LONG-TERM TRENDS IN DEMERSAL FISHERY RESOURCES OF GHANA IN RESPONSE TO FISHING PRESSURE[1]

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ABSTRACT

A brief review is presented of the structure of the Ghanaian fishing fleet, and of the changes they induced on their resource base since the 1960s. These change consist of a reduction of the biomass of longer lived fishes, particularly in shallower waters, and in conjunction with environmental fluctuation, the creation of opportunities for invasive species of fish (triggerfish *Balistes carolinensis*) and invertebrates (e.g., scallops) to experience short-lived population outburst. The relative impacts of fishing and environmental changes in generating these outbursts are difficult to disentangle. It is evident, however, that the effort jointly exerted by several Ghanaian fleets onto their supporting fisheries resources is excessive and that the country would benefit from a reduction of that effort.

RÉSUMÉ

La structure des flottilles de pêche du Ghana est présentée, ainsi que les changements que celles-ci on induit, depuis 1960, dans les ressources dont elles dépendent. Ces changements sont une réduction de la biomasse des poissons de moyenne et grande longévité, et conjointement avec des fluctuations environnementales, des opportunité pour les espèces invasives, telles que le baliste (*Balistes carolinensis*) et des invertébrés (par ex. des peignes), d'envahir des niches vacantes par une explosion de leur population. Bien que l'importance relative des effets de la pêche et de l'environnement soit, dans de tels cas, difficile à évaluer séparément, il est évident que l'effort de pêche du à l'ensemble des flottilles ghanéenne est excessive, et que le Ghana aurait grand avantage à réduire cet effort.

INTRODUCTION

Ghana, located in the western Gulf of Guinea sub-region, between the Côte d'Ivoire and Benin, has, or rather had, very rich fishery resources, and a long tradition of artisanal and distant-water water fishing, the latter a unique feature amongst West African countries (Alder and Sumaila 2004).

As in most other parts of the world (Pauly *et al.* 2002), Ghana's fisheries resources suffer from excessive fisheries pressure resulting in changes in ecosystem structure, reflected in declining catches of targeted species and, in combination with environmental changes, in short-lived outbursts of normally uncommon species (Koranteng 1998; 2002).

The most important changes recorded since 1950 are the strong fluctuations of round sardinella *Sardinella aurita* (Pezennec 1995), the proliferation and subsequent decline of triggerfish *Balistes carolinensis* (Ansa-Emmim 1979, Koranteng 1984, Caverivière 1991), increase in abundance of cuttlefish *Sepia officinalis* and globefish *Lagocephalus laevigatus* (Martos *et al.* 1990, Koranteng 1998) and the

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sudden appearance of the scallops *Chlamys purpuratus* and *Pecten jacobeus* in coastal waters (Mehl *et al.* 1999; Konan *et al.* 1999; Koranteng and Ofori-Adu, *in press*).

This contribution describes these and other fluctuations, with emphasis on the role of the industrial fisheries as the main driver for change, thus complementing the brief account of Alder and Sumaila (2004).

Fleets operating in Ghana, and their catches

Five distinct fisheries operate along the coast of Ghana:

- Artisanal fishing in lagoons and estuaries;
- Artisanal fishing (from canoes);
- Inshore trawling (including shrimping);
- Offshore (industrial) trawling;
- Tuna fishing with poles and lines, and purse seines (not discussed here).

Artisanal fishing in lagoons and estuaries, though locally involving substantial number of fishers and their small scale gear (gill net, throw net, weirs, etc.), has not been the subject of studies comparable in scope to those in neighbouring Côte d'Ivoire (see, e.g., Hem and Avit 1996). Sakumo lagoon, near Tema, studied in some detail in 1971 (Pauly 1975, 1976) has much deteriorated since (Ntiamoa-Baidu 1991; Pauly 1994), and this appears to be representative of other lagoons along the Ghanaian coast (Entsua-Mensah 2002). However, nationwide catch data are lacking which could be used to evaluate how the lagoon fisheries are performing, relative to the other Ghanaian fisheries.

The canoe fleet deploys various fishing gear types, notably beach seines, handlines and bottom set gillnets to catch demersal species, and purse seines to catch small pelagics, foremost *Sardinella aurita*. Consequently, the canoe fishery is much affected by the natural fluctuations of the sardinella. These fluctuation, and their impact on the fisheries are been previously discussed in some details in Pezennec and Koranteng (1998) and hence we abstain here from discussing this fishery further.

The inshore fleet consists of multipurpose vessels using purse seines to catch small pelagics during the upwelling seasons (December-January and July-September). For the rest of the year, these vessels, except those lacking strong engines, are used for bottom trawling. The fleet grew from two vessels in 1948 to over 260 operational units in 1984 (Mensah and Koranteng 1988; Koranteng 1996). However, the fleet has since declined in importance, as most of the vessels are old and barely seaworthy; only 178 inshore vessels operated in 2001.

The first Ghanaian industrial fishing trawlers were acquired about four decades ago principally for fishing in the productive, if distant waters of countries such as Angola and Mauritania (Koranteng, 1996). These vessels were forced to return, and to start operating in Ghanaian waters when, in the mid 1970s, these countries claimed 200 miles Exclusive Economic Zones.

With the exception of the tuna fishing fleet, all the fleets mentioned above thus operate in about the same area, and target similar species. This generates conflict among the fleets, especially between the canoe and the trawler fleets (including the shrimpers), with the latter very often destroying fixed nets set by the former.

Figure 1 shows the changes in the effort of inshore and industrial trawlers from 1972 to 1997. As may be seen, this portrays a persistent rise in industrial trawling effort and a decline of inshore vessels.

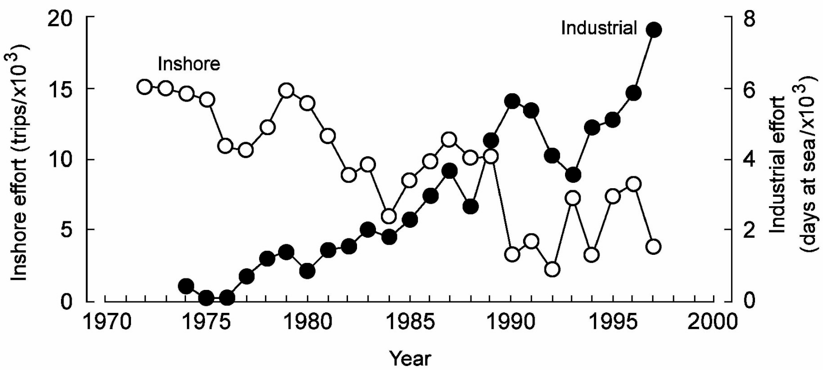

Figure 1 Fishing effort by the 'inshore' and industrial fleets in Ghanaian waters.

Figure 2 shows the annual landings of demersal fishes, molluscs and crustaceans by the inshore and industrial fleets, for the period 1960-1999, as compiled from by the Marine Fisheries Research Division (MFRD), in Tema, Ghana, and supplied to FAO. This shows consistent growth in landings until the mid 1980s, followed by stagnation and decrease in the last decade. [Note that the high landings from 1963 to 1966 probably originated from countries others than Ghana].

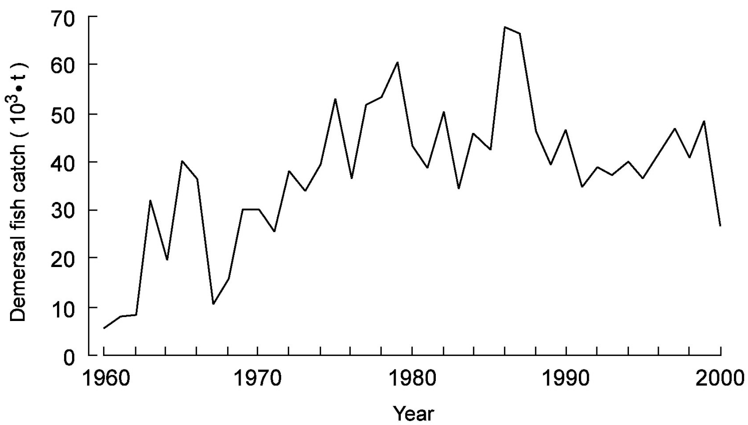

Figure 2 Demersal fish landings by the Ghanaian industrial fleets. The peak from 1962-1967 is due to catches from outside Ghanaian waters (see text).

Koranteng (2002, Figure 19-8) shows the calculated values, trend and seasonal variation of catch per effort by inshore trawlers for the period 1972-1990, considering only demersal species. Catch per effort increased in the mid-1970s, but declined since, indicating that the resources exploited by these trawlers are being overfished. This is here confirmed by Figure 3, documenting trends in the abundance of demersal resources as a function of depth. The inshore (0-30 m) densities have much declined since the Guinean Trawling Survey of 1963/1964, used here as baseline (Williams 1968 and see below). The densities in deeper waters appear to have changed less, but this is due, at least in part, to the year 2000 trawl survey having used a smaller cod end mesh size (2 cm) than previous surveys (4 cm), and to other changes in rigging and operation, all of which increased catchability and hence apparent density. The other reason why the biomass of deeper waters has declined less than that inshore is because much of the offshore grounds are rocky, and hard for bottom trawlers to exploit.

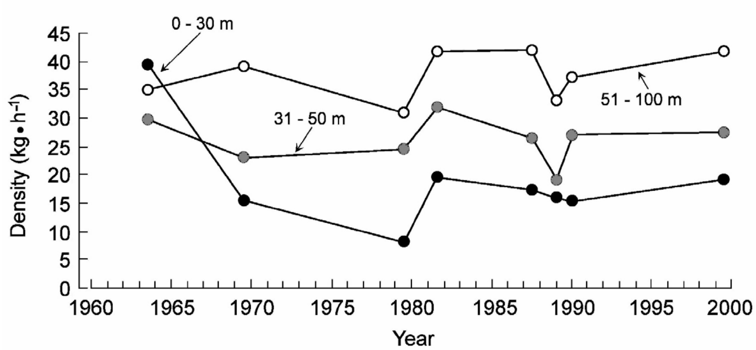

Figure 3 Apparent abundance of demersal resources on the shelf of Ghana, as estimated from successive bottom trawl surveys, 1963-2000. Note that the cod end mesh size in 2000 was half that in earlier survey, resulting in an overestimate of density for that year (see text).

CHANGES IN CATCH COMPOSITION AND RELATIVE ABUNDANCE IN THE ECOSYSTEM

Koranteng (1998) described the trawling surveys conducted in Ghanaian waters from 1956 to 1990. Except for the Guinean Trawling Survey conducted in 1963/64 under the auspices of the Organization of African Unity (Williams 1968) and the *R/V Dr. Fridtjof Nansen* Surveys conducted in 1999/2000 (Mehl *et al.* 1999; Torstensen *et al.* 2000), all surveys considered in this study were conducted by the MFRD.

Table 1 documents the change in species composition that went along with the density changes also estimated from these surveys. As may be seen, triggerfish *Balistes carolinensis,* which was not recorded among the 20 most abundant species in the 1963/64 surveys, increased in abundance to take the ninth position in the species rankings in 1969/70 and then topped the rankings for nearly twenty years.

Table 1. Top 20 taxa in terms of catch per effort in the Guinean Trawling Survey (1963/64; stations with depth <100 m only) and their ranks in subsequent surveys.

Species or genus	1963/64	1969/70	1979/80	1981/82	1987/88	1989	1990	1999/00
Brachydeuterus auritus	1	1	2	2	2	1	1	1
Pagellus bellottii	2	3	3	3	3	2	2	7
Dentex congoensis	3	23	11	11	14	11	-	15
Priacanthus arenatus	4	16	9	9	5	10	4	2
Sparus caeruleostictus	5	6	4	5	6	3	6	8
Epinephelus aeneus	6	10	7	7	11	4	11	22
Pseudupeneus prayensis	7	8	5	4	4	4	3	16
Dentex angolensis	8	-	10	19	18	27	-	28
Galeoides decadactylus	9	11	13	30	26	-	26	33
Pseudotolithus senegalensis	10	-	18	-	-	-	-	39
Loligo sp.	11	-	-	-	-	-	-	-
Paracubiceps ledanoisi	12	29	-	22	25	-	-	40
Dentex canariensis	13	4	6	6	7	6	8	9
Boops boops	14	13	22	14	31	19	20	4
Raja miraletus	15	-	-	29	21	24	17	-
Sphyraena sp.	16	12	21	28	32	22	-	-
Dactylopterus volitans	17	7	-	26	8	9	13	21
Drepane africana	18	-	-	-	-	-	33	-
Dentex gibbossus	19	26	16	13	23	-	33	-
Pseudotolithus brachygnathus	20	-	-	-	-	-	-	-
Balistes carolinensis	-	9	1	1	1	17	-	-

Overall, there was a reduction in density of snappers, groupers, seabreams and Atlantic bigeye (*Priacanthus arenatus*) between 1963/64 and the early 1980s. The decline of taxa such as groupers and snappers is not surprising, given the propensity of exploited high trophic level fishes to decline faster than low trophic level fishes and invertebrates (Pauly *et al.* 1998). We examine below the special cases represented by some fish and invertebrates that managed to withstand, and even to increase in the face of increasing fishing pressure.

SPECIAL CASES

Between 1969 and 1975, a shrimp fishery operated in and near the Volta estuary, yielding an average of 720 t, mainly *Penaeus notialis and Parapeneopsis atlantica*. In 1970, the fleet is question had grown to 18 shrimp vessels. The fishery collapsed, presumably due to excess effort and impact of the Volta dam at Akosombo, which modified the water flow into the Anyanui estuary and the adjacent Keta lagoon.

In 1986, commercial shrimping was resumed, with two vessels. By 1995, 17 industrial vessels were back in operation, and the shrimp catch (mainly *P. notialis*) had increased from about 5.4 t in 1986 to 317 t in 1995. Perhaps unsurprisingly, the fishery collapsed again (Koranteng 1998).

Triggerfish

From about 1973 and following a decline of the sardinella fishery in the western Gulf of Guinea, there was a dramatic increase in the abundance and landings of triggerfish (*Balistes carolinensis*) in the Ghanaian demersal fishery. In 1979-80, the demersal component of triggerfish assessed in bottom trawl surveys was put at 99,000 t (or 57.2 kg·ha^{-1}), or 62 percent of the total demersal fish biomass in Ghanaian coastal waters at the time.

Indeed, triggerfish dominated the Gulf of Guinea ecosystem, especially the waters from Ghana to Sierra Leone, for nearly twenty years, displacing *Brachydeuterus auritus* as the most abundant species off Ghana

For reasons still not understood, triggerfish declined in abundance from about 1988, and only a few specimens were caught in surveys conducted in the 1990s. Bakun (1996) described the proliferation of triggerfish in the Gulf of Guinea and its total domination of the ecosystem as "one of the most phenomenal episodes in the history of fish population dynamics."

Cuttlefish and Globefish

Cuttlefish *Sepia officinalis* and globefish *Lagocephalus laevigatus* were increasing at about the same time that the decline of triggerfish was observed. The increase in globefish abundance was short-lived, however, and fishing may not have anything to do with their subsequent decline, as this species was not targeted by any particular fleet. Cuttlefish has a wide depth distribution in Ghanaian waters. In a survey conducted in 1990, large concentrations of cuttlefish were encountered in deep waters (i.e. >50 m). However, the vessels that target cuttlefish operate mainly in shallower waters.

Scallops

Huge catches of up to 624 kg per h of trawling of the scallops *Chlamys purpuratus* and *Pecten jacobeus* were caught in three recent surveys (February 1999 - September 2000) along the coast of Ghana (Konan *et. al.* 1999; Mehl *et al.* 1999; Torstensen *et al.* 2000). Larger quantities of these two species were encountered in 2000 compared to 1999 and over wider area, in what appear to be the first occurrence of scallops in Ghanaian coastal waters (Koranteng and Ofori-Adu *in press*). However, a survey conducted in 2002 showed the distribution range and abundance of these scallops to have strongly declined, in the absence of any targeted fishing.

DISCUSSION

Koranteng (1998) showed that the changes of the biological and physical components of the Gulf of Guinea marine ecosystem and in nearshore forcing factors also effected demersal species aggregations in the sub-region. Moreover, the variation of these species assemblages were associated with boom and bust of populations of some fish and invertebrates species (Koranteng 1998, 2001).

Six demersal species assemblages have been identified in Ghanaian waters: sciaenid, lutjanid, sparid (shallow part), sparid (deep part), deep shelf and upper slope (Longhurst 1969; Koranteng 1998). The sciaenid and lutjanid assemblages are found in waters shallower than 40 m. The two sparid assemblages start at about 40 m and reach into deeper waters; the deep shelf and upper slope assemblages lie below the 100 m depth. Koranteng (1998) also showed that the dynamics of the assemblages are influenced by the physico-chemical features of their overlying water masses, especially temperature, salinity and dissolved oxygen, themselves impacted by the seasonal coastal upwelling off Ghana.Koranteng (1998) showed significant shifts in relative importance of three fish families (Sciaenidae, Lutjanidae and Sparidae) representing the three species assemblages on the continental shelf, and of *Balistes carolinensis*, between different marine 'climatic periods.' During the period when triggerfish dominated in the study area, which also corresponded to the period of low temperature and high salinity in the Gulf of Guinea, the total density of sciaenids declined. As well, some lutjanids (mainly snappers) were displaced by the expanding triggerfish with the latter occupying the niche of the former.

Studies of fish communities have shown that both natural and anthropogenic factors, both singly or jointly, can induce changes in the structure of species assemblages, threaten fish biodiversity, and impact the state of fishery resources (Brown *et al.* 1976, Overholtz and Tyler 1985, Greenstreet and Hall 1996). The observed changes also affected assemblage structure and have been attributed to increased industrial trawling, the proliferation of triggerfish and changes in the marine climate (Koranteng 2001).

However, while it remains difficult to disentangle fisheries and environmental effects when attempting to explain species outburst, we do know how excess fishing effort impacts on exploited stocks, and hence the need, in Ghana as elsewhere to reduce fishing effort to a level that allow for sustainable fisheries (Pauly *et al.* 2002). In Ghana, this implies a strong reduction of fishing effort, notably by the industrial fleet.

References

Ansa-Emmim, M. 1979. Occurrence of the triggerfish, *Balistes capriscus* (Gmel), on the continental shelf of Ghana, p. 20-27. *In:* Report of the special working group on the evaluation of demersal stocks of the Ivory Coast - Zaire sector, CECAF/ECAF SERIES/79/14(En), FAO, Rome.

Alder, J. and U.R. Sumaila. 2004. Western Africa: a fish basket of Europe past and present. Journal of Environment and Development 13(2):156-178

Bakun, A. 1996. Patterns in the Ocean: Ocean Processes and Marine Population Dynamics. University of California Sea Grant, San Diego, California, USA/Centro de Investigaciones Biológicas de Noroeste, La Paz, Baja California Sur, Mexico, 323 p.

Brown, B.E., J.A. Brennan, M.D. Grosslein, E.G. Heyerdahl, and R.C. Hennemuth. 1976. The effect of fishing on the marine finfish biomass in the Northwest Atlantic from the Gulf of Maine to Cape Haterras. International Commission for Northwest Atlantic Fisheries Research Bulletin 12: 49-68.

Caverivière, A. 1991. L'explosion démographique du baliste (*Balistes carolinensis*) en Afrique de l'ouest et son évolution en relation avec les tendances climatiques, p. 354–367. *In*: P. Cury and C. Roy (eds). Variabilité, instabilité et changement dans les pêcheries ouest africaines. Editions ORSTOM, Paris.

Entsua-Mensah, M. 2002. The contribution of coastal lagoons to the continental shelf ecosystem of Ghana, p 161-169. *In*: J.M. McGlade, P. Cury, K.A. Koranteng and N.J. Hardman-Mountford (eds.): The Gulf of Guinea Large Marine Ecosystem: Environmental Forcing and Sustainable Development of Marine Resources. Elsevier.

Greenstreet S.P.R. and S.J. Hall. 1996. Fishing and the groundfish assemblage structure in the north-western North Sea: an analysis of long-term spatial trends. Journal of Animal Ecology. 65: 577-598.

Hem, S. and J.L.B. Avit. 1996. Acadjas-enclos used in Côte d'Ivoire as an extensive aquaculture system, p. 46-53. *In*: R.S.V.Pullin, J. Lazard, M. Legendre, J.B. Amon Kothias and D. Pauly (eds.) Proceedings of the Third International Conference on Tilapia in Aquaculture, 11-16 November 1991, Abidjan, Côte d'Ivoire. ICLARM Conference Proceedings 41.

Konan, J., C. Isebor, K.A. Koranteng, N.Y. N'Goran, P. Amiengheme. 1999. A preliminary report on the trawl survey of demersal fishery resources in the Gulf of Guinea Large Marine Ecosystem (Côte d'Ivoire–Benin), 25 February-25 March, 1999. UNIDO/GEF Gulf of Guinea Large Marine Ecosystem Project, Abidjan, Côte d'Ivoire (*in press*).

Koranteng, K.A. 1984. A trawling Survey off Ghana, CECAF/TECH/84/63. Dakar, Senegal: CECAF Project (FAO). 72 p.

Koranteng, K.A. 1996. The marine artisanal fishery in Ghana: Recent developments and implications for resource evaluation, p. 498-509. *In*: R.M. Meyer, C. Zhang, M.L. Windsor, B.J. McCay, L.J. Hushak and R.M. Muth (eds). Fisheries Resource Utilization and Policy. Proceedings of the World Fisheries Congress, Theme 2, Edited by. New Delhi: Oxford & IBH Publishing Co. Pvt. Ltd.

Koranteng, K.A. 1998. The impacts of environmental forcing on the dynamics of demersal fishery resources of Ghana. PhD Thesis, University of Warwick (U.K.). 376 p.

Koranteng, K.A. 2001. Structure and dynamics of demersal assemblages on the continental shelf and upper slope off Ghana, West Africa. Mar. Ecol. Prog. Ser. 220: 1-12.

Koranteng, K.A. 2002. Status of demersal fishery on the inner continental shelf of Ghana, p. 261-274. *In*: McGlade, J.M., P.Cury, K.A. Koranteng and N.J. Hardman-Mountford (eds.): The Gulf of Guinea Large Marine Ecosystem: Environmental Forcing and Sustainable Development of Marine Resources. Elsevier Sc. 392 p.

Koranteng, K.A and J.M. McGlade 2001. Climatic Trends in Continental Shelf Waters off Ghana and in the Gulf of Guinea (West Africa), 1963 - 1992, Oceanologica Acta 24: 187-198.

Koranteng, K.A and D.W. Ofori-Adu. (*in press*). First Record of Significant Occurrence of Live Scallop Species of the Family Pectenidae in Ghanaian Coastal Waters. Presented at the 22nd Biennial Conference of the Ghana Science Association, Cape Coast, 5-9 August, 2001.

Longhurst, A.R. 1969. Species assemblages in tropical demersal fisheries, p. 147-168. *In*: Proceedings of the Symposium on the Oceanography and Fisheries Resources of the Tropical Atlantic. Results of the ECITA and GTS, Abidjan, Ivory Coast, 20-28 October 1966. UNESCO, Paris.

Martos, A.R., I.S. Yraola, L.F. Peralta and J.F.G. Jimenez. 1990. Informe de la Campana Guinea 90, Instituto Español de Oceanografia, Malaga, Spain.

Mehl, S., O. Alvheim, K.A. Koranteng and M. Tandstad. 1999. Surveys of the fish resources of the western Gulf of Guinea (Benin-Côte d'Ivoire), 19 April – 6 May, 1999. IMR (Norway) and MFRD (Ghana). 69 p.

Mensah M.A. and K.A. Koranteng. 1988. A review of the oceanography and fisheries resources in the coastal waters of Ghana. Marine Fisheries Research Report No. 8, Fisheries Research & Utilization Branch, Tema, Ghana, 35 p.

Ntiamoa-Baidu, Y., 1991. Conservation of coastal lagoons in Ghana: the traditional approach. Landscape Urban Ecol. 20:41-46.

Overholtz W.J. and A.V. Tyler. 1985. Long-term Response of the Demersal Fish Assemblages of Georges Bank. Fishery Bulletin 83(4):507-520.

Pauly, D. 1975. On the ecology of a small West African lagoon. Berichte der Deutschen Wissenschaftlichen Kommission für Meeresforschung 24(1): 46-62.

Pauly, D. 1976. The biology, fishery and potential for aquaculture of *Tilapia melanotheron* in a small West African lagoon. Aquaculture 7(1): 33-49.

Pauly, D. 1994. On reason, mythologies and natural resource conservation. Essay 14, p. 118-122. *In*: D. Pauly. On the sex of fish and the gender of scientists: essays in fisheries science. Chapman & Hall, London.

Pauly, D., V. Christensen, J. Dalsgaard, R. Froese and F.C. Torres Jr. 1998. Fishing down marine food webs. Science 279:860-863.

Pauly, D., Christensen, V., Guénette, S., Pitcher, T.J., Sumaila, U.R., Walters, C.J., Watson, R. and Zeller, D. 2002. Toward sustainability in world fisheries. Nature 418:689-695.

Pezennec O. 1995. Ecological importance of the Ivorian and Ghanaian minor upwelling season, p. 324-345. *In*: F.X. Bard and K.A. Koranteng.(eds) Dynamics and Use of Sardinella Resources from Upwelling off Ghana and Ivory Coast. Editions ORSTOM, Paris.

Pezennec, C. and K.A. Koranteng. 1998. Changes in the dynamics and biology of small pelagic fisheries off Côte d'Ivoire and Ghana, p. 329-343. *In*: M.H. Durand, P. Cury, R. Mendelssoln, A. Bakun, C. Roy and D. Pauly (eds.) Global versus global change in upwelling areas. Séries Colloques et Séminaires. ORSTOM, Paris.

Torstensen, E. O. Alvheim, K.A. Koranteng and M. Tandstad. 2000. Surveys of the fish resources of the western Gulf of Guinea (Benin, Togo, Ghana, Côte d'Ivoire), 29 August – 17 September, 2000. Preliminary cruise report, IMR (Norway)/MFRD (Ghana).

Williams F. 1968. Report on the Guinean Trawling Survey. Vols. I (828 p.), II (529 p) and III (551 p). Organisation of African Unity Scientific and Technical Research Commission (99). Lagos, Nigeria.