of 2003, to study the current operations of the inshore fleet in relation to the light and come out with findings which may either confirm, or dismiss, the charges leveled against them by the canoe fishers; this study was to cover a period of about four months. The MFRD was also to find out any operational deficiencies in the light fishing practice that could be brought into the management sphere in order to bring sanity and efficiency to the fishery and to come out with a report which may be used in managing the activities of the light fishing operators.

**3.1 Objectives of the Study**

The objectives of this study are to:

- Review previous research on the light fishing operations (LFO),
- Assess the impact of LFO on the small pelagic fishery,
- Assess how much fish is caught in terms of weight,
- Assess the sizes of fish caught as against the control,
- Where the fish is attracted from and the biological implication,
- Determine the effect on the quality of fish caught using organoleptic and other physico-chemical tests at the Food Research Institute,
- The socio-economic implications- lifestyle of fishers, greed etc.,
- The technical implication of the LFO for Gear (Nets, Vessels, Equipment etc.),
- The financial implications of increased investment versus dwindling stock – the Law of Diminishing Returns,
- Present a fair, balanced and scientific report to the Minister of State for Fisheries incorporating all aspects of the subject that would augur both for optimal exploitation of the resource and the sustainable livelihood of the operators.

**4.0 Methodology**

Observations of commercial operations of Light Fishing by Ghana's Inshore Purse Seine fleet were planned and carried out between the months of February and May, 2004. They consisted of using four teams, each with two officers, from the MFRD of the Directorate of Fisheries (DoF), Ministry of Food and Agriculture, Tema. The officers were aboard the commercial inshore vessels, as opportunistic observers, with the consent and cooperation of the vessel owners and crew.

The crew and skippers of the vessels did their normal fishing using their standard purse seine gears and their lighting equipment, while the teams from the MFRD recorded the scientific data and the catches. The vessels were in the 30 to 60 footer range with engine power of about 450HP. The nets are of average length of 1000 m length and a depth of about 40 m (See Annex A for details of vessels and equipment).

The teams observed vessels operations from Tema, Mumford and Elmina ports, during the lunar phase when the moon was out; a situation which tended to favour the light fishing operations. It was planned for each team to do four nightly trips with a vessel but in some instances this routine was not followed due to budgeting and operational constraints. The vessels leave port at dusk, fish throughout the night and return to port in the morning.

**4.1 Summary of Light Fishing Trials**

A total of 28 observation trips were undertaken between the periods under review. A majority of the trips were done in February and March (at the end of the minor upwelling period) during which time a total of 20 observations were made; four teams of two officers were used. The subsequent periods, April and May, witnessed 4 observations using two teams each with two officers. Four trips were undertaken daily in February and March and two daily trips in April and May; each trip started in the evening and returned early the following morning. The trips records show the times to and from the grounds and the duration of fishing (Annex B shows records of trips).

Each team recorded vessel name, size, the date and time of trip, fishing positions, times for lighting and times for shooting and hauling of net, biological data on length frequencies, species composition, bycatch, sample weight and total weight of the catches.( Annex C shows data recorded by all the teams).

The samples were obtained randomly by dipping a bucket into the catch as the catch emerges from the water and the length frequencies of the various species therein are then taken using a standard measuring board. The samples were made up of mostly pelagic and semi-pelagic species and some demersal species caught during the trip; however, our particular focus was on the Sardinella aurita and Scomber *japonicus*, the small pelagics that constitute the mainstay of the purse seine light attraction fishery i.e. Tables I to VI show data collected during the period under review.

After measuring they are then weighed with a spring scale and the total weight of the catch estimated by weighing one bucket full of fish and multiplying the result in kilograms by the total number of buckets that make up a crate and the total number of crates that make up the catch (as estimated by the Skipper).

The samples are then put in sampling bags with labels detailing trip date, vessel, haul number and sample number and then stored in an ice box; the ice sometimes was provided by the crew. After the trip the samples are taken to the MFRD laboratory for further analysis of condition and maturity stages. (Annex D shows record of laboratory results).

During the trips observations were also made of storage and preservation practices on the vessels.

**5.0 Results**

Table 1a: Catches (kg.) from Light Fishing Trials

| Trip No. | Date | Species | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Round Sardine | Flat Sardine | Horse Mackerel | Big Eye | Burrito | Big Eye Scad | Chub Mackerel | Palometa | Dolphinfish | Decapterus punctatus |
| 1. | Feb. | 113.5 | 12.0 | - | - | 6.0 | 14.0 | 7.0 | - | - | - |
| 2. | $March_E$ | 9.0 | 81.0 | - | - | 0 | 0 | 0 | - | - | - |
| 3. | $March_M$ | 7.0 | - | - | - | 0 | 0 | 0 | 19.2 | 2.8 | 133.0 |
| 4. | April | 4432.5 | - | 6.0 | 6.0 | 0 | 816.0 | 2840.7 | - | - | 1.1 |
| 5. | May | 1091.5 | - | 104.0 | 4.5 | 272.0 | 17.5 | 0 | - | - | - |
| **Total** | | **5653.5** | **93.0** | **110.0** | **10.5** | **278.0** | **847.5** | **2847.7** | **19.2** | **2.8** | **134.1** |

$March_E$ =Trip took place in Elmina; $March_M$ = Trip took place in Mumford.

Table 1b: Monthly Totals of Catches (kg.)

| **Species** | **February** | **March $_E$** | **March $_M$** | **April** | **May** | **Species Total** |
|---|---|---|---|---|---|---|
| Sardinella aurita ( Round sardinella) | 307.1 | 9.0 | 7.0 | 5653.5 | 1091.5 | **7068.1** |
| S. maderensis (Flat sardinella) | 0 | 81.0 | 0 | 0 | 0 | **81.0** |
| Caranx rhoncus ( Horse mackerel) | 11.0 | 0 | 0 | 1936.0 | 17.5 | **1964.5** |
| Priancanthus arenatus (Bigeye) | 190.0 | 0 | 0 | 7.0 | 4.5 | **201.5** |
| Brachyodeuterus auritus (Burrito) | 44.0 | 0 | 0 | 0 | 272.0 | **316.0** |
| Caranx hippos (Big Eye Scad) | 710.8 | 0 | 0 | 5.0 | 104.0 | **819.8** |
| Scomber japonicus (Chub Mackerel) | 9.9 | 0 | 0 | 2840.7 | 93.0 | **2943.6** |
| Trachinotus glaucus (Palometa) | 0 | 0 | 19.2 | 0 | 0 | **19.2** |
| Corhyphzena hippurus (Dolphin fish) | 0 | 0 | 2.8 | 0 | 0 | **2.8** |
| Decapterus punctatus (Round scad) | 0 | 0 | 133.0 | 0 | 0 | **133.0** |
| **Catch Totals** | **1272.8** | **90.0** | **162.0** | **10442.2** | **1582.5** | **13549.5** |

Table 2: Modal Length of Target Species in Light Fishing Trials (kg.)

| Species | Size Range cm | Modal Class cm | Length @ First Maturity $L_M$ cm | Common Length Attained ( cm) * |
|---|---|---|---|---|
| Round sardine | 12 - 25 | 22 | 17.5 | 18 cm (35 cm Max.) |
| Burrito | 11 - 15 | 13 | 11.7 | 20 cm (27 cm Max) |
| Big Eye Scad | 21 - 28 | 22 & 25 | 22.8 | 25 cm (60 cm Max) |
| Horse mackerel | 20 - 24 | 23 | 21.9 | 20 cm (35 cm Max) |
| Chub mackerel | 11 - 25 | 17 | 17.3 | 40 cm (50 cm Max) |
| Big Eye | 11 - 21 | 18 | 16.0 | 30 cm (40 cm Max) |

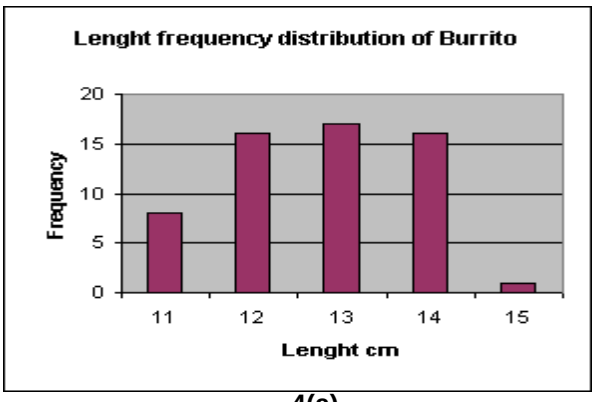
Table 3a: Average Number of Sets by Light Fishing Trials

| | February | March | April | May | Total/Ave. |
|---|---|---|---|---|---|
| No. of Days at Sea | 6 | 4 | 2 | 2 | 14 |
| No. of Sets Made | 15 | 6 | 3 | 5 | 29 |
| No. of Sets per Day | 2.5 | 2.5 | 1.5 | 2.5 | 2.07 |

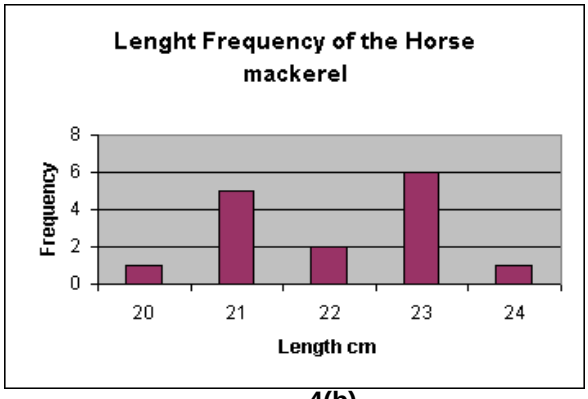
Table 3 b: Average Catch per Set by Light Fishing Trials

| | February | March | April | May | Total/Ave. |
|---|---|---|---|---|---|
| Catch Totals (kg) | 152.5 | 252.0 | 8102.3 | 1489.5 | **9996.3** |
| No. of Sets Made | 15 | 6 | 3 | 5 | 29 |
| Catch per Set | 10.17 | 42 | 2700.77 | 297.9 | 344.7 |

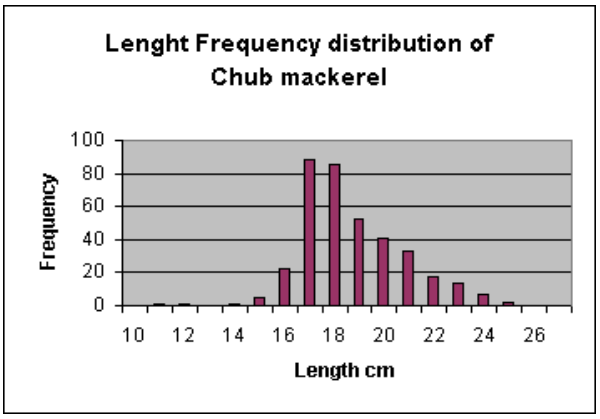
**Figures 4(a) – 4 (f): Length Frequency diagrams of species caught in Light Fishing Trials**



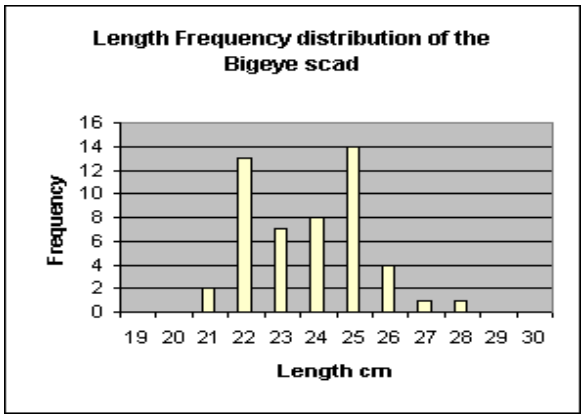

4(a)




4(b)

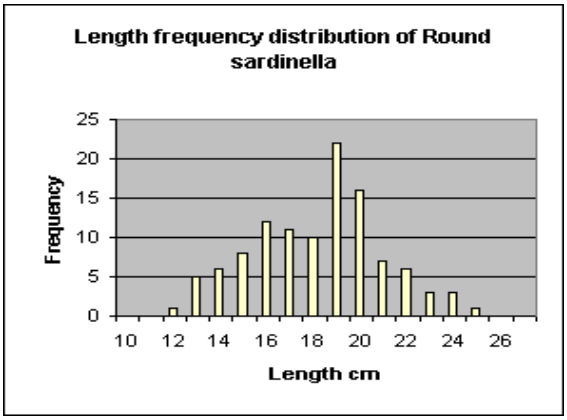



4(c)

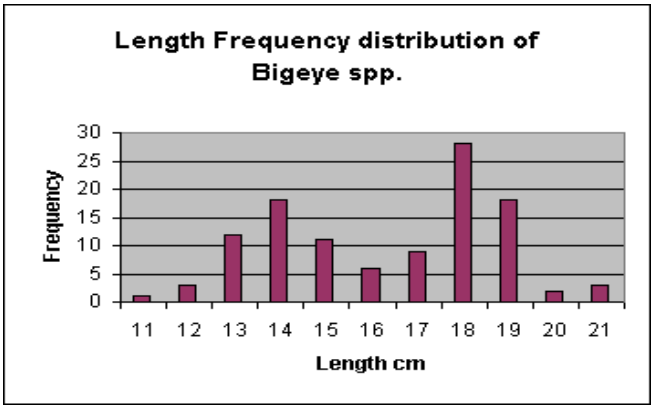



4(d)

**Figures 4(a) – 4 (f): Length Frequency diagrams of species caught in Light Fishing Trials ( cont'd..)**




4(e)




4(f)

**Table 5: Comparative Catch & Effort Data for Inshore and Canoe Fisheries.**

| | 2002 | | 2003 | |
|---|---|---|---|---|
| **Fishery** | Catch (mt) | Effort (days) | Catch (mt) | Effort (days) |
| **Canoe** | | 2284808 | | 1892120 |
| **Inshore** | 4957.03 | 26382 | 11892.83 | 17949 |
| **Total** | | 2311190 | | 1910069 |

A total of 10 fish species were identified in the study with 5 being the target species mainly sought by the inshore operators using light attraction in fishing. Dominant species were the round sardinella (*Sardinella aurita*), Chub mackerel (*Scomber japonicus*), Horse mackerel (*Caranx rhoncus*) and Burrito (*Brachyodeuterus auritus*); (Table 1).

Catch rates (Table 2) shows varying rates throughout the period ranging from 42 to 2700 kg per set with the highest in April. Number of sets made on average was approximately 7 per month with duration of setting of lights up to 6.5 hours. Over 60% of fish species sampled especially Sardinella aurita had attained length at first maturity. In most samples analysed, sizes of the Bigeye (*Priancanthus arenatus*) were rather small (pre-adult) indicating recruitment phase of the species during the month under study. Other species whose mean sizes were within common lengths attained were the *Caranx hippos* and *Caranx rhoncus* .

Analysis of the maturity stages of the dominant species show also a varying range from stages II-IV indicating a relatively high proportion of maturity for the *Scomber japonicus* and *Sardinella aurita* as against the other target species.

**6.0 Discussion**

Several fish species are adapted to take advantage of the rich sources of food within coastal areas through food webs. Although some species of fish are permanent inhabitants of sheltered inshore areas, a much larger number of species use highly productive waters as spawning grounds or nursery areas or both. Besides the number of species using coastal strips during part of their cycle, either as spawning adults or as juveniles, there are many more species, which seasonally visit inshore areas for food. These species are caught often by seine nets having small meshes. With the aid of light attraction these fishes are easily captured. The capture of these fishes off the major fishing season (where they normally are at a resting phase) naturally obstructs or impedes the biological cycle of the fish species. This could have serious repercussions on the spawning stock biomass.

In about the late 1990"s, landings of the small pelagics dropped from a high of 210 000 metric tons in 1995 to 164 000 metric tons in 1999 due to unfavorable climatic conditions and overexploitation of the resource. As a result of the dwindling catches coupled with the high cost of fishing inputs and fuel, fishermen have had bad fishing times. Fishermen have sought all means to catch more fish with the use of illegal meshes, unorthodox methods of fishing including the use of carbide. The incidence of the use of light attraction began seriously in the year 2001.

Considering mean catches of small pelagics by the inshore fleet before light fishing (i.e. 4500 metric tons between 1999-2000) and approximately 7000 metric tons in 2001-2003 where the intensity of light fishing was pronounce, there is seen no significant difference in landings (probability 0.000115 at 95% confidence limit) over the two periods. It can therefore be safely assumed that with the intensity of bulbs being used, coupled with the area of operation of species being sought (mainly on the eastern side of the shelf) there should be no cause for alarm.

However, looking at the yearly-annual variations in landings since 2002 and 2003 for both the inshore and canoe fleet, there seems to be an upward trend in landings probably due to the abundance of the resource. Canoe landings have increased by 20% as compared to the inshore fleet which has doubled their catches within the period. Also effort exerted by the inshore fleet seems to drop from 26382 days at sea (DAS) to 17949 (DAS) in the same period. This

decrease in effort coupled with the increased catches could be attributed to the intense use of light attraction in fishing which invariably could have some negative impact in the short to medium term.

Nevertheless, the root cause of all these allegations made against the inshore operators could stem from the fact that there is an apparent disrespect for rules and regulations pertaining to the fishery on both sides, operators are in the quest of realizing economic returns for their investments. Canoe fishermen using illegal meshes are certainly destroying juvenile fish and considering their numbers as against the few inshore vessels operating, one can imagine the damage they are causing. The allegations coming from the canoe operators that their livelihoods are being destroyed by the inshore operators because the lights “keep the fish trapped” further offshore from the area of operation of the canoes for them to make any meaningful harvest cannot be justified. The reduction in the quality of the inshore landings may be attributable more to the lack of adequate preservation practice than to the effect of the light attraction; the use of carbide may also play a significant part.

**7.0 Conclusion & Recommendation**

This study has so far demonstrated that the use of light attraction in fishing during the period has been variable. Catch rates were low at the earlier stages of the trials and became more favorable in the later stages; also there seems to be low sizes of fish during a particular month of the trials. This seems to indicate that light attraction may not be so effective during the minor upwelling period (January – February) and the possibility of catching juveniles is a cause for concern. In the light of these, more trials to seek baseline information during and after the period of major upwelling would be needed to give us more insight into the effects of light fishing on the fish stocks in relation to other factors, notably changing oceanographic regimes.

It is therefore recommended that:

- Light fishing experiment should be extended to cover the entire hydrographic regimes, i.e. April to June which is the Lean season, and also July – September, which is the major upwelling period;
- In the interim, commercial light fishing should be permitted only during the months of March and April for the next two years whilst more scientific data is gathered;
- A monitoring scheme should be put in place by the Directorate of Fisheries during the period to ensure that vessels do not breach the March – April time limit, do not land juvenile fish and that they adhere strictly to the demarcated zones;
- Harmful practices such as the use of illegal undersized meshes by all fishers should be addressed (i.e. rules and regulations must be enforced).