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ARTICLE

Exploitation Patterns of Anchovies (*Engraulis encrasicolus*) by Marine Artisanal Fisheries in Togo (West Africa)

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ABSTRACT

Pelagic fish, including sardines and anchovies (Order Clupeiformes), are the most common species taken by artisanal marine fisheries along the Togolese coast. We investigated fisher involvement as well as fish captures over a period of 10 years, particularly of the European anchovy (*Engraulis encrasicolus*). Our results indicate that 60% of fishers operated from the Lomé fishing harbour, most fishers being Ghanaians working seasonally in Togo. 63.7% of all the fishers used canoes with outboards, a higher percentage compared to the previous decades. Seven fishing gear type were identified, with bottom gillnet and surface gillnet being the most commonly used. However, in the most important fishing camp in the country in terms of fish production (Lomé fishing harbour), all fishers used shark nets. Overall, fisheries catches did not change significantly across years, but anchovy fishing effort and catch per unit of effort (CPUE) declined over the study period, suggesting some depletion of the species stocks on the Togolese coast and a demotivation of fishers.

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1. Introduction

Exploitation trends of fisheries in West Africa is little known and the data available on the subject fragmentary and outdated [1-7]. In Togo, around 200 fish species are found along the continental shelf [8-18]. Pelagics, particularly members of the Clupeidae family, the European anchovy (*Engraulis encrasicolus*) and sardinellas (*Sardinella* spp.) are the most exploited (unpublished data of the Fisheries and Aquaculture Office in Lomé). Fishing in Togo is an almost exclusively artisanal activity, supplying up to 80% of the national fish production (unpublished data of the Fisheries and Aquaculture Office in Lomé). However, trends in catches, and in particular pelagic fish, have declined since the 1980s [19], suggesting overexploitation of most fish and in particular these species [14-16].

Here, we first analyse the evolution of artisanal catches along the Togo coastline, then the fishing effort defined as both the number of boats and cumulative power of their engines, to quantify their impact (catch and selectivity) and their respective efficiency measured by the catch per unit of effort (CPUE). Finally, the trends of overall CPUE are computed for artisanal fisheries in the country, to assess possible impacts on the ecosystem.

2. Study area

The country's only shoreline (50 km) is found in the Maritime region (Figure 1). Maritime region is about 6,395 km^2. In the west, it borders the Volta Region of Ghana, and in the east, two departments of Benin [20]. It includes large conurbations, of which Lomé, the capital, alone accounts for 30% of the Togolese population. Our study area extends between 01° 11' and 01° 37' East longitude and between 06° 06' and 06° 14' North latitude (Figure 1).

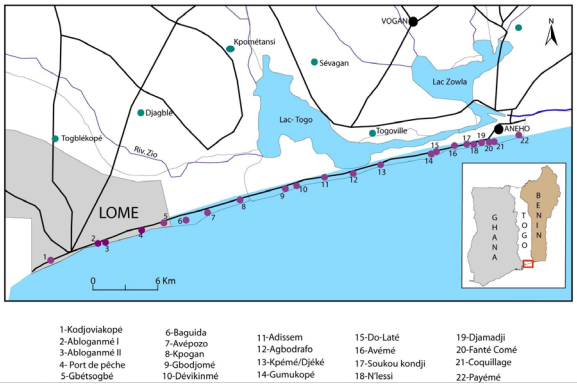

Figure 1. Map of the coastal area of Togo showing the fishing sites surveyed during the present study

Togo's continental shelf, as typical of other Gulf of Benin countries, is separated from the abyssal bottom by the Romanche fracture relative to the "Côte d'Ivoire-Ghana Ride". According to [8], the continental shelf varies from East to West between 20 km at the border with Benin to 31 km at the Ghana border. Its limit is between 85 and 110 m deep. Beyond the 100 m isobath, the continental shelf falls steeply by 15%. There are four bottom types: (1) Hard bottoms, well developed but not very extensive (less than 15 m) and coral reefs (coral reef continues in 50 m and then scattered heads); (2) Muddy sands corresponding to the littoral bottoms in the vicinity of the lagoon outlet and the funds beyond 35 m; (3) Sandy bottoms extending up to 35 m outside the lagoon spill area and (4) deep sandy mudflats that extend from 45 m, scattered with corals after 52-56 m depth [8].

3. Methods

Fisher and fish seller surveys were conducted from 1st to 21st December 2011. The whole Togolese coastline was crossed to identify any existing fishing camps. The position of each camp was recorded by GPS and then mapped using ArcGIS software to establish the extent of the main fishing areas. Interviews covered characteristics of fishers, description of fishing gear and techniques as well as product processing techniques and marketing channels.

Information on catches, CPUE and fishing effort were obtained from the Office of the Fisheries and Aquaculture (Lomé, Togo) for the period 1999-2009. The Fisheries Office identified four sites from which data on landings were collected. At least 5% of landings were recorded at each site during each field day. These data were first analysed by the Fisheries Office Data Manager with the Artfish software. Fishing effort expresses the number of days that fishing has been carried out. Off the line each trip is considered as a fishing day. CPUE expresses the quantity of fish caught per unit of effort and is expressed in kg/day. A 10-year data sequence covering the period 1999 to 2009 was analysed. Curves and graphs were developed from these data and made it possible to establish the variation in CPUE during the year as well as that between 1999 and 2009, the evolution of fishing effort and total production.

Inter-site differences in frequencies of motorised boats were tested by observed-versus-expected χ^2 test. Normality and homoscedasticity of the variables was tested by Shapiro-Wilk W test; when non-normal, the variables were log-transformed to achieve normality and homoscedasticity prior to applying any parametric test. Correlation between variables were done by Pearson's correlation coefficient using raw data or (log) transformed data when appropriate. Statistical analyses were performed with PASW version 15.0 software, with alpha set at 5%.

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4. Results

4.1. Characteristics of Artisanal Marine Fishing

We identified a total of 22 fishing camps (Figure 1) and a total of 125 stakeholders were interviewed (105 fishers and 20 fishmonger women).

We found that 71% of the artisanal marine fishers were Ghanaian in origin, the rest were Togolese. The interviews included the following ethnic groups: Ahloan (62.9% of the interviewees), Guin (7.6%), Fante (0.9%), Mina (4.8%), Ouatchi (3.8%) and Ewé (20%). Some interviewees have been settled along the Togolese coast for centuries (Ewé, Guin and Mina), while Ahloan have only arrived recently.

Most fishers used dugout canoes and boards of 6 - 15 m in length. The percentage of fishing canoes with outboards (25 - 40 hp) was on average 63.7%, but the differences among sites were statistically significant (χ^2= 635, df = 21, P < 0.0001). In particular, 95% of the canoes at the Lomé fishing harbour were with outboards, 75% in Adissem, 7.5% in Kpémé, and none at the other sites.

Seven types of fishing gear were identified, with bottom gillnet and surface gillnet being the most commonly used (Table 1). However, in the area of Lomé fishing harbour, the most important fishing camp in the country in terms of fish production, all fishers used shark nets (Table 1). The number of fishers per crew depended on the type of gear used, with up to 20 persons for those using beach seine and purse seine.

Table 1. Frequency of utilization of the various types of fishing gear used in the surveyed fishing camps along the coast of Togo

Fishing sites	Beach seine	Bottom gillnet	Surface gillnet	Fishing long-lines	Purse seine	Floating gear	Shark net	Total	Canoes	Motorised boats
Kodjoviakope	10	0	0	22	0	0	0	32	10	3
Ablogamé II	3	0	0	0	0	0	0	3	3	0
Ablogamé I	8	6	0	0	0	0	0	14	14	0
Fishing harbour	0	252	207	196	148	720	352	1875	277	277
Gbetsogbe	0	0	0	14	0	0	0	14	9	0
Baguida	0	24	0	0	0	0	0	24	2	2
Avepozo	0	50	5	0	0	0	0	55	25	0
Kpogan	0	84	0	6	0	0	0	90	13	3
Gbodjomé	2	100	0	0	0	0	0	102	8	0
Devikinme	3	30	0	0	0	0	0	33	8	0
Adissem	4	50	2	0	10	0	0	66	20	15
Agbodrafo	1	30	0	0	0	0	0	31	5	0
Kpeme/djeke	2	150	0	0	0	0	0	152	40	3
Goumoukope	3	72	4	0	0	0	0	79	9	5
Do late	2	0	0	0	0	6	0	8	2	0
Aveme	3	400	0	0	0	16	0	419	18	5
Soukou condji	1	0	0	0	0	0	0	1	1	1
N'lessi	3	12	0	0	0	0	0	15	6	0
Djamadji	0	0	0	6	0	0	0	6	3	0
Fante come	3	39	0	0	0	0	0	42	6	0
Coquillage	3	84	0	0	0	0	0	87	8	0
Payeme	0	100	0	0	0	0	0	100	6	0
Total	51	1483	218	244	158	742	352	3248	493	314

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4.2. Exploitation of Fisheries Resources

Monthly CPUE values varied considerably across years (period 1999-2009), with peaks concentrated in July, August, September and October (wet season; see Figure 2). Overall, annual fish catches were fairly stable throughout the study period (log-log relationships; r = -0.043; P = 0.900; Figure 3). CPUE increased by 59.9% from 450 kg/d in 1999 to 720 kg/d in 2009 (r = 0.77, P < 0.001; Figure 4a), whereas fishing effort decreased by 37% (r = - 0.71, P < 0.01; Figure 4b).

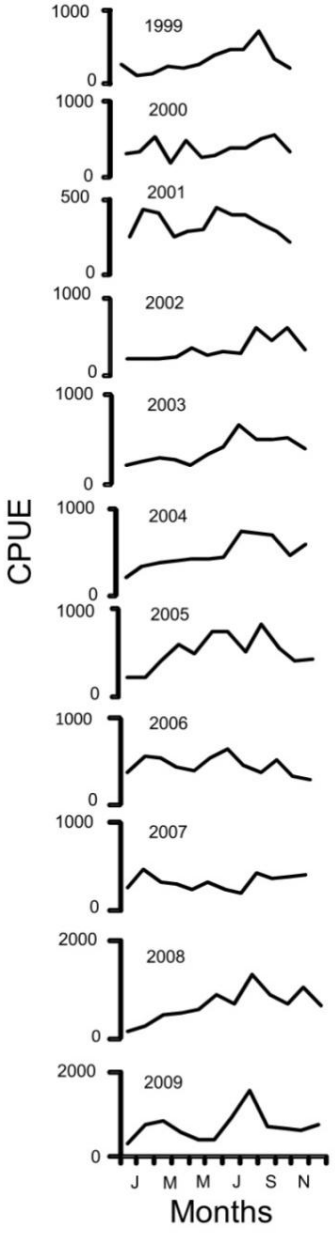

Figure 2. CPUE variation curves by year (period 1999-2009) and in relation to the various months of the year

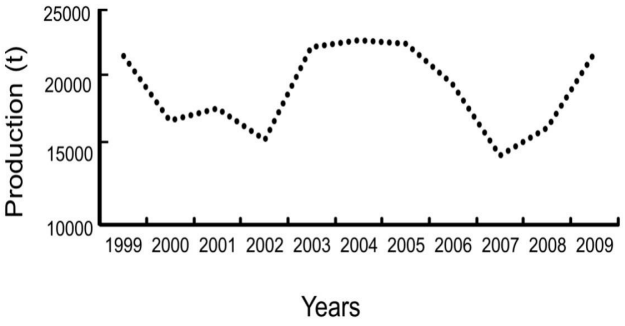

Figure 3. Variation in total production of fish along the coast of Togo during the period 1999-2009

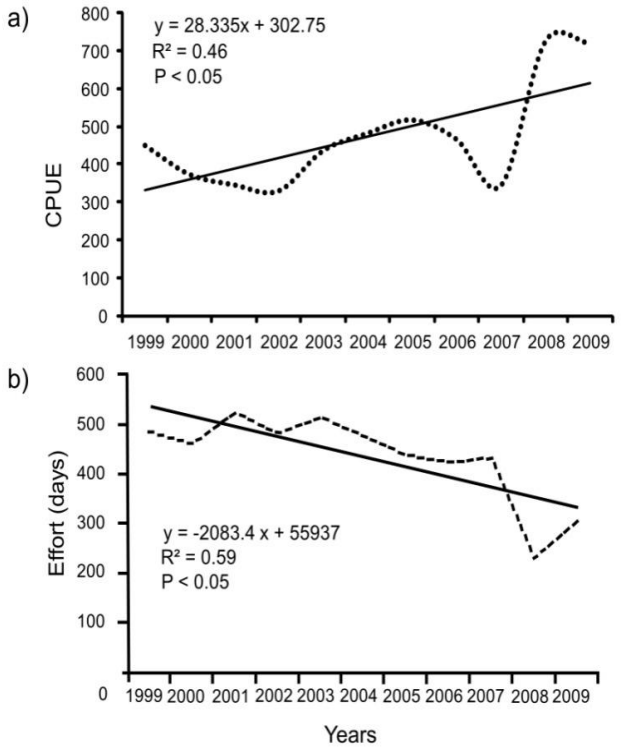

Figure 4. Variation in annual CPUE (graphic (A)) and variation in fishing effort (graphic (B)

Anchovy fishing took place year-round, with several peaks during the year, particularly from July to October (Figure 5). Catches declined by 72.29% from 1999 to 2009 (r = - 0.76, P < 0.0001; Figure 6), with significant drop in CPUE from 287.389 kg/d to 161.898 kg/d (r = - 0.61, P < 0.05; Figure 7a) and fishing effort by 50.8% (r = - 0.79, P < 0.0001; Figure 7b). Concurrently, the percentage of anchovy catches also declined significantly (r = - 0.72, P < 0.001) by about 73.3% during the study period (it accounted for about 45% in 1999 but was only 12% in the year 2009) (Figure 8).

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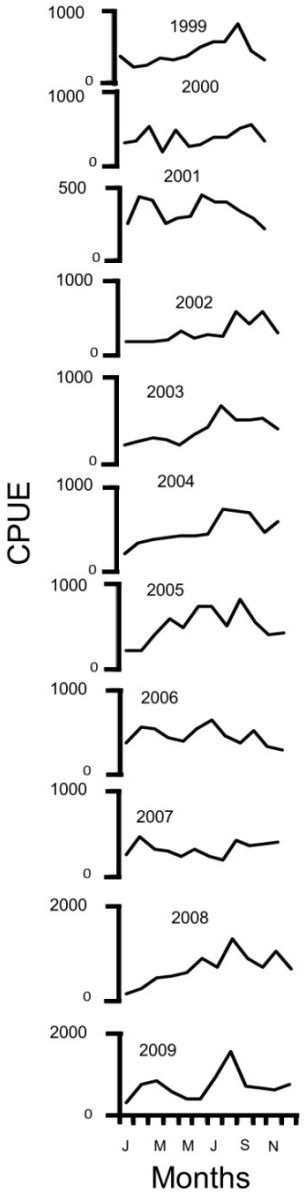

Figure 5. Variation of anchovy production by year and by month along the Togolese coast

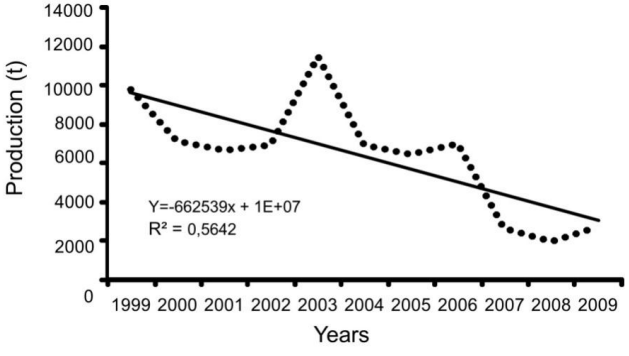

Figure 6. Variation of anchovy production along the Togolese coast between 1999 and 2009

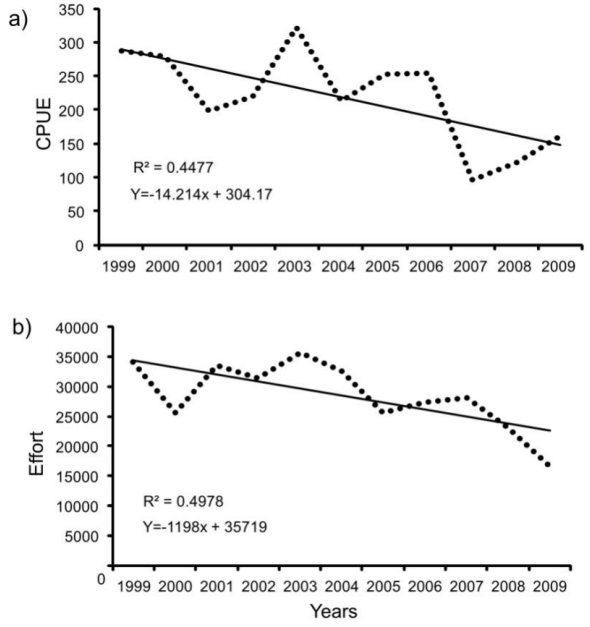

Figure 7. Variation of the CPUE for anchovies (graphic a) and in fishing effort for anchovies (graphic b) along the Togolese coast during the period 1999-2009

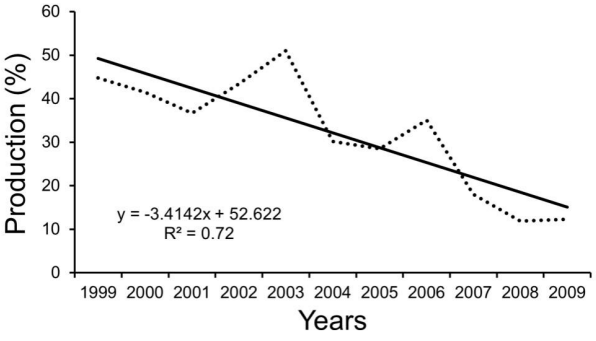

Figure 8. Evolution of the percentage of anchovy production in total production along the Togolese coast during the period 1999-2009

5. Discussion

The total number of fishers along the Togolese coast was estimated to be more than 5,000 in 2002 [7]. However, because fishing is highly seasonal it is difficult to estimate their exact numbers. What is clear is that fishing camps are unevenly distributed with the majority concentrated in the Lomé fishing harbour, which since its creation has facilitated greater access to the sea by reducing the rocky strip that emerges as a result of coastal erosion.

Our surveys revealed a higher percentage of Ghanaian fishers in Togo compared to previous data from [7] where 59.90%, 39.87% and 0.23% of Ghanaian, Togolese and Beninese fishers were reported, respectively. These dif-

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ferences between the two sources can be explained in part by the period of the year during which the surveys were conducted (FAO data being relative to the 1990s and confined to a short period of the year). In fact, although both our data and those of FAO clearly showed that sea fishing in Togo is largely dominated by Ghanaians, they are not permanent residents, so their importance varies from one period to another during the year. Most of them are seasonal fishers who spend around eight months in the country, arriving in Togo in April and returning to Ghana at the beginning of December. Fisher communities along the Togolese coast have been documented as having performed several exoduses and migrations throughout the recent history of the region [19].

We showed that the increase in yield was not correlated with fishing effort, and that the increase in CPUE was mainly due to improved fishing techniques. The latter was due to a rise in the number of bottom and surface gillnets owned by each fisher (up to 16 for an outing of 4 fishers at sea). Additionally, we also observed that a high number of canoes were now motorised; an increase of as much as 18% since 2002 [7]. Perhaps in line with the observed rise in fishing efficiency, our interviewees reported a decline in the number of fishers in some sites. According to some interviewed fishers, this decline was due to the fact that there has been a shift in fish distribution, with stocks now found further offshore. Given the low income typical from fishing, fishers often lack the means to purchase more elaborate equipment (e.g. motors) for boats to move further away from the coast as well as provide for their needs during the off season. Thus, if fishers want to keep up with this changing situation they become insolvent debtors of their consignees. Consignees, mostly women (fish sellers), finance all fishing activities in return for all fishing products. In the 1980s, consignees operated at an estimated interest rate of nearly 70% [21].

Other constraints also weaken the marine fishing sector in Togo. In particular, the lack of adequate regulations and enforcement will not halt the overexploitation of fish stocks, undermining the long-term sustainability of this sector. Hence, without proper guidelines, overexploitation of fish stocks will continue. Moreover, control of the impact of marine pollution from the disposal of phosphate sludge and from sewers needs to be improved.

Our study revealed that the season of highest exploitation of anchovies was July-October. The period coincides with the Ivorian-Ghanaian upwellings that reach the Togolese coasts with the arrival of the cold Benguela sea current (August) [22, 23]. Such upwellings are the main source of enrichment of coastal ecosystems in the Gulf of Guinea apart from the area between Guinea and Liberia where inflows from the rivers also play a significant role in the fishing seasonal cycle [23]. Anchovy productivity is closely related to the coastal upwellings that occur from Cape Palmas to Togo [19].

Various factors are likely to have caused the decline in anchovy production in recent years. These include overexploitation, recruitment processes, environmental and climatic factors. Moreover, since production is dependent on upwellings and the cold Benguela current, any modification of these processes will affect the fish stocks [24]. However, since the overall fish production has not declined, the decline issue is specific to anchovies and possibly to other ecologically similar species. We hypothesize that these massive declines of anchovies across the years may be also due to the sensitivity of these species to changes in the physico-chemical parameters. For instance, [25] believe that the dynamics of pelagic populations in upwelling systems is governed by a series of hydroclimatic processes such as water temperature, environmental richness, ocean circulation which could partly explain the variability of biomass of small pelagics. According to [26], the anchovy can be classified as a species with high reproductive potential but fragile balance. In addition to fishing effort, it is the environmental conditions that can cause a sudden change in its exploitable biomass. It should also be noted that at the global level, negative growth rates were recorded for the main producing countries of Turkey, Ghana, Spain, Morocco, Ukraine and France during the 1995- 2005[27]. According to [27], overexploitation is the main cause for this species' decline, but the drop in the Black Sea production in the 1990s has been attributed to the invasion of *Mnemiopsis* spp.

In economic terms, the production of small-scale maritime fishing in Togo between 1999 and 2009 has fluctuated considerably. The increase in the price of fish is not only the result of the need for more resources (as the population size of Lomé and surroundings has greatly increased in the last decades) but also a stagnant production in the face of increased needs.

The data processed in this study can only briefly explain some of the factors that determine productivity. The sustainability of the exploitation will necessarily involve fishery management mechanisms based on adequate scientific data as well as the development of appropriate monitoring mechanisms for the effective implementation of the policies and regulations put in place. Special attention must be given to this sector not only to ensure the sustainability of the fishing activities but also to preserve regional biological diversity, that may include finding other alternatives such as aquaculture. Unfortunately, the current state of research on exploited species and the lev-

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els of exploitation are not particularly well developed in this part of Africa. If the results of this study indicate that the drop in anchovy production is due to overexploitation, many questions remain unanswered regarding the currently prevailing environmental and climatic conditions that may influence the recruitment of the anchovies.

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